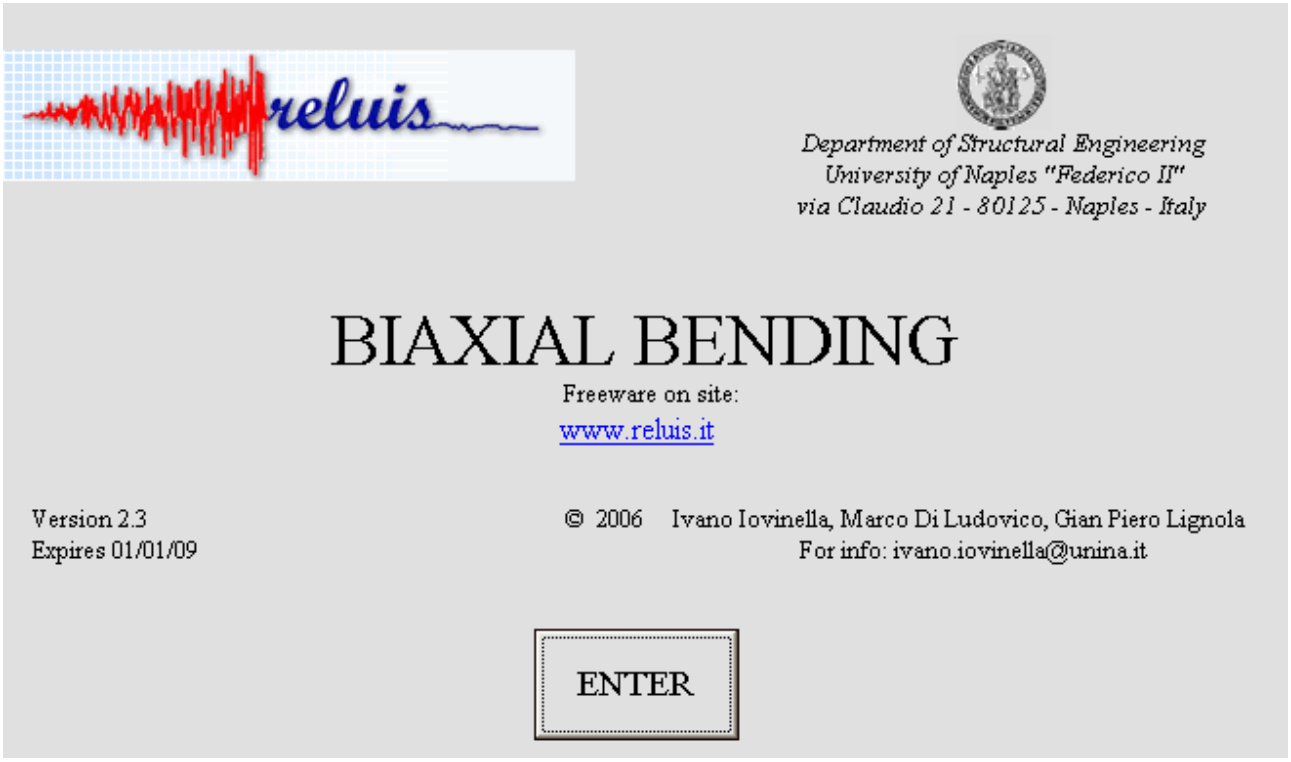
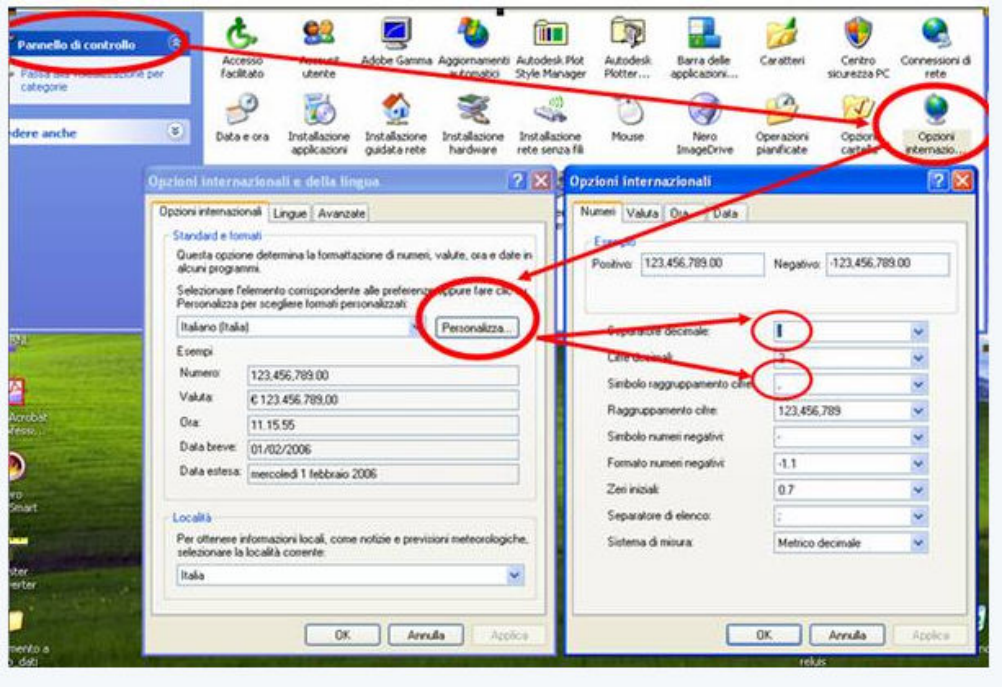


