





Scia Engineer

Prestressed concrete, construction stages, concrete checks All information in this document is subject to modification without prior notice. No part or this manual may be reproduced, stored in a database or retrieval system or published, in any form or in any way, electronically, mechanically, by print, photo print, microfilm or any other means without prior written permission from the publisher. Scia is not responsible for any direct or indirect damage because of imperfections in the documentation and/or the software.

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1

The post-tensioned bridge – tutorial from training

This paper describes one typical postensioned prestressed concrete bridge built in construction stages. The traffic load is taken from EN1991-2 with respect of EN1990/A1. The code for check is according to EN1992-1-1.

1.1 Project setup

The new project is created using button New and Structure is selected.

Select New Proje	ect				
New Project S	ystem Templates	2			
Structure	LTA	Free Form Modeller	Mwell	Modeller	

The settings of the project are necessary to set in *Project data*. The structure type *Frame XZ* should be selected for the TDA analysis of the structure (only frame XZ should be analyzed using TDA). At least one material should be selected in the project - *Concrete*. When concrete material is selected then automatically *Reinforcement material* (nonprestressed) is offered to user. The *Project level - Advanced* is recommended. The *Construction stages* model should be selected for modelling of structure using construction stages. National code for analysis and check is necessary to select *EC-EN*. Each country has its own *National annexes* for Eurocodes.

Project data				×
Basic data Fu	nctionality Loads	Protection		
CONTRACT OF	Data		Material	
	Name:	LD+AS	Concrete Material	⊠ C35/45 ▼
A CONTRACT	Part:	•	Reinforcement r Steel	n B 600C <u>▼</u>
			Timber Other	
	Description:	•	Aluminium	
	Author:	•		
SS 1	Date:	18. 01. 2009		
1 Kon			Code	
THE A	Structure: Frame XZ		National Code: EC - EN	
				▼
and the	Project Level:	Model:	National annex:	
	Advanced	Construction stages	▼ SVK	

The checkbox **Prestressing** should be turns on for modelling and calculation with prestressing in project. The Level of prestressing - **Advanced** is recommended. The checkbox **Mobile loads** should be turns on for mobile load analysis.

And in the owner of the owner owner owner owne				
Sec. 1	Dynamics		Prestressing	
200 × 10 20	Initial stress		Advanced	⊠
1 1 1 1	Subsoil			
and and	Nonlinearity		Fire resistance	
S. Aller	Stability		Hollow core slab	
AND CO.	Climatic loads			
Million .	Prestressing	⊠		
1	Pipelines			
10 C 10	Structural model			
and the state	Parameters			
Sec. 1	Mobile loads			
100 A 18	Overview drawings			
and and the	LTA - load cases			
and a second	External application checks			
Sec. 6	KP1 application			
St. 1999 (1994)	Property modifiers			

1.2 National annexes

National code for analysis and check is necessary to select *EC-EN*. Each country has its own *National annexes* for Eurocodes. This annex is possible to define by *National annex*. In current version user has to fill in all national annexes himself. From the version 2010.1 all necessary national annexes will be prepared and stored in program. User will be able to select appropriate national annexes according to country.

When user opens setup manager he can define several national annexes which he needs. There is possible to assign appropriate flag for selected country.

E	Setup manager 웹 말해 🕜 📸 💽 🖄 🚅 🗍 é C-EN VK	3 2	🛃 Al			×			
	Name	SVK	1						
Ш	National annex	Slovakia							
	EN 1990: Basic of structu							No. of Concession, Name	X
	Combinations	Natio	onal code				and the second second		
	EN 1991: Actions of struc								
	Wind	_				1			<u>^</u>
	Snow	_			D IN	1.11			
E	EN 1992: Design of concr	_	BS	CSN	DIN	EC - EN	France	NEN	
	General								
	EN 1993: Design of steel General				63				
	Design of joints								=
	EN 1994: Design of comp		Austria	Poland	SIA 26x	Slovakia	Sweden	IBC	
	General								
	EN 1997: Geotechnical d		:===						
	General								
	EN 1999: Design of alumi		Greece	Ireland	Italy	Romania	Slovenia	Spain	
	General								
					_				
						۲			
			Belgium	Bulgaria	Hungary	Portugal	Croatia	Latvia	
									Ψ.
	New Insert Edit Delet	BS	;						
									OK
									Cancel
		<u> </u>							

Each national annex has its own values of national annexes. Now user defines national annexes himself in that place in the program. These values are possible to edit for each design code. EN1990,

EN1991 and En1992 are important codes for us. National annexes for mentioned codes are shown in the following figures.

• National annexes for EN1990 – basic of structural design

⊟ SVK	Na	ame			SVK	
Combination		Combina	tion			
— (STR/GEO) alternative		(STR/C	iEO) alternative		EN 1990: 6.4.3.2 (3)	
Psi factors for buildings		Combina	tion		Eq.6.10	
i Load combination factors			tors for buildings		EN 1990: Annex A1 Tab	ble A1.1
			rs for buildings			
			ombination factor	-	5114000 A A4 7 I	1 44 0/01
			mental combinati	•	EN 1990: Annex A1 Tab	ole A1.2(B)
			actor permanent act		1,35	
			actor permanent act		1.00	
			actor for prestress ac actor for prestress ac		1,00	
			actor for prestress actor leading variable		1,50	
			actor accompanying		1.50	
			ion factor ksi [-]	ranabio a	0.85	
			actor for shrinkage a	ection [-]	1,00	
	E	- Funda	mental combinati	on (STR	EN 1990: Annex A1 Tab	ole A1.2(C)
		Partial	actor permanent act	ion - unfav	1.00	
		Psi fa	ctors	-		
		II.—	Load	Psi0	Psi1	Psi2
		1	CategoryA	0,7	0,5	0,3
		2	CategoryB	0,7	0,5	0,3
		3	CategoryC	0,7	0,7	0,6
		4	CategoryD	0,7	0,7	0,6
		5	CategoryE	0,1	0,9	0,8
		6	CategoryF	0,7	0,7	0,6
		7	CategoryG	0,7	0,5	0,3
		8	CategoryH	0	0	0
		9	Snow (Finland,)	0,7	0,5	0,2
		10	Snow H > 1000m	0,7	0,5	0,2
		11	Snow H < 1000m	0,5	0,2	0
		12	Wind	0.6	0.2	0
		13	Temperature	0.6	0.5	0

