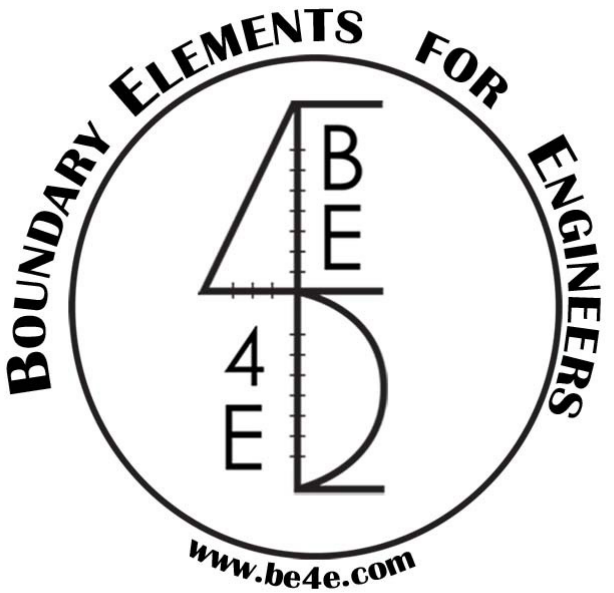


# The PLDesign module

## *USER MANUAL*

**PLPAK Version 2.00**
**STRUCTURAL ANALYSIS SOFTWARE USING**
**THE BOUNDARY ELEMENTS METHOD**

https://www.plpak.com
E-mail: plpak@be4e.com

# Table of Contents

## Disclaimer

Considerable time, effort and expense have gone into the development and documentation of the PLPAK™ software. The PLPAK™ software has been thoroughly tested and used. The PLPAK™ software should be used by engineers with good understanding of concrete behavior, pre-stressing and structural mechanics. The user accepts and understands that no warranty is expressed or implied by the developers or the distributors on the accuracy or the reliability of the PLPAK™ software. The user must explicitly understand the assumptions of the PLPAK™ software and must independently verify the results produced by the PLPAK™ software.

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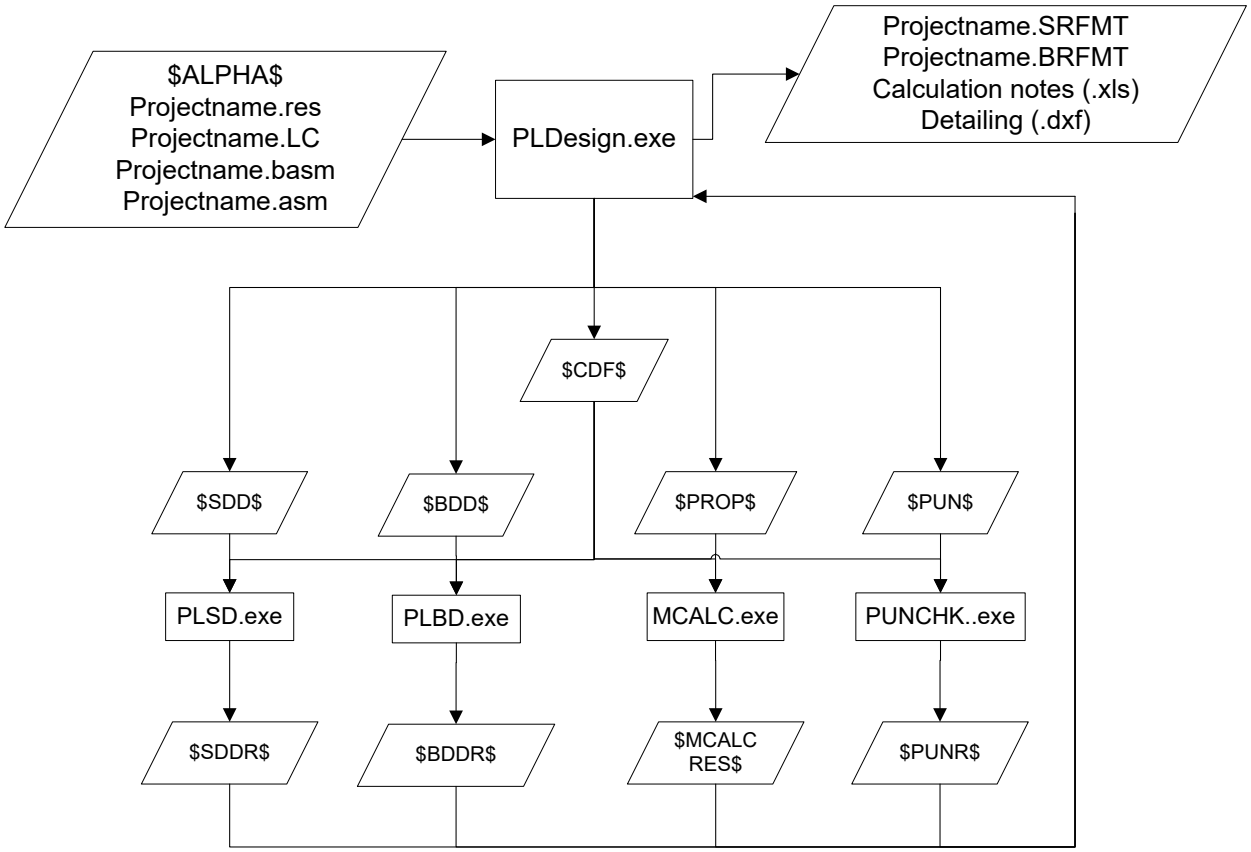
e-mail: plpak@be4e.com
web: https://www.plpak.com

## Introduction

The PLDesign is an add-on for the PLPAK software (www.plpak.com) that is responsible for the automated reinforced concrete design of the slab and beam sections analyzed by the PLPAK. The PLDesign utilizes the BEM features adopted by the PLPLAK to offer to the user easy, fast and efficient design and detailing that suits any structural engineering community expectations.

In this part of the manual, all the PLDesign commands and operations are going to be discussed explicitly.

## The PLDesign Operation Diagram




**PLDesign operation diagram**

| File | Description |
|---|---|
| **Projectname.LC** | Load case file |
| **Projectname.res** | Results file |
| **Projectname.basm** | Beam assembly file |
| **$SDD$** | Slab Design Data file |
| **$SDDR$** | Slab Design Data Reinforcement file |
| **$BDD$** | Beam Design Data file |
| **$BDDR$** | Beam Design Data Reinforcement file |
| **$PROP$** | Basic mesh Data file |
| **$MCALCRES$** | Basic mesh maximum moment |
| **$PUN$** | Punching Data file |
| **$PUNR$** | Maximum punching stress file |
| **Projectname.SRFMT** | Slab reinforcement file |
| **Projectname.BRFMT** | Beam reinforcement file |

**PLDesign file descriptions**

| Program | Description |
|---|---|
| **PLDesign.exe** | The main program that includes the user interface and controls the operation of other programs. |
| **PLSD.exe** | Slab designer |
| **PLBD.exe** | Beam designer |
| **Mcalc.exe** | Calculator of moment resistance of reinforcement mesh |
| **Punchk.exe** | Punching resistance calculator |

**PLDesign programs description**

## The PLDesign philosophy

The PLDesign is the PLPAK component that will be responsible for the structural design of reinforced concrete slab and beam objects. The philosophy of the PLDesign is based on giving valued capabilities to the user.

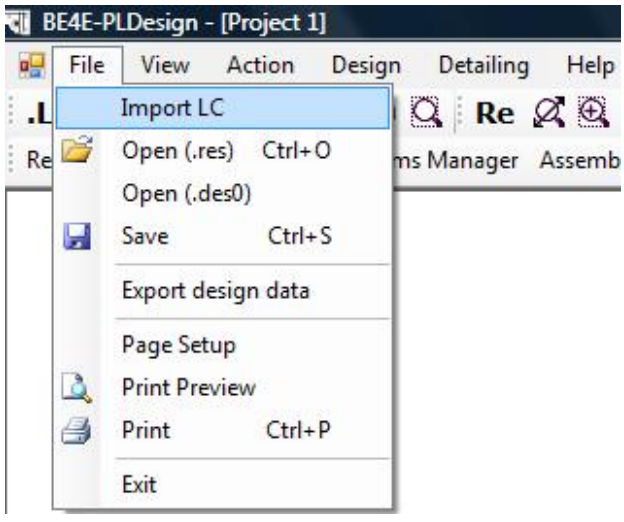
PLDesign capabilities:

The new interface should provide the user with the following capabilities:

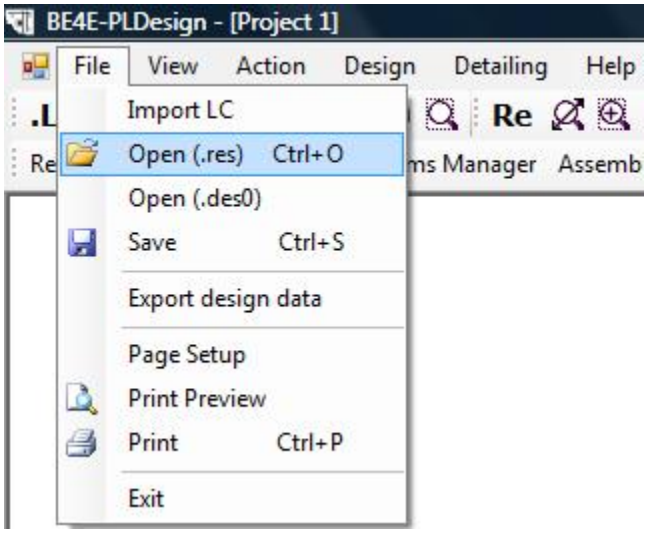
- To utilize BEM results in the structural design easily.
- To choose the design code and appropriate design parameters. Currently, the PLDesign has the following codes:
    - The American Code (ACI),
    - The Eurocode (EC2).
    - Egyptian Code Of Practice (ECOP)
- To create full design for slab parts under bending moment based on either contour or strip results.
- To check punching stresses in the slab around regular/ irregular load/support elements.
- To create full design for beams under bending moment, shear and torsional stresses directly on the plan of the problem.
- To choose the reinforcement layout.
- To perform an accurate analysis for deflection limits.
- To export basic detailing.
- To export design results in the required formats to be used in RVT11ToPLGen.

## Starting the PLDesign

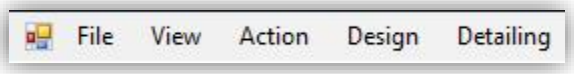
Step#1: Load the model from .LC file



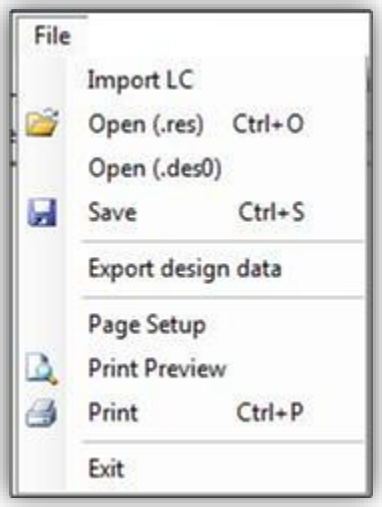
Step#2: Load the PLPost results already solved and saved as (*.res) **(If necessary)**




## The PLDesign Menus




### The File menu




#### File | Import LC

Imports a numerical boundary element already completed and solved in the PLPost. This model will be used for the design purpose.

