SeismoBuild

Verification Report

(ASCE 41-17)

For version 2018

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Seismosoft Ltd.
Piazza Castello 19
27100 Pavia (PV) - Italy
e-mail: info@seismosoft.com
website: www.seismosoft.com

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Chapter 1 INTRODUCTION

PRESENTATION OF THE ANALYSIS PROGRAM

SeismoBuild is an innovative Finite Elements package wholly and exclusively dedicated to seismic assessment and strengthening of reinforced concrete framed structures. The program is capable of fully carrying out the Code defined assessment methodologies from the structural modelling, through to the required analyses, and the corresponding member checks. Currently six Codes are supported (Eurocodes, the American Code for Seismic Evaluation and retrofit of Existing Buildings, ASCE 41-17, Italian National Seismic Codes NTC-08 and NTC-18, Greek Seismic Interventions Code KANEPE and the Turkish Seismic Evaluation Building Code TBDY). Both metric and imperial units, as well as European and US reinforcing rebar types are supported.

The rational and intuitive structure, as well as the simplicity of the package, which stem from the fact that it is the only software worldwide that is totally committed to seismic assessment, result in a very smooth learning curve, even for engineers that are not familiar with the Finite Elements method. The user-friendly, CAD-based, graphical interface increases the productivity significantly, to the point that the assessment of a multi-storey RC building may be completed within a few minutes, including the creation of the report and the CAD drawings to be submitted to the client.

The nonlinear analysis solver of SeismoBuild, which features both *geometric nonlinearities* and *material inelasticity,* is based on the advanced solution algorithms of SeismoStruct, a package that has been extensively used and verified by thousands of users for more than ten years. The accuracy of the solver in nonlinear analysis of framed structures is well demonstrated by the successes in many Blind Test Prediction Exercises.

The SeismoBuild results presented in this document were obtained using **version 2018** of the program, running on an AMD Phenom II X4 965 @ 3.40GHz machine with Windows 10 64-bit. All model files are included in SeismoStruct's installation folder.

STRUCTURE OF THE REPORT

The present report consists of a comprehensive collection of examples, which have been selected to test the various features that affect the member's capacity. It is structured in two main sections, which are briefly described below:

- In the first section (Chapter 2), the main relationships used for the Chord Rotation, Shear capacity and Beam-Column Joint checks used in ASCE 41-17 are summarized.
- In the second section (Chapter 3), the results for chord rotation and shear capacity produced by SeismoBuild are compared with the independent hand-calculations. The results are provided in tabular form;
- In the third section (Chapter 4), the results from checks for Beam-Column Joints capacity according to the ASCE 41-17 produced by SeismoBuild are compared with independent hand calculations. The results are provided in tabular form;

PROGRAM FEATURES COVERED BY THE PROGRAM

The aim of this section is to illustrate, through the table provided below, which program features (i.e. Codes, equations, member's advanced properties) are addressed in each example of the present report.

No. of Example	CODE	Section Type	File name	Element Type	Material Type	Equations	FRP	Adequate lap length	Inadequate relative lap length	Absolute lap length	Without detailing for earthquake resistance	Smooth (Plain) Longitudinal Bars	Knowledge Level	Comments
Example No. 1.1	ASCE 41-13	RECTANGULAR	ASCE_rcrs1.bpf	Primary	Existing			√					Usual	
Example No. 1.2			ASCE_rcrs2.bpf	Primary	Existing		√		√			√	Custom	
Example No. 1.3			ASCE_rcrs3.bpf	Primary	Existing		√	√				√	Usual	custom material
Example No. 1.4			ASCE_rcrs4.bpf	Secondary	New		√	√			√		Custom	
Example No. 1.5			ASCE_rcrs5.bpf	Secondary	New					√		√	Custom	additional bars
Example No. 1.6			ASCE_rcrs6.bpf	Secondary	New		√		√		√		Usual	
Example No. 1.7			ASCE_rcrs7.bpf	Secondary	Existing				√		√		Usual	
Example No. 1.8			ASCE_rcrs8.bpf	Secondary	Existing		√			√	√		Custom	custom FRP
Example No. 1.9			ASCE_rcrs9.bpf	Primary	New					√		√	Usual	custom material
Example No. 1.10			ASCE_rcrs10.bpf	Primary	New				√		√		Custom	
Example No. 1.11			ASCE_rcrs11.bpf	Secondary	Existing		√		√		√	√	Usual	additional bars
Example No. 1.12			ASCE_rcrs12.bpf	Primary	New			√				√	Custom	custom material
Example No. 1.13			ASCE_rcrs13.bpf	Secondary	Existing			√			√	√	Usual	
Example No. 1.14			ASCE_rcrs14.bpf	Primary	Existing		√			√	√		Usual	
Example No. 1.15			ASCE_rcrs15.bpf	Primary	Existing			√					Usual	
Example No. 1.16			ASCE_rcrs16.bpf	Primary	Existing			√					Usual	
Example No. 2.1	ASCE 41-13	L-Shaped	ASCE_rclcs1.bpf	Primary	Existing			√					Usual	
Example No. 2.2			ASCE_rclcs2.bpf	Primary	Existing		√		√			√	Custom	
Example No. 2.3			ASCE_rclcs3.bpf	Primary	Existing		√	√				√	Usual	custom material
Example No. 2.4			ASCE_rclcs4.bpf	Secondary	New		√	√			√		Custom	
Example No. 2.5			ASCE_rclcs5.bpf	Secondary	New					√		√	Usual	additional bars
Example No. 2.6			ASCE_rclcs6.bpf	Secondary	New		√		√		√		Usual	Assymetric
Example No. 2.7			ASCE_rclcs7.bpf	Secondary	Existing				√		√		Usual	
Example No. 2.8			ASCE_rclcs8.bpf	Secondary	Existing		√			√	√		Custom	
Example No. 2.9			ASCE_rclcs9.bpf	Primary	New					√		√	Usual	custom material
Example No. 2.10			ASCE_rclcs10.bpf	Primary	New				√		√		Custom	
Example No. 2.11			ASCE_rclcs11.bpf	Secondary	New		√		√		√	√	Usual	additional bars, custom FRP
Example No. 2.12			ASCE_rclcs12.bpf	Primary	New			√				√	Custom	custom material
Example No. 2.13			ASCE_rclcs13.bpf	Secondary	Existing			√			√	√	Usual	
Example No. 2.14			ASCE_rclcs14.bpf	Primary	Existing		√			√	√		Usual	
Example No. 2.15			ASCE_rclcs15.bpf	Secondary	Existing			√			√	√	Usual	
Example No. 2.16			ASCE_rclcs16.bpf	Secondary	Existing			√			√	√	Usual	
Example No. 3.1	ASCE 41-13	T-Shaped	ASCE_rctcs1.bpf	Primary	Existing			√					Usual	
Example No. 3.2			ASCE_rctcs2.bpf	Primary	Existing		√		√			√	Custom	
Example No. 3.3			ASCE_rctcs3.bpf	Primary	Existing		√	√				√	Usual	custom material
Example No. 3.4			ASCE_rctcs4.bpf	Secondary	New		√	√			√		Custom	
Example No. 3.5			ASCE_rctcs5.bpf	Secondary	New					√		√	Usual	additional bars
Example No. 3.6			ASCE_rctcs6.bpf	Secondary	New		√		√		√		Usual	Assymetric
Example No. 3.7			ASCE_rctcs7.bpf	Secondary	Existing				√		√		Usual	
Example No. 3.8			ASCE_rctcs8.bpf	Secondary	Existing		√			√	√		Custom	custom FRP
Example No. 3.9			ASCE_rctcs9.bpf	Primary	New					√		√	Usual	custom material
Example No. 3.10			ASCE_rctcs10.bpf	Primary	New				√		√		Usual	
Example No. 3.11			ASCE_rctcs11.bpf	Secondary	New		√		√		√	√	Usual	additional bars
Example No. 3.12			ASCE_rctcs12.bpf	Primary	New			√				√	Usual	custom material
Example No. 3.13			ASCE_rctcs13.bpf	Secondary	Existing			√			√	√	Custom	
Example No. 3.14			ASCE_rctcs14.bpf	Primary	Existing		√			√	√		Custom	
Example No. 2.15			ASCE_rctcs15.bpf	Secondary	Existing			√			√	√	Usual	
Example No. 2.16			ASCE_rctcs16.bpf	Secondary	Existing			√			√	√	Usual	
Example No. 4.1	ASCE 41-13	Circular	ASCE_rccs1.bpf	Primary	Existing			√					Usual	
Example No. 4.2			ASCE_rccs2.bpf	Primary	Existing		√		√			√	Custom	
Example No. 4.3			ASCE_rccs3.bpf	Primary	Existing		√	√				√	Usual	custom material
Example No. 4.4			ASCE_rccs4.bpf	Secondary	New		√	√			√		Custom	
Example No. 4.5			ASCE_rccs5.bpf	Secondary	New					√		√	Usual	additional bars
Example No. 4.6			ASCE_rccs6.bpf	Secondary	New		√		√		√		Usual	
Example No. 4.7			ASCE_rccs7.bpf	Secondary	Existing				√		√		Custom	
Example No. 4.8			ASCE_rccs8.bpf	Secondary	Existing		√			√	√		Custom	custom FRP
Example No. 4.9			ASCE_rccs9.bpf	Primary	New					√		√	Usual	custom material
Example No. 4.10			ASCE_rccs10.bpf	Primary	New				√		√		Custom	
Example No. 4.11			ASCE_rccs11.bpf	Secondary	New		√		√		√	√	Usual	additional bars
Example No. 4.12			ASCE_rccs12.bpf	Primary	New			√				√	Usual	custom material
Example No. 4.13			ASCE_rccs13.bpf	Secondary	Existing			√			√	√	Custom	
Example No. 4.14			ASCE_rccs14.bpf	Primary	Existing		√			√	√		Usual	
Example No. 2.15			ASCE_rccs15.bpf	Primary	New			√				√	Usual	
Example No. 2.16			ASCE_rccs16.bpf	Primary	New			√				√	Usual	
Example No. 5.1	ASCE 41-13	Wall	ASCE_rcrws1.bpf	Primary	Existing			√					Usual	
Example No. 5.2			ASCE_rcrws2.bpf	Primary	Existing		√		√			√	Custom	
Example No. 5.3			ASCE_rcrws3.bpf	Primary	Existing		√	√				√	Usual	custom material
Example No. 5.4			ASCE_rcrws4.bpf	Secondary	New		√	√			√		Custom	
Example No. 5.5			ASCE_rcrws5.bpf	Secondary	New					√		√	Usual	additional bars
Example No. 5.6			ASCE_rcrws6.bpf	Secondary	New		√		√		√		Usual	
Example No. 5.7			ASCE_rcrws7.bpf	Secondary	Existing				√		√		Usual	
Example No. 5.8			ASCE_rcrws8.bpf	Secondary	Existing		√			√	√		Custom	
Example No. 5.9			ASCE_rcrws9.bpf	Primary	New					√		√	Usual	custom material
Example No. 5.10			ASCE_rcrws10.bpf	Primary	New				√		√		Custom	custom FRP
Example No. 5.11			ASCE_rcrws11.bpf	Secondary	New		√		√		√	√	Usual	additional bars
Example No. 5.12			ASCE_rcrws12.bpf	Primary	New			√				√	Usual	custom material
Example No. 5.13			ASCE_rcrws13.bpf	Secondary	Existing			√			√	√	Custom	
Example No. 5.14			ASCE_rcrws14.bpf	Primary	Existing		√			√	√		Usual	
Example No. 6.1	ASCE 41-13	BEAM	ASCE_Beam1.bpf	Primary	Existing			√					Usual	
Example No. 6.2			ASCE_Beam2.bpf	Primary	Existing				√			√	Custom	
Example No. 6.3			ASCE_Beam3.bpf	Primary	Existing			√				√	Usual	custom material
Example No. 6.4			ASCE_Beam4.bpf	Secondary	New			√			√		Custom	
Example No. 6.5			ASCE_Beam5.bpf	Secondary	New					√		√	Usual	additional bars
Example No. 6.6			ASCE_Beam6.bpf	Secondary	New				√		√		Usual	Inclined
Example No. 6.7			ASCE_Beam7.bpf	Secondary	Existing				√		√		Usual	
Example No. 6.8			ASCE_Beam8.bpf	Secondary	Existing					√	√		Custom	
Example No. 6.9			ASCE_Beam9.bpf	Primary	New					√		√	Usual	custom material
Example No. 6.10			ASCE_Beam10.bpf	Primary	New				√		√		Custom	
Example No. 6.11			ASCE_Beam11.bpf	Secondary	New				√		√	√	Usual	additional bars
Example No. 6.12			ASCE_Beam12.bpf	Primary	New			√				√	Usual	custom material
Example No. 6.13			ASCE_Beam13.bpf	Secondary	Existing			√			√	√	Custom	
Example No. 6.14			ASCE_Beam14.bpf	Primary	Existing					√	√		Usual	
Example No. 7.1	ASCE 41-13	JACKETED RECTANGULAR	ASCE_rcjrs1.bpf	Primary	Existing+New			√					Usual	
Example No. 7.2			ASCE_rcjrs2.bpf	Primary	Existing+New		√		√			√	Custom	
Example No. 7.3			ASCE_rcjrs3.bpf	Primary	Existing+New		√	√				√	Usual	custom material
Example No. 7.4			ASCE_rcjrs4.bpf	Secondary	New+New		√	√			√		Custom	
Example No. 7.5			ASCE_rcjrs5.bpf	Secondary	New+New					√		√	Usual	additional bars
Example No. 7.6			ASCE_rcjrs6.bpf	Secondary	New+New		√		√		√		Usual	Assymetric
Example No. 7.7			ASCE_rcjrs7.bpf	Secondary	Existing+New				√		√		Usual	
Example No. 7.8			ASCE_rcjrs8.bpf	Secondary	Existing+New		√			√	√		Custom	
Example No. 7.9			ASCE_rcjrs9.bpf	Primary	New+New					√		√	Usual	custom material
Example No. 7.10			ASCE_rcjrs10.bpf	Primary	New+New				√		√		Custom	custom FRP
Example No. 7.11			ASCE_rcjrs11.bpf	Secondary	New+New		√		√		√	√	Usual	additional bars
Example No. 7.12			ASCE_rcjrs12.bpf	Primary	New+New			√				√	Usual	
Example No. 7.13			ASCE_rcjrs13.bpf	Secondary	Existing+New			√			√	√	Custom	custom material
Example No. 7.14			ASCE_rcjrs14.bpf	Primary	Existing+New		√			√	√		Custom	
Example No. 2.15			ASCE_rcjrs15.bpf	Seondary	New+New			√				√	Usual	
Example No. 2.16			ASCE_rcjrs16.bpf	Seondary	New+New			√				√	Usual	
Example No. 8.1	ASCE 41-13	JACKETED L-Section	ASCE_rcjlcs1.bpf	Primary	Existing+New			√					Usual	
Example No. 8.2			ASCE_rcjlcs2.bpf	Primary	Existing+New		√		√			√	Custom	
Example No. 8.3			ASCE_rcjlcs3.bpf	Primary	Existing+New		√	√				√	Usual	custom material
Example No. 8.4			ASCE_rcjlcs4.bpf	Secondary	New+New		√	√			√		Custom	
Example No. 8.5			ASCE_rcjlcs5.bpf	Secondary	New+New					√		√	Usual	
Example No. 8.6			ASCE_rcjlcs6.bpf	Secondary	New+New		√		√		√		Usual	assymetric
Example No. 8.7			ASCE_rcjlcs7.bpf	Secondary	Existing+New				√		√		Usual	additional bars
Example No. 8.8			ASCE_rcjlcs8.bpf	Secondary	Existing+New		√			√	√		Custom	
Example No. 8.9			ASCE_rcjlcs9.bpf	Primary	New+New					√		√	Usual	custom material
Example No. 8.10			ASCE_rcjlcs10.bpf	Primary	New+New		√		√		√		Custom	custom FRP
Example No. 8.11			ASCE_rcjlcs11.bpf	Secondary	New+New		√		√		√	√	Usual	additional bars
Example No. 8.12			ASCE_rcjlcs12.bpf	Primary	New+New			√				√	Usual	
Example No. 8.13			ASCE_rcjlcs13.bpf	Secondary	Existing+New			√			√	√	Custom	custom material
Example No. 8.14			ASCE_rcjlcs14.bpf	Primary	Existing+New		√			√	√		Custom	
Example No. 2.15			ASCE_rcjlcs15.bpf	Secondary	New+Existing			√			√	√	Usual	
Example No. 2.16			ASCE_rcjlcs16.bpf	Secondary	New+Existing			√			√	√	Usual	
Example No. 9.1	ASCE 41-13	JACKETED T-Section	ASCE_rcjtcs1.bpf	Primary	Existing+New			√					Usual	
Example No. 9.2			ASCE_rcjtcs2.bpf	Primary	Existing+New		√		√			√	Custom	
Example No. 9.3			ASCE_rcjtcs3.bpf	Primary	Existing+New		√	√				√	Usual	custom material
Example No. 9.4			ASCE_rcjtcs4.bpf	Secondary	New+New		√	√			√		Custom	
Example No. 9.5			ASCE_rcjtcs5.bpf	Secondary	New+New					√		√	Usual	
Example No. 9.6			ASCE_rcjtcs6.bpf	Secondary	New+New		√		√		√		Usual	assymetric
Example No. 9.7			ASCE_rcjtcs7.bpf	Secondary	Existing+New				√		√		Usual	additional bars
Example No. 9.8			ASCE_rcjtcs8.bpf	Secondary	Existing+New		√			√	√		Custom	
Example No. 9.9			ASCE_rcjtcs9.bpf	Primary	New+New					√		√	Usual	custom material
Example No. 9.10			ASCE_rcjtcs10.bpf	Primary	New+New		√		√		√		Custom	custom FRP
Example No. 9.11			ASCE_rcjtcs11.bpf	Secondary	New+New		√		√		√	√	Usual	additional bars
Example No. 9.12			ASCE_rcjtcs12.bpf	Primary	New+New			√				√	Usual	
Example No. 9.13			ASCE_rcjtcs13.bpf	Secondary	Existing+New			√			√	√	Custom	custom material
Example No. 9.14			ASCE_rcjtcs14.bpf	Primary	Existing+New		√			√	√		Custom	
Example No. 2.15			ASCE_rcjtcs15.bpf	Primary	New+Existing			√					Usual	
Example No. 2.16			ASCE_rcjtcs16.bpf	Primary	New+Existing			√					Usual	
Example No. 10.1	ASCE 41-13	JACKETED CIRCULAR	ASCE_rcjcs1.bpf	Primary	Existing+New			√					Usual	
Example No. 10.2			ASCE_rcjcs2.bpf	Primary	Existing+New		√		√			√	Custom	
Example No. 10.3			ASCE_rcjcs3.bpf	Primary	Existing+New		√	√				√	Usual	custom material
Example No. 10.4			ASCE_rcjcs4.bpf	Secondary	New+New		√	√			√		Custom	
Example No. 10.5			ASCE_rcjcs5.bpf	Secondary	New+New					√		√	Usual	
Example No. 10.6			ASCE_rcjcs6.bpf	Secondary	New+New		√		√		√		Usual	
Example No. 10.7			ASCE_rcjcs7.bpf	Secondary	Existing+New				√		√		Usual	additional bars
Example No. 10.8			ASCE_rcjcs8.bpf	Secondary	Existing+New		√			√	√		Custom	
Example No. 10.9			ASCE_rcjcs9.bpf	Primary	New+New					√		√	Usual	custom material
Example No. 10.10			ASCE_rcjcs10.bpf	Primary	New+New		√		√		√		Custom	custom FRP
Example No. 10.11			ASCE_rcjcs11.bpf	Secondary	New+New		√		√		√	√	Usual	additional bars
Example No. 10.12			ASCE_rcjcs12.bpf	Primary	New+New			√				√	Usual	
Example No. 10.13			ASCE_rcjcs13.bpf	Secondary	Existing+New			√			√	√	Custom	custom material
Example No. 10.14			ASCE_rcjcs14.bpf	Primary	Existing+New		√			√	√		Custom	
Example No. 2.15			ASCE_rcjcs15.bpf	Primary	New+New			√				√	Usual	
Example No. 2.16			ASCE_rcjcs16.bpf	Primary	New+New			√				√	Usual	
Example No. 11.1	ASCE 41-13	JACKETED BEAM	ASCE_JBeam1.bpf	Primary	Existing+New			√					Usual	
Example No. 11.2			ASCE_JBeam2.bpf	Primary	Existing+New				√			√	Custom	
Example No. 11.3			ASCE_JBeam3.bpf	Primary	Existing+New			√				√	Usual	custom material
Example No. 11.4			ASCE_JBeam4.bpf	Secondary	New+New			√			√		Custom	
Example No. 11.5			ASCE_JBeam5.bpf	Secondary	New+New					√		√	Usual	
Example No. 11.6			ASCE_JBeam6.bpf	Secondary	New+New				√		√		Usual	
Example No. 11.7			ASCE_JBeam7.bpf	Secondary	Existing+New				√		√		Usual	additional bars
Example No. 11.8			ASCE_JBeam8.bpf	Secondary	Existing+New					√	√		Custom	
Example No. 11.9			ASCE_JBeam9.bpf	Primary	New+New					√		√	Usual	custom material
Example No. 11.10			ASCE_JBeam10.bpf	Primary	New+New				√		√		Custom	
Example No. 11.11			ASCE_JBeam11.bpf	Secondary	New+New				√		√	√	Usual	additional bars
Example No. 11.12			ASCE_JBeam12.bpf	Primary	New+New			√				√	Usual	
Example No. 11.13			ASCE_JBeam13.bpf	Secondary	Existing+New			√			√	√	Custom	custom material
Example No. 11.14			ASCE_JBeam14.bpf	Primary	Existing+New					√	√		Custom	

As it is shown, in the above table, all the parameters that affect the chord rotation capacity and the shear capacity of all the section types have been examined.

Chapter 2 Capacity Models for Assessment and Checks according to American Society of Civil Engineers (ASCE 41-17)

In this chapter the parameters used for the structures assessment according to ASCE 41-17 are presented.

Capacity Models for Assessment and Checks

All the member checks (chord rotation capacity and shear capacity) should be carried out for all the elements of every floor, according to sections 10 of ASCE 41-17, 11 of ACI 318-11 and 11 of ACI 440, taking into account the Table 7-7 of ASCE 41-17. Interstorey drift ratio should be checked for shear walls controlled by shear. Moreover, beam-column joints checks can be employed in order to check the joint's shear force.

Deformation Capacity

The deformation capacity of beams, columns and walls controlled by flexure is defined in terms of the chord rotation θ, that is the angle between the tangent to the axis at the yielding end and the chord connecting that end with the end of the shear span (L_V=M/V=moment/shear at the end section). The chord rotation is also equal to the element drift ratio, which is the deflection at the end of the shear span with respect to the tangent to the axis at the yielding end divided by the shear span.

Deformation capacity of beams, columns and walls controlled by flexure is highly influenced by the lack of appropriate seismic resistant detailing in longitudinal reinforcement, as well as whether there are smooth bars. Inadequate development of splicing along the span (beams) and height (columns); and inadequate embedment into beam-column joints can control the members' response to seismic action, drastically limiting its capacity in respect to the situation in which the reinforcement is considered fully effective. The above limitations to the deformation capacity are taken into consideration.

The total chord rotation capacity at ultimate of concrete members under cyclic loading is calculated as the sum of the chord rotation at yielding and the plastic part of the chord rotation capacity

$$\theta = \theta_y + \theta_p$$

The chord rotation capacity at yield, θ_y, is calculated as described below:

- For beams and columns from the equation (4.29) of D.Biskinis (2007):

$$\theta_y = \frac{M_y L_s}{3EI_{eff}}$$

  where the effective stiffness value , EI_{eff}, is calculated according to Table 10-5 of ASCE 41-17.

- For walls according to equation (10-5) of ASCE 41-17:

$$\theta_y = \left(\frac{M_y}{E_c I}\right) l_p \qquad \text{(10-5) ASCE 41-17}$$

The plastic part of the chord rotation capacity is calculated as indicated below:

- For beams according to Table 10-7 of ASCE 41-17
- For non-circular columns according to Table 10-8 of ASCE 41-17 and for circular columns according to Table 10-9 of ASCE 41-17
- For walls controlled by flexure according to Table 10-19 of ASCE 41-17

The deformation capacity of walls controlled by shear is defined in terms of the interstorey drift ratio as indicated in Table 10-20 of ASCE 41-17.

The yield moment capacity is calculated according to the equations of Appendix 7A of KANEPE.

Users are advised to refer to the relevant publications for the definition of the other parameters and further details on the expressions.

FRP wrapping

The contribution of the FRP wrapping to members' capacity is taken into account in the calculation of the yield moment capacity.

Shear Capacity

The Shear capacity of columns is calculated through the following expression according to section 10.4.2.3 of ASCE 41-17.

$$V_n = kV_o = k\left[\alpha_{Col}\frac{A_v f_y d}{s} + \lambda\left(\frac{6\sqrt{f_c'}}{M/V_d}\sqrt{1+\frac{N_u}{6\sqrt{f_c'}A_g}}\right)0.8A_g\right] \text{ (lb/in.}^2\text{ units)}$$

$$V_n = kV_o = k\left[\alpha_{Col}\frac{A_v f_y d}{s} + \lambda\left(\frac{0.5\sqrt{f_c'}}{M/V_d}\sqrt{1+\frac{N_u}{0.5\sqrt{f_c'}A_g}}\right)0.8A_g\right] \text{ (Mpa units)} \qquad \text{(10-3) ASCE 41-17}$$

The shear strength of a shear wall is calculated from the following expression:

$$V_n = V_c + V_s \qquad \text{(22.5.1.1) ACI 318-14}$$

Where the shear strength of a shear wall provided by concrete should be the lesser of the values computed from the equations below:

$$V_c = 3.3\lambda\sqrt{f_c'}hd + \frac{N_u d}{4l_W} \qquad \text{(Table 11.5.4.6 (d)) ACI 318-14}$$

or

$$V_c = \left[0.6\lambda\sqrt{f_c'} + \frac{l_W\left(1.25\lambda\sqrt{f_c'}+0.2\frac{N_u}{l_W h}\right)}{\frac{M_u}{V_u}-\frac{l_W}{2}}\right]hd \qquad \text{(Table 11.5.4.6 (e)) ACI 318-14}$$

Equation (e) of Table 11.5.4.6 is not applied when the $(M_u/V_u\text{-}l_W/2)$ is negative.

The shear strength provided by the transverce reinforcement is computed from the following expression:

$$V_s = \frac{A_v f_{yt} d}{s} \qquad \text{(11.5.4.8) ACI 318-14}$$

According to ASCE 41-17 Unless otherwise noted, where the longitudinal spacing of transverse reinforcement exceeds half the component effective depth measured in the direction of shear, transverse reinforcement shall be assumed to have reduced effectiveness in resisting shear or torsion by a factor of 2(1 – s/d).

The value for V_n at any horizontal section for shear in plane of wall shall not be taken greater than $10\sqrt{f_c'}hd$ according to section 11.5.4.3 of ACI 318-14.

The shear capacity of beam sections is calculated from the equation (22.5.1.1) of ACI 318-14, with the shear strength provided by the transverce reinforcement computed from equation (11.5.4.8) of ACI 318-14 and the shear strength provided by concrete computed by the detailed calculation of section 22.5.5.1 of ACI 318-14, in particular as the least between the Vc values computed from the following equations. According to ASCE 41-17 Unless otherwise noted, where the longitudinal spacing of transverse reinforcement exceeds half the component effective depth measured in the direction of shear, transverse reinforcement shall be assumed to have reduced effectiveness in resisting shear or torsion by a factor of 2(1 – s/d).

$$V_c = \left(1.9\lambda\sqrt{f_c'} + 2500\rho_W \frac{V_u d}{M_u}\right) b_w d \qquad \text{(Table 22.5.5.1 (a)) ACI 318-14}$$

$$V_c = \left(1.9\lambda\sqrt{f_c'} + 2500\rho_W\right) b_w d \qquad \text{(Table 22.5.5.1 (b)) ACI 318-14}$$

$$V_c = 3.5\lambda\sqrt{f_c'} b_w d. \qquad \text{(Table 22.5.5.1 (c)) ACI 318-14}$$

Users are advised to refer to the relevant publications for the definition of the other parameters and further details on the expressions.

FRP wrapping

The shear resistance V_n, may be calculated from expression (10-3) of ASCE 41-17 for columns or the equation (11-2) of ACI 318-11 for beams and shear walls adding in V_s the contribution of the FRP jacket to the shear resistance.

The contribution of the FRP jacket to the shear resistance is computed through the following expression multiplied by a reduction factor ψ_f, as described in section 11.3 of ACI 440:

$$V_f = \frac{A_{fv} f_{fe} (\sin a + \cos a) d_{fv}}{s_f} \qquad \text{(11-3) ACI 440}$$

where

$$A_{fv} = 2nt_f w_f \qquad \text{(11-4) ACI 440}$$

and

$$f_{fe} = \varepsilon_{fe} E_f \qquad \text{(11-5) ACI 440}$$

The total shear strength provided by the sum of the FRP shear reinforcement and the steel shear reinforcement should be limited as indicated in the equation below:

$$V_s + V_f \le 8\sqrt{f_c'} b_w d \qquad \text{in in-lb units}$$

$$V_s + V_f \le 0.66\sqrt{f_c'} b_w d \qquad \text{in SI units} \qquad \text{(11-11) ACI 440}$$

Users are advised to refer to the relevant publications for the definition of the other parameters and further details on the expressions.

Joints Shear Force

The design shear force of joints is calculated through the following expression according to TBDY:

$$V_e = 1.25\, f_{yk} (A_{s1} + A_{s2}) - V_{kol} \qquad \text{(7.11) TBDY}$$

The equation of section 10.4.2.3.2 of ASCE 41-17 is employed for the calculation of the shear capacity of joints:

$$V_n = \lambda\gamma\sqrt{f_c'} A_j \qquad \text{(lb/in.}^2 \text{ units)}$$

$$V_n = 0.083\lambda\gamma\sqrt{f_c'} A_j \qquad \text{(MPa units)} \qquad \text{(10-4) ASCE 41-17}$$

The value for γ is defined in Table 10-12 of ASCE 41-17.

Users are advised to refer to the relevant publications for the definition of the other parameters and further details on the expressions.

Chapter 3 COMPARISON WITH INDEPENDENT HAND-CALCULATIONS – MEMBER CHECKS

As noted above, this chapter makes use of examples, and their corresponding independent hand-calculations.

EXAMPLES SET 1: RECTANGULAR COLUMN SECTION

EXAMPLE 1.1

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- Existing Material Sets type

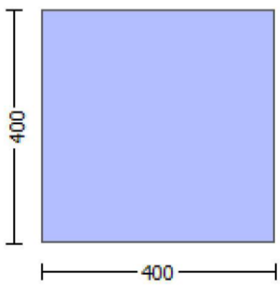
DESCRIPTION

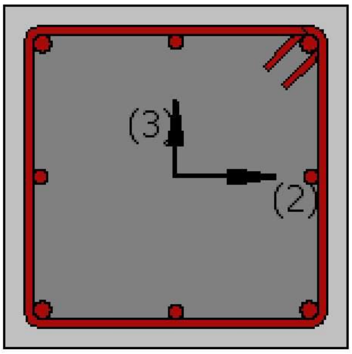
A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17 (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Knowledge Factor , KF= 1.00

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.1. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0057017	0.0057017
	Life Safety	Start	2	0.0389515	0.0389515
Shear Capacity [kN]	Life Safety	Start	2	265.425	265.425

COMPUTER FILES

- ASCE_rcrs1.bpf
- Report_ASCE_rcrs1.pdf

EXAMPLE 1.2

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sect
- Inadequate Lap Length with lb/lb,min = 0.30
- FRP Wrapping
- Existing Material Sets type

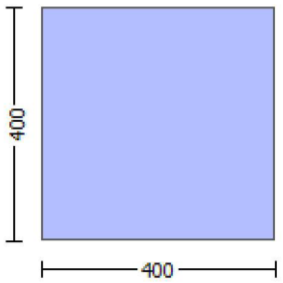
DESCRIPTION

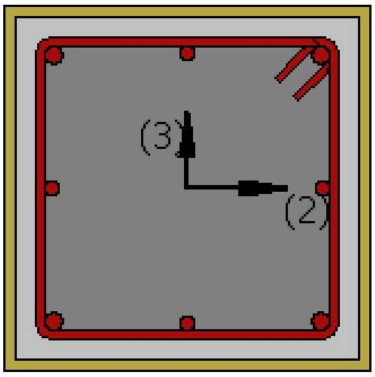
A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Knowledge Factor, KF=0.95

<u>Materials' Properties</u>

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.2. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0054425	0.0054425
	Collapse Prevention	End	2	0.0426202	0.0426202
Shear Capacity [kN]	Collapse Prevention	End	2	445.407	445.407

COMPUTER FILES

- ASCE_rcrs2.bpf
- Report_ASCE_rcrs2.pdf

EXAMPLE 1.3

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- FRP Wrapping
- Existing Material Sets type

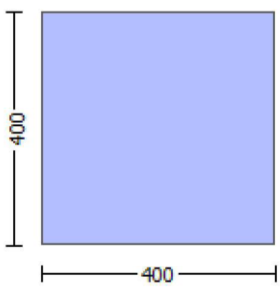
DESCRIPTION

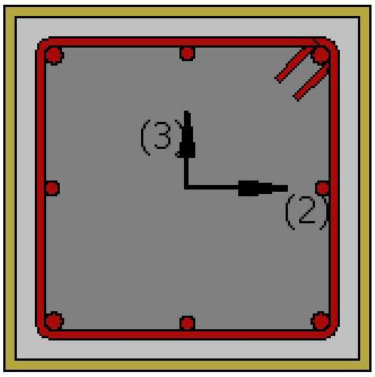
A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Primary Member: Concrete Strength, fc = fcm = 24.00
Existing material of Primary Member: Steel Strength, fs = fsm = 525.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 656.25

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 420.00

Member's Properties

Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars Without Lapping in the Vicinity of the End Regions
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.3. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0105014	0.0105014
	Life Safety	Start	3	0.048467	0.048467
Shear Capacity [kN]	Life Safety	Start	3	468.849	468.849

COMPUTER FILES

- ASCE_rcrs3.bpf
- Report_ASCE_rcrs3.pdf

EXAMPLE 1.4

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- FRP Wrapping
- New Material Sets type

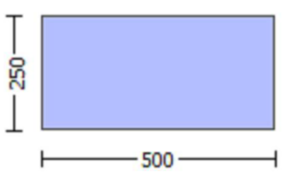
DESCRIPTION

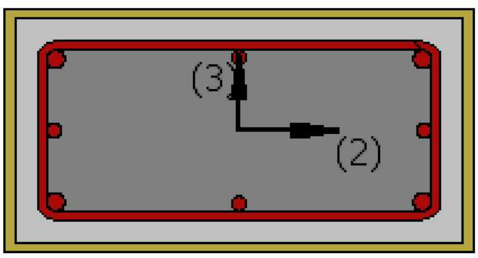
A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.85

Materials' Properties

Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 525.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 656.25

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 420.00

Member's Properties

Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.4. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0060023	0.0060023
	Collapse Prevention	Start	3	0.0647680	0.0647680
Shear Capacity [kN]	Collapse Prevention	Start	3	347.902	347.902

COMPUTER FILES

- ASCE_rcrs4.bpf
- Report_ASCE_rcrs4.pdf

EXAMPLE 1.5

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars Straight Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type

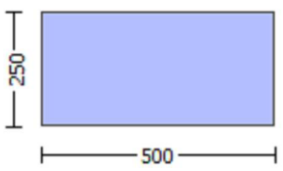
DESCRIPTION

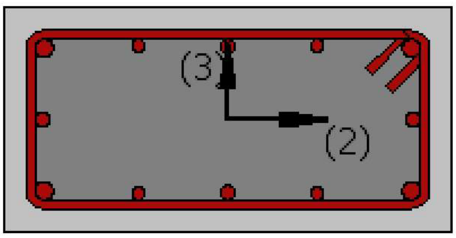
A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>
Knowledge Factor, KF = 0.95

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars Straight Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.5. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	2	0.0057693	0.0057693
	Life Safety	End	3	0.0357840	0.0357840
Shear Capacity [kN]	Life Safety	End	3	282.576	282.576

COMPUTER FILES

- ASCE_rcrs5.bpf
- Report_ASCE_rcrs5.pdf

EXAMPLE 1.6

SUCCINCT DATA

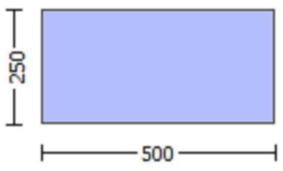
- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lb/lb,min = 0.30
- No FRP Wrapping
- New Material Sets type

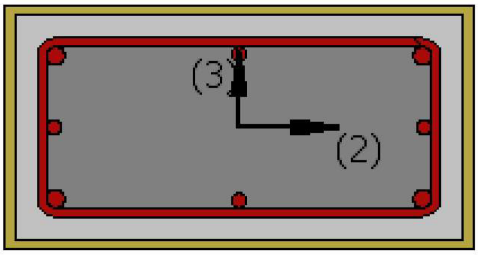
DESCRIPTION

A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

For Chord rotation Calculations
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L =3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/lb,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.6. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0052500	0.0052500
	Collapse Prevention	Start	2	0.0472499	0.0472499
Shear Capacity [kN]	Collapse Prevention	Start	2	394.895	394.895

COMPUTER FILES

- ASCE_rcrs6.bpf
- Report_ASCE_rcrs6.pdf

EXAMPLE 1.7

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars Straight Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- No FRP Wrapping
- Existing Material Sets type

