BE4E – PLPAK

Towards more realistic structural modeling

Design Package (PLDesign)

Table of content for lecture 3

- PLDesign Package.
  - PLDesign introduction
  - File needed to be exported before using PLDesign.
  - Starting PLDesign.
  - Load combinations & load envelopes.
  - Slabs design.
  - Design from PLPost results (strip design).
  - Design from PLPost results (contour design).
  - Design from PLDesign directly (strip based region).
  - Design from PLDesign directly (basic and additional reinforcement).

PLDesign Introduction

PLDesign is a Design Package for Slabs and beams using different codes Like (ACI, EC2 & ECP).

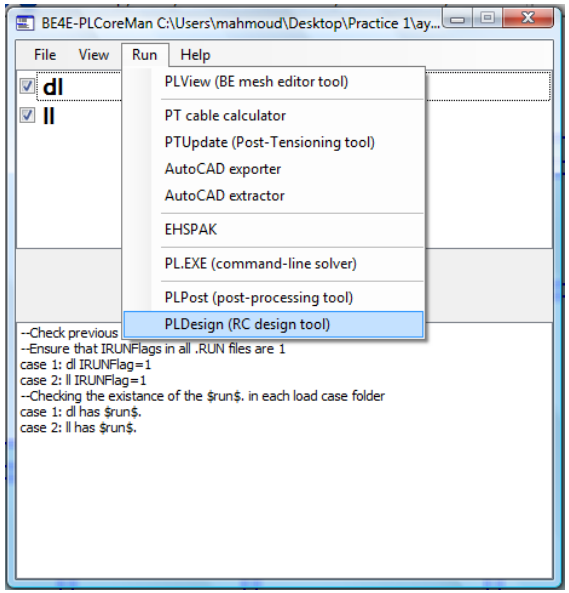
- PLDesign is not only consider about design, but also about detailing and calculation sheet forming.

- In PLDesign the user can check the reinforcement of section under any stresses (Bending, Shear and Torsion).

- In PLDesign the user can check deflection for slabs.

- In PLDesign the calculation is not only for Load combination, but also for Envelopes.

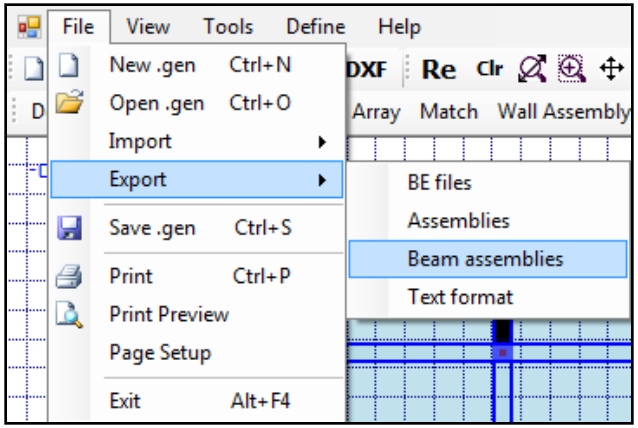
- The user can go to PLDesign by two ways either by using PLPost or PLCoreMan.



Files need to be exported before using PLDesign

Similarly as lecture 2 we are going to know if there is files need to be exported before using PLDesign.

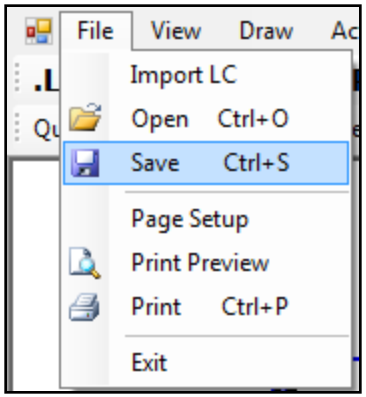
There are cases that user have to export file from PLGen before using PLDesign:



This case is used in beam design.

Save Beam assemblies, then restore it in PLDesign.

Another case but this time in PLPost before using PLDesign:



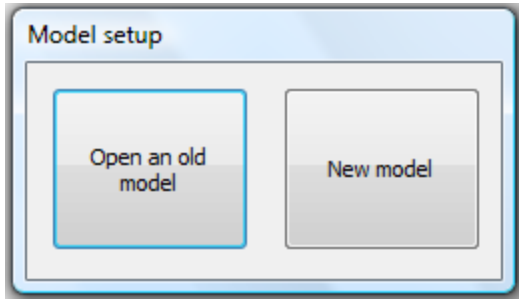
This case is used to restore analysis then design using PLDesign.

Save PLPost results, then restore it in PLDesign.

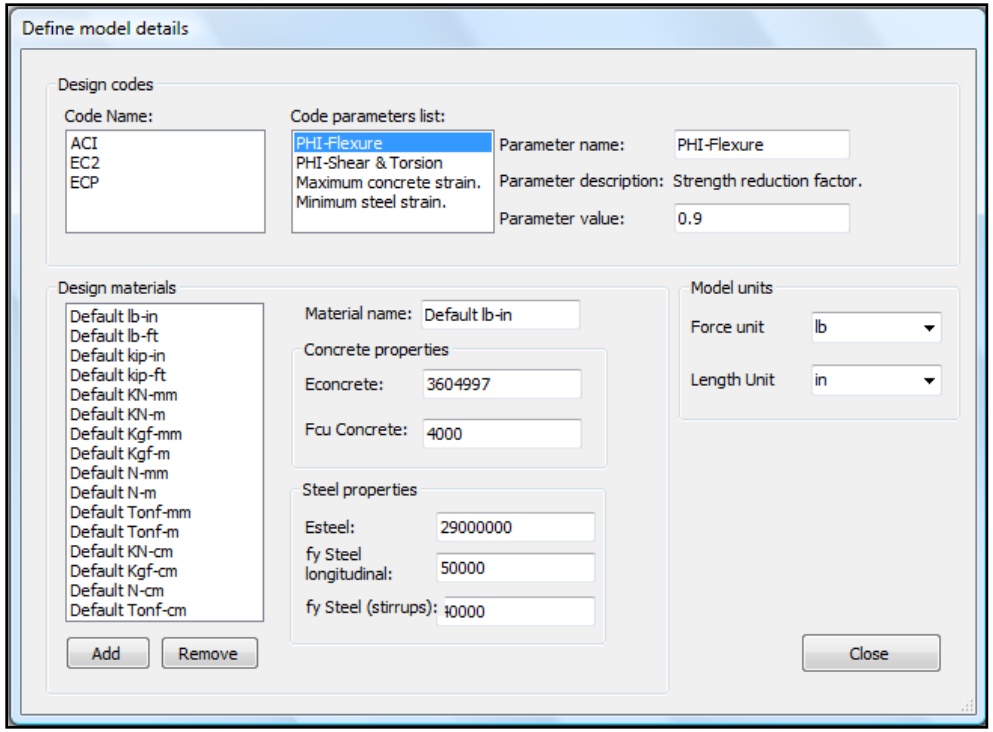
Starting PLDesign

Once the user open the PLDesign, a model setup window is open and ask if the model is a new model or an old model.

As it is start in PLDesign we will click on New model.



In case of using PLDesign before, the user can click on open an old model.



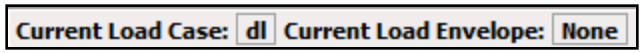
After clicking on New model, the user should define model details.

The model details are the code name and the code parameter, design material units and modify it if any, choosing model units.

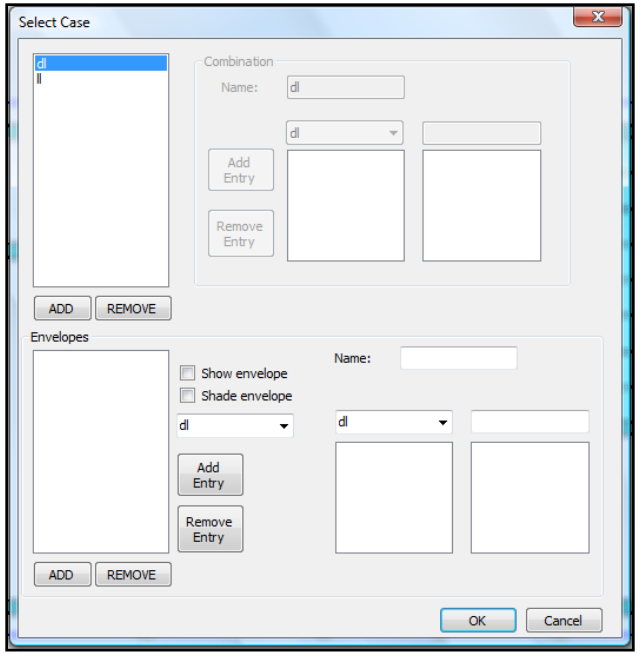
To save click close then choose (.LC) file need to be designed.

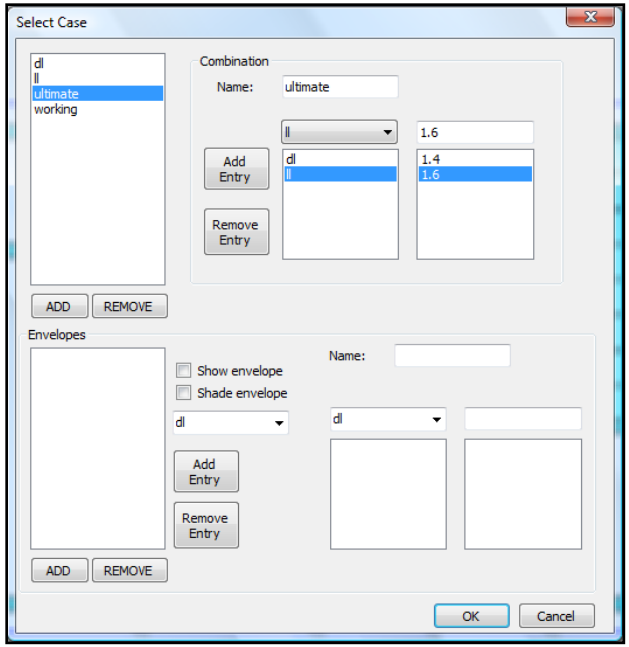
Load Combinations & Load Envelopes

The lower tabs of the PLDesign contain by default current load case is dead and current envelope is none.



If the user press double click on dead Load Combinations window will open.





The user can add cases like ultimate, Working cases, each case contains combination between Load cases inserted from PLGen and if there are any envelopes between them the user can insert also the envelope between combinations to achieve Max. straining actions.

Slabs Design

The user have many options to design slabs, these options are according to the purpose of design or what are the details that user need from PLDesign?

Purpose of design

- Design a Strip.
- Design a part of slab.
- Design the slab totally.

Reinforcement details

- Basic and additional reinforcement.
- top and bottom reinforcement.

Slab Design

Design from PLPost results

- Design from a strip.
- Design from contour.

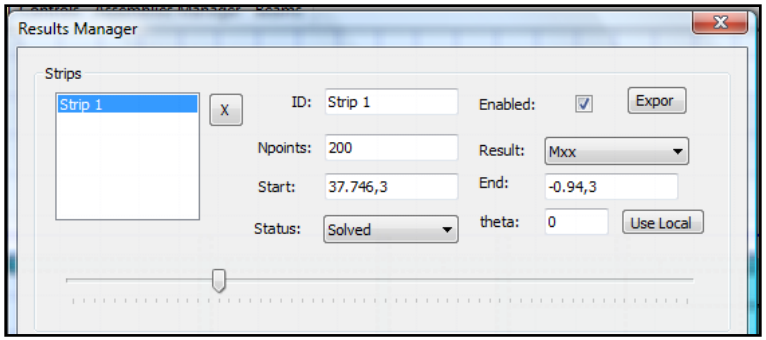
Design from PLDesgin directly

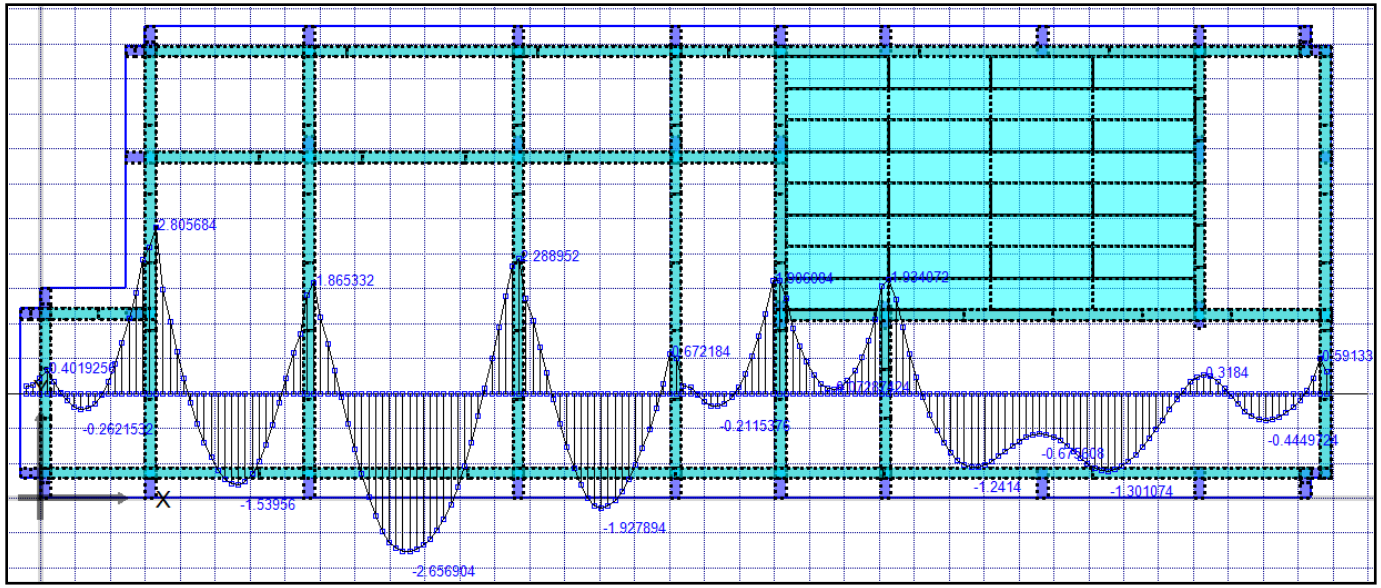
- Basic and additional areas.
- Strip based design.

Design from PLPost results (Strip design)

Design a certain strip with specific coordinates is one of the advantages of the PLDesign.

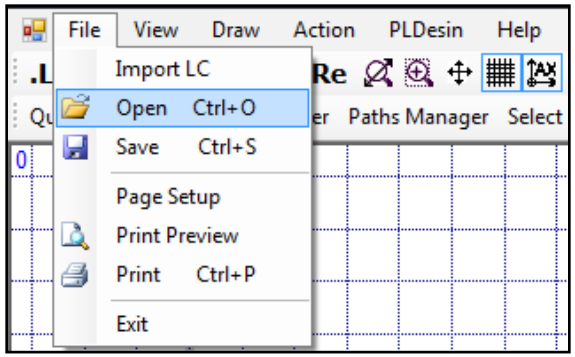
First the user have to save a strip from PLPost (a strip at y = 3.00m) as (.res) file.



