SeismoBuild

Verification Report

For version 2021

Copyright

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Table of Contents

SeismoBuild 1

Verification Report 1

Copyright 3

Chapter 1 INTRODUCTION 9
Presentation of the analysis program 9
Structure of the report 9
Program features covered by the program 9

Chapter 2 Capacity Models for Assessment and Checks according to EUROCODES 12
Capacity Models for Assessment and Checks 12
Deformation Capacity *12*
Shear Capacity *15*
Joints Shear Forces *16*
Joints Horizontal Hoops Area *16*
Joints Vertical Reinforcement Area *17*

Chapter 3 COMPARISON WITH INDEPENDENT HAND-CALCULATIONS – MEMBER CHECKS 18
EXAMPLES SET 1: Rectangular Column Section 18
EXAMPLE 1.1 ..... *18*
EXAMPLE 1.2 ..... *20*
EXAMPLE 1.3 ..... *21*
EXAMPLE 1.4 ..... *23*
EXAMPLE 1.5 ..... *25*
EXAMPLE 1.6 ..... *27*
EXAMPLE 1.7 ..... *29*
EXAMPLE 1.8 ..... *31*
EXAMPLE 1.9 ..... *33*
EXAMPLES SET 2: L-Shaped Column Section 35
EXAMPLE 2.1 ..... *35*
EXAMPLE 2.2 ..... *37*
EXAMPLE 2.3 ..... *39*
EXAMPLE 2.4 ..... *41*
EXAMPLE 2.5 ..... *43*
EXAMPLE 2.6 ..... *45*
EXAMPLE 2.7 ..... *47*
EXAMPLE 2.8 ..... *49*
EXAMPLE 2.9 ..... *51*
EXAMPLES SET 3: T-Shaped Column Section 53
EXAMPLE 3.1 ..... *53*
EXAMPLE 3.2 ..... *55*
EXAMPLE 3.3 ..... *57*
EXAMPLE 3.4 ..... *59*
EXAMPLE 3.5 ..... *61*
EXAMPLE 3.6 ..... *63*
EXAMPLE 3.7 ..... *65*
EXAMPLE 3.8 ..... *67*
EXAMPLE 3.9 ..... *69*
EXAMPLES SET 4: Circular Column Section 71

EXAMPLE 4.1 ..... *71*
EXAMPLE 4.2 ..... *73*
EXAMPLE 4.3 ..... *75*
EXAMPLE 4.4 ..... *77*
EXAMPLE 4.5 ..... *79*
EXAMPLE 4.6 ..... *81*
EXAMPLE 4.7 ..... *83*
EXAMPLE 4.8 ..... *85*
EXAMPLE 4.9 ..... *87*
EXAMPLE 4.10 ..... *89*
EXAMPLE 4.11 ..... *91*
EXAMPLE 4.12 ..... *93*
EXAMPLE 4.13 ..... *95*
EXAMPLES SET 5: Wall Section 97
EXAMPLE 5.1 ..... *97*
EXAMPLE 5.2 ..... *99*
EXAMPLE 5.3 ..... *101*
EXAMPLE 5.4 ..... *103*
EXAMPLE 5.5 ..... *105*
EXAMPLE 5.6 ..... *107*
EXAMPLE 5.7 ..... *109*
EXAMPLE 5.8 ..... *111*
EXAMPLE 5.9 ..... *113*
EXAMPLE 5.10 ..... *115*
EXAMPLES SET 6: Beam Section 117
EXAMPLE 6.1 ..... *117*
EXAMPLE 6.2 ..... *119*
EXAMPLE 6.3 ..... *121*
EXAMPLE 6.4 ..... *123*
EXAMPLE 6.5 ..... *125*
EXAMPLE 6.6 ..... *127*
EXAMPLE 6.7 ..... *129*
EXAMPLE 6.8 ..... *131*
EXAMPLE 6.9 ..... *133*
EXAMPLE 6.10 ..... *135*
EXAMPLE 6.11 ..... *137*
EXAMPLE 6.12 ..... *139*
EXAMPLE 6.13 ..... *141*
EXAMPLES SET 7: Jacketed Rectangular Column Section 143
EXAMPLE 7.1 ..... *143*
EXAMPLE 7.2 ..... *145*
EXAMPLE 7.3 ..... *147*
EXAMPLE 7.4 ..... *149*
EXAMPLE 7.5 ..... *151*
EXAMPLE 7.6 ..... *153*
EXAMPLE 7.7 ..... *155*
EXAMPLE 7.8 ..... *157*
EXAMPLE 7.9 ..... *160*
EXAMPLES SET 8: Jacketed L-Shaped Column Section 162
EXAMPLE 8.1 ..... *162*
EXAMPLE 8.2 ..... *164*
EXAMPLE 8.3 ..... *166*
EXAMPLE 8.4 ..... *168*
EXAMPLE 8.5 ..... *170*
EXAMPLE 8.6 ..... *172*
EXAMPLE 8.7 ..... *174*

EXAMPLE 8.8 ..... *176*
EXAMPLE 8.9 ..... *178*
EXAMPLE 8.10 ..... *180*
EXAMPLE 8.11 ..... *182*
EXAMPLES SET 9: Jacketed T-Shaped Column Section 185
EXAMPLE 9.1 ..... *185*
EXAMPLE 9.2 ..... *187*
EXAMPLE 9.3 ..... *189*
EXAMPLE 9.4 ..... *191*
EXAMPLE 9.5 ..... *193*
EXAMPLE 9.6 ..... *196*
EXAMPLE 9.7 ..... *198*
EXAMPLE 9.8 ..... *200*
EXAMPLE 9.9 ..... *202*
EXAMPLE 9.10 ..... *204*
EXAMPLE 9.11 ..... *207*
EXAMPLE 9.12 ..... *209*
EXAMPLES SET 10: Jacketed Circular Column Section 212
EXAMPLE 10.1 ..... *212*
EXAMPLE 10.2 ..... *214*
EXAMPLE 10.3 ..... *216*
EXAMPLE 10.4 ..... *219*
EXAMPLE 10.5 ..... *221*
EXAMPLE 10.6 ..... *223*
EXAMPLE 10.7 ..... *226*
EXAMPLES SET 11: Jacketed Beam Section 228
EXAMPLE 11.1 ..... *228*
EXAMPLE 11.2 ..... *230*
EXAMPLE 11.3 ..... *232*
EXAMPLE 11.4 ..... *234*
EXAMPLE 11.5 ..... *236*
EXAMPLE 11.6 ..... *238*
EXAMPLE 11.7 ..... *241*
EXAMPLE 11.8 ..... *243*
EXAMPLE 11.9 ..... *245*

Chapter 4 COMPARISON WITH INDEPENDENT HAND-CALCULATIONS – BEAM-COLUMN JOINTS CHECKS 248
EXAMPLE 1 ..... *250*
EXAMPLE 2 ..... *252*
EXAMPLE 3 ..... *254*
EXAMPLE 4 ..... *257*
EXAMPLE 5 ..... *260*
EXAMPLE 6 ..... *263*
EXAMPLE 7 ..... *266*
EXAMPLE 8 ..... *269*
EXAMPLE 9 ..... *272*
EXAMPLE 10 ..... *275*

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 2021** 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 Eurocode-8 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 Eurocode-8 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	Employed CODE	Section Type	File name	Element Type	Material Type	Equations	Jacketed	FRP	Adequate lap length	Inadequate relative lap length	Absolute lap length	Members with longitudinal bars without lapping in the vicinity of the end regions	Without detailing for earthquake resistance	Smooth (Plain) Longitudinal Bars	Cold-Worked Brittle Steel	Different Safety/Partial Factors from the default values
Example 1.1	EC8	Rectangular	EC_rect_1.bpf	Primary	Existing	A3+A10a			√							
Example 1.2			EC_rect_2.bpf	Primary	Existing	A1+A10a			√							
Example 1.3			EC_rect_3.bpf	Secondary	Existing	A3+A10a			√							
Example 1.4			EC_rect_4.bpf	Secondary	New	A1+A10b				√			√			
Example 1.5			EC_rect_5.bpf	Primary	new	A3+A10a					√				√	
Example 1.6			EC_rect_6.bpf	Primary	Existing	A3+A10b					√	√	√	√	√	
Example 1.7			EC_rect_7.bpf	Primary	Existing	A1+A10a			√							√
Example 1.8			EC_rect_8.bpf	Secondary	New	A1+A10a		√	√			√			√	
Example 1.9			EC_rect_9.bpf	Primary	Existing	A3+A10a		√		√						
Example 2.1		L-Shaped	EC_rclcs1.bpf	Primary	Existing	A1+A10b				√						√
Example 2.2			EC_rclcs2.bpf	Secondary	Existing	A3+A10a		√			√					
Example 2.3			EC_rclcs3.bpf	Primary	New	A3+A10b			√			√	√	√	√	
Example 2.4			EC_rclcs4.bpf	Primary	Existing	A1+A10a			√			√	√			
Example 2.5			EC_rclcs5.bpf	Secondary	New	A1+A10a		√		√						
Example 2.6			EC_rclcs6.bpf	Primary	Existing	A3+A10b					√					√
Example 2.7			EC_rclcs7.bpf	Secondary	Existing	A1+A10a			√					√	√	
Example 2.8			EC_rclcs8.bpf	Secondary	New	A1+A10b			√			√				
Example 2.9			EC_rclcs9.bpf	Secondary	Existing	A1+A10a					√	√		√		
Example 3.1		T-Shaped	EC_rctcs1.bpf	Primary	New	A1+A10a			√					√		√
Example 3.2			EC_rctcs2.bpf	Primary	Existing	A1+A10b			√							√
Example 3.3			EC_rctcs3.bpf	Primary	Existing	A3+A10a			√							√
Example 3.4			EC_rctcs4.bpf	Primary	Existing	A3+A10b			√			√				
Example 3.5			EC_rctcs5.bpf	Primary	New	A3+A10a					√		√		√	
Example 3.6			EC_rctcs6.bpf	Secondary	Existing	A1+A10a		√			√					√
Example 3.7			EC_rctcs7.bpf	Primary	New	A3+A10a					√		√	√		
Example 3.8			EC_rctcs8.bpf	Primary	New	A3+A10a					√	√		√		
Example 3.9			EC_rctcs9.bpf	Primary	Existing	A1+A10a		√	√				√		√	
Example 4.1		Circular	EC_rccs1.bpf	Primary	Existing	A3+A10b			√							
Example 4.2			EC_rccs2.bpf	Primary	Existing	A1+A10b			√							
Example 4.3			EC_rccs3.bpf	Secondary	New	A3+A10b				√		√				√
Example 4.4			EC_rccs4.bpf	Secondary	New	A1+A10b				√		√				
Example 4.5			EC_rccs5.bpf	Primary	New	A1+A10a			√				√	√	√	
Example 4.6			EC_rccs6.bpf	Secondary	Existing	A1+A10a		√			√	√				√
Example 4.7			EC_rccs7.bpf	Primary	Existing	A1+A10a		√			√	√	√	√	√	
Example 4.8			EC_rccs8.bpf	Primary	Existing	A3+A10a		√			√	√	√	√	√	
Example 4.9			EC_rccs9.bpf	Primary	Existing	A3+A10a		√			√	√		√		
Example 4.10			EC_rccs10.bpf	Primary	Existing	A3+A10a		√			√			√		
Example 4.11			EC_rccs11.bpf	Primary	Existing	A3+A10a			√							√
Example 4.12			EC_rccs12.bpf	Primary	Existing	A1+A10a		√			√			√		
Example 4.13			EC_rccs13.bpf	Primary	Existing	A1+A10a		√			√	√		√		
Example 5.1		Wall	EC_rcrws1.bpf	Primary	New	A3+A11a		√		√						
Example 5.2			EC_rcrws2.bpf	Secondary	Existing	A3+A11b			√			√	√		√	
Example 5.3			EC_rcrws3.bpf	Primary	Existing	A3+A11a			√							√
Example 5.4			EC_rcrws4.bpf	Primary	New	A3+A11b					√			√		√
Example 5.5			EC_rcrws5.bpf	Primary	Existing	A1+A11a				√		√	√			
Example 5.6			EC_rcrws6.bpf	Secondary	New	A1+A11a		√			√					√
Example 5.7			EC_rcrws7.bpf	Primary	New	A1+A11a			√					√	√	
Example 5.8			EC_rcrws8.bpf	Primary	Existing	A1+A11b			√							
Example 5.9			EC_rcrws9.bpf	Secondary	New	A1+A11b					√	√				
Example 5.10			EC_rcrws10.bpf	Primary	Existing	A1+A11a				√		√		√		
Example 6.1		Beams	EC_Beam1.bpf	Primary	Existing	A1+A10a			√							
Example 6.2			EC_Beam2.bpf	Primary	Existing	A1+A10a					√	√	√	√	√	
Example 6.3			EC_Beam3.bpf	Primary	Existing	A1+A10b					√	√	√	√	√	
Example 6.4			EC_Beam4.bpf	Primary	Existing	A3+A10a					√	√	√	√	√	
Example 6.5			EC_Beam5.bpf	Primary	Existing	A3+A10b					√	√	√	√	√	
Example 6.6			EC_Beam6.bpf	Primary	New	A3+A10b				√			√		√	
Example 6.7			EC_Beam7.bpf	Primary	New	A3+A10a				√			√		√	
Example 6.8			EC_Beam8.bpf	Primary	New	A1+A10a				√			√		√	
Example 6.9			EC_Beam9.bpf	Primary	New	A1+A10b				√			√		√	
Example 6.10			EC_Beam10.bpf	Secondary	New	A1+A10b				√			√		√	
Example 6.11			EC_Beam11.bpf	Primary	Existing	A3+A10b			√				√	√		√
Example 6.12			EC_Beam12.bpf	Primary	Existing	A1+A10b			√				√	√		√
Example 6.13			EC_Beam13.bpf	Primary	New	A3+A10b				√			√		√	
Example 7.1		Jacketed Rectangular	EC_rcjrs1.bpf	Primary	New+Existing	A1+A10a	√	√	√							√
Example 7.2			EC_rcjrs2.bpf	Secondary	New+Existing	A1+A10a	√				√	√	√			
Example 7.3			EC_rcjrs3.bpf	Secondary	New+Existing	A1+A10a	√			√				√	√	
Example 7.4			EC_rcjrs4.bpf	Primary	New+Existing	A1+A10b	√		√							
Example 7.5			EC_rcjrs5.bpf	Secondary	New+Existing	A1+A10b	√			√		√				
Example 7.6			EC_rcjrs6.bpf	Primary	New+Existing	A3+A10a	√			√				√		
Example 7.7			EC_rcjrs7.bpf	Secondary	New+Existing	A3+A10b	√	√			√					
Example 7.8			EC_rcjrs8.bpf	Secondary	New+Existing	A3+A10b	√	√		√						√
Example 7.9			EC_rcjrs9.bpf	Primary	New+Existing	A3+A10a	√		√			√	√		√	
Example 8.1		Jacketed L-Shaped	EC_rcjlcs1.bpf	Primary	New+Existing	A3+A10a	√				√					
Example 8.2			EC_rcjlcs2.bpf	Secondary	New+Existing	A3+A10a	√		√			√				√
Example 8.3			EC_rcjlcs3.bpf	Primary	New+Existing	A3+A10a	√			√			√	√		
Example 8.4			EC_rcjlcs4.bpf	Primary	New+Existing	A3+A10a	√	√	√						√	
Example 8.5			EC_rcjlcs5.bpf	Primary	New+Existing	A3+A10b	√		√							
Example 8.6			EC_rcjlcs6.bpf	Secondary	New+Existing	A3+A10b	√			√		√				
Example 8.7			EC_rcjlcs7.bpf	Primary	New+Existing	A1+A10b	√		√							
Example 8.8			EC_rcjlcs8.bpf	Secondary	New+Existing	A1+A10b	√		√			√				
Example 8.9			EC_rcjlcs9.bpf	Secondary	New+Existing	A1+A10a	√			√			√			√
Example 8.10			EC_rcjlcs10.bpf	Primary	New+Existing	A1+A10a	√		√			√			√	
Example 8.11			EC_rcjlcs11.bpf	Primary	New+Existing	A1+A10a	√	√			√			√		
Example 9.1		Jacketed T Section	EC_rcjtcs1.bpf	Primary	Existing + New	A3+A10b			√							
Example 9.2			EC_rcjtcs2.bpf	Secondary	Existing + New	A3+A10b				√		√				
Example 9.3			EC_rcjtcs3.bpf	Primary	Existing + New	A1+A10b			√							
Example 9.4			EC_rcjtcs4.bpf	Secondary	Existing + New	A1+A10b				√		√				
Example 9.5			EC_rcjtcs5.bpf	Primary	Existing + New	A1+A10a			√							√
Example 9.6			EC_rcjtcs6.bpf	Secondary	Existing + New	A1+A10a			√			√	√			
Example 9.7			EC_rcjtcs7.bpf	Primary	Existing + New	A1+A10a		√		√				√	√	
Example 9.8			EC_rcjtcs8.bpf	Secondary	Existing + New	A3+A10a			√							√
Example 9.9			EC_rcjtcs9.bpf	Primary	Existing + New	A3+A10a					√	√	√			
Example 9.10			EC_rcjtcs10.bpf	Primary	Existing + New	A3+A10a		√		√				√	√	
Example 9.11			EC_rcjtcs11.bpf	Primary	Existing + New	A1+A10a		√								√
Example 9.12			EC_rcjtcs12.bpf	Primary	Existing + New	A3+A10a		√		√		√		√		
Example 10.1		Jacketed Circular	EC_rcjcs1.bpf	Primary	Existing + New	A1+A10a			√							
Example 10.2			EC_rcjcs2.bpf	Primary	Existing + New	A3+A10a			√							
Example 10.3			EC_rcjcs3.bpf	Primary	Existing + Existing	A3+A10a		√		√					√	
Example 10.4			EC_rcjcs4.bpf	Secondary	Existing + Existing	A1+A10a		√			√		√	√	√	
Example 10.5			EC_rcjcs5.bpf	Secondary	Existing + Existing	A3+A10b		√			√		√	√	√	
Example 10.6			EC_rcjcs6.bpf	Primary	Existing + New	A3+A10b		√			√	√		√		√
Example 10.7			EC_rcjcs7.bpf	Primary	Existing + New	A1+A10b		√			√	√		√		√
Example 11.1		Jacketed Beam	EC_JBeam1.bpf	Primary	Existing + New	A1+A10b			√				√	√		√
Example 11.2			EC_JBeam2.bpf	Primary	Existing + New	A3+A10b			√				√	√		√
Example 11.3			EC_JBeam3.bpf	Primary	Existing + New	A3+A10a				√		√	√		√	
Example 11.4			EC_JBeam4.bpf	Primary	Existing + New	A1+A10a				√		√	√		√	
Example 11.5			EC_JBeam5.bpf	Secondary	Existing + Existing	A3+A10a										
Example 11.6			EC_JBeam6.bpf	Primary	Existing + New	A1+A10a				√		√	√	√	√	
Example 11.7			EC_JBeam7.bpf	Primary	Existing + New	A3+A10a				√		√	√	√	√	
Example 11.8			EC_JBeam8.bpf	Primary	Existing + New	A3+A10b				√		√	√	√	√	
Example 11.9			EC_JBeam9.bpf	Primary	Existing + New	A1+A10b				√		√	√	√	√	

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 EUROCODES

In this chapter the Capacity Models for Assessment and Checks according to the Eurocodes (EC8-Part1 and Part3) 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 Annex A of EN1998-3:2005, considering the members as primary or secondary seismic elements, designated in accordance with the definitions in EN1998-1:2004, 4.2.2(1)P, (2) and (3). Moreover, beam-column joints checks may be employed in order to check (i) the horizontal shear forces acting on the core of the joints; (ii) the joint's horizontal hoops area and (iii) whether adequate vertical reinforcement is provided to the column passing through the joint.

Deformation Capacity

The deformation capacity of beams, columns and walls 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 and columns is highly influenced by the lack of appropriate seismic resistant detailing in longitudinal reinforcement, as well as by the bars type, that is whether there are smooth bars or/and of cold-worked brittle steel. Inadequate development of splicing along the span (beams) and height (columns) and inadequate embedment into beam-column joints can control the member's 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 value for the chord rotation capacity for the limit state of near collapse (NC) is the value of the total chord rotation capacity (elastic plus inelastic part) at ultimate of concrete members under cyclic loading, which is calculated from the equations (A.1) and (A.3) of EC8: Part 3 (CEN, 2005b):

$$\theta_{um} = \frac{1}{\gamma_{el}} \cdot 0{,}016 \cdot (0{,}3^{\nu}) \left[\frac{\max(0{,}01;\omega')}{\max(0{,}01;\omega)} f_c\right]^{0{,}225} \cdot \left(\min(9, \frac{L_V}{h})\right)^{0{,}35} 25^{\left(\alpha\rho_{sx}\frac{f_{yw}}{f_c}\right)} (1{,}25^{100\rho_d})$$

(A.1) EC8: Part 3

Where γ_{el} is equal to 1,5 for primary seismic elements and to 1,0 for secondary seismic ones and L_V is the ratio between bending moment, M, and shear force, V. The remaining relevant parameters are defined in section A.3.2.2 of EC8: Part 3.

In walls the value given by the equation (A.1) is multiplied by 0,58.

The total chord rotation capacity at ultimate of concrete members under cyclic loading may be also calculated as the summary of the chord rotation at yielding and the plastic part of the chord rotation capacity calculated from the following expression:

$$\theta_{um}^{pl} = \theta_{um} - \theta_y = \frac{1}{\gamma_{el}} \cdot 0{,}0145 \cdot (0{,}25^{\nu}) \left[\frac{\max(0{,}01;\omega')}{\max(0{,}01;\omega)}\right]^{0{,}3} \cdot f_c^{\,0{,}2} \cdot \left(\min\left(9, \frac{L_V}{h}\right)\right)^{0{,}35} 25^{\left(\alpha\rho_{sx}\frac{f_{yw}}{f_c}\right)} (1{,}275^{100\rho_d})$$

(A.3) EC8: Part 3

Where γ_{el} is equal to 1,8 for primary seismic elements and to 1,0 for secondary seismic ones; the chord rotation at yielding, θ_y, is calculated in accordance with the section A.3.2.4 of EC8: Part 3 and the remaining relevant parameters are defined in section A.3.2.2 of EC8: Part 3.

In walls the value of θ_{um}^{pl} given by the equation (A.3) is multiplied by 0,6.

The chord rotation capacity corresponding to the limit state of significant damage (SD) is assumed to be ¾ of the ultimate chord rotation, calculated from the equations above.

The chord rotation capacity that corresponds to the limit state of damage limitation (DL) is given by the chord rotation at yielding, evaluated as:

For beams and columns:

$$\theta_y = \varphi_y \frac{L_V + \alpha_V z}{3} + 0{,}0014\left(1 + 1{,}5\frac{h}{L_V}\right) + \frac{\varepsilon_y}{d-d'}\frac{d_{bL} f_y}{6\sqrt{f_c}}$$ (A.10a) EC8: Part 3

For walls or rectangular T- or barbelled section:

$$\theta_y = \varphi_y \frac{L_V + \alpha_V z}{3} + 0{,}0013 + \frac{\varepsilon_y}{d-d'}\frac{d_{bL} f_y}{6\sqrt{f_c}}$$ (A.11a) EC8: Part 3

Or from alternative and equivalent expressions for beams and columns

$$\theta_y = \varphi_y \frac{L_V + \alpha_V z}{3} + 0{,}0014\left(1 + 1{,}5\frac{h}{L_V}\right) + \varphi_y \frac{d_{bL} f_y}{8\sqrt{f_c}}$$ (A.10b) EC8: Part 3

For walls or rectangular T- or barbelled section:

$$\theta_y = \varphi_y \frac{L_V + \alpha_V z}{3} + 0{,}0013 + \varphi_y \frac{d_{bL} f_y}{8\sqrt{f_c}}$$ (A.11b) EC8: Part 3

Where α_V is equal to zero if the yielding bending moment is lower than L_V multiplied by the concrete shear resistance – $V_{R,c}$ - and 1.0 otherwise. $V_{R,c}$ is calculated according to EN1992-1-1:2004 provisions for concrete elements without shear reinforcement. The remaining relevant parameters are defined in section A.3.2.4 of EC8: Part 3.

The yield curvature of the end section is calculated according to the following expression for the sections whose compressive zone is of constant width and for the case that the section's yielding is due to steel yielding.

$$\varphi_y = (1/r)_y = \frac{f_y}{E_s(1-\xi_y)d}$$

If the section yields due to the deformation non-linearities of the concrete in compression, that is for deformation of the edge compressive fibre larger than $\varepsilon_c \approx 1.8\, f_c/E_c$, then the yield curvature is calculated according to the following expression:

$$\varphi_y = (1/r)_y = \frac{\varepsilon_c}{\xi_y d} \approx \frac{1.8 f_c}{E_c \xi_y d}$$

The lower from the two values above is used for the calculation of the chord rotation capacity.

According to Annex A of EN1998-3 the chord rotation capacity is highly influenced by a number of different factors such as the type of the longitudinal bars. If cold-worked brittle steel is used the plastic part of chord rotation is divided by 2, whereas if smooth (plain) longitudinal bars are applied, section A.3.2.2(5) of Annex A is employed, taking, also, into consideration whether the longitudinal bars are well lapped or not. In case of members with lack of appropriate seismic resistant detailing the values given by expressions (A.1) and (A.3) are divided by 1,2. Moreover, if the deformed (high bond)

longitudinal bars have straight ends lapped starting at the end section of the member, the plastic part of chord rotation is calculated with the value of the compression reinforcement ratio, ω', doubled over the value applying outside the lap splice. In addition, in sections where the reinforcement lap length l_o is less than the minimum lap length for ultimate deformation $l_{ou,min}$, the plastic part of the chord rotation capacity, given in (A.3) EC8: Part 3 equation, is multiplied by the ratio $l_o/l_{ou,min}$, for more information about the calculation of $l_{ou,min}$ you may refer to A.3.2.2(4) of Annex A, while the value for chord rotation at yielding, θ_y accounts for the effect of the lapping in accordance with A.3.2.4(3) of Annex A.

In the case of circular column sections, the equations above cannot be employed for the calculation of the elements' chord rotation capacity. In SeismoBuild the equations below suggested by D. Biskinis and M. N. Fardis [2013] are employed for θ_y and θ_u.

$$\theta_y = \varphi_y \frac{L_V + \alpha_V z}{3} + 0.0027\left(1 - \min\left(1; \frac{2}{15}\frac{L_s}{D}\right)\right) + \alpha_{sl}\frac{\varphi_y d_{bL} f_y}{8\sqrt{f_c}}$$

Where f_y and f_c values are in MPa, α_V=1 if V_{Rc}<V_{My}, V_{Rc} is calculated according to Eurocode 2 (CEN 2004), otherwise α_V=0, and α_{sl}=0 if pull-out of the tension bars from their anchorage zone beyond the yielding end is physically impossible, otherwise α_{sl}=1.

$$\theta_u = \left(\theta_y + (\varphi_u - \varphi_y)L_{pl}\left(1 - 0.5\,L_{pl}/L_s\right) + \alpha_{sl}\Delta\theta_{u,slip}\right)/\gamma_{el}$$

Where γ_{el} is equal to 2.0 for primary seismic elements and to 1.0 for secondary seismic elements, $\Delta\theta_{u,slip}$ and L_{pl} are calculated according to the following equations:

$$\Delta\theta_{u,slip} = 10 d_{bl}\left(\varphi_u + \varphi_y\right)/2$$

$$L_{pl} = 0.6D\left[1 + \frac{1}{6}\min\left(9; \frac{L_s}{D}\right)\right]$$

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

Concrete Jacketing

The following assumptions are made in order to evaluate the deformation capacities of the jacketed members, according to Annex A of EN1998-3:2005: (i) the jacketed element behaves monolithically, (ii) the full axial load is assumed to act on the jacketed member, disregarding the fact that the axial load is originally applied to the old column, and (iii) the concrete properties of the jacket are assumed to apply over the full section of the element.

The values of the jacketed members for M_y^*, $\theta_y^*$and θ_u^* that are adopted in the capacity verifications depend on the corresponding values calculated under the assumptions above, according to the following equations of Annex A of EN1998-3:2005:

The yield moment:

$$M_y^* = M_y \qquad \text{(A.18) EC8: Part 3}$$

The chord rotation at yield:

$$\theta_y^* = 1.05\theta_y \qquad \text{(A.19a) EC8: Part 3}$$

The ultimate chord rotation:

$$\theta_u^* = \theta_u \qquad \text{(A.20) EC8: Part 3}$$

FRP wrapping

The contribution of the FRP wrapping to members' capacity is taken into account, according to Annex A of EN1998-3:2005, as described below:

The effect of FRP wrapping on the members' flexural resistance at yielding is neglected, with the θ_y computed in accordance with A3.2.1(2) to (4).

The total chord rotation capacity and its plastic part for the members of rectangular sections with corners rounded is calculated through the expressions (A.1) and (A.3), respectively, with the exponent of the term due to confinement increased by $\alpha\rho_f f_{f,e}$, where α is the confinement effectiveness factor, ρ_f the FRP ratio parallel to the loading direction and $f_{f,e}$ the effectiveness stress given from the (A.35) equation of EC8: Part 3.

Shear Capacity

Shear capacity is calculated through the following expression according to Annex A of EN1998-3:2005, as controlled by the stirrups, accounting for the reduction due to the plastic part of ductility demand.

$$V_R = \frac{1}{\gamma_{el}}\left[\frac{h-x}{2L_V}\min(N; 0{,}55A_c f_c) + \left(1 - 0{,}05\min\left(5; \mu_\Delta^{pl}\right)\right)\cdot \left[0{,}16\max(0{,}5; 100\rho_{tot})\left(1 - 0{,}16\min\left(5; \frac{L_V}{h}\right)\right)\sqrt{f_c}A_c + V_w\right]\right] \quad \text{(A.12) EC8: Part 3}$$

Where γ_{el} is equal to 1,15 for primary seismic elements and to 1,0 for secondary ones, the other variables are calculated as defined in A.3.3.1 of Annex A of EN1998-3.

The shear strength of a concrete wall is not taken greater than the value corresponding to failure by web crushing, $V_{R,max}$, which under cyclic loading is calculated according to A3.3.1(2) of Annex A of EN1998-3:2005 from the following expression:

$$V_{R,max} = \frac{0{,}85\left(1-0{,}06\min\left(5;\mu_\Delta^{pl}\right)\right)}{\gamma_{el}}\left(1 + 1{,}8\min\left(0{,}15; \frac{N}{A_c f_c}\right)\right)\left(1 + 0{,}25\max(1{,}75; 100\rho_{tot})\right)\cdot\left(1 - 0{,}2\min\left(2; \frac{L_V}{h}\right)\right)\sqrt{f_c}b_w z \quad \text{(A.15) EC8: Part 3}$$

If in a concrete column the shear span ratio (L_V/h) at the end section with the maximum of the two end moments is less or equal to 2, the shear strength is not taken greater than the value corresponding to the failure by web crushing along the diagonal of the column after flexural yielding, $V_{R,max}$, which under cyclic loading is calculated according to A3.3.1(3) of Annex A of EN1998-3:2005 from the following expression:

$$V_{R,max} = \frac{4/7\left(1 - 0{,}02\min\left(5; \mu_\Delta^{pl}\right)\right)}{\gamma_{el}}\left(1 + 1{,}35\frac{N}{A_c f_c}\right)\left(1 + 0{,}45(100\rho_{tot})\right)\sqrt{\min(40; f_c)}b_w z \sin 2\delta \quad \text{(A.16) EC8: Part 3}$$

Where δ is the angle between the diagonal and the axis of the column ($\tan\delta = h/2L_V$).

Concrete Jacketing

The following assumptions are made in order to evaluate the strength of the jacketed members, according to Annex A of EN1998-3:2005: (i) the jacketed element behaves monolithically, (ii) the full axial load is assumed to act on the jacketed member, disregarding the fact that the axial load is originally applied to the old column, and (iii) the concrete properties of the jacket are assumed to apply over the full section of the element.

The value for the shear capacity, V_R^*, of the jacketed members that is adopted in the capacity verifications depend on the corresponding value calculated under the assumptions above, according to the following equation of Annex A of EN1998-3:2005:

$$V_R^* = 0.9V_R \quad \text{(A.17) EC8: Part 3}$$

FRP wrapping

According to section A.4.4.2(9) of Annex A of EN1998-3:2005, in members with their plastic hinge region fully wrapped in an FRP jacket over a length at least equal to the member depth, the cyclic resistance V_R, may be calculated from expression (A.12) of EC8: Part 3 adding in V_w the contribution of the FRP jacket to shear resistance. The contribution of the FRP jacket to V_w is computed through the following expression:

$$V_{w,f} = 0{,}5\rho_f b_w z f_{u,fd} \qquad \text{(A.33) EC8: Part 3}$$

where ρ_f is the geometric ratio of the FRP, z the length of the internal lever arm and $f_{u,fd}$ the design value of the FRP ultimate strength.

Joints Shear Forces

The diagonal compression induced in the joint by the diagonal strut mechanism shall not exceed the compressive strength of concrete in the presence of transverse tensile strains. EN 1998-1:2004 defines that this requirement is satisfied by means of the subsequent rules:

For interior beam-column joints the following expression should be satisfied:

$$V_{jhd} \le \eta f_{cd} \sqrt{1 - \frac{\nu_d}{\eta}}\, b_j h_{jc} \qquad \text{(5.33) EC8: Part 1}$$

For exterior beam-column joints the corresponding equation is the following:

$$V_{jhd} \le 80\% \eta f_{cd} \sqrt{1 - \frac{\nu_d}{\eta}}\, b_j h_{jc}$$

V_{jhd} is the horizontal shear acting on the core of a joint between primary seismic beams and columns elements and is determined taking into account the most adverse conditions under seismic actions, i.e. capacity design conditions for the beams framing into the joint and the lowest compatible values of shear forces in the other framing elements. The expressions for the horizontal shear force acting on the concrete core of the joints are the following:

For interior beam-column joints:

$$V_{jhd} = \gamma_{Rd} (A_{s1} + A_{s2}) f_{yd} - V_C \qquad \text{(5.22) EC8: Part 1}$$

For exterior beam-column joints:

$$V_{jhd} = \gamma_{Rd} A_{s1} f_{yd} - V_C \qquad \text{(5.23) EC8: Part 1}$$

For information about the values in the equations above users may refer to sections 5.5.3.3(2) and 5.5.2.3(2) of EN 1998-1:2004.

