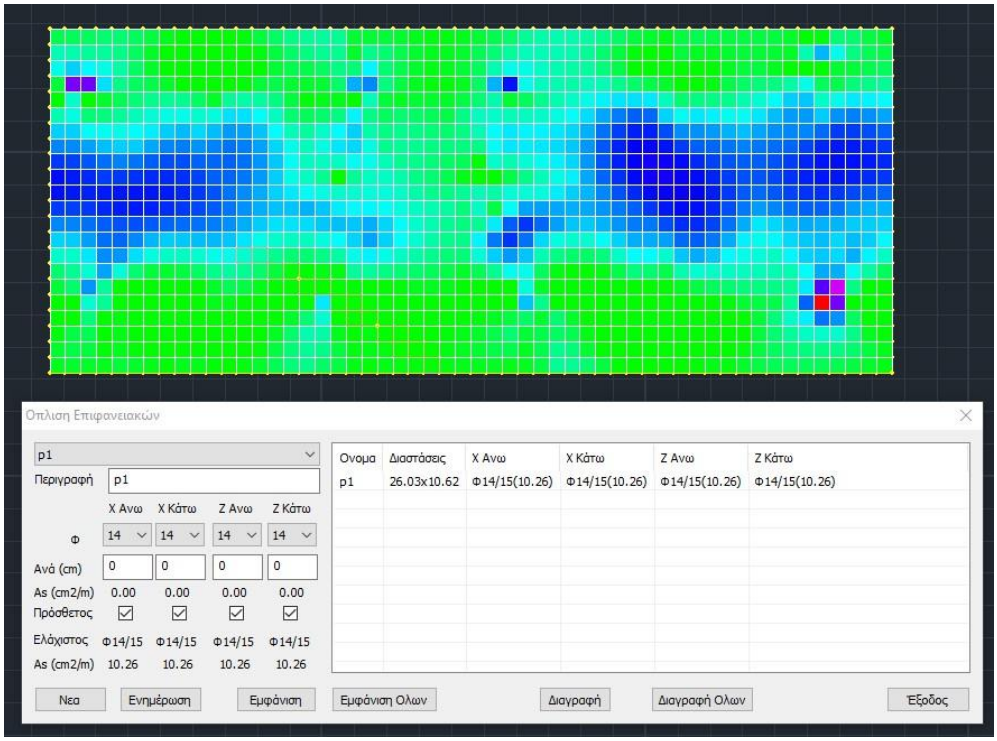
SCADA Pro 25tm
Structural Analysis & Design

User Manual

F. SURFACE DIMENSIONING



ACE HELLAS
INTEGRATED SOLUTIONS

CONTENTS

1. Surface

In the new version of SCADA Pro a new integrated tool has been added for calculation and design of reinforcement of foundation or superstructure slabs, slabs which have been simulated with surface finite elements.
The reinforcement of these plates can be mounted,

- or uniform over the entire surface,
- either by separating the plate into regions

and can be,

- either of the form minimum additional reinforcement to be fitted +
- or as a total final reinforcement.

The program can automatically calculate the reinforcement to be placed in either of the above two formats. The reinforcement can also be placed "manually" by the designer with an automatic graphical adequacy check.

Attention!
The process is executed per level and the commands work ONLY in plan view and not in the 3D vector.

In summary, the path to completion is as follows:

1. Parameters

Here the maximum and minimum reinforcements that will be placed (distances, diameters) are defined and the combination with which the required reinforcements will be calculated is also selected.

2. Show Required Armament (Combinations)

With this option we can see the required reinforcement in cm2/m per direction (X or Z) and per reinforcement layer (Top - Bottom) from any load, combination or envelope, in order to decide with which combination we will reinforce our plate. This choice is the same as the one in the results section (*see use 9. Results*).

3. Calculation of Minimum Armament

With this option the program calculates the minimum reinforcement for the whole surface, the same everywhere (top - bottom, X and Z direction).

4. Arming areas

Here we graphically define one or more reinforcement areas, i.e. areas where there is a requirement for reinforcement thickening. We have two options:

α. Place additional reinforcement beyond the minimum calculated in the previous step.

β. To place a total final reinforcement, ignoring the minimum.

5. Automatic Area Armament Calculation

With this option, the program calculates automatically and only for the reinforcement areas that we defined in the previous step, the reinforcement to be placed, so that there is sufficiency, i.e. it is greater than the required one. In addition to the automatic calculation, we can also manually meet the requirement by selecting the appropriate reinforcement ourselves.

6. Showing Required Armament (As)

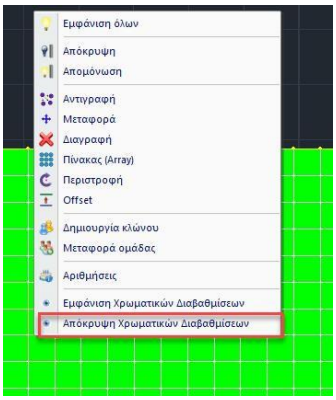
7. Show Mounted Armament (As)

8. Armament Adequacy Check

Each of these three options shows in colour gradation in cm2/m respectively the Required, the Installed and, in adequacy option, the difference between Installed minus Required reinforcement. If this difference is 0 or positive, it is displayed in green, while if it is negative, the areas where the installed reinforcement is not sufficient are displayed in colour.

Attention!

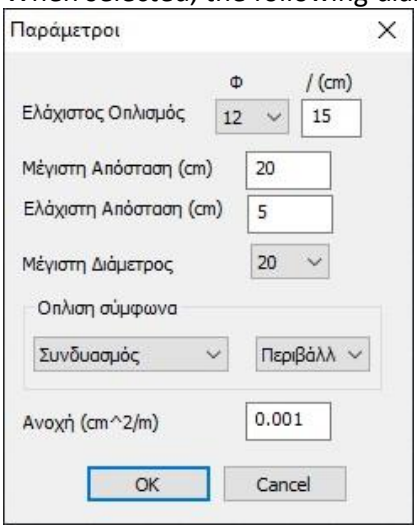
All color gradations appearances are hidden by right-clicking on the desktop and from the menu that appears, selecting "Hide Color Gradients"



Let's now look at the operation of the commands in detail

1.1 Parameters

When selected, the following dialog box appears



NOTE: Please note that all the parameters mentioned here refer to all the reinforcements (horizontal, vertical, upper, lower).

With the "**Minimum Armament**" option we set:
a minimum reinforcement to be installed, regardless of the requirement.

NOTE: The program, when calculating the minimum reinforcement and also automatically calculating the reinforcement of the areas, takes this parameter and the construction provisions of the respective regulation into account and places the greater of the two.

With the options "**Maximum Distance**", "**Minimum Distance**" and "**Maximum Diameter**" we set the respective minimum and maximum distances between the irons and the maximum diameter to be used.
The minimum diameter is that specified in the minimum reinforcement.