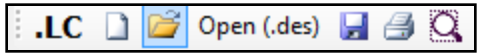


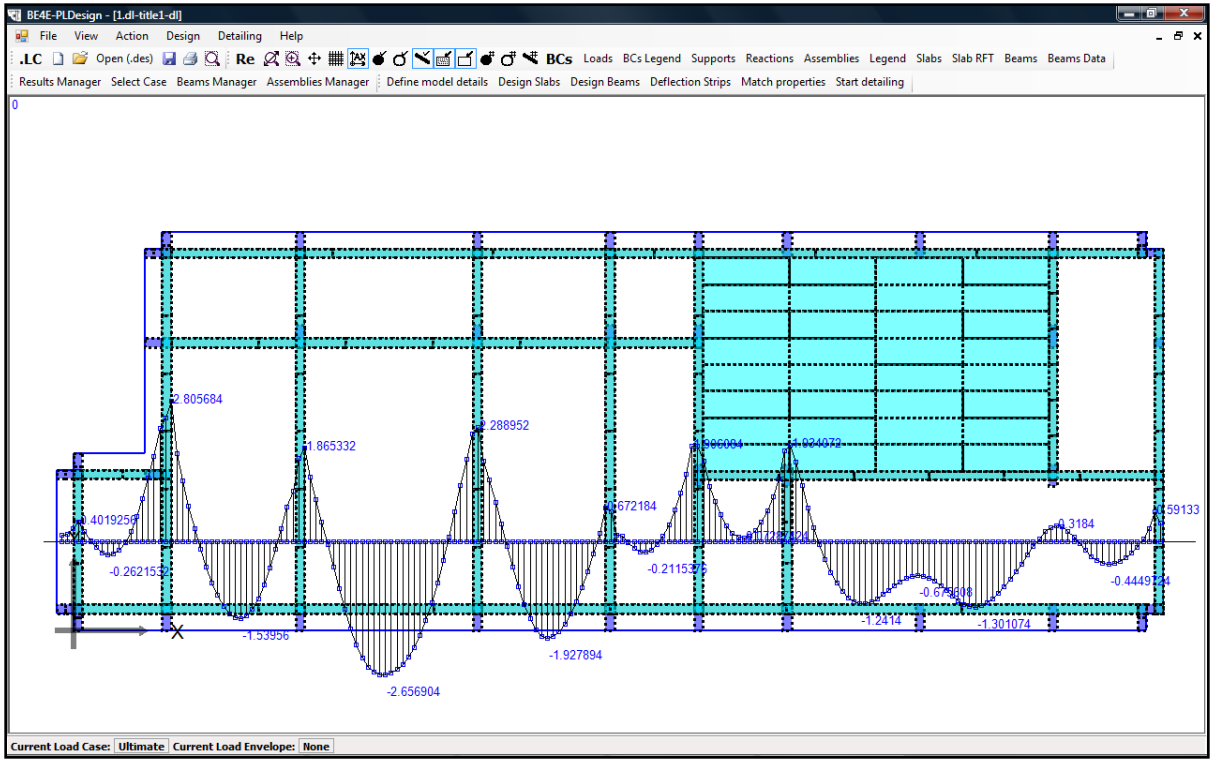
Design from PLPost results (Strip design)

Load the saved (.res) file in PLDesign.



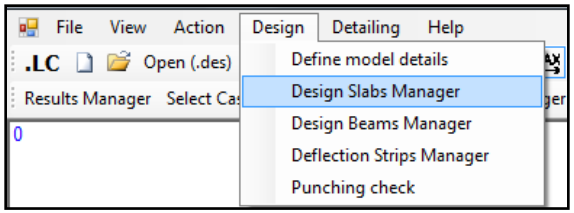
OR



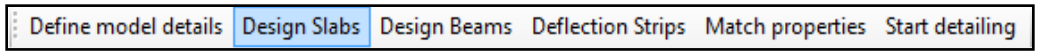


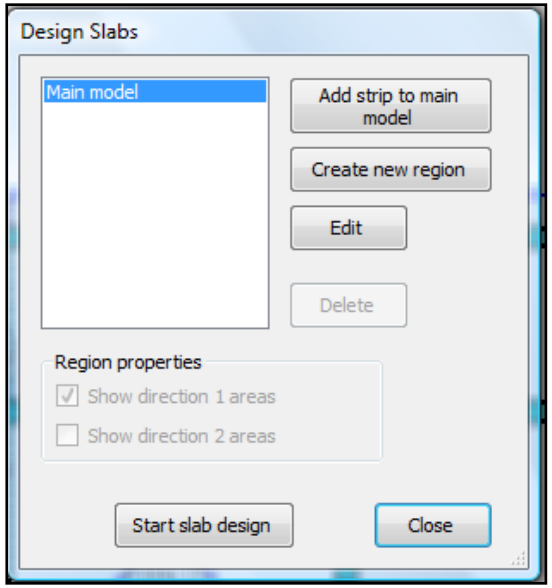
Design from PLPost results (Strip design)

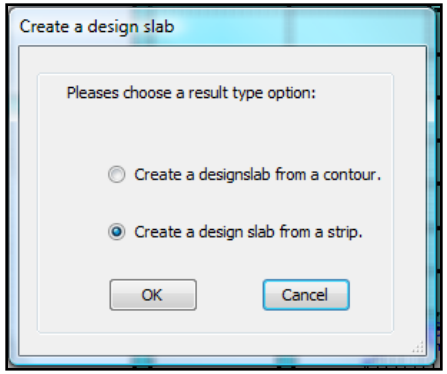
Open Design Slabs Manager, then press on add strip to main model tab.

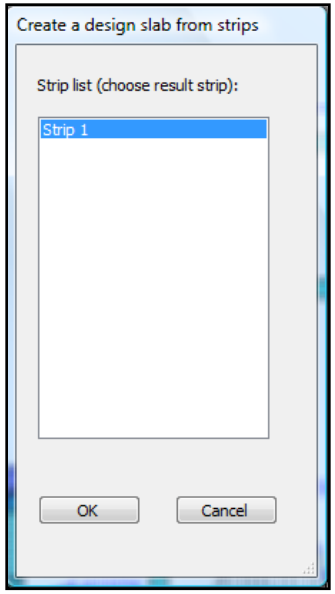


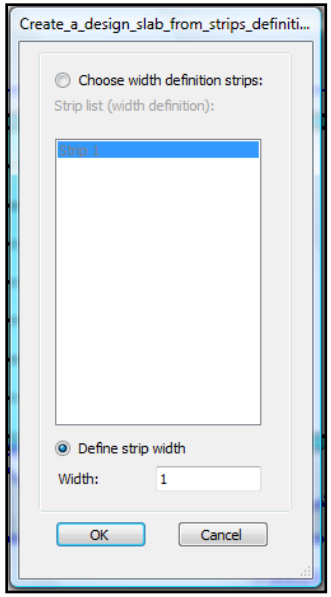
OR







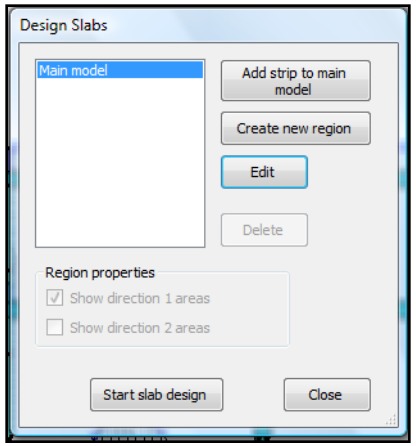


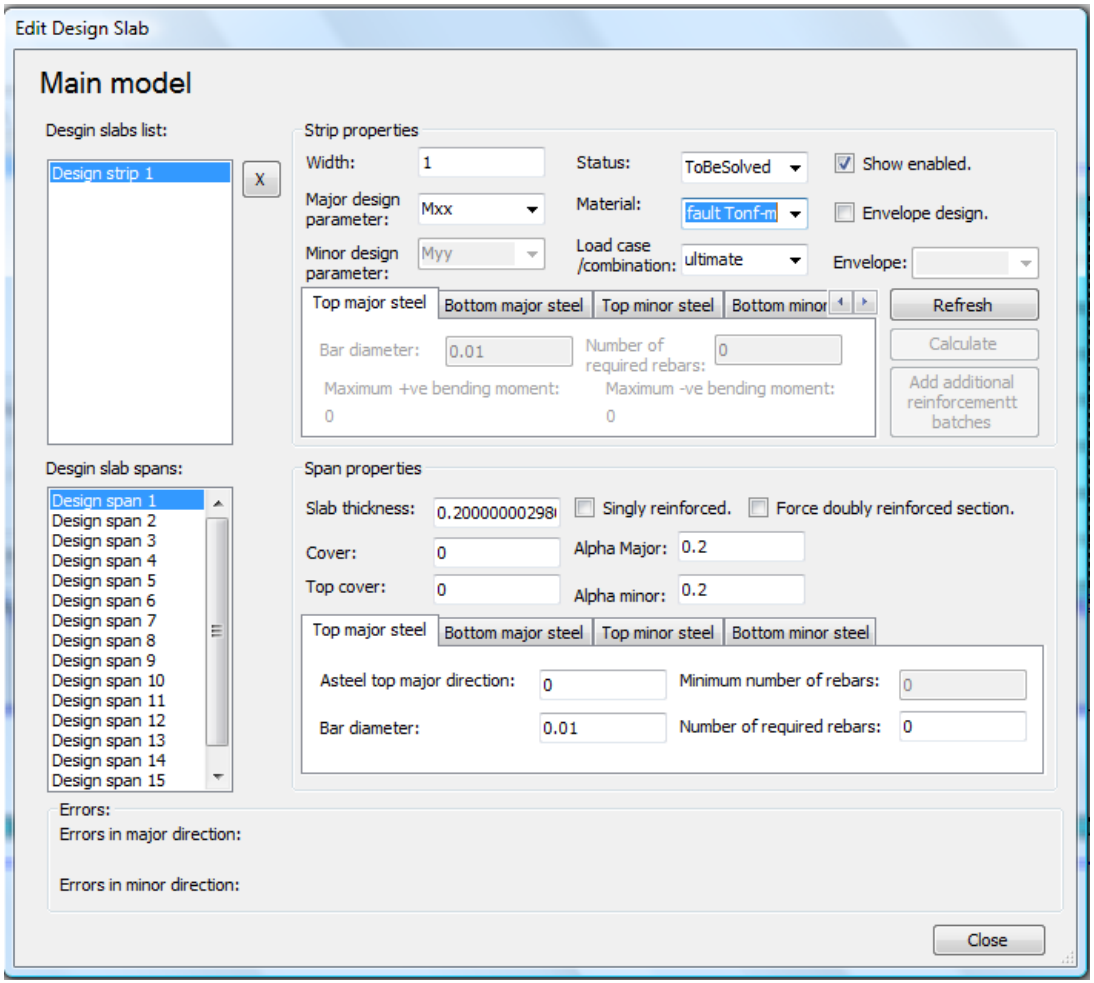


Choose a design slab from a strip which will open a strip list to choose from them, then determine the width of the strip.

Design from PLPost results (Strip design)

Press on Edit to open Design Slab Manager.

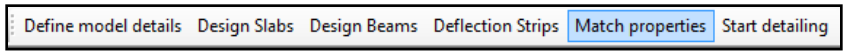


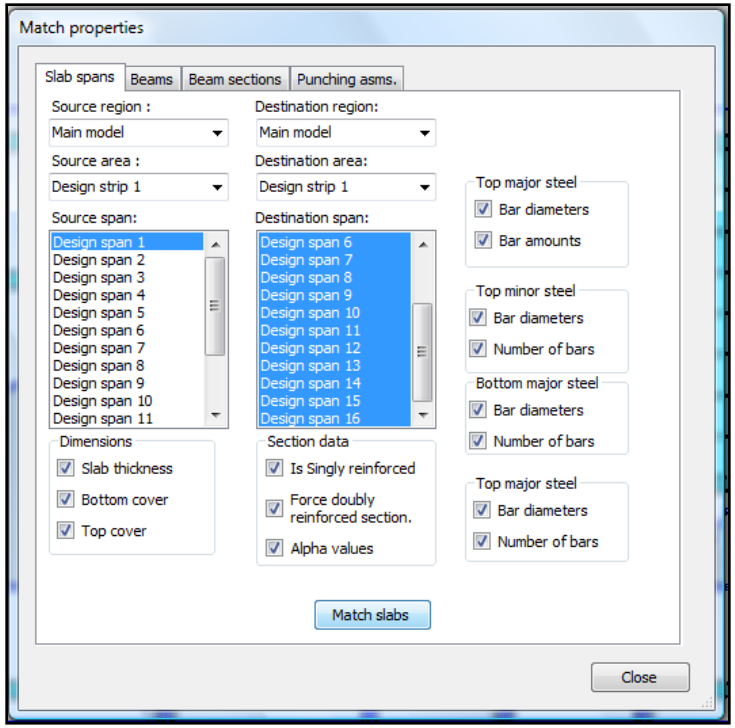


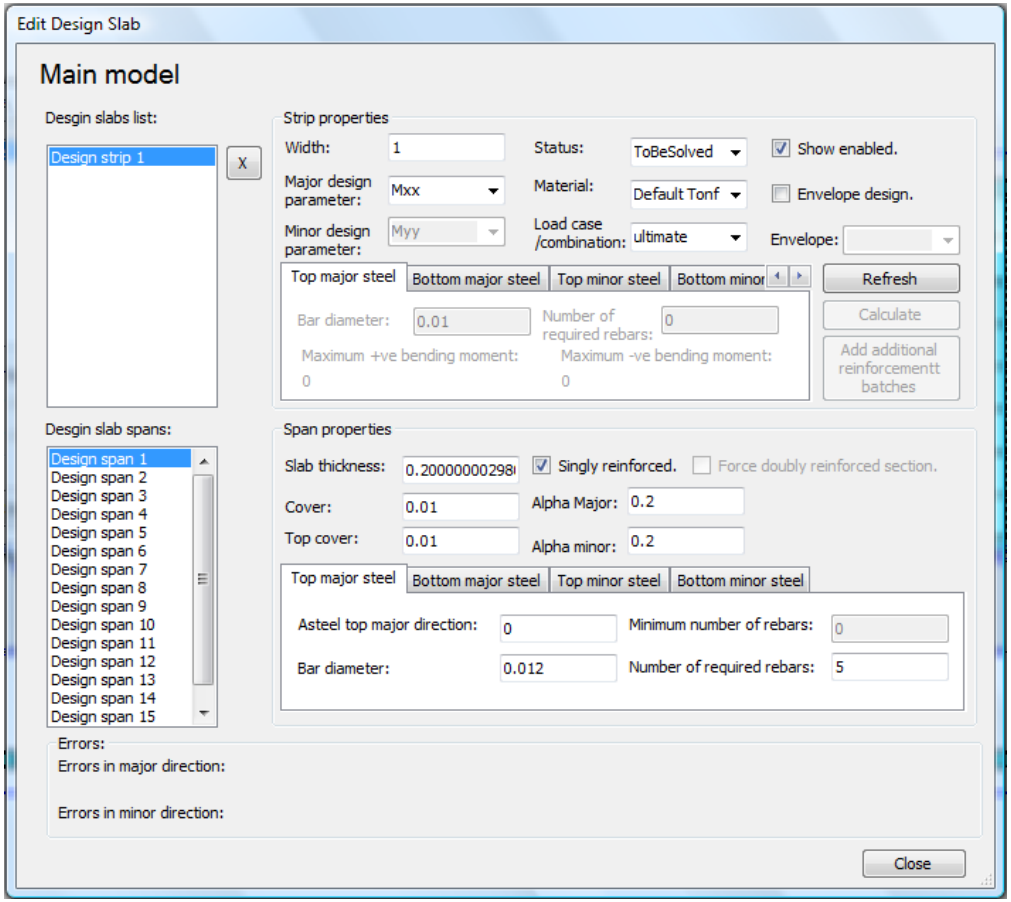
The Main model is divided into two parts: Strip properties and Span properties. The strip properties contains information for the strip like width, Major design parameter, Material units, Load cases/combinations. While span properties contains information for the section like thickness, cover, bar diameter, number of rebars, number of required rebars.

Design from PLPost results (Strip design)

Adjust the main model by choosing the design parameter and inserting all information (cover, bar diameter and number of bars) for one span.