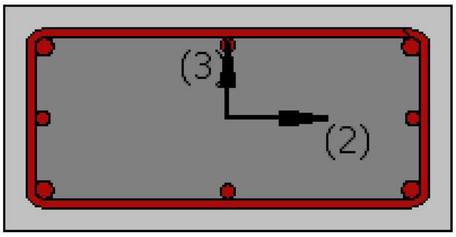
DESCRIPTION

A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES



Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

For Chord rotation Calculations
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars Straight Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.7. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Life Safety	End	2	0.025916	0.025916
	Operational Level	Start	3	0.0060125	0.0060125
Shear Capacity [kN]	Operational Level	Start	3	226.281	226.281

COMPUTER FILES

- ASCE_rcrs7.bpf
- Report_ASCE_rcrs7.pdf

EXAMPLE 1.8

SUCCINCT DATA

- Secondary Member

- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- FRP Wrapping
- Existing Material Sets type

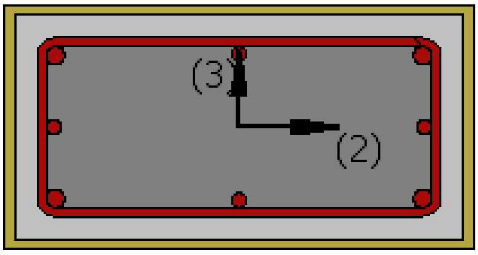
DESCRIPTION

A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES



Units in N, mm

Knowledge Factor, KF = 0.90

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Section Height, H = 250.00
Section Width, W = 500.00

Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.8. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	2	0.0059849	0.0059849
	Collapse Prevention	End	3	0.0384712	0.0384712
Shear Capacity [kN]	Immediate Occupancy	Start	2	284.427	284.427

COMPUTER FILES

- ASCE_rcrs8.bpf
- Report_ASCE_rcrs8.pdf

EXAMPLE 1.9

SUCCINCT DATA

- Primary Member
- Smooth Bars

- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = lb = 300.00
- No FRP Wrapping
- New Material Sets type

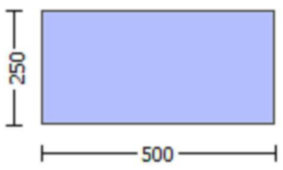
DESCRIPTION

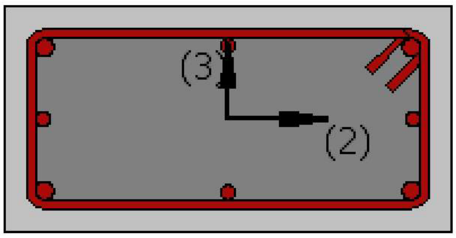
A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, κ = 1.00

Materials' Properties

Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 525.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 656.25

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 420.00

Member's Properties

Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00

Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.9. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.9

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0004687	0.0004687
	Collapse Prevention	Start	2	0.0330441	0.0330441
Shear Capacity [kN]	Collapse Prevention	Start	2	244.283	244.283

OMPUTER FILES

- ASCE_rcrs9.bpf
- Report_ASCE_rcrs9.pdf

EXAMPLE 1.10

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lb/lb,min = 0.30
- No FRP Wrapping
- New Material Sets type

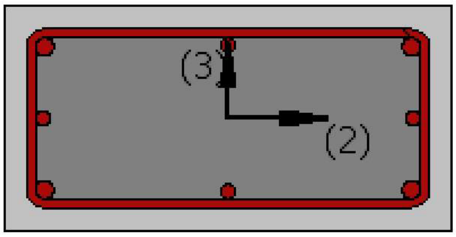
DESCRIPTION

A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES



<u>Units in N, mm</u>

Knowledge Factor, κ = 0.80

<u>Materials' Properties</u>

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45

<u>For Shear Capacity Calculations</u>
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 420.00

<u>Member's Properties</u>

Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/lb,min = 0.30
No FRP Wrapping Data

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.10. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.10

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0058470	0.0058470
	Life Safety	End	2	0.0258495	0.0258495
Shear Capacity [kN]	Life Safety	End	2	439.646	439.646

COMPUTER FILES

- ASCE_rcrs10.bpf
- Report_ASCE_rcrs10.pdf

EXAMPLE 1.11

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lb/lb,min = 0.30
- FRP Wrapping
- Existing Material Sets type

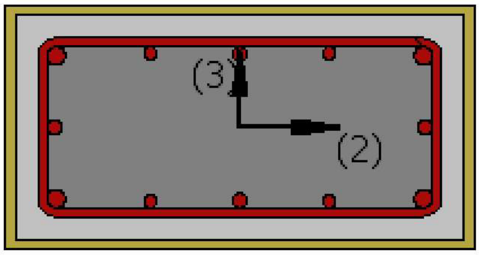
DESCRIPTION

A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES



Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/lb,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.11. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.11

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0069270	0.0069270
	Life Safety	Start	3	0.0369804	0.0369804
Shear Capacity [kN]	Operational Level	End	2	366.317	366.317

COMPUTER FILES

- ASCE_rcrs11.bpf
- Report_ASCE_rcrs11.pdf

EXAMPLE 1.12

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type

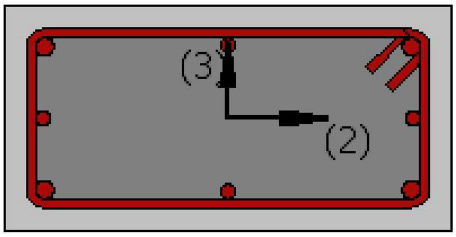
DESCRIPTION

A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES



Units in N, mm

Knowledge Factor, κ = 0.85

Materials' Properties

Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Primary Member: Concrete Strength, fc = fcm = 30.00
New material of Primary Member: Steel Strength, fs = fsm = 525.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 656.25

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 420.00

Member's Properties

Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping Data

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.12. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.12

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0141763	0.0141763
	Collapse Prevention	Start	3	0.0603286	0.0603286
Shear Capacity [kN]	Immediate Occupancy	End	2	376.230	376.230

COMPUTER FILES

- ASCE_rcrs12.bpf
- Report_ASCE_rcrs12.pdf

EXAMPLE 1.13

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- Existing Material Sets type

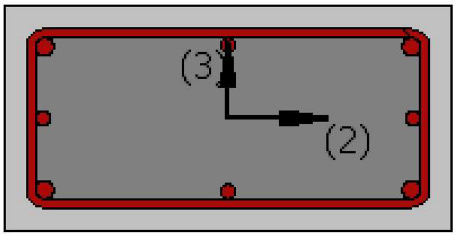
DESCRIPTION

A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES



Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.13. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.13

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0139803	0.0139803
	Life Safety	Start	2	0.0329886	0.0329886
Shear Capacity [kN]	Life Safety	Start	2	169.988	169.988

COMPUTER FILES

- ASCE_rcrs13.bpf
- Report_ASCE_rcrs13.pdf

EXAMPLE 1.14

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = lb = 300.00
- FRP Wrapping
- Existing Material Sets type

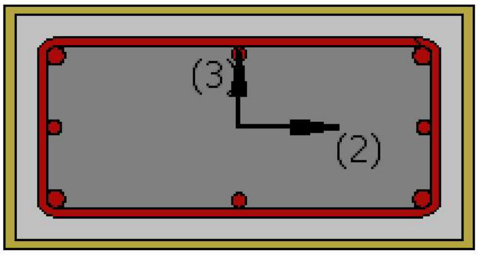
DESCRIPTION

A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES



Units in N, mm

Knowledge Factor, κ = 1.00

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.14. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.14

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0006963	0.0006963
	Collapse Prevention	End	2	0.0441006	0.0441006
Shear Capacity [kN]	Immediate Occupancy	End	3	248.574	248.574

COMPUTER FILES

- ASCE_rcrs14.bpf
- Report_ASCE_rcrs14.pdf

EXAMPLE 1.15

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lb/ld>=1)
- No FRP Wrapping
- Existing Material Sets type

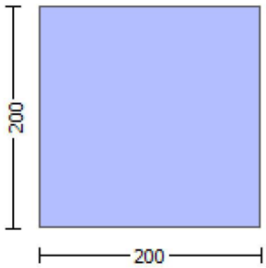
DESCRIPTION

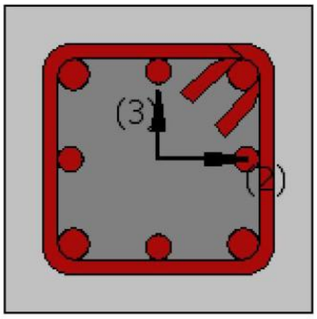
A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, κ = 1.00

Materials' Properties

Concrete Elasticity, Ec = 19940.411
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 625.00

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 18.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Section Height, H = 200.00
Section Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lb/ld>=1)
No FRP Wrapping Data

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.15. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.15

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0104714	0.0104714
	Life Safety	Start	2	0.0558556	0.0558556
Shear Capacity [kN]	Life Safety	Start	2	265.425	265.425

COMPUTER FILES

- ASCE_rcrs15.bpf
- Report_ASCE_rcrs15.pdf

EXAMPLE 1.16

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lb/ld>=1)
- No FRP Wrapping
- Existing Material Sets type

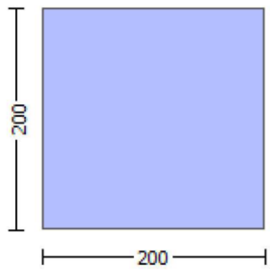
DESCRIPTION

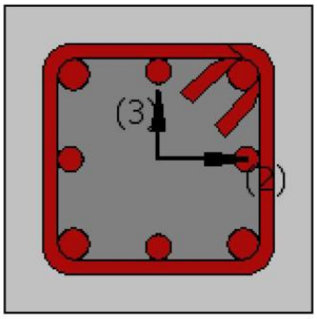
A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, κ = 1.00

Materials' Properties

Concrete Elasticity, Ec = 19940.411
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 12.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 400.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = fsm = 400.00

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 18.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Section Height, H = 200.00
Section Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lb/ld>=1)
No FRP Wrapping Data

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.16. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.16

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0453476	0.0453476
	Life Safety	Start	2	0.0166916	0.0166916
Shear Capacity [kN]	Life Safety	Start	2	265.425	265.425

COMPUTER FILES

- ASCE_rcrs16.bpf
- Report_ASCE_rcrs16.pdf

EXAMPLES SET 2: L-SHAPED COLUMN SECTION

EXAMPLE 2.1

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- Existing Material Sets type

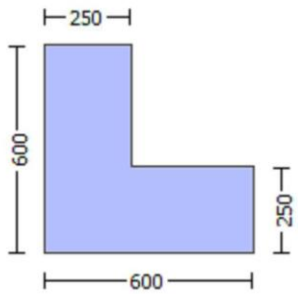
DESCRIPTION

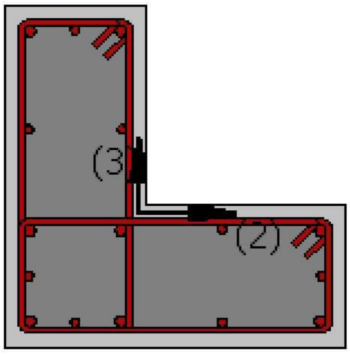
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.18. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0031930	0.0031930
	Life Safety	Start	2	0.0436028	0.0436028
Shear Capacity [kN]	Life Safety	Start	2	379.586	379.586

COMPUTER FILES

- ASCE_rclcs1.bpf
- Report_ASCE_rclcs1.pdf

EXAMPLE 2.2

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- Existing Material Sets type

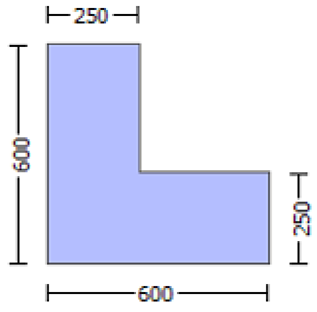
DESCRIPTION

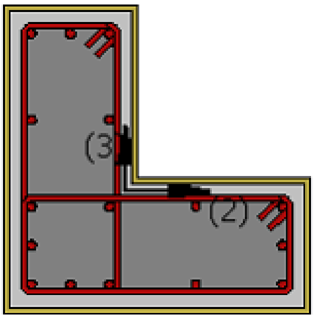
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.90

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
For Shear Capacity Calculations
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1

Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.19. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0057202	0.0057202
	Collapse Prevention	End	2	0.0393551	0.0393551
Shear Capacity [kN]	Immediate Occupancy	Start	3	341.618	341.618

COMPUTER FILES

- ASCE_rclcs2.bpf
- Report_ASCE_rclcs2.pdf

EXAMPLE 2.3

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- FRP Wrapping
- Existing Material Sets type

DESCRIPTION

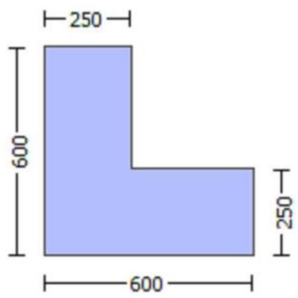
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

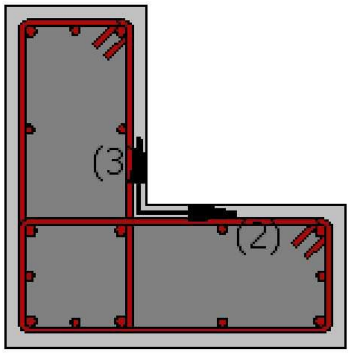
The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The

employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Primary Member: Concrete Strength, fc = fcm = 24.00
Existing material of Primary Member: Steel Strength, fs = fsm = 525.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 656.25

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 420.00

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01

Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.20. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0056395	0.0056395
	Life Safety	Start	3	0.0514996	0.0514996
Shear Capacity [kN]	Life Safety	Start	3	379.576	379.576

COMPUTER FILES

- ASCE_rclcs3.bpf
- Report_ASCE_rclcs3.pdf

EXAMPLE 2.4

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- FRP Wrapping
- New Material Sets type

DESCRIPTION

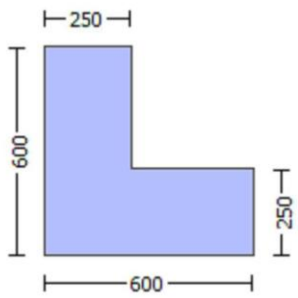
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

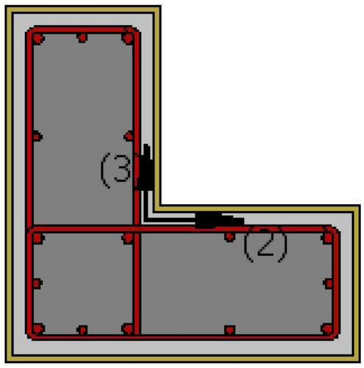
The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The

employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.80

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01

Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.21. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0036396	0.0036396
	Collapse Prevention	Start	3	0.0639696	0.0639696
Shear Capacity [kN]	Collapse Prevention	Start	3	474.270	474.270

COMPUTER FILES

- ASCE_rclcs4.bpf
- Report_ASCE_rclcs4.pdf

EXAMPLE 2.5

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type

DESCRIPTION

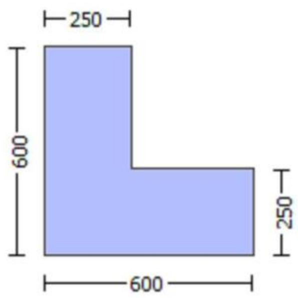
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

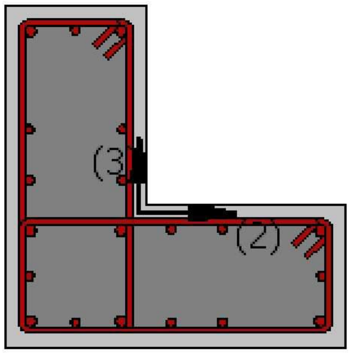
The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The

employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00.
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.22. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	2	0.0038585	0.0038585
	Life Safety	End	3	0.0314700	0.0314700
Shear Capacity [kN]	Operational Level	Start	2	474.293	474.293

COMPUTER FILES

- ASCE_rclcs5.bpf
- Report_ASCE_rclcs5.pdf

EXAMPLE 2.6

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lb/lb,min = 0.30
- FRP Wrapping
- New Material Sets type

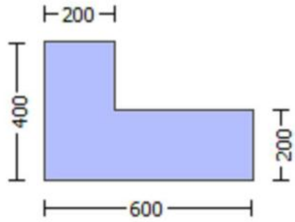
DESCRIPTION

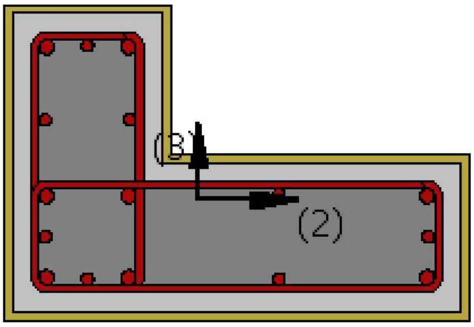
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 600.00
Min Width, Wmin = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/lb,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1

Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.23. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0028853	0.0028853
	Collapse Prevention	Start	2	0.0485561	0.0485561
Shear Capacity [kN]	Immediate Occupancy	End	2	439.706	439.706

COMPUTER FILES

- ASCE_rclcs6.bpf
- Report_ASCE_rclcs6.pdf

EXAMPLE 2.7

SUCCINCT DATA

- Secondary Member
- RibbedBars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lb/lb,min = 0.30
- No FRP Wrapping
- Existing Material Sets type

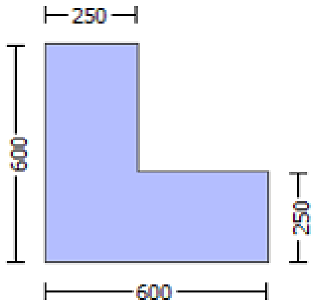
DESCRIPTION

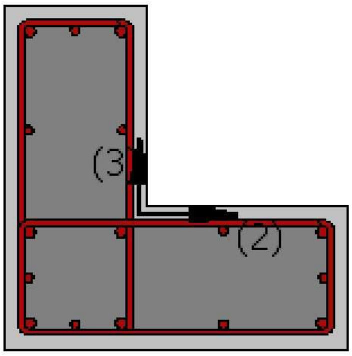
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/lb,min = 0.30
No FRP Wrapping Data

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.24. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0063575	0.0063575
	Life Safety	End	2	0.0317223	0.0317223
Shear Capacity [kN]	Life Safety	End	2	440.330	440.330

COMPUTER FILES

- ASCE_rclcs7.bpf
- Report_ASCE_rclcs7.pdf

EXAMPLE 2.8

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- FRP Wrapping
- Existing Material Sets type

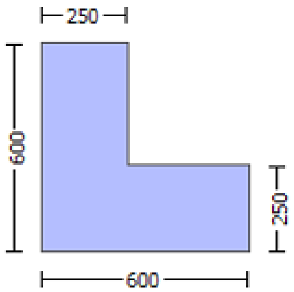
DESCRIPTION

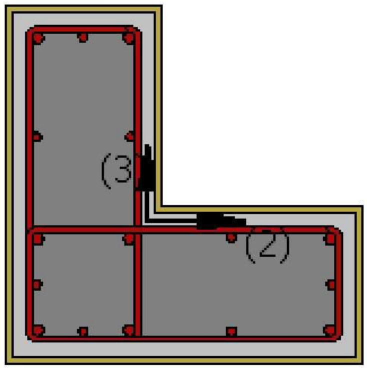
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.77

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1

Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.25. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	2	0.0038869	0.0038869
	Collapse Prevention	End	3	0.0328789	0.0328789
Shear Capacity [kN]	Collapse Prevention	End	3	339.055	339.055

COMPUTER FILES

- ASCE_rclcs8.bpf
- Report_ASCE_rclcs8.pdf

EXAMPLE 2.9

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type

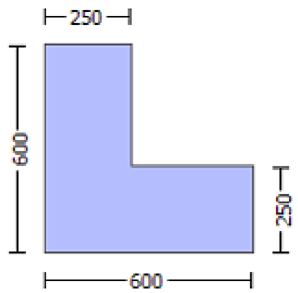
DESCRIPTION

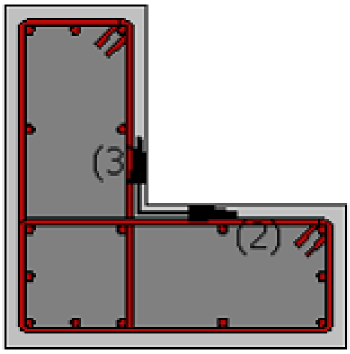
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties
Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Primary Member: Concrete Strength, fc = fcm = 24.00
New material of Primary Member: Steel Strength, fs = fsm = 525.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 656.25

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 420.00

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.26. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.9

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0004555	0.0004555
	Collapse Prevention	Start	2	0.0327243	0.0327243
Shear Capacity [kN]	Collapse Prevention	Start	2	420.501	420.501

COMPUTER FILES

- ASCE_rclcs9.bpf
- Report_ASCE_rclcs9.pdf

EXAMPLE 2.10

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- No FRP Wrapping
- New Material Sets type

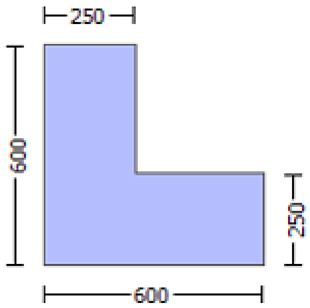
DESCRIPTION

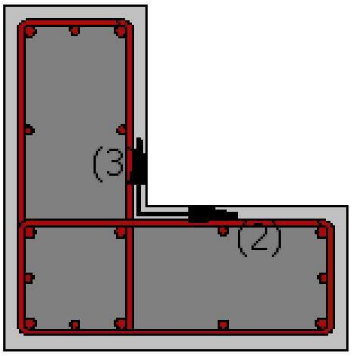
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.86

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping Data

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.27. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.10

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0063206	0.0063206
	Life Safety	End	2	0.0227514	0.0227514
Shear Capacity [kN]	Immediate Occupancy	Start	3	431.734	431.734

COMPUTER FILES

- ASCE_rclcs10.bpf
- Report_ASCE_rclcs10.pdf

EXAMPLE 2.11

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type

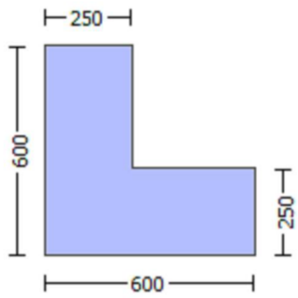
DESCRIPTION

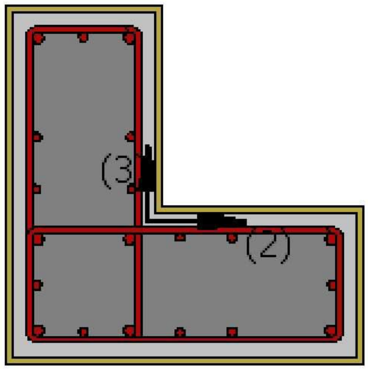
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
SmoothBars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°

Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.28. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.11

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0019057	0.0019057
	Life Safety	Start	3	0.0370379	0.0370379
Shear Capacity [kN]	Life Safety	Start	3	474.261	474.261

COMPUTER FILES

- ASCE_rclcs11.bpf
- Report_ASCE_rclcs11.pdf

EXAMPLE 2.12

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type

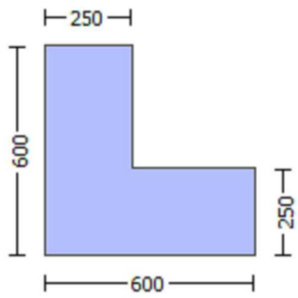
DESCRIPTION

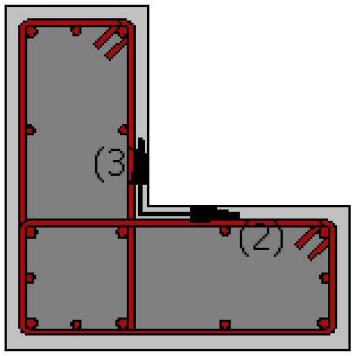
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.96

Materials' Properties

Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Primary Member: Concrete Strength, fc = fcm = 24.00
New material of Primary Member: Steel Strength, fs = fsm = 525.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 656.25

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 420.00

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
SmoothBars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.29. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.12

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0052617	0.0052617
	Collapse Prevention	Start	3	0.0618246	0.0618246
Shear Capacity [kN]	Collapse Prevention	Start	3	379.576	379.576

COMPUTER FILES

- ASCE_rclcs12.bpf
- Report_ASCE_rclcs12.pdf

EXAMPLE 2.13

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- Existing Material Sets type

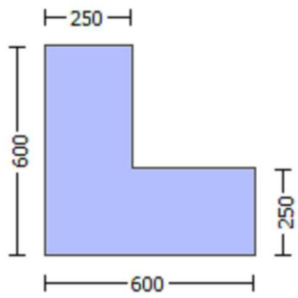
DESCRIPTION

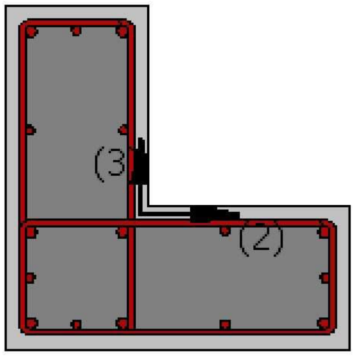
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
SmoothBars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.30. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.13

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0113121	0.0113121
	Life Safety	Start	2	0.0366319	0.0366319
Shear Capacity [kN]	Operational Level	Start	3	204.335	204.335

COMPUTER FILES

- ASCE_rclcs13.bpf
- Report_ASCE_rclcs13.pdf

EXAMPLE 2.14

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- FRP Wrapping
- Existing Material Sets type

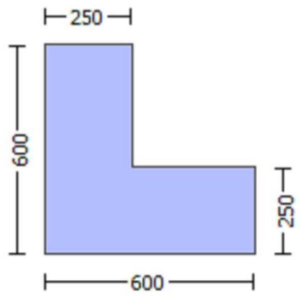
DESCRIPTION

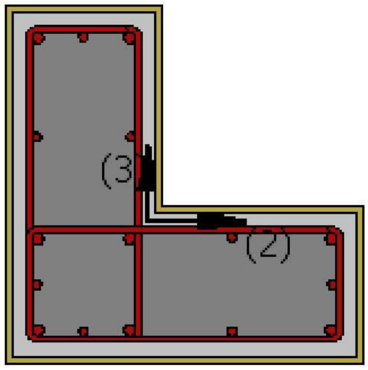
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Steel Elasticity, Es = 200000.00
Concrete Elasticity, Ec = 21019.039

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1

Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.31. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.14

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0006729	0.0006729
	Collapse Prevention	End	2	0.0438518	0.0438518
Shear Capacity [kN]	Immediate Occupancy	End	3	440.305	440.305

COMPUTER FILES

- ASCE_rclcs14.bpf
- Report_ASCE_rclcs14.pdf

EXAMPLE 2.15

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- Existing Material Sets type

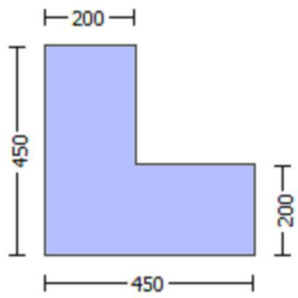
DESCRIPTION

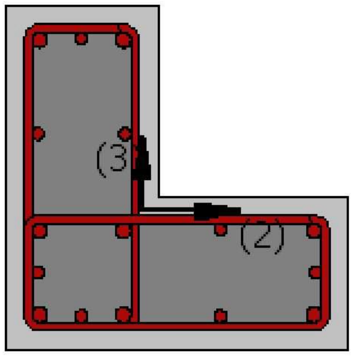
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 19940.411
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = fsm = 444.44

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 12.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.0

Member's Properties
Max Height, Hmax = 450.00
Min Height, Hmin = 200.00
Max Width, Wmax = 450.00
Min Width, Wmin = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
SmoothBars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.32. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.15

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0123513	0.0123514
	Life Safety	Start	2	0.0346719	0.0346715
Shear Capacity [kN]	Operational Level	Start	3	206.186	206.188

NOTE: The small difference in the Shear Capacity values is due to the rounding of the shear capacity value exported to the Report.

COMPUTER FILES

- ASCE_rclcs15.bpf
- Report_ASCE_rclcs15.pdf

EXAMPLE 2.16

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- Existing Material Sets type

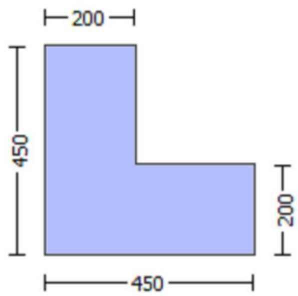
DESCRIPTION

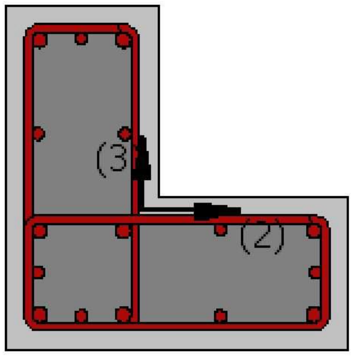
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 19940.411
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = fsm = 444.44

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 12.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.0

Member's Properties
Max Height, Hmax = 450.00
Min Height, Hmin = 200.00
Max Width, Wmax = 450.00
Min Width, Wmin = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
SmoothBars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.33. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.16

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0123513	0.0123514
	Life Safety	Start	2	0.0011697	0.0011697
Shear Capacity [kN]	Operational Level	Start	3	148.561	148.562

NOTE: The small difference in the Shear Capacity values is due to the rounding of the shear capacity value exported to the Report.

COMPUTER FILES

- ASCE_rclcs16.bpf
- Report_ASCE_rclcs16.pdf

EXAMPLES SET 3: T-SHAPED COLUMN SECTION

EXAMPLE 3.1

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- Existing Material Sets type

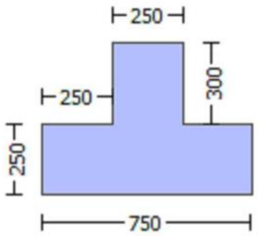
DESCRIPTION

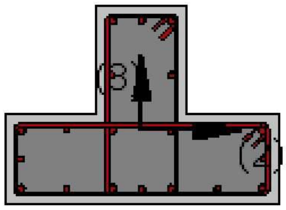
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, Hmax = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.34. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0032199	0.0032199
	Life Safety	Start	2	0.0440946	0.0440946
Shear Capacity [kN]	Operational Level	End	3	386.774	386.774

COMPUTER FILES

- ASCE_rctcs1.bpf
- Report_ASCE_rctcs1.pdf

EXAMPLE 3.2

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- Existing Material Sets type

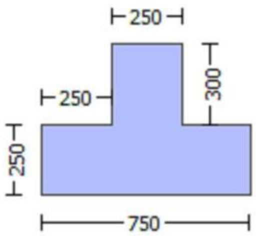
DESCRIPTION

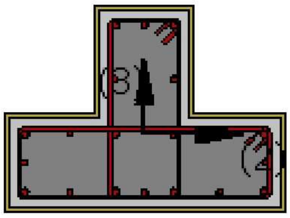
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.85

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, Hmax = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1

Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.35. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0046068	0.0046068
	Collapse Prevention	End	2	0.0535352	0.0535352
Shear Capacity [kN]	Immediate Occupancy	Start	3	295.886	295.886

COMPUTER FILES

- ASCE_rctcs2.bpf
- Report_ASCE_rctcs2.pdf

EXAMPLE 3.3

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- FRP Wrapping
- Existing Material Sets type

DESCRIPTION

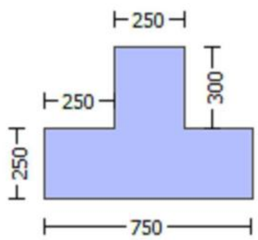
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

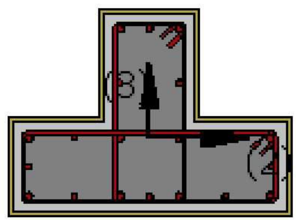
The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The

employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Primary Member: Concrete Strength, fc = fcm = 24.00
Existing material of Primary Member: Steel Strength, fs = fsm = 525.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 656.25

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 420.00

Member's Properties

Max Height, Hmax = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00

Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

> **NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.**

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.36. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0069868	0.0069868
	Life Safety	Start	3	0.0499861	0.0499861
Shear Capacity [kN]	Operational Level	End	2	550.083	550.083

COMPUTER FILES

- ASCE_rctcs3.bpf
- Report_ASCE_rctcs3.pdf

EXAMPLE 3.4

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- FRP Wrapping
- New Material Sets type

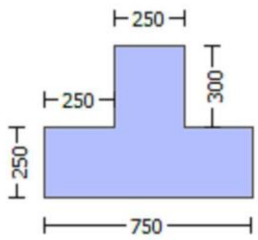
DESCRIPTION

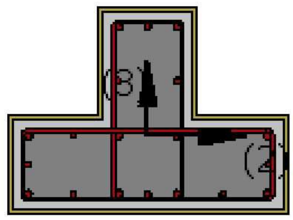
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.89

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, Hmax = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars Straight Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)

Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.37. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0034629	0.0034629
	Collapse Prevention	Start	3	0.0627441	0.0627441
Shear Capacity [kN]	Immediate Occupancy	End	3	482.209	482.209

COMPUTER FILES

- ASCE_rctcs4.bpf
- Report_ASCE_rctcs4.pdf

EXAMPLE 3.5

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type

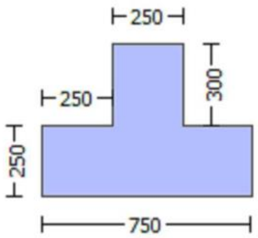
DESCRIPTION

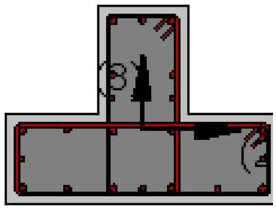
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Knowledge Factor, KF = 1.00

<u>Materials' Properties</u>

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45

<u>For Shear Capacity Calculations</u>
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

<u>Member's Properties</u>

Max Height, Hmax = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.38. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	2	0.0024584	0.0024584
	Life Safety	End	3	0.0304079	0.0304079
Shear Capacity [kN]	Life Safety	End	3	482.740	482.740

COMPUTER FILES

- ASCE_rctcs5.bpf
- Report_ASCE_rctcs5.pdf

EXAMPLE 3.6

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type

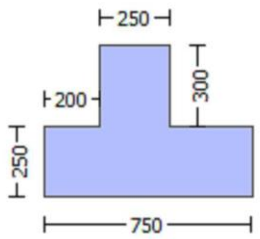
DESCRIPTION

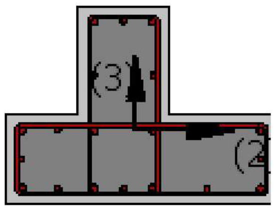
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, Hmax = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°

Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.39. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0030636	0.0030636
	Collapse Prevention	Start	2	0.0659955	0.0659955
Shear Capacity [kN]	Immediate Occupancy	End	2	687.149	687.149

COMPUTER FILES

- ASCE_rctcs6.bpf
- Report_ASCE_rctcs6.pdf

EXAMPLE 3.7

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- No FRP Wrapping
- Existing Material Sets type

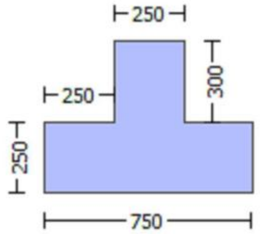
DESCRIPTION

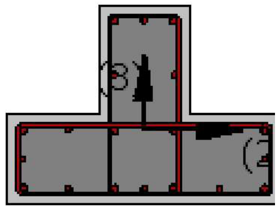
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, Hmax = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.40. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0054210	0.0054210
	Life Safety	End	2	0.0291577	0.0291577
Shear Capacity [kN]	Operational Level	Start	3	348.122	348.122

COMPUTER FILES

- ASCE_rctcs7.bpf
- Report_ASCE_rctcs7.pdf

EXAMPLE 3.8

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- FRP Wrapping
- Existing Material Sets type

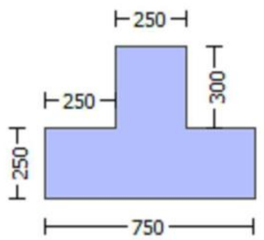
DESCRIPTION

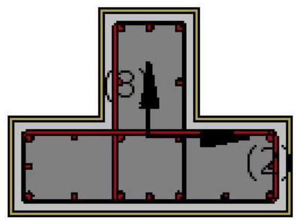
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.93

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, Hmax = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°

Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.41. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	2	0.0058383	0.0058383
	Collapse Prevention	End	3	0.0396240	0.0396240
Shear Capacity [kN]	Collapse Prevention	End	3	359.104	359.104

COMPUTER FILES

- ASCE_rctcs8.bpf
- Report_ASCE_rctcs8.pdf

EXAMPLE 3.9

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type

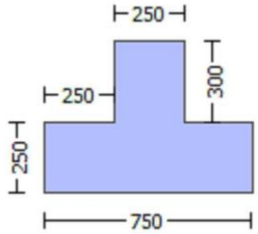
DESCRIPTION

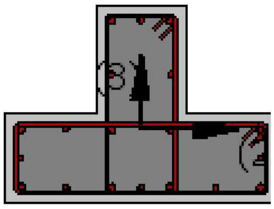
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 28781.504
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, Hmax = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.42. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.9

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0003835	0. 0003835
	Collapse Prevention	Start	2	0.0292333	0.0292333
Shear Capacity [kN]	Operational Level	End	3	452.316	452.316

COMPUTER FILES

- ASCE_rctcs9.bpf
- Report_ASCE_rctcs9.pdf

EXAMPLE 3.10

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- No FRP Wrapping
- New Material Sets type