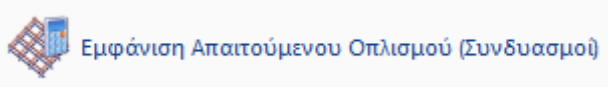
Attention is needed here especially in the definition of the minimum distance because, if the requirement is large, the program in the automatic calculation will not calculate any reinforcement if the required distance is less than the minimum!

Then we define the combination, load or envelope according to the calculation of the required reinforcement will be made.

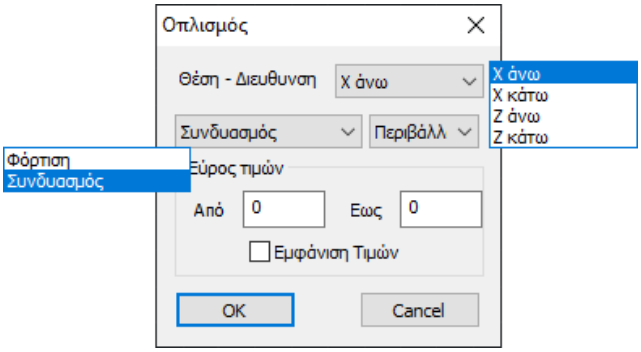
In the "Tolerance" option we have the possibility to set a tolerance margin of the value of the calculated minimum reinforcement so that, when the calculation of the required reinforcement of each area is made, a single minimum reinforcement is calculated in the range of values defined by the tolerance and the initial minimum reinforcement.
That is, the value of the tolerance is added to the As of the minimum reinforcement and those values of required reinforcement that are within this range are taken into account as a requirement, not with their actual value, but with the value corresponding to the As of the minimum required reinforcement.

EXAMPLE:
For example, if we have placed a minimum reinforcement F12/15 corresponding to 7.53 cm2/m and we have set a tolerance of 0 cm2/m, then all quadrilateral elements with a reinforcement requirement less than or equal to 7.53 cm2/m will be shown in the corresponding colour gradient to be sufficient.
If we now, for the same case, set a tolerance of 2 cm2/m then, to the previous four-sided elements that seemed to be sufficient (for an As requirement of less than or equal to 7.53 cm2/m) will be added those elements that have a reinforcement requirement value up to 7.53 cm2/m + 2 cm2/m = 9.53 cm2/m. In fact, these elements will not be shown in the corresponding colour graduation of the required reinforcement not with their actual value but with the minimum reinforcement value of 7.53 cm2/m.

1.2 Show Required Armament (Combinations)

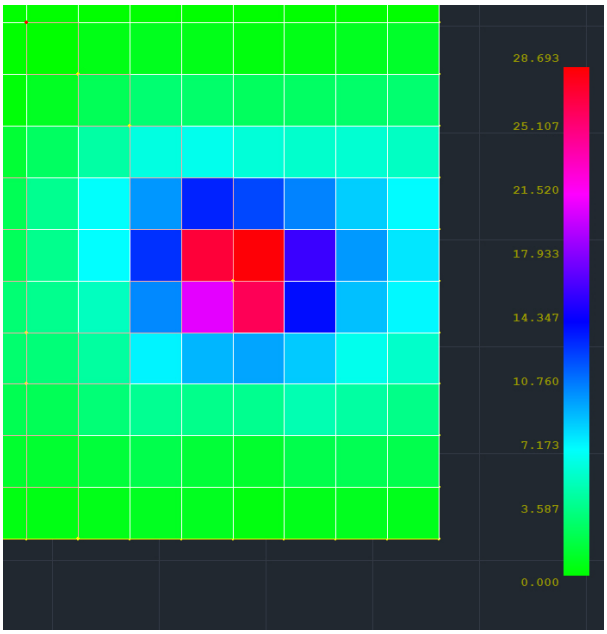


When selected, the following dialog box appears



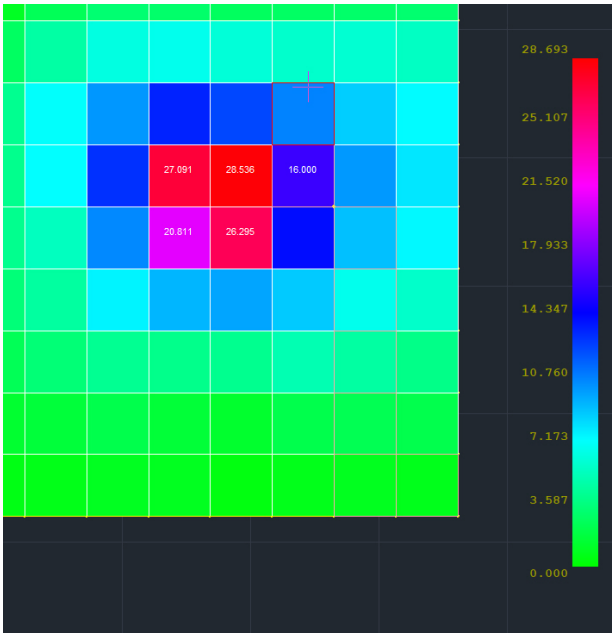
Here we can see the required reinforcement from whichever combination, load or envelope we chose.
The reinforcement is shown either X (horizontal) or Z (vertical) above and below and the directions refer to the universal axes.

The "**Show Values**" option also displays the numeric value within each quadrilateral element, while the "**Range of Values**" option, with numeric values enabled, only displays values in the elements within the range of values that we specified.



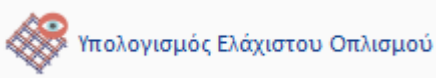
Reinforcement required without displaying values

Required reinforcement with displayed values



Required reinforcement with a value range of 15 - 30 cm2/m.

1.3 Calculation of Minimum Armament



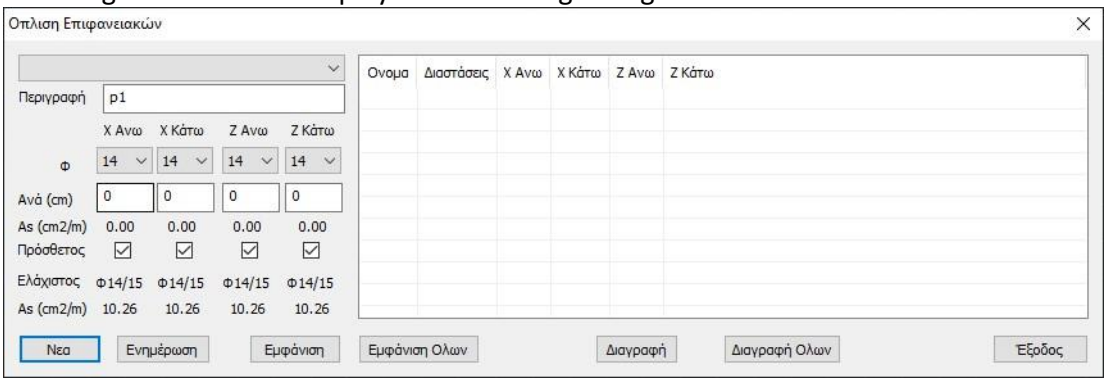
With this option the program calculates the minimum reinforcement for the whole surface, the same everywhere (top - bottom, X and Z direction).