Joints Horizontal Hoops Area

According to EN 1998-1:2004, adequate confinement of the joint should be provided, to limit the maximum diagonal tensile stress of concrete. This requirement may be satisfied by providing horizontal hoops calculated from the following expression:

$$\frac{A_{sh} f_{ywd}}{b_j h_{jw}} \ge \frac{\left(\frac{V_{jhd}}{b_j h_{jc}}\right)^2}{f_{ctd} + \nu_d f_{cd}} - f_{ctd} \qquad \text{(5.35) EC8: Part 1}$$

Where A_{sh} is the total area of the horizontal hoops and f_{ctb} is the design value of the tensile strength of concrete. For the definition of the other values users may refer to section 5.5.3.3(3) of EN 1998-1:2004.

Alternatively, the integrity of the joint after diagonal cracking may be ensured by horizontal hoop reinforcement. The total area of horizontal hoops that should be provided in the joint is calculated from the following equations:

For interior joints:

$$A_{sh} f_{ywd} \geq \gamma_{Rd} (A_{s1} + A_{s2}) f_{yd} (1 - 0{,}8\nu_d) \quad \text{(5.36a) EC8: Part 1}$$

For exterior joints:

$$A_{sh} f_{ywd} \geq \gamma_{Rd} A_{s2} f_{yd} (1 - 0{,}8\nu_d) \quad \text{(5.36b) EC8: Part 1}$$

Where γ_{Rd} is equal to 1,2; for the definition of the other values users may refer to section 5.5.3.3(4) of EN 1998-1:2004.

Joints Vertical Reinforcement Area

Adequate vertical reinforcement of the column passing through the joint should be provided according to section 5.5.3.3(6) of EN 1998-1:2004, so that the following expression is satisfied:

$$A_{sv,i} \geq (2/3) A_{sh} (h_{jc} / h_{jw}) \quad \text{(5.37) EC8: Part 1}$$

With $A_{sv,i}$ denoting the total area of the intermediate bars placed in the relevant column faces between corner bars of the column, including bars contributing to the longitudinal reinforcement of columns.

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
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

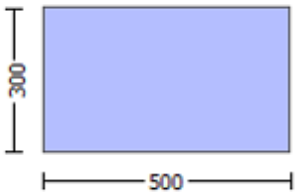
DESCRIPTION

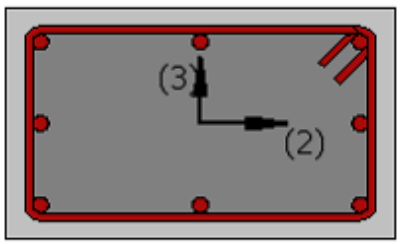
A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild, in all the defined Limit States according to EN 1998-3 (i.e. limit states of Damage Limitation (DL), Significant Damage (SD) and Near Collapse (NC)), are compared with hand calculations.

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





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

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Section Height, H = 300.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.0104187	0.0104187022
	Significant Damage	End	3	0.040682	0.040682
	Near Collapse	Start	3	0.0384410	0.0384410
Shear Capacity [kN]	Damage Limitation	Start	2	201.671488	201.671488
	Significant Damage	End	3	112.195175	112.195175
	Near Collapse	Start	2	201.809561	201.809561

COMPUTER FILES

- EC_rect1.bpf
- Report_EC_rect1.pdf

EXAMPLE 1.2

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
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

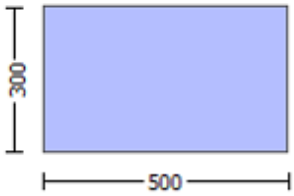
DESCRIPTION

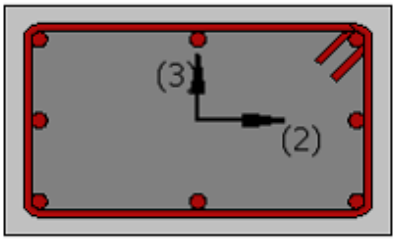
A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild, in all the defined Limit States according to EN 1998-3 (i.e. limit states of Damage Limitation (DL), Significant Damage (SD) and Near Collapse (NC)), are compared with hand calculations.

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete
Strength, fc = fcm/(Cf*γc) = 11.11111

Existing material of Primary Member: Steel
Strength, fs = fs/(Cf*γs) = 322.0612

Member's Properties

Section Height, H = 300.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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 3.2. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.0104187	0.0104187
	Significant Damage	End	3	0.0357368	0.0357368
	Near Collapse	Start	2	0.03786283	0.03786283
Shear Capacity	Damage Limitation	Start	3	112.195175	112.195175
	Significant Damage	End	2	276.373676	276.373676
	Near Collapse	Start	2	201.807613	201.807613

COMPUTER FILES

- EC_rect2.bpf
- Report_EC_rect2.pdf

EXAMPLE 1.3

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
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

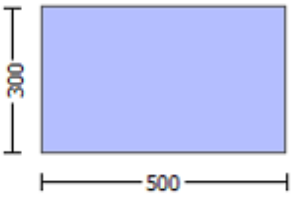
DESCRIPTION

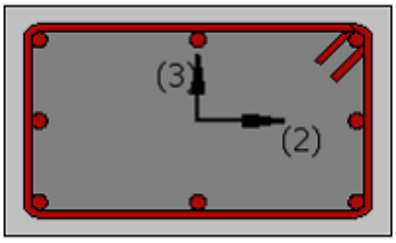
A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild, in all the defined Limit States according to EN 1998-3 (i.e. limit states of Damage Limitation (DL), Significant Damage (SD) and Near Collapse (NC)), are compared with hand calculations.

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Secondary Member: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material of Secondary Member: Steel Strength,
fs = fs/Cf = 370.3704

Member's Properties

Section Height, H = 300.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member

γel = 1.00 for Chord Rotation and Shear Capacity checks
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 3.3. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.0099984	0.0099984
	Significant Damage	End	3	0.0288774	0.0288774
	Near Collapse	Start	3	0.06399196	0.06399196
Shear Capacity	Damage Limitation	Start	2	265.565072	265.565072
	Significant Damage	End	3	147.564435	147.564435
	Near Collapse	Start	2	265.716804	265.716804

COMPUTER FILES

- EC_rect3.bpf
- Report_EC_rect3.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
- Inadequate Lap Length with lo/lou,min = 0.40
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type

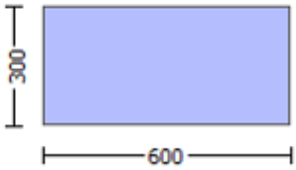
DESCRIPTION

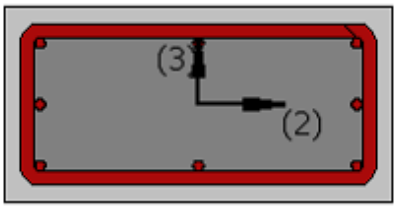
A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild, in all the defined Limit States according to EN 1998-3 (i.e. limit states of Damage Limitation (DL), Significant Damage (SD) and Near Collapse (NC)), are compared with hand calculations.

The employed equations are the (A.1) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00

For Shear Capacity Calculations

New material of Secondary Member: Concrete Strength,
fc = fck = 25.00
New material of Secondary Member: Steel Strength,
fs = fsk = 500.00

Member's Properties

Section Height, H = 300.00
Section Width, W = 600.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
γel = 1.00 for Chord Rotation and Shear Capacity checks
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 = 0.40
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 3.4. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.01075826	0.01075826
	Significant Damage	Start	3	0.0199336	0.0199336
	Near Collapse	End	3	0.016910	0.016910
Shear Capacity [kN]	Damage Limitation	Start	2	600.699586	600.699586
	Significant Damage	Start	3	259.379943	259.379943
	Near Collapse	Start	2	600.929113	600.929113

COMPUTER FILES

- EC_rect4.bpf
- Report_EC_rect4.pdf

EXAMPLE 1.5

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Cold Worked-Brittle Steel
- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 600.00
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type

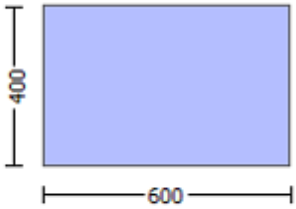
DESCRIPTION

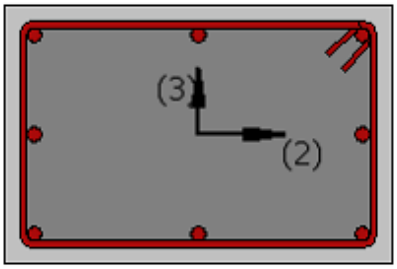
A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild, in all the defined Limit States according to EN 1998-3 (i.e. limit states of Damage Limitation (DL), Significant Damage (SD) and Near Collapse (NC)), are compared with hand calculations.

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00

For Shear Capacity Calculations

New material of Primary Member: Concrete Strength,
fc = fck/γc = 16.66667
New material of Primary Member: Steel Strength,
fs = fsk/γs = 434.7826

Member's Properties

Section Height, H = 400.00
Section Width, W = 600.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Ribbed Bars
Cold Worked-Brittle Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 600.00
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 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.00936494	0.00936494
	Significant Damage	Start	3	0.0101778	0.0101778
	Near Collapse	Start	3	0.01186125	0.01186125
Shear Capacity	Damage Limitation	End	2	397.38121	397.38121
	Significant Damage	Start	3	213.753988	213.753988
	Near Collapse	Start	3	213.875725	213.875725

COMPUTER FILES

- EC_rect5.bpf
- Report_EC_rect5.pdf

EXAMPLE 1.6

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Cold Worked-Brittle Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars Without Lapping in the Vicinity of the End Regions
- Lap Length lo = 500.00
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

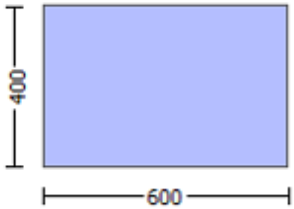
DESCRIPTION

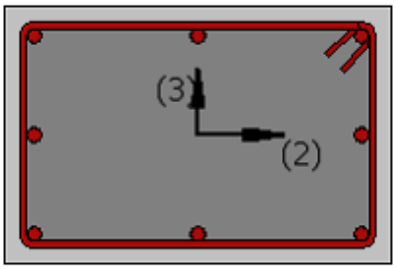
A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild, in all the defined Limit States according to EN 1998-3 (i.e. limit states of Damage Limitation (DL), Significant Damage (SD) and Near Collapse (NC)), are compared with hand calculations.

The employed equations are the (A.3) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Section Height, H = 300.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Smooth Bars
Cold Worked-Brittle Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars Without Lapping in the Vicinity of the End Regions
Lap Length lo = 500.00
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 3.6. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00939444	0.00939444
	Significant Damage	Start	3	0.0130307	0.0130307
	Near Collapse	Start	3	0.01565229	0.01565229
Shear Capacity	Damage Limitation	Start	2	146.883915	146.883915
	Significant Damage	Start	3	103.827587	103.827587
	Near Collapse	End	2	203.776579	203.776579

COMPUTER FILES

- EC_rect6.bpf
- Report_EC_rect6.pdf

EXAMPLE 1.7

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
- Not the Program's Default Safety/Confidence Factors
- Existing Material Sets type

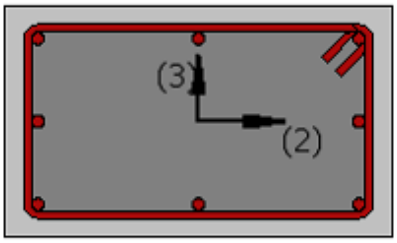
DESCRIPTION

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 employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES



Units in N, mm

Confidence Factor, Cf = 1.35

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 14.81481
Existing material: Steel Strength,
fs = fs/Cf = 329.2181

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 12.34568
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 274.3484

Member's Properties

Section Height, H = 300.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.20 for Chord Rotation and Shear Capacity checks
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 3.7. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00792684	0.00792684
	Significant Damage	End	2	0.04346092	0.04346092
	Near Collapse	Start	3	0.05077280	0.05077280
Shear Capacity	Damage Limitation	End	2	211.046498	211.046498

COMPUTER FILES

- EC_rect7.bpf
- Report_EC_rect7.pdf

EXAMPLE 1.8

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Cold Worked-Brittle 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 (Type: Glass)
- Program's Default Safety/Confidence Factors
- New Material Sets type

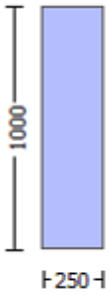
DESCRIPTION

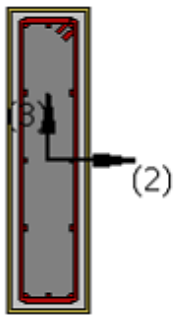
A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00

For Shear Capacity Calculations

New material of Secondary Member: Concrete Strength,
fc = fck = 25.00
New material of Secondary Member: Steel Strength,
fs = fsk = 500.00

Member's Properties

Section Height, H = 1000.00
Section Width, W = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
γel = 1.00 for Chord Rotation and Shear Capacity checks
Ribbed Bars
Cold Worked-Brittle 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: Glass
Cured laminate properties (design values)
Thickness, t = 0.3556
Tensile Strength, ffu = 225.00
Tensile Modulus, Ef = 15044.00
Elongation, efu = 0.0125
Number of directions, NoDir = 2
Fiber orientations, bi: 0.00°, 90.00°
Number of layers, NL = 3
Radius of rounding corners, R = 30.00

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 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.00628276	0.00628276
	Significant Damage	End	3	0.0601285	0.0601285
	Near Collapse	Start	3	0.04145655	0.04145658
Shear Capacity	Near Collapse	Start	3	307.000865	307.000865

NOTE: For the selected shear capacity check the limitation of the equation (A.16) of EC8: Part 3 is employed.

COMPUTER FILES

- EC_rect8.bpf
- Report_EC_rect8.pdf

EXAMPLE 1.9

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
- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping (Type: Carbon)
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

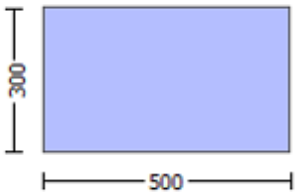
DESCRIPTION

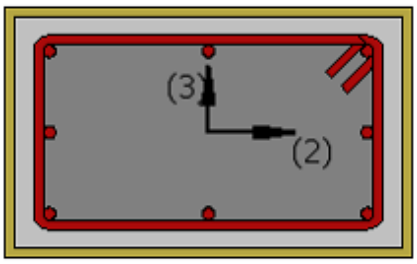
A rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Section Height, H = 300.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3600.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 745.00
Tensile Modulus, Ef = 61500.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°

Number of layers, NL = 1
Radius of rounding corners, R = 30.00

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

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00937003	0.00937003
	Significant Damage	Start	3	0.0189556	0.0189556
	Near Collapse	End	2	0.04401857	0.04401857
Shear Capacity	Significant Damage	Start	3	255.839648	255.839648

COMPUTER FILES

- EC_rect9.bpf
- Report_EC_rect9.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
- Inadequate Lap Length with lo/lou,min = 0.30
- No FRP Wrapping
- Not the Program's Default Safety/Confidence Factors
- Existing Material Sets type

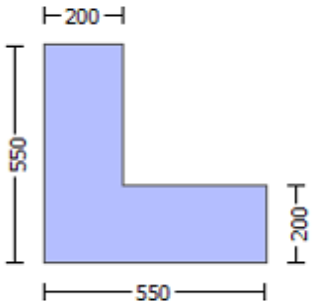
DESCRIPTION

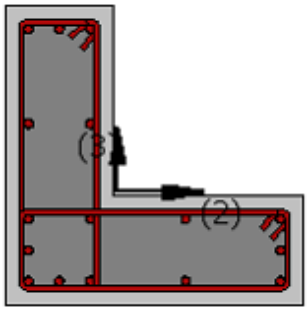
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.35

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 14.81481
Existing material: Steel Strength,
fs = fs/Cf = 329.2181

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 13.46801
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 299.2892

Member's Properties

Max Height, Hmax = 550.00
Min Height, Hmin = 200.00
Max Width, Wmax = 550.00
Min Width, Wmin = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.60 for Chord Rotation checks and
γel = 1.10 for Shear Capacity checks
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
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 3.10. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00489533	0.00489533
	Significant Damage	Start	3	0.0268316	0.0268316
	Near Collapse	End	2	0.021954	0.021954
Shear Capacity [kN]	Near Collapse	Start	3	281.165601	281.165597

COMPUTER FILES

- EC_rclcs1.bpf
- Report_EC_rclcs1.pdf

EXAMPLE 2.2

SUCCINCT DATA

- Secondary 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
- Lap Length lo = 400.00
- FRP Wrapping (Type: Carbon)
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

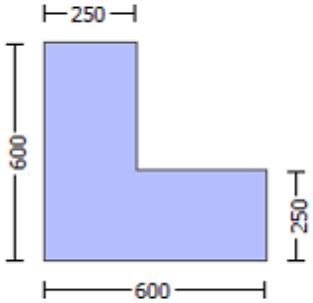
DESCRIPTION

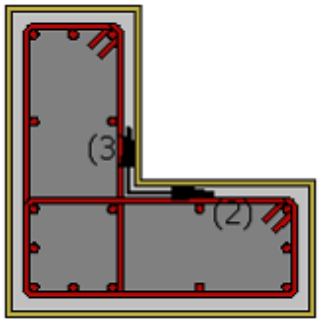
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the -X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Secondary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 370.3704

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
γel = 1.00 for Chord Rotation and Shear Capacity checks
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
Lap Length lo = 400.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 0.241
Tensile Strength, ffu = 489.00
Tensile Modulus, Ef = 42468.00
Elongation, efu = 0.0097
Number of directions, NoDir = 2
Fiber orientations, bi: 0.00°, 90.00°
Number of layers, NL = 2
Radius of rounding corners, R = 50.00

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 2.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.00953838	0.00953839
	Significant Damage	End	2	0.0600258	0.0600258
	Near Collapse	End	3	0.0356595	0.0356596
Shear Capacity	Near Collapse	Start	3	428.446022	428.446022

COMPUTER FILES

- EC_rclcs2.bpf
- Report_EC_rclcs2.pdf

EXAMPLE 2.3

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Cold Worked-Brittle 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
- Program's Default Safety/Confidence Factors
- New Material Sets type

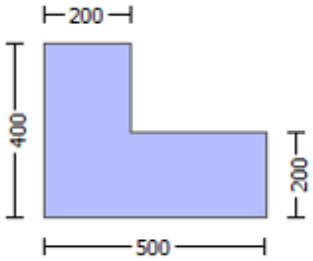
DESCRIPTION

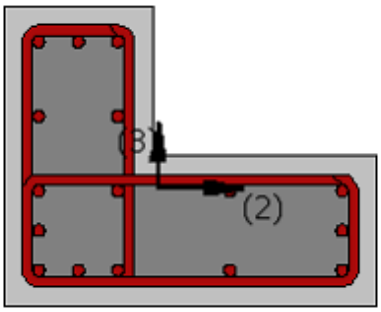
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

New material: Concrete Strength,

fc = fck = 25.00
New material: Steel Strength,

fs = fsk = 500.00

For Shear Capacity Calculations

New material of Primary Member: Concrete Strength,

fc = fck/γc = 16.66667
New material of Primary Member: Steel Strength,

fs = fsk/γs = 434.7826

Member's Properties

Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 500.00
Min Width, Wmin = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Smooth Bars
Cold Worked-Brittle 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

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 2.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.009460	0.009460
	Significant Damage	End	3	0.016422	0.016422
	Near Collapse	Start	2	0.0171637	0.0171637
Shear Capacity	Near Collapse	End	3	516.563019	516.563019

COMPUTER FILES

- EC_rclcs3.bpf
- Report_EC_rclcs3.pdf

EXAMPLE 2.4

SUCCINCT DATA

- Primary 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
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

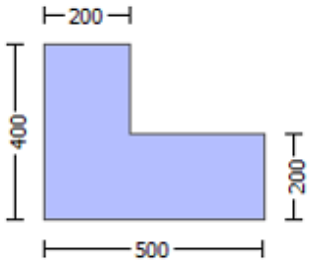
DESCRIPTION

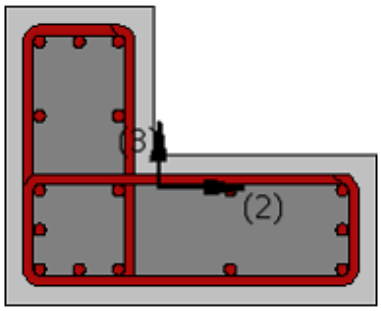
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 500.00
Min Width, Wmin = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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
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 2.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.00782496	0.00782496
	Significant Damage	Start	2	0.0540664	0.0540664
	Near Collapse	Start	3	0.03126635	0.03126635
Shear Capacity	Near Collapse	End	3	324.911972	324.911972

COMPUTER FILES

- EC_rclcs4.bpf
- Report_EC_rclcs4.pdf

EXAMPLE 2.5

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
- FRP Wrapping (Type: Glass)
- Program's Default Safety/Confidence Factors
- New Material Sets type

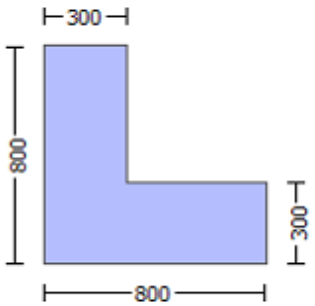
DESCRIPTION

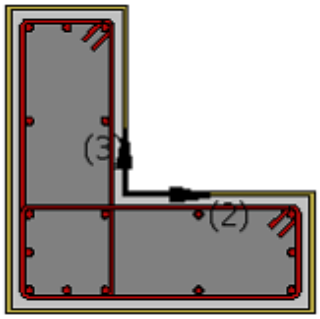
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00

For Shear Capacity Calculations

New material of Secondary Member: Concrete Strength,
fc = fck = 25.00
New material of Secondary Member: Steel Strength,
fs = fsk = 500.00

Member's Properties

Max Height, Hmax = 800.00
Min Height, Hmin = 300.00
Max Width, Wmax = 800.00
Min Width, Wmin = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
γel = 1.00 for Chord Rotation and Shear Capacity checks
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
FRP Wrapping Data
Type: Glass
Dry properties (design values)
Thickness, t = 0.067
Tensile Strength, ffu = 2429.00
Tensile Modulus, Ef = 52143.00
Elongation, efu = 0.045
Number of directions, NoDir = 2
Fiber orientations, bi: 0.00°, 90.00°
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 2.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00755566	0.00755566
	Significant Damage	Start	3	0.041613	0.041613
	Near Collapse	End	2	0.03587591	0.03587591
Shear Capacity [kN]	Damage Limitation	Start	3	1268.16925	1268.16928

COMPUTER FILES

- EC_rclcs5.bpf
- Report_EC_rclcs5.pdf

EXAMPLE 2.6

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
- Lap Length lo = 400.00
- No FRP Wrapping
- Not the Program's Default Safety/Confidence Factors
- Existing Material Sets type

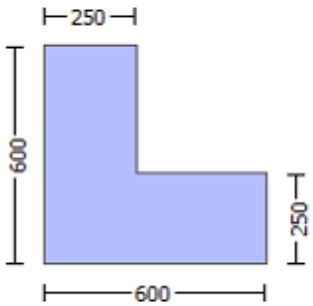
DESCRIPTION

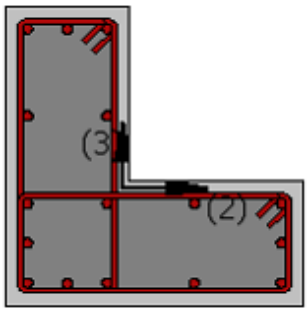
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.35

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 14.81481
Existing material: Steel Strength,
fs = fs/Cf = 329.2181

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 13.46801
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 299.2892

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
γel = 1.60 for Chord Rotation checks and
γel = 1.10 for Shear Capacity checks
Ribbed 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 = 400.00
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 3.15. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.00650274	0.00650274
	Significant Damage	End	2	0.0274457	0.0274457
	Near Collapse	Start	3	0.056107	0.056107
Shear Capacity	Significant Damage	Start	3	354.438613	354.438613

COMPUTER FILES

- EC_rclcs6.bpf
- Report_EC_rclcs6.pdf

EXAMPLE 2.7

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Cold Worked-Brittle 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
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

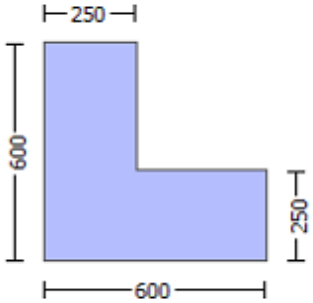
DESCRIPTION

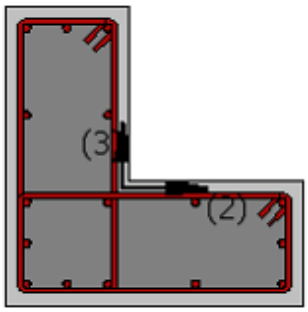
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Secondary Member: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material of Secondary Member: Steel Strength,
fs = fs/Cf = 370.3704

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
γel = 1.00 for Chord Rotation and Shear Capacity checks
Smooth Bars
Cold Worked-Brittle 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 3.16. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.00788462	0.00788462
	Significant Damage	End	3	0.0279214	0.0279214
	Near Collapse	Start	2	0.07612857	0.07612857
Shear Capacity [kN]	Near Collapse	Start	3	420.801404	420.801408

COMPUTER FILES

- EC_rclcs7.bpf
- Report_EC_rclcs7.pdf

EXAMPLE 2.8

SUCCINCT DATA

- Secondary 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)
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type

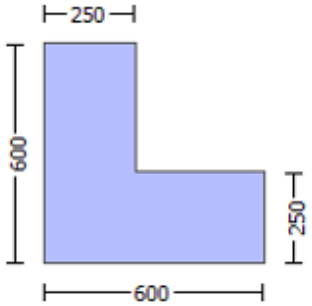
DESCRIPTION

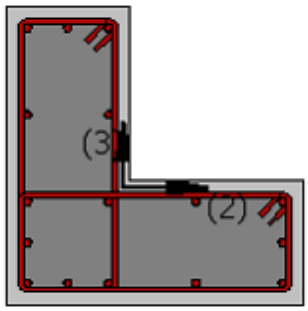
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00

For Shear Capacity Calculations

New material of Secondary Member: Concrete Strength,
fc = fck = 25.00
New material of Secondary Member: Steel Strength,
fs = fsk = 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
γel = 1.00 for Chord Rotation and Shear Capacity checks
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)
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 3.17. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.00820851	0.00820851
	Significant Damage	Start	2	0.092057	0.092057
	Near Collapse	Start	3	0.06702649	0.06702649
Shear Capacity	Damage Limitation	End	2	669.053033	669.053033

COMPUTER FILES

- EC_rclcs8.bpf
- Report_EC_rclcs8.pdf

EXAMPLE 2.9

SUCCINCT DATA

- Secondary 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
- Lap Length lo = 550.00
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

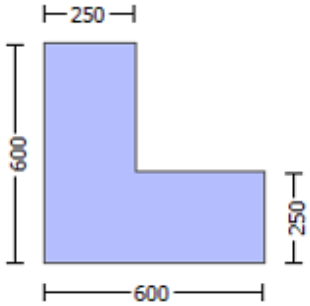
DESCRIPTION

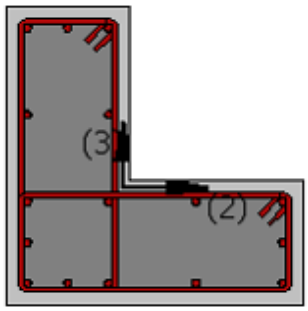
An L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Secondary Member: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material of Secondary Member: Steel Strength,
fs = fs/Cf = 370.3704

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
γel = 1.00 for Chord Rotation and Shear Capacity checks
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
Lap Length lo = 550.00
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 3.18. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 2.9

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00873594	0.00873594
	Significant Damage	Start	3	0.071420	0.071420
	Near Collapse	End	2	0.04228210	0.04228210
Shear Capacity	Near Collapse	End	2	508.073346	508.073346

COMPUTER FILES

- EC_rclcs9.bpf
- Report_EC_rclcs9.pdf

EXAMPLES SET 3: T-SHAPED COLUMN SECTION

EXAMPLE 3.1

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)
- No FRP Wrapping
- Not the Program's Default Safety/Confidence Factors
- New Material Sets type

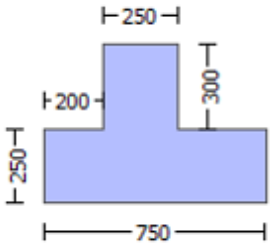
DESCRIPTION

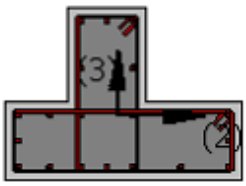
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.35

Materials' Properties

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

For Chord rotation Calculations

New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00

For Shear Capacity Calculations

New material of Primary Member: Concrete Strength,
fc = fck/γc = 16.66667
New material of Primary Member: Steel Strength,
fs = fsk/γs = 434.7826

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
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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)
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 3.19. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.00900524	0.00900524
	Significant Damage	End	2	0.029034	0.029034
	Near Collapse	Start	3	0.03206235	0.03206235
Shear Capacity [kN]	Damage Limitation	Start	2	546.997913	546.997901

COMPUTER FILES

- EC_rctcs1.bpf
- Report_EC_rctcs1.pdf

EXAMPLE 3.2

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
- Not the Program's Default Safety/Confidence Factors
- Existing Material Sets type

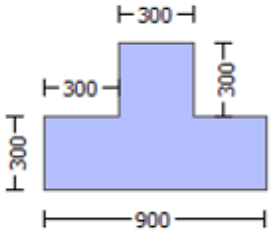
DESCRIPTION

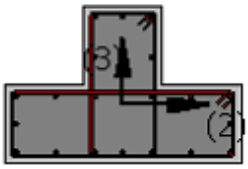
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 300.00
Max Width, Wmax = 900.00
Min Width, Wmin = 300.00
Eccentricity, Ecc = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.50 for Shear Capacity checks
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 3.20. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.00541725	0.00541725
	Significant Damage	End	3	0.025427	0.0254272
	Near Collapse	Start	2	0.02972877	0.02972877
Shear Capacity [kN]	Significant Damage	Start	3	277.682959	277.682966

COMPUTER FILES

- EC_rctcs2.bpf
- Report_EC_rctcs2.pdf

EXAMPLE 3.3

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
- Not the Program's Default Safety/Confidence Factors
- Existing Material Sets type

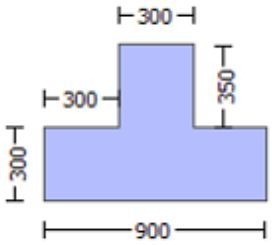
DESCRIPTION

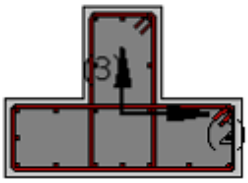
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.00

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 20.00
Existing material: Steel Strength,
fs = fs/Cf = 444.4444

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 18.18182
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 404.0404

Member's Properties

Max Height, Hmax = 650.00
Min Height, Hmin = 300.00
Max Width, Wmax = 900.00
Min Width, Wmin = 300.00
Eccentricity, Ecc = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.60 for Chord Rotation checks and
γel = 1.10 for Shear Capacity checks
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 3.21. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.00977627	0.00977627
	Significant Damage	Start	2	0.084177	0.084177
	Near Collapse	Start	3	0.036163	0.036163
Shear Capacity [kN]	Near Collapse	End	2	607.466158	607.466158

COMPUTER FILES

- EC_rctcs3.bpf
- Report_EC_rctcs3.pdf

EXAMPLE 3.4

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- With 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
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

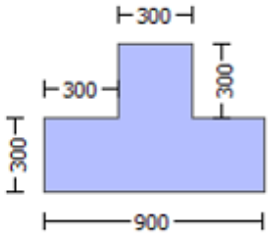
DESCRIPTION

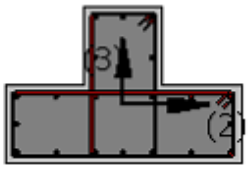
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 300.00
Max Width, Wmax = 900.00
Min Width, Wmin = 300.00
Eccentricity, Ecc = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Ribbed Bars
Ductile Steel
With 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

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 3.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00630557	0.00630557
	Significant Damage	Start	3	0.062732	0.062732
	Near Collapse	End	2	0.05389076	0.05389076
Shear Capacity [kN]	Near Collapse	End	2	610.505412	610.505447

COMPUTER FILES

- EC_rctcs4.bpf
- Report_EC_rctcs4.pdf

EXAMPLE 3.5

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Cold Worked-Brittle 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 = 600.00
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type

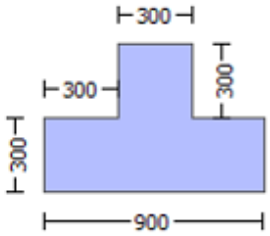
DESCRIPTION

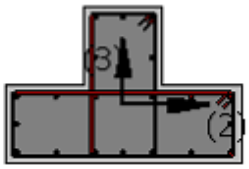
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

New material: Concrete Strength,
fc = fcm/Cf = 25.00
New material: Steel Strength,
fs = fs/Cf = 500.00

For Shear Capacity Calculations

New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 300.00
Max Width, Wmax = 900.00
Min Width, Wmin = 300.00
Eccentricity, Ecc = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Ribbed Bars
Cold Worked-Brittle 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 = 600.00
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 3.23. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.00994471	0.00994471
	Significant Damage	End	2	0.011413	0.011413
	Near Collapse	End	3	0.01585501	0.01585501
Shear Capacity [kN]	Significant Damage	End	2	735.889452	735.889452