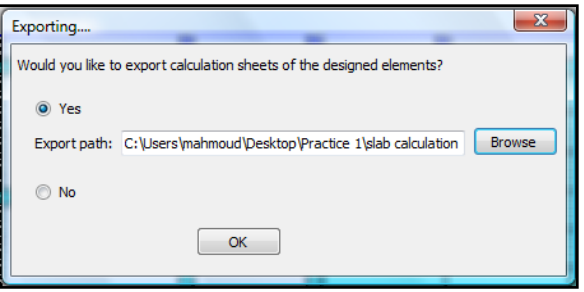


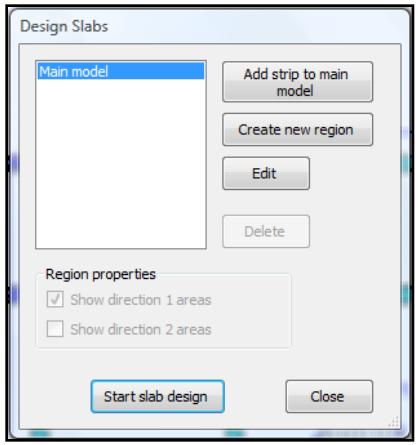


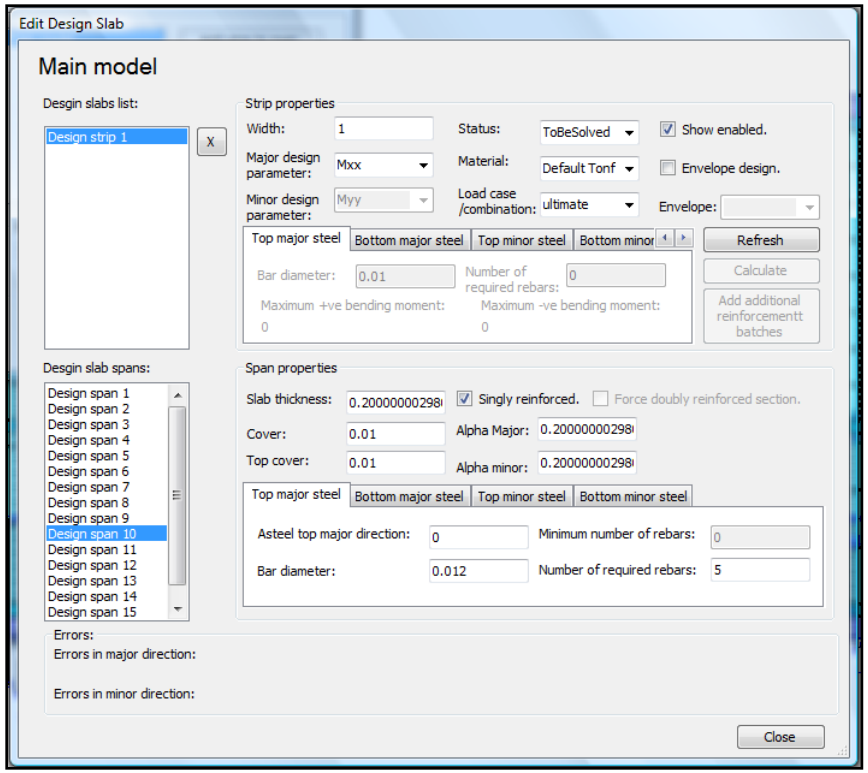
Are we going to adjust all spans?

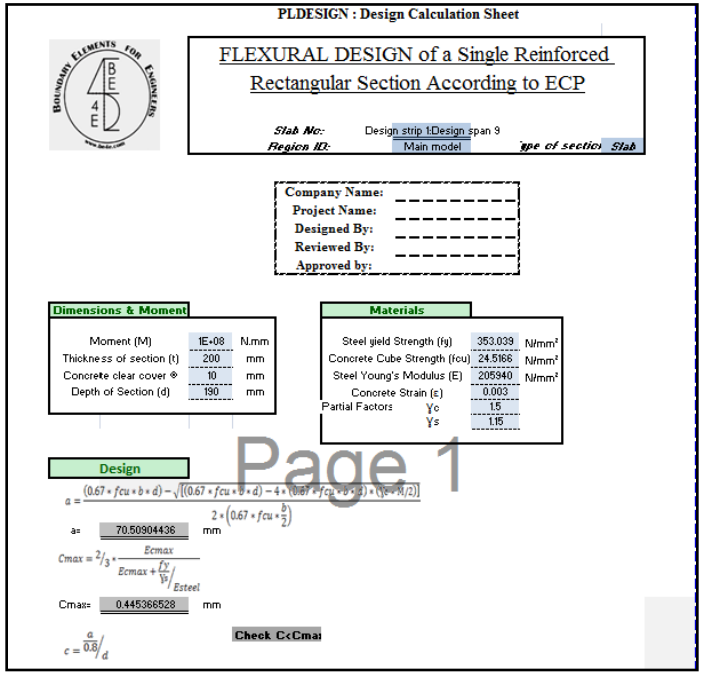
Design from PLPost results (Strip design)

Check that all spans are matched then start slab design.





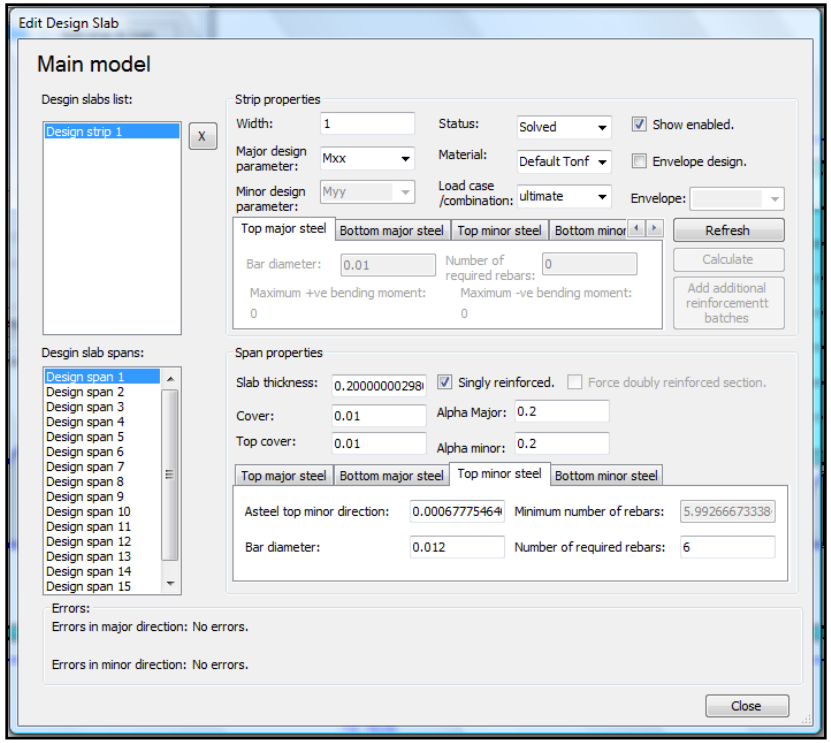




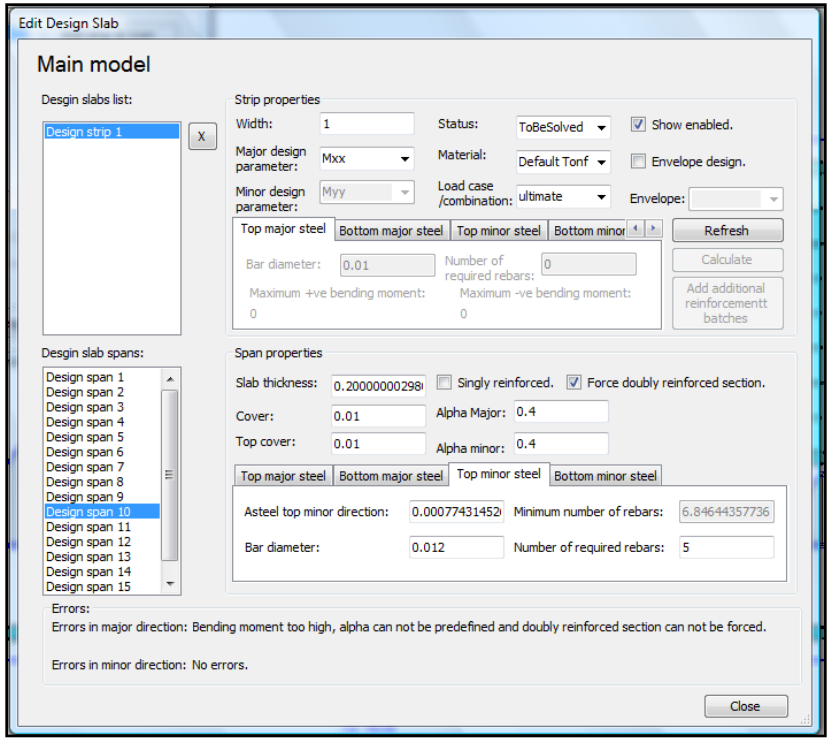
The PLDesign is automatically export the calculation sheet for slab every section has two files one for moment in X-direction and the other for Y-direction.

Design from PLPost results (Strip design)

Check that all spans are safe and modify the number of bars and bar diameter if needed.



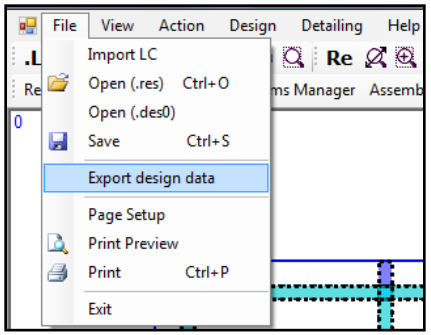
Case of safe section

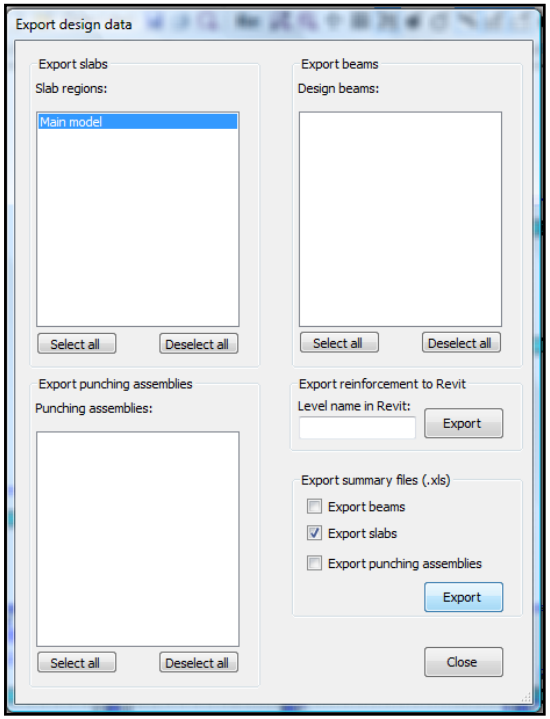


Case of unsafe section

Design from PLPost results (Strip design)

Instead of every strip contains two excel files, the user can export a summary for slab reinforcement.

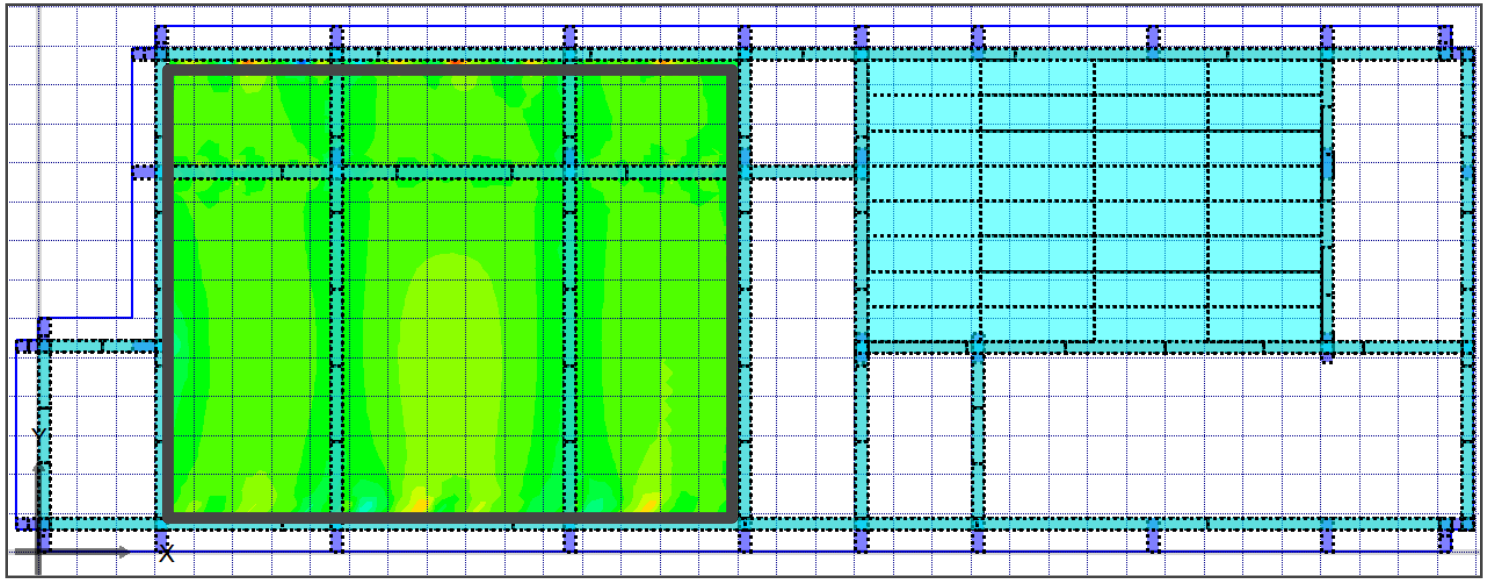


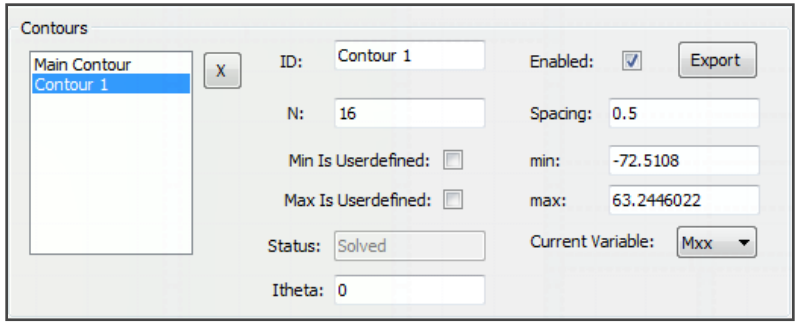


Region name	Area name	Major design moment	Strip name	Top major rft.	Bot. major rft.	Top minor rft.	Bot minor rft.
Main model	Design strip 1	Mxx	Design span 1	5 Φ 0.012	6 Φ 0.012	**6 Φ 0.012**	5 Φ 0.012
			Design span 2	5 Φ 0.012	5 Φ 0.012	**10 Φ 0.016**	5 Φ 0.012
			Design span 3	5 Φ 0.012	6 Φ 0.012	10 Φ 0.016	5 Φ 0.012
			Design span 4	6 Φ 0.016	5 Φ 0.012	9 Φ 0.018	5 Φ 0.012
			Design span 5	5 Φ 0.012	9 Φ 0.018	5 Φ 0.012	7 Φ 0.012
			Design span 6	6 Φ 0.012	5 Φ 0.012	6 Φ 0.012	5 Φ 0.012
			Design span 7	5 Φ 0.012	7 Φ 0.012	7 Φ 0.012	5 Φ 0.012
			Design span 8	9 Φ 0.016	5 Φ 0.012	7 Φ 0.016	5 Φ 0.012
			Design span 9	5 Φ 0.012	5 Φ 0.012	5 Φ 0.012	5 Φ 0.012
			Design span 10	5 Φ 0.012	5 Φ 0.012	5 Φ 0.012	5 Φ 0.012
			Design span 11	5 Φ 0.012	8 Φ 0.018	7 Φ 0.016	5 Φ 0.012
			Design span 12	7 Φ 0.016	5 Φ 0.012	9 Φ 0.012	5 Φ 0.012
			Design span 13	5 Φ 0.012	5 Φ 0.012	5 Φ 0.012	5 Φ 0.012
			Design span 14	6 Φ 0.012	5 Φ 0.012	6 Φ 0.012	5 Φ 0.012
			Design span 15	5 Φ 0.012	6 Φ 0.012	6 Φ 0.012	5 Φ 0.012
			Design span 16	5 Φ 0.012	5 Φ 0.012	5 Φ 0.012	5 Φ 0.012

Design from PLPost results (Contour design)

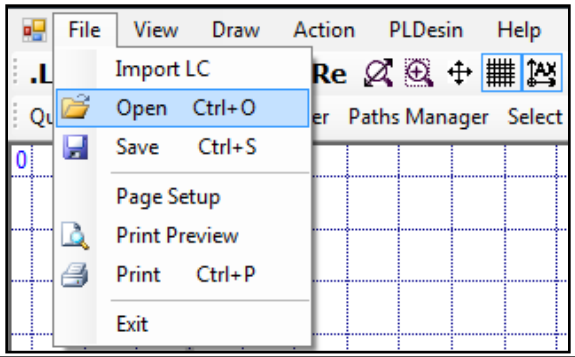
Similarly as Strip design the user should save results in PLPost then load it again in PLDesign.



