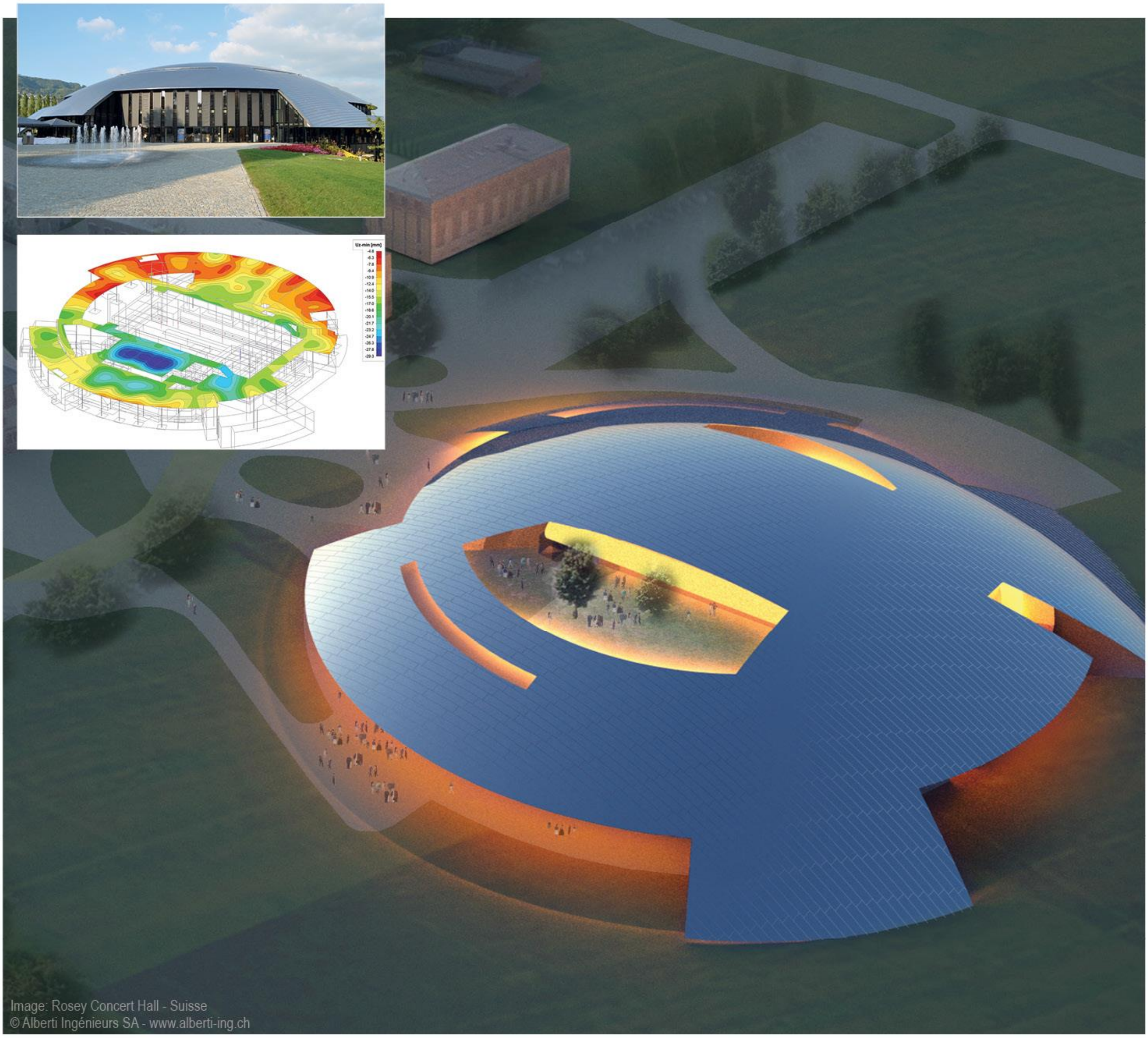
SCIA ENGINEER



Advanced Concept Training

Punching Design

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Theoretical background

1. General

Punching shear can result from a concentrated load or reaction acting on a relatively small area, called the loaded area A_{load} of a slab or a foundation.

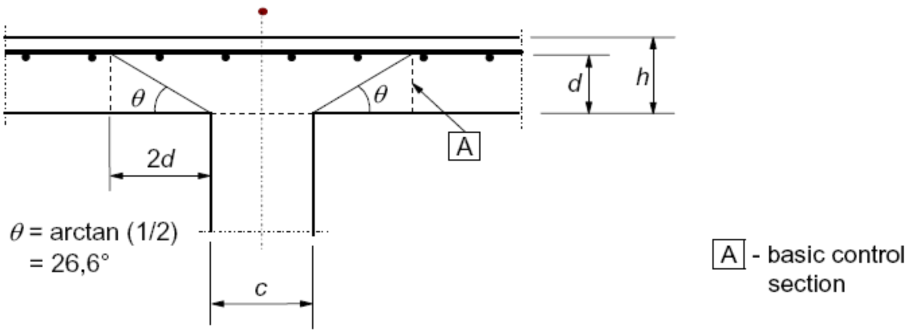
The most common situations where punching shear has to be considered is the region immediately surrounding a column in a flat ceiling plate or where column is supported on foundation plate.
The following problem types can be distinguished: interior, edge and corner columns.
Design of punching shear reinforcement is based on clause 6.4 of EN 1992-1-1: 2004 / A1:2014 + National Annexes.

The verification reveals either that the load-bearing capacity of the reinforced concrete is sufficiently high, or that punching shear reinforcement must be designed and installed. If the verification limits are exceeded, the verification result is marked as not permissible. In this case, the user must change the model parameters or select a suitable design alternative.

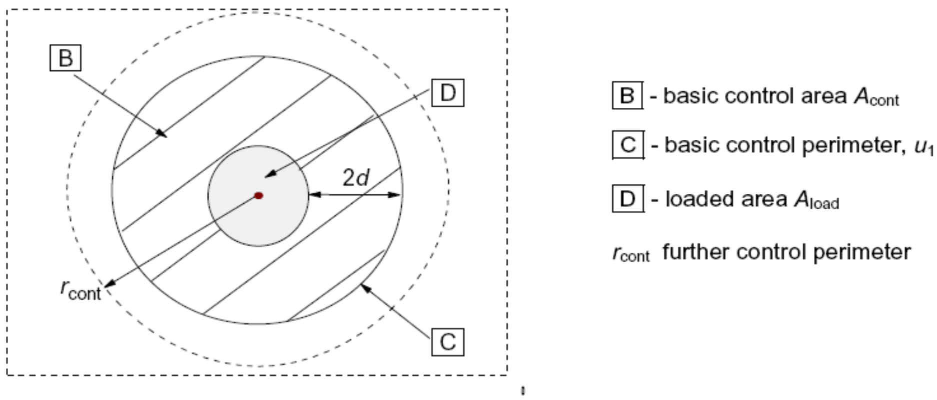
The verification of punching failure at the ultimate limit state can be resumed as follows:

- Check of the the shear resistance at the face of the column noted u_0, and at the basic control perimeter named u_1.
- If shear reinforcement is required, a further perimeter $u_{out,ef}$ should be found where shear reinforcement is no longer required.

Those control perimeters are shown in the following pictures:



a) Section

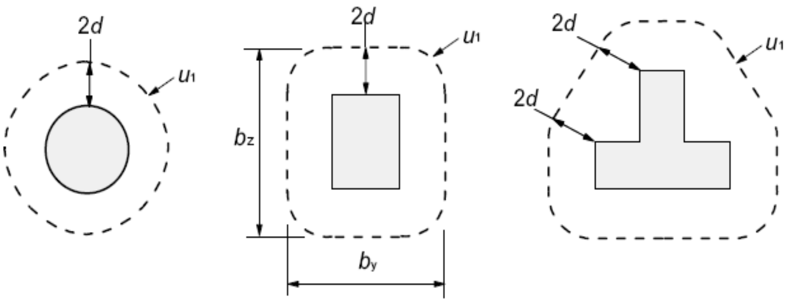


b) Plan

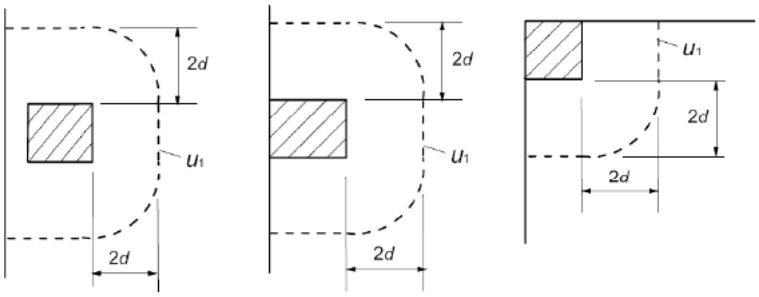
2. Load distribution and basic control perimeter

Basic control perimeter u_1

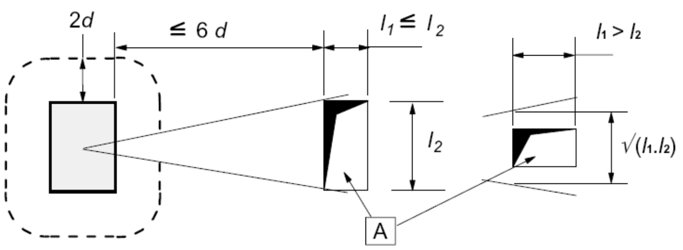
The basic control perimeter u_1 is taken at a distance 2d from the loaded area, where d is the effective depth.



