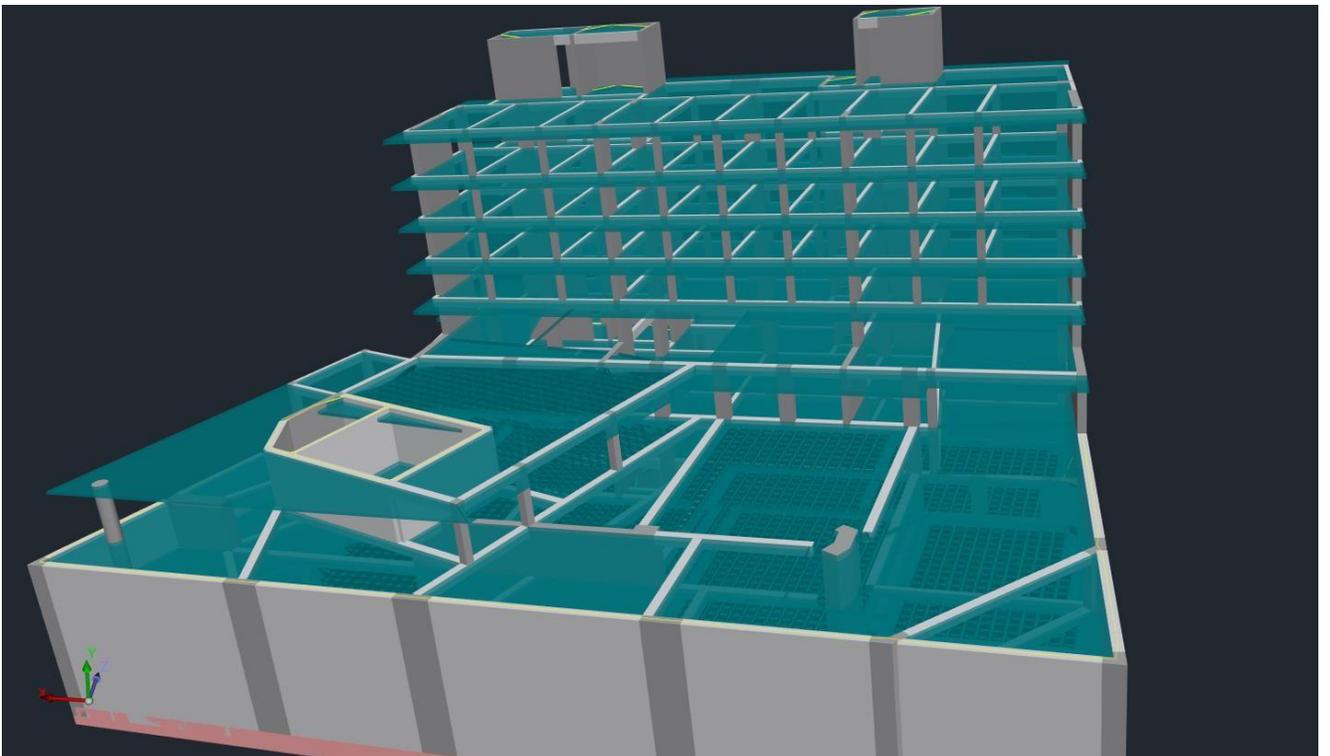




**SCADA Pro 25<sup>tm</sup>**  
Structural Analysis & Design

# User Manual

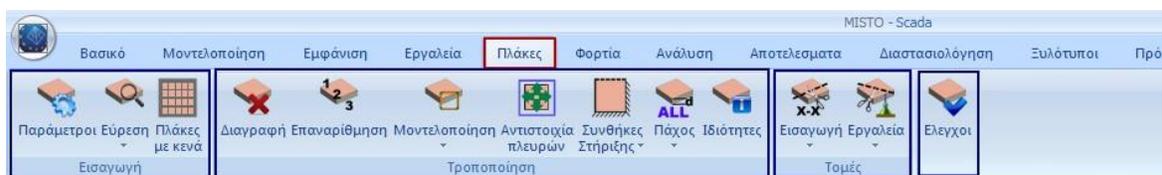
## 6. SLABS



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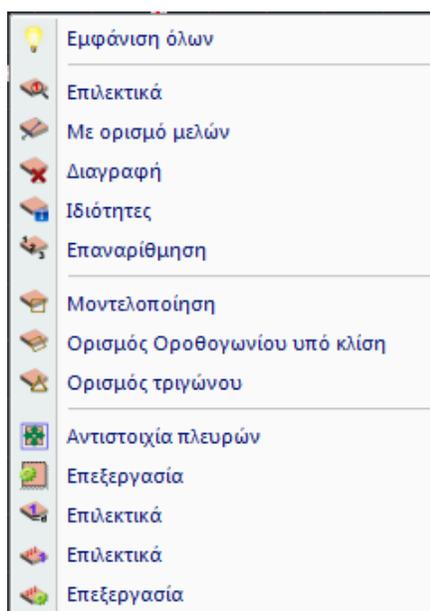
# Chapter 6: Slabs



The 6th Module is called "SLABS" and includes the following 4 groups of commands:

- ✓ Introduction
- ✓ Amendment
- ✓ Sections
- ✓ Checks

When the "FACTS" section is selected, a right click on the desktop opens all corresponding commands in list format. The user can execute the commands, either by selecting them from the Module or from within the list.



## Introduction



The "Insert" command group contains the commands that allow the user to insert the plates into the study.

### IMPORTANT OBSERVATION:

A prerequisite for the introduction of plates is the existence of the mathematical model of the study. For the application of the commands of the "Plates" field, the two-dimensional representation of the vector is recommended. The commands shall be applied on a level-by-level basis.

## 1.1 Parameters

Enter in mm the minimum slab thickness and coating.

If you are importing Zoellner type plates, please enter their respective geometric characteristics.



**Παράμετροι Πλακών** ✕

Ελάχιστο Πάχος (mm)

Zoellner-Sandwich - Μικτή

Πάχος Ανω Πλάκας (mm)

Πάχος Κάτω Πλάκας (mm)

Πλάτος Δοκού (mm)

Κενό (mm)

Επικάλυψη Οπλισμού (mm)

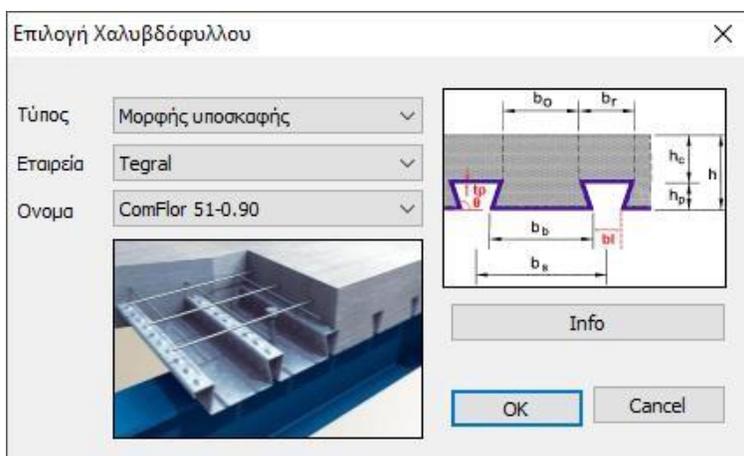
Σύμμικτες πλάκες

Αυτόματος χαρακτηρισμός πλακών ως σύμμικτες

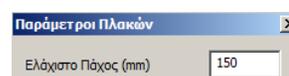
Φάση κατασκευής ▼

Χαλυβδόφυλλο

 The lower part of the window concerns the Sandstone slabs and here we define both their characterization and the Chaloboam slabs. A detailed description of the Sandwich Slabs can be found in the corresponding manual (see User Manual D. Design of Sandwich Slabs).