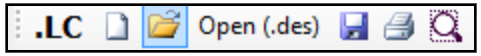


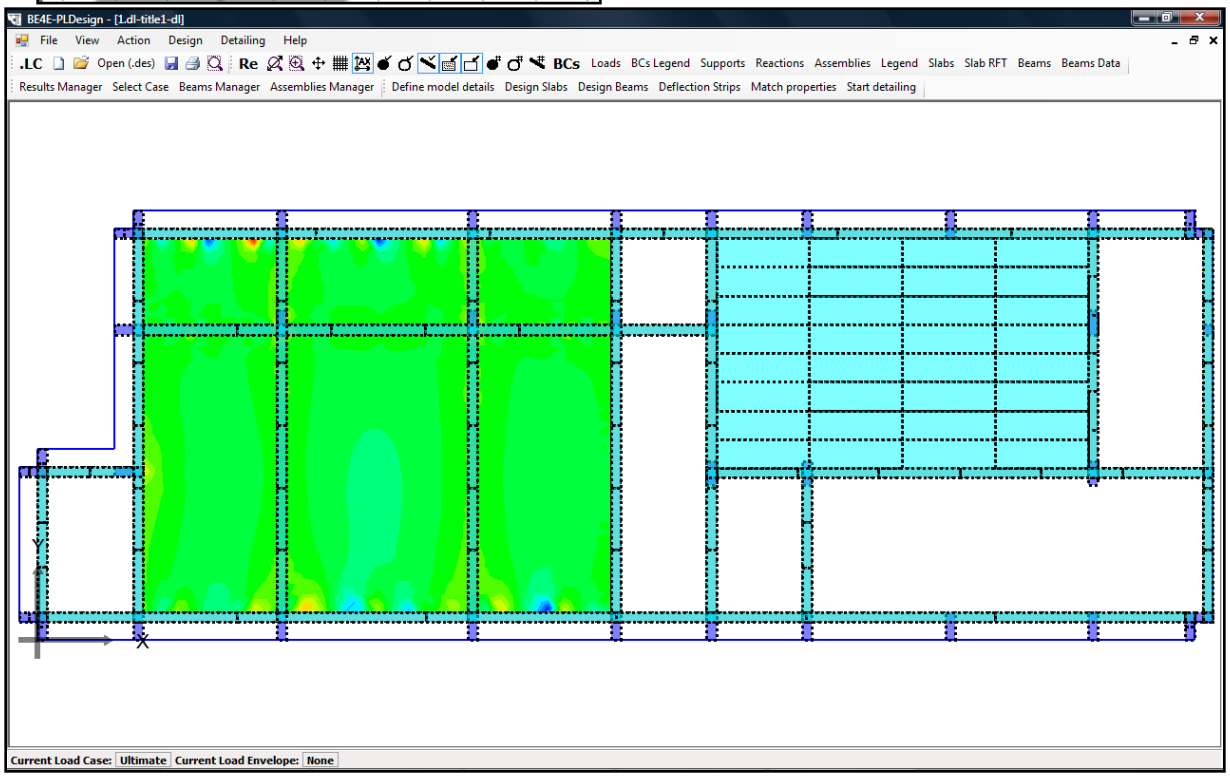
Design from PLPost results (Contour design)

Load the saved (.res) file in PLDesign.



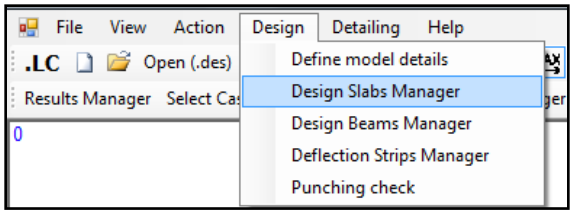
OR



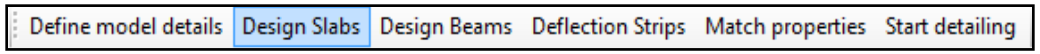


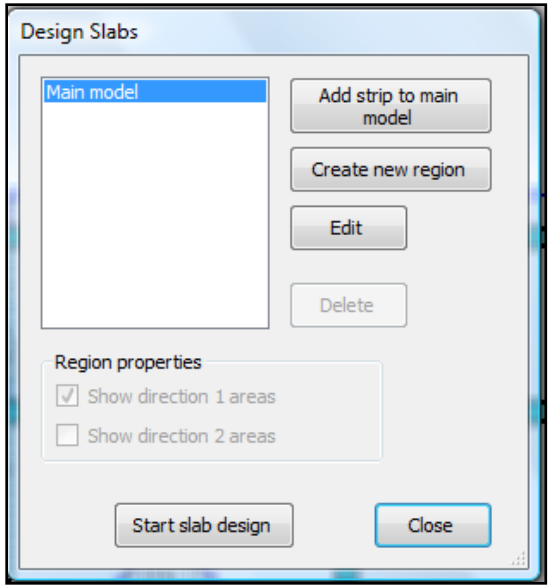
Design from PLPost results (Contour design)

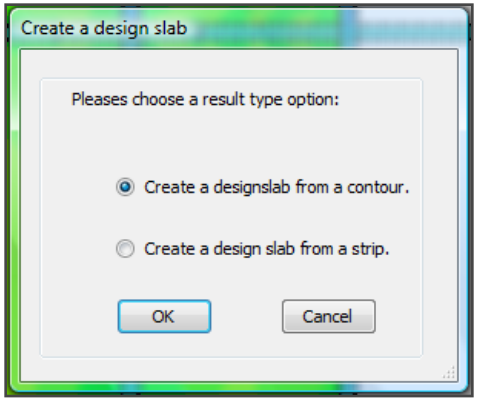
Open Design Slabs Manager, then press on add strip to main model tab.

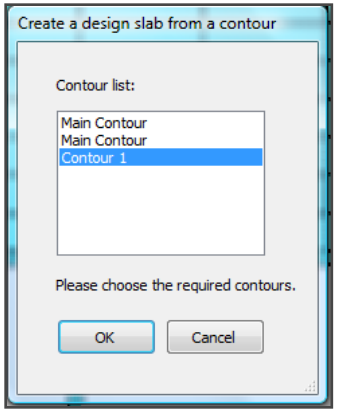


OR





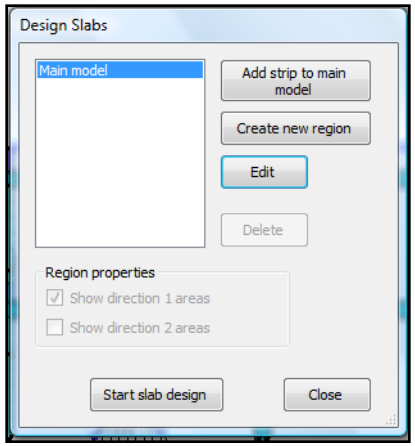


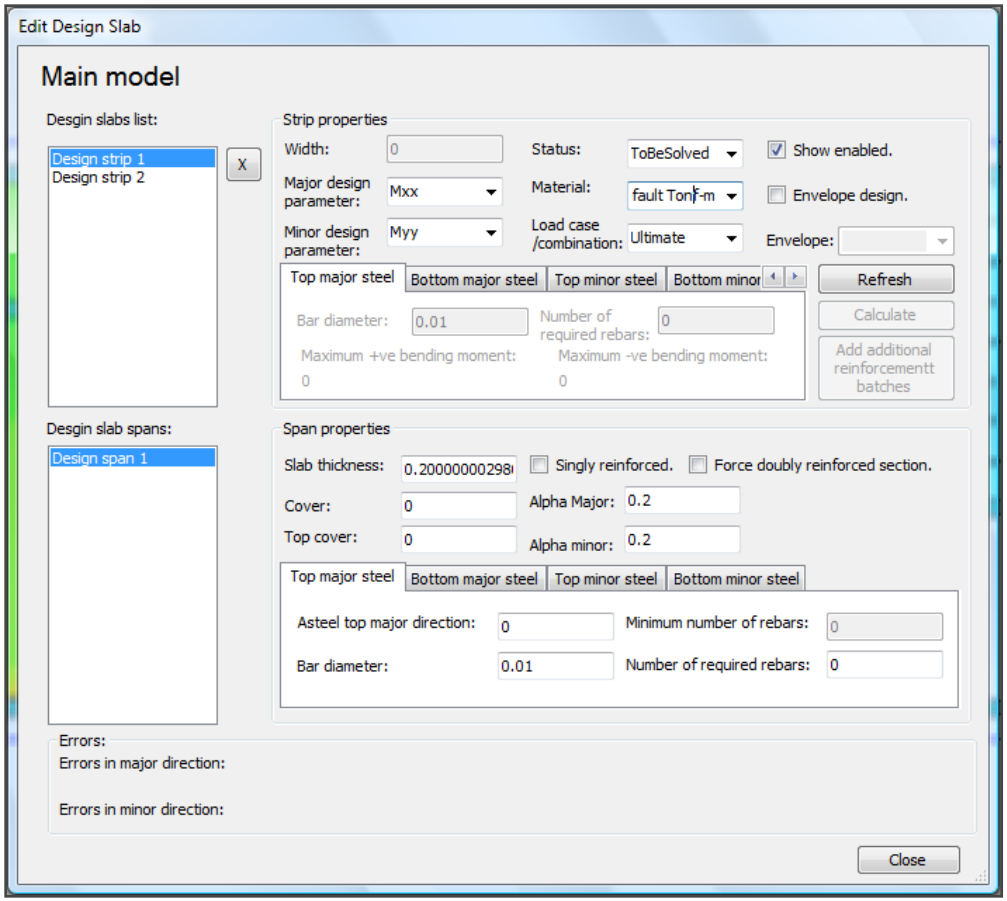


Choose a design slab from a contour which will open a contour list to determine the contour area needed to be designed.

Design from PLPost results (Contour design)

Press on Edit to open Design Slab Manager.

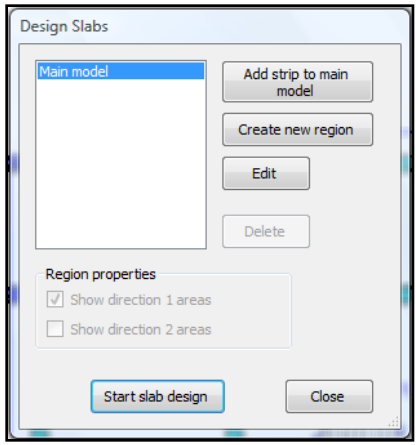


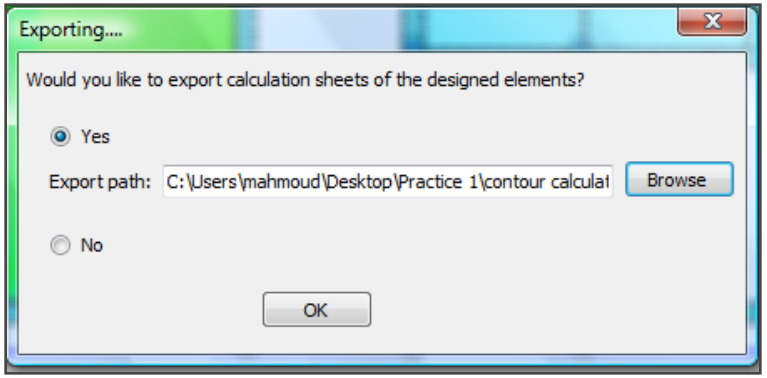


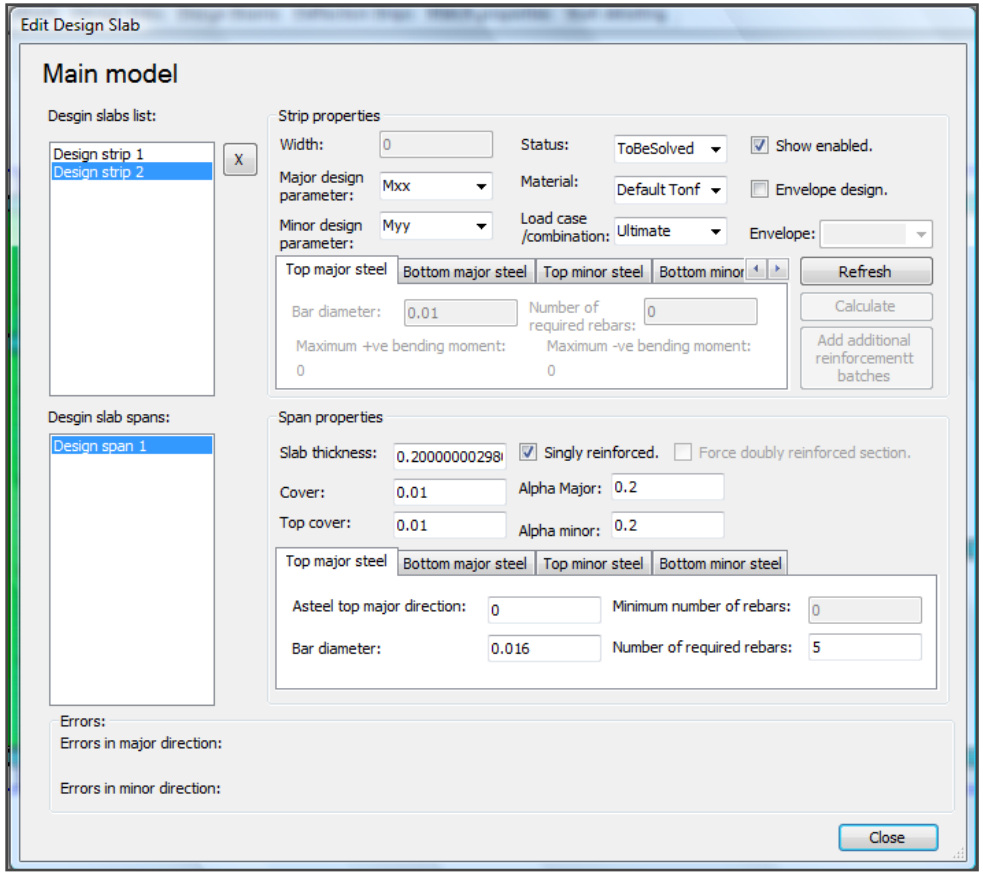
Similarly as Strip design, the user should adjust the Design slab list and Design span list.
But in contour design we note that there are 2 design strips one of them is vertical (strip 1) and the other is horizontal (strip 2) each strip should adjust it's properties.

Design from PLPost results (Contour design)

After adjusting the main model, it is time for solving the slab by pressing start slab design.







Export the design calculation sheet.