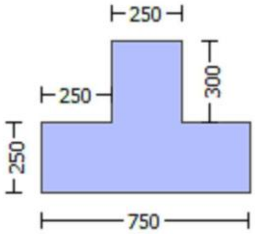
DESCRIPTION

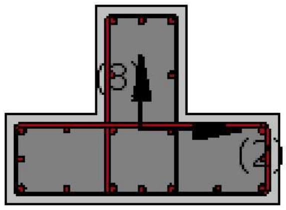
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, Hmax = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping Data

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.43. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.10

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0053945	0.0053945
	Life Safety	End	2	0.0209809	0.0209809
Shear Capacity [kN]	Immediate Occupancy	Start	3	404.631	404.631

COMPUTER FILES

- ASCE_rctcs10.bpf
- Report_ASCE_rctcs10.pdf

EXAMPLE 3.11

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type

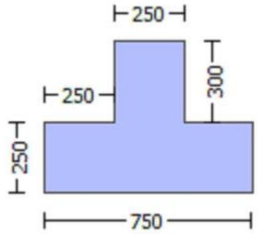
DESCRIPTION

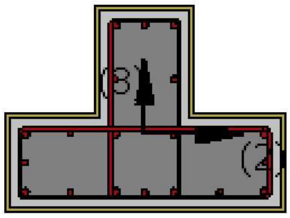
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, Hmax = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°

Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.44. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.11

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0017666	0.0017666
	Life Safety	Start	3	0.0506044	0.0506044
Shear Capacity [kN]	Life Safety	Start	3	434.899	434.899

COMPUTER FILES

- ASCE_rctcs11.bpf
- Report_ASCE_rctcs11.pdf

EXAMPLE 3.12

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type

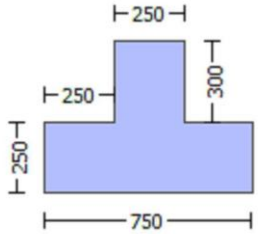
DESCRIPTION

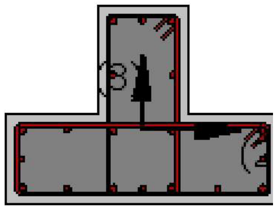
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 28781.504
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, Hmax = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping Data

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.45. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.12

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0067762	0.0067762
	Collapse Prevention	Start	3	0.0523034	0.0523034
Shear Capacity [kN]	Collapse Prevention	Start	3	404.651	404.651

COMPUTER FILES

- ASCE_rctcs12.bpf
- Report_ASCE_rctcs12.pdf

EXAMPLE 3.13

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- ExistingMaterial Sets type

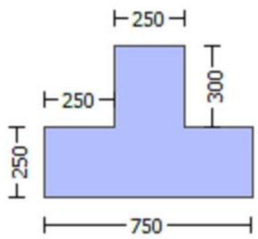
DESCRIPTION

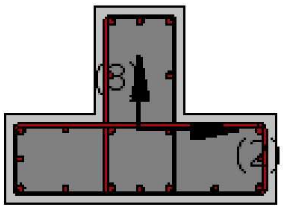
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Knowledge Factor, KF = 0.85

<u>Materials' Properties</u>

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

<u>For Shear Capacity Calculations</u>
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

<u>Member's Properties</u>

Max Height, Hmax = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.46. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.13

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0081952	0.0081952
	Life Safety	Start	2	0.0310498	0.0310498
Shear Capacity [kN]	Operational Level	Start	3	159.342	159.342

COMPUTER FILES

- ASCE_rctcs13.bpf
- Report_ASCE_rctcs13.pdf

EXAMPLE 3.14

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars Straight Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- FRP Wrapping
- ExistingMaterial Sets type

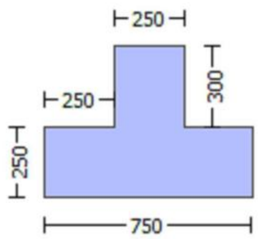
DESCRIPTION

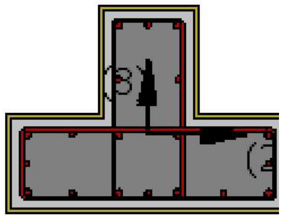
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.90

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, Hmax = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°

Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.47. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.14

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0018757	0.0018757
	Collapse Prevention	End	2	0.0456259	0.0456259
Shear Capacity [kN]	Immediate Occupancy	End	3	151.053	151.053

COMPUTER FILES

- ASCE_rctcs14.bpf
- Report_ASCE_rctcs14.pdf

EXAMPLE 3.15

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars Straight Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min = lb/ld >=1)
- No FRP Wrapping
- Existing Material Sets type

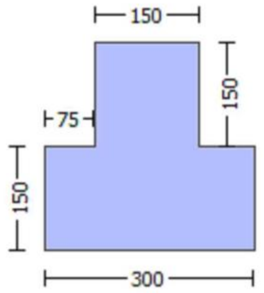
DESCRIPTION

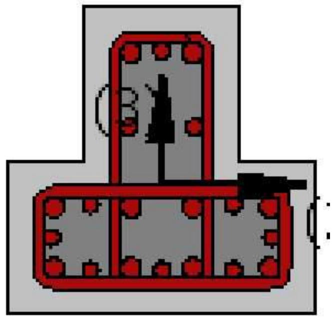
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.85

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = fsm = 444.44

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, Hmax = 300.00
Min Height, Hmin = 150.00
Max Width, Wmax = 300.00
Min Width, Wmin = 150.00
Eccentricity, Ecc = 75.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.48. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.15

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0295025	0.0295025
	Life Safety	Start	2	0.0478975	0.0478975
Shear Capacity [kN]	Operational Level	Start	3	104.465	104.465

COMPUTER FILES

- ASCE_rctcs15.bpf
- Report_ASCE_rctcs15.pdf

EXAMPLE 3.16

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars Straight Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min = lb/ld >=1)
- No FRP Wrapping
- Existing Material Sets type

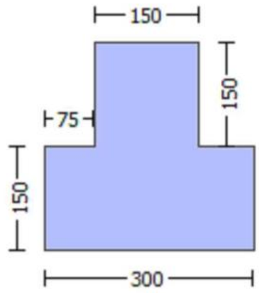
DESCRIPTION

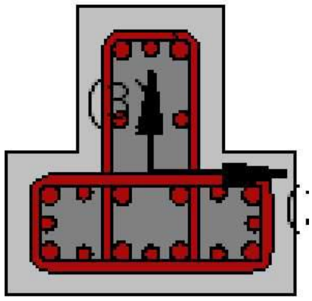
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.85

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = fsm = 444.44

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00 No FRP Wrapping

Member's Properties

Max Height, Hmax = 300.00
Min Height, Hmin = 150.00
Max Width, Wmax = 300.00
Min Width, Wmin = 150.00
Eccentricity, Ecc = 75.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.49. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.16

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0335758	0.0335758
	Life Safety	Start	2	0.0396267	0.0396267
Shear Capacity [kN]	Operational Level	Start	3	109.333	109.333

COMPUTER FILES

- ASCE_rctcs16.bpf
- Report_ASCE_rctcs16.pdf

EXAMPLES SET 4: CIRCULAR COLUMN SECTION

EXAMPLE 4.1

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- Existing Material Sets type

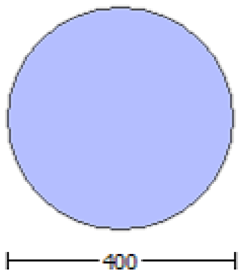
DESCRIPTION

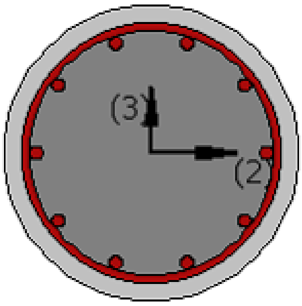
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.50. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0079414	0.0079414
	Life Safety	Start	2	0.0619788	0.0619788
Shear Capacity [kN]	Life Safety	Start	2	208.476	208.476

COMPUTER FILES

- ASCE_rccs1.bpf
- Report_ASCE_rccs1.pdf

EXAMPLE 4.2

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- Existing Material Sets type

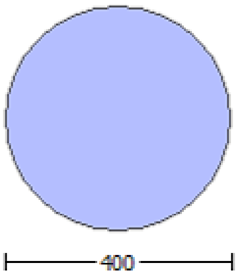
DESCRIPTION

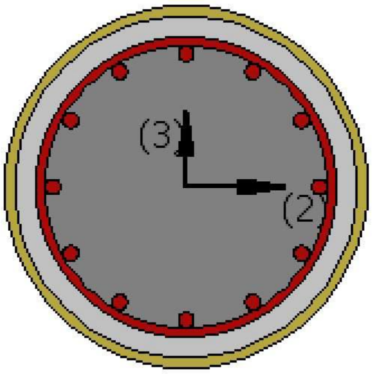
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.85

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.51. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity	Immediate Occupancy	Start	3	0.0147376	0.0147376
	Collapse Prevention	End	2	0.0430652	0.0430652
Shear Capacity [kN]	Immediate Occupancy	Start	3	267.606	267.606

COMPUTER FILES

- ASCE_rccs2.bpf
- Report_ASCE_rccs2.pdf

EXAMPLE 4.3

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- FRP Wrapping
- Existing Material Sets type

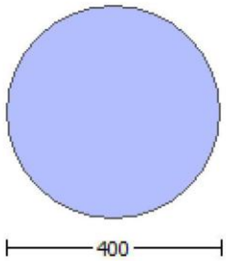
DESCRIPTION

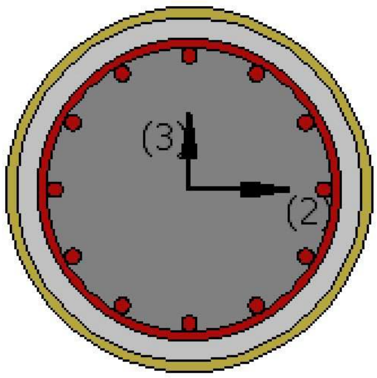
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Primary Member: Concrete Strength, fc = fcm = 24.00
Existing material of Primary Member: Steel Strength, fs = fsm = 525.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 656.25

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 420.00

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.52. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity	Operational Level	End	2	0.0214777	0.0214777
	Life Safety	Start	3	0.0860797	0.0860797
Shear Capacity [kN]	Operational Level	End	2	314.830	314.830

COMPUTER FILES

- ASCE_rccs3.bpf
- Report_ASCE_rccs3.pdf

EXAMPLE 4.4

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- FRP Wrapping
- New Material Sets type

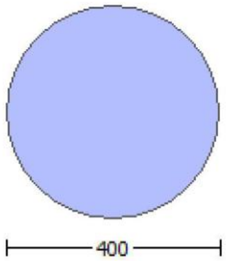
DESCRIPTION

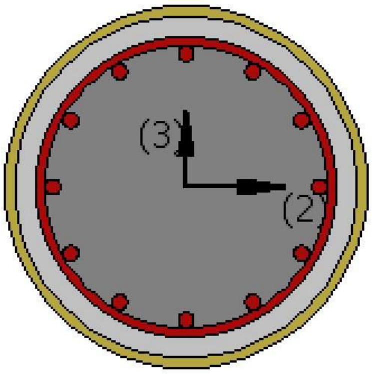
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.90

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

> **NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.**

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.53. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0079786	0.0079786
	Collapse Prevention	Start	3	0.1013397	0.1013397
Shear Capacity [kN]	Immediate Occupancy	End	3	393.301	393.301

COMPUTER FILES

- ASCE_rccs4.bpf
- Report_ASCE_rccs4.pdf

EXAMPLE 4.5

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type

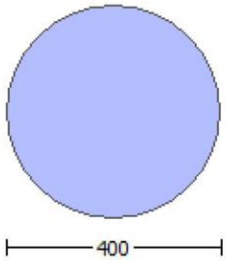
DESCRIPTION

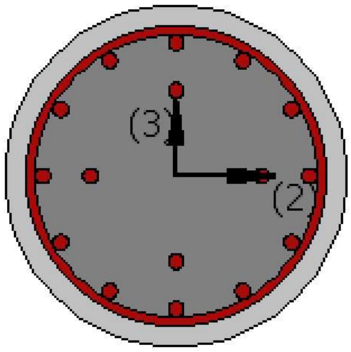
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.54. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	2	0.0073756	0.0073756
	Life Safety	End	3	0.0309451	0.0309451
Shear Capacity [kN]	Life Safety	End	3	323.577	323.577

COMPUTER FILES

- ASCE_rccs5.bpf
- Report_ASCE_rccs5.pdf

EXAMPLE 4.6

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type

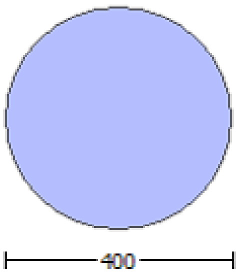
DESCRIPTION

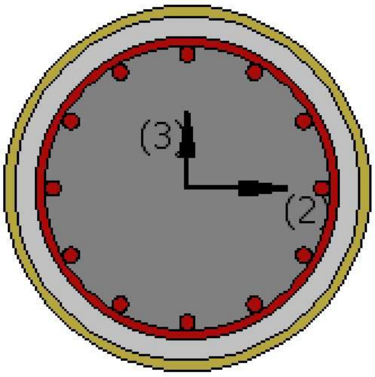
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.55. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0084443	0.0084443
	Collapse Prevention	Start	2	0.0684447	0.0684447
Shear Capacity [kN]	Collapse Prevention	Start	2	330.223	330.223

COMPUTER FILES

- ASCE_rccs6.bpf
- Report_ASCE_rccs6.pdf

EXAMPLE 4.7

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- No FRP Wrapping
- Existing Material Sets type

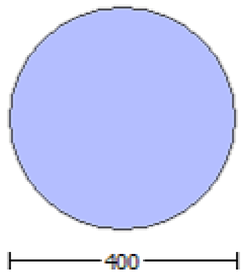
DESCRIPTION

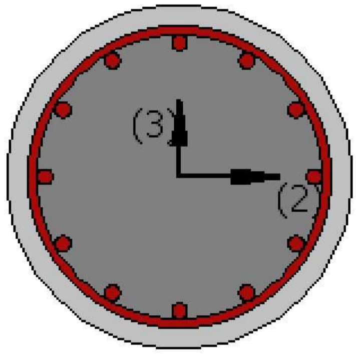
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Knowledge Factor, KF = 0.80

<u>Materials' Properties</u>

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

<u>For Shear Capacity Calculations</u>
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

<u>Member's Properties</u>

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping Data

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.56. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0131418	0.0131418
	Life Safety	End	2	0.0301417	0.0301417
Shear Capacity [kN]	Operational Level	Start	3	207.232	207.232

COMPUTER FILES

- ASCE_rccs7.bpf
- Report_ASCE_rccs7.pdf

EXAMPLE 4.8

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- FRP Wrapping
- Existing Material Sets type

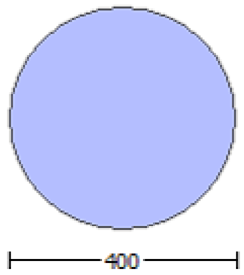
DESCRIPTION

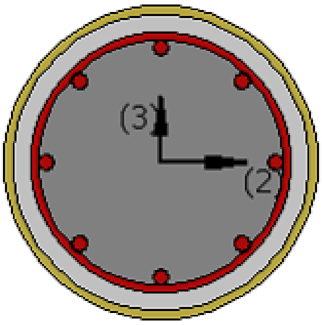
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.80

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.57. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	2	0.008	0.008
	Collapse Prevention	End	3	0.0351100	0.0351100
Shear Capacity [kN]	Immediate Occupancy	Start	2	211.415	211.415

COMPUTER FILES

- ASCE_rccs8.bpf
- Report_ASCE_rccs8.pdf

EXAMPLE 4.9

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type

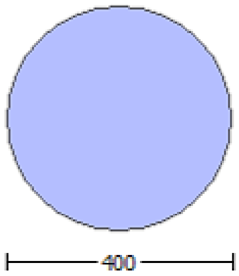
DESCRIPTION

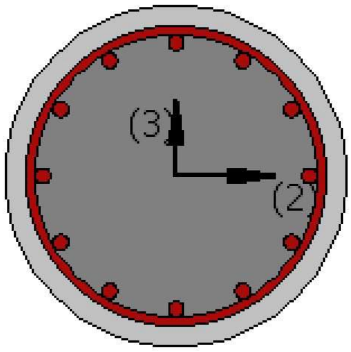
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 24870.062
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Primary Member: Concrete Strength, fc = fcm = 28.00
New material of Primary Member: Steel Strength, fs = fsm = 420.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 525.00

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.58. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4.9

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0010929	0.0010929
	Collapse Prevention	Start	2	0.0467222	0.0467222
Shear Capacity [kN]	Collapse Prevention	Start	2	214.388	214.388

COMPUTER FILES

- ASCE_rccs9.bpf
- Report_ASCE_rccs9.pdf

EXAMPLE 4.10

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- No FRP Wrapping
- New Material Sets type

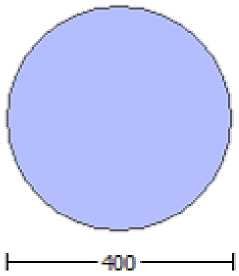
DESCRIPTION

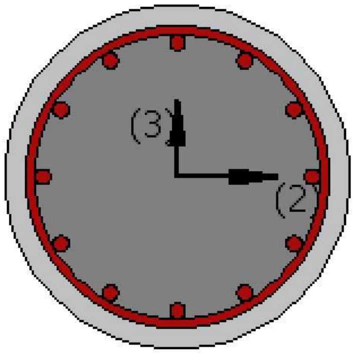
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.75

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.59. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4. 10

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0156324	0.0156324
	Life Safety	End	2	0.0372831	0.0372831
Shear Capacity [kN]	Immediate Occupancy	Start	3	323.561	323.561

COMPUTER FILES

- ASCE_rccs10.bpf
- Report_ASCE_rccs10.pdf

EXAMPLE 4.11

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type

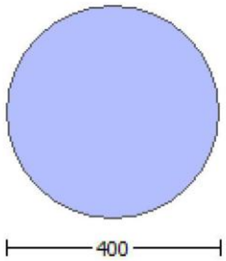
DESCRIPTION

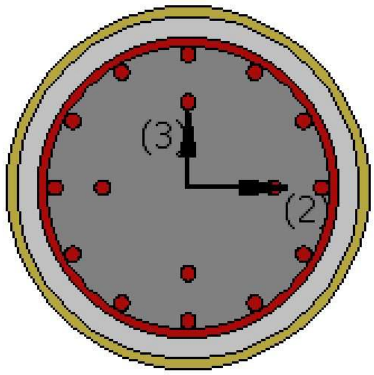
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

> **NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.**

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.60. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4. 11

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0101084	0.0101084
	Life Safety	Start	3	0.0502246	0.0502246
Shear Capacity [kN]	Operationl Level	End	2	393.311	393.311

COMPUTER FILES

- ASCE_rccs11.bpf
- Report_ASCE_rccs11.pdf

EXAMPLE 4.12

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Section
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type

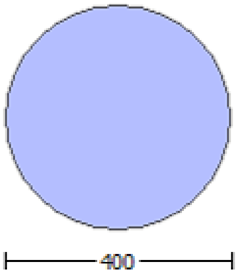
DESCRIPTION

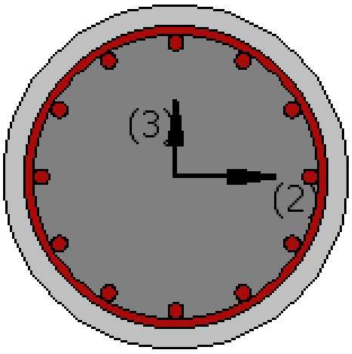
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 24870.062
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Primary Member: Concrete Strength, fc = fcm = 28.00
New material of Primary Member: Steel Strength, fs = fsm = 420.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 525.00

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping Data

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.61. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4. 12

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0164748	0.0164748
	Collapse Prevention	Start	3	0.0828339	0.0828339
Shear Capacity [kN]	Immediate Occupancy	End	2	270.862	270.862

COMPUTER FILES

- ASCE_rccs12.bpf
- Report_ASCE_rccs12.pdf

EXAMPLE 4.13

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- Existing Material Sets type

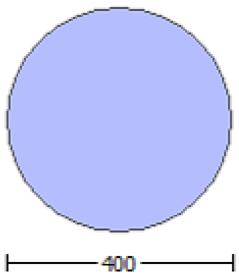
DESCRIPTION

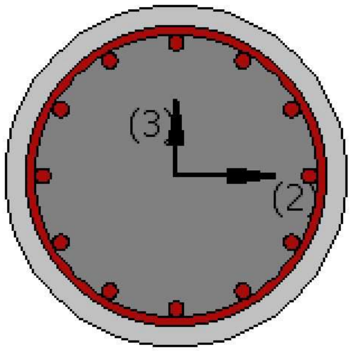
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.86

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Section
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.62. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4. 13

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0285949	0.0285949
	Life Safety	Start	2	0.0430952	0.0430952
Shear Capacity [kN]	Life Safety	Start	2	91.016	91.016

COMPUTER FILES

- ASCE_rccs13.bpf
- Report_ASCE_rccs13.pdf

EXAMPLE 4.14

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- FRP Wrapping
- Existing Material Sets type

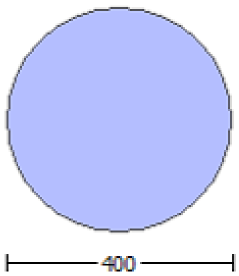
DESCRIPTION

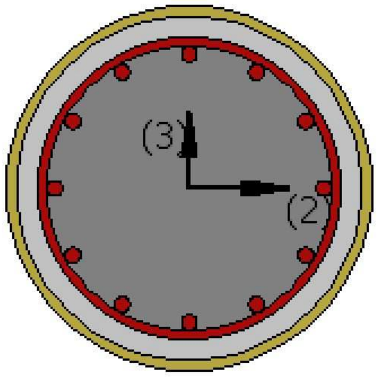
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.63. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4. 14

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0018634	0.0018634
	Collapse Prevention	End	2	0.0513173	0.0513173
Shear Capacity [kN]	Immediate Occupancy	End	3	286.337	286.337

COMPUTER FILES

- ASCE_rccs14.bpf
- Report_ASCE_rccs14.pdf

EXAMPLE 4.15

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type

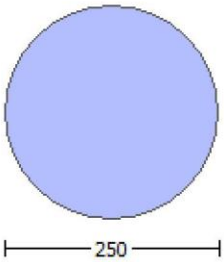
DESCRIPTION

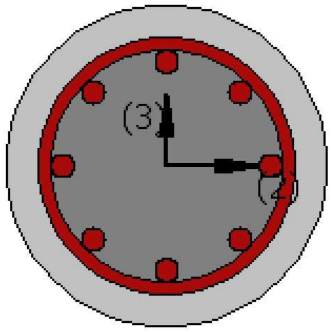
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 100

Materials' Properties

Concrete Elasticity, Ec = 18203.022
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Primary Member: Concrete Strength, fc = fcm = 15.00
New material of Primary Member: Steel Strength, fs = fsm = 420.0
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 525.00

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 10.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.0

Member's Properties

Diameter, D = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Section
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.64. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4. 15

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Collapse Prevention	Start	3	0.0711117	0.0711117
	Immediate Occupation	End	2	0.0177781	0.0177781
Shear Capacity [kN]	Collapse Prevention	Start	3	270.862	270.862

COMPUTER FILES

- ASCE_rccs15.bpf
- Report_ASCE_rccs15.pdf

EXAMPLE 4.16

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type

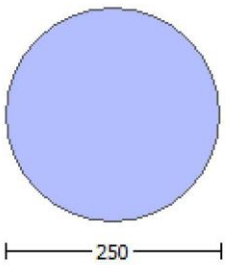
DESCRIPTION

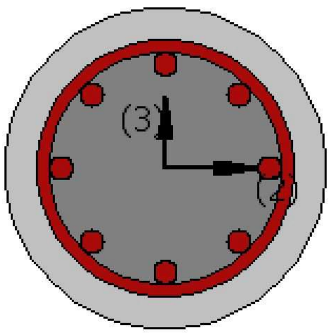
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 100

Materials' Properties

Concrete Elasticity, Ec = 18203.022
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations
New material of Primary Member: Concrete Strength, fc = fcm = 15.00
New material of Primary Member: Steel Strength, fs = fsm = 420.0
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 525.00

For Shear Capacity Calculations
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 10.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.0

Member's Properties

Diameter, D = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Section
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.65. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4. 16

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Collapse Prevention	Start	3	0.0962133	0.0962133
	Immediate Occupation	End	2	0.0213033	0.0213033
Shear Capacity [kN]	Collapse Prevention	Start	3	146.498	146.498

COMPUTER FILES

- ASCE_rccs16.bpf
- Report_ASCE_rccs16.pdf

EXAMPLES SET 5: WALL SECTION

EXAMPLE 5.1

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- Existing Material Sets type

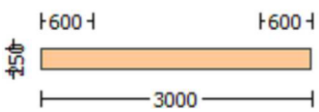
DESCRIPTION

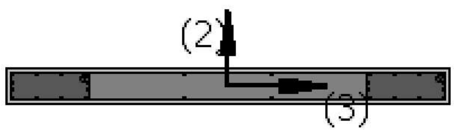
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
New material of Primary Member: Concrete Strength, fc = fcm = 20.00
New material of Primary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.56

<u>For Shear Capacity Calculations</u>:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

<u>Member's Properties</u>

Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The wall member is modeled through an inelastic force-based frame element (infrmFB) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.66. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0038582	0.0038582
	Life Safety Considering wall controlled by Shear. Final interstorey drift Capacity: δu,R	Start	2	0.015	0.015
Shear Capacity [kN]	Life Safety	Start	2	166.860	166.860

COMPUTER FILES

- ASCE_rcrws1.bpf
- Report_ASCE_rcrws1.pdf

EXAMPLE 5.2

SUCCINCT DATA

- Primary Member
- SmoothBars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- Existing Material Sets type

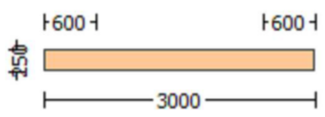
DESCRIPTION

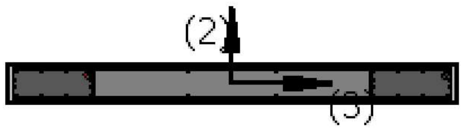
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.90

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material of Primary Member: Concrete Strength, fc = fcm = 20.00
New material of Primary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.56

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The wall member is modeled through an inelastic force-based frame element (infrmFB) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.67. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0027463	0.0027463
	Collapse Prevention	End	2	0.0149043	0.0149043
Shear Capacity [kN]	Immediate Occupancy	Start	3	1792.800	1792.800

COMPUTER FILES

- ASCE_rcrws2.bpf
- Report_ASCE_rcrws2.pdf

EXAMPLE 5.3

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- FRP Wrapping
- Existing Material Sets type

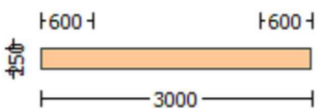
DESCRIPTION

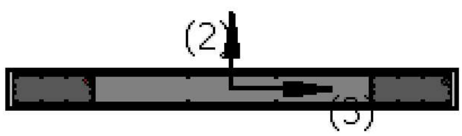
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Confidence Factor, Cf = 1.00

Materials' Properties

Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material of Primary Member: Concrete Strength, fc = fcm = 16.00
Existing material of Primary Member: Steel Strength, fs = fsm = 420.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 525.00

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 420.00

Member's Properties

Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The wall member is modeled through an inelastic force-based frame element (infrmFB) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.68. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level Considering wall controlled by Shear. Final interstorey drift Capacity: δu,R	End	2	0.004	0.004
	Life Safety	Start	3	0.0097905	0.0097905
Shear Capacity [kN]	Life Safety	Start	3	1992.0	1992.0

COMPUTER FILES

- ASCE_rcrws3.bpf
- Report_ASCE_rcrws3.pdf

EXAMPLE 5.4

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars Straight Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- FRP Wrapping
- New Material Sets type

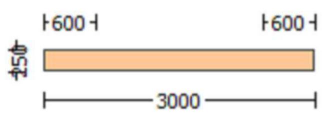
DESCRIPTION

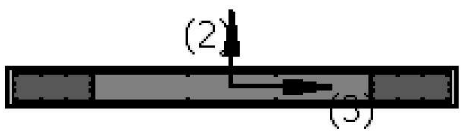
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.85

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material of Primary Member: Concrete Strength, fc = fcm = 25.00
Existing material of Primary Member: Steel Strength, fs = fsm = 500.00
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 625.00

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The wall member is modeled through an inelastic force-based frame element (infrmFB) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.69. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0038354	0.0038354
	Collapse Prevention	Start	3	0.0168349	0.0168349
Shear Capacity [kN]	Immediate Occupancy	End	3	2.490	2.490

COMPUTER FILES

- ASCE_rcrws4.bpf
- Report_ASCE_rcrws4.pdf

EXAMPLE 5.5

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type

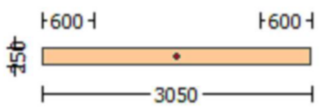
DESCRIPTION

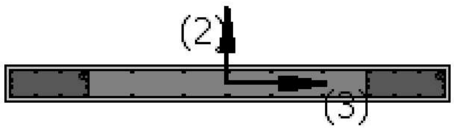
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material of Primary Member: Concrete Strength, fc = fcm = 33.00
Existing material of Primary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The wall member is modeled through an inelastic force-based frame element (infrmFB) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.70. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	2	0.0044627	0.0044627
	Life Safety	End	3	0.0089294	0.0089294
Shear Capacity [kN]	Operational Level	Start	2	508.053	508.053

COMPUTER FILES

- ASCE_rcrws5.bpf
- Report_ASCE_rcrws5.pdf

EXAMPLE 5.6

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars Without Lapping in the Vicinity of the End Regions
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type

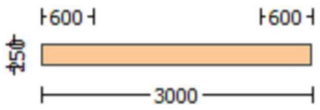
DESCRIPTION

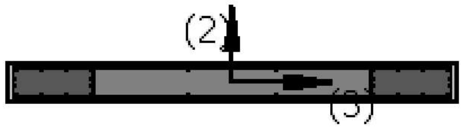
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material of Primary Member: Concrete Strength, fc = fcm = 25.00
Existing material of Primary Member: Steel Strength, fs = fsm = 500.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 625.00

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The wall member is modeled through an inelastic force-based frame element (infrmFB) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.71. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0045470	0.0045470
	Collapse Prevention	Start	2	0.0165474	0.0165474
Shear Capacity [kN]	Immediate Occupancy	End	2	601.130	601.130

COMPUTER FILES

- ASCE_rcrws6.bpf
- Report_ASCE_rcrws6.pdf

EXAMPLE 5.7

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- No FRP Wrapping
- Existing Material Sets type

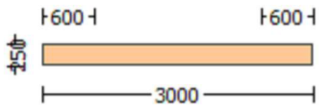
DESCRIPTION

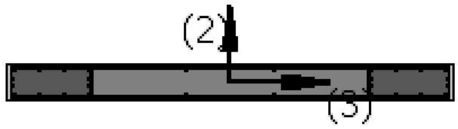
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material of Primary Member: Concrete Strength, fc = fcm = 16.00
Existing material of Primary Member: Steel Strength, fs = fsm = 400.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 500.00

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The wall member is modeled through an inelastic force-based frame element (infrmFB) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.72. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0030522	0.0030522
	Life Safety Considering wall controlled by Shear. Final interstorey drift Capacity: δu,R	End	2	0.015	0.015
Shear Capacity [kN]	Operational Level	Start	3	1467.9	1467.84

NOTE: The small difference between the Shear Capacity obtained from the Hand Calculations and SeismoBuild is due to the rounding of the shear capacity value exported to the Report.

COMPUTER FILES

- ASCE_rcrws7.bpf
- Report_ASCE_rcrws7.pdf

EXAMPLE 5.8

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- FRP Wrapping
- Existing Material Sets type

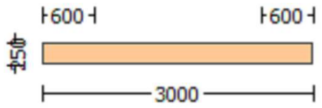
DESCRIPTION

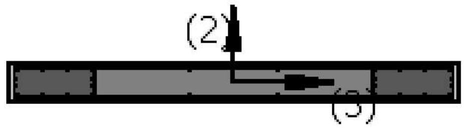
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.85

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material of Primary Member: Concrete Strength, fc = fcm = 16.00
Existing material of Primary Member: Steel Strength, fs = fsm = 400.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 500.00

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1

Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The wall member is modeled through an inelastic force-based frame element (infrmFB) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.73. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0027713	0.0027713
	Collapse Prevention	Start	3	0.0138210	0.0138210
Shear Capacity [kN]	Collapse Prevention	End	3	1693.2	1693.2

COMPUTER FILES

- ASCE_rcrws8.bpf
- Report_ASCE_rcrws8.pdf

EXAMPLE 5.9

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type

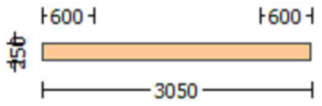
DESCRIPTION

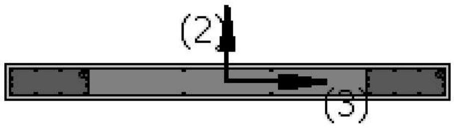
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material of Primary Member: Concrete Strength, fc = fcm = 30.00
Existing material of Primary Member: Steel Strength, fs = fsm = 625.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The wall member is modeled through an inelastic force-based frame element (infrmFB) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.74. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.9

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0027673	0.0027673
	Collapse Prevention	Start	2	0.0154053	0.0154053
Shear Capacity [kN]	Collapse Prevention	Start	2	242.034	242.034

COMPUTER FILES

- ASCE_rcrws9.bpf
- Report_ASCE_rcrws9.pdf

EXAMPLE 5.10

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type

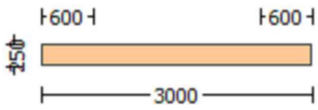
DESCRIPTION

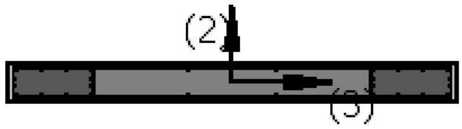
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.90

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material of Primary Member: Concrete Strength, fc = fcm = 25.00
Existing material of Primary Member: Steel Strength, fs = fsm = 500.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 625.00

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1

Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The wall member is modeled through an inelastic force-based frame element (infrmFB) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.75. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.10

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0030365	0.0030365
	Life Safety	End	2	0.0085470	0.0085470
Shear Capacity [kN]	Immediate Occupancy	Start	3	2490.0	2490.0

COMPUTER FILES

- ASCE_rcrws10.bpf
- Report_ASCE_rcrws10.pdf

EXAMPLE 5.11

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type

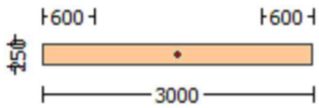
DESCRIPTION

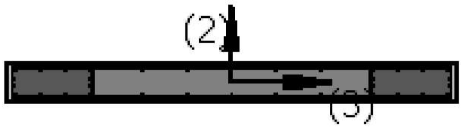
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material of Primary Member: Concrete Strength, fc = fcm = 33.00
Existing material of Primary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1

Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The wall member is modeled through an inelastic force-based frame element (infrmFB) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.76. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.11

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0025917	0.0025917
	Life Safety	Start	3	0.0091870	0.0091870
Shear Capacity [kN]	Operational Level	End	2	385.904	385.903

NOTE: The small difference between the Shear Capacity obtained from the Hand Calculations and SeismoBuild is due to the rounding of the shear capacity value exported to the Report.