NOTE: The minimum reinforcement is calculated from the minimum reinforcement of the parameters and the corresponding regulations and the worst (largest) of the two is placed.

1.4 Arming areas

With this option it is possible to graphically define one or more arming areas.
If we define an area, a reinforcement will be placed in the whole area, which can obviously be differentiated by direction (X and Z) and by layer of placement (top - bottom). This reinforcement can also be either total final reinforcement (ignoring the minimum reinforcement), or original minimum reinforcement + additional reinforcement.

Let's look at the functions in detail:
Selecting the command displays the following dialog box:

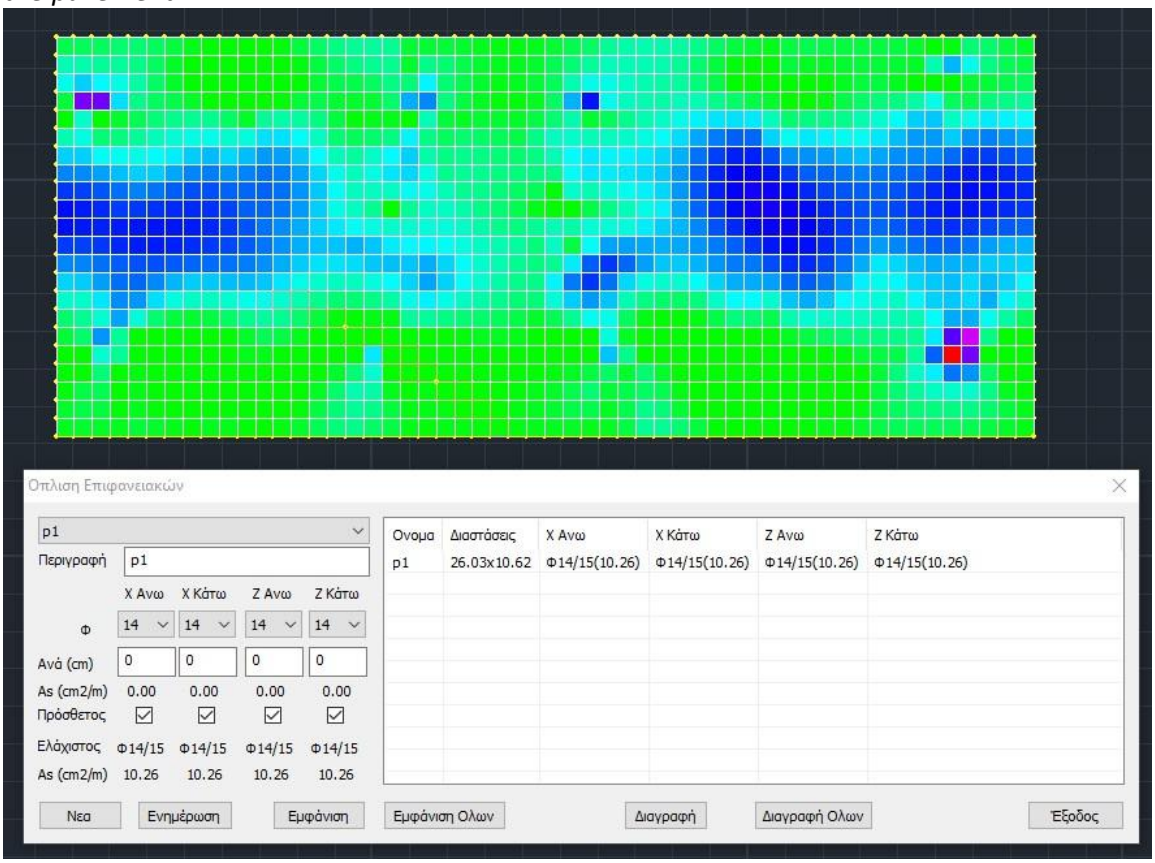


NOTE: Note that all other menu commands work dynamically and simultaneously with this window open, which is very useful and instructive.

To define a new area, we press the "**New**" button and graphically define the arming area with a window.

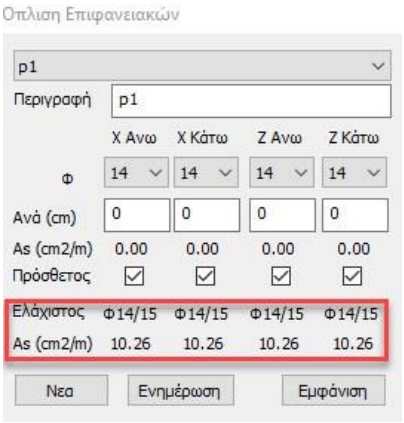
EXAMPLE:

In the example below, the entire surface of the pavement has been defined as one surface of the pavement.

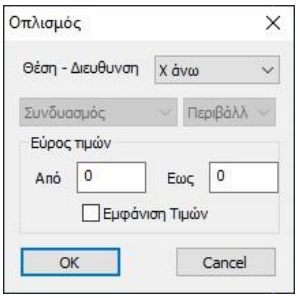


The area is automatically named p1 and on the right are shown its dimensions and, for each of the four reinforcement cases, the corresponding reinforcement.