The program "BIAXIAL" allows computing with reference to any RC cross-sections (also circular) subjected to axial load and uniaxial or biaxial flexure: a) the cross-section ultimate moments referred to a centroidal coordinate system; b) the three-dimensional interaction P-M_x-M_y; c) the moment-curvature diagram

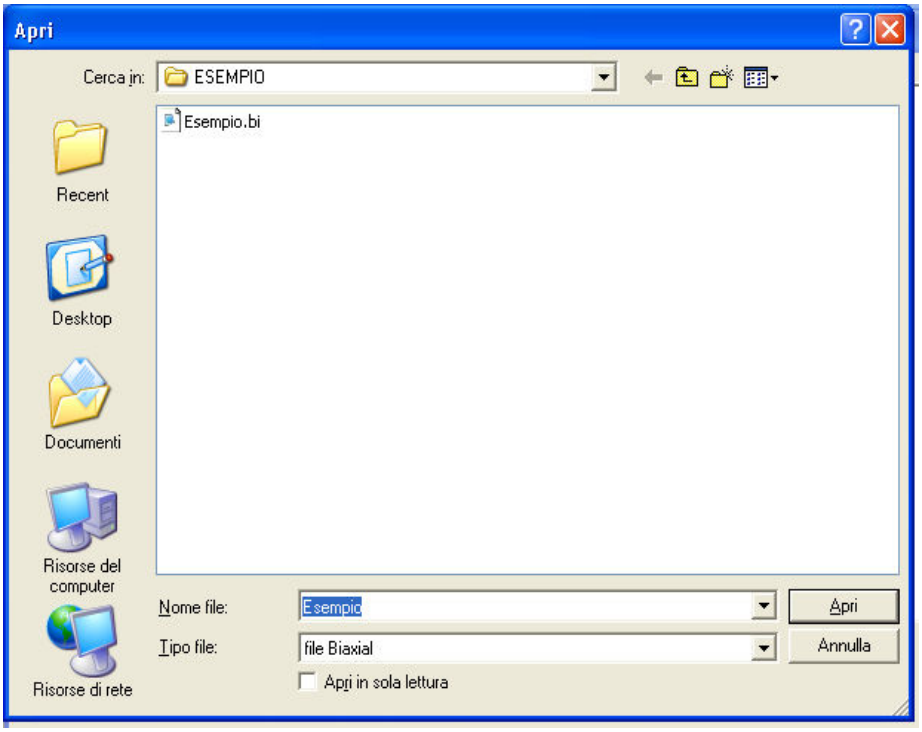
The program can be free downloaded from the web-site www.reluis.unina.it and it expires after 90 days beginning from the last release date. After such period the software can be again free downloaded in its update version from the same web-site.

INTRODUCTION NOTES

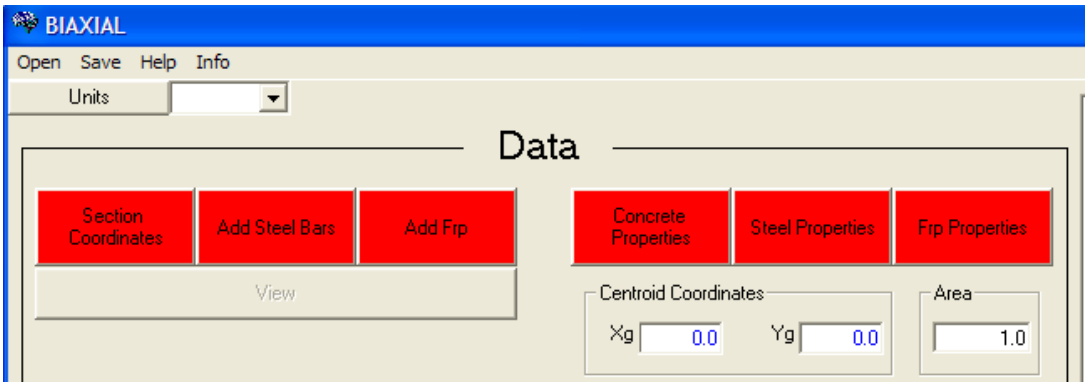
To a correct program utilization, the system language settings have to be: *decimal separator:* "."*; number grouping*: ",".