COMPUTER FILES

- ASCE_rcrws11.bpf
- Report_ASCE_rcrws11.pdf

EXAMPLE 5.12

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type

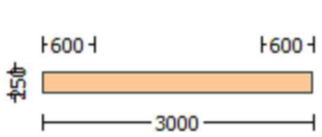
DESCRIPTION

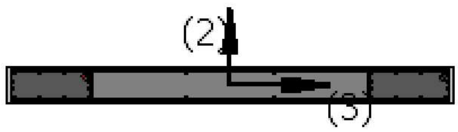
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material of Primary Member: Concrete Strength, fc = fcm = 30.00
Existing material of Primary Member: Steel Strength, fs = fsm = 625.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping Data

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The wall member is modeled through an inelastic force-based frame element (infrmFB) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.77. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.12

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy Considering wall controlled by Shear. Final interstorey drift Capacity: δu,R	End	2	0.004	0.004
	Collapse Prevetion	Start	3	0.0169179	0.0169179
Shear Capacity [kN]	Immediate Occupancy	End	2	242.595	242.595

COMPUTER FILES

- ASCE_rcrws12.bpf
- Report_ASCE_rcrws12.pdf

EXAMPLE 5.13

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- Existing Material Sets type

DESCRIPTION

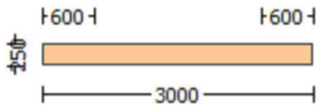
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

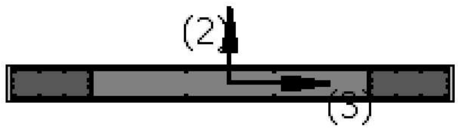
The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The

employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.85

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material of Primary Member: Concrete Strength, fc = fcm = 16.00
Existing material of Primary Member: Steel Strength, fs = fsm = 400.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 500.00

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The wall member is modeled through an inelastic force-based frame element (infrmFB) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.78. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.13

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0032804	0.0032804
	Life Safety Considering wall controlled by Shear. Final interstorey drift Capacity: δu,R	Start	2	0.015	0.015
Shear Capacity [kN]	Life Safety	Start	2	177.167	177.167

COMPUTER FILES

- ASCE_rcrws13.bpf
- Report_ASCE_rcrws13.pdf

EXAMPLE 5.14

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- FRP Wrapping
- Existing Material Sets type

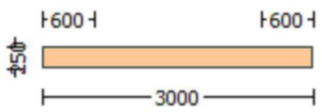
DESCRIPTION

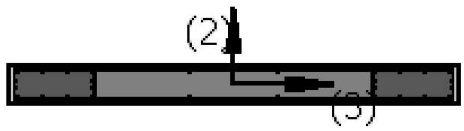
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material of Primary Member: Concrete Strength, fc = fcm = 16.00
Existing material of Primary Member: Steel Strength, fs = fsm = 400.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 500.00

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1

Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The wall member is modeled through an inelastic force-based frame element (infrmFB) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.79. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.14

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0032597	0.0032597
	Collapse Prevention Considering wall controlled by Shear. Final interstorey drift Capacity: δu,R	End	2	0.02	0.02
Shear Capacity [kN]	Immediate Occupancy	End	3	314.648	314.648

COMPUTER FILES

- ASCE_rcrws14.bpf
- Report_ASCE_rcrws14.pdf

EXAMPLES SET 6: BEAM SECTION

EXAMPLE 6.1

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- With detailing for earthquake resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- Existing Material Sets type

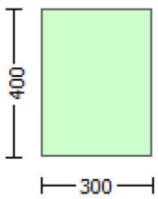
DESCRIPTION

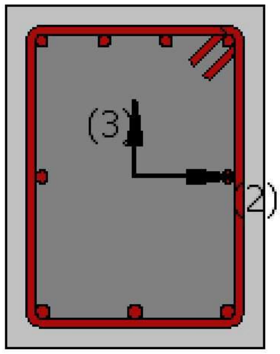
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Section Height, H = 400.00
Section Width, W = 300.00
Cover Thickness, c = 25.00
Element Length, L = 1850.00
Primary Member
Ribbed Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.80. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0087273	0.0087273
	Life Safety	Start	2	0.0254565	0.0254565
Shear Capacity [kN]	Life Safety	Start	2	136.838	136.838

COMPUTER FILES

- ASCE_Beam1.bpf
- Report_ASCE_Beam1.pdf

EXAMPLE 6.2

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- No FRP Wrapping
- Existing Material Sets type

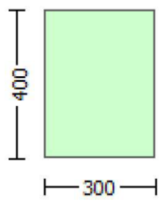
DESCRIPTION

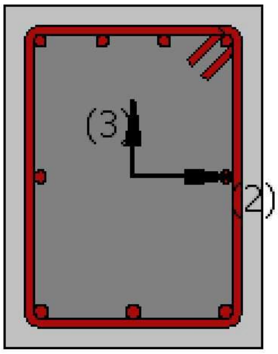
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.85

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Section Height, H = 400.00
Section Width, W = 300.00
Cover Thickness, c = 25.00
Element Length, L = 1750.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.81. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0060259	0.0060259
	Collapse Prevention	End	2	0.0265346	0.0265346
Shear Capacity [kN]	Immediate Occupancy	Start	3	167.462	167.462

COMPUTER FILES

- ASCE_Beam2.bpf
- Report_ASCE_Beam2.pdf

EXAMPLE 6.3

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- Existing Material Sets type

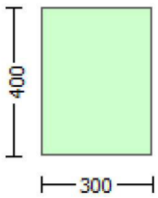
DESCRIPTION

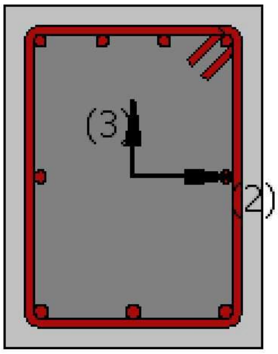
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material of Primary Member: Concrete Strength, fc = fcm = 24.00
Existing material of Primary Member: Steel Strength, fs = fsm = 525.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 656.25

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 420.00

Member's Properties

Section Height, H = 400.00
Section Width, W = 300.00
Cover Thickness, c = 25.00
Element Length, L = 1850.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

> **NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.**

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.82. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0073382	0.0073382
	Life Safety	Start	3	0.0240430	0.0240430
Shear Capacity [kN]	Life Safety	Start	3	203.706	203.706

COMPUTER FILES

- ASCE_Beam3.bpf
- Report_ASCE_Beam3.pdf

EXAMPLE 6.4

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type

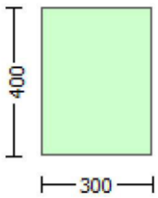
DESCRIPTION

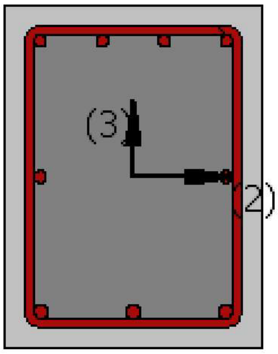
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.90

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Section Height, H = 400.00
Section Width, W = 300.00
Cover Thickness, c = 25.00
Element Length, L = 1850.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.83. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0086865	0.0086865
	Collapse Prevention	Start	3	0.0336862	0.0336862
Shear Capacity [kN]	Collapse Prevention	Start	3	245.858	245.858

COMPUTER FILES

- ASCE_Beam4.bpf
- Report_ASCE_Beam4.pdf

EXAMPLE 6.5

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo=300.00
- No FRP Wrapping
- New Material Sets type

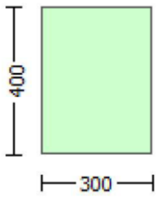
DESCRIPTION

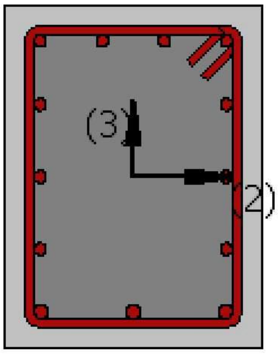
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Section Height, H = 400.00
Section Width, W = 300.00
Cover Thickness, c = 25.00
Element Length, L = 1850.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo=300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.84. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	2	0.0082791	0.0082791
	Life Safety	End	3	0.0225644	0.0225644
Shear Capacity [kN]	Life Safety	End	3	251.384	251.384

COMPUTER FILES

- ASCE_Beam5.bpf
- Report_ASCE_Beam5.pdf

EXAMPLE 6.6

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min=0.30
- No FRP Wrapping
- New Material Sets type

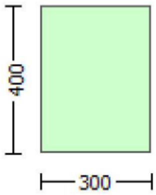
DESCRIPTION

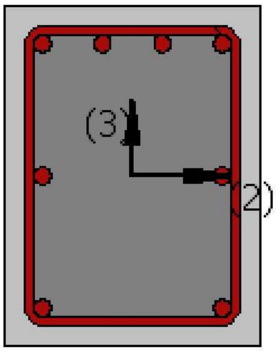
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Section Height, H = 400.00
Section Width, W = 300.00
Cover Thickness, c = 25.00
Element Length, L = 1892.749
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min=0.30
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.85. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0063250	0.0063250
	Collapse Prevention	Start	2	0.0324517	0.0324517
Shear Capacity [kN]	Collapse Prevention	Start	2	171.048	171.048

COMPUTER FILES

- ASCE_Beam6.bpf
- Report_ASCE_Beam6.pdf

EXAMPLE 6.7

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars Straight Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min=0.30
- No FRP Wrapping
- Existing Material Sets type

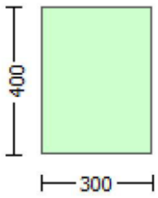
DESCRIPTION

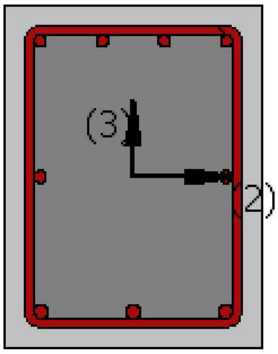
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Section Height, H = 400.00
Section Width, W = 300.00
Cover Thickness, c = 25.00
Element Length, L = 1850.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min=0.30
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.86. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0071211	0.0071211
	Life Safety	End	2	0.0205894	0.0205894
Shear Capacity [kN]	Operational Level	Start	3	196.446	196.446

COMPUTER FILES

- ASCE_Beam7.bpf
- Report_ASCE_Beam7.pdf

EXAMPLE 6.8

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- Existing Material Sets type

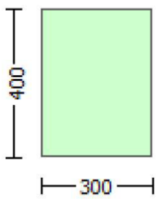
DESCRIPTION

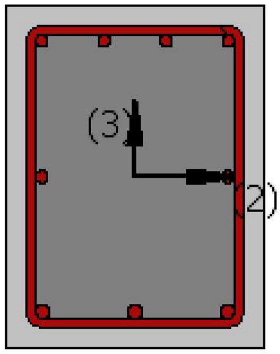
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.86

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Section Height, H = 400.00
Section Width, W = 300.00
Cover Thickness, c = 25.00
Element Length, L = 1850.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.87. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	2	0.0070961	0.0070961
	Collapse Prevention	End	3	0.0282576	0.0282576
Shear Capacity [kN]	Immediate Occupancy	Start	2	117.681	117.681

COMPUTER FILES

- ASCE_Beam8.bpf
- Report_ASCE_Beam8.pdf

EXAMPLE 6.9

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type

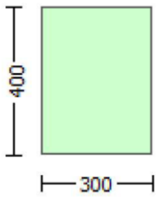
DESCRIPTION

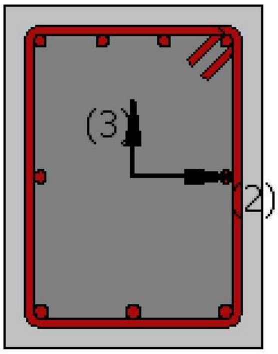
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF =1.00

Materials' Properties

Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material of Primary Member: Concrete Strength, fc = fcm = 30.00
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Section Height, H = 400.00
Section Width, W = 300.00
Cover Thickness, c = 25.00
Element Length, L = 1850.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.88. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.9

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0069017	0.0069017
	Collapse Prevention	Start	2	0.0323829	0.0323829
Shear Capacity [kN]	Collapse Prevention	Start	2	162.940	162.940

COMPUTER FILES

- ASCE_Beam9.bpf
- Report_ASCE_Beam9.pdf

EXAMPLE 6.10

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min=0.30
- No FRP Wrapping
- New Material Sets type

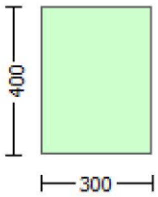
DESCRIPTION

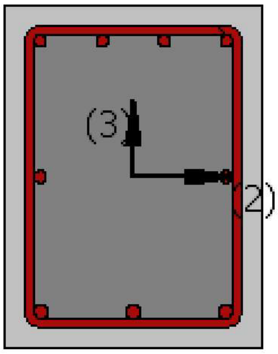
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.90

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Section Height, H = 400.00
Section Width, W = 300.00
Cover Thickness, c = 25.00
Element Length, L =1850.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min=0.30
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.89. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.10

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0070659	0.0070659
	Life Safety	End	2	0.0212687	0.0212687
Shear Capacity [kN]	Life Safety	End	2	171.048	171.048

COMPUTER FILES

- ASCE_Beam10.bpf
- Report_ASCE_Beam10.pdf

EXAMPLE 6.11

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- No FRP Wrapping
- New Material Sets type

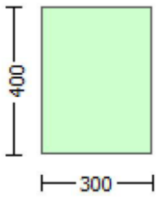
DESCRIPTION

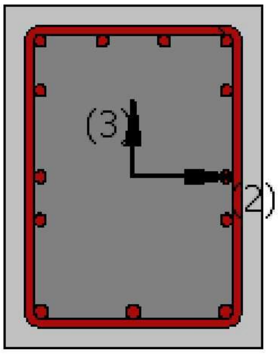
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Section Height, H = 400.00
Section Width, W = 300.00
Cover Thickness, c = 25.00
Element Length, L = 1850.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.90. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.11

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0069238	0.0069238
	Life Safety	Start	3	0.0229500	0.0229500
Shear Capacity [kN]	Operational Level	End	2	171.048	171.048

COMPUTER FILES

- ASCE_Beam11.bpf
- Report_ASCE_Beam11.pdf

EXAMPLE 6.12

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length(lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type

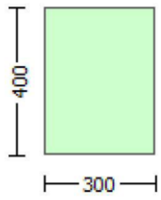
DESCRIPTION

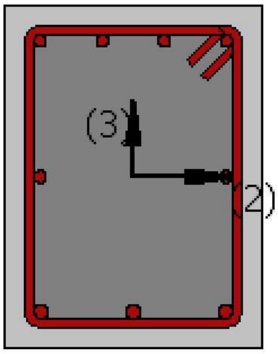
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material of Primary Member: Concrete Strength, fc = fcm = 30.00
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Section Height, H = 40.00
Section Width, W = 300.00
Cover Thickness, c = 25.00
Element Length, L = 1850.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.91. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.12

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0076696	0.0076696
	Collapse Prevention	Start	3	0.0343357	0.0343357
Shear Capacity [kN]	Immediate Occupancy	End	2	162.940	162.940

COMPUTER FILES

- ASCE_Beam12.bpf
- Report_ASCE_Beam12.pdf

EXAMPLE 6.13

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- Existing Material Sets type

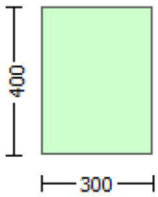
DESCRIPTION

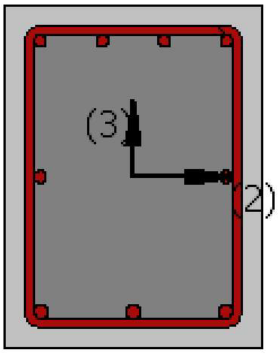
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Knowledge Factor, KF = 0.75

<u>Materials' Properties</u>

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

<u>For Shear Capacity Calculations</u>:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

<u>Member's Properties</u>

Section Height, H = 400.00
Section Width, W = 300.00
Cover Thickness, c = 25.00
Element Length, L = 1850.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.92. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.13

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0065458	0.0065458
	Life Safety	Start	2	0.0182008	0.0182008
Shear Capacity [kN]	Life Safety	Start	2	102.629	102.629

COMPUTER FILES

- ASCE_Beam13.bpf
- Report_ASCE_Beam13.pdf

EXAMPLE 6.14

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- Existing Material Sets type

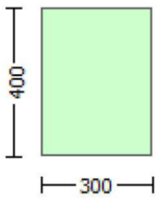
DESCRIPTION

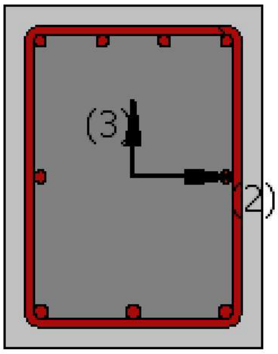
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Note: Especially for the calculation of moment strengths, the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations:
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Section Height, H = 400.00
Section Width, W = 300.00
Cover Thickness, c = 25.00
Element Length, L = 1850.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.93. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.14

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0078447	0.0078447
	Collapse Prevention	End	2	0.0318630	0.0318630
Shear Capacity [kN]	Immediate Occupancy	End	3	200.646	200.646

COMPUTER FILES

- ASCE_Beam14.bpf
- Report_ASCE_Beam14.pdf

EXAMPLES SET 7: JACKETED RECTANGULAR COLUMN SECTION

EXAMPLE 7.1

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping Data
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

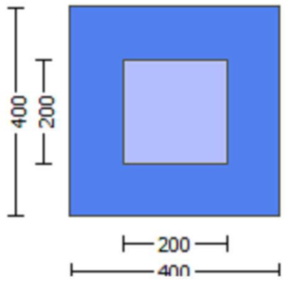
DESCRIPTION

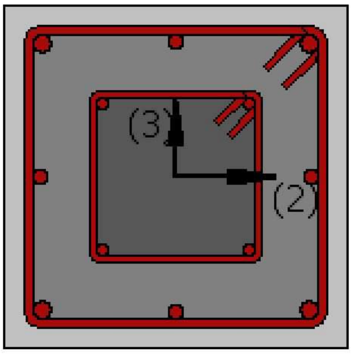
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.5556
New material: Steel Strength, fs = 1.25*fsm = 694.4444

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.4444
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556

For Shear Capacity Calculations:
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

External Height, H = 400.00
External Width, W = 00.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.94. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0056647	0.0056647
	Life Safety	Start	2	0.0395104	0.0395104
Shear Capacity [kN]	Operational Level	End	3	404.607	404.607

COMPUTER FILES

- ASCE_rcjrs1.bpf
- Report_ASCE_rcjrs1.pdf

EXAMPLE 7.2

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lb/lb,min = 0.30
- FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

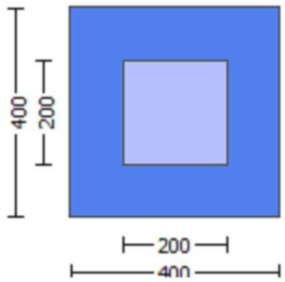
DESCRIPTION

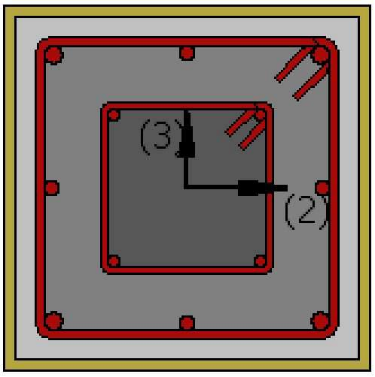
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.85

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.5556
New material: Steel Strength, fs = 1.25*fsm = 694.4444

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.4444
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556

For Shear Capacity Calculations:
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/lb,min = 0.30
FRP Wrapping Data

Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.95. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0060404	0.0060404
	Collapse Prevention	End	2	0.0540193	0.0540193
Shear Capacity [kN]	Immediate Occupancy	Start	3	475.023	475.023

COMPUTER FILES

- ASCE_rcjrs2.bpf
- Report_ASCE_rcjrs2.pdf

EXAMPLE 7.3

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1
- FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

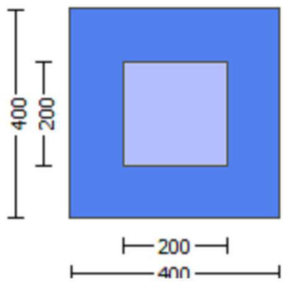
DESCRIPTION

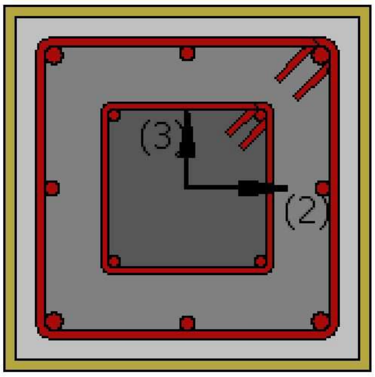
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 28781.504
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 37.50
Existing material: Steel Strength, fs = fsm = 625.00
Existing material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00

Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.964. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0125496	0.0125496
	Life Safety	Start	3	0.0521093	0.0521093
Shear Capacity [kN]	Operational Level	End	2	540.153	540.153

COMPUTER FILES

- ASCE_rcjrs3.bpf
- Report_ASCE_rcjrs3.pdf

EXAMPLE 7.4

SUCCINCT DATA

- Secondary Member

- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing column

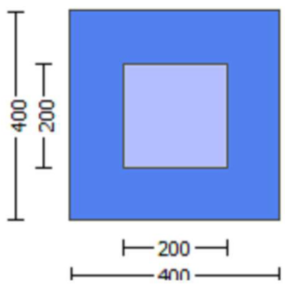
DESCRIPTION

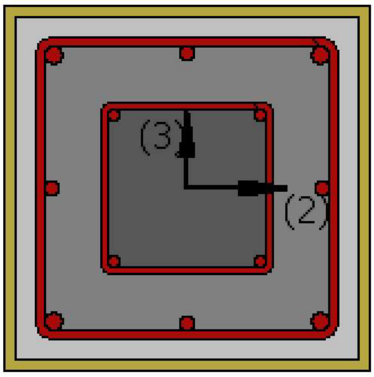
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Knowledge Factor, KF = 0.80

<u>Materials' Properties</u>

<u>Jacket:</u>
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45
<u>Existing Column:</u>
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

<u>For Shear Capacity Calculations</u>:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 555.56
Existing material: Steel Strength, fs = 1.25*fsm =694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.97. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0063065	0.0063065
	Collapse Prevention	Start	3	0.0635230	0.0635230

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Shear Capacity [kN]	Immediate Occupancy	End	3	585.778	585.778

COMPUTER FILES

- ASCE_rcjrs4.bpf
- Report_ASCE_rcjrs4.pdf

EXAMPLE 7.5

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing column

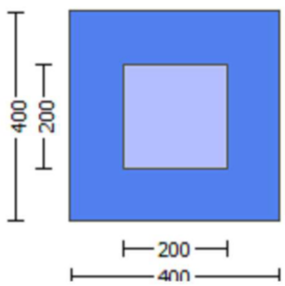
DESCRIPTION

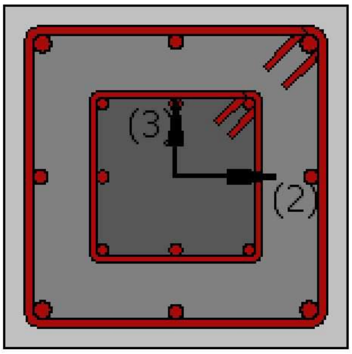
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 555.56
Existing material: Steel Strength, fs = 1.25*fsm =694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.98. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	2	0.0036391	0.0036391
	Life Safety	Start	3	0.0356083	0.0356083

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Shear Capacity [kN]	Operational Level	Start	2	331.644	331.644

COMPUTER FILES

- ASCE_rcjrs5.bpf
- Report_ASCE_rcjrs5.pdf

EXAMPLE 7.6

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing column

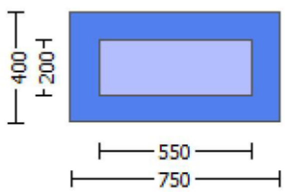
DESCRIPTION

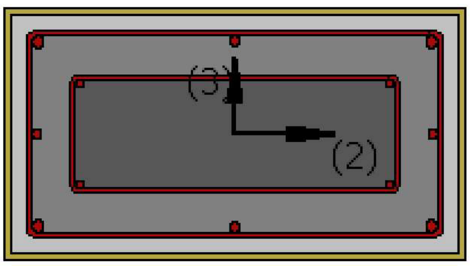
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Knowledge Factor, KF = 1.00

<u>Materials' Properties</u>

<u>Jacket:</u>
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 555.56
Existing material: Steel Strength, fs = 1.25*fsm =694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.99. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0020344	0.0020344
	Collapse Prevention	Start	2	0.0349543	0.0349543
Shear Capacity [kN]	Collapse Prevention	Start	2	948.849	948.849

COMPUTER FILES

- ASCE_rcjrs6.bpf
- Report_ASCE_rcjrs6.pdf

EXAMPLE 7.7

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 13
- Longitudinal Bars Straight Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

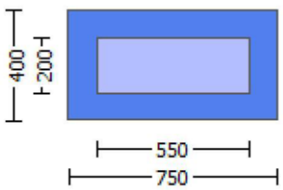
DESCRIPTION

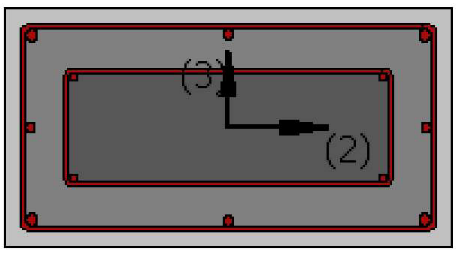
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
Existing material: Steel Strength, fs = 1.25*fsm =555.55

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.100. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0026471	0.0026471
	Life Safety	End	2	0.0179060	0.0179060
Shear Capacity [kN]	Operational Level	Start	3	534.028	534.028

COMPUTER FILES

- ASCE_rcjrs7.bpf
- Report_ASCE_rcjrs7.pdf

EXAMPLE 7.8

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- FRP Wrapping Data
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

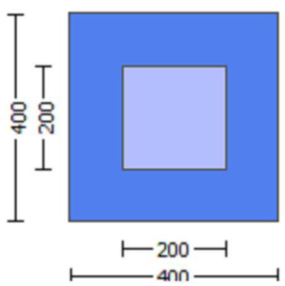
DESCRIPTION

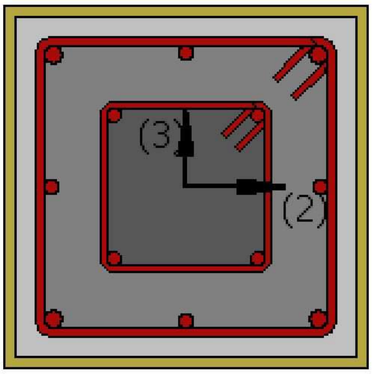
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Knowledge Factor, KF = 0.80

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
Existing material: Steel Strength, fs = 1.25*fsm =555.55

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.101. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	2	0.0033230	0.0033230
	Collapse Prevention	End	3	0.0342643	0.0342643
Shear Capacity [kN]	Immediate Occupancy	Start	2	385.806	385.806

COMPUTER FILES

- ASCE_rcjrs8.bpf
- Report_ASCE_rcjrs8.pdf

EXAMPLE 7.9

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing column

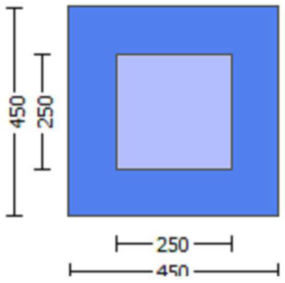
DESCRIPTION

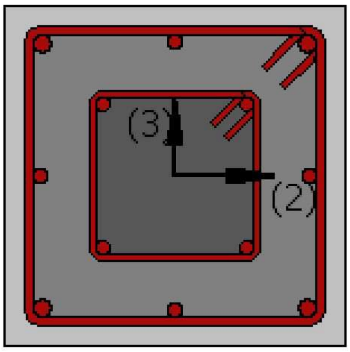
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 30.00
Existing material: Steel Strength, fs = fsm = 625.00
Existing material: Steel Strength, fs = 1.25*fsm =781.25

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.102. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.9

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0004530	0.0004530
	Collapse Prevention	Start	2	0.0382066	0.0382066
Shear Capacity [kN]	Operational Level	End	3	464.717	464.717

COMPUTER FILES

- ASCE_rcjrs9.bpf
- Report_ASCE_rcjrs9.pdf

EXAMPLE 7.10

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing column

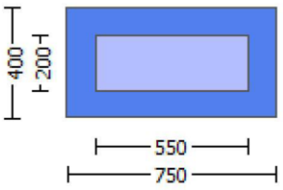
DESCRIPTION

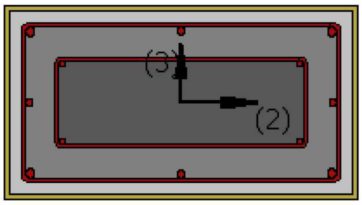
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.90

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 555.56
Existing material: Steel Strength, fs = 1.25*fsm =694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)

Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.103. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.10

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.002706	0.002706
	Life Safety	End	2	0.0274056	0.0274056
Shear Capacity [kN]	Immediate Occupancy	Start	3	776.632	776.632

COMPUTER FILES

- ASCE_rcjrs10.bpf
- Report_ASCE_rcjrs10.pdf

EXAMPLE 7.11

SUCCINCT DATA

- Secondary Member
- SmoothBars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

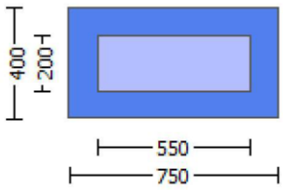
DESCRIPTION

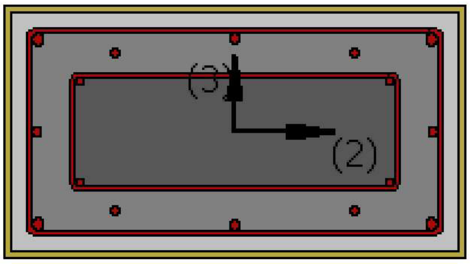
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 555.56
Existing material: Steel Strength, fs = 1.25*fsm =694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member

Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.104. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.11

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0024982	0.0024982
	Life Safety	Start	3	0.0332822	0.0332822
Shear Capacity [kN]	Operational Level	End	2	1100.268	1100.300

COMPUTER FILES

- ASCE_rcjrs11.bpf
- Report_ASCE_rcjrs11.pdf

EXAMPLE 7.12

SUCCINCT DATA

- Primary Member
- SmoothBars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections

- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing column

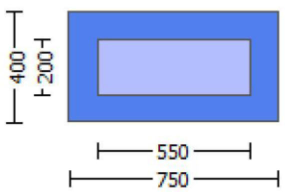
DESCRIPTION

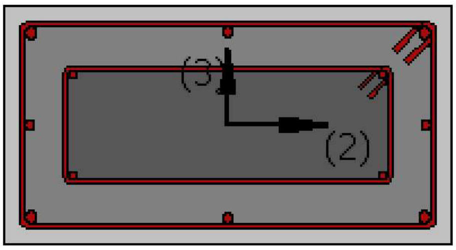
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>**Units in N, mm**</u>

Knowledge Factor, KF = 1.00

<u>**Materials' Properties**</u>

<u>Jacket:</u>
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

<u>For Shear Capacity Calculations</u>:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

<u>Existing Column:</u>
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
Existing material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 555.56
Existing material: Steel Strength, fs = 1.25*fsm =694.45

<u>For Shear Capacity Calculations</u>:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.105. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.12

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0081964	0.0081964
	Collapse Prevention	Start	3	0.0508905	0.0508905
Shear Capacity [kN]	Collapse Prevention	Start	3	554.150	554.150

COMPUTER FILES

- ASCE_rcjrs12.bpf
- Report_ASCE_rcjrs12.pdf

EXAMPLE 7.13

SUCCINCT DATA

- Secondary Member
- SmoothBars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars Without Lapping in the Vicinity of the End Regions
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping

- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

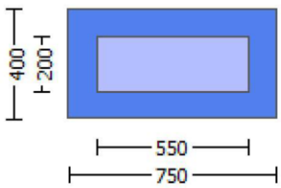
DESCRIPTION

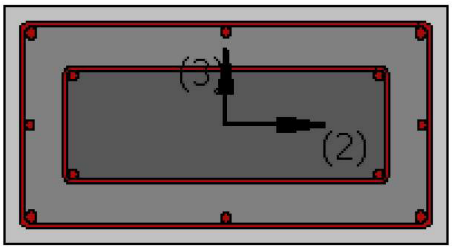
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.85

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 24.00
Existing material: Steel Strength, fs = fsm = 500.00
Existing material: Steel Strength, fs = 1.25*fsm =625.00

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

External Height, H = 400.00
External Width, W = 750.00

Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.106. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.13

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0082194	0.0082194
	Life Safety	Start	2	0.0279051	0.0279051
Shear Capacity [kN]	Life Safety	Start	2	571.862	571.862

COMPUTER FILES

- ASCE_rcjrs13.bpf
- Report_ASCE_rcjrs13.pdf

EXAMPLE 7.14

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

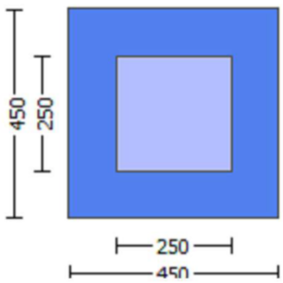
DESCRIPTION

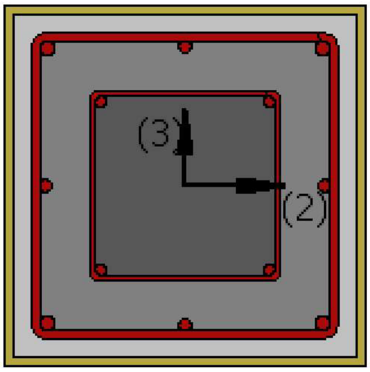
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.85

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
Existing material: Steel Strength, fs = 1.25*fsm =555.55

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

External Height, H = 450.00
External Width, W = 450.00
Internal Height, H = 250.00

Internal Width, W = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.107. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.14

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0005525	0.0005525
	Collapse Prevention	End	2	0.0355864	0.0355864
Shear Capacity [kN]	Immediate Occupancy	End	3	594.192	594.192

COMPUTER FILES

- ASCE_rcjrs14.bpf
- Report_ASCE_rcjrs14.pdf

EXAMPLE 7.15

SUCCINCT DATA

- Secondary Member
- SmoothBars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped in the Vicinity of the End Regions
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

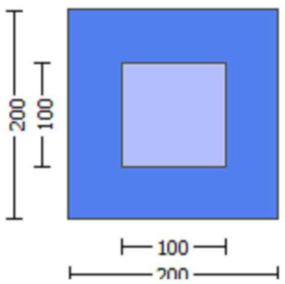
DESCRIPTION

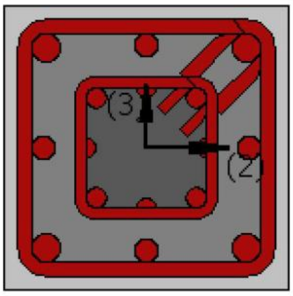
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 781.25
Existing Column:
Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 500.00
Existing material: Steel Strength, fs = fsm =555.56

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Height, H = 200.00
External Width, W = 2000.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 10.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.108. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.15

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	2	0.0430422	0.0430422
	Life Safety	Start	3	0.1251332	0.1251332
Shear Capacity [kN]	Life Safety	End	3	177.628	177.628

COMPUTER FILES

- ASCE_rcjrs15.bpf
- Report_ASCE_rcjrs15.pdf

EXAMPLE 7.16

SUCCINCT DATA

- Secondary Member
- SmoothBars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped in the Vicinity of the End Regions
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

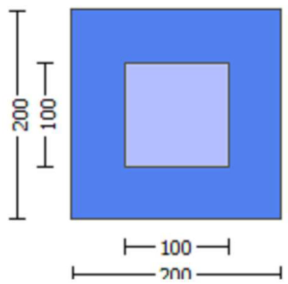
DESCRIPTION

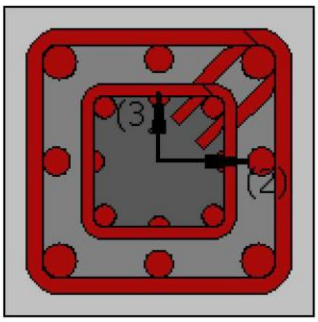
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 781.25
Existing Column:
Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

<u>For Chord rotation Calculations</u>:
Existing material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 500.00
Existing material: Steel Strength, fs = fsm =555.56

<u>For Shear Capacity Calculations</u>:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

<u>Member's Properties</u>

External Height, H = 200.00
External Width, W = 2000.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.109. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.16

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	2	0.0198895	0.0198895
	Life Safety	Start	3	0.0788670	0.0788670
Shear Capacity [kN]	Life Safety	End	3	235.803	235.803

COMPUTER FILES

- ASCE_rcjrs16.bpf
- Report_ASCE_rcjrs16.pdf

EXAMPLES SET 8: JACKETED L-SHAPED COLUMN SECTION

EXAMPLE 8.1

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

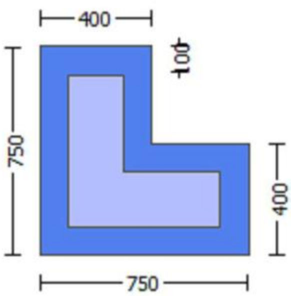
DESCRIPTION

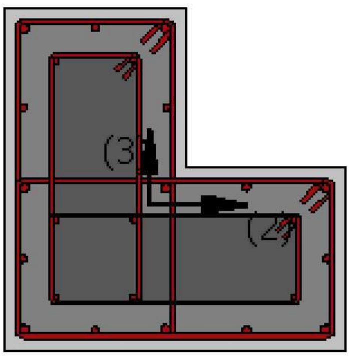
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
Existing material: Steel Strength, fs = 1.25*fsm =555.55

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, Hmax = 750.00
Min Height, Hmin = 400.00
Max Width, Wmax = 750.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.110. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0026579	0.0026579
	Life Safety	Start	2	0.0365177	0.0365177
Shear Capacity [kN]	Life Safety	Start	2	875.821	875.821

COMPUTER FILES

- ASCE_rcjlcs1.bpf

- Report_ASCE_rcjlcs1.pdf

EXAMPLE 8.2

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

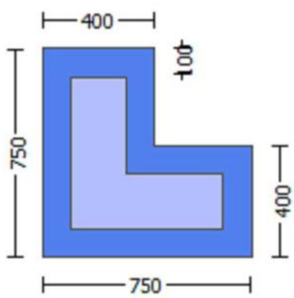
DESCRIPTION

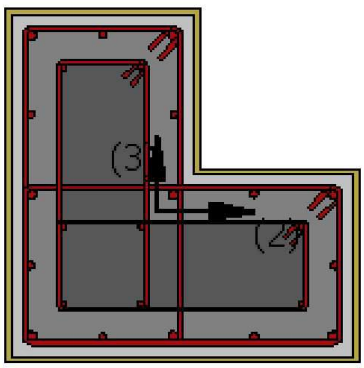
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Knowledge Factor, KF = 0.80

<u>Materials' Properties</u>

<u>Jacket:</u>
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

<u>For Shear Capacity Calculations</u>:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
Existing material: Steel Strength, fs = 1.25*fsm =555.55

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, Hmax = 750.00
Min Height, Hmin = 400.00
Max Width, Wmax = 750.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.111. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0019368	0.0019368
	Collapse Prevention	End	2	0.0485998	0.0485998
Shear Capacity [kN]	Immediate Occupancy	Start	3	720.058	720.058

COMPUTER FILES

- ASCE_rcjlcs2.bpf
- Report_ASCE_rcjlcs2.pdf

EXAMPLE 8.3

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

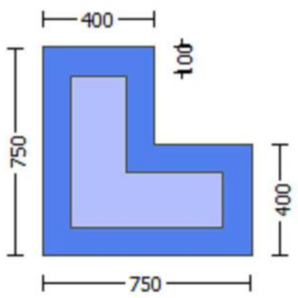
DESCRIPTION

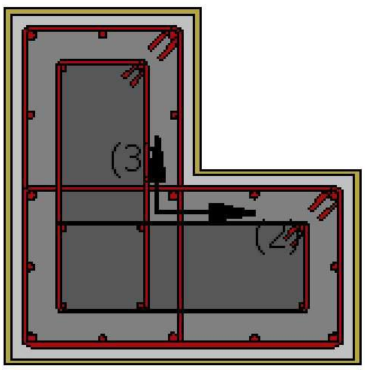
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 24.00
Existing material: Steel Strength, fs = fsm = 525.00
Existing material: Steel Strength, fs = 1.25*fsm =656.25

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 420.00

Member's Properties

Max Height, Hmax = 750.00
Min Height, Hmin = 400.00
Max Width, Wmax = 750.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.112. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0033335	0.0033335
	Life Safety	Start	3	0.0425475	0.0425475
Shear Capacity [kN]	Operational Level	End	2	943.739	943.739

COMPUTER FILES

- ASCE_rcjlcs3.bpf
- Report_ASCE_rcjlcs3.pdf

EXAMPLE 8.4

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing column

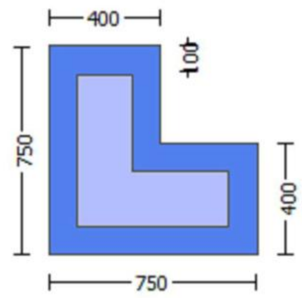
DESCRIPTION

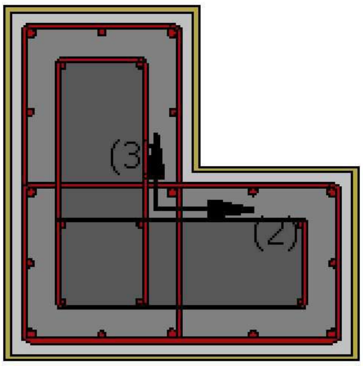
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.90

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 555.56
Existing material: Steel Strength, fs = 1.25*fsm =694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, Hmax = 750.00
Min Height, Hmin = 400.00
Max Width, Wmax = 750.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon

Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.113. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0030672	0.0030672
	Collapse Prevention	Start	3	0.0547348	0.0547348
Shear Capacity [kN]	Collapse Prevention	Start	3	1100.9	1100.86

NOTE: The small difference in the Shear Capacity values is due to the rounding of the shear capacity value exported to the Report.

