

Example 6 Masonry Structure Analysis and Design







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• OVERVIEW

SCADA Pro new version is a result of more than 40 years of research and development while containing all the innovative capabilities and top-notch tools for the construction business.

SCADA Pro utilizes a compact and fully adequate platform for constructing new buildings (analysis and design) or existing ones (check, assessment, and retrofitting).

The software employs the Finite Element Method, combining line and plane finite elements in a smooth way. For design purposes, the user is offered all the Eurocodes as well as all the relevant Greek regulations (N.E.A.K, N.K.O.S., E.K.O.S. 2000, E.A.K. 2000, E.A.K. 2003, Old Antiseismic, Method of permissible stresses, KAN.EPE).

There are numerous possibilities offered for the modeling of various kind of structures. Structures made of reinforced concrete, steel, timber, masonry, or composite structures are now fully feasible.

Several smart operations add on to the practicality and usability of the software. The user can produce the model of a structure no matter how complicated it is, work at ease with the 3D model, process through the steps of analysis and design in a convenient way, up to the conclusion of what initially may seem the most demanding project.

SCADA Pro is presented to you as a powerful tool to meet the highest needs of modern civil engineering!

• INTRODUCTION

The current manual comes as an aid for a new user of SCADA Pro, making the interface of the software as familiar as possible. It consists of several chapters, where one after the other, describes the consecutive steps of a simple example of a loadbearing masonry project. The most useful information is presented, in regards to the best possible understanding of the

software commands and logic, as well as the process that has to be followed.

• THE NEW INTERFACE

The new interface of the SCADA Pro software is based on the RIBBON structure, thus, the several commands and tools are reached neatly. The main idea of the RIBBON structure is the grouping of commands that have small differences and work in the same context, in a prominent position different to each group. This converts the use of a command, from a tedious searching procedure through menus and toolbars, into an easy to remember the chain of two or three clicks of the mouse button.

The user can collect his/her most popular commands into a new group, for an even faster access. This group remains as it is for future analyses after the program ends. Different commands can be added to it or removed from it, and its placing in the workspace may be altered through the "Customize Quick Access Toolbar" utility.

Cus	tomize Quick Access Toolbar
V	Quick Print
	More Commands
	Show Below the Ribbon
	Minimize the Ribbon



Project Data
石 - 🥐
🖧 Arcs
Circles
Beams
Columns
🖶 🛶 Footings
🖶 📥 Nodes
🕂 🖅 Mathbeams
🚊 📲 🖁 MathColumns
Surf 3D
🗄 🛶 Slabs

Apart from the RIBBON structure, all the entities that a structure consists of are presented in a tree structure, at the left side of the SCADA Pro main window, either for the whole structure or at each level of the structure. This categorization enhances the use of each entity. When the tree structure is choosing an entity, it is highlighted at the graphical interface and the level of the structure that contains this entity is isolated. At the same time, at the right side of the window, the entity's properties appear. The user can check or modify any of these properties at once. Conversely, the entity can also be chosen at the graphical interface, and automatically it is presented, at the left side in the tree

structure and at the right side with its properties. The right-click mouse button can be very helpful here, since several commands and features, distinct for each entity, can be activated with it.



The "Properties" list that shows up at the right side of the window, not only shows all the properties of the entity shown but can be used for any quick and easy changes, the user wants to make, too.



1. GENERAL DESCRIPTION

1.1 Geometry

The considered single floor masonry structure consists of 6 views with openings and raft foundation.



1.2 Materials

All walls are of single-leaf type with dimensional natural stone units 20x20x25 and M5 mortar named, "Wall M5 0.50". For the raft, concrete C20/25 and Reinforcing Steel B500C was used.

1.3 Regulations

Eurocode 8 (EC8, EN1998) for seismic loads. Eurocode 2 (EC2, EN1992) for the design of the concrete elements.

1.4 Load and Analysis assumptions

Dynamic Spectrum Analysis with pairs of torsional moment along the same direction. The loads by the method above are:

(1) G (dead)

(2) Q (live)

(3) EX (node loads, seismic forces along XI axes, derived from dynamic analysis).

(4) EZ (node loads, seismic forces along ZII axes, derived from dynamic analysis).

(5) Erx \pm (node torsional moments, derived from node seismic forces along XI axes, offset by the accidental eccentricity $\pm 2e\tau zi$).



(6)Erz±(node torsional moments, derived from node seismic forces along ZII XI axes, offset by the accidental eccentricity ±2etxi.

(7)EY (seismic vertical component –seismic force along y direction- derived from dynamic analysis).

1.5 Notes

All the commands that were used in this example, as well as the rest of the commands, are explained in detail in the manual that accompanies the program.



2. DATA INPUT - MODELING

SCADA Pro is enriched with a masonry library while the user can automatically create the masonry model using only the centered outline of the structure and modify each side through the Templates editor.

1. The **Templates** command can be used in two ways so that it fulfills every modeling demands.



Use the **button** located at the initialization window, or select "New" **w** see as from the menu, to create a new file. In the dialog box that appears define the data of the new project.

New Project	_ · ·		
Project Name MASC	DNRY		
Details Masor	nry Structure Analysis and Design	~ ~	
Location Folders: c:\ Drives:	c: ✓	Network	
C:\ 2015 ACE ERP ACE HELL AS Autodesk	AS FILES	ОК	
camtasia_ cusmel cusmel	projects V	Cancel	

▲ The name of the file can contain up to 8 characters of the Latin alphabet without any symbols (/, -, _) nor spaces. You can add a description or add some information related to the structure, in the "Info" field.





Masonry

2.1 Masonry library – wall definition:

Arbitrary Concrete Section

Libraries

Inside the "Modeling" unit, in "Libraries" group, the "Masonry" command, opens the respective library:

opertie	s of masonry		
Masonry	y Brick blocks wall - M2 25 cm 🗸 🗸		Type Existing
ame	Masonry Brick blocks wall - M2 25 cm		Concrete jacket Thickness 0 Single Sided V
ype	Load-bearing V Single-leaf wall V ?		Cocrete Steel
			C20/25 V S500 V
Masonr	ry uni Common brick 6x9x19		Φ 8 / 10 cm fRdo,c(MPa)=
	Thickness 25 fb=1.6733 fbc=2.0000 ε=15.00		Anchorage Without any additional care ~
Mortar	Mortar Cement-M2 V		
	General purpose designed masonry mortar fm=2.0000		
Wall	? L1 (cm) 0 t1 (cm) 0 t2 (cm) 0		
Shell B	edded Wall		
Total v			
		+ U	Filled vertical joints (3.6.2)
		t1	Bed join of thickness >15 mm
Masonr	y uni	t2	Thickness (Equivalent) 25
	Thickness 0		See 15
Mortar	\sim		Specific weight (NV/m3)
		Masonry units -	Compressive strength ik 0.794381
Wall	? L1 (cm) 0 t1 (cm) 0 t2 (cm) 0	Mortars library	(GPa) Modulus of elasticity 1000 0.794381
			Characteristic strength fvk0 (N/mm2)
Concre	ete infill fck (N/mm2) Thickness	New	Maximum shear strength fvkmax (N/mm2) 0.108766
ezu/25	ability level Execution control	Save	Flexural strength fxk1 0.1 (N/mm2)
	KL1:Limited V dass 1 V	Exit	Flexural strength fxk2 0.2 (N/mm2)

Choose a predefined wall, or create a new one. Type a name for the wall, select the "Type" from the drop-down list and define the related properties for the "Masonry Unit", "Mortar", "Piers", "Concrete Infill" and "Concrete Jacket".

- ▲ Depending on the selected TYPE of masonry, in the dialog box, some fields are enabled or disabled.
- 1 The definition for each type is displayed by clicking the 2 button on the right.



EXAMPLE

Name: Wall 1

Type: Grouted Cavity Wall

All fields of the window are active, since this type requires the definition of two single walls and a concrete infill.