In case the loaded area is close to an edge or a corner:



In case there is openings near the loaded area, they are dealt with according to clause 6.4.2(3).
If the shortest distance between the perimeter of the loaded area and the edge of the opening does not exceed 6d (see figure), part of the control perimeter contained between two tangents drawn to the outline of the opening from the center of the loaded area is ineffective.



A - opening

In SCIA Engineer, openings inputted in the Structure menu are automatically considered according to the previous criteria.

Effective depth d_{eff}

The effective depth of the slab, is assumed constant and is calculated according to formula 6.32 from EN1992-1-1:

$$d_{eff} = \frac{(d_y + d_z)}{2}$$

where d_y and d_z are the effective depths of the reinforcement in two orthogonal directions.

3. Punching shear calculation

The punching shear calculation is done according to EN1992-1-1 art.6.4.3.

First the design shear resistances along the control sections are calculated:

- $v_{Rd,c}$ design value of the shear resistance of a slab *without* punching shear reinforcement along the control section considered
- $v_{Rd,cs}$ design value of the punching shear resistance of a slab *with* punching shear reinforcement along the control section considered
- $v_{Rd,max}$ design value of the *maximum* punching shear resistance along the control section considered

Then the following checks should be performed.

Check at the column perimeter u_0

At the column perimeter u_0, or at the perimeter of the loaded area, the maximum punching shear stress should not be exceeded.

$$v_{Ed0} \leq v_{Rd,max}$$

v_{Ed0} design shear stress at the column perimeter u_0
$v_{Rd,max}$ = 0.4· v ·fcd
v = 1 - f_{ck}/250

Check at the basic control perimeter u_1

At the basic control perimeter u_1:

- If $v_{Ed} \leq v_{Rd,c}$ Punching reinforcement is not needed
- If $v_{Ed} > v_{Rd,c}$ Punching reinforcement is needed

The punching shear resistance of a plate $V_{Rd,c}$ is calculated according to formula 6.47, EN1992-1-1:

$$v_{Rd,c} = C_{Rd,c}\, k\, (100\rho_l\ f_{ck})^{1/3} + k_1\sigma_{cp} \geq \left(v_{min} + k_1\sigma_{cp}\right)$$

In SCIA Engineer, normal concrete stresses are not taken into, so $k_1 . \sigma_{cp} = 0$. This results in the following formula:

$$v_{Rd,c} = C_{Rd,c}\, k\, (100\rho_l\ f_{ck})^{1/3} \geq v_{min}$$

$C_{Rd,c}$ = 0.18 / γ_c

$$k = 1 + \sqrt{\frac{200}{d}} \leq 2{,}0 \quad d \text{ in mm}$$

ρ_l average reinforcement ratio in specific distance around column
f_{ck} characteristic concrete compressive strength in MPa
v_{min} = $0.035 \cdot k^{3/2} \cdot f_{ck}^{1/2}$

The maximum shear stress v_{Ed} is calculated for considered control perimeter u_i according to clause 6.4.3(1) as follows:

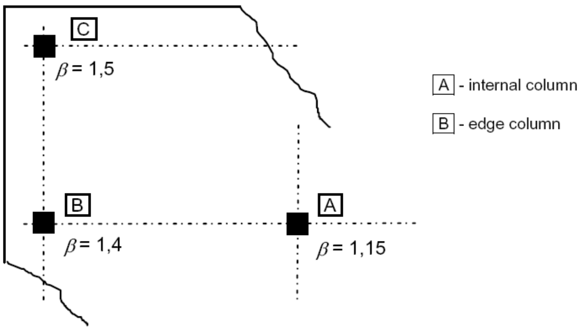
$$v_{Ed} = \beta \frac{V_{Ed}}{u_i d}$$

The β-factor is to consider the non-uniform load transfer (due to unbalanced bending moment). If the load transfer is non-uniform, local peak loading should be compensated by help of this β-factor.

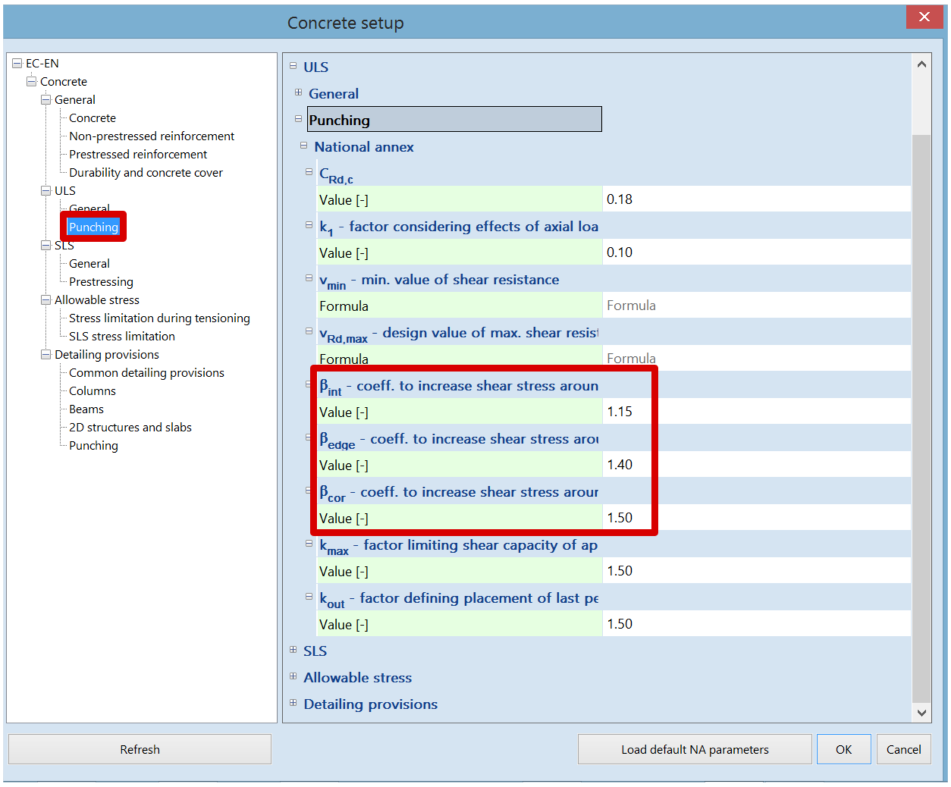
In case that lateral stability of the structure does not depend on frame action between the slabs and the columns, and where the adjacent spans do not differ in length by more than 25%, approximate values for β may be used according to clause 6.4.3(6).

In SCIA Engineer, the user must decide whether these approximate values can be used, because the program cannot check the preconditions described above.

By default, the recommended approximated values are:



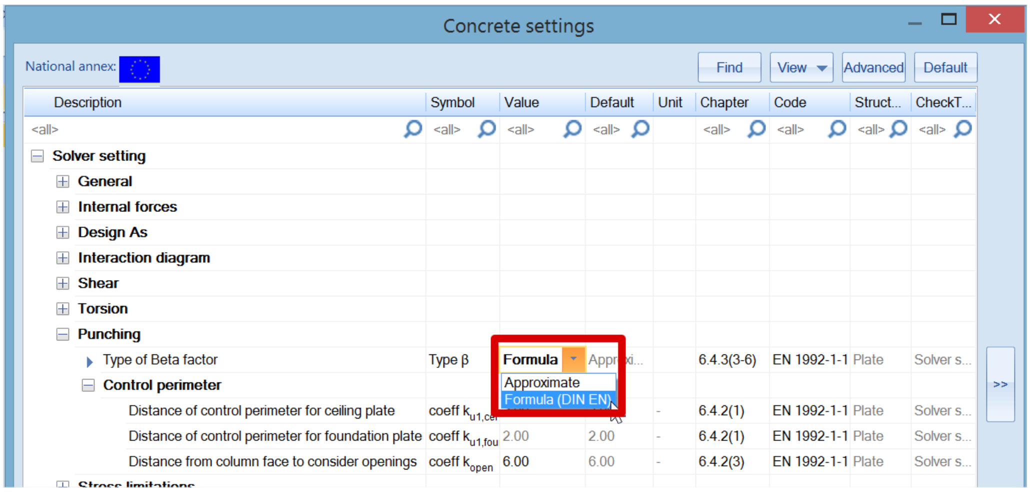
Those values might be different according to the National Annexes and can be viewed in the National Annexes setup:



Otherwise, as described in art 6.4.3, the β-factor can be calculated by the following general formula:

$$\beta = 1 + \sqrt{\left(k_y \cdot \frac{M_{Ed,y}}{V_{Ed}} \cdot \frac{u_1}{W_{1y}}\right)^2 + \left(k_z \cdot \frac{M_{Ed,z}}{V_{Ed}} \cdot \frac{u_1}{W_{1z}}\right)^2}$$

Calculation of β-factor with general formula can be set in Concrete setup > Punching:



Design of punching reinforcement if required

In case that $v_{Ed} > v_{Rd,c}$, punching reinforcement should be designed.