### File | Open (.res)

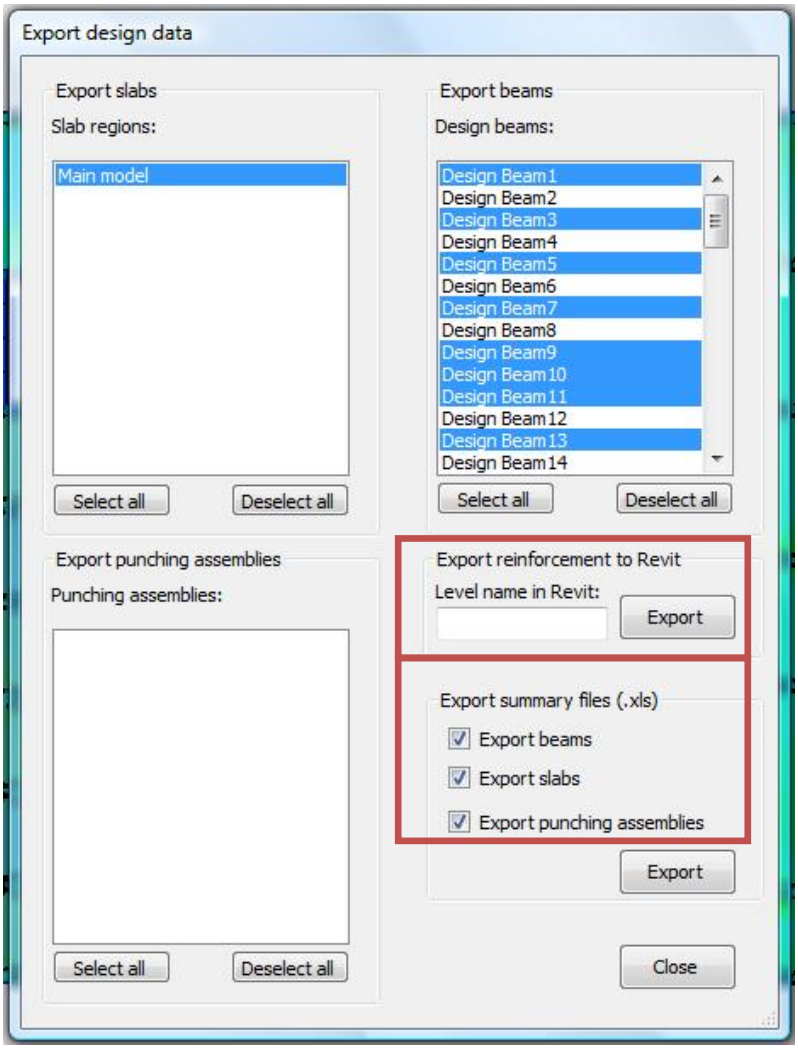
Opens the results already saved by the user in the PLPost (either global or local contours, strips or other results) already solved.

### File | Open (.des())

Opens a design result already saved in the PLDesign.

### File | Export Design Data

This window is used to export the PLDesign design data to Excel & Revit for detailing. In this window you can define the required slabs and beams for export. The host level in Revit files can be imported in Revit using the Load Reinforcement from PLDesign tool. The tab gives the user a great advantage to export the model already designed to AutoDesk Revit to preview the required detailing for each section.



### File | Page setup

Brings up a dialog box in which the user can choose the size of the paper, the orientation and the margins

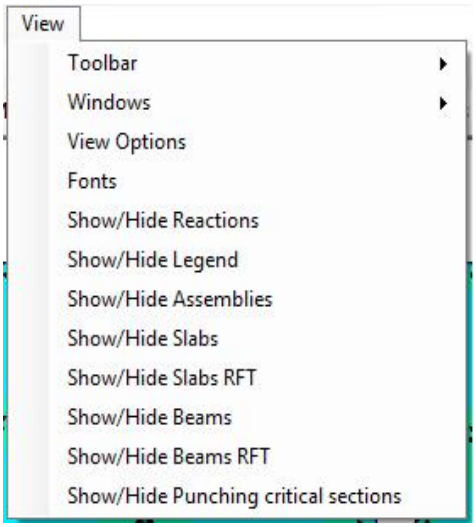
### File | Print Preview

Brings up a small window in which the user can preview the .des file before printing

### File | Print

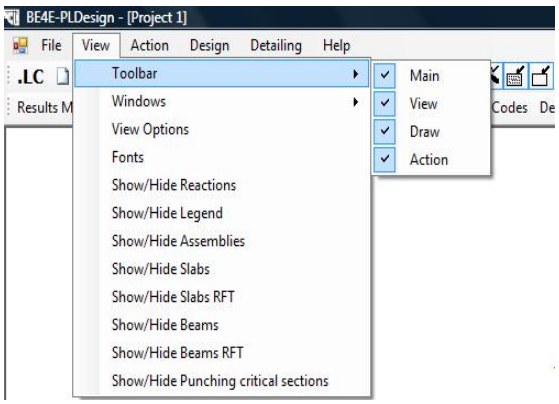
Brings up a dialog box in which the user can choose the printer and print the current .des file

## The View Menu



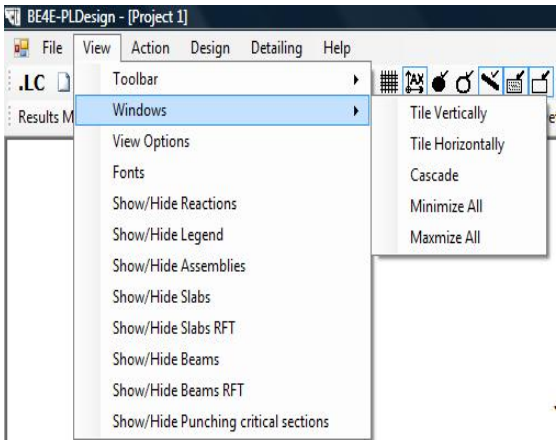

### View | Toolbar

Used to control which toolbars should appear on the screen, the same function can be performed using right click on any toolbar. The mark beside a toolbar implies that it is selected.



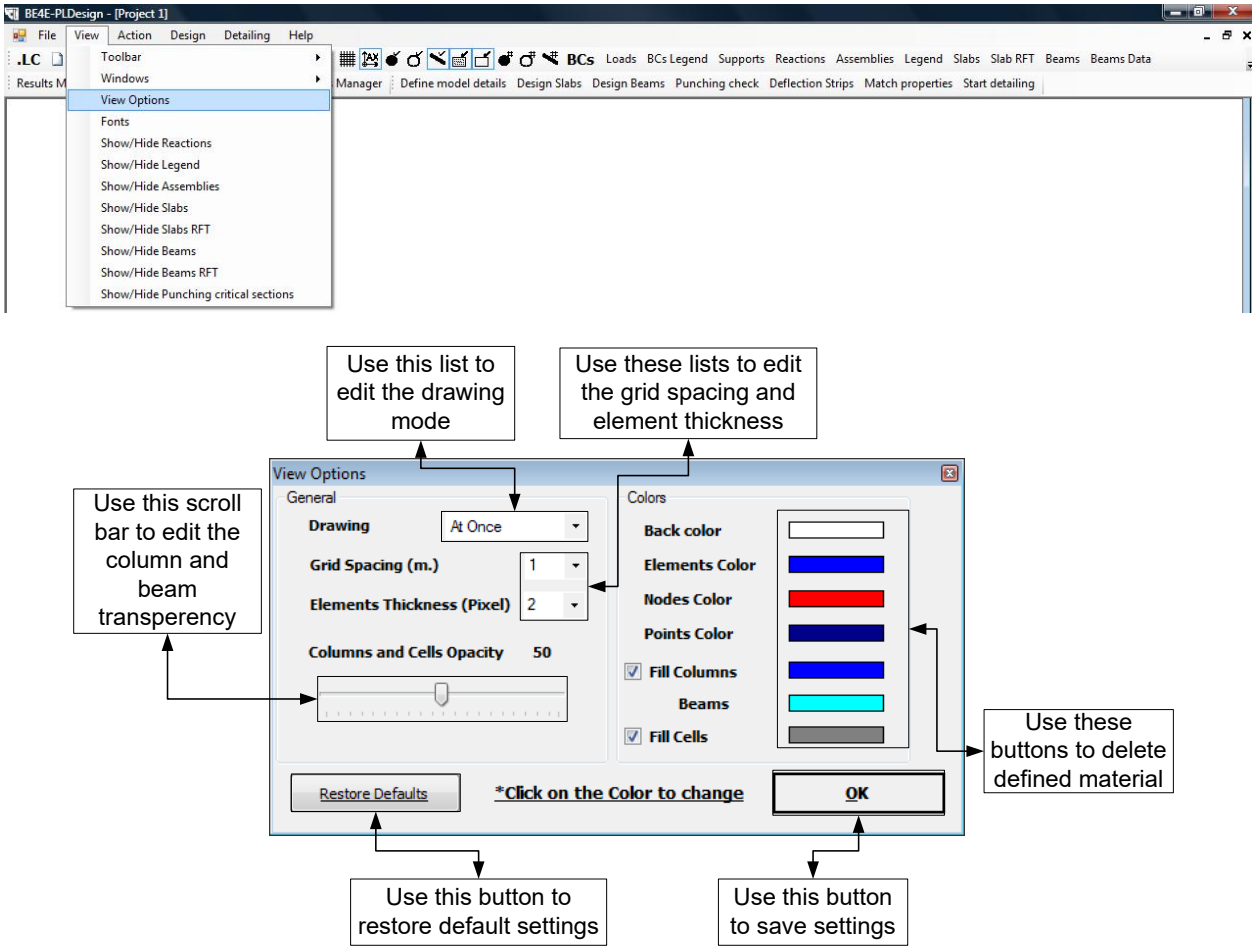

### View | Windows

Used to choose window options while using more than a single PLDesign interface at the same time.

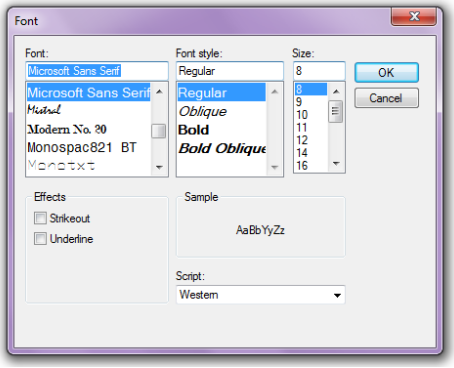



## View | View Options

Clicking on view options allow you to change the drawing sequence of the result elements, grid spacing, element thickness, opacity & colors of different elements.



## View | Fonts

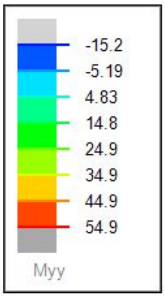



## View | Show/Hide Reactions

The Show/Hide commands can be used to show or hide Loads, No. of divisions of every element, Co-ordinates of the cursor, grid and axis

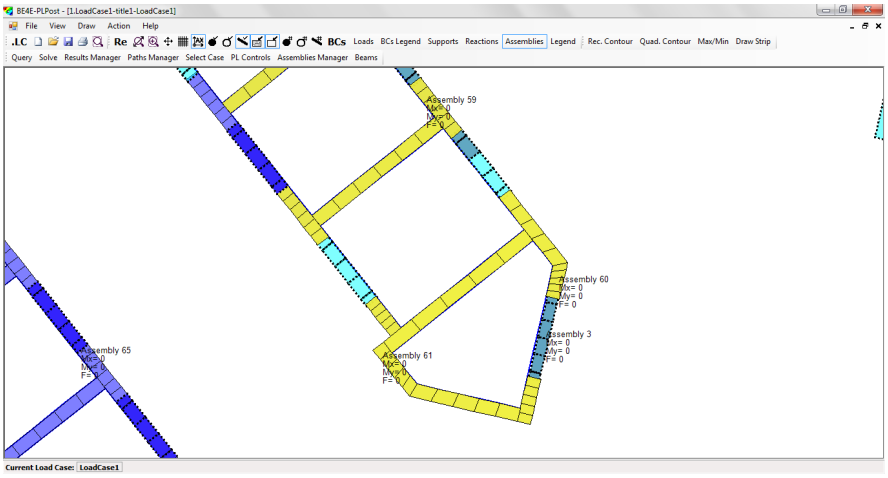
## View | Show/Hide Legend

The Show/Hide legend command is used to view the legend corresponding to the contours displayed by the user.