In any moment the user can save the inserted data by using the ”Save” menu. By the “Open” menu it is possible to open a saved cross-section. Such dialog boxes are those typically of Windows. The file will be saved in *.bi format.

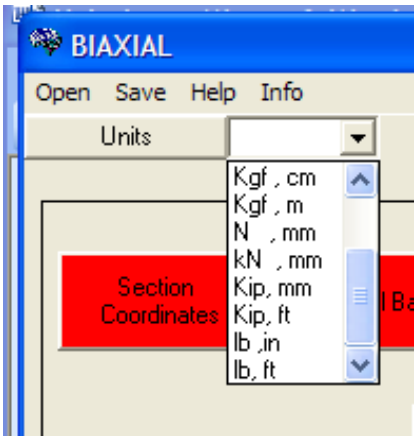


In the main screen, the input data dialog box are shown in a red color. Once the data will be inserted in each dialog box, the color red will become green.


BIAXIAL
Open
Save
Help
Info
Units
Data
Section Coordinates
Add Steel Bars
Add Frp
View
Concrete Properties
Steel Properties
Frp Properties
Centroid Coordinates
Xg
0.0
Yg
0.0
Area
1.0

STEP by STEP DATA APPLICATION PROCEDURE

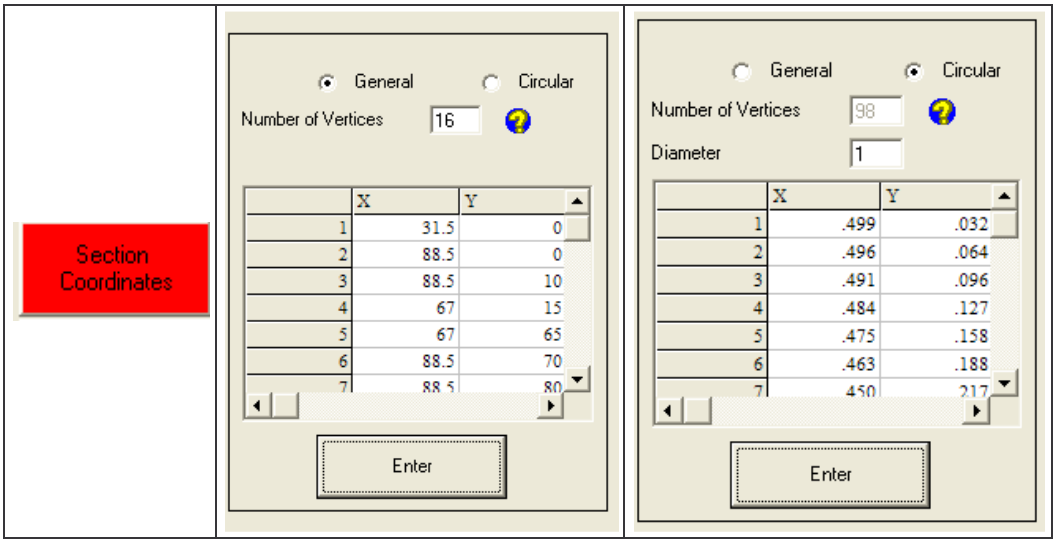
- # UNITS SELECTION



The program allows using any units; it is necessary, however, to be consistent. The results will be displayed in the chosen units. At the top of the main screen there is a menu library from which the user can select the units; once selected, such units will be displayed in each dialog box.
It is important to note that the units choice from the menu library is not strictly necessary (the program works in any case) but represents just a tool to simplify the use of the program.