If punching reinforcement is required, the outer control perimeter u_{out} beyond which the reinforcement is no longer needed is calculated acc. to clause 6.4.5(4):

$$u_{out,ef} = \frac{\beta V_{Ed}}{v_{Rd,c} d}$$

Calculation of the required punching reinforcement

In SCIA Engineer, the shear reinforcement is designed using the following assumptions:

- the distribution of the shear links is considered as radial only
- only vertical shear links are supported
- the shape of reinforcement perimeters around the column is the same as for the shape of the basic control perimeter

The required area $A_{sw,req}$ of one perimeter of shear reinforcement around the column assumed as radially distributed vertical shear links is calculated as:

$$\mathrm{Asw,req} = \frac{(\mathrm{vEd,u1} - 0.75 \cdot \mathrm{vRd,c}) \cdot \mathrm{u1} \cdot \mathrm{sr}}{1.5 \cdot \mathrm{fywd,ef}}$$

$f_{ywd,ef}$ effective design strength of the punching reinforcement acc. to formula:
$f_{ywd,ef} = 200 + 0.25 \cdot d_{eff} \leq f_{ywd}$

Detailing provisions for the punching reinforcement

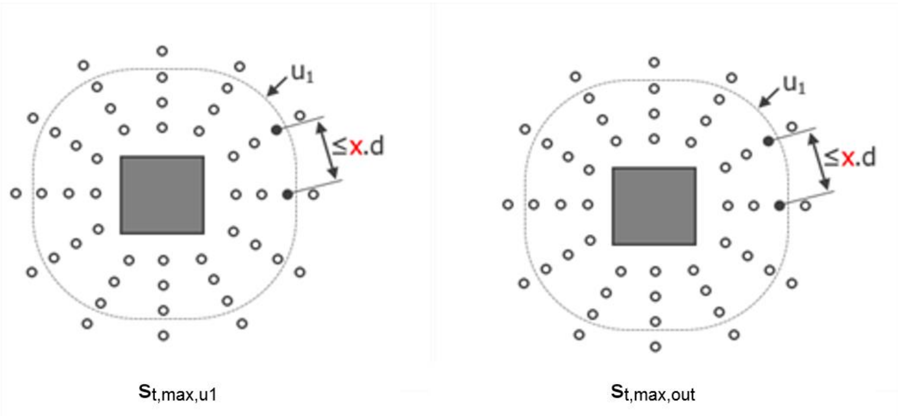
The required area might be adjusted to fulfil detailing provision rules acc. to clause 9.4.3(1), so that number of shear links n_s per each reinforcement perimeter is:

$$n_s = max\left\{\frac{4 \cdot A_{sw,req}}{\pi \cdot {d_s}^2}; \frac{u_{1,last}}{s_{t,max,u1}}; \frac{u_{s,last}}{s_{t,max,out}}\right\}$$

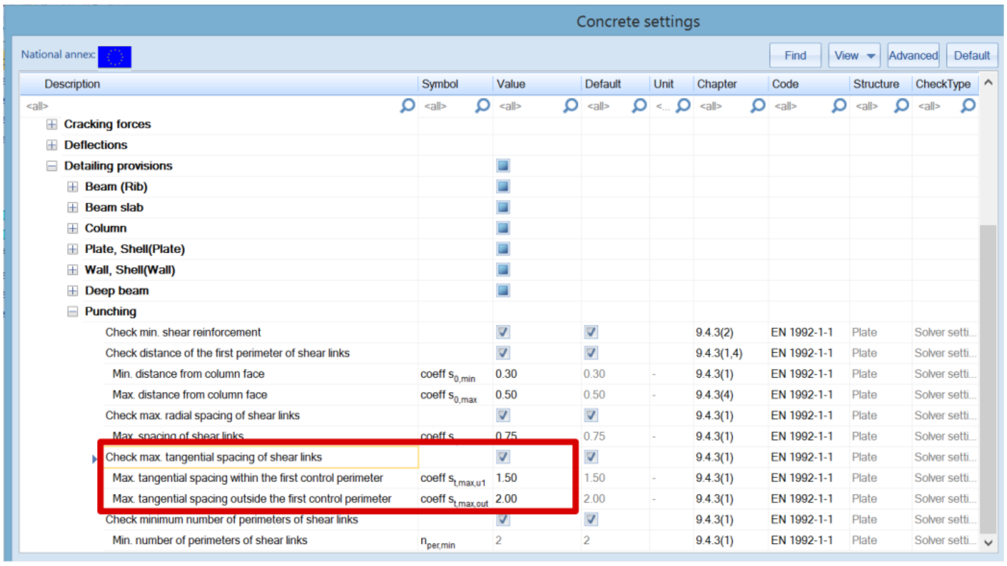
d_s diameter of shear link

$\frac{u_{1,last}}{s_{t,max,u1}}$ condition of maximum allowed tangential spacing of links of reinforcement perimeters placed within the basic control perimeter ($u_{1,last}$ is length of last perimeter of shear reinforcement there)

$\frac{u_{s,last}}{s_{t,max,out}}$ condition of maximum allowed tangential spacing of links of reinforcement perimeters placed outside the basic control perimeter ($u_{s,last}$ is length of last perimeter of shear reinforcement there)



In SCIA Engineer, limitation of spacing $s_{t,max,u1}$ and $s_{t,max,out}$ are set in Concrete setup > Detailing provisions > Punching:



Concrete settings

National annex: | Find | View | Advanced | Default

Description	Symbol	Value	Default	Unit	Chapter	Code	Structure	CheckType
<all>	<all>	<all>	<all>	<...	<all>	<all>	<all>	<all>
Cracking forces								
Deflections								
Detailing provisions		■						
Beam (Rib)		■						
Beam slab		■						
Column		■						
Plate, Shell(Plate)		■						
Wall, Shell(Wall)		■						
Deep beam		■						
Punching								
Check min. shear reinforcement		☑	☑		9.4.3(2)	EN 1992-1-1	Plate	Solver setti...
Check distance of the first perimeter of shear links		☑	☑		9.4.3(1,4)	EN 1992-1-1	Plate	Solver setti...
Min. distance from column face	coeff $s_{0,min}$	0.30	0.30	-	9.4.3(1)	EN 1992-1-1	Plate	Solver setti...
Max. distance from column face	coeff $s_{0,max}$	0.50	0.50	-	9.4.3(4)	EN 1992-1-1	Plate	Solver setti...
Check max. radial spacing of shear links		☑	☑		9.4.3(1)	EN 1992-1-1	Plate	Solver setti...
Max. spacing of shear links	coeff s	0.75	0.75	-	9.4.3(1)	EN 1992-1-1	Plate	Solver setti...
Check max. tangential spacing of shear links		☑	☑		9.4.3(1)	EN 1992-1-1	Plate	Solver setti...
Max. tangential spacing within the first control perimeter	coeff $s_{t,max,u1}$	1.50	1.50	-	9.4.3(1)	EN 1992-1-1	Plate	Solver setti...
Max. tangential spacing outside the first control perimeter	coeff $s_{t,max,out}$	2.00	2.00	-	9.4.3(1)	EN 1992-1-1	Plate	Solver setti...
Check minimum number of perimeters of shear links		☑	☑		9.4.3(1)	EN 1992-1-1	Plate	Solver setti...
Min. number of perimeters of shear links	$n_{per,min}$	2	2		9.4.3(1)	EN 1992-1-1	Plate	Solver setti...

The last condition, which must be fulfilled acc. to clause 9.4.3(2) is minimum reinforcement area of single shear link $A_{sw1,min}$ acc. to formula (9.11):

$$A_{sw1,min} = \frac{0.08 \cdot \sqrt{f_{ck} / f_{ywk}} \cdot s_r \cdot s_t}{1.5}$$

s_r spacing of shear links in the radial direction

s_t spacing of shear links in the tangential direction

The final designed area of each perimeter of shear reinforcement around the column is:

$$A_{sw} = n_s \cdot \pi \cdot d_s^2 / 4 \geq n_s \cdot A_{sw1,min}$$

The required number of shear reinforcement perimeters around column, n_{per}, is determined based on clause 6.4.5(4), which specifies that the outermost perimeter of shear reinforcement, $a_{s,last} = s_0 + s_r \cdot n_{per}$, should be placed at a distance not greater than $k_{out} \cdot d_{eff}$ within u_{out}. The following formula for n_{per} is derived:

$$n_{per} = [(a_{out} - s_0 - k_{out} \cdot d_{eff}) / s_r] + 1 \geq n_{per,min}$$

k_{out} coefficient to determine the maximum distance of last perimeter from u_{out}.
Default value is 1,5. This is a National Annexes parameter.

$n_{per,min}$ minimum number of reinforcement perimeters around column required acc. to clause 9.4.3(1).
Default value is 2 in Concrete setup > Detailing provisions > Punching.

a_{out} distance of the outer perimeter u_{out}.

The total amount of shear reinforcement $A_{sw,tot}$ around the column is then calculated as:

$$A_{sw,tot} = n_{per} \cdot A_{sw}$$

Punching Design in SCIA Engineer

1. Configuration

The punching check in SCIA Engineer is only available when a real column or a nodal support have been connected to a plate. No punching check can be performed for a point load or a little surface load applied to the plate.

SCIA Engineer supports circular and rectangular cross sections only for the punching check.

The column position with regard to the edges of the plate and the openings is recognize. Also, for the punching check, all edges and angles of the plate are taken as straight... so if they are not in your model, the program makes an approximation.

SCIA Engineer doesn't support all punching cases of column-plate connection. The list of all current limitations can be found in our webhelp. Each unsupported configuration is mentioned in the list of Errors/warning/notes of the report in the punching check report.