Properties of masonry	\$		>
Masonry Brick blocks wall - M2 25 cm V Name Masonry Brick blocks wall - M2 25 cm Type Load-bearing V Grouted cavity wall V		ype Existing Concrete jacket Thickness Single Side Cocrete Steel Steel	v ed v
Masonry uni Common brick 6x9x19 Thickness 9 fb=1.6733 fbc=2.0000 ε=15.00 Mortar Mortar Cement-M2 General purpose designed masonry mortar fm=2.0000 Wall ? L1 (cm) 0 t1 (cm) Shell Bedded Wall 0 ? Total width of the two mortar strips g (cm) 0 ?		• 8 / 10 cm fRdo,c(MPa)= Anchorage Without any additional of	0.00 :are ~
tef=9.00 k=0.45 fk=0.7944 Masonry uni Brick blocks Perforated 6x9x19 Thickness 9 fb=3.3467 fbc=4.0000 ε=15.00 Mortar Mortar Cement-M2 General purpose designed masonry mortar fm=2.0000 Wall ? L1 (cm) 0 t1 (cm) 0 t2 (cm) 0	Masonry units - Mortars library	Filled vertical joints (3.6.2) Bed join of thickness >15 mm Thickness (Equivalent) 25 Specific weight (KN/m3) 17 Compressive strength fk 0.7 Modulus of elasticity 1000 0.7	? .8 '94381 794381
tef=9.00 k=0.45 fk=1.2905 Concrete infill fck (N/mm2) Thickness C20/25 20 7 E=30.00 ε=25.00 3 Data reliability level KL 1:Limited Execution control class 1 ~	New Save Exit	Characteristic strength fvk0 0.1 (N/mm2) 0.1 Maximum shear strength fvkmax (N/mm2) 0.1 Flexural strength fxk1 0.1 (N/mm2) 0.1 Flexural strength fxk2 0.2	.506 L
Tensile strength fwt (N/mm2)	n (N/mm2) 0	Mean Compressive strength 0	

In Wall1 & Wall2 define

units: the type and thickness **Mortars**: the type and the corresponding factors are updated automatically.

fb=3.3467 fbc=4.0000 ɛ=15.00

Masonry Units -Mortars Libray

In the command "*Masonry Units – Mortars Library*" you will find standard typologies of clay bricks, mortar and masonry. You can enter other bricks and mortar, by simply typing the name and specifying the class and group, for the compressive strength (which is updated automatically). Then select the button "New".



You can also change the class and group of an existing masonry or mortar and update it by clicking "Submit".

In the field "Masonry Units", select from the drop-down lists the type of bricks and mortar, and create a new type of masonry by clicking "New". The weight and strength are calculated automatically.

×
Mortars
✓ Mortar Cement-M5 ✓
Name Mortar Cement-M5
Type General purpose designed masonry mortar ?
Resistan M5 V Compressive strength fm 5
New Save

For this example we chose:

1.1.1 Masonry units

ison y c	inits						
Stones 2	0x20x25				×		
ame	Stones 20x20x25			Brick blocks Perfora Brick blocks Perfora	ated 6x9x19 ated 9x9x19		
ype	Dimensioned natural stone units			VTONG 20x25x60 YTONG 25x25x60	ated 12x14x25		
lass	п	~ ? Gr	oup 1	1 Stones - stones erratic 20x15x30 Stones - stones drilled 20x20x25			
Resistan	ce calculation from o	dimensions	n) d7 (mm)	Ā	Stones 20x20x25	<u> </u>	
dy 📕	dz M	200 200 lean compressiv	250 ve strength f	1.15 bc 8			
dy dy dy	dz M c weight ε (KN/m3)	200 200 lean compressiv 26	ve strength f	1.15 bc 8 New	,		

Type: Dimensional natural stone units (select from list) Category: II, Group: 1 (select from list)



▲ For further information regarding the Category and Group of your selection click the button on the right.

? Masonry units may be Category I of II

category I

Units with a declared compressive strength with a probability of failure to reach it not exceeding 5%. This may be determined via the mean or characteristic value

➢ category II

not intended to comply with the level of confidence of Category 1 units (lower confidence level than for I)

	Materials and limits for Masonry Units								
	Group 1 (all		Group 2		Group 3		Group 4		
	materials)	Units	Vertical holes				Horizontal	holes	
Volume of all holes (% of the gross volume)	≤25	clay	>25;≤55		≥25;≤70		>25;≤70		
		calcium silicate	>25;≤55		not used		not used		
		concrete ^b	>25;≤60		>25;≤70		>25;≤50		
Volume of any hole (% of the gross volume)	≤ 12 ₅ 5	clay	each of multiple holes of 12,5	each of multiple holes ≤ 2 gripholes up to a total eac of 12.5 of :		each of multiple holes ≤ 2 gripholes up to a total of 12.5		each of multiple holes ≤30	
		calcium silicate	each of multiple holes total of 30	each of multiple holes ≤ 15 gripholes up to a not used total of 30			not used		
		concrete ^b	each of multiple holes ≤ 30 gripholes up to a total of 30		each of multiple holes ≤ 30 gripholes up to a total of 30		each of multiple holes ≤25		
Declared values of thickness of webs and shells (mm)	No requirement		web	shell	web	shell	web	shell	
		clay	≥5	≥8	≥3	≥6	≥5	≥6	
		calcium silicate	≥5	≥ 10	not used		not used		
		concrete ^b	≥ 15	≥ 18	≥ 15	≥ 15	≥20	≥20	
Declared value of combined thickness ^a of webs and shells (% of the	e No requirement	clay	≥ 16		≥ 12		≥ 12		
overall width)		calcium silicate	≥20		not used		not used		
		concrete ^b	≥ 18		≥ 15		≥45		
a. The combined thickness is the thickness of the webs and shells, design dimensions of units	measured horizontall	ly in the relevant	direction. The check is t	o be seen as a qualification	n test and need only be r	repeated in the case of prin	cipal change	es to the	

b. In the case of conical holes, or cellular holes, use the mean value of the thickness of the webs and the shells.

For the Strength Calculation from Dimensions, type the dimensions of the masonry unit and the reduction factor δ , is automatically filled.

Resistance calculation from	n dimensions
	dx (mm) dy (mm) dz (mm) δ
dy	200 200 250 1.15 ?
dx dz	Mean compressive strength fbc 8
	Mean compressive su engur Ibc

Type the "Compressive Strength" fbc, which is the average value of experiments regarding the compressive strength of the masonry units and the "Specific Weight ϵ ".

Specific weight ε (KN/m3)	26
Compressive strength fb	9.2

The program automatically calculates the "Compressive Strength" fb.



Compressi	ive strength fb 9.2	
Select	New to store in the masonry library this	masonry unit.
L Eve	ry time that you save a masonry unit this is st rent and any future project as well.	ored permanently and is available for the
1.1.2	Vortar	
Mortars		
Mortar C	ement-M5 v	
Name	Mortar Cement-M5	
Type	General purpose designed masonry mortar 2	Concert purpose designed processory poster
Resistan	M5 Compressive strength fm 5	General purpose prescribed masonry mortar
recorden		Lightweight mortar of density <=800 Kg/m3
	New Save	Lightweight mortar of density <=1500 kg/m5
Name: N Type: Ge Strength	lortar-M5(select from list) neral Purpose Mortar (select from list) : M5 (select from list)	
The com	pressive strength Fm is automatically filled in	by the program
Select new mas	Save and Exit to return to the return unit, which is now located in the list.	masonry library, where you can select the
Masonry un	i Stones 20x20x25	
	Stones 20x20x50 Brick blocks Perforented 6v9x19	1
Mortar	Brick blocks Perforated 9x9x19 Brick blocks Perforated 12x14x25	
a contraction of the second se	YTONG 20x25x60 YTONG 25x25x60	
wall	Stones - stones erratic 20x15x30 Stones - stones drilled 20x20x25	
	Concrete blocks Common brick 6x9x19	
	Stones 20x20x25 Stones 20x20x25	