National annexes for EN1991 – wind + snow

Setup manager			
			SVK
		me	SVK
i⊒- Wind		Vind	
Wind pressure according to EC1		Wind pressure according to EC1	
		basic wind velocity m/s [m/sec]	26,200
		directional factor [-]	1,00
		season factor [-]	1,00
		orography factor [-]	1,00
		turbulence factor [-]	1,00
		probability factor [-]	1,00
		kg/m3 air density	1,25
	Ē	Probability	
		probability p for an annual exceedence	2
		shape factor [-]	0,20
		exponent [-]	0,50
	E	Roughness	
		Roughness	category 0 💌
		Kr [-]	0,16
		z 0 [m]	0,003
		z min [m]	1,000

Setup manager SVK ⊡- SVK Name 🗄 - Snow Snow EC code snow description EC code snow description Characteristic value of snow load [kN/m. 1,00 1,00 Exposure coefficient [-] 1,00 Thermal coefficient [-] 2,00 Exceptional coefficient [-]

• National annexes for EN1992 - concrete checks

Concrete setup	COLUMN DATES		
Type of values NA NA Image: Constraint of the second s	SVK General G	kt - time reduction factor 3.1.2 (4) [-] k1_red - coeff. for calculation of rati k2_red - coeff. for calculation of rati k3_red - coeff. for calculation of rati k4_red - coeff. for calculation of rati k5_red - coeff. for calculation of rati	1,20 90,00 1,00 1,00 0,85 0,44 1,25(0,6+0,0014/eps_cu2) ✓ 0,54 1,25(0,6+0,0014/eps_cu2) ✓ 0,70 0,80 0,80 0,80 1 1 0,85

2 Model

2.1 Structure

2.1.1 Cross-sections

The structure is defined by standard modelling using in *Scia Engineer (SEN)*. The cross-sections are defined in CSS library using button *New*. There are several predefined *Precast* and *Bridge CSS*.

New cross-section		
Available groups	Available items of this group	Items in project
Concrete Ceometric shapes Numerical		CS1 - General cross-section CS2 - General cross-section CS3 - General cross-section
General Precast	Uvîî	
		→
	T -	
Box girder		
	Profile Library filter	Add Close

The General CSS enables to user prepares completely different CSS himself. It is possible to define it using definition of polygons directly in SEN or import CSS from dwg or dxf format.

ars <u>DPP_NK hruba</u> DPP_NK tenka DPP1_okraj a rozpiska UPP2_opojis 0 Defpojnts	Entity types Ø Block Ø Dimension Ine Ø MT ext Ø Polyline	Selection mode Polygons Scale	Clear selection (Import selected
koty+popis Enable all Disable all	Text Enable all Disable all	Insertion point Sizes [77449×30548 Connect single curves to closed p	Centre 🔻	Cancel
iow all objects		Select curves	Connect curves	*
E		Enable all Disable all Disable all	Enable all Disable all Disable all Connect single curves to closed p	Enable all Disable all Disable all Connect single curves to closed polygons Select curves Connect single curves Connect curves

The CSS in the drawing format has to be prepared by Lines and Polylines. Connect all polylines is necessary to do as first (*Select curves>Connect curves*). Then polylines are created.

ayers	Entity types	Selection mode	
DPP_NK hruba	Block	Polygons Clear selection	port selected
_DPP_NK tenka	Dimension		Import all
_DPP1_okraj a rozpiska _DPP2_popis	Ine ✓ MText	Scale 1	Cancel
	V Polyline	Insertion point	Cancer
Defpoints	V Text		
koty+popis		Sizes 77449×30548	
Enable all Disable all	Enable all Disa		
Enable all Disable all		able all Connect single curves to closed polygons	
		End Connect curves	
Show all objects			
		Result	
		Result Doubled curves 0	
		Doubled curves 0 Unconnected curves 0	
		Doubled curves 0	
		Doubled curves 0 Unconnected curves 0 Connected curves 33	
		Doubled curves 0 Unconnected curves 0 Connected curves 33 Created polylines 3	
		Doubled curves 0 Unconnected curves 0 Connected curves 33	
		Doubled curves 0 Unconnected curves 0 Connected curves 33 Created polylines 3	
		Doubled curves 0 Unconnected curves 0 Connected curves 33 Created polylines 3	

The selection of polygons and polygons openings is necessary for proper import from drawing format. User selects **Selection mode>Polygons** and selects outer polyline. Then he switches to **Polygons openings** and selects the polylines representing the openings. Afterthat the CSS can be imported from drawing format to SEN as general CSS

Import - S:\Diplomka\Podklad	y∖opr-V2-Průřezy.dwg			
Layers	Entity types	Selection mode		Import selected
DPP_NK hruba	Block	Polygonal openings 💌	Clear selection	
DPP_NK tenka DPP1_okraj a rozpiska	✓ Dimension ✓ Line			Import all
DPP2_popis	MText	Scale	1	Cancel
Defpoints	✓ Polyline ✓ Text	Insertion point	Centre 💌	
koty+popis		Sizes		
		77449×30548		
Enable all Disable all	Enable all Disable all	Connect single curves to clo	osed polygons	
Show all objects		Select curves	Connect curves	
				^
		·	(
[[]	