Summary

Name	Case	Punching case	Punching shape	$UC_{vRd,max}$ [-]	$UC_{vRd,c}$ [-]	Shear reinforcement perimeters	$UC_{vRd,cs}$ [-]	$UC_{Asw,det}$ [-]	UC [-] Check	Errors, warnings, notes
N61	ULS/1	N/A	N/A	**3.00**	**3.00**	N/A	-	-	3.00 NOT OK	W6/131
N63	ULS/1	N/A	N/A	**3.00**	**3.00**	N/A	-	-	3.00 NOT OK	W6/124

Concrete

Name	Case	Punching case	Punching shape	V_{Ed} [kN] β [-]	$M_{Ed,y}$ [kNm] $M_{Ed,z}$ [kNm]	Plate h [mm]	Material f_{cd} [MPa]	d_{eff} [mm] ρ_l [%]	u_0 [m] u_1 [m]	$v_{Ed,u0}$ [MPa] $v_{Ed,u1}$ [MPa]	$v_{Rd,max}$ [MPa] $v_{Rd,c}$ [MPa]	$UC_{vRd,max}$ [-] $UC_{vRd,c}$ [-]
N61	ULS/1	N/A	N/A	- -	- -	N/A -	N/A -	- -	- -	- -	- -	**3.00** **3.00**
N63	ULS/1	N/A	N/A	- -	- -	N/A -	N/A -	- -	- -	- -	- -	**3.00** **3.00**

E/W/N	Present on members
W6/131	N61
W6/124	N63

E/W/N	Description	Solution
W6/131	Node cannot be calculated for punching. The connected column has not supported type of cross-section.	
W6/124	Node cannot be calculated for punching. The connected column goes through the plate.	Split the column in the node to get a separate column above and below the plate.

2. Choice of reinforcement

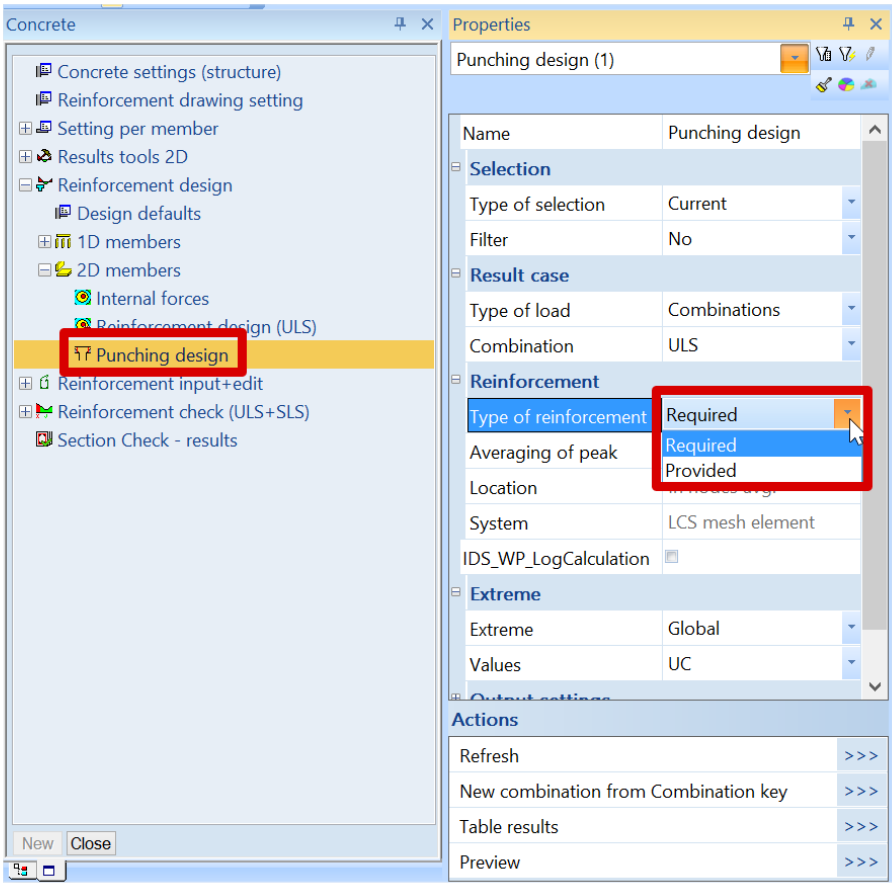
The punching design will check if the longitudinal reinforcement As in the plate is sufficient to resist to the shear force around a column-plate or nodal support-plate connection.

In SCIA Engineer the user can choose between 2 types of reinforcement for the punching check/design:

- As, required – calculated by the software for a specific load combination
- As,provided – user set in Reinforcement design > Design defaults

NOTE: practical reinforcement inputted by user manually in Reinforcement input+edit > Reinforcement 2D is not considered for punching design!

The choice between As,required and As,provided is done in the Properties window for Punching design:



3. Punching check

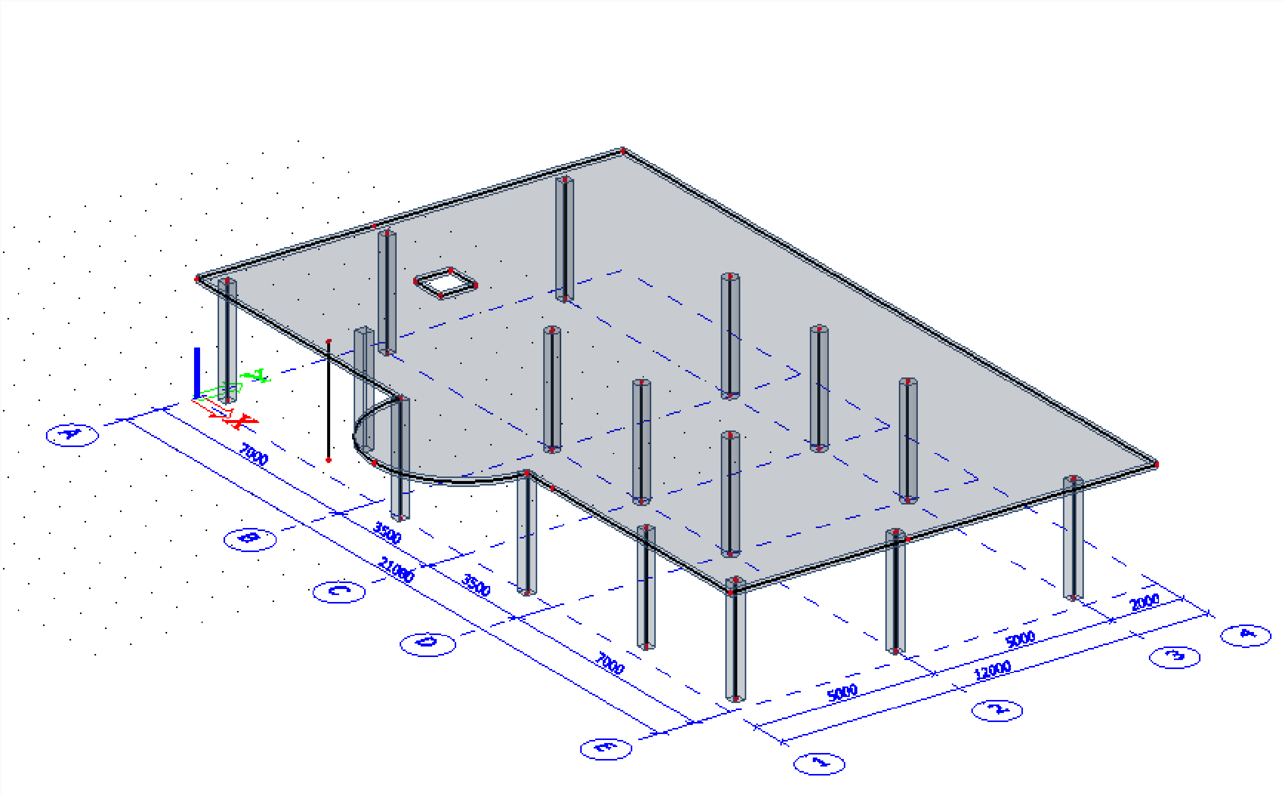
Studied example: ***punching.esa***

Geometry:
Concrete class C30/37
Reinforcement class B500B
Plate thickness 200 mm
Column cross-section 10 x R 300x300 mm² and 6 x circular C400 mm²

Plate and columns are connected to each other by means of the action Connect members/nodes.