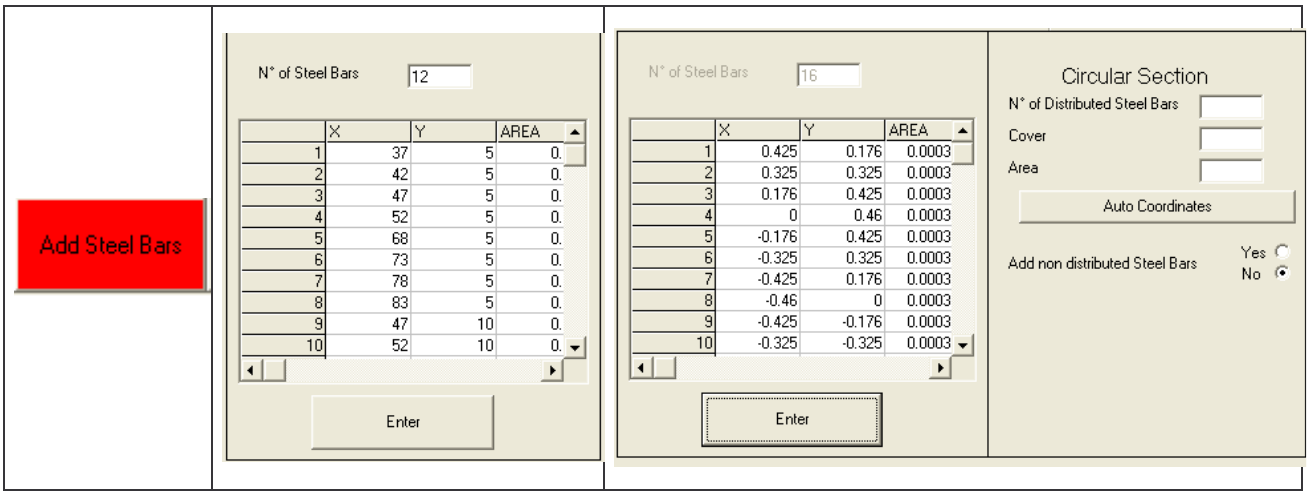
- **GEOMETRICAL DATA**

SECTION COORDINATES



The "Section Coordinates" dialog box allows inserting the concrete cross-section vertices by indicating the number of the vertices and their coordinates. The vertices of the external perimeter have to be inserted anticlockwise while in the case of hollow cross-section the vertices of the internal perimeter has to be inserted in a clockwise direction In order to analyze also circular cross-section in a simply way, it is possible to click on the "*circular*" button. In such case, the cross-section data required is only the diameter. Once the diameter has be inserted the program automatically provides the coordinates vertices of the polygon (with 98 sides) inscribed in the circumference with such diameter.

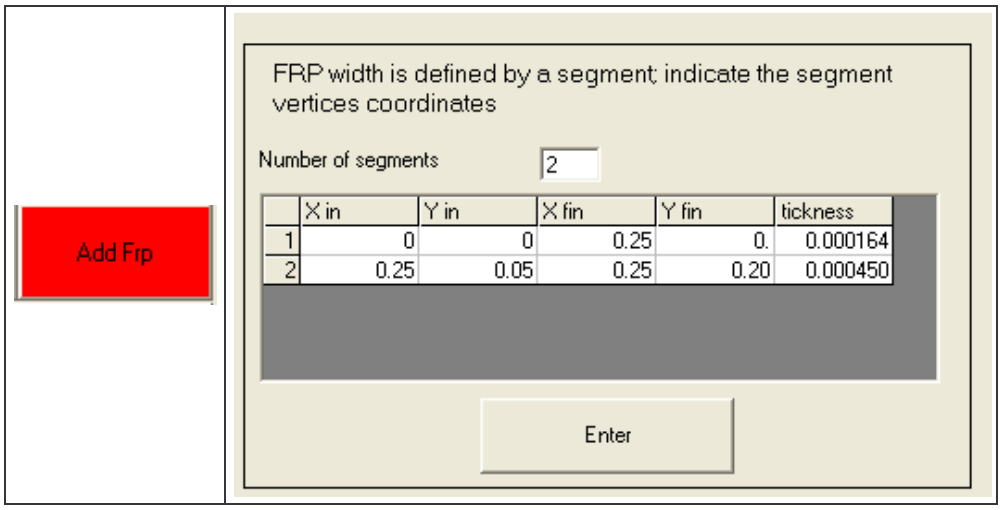
ADD STEEL BARS



The "Add Steel Bars" dialog box allows inserting the steel reinforcement. Once steel rebars number is entered in the apposite box, it is necessary inserting the coordinates of each bar centroid and its area. In the case of circular cross-sections, in order to allow inserting a distributed steel reinforcement (along the cross-section perimeter) in a simplified way, it is possible to indicate only the number of steel rebars, its area and the concrete cover. The program automatically provides the coordinates of the steel rebars.

If the user needs to add some others steel rebars in the cross-section, it is possible to use the option "*Add not distributed steel bar"*; in such case the area and the coordinates of the added rebars have to be inserted manually by the user.