COMPUTER FILES

- EC_rctcs5.bpf
- Report_EC_rctcs5.pdf

EXAMPLE 3.6

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
- Lap Length lo = 500.00
- FRP Wrapping Data (Type: Carbon)
- Not the Program's Default Safety/Confidence Factors
- Existing Material Sets type

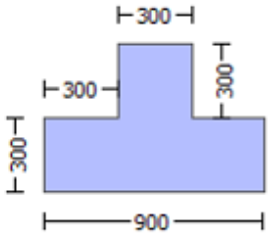
DESCRIPTION

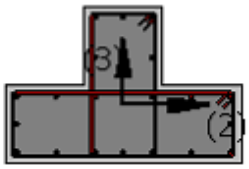
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Secondary Member: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material of Secondary Member: Steel Strength,
fs = fs/Cf = 370.3704

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 300.00
Max Width, Wmax = 900.00
Min Width, Wmin = 300.00
Eccentricity, Ecc = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
γel = 1.20 for Chord Rotation and Shear Capacity checks
Ribbed 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 = 500.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 0.51
Tensile Strength, ffu = 724.00
Tensile Modulus, Ef = 56500.00
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 3.24. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.0058572	0.0058572
	Significant Damage	End	3	0.022848	0.022848
	Near Collapse	Start	2	0.04578769	0.04578769
Shear Capacity [kN]	Near Collapse	End	3	605.292847	605.292861

COMPUTER FILES

- EC_rctcs6.bpf
- Report_EC_rctcs6.pdf

EXAMPLE 3.7

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
- Lap Length lo = 600.00
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type

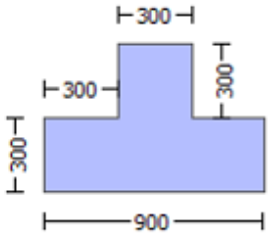
DESCRIPTION

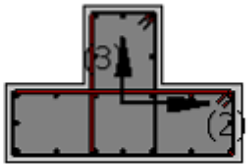
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

New material: Concrete Strength,
fc = fcm/Cf = 25.00
New material: Steel Strength,
fs = fs/Cf = 500.00

For Shear Capacity Calculations

New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 300.00
Max Width, Wmax = 900.00
Min Width, Wmin = 300.00
Eccentricity, Ecc = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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
Lap Length lo = 600.00
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 3.25. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.00997309	0.00997309
	Significant Damage	Start	2	0.0268639	0.0268639
	Near Collapse	Start	3	0.04391762	0.04391762
Shear Capacity [kN]	Damage Limitation	Start	2	657.179026	657.179013

COMPUTER FILES

- EC_rctcs7.bpf
- Report_EC_rctcs7.pdf

EXAMPLE 3.8

SUCCINCT DATA

- 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
- Lap Length lo = 600.00
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type

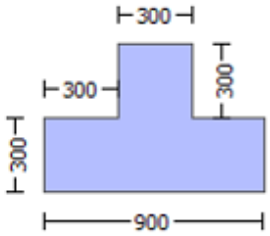
DESCRIPTION

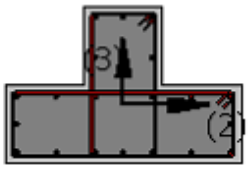
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

New material: Concrete Strength,
fc = fcm/Cf = 25.00
New material: Steel Strength,
fs = fs/Cf = 500.00

For Shear Capacity Calculations

New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 300.00
Max Width, Wmax = 900.00
Min Width, Wmin = 300.00
Eccentricity, Ecc = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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
Lap Length lo = 600.00
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 3.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00783303	0.00783303
	Significant Damage	Start	3	0.02531787	0.02531787
	Near Collapse	End	2	0.022987347	0.022987347
Shear Capacity [kN]	Damage Limitation	End	2	735.8405715	735.8405715

COMPUTER FILES

- EC_rctcs8.bpf
- Report_EC_rctcs8.pdf

EXAMPLE 3.9

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Cold Worked-Brittle 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)
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

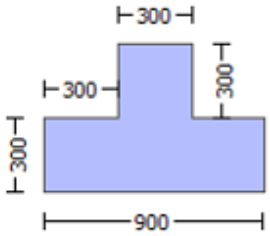
DESCRIPTION

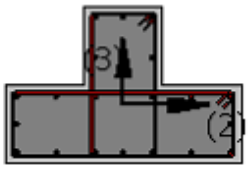
A T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 300.00
Max Width, Wmax = 900.00
Min Width, Wmin = 300.00
Eccentricity, Ecc = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Ribbed Bars
Cold Worked-Brittle 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
Dry properties (design values)
Thickness, t = 0.046
Tensile Strength, ffu = 3800.00
Tensile Modulus, Ef = 230000.00
Elongation, efu = 0.015
Number of directions, NoDir = 2
Fiber orientations, bi: 0.00°, 90.00°

Number of layers, NL = 3
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 3.27. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 3.9

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.00629212	0.00629212
	Significant Damage	End	2	0.02191389	0.02191389
	Near Collapse	End	3	0.01910817	0.01910817
Shear Capacity [kN]	Near Collapse	End	3	552.724877	552.724905

COMPUTER FILES

- EC_rctcs9.bpf
- Report_EC_rctcs9.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
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

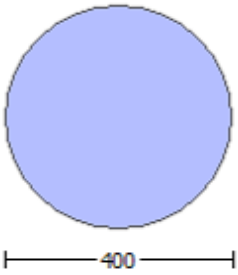
DESCRIPTION

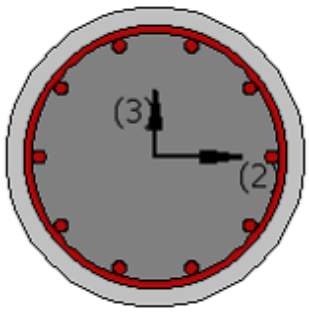
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.3) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 2.00 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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 3.28. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.01032524	0.01032524
	Significant Damage	Start	3	0.0246844	0.0246844
	Near Collapse	Start	2	0.02487332	0.02487332
Shear Capacity [kN]	Significant Damage	Start	3	153.055108	153.055108

COMPUTER FILES

- EC_rccs1.bpf
- Report_EC_rccs1.pdf

EXAMPLE 4.2

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
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

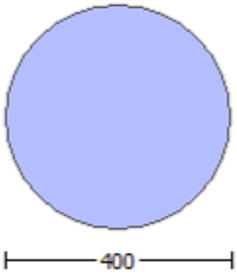
DESCRIPTION

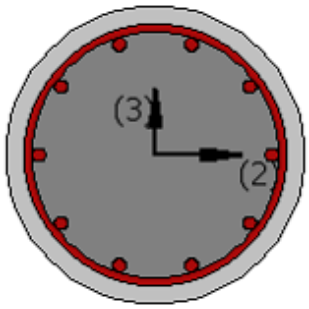
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.1) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 2.00 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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 3.29. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.01032523	0.01032523
	Significant Damage	Start	2	0.018654986	0.018654986
	Near Collapse	Start	3	0.0329135	0.0329135
Shear Capacity [kN]	Near Collapse	End	2	191.693113	191.6931126

COMPUTER FILES

- EC_rccs2.bpf
- Report_EC_rccs2.pdf

EXAMPLE 4.3

SUCCINCT DATA

- Secondary 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
- Inadequate Lap Length with lo/lou,min = 0.20
- No FRP Wrapping
- Not the Program's Default Safety/Confidence Factors
- New Material Sets type

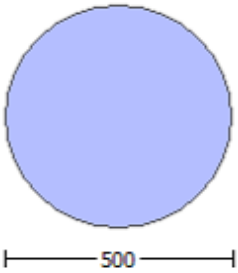
DESCRIPTION

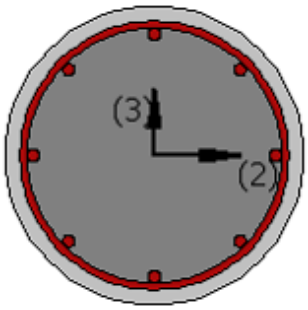
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.3) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00

For Shear Capacity Calculations

New material of Secondary Member: Concrete Strength,
fc = fck = 25.00
New material of Secondary Member: Steel Strength,
fs = fsk = 500.00

Member's Properties

Diameter, D = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
γel = 1.00 for Chord Rotation and Shear Capacity checks
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
Inadequate Lap Length with lo/lou,min = 0.20
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 4.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00455569	0.00455569
	Significant Damage	Start	3	0.004554	0.004554
	Near Collapse	End	2	0.00512734	0.00512741
Shear Capacity [kN]	Damage Limitation	End	3	475.613841	475.613841

COMPUTER FILES

- EC_rccs3.bpf
- Report_EC_rccs3.pdf

EXAMPLE 4.4

SUCCINCT DATA

- Secondary 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
- Inadequate Lap Length with lo/lou,min = 0.30
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type

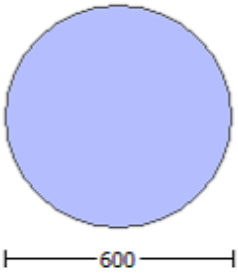
DESCRIPTION

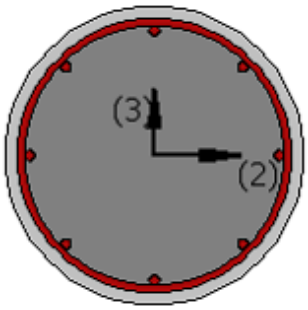
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.1) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00

For Shear Capacity Calculations

New material of Secondary Member: Concrete Strength,
fc = fck = 25.00
New material of Secondary Member: Steel Strength,
fs = fsk = 500.00

Member's Properties

Diameter, D = 600.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
γel = 1.00 for Chord Rotation and Shear Capacity checks
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
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 3.31. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.00487128	0.00487128
	Significant Damage	End	2	0.00695712	0.00695712
	Near Collapse	End	3	0.00670463	0.00670463
Shear Capacity [kN]	Significant Damage	Start	2	519.817113	519.817113

COMPUTER FILES

- EC_rccs4.bpf
- Report_EC_rccs4.pdf

EXAMPLE 4.5

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Cold Worked-Brittle 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
- Program's Default Safety/Confidence Factors
- New Material Sets type

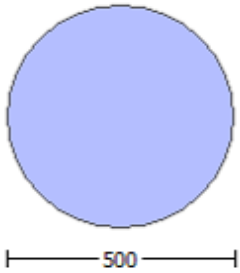
DESCRIPTION

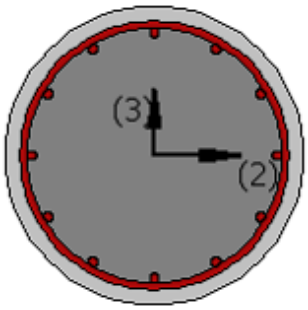
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.1) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00

For Shear Capacity Calculations

New material of Primary Member: Concrete Strength,
fc = fck/γc = 16.66667
New material of Primary Member: Steel Strength,
fs = fsk/γs = 434.7826

Member's Properties

Diameter, D = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 2.00 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Smooth Bars
Cold Worked-Brittle 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 4.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.00979151	0.00979151
	Significant Damage	End	3	0.00734363	0.00734363
	Near Collapse	Start	2	0.01352143	0.01352143
Shear Capacity [kN]	Significant Damage	Start	2	322.276143	322.276143

COMPUTER FILES

- EC_rccs5.bpf
- Report_EC_rccs5.pdf

EXAMPLE 4.6

SUCCINCT DATA

- Secondary 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
- Lap Length lo = 400.00
- FRP Wrapping Data (Type: Carbon)
- Not the Program's Default Safety/Confidence Factors
- Existing Material Sets type

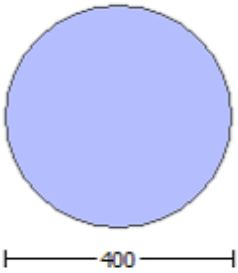
DESCRIPTION

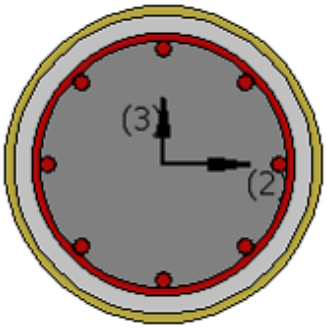
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.1) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.35

Materials' Properties
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 14.81481
Existing material: Steel Strength,
fs = fs/Cf = 329.2181

For Shear Capacity Calculations

Existing material of Secondary Member: Concrete Strength,
fc = fcm/Cf = 14.81481
Existing material of Secondary Member: Steel Strength,
fs = fs/Cf = 329.2181

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
γel = 1.60 for Chord Rotation checks and
γel = 1.10 for Shear Capacity checks
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
Lap Length lo = 400.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 668.00
Tensile Modulus, Ef = 55300.00
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 3.33. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.00924718	0.00924718
	Significant Damage	Start	2	0.0693538	0.00924718
	Near Collapse	Start	3	0.01150075	0.01150075
Shear Capacity [kN]	Near Collapse	End	2	293.931524	293.931652

COMPUTER FILES

- EC_rccs6.bpf
- Report_EC_rccs6.pdf

EXAMPLE 4.7

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Cold Worked-Brittle Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars Without Lapping in the Vicinity of the End Regions
- Lap Length lo = 200.00
- FRP Wrapping Data (Type: Glass)
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

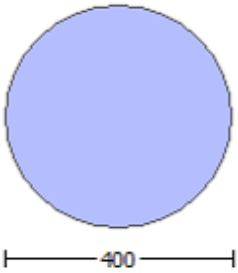
DESCRIPTION

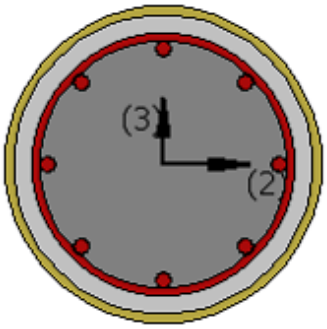
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.1) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 2.00 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Smooth Bars
Cold Worked-Brittle Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars Without Lapping in the Vicinity of the End Regions
Lap Length lo = 200.00
FRP Wrapping Data
Type: Glass
Dry properties (design values)
Thickness, t = 0.1096
Tensile Strength, ffu = 2600.00
Tensile Modulus, Ef = 73000.00
Elongation, efu = 0.035
Number of directions, NoDir = 4
Fiber orientations, bi: 0.00°, 90.00°, 45.00°, -45.00°
Number of layers, NL = 4
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 3.34. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.01888551	0.01888551
	Significant Damage	Start	3	0.01906102	0.01906102
	Near Collapse	End	2	0.01888551	0.01888551
Shear Capacity [kN]	Near Collapse	End	3	212.357318	212.357318

COMPUTER FILES

- EC_rccs7.bpf
- Report_EC_rccs7.pdf

EXAMPLE 4.8

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Cold Worked-Brittle Steel
- Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
- Longitudinal Bars Without Lapping in the Vicinity of the End Regions
- Lap Length lo = 200.00
- FRP Wrapping Data (Type: Glass)
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

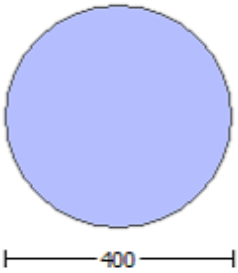
DESCRIPTION

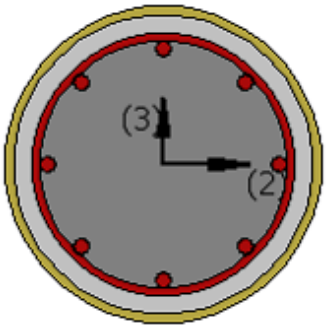
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.3) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 2.00 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Smooth Bars
Cold Worked-Brittle Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars Without Lapping in the Vicinity of the End Regions
Lap Length lo = 200.00
FRP Wrapping Data
Type: Glass
Dry properties (design values)
Thickness, t = 0.1096
Tensile Strength, ffu = 2600.00
Tensile Modulus, Ef = 73000.00
Elongation, efu = 0.035
Number of directions, NoDir = 4
Fiber orientations, bi: 0.00°, 90.00°, 45.00°, -45.00°
Number of layers, NL = 4
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 4.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.02789953	0.02789953
	Significant Damage	End	2	0.0141638	0.0141638
	Near Collapse	End	3	0.0188855	0.0188855
Shear Capacity [kN]	Damage Limitation	Start	2	196.509181	196.509181

COMPUTER FILES

- EC_rccs8.bpf
- Report_EC_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 Without Lapping in the Vicinity of the End Regions
- Lap Length lo = 200.00
- FRP Wrapping Data (Type: Glass)
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

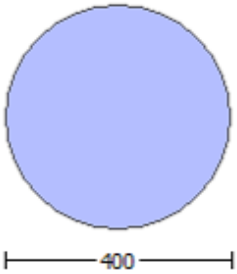
DESCRIPTION

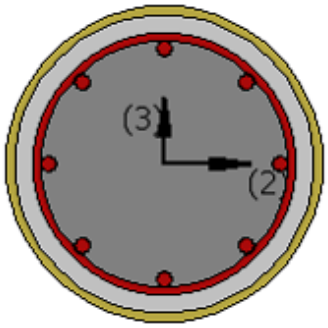
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.3) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 2.00 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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
Lap Length lo = 200.00
FRP Wrapping Data
Type: Glass
Dry properties (design values)
Thickness, t = 0.1096
Tensile Strength, ffu = 2600.00
Tensile Modulus, Ef = 73000.00
Elongation, efu = 0.035
Number of directions, NoDir = 4
Fiber orientations, bi: 0.00°, 90.00°, 45.00°, -45.00°
Number of layers, NL = 4
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 4.9

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.01888551	0.01888551
	Significant Damage	End	3	0.01416413	0.01416413
	Near Collapse	Start	2	0.01888551	0.01888551
Shear Capacity [kN]	Significant Damage	Start	3	212.357318	212.357318

COMPUTER FILES

- EC_rccs9.bpf
- Report_EC_rccs9.pdf

EXAMPLE 4.10

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 = 600.00
- FRP Wrapping Data (Type: Glass)
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

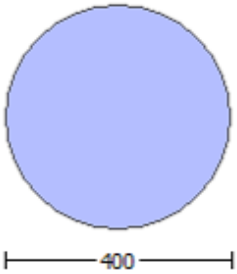
DESCRIPTION

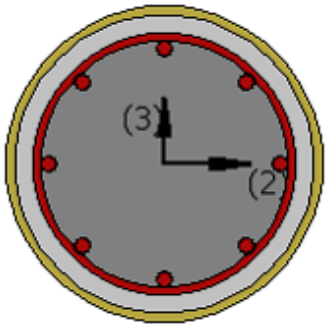
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.3) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 2.00 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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 = 600.00
FRP Wrapping Data
Type: Glass
Dry properties (design values)
Thickness, t = 0.1096
Tensile Strength, ffu = 2600.00
Tensile Modulus, Ef = 73000.00
Elongation, efu = 0.035
Number of directions, NoDir = 4
Fiber orientations, bi: 0.00°, 90.00°, 45.00°, -45.00°
Number of layers, NL = 4
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 4. 10

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.01104645	0.01104645
	Significant Damage	Start	2	0.0112949	0.0112949
	Near Collapse	Start	3	0.02116099	0.02116099
Shear Capacity [kN]	Near Collapse	End	2	212.397794	212.397794

COMPUTER FILES

- EC_rccs10.bpf
- Report_EC_rccs10.pdf

EXAMPLE 4.11

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
- Not the Program's Default Safety/Confidence Factors
- Existing Material Sets type

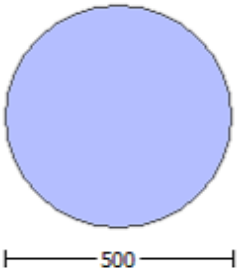
DESCRIPTION

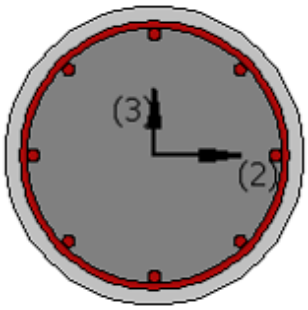
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.3) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 15.15152
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 336.7003

Member's Properties

Diameter, D = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 2.00 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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 3.38. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4. 11

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00833318	0.00833371
	Significant Damage	Start	3	0.0195967	0.0195967
	Near Collapse	End	2	0.02023483	0.02023483
Shear Capacity [kN]	Damage Limitation	End	3	285.439217	285.439217

COMPUTER FILES

- EC_rccs11.bpf
- Report_EC_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 Sections
- Lap Length lo = 600.00
- FRP Wrapping Data (Type: Glass)
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

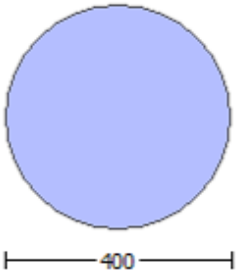
DESCRIPTION

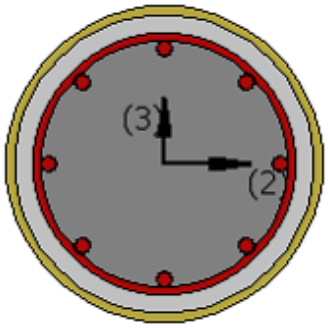
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.1) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 2.00 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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 = 600.00
FRP Wrapping Data
Type: Glass
Dry properties (design values)
Thickness, t = 0.1096
Tensile Strength, ffu = 2600.00
Tensile Modulus, Ef = 73000.00
Elongation, efu = 0.035
Number of directions, NoDir = 4
Fiber orientations, bi: 0.00°, 90.00°, 45.00°, -45.00°
Number of layers, NL = 4
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 4. 12

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.01542734	0.01542734
	Significant Damage	End	2	0.01268498	0.01268498
	Near Collapse	End	3	0.0117042	0.0117042
Shear Capacity [kN]	Damage Limitation	Start	2	212.357318	212.357318

COMPUTER FILES

- EC_rccs12.bpf
- Report_EC_rccs12.pdf

EXAMPLE 4.13

SUCCINCT DATA

- 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
- Lap Length lo = 200.00
- FRP Wrapping Data (Type: Glass)
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

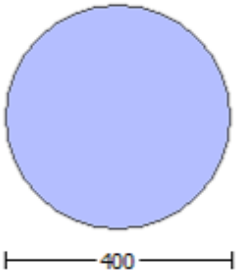
DESCRIPTION

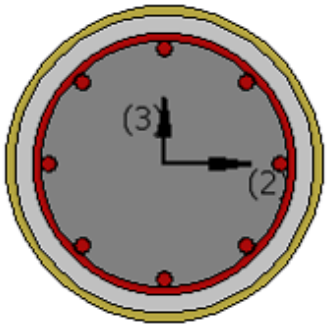
A circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.1) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 2.00 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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
Lap Length lo = 200.00
FRP Wrapping Data
Type: Glass
Dry properties (design values)
Thickness, t = 0.1096
Tensile Strength, ffu = 2600.00
Tensile Modulus, Ef = 73000.00
Elongation, efu = 0.035
Number of directions, NoDir = 4
Fiber orientations, bi: 0.00°, 90.00°, 45.00°, -45.00°
Number of layers, NL = 4
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 3.40. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 4. 13

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.01888551	0.01888551
	Significant Damage	End	3	0.01416413	0.01416413
	Near Collapse	Start	2	0.01888551	0.01888551
Shear Capacity [kN]	Damage Limitation	Start	3	212.357318	212.357318

COMPUTER FILES

- EC_rccs13.bpf
- Report_EC_rccs13.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
- Inadequate Lap Length with lo/lou,min = 0.40
- FRP Wrapping Data (Type: Carbon)
- Program's Default Safety/Confidence Factors
- New Material Sets type

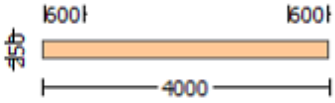
DESCRIPTION

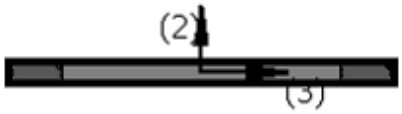
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.11a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.15) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00

For Shear Capacity Calculations

New material of Primary Member: Concrete Strength,
fc = fck/γc = 16.66667
New material of Primary Member: Steel Strength,
fs = fsk/γs = 434.7826

Member's Properties

Total Height, Htot = 4000.00
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
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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 = 0.40
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 0.10
Tensile Strength, ffu = 4800.00
Tensile Modulus, Ef = 230000.00
Elongation, efu = 0.021
Number of directions, NoDir = 2
Fiber orientations, bi: 0.00°, 90.00°
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 3.41. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.0138971	0. 0.0138971
	Significant Damage	Start	2	0.0102787	0.0102787
	Near Collapse	Start	3	0.03499951	0.03499951
Shear Capacity [kN]	Significant Damage	End	2	375.858692	375.858692

COMPUTER FILES

- EC_rcrws1.bpf
- Report_EC_rcrws1.pdf

EXAMPLE 5.2

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Cold Worked-Brittle 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
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

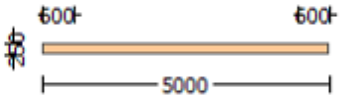
DESCRIPTION

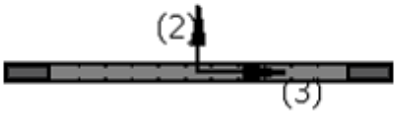
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.11b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.15) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Secondary Member: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material of Secondary Member: Steel Strength,
fs = fs/Cf = 370.3704

Member's Properties

Total Height, Htot = 5000.00
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
γel = 1.00 for Chord Rotation and Shear Capacity checks
Ribbed Bars
Cold Worked-Brittle 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

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 3.42. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00244395	0.00244395
	Significant Damage	Start	3	0.02647994	0.02647994
	Near Collapse	End	2	0.00704358	0.00704358
Shear Capacity [kN]	Near Collapse	End	3	2403.023255	2403.023253

COMPUTER FILES

- EC_rcrws2.bpf
- Report_EC_rcrws2.pdf

EXAMPLE 5.3

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
- Not the Program's Default Safety/Confidence Factors
- Existing Material Sets type

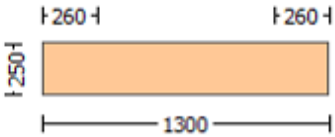
DESCRIPTION

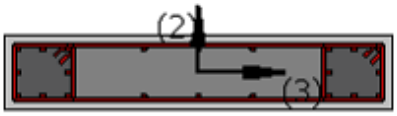
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.11a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.15) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.00

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 20.00
Existing material: Steel Strength,
fs = fs/Cf = 444.4444

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 14.28571
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 317.4603

Member's Properties

Total Height, Htot = 1300.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 260.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.60 for Chord Rotation checks and
γel = 1.40 for Shear Capacity checks
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 3.43. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.0145856	0.0145856
	Significant Damage	End	2	0.01918646	0.01918646
	Near Collapse	End	3	0.08801043	0.08801043
Shear Capacity [kN]	Damage Limitation	Start	2	244.631011	244.631011

COMPUTER FILES

- EC_rcrws3.bpf
- Report_EC_rcrws3.pdf

EXAMPLE 5.4

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 = 500.00
- No FRP Wrapping
- Not the Program's Default Safety/Confidence Factors
- New Material Sets type

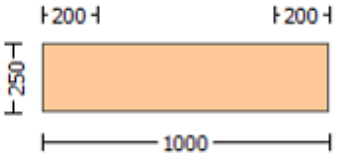
DESCRIPTION

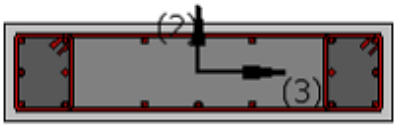
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.11b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.15) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00

For Shear Capacity Calculations

New material of Primary Member: Concrete Strength,
fc = fck/γc = 16.66667
New material of Primary Member: Steel Strength,
fs = fsk/γs = 434.7826

Member's Properties

Total Height, Htot = 1000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 200.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.50 for Shear Capacity checks
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 = 500.00
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 3.44. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.00466343	0.00466343
	Significant Damage	End	3	0.03024414	0.03024414
	Near Collapse	Start	2	0.00953546	0.009535456
Shear Capacity [kN]	Significant Damage	Start	3	467.526246	467.526246

NOTE: For the selected shear capacity check the limitation of the equation (A.15) of EC8: Part 3 is employed.

COMPUTER FILES

- EC_rcrws4.bpf
- Report_EC_rcrws4.pdf

EXAMPLE 5.5

SUCCINCT DATA

- Primary 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 = 0.40
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

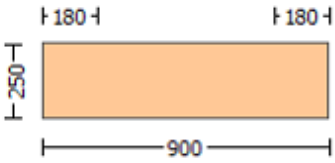
DESCRIPTION

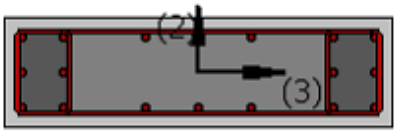
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.11a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.15) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Total Height, Htot = 900.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 180.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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 = 0.40
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 3.45. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.01065072	0.01065072
	Significant Damage	Start	2	0.01254987	0.01254987
	Near Collapse	Start	3	0.023300	0.023300
Shear Capacity [kN]	Near Collapse	End	2	203.757423	203.75742266

COMPUTER FILES

- EC_rcrws5.bpf
- Report_EC_rcrws5.pdf

EXAMPLE 5.6

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
- Adequate Lap Length (lo/lou,min>=1)
- FRP Wrapping Data (Type: Carbon)
- Not the Program's Default Safety/Confidence Factors
- New Material Sets type

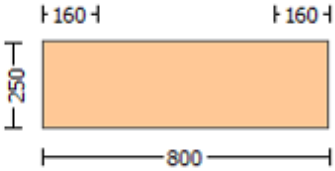
DESCRIPTION

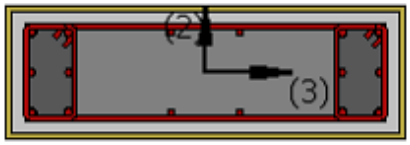
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.11a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.15) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.35

Materials' Properties

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

For Chord rotation Calculations

New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00

Existing material of Primary Member: Concrete
New material of Secondary Member: Concrete Strength,
fc = fck = 25.00
New material of Secondary Member: Steel Strength,
fs = fsk = 500.00

For Shear Capacity Calculations

Member's Properties

Total Height, Htot = 800.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 160.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
γel = 1.30 for Chord Rotation and Shear Capacity checks
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)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 489.00
Tensile Modulus, Ef = 42468.00
Elongation, efu = 0.0098
Number of directions, NoDir = 2
Fiber orientations, bi: 0.00°, 90.00°

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 3.46. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00745266	0.007452655
	Significant Damage	Start	3	0.0541171	0.0541171
	Near Collapse	End	2	0.0269459	0.0269459
Shear Capacity [kN]	Near Collapse	End	3	698.3168388	698.3168388

NOTE: For the selected shear capacity check the limitation of the equation (A.15) of EC8: Part 3 is employed.

COMPUTER FILES

- EC_rcrws6.bpf
- Report_EC_rcrws6.pdf

EXAMPLE 5.7

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Cold Worked-Brittle 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
- Program's Default Safety/Confidence Factors
- New Material Sets type

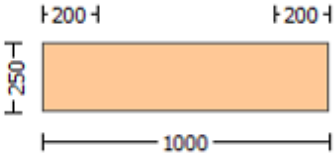
DESCRIPTION

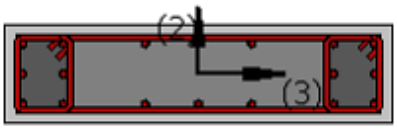
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.11a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.15) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00

For Shear Capacity Calculations

New material of Primary Member: Concrete Strength,
fc = fck/γc = 16.66667
New material of Primary Member: Steel Strength,
fs = fsk/γs = 434.7826

Member's Properties

Total Height, Htot = 1000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 200.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Smooth Bars
Cold Worked-Brittle 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 3.47. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.01646857	0.01646857
	Significant Damage	End	2	0.00872658	0.00872658
	Near Collapse	End	3	0.02715554	0.02715554
Shear Capacity [kN]	Significant Damage	Start	2	507.640249	507.6402487

COMPUTER FILES

- EC_rcrws7.bpf
- Report_EC_rcrws7.pdf

EXAMPLE 5.8

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
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

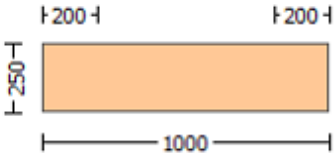
DESCRIPTION

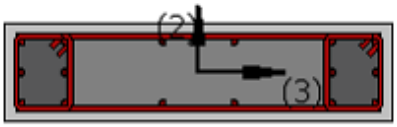
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.11b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.15) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Total Height, Htot = 1000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 200.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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 3.48. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.00269543	0.00269543
	Significant Damage	End	3	0.0431335	0.0431335
	Near Collapse	Start	2	0.04384711	0.04384711
Shear Capacity [kN]	Near Collapse	Start	3	429.762384	429.762384

NOTE: For the selected shear capacity check the limitation of the equation (A.15) of EC8: Part 3 is employed.