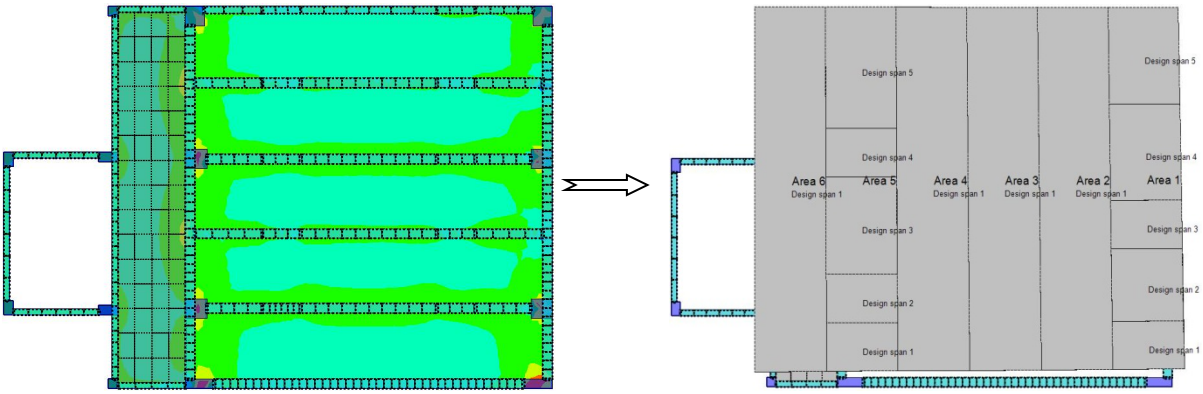

## View | Show/Hide Assemblies

The Show/Hide command is used to show the Straining actions of Assemblies (Shear walls without beams, Columns loads without beams).



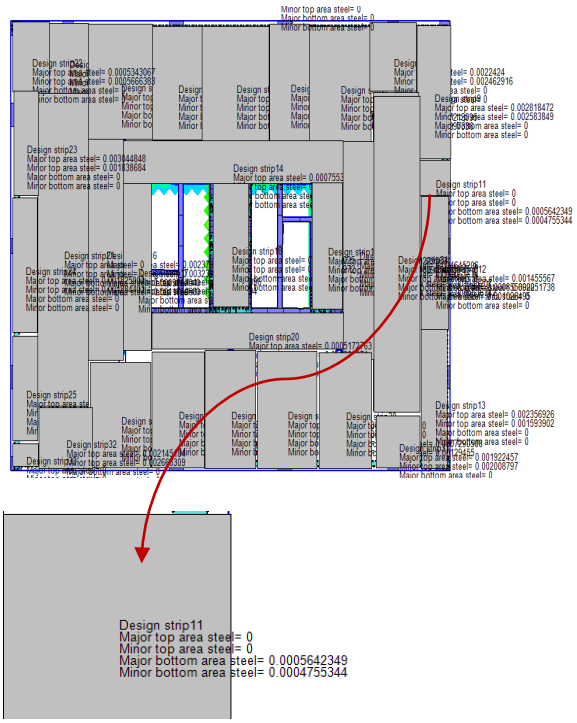
## View | Show/Hide Slabs

Used to preview a numbering for each rectangular or quadrilateral contour used for the slabs design.



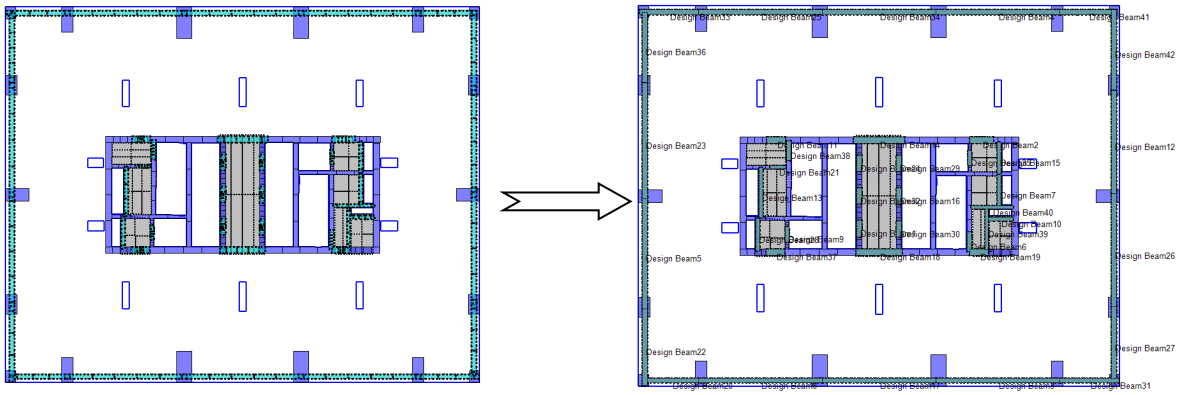

## View | Show/Hide Slab RFT

Used to preview the reinforcement required for each design slab in both major and minor directions.




## View | Show/Hide Beams

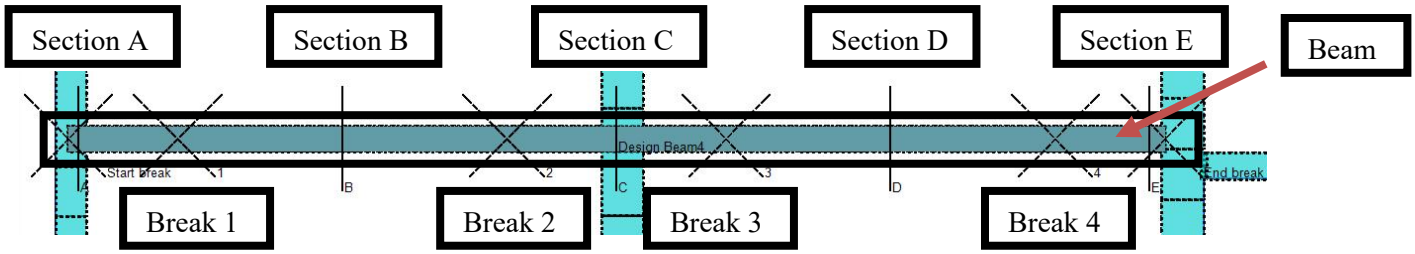

The Show/Hide Beam Command allows the user to recognize each beam name necessary for the design.



### View | Show/Hide Beams RFT

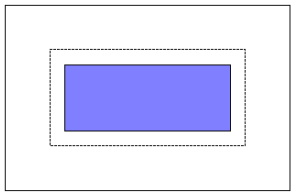
The Show/Hide Beams RFT command allows the user to be acquainted with the beams components such as sections and breaks which are set by the user as shown later.

Hint about Sections and Breaks of the beams: Each beam is divided into three regions defined by four breaks surrounding them (Start Break, End Break, Break 3, Break 4).The most critical section in each region is chosen relative to the region's length (0.5 of the middle region, and 0.1 starting from the ends of the left and right region).

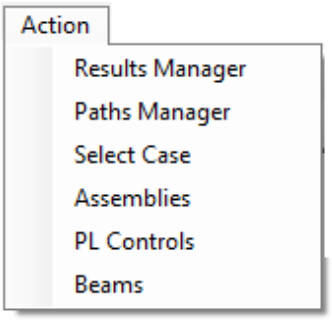



### View | Show/Hide Punching Critical Sections

The Show/Hide Punching critical section command shows/hides punching critical sections.

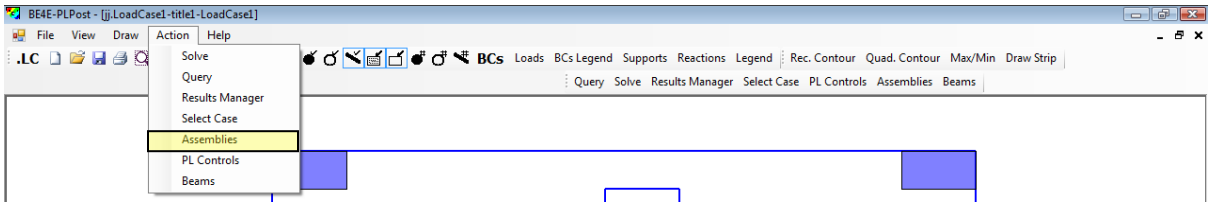


## The Action menu




### Action | Results Manager

This command shows the results manager which is used to control the properties of the strips and result areas which have been previously drawn.



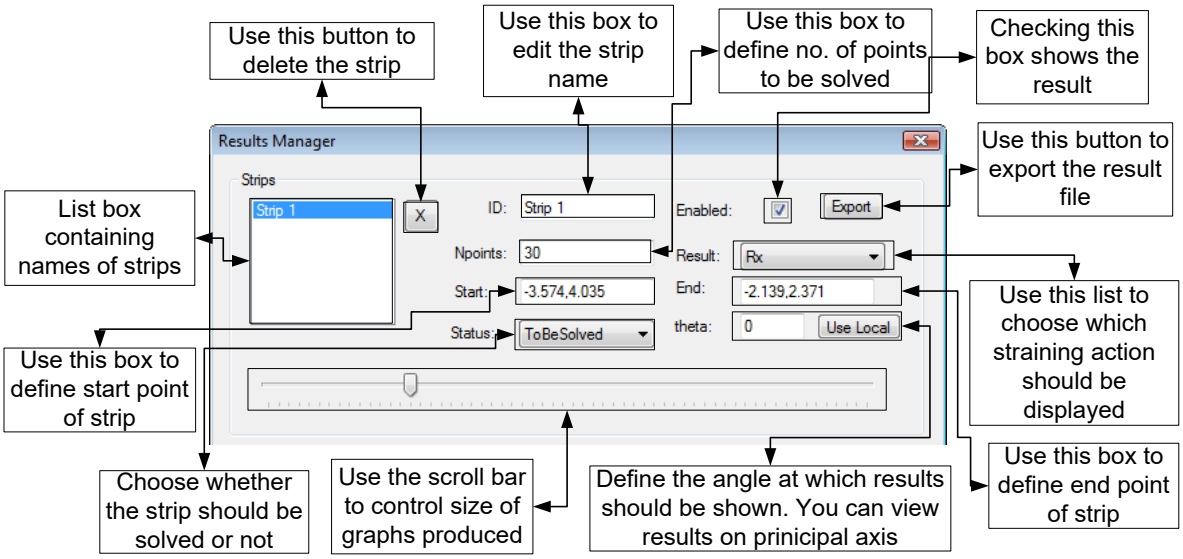

### *PLPost Results*

The following table shows the results that can be shown by PLPost.