**IMPORTANT OBSERVATIONS:**

In the initial recognition of the slab, the program takes into account the value for the Minimum slab thickness given in the "Parameters", calculates the required one (based on **E.K.O.S.**) and by comparing the two values, keeps the maximum one.



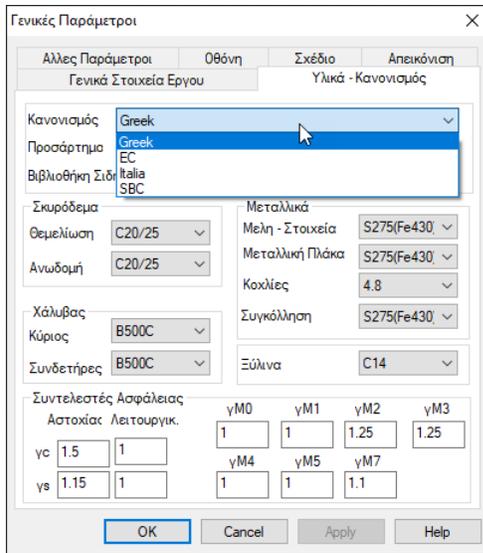
In case the design is based on **EURODATA**, then the **Final Thickness** of the slab will be obtained after the **Deformation Check**, but it cannot be proposed in the initial identification of the slab because its calculation requires its reinforcements.

**1.2 Retrieved from**

In SCADA Pro the import of the plates is done in 2 ways. Either automatically, (in total on the whole active floor or selectively), or by user-defined membership.

**OBSERVATION:**

The selection of the country in the General Parameters when starting a new study determines the choice of the type of slab to be inserted during the "Find"



For Greece, the most common type of slab is the solid type. The program automatically inserts solid slabs, giving the user the possibility to modify them at will.

### 1.2.1 Overall

Automatic insertion of solid slabs, in all closed contours of the active floor.

### 1.2.2 Selectively

Selective insertion of solid plates, by left-clicking inside closed contours.

After inserting a slab, its symbol appears with relevant information: its number and its thickness in cm (the largest value between the minimum value you set and the one obtained by checking the bending arrow),



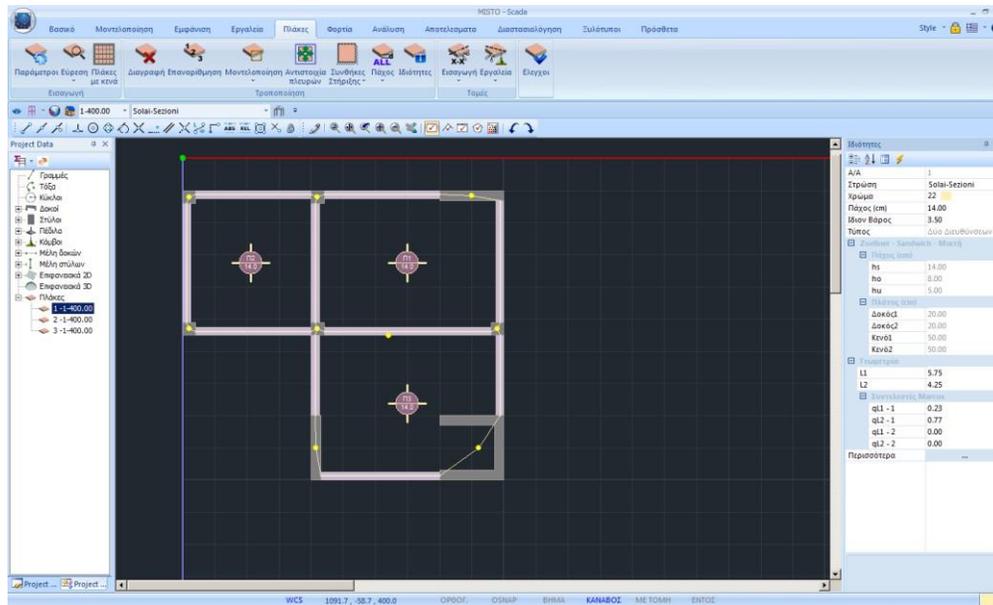
in a little circle. Around the circle, lines are shown representing the support conditions of the plate:

- Thick line: continuity of plates, hence footing.
- Thin line: discontinuity of plates, hence joint.
- Without line: free edge (in case of balconies).

#### OBSERVATION:



The ? inside the plate symbol indicates that the plate has not been rendered correctly and needs "Modeling".



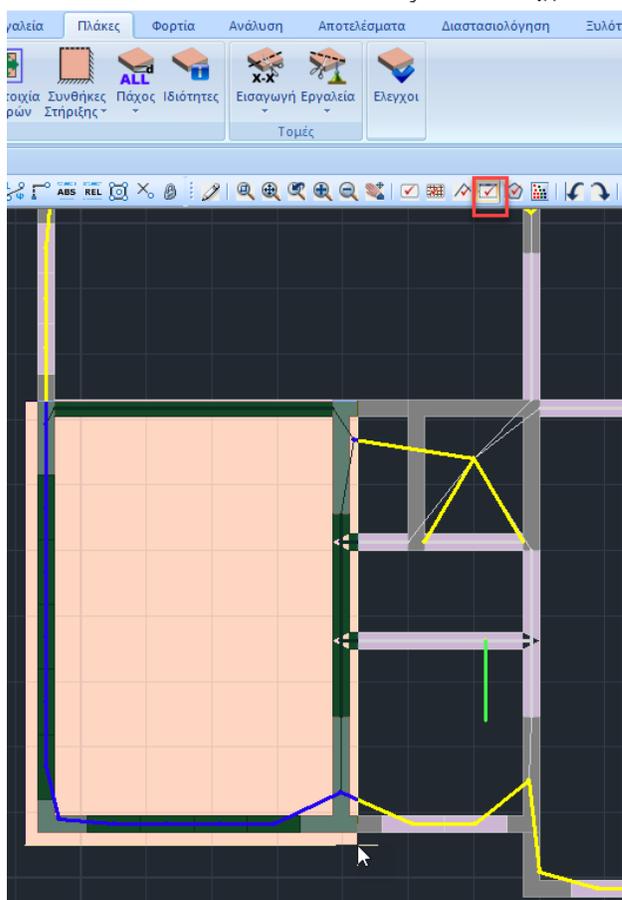
### 1.2.3 By appointment of members

Manual insertion of solid plates. Select successively, one by one, the elements that enclose the plate (beams (the inner periphery), linear members, lines) in clockwise direction. Right click to finish.