Design from PLPost results (Contour design)

Dimensions & Moment

Moment (M)	8E+07	N.mm
Thickness of section (t)	200	mm
Concrete clear cover ⊕	10	mm
Depth of Section (d)	190	mm
Compression st Depth (dm)	10	mm

Materials

Steel yield Strength (fy)	353.04	N/mm²
Concrete Cube Strength (fcu)	24.517	N/mm²
Steel Young's Modulus (E)	205940	N/mm²
Concrete Strain (ε)	0.003	
Partial Factors γc	1.5	
γs	1.15	

Design

Page 1

$$a = \frac{(0.67 * fcu * b * d) - \sqrt{[(0.67 * fcu * b * d) - 4 * (0.67 * fcu * b * d) * (\gamma c * M)]}}{2 * \left(0.67 * fcu * \frac{b}{2}\right)}$$ a= 45.548 mm

$$Cmax = \frac{2}{3} * \frac{Ecmax}{Ecmax + \frac{fy}{\gamma s} / Esteel}$$ Cmax= 0.4454 mm

Check C>Cmax d'/d= 0.15

$$c = \frac{a}{0.8} / d$$ C= 0.2997 mm dmmax= 28.5 Check dmmax>dm

$$Area\ steel = \frac{0.67 * fcu * b * a * \gamma s}{\gamma c * fy}$$ 649.9 mm^2 #REF!

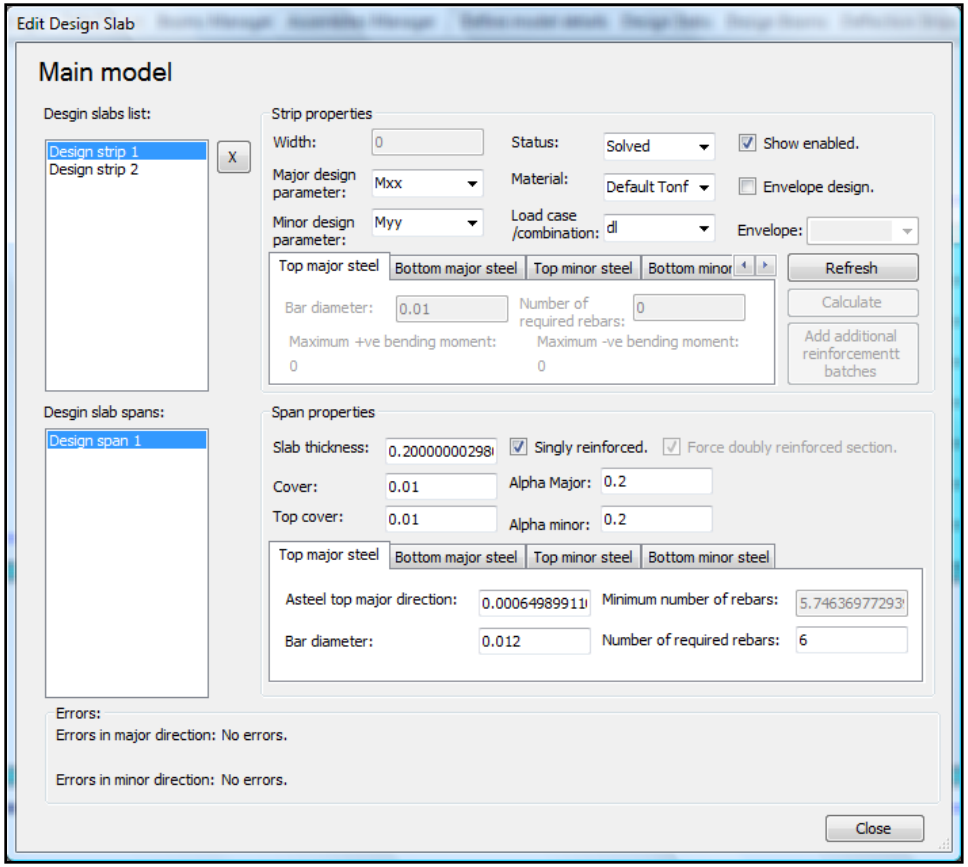
$$\text{Max Moment} \frac{0.67 * fcu * 0.8 * b * d * 460 * d - \frac{0.4 * d * 460}{690 + fy}}{(690 + fy) * \gamma c}$$ 114871136.4 N.mm

$$Area\ steel\ compression = \frac{(M - Mumax) * \gamma s}{fy * (d - dm)}$$ 0 mm^2

Check Area steel Maximum

$$Area\ steel\ max = (\mu * fcu) * (b * d) + Ascompression$$ 3260.711176 mm^2

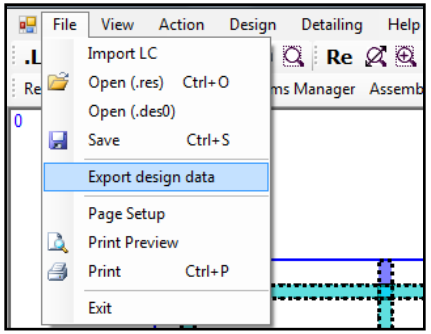
The PLDesign is automatically export the calculation sheet for slab every section has two files one for moment in X-direction and the other for Y-direction.

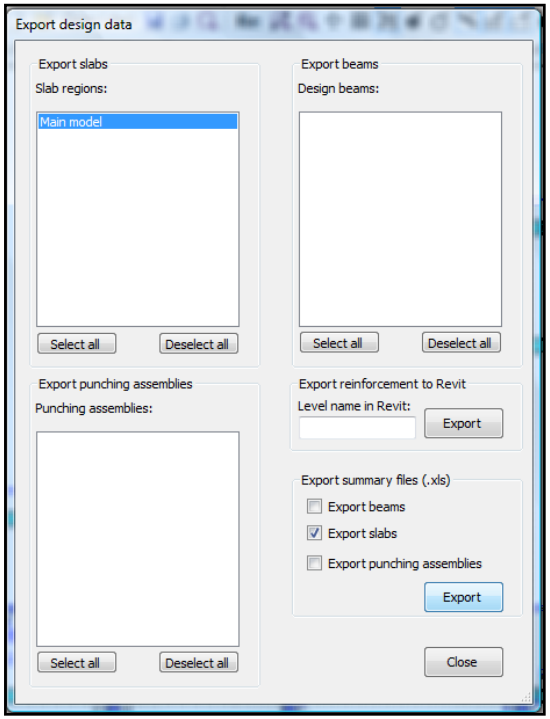


Check that all spans are safe and modify the number of bars and bar diameter if needed.

Design from PLPost results (Contour design)

Instead of every strip contains two excel files, the user can export a summary for slab reinforcement.





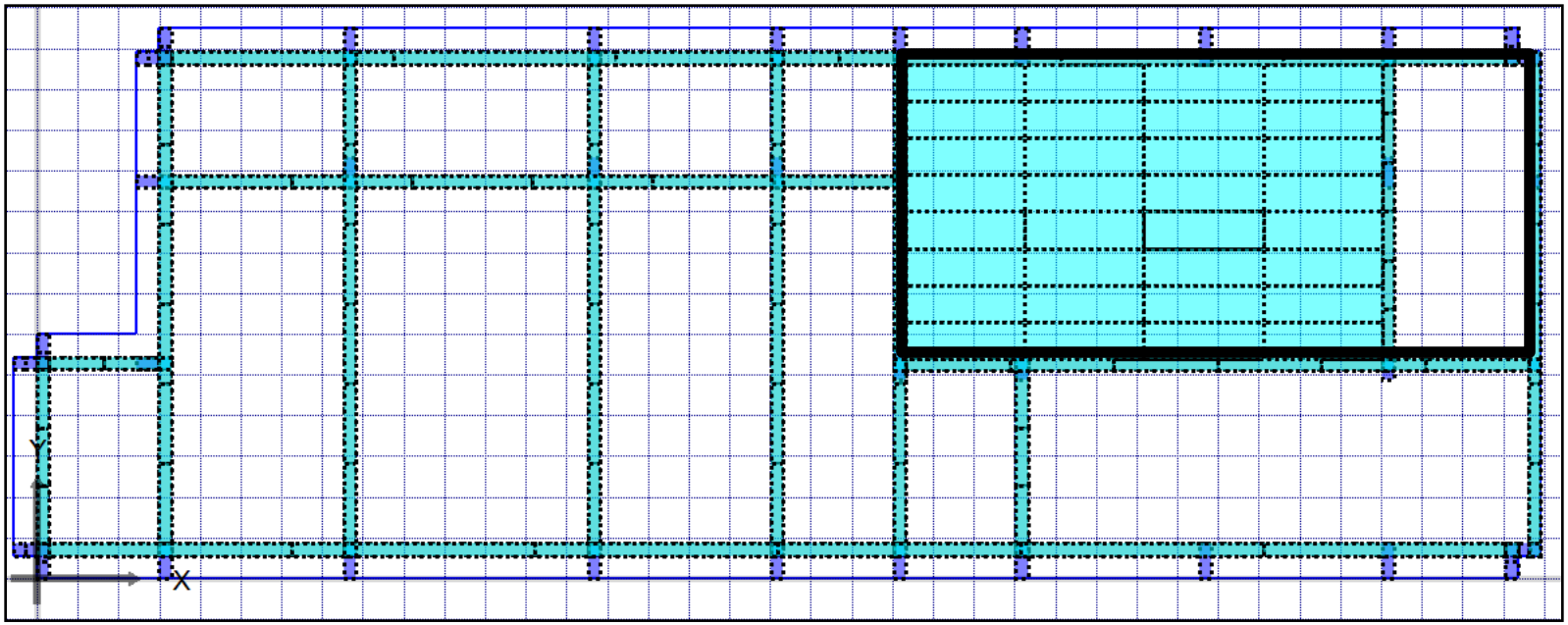
PLDESIGN : Slab reinforcement sheet

Company Name:
Project Name:
Designed By:
Reviewed By:
Approved by:

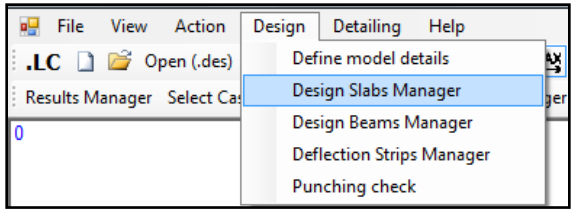
Region name	Area name	Major design momen	Strip name	Top major rft	Bot. major rft	Top minor rft	Bot minor rft.
Main model	Design strip 1	Mxx	Design span 1	6 Φ 0.012	0 Φ 0.012	**5 Φ 0.016**	0 Φ 0.012
	Design strip 2	Mxx	Design span 1	5 Φ 0.012	5 Φ 0.012	**5 Φ 0.012**	5 Φ 0.012

Design from PLDesign directly (Strip based region)

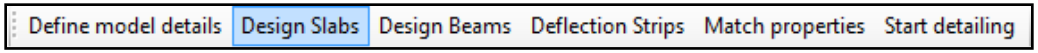
The user has no need to use PLPost, he could use PLDesign directly.



Design based region's idea is dividing the selected slab into number of horizontal and vertical strips, these numbers are selected by the user and could be changed according to the dimension of slab, then the PLDesign calculate automatically the straining action for the selected part and design it.

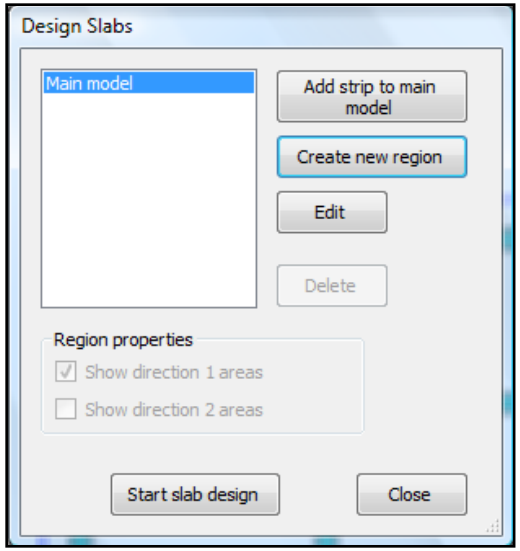


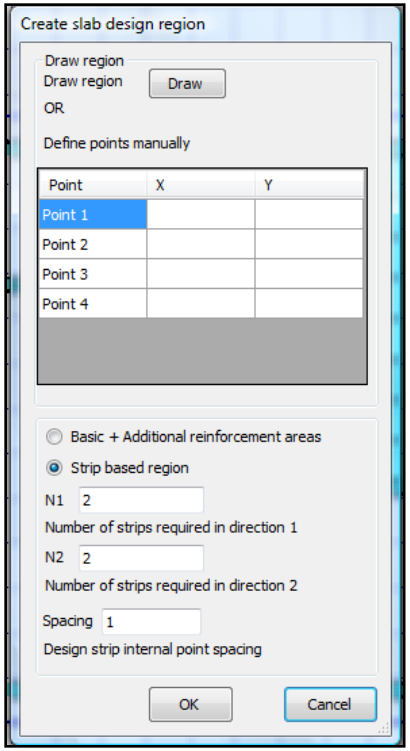
OR

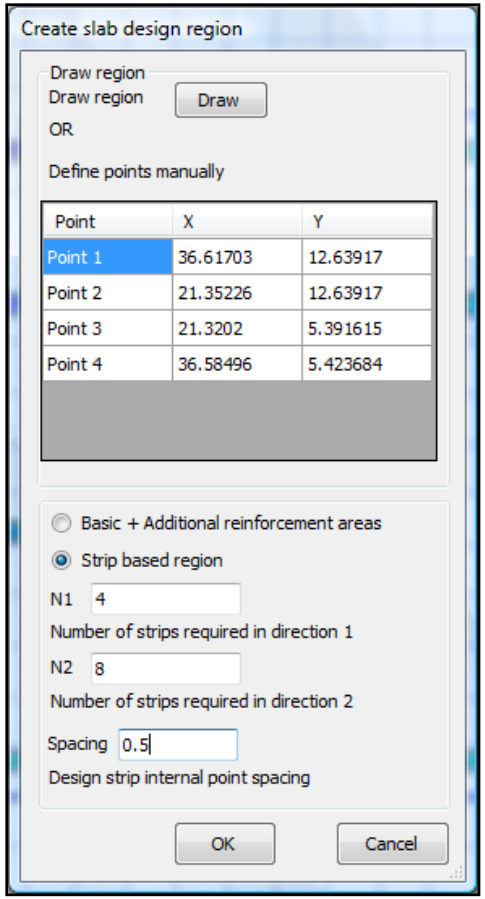


Design from PLDesign directly (Strip based region)

The two previous methods, the user use add strip to main model tab now he should use create new region as far there is no previous analysis.



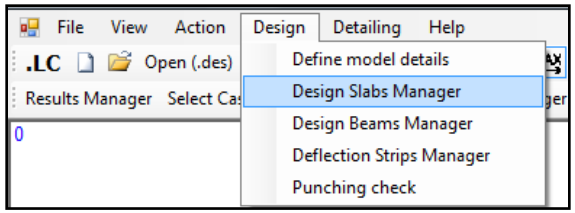




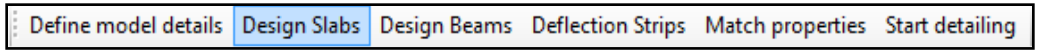
The user should draw the area needed to be designed by Draw tab, then choose Strip based region, and select the number of horizontal /vertical strips and select the spacing.