COMPUTER FILES

- ASCE_rcjlcs4.bpf
- Report_ASCE_rcjlcs4.pdf

EXAMPLE 8.5

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00.
- No FRP Wrapping

- New Material Sets type for the Jacket and New Material Sets type for the Existing column

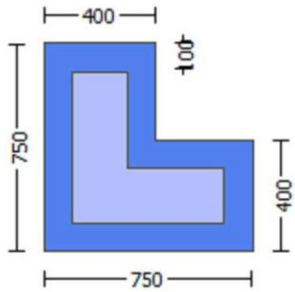
DESCRIPTION

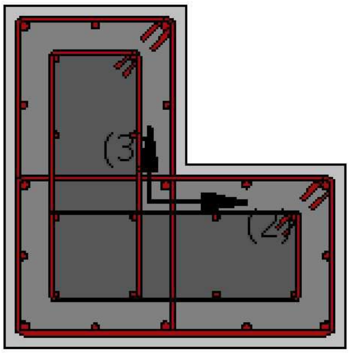
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 555.56
Existing material: Steel Strength, fs = 1.25*fsm =694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, Hmax = 750.00
Min Height, Hmin = 400.00

Max Width, Wmax = 750.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.114. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	2	0.001521	0.001521
	Life Safety	End	3	0.0280248	0.0280248
Shear Capacity [kN]	Operational Level	Start	2	949.076	949.076

COMPUTER FILES

- ASCE_rcjlcs5.bpf
- Report_ASCE_rcjlcs5.pdf

EXAMPLE 8.6

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- No FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing column

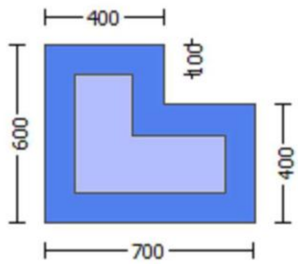
DESCRIPTION

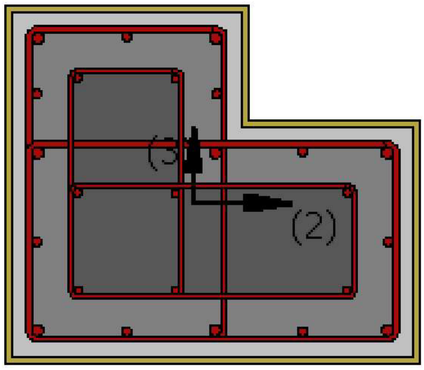
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 555.56
Existing material: Steel Strength, fs = 1.25*fsm =694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 400.00
Max Width, Wmax = 700.00

Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.115. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0013132	0.0013132
	Collapse Prevention	Start	2	0.0631083	0.0631083
Shear Capacity [kN]	Collapse Prevention	Start	2	885.527	885.527

COMPUTER FILES

- ASCE_rcjlcs6.bpf
- Report_ASCE_rcjlcs6.pdf

EXAMPLE 8.7

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

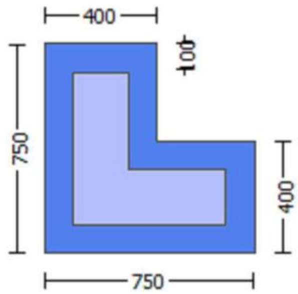
DESCRIPTION

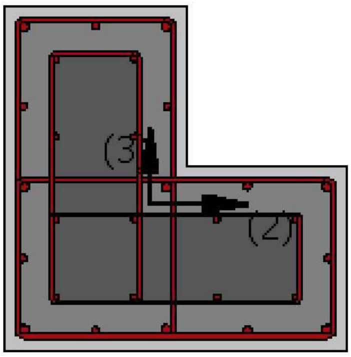
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
Existing material: Steel Strength, fs = 1.25*fsm =555.5556

<u>For Shear Capacity Calculations</u>:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

<u>Member's Properties</u>

Max Height, Hmax = 750.00
Min Height, Hmin = 400.00
Max Width, Wmax = 750.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping Data

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.116. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	2	0.0017680	0.0017680
	Collapse Prevention	End	3	0.0392274	0.0392274
Shear Capacity [kN]	Immediate Occupancy	Start	2	876.340	876.340

COMPUTER FILES

- ASCE_rcjlcs7.bpf
- Report_ASCE_rcjlcs7.pdf

EXAMPLE 8.8

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

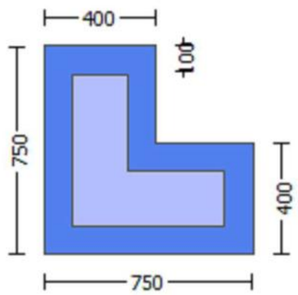
DESCRIPTION

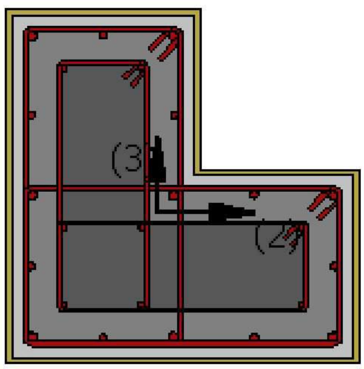
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.85

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

<u>For Chord rotation Calculations</u>:
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
Existing material: Steel Strength, fs = 1.25*fsm =555.5556

<u>For Shear Capacity Calculations</u>:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

<u>Member's Properties</u>

Max Height, Hmax = 750.00
Min Height, Hmin = 400.00
Max Width, Wmax = 750.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.117. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0024791	0.0024791
	Life Safety	End	2	0.0262696	0.0262696
Shear Capacity [kN]	Operational Level	Start	3	765.236	765.236

COMPUTER FILES

- ASCE_rcjlcs8.bpf
- Report_ASCE_rcjlcs8.pdf

EXAMPLE 8.9

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing column

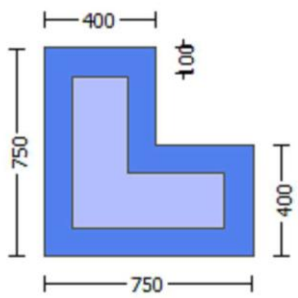
DESCRIPTION

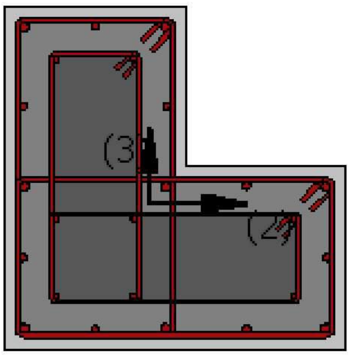
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 30.00
Existing material: Steel Strength, fs = fsm = 625.00
Existing material: Steel Strength, fs = 1.25*fsm =781.25

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, Hmax = 750.00
Min Height, Hmin = 400.00
Max Width, Wmax = 750.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.118. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.9

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0001971	0.0001971
	Collapse Prevention	Start	2	0.0403885	0.0403885
Shear Capacity [kN]	Collapse Prevention	Start	2	848.936	848.936

COMPUTER FILES

- ASCE_rcjlcs9.bpf
- Report_ASCE_rcjlcs9.pdf

EXAMPLE 8.10

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing column

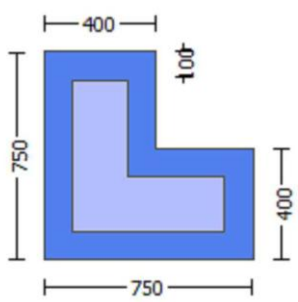
DESCRIPTION

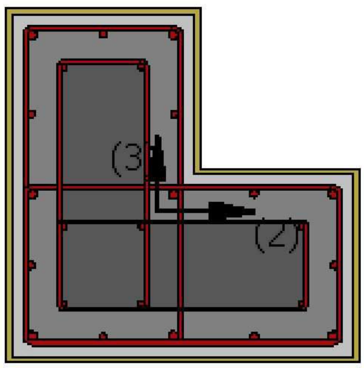
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0,87

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 555.56
Existing material: Steel Strength, fs = 1.25*fsm =694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, Hmax = 750.00
Min Height, Hmin = 400.00
Max Width, Wmax = 750.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.119. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.10

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.002484	0.002484
	Life Safety	End	2	0.0454431	0.0454431
Shear Capacity [kN]	Immediate Occupancy	Start	3	948.969	948.969

COMPUTER FILES

- ASCE_rcjlcs10.bpf
- Report_ASCE_rcjlcs10.pdf

EXAMPLE 8.11

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing column

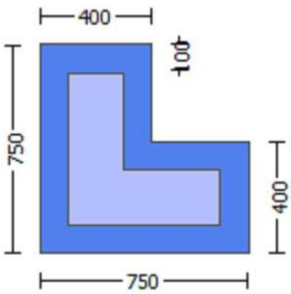
DESCRIPTION

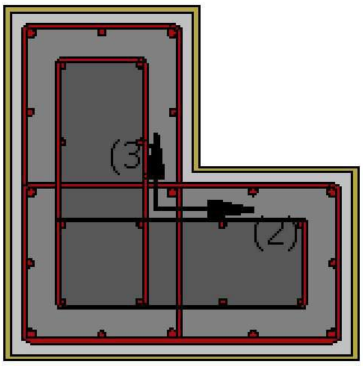
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 555.56
Existing material: Steel Strength, fs = 1.25*fsm =694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, Hmax = 750.00
Min Height, Hmin = 400.00
Max Width, Wmax = 750.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon

Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.120. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.11

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0003981	0.0003981
	Life Safety	Start	3	0.0326730	0.0326730
Shear Capacity [kN]	Life Safety	Start	2	948.974	948.974

COMPUTER FILES

- ASCE_rcjlcs11.bpf
- Report_ASCE_rcjlcs11.pdf

EXAMPLE 8.12

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing column

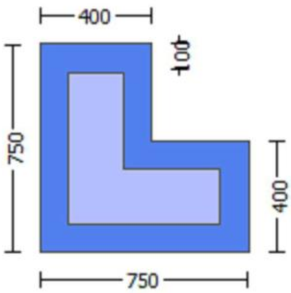
DESCRIPTION

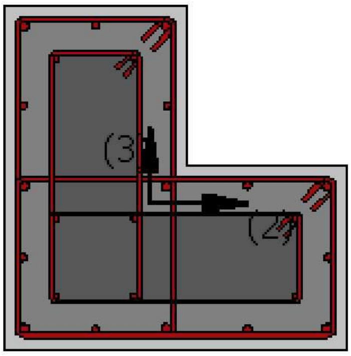
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Knowledge Factor, KF = 1.00

<u>Materials' Properties</u>

<u>Jacket:</u>
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

<u>For Shear Capacity Calculations</u>:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

<u>Existing Column:</u>
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
Existing material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 555.56
Existing material: Steel Strength, fs = 1.25*fsm =694.45

<u>For Shear Capacity Calculations</u>:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

<u>Member's Properties</u>

Max Height, Hmax = 750.00
Min Height, Hmin = 400.00
Max Width, Wmax = 750.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00

Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping Data

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.121. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.12

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0031475	0.0031475
	Collapse Prevention	Start	3	0.0495845	0.0495845
Shear Capacity [kN]	Collapse Prevention	Start	3	948.970	948.970

COMPUTER FILES

- ASCE_rcjlcs12.bpf
- Report_ASCE_rcjlcs12.pdf

EXAMPLE 8.13

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

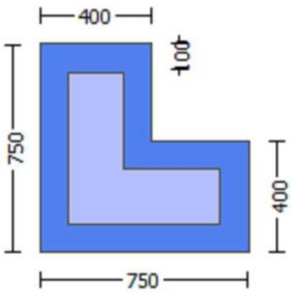
DESCRIPTION

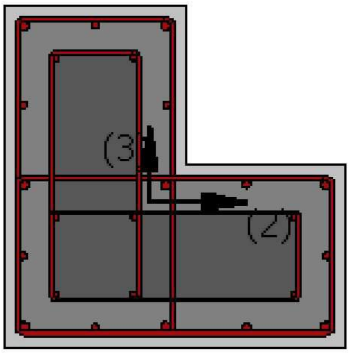
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Knowledge Factor, KF = 0.90

<u>Materials' Properties</u>

<u>Jacket:</u>
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 781.25

<u>For Shear Capacity Calculations</u>:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

<u>Existing Column:</u>
Concrete Elasticity, Ec =19940.411
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
Existing material: Concrete Strength, fc = fcm = 18.00
Existing material: Steel Strength, fs = fsm = 500.00
Existing material: Steel Strength, fs = 1.25*fsm =625.00

<u>For Shear Capacity Calculations</u>:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 12.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

<u>Member's Properties</u>

Max Height, Hmax = 750.00
Min Height, Hmin = 400.00
Max Width, Wmax = 750.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00

Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.122. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.13

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.006095	0.006095
	Life Safety	Start	2	0.0349844	0.0349844
Shear Capacity [kN]	Life Safety	Start	2	698.851	698.851

COMPUTER FILES

- ASCE_rcjlcs13.bpf
- Report_ASCE_rcjlcs13.pdf

EXAMPLE 8.14

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

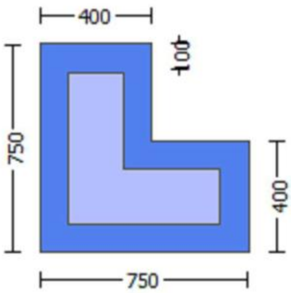
DESCRIPTION

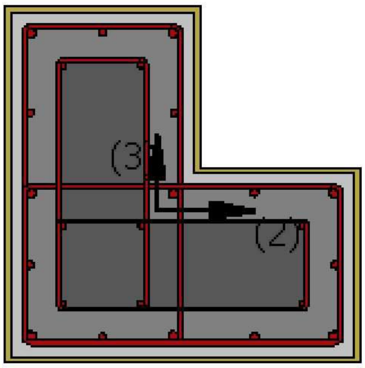
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





__**Units in N, mm**__

Knowledge Factor, KF = 0.90

__**Materials' Properties**__

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
Existing material: Steel Strength, fs = 1.25*fsm =555.55

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

__**Member's Properties**__

Max Height, Hmax = 750.00
Min Height, Hmin = 400.00
Max Width, Wmax = 750.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00

Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.123. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.14

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0002558	0.0002558
	Collapse Prevention	End	2	0.0314501	0.0314501
Shear Capacity [kN]	Immediate Occupancy	End	3	684.441	684.441

COMPUTER FILES

- ASCE_rcjlcs14.bpf
- Report_ASCE_rcjlcs14.pdf

EXAMPLE 8.15

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel

- Without Detailing for Earthquake Resistance (including stirrups not closed at 135
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

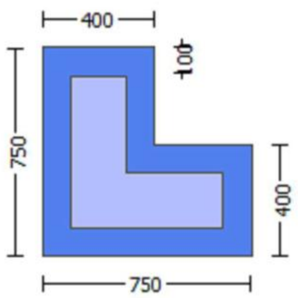
DESCRIPTION

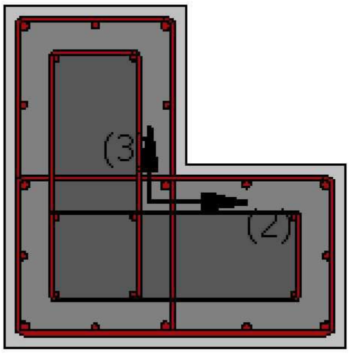
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.90

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 19940.411
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec =19940.411
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
Existing material: Concrete Strength, fc = fcm = 18.00
Existing material: Steel Strength, fs = fsm = 500.00
Existing material: Steel Strength, fs = 1.25*fsm =625.00

<u>For Shear Capacity Calculations</u>:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 12.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

<u>Member's Properties</u>

Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.124. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.15

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0378413	0.0378413
	Life Safety	Start	2	0.0372130	0.0372130
Shear Capacity [kN]	Life Safety	Start	2	267.030	267.030

COMPUTER FILES

- ASCE_rcjlcs15.bpf
- Report_ASCE_rcjlcs15.pdf

EXAMPLE 8.16

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

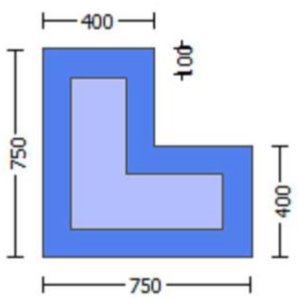
DESCRIPTION

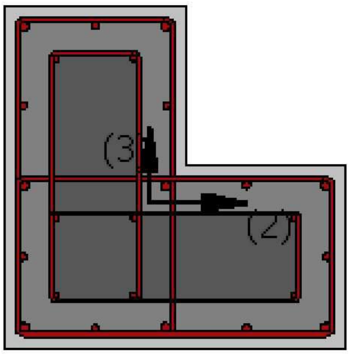
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.90

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 19940.411
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec =19940.411
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 18.00
Existing material: Steel Strength, fs = fsm = 500.00
Existing material: Steel Strength, fs = 1.25*fsm =625.00

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 12.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.125. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.16

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0131113	0.0131114
	Life Safety	Start	2	0.0380477	0.0380491
Shear Capacity [kN]	Life Safety	Start	2	258.166	258.165

NOTE: The small difference between the Chord Rotation Capacity obtained from the Hand Calculations and SeismoBuild is due to the rounding of the shear capacity value exported to the Report.

COMPUTER FILES

- ASCE_rcjlcs16.bpf
- Report_ASCE_rcjlcs16.pdf

EXAMPLES SET 9: JACKETED T-SHAPED COLUMN SECTION

EXAMPLE 9.1

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars Straight Ends Lapped Starting at the
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

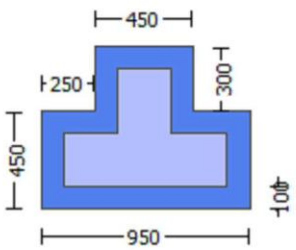
DESCRIPTION

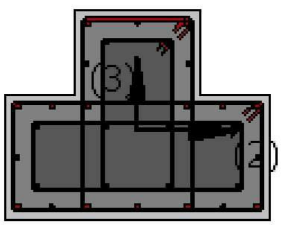
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.4444

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
Existing material: Steel Strength, fs = 1.25*fsm =555.5556

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, H_{max} = 750.00
Min Width, H_{min} = 450.00
Max Width, W_{max} = 950.00
Min Width, W_{min} = 450.00
Eccentricity, E_{cc} = 250.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.126. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0028242	0.0028242
	Life Safety	Start	2	0.0354310	0.0354310
Shear Capacity [kN]	Operational Level	End	3	1130.1	1130.060

NOTE: The small difference between the Shear Capacity obtained from the Hand Calculations and SeismoBuild is due to the rounding of the shear capacity value exported to the Report.

COMPUTER FILES

- ASCE_rcjtcs1.bpf
- Report_ ASCE_rcjtcs1.pdf

EXAMPLE 9.2

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min=0.30
- FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

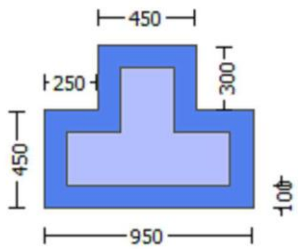
DESCRIPTION

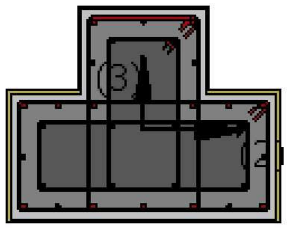
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.85

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.4444

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
Existing material: Steel Strength, fs = 1.25*fsm =555.5556

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, H_{max} = 750.00
Min Width, H_{min} = 450.00
Max Width, W_{max} = 950.00
Min Width, W_{min} = 450.00
Eccentricity, E_{cc} = 250.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min=0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.127. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0020947	0.0020947
	Collapse Prevention	End	2	0.0365195	0.0365195
Shear Capacity [kN]	Immediate Occupancy	Start	3	857.719	857.719

COMPUTER FILES

- ASCE_rcjtcs2.bpf
- Report_ ASCE_rcjtcs2.pdf

EXAMPLE 9.3

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length(lo/lou,min>=1)
- FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

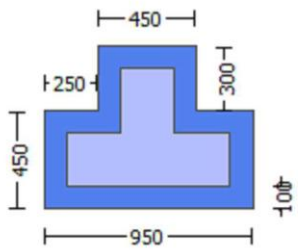
DESCRIPTION

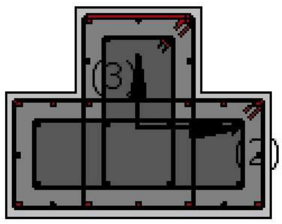
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 24.00
Existing material: Steel Strength, fs = fsm = 525.00
Existing material: Steel Strength, fs = 1.25*fsm =656.25

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, H_{max} = 750.00
Min Width, H_{min} = 450.00
Max Width, W_{max} = 950.00
Min Width, W_{min} = 450.00
Eccentricity, E_{cc} = 250.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars Without Lapping in the Vicinity of the End Regions
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.128. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0039600	0.0039600
	Life Safety	Start	3	0.0423750	0.0423750
Shear Capacity [kN]	Life Safety	Start	3	925.444	925.444

COMPUTER FILES

- ASCE_rcjtcs3.bpf
- Report_ ASCE_rcjtcs3.pdf

EXAMPLE 9.4

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections

- Adequate Lap Length (lo/lou,min>=1)
- FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing column

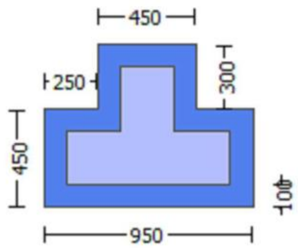
DESCRIPTION

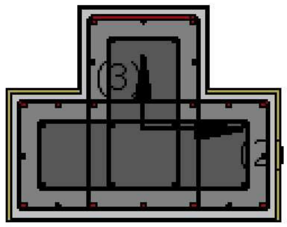
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.90

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 555.56
Existing material: Steel Strength, fs = 1.25*fsm =694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, H_{max} = 750.00
Min Width, H_{min} = 450.00
Max Width, W_{max} = 950.00
Min Width, W_{min} = 450.00
Eccentricity, E_{cc} = 250.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.129. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0034401	0.0034401
	Collapse Prevention	Start	3	0.0541267	0.0541267
Shear Capacity [kN]	Immediate Occupancy	End	3	1238.6	1238.584

NOTE: The small difference between the Shear capacity obtained from the Hand Calculations and SeismoBuild is due to the rounding of the shear capacity value exported to the Report.

COMPUTER FILES

- ASCE_rcjtcs4.bpf
- Report_ ASCE_rcjtcs4.pdf

EXAMPLE 9.5

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- New Material Sets type for the Jacket and New Material Sets type for the Existing column

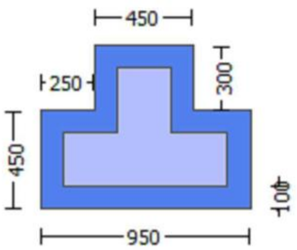
DESCRIPTION

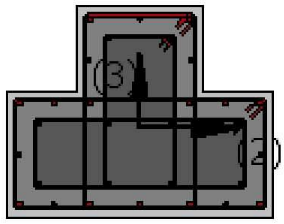
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 555.56
Existing material: Steel Strength, fs = 1.25*fsm =694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, H_{max} = 750.00
Min Width, H_{min} = 450.00
Max Width, W_{max} = 950.00
Min Width, W_{min} = 450.00
Eccentricity, E_{cc} = 250.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.130. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	2	0.0013390	0.0013390
	Life Safety	End	3	0.0276040	0.0276040
Shear Capacity [kN]	Operational Level	Start	2	1217.4	1217.447

NOTE: The small difference between the Shear capacity obtained from the Hand Calculations and SeismoBuild is due to the rounding of the shear capacity value exported to the Report.

COMPUTER FILES

- ASCE_rcjtcs5.bpf
- Report_ ASCE_rcjtcs5.pdf

EXAMPLE 9.6

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing column

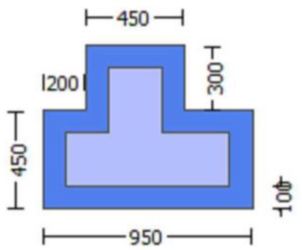
DESCRIPTION

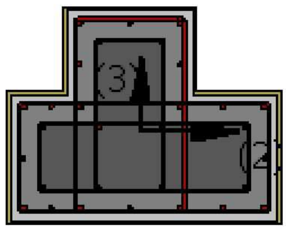
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 555.56
Existing material: Steel Strength, fs = 1.25*fsm =694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, H_{max} = 750.00
Min Width, H_{min} = 450.00
Max Width, W_{max} = 950.00
Min Width, W_{min} = 450.00
Eccentricity, E_{cc} = 200.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00

Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.131. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity	Immediate Occuancy	End	2	0.0012061	0.0012061
	Collapse Prevention	Start	2	0.0444372	0.0444372
Shear Capacity [kN]	Collapse Prevention	Start	2	1352.0	1351.973

NOTE: The small difference between the Shear capacity obtained from the Hand Calculations and SeismoBuild is due to the rounding of the shear capacity value exported to the Report.

COMPUTER FILES

- ASCE_rcjtcs6.bpf
- Report_ ASCE_rcjtcs6.pdf

EXAMPLE 9.7

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min=0.30
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

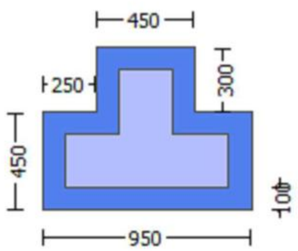
DESCRIPTION

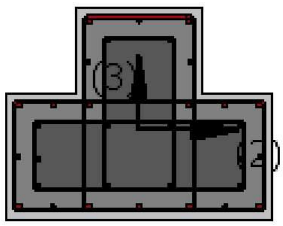
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Knowledge Factor, KF = 1.00

<u>Materials' Properties</u>

<u>Jacket:</u>
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

<u>For Shear Capacity Calculations</u>:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444,44
Existing material: Steel Strength, fs = 1.25*fsm =555.55

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, H_{max} = 750.00
Min Width, H_{min} = 450.00
Max Width, W_{max} = 950.00
Min Width, W_{min} = 450.00
Eccentricity, E_{cc} = 250.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min= 0.30
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.132. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0025863	0.0025863
	Life Safety	End	2	0.0241424	0.0241424
Shear Capacity [kN]	Operational Level	Start	3	1004.7	1004.709

NOTE: The small difference between the Shear capacity obtained from the Hand Calculations and SeismoBuild is due to the rounding of the shear capacity value exported to the Report

COMPUTER FILES

- ASCE_rcjtcs7.bpf
- Report_ TBDY_rcjtcs7.pdf

EXAMPLE 9.8

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

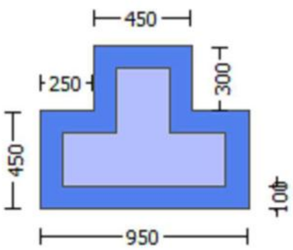
DESCRIPTION

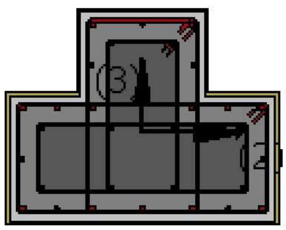
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.90

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444,44
Existing material: Steel Strength, fs = 1.25*fsm =555.55

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Max Height, H_{max} = 750.00
Min Width, H_{min} = 450.00
Max Width, W_{max} = 950.00
Min Width, W_{min} = 450.00
Eccentricity, E_{cc} = 250.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars Straight Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.133. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	2	0.0019152	0.0019152
	Collapse Prevention	End	3	0.0380613	0.0380613
Shear Capacity [kN]	Immediate Occupancy	Start	2	1111.4	1111.396

NOTE: The small difference between the Shear capacity obtained from the Hand Calculations and SeismoBuild is due to the rounding of the shear capacity value exported to the Report.

COMPUTER FILES

- ASCE_rcjtcs8.bpf
- Report_ ASCE_rcjtcs8.pdf

EXAMPLE 9.9

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End SectionsLap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing column

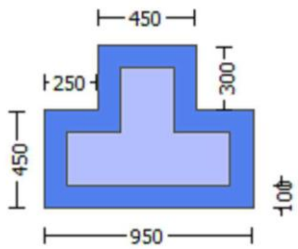
DESCRIPTION

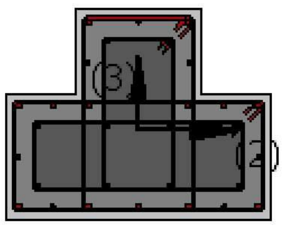
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 6525.00
New material: Steel Strength, fs = 1.25*fsm =555.55

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, H_{max} = 750.00
Min Width, H_{min} = 450.00
Max Width, W_{max} = 950.00
Min Width, W_{min} = 450.00
Eccentricity, E_{cc} = 250.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.134. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.9

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0001967	0.0001967
	Collapse Prevention	Start	2	0.0338982	0.0338982
Shear Capacity [kN]	Collapse Prevention	Start	2	1194.3	1194.289

NOTE: The small difference between the Shear capacity obtained from the Hand Calculations and SeismoBuild is due to the rounding of the shear capacity value exported to the Report.

COMPUTER FILES

- ASCE_rcjtcs9.bpf
- Report_ ASCE_rcjtcs9.pdf

EXAMPLE 9.10

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length withlo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing column

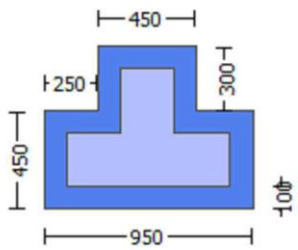
DESCRIPTION

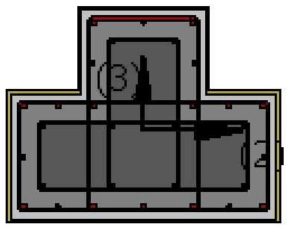
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.80

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm =694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, H_{max} = 750.00
Min Width, H_{min} = 450.00
Max Width, W_{max} = 950.00
Min Width, W_{min} = 450.00
Eccentricity, E_{cc} = 250.00
Jacket Thickness, t_j = 100.00

Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.135. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.10

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0024396	0.0024396
	Life Safety	End	2	0.0309284	0.0309284
Shear Capacity [kN]	Immediate Occupancy	Start	3	1108.1	1108.090

NOTE: The small difference between the Shear capacity obtained from the Hand Calculations and SeismoBuild is due to the rounding of the shear capacity value exported to the Report.

COMPUTER FILES

- ASCE_rcjtcs10.bpf
- Report_ ASCE_rcjtcs10.pdf

EXAMPLE 9.11

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing column

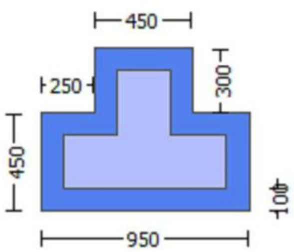
DESCRIPTION

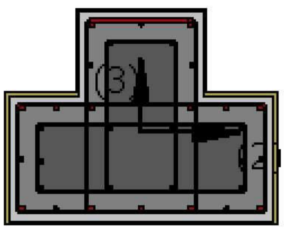
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Knowledge Factor, KF = 1.00

<u>Materials' Properties</u>

<u>Jacket:</u>
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

<u>For Shear Capacity Calculations</u>:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm =694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Max Height, H_{max} = 750.00
Min Width, H_{min} = 450.00
Max Width, W_{max} = 950.00
Min Width, W_{min} = 450.00
Eccentricity, E_{cc} = 250.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.136. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.11

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0009446	0.0009446
	Life Safety	Start	3	0.0325098	0.0325098
Shear Capacity [kN]	Life Safety	End	2	1100.5	1100.510

NOTE: The small difference between the Shear capacity obtained from the Hand Calculations and SeismoBuild is due to the rounding of the shear capacity value exported to the Report.

COMPUTER FILES

- ASCE_rcjtcs11.bpf
- Report_ ASCE_rcjtcs11.pdf

EXAMPLE 9.12

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing column

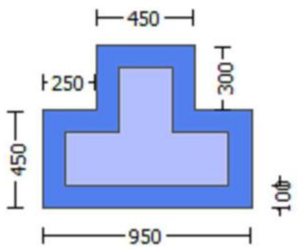
DESCRIPTION

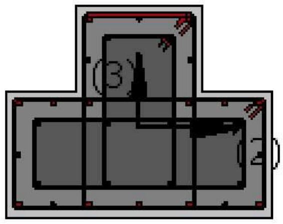
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm =694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

Section Max Height, H_{max} = 750.00
Section Min Width, H_{min} = 450.00
Section Max Width, W_{max} = 950.00
Section Min Width, W_{min} = 450.00
Eccentricity, E_{cc} = 250.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

> **NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.**

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.137. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.12

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0040705	0.0040705
	Collapse Prevention	Start	3	0.0492964	0.0492964
Shear Capacity [kN]	Immediate Occupancy	End	2	1432.100	1432.100

COMPUTER FILES

- ASCE_rcjtcs12.bpf
- Report_ ASCE_rcjtcs12.pdf

EXAMPLE 9.13

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End SectionsAdequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

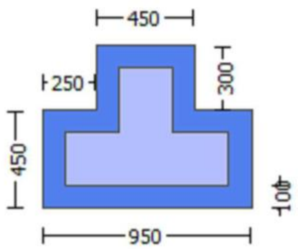
DESCRIPTION

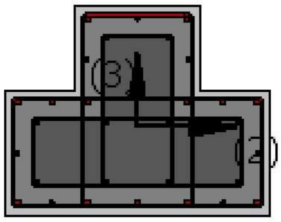
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.80

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 24.00
New material: Steel Strength, fs = fsm = 525.00
New material: Steel Strength, fs = 1.25*fsm =656.25

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Section Max Height, H_{max} = 750.00
Section Min Width, H_{min} = 450.00
Section Max Width, W_{max} = 950.00
Section Min Width, W_{min} = 450.00
Eccentricity, E_{cc} = 250.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

> **NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.**

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.138. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.13

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0058986	0.0058986
	Life Safety	Start	2	0.0337370	0.0337370
Shear Capacity [kN]	Life Safety	Start	2	921.379	921.379

COMPUTER FILES

- ASCE_rcjtcs13.bpf
- Report_ ASCE_rcjtcs13.pdf

EXAMPLE 9.14

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

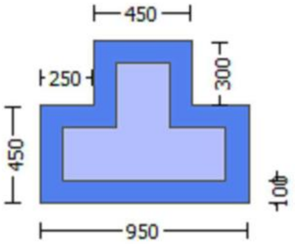
DESCRIPTION

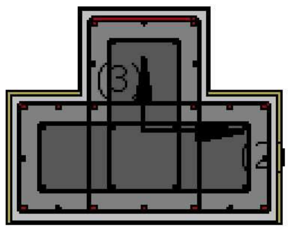
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.80

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 20.00
New material: Steel Strength, fs = fsm = 444.44
New material: Steel Strength, fs = 1.25*fsm =555.55

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

Section Max Height, H_{max} = 750.00
Section Min Width, H_{min} = 450.00
Section Max Width, W_{max} = 950.00
Section Min Width, W_{min} = 450.00
Eccentricity, E_{cc} = 250.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00

FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.139. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.14

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0002276	0.0002276
	Collapse Prevention	End	2	0.0222877	0.0222877
Shear Capacity [kN]	Immediate Occupancy	End	3	532.765	532.765

COMPUTER FILES

- ASCE_rcjtcs14.bpf
- Report_ ASCE_rcjtcs14.pdf

EXAMPLE 9.15

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min = lb/ld >=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and Exiting Material Sets type for the Existing column

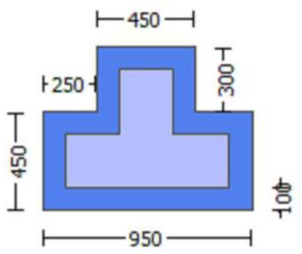
DESCRIPTION

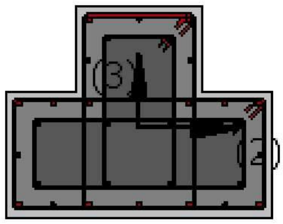
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.80

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 19940.411
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 18.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 12.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 12.00
New material: Steel Strength, fs = fsm = 525.00
New material: Steel Strength, fs = 1.25*fsm =694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 8.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 420.00

Member's Properties

Max Height, H_{max} = 750.00
Min Width, H_{min} = 450.00

Max Width, W_{max} = 950.00
Min Width, W_{min} = 450.00
Eccentricity, E_{cc} = 250.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.140. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.15

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Life Safety	Start	2	0.0192082	0.0192082
	Operational Level	Start	3	0.0026378	0.0026378
Shear Capacity [kN]	Operational Level	Start	3	734.493	734.493

COMPUTER FILES

- ASCE_rcjtcs15.bpf
- Report_ ASCE_rcjtcs15.pdf

EXAMPLE 9.16

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min = lb/ld >=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and Exiting Material Sets type for the Existing column

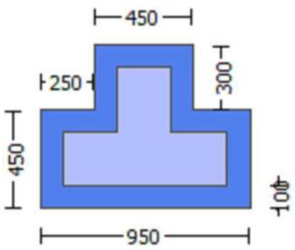
DESCRIPTION

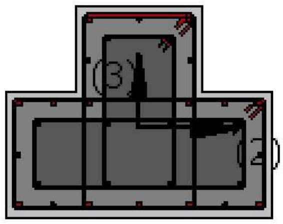
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.80

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 19940.411
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 18.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 12.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 12.00
New material: Steel Strength, fs = fsm = 525.00
New material: Steel Strength, fs = 1.25*fsm =694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 8.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 420.00

Member's Properties

Max Height, H_{max} = 750.00
Min Width, H_{min} = 450.00

Max Width, W_{max} = 950.00
Min Width, W_{min} = 450.00
Eccentricity, E_{cc} = 250.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.141. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.16

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Life Safety	Start	2	0.0103522	0.0103522
	Operational Level	Start	3	0.0108117	0.0108117
Shear Capacity [kN]	Operational Level	Start	3	792.832	792.833

NOTE: The small difference between the Shear capacity obtained from the Hand Calculations and SeismoBuild is due to the rounding of the shear capacity value exported to the Report.