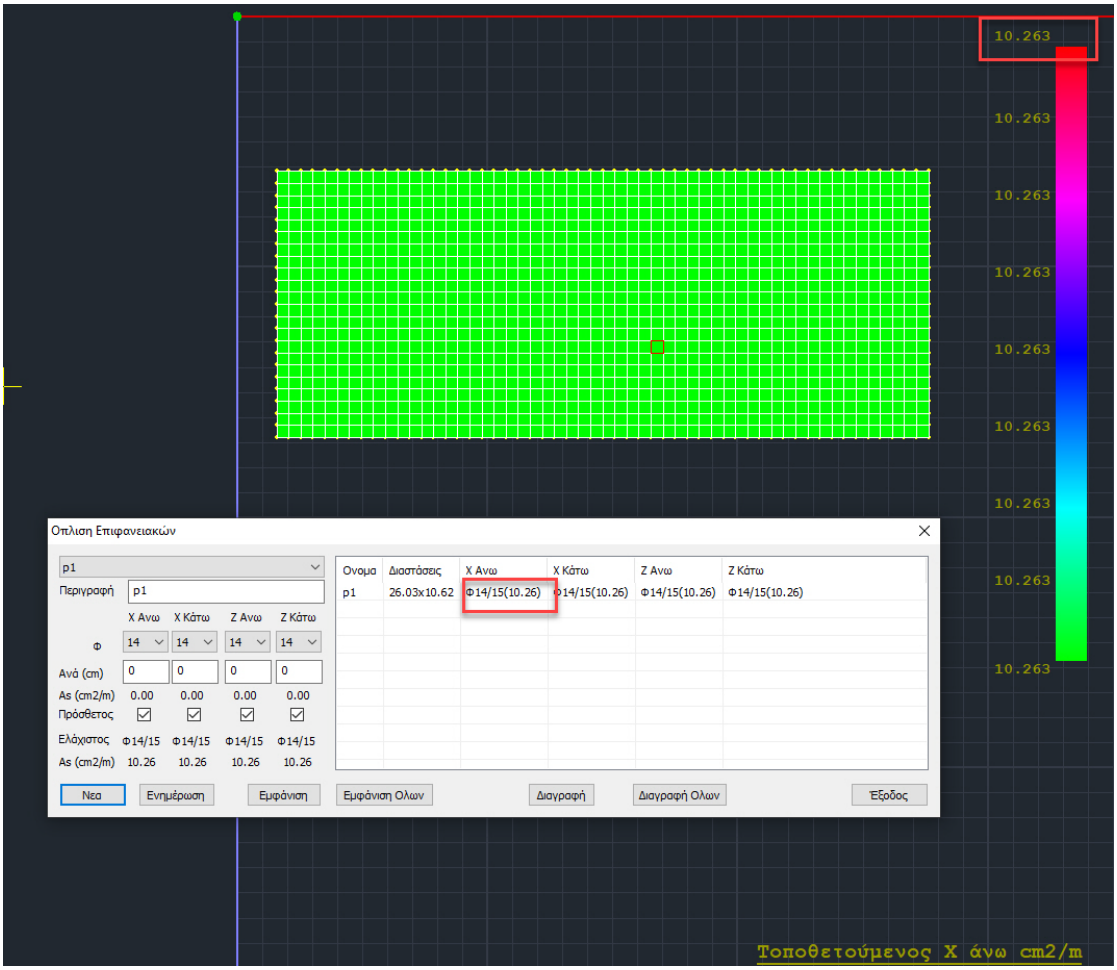
In this example, the minimum reinforcement calculated in a previous step is indicated, which, as already mentioned, is the same for all four cases of armouring and is displayed in the left part of the window for information.



With this window open and selecting from the menu the appearance of the mounted reinforcement, for example X upper

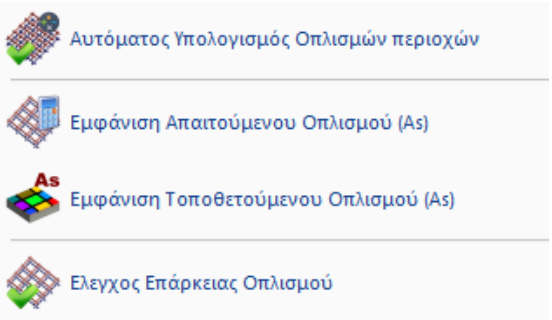


we can see the minimum reinforcement to be installed *(Φ14/15= 10.26 cm2/m)*



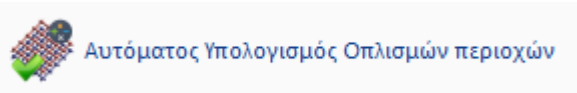
There are two ways of calculating the reinforcement to be placed:

I. Automatic mode

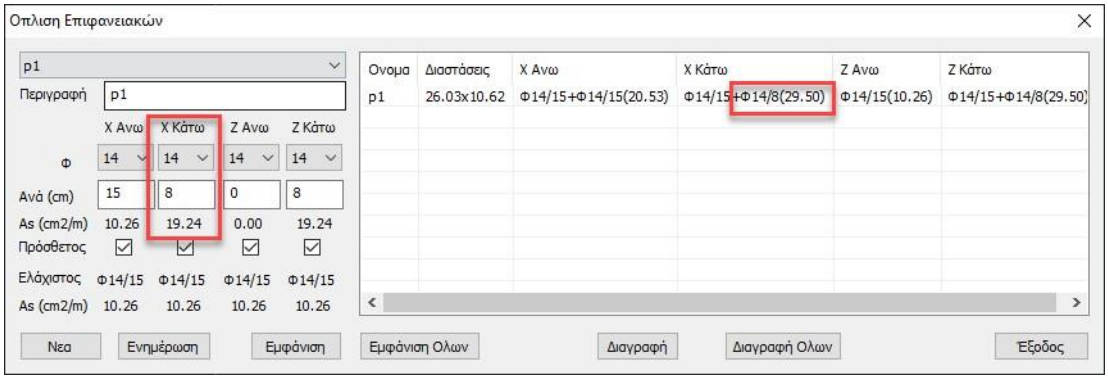


1.5 Automatic calculation of Area Armaments

With the window open, select from the menu "**Automatic calculation of Area Armaments**"



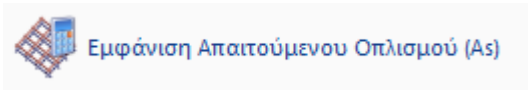
the program calculates the additional placed reinforcement required to cover the required reinforcement, always for each area defined.