Design from PLDesign directly (Strip based region)

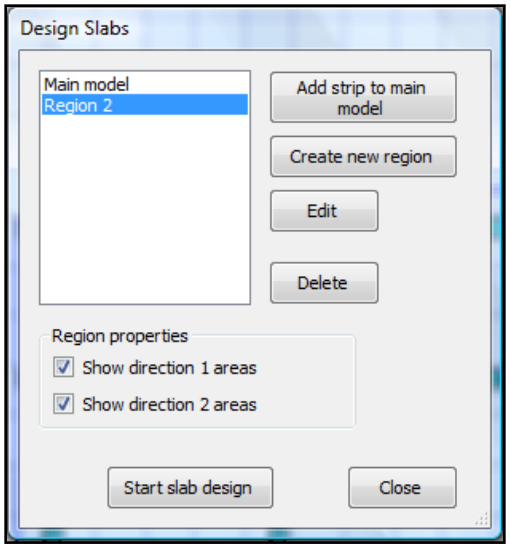
The PLDesign starts the analysis similarly as PLPost

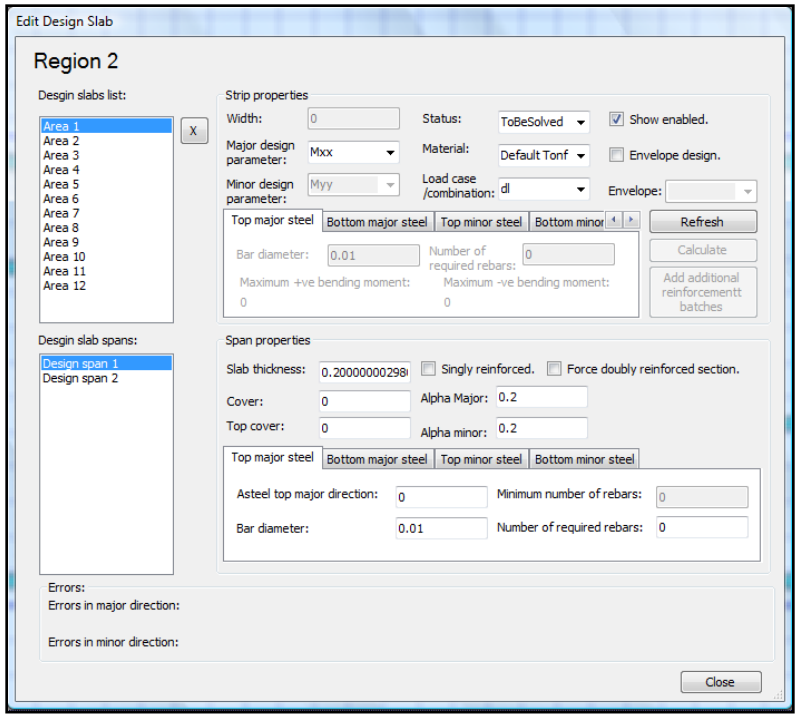


OR



Press on Design slab manager to see that a new region has been created.

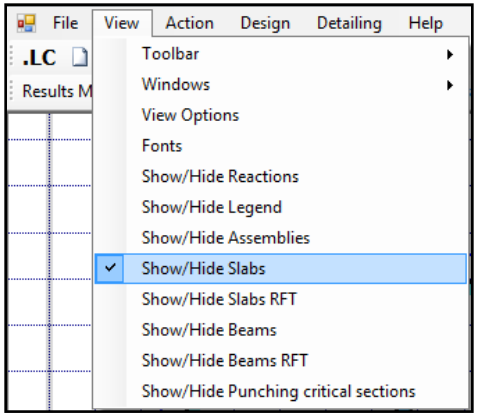




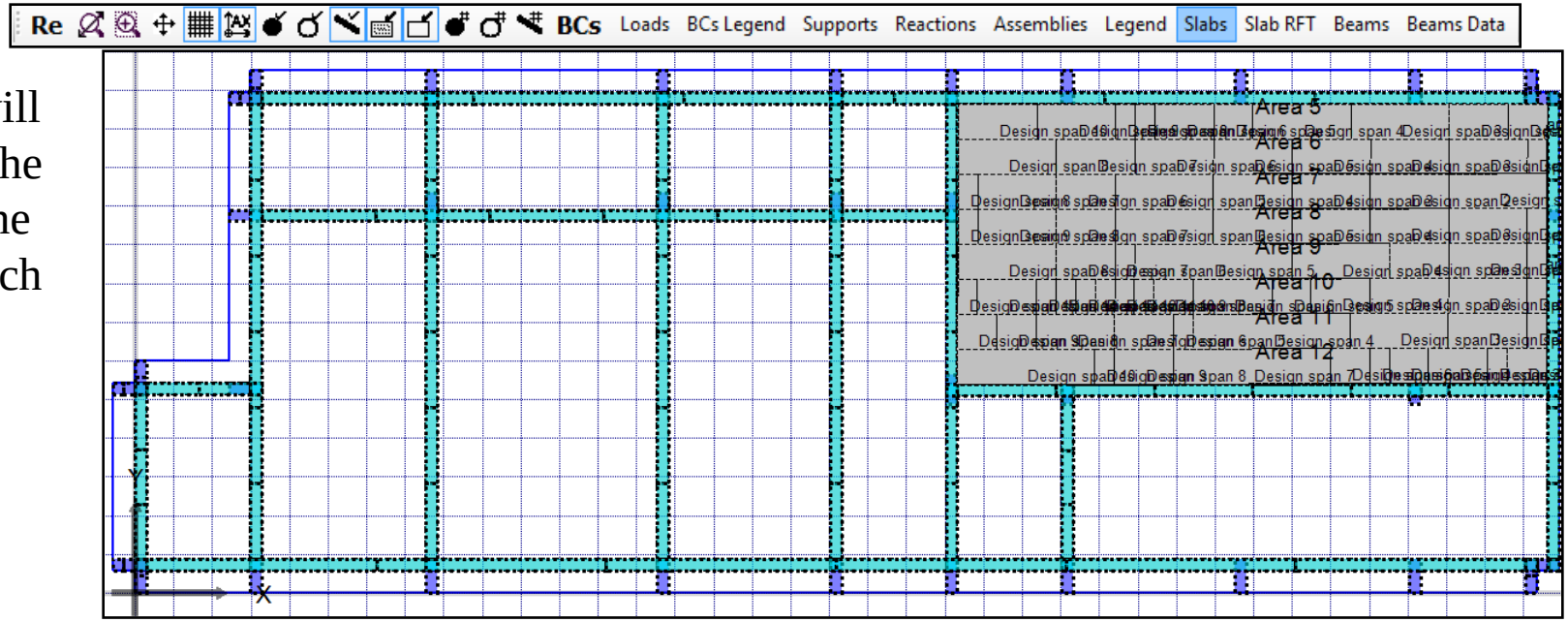
Go to Edit slab design to see that the slab is divided into 12 areas (8 horizontal and 4 vertical) each area divided into a number of spans.

Design from PLDesign directly (Strip based region)

The horizontal areas should be designed on moment in x-direction and the vertical areas on moment in y-direction.



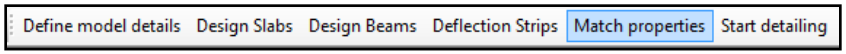
OR

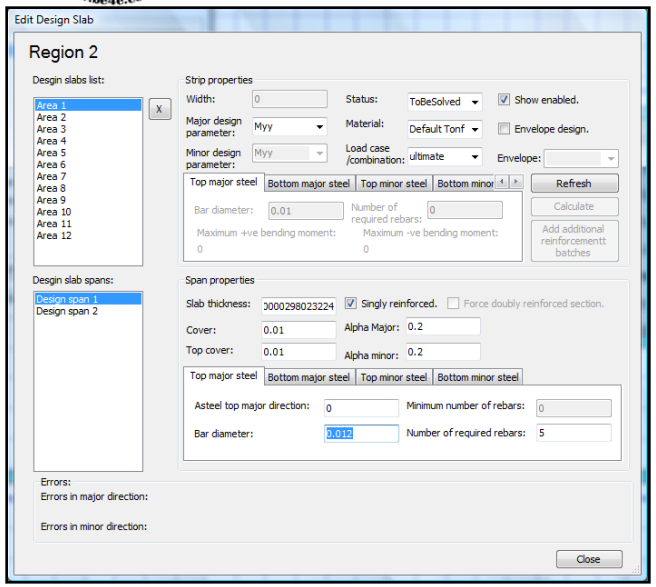


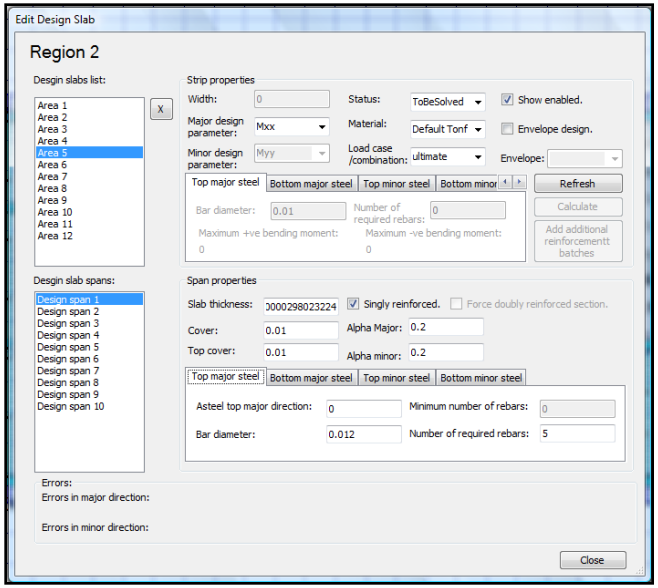
The user will recognize the area and the spans in each area.

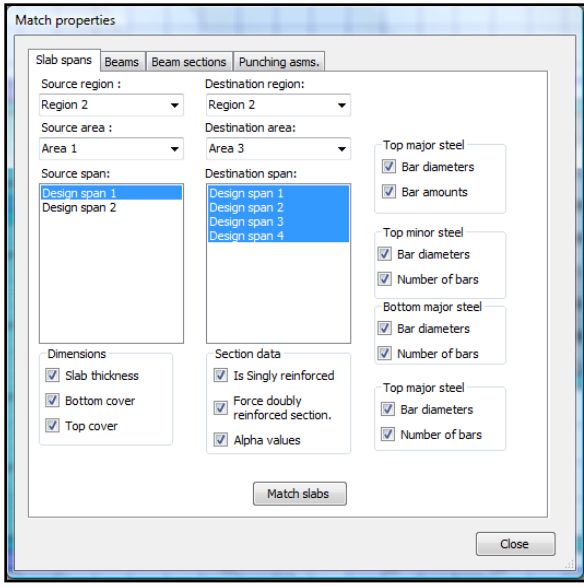
Design from PLDesign directly (Strip based region)

Edit one Span in one area then match the properties for all spans.



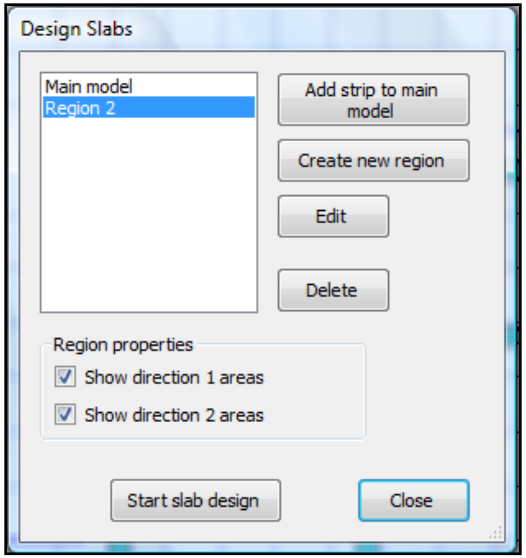




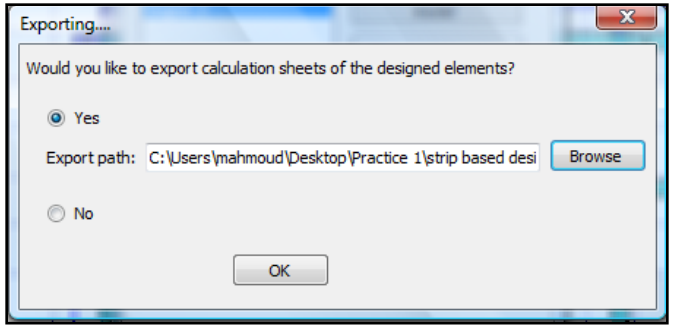


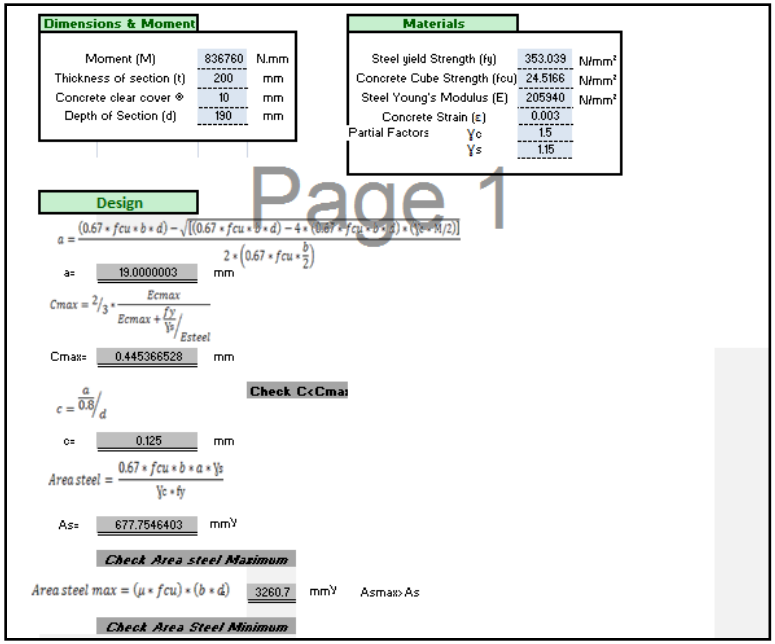
The user match properties twice one for areas in y-direction and the other of the spans in x-directions, then he has to check the sections before starting slab design.

Design from PLDesign directly (Strip based region)



Before starting slab design, the user should check mark on show direction 2 areas.



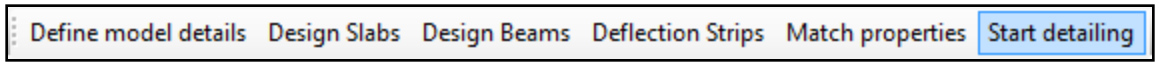


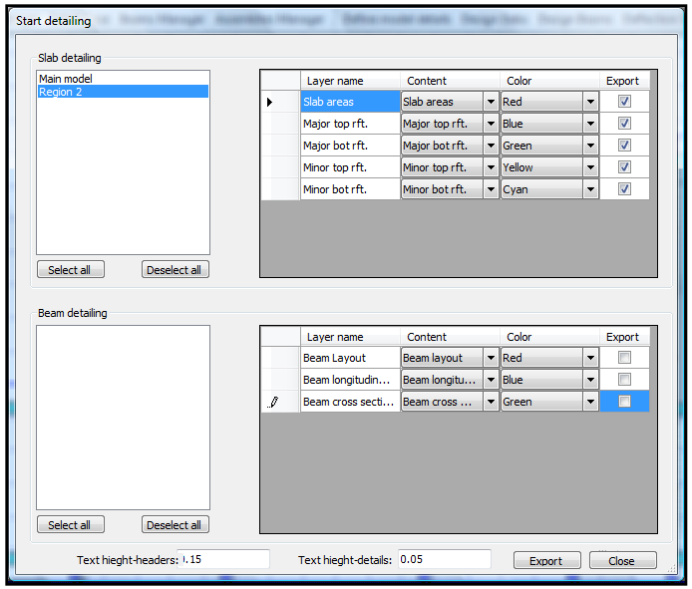
Area 5	Mxx	Design span 1	5 Φ 0.012	6 Φ 0.012	5 Φ 0.012	6 Φ 0.012
		Design span 2	5 Φ 0.012	6 Φ 0.012	5 Φ 0.012	6 Φ 0.012
		Design span 3	6 Φ 0.012	5 Φ 0.012	6 Φ 0.012	5 Φ 0.012
		Design span 4	5 Φ 0.012	6 Φ 0.012	5 Φ 0.012	6 Φ 0.012
		Design span 5	7 Φ 0.012	5 Φ 0.012	5 Φ 0.012	6 Φ 0.012
		Design span 6	5 Φ 0.012	7 Φ 0.012	5 Φ 0.012	6 Φ 0.012
		Design span 7	5 Φ 0.012	6 Φ 0.012	6 Φ 0.012	5 Φ 0.012
		Design span 8	6 Φ 0.012	5 Φ 0.012	6 Φ 0.012	5 Φ 0.012
		Design span 9	6 Φ 0.012	5 Φ 0.012	6 Φ 0.012	5 Φ 0.012
		Design span 10	6 Φ 0.012	5 Φ 0.012	5 Φ 0.012	6 Φ 0.012
Area 6	Mxx	Design span 1	6 Φ 0.012	5 Φ 0.012	6 Φ 0.012	5 Φ 0.012
		Design span 2	5 Φ 0.012	6 Φ 0.012	5 Φ 0.012	6 Φ 0.012
		Design span 3	6 Φ 0.012	5 Φ 0.012	5 Φ 0.012	6 Φ 0.012
		Design span 4	5 Φ 0.012	6 Φ 0.012	5 Φ 0.012	6 Φ 0.012
		Design span 5	6 Φ 0.012	5 Φ 0.012	5 Φ 0.012	6 Φ 0.012
		Design span 6	5 Φ 0.012	6 Φ 0.012	6 Φ 0.012	5 Φ 0.012
		Design span 7	6 Φ 0.012	5 Φ 0.012	6 Φ 0.012	5 Φ 0.012
		Design span 8	5 Φ 0.012	6 Φ 0.012	5 Φ 0.012	6 Φ 0.012