Manual input is required in cases where the contours of the slabs consist of several members, and the program has difficulty in recognizing them (e.g. basement ceiling slabs with perimeter walls).

### 1.2.4 With window

A new command of SCADA Pro for the manual insertion of solid plates but with greater ease than "Define members" since it is enough to select the command and with a windowed selection to describe the surface of the plate, without selecting the elements one by one.

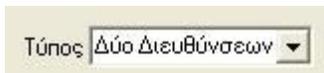
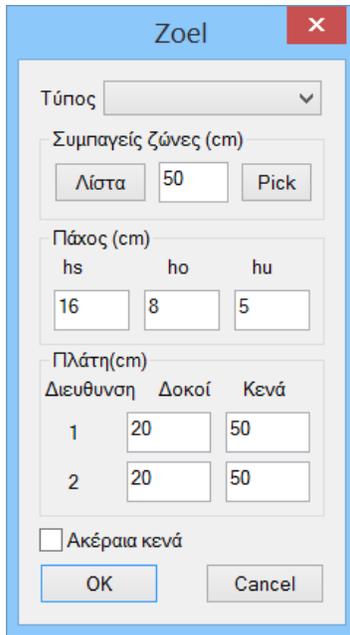


### 1.3 Plates with gaps



Command to modify a solid slab to a slab with gaps (Zoellner or Sandwich).

Select the command and the plate, by pressing with the mouse a point inside it the following dialog box appears:



In the "Type" field you select whether the blank slab will be one or two Addresses (one or two-way or four-way).



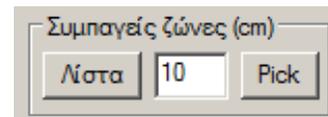
Then you define the widths of the solid belts. Enter the width in the corresponding field and press the **Pick** button.

Select the side (beam side) on which the solid zone boundary will be placed parallel to the previously defined width. Show one beam per direction (and not all if there is more than one). Draw the line (boundary of the compact zone) and finally select with the mouse the half-plane of its definition.

The procedure is repeated for the remaining solid zones.

**OBSERVATIONS:**

- ⚠ Show one beam per direction (not all if there is more than one).
- ⚠ Solid bands shall be given continuously and circularly, clockwise or anticlockwise.
- ⚠ If you press the right mouse button (cancel) between the definitions of 2 adjacent zones, the dialog box for defining the plate with spaces appears again, so you set a different width for the next zone you enter.



After defining the last compact zone, press the right mouse button and return to the window where you can enter the rest of the plate's data such as its thickness, the dimensions of the diagonals and the gaps.

The next section is about determining the thickness of the slab.

- In the hs field enter the total thickness we want the slab to have in centimeters (cm).
- In the ho field enter the thickness of the upper solid part of the slab in centimetres (cm).
- In the hu field enter the thickness of the lower solid part of the plate in centimetres (if it is a Sandwich plate). If the plate is not a Sandwich plate this value is 0.

Πάχος (cm)		
hs	ho	hu
22.2	80	50

The next section deals with the widths of the diagonals and the gaps between them.

Enter for each direction the width of the beam and the gap respectively.

- Address 1 is the address that is parallel to the side of the slab you indicate, when the program then asks you for the address where the blanks will be placed parallel. On single-address Zoellner plates, address 1 is the main address of the plate.
- Address 2 is respectively the other address.

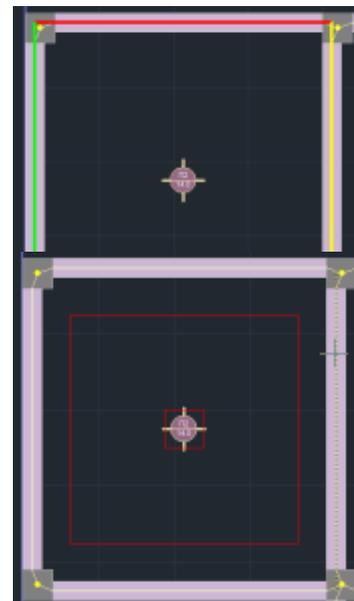
Πλάτη (cm)		
Διευθυνση	Δοκοί	Κενό
1	20	50
2	20	50

If you check the "Integer Gaps" option will be drawn.

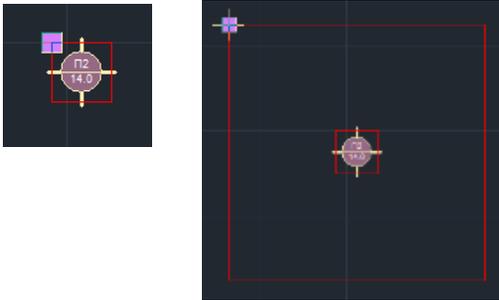
integer blanks

By pressing the "OK" button, the mathematical model of the selected plate appears on the screen and the program asks you to select the 1st direction (the side of the plate where the beam of the 1st direction will be parallel).

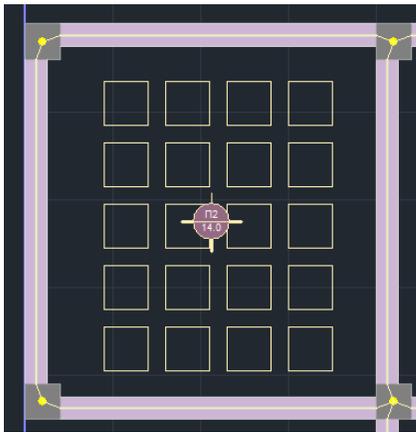
Select a side from the plate model and the blank with the dimensions you have defined in the Geometric Elements is automatically placed in the centre of the plate.



Then select a vertex of the blank and set from which vertex of the frame defined by the solid bands to start placing the blanks.