	s of masonry		×
Masonr	y stone wall - M5 50 cm 🗸 🗸		Type Existing V
lame	Masonry stone wall - M5 50 cm		Thickness 0 Single Sided V
уре	Load-bearing V Single-leaf wall V ?		Cocrete Steel
Magazz	Stopps 20v20v50		C20/25 ~ S500 ~
Masoni	Thickness 50 fb=9 2000 fbc=8 0000 s=26.00		Φ 8 / 10 cm fRdo,c(MPa)=
Mortar	Mortar Cement-M5		Anchorage Without any additional care \checkmark
	General purpose designed masonry mortar fm=5.0000		
Wall	? L1 (cm) 0 t1 (cm) 0 t2 (cm) 0		
Shell B	edded Wall		
Total v	vidth of the two mortar strips g (cm) 0 ?		
		L1	Filled vertical joints (3.6.2)
		t1	Bed join of thickness >15 mm
Masonr	y uni		Thickness (Equivalent) 50
	Thickness 0		Specific weight (KN/m3) 26
Mortar	~ ~		Compressive strength fk 3.447902
ar_0		Masonry units - Mortars library	Modulus of elasticity 1000 3.447902
waii			(GPa)
			(N/mm2)
Concre	te infill fck (N/mm2) Thickness	New	Maximum shear strength fykmax (N/mm2)
C20/25	20 0	Save	Flexural strength fxk1 0.1
ata reli	ability level KI 1:1 imited Execution control	Evit	(N/mm2)
	Class 1 V	EXIC	(N/mm2)
Т	ensile strength fwt (N/mm2) 0 Equal biaxial compr. strengt	h (N/mm2) 0	Mean Compressive strength 0 fm (N/mm2)
ame: pe: S ason idth: Th ar	Wall M5 0.50 (type) Single-leaf (select from list) Try unit: Dimensional natural stone units (prev 50 cm (type) he total masonry results are calculated by the re transferred to the summary table on the rig	riously defined e program bas ght. fb=9.2000	d) and sed on the input data and the formula ϵ and the formula
	r: Mortar-M5		
ortai			
ortai Peneral	rescribed Masonry Unit fm is automatically up I purpose designed masonry mortar fm=5.0000	odated.	



In case you had selected **Cavity Wall**, the second field regarding the masonry units and mortar for the second part of the wall will be enabled for editing as you did for the first wall. For **Shell Bedded Wall**, the field regarding the total width of the two mortar strips g will be enabled (see

3.6.1.4 for the calculation of the Specific Strength []). For struts, type the dimensions



according to the image 5.10 (see. 5.5.1.3)

to calculate the active thickness according to equation

Thickness (Equivalent)	50
Specific weight (KN/m3)	26
Compressive strength fk	3.447902
Modulus of elasticity 1000 (GPa)	3.447902
Characteristic strength fvk0 (N/mm2)	0.1
Maximum shear strength fvkmax (N/mm2)	0.598
Flexural strength fxk1 (N/mm2)	0.1
Flexural strength fxk2 (N/mm2)	0.4
Mean Compressive strength fm (N/mm2)	0

The total masonry results are calculated by the program based on the input data and they are transferred to the summary table. If the user knows the values of the equivalent wall, these can be defined manually.



2.2 Modeling:

2.2.1 Templates:

1st **MODE:** The Templates tool, includes a standard masonry structure, which can be modified accordingly, so that it can match the demands of a simple project.

Select the insertion point and choose from the drop-down list "Masonry"

sonry	-

L	y1				
	G	201	netry		*
	Nu	ımb	er of front views	4	
	Alo	ong	У	1	
	Dis	star	nce y	300,00	
	Wi	tdh	1 (cm)	30,00	
	Th	ickr	ness (cm)	20,00	=
	Po	siti	on Angle	0,00	
Ξ	Di	sta	ance along y		
	Ly	1 (0	cm)	300,00	
Ξ	Fr	on	t Views		
	Bre	еак		NO NO	
		FR Ch		0.00	
		Ste	art x (cm)	0,00	
		Le	nath(cm)	400.00	
		Δn	ale	-90.00	
		Wi	tdh (cm)	30.00	
		Th	ickness (cm)	20.00	
		Op	ening	2	
		Ξ	Opening 1		
			Start x (cm)	50,00	
			Start y (cm)	100,00	
			Width(cm)	100,00	
			Height(cm)	100,00	
		Ξ	Opening 2		
			Start x (cm)	250,00	
			Start y (cm)	100,00	
			Width(cm)	100,00	Ļ
			Hoight(cm)	100.00	•

Define the geometry; the number of views, the repetitions on y direction (number of floors) and the distance between them (floor height). Type the values of the width, the thickness of the walls and the angle position according to X, Z global axes to define the direction of the surface in the interface.

If there are more than one floors, you can change the floor height in the field "Distance along Y".

The activation of the checkbox "Division", regarding the front views is optional. With this command, each front view is slivered in more than one surfaces, with limits in the middle of the opening, so, each view is simulated from continuous surfaces without holes. Otherwise, in the simulation process each view contains one surface with its existing holes.

For each view define: (i) the coordinates of the start point and the angle for the rotation of the structure according to X, Z global axes (see the drawing) counterclockwise, (ii) the length and the thickness of the wall and (iii) the number of the openings.

Similarly, define the geometry and the position of each opening.



Click the button "OK" to import the defined structure in the interface.

Proceed to calculate the mesh, as described above.



command

2.2.2 Front View Identification:

2nd MODE: SCADA Pro gives you the possibility to create a masonry structure on any external boundary, by using the tool "Templates", quickly and easily.

The process is the following:

- 1. Enter a plan view in DXF or DWG file format by using the
- 2. Use the command "Layers" to open the list of the design layers.

Layers
DW Bwe Move
Delete
Layers
Freeze Layers
DEF Rotate

Import

3. Select from the list the layer containing the walls and click on "Convert Lines, Arcs".

Import File Layers			×
Number o-prov-5 s-scala s-scala-kagelo s-scala-lept	Visible Q Q Q Q	^	Select All Cancel Option Visible Non Visible
s-walls s-wc s-ypost-hatch TOIXOS			Convert Lines - Arcs OK
top-oria oik.	<u>×</u>	~	Cancel

▲ In case that you do not have a .dxf or .dwg file, you can design the plan level directly to the XZ level of the SCADA environment.







Masonry V	Ly (
	Pro	perty	Value		
	-	Geometry			
		Number of front	6		
		Along y	1		
		Distance y	300.00		
		Width (cm)	30.00		
		Thickness (cm)	50.00		
	_	Position Angle	0.0		\times
		Ustance along j	200.00		
		Eyr (cill)	300.00		
		Divide			
		E Front View 1			
		Start x (cm)	1400.00		
Open Save			OK	Cancel	

The program identifies automatically the geometry of the floor plan view. By default the height is defined and the views are created versus the global axes.

5. The user has to define the number of the floors and the corresponding heights, as well as the openings on each view by following the 1st MODE procedure.



Since you have completed the process for each side and each opening, insert the project on the desktop by selecting the button "OK".



You can save the formed model as an .stp file, by clicking the Save button, creating in this way your very own template library. Click Open to call a saved file and load the model at any point.

WARNING: Make sure that the Equivalent Thickness of the wall defined to the library has the same value as the Thickness defined in the Templates.

Property	Value		Properties of masonry X
Geometry		^	Masonry stone wall - M5 50 cm Vipe Existing Concrete joolet
Number of front Along y Distance y Width (cm) Thickness (cm)	6 1 300.00 30.00 50.00		Type Load-bearing Single-leaf wall ? Masony un (\$50mes 20x20x25 ~ ~ Trichness 50 fb=-9.2000 fbc=8.0000 c=26.00 ~ Mortar Matrix Cement M5 ~ ~ Masony un (\$50mes 20x20x25 ~ ~ ~ Trichness 50 fb=-9.2000 fbc=8.0000 c=26.00 ~ ~ Mortar Matrix Cement M5 ~ ~ ~ ~ Shell Bedded Wall 1 t (m) 0 12 (m) 0 . <t< th=""></t<>
Position Angle Distance along Ly1 (cm)	0.0 y 300.00		Thickness (Equivalent) 50
Divide Front Views 1 Start x (cm)	1400.00	~	Wall 2 L1 (cm) 0 t2 (cm) 0 Modular of elasticity Modular of elasticity ID00 3-447902 Concrete Infili fdx. 0µ/mm2) Tricdness Modular of elasticity 0

WARNING: In the templates field you can define a single value of thickness for all walls. To edit the thickness of some walls, you open the "Plate Elements Creation" form and you modify the values respectively.

As soon as you have completed the process for each side and each opening, insert the project on the desktop by selecting the button "OK".



Inside SCADA environment, you can see the outlines for each view and its openings in 3D presentation.



2.3 Mesh Group Definition:

As soon as the model is imported in SCADA environment, select the 3D "Mesh" command inside "Surface Elements" group.