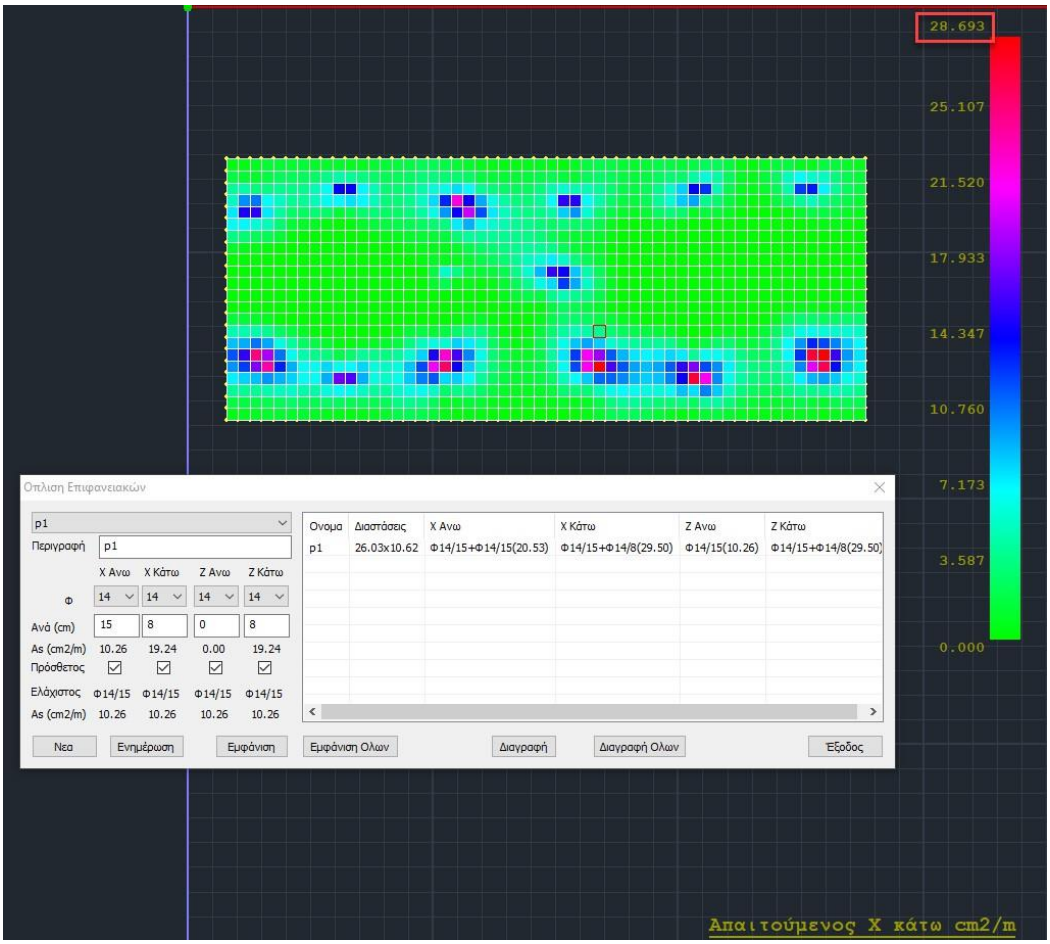
EXAMPLE:

For example, for X Down additional Φ14/8 were required which is 19.24 cm2/m with a fitting set of Φ14/15 (10.26) (minimum) + Φ14/8 (19.24) (additional) = 29.5 cm2/m. Obviously the maximum required X Lower reinforcement, always for this particular area, is something less than 29.5 cm2/m. The choice of the additive was based on the original reinforcement parameters (minimum, maximum diameter and corresponding spacings).

1.6 Showing Required Armament (As)

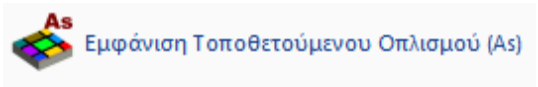


To see the required reinforcement, with the window open select the corresponding display option "**Show required reinforcement**"

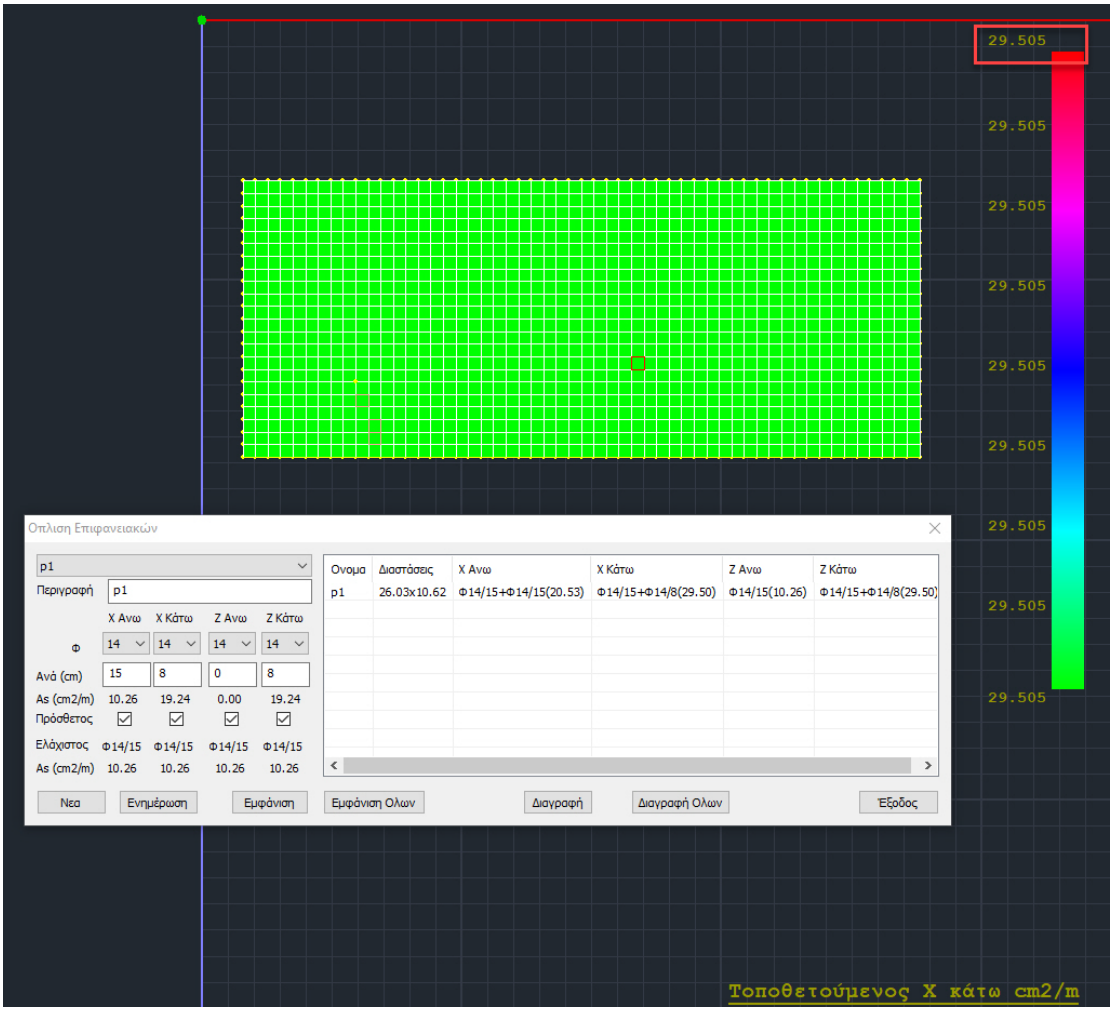


We see that the maximum requirement for X Down is 28.69 cm2/m.