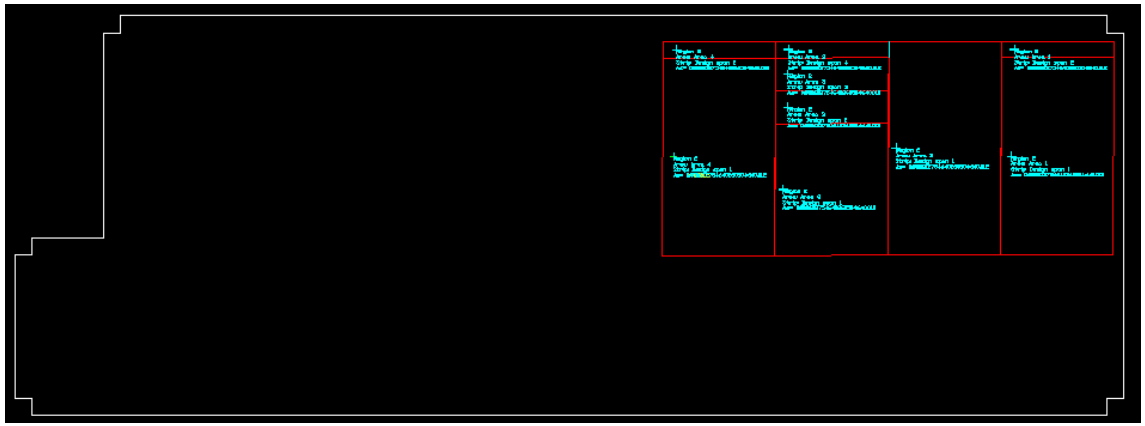
Design from PLDesign directly (Strip based region)

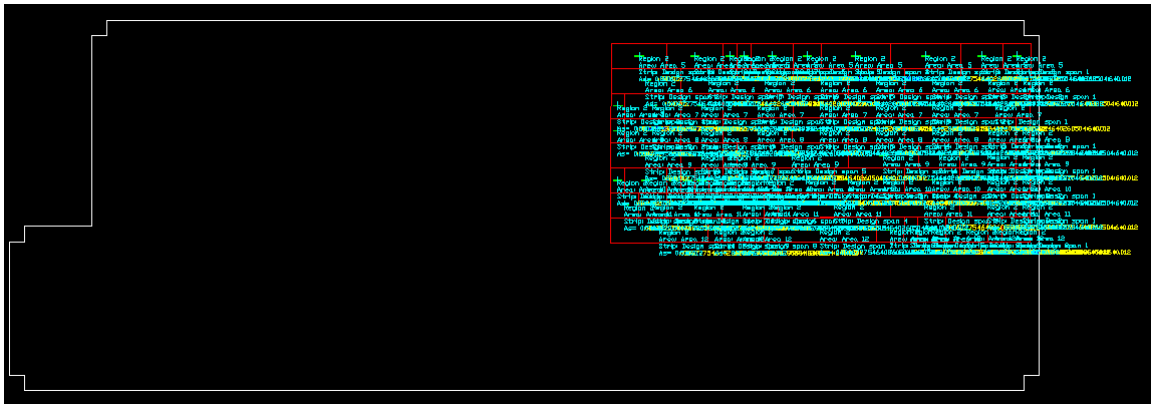
One of PLDesign advantages is the detailing where the user after finishing the design, he can see slab detailing.

OR





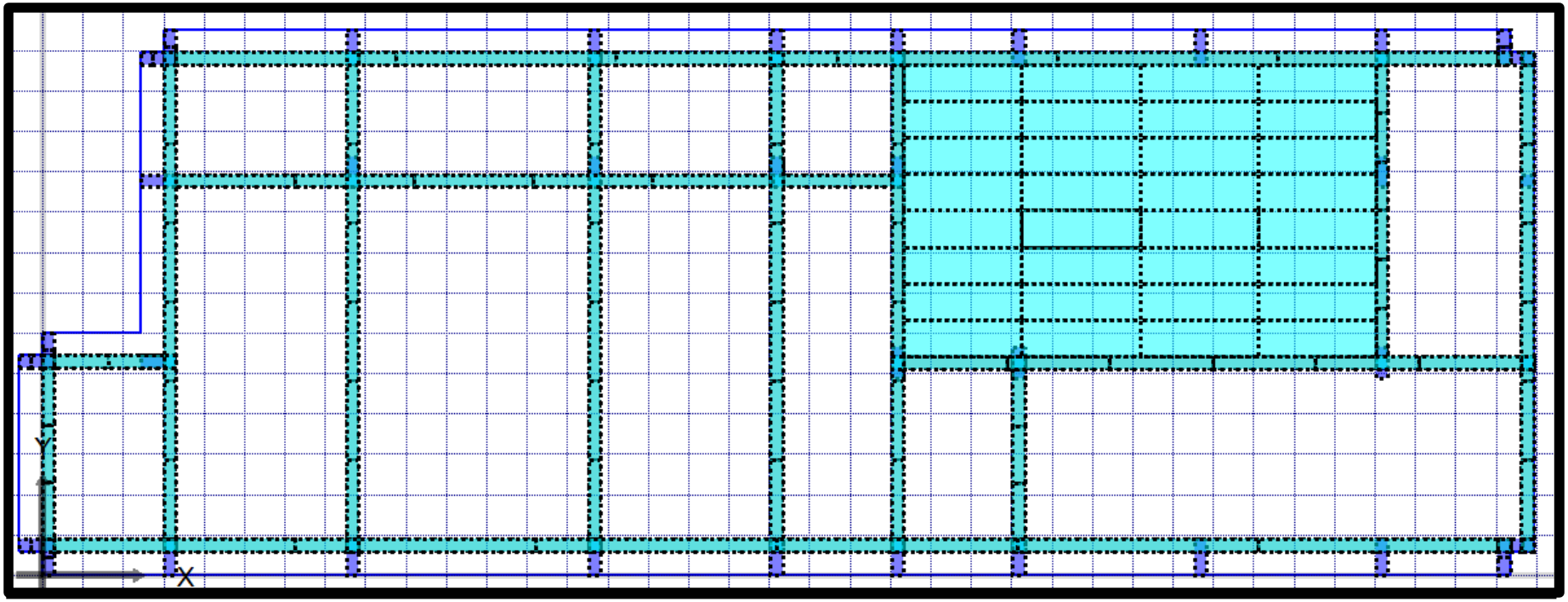


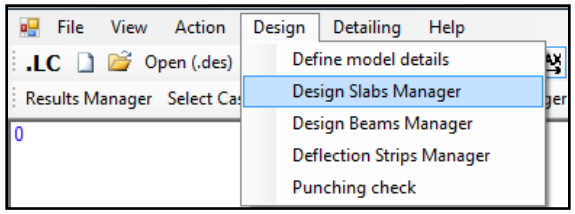


The user will have (.Dxf) file, the file contain two drawings one for horizontal areas and the other for vertical areas.

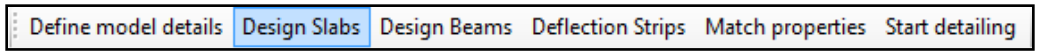
Design from PLDesign directly (Basic and additional RFT)

This method is very famous in flat slabs and can be shown very simply.



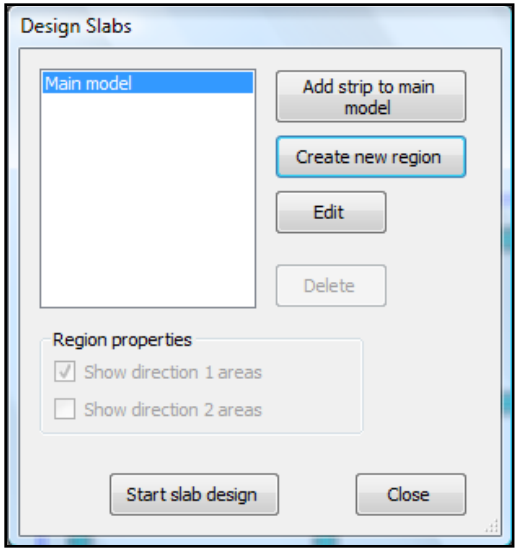


OR

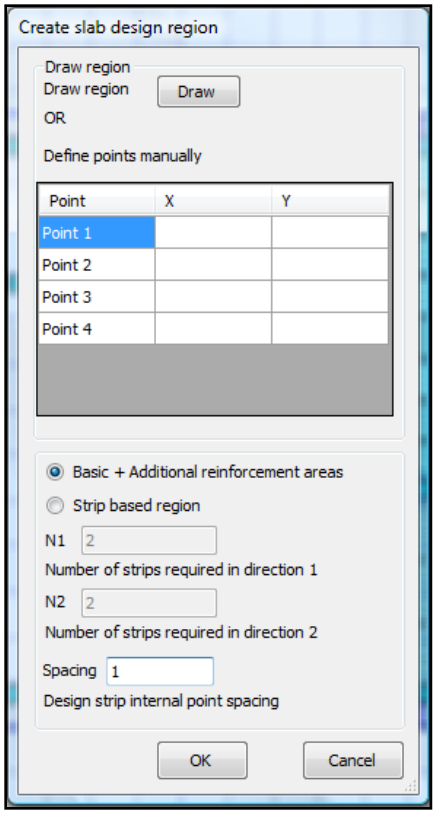


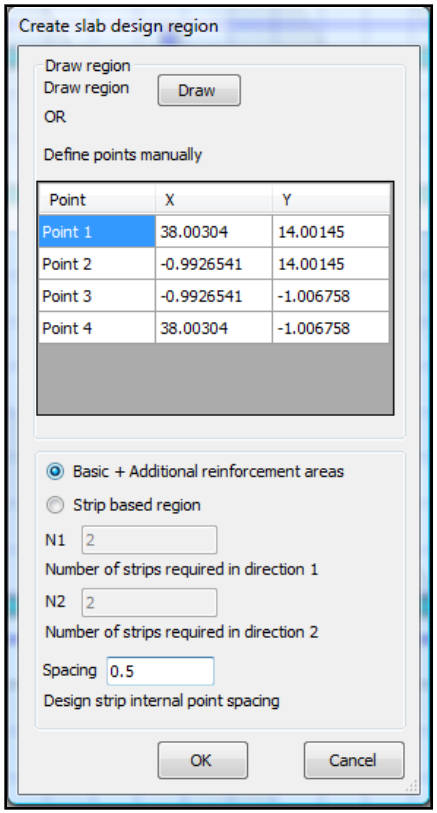
Design from PLDesign directly (Basic and additional RFT)

We are also going to use Create new region



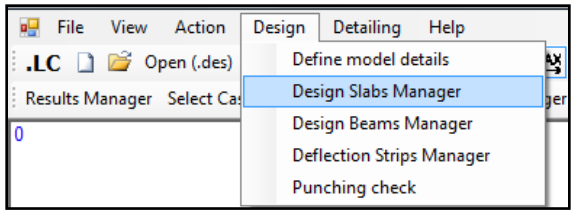
The user should draw the area needed to be designed by Draw tab, then select the spacing for the analysis.



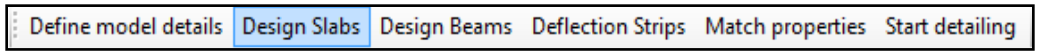


Design from PLDesign directly (Basic and additional RFT)

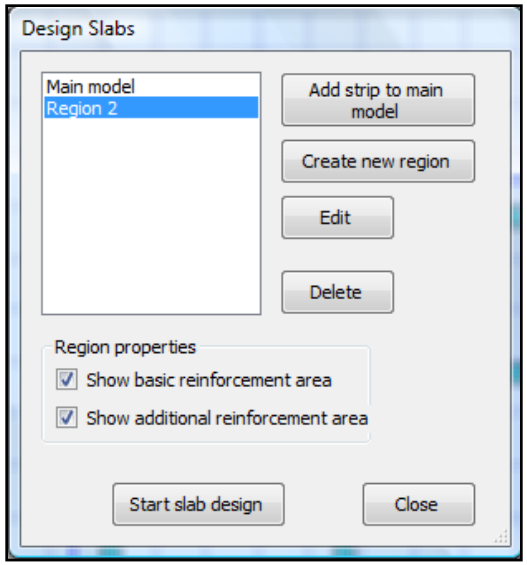
The PLDesign starts the analysis similarly as PLPost

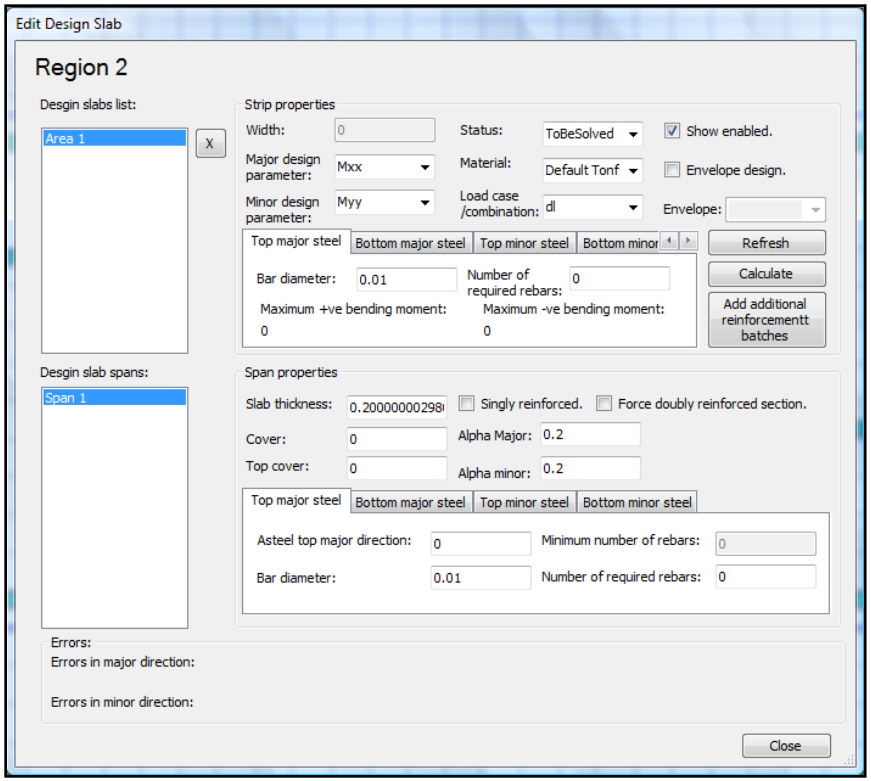


OR



Press on Design slab manager to see that a new region has been created.