In the dialog window that opens, the Mesh Groups list, contains the 1 PLATE mesh, with its corresponding surfaces (one for each view). By selecting the 1 PLATE the fields regarding the Density, Width, Thickness etc (previously defined at Templates) values, are automatically filled in.

Plate Elemen	ts Creati	on							×
Description	PLATE			Material Mason	ry	~	Туре	Mase	onry stone 🗸
Elem	ent		Ks (Mpa/cm)	Isotropic		Orthotr	opic	Angl	e 0
Plate		~	300		_				
Density	Widt	h (cm)	Thickness	Exx (GPa)	3.4	47902642	Gxy (GPa)) 1	.379161056
0.20 ~	30		50	Eyy (GPa)	3.4	47902642	ε <mark>(kN/m3)</mark>	2	6
Descrip	Descriptions Mesh Mesh Groups Flat Surface		sh	Ezz (GPa)	3.4	147902642 atx*10-5		1	
Mesh Group			Flat Surface	vxy(0.1-0.3)	0		aty*10-5	1	
		2P S1/2/3(2) 3P S1/2/3(2) 4P S1/3/2(2) 4P S1/4/2 5P S1/5/2		vxz(0.1-0.3) 0			atxy*10-	5 1	
				vyz(0.1-0.3)	0		Exx *	vxz = E	yy * vxy
		6P S	51/6/2(2)	Redefinitio	n	Steel Rei	nforcement		
				Del From Lis		S220	~	:	OK
				Derromus		Cover	_	-	5-0
				New		20	mm		Exit

In the type, select from the list the previously defined wall from the library, and the respective fields Exx, Gxy and special weight ε are automatically updated.

Steel reinforcement and Cover





2.3.1 Mesh	i sub-Group Definit	ion:
Descriptions Mesh Groups	Mesh Flat Surface 1P S1/1/3(2) 2P S1/2/3(2) 3P S1/3/2(2) 4P S1/4/2 5P S1/5/2 6P S1/6/2(2)	

The derived from templates mesh model comes along with the Mesh group (1 PLATE) and a surface for each view.

1P S1/1/3(2) In the Surface name

- The first number is the number of the view, •
- The P letter stands for flatness •
- The number inside the parenthesis, defines the number of holes in the respective view. •

Activate the Mesh and select a surface. The fields are updated accordingly by the defined values of the selected surface, ×

Plate Elements Creat	stion
----------------------	-------

Description	S1/1/3		Material Mason	ry	~	Туре	Masonry stone 🗸
Eleme	nt	Ks (Mpa/cm)	 Isotropic 	(Orthotr	opic	Angle 0
Plate	~	300					
Density	Width (cm)	Thickness	Exx (GPa)	3.44	17902642	Gxy (GPa)	1.379161056
0.20 ~	30	50	Eyy (GPa)	3.44	17902642	ε <mark>(kN/m3)</mark>	26
Descripti	ons 🗹 M	lesh	Ezz (GPa)	0		atx*10-5	1
Mesh Groups	F	lat Surface	vxy(0.1-0.3)	0		aty*10-5	1
1 PLA	E 1P 2P 3P	S1/1/3(2) S1/2/3(2) S1/3/2(2)	vxz(0.1-0.3)	0		atxy*10-5	1
	4P 5P	S1/4/2 S1/5/2	vyz(0.1-0.3)	0		Exx * v	xz = Eyy * vxy
	6P	S1/6/2(2)	- 10.00		Steel Re	inforcement	
			Redefinitio	n	S220	~	ОК
			Del From Lis	st	Cover		
			New		20	mm	Exit

Enabling in this way the modification of any parameter (name, density, width, thickness type etc.) Redefinition regarding the selected surface. Finally, click to apply the modifications.



2.3.2 Raft and mesh areas external boundary definition:

From the command group "Basic" select "Line" to draw the closed contour of the arbitrary cross section. Use snap tools for help.





Description	RAFT			Material Co	ncrete	~	Туре	C20/25	
Eleme	ent		Ks (Mpa/cm)	Isotropic	(Orthot	ropic	Angle	0
Plate O.E.F	Widt	~ (cm)	0.5 Thickness	Exx (GPa)	30		Gxy (GPa)	12.5	
0.20 ~	30		50	Eyy (GPa)	30		ε (kN/m3)	25	
Descript	ions	⊠ Me	sh	Ezz (GPa)	30		atx*10-5	1	
Mesh Group:	I	Fla	t Surface	vxy(0.1-0.	3) 0.2		aty*10-5	1	
1 PLA	IE	1P S 2P S 3P S	1/1/3(2) 1/2/3(2) 1/3/2(2)	vxz(0.1-0.	3) 0.2		atxy*10-5	1	
4 P S 5 P S 6 P S 7 P S		4P S 5P S	1/4/2 1/5/2	vyz(0.1-0.3)			Exx * v	xz = Eyy	*vxy
		6P S	1/6/2(2) AFT	Redefin	tion	Steel R	einforcement		
				Del Fron	List	S220 Cover	~	C	Ж
				Nev	6	20	mm	E	xit

2.3.3 Surface Calculation:



Select the Calculation command. In the dialog box that opens, the mesh list contains the 1PLATE group and its respective surfaces.

1 PLATE				~	Calculation	
Number	Visible	Colour	σ		Change Direction Auto	
1 S1/1/3(2)	Ø	36	Х			
2 S1/2/3(2)	Ø	36	Х		X Y Z LINE	
3 S1/3/2(2)	Ø	36	Х		Start End	
4 S1/4/2	Ø	36	Х		X 0 0	
5 S1/5/2	Ø	36	Х		Y O	i 🗌
6 S1/6/2(2)	Ø	36	Х			
7 RAFT	Ø	36	Х		Z 0 0	
					Select All	
					Visible Non Visible	
					Creating Holes in the Column's location	
					Cancel - Delete	
					Holes Lines	
					Point Properties	
	_				Mach Math Made	

23





To create the mathematical model of the structure, from "Tools" unit select "Calculation" and click OK on the dialog window that opens:









Finally, for views of which the local axis is <u>parallel to the global axes X or Z</u>, select them and click or respectively, to define the main direction of the steel reinforcement (direction X or Z). For surfaces that run along X direction (vertical to Z axis) click X, while for surfaces that run along Z direction (vertical to X axis) click Z.



• For views that are not parallel or perpendicular to the global axes, the main reinforcement direction is automatically defined.

In this example, for views 2,3,4,6,7 the x local axis is parallel to global X







3. LOADS DEFINITION

3.1 Manually imported:



"Member Loads" commands' group contains the commands for insert, edit, view and copy the loads of members, nodes and surfaces finite elements.

For this example, to apply the loads regarding the slab that shelters the structure, to the top nodes of the perimeter, follow the procedure described next:





Click: In sert Loads Load Case Load Proper Load Type	sert Kινητά Φορτία	.1
Description Fx (kN) Fy (kN)	O Value j (kN/m) O -1.4 Dist.j (cm) O	+FZ ,
Fz (kN) Apply To	0 Predefined Global x.y.x V Description	FX i +FY
1 1 2 1 <	F 0.00/-5.15/0.00 F 0.00/-1.40/0.00	Clear by Sele
Click: C	K to apply the defined loads	



Basic Modeling View LIC LIG Sees Groups Load Load Cases Groups Line t Edit Vield Lines t	Image: Signed participation For the second participation Analysis Post-Processor Members Design Drawings-Detailing Addons Image: Signed participation Image:	
Definition Slab Loads	Member Loads Display Loads	×
8		Level XZ
Project Data	LC LG1 LG2 LG3 LG4 LG5 LG6 LG7 LG8 LG9 LG10 LC1 ON LC2 ON	A/A ^ ^ 0 ON 1 ON
Columns Footings Nodes Mathbeams I MathColumns Surf 2D Surf 3D Slabs	Image: Second	

3.2 Load Destribution on the Surface

The new version of SCADA Pro comes with a new tool for the automatic distribution and application of loads on mesh areas.

Load distribution on the surface

Tools

Analytical description on how to use this command can be found in chapter 6 "LOADS" on page 21.



4. ANALYSIS

Proceed?