ADD FRP



It is also possible to perfrom the calculations on fiber-reinforced cross sections.
In order to insert external reinforcement, one could specify the initial and final coordinates and the tickness of the FRP segment by clicking the "*Add FRP"* button. For example, the data introduced in the dialogue box "Add Frp" above, corresponds to the reinforcement segment shown below in Figure 1.

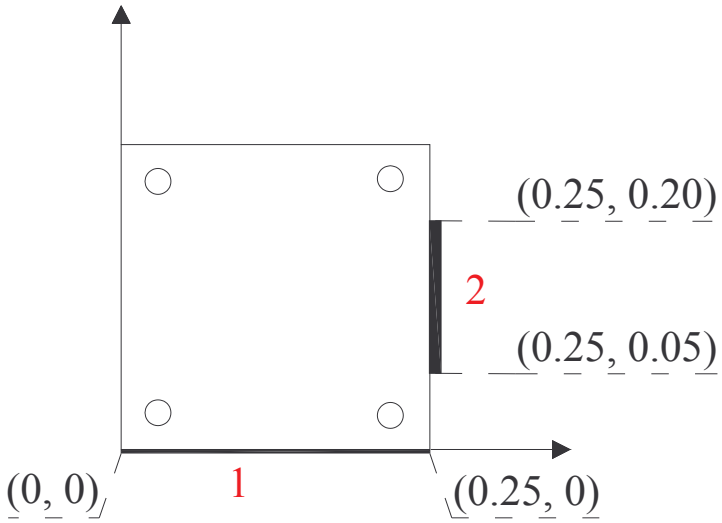
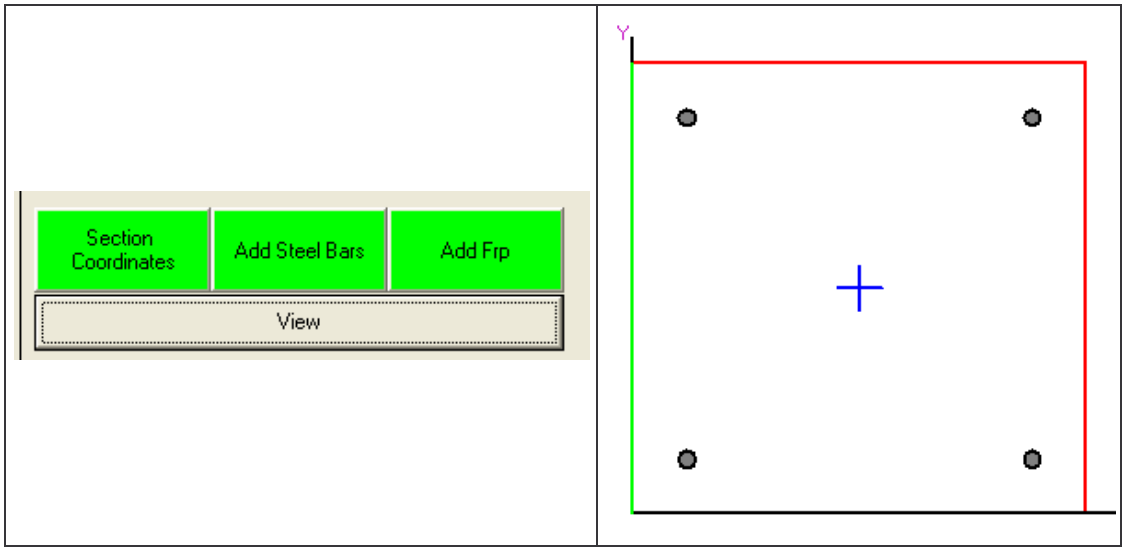