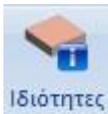


Selecting this point completes the process of inserting a plate with blanks and the plate is displayed on the screen as shown in the image below:

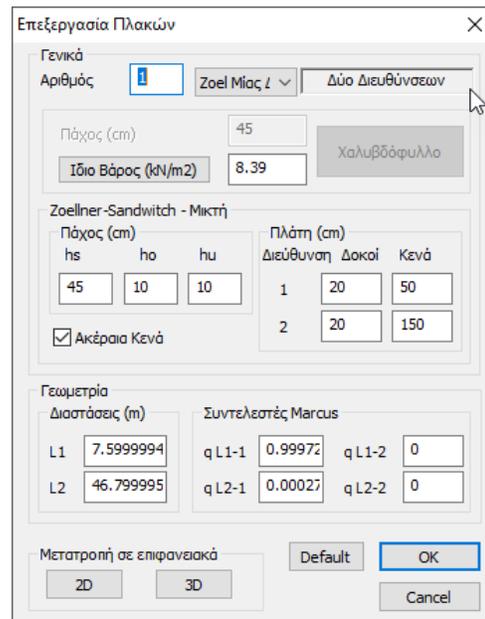


**NOTE:**

After converting a Solid slab to a Slab with Blanks,



in the command dialog box press the **Ιδίο Βάρος (kN/m2)** button to calculate the new weight of the slab with blanks. (The initial value is for the Solid slab)



## Amendment



After inserting the plates, through the "Modify" commands, you :

- Delete
- Renumber
- Model
- Match the sides of the model
- Work out the support conditions, the thickness
- See the properties

### 2.1 Delete



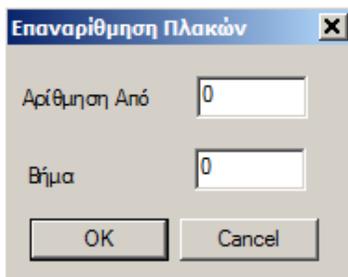
To delete one or more plates, select the command and one of the  options to show the plates to be deleted. Right-click to finish.

### 2.2 Renumbering



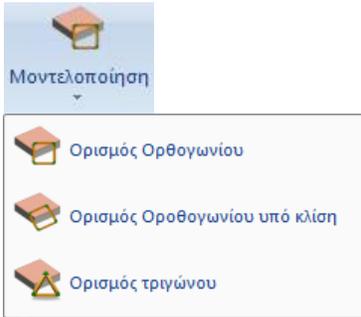
Select the command to change the numbering of the plates that were placed and numbered automatically by the program.

In the context of dialogue:



enter the first number and the numbering step. Left-click to show the plates to be renumbered in sequence.

## 2.3 Modelling



In order to be able to solve randomly shaped plates, they must first be "modelled" with an equivalent rectangular, oblique rectangular or triangular plate. That is, a plate with one of the above shapes must be defined that approximates the real one (geometry definition).

### OBSERVATION:

The need for "Modelling" is evident through the ? plate symbol, indicating that the plate has not been correctly attributed.



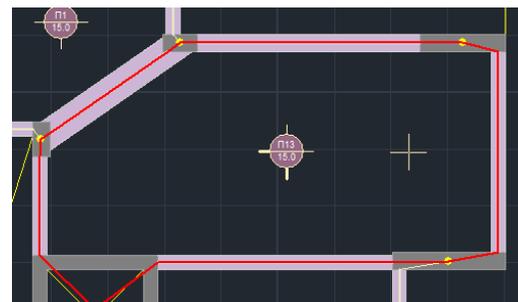
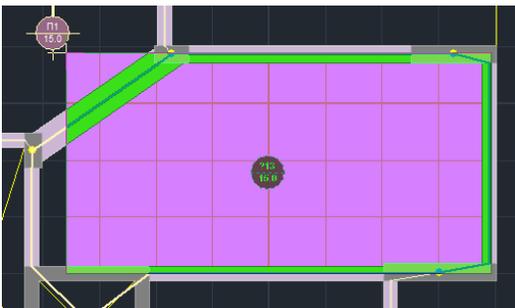
### 2.3.1 Definition of Rectangle



Use this command to model slabs with an equivalent rectangular slab. The sides of this slab are parallel to the x and z (horizontal rectangle) universal axes. Select the command and left-click inside the surface of the plate, the one to be modelled.

To define the equivalent rectangle:

- Left click, on the first top.
- Move the mouse diagonally to the second vertex of the diagonal and
- Left click to form the rectangle and create the equivalent plate.



### 2.3.2 Definition of Rectangle on a slope



Use this command to model slabs with an equivalent rectangular slab on a slope. This slab is a rectangular slab with sides at an angle with respect to the x and z axes (rectangular slope).

Select the command and left-click inside the surface of the plate, the one to be modelled.

To define the equivalent rectangle under slope:

- Choose one side of the slab you are modelling with which the equivalent parallelogram will be parallel.
- Left click, on the first top.
- Move the mouse diagonally to the second vertex of the diagonal and
- Left click to form the rectangle with a slope and create the equivalent plate.

### 2.3.3 Triangle definition



Use this command to model triangular plates. The equivalent plate you create is a triangular plate. You select the slab of the level to be modeled, and then you define the 3 vertices of the equivalent triangle.

To define the equivalent triangle:

- Select the plate to be modeled by pressing with the mouse any point inside its surface.
- Left click on the three sides of the equivalent triangle

#### **OBSERVATION:**

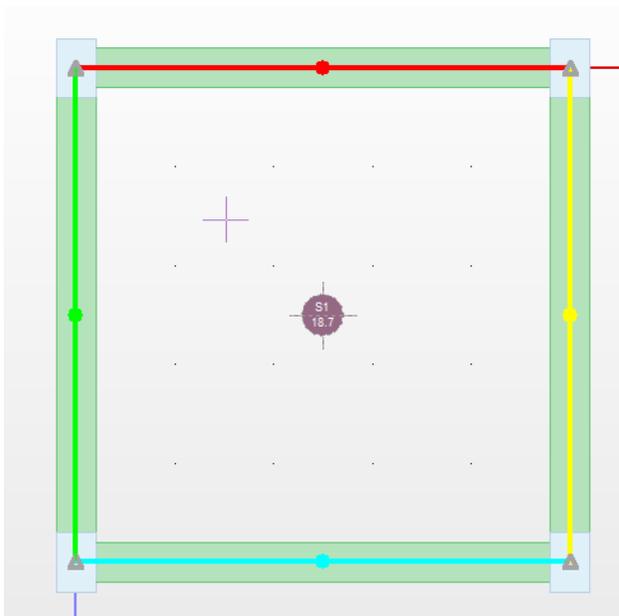
Triangular slabs must always be modelled and their sides must be assigned even if they do not show "?" in their designation.

## 2.4 Correspondence of ribs

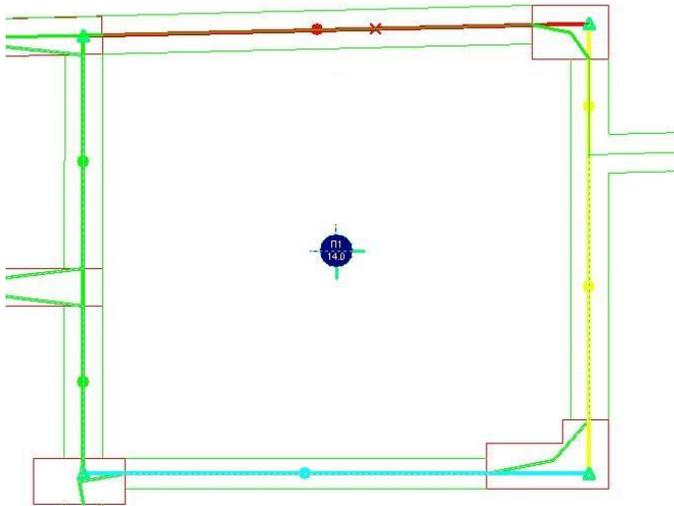
After modelling the shape of the non-rectangular plates, the correspondences of the sides and vertices of the equivalent plate with those of the real plate must be defined. This process is used to assign the members of the physical model of the plates to the sides of the mathematician to be solved and to match the lengths of the sides of the physical and mathematician.