COMPUTER FILES

- ASCE_rcjtcs16.bpf
- Report_ ASCE_rcjtcs16.pdf

EXAMPLES SET 10: JACKETED CIRCULAR COLUMN SECTION

EXAMPLE 10.1

SUCCINCT DATA

- Primary Member
- Ribbed Bars

- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length(lo/lou,min> = 1)
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Column

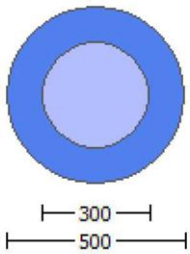
DESCRIPTION

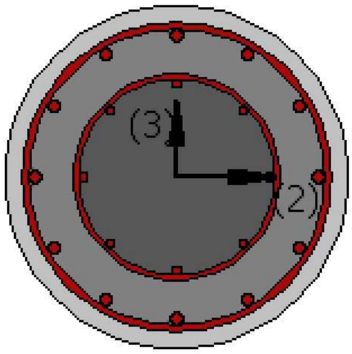
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.4444

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 20.00
New material: Steel Strength, fs = fsm = 444.44
New material: Steel Strength, fs = 1.25*fsm =555.5556

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

External Diameter, Dext = 500.00
Internal Diameter, Dint = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lb/lb,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.142. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0065022	0.0065022
	Life Safety	Start	2	0.0487476	0.0487476
Shear Capacity [kN]	Operational Level	End	3	430.747	430.747

COMPUTER FILES

- ASCE_rcjcs1.bpf
- Report_ASCE_rcjcs1.pdf

EXAMPLE 10.2

SUCCINCT DATA

- Primary Member
- Smooth Bars

- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Column

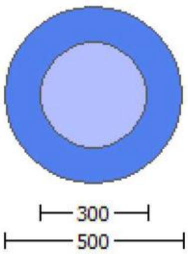
DESCRIPTION

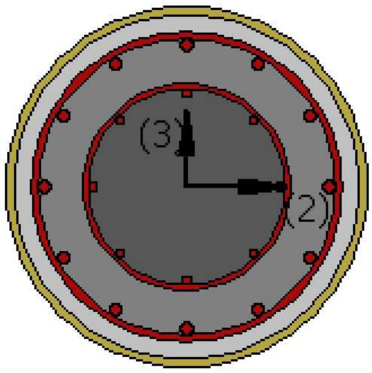
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.5

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.4444

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 20.00
New material: Steel Strength, fs = fsm = 444.44
New material: Steel Strength, fs = 1.25*fsm =555.5556

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00

New material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

External Diameter, Dext = 500.00
Internal Diameter, Dint = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.143. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0079234	0.0079234
	Collapse Prevention	End	2	0.0396607	0.0396607
Shear Capacity [kN]	Collapse Prevention	End	2	487.404	487.404

COMPUTER FILES

- ASCE_rcjcs2.bpf
- Report_ASCE_rcjcs2.pdf

EXAMPLE 10.3

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- FRP Wrapping
- New Material Sets type for the Jacket and Existing for the Existing Column

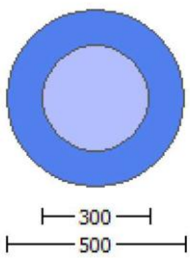
DESCRIPTION

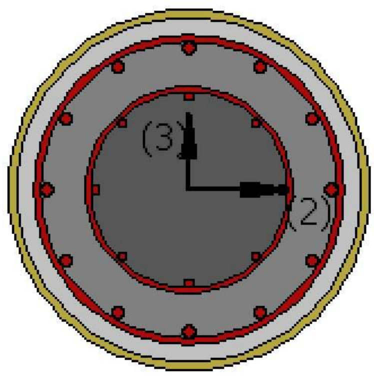
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Knowledge Factor, KF = 1.00

<u>Materials' Properties</u>

<u>Jacket:</u>
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00

New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 24.00
New material: Steel Strength, fs = fsm = 525.00
New material: Steel Strength, fs = 1.25*fsm =656.25

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 420.00

Member's Properties

External Diameter, Dext = 500.00
Internal Diameter, Dint = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.144. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0144697	0.0144697
	Life Safety	Start	3	0.0693782	0.0693782
Shear Capacity [kN]	Operational Level	Start	3	529.689	529.689

COMPUTER FILES

- ASCE_rcjcs3.bpf
- Report_ASCE_rcjcs3.pdf

EXAMPLE 10.4

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- FRP Wrapping
- New Material Sets type for the Jacket and New for the Existing Column

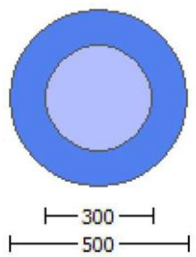
DESCRIPTION

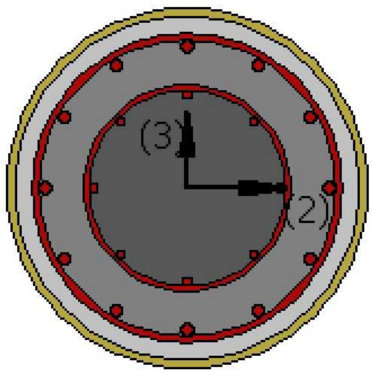
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.90

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Diameter, Dext = 500.00
Internal Diameter, Dint = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.145. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0065965	0.0065965
	Collapse Prevention	Start	3	0.0840950	0.0840950
Shear Capacity [kN]	Immediate Occupancy	End	3	614.520	614.520

COMPUTER FILES

- ASCE_rcjcs4.bpf
- Report_ASCE_rcjcs4.pdf

EXAMPLE 10.5

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type for the Jacket and New for the Existing Column

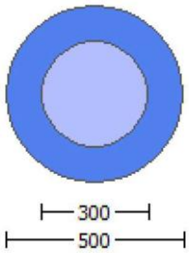
DESCRIPTION

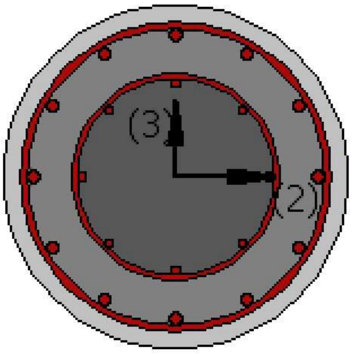
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Diameter, Dext = 500.00
Internal Diameter, Dint = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.146. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0006142	0.0006142
	Life Safety	Start	3	0.0272995	0.0272995
Shear Capacity [kN]	Operational Level	Start	2	345.303	345.303

COMPUTER FILES

- ASCE_rcjcs5.bpf
- Report_ASCE_rcjcs5.pdf

EXAMPLE 10.6

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type for the Jacket and New for the Existing Column

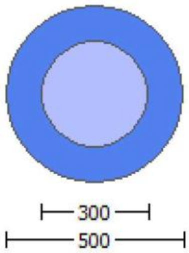
DESCRIPTION

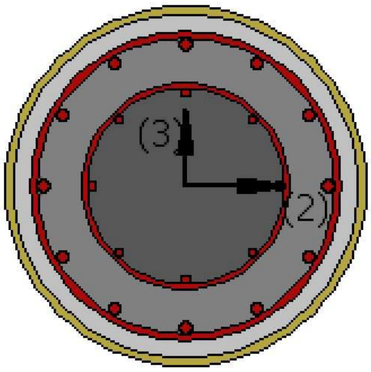
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Diameter, Dext = 500.00
Internal Diameter, Dint = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)

Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.147. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0045259	0.0045259
	Collapse Prevention	Start	2	0.0465259	0.0465259
Shear Capacity [kN]	Immediate Occupancy	Start	2	515.957	515.957

COMPUTER FILES

- ASCE_rcjcs6.bpf
- Report_ ASCE_rcjcs6.pdf

EXAMPLE 10.7

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Column

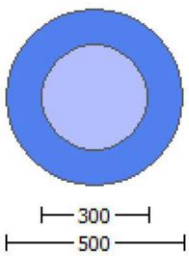
DESCRIPTION

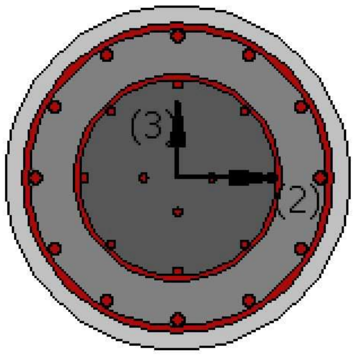
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Knowledge Factor, KF = 1.00

<u>Materials' Properties</u>

<u>Jacket:</u>
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

<u>For Shear Capacity Calculations</u>:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

<u>Existing Column:</u>
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
New material: Concrete Strength, fc = fcm = 20.00
New material: Steel Strength, fs = fsm = 444.44
New material: Steel Strength, fs = 1.25*fsm = 555.55

<u>For Shear Capacity Calculations</u>:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

<u>Member's Properties</u>

External Diameter, Dext = 500.00
Internal Diameter, Dint = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars

Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping Data

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.148. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0084945	0.0084945
	Life Safety	End	2	0.0254019	0.0254019
Shear Capacity [kN]	Operational Level	Start	2	339.072	339.072

COMPUTER FILES

- ASCE_rcjcs7.bpf
- Report_ASCE_rcjcs7.pdf

EXAMPLE 10.8

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- FRP Wrapping Data
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Column

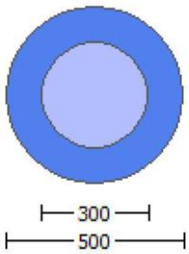
DESCRIPTION

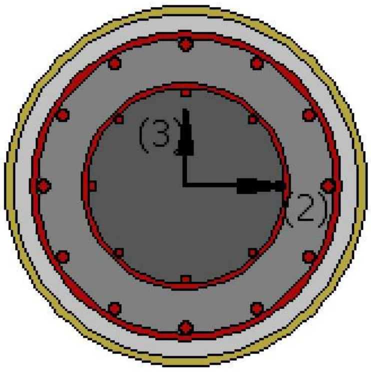
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.85

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 20.00
New material: Steel Strength, fs = fsm = 444.44
New material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

External Diameter, Dext = 500.00
Internal Diameter, Dint = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length lo = 300.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.149. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0010941	0.0010941
	Collapse Prevention	Start	2	0.0474707	0.0474707
Shear Capacity [kN]	Immediate Occupancy	Start	2	481.412	481.412

COMPUTER FILES

- ASCE_rcjcs8.bpf
- Report_ASCE_rcjcs8.pdf

EXAMPLE 10.9

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing Column

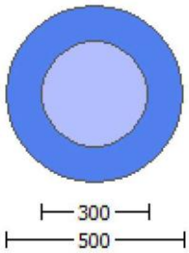
DESCRIPTION

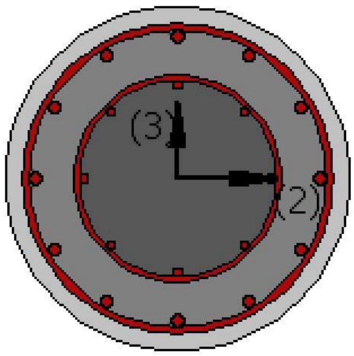
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF =1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Diameter, Dext = 500.00
Internal Diameter, Dint = 300.00

Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.150. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.9

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0064825	0.0064825
	Collapse Prevention	Start	2	0.0328584	0.0328584
Shear Capacity [kN]	Operational Level	Start	2	334.975	334.975

COMPUTER FILES

- ASCE_rcjcs9.bpf
- Report_ASCE_rcjcs9.pdf

EXAMPLE 10.10

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing Column

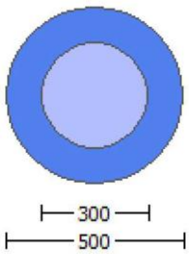
DESCRIPTION

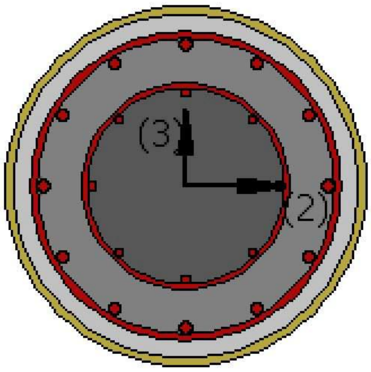
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.75

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Diameter, Dext = 500.00
Internal Diameter, Dint = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars

Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End SectionsInadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.151. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.10

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0090635	0.0090635
	Life Safety	End	2	0.0495306	0.0495306
Shear Capacity [kN]	Immediate Occupancy	Start	2	515.957	515.957

COMPUTER FILES

- ASCE_rcjcs10.bpf
- Report_ASCE_rcjcs10.pdf

EXAMPLE 10.11

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30

- FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing Column

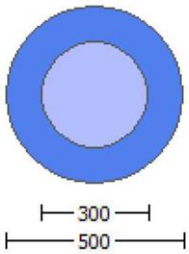
DESCRIPTION

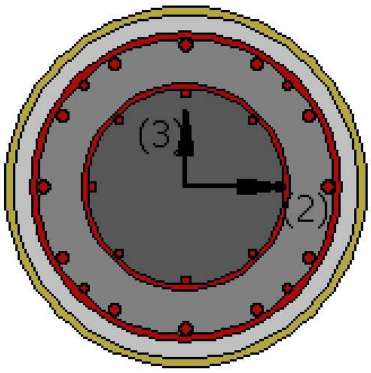
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Knowledge Factor, KF = 1.00

<u>Materials' Properties</u>

<u>Jacket:</u>
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

<u>For Shear Capacity Calculations</u>:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

<u>Existing Column:</u>
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

<u>For Shear Capacity Calculations</u>:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Diameter, Dext = 500.00
Internal Diameter, Dint = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.3
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.152. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.11

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0051658	0.0051658
	Life Safety	Start	3	0.0553342	0.0553342
Shear Capacity [kN]	Operational Level	Start	2	515.961	515.961

COMPUTER FILES

- ASCE_rcjcs11.bpf
- Report_ASCE_rcjcs11.pdf

EXAMPLE 10.12

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing Column

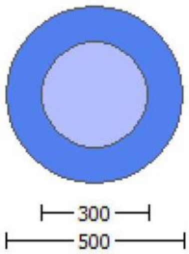
DESCRIPTION

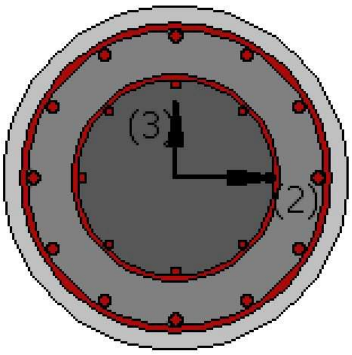
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Diameter, Dext = 500.00
Internal Diameter, Dint = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.153. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.12

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0122955	0.0122955
	Collapse Prevention	Start	3	0.0699601	0.0699601
Shear Capacity [kN]	Operational Level	Start	2	345.303	345.303

COMPUTER FILES

- ASCE_rcjcs12.bpf
- Report_ASCE_rcjcs12.pdf

EXAMPLE 10.13

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Column

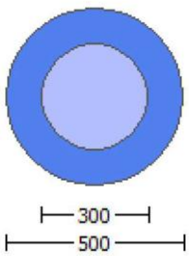
DESCRIPTION

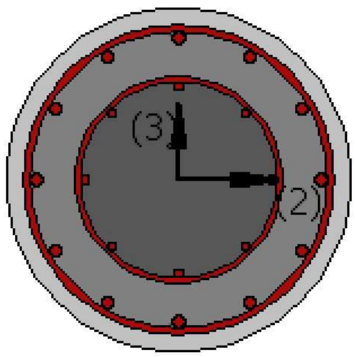
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.80

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 24.00
New material: Steel Strength, fs = fsm = 525.00
New material: Steel Strength, fs = 1.25*fsm = 656.25

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 420.00

Member's Properties

External Diameter, Dext = 500.00
Internal Diameter, Dint = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.154. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.13

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0179092	0.0179092
	Life Safety	Start	2	0.0414000	0.0414000
Shear Capacity [kN]	Operatioanal Level	Start	2	265.413	265.413

COMPUTER FILES

- ASCE_rcjcs13.bpf
- Report_ASCE_rcjcs13.pdf

EXAMPLE 10.14

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = lb = 300.00
- FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Column

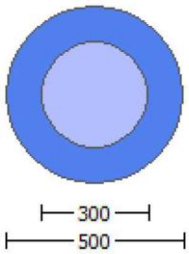
DESCRIPTION

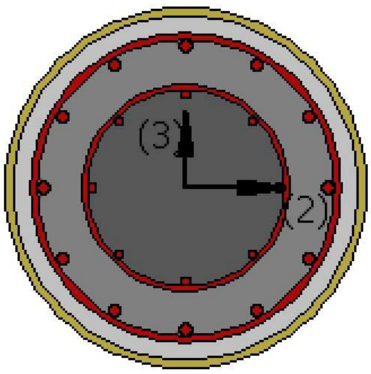
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.80

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations:
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

External Diameter, Dext = 500.00
Internal Diameter, Dint = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.155. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.14

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0010214	0.0010214
	Collapse Prevention	End	2	0.0471071	0.0471071
Shear Capacity [kN]	Operational Level	Start	2	396.407	396.407

COMPUTER FILES

- ASCE_rcjcs14.bpf
- Report_ASCE_rcjcs14.pdf

EXAMPLE 10.15

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min = lb/ld >=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and New for the Existing Column

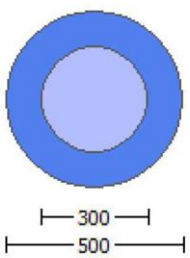
DESCRIPTION

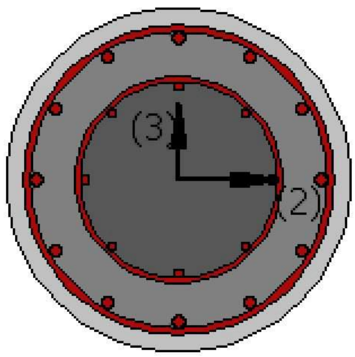
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Diameter, Dext = 350.00
Internal Diameter, Dint = 200.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.156. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.15

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0121590	0.0121590
	Collapse Prevention	Start	3	0.0520994	0.0521002
Shear Capacity [kN]	Operational Level	Start	2	345.303	345.303

NOTE: The small difference between the Chord Rotation Capacity obtained from the Hand Calculations and SeismoBuild is due to the rounding of the shear capacity value exported to the Report.

COMPUTER FILES

- ASCE_rcjcs15.bpf

- Report_ASCE_rcjcs15.pdf

EXAMPLE 10.16

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min = lb/ld >=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and New for the Existing Column

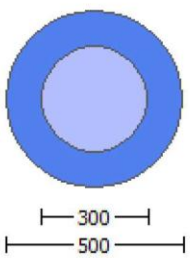
DESCRIPTION

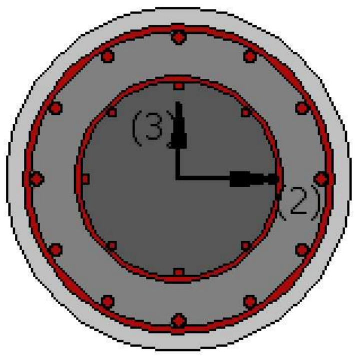
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Diameter, Dext = 350.00
Internal Diameter, Dint = 200.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The column member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH) fully restrained at its support.

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.157. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.16

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0121590	0.0121590
	Collapse Prevention	Start	3	0.042206	0.042206
Shear Capacity [kN]	Operational Level	Start	2	345.303	345.303

COMPUTER FILES

- ASCE_rcjcs16.bpf
- Report_ASCE_rcjcs16.pdf

EXAMPLES SET 11: JACKETED BEAM SECTION

EXAMPLE 11.1

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length(lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Beam

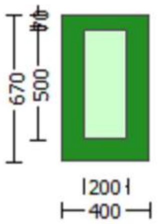
DESCRIPTION

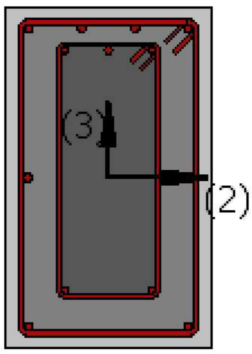
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
New material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations:
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1))
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.158. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0087038	0.0087038
	Life Safety	Start	2	0.0265184	0.0265184

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Shear Capacity [kN]	Operational Level	End	3	476.752	476.752

COMPUTER FILES

- ASCE_JBeam1.bpf
- ASCE_ TBDY_JBeam1.pdf

EXAMPLE 11.2

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Beam

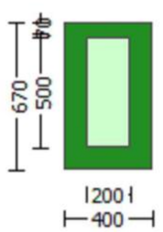
DESCRIPTION

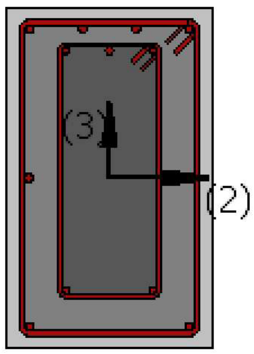
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.85

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 20.00
New material: Steel Strength, fs = fsm = 444.44
New material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations:
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties
External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.159. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0060209	0.0060209
	Collapse Prevention	End	2	0.0258962	0.0258962
Shear Capacity [kN]	Immediate Occupancy	Start	3	403.544	403.544

COMPUTER FILES

- ASCE_JBeam2.bpf
- Report_ASCE_JBeam2.pdf

EXAMPLE 11.3

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Beam

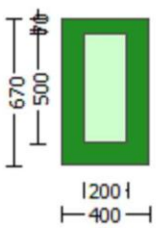
DESCRIPTION

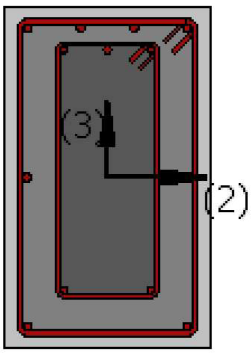
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 24.00
New material: Steel Strength, fs = fsm = 525.00
New material: Steel Strength, fs = 1.25*fsm = 656.25

For Shear Capacity Calculations:
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 420.00

Member's Properties

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.160. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0109653	0.0109653
	Life Safety	Start	3	0.0240999	0.0240999
Shear Capacity [kN]	Operational Level	End	2	315.128	315.128

COMPUTER FILES

- ASCE_JBeam3.bpf
- Report_ASCE_JBeam3.pdf

EXAMPLE 11.4

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing Beam

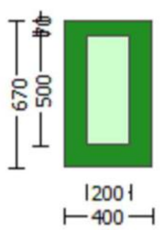
DESCRIPTION

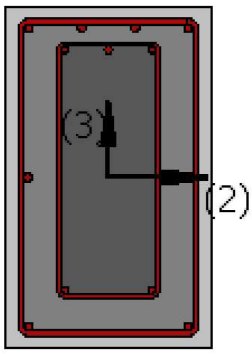
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.85

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:

New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties
External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.161. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0084412	0.0084412
	Collapse Prevention	Start	3	0.0334404	0.0334404
Shear Capacity [kN]	Immediate Occupancy	End	3	494.205	494.208

NOTE: The small difference between the Shear capacity obtained from the Hand Calculations and SeismoBuild is due to the rounding of the shear capacity value exported to the Report.

COMPUTER FILES

- ASCE_JBeam4.bpf
- Report_ASCE_JBeam4.pdf

EXAMPLE 11.5

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing Beam

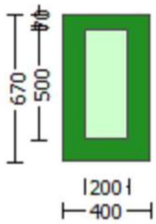
DESCRIPTION

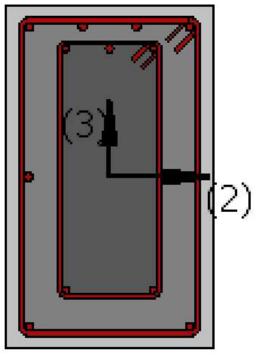
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:

New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.162. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	2	0.0130761	0.0130761
	Life Safety	End	2	0.0204694	0.0204694
Shear Capacity [kN]	Life Safety	End	3	492.752	492.752

COMPUTER FILES

- ASCE_JBeam5.bpf
- Report_ASCE_JBeam5.pdf

EXAMPLE 11.6

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min=0.30
- No FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing Beam

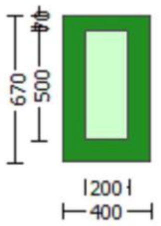
DESCRIPTION

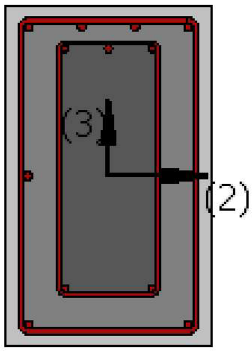
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:

New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.163. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0105334	0.0105334
	Collapse Prevention	Start	2	0.0337926	0.0337926
Shear Capacity [kN]	Collapse Prevention	Start	2	339.072	339.072

COMPUTER FILES

- ASCE_JBeam6.bpf
- Report_ASCE_JBeam6.pdf

EXAMPLE 11.7

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min=0.30
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Beam

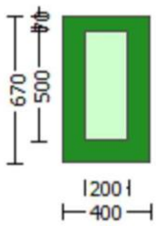
DESCRIPTION

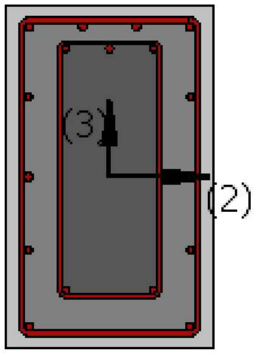
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
Existing material: Steel Strength, fs = 1.25*fsm = 555.56

For Shear Capacity Calculations:
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations (Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.164. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0076939	0.0076939
	Life Safety	End	2	0.0205827	0.0205827
Shear Capacity [kN]	Operational Level	Start	3	468.150	468.150

COMPUTER FILES

- ASCE_JBeam7.bpf
- Report_ASCE_JBeam7.pdf

EXAMPLE 11.8

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Beam

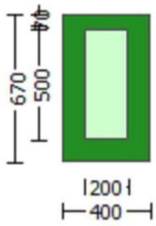
DESCRIPTION

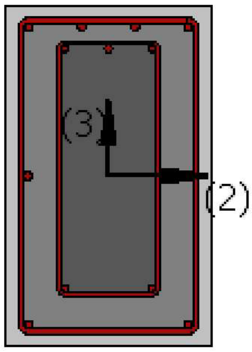
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.90

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
Existing material: Steel Strength, fs = 1.25*fsm = 555.56

For Shear Capacity Calculations:
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00

Member's Properties

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.165. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	2	0.0133137	0.0133137
	Collapse Prevention	End	3	0.0294028	0.0294028
Shear Capacity [kN]	Immediate Occupancy	Start	2	294.423	294.423

COMPUTER FILES

- ASCE_JBeam8.bpf
- Reportt_ASCE_JBeam8.pdf

EXAMPLE 11.9

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing Beam

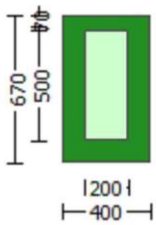
DESCRIPTION

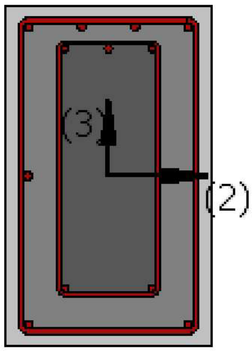
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Existing Column:
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Jacket:
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 30.00
Existing material: Steel Strength, fs = fsm = 625.00
Existing material: Steel Strength, fs = 1.25*fsm = 781.25

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound =20.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.166. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.9

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	3	0.0066567	0.0066567
	Collapse Prevention	Start	2	0.0323132	0.0323132
Shear Capacity [kN]	Collapse Prevention	Start	2	320.964	320.964

COMPUTER FILES

- ASCE_JBeam9.bpf
- Report_ASCE_JBeam9.pdf

EXAMPLE 11.10

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- No FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing Beam

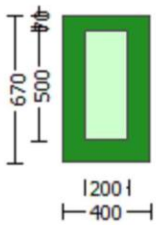
DESCRIPTION

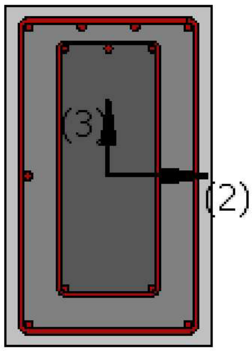
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 0.85

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 555.56
Existing material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound =25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

> **NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.**

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.167. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.10

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	Start	3	0.0069315	0.0069315
	Life Safety	End	2	0.0205334	0.0205334
Shear Capacity [kN]	Immediate Occupancy	Start	3	489.504	489.504

COMPUTER FILES

- ASCE_JBeam10.bpf
- Report_ASCE_JBeam10.pdf

EXAMPLE 11.11

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length with lo/lou,min = 0.30
- No FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing Beam

DESCRIPTION

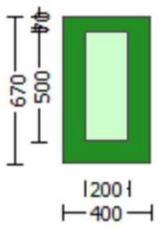
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

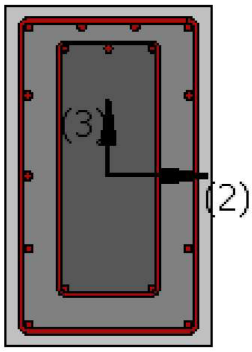
The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The

employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 555.56
Existing material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound =25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

> **NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.**

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.168. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.11

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	End	2	0.0105867	0.0105867
	Life Safety	Start	3	0.0224565	0.0224565
Shear Capacity [kN]	Operational Level	End	2	339.072	339.072

COMPUTER FILES

- ASCE_JBeam11.bpf
- Report_ASCE_JBeam11.pdf

EXAMPLE 11.12

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Ductile Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and New Material Sets type for the Existing Beam

DESCRIPTION

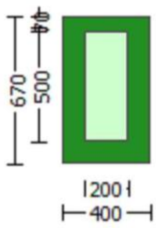
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

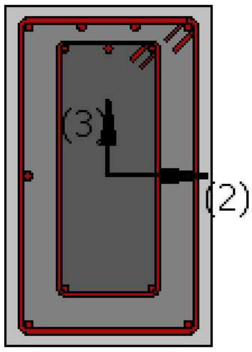
The resulting chord rotation capacity, strain and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The

employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Knowledge Factor, KF = 1.00

Materials' Properties

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
Existing material: Steel Strength, fs = fsm = 555.56
Existing material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Primary Member: Concrete Strength, fc = fc_lower_bound =25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Member's Properties

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.169. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.12

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	2	0.0109490	0.0109490
	Collapse Prevention	Start	3	0.0334404	0.0334404
Shear Capacity [kN]	Immediate Occupancy	End	2	339.072	339.072

COMPUTER FILES

- ASCE_JBeam12.bpf
- Report_ASCE_JBeam12.pdf

EXAMPLE 11.13

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Beam

DESCRIPTION

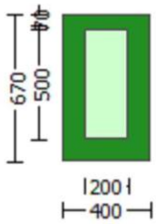
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

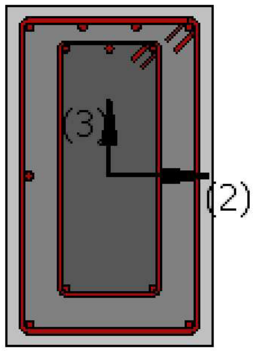
The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The

employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





<u>Units in N, mm</u>

Knowledge Factor, KF = 0.87

<u>Materials' Properties</u>

<u>Jacket:</u>
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
New material: Steel Strength, fs = 1.25*fsm = 781.25

<u>For Shear Capacity Calculations</u>:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

<u>Existing Column:</u>
Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00

<u>For Chord rotation Calculations</u>:
Existing material: Concrete Strength, fc = fcm = 24.00
Existing material: Steel Strength, fs = fsm = 525.00
Existing material: Steel Strength, fs = 1.25*fsm = 656.25

<u>For Shear Capacity Calculations</u>:
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound =16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 420.00

<u>Member's Properties</u>

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars

Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lb/lb,min>=1)
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.170. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.13

Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Operational Level	Start	3	0.0079194	0.0079194
	Life Safety	Start	2	0.0284834	0.0284834
Shear Capacity [kN]	Life Safety	Start	2	274.162	274.162

COMPUTER FILES

- ASCE_JBeam13.bpf
- Report_ASCE_JBeam13.pdf

EXAMPLE 11.14

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 300.00
- No FRP Wrapping
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Beam

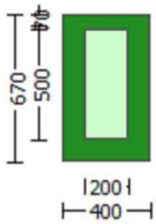
DESCRIPTION

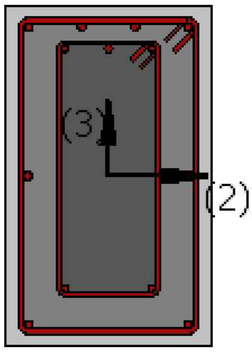
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The Chord Rotation Capacity is checked according to the tables 10-7, 10-8 and 10-9 and 10-19 of ASCE 41-17 and according to the equations (10-5) of ASCE 41-17 and (4.29) of D.Biskinis (2007). The employed equations are the (10-3) of ASCE 41-17, (22.5.1.1), (11.5.4.8), Table 11.5.4.6 and Table 22.5.5.1 of ACI 318-14 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





__Units in N, mm__

Knowledge Factor, KF = 0.90

__Materials' Properties__

Jacket:
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm 555.56
New material: Steel Strength, fs = 1.25*fsm = 694.45

For Shear Capacity Calculations:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Existing Column:
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations:
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
Existing material: Steel Strength, fs = 1.25*fsm = 555.55

For Shear Capacity Calculations:
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound =16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

__Member's Properties__

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member

Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

The beam member is modeled through an inelastic plastic-hinge force-based frame element (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 3.171. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.14