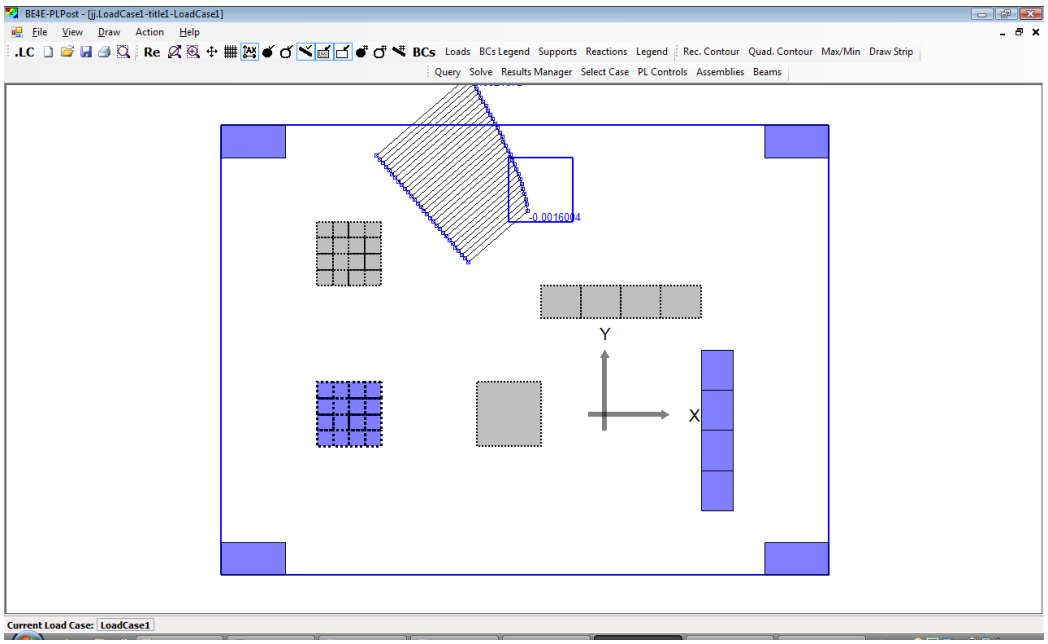
| Quantity | Description |
|---|---|
| Rx | Rotation about the X axis |
| Ry | Rotation about the Y axis |
| Uz | Deflection in Z axis direction |
| Mxx | Bendng moment in X direction |
| Mxy | Twisting moments about X and Y directions |
| Myy | Bendng moment in Y direction |
| Qx | Shear Force in X direction |
| Qy | Shear Force in Y direction |
| Mii | Bendng moment in i direction |
| Mij | Twisting moments about i and j directions |
| Mjj | Bendng moment in j direction |
| Qi | Shear Force in i direction |
| Qj | Shear Force in j direction |
| Mmax | Maximum principal bending moment |
| Mmin | Minimum principal bending moment |

| | |
|---|---|
| Mxxdes | Design moment in X direction |
| Myydes | Design moment in Y direction |
| Miides | Design moment in i direction |
| Mjjdes | Design moment in j direction |

### *Strips:*

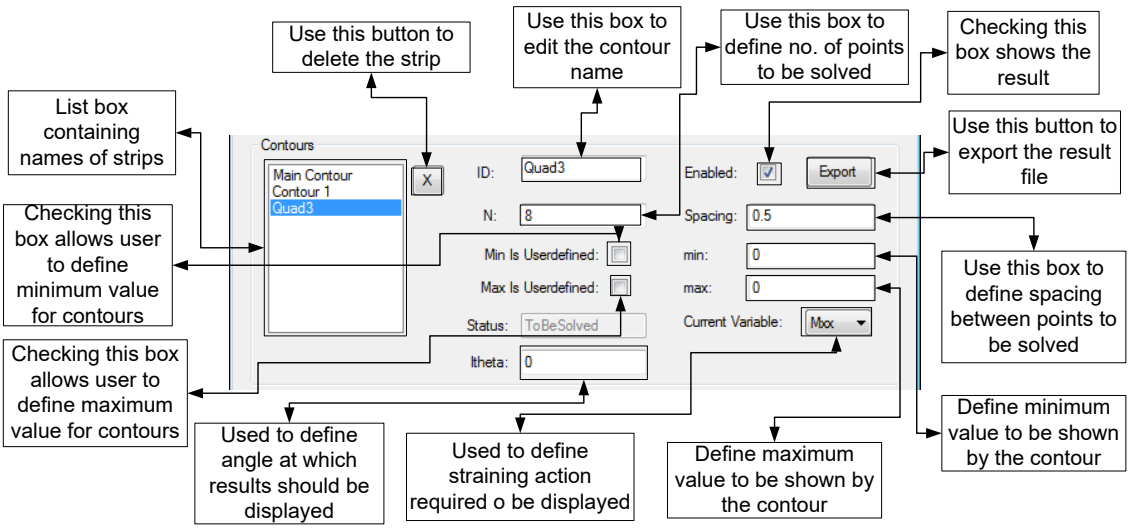


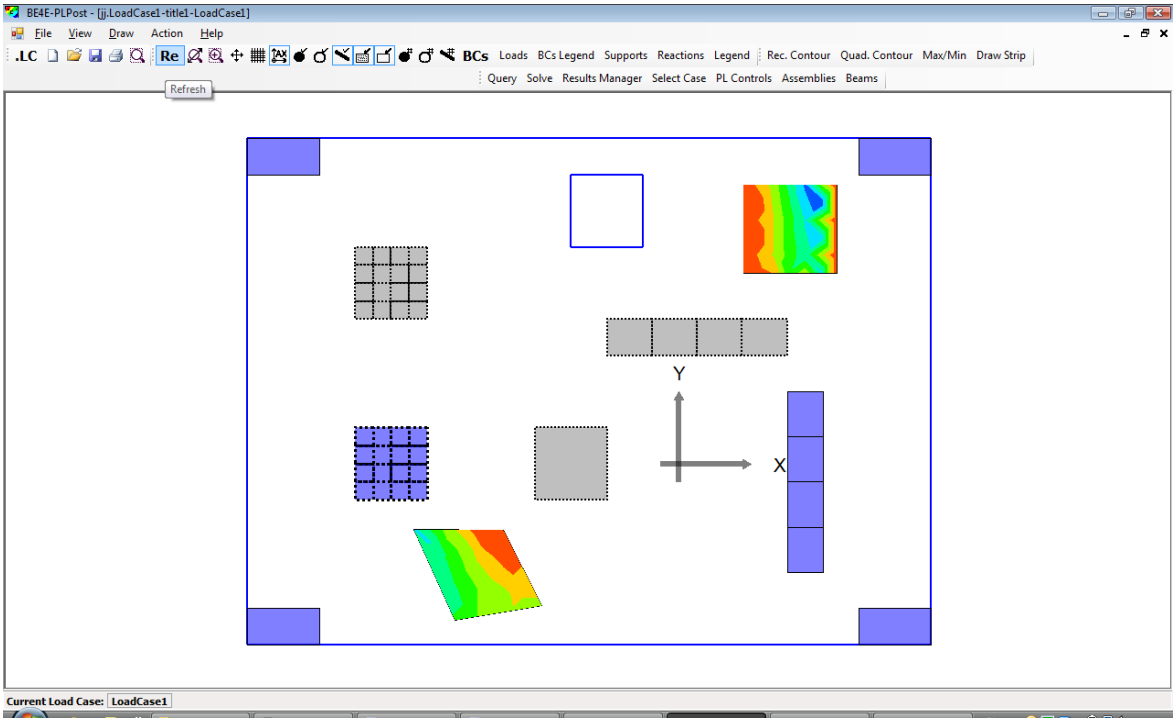

Strips: This part of results manager is used to control strip properties including ID, Start and End points, No. of points within the strip, type of stress resultant that is required to be displayed at this strip. Export command is used to export a tabulated format of the strip results, the produced tables can be used by any spreadsheet software.



### *Contours:*

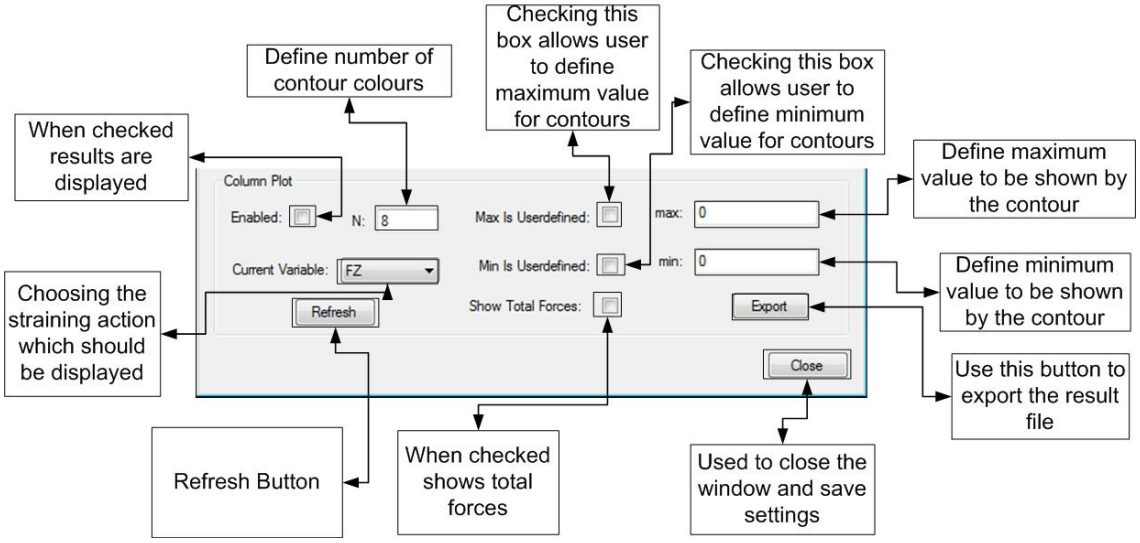
This part of the Results Manager is used to control properties of the contour areas. Main Contour is used to display contours all over the model, this is the only contour that can not be deleted. Using this dialogue you can control Contour ID, Type of stress component to be displayed, N which is the number of colours within the contour, spacing between points to be solved within the contour. Export command is used to export a tabulated format of the strip results, the produced tables can be used by any spreadsheet software.