COMPUTER FILES

- EC_rcrws8.bpf
- Report_EC_rcrws8.pdf

EXAMPLE 5.9

SUCCINCT DATA

- Secondary 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
- Lap Length lo = 300.00
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type

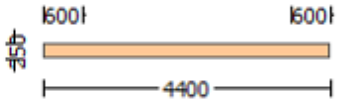
DESCRIPTION

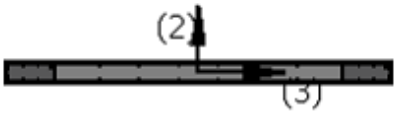
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.11b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.15) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00

For Shear Capacity Calculations

New material of Secondary Member: Concrete Strength,
fc = fck = 25.00
New material of Secondary Member: Steel Strength,
fs = fsk = 500.00

Member's Properties

Total Height, Htot = 4400.00
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
γel = 1.00 for Chord Rotation Shear Capacity checks
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
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 3.49. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.9

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.00759772	0.00759772
	Significant Damage	Start	2	0.006247	0.006247
	Near Collapse	Start	3	0.02014808	0.02014808
Shear Capacity [kN]	Damage Limitation	End	2	387.9313	387.9313

COMPUTER FILES

- EC_rcrws9.bpf
- Report_EC_rcrws9.pdf

EXAMPLE 5.10

SUCCINCT DATA

- 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
- Inadequate Lap Length with lo/lou,min = 0.40
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

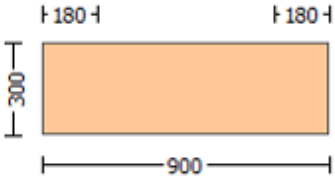
DESCRIPTION

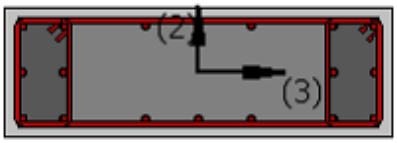
A wall section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.11a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.15) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Total Height, Htot = 900.00
Edges Width, Wedg = 300.00
Edges Height, Hedg = 180.00
Web Width, Wweb = 300.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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
Inadequate Lap Length with lo/lou,min = 0.40
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 3.50. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 5.10

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00552942	0.00552942
	Significant Damage	Start	3	0.0135411	0.0135411
	Near Collapse	End	2	0.00683378	0.00683378
Shear Capacity [kN]	Significant Damage	End	3	436.624374	436.624374

COMPUTER FILES

- EC_rcrws10.bpf
- Report_EC_rcrws10.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
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

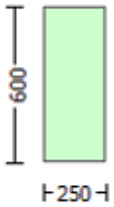
DESCRIPTION

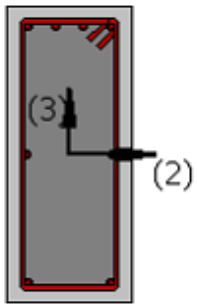
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Section Height, H = 600.00
Section Width, W = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3500.00
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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 3.51. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.0197672	0.0197672
	Significant Damage	Start	2	0.0390607	0.0390607
	Near Collapse	Start	3	0.02711692	0.02711692
Shear Capacity [kN]	Significant Damage	End	2	58.1877168	58.1877168

COMPUTER FILES

- EC_Beam1.bpf
- Report_EC_Beam1.pdf

EXAMPLE 6.2

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Cold worked-Brittle Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars Without Lapping in the Vicinity of the End Regions
- Lap Length lo=200.00
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

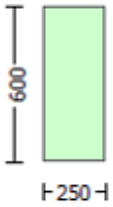
DESCRIPTION

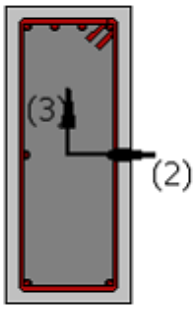
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Section Height, H = 600.00
Section Width, W = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3500.00
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Smooth Bars
Cold Worked-Brittle Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars Without Lapping in the Vicinity of the End Regions
Lap Length lo=200.00
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 3.52. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.01192622	0.01192622
	Significant Damage	End	3	0.0073898	0.0073898
	Near Collapse	End	2	0.00616648	0.00616648
Shear Capacity [kN]	Significant Damage	Start	3	161.7735405	161.7735405

COMPUTER FILES

- EC_Beam2.bpf
- Report_Beam2.pdf

EXAMPLE 6.3

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Cold worked-Brittle Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars Without Lapping in the Vicinity of the End Regions
- Lap Length lo=200.00
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

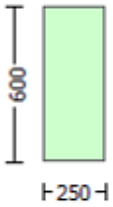
DESCRIPTION

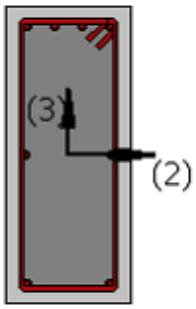
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Section Height, H = 600.00
Section Width, W = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3500.00
Primary Member
γel = 1.50for Chord Rotation checks and
γel = 1.15for Shear Capacity checks
Smooth Bars
Cold Worked-Brittle Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars Without Lapping in the Vicinity of the End Regions
Lap Length lo=200.00
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 3.53. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.00707438	0.00707438
	Significant Damage	End	2	0.00439476	0.00439476
	Near Collapse	End	3	0.00983943	0.00983943
Shear Capacity [kN]	Significant Damage	Start	2	838.65716	838.65716

COMPUTER FILES

- EC_Beam3.bpf
- Report_Beam3.pdf

EXAMPLE 6.4

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Cold worked-Brittle Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars Without Lapping in the Vicinity of the End Regions
- Lap Length lo=200.00
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

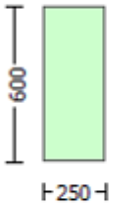
DESCRIPTION

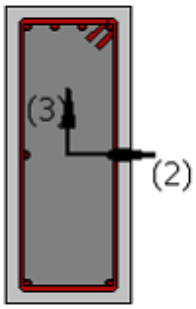
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Section Height, H = 600.00
Section Width, W = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3500.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Smooth Bars
Cold Worked-Brittle Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars Without Lapping in the Vicinity of the End Regions
Lap Length lo=200.00
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 3.54. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.00571087	0.00571087
	Significant Damage	Start	3	0.00668240	0.00668240
	Near Collapse	Start	2	0.009185526	0.009185526
Shear Capacity [kN]	Significant Damage	End	3	185.277113	185.277115

COMPUTER FILES

- EC_Beam4.bpf
- Report_Beam4.pdf

EXAMPLE 6.5

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Cold worked-Brittle Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars Without Lapping in the Vicinity of the End Regions
- Lap Length lo=200.00
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- Existing Material Sets type

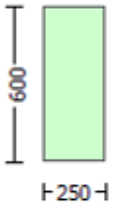
DESCRIPTION

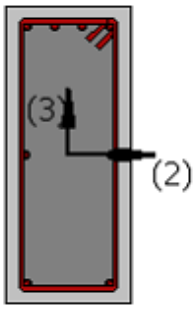
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Section Height, H = 600.00
Section Width, W = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3500.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Smooth Bars
Cold Worked-Brittle Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars Without Lapping in the Vicinity of the End Regions
Lap Length lo=200.00
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 3.55. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.01943394	0.01943394
	Significant Damage	Start	2	0.0113808	0.0113808
	Near Collapse	Start	3	0.00848131	0.00848131
Shear Capacity [kN]	Near Collapse	End	2	58.188983	58.1889844

COMPUTER FILES

- EC_Beam5.bpf
- Report_Beam5.pdf

EXAMPLE 6.6

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Cold worked-Brittle 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=0.40
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type

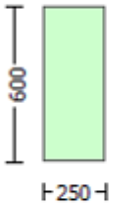
DESCRIPTION

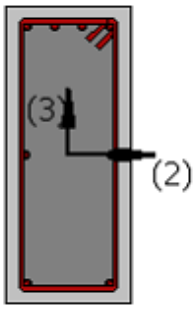
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

New material: Concrete Strength,
fc = fcm/Cf = 25.00
New material: Steel Strength,
fs = fs/Cf = 500.00

For Shear Capacity Calculations

New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826

Member's Properties

Section Height, H = 600.00
Section Width, W = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3500.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Ribbed Bars
Cold Worked-Brittle 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=0.40
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 3.56. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.0149626	0.0149626
	Significant Damage	End	3	0.0215212	0.0215212
	Near Collapse	End	2	0.01060095	0.01060095
Shear Capacity [kN]	Near Collapse	Start	3	216.558027	216.558024

COMPUTER FILES

- EC_Beam6.bpf
- Report_Beam6.pdf

EXAMPLE 6.7

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Cold worked-Brittle 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=0.40
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type

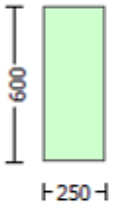
DESCRIPTION

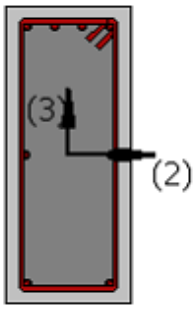
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

New material: Concrete Strength,
fc = fcm/Cf = 25.00
New material: Steel Strength,
fs = fs/Cf = 500.00

For Shear Capacity Calculations

New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826

Member's Properties

Section Height, H = 600.00
Section Width, W = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3500.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Ribbed Bars
Cold Worked-Brittle 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=0.40
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 3.57. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.00939618	0.00939618
	Significant Damage	End	2	0.00776289	0.00776289
	Near Collapse	End	3	0.02604450	0.02604450
Shear Capacity [kN]	Near Collapse	Start	2	99.499361	99.499365

COMPUTER FILES

- EC_Beam7.bpf
- Report_Beam7.pdf

EXAMPLE 6.8

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Cold worked-Brittle 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=0.40
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type

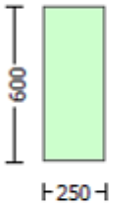
DESCRIPTION

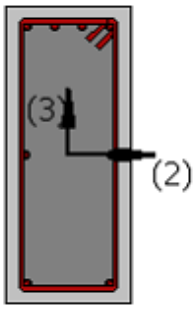
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

New material: Concrete Strength,
fc = fcm/Cf = 25.00
New material: Steel Strength,
fs = fs/Cf = 500.00

For Shear Capacity Calculations

New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826

Member's Properties

Section Height, H = 600.00
Section Width, W = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3500.00
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Ribbed Bars
Cold Worked-Brittle 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=0.40
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 3.58. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.00665926	0.00665926
	Significant Damage	Start	3	0.0086558	0.0086558
	Near Collapse	Start	2	0.01538506	0.01538506
Shear Capacity [kN]	Near Collapse	End	3	245.637930	245.637935

COMPUTER FILES

- EC_Beam8.bpf
- Report_Beam8.pdf

EXAMPLE 6.9

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Cold worked-Brittle 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=0.40
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type

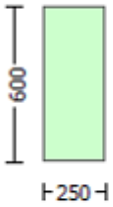
DESCRIPTION

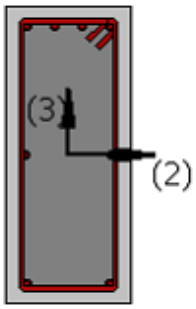
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

New material: Concrete Strength,
fc = fcm/Cf = 25.00
New material: Steel Strength,
fs = fs/Cf = 500.00

For Shear Capacity Calculations

New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826

Member's Properties

Section Height, H = 600.00
Section Width, W = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3500.00
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Ribbed Bars
Cold Worked-Brittle 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=0.40
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 3.59. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.9

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.02481501	0.02481501
	Significant Damage	Start	2	0.01568262	0.01568262
	Near Collapse	Start	3	0.01290532	0.01290532
Shear Capacity [kN]	Damage Limitation	End	2	77.433647	77.433647

COMPUTER FILES

- EC_Beam9.bpf
- Report_Beam9.pdf

EXAMPLE 6.10

SUCCINCT DATA

- Secondary Member
- Ribbed Bars
- Cold worked-Brittle 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=0.20
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type

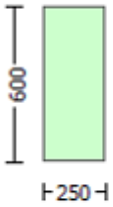
DESCRIPTION

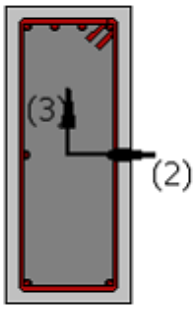
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

New material: Concrete Strength,
fc = fcm/Cf = 25.00
New material: Steel Strength,
fs = fs/Cf = 500.00

For Shear Capacity Calculations

New material of Secondary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Secondary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826

Member's Properties

Section Height, H = 600.00
Section Width, W = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3500.00
Secondary Member
γel = 1.00 for Chord Rotation and Shear Capacity checks
Ribbed Bars
Cold Worked-Brittle 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=0.20
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 3.60. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.10

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00928888	0.00928888
	Significant Damage	End	3	0.0143968	0.0143968
	Near Collapse	End	2	0.0082116	0.0082116
Shear Capacity [kN]	Damage Limitation	Start	3	287.3541664	287.3541664

COMPUTER FILES

- EC_Beam10.bpf
- Report_Beam10.pdf

EXAMPLE 6.11

SUCCINCT DATA

- Primary 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
- Not the Program's Default Safety/Confidence Factors
- Existing Material Sets type

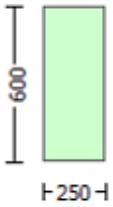
DESCRIPTION

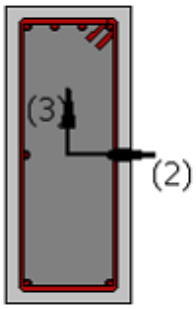
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.25

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.00
Existing material: Steel Strength,
fs = fs/Cf = 355.5556

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 10.32258
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 296.2963

Member's Properties

Section Height, H = 600.00
Section Width, W = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3500.00
Primary Member
γel = 1.85 for Chord Rotation checks and
γel = 1.20 for Shear Capacity checks
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 3.61. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.11

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.00684895	0.00684895
	Significant Damage	End	2	0.0106534	0.0106534
	Near Collapse	End	3	0.03373156	0.03373156
Shear Capacity [kN]	Damage Limitation	Start	2	68.977011	68.9770067

COMPUTER FILES

- EC_Beam11.bpf
- Report_Beam11.pdf

EXAMPLE 6.12

SUCCINCT DATA

- Primary 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
- Not the Program's Default Safety/Confidence Factors
- Existing Material Sets type

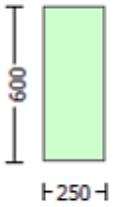
DESCRIPTION

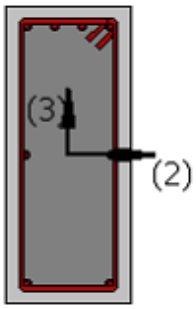
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.25

Materials' Properties

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

For Chord rotation Calculations

Existing material: Concrete Strength,
fc = fcm/Cf = 16.00
Existing material: Steel Strength,
fs = fs/Cf = 355.5556

For Shear Capacity Calculations

Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 10.32258
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 296.2963

Member's Properties

Section Height, H = 600.00
Section Width, W = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3500.00
Primary Member
γel = 1.55 for Chord Rotation checks and
γel = 1.20 for Shear Capacity checks
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 3.62. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.12

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.00552141	0.00552141
	Significant Damage	Start	3	0.0132258	0.0132258
	Near Collapse	Start	2	0.0250859	0.0250859
Shear Capacity [kN]	Damage Limitation	End	3	166.0423375	166.0423375

COMPUTER FILES

- EC_Beam12.bpf
- Report_Beam12.pdf

EXAMPLE 6.13

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Cold worked-Brittle 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=0.40
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type

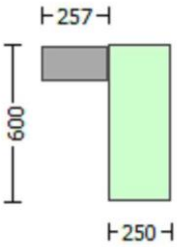
DESCRIPTION

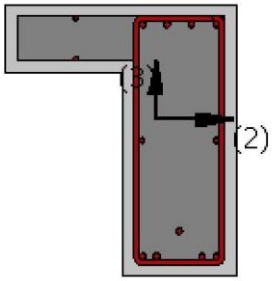
A beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

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

For Chord rotation Calculations

New material: Concrete Strength,
fc = fcm/Cf = 25.00
New material: Steel Strength,
fs = fs/Cf = 500.00

For Shear Capacity Calculations

New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826

Member's Properties

Section Height, H = 600.00
Section Width, W = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3500.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Ribbed Bars
Cold Worked-Brittle 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=0.40
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 3.63. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 6.13

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.00817228	0.00817228
	Significant Damage	Start	2	0.0090878	0.0090878
	Near Collapse	Start	3	0.02194658	0.02194658
Shear Capacity [kN]	Significant Damage	End	2	174.59153	174.59153

COMPUTER FILES

- EC_Beam13.bpf
- Report_Beam13.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)
- FRP Wrapping Data (Type: Carbon)
- Not the Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

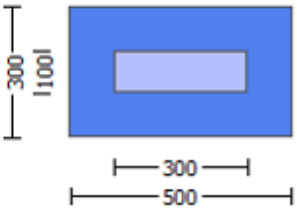
DESCRIPTION

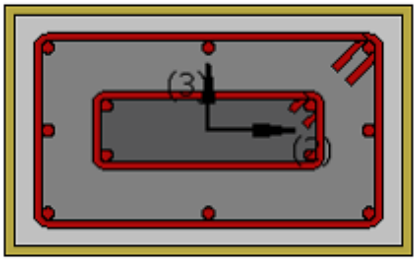
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.35

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing COlumn, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 14.81481
Existing material: Steel Strength,
fs = fs/Cf = 329.2181

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fck/γc = 20.83333
New material of Primary Member: Steel Strength,
fs = fsk/γs = 416.6667
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 12.34568
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 274.3484

Member's Properties

External Height, H = 300.00
External Width, W = 500.00
Internal Height, H = 100.00
Internal Width, W = 300.00
Cover Thickness, c = 25.00
Element Length, L = 4000.00
Primary Member
γel = 1.60 for Chord Rotation checks and
γel = 1.20 for Shear Capacity checks
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)
FRP Wrapping Data
Type: Carbon

Dry properties (design values)
Thickness, t = 0.106
Tensile Strength, ffu = 4800.00
Tensile Modulus, Ef = 230000.00
Elongation, efu = 0.021
Number of directions, NoDir = 4
Fiber orientations, bi: 0.00°, 90.00°, 45.00°, -45.00°
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 3.64. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.01274702	0.01274702
	Significant Damage	Start	3	0.0391667	0.0391664
	Near Collapse	End	2	0.1101413	0.1101413
Shear Capacity [kN]	Near Collapse	End	3	148.168952	148.1689515

COMPUTER FILES

- EC_rcjrs1.bpf
- Report_EC_rcjrs1.pdf

EXAMPLE 7.2

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
- Lap Length lo = 500.00
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

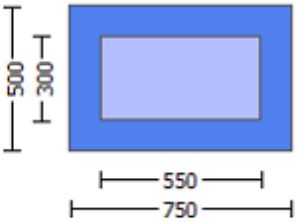
DESCRIPTION

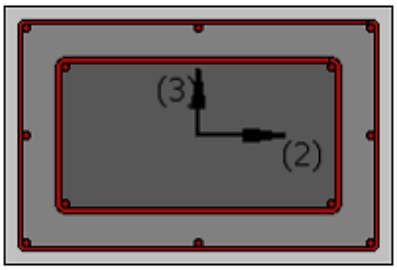
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing COlumn, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Secondary Member: Concrete Strength,
fc = fck = 25.00
New material of Secondary Member: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material of Secondary Member: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material of Secondary Member: Steel Strength,
fs = fs/Cf = 370.3704

Member's Properties

External Height, H = 500.00
External Width, W = 750.00
Internal Height, H = 300.00
Internal Width, W = 550.00

Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
γel = 1.00 for Chord Rotation and Shear Capacity checks
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
Lap Length lo = 500.00
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 3.65. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.00695615	0.00695615
	Significant Damage	End	2	0.0236738	0.0236738
	Near Collapse	End	2	0.03155368	0.03155368
Shear Capacity [kN]	Damage Limitation	Start	2	785.587375	785.587367

COMPUTER FILES

- EC_rcjrs2.bpf
- Report_EC_rcjrs2.pdf

EXAMPLE 7.3

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Cold Worked-Brittle 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
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

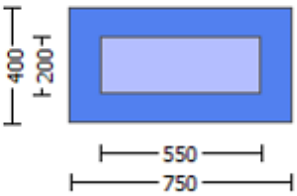
DESCRIPTION

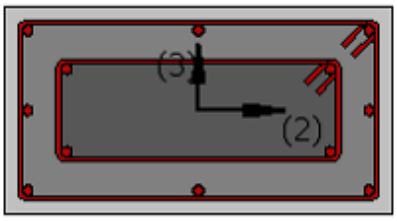
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing COlumn, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Secondary Member: Concrete Strength,
fc = fck = 25.00
New material of Secondary Member: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material of Secondary Member: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material of Secondary Member: Steel Strength,
fs = fs/Cf = 370.3704

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
γel = 1.00 for Chord Rotation and Shear Capacity checks
Smooth Bars
Cold Worked-Brittle 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 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 3.66. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.00989657	0.00989657
	Significant Damage	End	3	0.0100888	0.0100888
	Near Collapse	Start	2	0.02731987	0.02731987
Shear Capacity [kN]	Significant Damage	Start	3	399.260822	399.2608215

COMPUTER FILES

- EC_rcjrs3.bpf
- Report_EC_rcjrs3.pdf

EXAMPLE 7.4

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
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

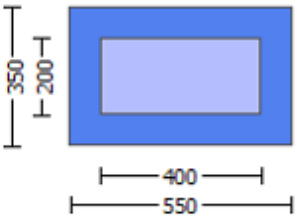
DESCRIPTION

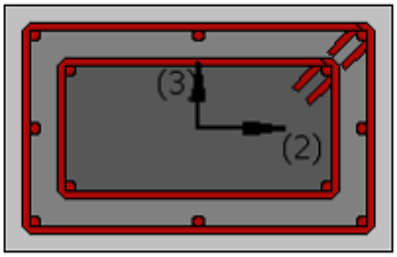
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing COlumn, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fck/γc = 16.66667
New material of Primary Member: Steel Strength,
fs = fsk/γs = 434.7826
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

External Height, H = 350.00
External Width, W = 550.00
Internal Height, H = 200.00
Internal Width, W = 400.00

Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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 3.67. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.00741219	0.007412185
	Significant Damage	Start	2	0.03968407	0.03968407
	Near Collapse	Start	3	0.03659722	0.03659722
Shear Capacity [kN]	Near Collapse	End	2	456.198336	456.1983357

COMPUTER FILES

- EC_rcjrs4.bpf
- Report_EC_rcjrs4.pdf

EXAMPLE 7.5

SUCCINCT DATA

- Secondary 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
- Inadequate Lap Length with lo/lou,min = 0.20
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

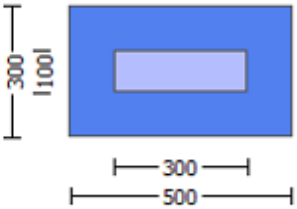
DESCRIPTION

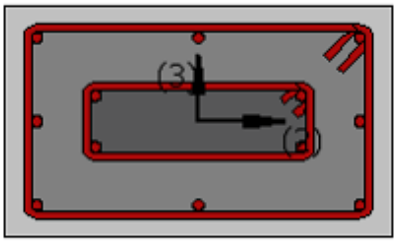
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing COlumn, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Secondary Member: Concrete Strength,
fc = fck = 25.00
New material of Secondary Member: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material of Secondary Member: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material of Secondary Member: Steel Strength,
fs = fs/Cf = 370.3704

Member's Properties

External Height, H = 300.00
External Width, W = 500.00
Internal Height, H = 100.00
Internal Width, W = 300.00

Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
γel = 1.00 for Chord Rotation and Shear Capacity checks
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
Inadequate Lap Length with lo/lou,min = 0.20
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 3.68. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00530373	0.00530373
	Significant Damage	Start	3	0.0143672	0.0143672
	Near Collapse	End	2	0.02865688	0.02865688
Shear Capacity [kN]	Near Collapse	End	3	116.495885	116.495885

COMPUTER FILES

- EC_rcjrs5.bpf
- Report_EC_rcjrs5.pdf

EXAMPLE 7.6

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
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

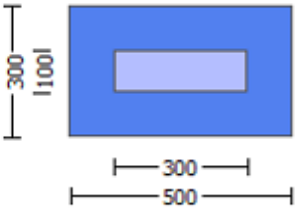
DESCRIPTION

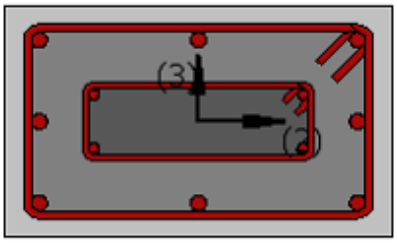
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing COlumn, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fck/γc = 16.66667
New material of Primary Member: Steel Strength,
fs = fsk/γs = 434.7826
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

External Height, H = 300.00
External Width, W = 500.00
Internal Height, H = 100.00
Internal Width, W = 300.00

Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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 3.69. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.01236137	0.01236135
	Significant Damage	End	2	0.01380497	0.01380497
	Near Collapse	End	3	0.05341341	0.05341341
Shear Capacity [kN]	Damage Limitation	Start	2	282.5204929	282.5204929

COMPUTER FILES

- EC_rcjrs6.bpf
- Report_EC_rcjrs6.pdf

EXAMPLE 7.7

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
- Lap Length lo = 500.00
- FRP Wrapping Data (Type: Carbon)
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

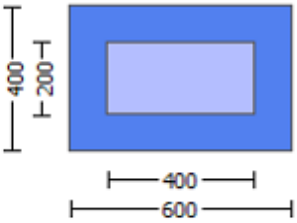
DESCRIPTION

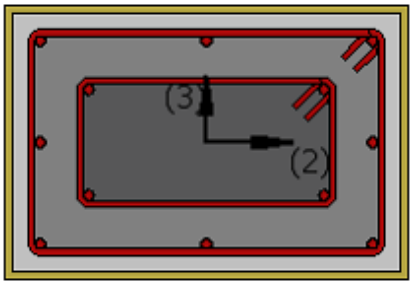
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing COlumn, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Secondary Member: Concrete Strength,
fc = fck = 25.00
New material of Secondary Member: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm/Cf = 16.66667
Existing material of Secondary Member: Steel Strength, fs = fs/Cf = 370.3704

Member's Properties

External Height, H = 400.00
External Width, W = 600.00
Internal Height, H = 200.00
Internal Width, W = 400.00
Cover Thickness, c = 25.00

Element Length, L = 3000.00
Secondary Member
γel = 1.00 for Chord Rotation and Shear Capacity checks
Ribbed 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 = 500.00
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 0.046
Tensile Strength, ffu = 3800.00
Tensile Modulus, Ef = 230000.00
Elongation, efu = 0.015
Number of directions, NoDir = 2
Fiber orientations, bi: 0.00°, 90.00°
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 3.70. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.00887978	0.00887978
	Significant Damage	End	3	0.0228167	0.0228167
	Near Collapse	Start	2	0.03523678	0.03523678
Shear Capacity [kN]	Significant Damage	Start	3	407.28303	407.28303

COMPUTER FILES

- EC_rcjrs7.bpf
- Report_EC_rcjrs7.pdf

EXAMPLE 7.8

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
- Inadequate Lap Length with lo/lou,min = 0.60
- FRP Wrapping Data (Type: Aramid)
- Not the Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

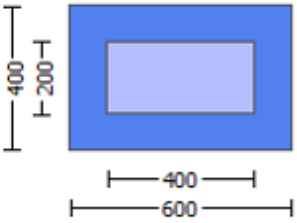
DESCRIPTION

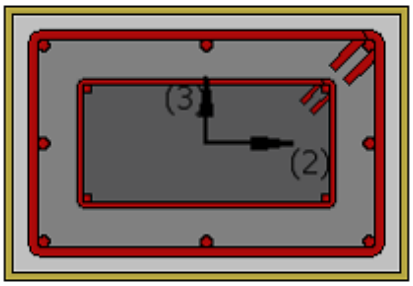
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.35

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing COlumn, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 14.81481
Existing material: Steel Strength,
fs = fs/Cf = 329.2181

For Shear Capacity Calculations

Jacket
New material of Secondary Member: Concrete Strength,
fc = fck = 25.00
New material of Secondary Member: Steel Strength,
fs = fsk = 500.00
Existing Column

Existing material of Secondary Member:
Concrete Strength,
fc = fcm/Cf = 14.81481

Existing material of Secondary Member: Steel Strength,
fs = fs/Cf = 329.2181

Member's Properties

External Height, H = 400.00
External Width, W = 600.00
Internal Height, H = 200.00
Internal Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
γel = 1.00 for Chord Rotation and Shear Capacity checks
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 = 0.60
FRP Wrapping Data
Type: Aramid
Dry properties (design values)
Thickness, t = 0.20
Tensile Strength, ffu = 2231.00
Tensile Modulus, Ef = 92308.00
Elongation, efu = 0.025
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 2
Radius of rounding corners, R = 50.00

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 3.71. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.00680759	0.00680759
	Significant Damage	Start	2	0.0817586	0.0817586
	Near Collapse	Start	3	0.06275275	0.06275275
Shear Capacity [kN]	Near Collapse	End	2	1185.988684	1185.988684

COMPUTER FILES

- EC_rcjrs8.bpf
- Report_EC_rcjrs8.pdf

EXAMPLE 7.9

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Cold Worked-Brittle 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
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

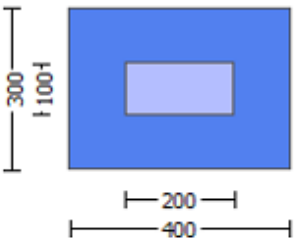
DESCRIPTION

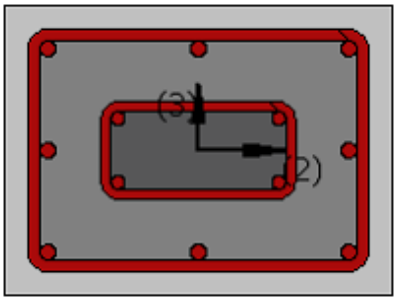
A jacketed rectangular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing COlumn, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column

Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fck/γc = 16.66667
New material of Primary Member: Steel Strength,
fs = fsk/γs = 434.7826
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

External Height, H = 300.00
External Width, W = 400.00
Internal Height, H = 100.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 4000.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Ribbed Bars
Cold Worked-Brittle 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

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 3.72. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 7.9

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.01383634	0.01383634
	Significant Damage	Start	3	0.02162202	0.02162202
	Near Collapse	End	2	0.05236105	0.05236105
Shear Capacity [kN]	Damage Limitation	End	3	207.088676	207.088676

COMPUTER FILES

- EC_rcjrs9.bpf
- Report_EC_rcjrs9.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
- Lap Length lo = 500.00
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

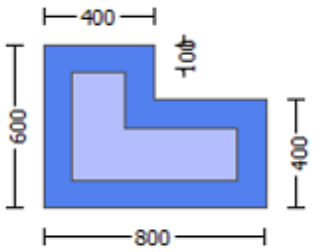
DESCRIPTION

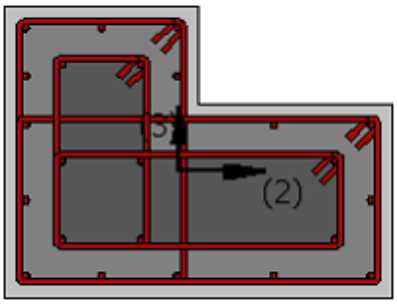
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Column, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

Jacket
New material of Primary Member: Concrete Strength,
fc = fck/γc = 16.66667
New material of Primary Member: Steel Strength,
fs = fsk/γs = 434.7826
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

For Shear Capacity Calculations

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 400.00
Max Width, Wmax = 800.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Ribbed 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 = 500.00
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 3.73. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.00943252	0.00943252
	Significant Damage	Start	2	0.0372897	0.0372897
	Near Collapse	End	2	0.0293963	0.0293963
Shear Capacity [kN]	Significant Damage	End	2	734.989300	734.989299

COMPUTER FILES

- EC_rcjlcs1.bpf
- Report_EC_rcjlcs1.pdf

EXAMPLE 8.2

SUCCINCT DATA

- Secondary 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)
- No FRP Wrapping
- Not the Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

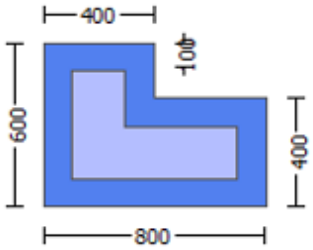
DESCRIPTION

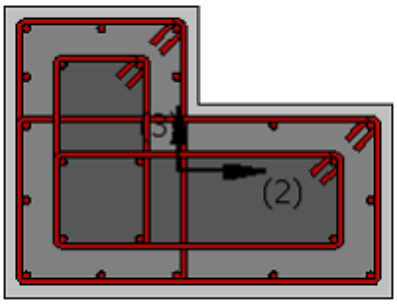
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.35

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Column, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 14.81481
Existing material: Steel Strength,
fs = fs/Cf = 329.2181

For Shear Capacity Calculations

Jacket
New material of Secondary Member: Concrete Strength,
fc = fck = 25.00
New material of Secondary Member: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material of Secondary Member: Concrete Strength,
fc = fcm/Cf = 14.81481
Existing material of Secondary Member: Steel Strength,
fs = fs/Cf = 329.2181

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 400.00
Max Width, Wmax = 800.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
γel = 1.20 for Chord Rotation and Shear Capacity checks
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)
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 3.74. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00773391	0.00773391
	Significant Damage	End	3	0.05048067	0.05048067
	Near Collapse	End	2	0.08793307	0.08793307
Shear Capacity [kN]	Significant Damage	Start	3	1060.609034	1060.609036

COMPUTER FILES

- EC_rcjlcs2.bpf
- Report_EC_rcjlcs2.pdf

EXAMPLE 8.3

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
- Inadequate Lap Length with lo/lou,min = 0.30
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

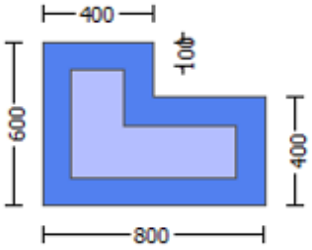
DESCRIPTION

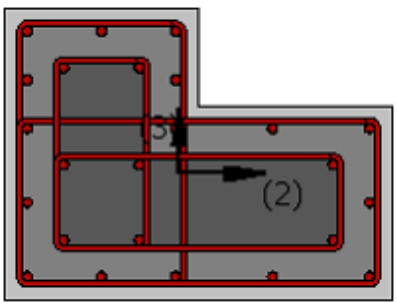
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Column, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fck/γc = 16.66667
New material of Primary Member: Steel Strength,
fs = fsk/γs = 434.7826
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 400.00
Max Width, Wmax = 800.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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 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 3.75. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.00899605	0.00899605
	Significant Damage	End	2	0.0119715	0.0119715
	Near Collapse	End	3	0.01647604	0.016476036
Shear Capacity [kN]	Significant Damage	Start	2	1300.820199	1300.8202

COMPUTER FILES

- EC_rcjlcs3.bpf
- Report_EC_rcjlcs3.pdf

EXAMPLE 8.4

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Cold Worked-Brittle 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)
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