	Cross-section editor		*			
i ţ	All Y Normal colour	💽 🕰 🗠 💺 💷 🏍 🐒 🗷	A) 🗈 🗄 🗂 🗥 👘 🔺 🕅	ដ 🖬 🖷 🥂 😰 🔍	🔍 🔍 🔍 🔊 📑 📭 🕮 🖶 🎒 🖩	🕅 🖹 🕅 🕂 🖓 🖡
1	NOXINE RA	V.				
	Polygon Polygonal opening Polygonal opening Section from lotrary Section from lotrary Polygonal opening Polygonal opening Thimwalled representation Add cut	General cross-section			N A	T
	Type (description) General	General cross-section				
	Buckling y-y	c	-			
	Buckling z-z	c	-			
	Fabrication	general	•			
	Display final shape	×				
	Display	Only basic shape	T			

The cross-sections (CSS) should be also *imported* from previous similar SEN project.

Cross-Sections						
Ja 😳 🖉 👬 🕅	ik ⊵ ຍ	⊆ ⊕ <mark>@</mark>	AI		• 9	_
()	Otevřít					
	Oblast hledání:	퉬 Brno_Adr			- 0 🖉) 📂 🛄 -
	P	Název	Datum zm	Тур	Velikost	Značky
	Poslední místa	EP_CrossS	ection.db4			
		EP_Source	Geometry.db4			
- 1	Plocha					
	Ū.					
	lukas_dlouhy					
	Počítač					
	Pocitac					
-	Sit					
		Název souboru:	EP_CrossSe	ection		▼ Otevřít
		Soubory typu:	Application	database file	(*.db4)	✓ Stomo
New Insert	Edit] Delete				Close	

The user can select which CSS will be import from user database file.

Read from database	
Project database	User database
CS1 - General cross-section CS2 - General cross-section CS3 - General cross-section	CS1 - General cross-section CS2 - General cross-section CS3 - General cross-section
Close	<< Copy to project <p><< Copy all</p>

The dialog of CSS looks like following

Cross-Sections			
🥕 🤮 🗶 👬 💕 💺	₽	🖸 🗠 🚭 😂 🖬 Al	• 7
CS1 - General cross		Name	CS1 🔺
CS2 - General cross		Туре	General cross-section
CS3 - General cross	Ξ	Parameters	=
		Mat 1	C35/45
		Edit	
	Ξ	General	
		Draw color	Normal colour
		Colour	
		Properties editable	
		Buckling editable	
		Buckling y-y	С
		Buckling z-z	c _
		Z	y
New Insert Edit		Delete	Close

2.1.2 Beams

The beams are defined using item *Structure>1D Member>Beam* with following properties.

tructure 4 ×	Horizontal beam			×
E-10 Member	Honzontal beam			
			Name	B1
🚋 Beam			Туре	beam (80)
Column		\wedge	Analysis model	Standard
Advanced Input	μα		CrossSection	CS1 - General cross-section -
Catalogue blocks			Alpha	0
		//	Member system-line at	centre
- A Import project (esa file)	1 7'		ez [mm]	0
DA members - New IDA men			LCS	standard
Tendons - Post-tensioned interna			FEM type	standard
			Buckling and relative lengths	Default
- Modelling/Drawing			Layer	Layer1 💌
É-175 Line	ez	E	Geometry	20. 30
🖓 Line			Length [m]	6,000
-A Lines from text			Insertion point	begin
🖕 🖉 Solid 🗮 📕				
Prism	1			
Cylinder				
Surface of revolution				
🖨 🐨 Open shell	10000			
Open shell - general poly				OK Cancel
Open shell - surface of re	d			The star of the

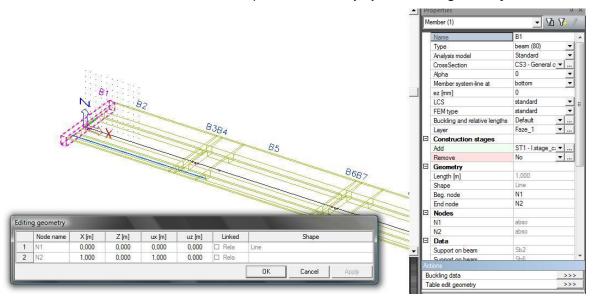
The following lengths of the beams will be defined in meters and appropriate CSS will be selected.

C	ucinic	
	B1	1,0
	B2	19,0
	B3	1,0
	B4	4,0
	B5	21,0
	B6	1,0
	B7	4,0
	B8	21,0
	B9	1,0
	B10	4,0
	B11	15,0
	B12	1,0

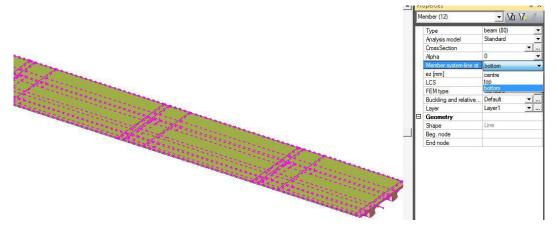
The user can see table of the beams in *Document>Structure>Members*