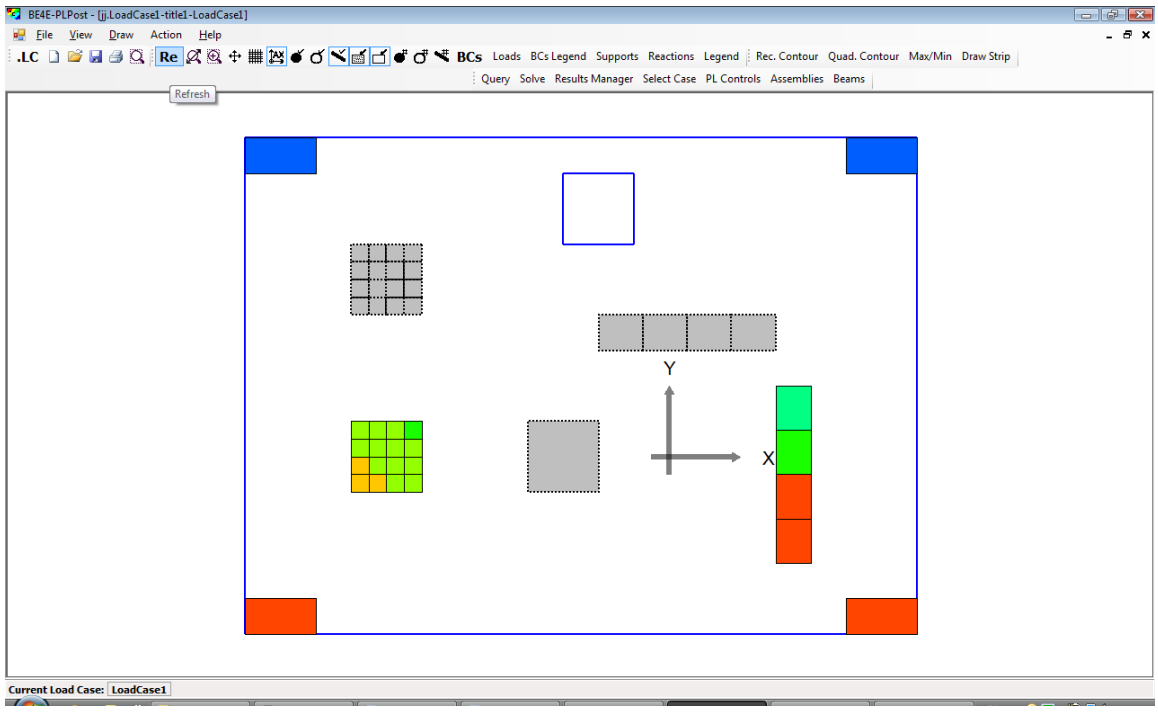


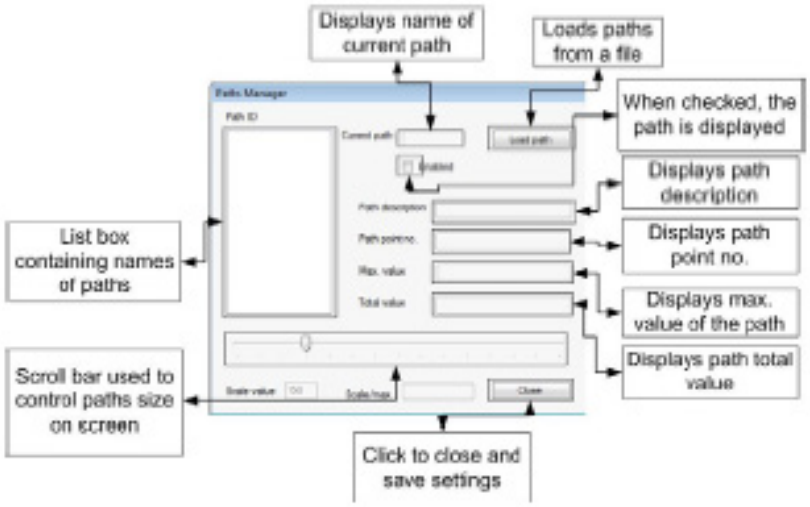
### *Column Plot:*

This part of result manager is used to show contour results at supports. This part is used to control the number of contour colours and type of stress component to be displayed. Export command is used to export a tabulated format of the strip results, the produced tables can be used by any spreadsheet software.



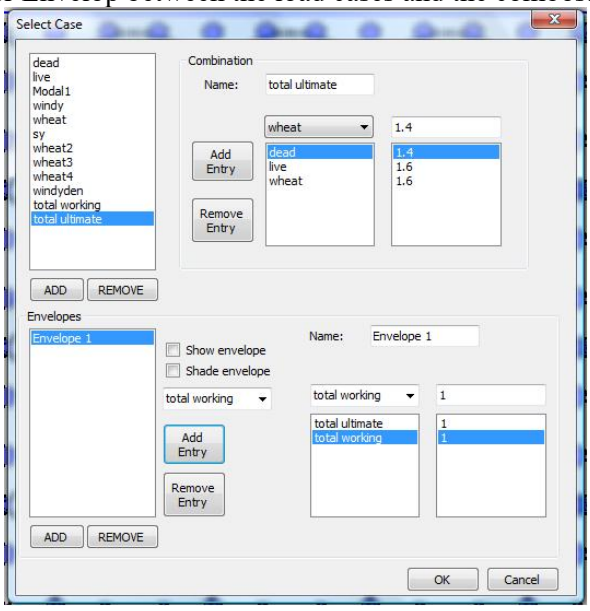



## Action | Paths Manager



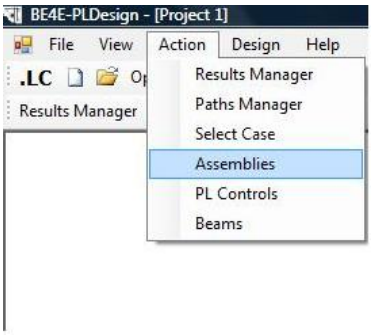

## Action | Select Case

This command is used to select the load cases or combos that are required for the design of the slabs and the beams. We can also enter Envelop between the load cases and the combos.




## Action | Assemblies

This command is used to show the cell properties. In order to show assembly results, type the cell number in the lower left box, then click add. The assembly results can be read at the normal X and Y directions or at any direction. The results at principal directions can be shown using the command “use principal”. The results can be exported to a file with a format that can be opened using any spreadsheet software.




Add assembly

Delete assembly

Display assembly name

Display assembly area

Export result file for assembly

When checked, allows the user to define CG manually

List box containing names of support assemblies

List box containing numbers of support assemblies

List box containing names of load assemblies

Sets "theta" to equal angle of principal direction

Displays straining actions and inertias in the "theta" direction

List box containing numbers of load assemblies

Displays straining actions and inertias

Export all result file for assembly load supports & load cells

Load assemblies file (.asm)

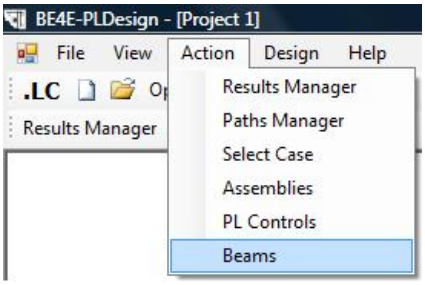
Click to close and save settings

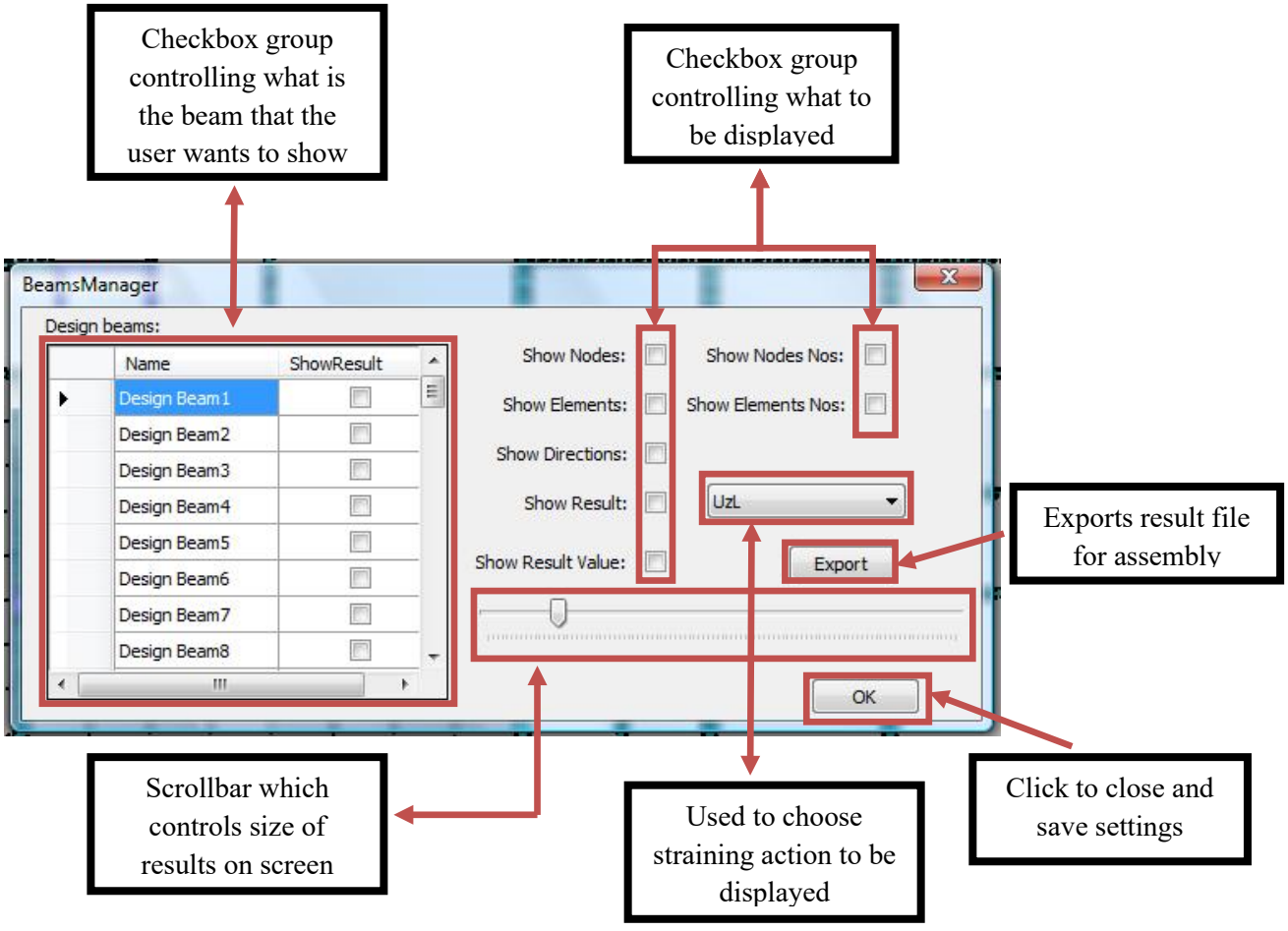
### Action | PL controls

Refer to PLCoreMan manual.

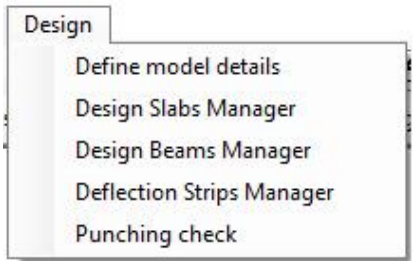
### Action | Beams

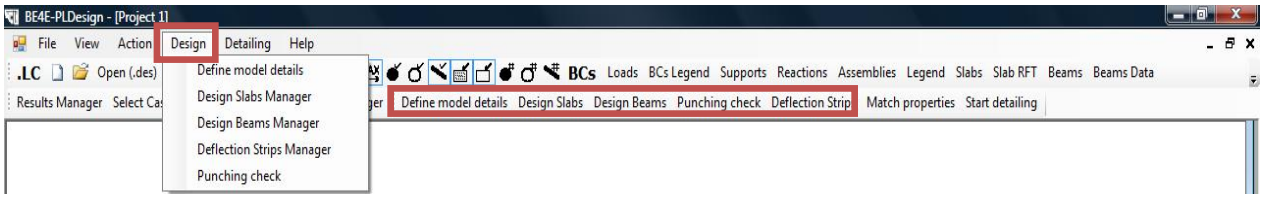
This command is used to display and edit beam results. The produced dialogue is used to show beam nodes, directions, and type of stress component that should be displayed on the beam.