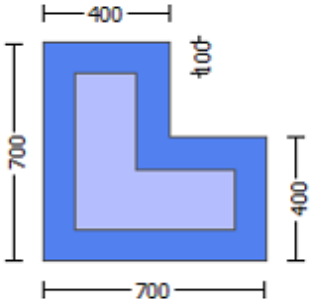
DESCRIPTION

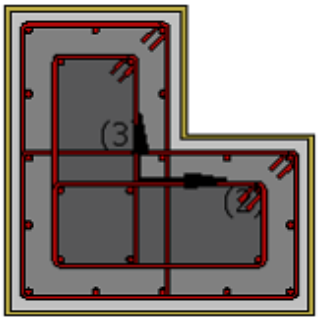
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Column, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fck/γc = 16.66667
New material of Primary Member: Steel Strength,
fs = fsk/γs = 434.7826
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Max Height, Hmax = 700.00
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
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Ribbed Bars
Cold Worked-Brittle 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 = 2
Radius of rounding corners, R = 50.00

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 3.76. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.00649059	0.00649059
	Significant Damage	Start	3	0.0557454	0.0557454
	Near Collapse	Start	2	0.06576519	0.06576519
Shear Capacity [kN]	Significant Damage	End	3	1611.068557	1611.068557

COMPUTER FILES

- EC_rcjlcs4.bpf
- Report_EC_rcjlcs4.pdf

EXAMPLE 8.5

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
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

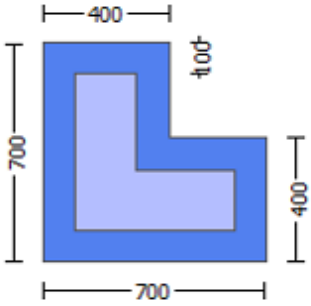
DESCRIPTION

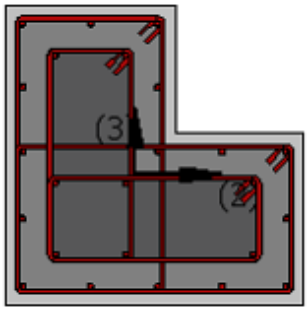
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Column, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fck/γc = 16.66667
New material of Primary Member: Steel Strength,
fs = fsk/γs = 434.7826
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Max Height, Hmax = 700.00
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
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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 3.77. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.00827658	0.00827658
	Significant Damage	Start	2	0.0595621	0.0595621
	Near Collapse	End	2	0.06913254	0.06913254
Shear Capacity [kN]	Near Collapse	End	2	863.608389	863.608389

COMPUTER FILES

- EC_rcjlcs5.bpf
- Report_EC_rcjlcs5.pdf

EXAMPLE 8.6

SUCCINCT DATA

- Secondary 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
- Inadequate Lap Length with lo/lou,min = 0.40
- No FRP Wrapping
- Program's Default Safety/Confidence Factors

- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

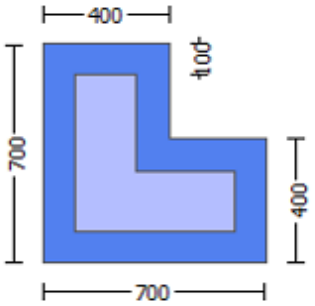
DESCRIPTION

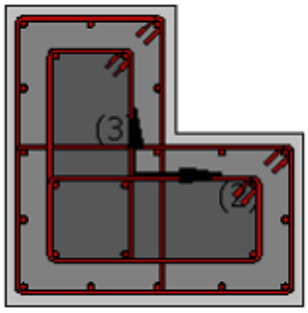
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Column, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Secondary Member: Concrete Strength,
fc = fck = 25.00
New material of Secondary Member: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material of Secondary Member: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material of Secondary Member: Steel Strength,
fs = fs/Cf = 370.3704

Member's Properties

Max Height, Hmax = 700.00
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
γel = 1.00 for Chord Rotation and Shear Capacity checks
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
Inadequate Lap Length with lo/lou,min = 0.40
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 3.78. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00611846	0.00611846
	Significant Damage	End	3	0.02256487	0.02256487
	Near Collapse	End	2	0.0413461	0.0413461
Shear Capacity [kN]	Near Collapse	Start	3	790.197568	790.197592

COMPUTER FILES

- EC_rcjlcs6.bpf
- Report_EC_rcjlcs6.pdf

EXAMPLE 8.7

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

- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

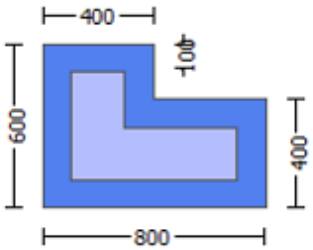
DESCRIPTION

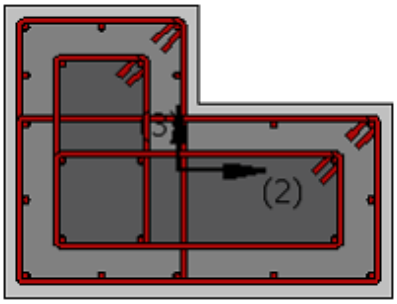
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Column, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fck/γc = 16.66667
New material of Primary Member: Steel Strength,
fs = fsk/γs = 434.7826
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 400.00
Max Width, Wmax = 800.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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 3.79. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00804653	0.00804653
	Significant Damage	Start	3	0.03695248	0.03695248
	Near Collapse	End	3	0.04305867	0.04305867
Shear Capacity [kN]	Near Collapse	Start	2	857.59244	857.59243

COMPUTER FILES

- EC_rcjlcs7.bpf
- Report_EC_rcjlcs7.pdf

EXAMPLE 8.8

SUCCINCT DATA

- Secondary 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)
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

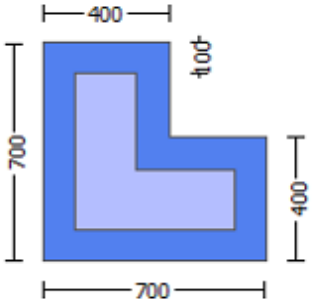
DESCRIPTION

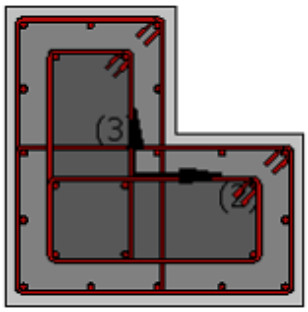
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Column, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Secondary Member: Concrete Strength,
fc = fck = 25.00
New material of Secondary Member: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material of Secondary Member: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material of Secondary Member: Steel Strength,
fs = fs/Cf = 370.3704

Member's Properties

Max Height, Hmax = 700.00
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 = 3500.00
Secondary Member
γel = 1.00 for Chord Rotation and Shear Capacity checks
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)
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 3.80. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.00823057	0.00823057
	Significant Damage	Start	3	0.09131064	0.09131064
	Near Collapse	Start	2	0.06800356	0.06800356
Shear Capacity [kN]	Near Collapse	End	3	1195.279758	1195.279758

COMPUTER FILES

- EC_rcjlcs8.bpf
- Report_EC_rcjlcs8.pdf

EXAMPLE 8.9

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 = 0.40
- No FRP Wrapping
- Not the Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

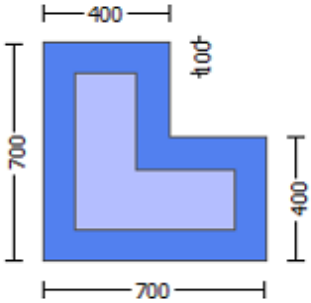
DESCRIPTION

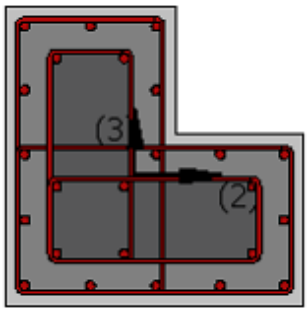
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.35

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Column, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 14.81481
Existing material: Steel Strength,
fs = fs/Cf = 329.2181

For Shear Capacity Calculations

Jacket
New material of Secondary Member: Concrete Strength,
fc = fck = 25.00
New material of Secondary Member: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material of Secondary Member: Concrete Strength,
fc = fcm/Cf = 14.81481
Existing material of Secondary Member: Steel Strength,
fs = fs/Cf = 329.2181

Member's Properties

Max Height, Hmax = 700.00
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
γel = 1.10 for Chord Rotation and Shear Capacity checks
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 = 0.40
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 3.81. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.9

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.00929162	0.00929162
	Significant Damage	Start	2	0.0284649	0.0284649
	Near Collapse	Start	3	0.04890748	0.04890747
Shear Capacity [kN]	Damage Limitation	End	2	703.534228	703.534228

COMPUTER FILES

- EC_rcjlcs9.bpf
- Report_EC_rcjlcs9.pdf

EXAMPLE 8.10

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Cold Worked-Brittle 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)
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

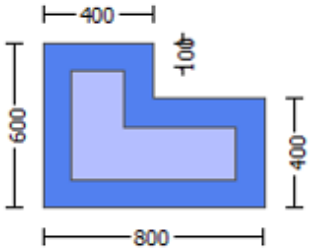
DESCRIPTION

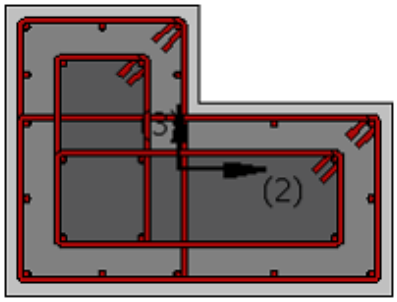
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Column, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fck/γc = 16.66667
New material of Primary Member: Steel Strength,
fs = fsk/γs = 434.7826
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 400.00
Max Width, Wmax = 800.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Ribbed Bars
Cold Worked-Brittle 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)
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 3.82. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.10

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.01005949	0.01005949
	Significant Damage	End	3	0.01582861	0.01582861
	Near Collapse	End	2	0.01411826	0.01411826
Shear Capacity [kN]	Near Collapse	End	3	587.607189	587.607189

COMPUTER FILES

- EC_rcjlcs10.bpf
- Report_EC_rcjlcs10.pdf

EXAMPLE 8.11

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
- Lap Length lo = 400.00
- FRP Wrapping Data (Type: Carbon)
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

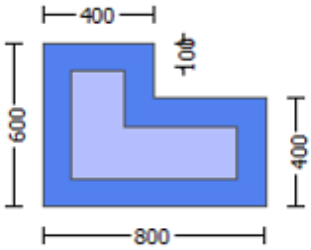
DESCRIPTION

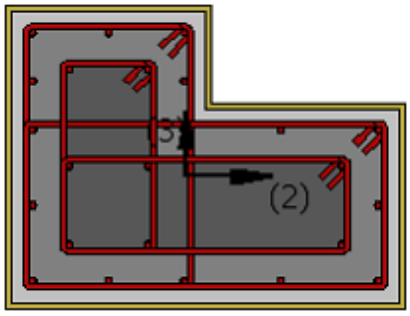
A jacketed L-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Column, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = fck = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fck/γc = 16.66667
New material of Primary Member: Steel Strength,
fs = fsk/γs = 434.7826
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel

Strength, fs = fs/(Cf*γs) = 322.0612

Member's Properties

Max Height, Hmax = 600.00
Min Height, Hmin = 400.00
Max Width, Wmax = 800.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Ribbed 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 = 400.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 0.25
Tensile Strength, ffu = 456.00
Tensile Modulus, Ef = 41400.00
Elongation, efu = 0.012
Number of directions, NoDir = 2
Fiber orientations, bi: 0.00°, 90.00°
Number of layers, NL = 2
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 3.83. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 8.11

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.00856543	0.00856543
	Significant Damage	End	2	0.0237002	0.0237002
	Near Collapse	End	2	0.05283809	0.05283809
Shear Capacity [kN]	Damage Limitation	Start	2	1113.817890	1113.817890

COMPUTER FILES

- EC_rcjlcs11.bpf
- Report_EC_rcjlcs11.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 With Ends Lapped Starting at the End Sections
- Adequate Lap Length(lo/lou,min>=1)
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

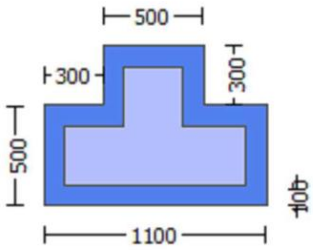
DESCRIPTION

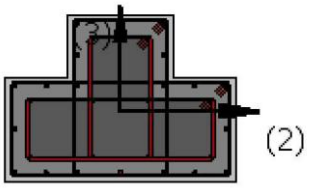
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed T-shaped column section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444

Concrete Elasticity for Existing Beam, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Max Height, H_{max} = 800.00
Min Width, H_{min} = 500.00
Max Width, W_{max} = 1100.00
Min Width, W_{min} = 500.00
Eccentricity, E_{cc} = 300.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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 3.84. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.01134853	0.01134853
	Significant Damage	Start	2	0.0507702	0.0507702
	Near Collapse	Start	3	0.08136491	0.08136491
Shear Capacity [kN]	Damage Limitation	End	2	1029.645706	1029.645706

COMPUTER FILES

- EC_rcjtcs1.bpf
- Report_ EC_rcjtcs1.pdf

EXAMPLE 9.2

SUCCINCT DATA

- Secondary 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
- Inadequate Lap Length with lo/lou,min=0.40
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

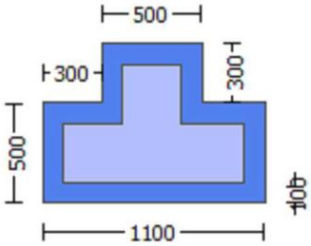
DESCRIPTION

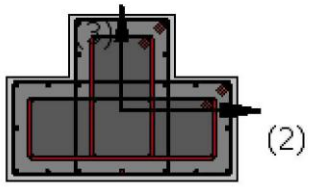
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed T-shaped column section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elastcity for Exsting Beam,Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Secondary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 25
New material of Secondary Member: Steel Strength,
fs = fs/(Cf*γs) = 500.00
Existing Column
Existing material of Secondary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
Existing material of Secondary Member: Steel Strength,
fs = fs/(Cf*γs) = 370.3704

Member's Properties

Max Height, H_{max} = 800.00
Min Width, H_{min} = 500.00
Max Width, W_{max} = 1100.00
Min Width, W_{min} = 500.00
Eccentricity, E_{cc} = 300.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
γel = 1.00 for Chord Rotation and Shear Capacity checks
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
Inadequate Lap Length with lo/lou,min=0.40
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 3.85. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00505008	0.00505008
	Significant Damage	End	3	0.0227725	0.0227725
	Near Collapse	End	2	0.03248326	0.03248326
Shear Capacity [kN]	Damage Limitation	End	3	1379.680768	1379.680768

COMPUTER FILES

- EC_rcjtcs2.bpf
- Report_ EC_rcjtcs2.pdf

EXAMPLE 9.3

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
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

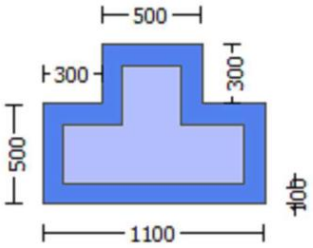
DESCRIPTION

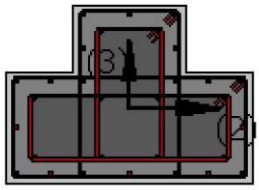
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed T-shaped column section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Beam, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

Jacket
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

For Shear Capacity Calculations

Member's Properties

Max Height, H_{max} = 800.00
Min Width, H_{min} = 500.00
Max Width, W_{max} = 1100.00
Min Width, W_{min} = 500.00
Eccentricity, E_{cc} = 300.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member

γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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 3.86. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.0068554	0.0068554
	Significant Damage	End	2	0.0420866	0.0420866
	Near Collapse	End	3	0.03676513	0.03676513
Shear Capacity [kN]	Significant Damage	Start	2	768.452387	768.452391

COMPUTER FILES

- EC_rcjtcs3.bpf
- Report_ EC_rcjtcs3.pdf

EXAMPLE 9.4

SUCCINCT DATA

- Secondary 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
- Inadequate Lap Length with lo/lou,min=0.60
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

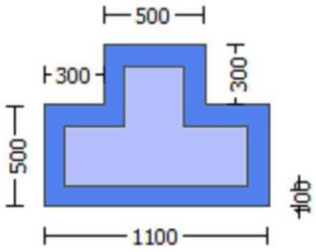
DESCRIPTION

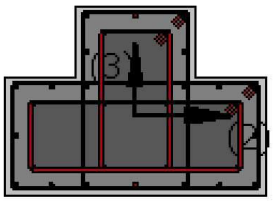
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed T-shaped column section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Beam, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Secondary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 25
New material of Secondary Member: Steel Strength,
fs = fs/(Cf*γs) = 500.00
Existing Column
Existing material of Secondary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
Existing material of Secondary Member: Steel Strength,
fs = fs/(Cf*γs) = 370.3704

Member's Properties

Max Height, H_{max} = 800.00
Min Width, H_{min} = 500.00
Max Width, W_{max} = 1100.00
Min Width, W_{min} = 500.00
Eccentricity, E_{cc} = 300.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
γel = 1.00 for Chord Rotation and Shear Capacity checks
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
Inadequate Lap Length with lo/lou,min=0.60
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 3.87. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.00612892	0.00612892
	Significant Damage	Start	3	0.0520031	0.0520031
	Near Collapse	Start	2	0.05553586	0.05553586
Shear Capacity [kN]	Significant Damage	Start	3	963.284615	963.284606

COMPUTER FILES

- EC_rcjtcs4.bpf
- Report_ EC_rcjtcs4.pdf

EXAMPLE 9.5

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
- Not The Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

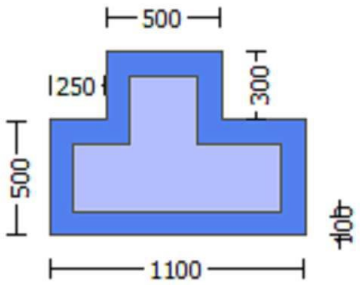
DESCRIPTION

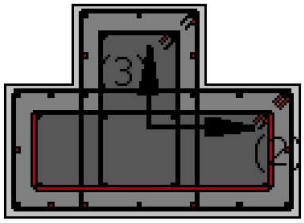
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed T-shaped column section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.35

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Beam, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 14.81481
Existing material: Steel Strength,
fs = fs/Cf = 329.2181

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 22.72727
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 454.5455

Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 13.46801

Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 299.2892

Member's Properties

Max Height, H_{max} = 800.00
Min Width, H_{min} = 500.00
Max Width, W_{max} = 1100.00
Min Width, W_{min} = 500.00
Eccentricity, E_{cc} = 250.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.10 for Chord Rotation and Shear Capacity checks
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 3.88. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.01145066	0.01145066
	Significant Damage	Start	2	0.0774792	0.0774792
	Near Collapse	Start	3	0.12328941	0.12328941
Shear Capacity [kN]	Near Collapse	End	2	1608.704207	1608.704207

COMPUTER FILES

- EC_rcjtcs5.bpf
- Report_ EC_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 Without Lapping in the Vicinity of the End Regions
- Adequate Lap Length(lo/lou,min>=1)
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

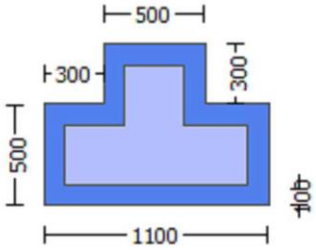
DESCRIPTION

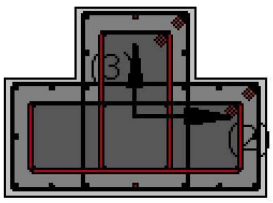
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed T-shaped column section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Beam, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667

Existing material: Steel Strength,
fs = fs/Cf = 370.3704

New material of Secondary Member: Steel Strength,
fs = fs/(Cf*γs) = 500.00
Existing Column
Existing material of Secondary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
Existing material of Secondary Member: Steel Strength,
fs = fs/(Cf*γs) = 370.3704

For Shear Capacity Calculations

Jacket
New material of Secondary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 25

Member's Properties

Max Height, H_{max} = 800.00
Min Width, H_{min} = 500.00
Max Width, W_{max} = 1100.00
Min Width, W_{min} = 500.00
Eccentricity, E_{cc} = 300.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
γel = 1.00 for Chord Rotation and Shear Capacity checks
Ribbed Bars
Ductile Steel
Without 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)
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 3.89. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00682473	0.00682473
	Significant Damage	End	3	0.0272849	0.0272849

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
	Near Collapse	End	2	0.0564078	0.0564078
Shear Capacity [kN]	Near Collapse	End	3	905.676049	905.676041

COMPUTER FILES

- EC_rcjtcs6.bpf
- Report_ EC_rcjtcs6.pdf

EXAMPLE 9.7

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Cold-Worked Brittle 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=0.20
- FRP Wrapping (Type: Carbon)
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

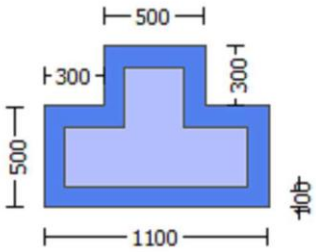
DESCRIPTION

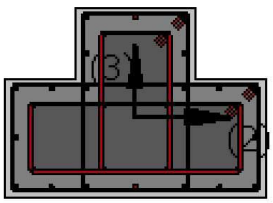
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed T-shaped column section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Beam, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Max Height, H_{max} = 800.00
Min Width, H_{min} = 500.00
Max Width, W_{max} = 1100.00
Min Width, W_{min} = 500.00
Eccentricity, E_{cc} = 300.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Smooth Bars
Cold-Worked Brittle 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= 0.20
FRP Wrapping
Type: Carbon
Cured laminate properties (design values)

Thickness, t = 1.00
Tensile Strength, ffu = 745.00
Tensile Modulus, Ef = 61500.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers = 2
Radius of rounding corners, R = 20.00

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 3.90. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.00678754	0.00678752
	Significant Damage	End	2	0.00784124	0.00784124
	Near Collapse	Start	3	0,0154771	0,0154771
Shear Capacity [kN]	Damage Limitation	Start	2	1483.3144	1483.3143

COMPUTER FILES

- EC_rcjtcs7.bpf
- Report_ EC_rcjtcs7.pdf

EXAMPLE 9.8

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
- Adequate Lap Length(lo/lou,min>=1)
- No FRP Wrapping
- Not The Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

DESCRIPTION

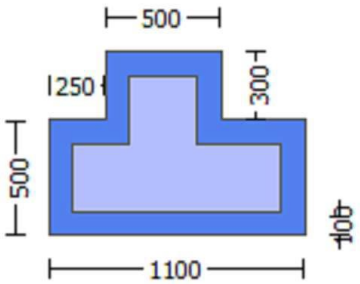
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

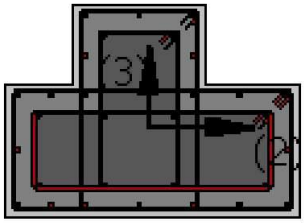
The resulting chord rotation capacity and shear capacity with the FE analysis program SeismoBuild are compared with hand calculations.

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed T-shaped column section is calculated from the (A.18), (A.19a)

and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.35

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Beam, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 14.81481
Existing material: Steel Strength,
fs = fs/Cf = 329.2181

For Shear Capacity Calculations

Jacket
New material of Secondary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 25
New material of Secondary Member: Steel Strength,
fs = fs/(Cf*γs) = 500.00
Existing Column
Existing material of Secondary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 14.81481
Existing material of Secondary Member: Steel Strength,
fs = fs/(Cf*γs) = 329.2181

Member's Properties

Max Height, H_{max} = 800.00
Min Width, H_{min} = 500.00
Max Width, W_{max} = 1100.00
Min Width, W_{min} = 500.00
Eccentricity, E_{cc} = 250.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member

γel = 1.25 for Chord Rotation checks and
γel = 1.25 for Shear Capacity checks
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 3.91. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.00597163	0.00597163
	Significant Damage	Start	3	0.08333568	0.08333568
	Near Collapse	Start	2	0.09118365	0.09118364
Shear Capacity [kN]	Damage Limitation	Start	3	1037.177548	1037.177541

COMPUTER FILES

- EC_rcjtcs8.bpf
- Report_ EC_rcjtcs8.pdf

EXAMPLE 9.9

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Ductile Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars Without Lapping in the Vicinity of the End Regions
- Lap Length lo = 400.00
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

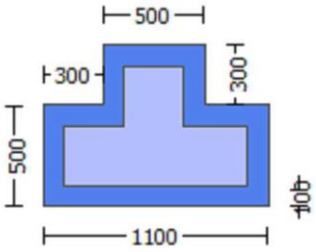
DESCRIPTION

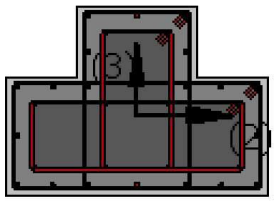
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed T-shaped column section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Beam, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Max Height, H_{max} = 800.00
Min Width, H_{min} = 500.00
Max Width, W_{max} = 1100.00
Min Width, W_{min} = 500.00
Eccentricity, E_{cc} = 300.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars Without Lapping in the Vicinity of the End Regions
Lap Length lo = 400.00
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 3.92. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.9

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.01037568	0.01037568
	Significant Damage	Start	2	0.01266536	0.01266536
	Near Collapse	Start	3	0.01911726	0.01911726
Shear Capacity [kN]	Significant Damage	End	2	707.119268	707.119268

COMPUTER FILES

- EC_rcjtcs9.bpf
- Report_ EC_rcjtcs9.pdf

EXAMPLE 9.10

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Cold–Worked Brittle Steel

- With Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Inadequate Lap Length withlo/lou,min = 0.30
- FRP Wrapping (Type: Carbon)
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

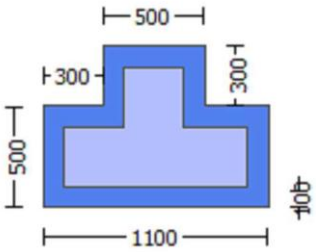
DESCRIPTION

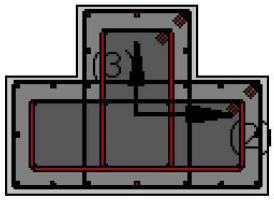
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed T-shaped column section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Beam, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667

New material of Primary Member: Steel
Strength,
fs = fs/(Cf*γs) = 434.7826
Existing Column
Existing material of Primary Member: Concrete
Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel
Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Max Height, H_{max} = 800.00
Min Width, H_{min} = 500.00
Max Width, W_{max} = 1100.00
Min Width, W_{min} = 500.00
Eccentricity, E_{cc} = 300.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Smooth Bars
Cold-Worked Brittle 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
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 489.00
Tensile Modulus, Ef = 42468.00
Elongation, efu = 0.0098
Number of directions, NoDir = 2
Fiber orientations, bi: 0.00°, 90.00°
Number of layers = 2
Radius of rounding corners, R = 60.00

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 3.93. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.10

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00663026	0.00663026
	Significant Damage	End	3	0.01124381	0.01124381
	Near Collapse	End	2	0.01103741	0.01103741
Shear Capacity [kN]	Significant Damage	End	3	1449.749131	1449.743125

COMPUTER FILES

- EC_rcjtcs10.bpf
- Report_ EC_rcjtcs10.pdf

EXAMPLE 9.11

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)
- FRP Wrapping (Type: Carbon)
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

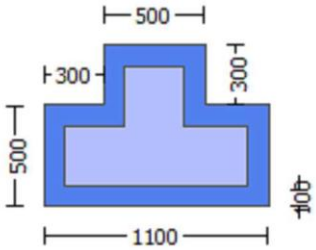
DESCRIPTION

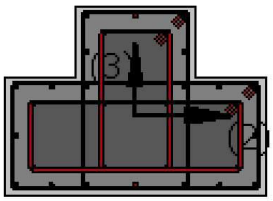
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed T-shaped column section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 30819.961
Concrete Elasticity for Existing Beam, Ec = 23025.204
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 35.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 20.00
Existing material: Steel Strength,
fs = fs/Cf = 370.3667

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 23.33333
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 13.33333
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.058

Member's Properties

Max Height, H_{max} = 750.00
Min Width, H_{min} = 450.00
Max Width, W_{max} = 9500.00
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
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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)
FRP Wrapping
Type: Carbon
Dry properties (design values)
Thickness, t = 0.129
Tensile Strength, ffu = 3200.00
Tensile Modulus, Ef = 220000.00
Elongation, efu = 0.017
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 3.94. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 9.11

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.00758581	0.00758581
	Significant Damage	End	2	0.0319984	0.0319984
	Near Collapse	End	3	0.04461422	0.04461422
Shear Capacity [kN]	Near Collapse	Start	2	1111.10	1111.10

COMPUTER FILES

- EC_rcjtcs11.bpf
- Report_ EC_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 Without Lapping in the Vicinity of the End Regions

- Inadequate Lap Length with lo/lou,min = 0.30
- FRP Wrapping (Type: Carbon)
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing column

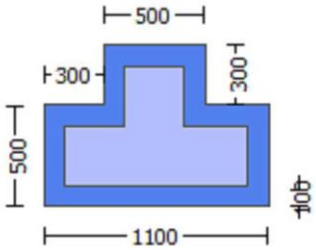
DESCRIPTION

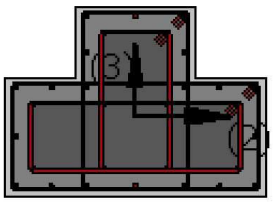
A jacketed T-shaped column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed T-shaped column section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Beam, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826
Existing Column
Existing material of Primary Member: Concrete Strength,

fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel
Strength,
fs = fs/(Cf*γs) = 322.0612

Member's Properties

Section Max Height, H_{max} = 800.00
Section Min Width, H_{min} = 500.00
Section Max Width, W_{max} = 1100.00
Section Min Width, W_{min} = 500.00
Eccentricity, E_{cc} = 300.00
Jacket Thickness, t_j = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 489.00
Tensile Modulus, Ef = 42468.00
Elongation, efu = 0.0098
Number of directions, NoDir = 2
Fiber orientations, bi: 0.00°, 90.00°
Number of layers, NL = 2
Radius of rounding corners, R = 60.00

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 9.12

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.00624289	0.00624289

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
	Significant Damage	Start	3	0.01412079	0.01412079
	Near Collapse	Start	2	0.01634081	0.01634081
Shear Capacity [kN]	Near Collapse	Start	3	1418.596067	1418.596065

COMPUTER FILES

- EC_rcjtcs12.bpf
- Report_ EC_rcjtcs12.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
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Column

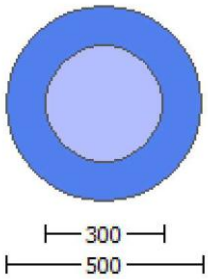
DESCRIPTION

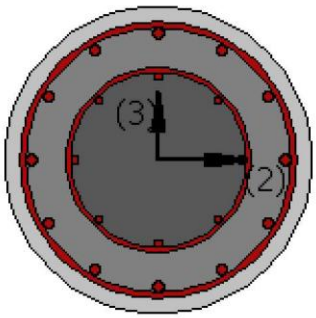
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.1) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed circular column section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Column,Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

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
γel = 2.00 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
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 3.96. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.01086806	0.01086806
	Significant Damage	Start	2	0.0155102	0.0155102
	Near Collapse	Start	3	0.0275186	0.0275186
Shear Capacity [kN]	Significant Damage	End	2	290.607516	290.607516

COMPUTER FILES

- EC_rcjcs1.bpf
- Report_EC_rcjcs1.pdf

EXAMPLE 10.2

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
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Column

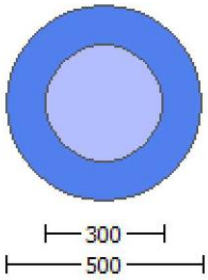
DESCRIPTION

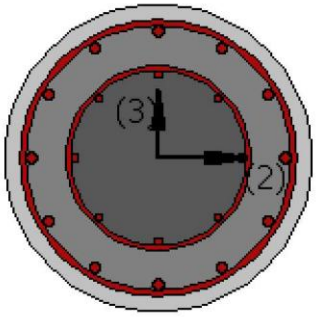
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.3) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed circular column section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Column,Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete
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
γel = 2.00 for Chord Rotation checks and

γel = 1.15 for Shear Capacity checks
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 3.97. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.01086807	0.01086806
	Significant Damage	End	3	0.0155102	0.0155102
	Near Collapse	End	2	0.02068031	0.02068034
Shear Capacity [kN]	Significant Damage	Start	3	290.607502	290.6075017

COMPUTER FILES

- EC_rcjcs2.bpf
- Report_EC_rcjcs2.pdf

EXAMPLE 10.3

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Cold Worked-Brittle 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 (Type: Carbon)
- Program's Default Safety/Confidence Factors
- Existing Material Sets type for the Jacket and for the Existing Column

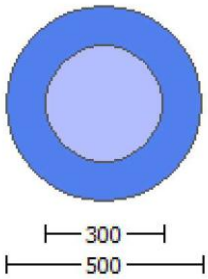
DESCRIPTION

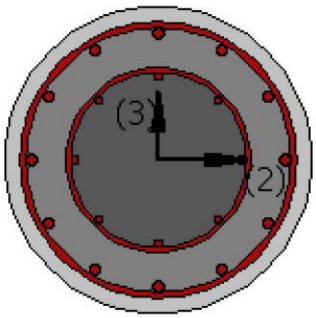
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.3) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed circular column section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 24870.062
Concrete Elasticity for Existing Column,Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
Existing material: Concrete Strength,
fc = f_{ck} = 23.33333
Existingmaterial: Steel Strength,
fs = fsk = 462.9667
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3667

Strength,
fc = fcm/(Cf*γc) = 15.55556
Existingmaterial of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 402.5797
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.058

For Shear Capacity Calculations

Jacket
Existingmaterial of Primary Member: Concrete

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
γel = 2.00 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Ribbed Bars
Cold Worked-Brittle 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
Thickness, t = 0.129
Tensile Strength, ffu = 3200.00
Tensile Modulus, Ef = 220000.00
Elongation, efu = 0.017
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers = 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 3.98. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.01511753	0.01511753
	Significant Damage	End	2	0.00819207	0.00819207
	Near Collapse	End	3	0.01092275	0.01092275
Shear Capacity [kN]	Damage Limitation	End	2	343.791849	343.791849