Yes

4.1 Masonry structure analysis by Eurocode:

As soon as you complete the modeling and load definition processes, move on to analysis. For masonry structures analysis, create an Eurocode analysis scenario, so that SCADA Pro will perform the analysis by the provisions of the Eurocodes.

1	EC8_General Dynamic (2) *	T.
New	Active Scenario	Run
	Scenarios	

Move to "Analysis" unit and from the "Scenarios" command group, click "New" to create an Eurocode scenario for masonry structures analysis.

Click "New" and in the dialog window that opens:

-select Nodes Renumbering according to Cuthill-McKee(II) method

-create a new scenario by selecting the type and the respective annex -> EC-8_ Dynamic

Scenario	×
Renumbering Nodes Cuthill-McKee(II)	Advanced Multi-Threaded Solver
Disable	Name
Seismic E.A.K.(Static) (0) Seismic E.A.K. (Dynamic-eti) (Analysis EC8_General ~
EC8_General Dynamic (2)	Type Dynamic ~
	Properties
	Elements Nodes
	Load Cases Masses
	New Update
	Exit
	Run
select from the list the Ei n the dialog box that ope	urocode scenario and click sectors . Ins, accept the warning regarding the diaphragm absence and c
Attention!	od is Incompatible

No



2	Paramete	ers	Mass Center	s (cm)			\sim	
3	Automatic Pro	cedure	Level	Х	Y	Z	^	
Proce	edure		0 - 0.00	0.00	0.00	0.00		
	Mass - Stiff	ness	1 - 300.00	0.00	300.00	0.00		
	Regularit	ty				_		
	Regular In Plan In Eleve	ation						
	Equivaler	nt			_	_		
	Analysis	S					~	
1	Initialize d	ata		I	Exit			
wo	Parameters	to to	update the p define the a	oaramete nalysis p	ers of the or arameters	current s	cenario	
NO Rara	Parameters	to	update the p define the a	oaramete nalysis p	ers of the o	current s	scenario	
NO NO Seismic	Parameters meters c Area	Characteristic	update the p define the a Periods	paramete nalysis p	ers of the carameters	current s	scenario	
WO C8 Para Seismic	Parameters umeters c Area Seismic Areas	Characteristic Spectrum Typ	update the p define the a Periods De Horizont	aramete nalysis p	Apply seism Down 0 -	ic actions on I	Levels XZ	300.00 ~
XO XO XO XO XO XO XO XO XO XO	Parameters imeters c Area Seismic Areas	Characteristic Spectrum Typ Type 1	Periods S,avg 1.2	al Vertical	Apply seism Down 0 -1 Dynamic Arr	ic actions on I	Levels XZ	300.00 ~
VO Seismic Zone	Parameters imeters c Area Seismic Areas I v a 0.16 *g	Characteristic Spectrum Typ Type 1 Soil	Periods S,avg 1.2 TB(S) 0.15	al vertical	Apply seism Down 0 -1 Dynamic Ar Eigenvalk	ic actions on I 0.00 ~ alysis	Levels XZ Up 1-3	300.00 ~
VO 8 Para Seismic Zone	Parameters	Characteristic Spectrum Type 1 Soil B	Periods S,avg 1.2 TB(S) 0.15 TC(S) 0.5 TD(C) 2.5	al Vertical	Apply seism Down 0 - 1 Dynamic Ar Eigenvall	ic actions on I 0.00 v alysis 0 Accura articipation fa	Levels XZ Up 1-3 acy 0.001 ctors	300.00 ~
XO XO XO XO XO XO XO XO XO XO	Parameters	Characteristic Spectrum Typ Type 1 Soil B	Periods S,avg 1.2 TB(S) 0.15 TC(S) 0.5 TD(S) 2.5	al Vertical 0.9 0.05 0.15 1	Apply seism Down 0 -1 Dynamic Ar Eigenvalu	ic actions on I 0.00 ~ alysis 0 Accura articipation fa 0 PFy	Levels XZ Up 1-3 acy 0.001 ctors Q PF2	300.00 ~ z
VO 8 Para Seismic Zone [Import Zone Spectr Respon	Parameters	Characteristic Spectrum Type 1 Soil B	update the p o define the a Periods De Horizont V S,avg 1.2 TB(S) 0.15 TC(S) 0.5 TD(S) 2.5	al vertical 0.9 0.05 0.15 1 DCM ~	Apply seism Down 0 Dynamic An Eigenval 2 Spectrum P PFx 2 Acc.Eccent	ic actions on I 0.00 v alysis articipation fa 0 PFy ricities	Levels XZ Up 1-3 acy 0.001 ctors Sd (T) Sd (TX)	x00.00 ~
IR Para Seismic Zone [Import Zone Spectr Respoi Z(%	Parameters	Characteristic Spectrum Typ Type 1 Soil B Duct zontal b0 2.5	Periods Periods Periods → S,avg 1.2 TB(S) 0.15 → TC(S) 0.5 TD(S) 2.5 ality Class Vertical	al Vertical 0.9 0.05 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.9	Apply seism Down 0 - 1 Dynamic Ar Eigenval 3 Spectrum P PFx 1 Acc.Eccent e Tix 1	ic actions on I alysis articipation fa PFy ricities 0.05 *Lx	Levels XZ Up 1-3 acy 0.001 ctors 0 Sd (T) Sd (TX) Sd (TY)	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
XVO XVO XVO XVO XVO XVO XVO XVO XVO XVO	Parameters	Characteristic Spectrum Typ Type 1 Soil B Duct zontal b0 2.5	update the p o define the a Periods De Horizont ✓ S,avg 1.2 TB(S) 0.15 TC(S) 0.5 TD(S) 2.5 ality Class ↓ Vertical	paramete nalysis p al Vertical 0.9 0.05 0.15 1 DCM b0 3 0.2	Apply seism Down 0 Dynamic Ar Eigenvak 1 Spectrum P PFx 1 Acc.Eccent e TIX 1	ic actions on I 0.00 alysis 10 Accura articipation fa 0.05 *Lx 0.05 *Lz	Levels XZ Up 1-3 acy 0.001 ctors Sd (T) Sd (TY) [Sd (TZ) [x 00.00 ~
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Zone Spectra Zone (% Respond Struct Cont Struct Cont Struct Cont Struct Cont Struct Cont Struct	Parameters	Characteristic Spectrum Typ Type 1 Soil B Duct zontal b0 2.5 Jpdate Spectrum 3.5 stype a Z	update the p o define the a Periods pe Horizont S,avg 1.2 TB(S) 0.15 TC(S) 0.5 TD(S) 2.5 bilty Class Vertical Sd(T) >= 3.5 qz Moment resisting frame Moment resisting frame	al Vertical 0.9 0.05 0.15 0.15 0.15 0.15 0.2 a*g 0.2 a*g mes type a	Apply seism Down 0 -1 Dynamic Ar Eigenval 2 Spectrum P PFx 0 Acc.Eccent e TIX 0 ETIX 0 Bays X 0 One Z 0 One	ic actions on I 0.00 ~ alysis 0 Accura articipation fa 0 PFy ricities 0.05 *Lz Setbacks x z (Levels XZ Up 1-3 acy 0.001 ctors 0 PFz Sd (TX) Sd (TX) Sd (TX) Sd (TZ) [All the other c	300.00 ~ 2 0 0 1 1 1 1 ases ases
VO VO VO VO VO VO VO VO VO VO	Parameters	Characteristic Spectrum Typ Type 1 Soil B Duct zontal b0 2.5 Jpdate Spectrum 3.5 stype a Z	update the p o define the a Periods De Horizont S,avg 1.2 TB(S) 0.15 TC(S) 2.5 slity Class Vertical Sd(T) >= 3.5 Ay 3.5 qz	al Vertical 0.9 0.05 0.15 1 DCM bo 3 0.2 a*g 0.2 a*g 0.2 a*g	Apply seism Down 0- Dynamic Arr Eigenval 1 Spectrum P PFx 1 PFx 1 Eigenval 1 Spectrum P PFx 1 Eigenval 2 Spectrum P Spectrum P Spec	ic actions on I 0.00 alysis 0 Accura articipation fa 0.05 %Lx 0.05 %Lz Setbacks X Z	Levels XZ Up 1-3 acy 0.001 ctors Sd (T) Sd (TX) Sd (TY) [Sd (TZ) [All the other c	x 00.00 x 0 0 1 1 1 ases ases
IP Para Seismic Zone I Import Zone Spectr Cone Struct Conf Struct Conf Struct Conf Struct Conf Struct Conf Struct Conf Struct Conf Conf Conf Conf Struct Conf Conf Conf Conf Conf Conf Conf Conf	Parameters ameters c Area Seismic Areas I v a 0.16 *g tance II v i 1 rum nse Spectrum Design b) 5 Horiz onse Spectrum Utural Type fined masonry frames inforced masonry seismity masonry.3.2.2 treete Moment Resisting	Characteristic Spectrum Typ Type 1 Soil B Duct zontal b0 2.5 Jpdate Spectrum 3.5 stype a Z 2.(5) Frames	update the p o define the a Periods pe Horizont S,avg 1.2 TB(S) 0.15 TC(S) 0.5 TD(S) 2.5 tilty Class Vertical Sd(T) >= az Moment resisiting frame Moment resisiting frame	al Vertical 0.9 0.05 0.15 0.15 0.15 0.15 0.2 a*g 0.2 a*g mes type a	Apply seism Down 0 -1 Dynamic Ar Eigenval 2 Spectrum P PFx 0 Acc.Eccent e TIX 0 e TIZ 0 Bays X 0 One Z 0 One	ic actions on I 0.00 ~ alysis 0 Accura articipation fa 0 PFy ricities 0.05 *Lx 0.05 *Lz Setbacks X _ z _ ting Frames	Levels XZ Up 1-3 acy 0.001 ctors 0 PFz Sd (TY) [Sd (TY) [Sd (TZ)] All the other c	300.00 ~ 2 0 0 1 1 1 1 ases ases