	ןוו <mark>ן</mark>	NEMETSCHEK De	scription	2					
*	1 Mo	mber 1D							
	Name	CrossSection	Length [m]	Shape	Beg. node	End node	Туре	FEM type	Layer
	B1	CS1 - General cross-section	1,000	Line	N1	N2	beam (80)	standard	Layer1
	B2				N2	N3			Layer1
									Layer1
	and the second se								Layer1
									Layer1
=									Layer1
									Layer1 Layer1
									Layer1
	B10	CS1 - General cross-section			N10				Layer1
	B11	CS1 - General cross-section			N11	N12		24	Layer1
	B12	CS1 - General cross-section	1,000	Line	N12	N13	beam (80)	standard	Layer1
		▲ 1. Me Name B1 B2 B3 B4 B5 B6 B5 B6 B5 B6 B7 B8 B9 B10 B11	E B CrossSection CrossSection B CrossSection CrossSection B CrossSection B CrossSection CrossSection B CrossSection CrossSection CrossSection CrossSection B CrossSection B CrossSection B CrossSection CrossSection B CrossSection CrossSection CrossSection CrossSection B	E B CrossSection Length Mame CrossSection Length M CrossSection Length M CrossSection Length CrossSection Length CrossSection Length CrossSection Length CrossSection Length CrossSection Longth CrossSection Length CrossSection Longth CrossSection Length Crost CrossSecti	E B CS1 - General cross-section CS1 - General cros con CS1 - General cross-section CS1 - General cros		NEMETSCHEK Description Scia Author 1. Member 1D Author 1. Member 1D Image: Scia B1 CS1 - General cross-section 1,000 B1 CS1 - General cross-section 1,000 B2 CS1 - General cross-section 1,000 B3 CS2 - General cross-section 1,000 B4 CS1 - General cross-section 4,000 B5 CS1 - General cross-section 1,000 B6 CS2 - General cross-section 1,000 B7 CS1 - General cross-section 1,000 B7 CS1 - General cross-section 1,000 B8 CS1 - General cross-section 1,000 B8 CS1 - General cross-section 1,000 B8 CS1 - General cross-section 1,000 B9 CS2 - General cross-section 1,000 B10 CS1 - General cross-section 1,000 B10 CS1 - General cross-section 1,000 B10 CS1 - General cross-section 1,000 B11	NEMETSCHEK Description Author Author 1. Member 1D Author B1 CS1 - General cross-section Length [m] Shape Beg, node End node Type B1 CS1 - General cross-section 1,000 Line N1 N2 beam (80) B2 CS1 - General cross-section 1,000 Line N4 beam (80) B3 CS2 - General cross-section 1,000 Line N4 beam (80) B4 CS1 - General cross-section 1,000 Line N4 beam (80) B5 CS1 - General cross-section 1,000 Line N5 N6 beam (80) B6 CS2 - General cross-section 1,000 Line N7 beam (80) B7 CS1 - General cross-section 1,000 Line N8 N9 beam (80) B8 CS1 - General cross-section 1,000 Line N10 N11 beam (80) B10 CS1 - General cross-section 1,000 Line	

The coordinates of the beam's nodes are possible to modify by Table edit geometry.

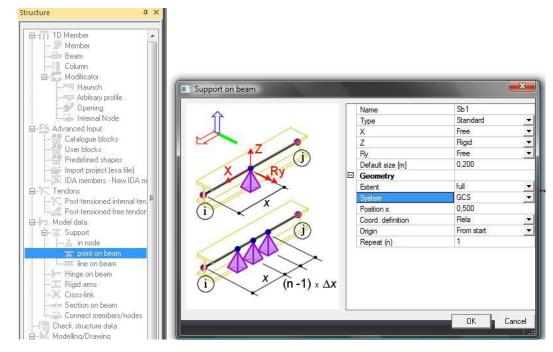


The *alignment* of the CSS should be changed to the *bottom* using filter of the beam in ones step because of different CSS in the structure.

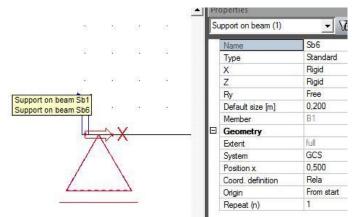


2.1.3 Supports

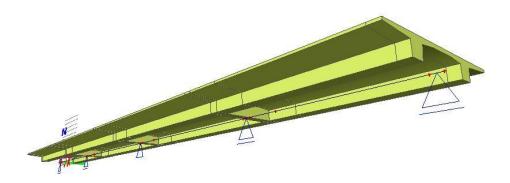
The supports should be defined using *Structure > Model data>Support>Point on beam.* The Z support is defined on support in the middle of the beam B1, B3, B9 and B12. The X, Z support is defined in the middle of the beam B6.



The additional support in the first beam has to be defined twice, because it is different during the construction stages.



The 3D perspective model of the structure looks like following.



2.1.4 Prestressing

The loadcase type Prestress has to be defined for definition of the postensioned tendons. The loadcase is defined using *Load cases, Combinations > Load cases.*

Z Project F [™] Structure 	Load cases) 🖸 🗠 🚭 🕞 🖬 🛛 Al	- V
Load Cases ↓↓↓ Load Groups ↓↓↓ Besult classes Construction stages ↓↓↓ Calculation, mesh	LC1 - Prestress	Name Description Action type LoadGroup	LC1 Prestress Permanent
Concrete Document Drawing Tools Libraries		Load type Direction	Self weight Self weight Standard
Haries Haries Haries Haries Tools Segment blocks			Prestress Primary effect
IIII Segment blocks	New Insert E	dit Delete	C

The postensioned tendons are possible to defined now in *Structure>Tendons>Internal postensioned tendons*. There are many input values and the most important is explained. The following items will be defined in this example.

Post-tensioned tendon				x
		Name	1e_01	
		Description	10_01	
66668		Number	2	
		Туре	Internal	
		Layer	Stage1	▼
ns 🖤 ng		Geometry	olugo i	
	U 14	Geometry input	Source geometry	-
		LCS - X	First beam from allocation	
		Projection of intermediate p	Perpendicularly	
		LCS	standard	- T
		Source geometry	SG1	T
		Origin of source geometry	Offset in LCS	
		Coord X [m]	0,000	
		Coord Y [m]	0.000	
		Coord Z [m]	0,000	
		Material		
		Material	Y1770S7-15,7	▼
		Number of tendon elements	15	
		Number of tendons in group	1	
		Area [mm^2]	2250	
		Diameter of duct [mm]	60,00	
		Load Case	LC1 - Prestress	▼
		Stressing		
		Type of stressing	Type 3	▼
		Prestressing from	Begin	-
		Coefficient of friction in curv	0,3	
		Unintentional angular displa	0,003	
		Anchorage set - begin [mm]	6,00	
		Stress during correcting - be	1410,00	
		Duration of keeping stress [300,00	
		Initial stress - begin [MPa]	1410,00	
		Overhang of tendon not incl	0,000	
		Overhang of tendon not incl	0,000	
		Distance between sections	0,500	
	Ac	tions		
	D	efault values		>>>
			ОК С	Cancel

- Name from 1e_01 up to 4e_16 30 tendons
- Layer the four different layers were defined according to construction stages which will be defined later Stage1, 2, 3 and 4. The name of tendon beginning on number 1 belongs to layer Stage 1 and other...