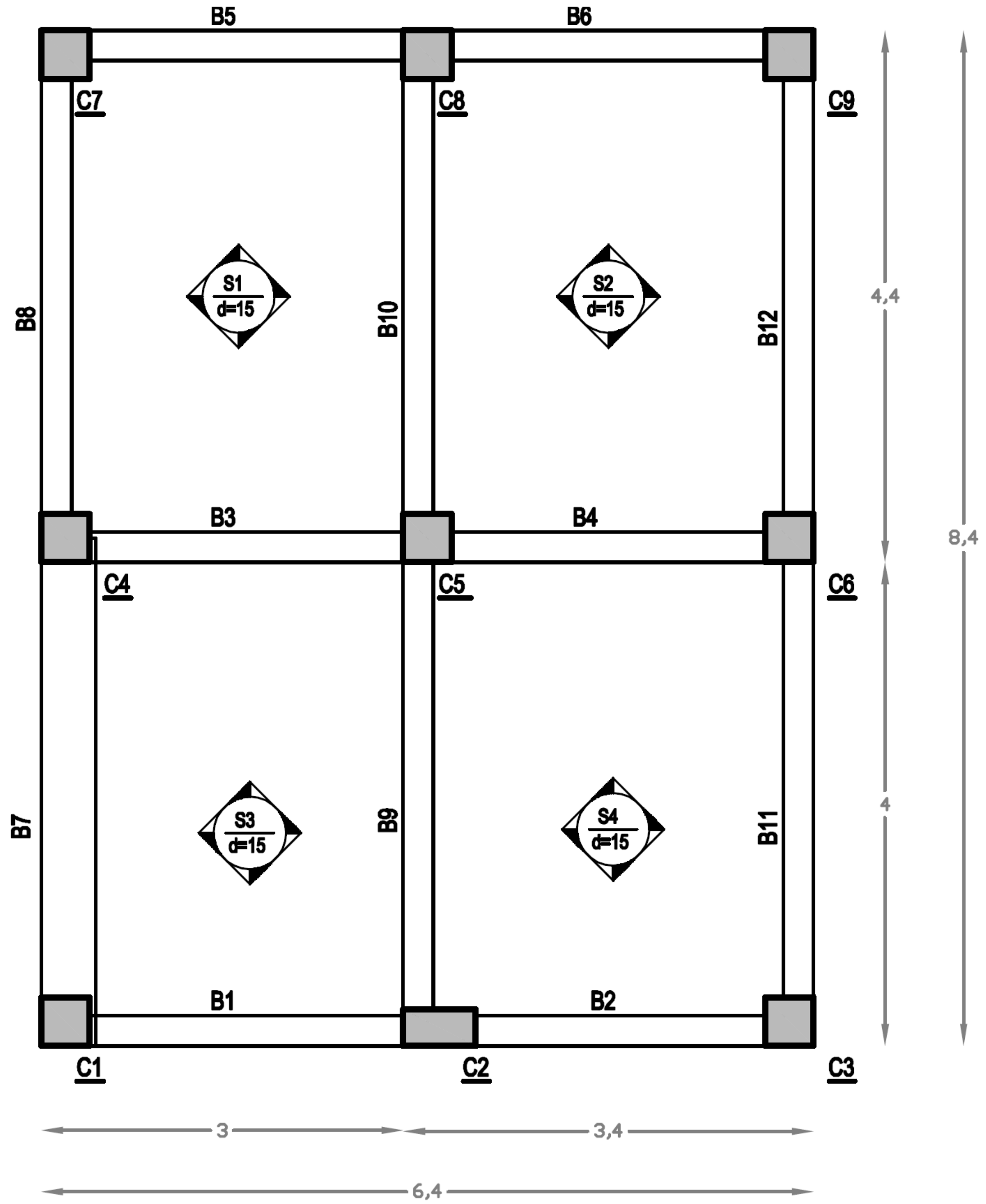
Check	Limit State	Edge	Local Axis	SeismoBuild 2018	Hand calculations
Chord Rotation Capacity [rad]	Immediate Occupancy	End	3	0.0068994	0.0068994
	Collapse Prevention	End	2	0.0276585	0.0276585
Shear Capacity [kN]	Immediate Occupancy	End	3	428.124	428.124

COMPUTER FILES

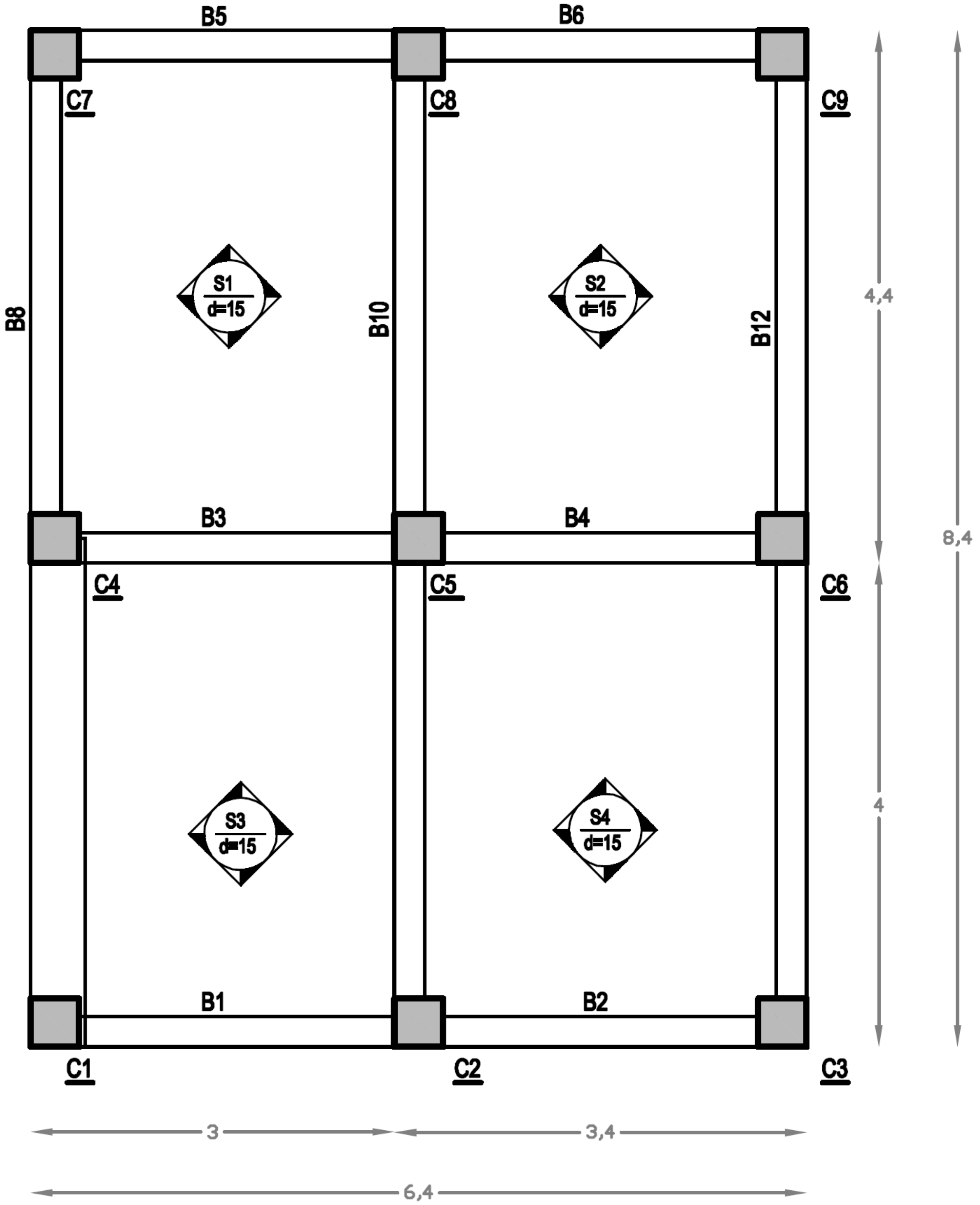
- ASCE_JBeam14.bpf
- Report_ASCE_JBeam14.pdf

Chapter 4 COMPARISON WITH INDEPENDENT HAND-CALCULATIONS – BEAM-COLUMN JOINTS CHECKS

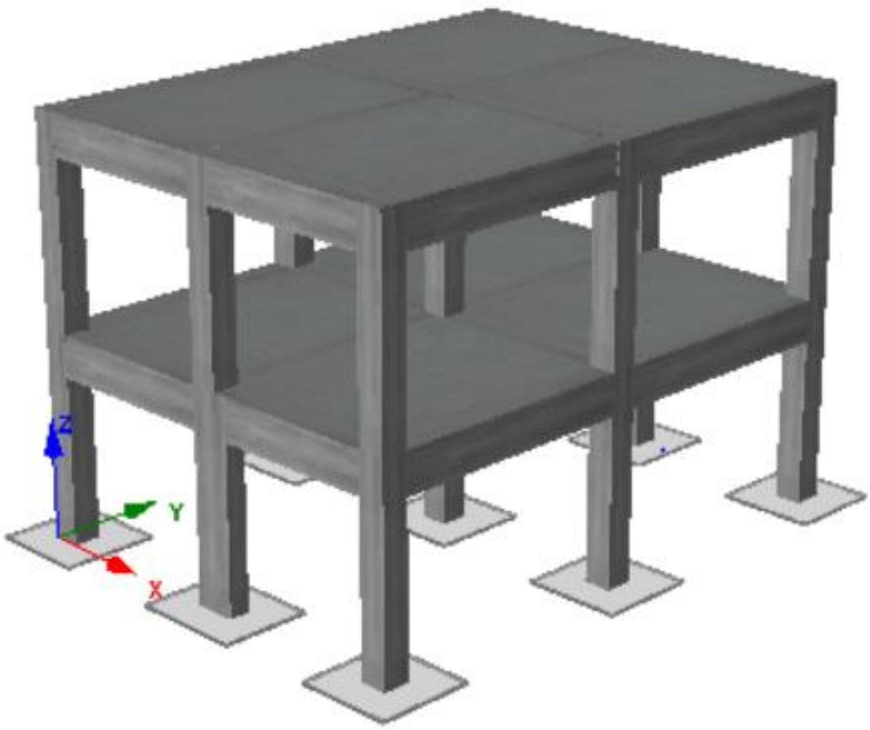
As noted above, this chapter makes use of examples, and their corresponding independent hand-calculations. A two storey 3D model with Typical Building Geometry (TBG) has been used for all the beam-columns joints examples. The plan views and the 3D model of the TBG are shown below:



1st floor Plan view of the building



2nd floor Plan view of the building



3D model of the building

EXAMPLE 1

SUCCINCT DATA

- Interior Joint: Beam B1- Column C2-Beam B2 of Floor 1
- Column Below:
  Rectangular Column section
  Primary Member
  Existing Material Sets type
- Beam B1:
  Beam section with effective width included
  Primary Member
  Existing Material Sets type
- Beam B2:
  Beam section with effective width included
  Primary Member
  Existing Material Sets type
- 1st and 2nd floor plan views are the same with TBG

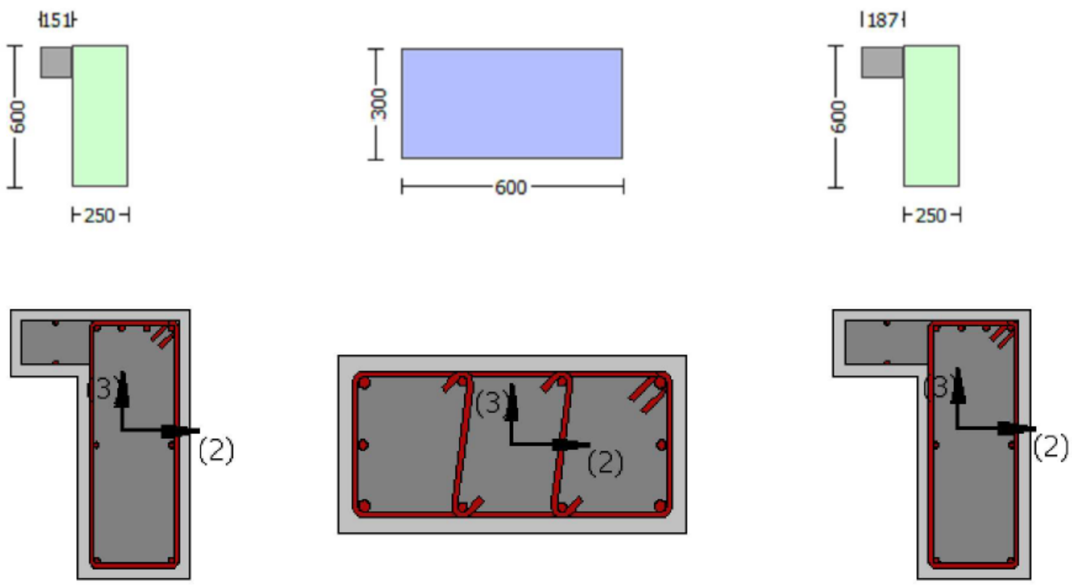
DESCRIPTION

The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting joints shear forces of the FE analysis program SeismoBuild are compared with hand calculations.

The employed equation is: (10-4) of ASCE 41-17 for Shear Capacity Checks.

GEOMETRY AND PROPERTIES



Units in N, mm

Knowledge Factor, KF=1.00

Materials' Properties

Column Below: Existing Material: fc_column = fc_lower_bound_column = 16,00
Beam B1: Existing Material: fc_column = fc_lower_bound_column = 16,00
Existing Material: fyd = fs_Lower_bound = 400,00
Beam B2: Existing Material: fc_column = fc_lower_bound_column = 16,00
Existing Material: fyd = fs_Lower_bound = 400,00

Members' Properties

Column Below

Section Height, H = 300.00
Section Width, W = 600.00

Beam B1

Section Height, H = 600.00
Section Width, W = 250.00

Beam B2

Section Height, H = 600.00
Section Width, W = 250.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

Beam and column members are modeled through the inelastic plastic-hinge force-based frame element type (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 4.1. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.1

Check	Limit State	Capacity	
		SeismoBuild 2018	Hand calculations
Shear Forces [kN]	Life Safety	996.456	996.456

COMPUTER FILES

- ASCE_Joint1.bpf
- Report_ASCE_Joint1.pdf

EXAMPLE 2

SUCCINCT DATA

- Exterior Joint: Column C2-Beam B9 of Floor 1
- Column Below:
  Rectangular Column section
  Primary Member
  Existing Material Sets type
- Beam B9:
  Beam section with effective width included
  Primary Member
  Existing Material Sets type
- 1st and 2nd floor plan views are the same with TBG

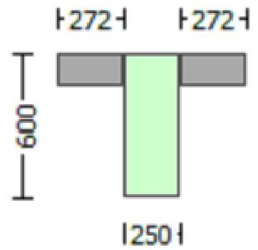
DESCRIPTION

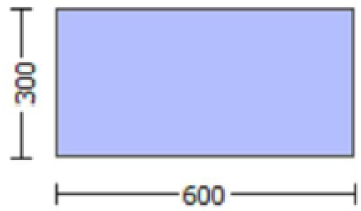
The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

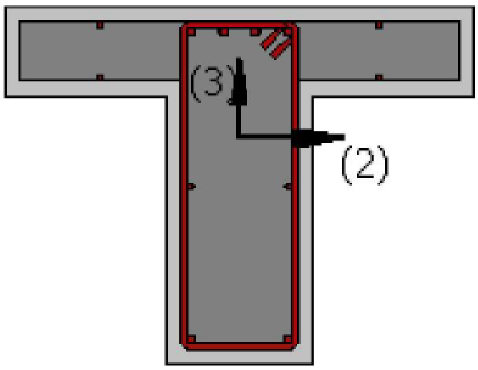
The resulting joints shear forces of the FE analysis program SeismoBuild are compared with hand calculations.

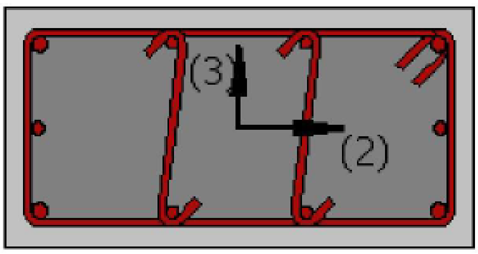
The employed equation is: (10-4) of ASCE 41-17 for Shear Capacity Checks.

GEOMETRY AND PROPERTIES









Units in N, mm

Knowledge Factor, KF=1.00

Materials' Properties

Column Below: Existing Material: fc_column = fc_lower_bound_column = 16,00
Beam B9: Existing Material: fc_beam = fc_lower_bound_beam = 16,00
Existing Material: fyd = fs_Lower_bound = 400,00

Members' Properties

Column Below

Section Height, H = 300.00
Section Width, W = 600.00

Beam B9

Section Height, H = 600.00
Section Width, W = 250.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

Beam and column members are modeled through the inelastic plastic-hinge force-based frame element type (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 4.2. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.2

Check	Limit State	Capacity	
		SeismoBuild 2018	Hand calculations
Shear Forces [kN]	Life Safety	373.671	373.671

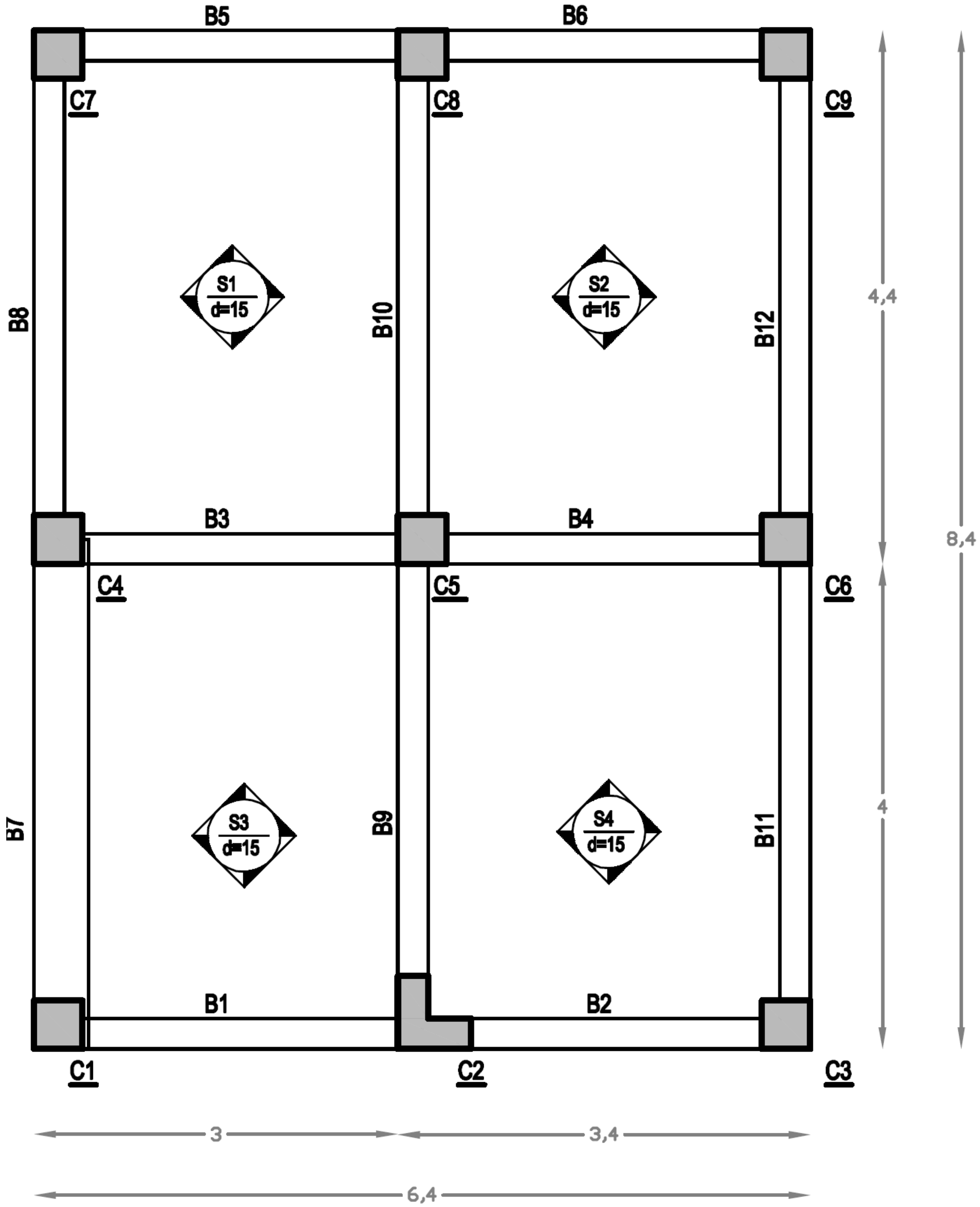
COMPUTER FILES

- ASCE_Joint2.bpf
- Report_ASCE_Joint2.pdf

EXAMPLE 3

SUCCINCT DATA

- Interior Joint: Beam B1-Column C2-Beam B2 of Floor 1
- Column Below:
  L-Shaped Column section
  Primary Member
  Existing Material Sets type
- Column Above:
  Rectangular Column section
  Primary Member
  Existing Material Sets type
- Beam B1:
  Beam section with effective width included
  Primary Member
  Existing Material Sets type
- Beam B2:
  Beam section with effective width included
  Primary Member
  New Material Sets type
- 2nd floor plan view is the same with TBG



1st floor Plan view of the building

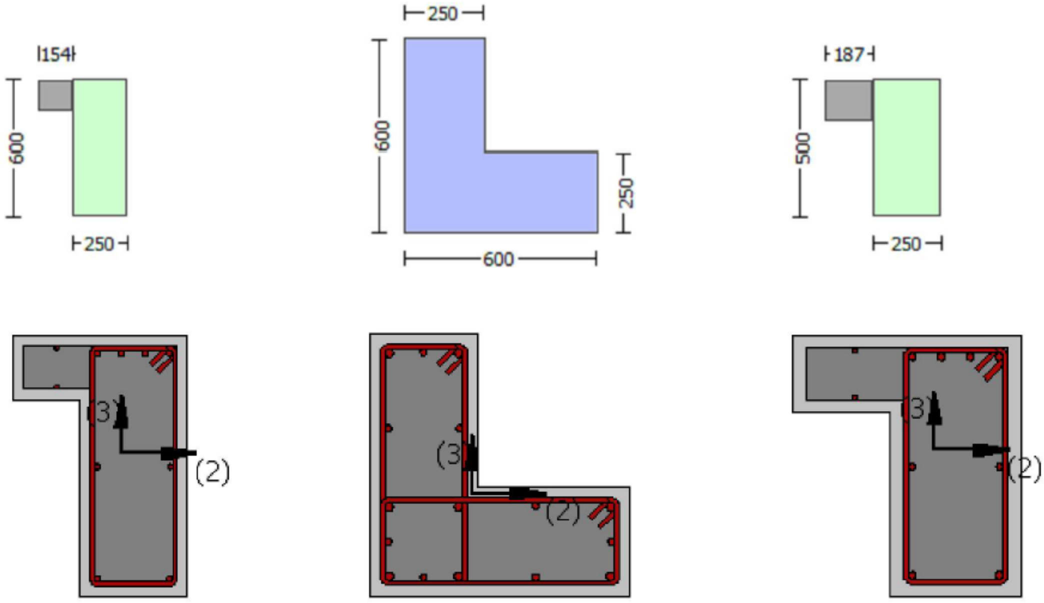
DESCRIPTION

The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting joints shear forces of the FE analysis program SeismoBuild are compared with hand calculations.

The employed equation is: (10-4) of ASCE 41-17 for Shear Capacity Checks.

GEOMETRY AND PROPERTIES



Units in N, mm

Knowledge Factor, KF=1.00

Materials' Properties

Column Below: Existing Material: fc_column = fc_lower_bound_column = 16,00
Beam B1: Existing Material: fc_beam = fc_lower_bound_beam = 16,00
Existing Material: fyd = fs_Lower_bound = 400,00
Beam B2: New Material: fcd_beam = fc_lower_bound_beam= 25,00
New Material: fyd = fs_Lower_bound = 500,00

Members' Properties

Column Below

Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00

Beam B1

Section Height, H = 500.00
Section Width, W = 250.00

Beam B2

Section Height, H = 600.00
Section Width, W = 250.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

Beam and column members are modeled through the inelastic plastic-hinge force-based frame element type (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 4.3. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.3

Check	Limit State	Capacity	
		SeismoBuild 2018	Hand calculations
Shear Forces [kN]	Collapse Prevention	996.456	996.456

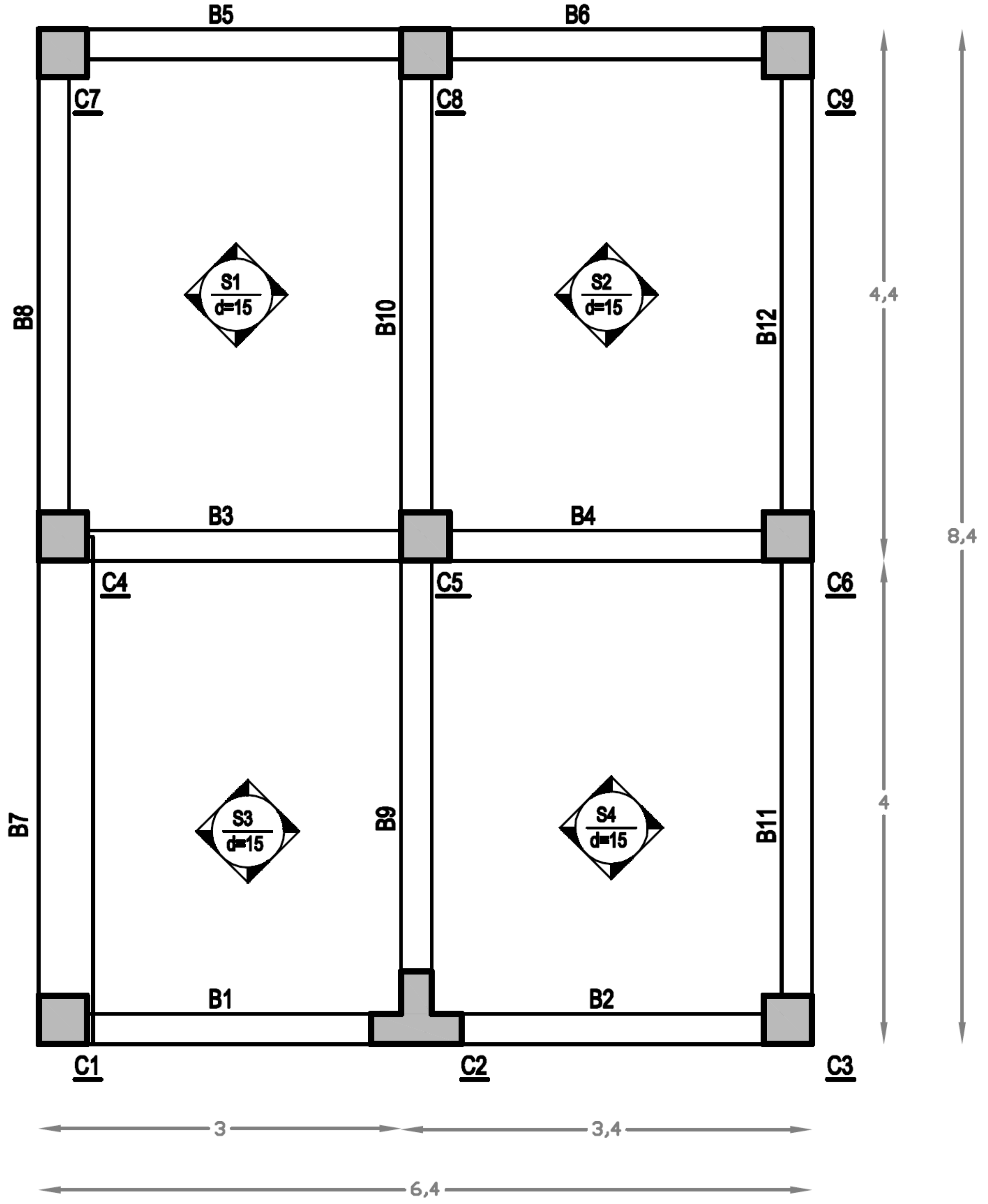
COMPUTER FILES

- ASCE_Joint3.bpf
- Report_ASCE_Joint3.pdf

EXAMPLE 4

SUCCINCT DATA

- Exterior Joint: Column C2-Beam B9 of Floor 1
- Column Below:
  T-Shaped Column section
  Primary Member
  Existing Material Sets type
- Column Above:
  Rectangular Column section
  Primary Member
  Existing Material Sets type
- Beam B9:
  Beam section with effective width included
  Primary Member
  Existing Material Sets type
- 2nd floor plan view is the same with TBG



1st floor Plan view of the building

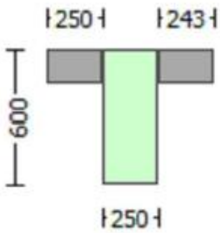
DESCRIPTION

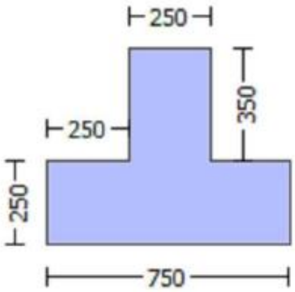
The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

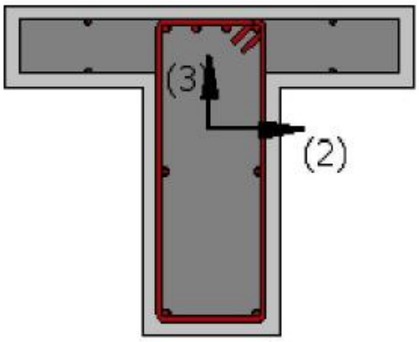
The resulting joints shear forces of the FE analysis program SeismoBuild are compared with hand calculations.

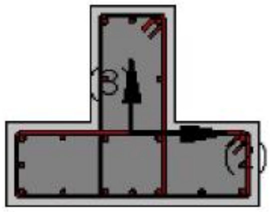
The employed equation is: (10-4) of ASCE 41-17 for Shear Capacity Checks.

GEOMETRY AND PROPERTIES









Units in N, mm

Knowledge Factor, KF=1.00

Materials' Properties

Column Below: Existing Material: fc_column = fc_lower_bound_column = 16,00
Beam B9: Existing Material: fc_beam = fc_lower_bound_beam = 16,00
Existing Material: fyd = fs_Lower_bound = 400,00

Members' Properties

Column Below

Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00

Beam B9
Section Height, H = 600.00
Section Width, W = 250.00

> **NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.**

MODELLING AND LOADING

Beam and column members are modeled through the inelastic plastic-hinge force-based frame element type (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 4.4. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.4

Check	Limit State	Capacity	
		SeismoBuild 2018	Hand calculations
Shear Forces [kN]	Life Safety	747.342	747.342

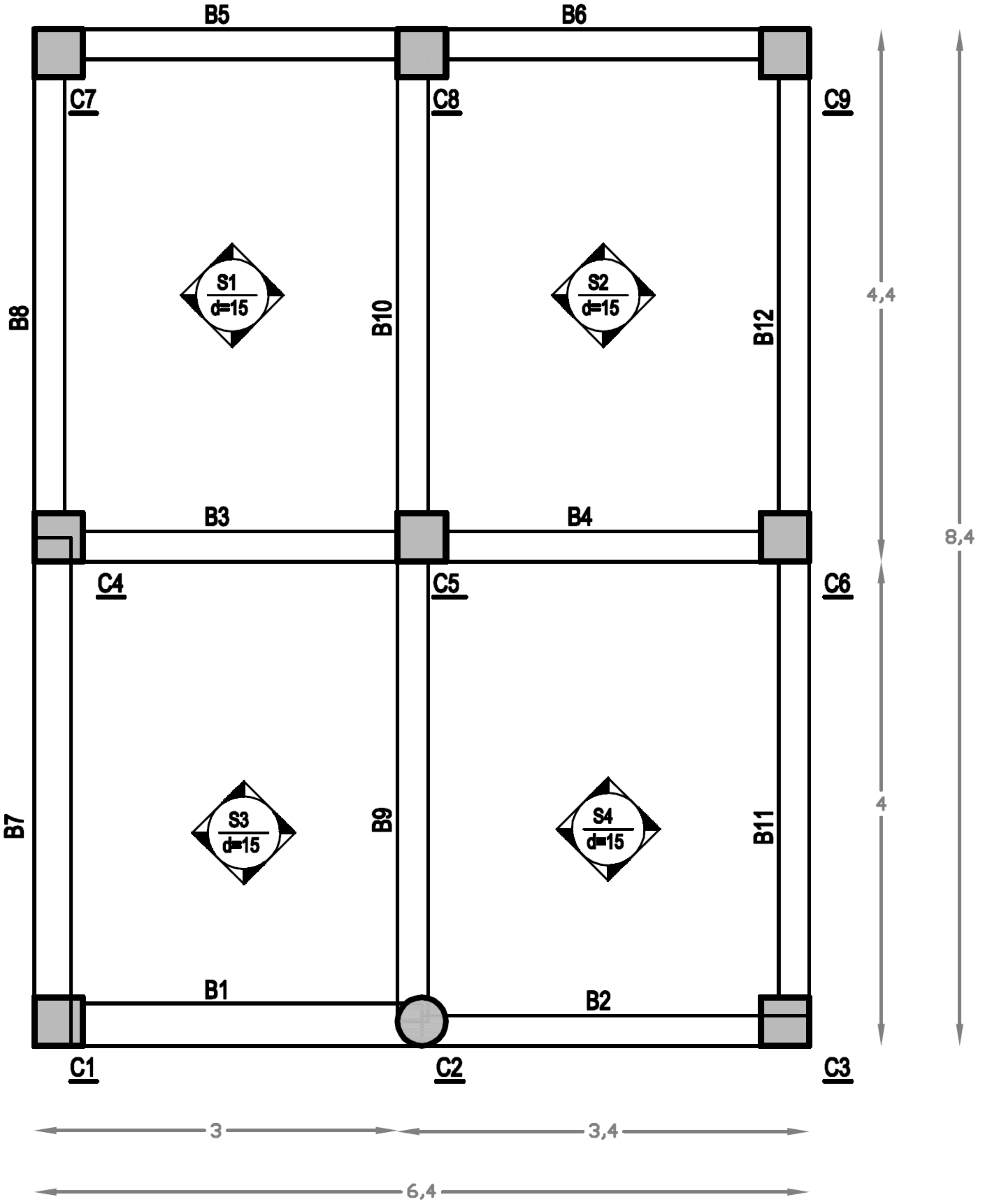
COMPUTER FILES

- ASCE_Joint4.bpf
- Report_ASCE_Joint4.pdf

EXAMPLE 5

SUCCINCT DATA

- Interior Joint: Beam B1-Column C2-Beam B2 of Floor 1
- Column Below:
  Circular Column section
  Primary Member
  New Material Sets type
- Column Above:
  Rectangular Column section
  Primary Member
  Existing Material Sets type
- Beam B1:
  Beam section with effective width included
  Primary Member
  Existing Material Sets type
- Beam B2:
  Beam section with effective width included
  Primary Member
  New Material Sets type
- 2nd floor plan view is the same with TBG



1st floor Plan view of the building

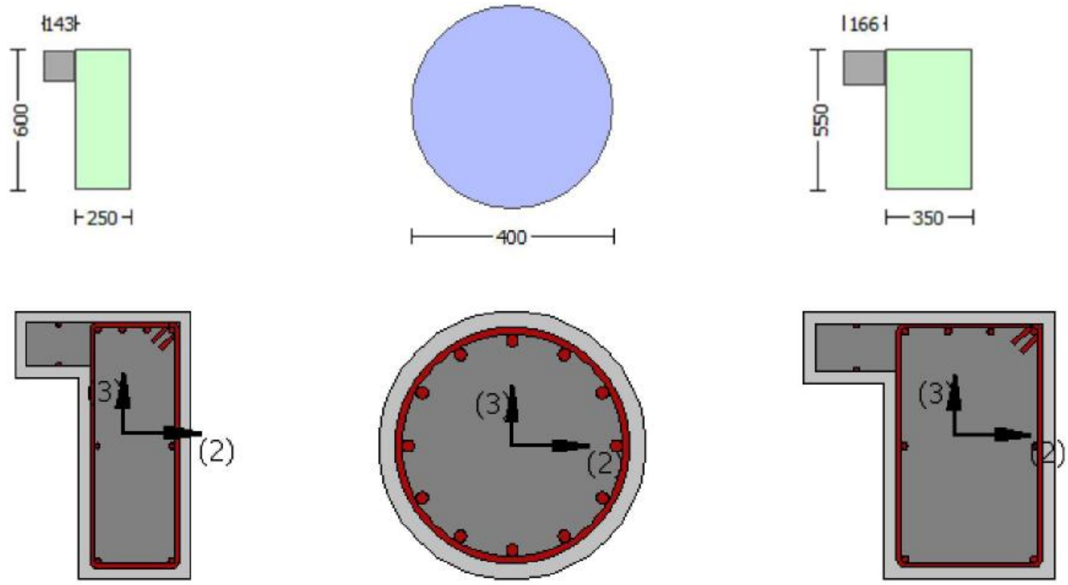
DESCRIPTION

The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting joints shear forces of the FE analysis program SeismoBuild are compared with hand calculations.

The employed equation is: (10-4) of ASCE 41-17 for Shear Capacity Checks.