-Define "Zone", "Importance" and "Soil". -select "Design" spectrum and



-at the type of structure field select "Confined Masonry" -Click OK to update the parameters and close the window.

Three Automatic Procedure to run the analysis.

Let the program to complete the process and click Exit.

	Parameters	Mass Center	rs (cm)			\sim
- 1	Automatic Procedure	Level	х	Y	Z	^
cedur	e	0 - 0.00	0.00	0.00	0.00	
	Mass - Stiffness	1 - 300.00	848.50	300.00	448.92	
	Regularity					
Re	egular					
	In Plan					- 11
	In Elevation					-
Γ	Equivalent					-
	Analysis					~
	Initialize data		ł	Exit		
	EC8_General Dynam	nic (2)	-			
	Active Scena	rio				
he	Active Scena	110	scena	rio activa	ited, sele	ct "C

coefficients of the dynamic analysis according to Eurocode.

Click "Save", to store the combinations file inside the folder of your project to use it later on during the "Post-Processor" and "Member Design" process.



G 1.35	VE		γG	E]			μ2	0.3			timate	(Ω+Σ\000)	S	erviceability	2		Calcula	tic
0 15				-						¥]ΣG+ψ	1Q+Σψ2Q	5	ZG+Q+2φ00 ΣG+ψ1Q+Σι	γ μ2Q		Calcula	iut
Q 1.5	γευ.5							Wind - Sn	now		ΣG+E·	+Σγψ2Q		ZG+Σψ2Q			Delete	. A
	Туре		Direction		LC1		_	LC2	_	LC3		LC4		LC5		LC6		
Scenario					EC-8_0	Gree	-	EC-8_Gree	-	EC-8_Gre	e 💻	EC-8_Gree.		EC-8_Gree	-	EC-8_G	ree 🗵	
Load Case					1		_	2	_	3		4		5	_	6		
Load Type					G		-	Q	-	ExD	<u> </u>	EzD	-	Erx	-	Erz	-	1
Actions							-	Category A	-		<u> </u>		-		-		-	1
Description																		
Comb.:1	Ultimate	-	No	•	1.35			1.50										
Comb.:2	Ultimate	-	No	-	1.00			0.50										
Comb.:3	Ultimate	-	Dir. +X	-	1.00			0.30		1.00		0.30		1.00		0.30		+
Comb.:4	Ultimate	-	Dir. +X	-	1.00			0.30		1.00		0.30		1.00		0.30		+
Comb.:5	Ultimate	-	Dir. +X	-	1.00			0.30		1.00		0.30		1.00		-0.30		
Comb.:6	Ultimate	-	Dir. +X	-	1.00			0.30		1.00		0.30		1.00		-0.30		
Comb.:7	Ultimate	-	Dir. +X	-	1.00			0.30		1.00		0.30		-1.00		0.30		
Comb.:8	Ultimate	-	Dir. +X	-	1.00			0.30		1.00		0.30		-1.00		0.30		
Comb.:9	Ultimate	•	Dir. +X	-	1.00			0.30		1.00		0.30		-1.00		-0.30		
a 1.40	Ultimate	-	Dir. +X	-	1.00			0.30		1.00		0.30		-1.00		-0.30		1
Comb.:10	Ultimate																	-
Comb.:10 Comb.:11	Ultimate	•	Dir. +X	-	1.00			0.30		1.00		-0.30		1.00		-0.30		
Comb.:10 Comb.:11 Comb.:12	Ultimate Ultimate	•	Dir. +X Dir. +X	• •	1.00 1.00			0.30 0.30		1.00 1.00		-0.30 -0.30		1.00 1.00		-0.30 -0.30		
Comb.:10 Comb.:11 Comb.:12	Ultimate Ultimate	•	Dir. +X Dir. +X	* *	1.00 1.00			0.30 0.30		1.00		-0.30 -0.30		1.00		-0.30 -0.30		
Comb.:10 Comb.:11 Comb.:12 < Add	Ultimate Ultimate Remove		Dir. +X Dir. +X	▼ ▼ Read	1.00	Save	e	0.30 0.30 TXT		1.00 1.00 Defa	ult Com	-0.30 -0.30 binations		1.00	(-0.30 -0.30 DK	Ca	ar
Comb.:10 Comb.:11 Comb.:12 < Add	Ultimate Ultimate Remove		Dir. +X Dir. +X	▼ ▼ Read	1.00	Save	e	0.30 0.30 TXT		1.00 1.00 Defa	ult Com	-0.30 -0.30 binations		1.00	(-0.30 -0.30 DK	Ca	ar
Comb.:10 Comb.:11 Comb.:12 < Add	Ultimate Ultimate Remove		Dir. +X Dir. +X	Read	1.00	Save	e	0.30 0.30 TXT		1.00 1.00 Defa	ult Com	-0.30 -0.30 binations		1.00		-0.30 -0.30 ОК	Ca	arr
Comb.:10 Comb.:11 Comb.:12	Ultimate Ultimate Remove	V V	Dir. +X Dir. +X	▼ ▼ Read	1.00	Save	e	0.30 0.30 TXT [caar	1.00 1.00 Defa	ult Com	-0.30 -0.30 binations		1.00	(-0.30 -0.30	Ca	ar
Comb.:10 Comb.:11 Comb.:12 < Add Save As → → ↑ ↑	Ultimate Ultimate Remove	V V Disk (C:	Dir. +X Dir. +X	Read	1.00	Save	e ~	0.30 0.30 TXT Č Search s	caar	1.00 1.00 Defa	ult Com	-0.30 -0.30 binations		1.00	(-0.30 -0.30	Ca	an
Comb.:10 Comb.:11 Comb.:12 Add Save As ← → ∨ ↑ Organize ▼	Vitimate Ultimate Ultimate Remove	Disk (C:	Dir. +X Dir. +X	Read	1.00	Save	e ~	0.30 0.30 TXT	caar	1.00 1.00 Defa	ult Com	-0.30 -0.30 binations ×		1.00	(-0.30 -0.30	Ca	arı
Comb.:10 Comb.:11 Comb.:12 Add Save As Save As Corganize \checkmark Organize \checkmark	Remove	Disk (C:	Dir. +X Dir. +X	Read	1.00	Save	e ~	0.30 0.30 TXT	caar	1.00 1.00 Defa	ult Com	-0.30 -0.30 binations ×		1.00	(-0.30 -0.30	Ca	an
Comb.:10 Comb.:11 Comb.:12	Remove	Disk (C:	Dir. +X Dir. +X	Read	1.00	Save	e	0.30 0.30 TXT [7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	caar d 00 PN	1.00 1.00 Defa hal Type VI File for VI File for	ult Com	-0.30 -0.30 ibinations		1.00 1.00	(-0.30 -0.30	Ca	an
Comb.:10 Comb.:11 Comb.:12 < Add Save As ← → ~ ↑ Organize ▼ This PC ⇒ A360 Drive ■ Desktop Desktop	Remove	Disk (C: Scer Certification Scer	Dir. +X Dir. +X	Read	1.00	Save	e V	0.30 0.30 TXT © Search so Date modifie 2/23/2016 4:0 2/23/2016 4:0	caar d 00 PN 60 PN	1.00 1.00 Defa Type M File fc M File fc M CMB	older File	-0.30 -0.30 ibinations		1.00 1.00	(-0.30 -0.30	Ca	317
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5. RESULTS 5.1 Deformed shape of Model: Move to "Results" unit and check the deformation of the model. Combinations Select and calculate (click Calculation) the combinations that you previously saved (Select the File). Load Combinations × Load Combinations × C:\a5\scaanal\EC-8_Greek Load Load 7 Load Load 101 EC-8_Greek Dynamic (2).cmb \sim \sim default.cmb Combinations Select _Greek Dynamic (2).cmb Calculation Calculation End Calc Cancel OK OK Cancel Diagrams-Stress Contours Model **Diagrams-Stress Contours** Select from the list and in the dialog window, select to view "Plate Elements" -> "DY Deformations" caused by "Load Case 1" for all model (Select All): Select Magnitude × Plate Element ~ Deformations ✓ 3D Member ∨ 1: 10 ?? ✓ DY ✓ Load Case ✓ 1 Pick Select All Clear All At the bottom bar activate: VALUES LIMITS COL. LOGNITUDINAL PHYSICAL BAR Color representation and Values bar, to view the next image:









6. DESIGN

6.1 Design Scenario Creation in accordance to Eurocode provisions:

For masonry structures, SCADA Pro embeds the checks of the Eurocode 6. Thus it is necessary to create a Eurocode design scenario to perform the respective checks with the "Masonry Design" command.

Scenario							×	
1				Name Type	1 EC6-E	C8(3)	~	Move to "Design" unit and click
				New		Upd	late	New to create the desired
				Design De	lete ete	Conn	ections	name and click "New".
	Exi	t		Steel		Apply		
						EC6-EC8(i	3) 1 (0) Scenario	• Para-
Select	the	consi	dered	scenario	0			and and click meters.
	Insert	Combin	ations		that o	pens the	e folder v	vith the registered .cmb files. Select
the file combinati	and ons a	press nd by (clickin	Combir g OK the w	indow	Calculation	n	. The program calculates the
Structural Compo	nent Para	meters				×		
Steel Reinfor Combination	cement s	Capac Slabs	city Design Beam	Steel s Column	Timber s	structures Footings		
Combinations of	Load Sets	(101)	Ult. S	erv. +XX	+Z	-Z No		
Combinations 1(5) +1.35Lc1 2(1) +1.00Lc1 3(2) +1.00Lc1 4(2) +1.00Lc1 5(2) +1.00Lc1 7(2) +1.00Lc1 8(2) +1.00Lc1 9(2) +1.00Lc1 10(2) +1.00Lc2 <	+1.50Lc2 +0.50Lc2 +0.30Lc2+1 +0.30Lc2+1 +0.30Lc2+1 +0.30Lc2+1 +0.30Lc2+1 +0.30Lc2+1 1+0.30Lc2+	1.00Lc3+0.30 1.00Lc3+0.30 1.00Lc3+0.30 1.00Lc3+0.30 1.00Lc3+0.30 1.00Lc3+0.30 1.00Lc3+0.30 +1.00Lc3+0.3	Lc4+1.00Lc5 Lc4+1.00Lc5 Lc4+1.00Lc5 Lc4+1.00Lc5 Lc4-1.00Lc5 Lc4-1.00Lc5 Lc4-1.00Lc5 0Lc4-1.00Lc5	5+0.30Lc6+0.30Lc7 5+0.30Lc6-0.30Lc7 5-0.30Lc6+0.30Lc7 5+0.30Lc6+0.30Lc7 5+0.30Lc6+0.30Lc7 5+0.30Lc6+0.30Lc7 5-0.30Lc6+0.30Lc7 5-0.30Lc6-0.30Lc7	ULS/SLS ULS ULS ULS ULS ULS ULS ULS ULS ULS	Dir.		
Level Multipliers		17	· (1-θ)	EC-8_Greek Dynan	nic (2).cmb	~		
Level	Х	γ	Z	default.cmb EC-8_Greek Dynan	nic (2).cmb			
0 - 0.00	1.000	1.000	1.000	Combinatio	ons Calculati	on		
1 - 300.00	1.000	1.000	1.000	Combination C	nd Calc G+ψ2Q [1 utomatic Des	l01		
					OK	Cancel		



6.2 Masonry structure checks according to Eurocode 6:



2.

4.

Masonry design according to Eurocode 6 includes seven checks:



Wall subjected to in-plane bending



Wall subjected to out-of-plane bending across an axis parallel to the bed joints



Wall subjected to out-of-plane bending across an axis perpendicular to 3. the bed joints

- Wall subjected to shear loading
- 5. Wall subjected to mainly vertical loading, top
- Wall subjected to mainly vertical loading, middle 6.
- 7. Wall subjected to mainly vertical loading, bottom
- These seven adequacy checks are defined for each wall or each wall section (spandrel), according to the user defined division.

A Buildings that meet the requirements to be identified as "Simple" are excluded from all the above adequacy checks.

In the dialog box that opens, the user must identify the parts of the walls to make the required checks:



Maria I. S. Maria I.	111-00		~	1
Masonry design: New masonry b	fullaing (ECO)		Berformanco	
		~	Objective	
Description			A - DL 🛛 🗠	
l(cm) 0 Pick				
h(cm) 0 Pick				
Support: 4 Sides \sim				
New Update				
Delete le Masonry Buil				
Check Total Check	Results	Total Results	Exit	
Description 1_1 In "Description under the second se	ription" field, ty Use these fie	ype a name (at least fou	ur characters) f netry of the co	for the considered
I(cm) 0 Pick h(cm) 0 Pick	spandrel): Click the first at the end po	"Pick" to define the looints.	ength of the w	all by left clicking
	Pres start defin chor poin In th the f	s the button " Pick " ting and ending po- nition). After the star ed emerges from it, w t (second click). e same manner, press first one), to define the part (i.e. height definit	(the first one) ints of the ting point is o aiting to link i the second bur e y starting and ion).) to define the x part (i.e. length clicked, an elastic t with the ending tton "Pick" (under d ending points of
l(cm) 1000 Pick h(cm) 300 Pick	The values ar	e automatically assign	ed to the field	s "l" and "h".







Au	tom	atic Data	a Calcula	tion			SIM	PLE			Ex
					Crit	teria					
						The Perpend - Joints fully - Ungrouted - Ungrouted masonry unit	l Joint grout joints joints ts.	s are: ed with m with med	nortar. Hanical interlo	cking between	I
						Previous			1/37	Ne	xt
Building Data	_								1		
Level		Lx(m)	Lz(m)	Recess	es Area (m2)	Mass(KN/g) n	ΣL(m)	Awtot(m2)	ΣL>2m(m)	F
0 - 0.00	х	0.00	0.00			0.000					
	z										
1 - 300.00	x										
	z										
Walls Data											
Leve	ł	L(m)	h(m)	t(m)	hανοιγμ.(m)	hef(m)	fb(N	/mm2)	fm(N/mm2)	
1_1 0		9.00	3.00	0.50	2.00	2.70	9.20		5.00	NOT SIM	PL

The field "Criteria" presents one by one, the 37 requirements according to EC8, in order a building to be defined as "Simple". The user should see a tick next to any of the requirements that is satisfied, and move on to the next one.

All the requirements must be satisfied or the building cannot be characterized as "Simple". As said previously, only in case of a "Simple building", the design checks of EC6 are optional.

NOT SIN	1PLE	Exit
Criteria		
The area of project is not greater than above the level con	ions of recesses from t a percentage pmax of sidered.	he rectangular shape the total floor area
Previous	7 / 37	Next



The 37 criteria of the previous stage are the initial step of the "simple building" characterization procedure. It must also conform to the demands in Table 9.3 of EC8, in order the characterization to be finalized. These demands concern both the building in total and each wall consecutively, and the design check process starts with the command "Automatic Data Calculation" Automatic Data Calculation

(per Level/Wall).