Layers			×
🔎 📑 🍠 🖬 🕊 🗄)= 🎒 Al	×	7
Stage_1	no	Name	Stage_1
Stage_2	no	Comment	
Stage_3	yes	Colour	
Stage_4	yes	Structural model only	no no
stage	,	Current used activity	🗆 no
New Insert Ed	Jit Delete		Close

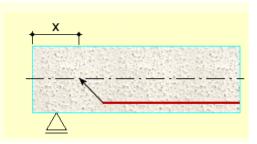
- Geometry input type Source geometry is used; there are three possibilities of definition of tendon geometry
 - **Source geometry** user defines geometry in library of SG
 - Direct input user defines geometry of tendon in 3D window directly; the imported geometry from CAD program should be used by this option
 - **Reference line with source geometry** the source geometry is winded on user defined reference line
- Allocation the beams (slabs) where tendons are allocated on should be selected

Select allocation men	nbers
Available	Selected
Name B1 B2 B3 B4 B11 B12	Name B5 B8 B6 B7 B9 B10 <
[<u> 0K </u>]	Cancel

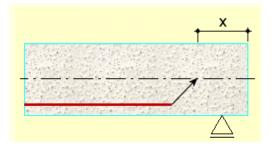
• LCS-X – the beam where start the local system of tendons; it could be a first beam from allocation or directly selected beam

		Geometry	
		Geometry input	Source geometi 💌
		Allocation	
		LCS - X	B1 💌
		Projection of inter	Perpendicularly 💌
B1 B2 B3 B4		LCS	standard 🔹
		Source geometry	SG2 <
		Geometry	
		Geometry input	Source geometi -
		Allocation	
		LCS - X	B2 💌
B3 B4		Projection of inter	Perpendicularly 💌
B3 B4		LCS	standard 💌
		Source geometry	SG2 ▼
	i 1	oouroo goomouy	

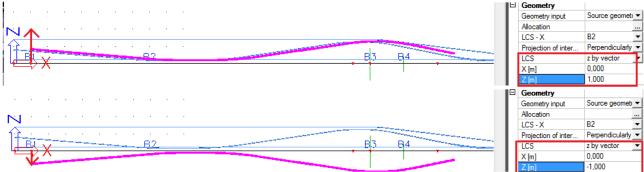
- Projection of intermediate points this option is relevant only in case of Hanging nodes
 - **Proportionally** user defines the length where the tendon effects are projected on
 - Way of location begin
 - *First node* the beginning of projected tendon effects to the beam is from the first node of the allocated beam
 - Location distance from the beginning of the beam



- Way of location end
 - Last node the beginning of projected tendon effects to the beam is to the last node of the allocated beam
 - Location distance from the end of the beam



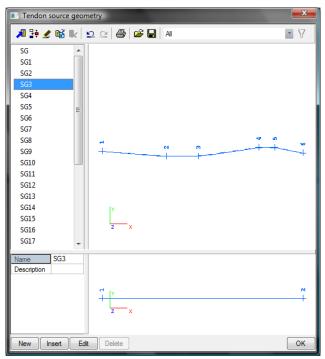
- o Perpendicularly tendon is projected directly in perpendiculars to the beams
- The hanging nodes are not available for TDA calculation
- LCS type of local axis of tendon
 - o Standard local axis of tendon is the same as local axis of the allocated element
 - Z by vector user sets the vector by points X and Z and the direction of z is according to these values



o Z by point – user sets the point which shows direction of local coordinate system

			Geometry		
			Geometry input	Source geometry	y 💌
NB1 A A A A A B2 A A	B3	B4	Allocation		
			LCS - X	B2	-
		and the second second	Projection of interm	Perpendicularly	-
X	į į		LCS	z by point	-
			X-coor [m]	0,000	
				1,000	
			Z-coor [m]	1,000	
		I		1,000	_
			Geometry		_
	PZ	R4	Geometry Geometry input	Source geometry	
NBF B2	B3	B4	Geometry Geometry input Allocation	Source geometry	•
NBF B2		B4	Geometry Geometry input Allocation LCS - X		
			Geometry Geometry input Allocation LCS - X Projection of interm	Source geometry B2	
NB1 · · · · · · B2 · ·			Geometry Geometry input Allocation LCS - X Projection of interm LCS	Source geometry B2 Perpendicularly	_

- Z from UCS XXX
- Source geometry 30 types of SG will be defined by user



The source geometry should be also imported from user database file.