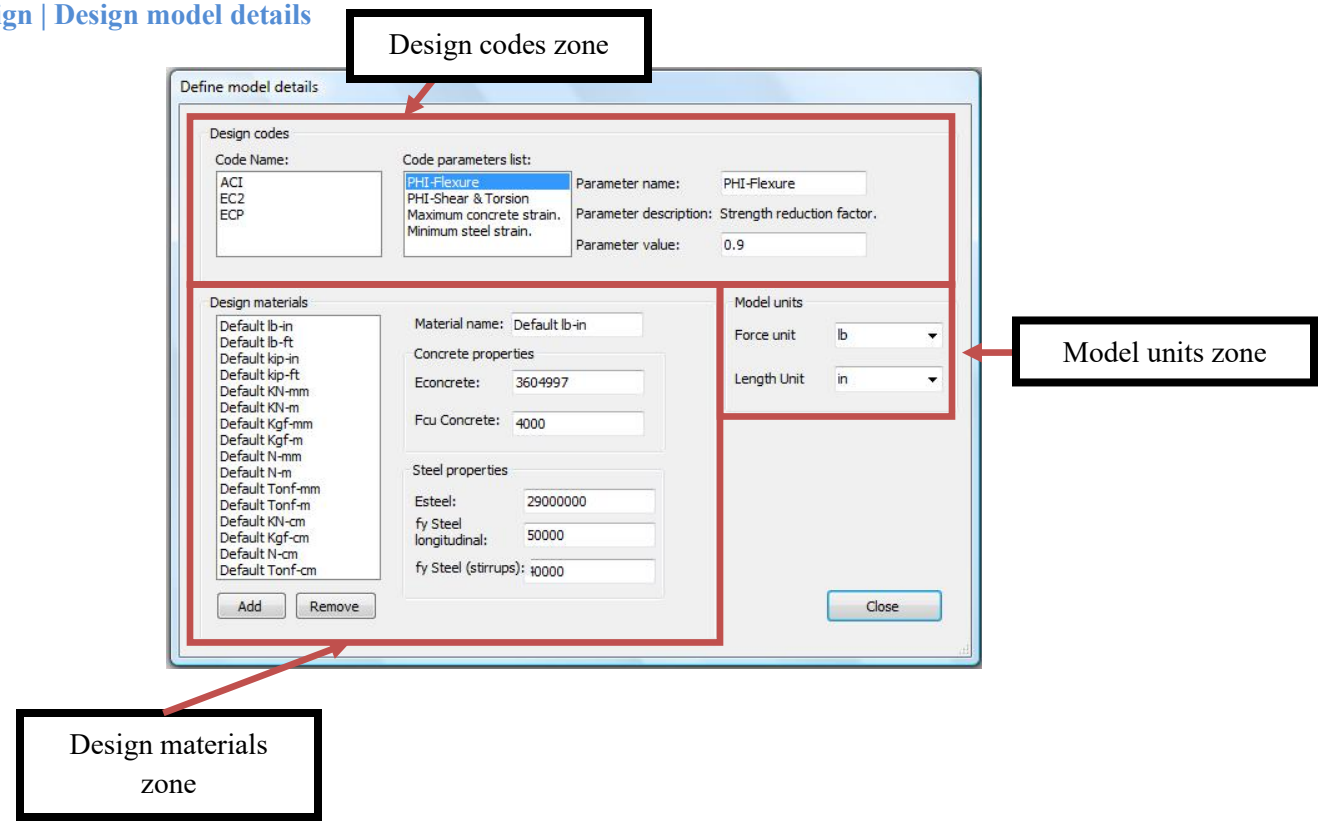



## The Design menu



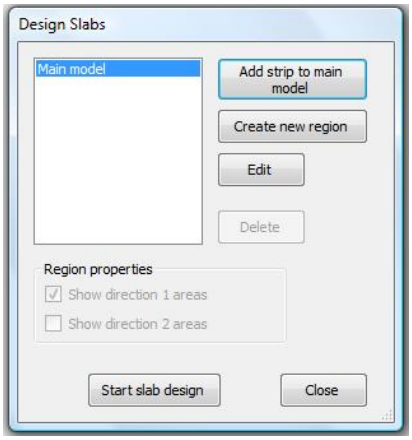

### Design | Design model details



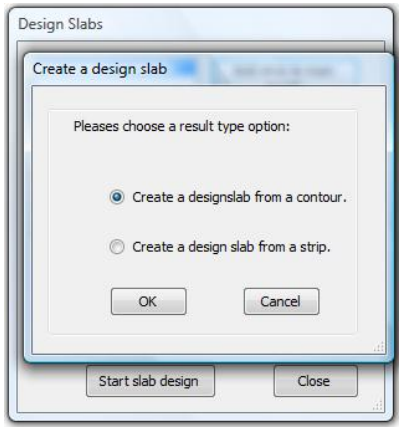
- The design codes allow the user to choose the required design code and to change the relevant design parameters. Currently, PLDesign supports ACI, EC2 and ECP.
- Throughout the PLPAK components, all the models were unit less; i.e., the user had to keep his units consistent. In PLDesign, the model units have to be defined; therefore, the model unit zone can be used by the user to define the models that he has been using so far throughout the model.
- The design materials zone allows the user to create and define the properties of any number of required design materials. The design materials are then attached to design slabs or beam sections.

### Design | Design Slabs

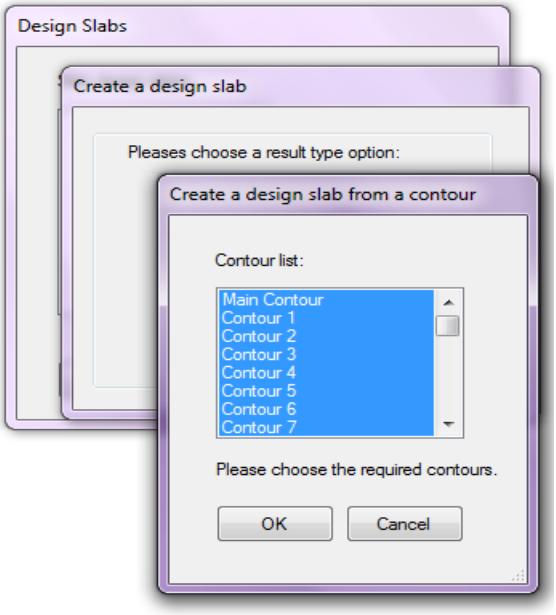
This is the PLDesign menu that can be used to design slab parts under flexural stresses.



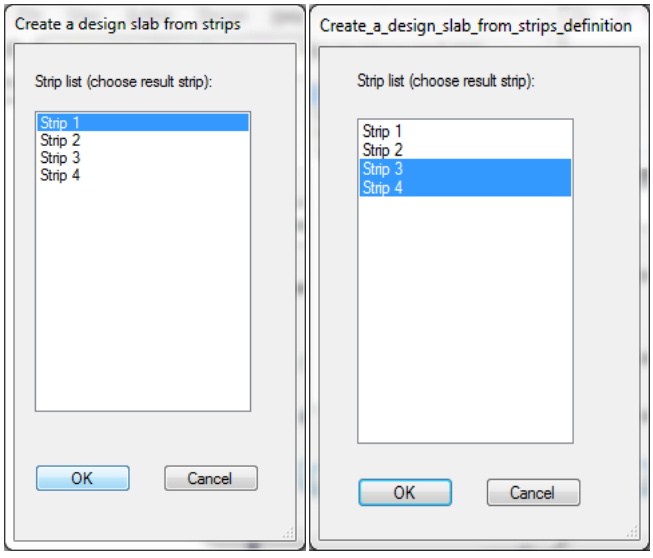

When you choose to "Add strip to main model" a design slab, this dialogue box will allow you to create design slabs from ready local contours or strip results (present in the Results Manager).



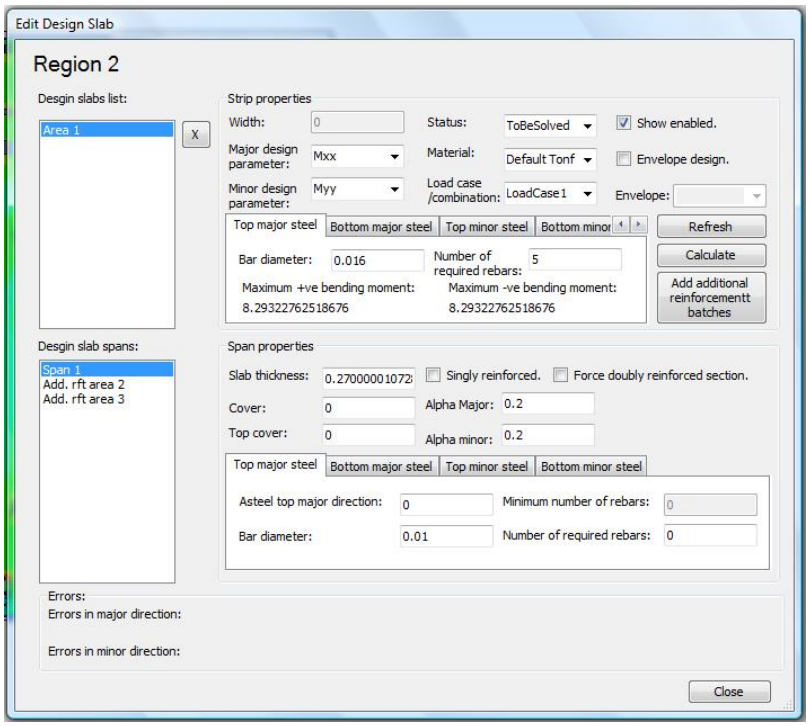
If you choose to create design slabs from contours, you will reach this mean that can be used to create multiple design slabs from local contours.




If you choose to create design slabs from strips, you will reach this menu that can be used to create design slabs from strips. The definition of a design slab from a strip requires the user to define the main strip and the area definition strips.

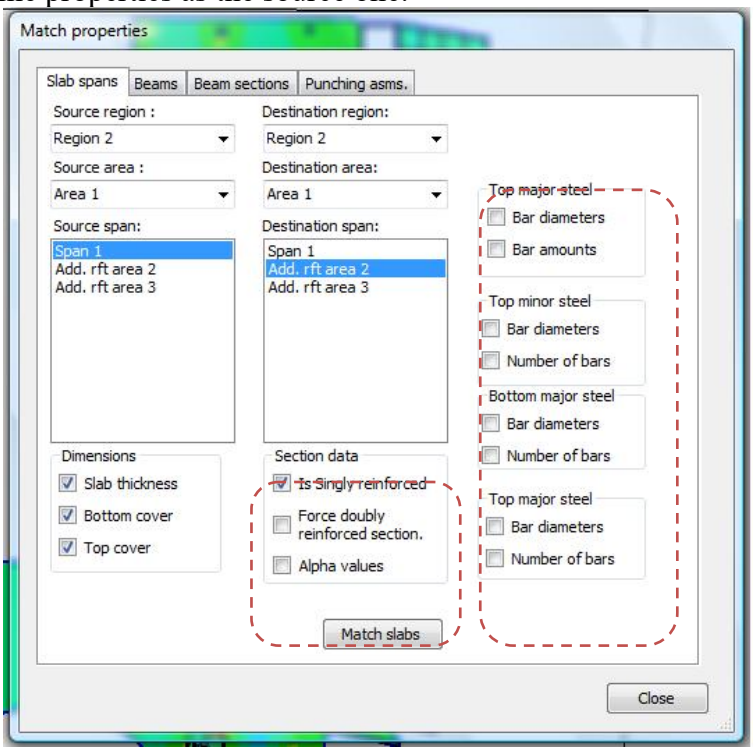



After creating your design slabs, you can edit them directly from the Edit Design Slab menu shown below. This menu can be used to modify all possible slab design properties, reinforcement layout. In addition, it will display design errors if any.