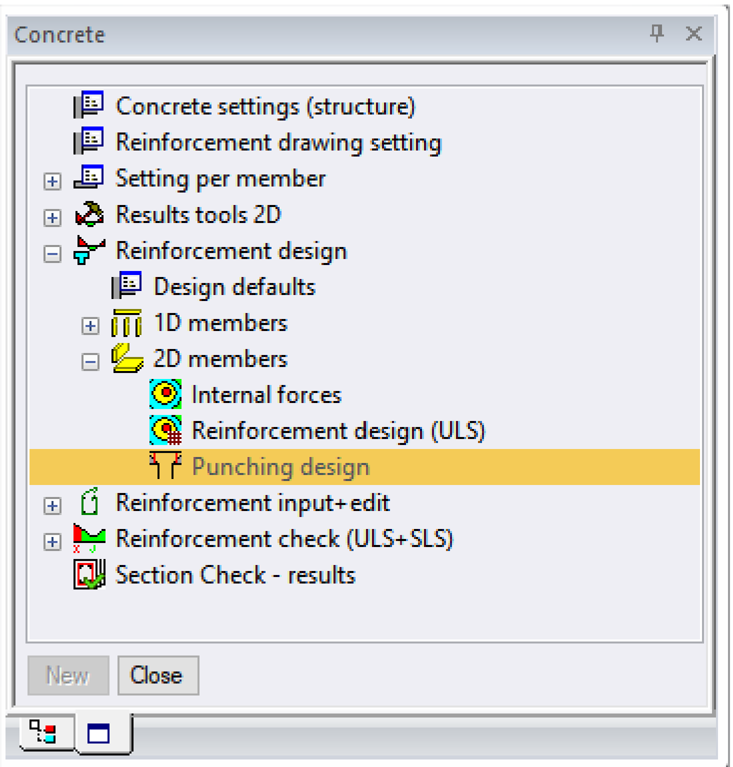
Loading:
*Load cases
SW: Self weight
DL: Dead Load = Surface load -1 kN/m² + Line force on edges -1 kN/m
LL: Live Load = Surface load -1 kN/m²
LL1: Additional case for further study= -25 kN/m², to be explained later

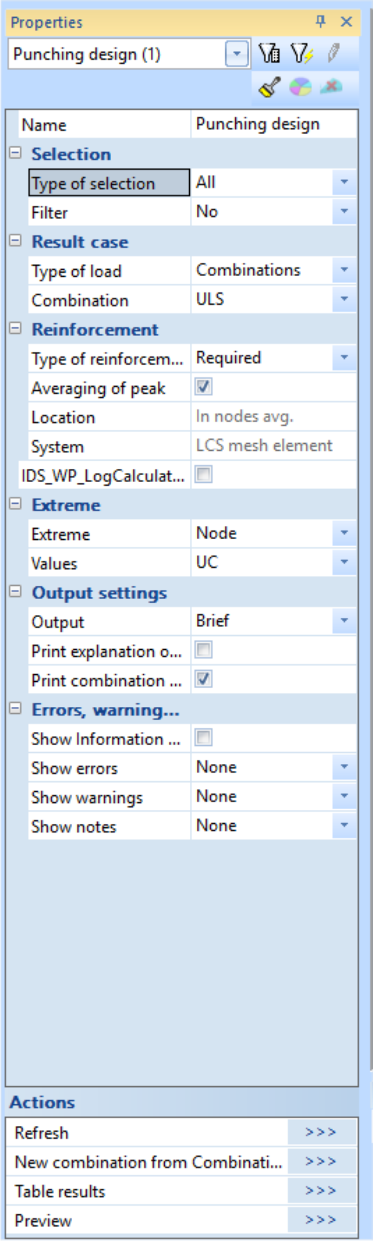
*Combinations
ULS (Type EN – ULS (STR/GEO Set B)) = SW, DL, LL
SLS (Type EN – SLS Quasi Permanent) = SW, DL, LL



Work method

The **Punching Design** command can be selected in the tree menu of service Concrete > Reinforcement design > 2D members. The command is available, when EC - EN national code is selected in Project data and the linear or non-linear static analysis is done for the model containing 2D members from concrete material. Once the command is selected, appropriate parameters are listed and can be adjusted in property window with following options:

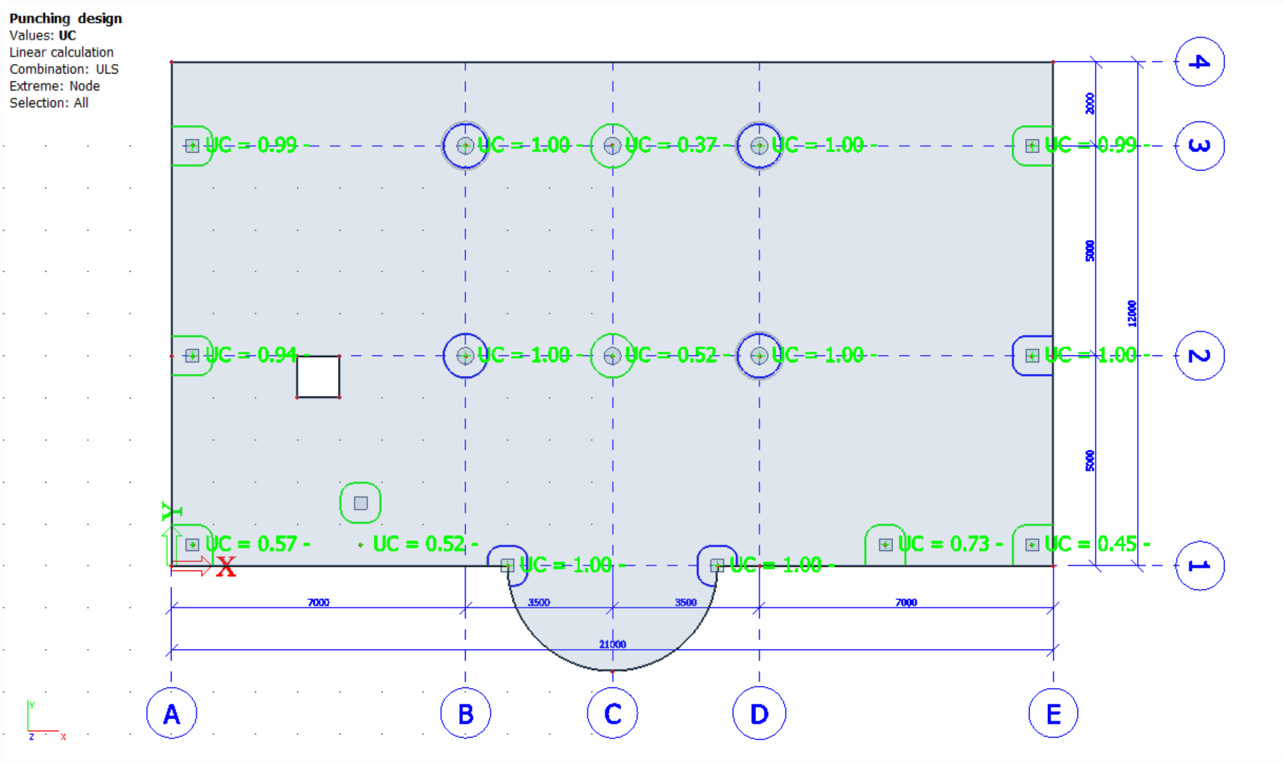




- Set the type of Selection to ALL, the Type of load to Combination ULS and the type of Reinforcement to Required then click Refresh

You will notice that the UC for every node will be displayed along with the control parameter in colour. In total there are 3 colours (Green, blue and red).

- Green: Shear capacity <u>without</u> reinforcement is sufficient ($UC_{vRd,c} \leq 1.0$ and $UC_{vRd,max} \leq 1.0$)
- Blue: Shear capacity <u>with</u> shear reinforcement is sufficient ($UC_{vRd,c} > 1.0$ but $UC_{vRd,cs} \leq 1.0$)
- Red: Plate is not designable by application of reinforcement or maximum shear capacity of concrete adjacent to the column is not sufficient ($UC_{vRd,cs} > 1.0$ or $UC_{vRd,max} > 1.0$)



- Presentation of results as a numerical output is possible via Preview and / or Table results. For the Punching Design, there is available two types of output:
    - Brief - contains just a summary table with basic results

Punching design

Linear calculation
Combination: ULS
Extreme: Node
Selection: All
Summary

Name	Case	Punching case	Punching shape	$UC_{vRd,max}$ [-]	$UC_{vRd,c}$ [-]	Shear reinforcement perimeters	$UC_{vRd,cs}$ [-]	$UC_{Asw,det}$ [-]	UC [-] Check
N15	ULS/1	Corner column	Rectangle (300;300)	**0.87**	**1.03**	3x 7Ø8(radial) 80+2x80=240	**0.68**	**1.00**	1.00 OK, BUT
N20	ULS/1	Corner column	Rectangle (300;300)	**0.86**	**1.02**	3x 7Ø8(radial) 80+2x80=240	**0.68**	**1.00**	1.00 OK, BUT
N53	ULS/1	Internal column	Circle (400)	**0.37**	**1.10**	3x 9Ø8(radial) 80+2x80=240	**0.74**	**1.00**	1.00 OK, BUT
N55	ULS/1	Internal column	Circle (400)	**0.12**	**0.37**	not required	-	-	0.37 OK
N57	ULS/1	Internal column	Circle (400)	**0.37**	**1.11**	3x 9Ø8(radial) 80+2x80=240	**0.74**	**1.00**	1.00 OK, BUT
N59	ULS/1	Internal column	Circle (400)	**0.34**	**1.02**	3x 9Ø8(radial) 80+2x80=240	**0.68**	**1.00**	1.00 OK, BUT
N61	ULS/1	Internal column	Circle (400)	**0.17**	**0.52**	not required	-	-	0.52 OK
N63	ULS/1	Internal column	Circle (400)	**0.37**	**1.10**	3x 9Ø8(radial) 80+2x80=240	**0.73**	**1.00**	1.00 OK, BUT
N88	ULS/1	Edge column	Rectangle (300;300)	**0.43**	**1.00**	3x 8Ø8(radial) 80+2x80=240	**0.67**	**1.00**	1.00 OK, BUT
N90	ULS/1	Edge column	Rectangle (300;300)	**0.43**	**0.99**	not required	-	-	0.99 OK
N95	ULS/1	Corner column	Rectangle (300;300)	**0.22**	**0.45**	not required	-	-	0.45 OK
N97	ULS/1	Edge column	Rectangle (300;300)	**0.40**	**0.94**	not required	-	-	0.94 OK
N99	ULS/1	Edge column	Rectangle (300;300)	**0.42**	**0.99**	not required	-	-	0.99 OK
N101	ULS/1	Corner column	Rectangle (300;300)	**0.27**	**0.57**	not required	-	-	0.57 OK
N103	ULS/1	Edge column	Rectangle	**0.32**	**0.73**	not required	-	-	0.73