Select the command and the working plate by pressing with the mouse a point inside its surface and the equivalent rectangle or triangle (mathematical model of the plate) is displayed:



- Select one side of the mathematical model of the plate, so an X appears on it.
- Then select the physical members that you want to assign to this group. side of the mathematical model of the plate. These physical members are indicated by a dot in the middle which, by matching, becomes the same colour as the side of the mathematician.
- Right-click to complete the mapping on one side and continue the process for the remaining sides of the mathematical model.

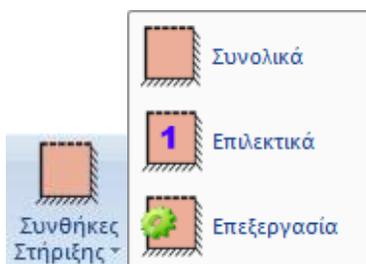


- Finally, assign each vertex of the equivalent rectangle (which symbolized by a triangle) at points in the physical model to make the reduction of the length of the sides of the mathematician to the physical ones, so that the loads of the equivalent plate will be distributed to the actual lengths of the physical members. The matching is done by first selecting the vertex of the mathematical model and then pointing the mouse at its new position. The process is repeated for the remaining 3 vertices of the mathematical model without cancelling with the right mouse button.

#### OBSERVATIONS:

- ⚠ When matching the sides of the mathematical and physical model, you do not need select the columns.
- ⚠ If the sides of the mathematical model appear in the same colour as the dots of the physical members before the sides are matched, then they do not need to be matched unless you wish to make changes.

### 2.5 Support conditions

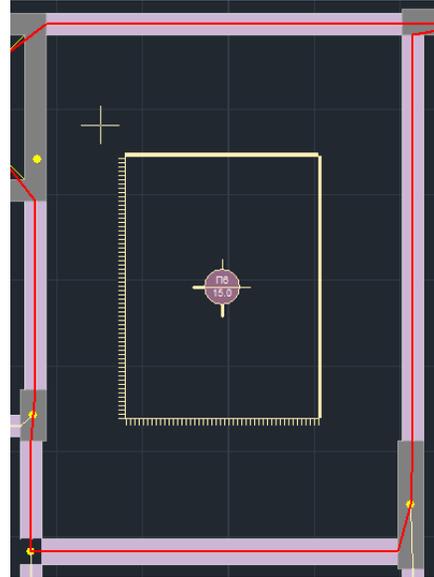


With this command, the program automatically determines the support conditions of the plates, which must be previously identified and modelled.

The notation used by the program is :

-  : credit
-  : support (articulation)
-  : free end

Initially the program considers free edges at edge positions, supports where there is no continuity with another plate and butressing where there is.



### 2.5.1 Overall



Select the command to set the support conditions automatically and globally for all modelled slabs of the active floor.

### 2.5.2 Selectively



Select the command to set the support conditions globally, that after calling the command you point the mouse at an interior point of the plate(s) you want to see the support conditions.

### 2.5.3 Edit



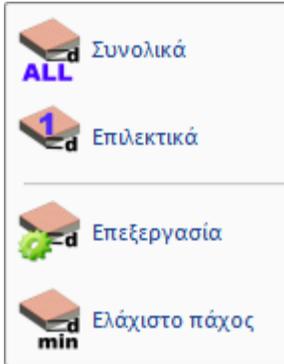
Select the command to modify the support conditions of the plates. Calling the command displays the specified support conditions for each identified plate on the screen. The change is made by moving the mouse over them and pressing the left mouse button. At each press the transition from one condition to another is made:

credit  $\Rightarrow$  support  $\Rightarrow$  free end.

## 2.6 Thickness



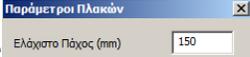
This option automatically performs a looseness check for the identified slabs and determines the required slab thickness in mm. The calculation is done for all the plates in total.



### ATTENTION:

⚠ Any manual modification you make to the imported plates requires recalculation of their thickness.

### OBSERVATIONS:

⚠ Here the program, taking into account the default value  for the Minimum plate thickness given in "Parameters", calculates the required one, and comparing the two values, keeps the maximum one.

⚠ The required thickness is determined by the formula:  $hf = d + \text{coating}$ , where :

- $d$  (static height)  $\geq a/30$  for solid slabs
- $d$  (static height)  $\geq a/25$  for plates with infill bodies  $d$
- (static height)  $\geq a/20$  for slabs with ribs

$a$ : the ratio between the ideal length and the theoretical opening, given in the table paragraph 16.2. of the **NRC**.

Select:

### 2.6.1 Overall



for automatic calculation of the thickness of all slabs of the active level.

### 2.6.2 Selectively



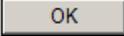
to calculate the thickness of the slabs you select by left-clicking.

### 2.6.3 Edit



to modify the thickness of the plates specified with the previous commands.



Select the command and in the dialog box:  , enter the new value for the thickness, "OK" and then select the plates that will get this new thickness. The new thickness is indicated in the plate indicator symbol.

### 2.6.4 Minimum thickness



if with the edit command, you change the "Minimum" thickness and give a larger value, then the "Minimum Thickness" command will reset the original value of the thickness of the selected plate.

#### ATTENTION:

 In case the design is based on **EURODATA**, then the **Final Thickness** of the slab will be obtained after the **Deformation Check**.

#### OBSERVATION:

In the new version of SCADA Pro, the **deformation control** of the plates has been added.

The deformation check is based on 7.4.2 and 7.4.3 of EC2 and is presented at the end of the results of each plate and if the scenario is not ECOS.

The results of the two tests are shown separately.

ΥΠΟΛΟΓΙΣΜΟΣ ΠΑΡΑΜΟΡΦΩΣΕΩΝ (EC2 παρ.7.4.2 & παρ.7.4.3)									
l/d	l/d	Επάρκεια	Προτειν.ελάχ. πάχος hs (mm)	Max. M (κNm)	du1 (mm)	a	l/a (επιτρ) (mm)	Επάρκεια	
34.59	80.10	NAI	77	-7.64	0.42	250	18.40	NAI	

In the first check a minimum proposed thickness is obtained, but it cannot be proposed in the initial identification of the plate because its calculation requires the reinforcements.

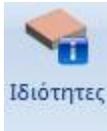
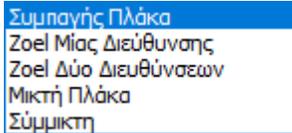
In the calculation of the first check, no intensive quantities are used, while the second check is carried out with the functional combination(s).

#### OBSERVATION:

 In case of **Insufficiency**, the user should modify the original thickness, using the Edit command, and set in its place the **Preferred minimum thickness hs (mm)**.