1.7 Show Mounted Armament (As)



Selecting *the* "**Show Placed Reinforcement**" for X Down, *we see 29.5 cm2/m that have been installed.*

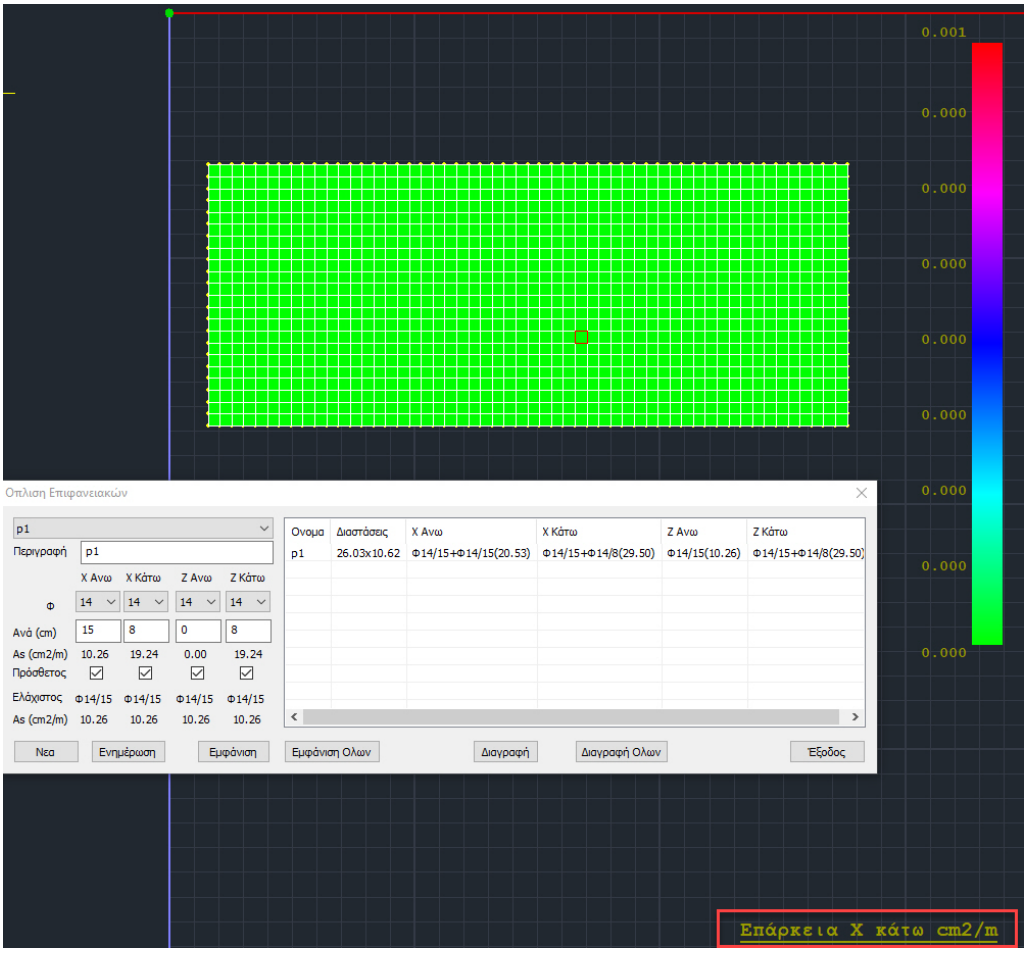


1.8 Armament Adequacy Check

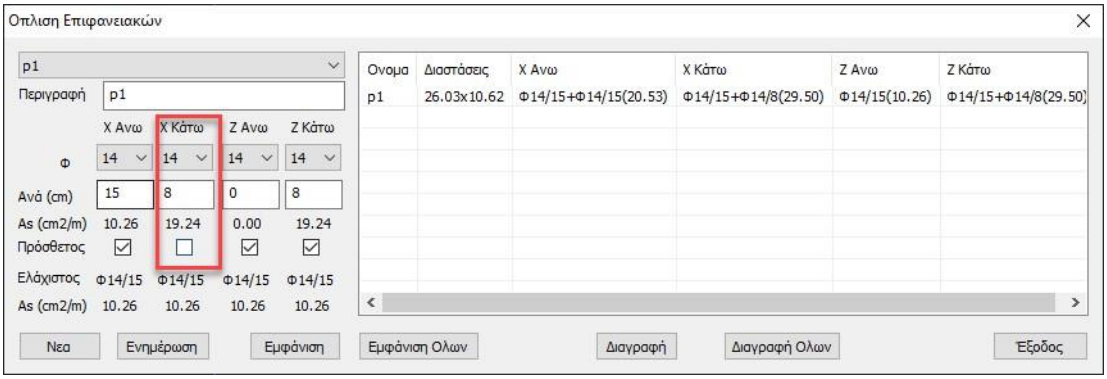
Finally, with the "**Reinforcement Adequacy Check**" option, we can see the difference between the difference between the Installed minus the Required reinforcement, with a color gradation.

If this difference is 0 or positive, it is shown in green, while if it is negative, the areas where the reinforcement is not sufficient are shown in a colour gradient.

In this example the difference is almost zero

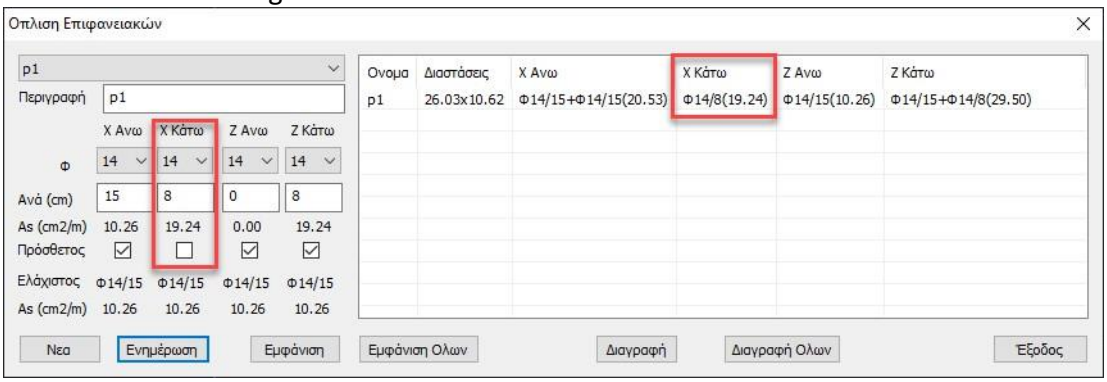


Now, if we wanted to ar+additional armament, but with total, final armament, ignoring the initial minimum armament, uncheck the option "**Additional**" in the corresponding section X Lower