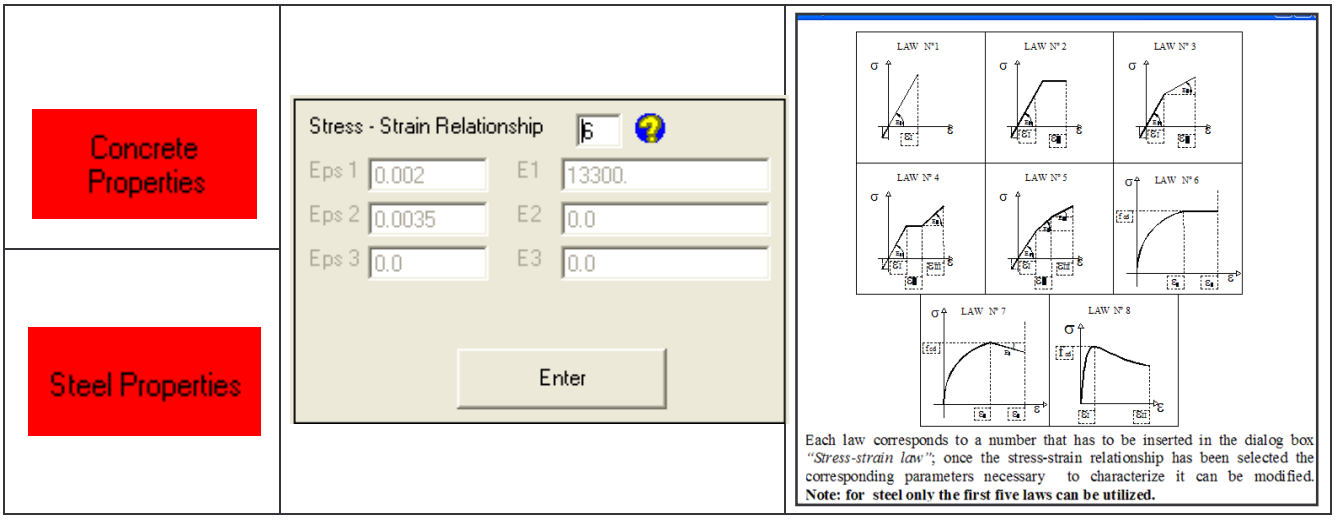
Figure 1

VIEW GEOMETRY



At this stage the cross-section can be visualized in the white window on the right side by using the button “View”. The program provides also the concrete cross-section centroid and area.

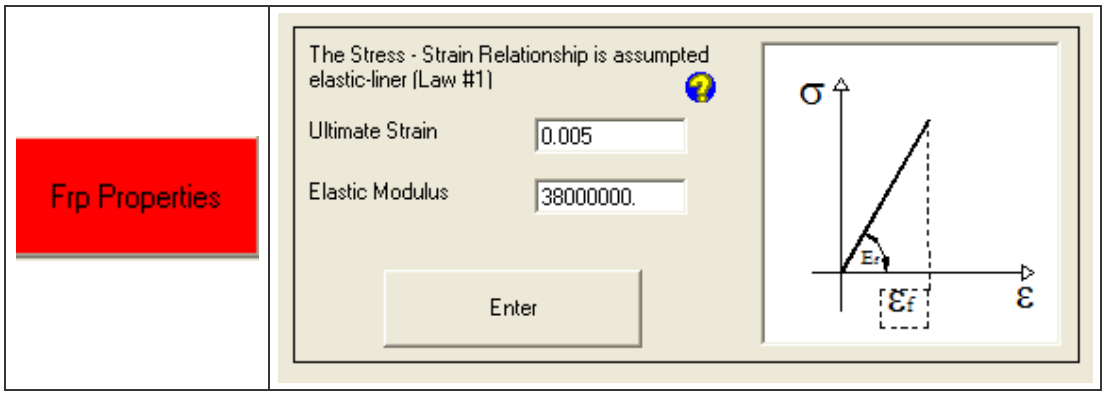
- **MATERIALS PROPERTIES**



After the geometry data have been inserted, it is necessary to specify the materials properties. Eight pre-defined stress-strain relationship are available. Each law corresponds to a number that has to be inserted in the dialog box *"Stress-strain Relatioship"*; once the stress-strain relationship has been selectedthe corresponding parameters necessary to characterize it can be modified. By press the "?" it is possible to visualize the 8 pre-defined stress-strain laws with the corresponding main parameters to insert. The Steel and Concrete Stress-strain Relatioship can be insert by press the boxes "Concrete Properties" and "Stell Properties".

Note: for steel only the first five laws can be utilized.

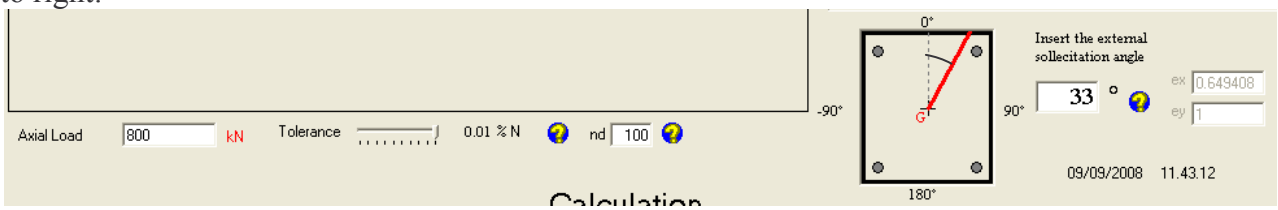
- **FRP**



If the section to analize has reinforcement, it is necessary to specify the FRP properties across the dialogue box *"Frp Properties"*. The Stress – Strain Relationship is assumed linear-elastic as it is shown in the previous picture. The two parameters necessary to characterize the stress-strain law should be introduced in the dialogue box.