- Standard - contains the same summary table as in Brief output supplemented by additional tables providing further semi-results

Shear Capacity without Reinforcement is sufficient

Select Node N61 and change the type of selection to current.
A brief output will show:

Punching design

Linear calculation
Combination: ULS
Extreme: Node
Selection: N61
Summary

Name	Case	Punching case	Punching shape	$UC_{vRd,max}$ [-]	$UC_{vRd,c}$ [-]	Shear reinforcement perimeters	$UC_{vRd,cs}$ [-]	$UC_{Asw,det}$ [-]	UC [-] Check
N61	ULS/1	Internal column	Circle (400)	**0.18**	**0.56**	not required	-	-	0.56 OK

We can see that the UC<1, lets look at the standard output for this node:

Punching design

Linear calculation
Combination: ULS
Extreme: Node
Selection: N61
Summary

Name	Case	Punching case	Punching shape	$UC_{vRd,max}$ [-]	$UC_{vRd,c}$ [-]	Shear reinforcement perimeters	$UC_{vRd,cs}$ [-]	$UC_{Asw,det}$ [-]	UC [-] Check
N61	ULS/1	Internal column	Circle (400)	**0.18**	**0.56**	not required	-	-	0.56 OK

Concrete

Name	Case	Punching case	Punching shape	V_{Ed} [kN] β [-]	$M_{Ed,y}$ [kNm] $M_{Ed,z}$ [kNm]	Plate h [mm]	Material f_{cd} [MPa]	d_{eff} [mm] ρ_l [%]	u_0 [m] u_1 [m]	$V_{Ed,u0}$ [MPa] $V_{Ed,u1}$ [MPa]	$V_{Rd,max}$ [MPa] $V_{Rd,c}$ [MPa]	$UC_{vRd,max}$ [-] $UC_{vRd,c}$ [-]
N61	ULS/1	Internal column	Circle (400)	**128.83** 1.15	0.38 10.32	Ceiling 200.00	C30/37 20.00	154.00 0.33	1.257 3.192	0.77 0.30	4.22 0.54	**0.18** **0.56**

We can see that $V_{Ed,u1}$ = 0.30 MPa < $V_{Rd,c}$ = 0.54 MPa so the shear capacity without reinforcement is sufficient. The control parameter is displayed in Green colour.

Shear Capacity with Reinforcement is sufficient

Let us look now at the standard output for node N59:

Punching design

Linear calculation
Combination: ULS
Extreme: Node
Selection: N59

Summary

Name	Case	Punching case	Punching shape	$UC_{vRd,max}$ [-]	$UC_{vRd,c}$ [-]	Shear reinforcement perimeters	$UC_{vRd,cs}$ [-]	$UC_{Asw,det}$ [-]	UC [-] Check
N59	ULS/1	Internal column	Circle (400)	**0.36**	**1.09**	3x 10Ø8(radial) 70+2x90=250	**0.73**	**0.92**	0.92 OK, BUT

Concrete

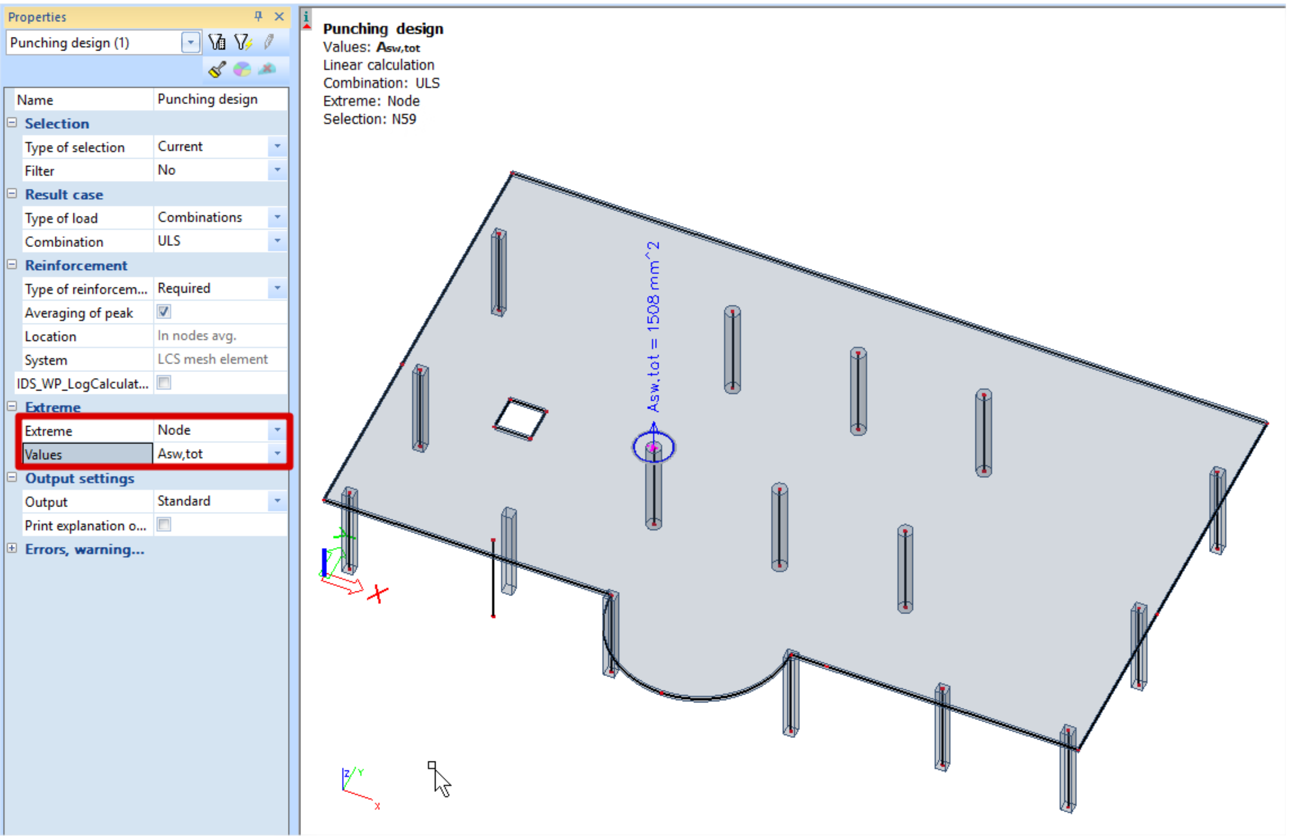
Name	Case	Punching case	Punching shape	V_{Ed} [kN] / β [-]	$M_{Ed,y}$ [kNm] / $M_{Ed,z}$ [kNm]	Plate h [mm]	Material f_{cd} [MPa]	d_{eff} [mm] / ρ_l [%]	u_0 [m] / u_1 [m]	$v_{Ed,u0}$ [MPa] / $v_{Ed,u1}$ [MPa]	$v_{Rd,max}$ [MPa] / $v_{Rd,c}$ [MPa]	$UC_{vRd,max}$ [-] / $UC_{vRd,c}$ [-]
N59	ULS/1	Internal column	Circle (400)	**252.59** 1.15	25.08 0.42	Ceiling 200.00	C30/37 20.00	154.00 0.38	1.257 3.192	1.50 0.59	4.22 0.54	**0.36** **1.09**

Reinforcement

Name	Case	Shear reinforcement perimeters	u_{out} [m] / a_{out} [mm]	$s_{t,u1}$ [mm] / $s_{t,out}$ [mm]	Control perimeters (distance/capacity)	Material $f_{ywd,ef}$ [MPa]	$A_{sw,req}$ [mm²] / $A_{sw1,min}$ [mm²]	A_{sw} [mm²] / $A_{sw,tot}$ [mm²]	$v_{Rd,cs}$ [MPa] / $k_{max}v_{rd,c}$ [MPa]	$UC_{vRd,cs}$ [-] / $UC_{Asw,det}$ [-]
N59	ULS/1	3x 10Ø8(radial) 70+2x90=250	3.477 355	283 283	308/73%	B 500B 288.5	122 15	503 **1508**	1.16 0.81	**0.73** **0.92**

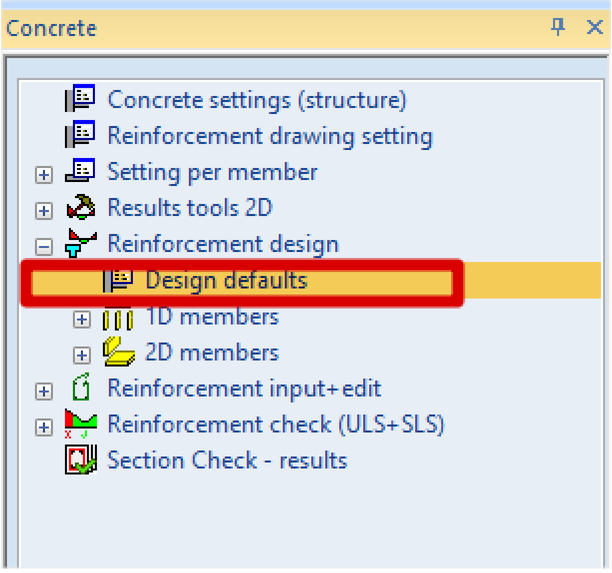
We can see here that $V_{Ed,u1}$ = 0.59 MPa < $V_{Rd,c}$= 0.54 MPa and the $UC_{vRd,c}$=1.09 > 1.
So shear reinforcement needs to be designed. The final value is $A_{sw,tot}$ = 1508 mm^2 which take into account detailing provisions.
The control parameter is displayed in blue colour.