∄ ∄ 2 16 1 ≤ 2	හ ලේ සු දු <mark>ල</mark>	All	× • 7	F	ost-tensioned tendon (1
SG - geometrie_1	-		е +	E	Name Description Number Type Layer Geometry Geometry input Allocation LCS - X
	V Uložit jako				Projection of intermed
Name SG Description geometri		x be user DocumentTerr PW prof ProjectData PROPCTRL set Toolbars		⊙ Ø	
New Insert Edit	e 🧐	Název souboru:	EP SourceGeometry	-	Uložit

• Origin of SG - type of origin of SG

o Offset in LCS – the origin can be set related to local coordinates of the beam

	E	Geometry		
		Geometry input	Source geometi	•
		Allocation		
		LCS - X	B2	-
B1 B2 B3 B4		Projection of inter	Perpendicularly	-
B1 V B3 B4		LCS	standard	-
		Source geometry	SG2 💌 .	
		Origin of source ge	Offset in LCS	•
		Coord X [m]	2,000	
		Coord Y [m]	0.000	
		Coord Z [m]	2,000	

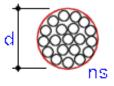
o Coordinate in GCS – the origin is set related to global coordinates of the file

	Ξ	Geometry	
	ι.	Geometry input	Source geometi -
NT CONTRACTOR CONTRACTOR	ι.	Allocation	
	ι.	LCS - X	B2 💌
	ι.	Projection of inter	Perpendicularly 💌
B2 B2 B4	ι.	LCS	standard 💌
	ι.	Source geometry	SG2 🔻
	11	Origin of source ge	Coordinate in G 💌
	Ш	Coord X [m]	2,000
		Coord Y [m]	0,000
		Coord Z [m]	2,000

• *Material* – material Y1770S7-15,7 is used;

		Name	Y1770S7-15.7	_
C35/45		Selector switch		-1
Y1770S7-15,7		Code independent		-
	12	Material type	Prestressing strand	
		Thermal expansion [m	0.00	믭
		Unit mass [kg/m^3]	7850.00	-
		E modulus [MPa]	1.9500e+005	-1
		Poisson coeff.	0.15	-1
		Independent G modulus		-1
		G modulus [MPa]	8.4783e+004	-1
		Log. decrement	0.15	-1
		Colour	0,10	-1
		Specific heat [J/gK]	6.0000e-001	-
		Thermal conductivity [4.5000e+001	-1
		Diameter [mm]	15.7	-1
		Area [mm ²]	150	-1
	Ð	EN 1992-1-1		-1
		Define by prEN 10138		
		Characteristic tensile st	1770.0	
		Characteristic 0,1% pro		
		Characteristic strain at	350,0	
		Ductility factor (k = fpk	1,13	
		Design yield strength	1356,5	
		Design yield strength		1
			315,0	1
		Surface characteristics	Plain	•
		Relaxation class	Class 2 - low relaxation wires and strands	٦
		Production	Low-relaxation	•
		User relaxation		٦
		Relaxation table	>>>	
	E	Stress-strain diag		٦
		Type of diagram	Bi-linear with an inclined top branch	-

• Number of elements in tendon- 15 → tendon has 15 strands



Number of tendons in group – 1 → only 1 tendon exists with the same properties and geometry



- Diameter of the duct 80mm
- Stressing
 - Type of stressing type 3
 - Prestressing from End
 - o Stress during correcting 1410MPa
 - o Initial stress 1410MPa

Another value are taken from default settings Libraries>Setup > Prestressing-Postensioned

। 🖔 🖏 🍓 🕹 🕄 🕄 🖓 💲	Setup manager	The second s	
	Columns	Concrete	
Main 🕂 🗙	Beams	Allowable stress	
		Detailing provisions	
Project	Interaction diagram	Reinforcement and reinforcemen	
Line grid and storeys	- Shear	Input of reinforcement	
f ^{st2}] Structure	- 1D structures	Hooks	
	Construction joint	Automatic reinforcement design	
E Contractions	Details	Prestressing pre-tensioned	
····- Construction stages 	- Anchorage check	Prestressing pre-tensioned Prestressing post-tensioned	
Calculation, mesh	Bearing checks	Post-tensioned	
Concrete	🖨 SLS		0.06
Hobile loads	Creep	Diamotor or adot [m]	.00
	Crack proof		.00
	Code Dependent Deflections		.3
	Allowable stress		0.003
Materials	Calculation		
I Cross-sections	Detailing provisions		Begin
Setup	Columns Beams		ype 3
Catalogue blocks	Beams Figure Reinforcement and reinforcement des		0.01
	Input of reinforcement		0,00
🗄 🗐 Structure, Analysis		initial choice beginning [initia]	440,00
🖃 🗐 Steel	Anchorage of stirrups	a subset of a family of	0.00
	- Anchorage of sumps	ourood daming concounty boghtning [440,00
Hall connection	- Automatic reinforcement design	chock daming concerning end [a]	0.00
E Concrete, reinforcemer	- Prestressing pre-tensioned		.00
		Paration of Hooping duote [cool	00,00
Subsoil, foundation			.00
	Warnings and errors		0,00
Fire heat	- Connection		,50
Heat transfer	General data	Bill of prestress material	
	Frame bolted/welded		,50
H	Base plate		,50
	- Expert system	Shortening of duct in the anchors [m] 0	.40
	- Bolted diagonal	Cross-section characteristics	
	- Thickness	Warnings and errors	
	÷	Connection	

The parameters brief table of tendon is possible to view in document *Structure>Tendons>Internal tendons.*