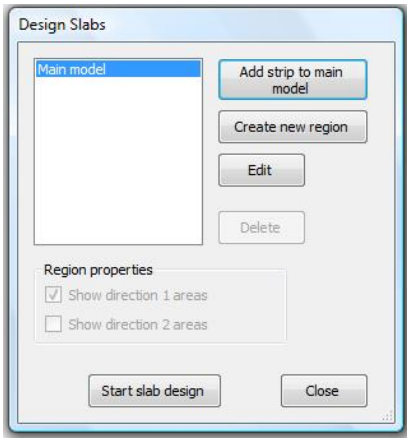



- Slabs: Match Properties

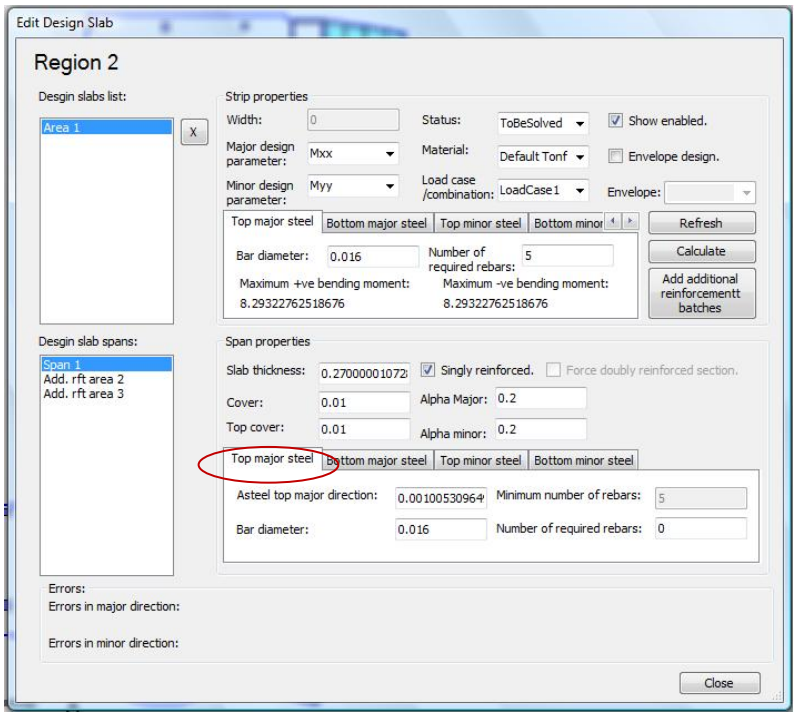

The match properties command is used to match a slab (Source Slab) to other slabs (Destination Slab) having the same properties as the source one.

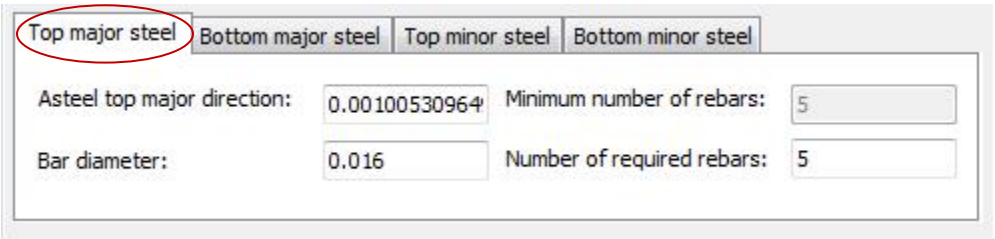


- Make sure that the bordered boxes are toggled ‘off’; else wise the reinforcement of the first slab (Source Slab) will be similar to the Destination slabs.




Press on “Start slab design” to start showing the as required for each design slab in both X and Y directions.

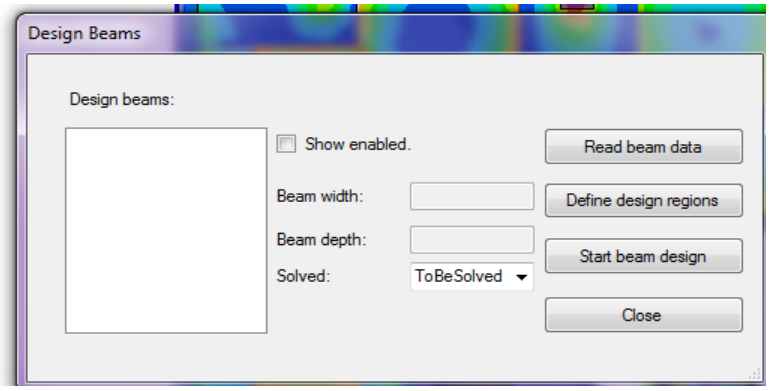


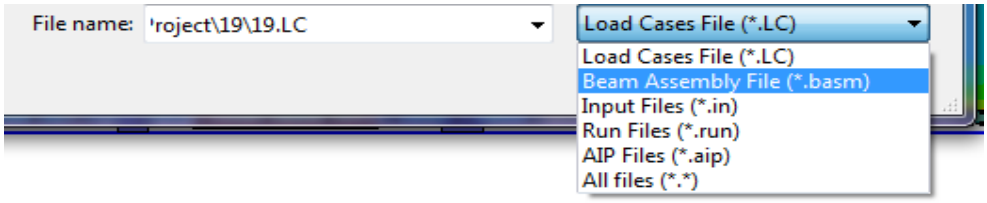

Choose the Bar Diameter, the corresponding minimum number of rebar will show up, thus input the integer number of required rebar.

### Design | Design Beams

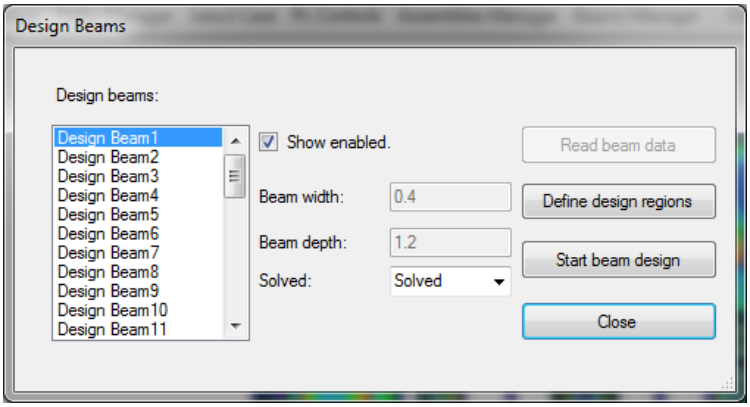
The following is the main design beams window. When opening this window, the beams have to be loaded from the Read Beam Data button. This button will ask the user to read the beam assembly file (.basm) that should have been previously exported from the PLGen.



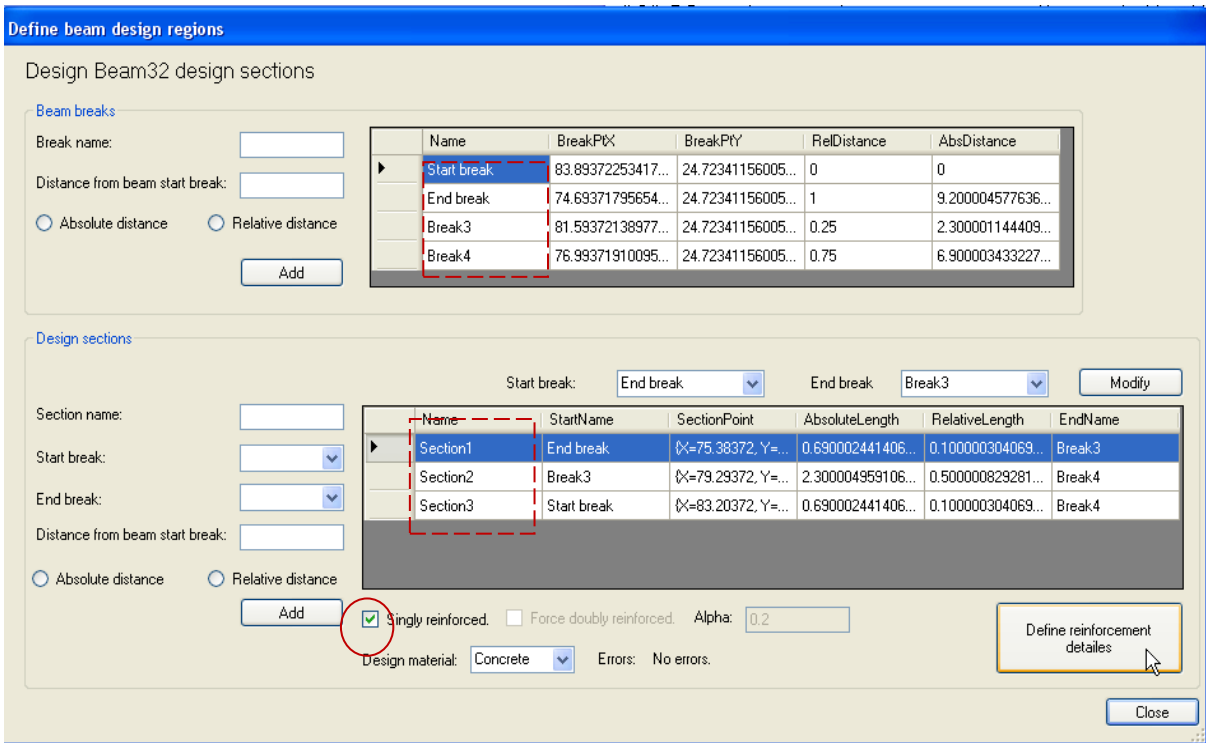

Press "Read Beam Data"




Open (.basm)




After loading the beams, the beam breaks and design sections positions can be defined using the "Define design regions" button. This menu allows the user to define and/or modify break and section positions using their relative or absolute position simultaneously.