You can also show the $A_{sw,tot}$ graphically:

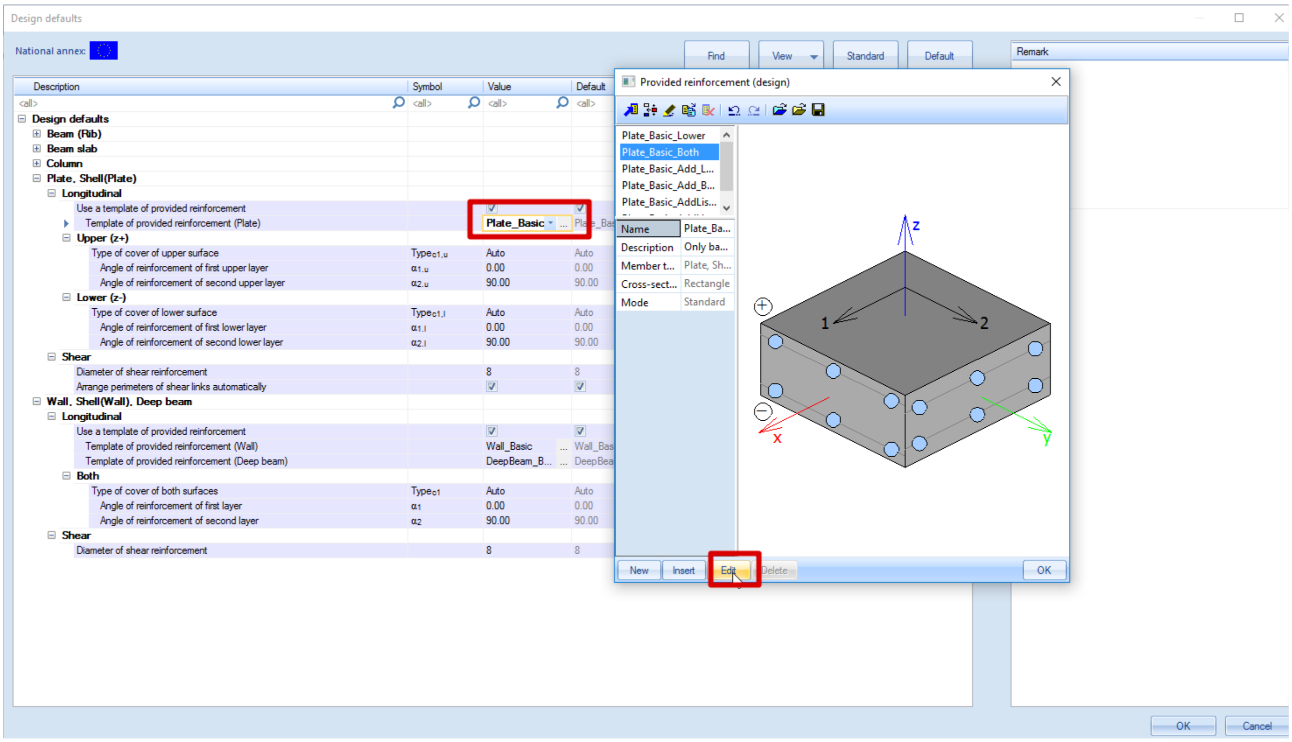


Use of Provided Reinforcement

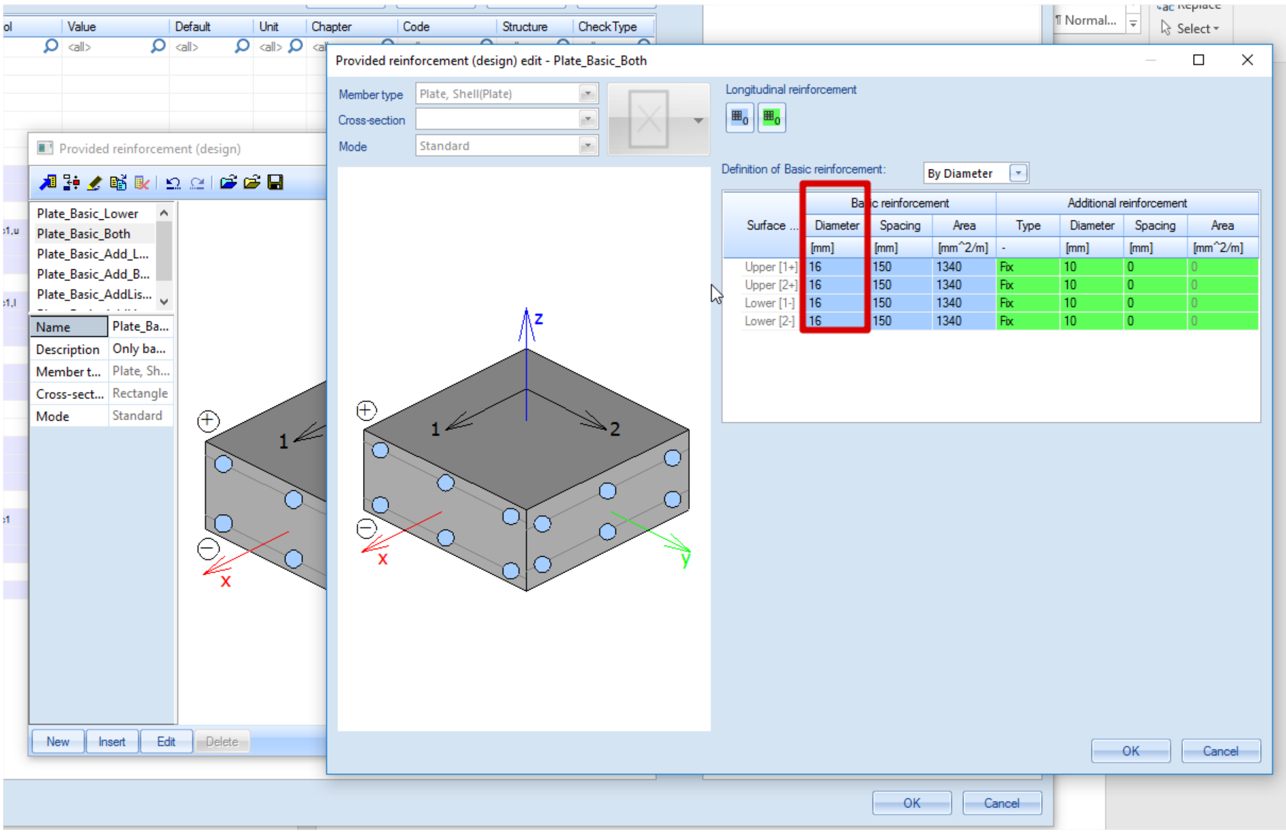
Lets add some provided reinforcement to the plate.
In the Concrete Main tree go to: Reinforcement > Design Defaults :



Activate the provided template for the plates in Reinforcement design > Design default:



Here you can choose between the different templates.
You can give a basic provided reinforcement without any additional reinforcement or allow SCIA Engineer to calculate additional reinforcement when needed.
For this example we will define the basic reinforcement without additional reinforcement and we will use diameter 16mm with a spacing of 150mm.



Now look at the standard output for node N59. With the required reinforced we needed additional shear reinforcement but with the provided reinforcement set above no need for shear reinforcement:

Punching design

Linear calculation
Combination: ULS
Extreme: Node
Selection: N59

Summary

Name	Case	Punching case	Punching shape	$UC_{vRd,max}$ [-]	$UC_{vRd,c}$ [-]	Shear reinforcement perimeters	$UC_{vRd,cs}$ [-]	UC $_{Asw,det}$ [-]	UC [-] Check
N59	ULS/1	Internal column	Circle (400)	**0.36**	**0.83**	not required	-	-	0.83 OK