- # LOAD ASSIGNMENTS

In the middle of the main screen there is the edit zone referred to the load assignments; from left to right:



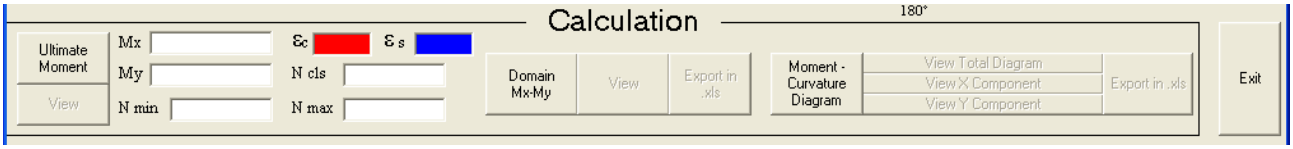
- **Axial load value**

- **External load orientation angle** expressed defined as the angle between vertical axe and external load application point

- **Tolerance** expressed in function of the axial load P. It is the maximum allowed difference between the external and internal axial load and orientation angle. Lower tolerance values provide more accurate results but higher solution time .

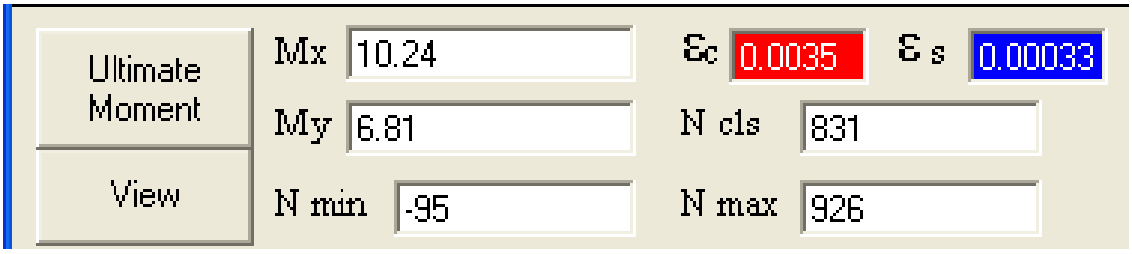
- **nd** –number of discretization fibers, is the number of fibers used to discretize the entire concrete cross-section along each side. The maximum value that can be edited is 1000. As before, a higher number of fibers provides more accurate results but hig her solution time.

- **CALCULATIONS**



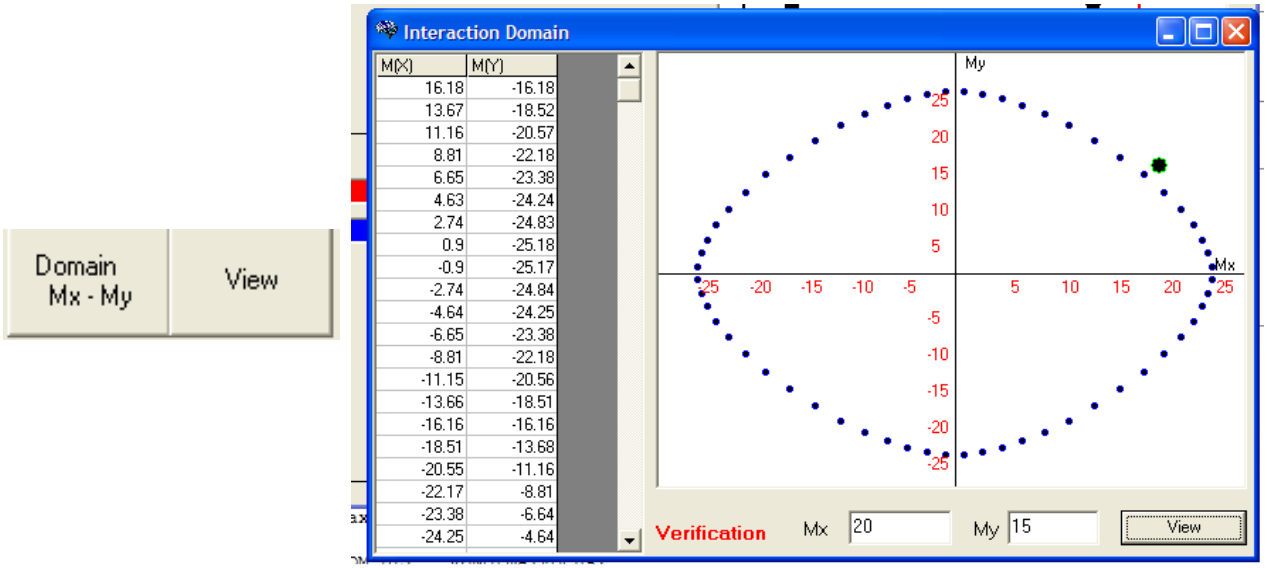
The calculation section is in the low-left corner of the main screen. The are three different button that allow (once the "ForTran" execution is finished) to visualize the calculation results.