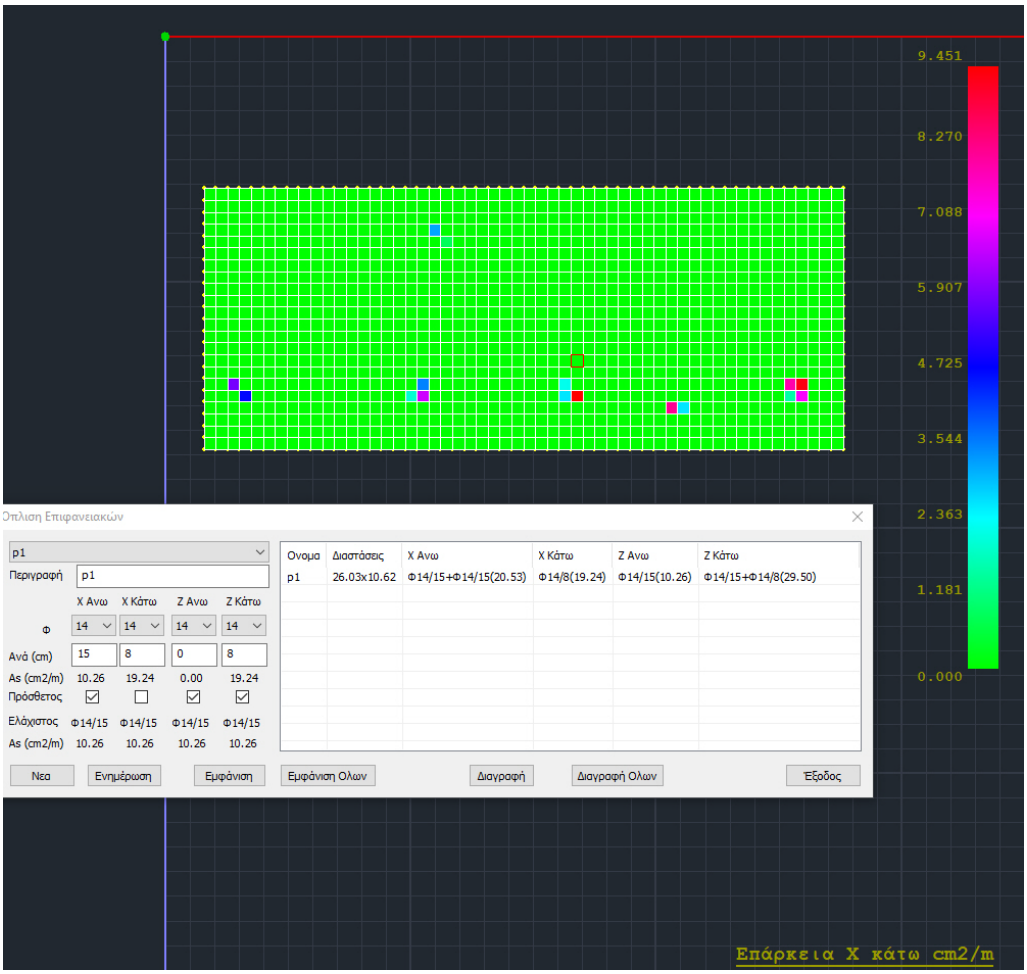
and press the "**Update**" button in order to update this area with this option.

We now see on the right



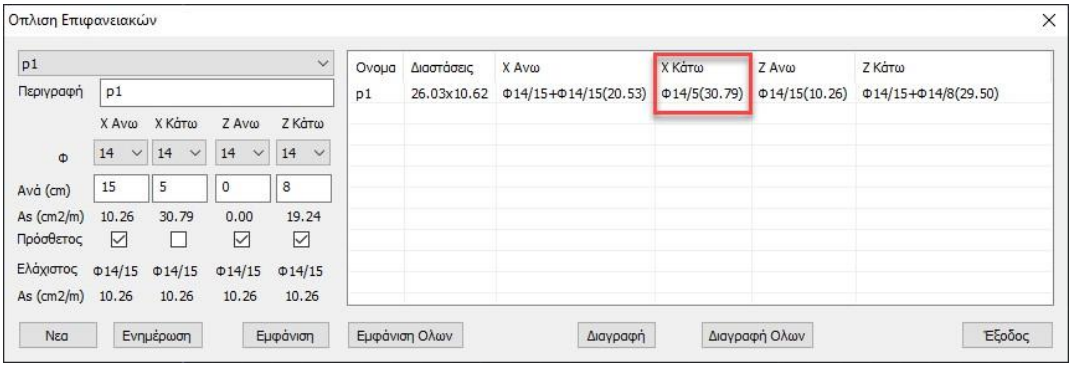
that as reinforcement there is left as total, final reinforcement, the additional reinforcement that was previously calculated and which is obviously no longer sufficient.

We can see this with the "**Armament Adequacy Check**"



where in the areas concerned the required is greater than the installed (*the maximum requirement is 9.45 cm2/m*).

By re-selecting the "**Automatic Area Armament Calculation**" option, the program calculates a new total, final armament



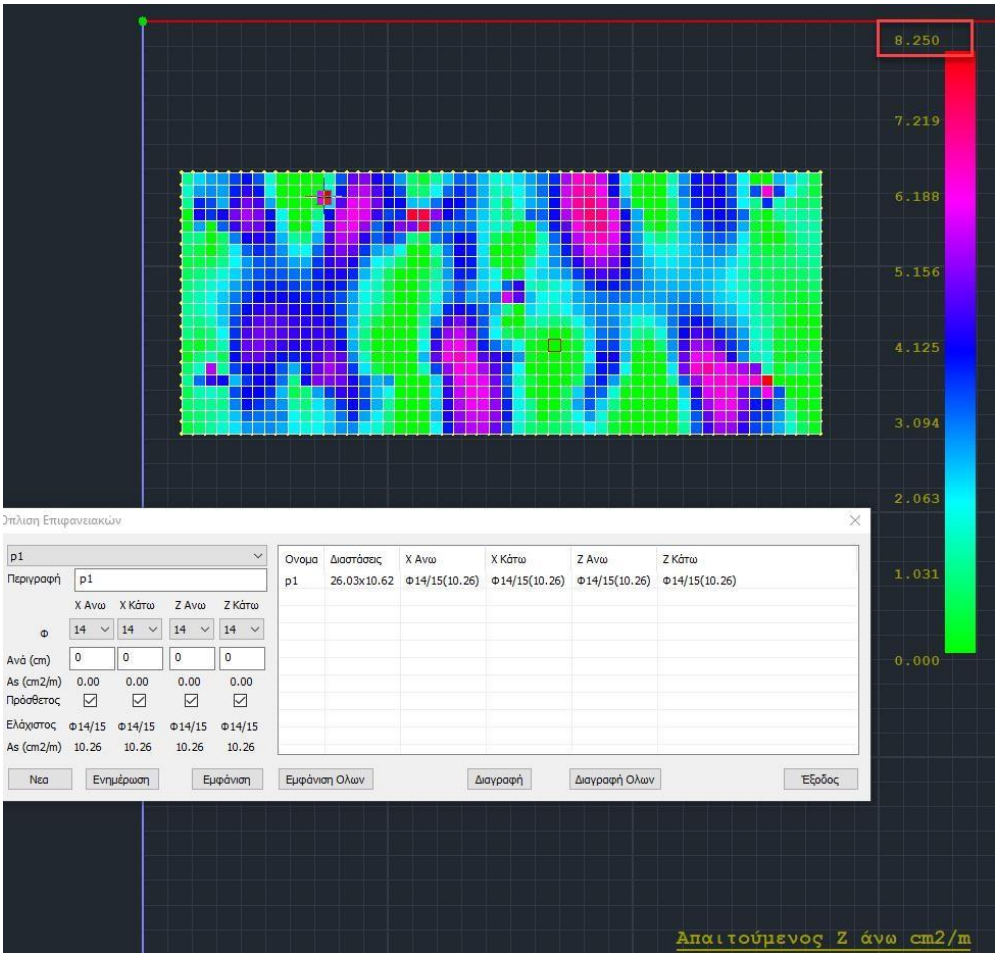
F14/5 (30.79 cm2/m) in order to meet the maximum requirement of 28.69 cm2/m.