GEOMETRY AND PROPERTIES



Units in N, mm

Knowledge Factor, KF=1.00

Materials' Properties

Column Below:	New Material: fc_column = fc_lower_bound_column = 25,00
Beam B1:	Existing Material: fc_beam = fc_lower_bound_beam = 16,00
	Existing Material: fyd = fs_Lower_bound = 400,00
Beam B2:	New Material: fc_column = fc_lower_bound_column = 25,00
	New Material: fyd = fs_Lower_bound = 500,00

Members' Properties

Column Below

Diameter, D = 400.00

Beam B1

Section Height, H = 550.00
Section Width, W = 350.00

Beam B2

Section Height, H = 600.00
Section Width, W = 250.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

Beam and column members are modeled through the inelastic plastic-hinge force-based frame element type (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 4.5. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.5

Check	Limit State	Capacity	
		SeismoBuild 2018	Hand calculations
Shear Forces [kN]	Immediate Occupancy	830.380	830.37805

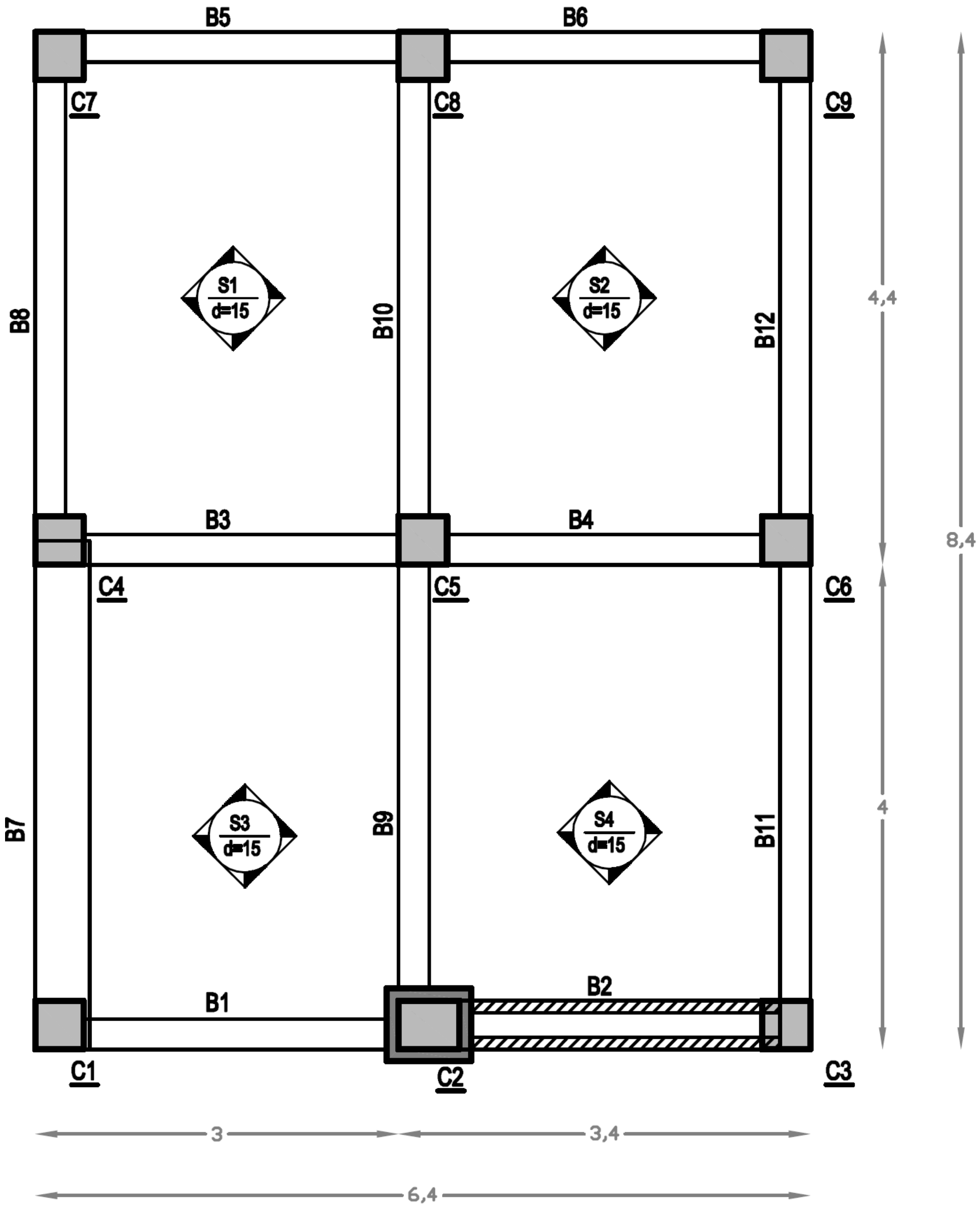
COMPUTER FILES

- ASCE_Joint5.bpf
- Report_ASCE_Joint5.pdf

EXAMPLE 6

SUCCINCT DATA

- Interior Joint: Beam B1-Column C2-Beam B2 of Floor 1
- Column Below:
  Jacketed Rectangular Column section
  Primary Member
  New Material Sets type for the Jacket and Existing Material Sets type for the Existing column
- Column Above:
  Rectangular Column section
  Primary Member
  Existing Material Sets type
- Beam B1:
  Beam section with effective width included
  Primary Member
  Existing Material Sets type
- Beam B2:
  Jacketed Beam section with effective width included
  Primary Member
  New Material Sets type for the Jacket and Existing Material Sets type for the Existing beam
- 2^{nd} floor plan view is the same with TBG



1st floor Plan view of the building

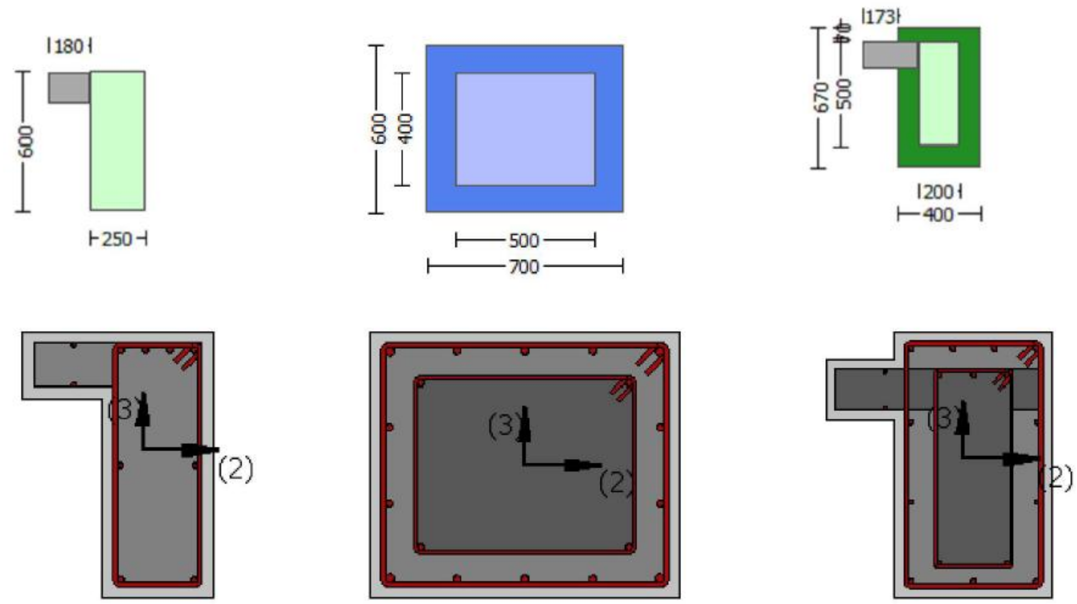
DESCRIPTION

The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting joints shear forces of the FE analysis program SeismoBuild are compared with hand calculations.

The employed equation is: (10-4) of ASCE 41-17 for Shear Capacity Checks.

The employed equation is: (10-4) of ASCE 41-17 for Shear Capacity Checks GEOMETRY AND PROPERTIES



<u>Units in N, mm</u>

Knowledge Factor, KF=1.00

<u>Materials' Properties</u>

Column Below: Existing Material: fc_column = fc_lower_bound_column = 16,00
New Material: fc_column = fc_lower_column_beam = 25,00
Beam B1: Existing Material: fc_beam = fc_lower_bound_beam = 16,00
Existing Material: fyd = fs_Lower_bound = 400,00
Beam B2: Existing Material: fc_beam = fc_lower_bound_beam = 16,00
New Material: fc_beam = fc_lower_bound_beam = 25,00
New Material: fyd_jacket = fs_Lower_bound_jacket = 500,00
Existing Material: fyd_core = fs_Lower_bound_core = 400,00

<u>Members' Properties</u>

<u>Column Below</u>

External Height, H = 600.00
External Width, W = 700.00
Internal Height, H = 400.00
Internal Width, W = 500.00

<u>Beam B1</u>

Section Height, H = 600.00
Section Width, W = 250.00

<u>Beam B2</u>

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

Beam and column members are modeled through the inelastic plastic-hinge force-based frame element type (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 4.6. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.6

Check	Limit State	Capacity	
		SeismoBuild 2018	Hand calculations
Shear Forces [kN]	Collapse Prevention	2092.6	2092.557

NOTE: The small difference in the Shear Forces values is due to the rounding of the shear capacity value exported to the Report.

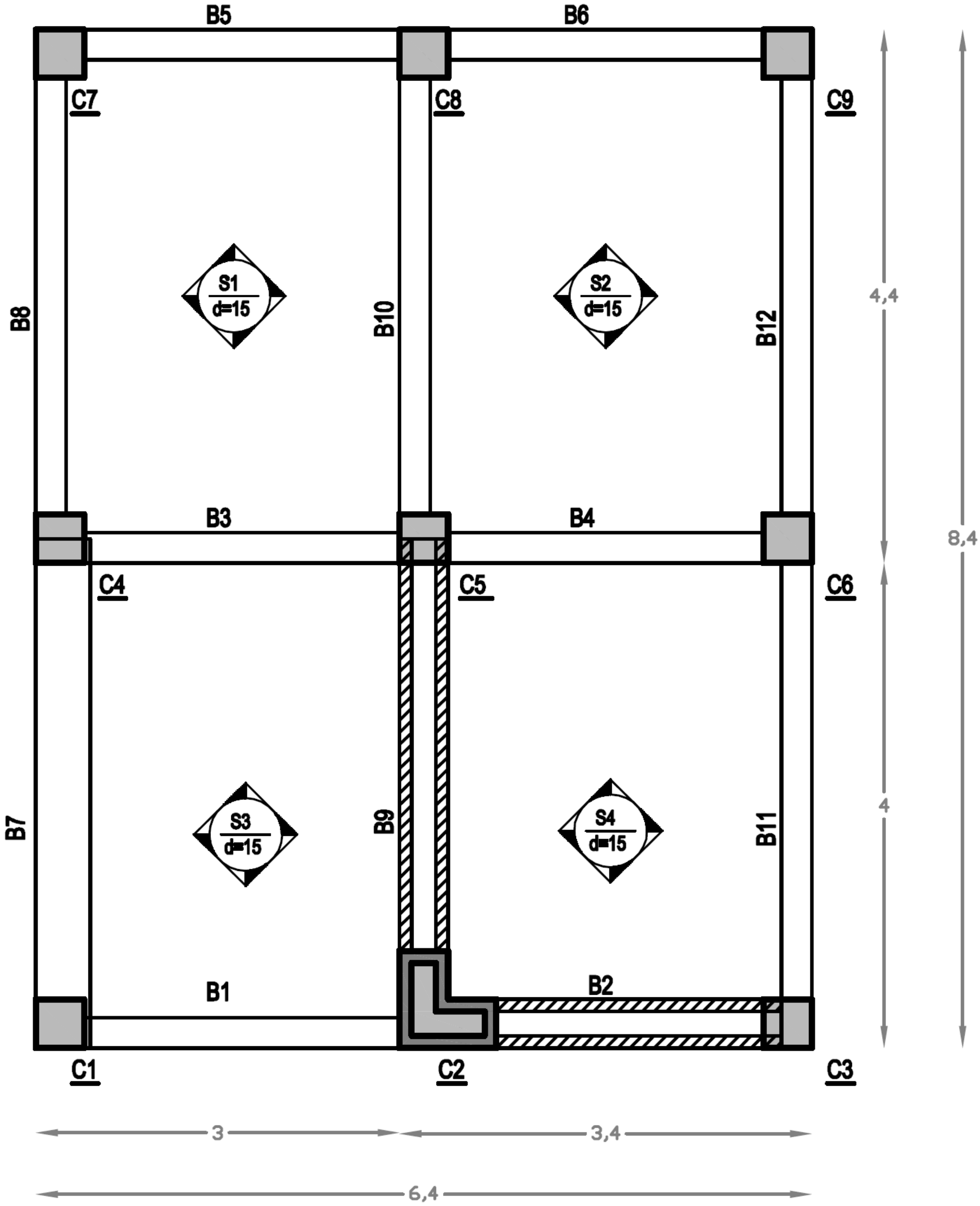
COMPUTER FILES

- ASCE_Joint6.bpf
- Report_ASCE_Joint6.pdf

EXAMPLE 7

SUCCINCT DATA

- Exterior Joint: Column C2-Beam B9 of Floor 1
- Column Below:
  Jacketed L-Shaped Column section
  Primary Member
  New Material Sets type for the Jacket and Existing Material Sets type for the Existing column
- Column Above:
  Rectangular Column section
  Primary Member
  Existing Material Sets type
- Beam B9:
  Jacketed Beam section with effective width included
  Primary Member
  New Material Sets type for the Jacket and Existing Material Sets type for the Existing beam
- 2nd floor plan view is the same with TBG



1st floor Plan view of the building

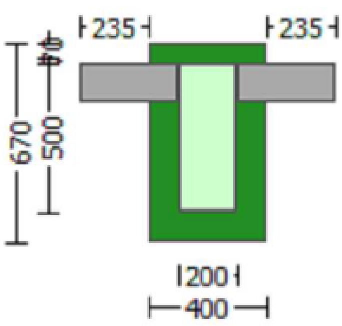
DESCRIPTION

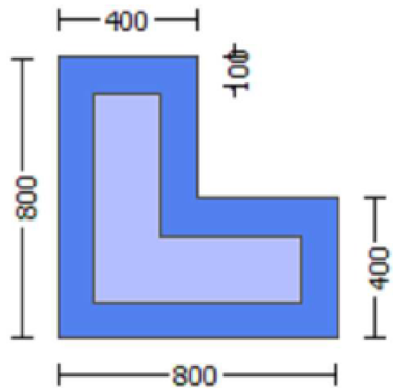
The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

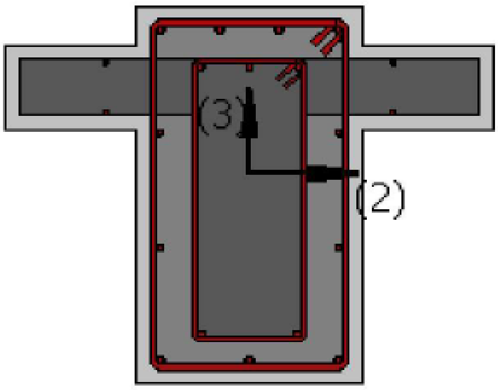
The resulting joints shear forces of the FE analysis program SeismoBuild are compared with hand calculations.

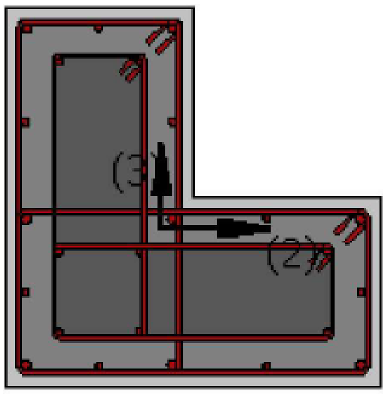
The employed equation is: (10-4) of ASCE 41-17 for Shear Capacity Checks.

GEOMETRY AND PROPERTIES









<u>Units in N, mm</u>

Knowledge Factor, KF=1.00

<u>Materials' Properties</u>

Column Below: Existing Material: fc_column = fc_lower_bound_column = 16,00
New Material: fc_column = fc_lower_bound_column = 25,00
Beam B9: Existing Material: fc_beam = fc_lower_bound_beam = 16,00
New Material: fc_beam = fc_lower_bound_beam = 25,00
New Material: fyd_jacket = fs_Lower_bound_jacket = 500,00
Existing Material: fyd_core = fs_Lower_bound_core = 400,00

<u>Members' Properties</u>

<u>Column Below</u>

Max Height, Hmax = 800.00
Min Height, Hmin = 400.00
Max Width, Wmax = 800.00
Min Width, Wmin = 400.00

<u>Beam B9</u>

External Height, H = 670.00
External Width, W = 400.00

Internal Height, H = 500.00
Internal Width, W = 200.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

Beam and column members are modeled through the inelastic plastic-hinge force-based frame element type (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 4.7. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.7

Check	Limit State	Capacity	
		SeismoBuild 2018	Hand calculations
Shear Forces [kN]	Operational Level	1594.3	1594.329

NOTE: The small difference in the Shear Forces values is due to the rounding of the shear capacity value exported to the Report.

COMPUTER FILES

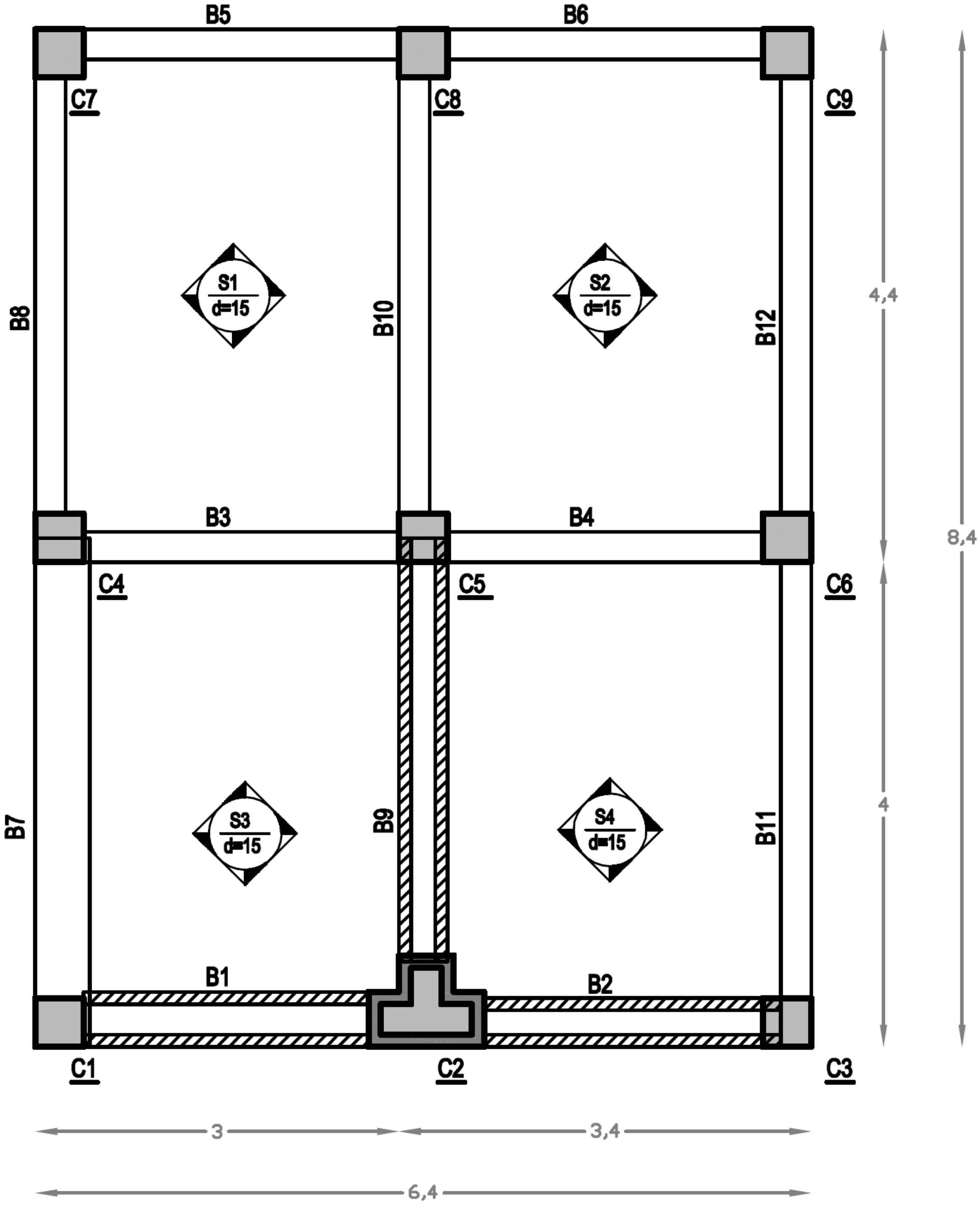
- ASCE_Joint7.bpf
- Report_ASCE_Joint7.pdf

EXAMPLE 8

SUCCINCT DATA

- Interior Joint: Beam B1-Column C2-Beam B2 of Floor 1
- Column Below:
  Jacketed T-Shaped Column section
  Primary Member
  New Material Sets type for the Jacket and Existing Material Sets type for the Existing column
- Column Above:
  Rectangular Column section
  Primary Member
  Existing Material Sets type
- Beam B1:
  Jacketed Beam section with effective width included
  Primary Member
  New Material Sets type for the Jacket and Existing Material Sets type for the Existing beam
- Beam B2:
  Jacketed Beam section with effective width included
  Primary Member
  New Material Sets type for the Jacket and Existing Material Sets type for the Existing beam

- 2nd floor plan view is the same with TBG



1st floor Plan view of the building

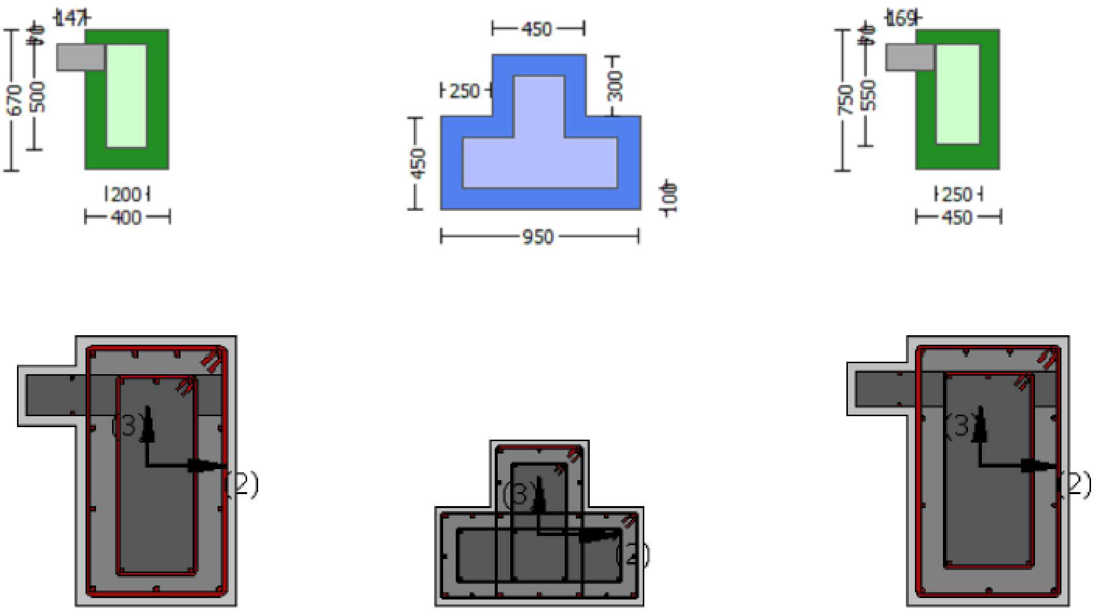
DESCRIPTION

The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting joints shear forces of the FE analysis program SeismoBuild are compared with hand calculations.

The employed equation is: (10-4) of ASCE 41-17 for Shear Capacity Checks.

GEOMETRY AND PROPERTIES



<u>Units in N, mm</u>

Knowledge Factor, KF=1.00

<u>Materials' Properties</u>

Column Below:	Existing Material: fc_column = fc_lower_bound_column = 16,00
	New Material: fc_column = fc_lower_bound_column = 25,00
Beam B1:	Existing Material: fc_beam = fc_lower_bound_beam = 16,00
	New Material: fc_beam = fc_lower_bound_beam = 25,00
	New Material: fyd_jacket = fs_Lower_bound_jacket = 500,00
	Existing Material: fyd_core = fs_Lower_bound_core = 400,00
Beam B2:	Existing Material: fc_beam = fc_lower_bound_beam = 16,00
	New Material: fc_beam = fc_lower_bound_beam = 25,00
	New Material: fyd_jacket = fs_Lower_bound_jacket = 500,00
	Existing Material: fyd_core = fs_Lower_bound_core = 400,00

<u>Members' Properties</u>

<u>Column Below</u>

Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00

Beam B1

External Height, H = 750.00
External Width, W = 450.00
Internal Height, H = 550.00
Internal Width, W = 250.00

Beam B2

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

Beam and column members are modeled through the inelastic plastic-hinge force-based frame element type (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 4.8. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.8

Check	Limit State	Capacity	
		SeismoBuild 2018	Hand calculations
Shear Forces [kN]	Life Safety	1490.0	1490.0

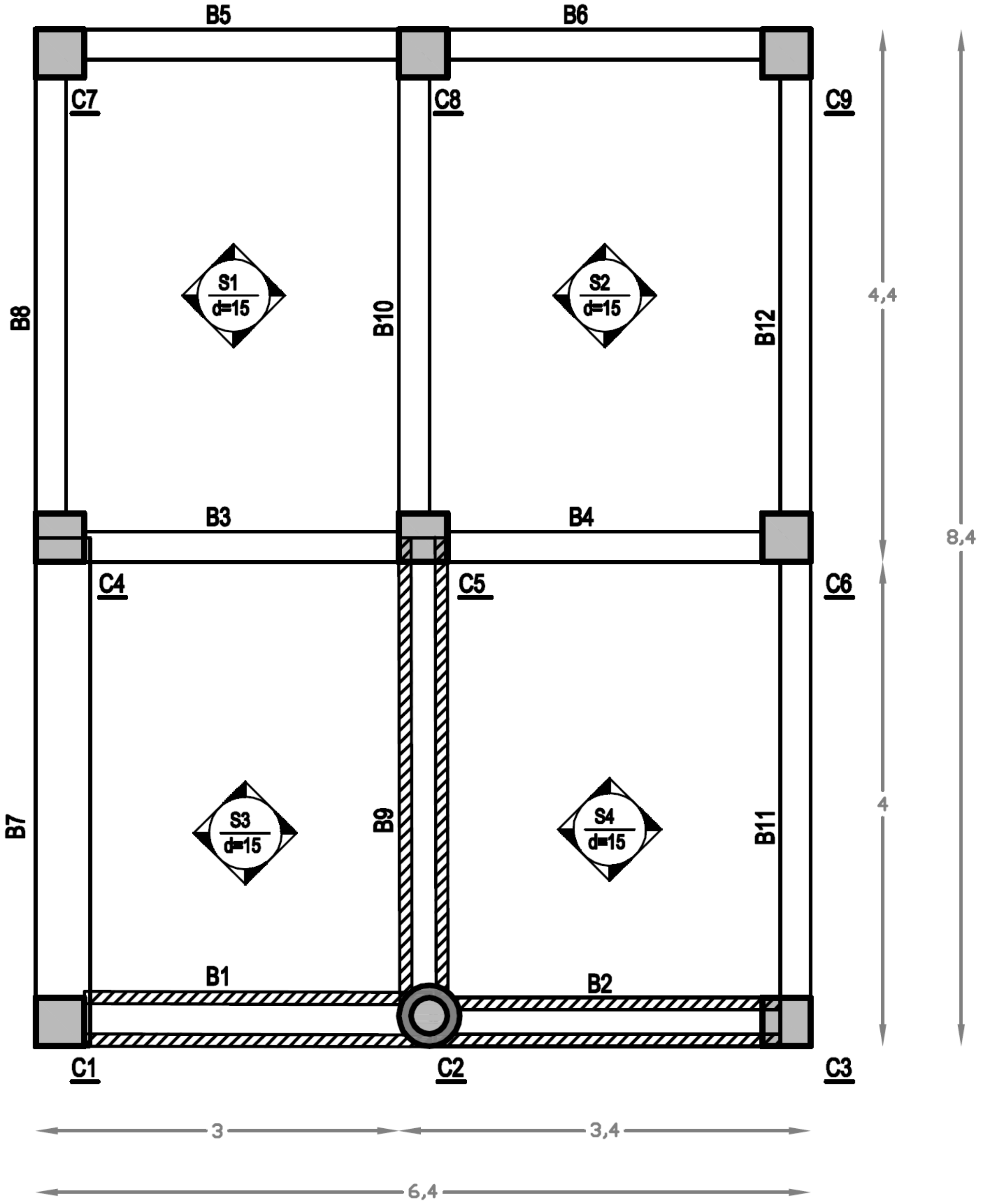
COMPUTER FILES

- ASCE_Joint8.bpf
- Report_ASCE_Joint8.pdf

EXAMPLE 9

SUCCINCT DATA

- Exterior Joint: Column C2-Beam B9 of Floor 1
- Column Below:
  Jacketed Circular Column section
  Primary Member
  New Material Sets type for the Jacket and Existing Material Sets type for the Existing column
- Column Above:
  Rectangular Column section
  Primary Member
  Existing Material Sets type
- Beam B9:
  Jacketed Beam section with effective width included
  Primary Member
  New Material Sets type for the Jacket and Existing Material Sets type for the Existing beam
- 2nd floor plan view is the same with TBG



1st floor Plan view of the building

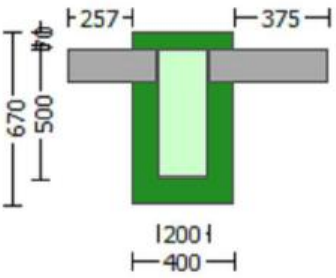
DESCRIPTION

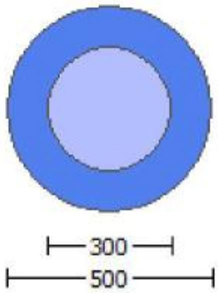
The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

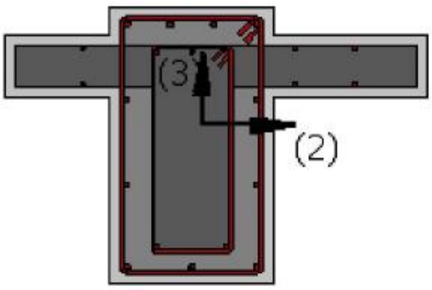
The resulting joints shear forces of the FE analysis program SeismoBuild are compared with hand calculations.

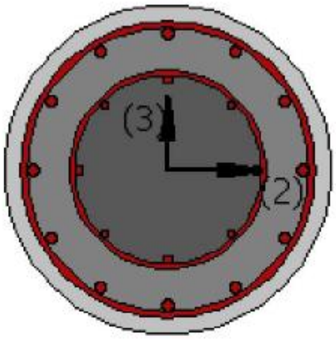
The employed equation is: (10-4) of ASCE 41-17 for Shear Capacity Checks.

GEOMETRY AND PROPERTIES









Units in N, mm

Knowledge Factor, KF=0.75

Materials' Properties

Column Below: Existing Material: fc_column = fc_lower_bound_column = 16,00
New Material: fc_column = fc_lower_bound_column = 25,00
Beam B9: Existing Material: fc_beam = fc_lower_bound_beam = 16,00
New Material: fc_beam = fc_lower_bound_beam = 25,00
New Material: fyd_jacket = fs_Lower_bound_jacket = 500,00
Existing Material: fyd_core = fs_Lower_bound_core = 400,00

Members' Properties

Column Below

External Diameter, D = 500.00
Internal Diameter, D = 300.00

Beam B9

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00

NOTE: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

Beam and column members are modeled through the inelastic plastic-hinge force-based frame element type (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 4.9. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.9

Check	Limit State	Capacity	
		SeismoBuild 2018	Hand calculations
Shear Forces [kN]	Life Safety	770.238	770.238

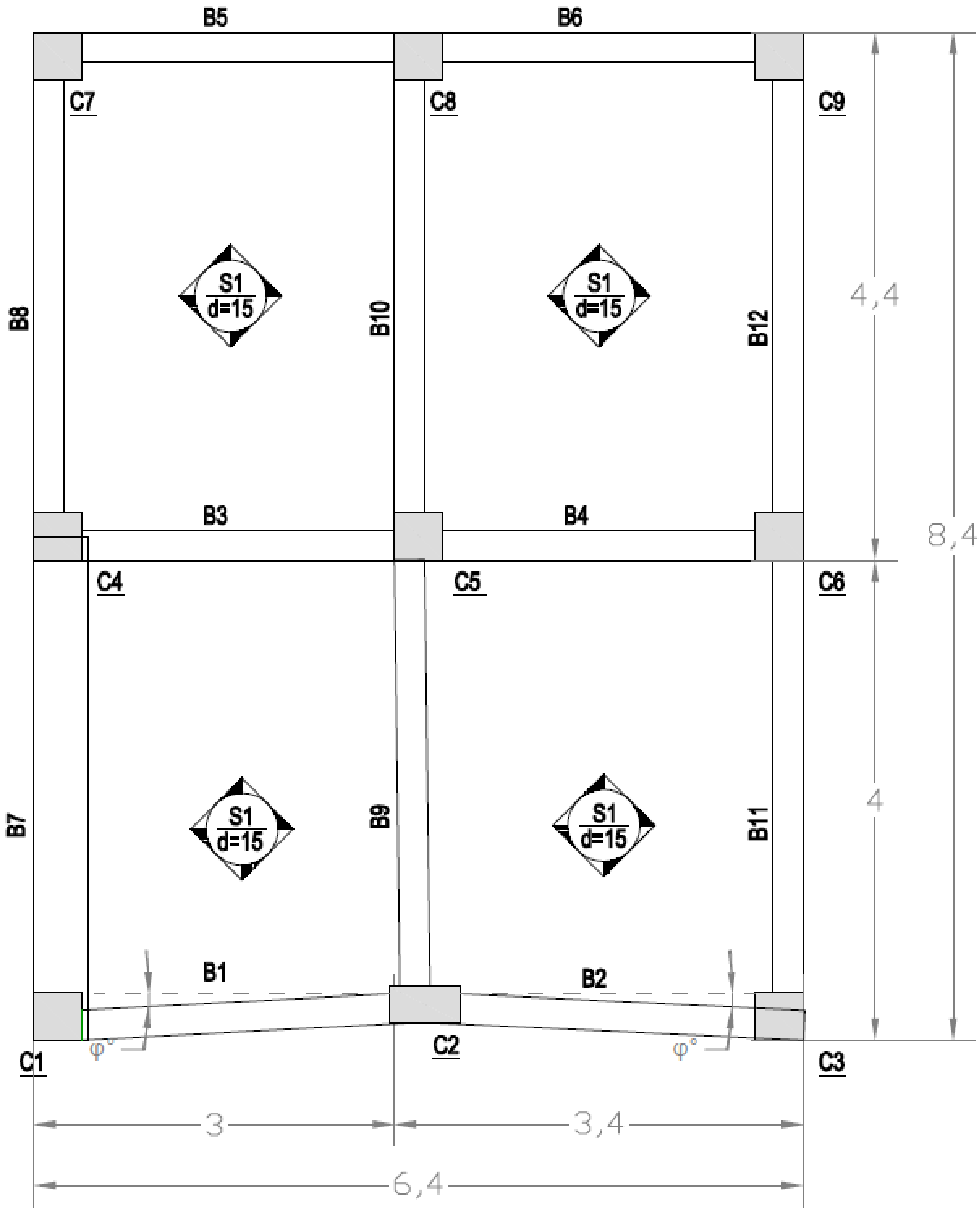
COMPUTER FILES

- ASCE_Joint9.bpf
- Report_ASCE_Joint9.pdf

EXAMPLE 10

SUCCINCT DATA

- Interior Joint: Beam B1- Column C2-Beam B2 of Floor 1
- Column Below:
  Rectangular Column section
  Primary Member
  Existing Material Sets type
- Column Above:
  Rectangular Column section
  Secondary Member
  Existing Material Sets type
- Beam B1:
  Beam section with effective width included
  Primary Member
  Existing Material Sets type
- Beam B2:
  Beam section with effective width included
  Primary Member
  Existing Material Sets type
- 2nd floor plan view is the same with TBG



1st floor Plan view of the building

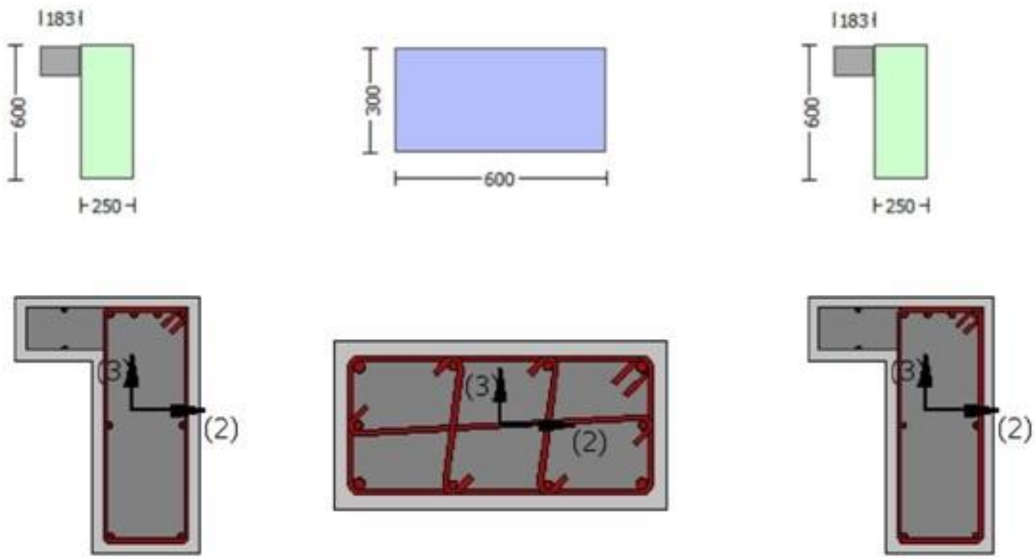
DESCRIPTION

The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting joints shear forces of the FE analysis program SeismoBuild are compared with hand calculations.

The employed equation is: (10-4) of ASCE 41-17 for Shear Capacity Checks.

GEOMETRY AND PROPERTIES



Units in N, mm

Knowledge Factor, KF=0.90

Materials' Properties

Column Below: Existing Material: fc_column = fc_lower_bound_column = 16,00
Beam B1: Existing Material: fc_beam = fc_lower_bound_beam = 16,00
Existing Material: fyd = fs_Lower_bound = 400,00
Beam B2: Existing Material: fc_beam = fc_lower_bound_beam = 16,00
Existing Material: fyd = fs_Lower_bound = 400,00

Members' Properties

Column Below

Section Height, H = 300.00
Section Width, W = 600.00

Beam B1

Section Height, H = 600.00
Section Width, W = 250.00

Beam B2

Section Height, H = 600.00
Section Width, W = 250.00

NOTE 1: If the rotation angle between beam B2 and column C2(φ°) is less than 45°then the beam B2 is taken as horizontal. Else, if $\varphi > 45^{\circ}$then the beam B2 is taken as vertical.

NOTE 2: All the required values for hand calculations may be exported to the Report by selecting the member of interest in the *Detailed Calculations(Annex)* tab of the Print-out Options module.

MODELLING AND LOADING

Beam and column members are modeled through the inelastic plastic-hinge force-based frame element type (infrmFBPH).

ANALYSIS TYPE

Pushover analysis (Uniaxial without Eccentricity-Uniform +X)

RESULTS COMPARISON

The most significant results are compared in the table below:

Table 4.10. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.10

Check	Limit State	Capacity	
		SeismoBuild 2018	Hand calculations
Shear Forces [kN]	Immediate Occupancy	871.967	871.967

COMPUTER FILES

- ASCE_Joint10.bpf
- Report_ASCE_Joint10.pdf