COMPUTER FILES

- EC_rcjcs3.bpf
- Report_EC_rcjcs3.pdf

EXAMPLE 10.4

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Cold Worked-Brittle Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 600.00
- FRP Wrapping (Type: Carbon)
- Program's Default Safety/Confidence Factors
- Existing Material Sets type for the Jacket and for the Existing Column

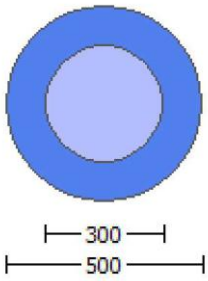
DESCRIPTION

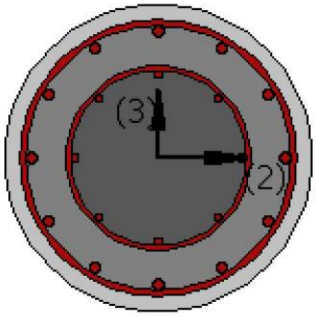
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.1) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed circular column section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Concrete Elasticity for Jacket, Ec = 24870.062
Concrete Elasticity for Existing Column,Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
Existing material: Concrete Strength,
fc = f_{ck} = 23.33333

Existing material: Steel Strength,
fs = fsk = 462.9667
Existing Column
Existing material: Concrete Strength,

fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3667

For Shear Capacity Calculations

Jacket
Existingmaterial of Secondary Member:
Concrete Strength,
fc = fcm/(Cf*γc) = 23.33333
Existing material of Secondary Member: Steel Strength,
fs = fs/(Cf*γs) = 462.9667
Existing Column
Existing material of Secondary Member:
Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
Existing material of Secondary Member: Steel Strength,
fs = fs/(Cf*γs) = 370.3667

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
γel = 1.00 for Chord Rotation and Shear Capacity checks
Smooth Bars
Cold Worked-Brittle Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length with lo = 600.00
FRP Wrapping Data
Type: Carbon
Thickness, t = 0.129
Tensile Strength, ffu = 3200.00
Tensile Modulus, Ef = 220000.00
Elongation, efu = 0.017
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers = 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 10.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.01092276	0.01092276
	Significant Damage	Start	3	0.0164184	0.0164184
	Near Collapse	Start	2	0.01562686	0.01562686
Shear Capacity [kN]	Damage Limitation	Start	2	383.918690	383.918690

COMPUTER FILES

- EC_rcjcs4.bpf
- Report_EC_rcjcs4.pdf

EXAMPLE 10.5

SUCCINCT DATA

- Secondary Member
- Smooth Bars
- Cold Worked-Brittle Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars With Ends Lapped Starting at the End Sections
- Lap Length lo = 600.00
- FRP Wrapping (Type: Carbon)
- Program's Default Safety/Confidence Factors
- Existing Material Sets type for the Jacket and for the Existing Column

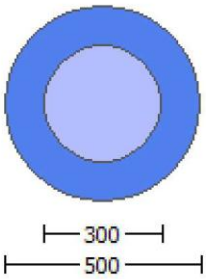
DESCRIPTION

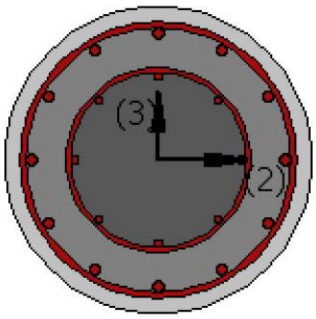
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.3) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed circular column section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 24870.062
Concrete Elasticity for Existing Column,Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
Existing material: Concrete Strength,
fc = f_{ck} = 23.33333
Existing material: Steel Strength,
fs = fsk = 462.9667
Existing Column
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3667

Concrete Strength,
fc = fcm/(Cf*γc) = 23.33333
Existing material of Secondary Member: Steel Strength,
fs = fs/(Cf*γs) = 462.9667
Existing Column
Existing material of Secondary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
Existing material of Secondary Member: Steel Strength,
fs = fs/(Cf*γs) = 370.3667

For Shear Capacity Calculations

Jacket
Existingmaterial of Secondary Member:

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
γel = 1.00 for Chord Rotation and Shear Capacity checks
Smooth Bars
Cold Worked-Brittle Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length with lo = 600.00
FRP Wrapping Data
Type: Carbon

Thickness, t = 0.129
Tensile Strength, ffu = 3200.00
Tensile Modulus, Ef = 220000.00
Elongation, efu = 0.017
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers = 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 3.100. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.01092276	0.01092276
	Significant Damage	Start	2	0.0132427	0.0132427
	Near Collapse	Start	3	0.02459969	0.02459969
Shear Capacity [kN]	Near Collapse	Start	3	449.039729	449.039729

COMPUTER FILES

- EC_rcjcs5.bpf
- Report_EC_rcjcs5.pdf

EXAMPLE 10.6

SUCCINCT DATA

- 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
- Lap Length lo = 600.00
- FRP Wrapping (Type: Glass)
- Not the Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Column

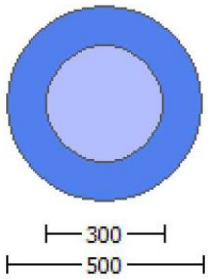
DESCRIPTION

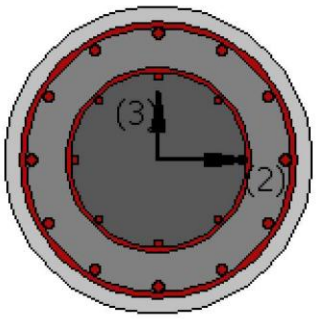
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.3) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed circular column section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.40

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Column,Ec = 24870.062
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
Newmaterial: Steel Strength,
fs = fsk = 500.00
Existing Column
Existingmaterial: Concrete Strength,
fc = fcm/Cf = 20.00
Existingmaterial: Steel Strength,
fs = fs/Cf = 396.8286

Strength,
fc = fcm/(Cf*γc) = 15.625
Newmaterial of PrimaryMember: Steel Strength,
fs = fs/(Cf*γs) = 400.00
Existing Column
Existing material of PrimaryMember: Concrete Strength,
fc = fcm/(Cf*γc) = 12.50
Existingmaterial of PrimaryMember: Steel Strength,
fs = fs/(Cf*γs) = 317.4629

For Shear Capacity Calculations

Jacket
Newmaterial of Primary Member: Concrete

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
γel = 2.10 for Chord Rotation checks
γel = 1.25 for Shear Capacity checks
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
Lap Length with lo = 600.00
FRP Wrapping Data
Type: Glass
Thickness, t = 0.33
Tensile Strength, ffu = 244.00
Tensile Modulus, Ef = 16215.00
Elongation, efu = 0.0143
Number of directions, NoDir = 2
Fiber orientations, bi: 0.00°, 90.00°
Number of layers = 4
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 10.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.01888375	0.018883745
	Significant Damage	End	3	0.0141628	0.0141628
	Near Collapse	End	2	0.01888375	0.01888375
Shear Capacity [kN]	Near Collapse	End	2	299.388254	299.388254

COMPUTER FILES

- EC_rcjcs6.bpf
- Report_ EC_rcjcs6.pdf

EXAMPLE 10.7

SUCCINCT DATA

- 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
- Lap Length lo = 600.00
- FRP Wrapping (Type: Glass)
- Not the Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Column

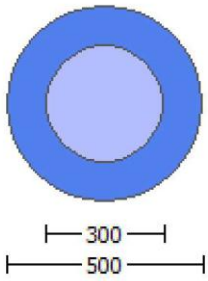
DESCRIPTION

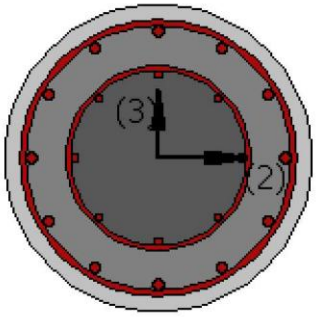
A jacketed circular column section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The equations of the (A.1) and (A.10) of EC8: Part 3 for Chord Rotation Capacity checks cannot be employed in the case of circular column sections. The employed equations in SeismoBuild are those suggested by D. Biskinis and M. N. Fardis [2013]. The equation (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks. The final chord rotation capacity of the jacketed circular column section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.40

Materials' Properties
Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Column,Ec = 24870.062
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00

New material: Steel Strength,
fs = fsk = 500.00
Existing Column
Existing material: Concrete Strength,

fc = fcm/Cf = 20.00
Existing material: Steel Strength,
fs = fs/Cf = 396.8286

fs = fs/(Cf*γs) = 400.00
Existing Column
Existing material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 12.50
Existing material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 317.4629

For Shear Capacity Calculations

Jacket
Newmaterial of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 15.625
New material of Primary Member: Steel Strength,

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
γel = 2.10 for Chord Rotation checks
γel = 1.25 for Shear Capacity checks
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
Lap Length with lo = 600.00
FRP Wrapping Data
Type: Glass
Thickness, t = 0.33
Tensile Strength, ffu = 244.00
Tensile Modulus, Ef = 16215.00
Elongation, efu = 0.0143
Number of directions, NoDir = 2
Fiber orientations, bi: 0.00°, 90.00°
Number of layers = 4
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 3.102. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 10.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.02757276	0.02757276
	Significant Damage	End	2	0.0141628	0.0141628
	Near Collapse	End	2	0.01888375	0.01888375
Shear Capacity [kN]	Damage Limitation	End	3	299.282678	299.282678

COMPUTER FILES

- EC_rcjcs7.bpf
- Report_EC_rcjcs7.pdf

EXAMPLES SET 11: JACKETED BEAM SECTION

EXAMPLE 11.1

SUCCINCT DATA

- Primary 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
- Not the Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Beam

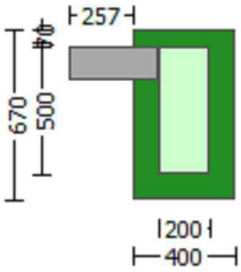
DESCRIPTION

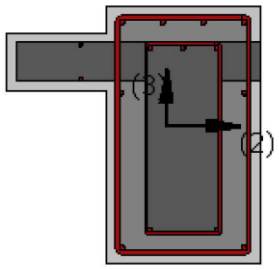
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12)checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.25

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Beam, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Beam
Existing material: Concrete Strength,
fc = fcm/Cf = 16.00
Existing material: Steel Strength,
fs = fs/Cf = 355.5556

Jacket
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.12903
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 416.6667
Existing Beam
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 10.32258
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 296.2963

For Shear Capacity Calculations

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 = 3500.00
Primary Member
γel = 1.55 for Chord Rotation checks and
γel = 1.20 for Shear Capacity checks
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 3.103. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.1

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.01286686	0.01286686
	Significant Damage	End	3	0.019568	0.019568
	Near Collapse	End	2	0.0145230	0.0145299
Shear Capacity [kN]	Significant Damage	Start	3	242.413481	242.413481

COMPUTER FILES

- EC_JBeam1.bpf
- Report_ EC_JBeam1.pdf

EXAMPLE 11.2

SUCCINCT DATA

- Primary 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
- Not the Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Beam

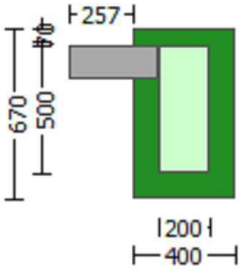
DESCRIPTION

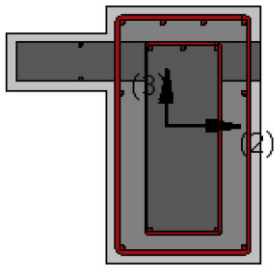
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10b)of EC8: Part 3 for Chord Rotation Capacity checks and (A.12)checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.25

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Beam, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Beam
Existing material: Concrete Strength,
fc = fcm/Cf = 16.00
Existing material: Steel Strength,
fs = fs/Cf = 355.5556

Jacket
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.12903
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 416.6667
Existing Beam
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 10.32258
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 296.2963

For Shear Capacity Calculations

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 = 3500.00
Primary Member

γel = 1.85 for Chord Rotation checks and
γel = 1.20 for Shear Capacity checks
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 3.104. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.2

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.00701133	0.00701133
	Significant Damage	End	2	0.00987516	0.00987516
	Near Collapse	End	3	0.0224479	0.0224479
Shear Capacity [kN]	Near Collapse	End	2	131.712227	131.712227

COMPUTER FILES

- EC_JBeam2.bpf
- Report_EC_JBeam2.pdf

EXAMPLE 11.3

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Cold Worked-Brittle Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars Without Lapping in the Vicinity of the End Regions
- Inadequate Lap Length with lo/lou,min=0.40
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Beam

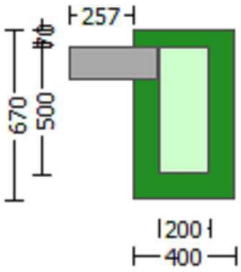
DESCRIPTION

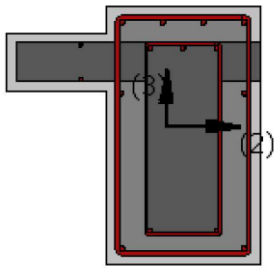
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Beam, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Beam
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826
Existing Beam
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

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 = 3500.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Ribbed Bars
Cold Worked-Brittle Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars Without Lapping in the Vicinity of the End Regions
Inadequate Lap Length with lo/lou,min=0.40
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 3.105. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.3

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.00632842	0.00632842
	Significant Damage	Start	3	0.0081833	0.0081833
	Near Collapse	Start	2	0.0140528	0.0140528
Shear Capacity [kN]	Damage Limitation	Start	2	195.519243	195.519243

COMPUTER FILES

- EC_JBeam3.bpf
- Report_EC_JBeam3.pdf

EXAMPLE 11.4

SUCCINCT DATA

- Primary Member
- Ribbed Bars
- Cold Worked-Brittle Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars Without Lapping in the Vicinity of the End Regions

- Inadequate Lap Length with lo/lou,min=0.40
- No FRP Wrapping
- Not the Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Beam

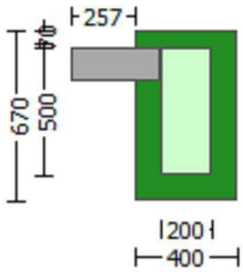
DESCRIPTION

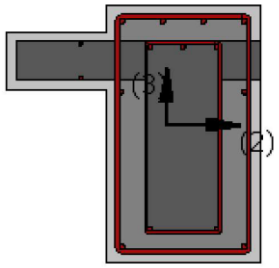
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Beam,Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Beam
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826
Existing Beam
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
New material of Primary Member: Steel

Strength,
fs = fs/(Cf*γs) = 322.0612
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 = 3500.00
Primary Member
γel = 1.50 for Chord Rotation and Shear Capacity checks
Ribbed Bars
Cold Worked-Brittle Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars Without Lapping in the Vicinity of the End Regions
Inadequate Lap Length with lo/lou,min=0.40
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 3.106. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.4

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.01257816	0.01257816
	Significant Damage	Start	2	0.01477839	0.01477839
	Near Collapse	Start	3	0.0124148	0.0124148
Shear Capacity [kN]	Significant Damage	End	2	143.578288	143.578288

COMPUTER FILES

- EC_JBeam4.bpf
- Report_EC_JBeam4.pdf

EXAMPLE 11.5

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
- Adequate Lap Length (lo/lou,min>=1)
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- Existing Material Sets type for the Jacket and Existing Material Sets type for the Existing Beam

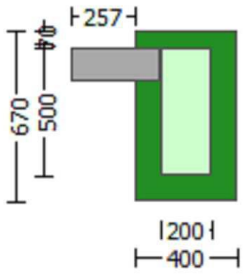
DESCRIPTION

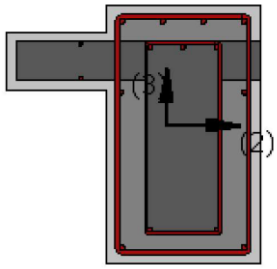
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 23025.204
Concrete Elasticity for Existing Beam, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
Existing material: Concrete Strength,
fc = f_{ck} = 20.00
Existingmaterial: Steel Strength,
fs = fsk = 203.70
Existing Beam
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3667

For Shear Capacity Calculations

Jacket
Existing material of Secondary Member:
Concrete Strength,
fc = fcm/(Cf*γc) = 20.00
Existingmaterial of SecondaryMember: Steel Strength,
fs = fs/(Cf*γs) = 203.70
Existing Beam
Existingmaterial of SecondaryMember:

Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
Existingmaterial of SecondaryMember: Steel

Strength,
fs = fs/(Cf*γs) = 370.3667

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 = 3500.00
Secondary Member
γel = 1.00 for Chord Rotation and Shear Capacity checks
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 3.107. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.5

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.00837103	0.00837103
	Significant Damage	End	3	0.0447721	0.0447721
	Near Collapse	End	2	0.0376745	0.0376745
Shear Capacity [kN]	Near Collapse	Start	2	237.835591	237.835581

COMPUTER FILES

- EC_JBeam5.bpf
- Report_EC_JBeam5.pdf

EXAMPLE 11.6

SUCCINCT DATA

- Primary Member

- Smooth Bars
- Cold Worked-Brittle Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars Without Lapping in the Vicinity of the End Regions
- Inadequate Lap Length with lo/lou,min=0.30
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Beam

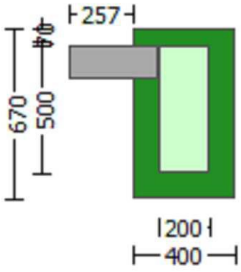
DESCRIPTION

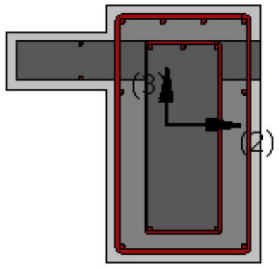
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Beam, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Beam
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete

Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel
Strength,
fs = fs/(Cf*γs) = 434.7826
Existing Beam
New material of Primary Member: Concrete
Strength,
fc = fcm/(Cf*γc) = 11.11111
New material of Primary Member: Steel
Strength,
fs = fs/(Cf*γs) = 322.0612

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 = 3500.00
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Smooth Bars
Cold Worked-Brittle Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars Without Lapping in the Vicinity of the End Regions
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 3.108. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.6

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	3	0.00731358	0.00731358
	Significant Damage	End	2	0.00338198	0.00338198
	Near Collapse	End	3	0.00720206	0.00720206
Shear Capacity [kN]	Damage Limitation	End	3	311.098927	311.098926

COMPUTER FILES

- EC_JBeam6.bpf
- Report_EC_JBeam6.pdf

EXAMPLE 11.7

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Cold Worked-Brittle Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars Without Lapping in the Vicinity of the End Regions
- Inadequate Lap Length with lo/lou,min=0.30
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Beam

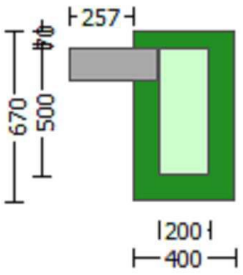
DESCRIPTION

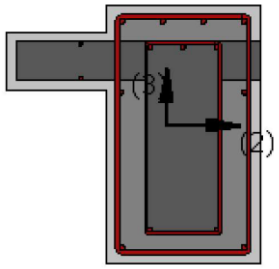
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10a) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Beam, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00

Existing Beam
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

fs = fs/(Cf*γs) = 434.7826
Existing Beam
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,

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 = 3500.00
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Smooth Bars
Cold Worked-Brittle Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars Without Lapping in the Vicinity of the End Regions
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 3.109. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.7

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	2	0.00632842	0.00632842
	Significant Damage	Start	3	0.00675675	0.00675675
	Near Collapse	Start	2	0.01120115	0.01120115
Shear Capacity [kN]	Significant Damage	Start	2	185.1167793	185.1167793

COMPUTER FILES

- EC_JBeam7.bpf
- Report_EC_JBeam7.pdf

EXAMPLE 11.8

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Cold Worked-Brittle Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars Without Lapping in the Vicinity of the End Regions
- Inadequate Lap Length with lo/lou,min=0.30
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Beam

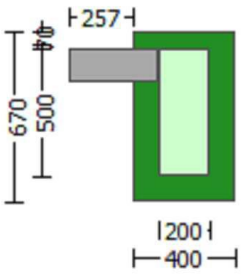
DESCRIPTION

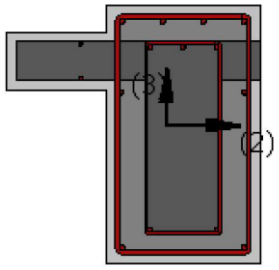
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.3) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties
Jacket:

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Beam, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Beam
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826
Existing Beam
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

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 = 3500.00
Primary Member
γel = 1.80 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Smooth Bars
Cold Worked-Brittle Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars Without Lapping in the Vicinity of the End Regions
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 3.110. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.8

Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	End	3	0.0123221	0.0123221
	Significant Damage	Start	2	0.0124384	0.0124384
	Near Collapse	Start	3	0.00978775	0.00978775
Shear Capacity [kN]	Damage Limitation	Start	3	265.110038	265.110038

COMPUTER FILES

- EC_JBeam8.bpf
- Reportt_EC_JBeam8.pdf

EXAMPLE 11.9

SUCCINCT DATA

- Primary Member
- Smooth Bars
- Cold Worked-Brittle Steel
- Without Detailing for Earthquake Resistance (including stirrups closed at 135°)
- Longitudinal Bars Without Lapping in the Vicinity of the End Regions
- Inadequate Lap Length with lo/lou,min=0.30
- No FRP Wrapping
- Program's Default Safety/Confidence Factors
- New Material Sets type for the Jacket and Existing Material Sets type for the Existing Beam

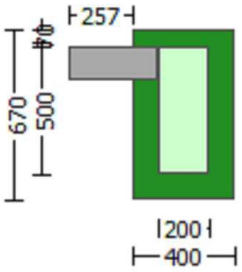
DESCRIPTION

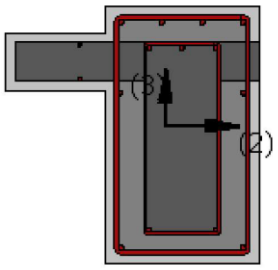
A jacketed beam section is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

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

The employed equations are the (A.1) and (A.10b) of EC8: Part 3 for Chord Rotation Capacity checks and (A.12) checking also if the (A.16) is employed of EC8: Part 3 for Shear Capacity checks.The final chord rotation capacity of the jacketed section is calculated from the (A.18), (A.19a) and (A.20) equations of EC8: Part 3 and the final shear capacity from the (A.17) equation of EC8: Part 3.

GEOMETRY AND PROPERTIES





Units in N, mm

Confidence Factor, Cf = 1.20

Materials' Properties

Concrete Elasticity for Jacket, Ec = 26999.444
Concrete Elasticity for Existing Beam, Ec = 21019.039
Steel Elasticity, Es = 200000.00

For Chord rotation Calculations

Jacket
New material: Concrete Strength,
fc = f_{ck} = 25.00
New material: Steel Strength,
fs = fsk = 500.00
Existing Beam
Existing material: Concrete Strength,
fc = fcm/Cf = 16.66667
Existing material: Steel Strength,
fs = fs/Cf = 370.3704

For Shear Capacity Calculations

Jacket
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 16.66667
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 434.7826
Existing Beam
New material of Primary Member: Concrete Strength,
fc = fcm/(Cf*γc) = 11.11111
New material of Primary Member: Steel Strength,
fs = fs/(Cf*γs) = 322.0612

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 = 3500.00
Primary Member
γel = 1.50 for Chord Rotation checks and
γel = 1.15 for Shear Capacity checks
Smooth Bars
Cold Worked-Brittle Steel
Without Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars Without Lapping in the Vicinity of the End Regions
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 3.111. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 11.9

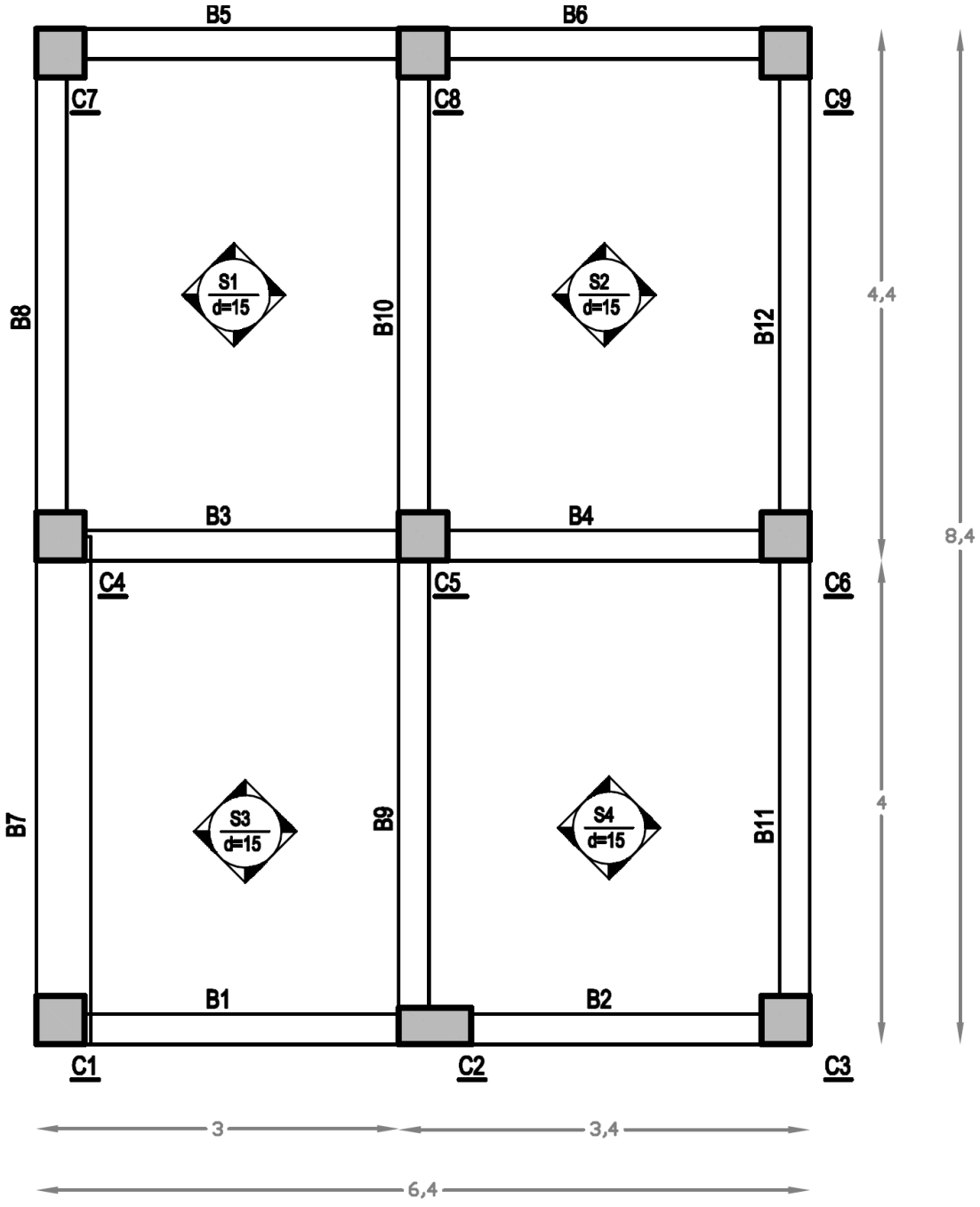
Check	Limit State	Edge	Local Axis	SeismoBuild 2021	Hand calculations
Chord Rotation Capacity	Damage Limitation	Start	2	0.01299486	0.01299486
	Significant Damage	End	3	0.00571657	0.00571657
	Near Collapse	End	2	0.00475999	0.00475999
Shear Capacity [kN]	Near Collapse	End	3	306.700957	306.700952

COMPUTER FILES

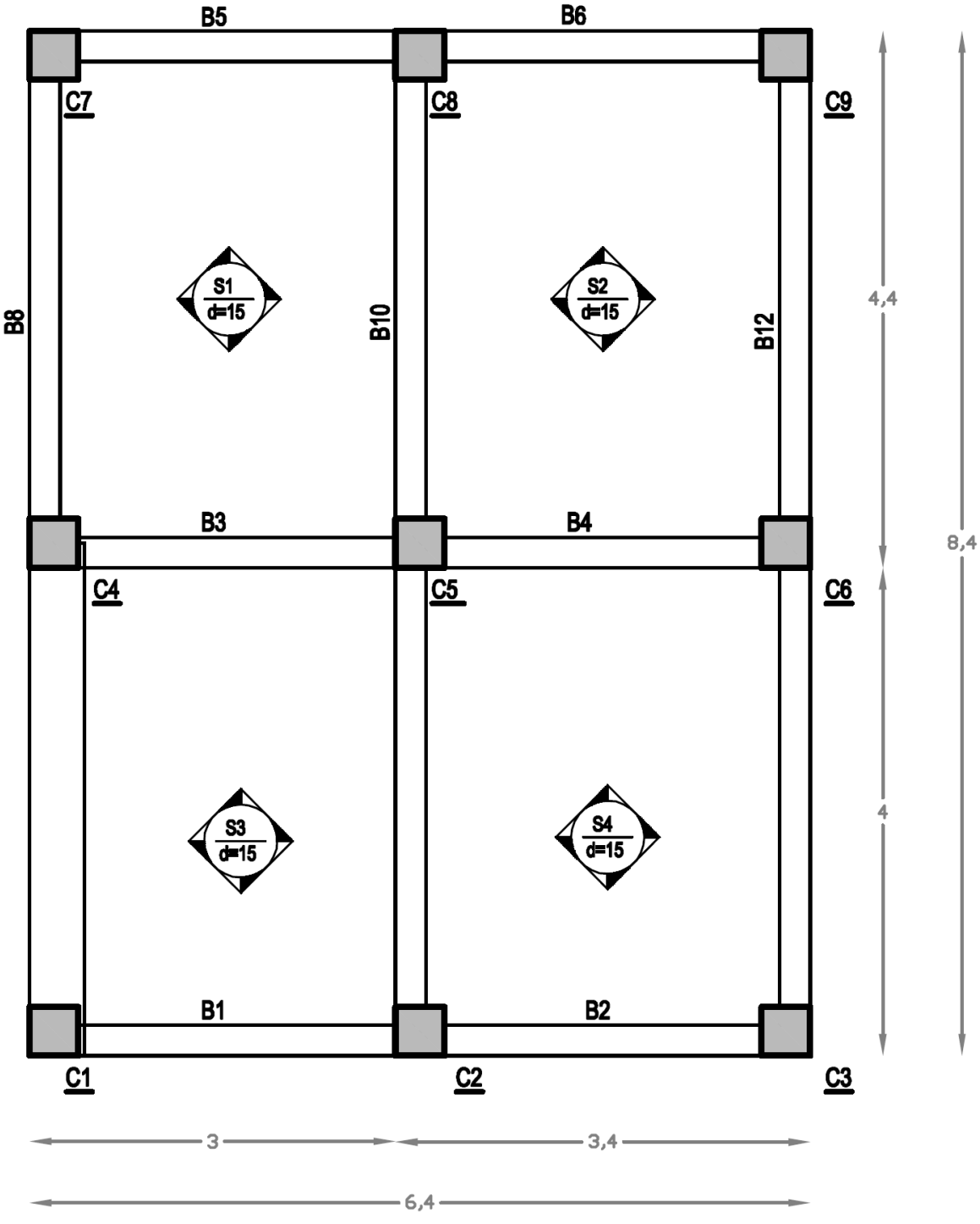
- EC_JBeam9.bpf
- Report_EC_JBeam9.pdf

Chapter 4 COMPARISON WITH INDEPENDENT HAND-CALCULATIONS – BEAM-COLUMN JOINTS CHECKS

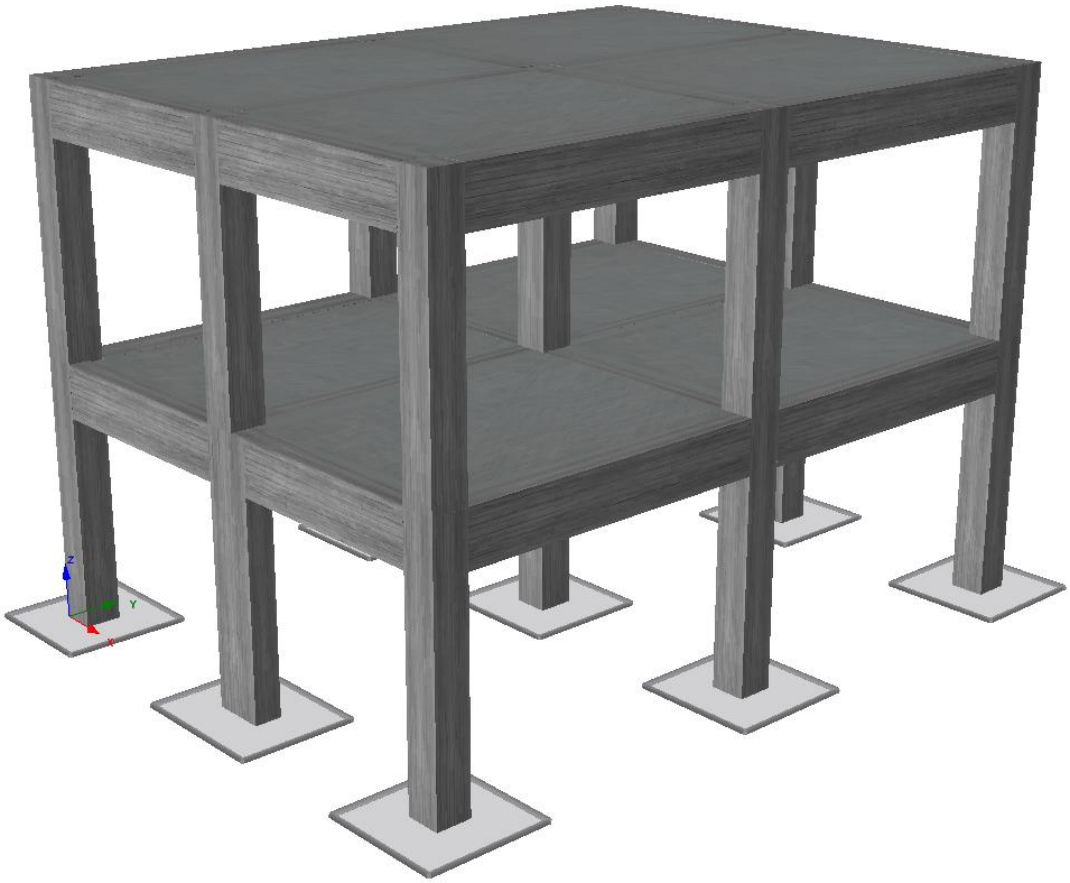
As noted above, this chapter makes use of examples, and their corresponding independent hand-calculations. A two storey 3D model with Typical Building Geometry (TBG) has been used for all the beam-columns joints examples. The plan views and the 3D model of the TBG are shown below:



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
- Program's Default Safety/Confidence Factors
- 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
- 1st and 2nd floor plan views are the same with TBG

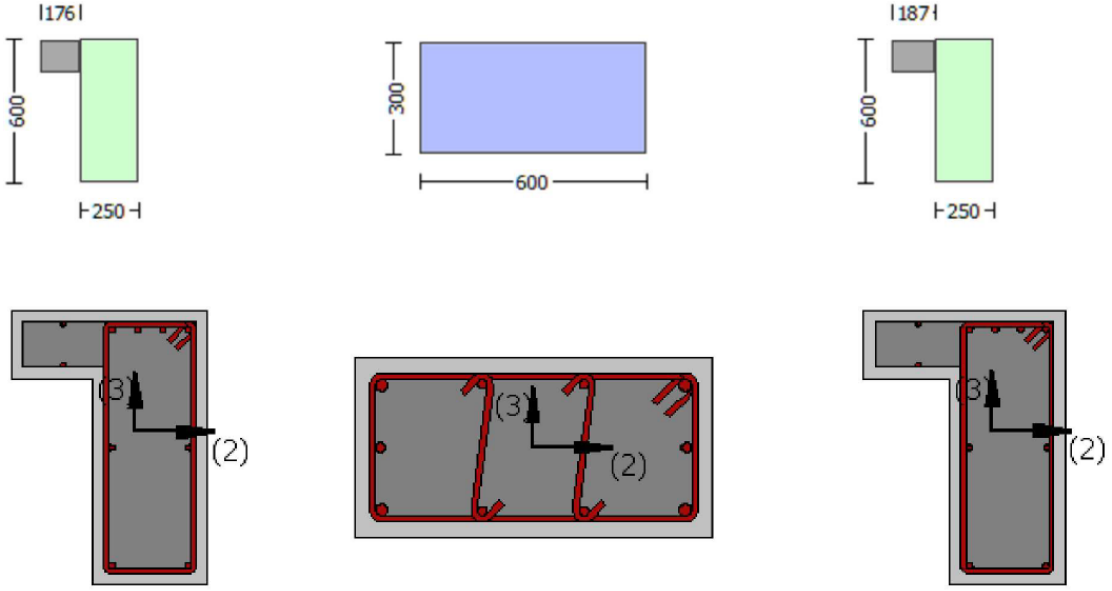
DESCRIPTION

The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting joints shear forces, horizontal hoops area and vertical reinforcement area of the FE analysis program SeismoBuild are compared with hand calculations.