## 2.7 Properties

This command allows you to view and edit the details of the plates that have been identified and modelled, as well as modify the type of plate:



Select the command and a plate. In the dialog box:

Επεξεργασία Πλακών
✕

**Γενικά**

Αριθμός:  Συμπαγής

Πάχος (cm)  Ιδιο Βάρος (kN/m<sup>2</sup>)

**Zoellner-Sandwich - Μικτή**

Πάχος (cm)			Πλάτη (cm)		
hs	ho	hu	Διεύθυνση	Δοκοί	Κενά
<input type="text" value="45"/>	<input type="text" value="10"/>	<input type="text" value="10"/>	1	<input type="text" value="20"/>	<input type="text" value="50"/>
			2	<input type="text" value="20"/>	<input type="text" value="150"/>

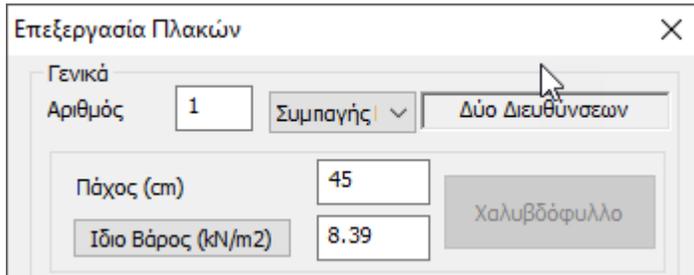
Ακέραια Κενά

**Γεωμετρία**

Διαστάσεις (m)		Συντελεστές Marcus			
L1	<input type="text" value="7.5999994"/>	q L1-1	<input type="text" value="0.99972"/>	q L1-2	<input type="text" value="0"/>
L2	<input type="text" value="46.799995"/>	q L2-1	<input type="text" value="0.00027"/>	q L2-2	<input type="text" value="0"/>

Μετατροπή σε επιφανειακά

- The first section "**General**" contains general information about the plate such as:



its number, the type of plate (Compact or Zoellner or Composite).

The thickness in cm is then indicated

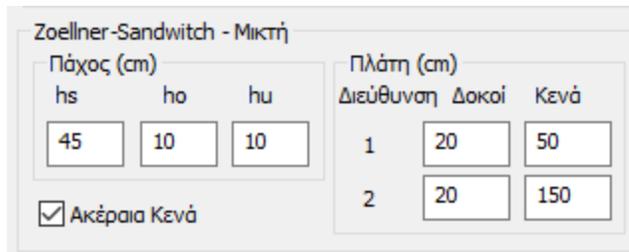
- The field refers to the solid plates and to update the changes of the plate type, press the button

and finally the same weight in KN/m<sup>2</sup>.

**OBSERVATION:**

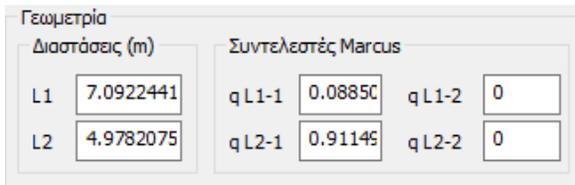
It makes sense and you can change the type of plate from Zoellner to solid. From the above fields you cannot modify the type (Two Addresses) (read only field).

- The next section "**Zoellner-Sandwich-Mixed**" is activated and concerns the Zoellner plate elements.



There are and you can modify the fields of total thickness, top and bottom solid part of the plate as well as the dimensions of the spacers and gaps.

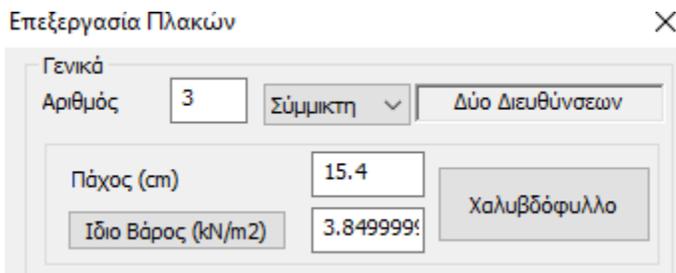
- The last section deals with the **geometry** of the plate.



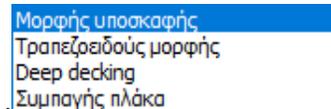
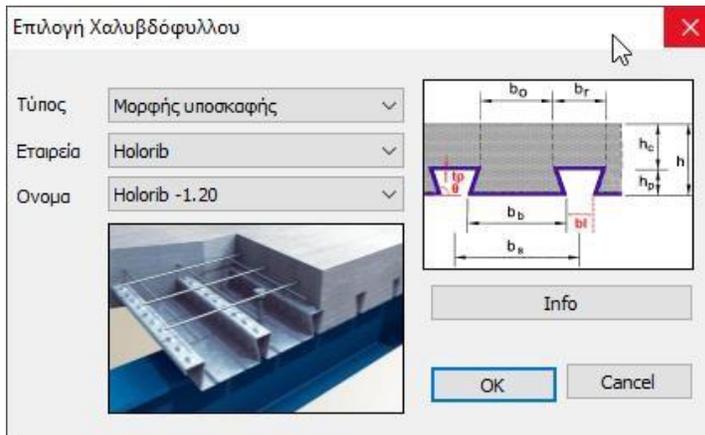
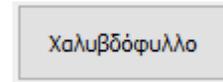
Specifically, the dimensions of the plate L1 and L2 are given as well as the load distribution coefficients qL1-1 and qL2-1 (Marcus coefficients).

**OBSERVATION:**

The Marcus coefficients present in the fields "qL1-2" and "qL2-2" refer only to three-dimensional plate. In all other cases they are 0.

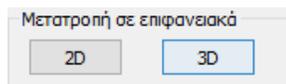


In the case where you have designated **Commutators plates**, then you activate the button

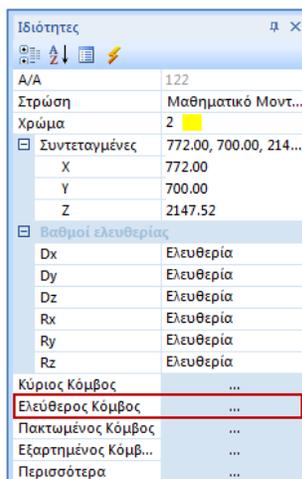


Allowing the selection of steel sheets of different types, company and name.

- **Conversion to surface:**



In addition you have the ability to convert a slab by choosing to model it with 2d and 3d mesh.



You start by freeing the perimeter nodes belonging to this plate, as they probably belong to a baffle by that time.

This can be done for each node individually by reporting its details and clicking on the button next to "Free Node" , or for several nodes collectively, by editing multiple options.



- Select **Ιδιότητες** and a plaque.