Document 4 ×	b 😃 🖪 🖪	9 <mark> </mark>		🧻 defau	ult 🔤 l	🖉 🛗 default	* 🗉	.
DOC-Default	1. Po	st-tension	ned tendon					
□ Default Post-tensioned tendon (1)	Nar	пе Туре	Material	Layer	Diameter of duct [mm]	Load Case	Type of stressing	Allocation
	1e_0	1 Internal	Y1770S7-16,0-A	Faze_1	80,00	Kable I.Etapa	Type 3	B1, B2, B3, B4
Beam construction stage	1e11	Internal	Y1770S7-16,0-A			Kable I.Etapa	Type 3	B1, B2, B3, B4
Construction stages	1e03	Internal	Y1770S7-16,0-A			Kable I.Etapa	Type 3	B1, B2, B3, B4
document item	1e13	Internal	Y1770S7-16,0-A			Kable I.Etapa	Type 3	B1, B2, B3, B4
document item		Internal	Y1770S7-16,0-A			Kable I.Etapa	Type 3	B1, B2, B3, B4
Default	1e15	Internal	Y1770S7-16,0-A			Kable I.Etapa	Type 3	B1, B2, B3, B4
Project	2e02	Internal	Y1770S7-16,0-A	1774	22	Kable II.Etapa	Type 3	B1, B2, B3, B4, B6, B7, B8
 Libraries Sets 	2e12	Internal	Y1770S7-16,0-A	Faze_2	80,08	Kable II.Etapa	Type 3	B1, B2, B3, B4, B6, B7, B8
Solver and Mesh	2e4	Internal	Y1770S7-16,0-A	Faze_2	80,08	Kable II.Etapa	Type 3	B1, B2, B3, B4, B6, B7, B8
Structure	2e14	Internal	Y1770S7-16,0-A	Faze_2	80,00	Kable II.Etapa	Type 3	B1, B2, B3, B4, B6, B7, B8
Nodes Members	≡ 2e08	Internal	Y1770S7-16,0-A	Faze_2	80,00	Kable II.Etapa	Туре 3	B1, B2, B3, B4, B6, B7, B8
Tendons	2e16	Internal	Y1770S7-16,0-A	Faze_2	80,08	Kable II.Etapa	Type 3	B1, B2, B3, B4, B6, B7, B8
Internal tendons Point supports on member	3e01	Internal	Y1770S7-16,0-A	Faze_3	80,00	Kable III.Etapa	Type 3	B5, B6, B7, B8, B10
Load	3e11	Internal	Y1770S7-16,0-A	Faze_3	80,00	Kable III.Etapa	Type 3	85, 86, 87, 88, 810
Construction stages Results	3e03	Internal	Y1770S7-16,0-A	Faze_3	80,00	Kable III.Etapa	Type 3	B5, B6, B7, B8, B10
Solver Files	3e13	Internal	Y1770S7-16,0-A	Faze_3	80,00	Kable III.Etapa	Type 3	85, 86, 87, 88, 810
Steel	3e05	Internal	Y1770S7-16,0-A	Faze_3	80,00	Kable III.Etapa	Type 3	85, 86, 87, 88, 810
Aluminium Custom check	3e15	Internal	Y1770S7-16,0-A	Faze_3	80,00	Kable III.Etapa	Type 3	85, 86, 87, 88, 810
Pipeline	4e01	Internal	Y1770S7-16,0-A	Faze_4	80,00	Kable IV.Etapa	Type 3	B11, B12
	- 4e11	Internal	Y1770S7-16,0-A	Faze_4	80,00	Kable IV.Etapa	Type 3	B11, B12
Timber	4e02	Internal	Y1770S7-16,0-A	Faze_4	80,00	Kable IV.Etapa	Type 3	88, 89, 810, 81 812
<<< Add Close	4e12	Internal	Y1770S7-16,0-A	Faze_4	00,08	Kable IV.Etapa	Туре 3	88, 89, 810, 81

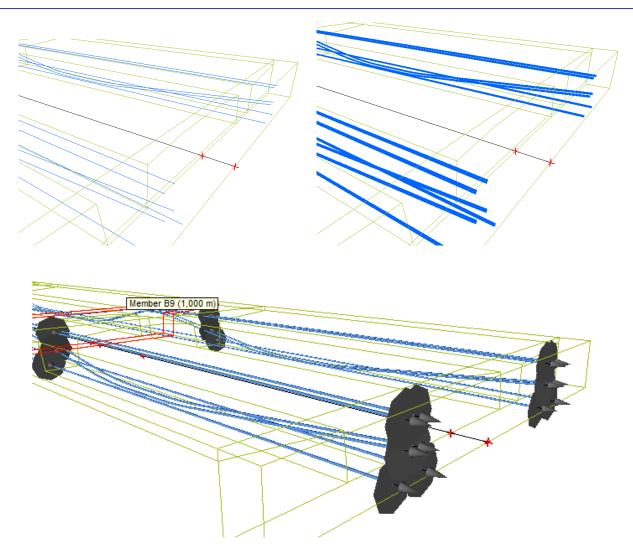
The tendon shorterm losses should be dispalyed for each selected tendons

IND	2009 - 23-342-	and the state of the state		and the second second second second		×	: 🗖 🔒 🖬		🌣 🌿 🗅
-									ф >
	A Distance of the local distance of the loca	🔟 🔟 📑 default	📩 🕮 💾 default	· II III			ndon (1)	- 1	δ V/ Ø
Tendon na	ame: TND toryofstressing:3							TND	
		orageset and long-termin	elaxationlossesfrominit	altendonstress.					
Tendonstr	essedfromit'sbeg	inning.						10	
Theoretics	esetios sappe ar so altendo nelo no atio	venthe wholelen gthoften nbeforet ran sfer0,081[m]	idon.					Internal	
Theoretica	altendonelongatio	naftertransfer0,075[m]						Layer1	·
x	Frictional loss	Anchorage set loss	Short-term relaxation	Stress after anchoring / transfer	Relaxation	Relax, t			
[m]	[MPa]	[MP a]	[MP a]	[MP a]	passed	pass	ut	Source geometry	-
0,000	0,00	-1 22,29	0,00	1317,71	[MPa] -10,49	[MP :			
0,500	-0,76	-122,29	0,00	1317,71	-10,49	-5		First beam from all	locatic 💌
1,000	-1,51	-119,39	0,00	1319,10	-10,33	-6	ntermedia	Perpendicularly	-
1,500	-2,27	-117,94	0,00	1319,79	-10,26	-5		standard	-
2,000	-3,02	-116,50	0,00	1320,48	-10,18	-5	etry	SG - geometrie_1	· · · ·
2,500	-3,78	-115,05	0,00	1321,18	-10,11	-5		Offset in LCS	-
3,000	-4,53	-113,60	0,00	1321,87	-10,03	-5	po goomony	0,000	
3,500		-112,15	0,00	1322,56	-9,96		-	0,000	
E Ready [cs	5]		•			্র ব		0.000	
	(50%)			Transmit Ion					
	1000.00			Automa at				Y1770S7-15.7	·
	1403.00						don elem	15	
	1200.00						idons in g	2	
	(am.)e/22						idons in g	4500	
							uct [mm]	80.00	
	100.00						her [mm]	LC1 · Předpeti	·
	600.00							LUT · Freapen	· ···
	40.00						ing	Туре 3	·
	0.00						rom	Begin	
	-]]]]]]]]]]]]]]]]]]]]]]]]]]]]]]]]]]]]]]]	REFEE			- Contraction of the Contraction	12.2823	ي النبية
	10		0 0 0 0 0 0 0 0 0 0	10.9 10.1 10.1 10.1 10.1 10.1 10.1 10.1			01		>>>
					1				>>>
Selected tend	lon	Origin value from: 0	Irigin 💌 + [0,	0 MPa Vertical axis: 200,0	MPa				>>>
						a 1			>>>
TND		Text scale: 0.	5	Vertical scale: 1 🕂		Close	-		And in case of the local division of the loc