The employed equations are: (5.33) of EC8: Part 1 for Shear Forces checks, (5.36a) of EC8: Part 1 for Horizontal Hoops Area checks and (5.37) of EC8: Part 1 for Vertical Reinforcement Area checks.

GEOMETRY AND PROPERTIES



Units in N, mm

Materials' Properties

Column Below: Existing Material: fcd_column = fcm_column/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058
Column Above: Existing Material: fcd_column = fcm_column/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058
Beam B1: Existing Material: fcd_beam = fcm_beam/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058
Beam B2: Existing Material: fcd_beam = fcm_beam/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058

Members' Properties

Column Below

Section Height, H = 300.00
Section Width, W = 600.00

Column Above

Section Height, H = 400.00
Section Width, W = 400.00

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	SeismoBuild 2021		Hand calculations	
		Demand	Capacity	Demand	Capacity
Shear Forces [kN]	Damage Limitation	347.72444	997.459106	347.72444	997.459106
Horizontal Hoops Area [mm²]		1080.504	863.9380	1080.504	863.9380
Joints Vertical Reinforcement Area [mm²]		575.959	402.124	575.959	402.124

COMPUTER FILES

- EC_Joint1.bpf
- Report_EC_Joint1.pdf

EXAMPLE 2

SUCCINCT DATA

- Exterior Joint: Column C2-Beam B9 of Floor 1
- Program's Default Safety/Confidence Factors
- Column Below:
  Rectangular Column section
  Primary Member
  Existing Material Sets type
- Column Above:
  Rectangular Column section
  Secondary 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

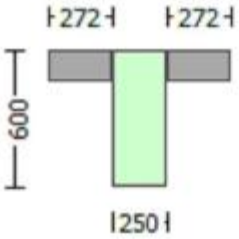
DESCRIPTION

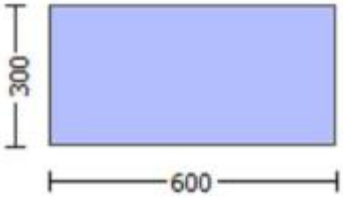
The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

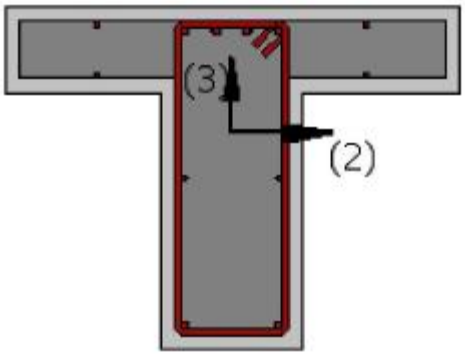
The resulting joints shear forces, horizontal hoops area and vertical reinforcement area of the FE analysis program SeismoBuild are compared with hand calculations.

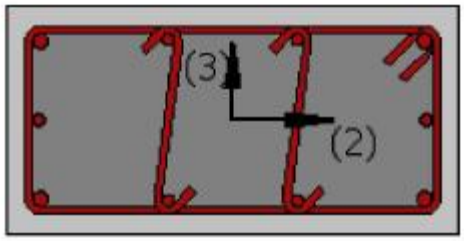
The employed equations are: (5.33) of EC8: Part 1 for Shear Forces checks, (5.36b) of EC8: Part 1 for Horizontal Hoops Area checks and (5.37) of EC8: Part 1 for Vertical Reinforcement Area checks.

GEOMETRY AND PROPERTIES









Units in N, mm

Materials' Properties

Column Below: Existing Material: fcd_column = fcm_column/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058
Column Above: Existing Material: fcd_column = fcm_column/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058
Beam B9: Existing Material: fcd_beam = fcm_beam/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058

Members' Properties

Column Below

Section Height, H = 300.00
Section Width, W = 600.00

Column Above

Section Height, H = 400.00
Section Width, W = 400.00

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	SeismoBuild 2021		Hand calculations	
		Demand	Capacity	Demand	Capacity
Shear Forces [kN]	Significant Damage	235.14204	484.842583	235.14204	484.842583
Horizontal Hoops Area [mm²]		349.8351	1727.8760	349.8351	1727.8760
Joints Vertical Reinforcement Area [mm²]		523.599	804.2477	523.599	804.2477

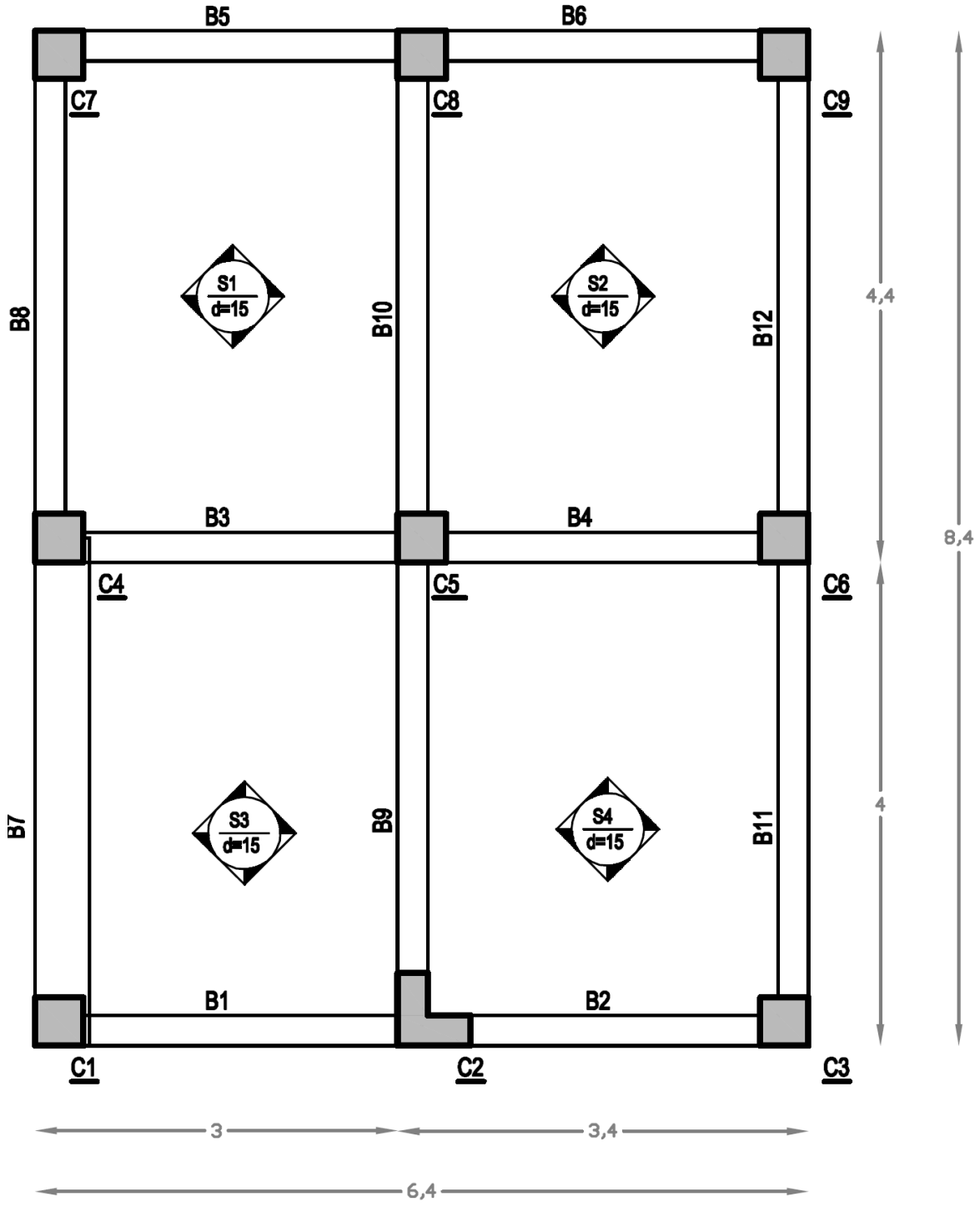
COMPUTER FILES

- EC_Joint2.bpf
- Report_EC_Joint2.pdf

EXAMPLE 3

SUCCINCT DATA

- Interior Joint: Beam B1-Column C2-Beam B2 of Floor 1
- Not the Program's Default Safety/Confidence Factors
- 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

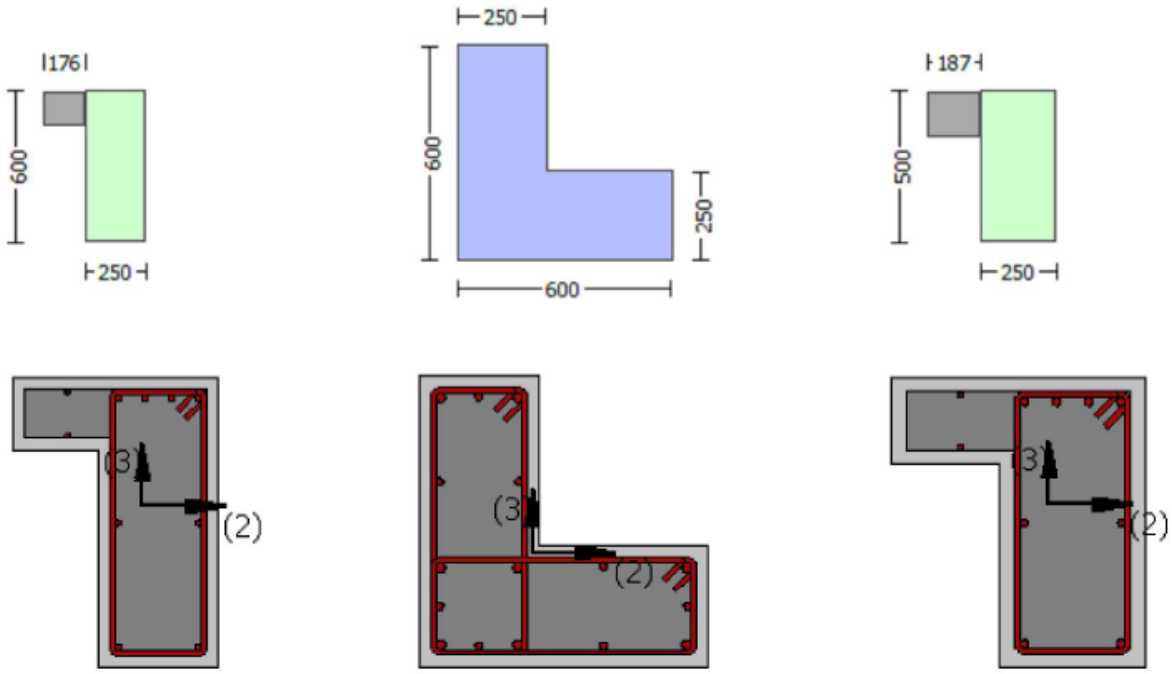
DESCRIPTION

The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting joints shear forces, horizontal hoops area and vertical reinforcement area of the FE analysis program SeismoBuild are compared with hand calculations.

The employed equations are: (5.33) of EC8: Part 1 for Shear Forces checks, (5.35) of EC8: Part 1 for Horizontal Hoops Area checks and (5.37) of EC8: Part 1 for Vertical Reinforcement Area checks.

GEOMETRY AND PROPERTIES



Units in N, mm

Materials' Properties

Column Below: Existing Material: fcd_column = fcm_column/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058
Column Above: Existing Material: fcd_column = fcm_column/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058
Beam B1: Existing Material: fcd_beam = fcm_beam/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058
Beam B2: New Material: fcd_beam = fck_beam/γc = 16.66667
fyd = fsk/γs = 434.7826

Members' Properties

Column Below

Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00

Column Above

Section Height, H = 400.00
Section Width, W = 400.00

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	SeismoBuild 2021		Hand calculations	
		Demand	Capacity	Demand	Capacity
Shear Forces [kN]	Near Collapse	494.544225	835.480776	494.544225	835.480776
Horizontal Hoops Area [mm²]		4311.085	706.85835	4311.085	706.85835
Joints Vertical Reinforcement Area [mm²]		575.959	402.1239	575.959	402.1239

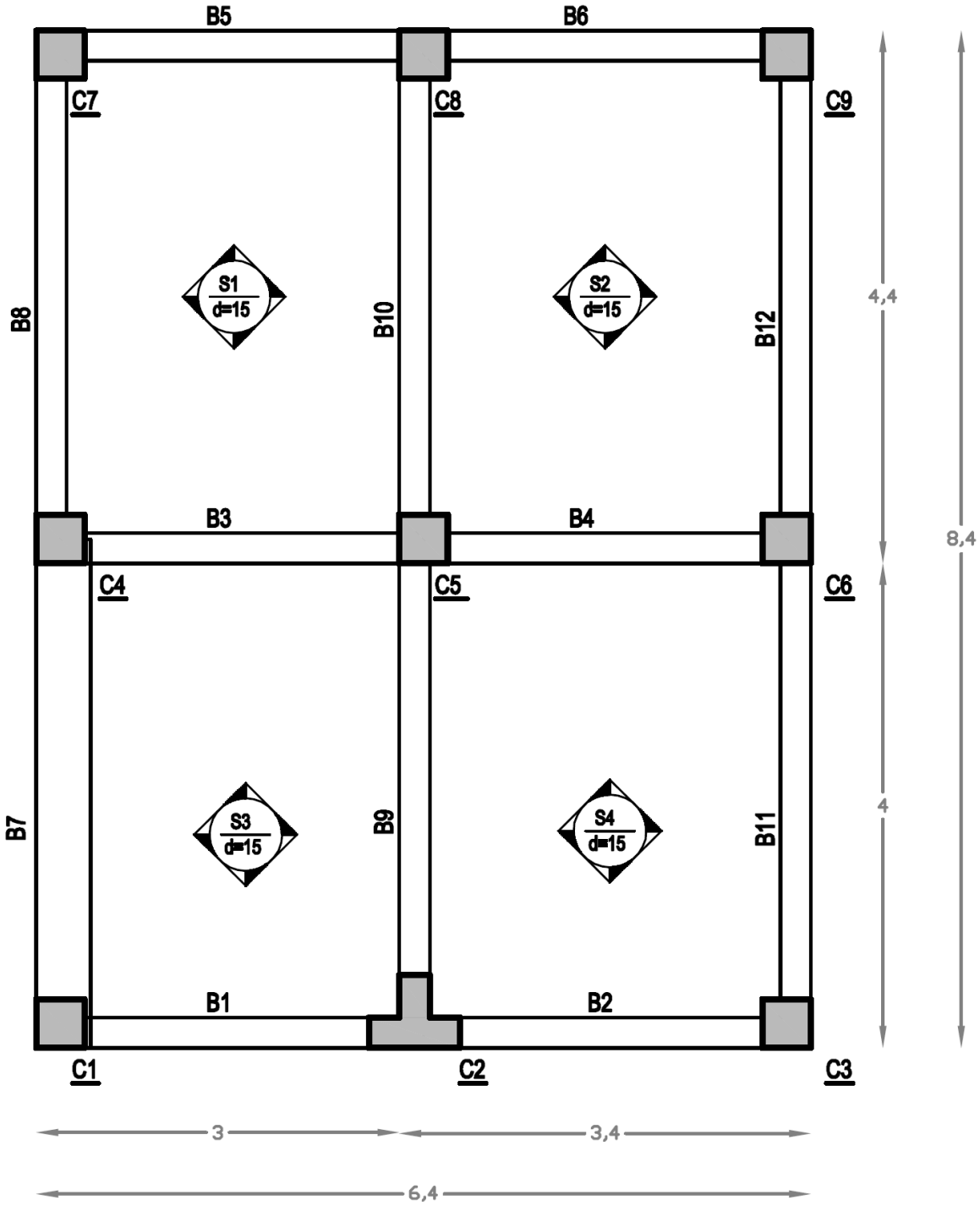
COMPUTER FILES

- EC_Joint3.bpf
- Report_EC_Joint3.pdf

EXAMPLE 4

SUCCINCT DATA

- Exterior Joint: Column C2-Beam B9 of Floor 1
- Program's Default Safety/Confidence Factors
- 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

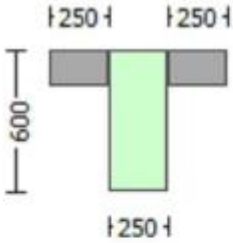
DESCRIPTION

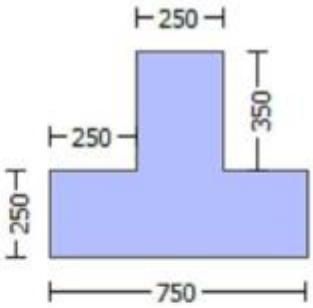
The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

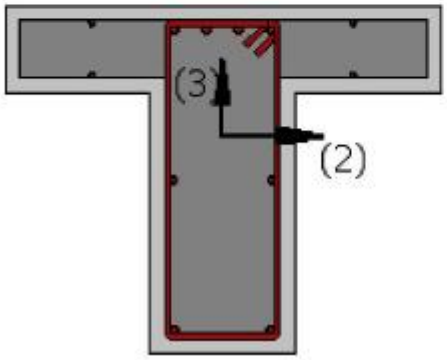
The resulting joints shear forces, horizontal hoops area and vertical reinforcement area of the FE analysis program SeismoBuild are compared with hand calculations.

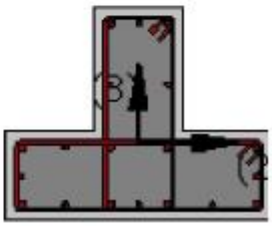
The employed equations are: (5.33) of EC8: Part 1 for Shear Forces checks, (5.36b) of EC8: Part 1 for Horizontal Hoops Area checks and (5.37) of EC8: Part 1 for Vertical Reinforcement Area checks.

GEOMETRY AND PROPERTIES









Units in N, mm

Materials' Properties

Column Below: Existing Material: fcd_column = fcm_column/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058
Column Above: Existing Material: fcd_column = fcm_column/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058
Beam B9: Existing Material: fcd_beam = fcm_beam/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058

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

Column Above

Section Height, H = 400.00
Section Width, W = 400.00

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	SeismoBuild 2021		Hand calculations	
		Demand	Capacity	Demand	Capacity
Shear Forces [kN]	Damage Limitation	237.01609	667.523105	237.01609	667.523105
Horizontal Hoops Area [mm²]		684.0777	863.9380	684.0777	863.9380
Joints Vertical Reinforcement Area [mm²]		575.9587	402.1239	575.9587	402.1239

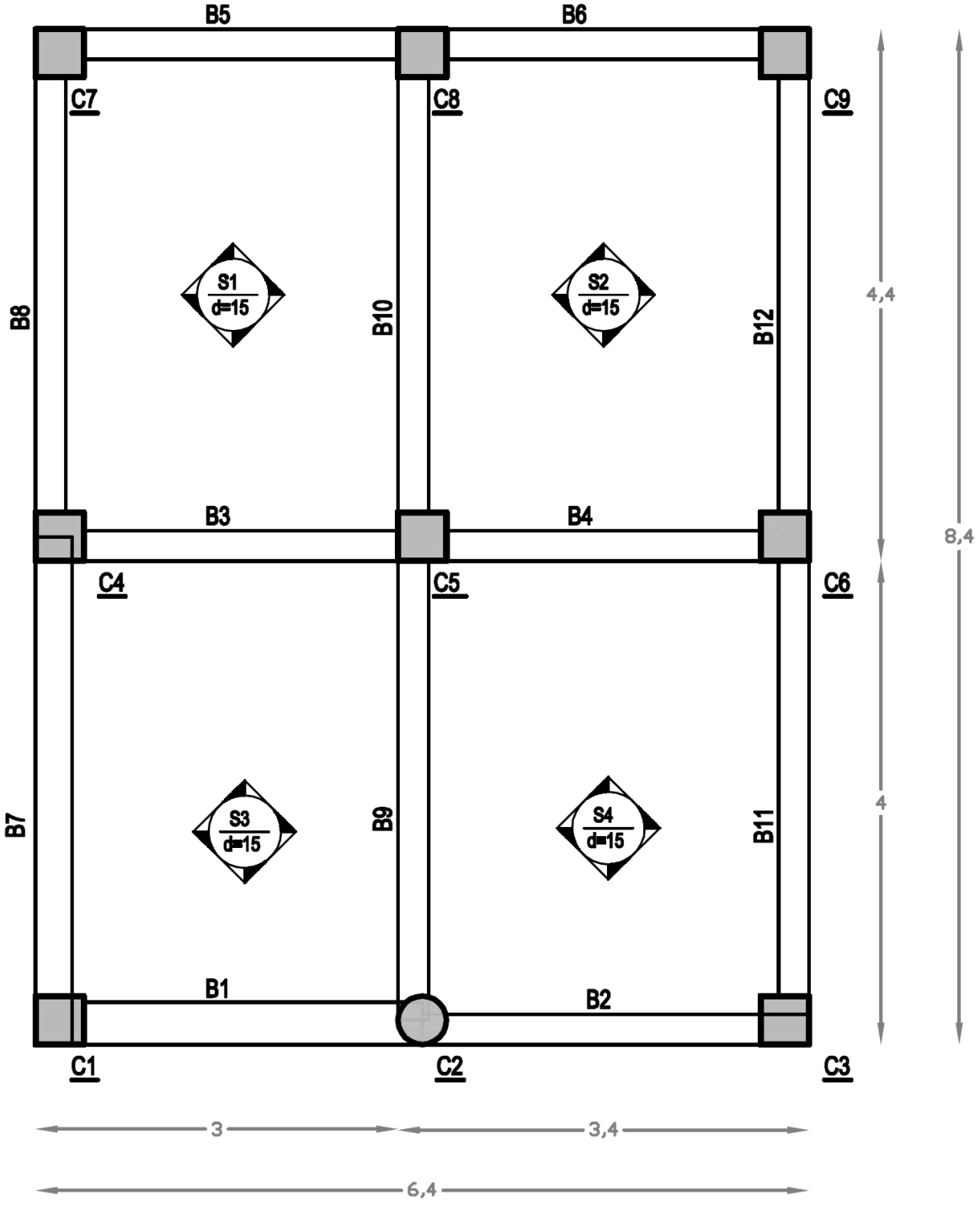
COMPUTER FILES

- EC_Joint4.bpf
- Report_EC_Joint4.pdf

EXAMPLE 5

SUCCINCT DATA

- Interior Joint: Beam B1-Column C2-Beam B2 of Floor 1
- Program's Default Safety/Confidence Factors
- 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

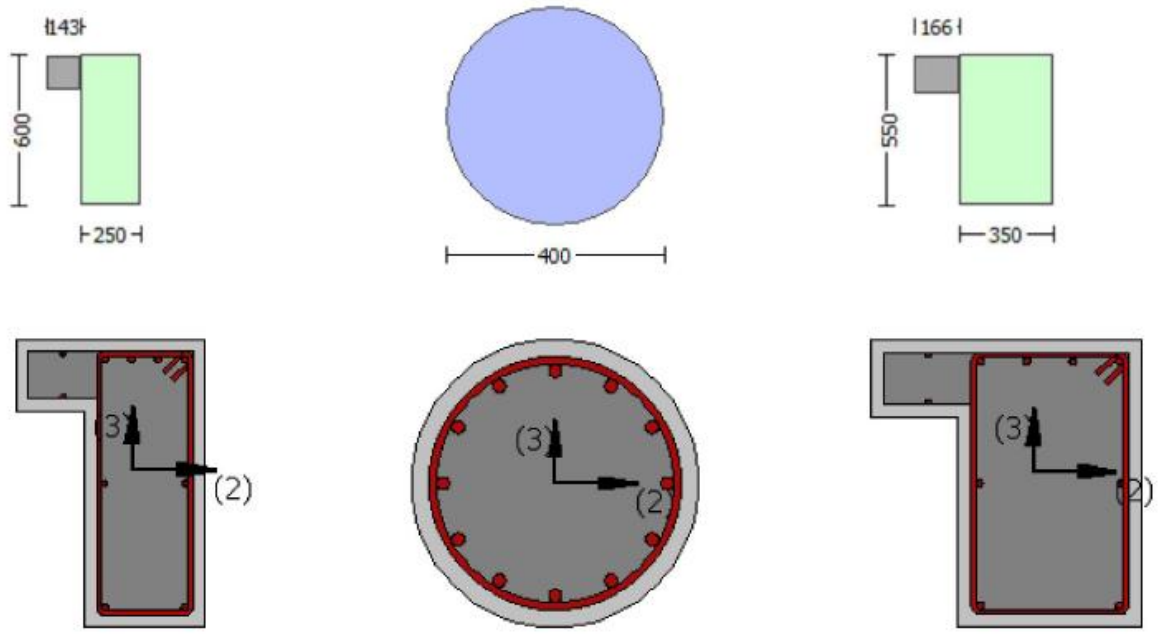
DESCRIPTION

The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting joints shear forces, horizontal hoops area and vertical reinforcement area of the FE analysis program SeismoBuild are compared with hand calculations.

The employed equations are: (5.33) of EC8: Part 1 for Shear Forces checks, (5.35) of EC8: Part 1 for Horizontal Hoops Area checks and (5.37) of EC8: Part 1 for Vertical Reinforcement Area checks.

GEOMETRY AND PROPERTIES



Units in N, mm

Materials' Properties

Column Below: New Material: fcd_column = fck_column/γc = 16.66667
fywd = fsk_column/γs = 434.7826
Column Above: Existing Material: fcd_column = fcm_column/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058
Beam B1: Existing Material: fcd_beam = fcm_beam/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058
Beam B2: New Material: fcd_beam = fck_beam/γc = 16.66667
fyd = fsk/γs = 434.7826

Members' Properties

Column Below

Diameter, D = 400.00

Column Above

Section Height, H = 400.00
Section Width, W = 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	SeismoBuild 2021		Hand calculations	
		Demand	Capacity	Demand	Capacity
Shear Forces [kN]	Significant Damage	474.58400	854.812318	444.2824	852.3008
Horizontal Hoops Area [mm²]		4312,657	616.8503	4312,657	616.8503
Joints Vertical Reinforcement Area [mm²]		287.8635	2544.6900	287.8635	2544.6900

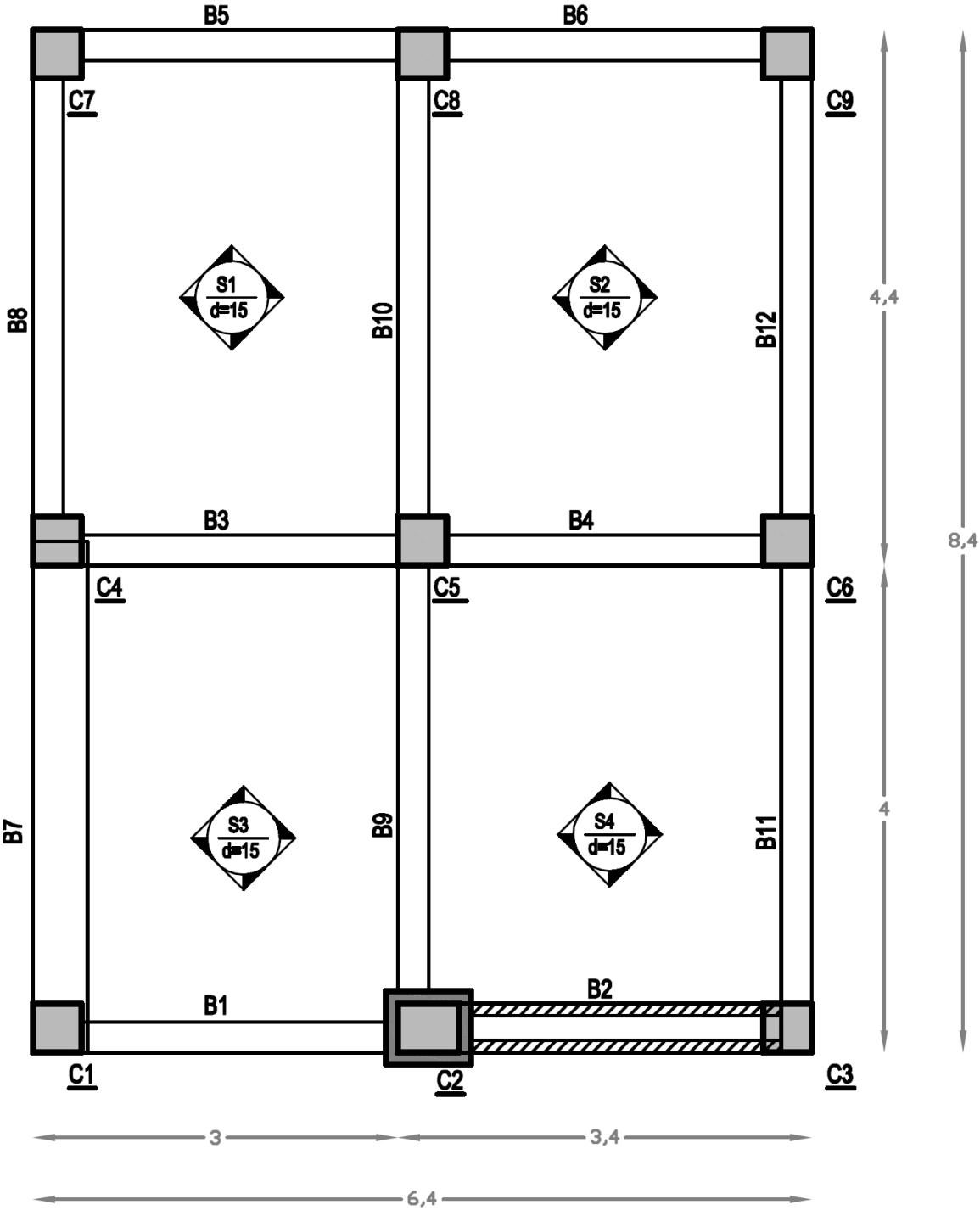
COMPUTER FILES

- EC_Joint5.bpf
- Report_EC_Joint5.pdf

EXAMPLE 6

SUCCINCT DATA

- Interior Joint: Beam B1-Column C2-Beam B2 of Floor 1
- Program's Default Safety/Confidence Factors
- 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
- 2nd floor plan view is the same with TBG



1st floor Plan view of the building

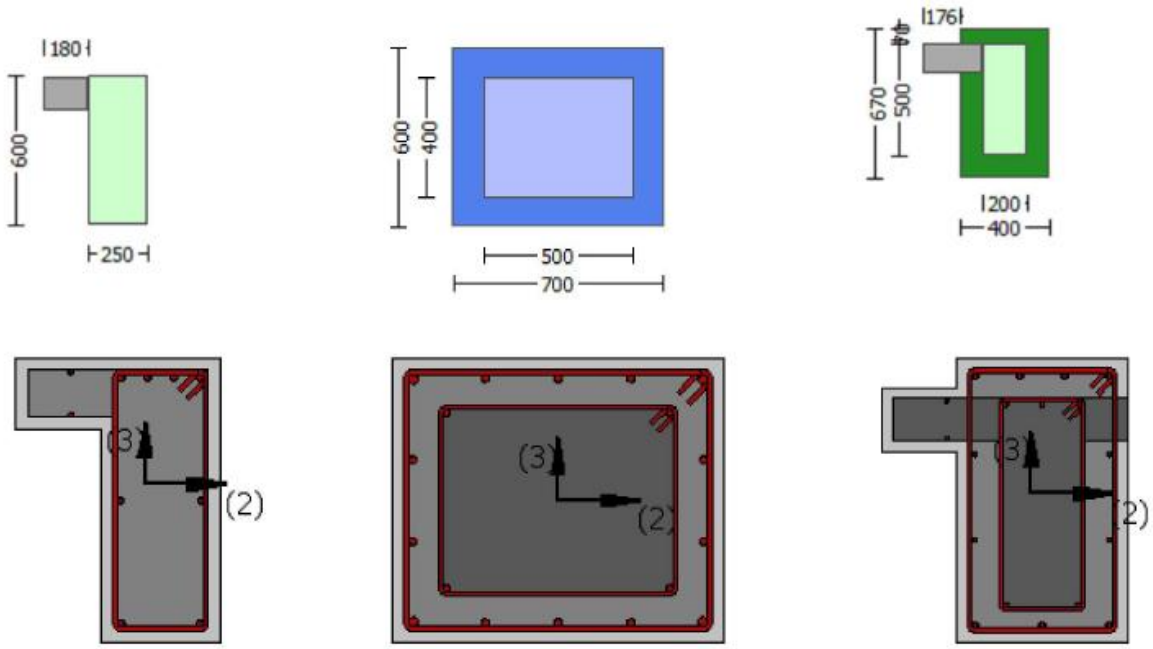
DESCRIPTION

The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting joints shear forces, horizontal hoops area and vertical reinforcement area of the FE analysis program SeismoBuild are compared with hand calculations.