In the dialog box that opens:

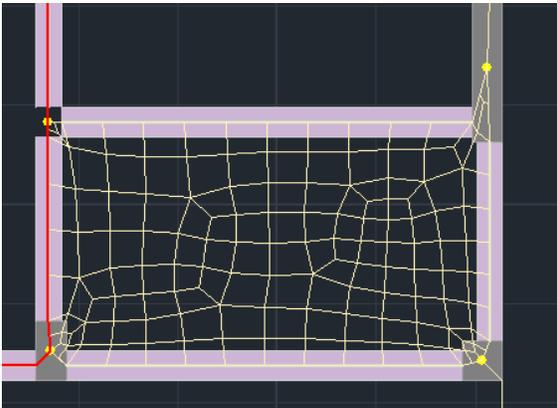
- Select **Convert to 2D surface** and **OK**.

- In the window that appears, enter:

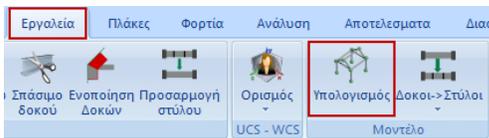
- Description ,
- Element Plate ,

- Thickness equal to the thickness of the plate,
- Finite width and one
- Density depending on the shape of the slab (usually a value around 0.20 is sufficient).
- Also , change the Quality of Concrete if necessary.
- Select New and OK.

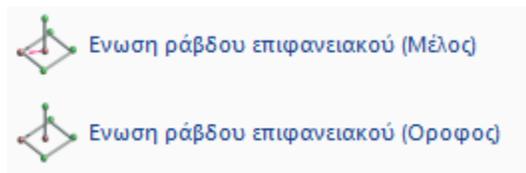
The program creates the finite element mesh.



- Then the calculation of the model must be done.



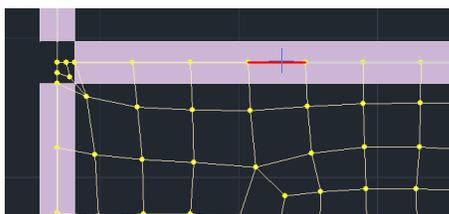
- The last step is the "**breaking**" of the perimeter members of the beams at the points where finite surface element nodes were created, using the **Tools** command> **Members**>



, and selection of the member

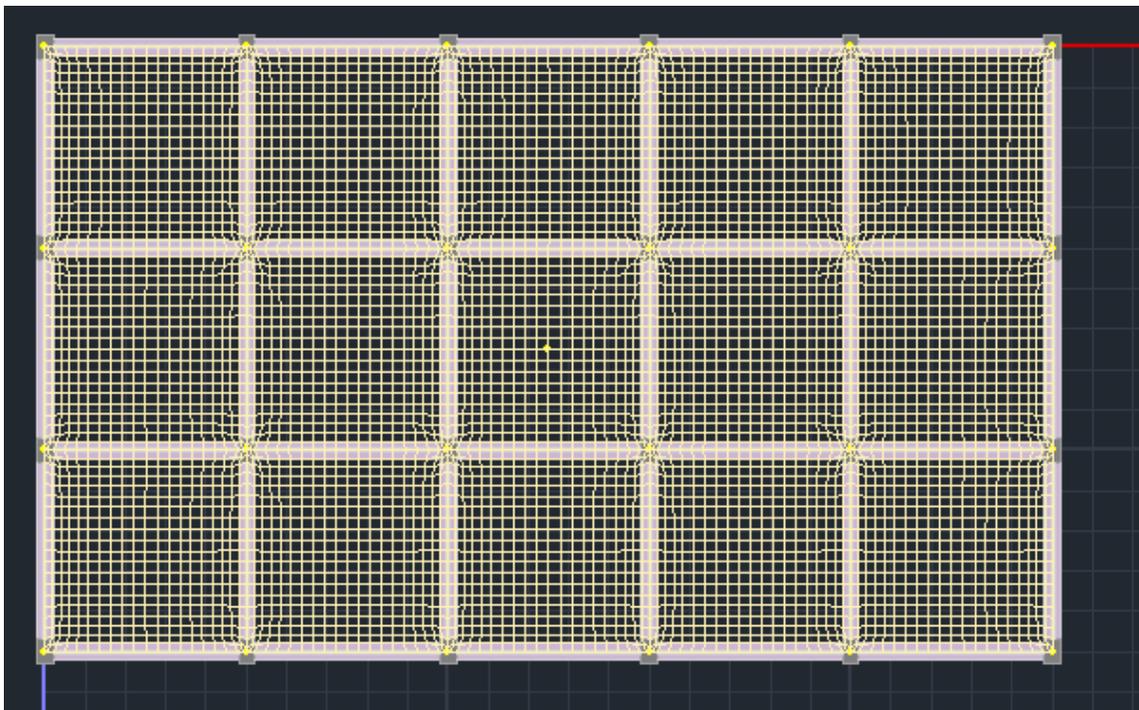
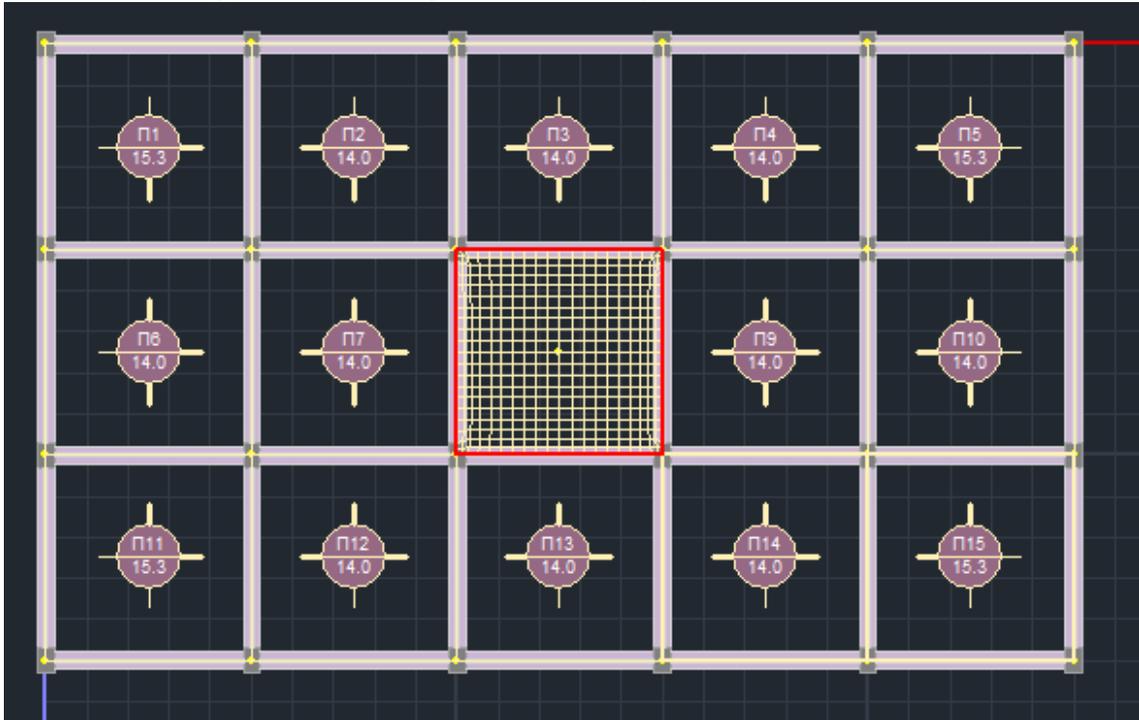
, in total for all members of the floor where they occur on the surface.