- **ULTIMATE MOMENT**



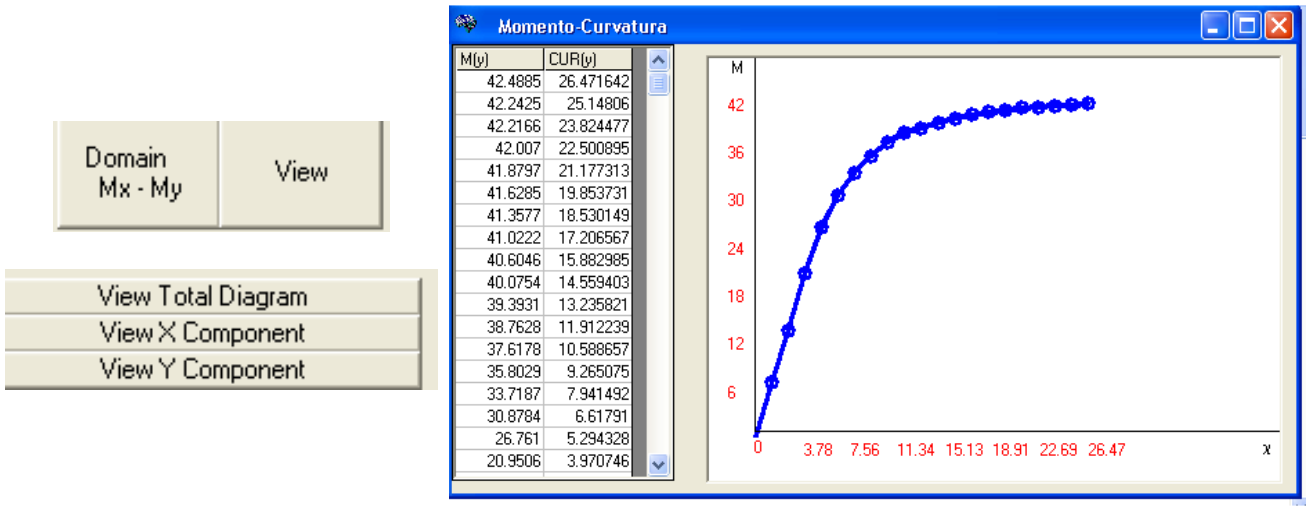
By clicking the "*Ultimate moment"* button the program determines the ultimate moment referred to the centroidal x and y axis; the maximum compressive concrete strain and the maximum tensile steel strain are also showed in the right boxes on the right. Such results can be visualized by clicking the "*View*" button. The value of N_{cls} , N_{min} ed N_{max} are maximum axial load of the concrete, the minimum axial load of the steel and the maximum axial load of the section (steel plus concrete).

▪ INTERACTION DOMAIN



By clicking the *"Interaction Domain"* button, the program determines the interaction domain. The results, both in a graphical and numerical manner, can be visualized in an apposite dialog box that appears by clicking on the "*View*" button. It is also possible to verify the cross-section by inserting the external acting moment and checking that it is represented by a point within the domain surface. The determined moment values for the domain construction can be utilized for others application by opening (with any type of text editor program) the "MOM.out" file (that is automatically produced by the program). In such way it is possible to use the program results also with other programs (i.e. excel) for the graphical view and for further applications.

- # MOMENT-CURVATURE DIAGRAM



Also in this case once the "*Moment-Curvature Diagram"* button is clicked, both the numerical results and the diagram can be visualized (by clicking on the "*View*" button"). The curvature and the moments referred to the x-axis and the y-axis are computed; the moment-curvature diagram is obtained by using the SRSS method.The numerical results are reported in the left side of the dialog box and can be used for other applications by opening (with any type of text editor program) the "CUR.out" file (that is automatically produced by the program). In such way it is possible to use the program results also with other programs (i.e. excel) for the graphical view and for further applications.

Note: In the folder where the user has saved the cross-section data, there will be a file "1.in" in which all the input data are available.