Δ Again, a failed check means that the building cannot be characterized as "Simple"

Building Data											
Level		Lx(m)	Lz(m)	Recesses Area (m2)	Mass(KN/g)	n	ΣL(m)	Awtot(m2)	ΣL>2m(m)	к	
0 - 0.00	x	0.00	0.00		0.000	5	10.72	5.36	4.72		
	z					7	10.02	5.01	3.00		
1 - 300.00	x					0	0	0	0		
	z					0	0	0	0		

Walls Data

	Level	L(m)	h(m)	t(m)	hανοιγμ.(m)	hef(m)	fb(N/mm2)	fm(N/mm2)	
1_1	0	9.00	3.00	0.50	2.00	2.70	9.20	5.00	NOT SIMPLE
1_2	0	9.00	3.00	0.50	2.20	2.70	9.20	5.00	NOT SIMPLE
1_3	0	6.02	3.00	0.50	1.00	2.40	9.20	5.00	NOT SIMPLE
1_4	0	4.72	3.00	0.50	0.00	2.14	9.20	5.00	NOT SIMPLE

In case of "NOT SIMPLE" structures, the adequacy checks by EC6 provisions must be performed.

Check Automatic application of the seven design checks for a selected part of the wall.



Masonry design: Nev	v masonry b	uilding (EC6)					Х
1_1					\sim	Performan	nce /e
Description 1_1						A - DL	\sim
l(cm) 900 F	Pick Che	eck Ratio	Strengt	th Load	σδ/Φ	1	^
h(cm) 300 F	Pick Che	eck 1 0.81(30) 61.92	50.25	9.95	5.00	
Support: 4 Sides	Che	eck 2 10.31	(37) 10.00	103.10	13.33	3.00	
	Che	eck 3 2.23(54) 11.11	-24.82	0.00	1.00	- 1
New Upda	ate Che	eck 4 3.53(1) 25.34	-89.39	57.48	1.50	×
Delete le Masor	nry Buil <					>	
Check Tota	al Check	Results	Т	otal Results		Exit	

Total Check Automatic application of the seven checks in the structure in total.

Masonry des	ign: New maso	nry buildi	ng (EC6)				Х
1_1						✓ Pe	rformance
Description	1_1						A - DL 🗸
l(cm) 900) Pick	Wall	Check 1	Check 2	Check 3	Check 4	Chec ^
h(cm) 300) Pick	1_1	0.81(30)	10.31(37)	2.23(64)	3.53(1)	1028
Support: 4 S	ides 🗸	1_2	0.86(62)	214.17	2.31(64)	2.54(1)	1947
		1_3	0.53(39)	5.90(32)	1.18(30)	0.99(37)	6873
New	Update	1_4	0.25(32)	2.78(39)	0.96(1)	0.31(64)	0.19 🗡
Delete	le Masonry Buil	<					>
Check	Total Check		Results	Total	Results		Exit

The design checks are applied on sections (horizontal and vertical) concerning the EC6 design code.

▲ SCADA Pro scans each selected wall, at first horizontally and then vertically, the wall sections (strips of finite elements) are detected, and all the checks are applied in each section.

▲ During the scan, each strip of finite elements is colored according to the results of the design checks; blue-green (all design checks of the section are satisfied) or red (one or more design checks of the sections are not satisfied.

Since the design checks' procedure has been completed, the user can elaborate on the results.



The comm selected wa	and "Results" all or part of w	Result	bs pres	ents the i	results of	all the c	lesign che	cks for the
1_1						~ P	erformance Objective	
Description	1_1						A - DL V	
l(cm) 900	Pick	Check	Ratio	Strength	Load	σδ/Φ 130.54	4.72	
Support: 4 S	ides 🗸	Check 2	2.78(39)	15.72	43.73	13.33	4.72	
Support 10		Check 3	0.96(1)	33.33	32.16	0.00	3.00	
New	Update	Check 4	0.31(64)	219.00	-68.86	471.70	4.72 🗸	
Delete	le Masonry Buil	<					>	
Check	Total Check		Results	Tota	Results		Exit	
building						~ Pe	erformance	
Description	1 1							
l(cm) 900) Pick	Wall	Check 1	Check 2	Check 3	Check 4	Cher ^	
h(cm) 300	D Pick	1_1	0.81(30)	10.31(37)	2.23(64)	3.53(1)	1028	
Support: 4 S	ides 🗸	1_2	0.86(62)	214.17	2.31(64)	2.54(1)	1947	
		1_3	0.53(39)	5.90(32)	1.18(30)	0.99(37)	687:	
New	Update	1_4	0.25(32)	2.78(39)	0.96(1)	0.31(64)	0.19 🗡	
Delete	le Masonry Buil	<					>	
Check	Total Check		Results	Tota	Results		Exit	
For better a	and more deta	ailed appe	arance of	these resu	lts view th	ne "Printo	ut"	

app



7. PRINTING

Through the "Addons" unit select the "Print" command and in the dialog box select Masonry, to expand the wall list.

Availiable Chapters	Printout	Number of Pages						
• General	Wall:1_1		Bu	ilding Data				
Analysis	Wall:1_2			Move Up				
Reinforcement	Wall:1_3 Wall:1_4		M	ove Down				
⊡ Steel ⊡ Timber				Delete				
Masonry				elete All				
			T	osert File				
			Erro	Correction				
Masonry Assessment			Eno	Correction				
Bill of Materials			- Fa	mat Dage				
			FO					
			Pagi	ing U				
			Evo	ort Printout				
			Exp	ortPrintout				
				Print				
			Pro	ject Report				
				Save				
				Cancel				
uble click in each Project Report to e	wall, to tran xport the Proje	nsfer the r ct Report.	espective	data to	the re	eport	and	cl
uble click in each Project Report to e	wall, to tran	nsfer the r ct Report.	espective	data to	the re	eport	and	cl
Uble click in each Project Report to e Save - M R C C C	wall, to tran	Isfer the r ct Report.	espective	data to		eport	and	cli
uble click in each Project Report to e Save ~ W A C O C O C O C O C O C O C O C O C O C	wall, to tran xport the Proje	Insfer the r ct Report.	espective	data to	Page 72 000 cm 000 cm 13 cm	eport	and	cli
uble click in each Project Report to e Save • • • • • • • • • • • • • • • • • • •	wall, to tran xport the Proje	Isfer the r ct Report.	espective gene bending sorse an axis err Rection property: Comman Rection property: Rection property:	data to mrd5ular 16 Pre Sed point	Page : 2 200 00 cm 300 00 cm 300 cm 300 cm 300 cm	eport	and	cli
uble click in each Project Report to e Save • • • • • • • • • • • • • • • • • • •	wall, to tran xport the Project I of 12 P I From (1) 4 20(m) M8 500m 20 20 20 20 20 20 20 20 20 20	Asfer the r ct Report.	espective	data to mediouar to the land points m min - 1,000 3 + 1 + 1 min	Page : 2 Page : 2 ROT OF COM NOT OF COM 135 cm Ref Page : 2 NOT OF COM 135 cm Ref Page : 2	eport	and	cli
Able click in each Project Report to e	wall, to tran xport the Projec 1 of 12 P Prop.1 4 0 00(0) 4 00(0) 4 00(0) 4 00(0) 4 00(0) 5 00 5 0	Asfer the r ct Report.	espective	data to mediuler to be bed joint:	Page : 2 000 00 cm 1.35 cm R0 1.35 cm	eport	and	cli
uble click in each Project Report to e Save • • • • • • • • • • • • • • • • • • •	wall, to tran xport the Projec 1 of 12 Prop 11 Prop 11 Prop 11 Prop 12 Prop 11 Prop 12 Prop 11 Prop 12 Prop 11 Prop 11	Asfer the r ct Report.	espective earne banding soroct an axis part secton properties earne banding soroct an axis part secton properties earne banding soroct an axis part earne banding soroct an axis part earne banding soroct an axis part secton properties banding (EOS 88.2) secton properties secton properties earned ord o	data to andGuter to be bed joint:	Page : 2 Page : 2 000 00 cm 1.35 cm 100 r cc	eport	and	cli
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