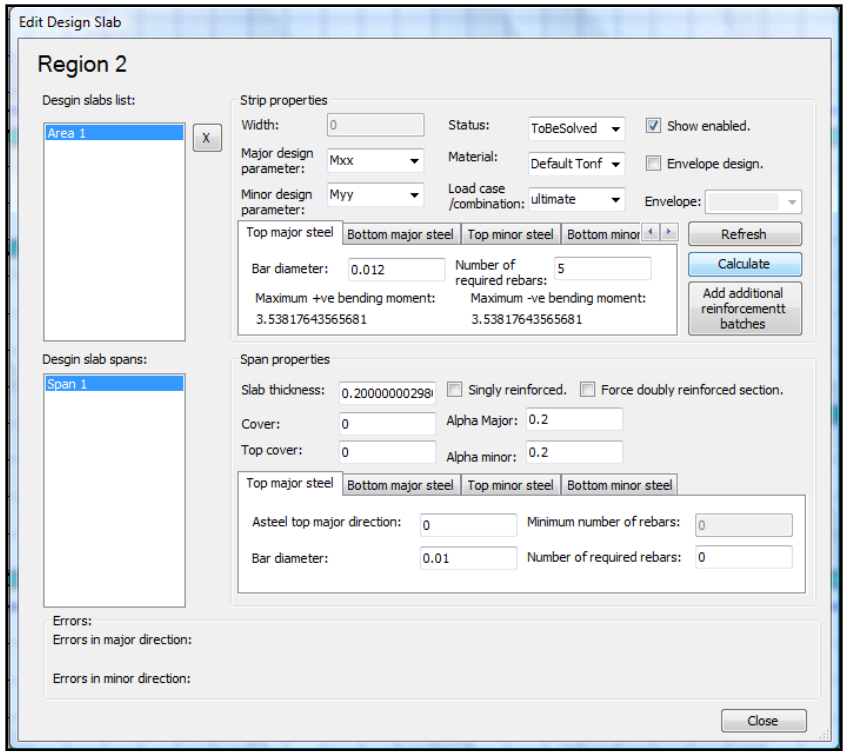


Go to Edit slab design to see that the slab is one area

The upper section of strip properties is for the basic reinforcement and the lower is for additional reinforcement.

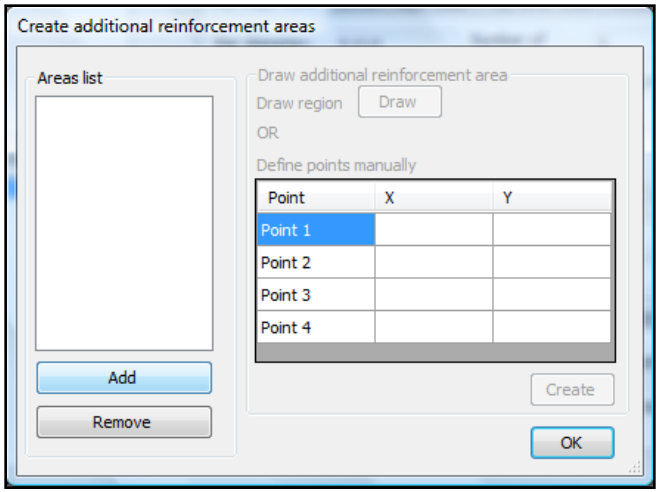
Design from PLDesign directly (Basic and additional RFT)

The user has to insert the major/minor design parameter, Load case/combination, material units, Bar diameter and number of bars, then press calculate and refresh.



The PLDesign calculate the maximum +ve and –ve moments.

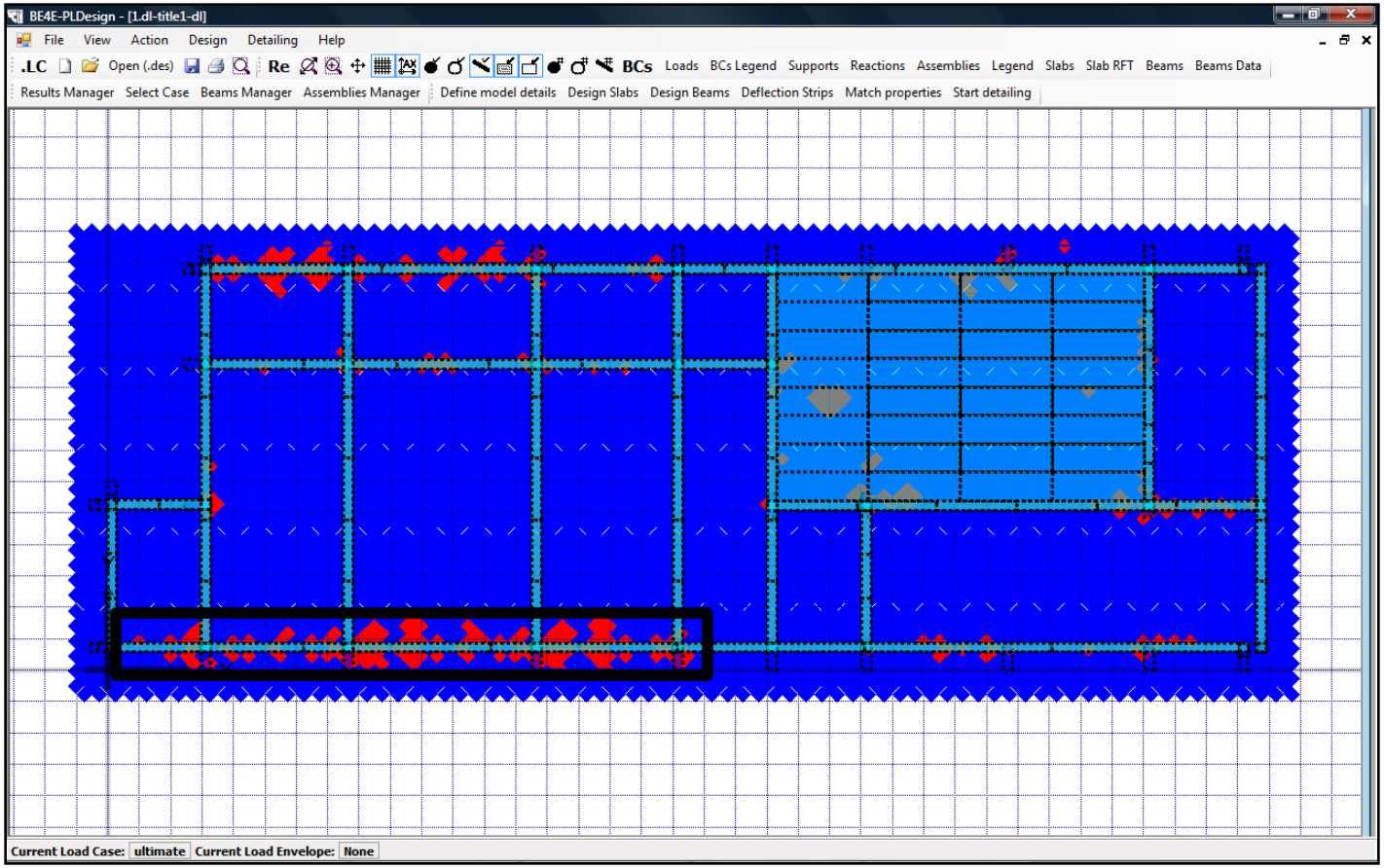
Click on add additional reinforcement batches to show areas for additional reinforcement.



Press on add additional areas then draw to show parts of slab need additional reinforcement.

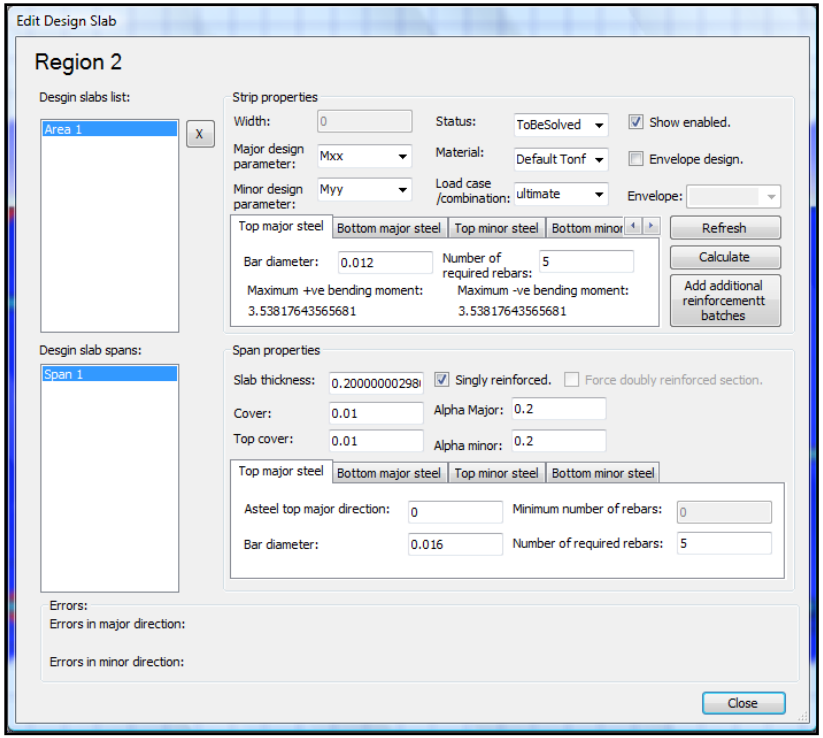
Design from PLDesign directly (Basic and additional RFT)

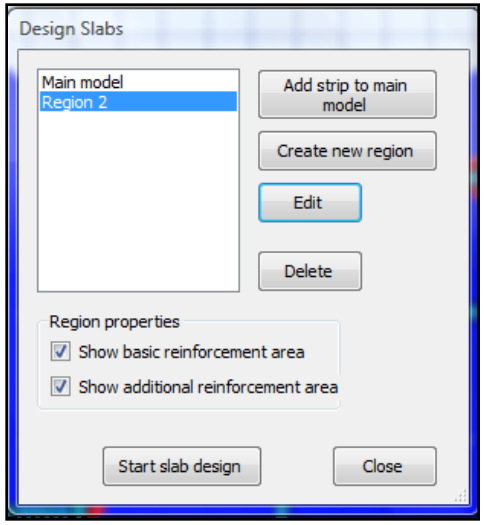
The blue area is safe for the basic reinforcement, but the red areas are not safe.



Design from PLDesign directly (Basic and additional RFT)

After drawing the additional areas, the user should select cover, bar diameter and number of required bars in span properties.

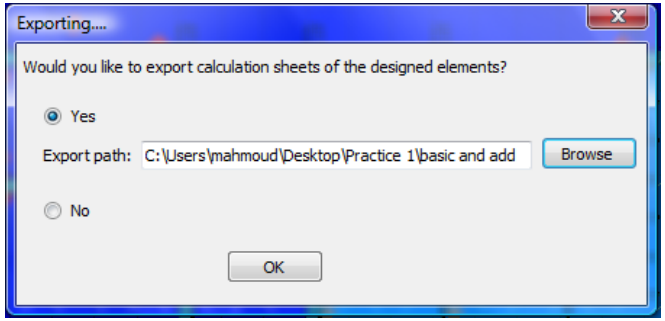


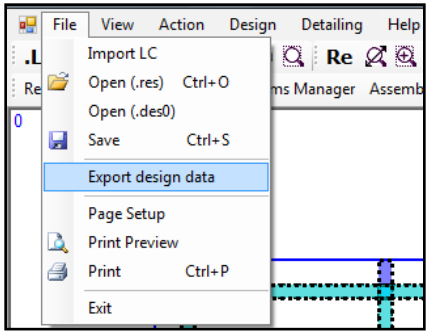


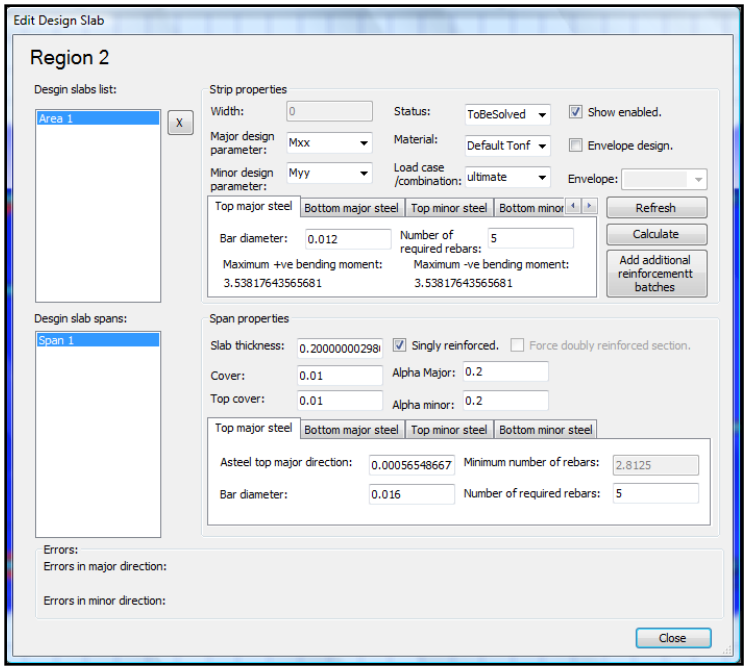
Check the mark box of show additional reinforcement area, then Start slab design.

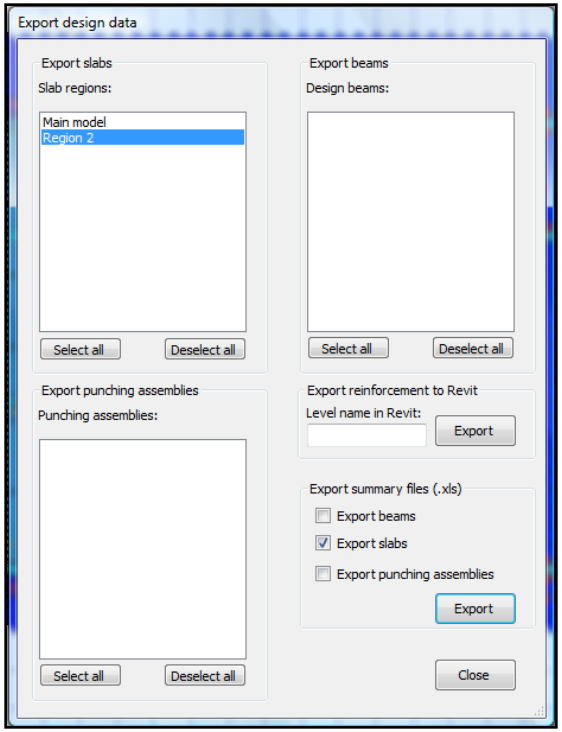
Design from PLDesign directly (Basic and additional RFT)

Export the calculation sheet files, then check the reinforcement and export the data sheet summary.









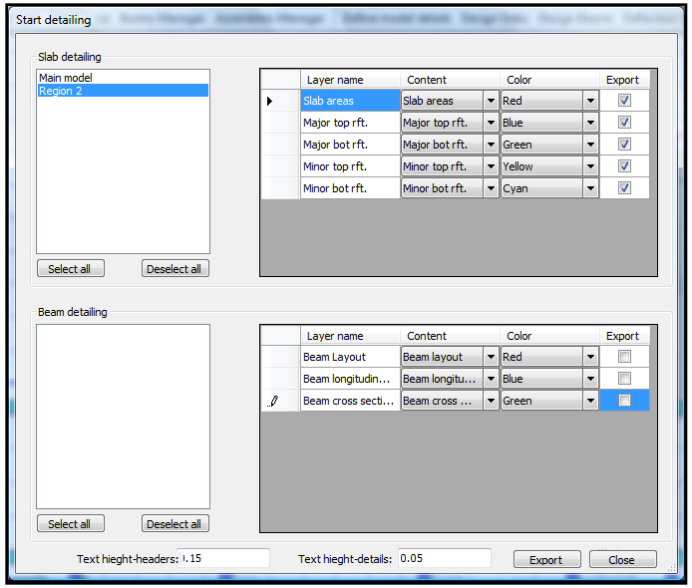
Design from PLDesign directly (Basic and additional RFT)

PLDESIGN : Slab reinforcement sheet

Company Name:
Project Name:
Designed By:
Reviewed By:
Approved by:

Region name	Area name	Major design moment	Strip name	Top major rft.	Bot. major rft.	Top minor rft.	Bot minor rft.
Region 2	Area 1	Mxx	Span 1	5 Φ 0.016	5 Φ 0.016	5 Φ 0.016	5 Φ 0.016

Now the user can also see slab detailing as strip based region.



OR