The employed equations are: (5.33) of EC8: Part 1 for Shear Forces checks, (5.35) of EC8: Part 1 for Horizontal Hoops Area checks and (5.37) of EC8: Part 1 for Vertical Reinforcement Area checks.

GEOMETRY AND PROPERTIES



Units in N, mm

Materials' Properties

Column Below: Existing Material: fcd_column = fcm_column/(γc*Confidence Factor) = 11.11111
New Material: fcd_column = fck_column/γc = 16.66667
fywd = fsk_column/γs = 434.7826

Column Above: Existing Material: fcd_column = fcm_column/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058

Beam B1: Existing Material: fcd_beam = fcm_beam/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058

Beam B2: Existing Material: fcd_beam = fcm_beam/(γc*Confidence Factor) = 11.11111
fyd_core = fsm_core/(γs*Confidence Factor) = 322.058
New Material: fyd_jacket = fsk_jacket/γs = 434.7826

Members' Properties

Column Below

External Height, H = 600.00
External Width, W = 700.00
Internal Height, H = 400.00
Internal Width, W = 500.00

Column Above

Section Height, H = 400.00
Section Width, W = 400.00

Beam B1

Section Height, H = 600.00
Section 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 4.6. Comparison between SeismoBuild and hand-calculated results for EXAMPLE 1.6

Check	Limit State	SeismoBuild 2021		Hand calculations	
		Demand	Capacity	Demand	Capacity
Shear Forces [kN]	Near Collapse	765.70475	2350.168407	765.70475	2350.168407
Horizontal Hoops Area [mm²]		1826.207	863.9380	1826.207	863.9380
Joints Vertical Reinforcement Area [mm²]		680.678	804.2477	680.678	804.2477

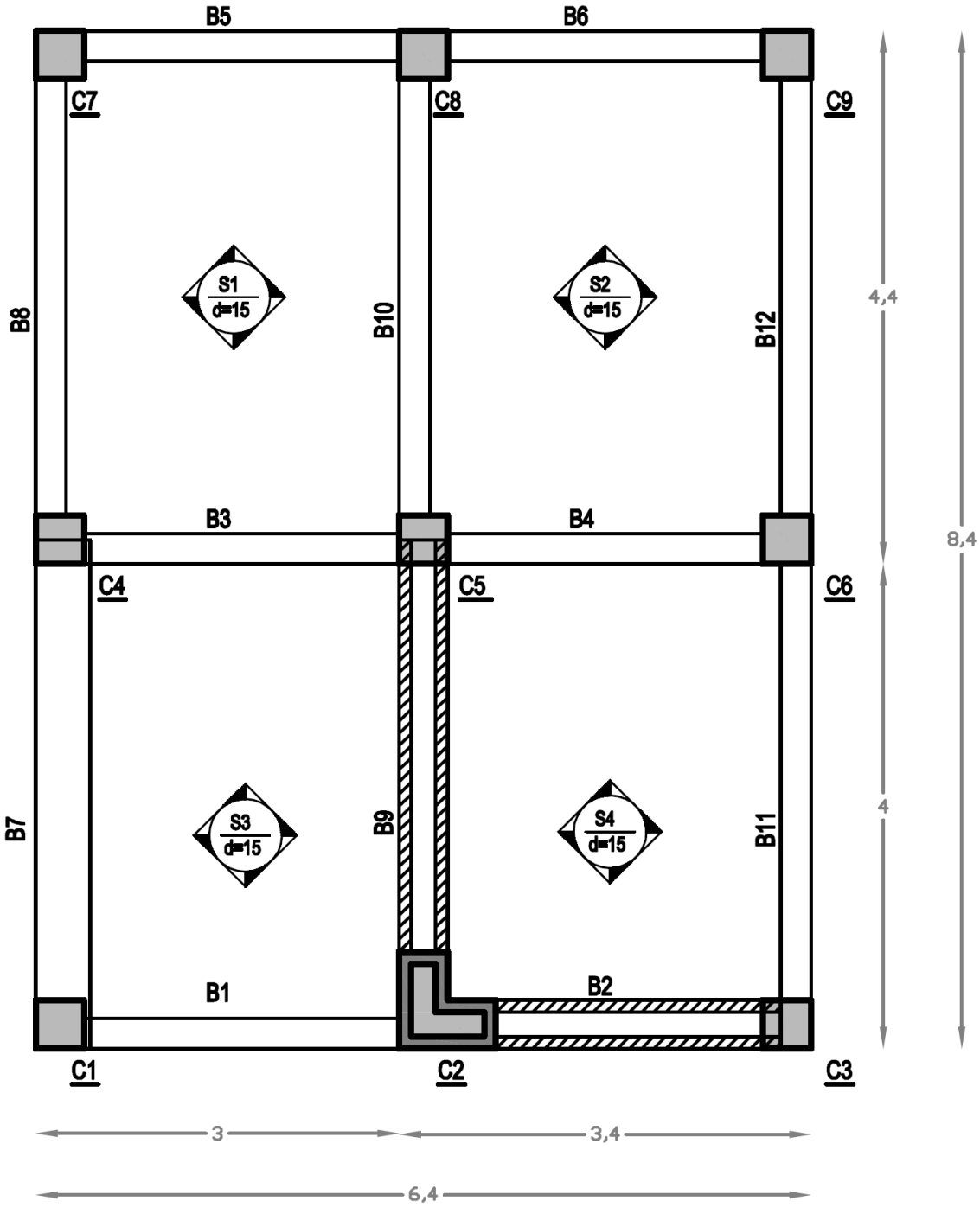
COMPUTER FILES

- EC_Joint6.bpf
- Report_EC_Joint6.pdf

EXAMPLE 7

SUCCINCT DATA

- Exterior Joint: Column C2-Beam B9 of Floor 1
- Program's Default Safety/Confidence Factors
- 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

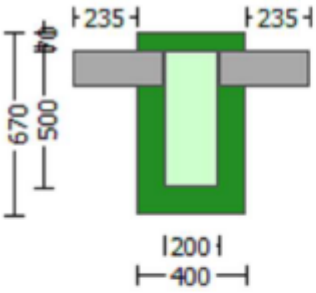
DESCRIPTION

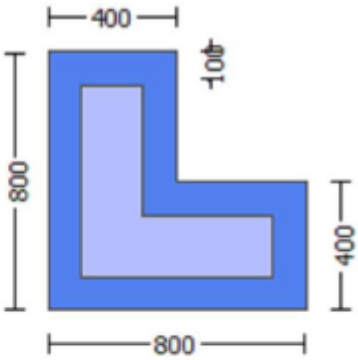
The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

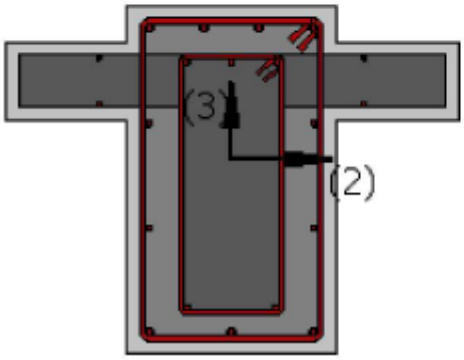
The resulting joints shear forces, horizontal hoops area and vertical reinforcement area of the FE analysis program SeismoBuild are compared with hand calculations.

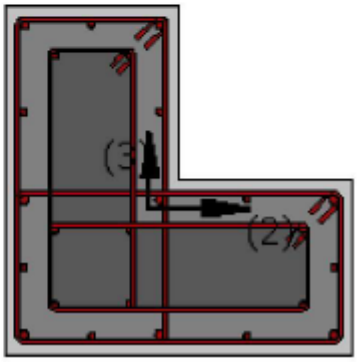
The employed equations are: (5.33) of EC8: Part 1 for Shear Forces checks, (5.36b) of EC8: Part 1 for Horizontal Hoops Area checks and (5.37) of EC8: Part 1 for Vertical Reinforcement Area checks.

GEOMETRY AND PROPERTIES









Units in N, mm

Materials' Properties

Column Below: Existing Material: fcd_column = fcm_column/(γc*Confidence Factor) = 11.11111
New Material: fcd_column = fck_column/γc = 16.66667
fywd = fsk_column/γs = 434.7826

Column Above: Existing Material: fcd_column = fcm_column/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058

Beam B9: Existing Material: fcd_beam = fcm_beam/(γc*Confidence Factor) = 11.11111
fyd_core = fsm_core/(γs*Confidence Factor) = 322.058
New Material: fyd_jacket = fsk_jacket/γs = 434.7826

Members' Properties

Column Below

Max Height, Hmax = 800.00
Min Height, Hmin = 400.00
Max Width, Wmax = 800.00
Min Width, Wmin = 400.00
Jacket Thickness, tj = 100.00

Column Above

Section Height, H = 400.00
Section Width, W = 400.00

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

Check	Limit State	SeismoBuild 2021		Hand calculations	
		Demand	Capacity	Demand	Capacity
Shear Forces [kN]	Damage Limitation	451.37853	1444.0477	451.37853	1444.0477
Horizontal Hoops Area [mm²]		739.2026	973.894	739.2026	973.894
Joints Vertical Reinforcement Area [mm²]		785.398	402.1239	785.398	402.1239

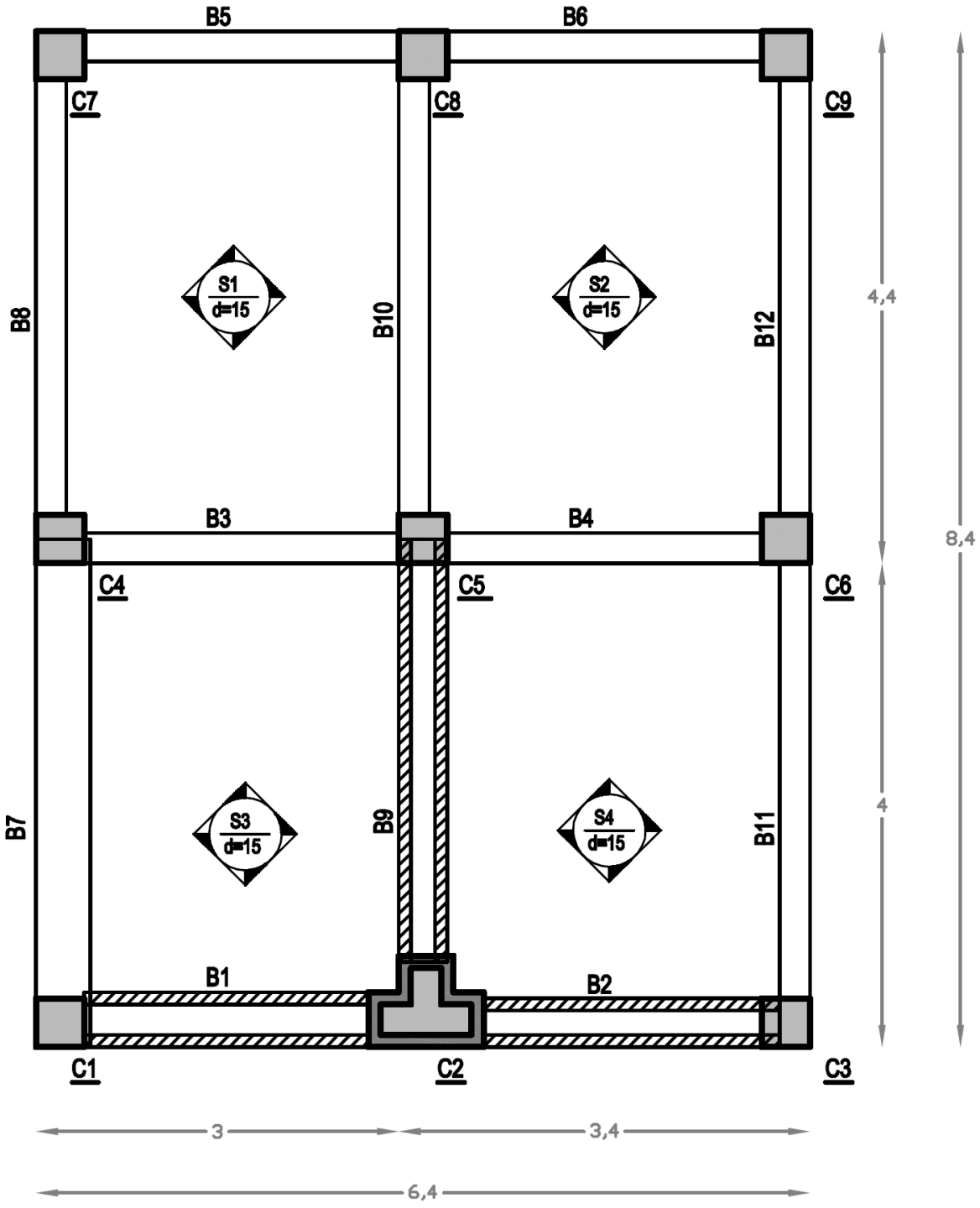
COMPUTER FILES

- EC_Joint7.bpf
- Report_EC_Joint7.pdf

EXAMPLE 8

SUCCINCT DATA

- Interior Joint: Beam B1-Column C2-Beam B2 of Floor 1
- Program's Default Safety/Confidence Factors
- 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

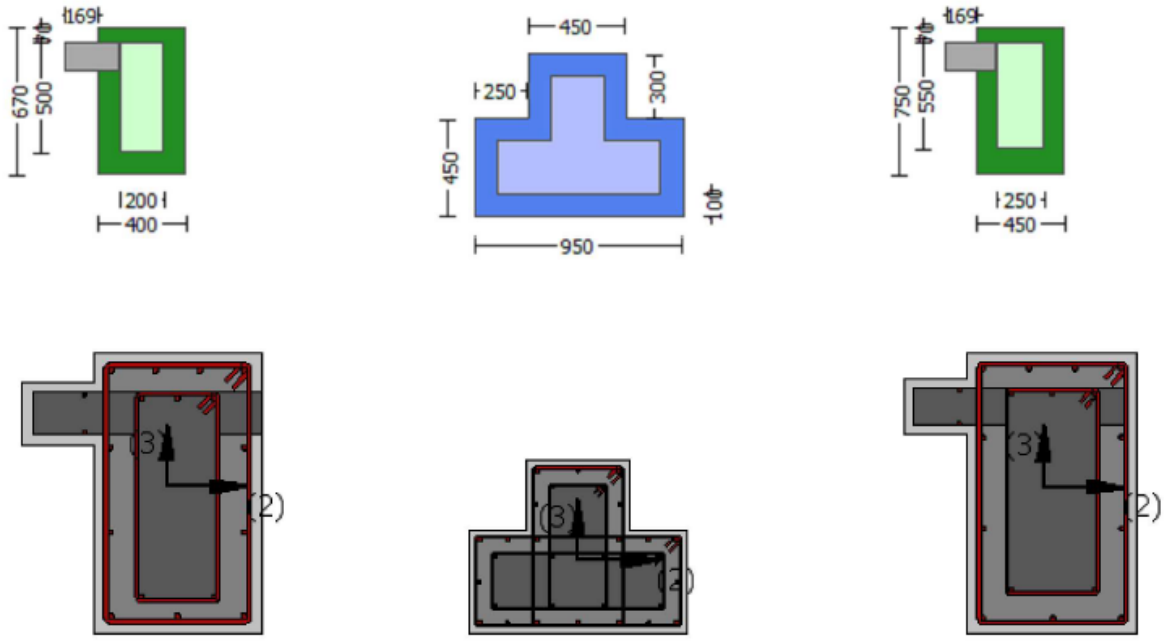
DESCRIPTION

The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting joints shear forces, horizontal hoops area and vertical reinforcement area of the FE analysis program SeismoBuild are compared with hand calculations.

The employed equations are: (5.33) of EC8: Part 1 for Shear Forces checks, (5.36a) of EC8: Part 1 for Horizontal Hoops Area checks and (5.37) of EC8: Part 1 for Vertical Reinforcement Area checks.

GEOMETRY AND PROPERTIES



Units in N, mm

Materials' Properties

Column Below: Existing Material: fcd_column = fcm_column/(γc*Confidence Factor) = 11.11111
New Material: fcd_column = fck_column/γc = 16.66667
fywd = fsk_column/γs = 434.7826

Column Above: Existing Material: fcd_column = fcm_column/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058

Beam B1: Existing Material: fcd_beam = fcm_beam/(γc*Confidence Factor) = 11.11111
fyd_core = fsm_core/(γs*Confidence Factor) = 322.058
New Material: fyd_jacket = fsk_jacket/γs = 434.7826

Beam B2: Existing Material: fcd_beam = fcm_beam/(γc*Confidence Factor) = 11.11111
fyd_core = fsm_core/(γs*Confidence Factor) = 322.058
New Material: fyd_jacket = fsk_jacket/γs = 434.7826

Members' Properties

Column Below

Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00

Column Above

Section Height, H = 400.00
Section Width, W = 400.00

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	SeismoBuild 2021		Hand calculations	
		Demand	Capacity	Demand	Capacity
Shear Forces [kN]	Significant Damage	755.71645	2455.793149	755.71645	2455.793148
Horizontal Hoops Area [mm²]		1755.2567	973.8937	1755.2567	973.8937
Joints Vertical Reinforcement Area [mm²]		942.478	402.1239	942.478	402.1239

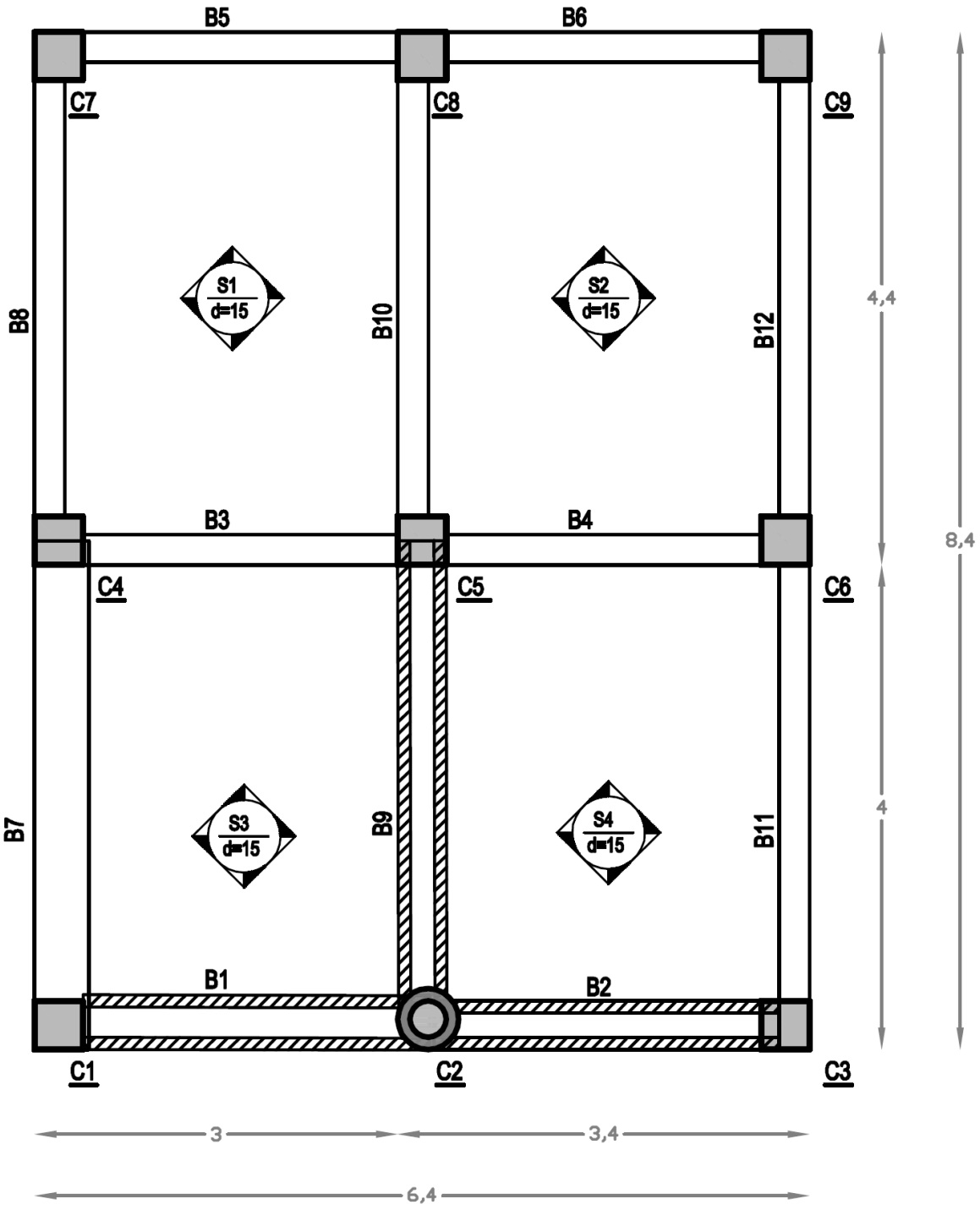
COMPUTER FILES

- EC_Joint8.bpf
- Report_EC_Joint8.pdf

EXAMPLE 9

SUCCINCT DATA

- Exterior Joint: Column C2-Beam B9 of Floor 1
- Program's Default Safety/Confidence Factors
- 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

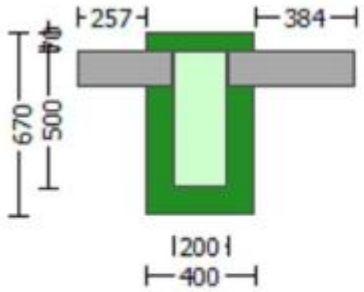
DESCRIPTION

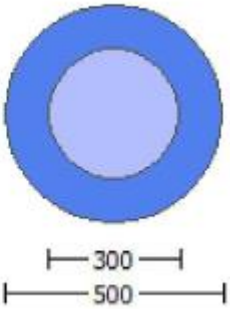
The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

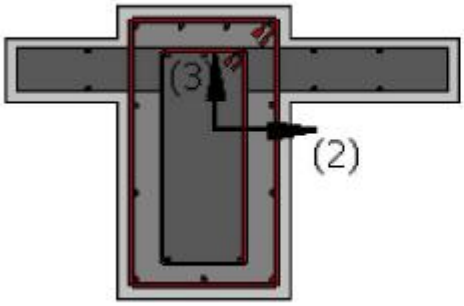
The resulting joints shear forces, horizontal hoops area and vertical reinforcement area of the FE analysis program SeismoBuild are compared with hand calculations.

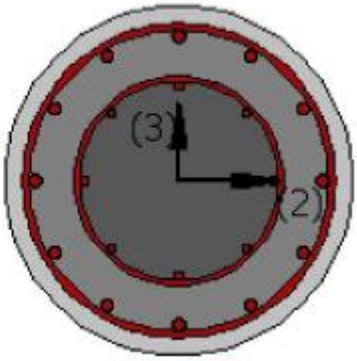
The employed equations are: (5.33) of EC8: Part 1 for Shear Forces checks, (5.36b) of EC8: Part 1 for Horizontal Hoops Area checks and (5.37) of EC8: Part 1 for Vertical Reinforcement Area checks.

GEOMETRY AND PROPERTIES









Units in N, mm

Materials' Properties

Column Below: Existing Material: fcd_column = fcm_column/(γc*Confidence Factor) = 11.11111
New Material: fcd_column = fck_column/γc = 16.66667
fywd = fsk_column/γs = 434.7826

Column Above: Existing Material: fcd_column = fcm_column/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058

Beam B9: Existing Material: fcd_beam = fcm_beam/(γc*Confidence Factor) = 11.11111
fyd_core = fsm_core/(γs*Confidence Factor) = 322.058
New Material: fyd_jacket = fsk_jacket/γs = 434.7826

Members' Properties

Column Below

External Diameter, D = 500.00
Internal Diameter, D = 300.00

Column Above

Section Height, H = 400.00
Section Width, W = 400.00

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	SeismoBuild 2021		Hand calculations	
		Demand	Capacity	Demand	Capacity
Shear Forces [kN]	Near Collapse	450.03669	1089.621708	450.03669	1089.621708
Horizontal Hoops Area [mm²]		702.9074	764.8943	702.9074	764.8943
Joints Vertical Reinforcement Area [mm²]		370.1102	2544.6900	370.1102	2544.6900

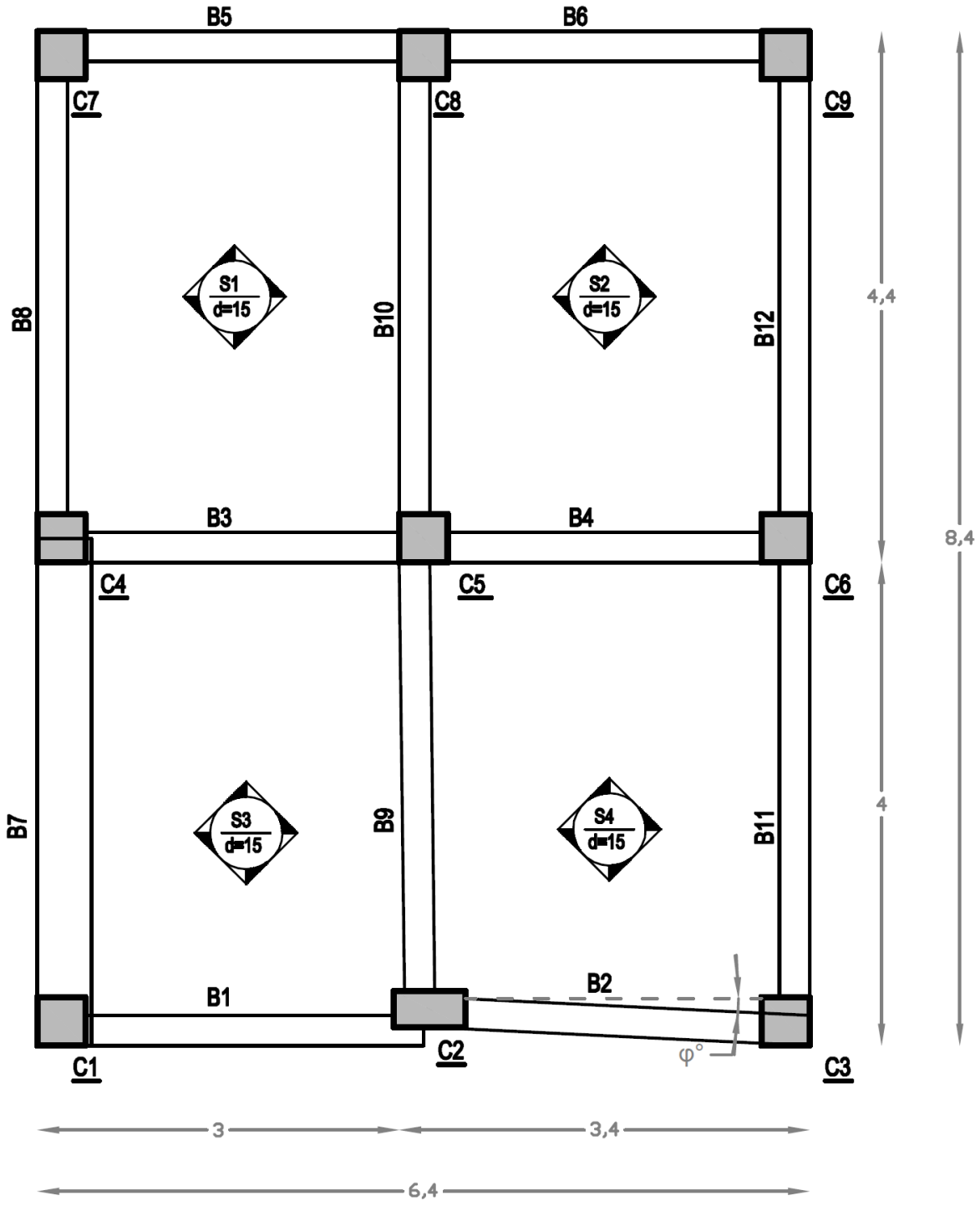
COMPUTER FILES

- EC_Joint9.bpf
- Report_EC_Joint9.pdf

EXAMPLE 10

SUCCINCT DATA

- Interior Joint: Beam B1- Column C2-Beam B2 of Floor 1
- Program's Default Safety/Confidence Factors
- 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

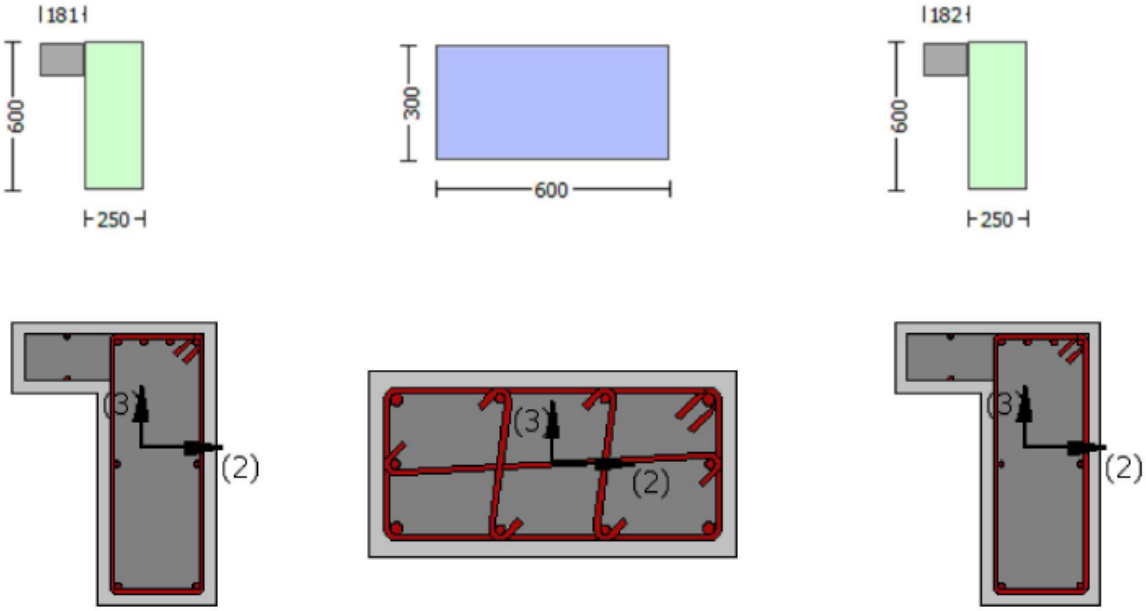
DESCRIPTION

The 3D model is subjected to a Uniaxial without Eccentricity-Uniform Pushover Analysis in the +X direction.

The resulting joints shear forces, horizontal hoops area and vertical reinforcement area of the FE analysis program SeismoBuild are compared with hand calculations.

The employed equations are: (5.33) of EC8: Part 1 for Shear Forces checks, (5.35) of EC8: Part 1 for Horizontal Hoops Area checks and (5.37) of EC8: Part 1 for Vertical Reinforcement Area checks.

GEOMETRY AND PROPERTIES



Units in N, mm

Materials' Properties

Column Below: Existing Material: fcd_column = fcm_column/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058
Column Above: Existing Material: fcd_column = fcm_column/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058
Beam B1: Existing Material: fcd_beam = fcm_beam/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058
Beam B2: Existing Material: fcd_beam = fcm_beam/(γc*Confidence Factor) = 11.11111
fyd = fsm/(γs*Confidence Factor) = 322.058

Members' Properties

Column Below

Section Height, H = 300.00
Section Width, W = 600.00

Column Above

Section Height, H = 400.00
Section Width, W = 400.00

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: The structural eccentricity between beam B1 and column C2 is not taken into account according to Eurocode 8-Part 1.

NOTE 2: 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 φ > 45°then the beam B2 is taken as vertical.

NOTE 3: 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	SeismoBuild 2021		Hand calculations	
		Demand	Capacity	Demand	Capacity
Shear Forces [kN]	Damage Limitation	341.91211	999.572049	341.91211	999.572049
Horizontal Hoops Area [mm²]		1358.269	1295.907	1358.269	1295.907
Joints Vertical Reinforcement Area [mm²]		863.9380	402.124	863.9380	402.124

COMPUTER FILES

- EC_Joint10.bpf
- Report_EC_Joint10.pdf