II. Manual mode

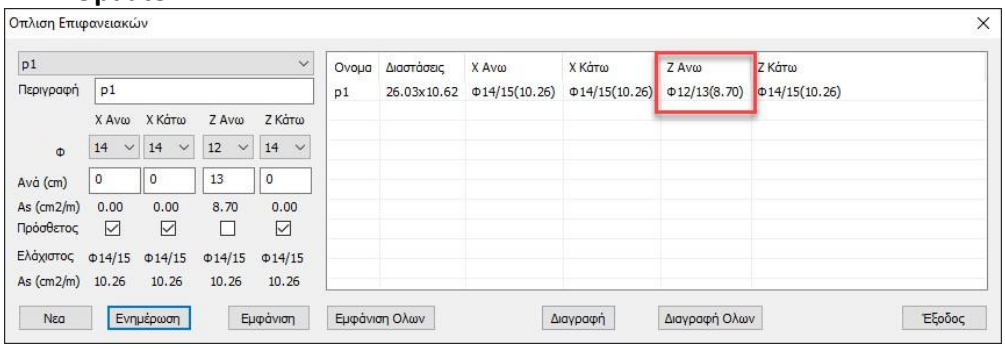
The other way of calculating the reinforcement to be placed, either in the form of a minimum + additional, or in the form of total, final reinforcement is to place the desired reinforcement in each of the four cases, based on the adequacy check.

Let's look at it with an example:

EXAMPLE:
For Z Upper reinforcement, the maximum requirement for the whole area is 8.25 cm2/m.



- Uncheck the additive for Z Upper and place such an armature, so as to cover 8.25 cm2/m, *for example Φ12/13 (8.70 cm2/m)* and press the button "**Update**."

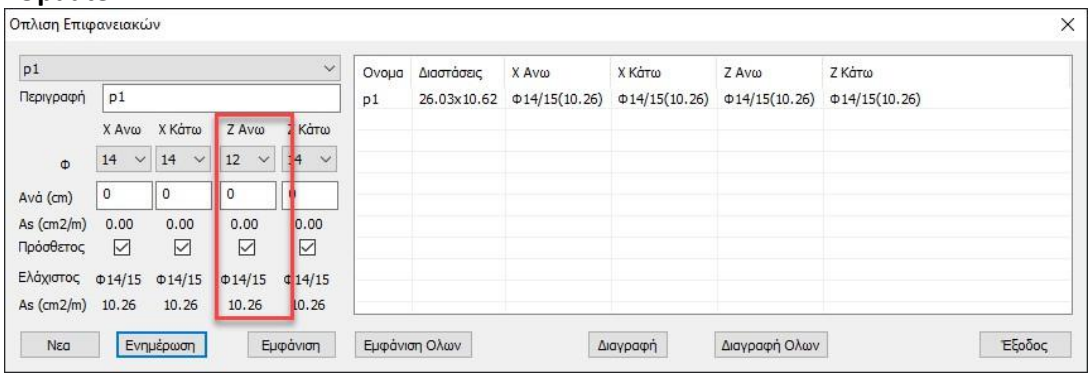


Now, apparently the proficiency check comes up with zero and we have met our requirement.

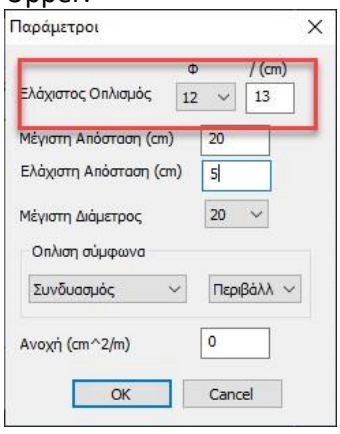
- Also, another way to implement the Z Upper placed reinforcement would be to change the minimum reinforcement to meet the 8.26 cm2/m requirement.

Recall that in this way the minimum armament, because it is uniform, will change for all four cases (X, Z, Upper, Lower)

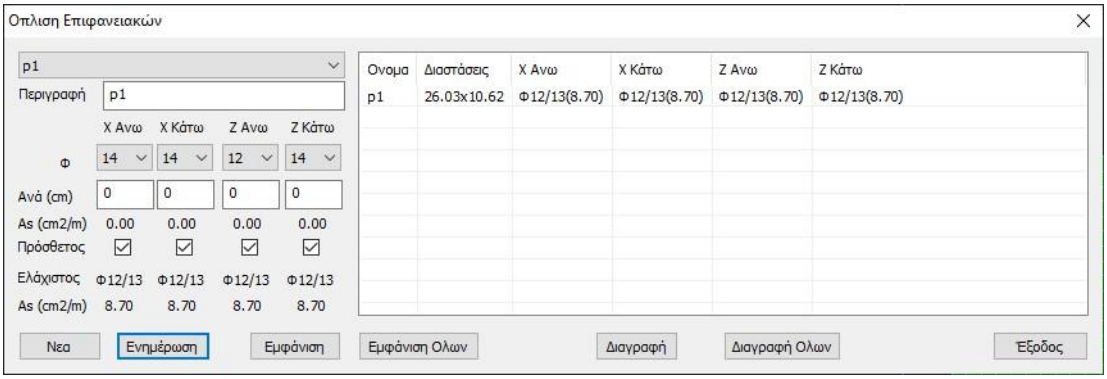
Check the "**Additive**" option for Z Upper, reset the "Per" and press the "**Update**."



Now and at Z Ano the minimum armament that was originally calculated F14/15 has been reintroduced. With the window open we select from the "**Parameters**" menu and set the minimum reinforcement everywhere to F12/13 which we know covers the requirement for Z Upper.



Then we select "**Calculate Minimum Armament**".
The arming areas window is automatically updated with the new minimum reinforcement f12/13 that now covers Z Upper.



With the "**Show**" option we see graphically the area we have defined, while with the "**Show All**" option we see all areas at the same time.

The "**Delete**" button deletes the selected region, while the "Delete All" option deletes all regions simultaneously.

OBSERVATION:
If no areas are defined at all, the program will place the minimum reinforcement everywhere. Recall that the "Automatic Area Armament Calculation" does not work as long as there are no areas. Also, in the formwork, as we will see below, no reinforcement is planned in areas that are not defined.