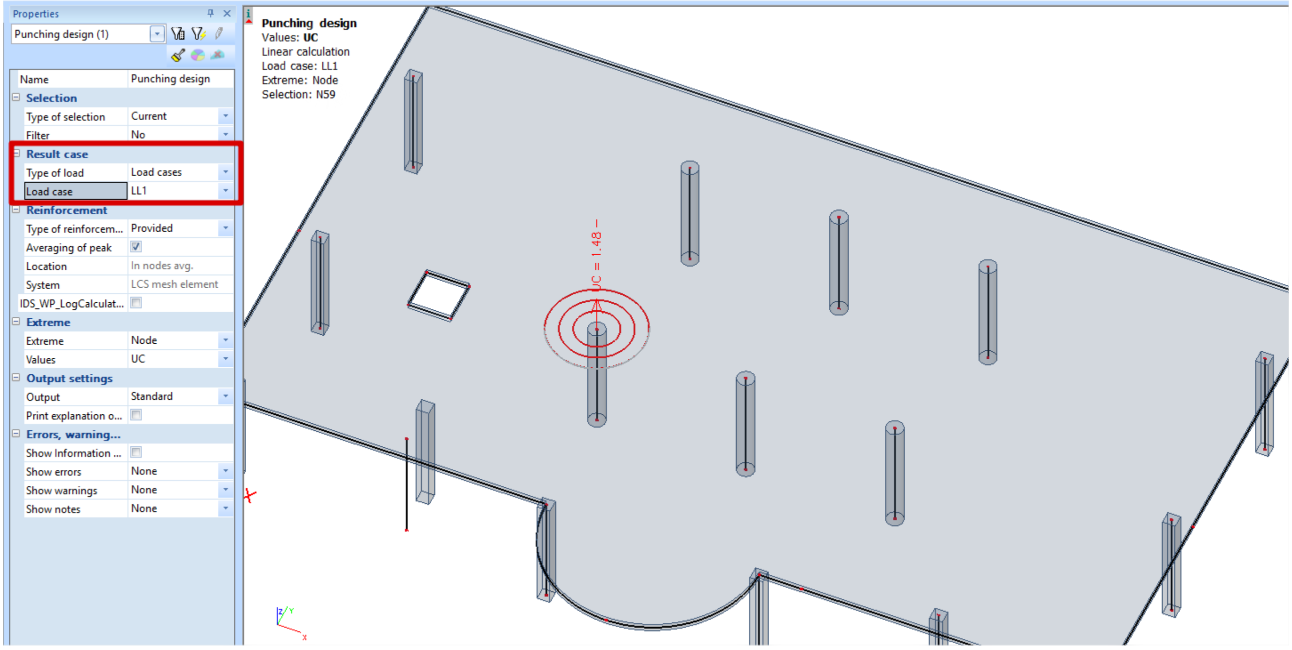
Concrete

Name	Case	Punching case	Punching shape	V_{Ed} [kN] β [-]	$M_{Ed,y}$ [kNm] $M_{Ed,z}$ [kNm]	Plate h [mm]	Material f_{cd} [MPa]	d_{eff} [mm] ρ_l [%]	u_0 [m] u_1 [m]	$V_{Ed,u0}$ [MPa] $V_{Ed,u1}$ [MPa]	$V_{Rd,max}$ [MPa] $V_{Rd,c}$ [MPa]	$UC_{vRd,max}$ [-] $UC_{vRd,c}$ [-]
N59	ULS/1	Internal column	Circle (400)	**252.59** 1.15	25.08 0.42	Ceiling 200.00	C30/37 20.00	154.00 0.87	1.257 3.192	1.50 0.59	4.22 0.71	**0.36** **0.83**

We can see that $V_{Ed,u1}$ = 0.59 MPa < $V_{Rd,c}$ = 0.71 MPa so the shear capacity without reinforcement is sufficient. The control parameter is now displayed in Green colour instead of blue.

Unity check is Not OK: control perimeter in red

Change the Type of Result to Load Case LL1 and display the result for node N59:



Control perimeter is now displayed in red and the UC = 1.48 > 1.

Take a look at the Standard Output:

Punching design

Linear calculation
Load case: LL1
Extreme: Node
Selection: N59

Summary

Name	Case	Punching case	Punching shape	$UC_{vRd,max}$ [-]	$UC_{vRd,c}$ [-]	Shear reinforcement perimeters	$UC_{vRd,cs}$ [-]	$UC_{Asw,det}$ [-]	UC [-] Check
N59	LL1	Internal column	Circle (400)	**0.95**	**2.22**	7x 26Ø8(radial) 70+6x110=730	**1.48**	**0.97**	1.48 NOT OK

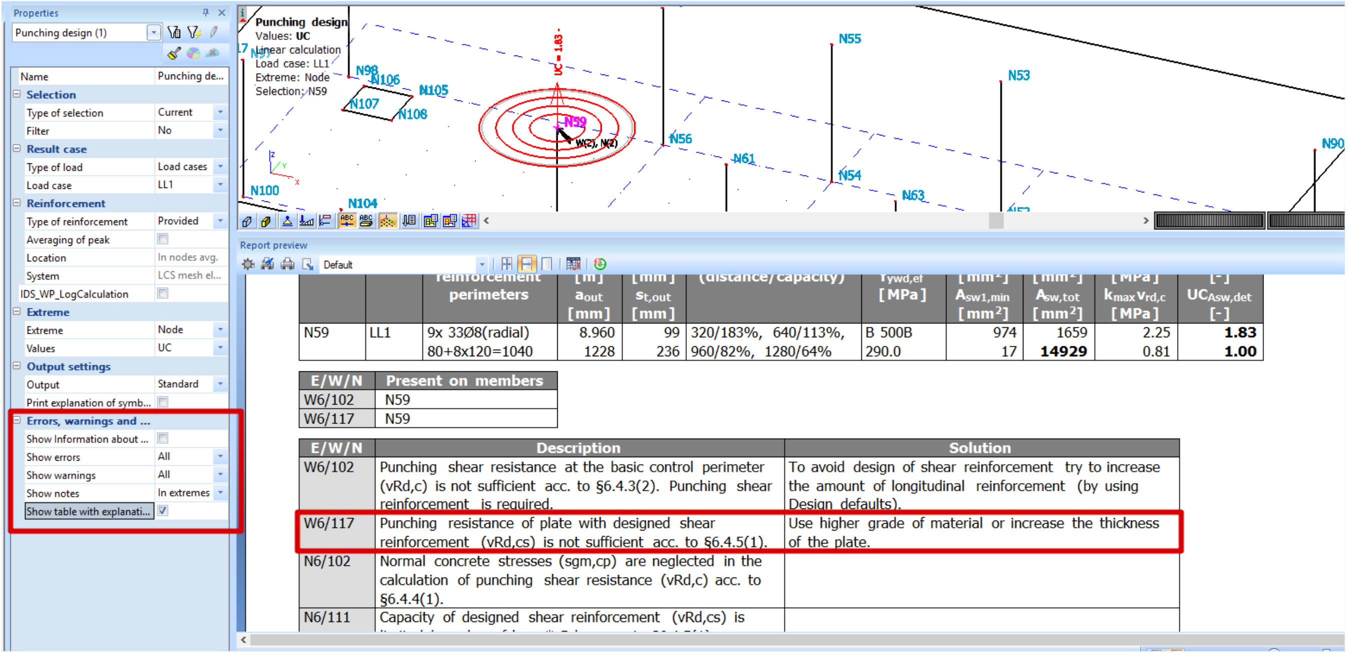
Concrete

Name	Case	Punching case	Punching shape	V_{Ed} [kN] β [-]	$M_{Ed,y}$ [kNm] $M_{Ed,z}$ [kNm]	Plate h [mm]	Material f_{cd} [MPa]	d_{eff} [mm] ρ_l [%]	u_0 [m] u_1 [m]	$v_{Ed,u0}$ [MPa] $v_{Ed,u1}$ [MPa]	$v_{Rd,max}$ [MPa] $v_{Rd,c}$ [MPa]	$UC_{vRd,max}$ [-] $UC_{vRd,c}$ [-]
N59	LL1	Internal column	Circle (400)	**675.93** 1.15	66.83 5.06	Ceiling 200.00	C30/37 20.00	154.00 0.87	1.257 3.192	4.02 1.58	4.22 0.71	**0.95** **2.22**

Reinforcement

Name	Case	Shear reinforcement perimeters	u_{out} [m] a_{out} [mm]	$s_{t,u1}$ [mm] $s_{t,out}$ [mm]	Control perimeters (distance/capacity)	Material $f_{ywd,ef}$ [MPa]	$A_{sw,req}$ [mm²] $A_{sw1,min}$ [mm²]	A_{sw} [mm²] $A_{sw,tot}$ [mm²]	$v_{Rd,cs}$ [MPa] $k_{max}v_{rd,c}$ [MPa]	$UC_{vRd,cs}$ [-] $UC_{Asw,det}$ [-]
N59	LL1	7x 26Ø8(radial) 70+6x110=730	7.086 929	118 225	308/148%, 616/92%, 924/67%	B 500B 288.5	850 14	1307 **9148**	2.15 1.07	**1.48** **0.97**

We can also show the errors and warning in the output by checking this option in the properties window:


Properties
Punching design (1)
Name
Punching de...
Selection
Type of selection
Current
Filter
No
Result case
Type of load
Load cases
Load case
LL1
Reinforcement
Type of reinforcement
Provided
Averaging of peak
Location
In nodes avg.
System
LCS mesh el...
IDS_WP_LogCalculation
Extreme
Extreme
Node
Values
UC
Output settings
Output
Standard
Print explanation of symb...
Errors, warnings and ...
Show Information about ...
Show errors
All
Show warnings
All
Show notes
In extremes
Show table with explanati...
Punching design
Values: UC
Linear calculation
Load case: LL1
Extreme: Node
Selection: N59
N55
N53
N105
N107
N106
N56
N61
N54
N63
N90
N100
N104
Report preview
Default
N59 | LL1 | 9x 3308(radial) 80+8x120=1040 | 8.960 1228 | 99 236 | 320/183%, 640/113%, 960/82%, 1280/64% | B 500B 290.0 | 974 17 | 1659 14929 | 2.25 0.81 | 1.83 1.00
E/W/N | Present on members
W6/102 | N59
W6/117 | N59
E/W/N | Description | Solution
W6/102 | Punching shear resistance at the basic control perimeter (vRd,c) is not sufficient acc. to §6.4.3(2). Punching shear reinforcement is required. | To avoid design of shear reinforcement try to increase the amount of longitudinal reinforcement (by using Design defaults).
W6/117 | Punching resistance of plate with designed shear reinforcement (vRd,cs) is not sufficient acc. to §6.4.5(1). | Use higher grade of material or increase the thickness of the plate.
N6/102 | Normal concrete stresses (sgm,cp) are neglected in the calculation of punching shear resistance (vRd,c) acc. to §6.4.4(1).
N6/111 | Capacity of designed shear reinforcement (vRd,cs) is