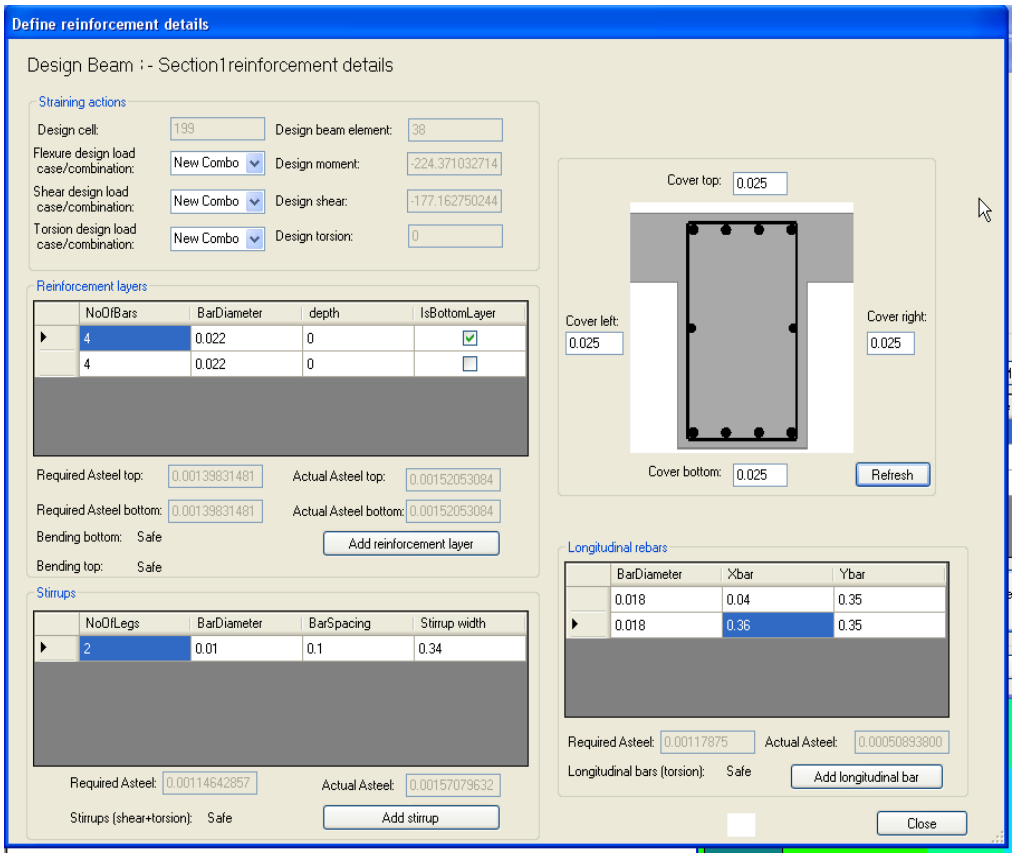



**Defining the Sections and Preparing for reinforcement**

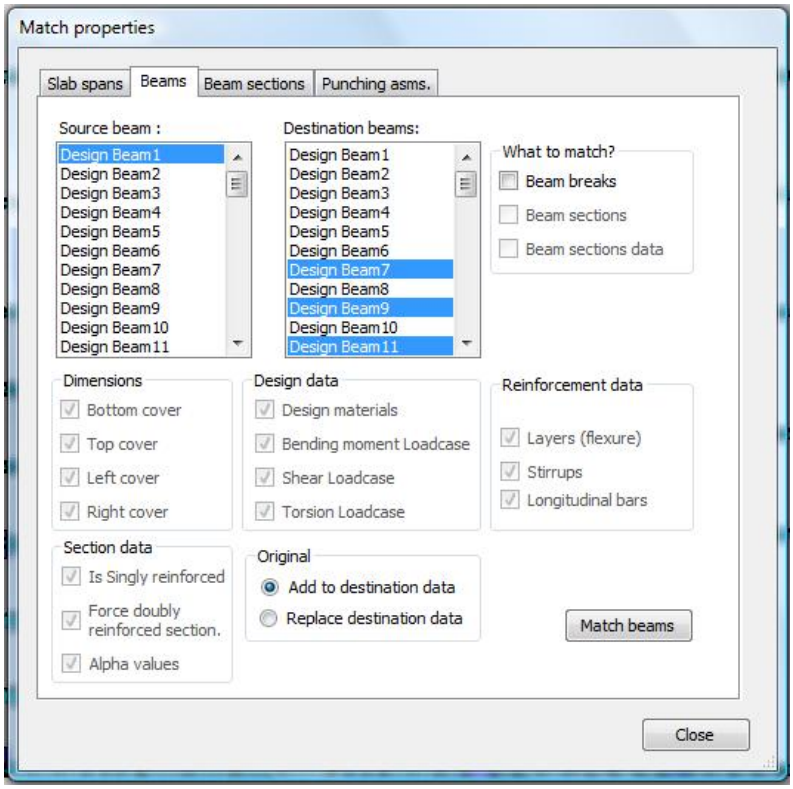
Clicking on "Define reinforcement details" will take the user to the following menu that can be used to define design load cases for each section straining action. The menu functions as a reinforcement builder that can be used to define section reinforcement layers, stirrups and longitudinal bars. In addition, it calculates the reinforcement amount built and compares it to the required area of steel and informs the user whether the section is safe or not.

The reinforcement of a beam section is defined by three distinct types of reinforcement:

- Reinforcement Layers for top and bottom steel to withstand flexure in beams.
- Stirrups to withstand shear and torsion in beams.
- Longitudinal reinforcement to withstand torsion in beams or any other purpose.

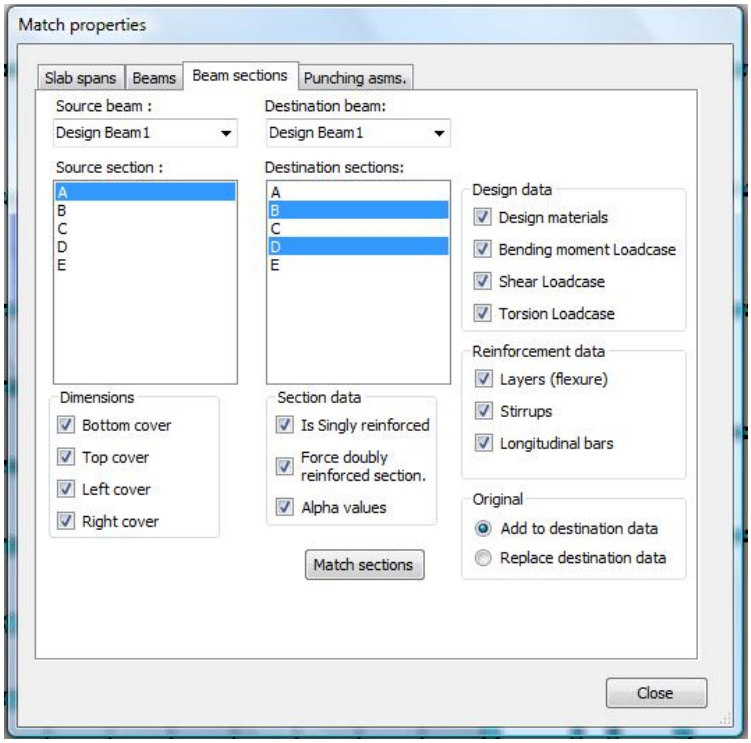



- Beams: Match Properties




**Similar beams are matched with the same reinforcement**

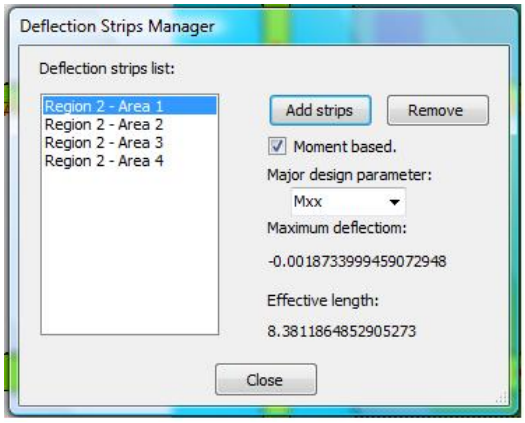
The users can also match properties for the sections in one beam



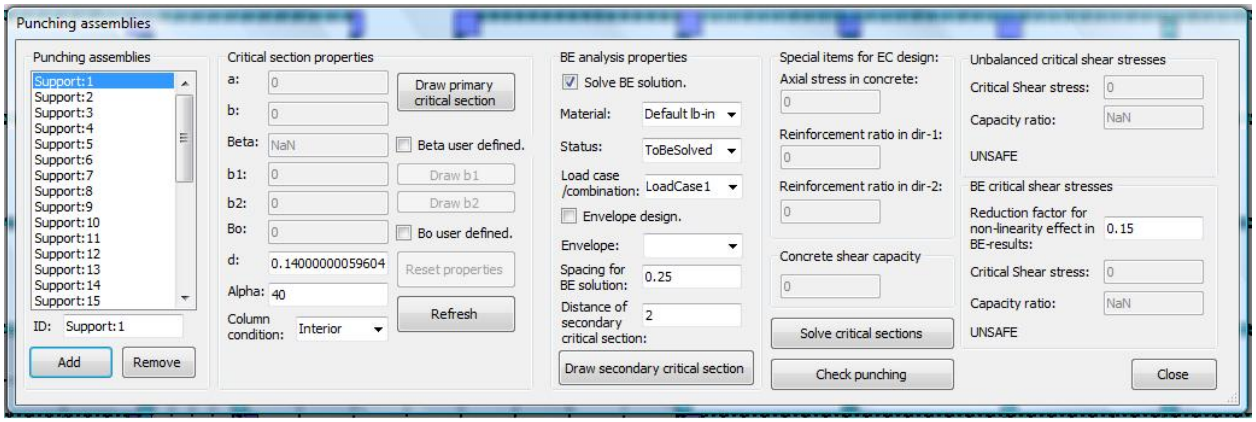

**Similar beam sections are matched with the same reinforcement**

## Design | Deflection Strips Manager

It shows the Maximum deflection (according to selected moment) & the effective length of any selected strip.




## Design | Punching check




The variables defines in the critical section properties window are similar to punching critical section properties as stated by ACI-318.

These variables are:

a,b: critical section dimensions

Beta: ratio between b and a

b1: dimension of the critical section in the direction of the analysis

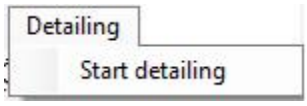
b2: dimension of the critical section in the direction perpendicular to b1

Bo: perimeter of the critical section

d: depth of the slab at this point

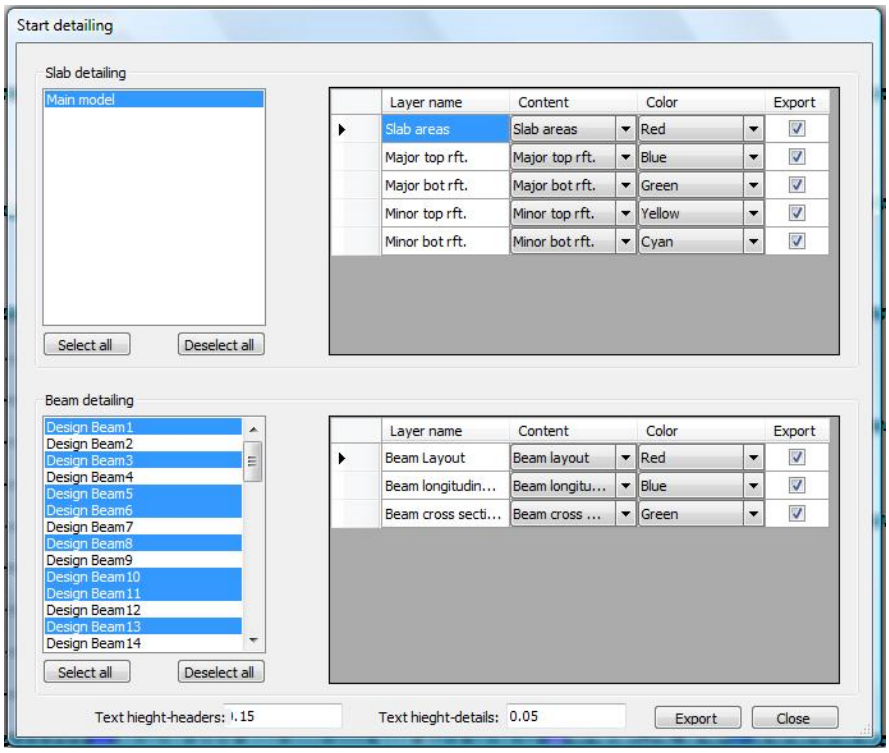
Alpha: Constant defined based on the position of the column

## The Detailing menu





PLDesign can be used to export design drawings for the designed beams and slabs. The drawings are exported in (.dxf) format. The PLDesign allows the user to choose the drawing components, layers and their respective colors.

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