⚠ *Zooming in on a beam, you see that its mathematical member is broken into conjugate members joined to the surface members.*

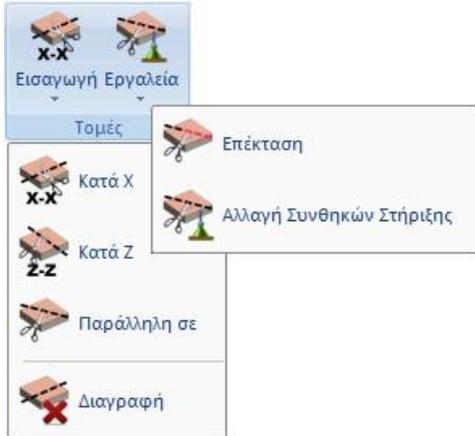


**OBSERVATION:**

Similarly for the conversion to 3D. The difference between 2D and 3D is that the conversion to 3D is for the whole floor, i.e. it converts all the slabs on the floor to 3D surface slabs, whereas choosing to convert a single slab to 2D only converts the selected slab.



## Sections



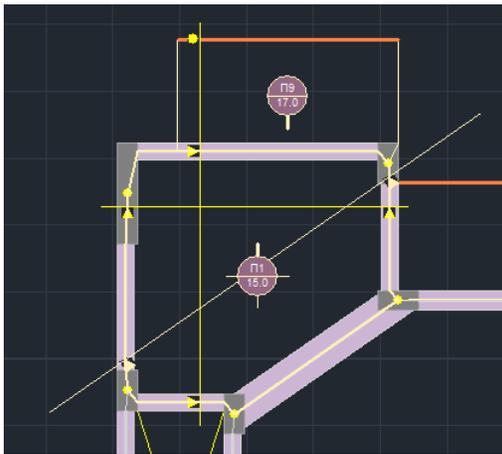
### OBSERVATIONS:

The design of the sections is a prerequisite for the solution and dimensioning of the plates.

They are the "guides" for the design of the reinforcement on the formwork and the appearance of the diagrams.

Depending on the type and shape of the slab, one or more incisions are required in one or more directions.

### 3.1 Introduction



Select "Intersection by x" and "Intersection by z" and insert with the mouse the intersections on edge-to-edge plan views, parallel to the X-X and Z-Z global axis, respectively.

The "Intersection parallel to" command allows you to insert intersections parallel to a line of the drawing which you select before inserting the intersection.

To delete one or more sections, select "Delete Section" and left-click on the section you want to delete.

### 3.2 Tools

In the tools there are the section editing commands for extending and changing the support conditions



: select the command and the end of the section you want to extend and set its new position.



: select the command and left-click on the support to modify the support condition. The change from one type

to the other is done sequentially.

⚠ The notations used by the program for the types of section supports are :

● : free end of cut (cut on edges - ends of projections, triangles, etc.)

▲ : simple support - reaction

□ : founder

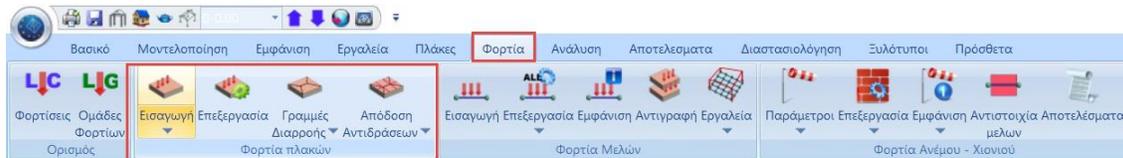
⚠ Changing the type of support is done by left clicking on the support. Changing from one type to another is done sequentially.

## Checks

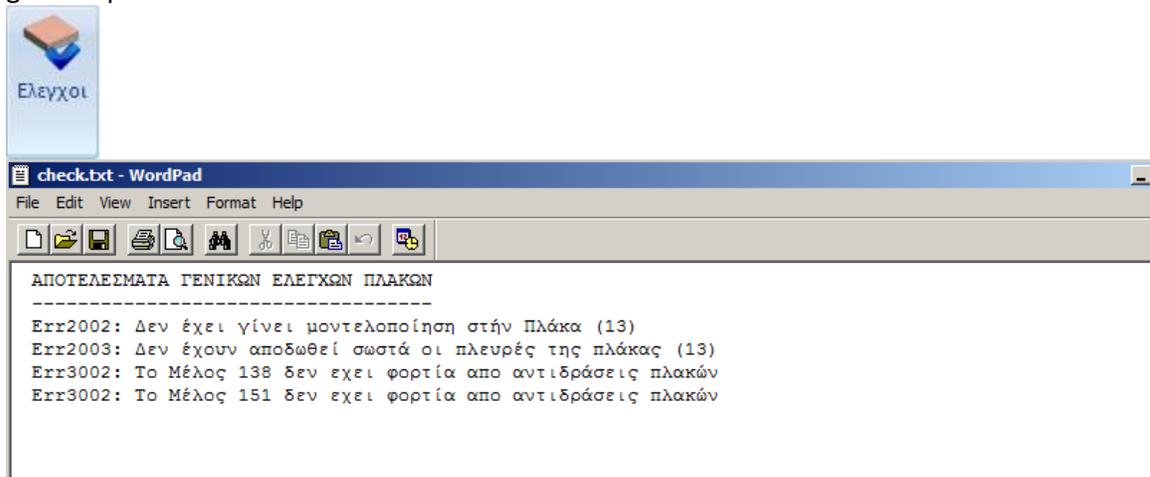
The Checks command should always be run to avoid possible errors.

### OBSERVATION:

However, to avoid notifications regarding plate reactions, it is better to first run the plate load found in the next section "**Loads**">>"**Plate Loads**" and then check the checks.



Select the checks command. Opens a .txt file that informs the user of the results of the general plate checks for each level.



If the file is blank, it means there are no errors. Otherwise, before proceeding to "Loads" correct all the errors in the plates.

### RESULTS OF GENERAL INSPECTIONS OF PLANKS

error2006	There is a problem on the plate (%-d, %-d)\n
Error2001	There are plates with the same numbering (%-d)\n
Error2002	No modeling has been done on the Plate (%-d)\n
Error2003	The sides of the plate are not correctly assigned (%-d)\n
Error2003	The sides of the plate (%-d)\n are not correctly assigned
error2004	Plate thickness less than min (looseness check) (%-d)\n
Error2005	Plate thickness less than the sum of Upper thickness + Lower thickness (%-d)\n
Error3001	There may be a load with the wrong sign (%-s=%-.2f)
warning3002	State %-d has no plate reactions loads\n
Error3003	Plate %-d