The tendons are drawing in 3D window depending on View parameters settings.

View	v parameters setting		
0	Check / Uncheck group	Lock position	
_	Modelling/Drawing 🛛 🚱 Attr Structure 🔠 Labels	ibutes 📝 Misc. Q View ▲ Model 🛃 Loads/masses	
	Check / Uncheck all		
Ξ	Service		
	Display on opening the service	✓	
	Structure		
	Style + colour	normal 🔹	
	Draw member system line	▼	
	Member system line style	system line 💽 👻	
	Model type	analysis model 🔹	
	Display both models		
	Member surface		
	Rendering	wired 🔹	
	Draw cross-section		
	Cross-section style	section 🔹	
	Structure nodes		
	Display		
	Mark style	Dot 🗸	
Ð	Member parameters		
	System lengths		View parameters setting
	Member nonlinearities	V	Check / Uncheck group Lock position
	FEM type		🖴 Structure 🚇 Labels 👗 Model 🛃 Loads/masses
Ξ	l endons		🔛 Modelling/Drawing 🚭 Attributes 🏼 🖉 Misc. 🔍 View
	Display		🔲 Check / Uncheck all
	Style of display geometry	Final 🔹	E Members
	Color of tendons	normal 🗾	Transparent mode Fine 💌
	Tendon drawing type	3D 🗸	Drawing style for Model+Loads
	Direction of stressing		Style / Rendering rendered Show add data, results at System line
	Vertices		Result diagram
	Anchors		Results

There are three possibilities of displaying of tendons in 3D window – thin line, diameter, 3D. Anchors and directions of stressing are also possible to display. 3D drawing with rendered model can give very nice pictures.



2.2 Load

2.2.1 Loadcases

The loadcases have to be defined before construction stages are defined. The following list of load cases will be defined. There are several possibilities of load definition.

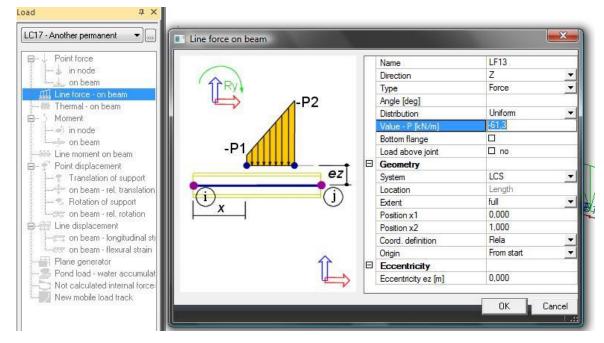
- Permanent
 - o Type
 - Standard necessary for definition of stages in construction stages library, could be empty loadcase used only for definition of stages
 - Selfweight loadcase from load of selweight
 - Prestress necessary for definition of prestressing
 - o Loadgroup
 - Link to library of Load group see (4.1)
- Variable
 - o Specification
 - Standard
 - Temperature only thermal load should be defined in this LC
 - o Loadgroup
 - Link to library of Load group see (4.1)

2.2.2 Loads

Load is defined according to type of load using Loads. For example - permanent load (road, safety fence and other bridge accessories) is defined in loadcase *LC17-Another permanent – type permanent*

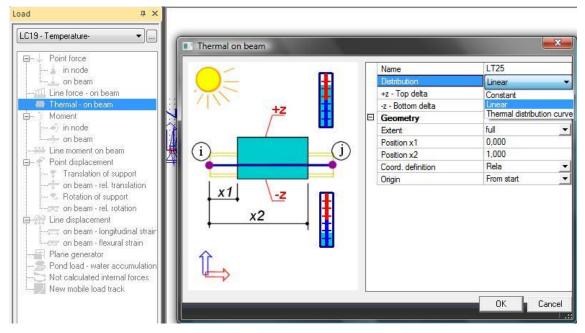
Load cases		-		×
🎜 🤮 🖋 👪 ⊵	e	i 😂 🗳 🖬 🛛 Al	1	7
LC1 - Prestress I.Stage	*	Name	LC27	
LC2 - Prestress II.Stage		Description	ULS_100	
LC3 - Prestress III.Stage		Action type	Permanent	
LC4 - Prestress IV.Stage		LoadGroup	LG1	▼
LC5 - Casting I.Stage		Load type	Standard	-
LC6 - Prestress I.Stage				
LC7 - Casting II.Stage				
LC8 - Prestress II.Stage	=			
LC9 - Casting III.Stage				
LC10 - Prestress III.Stage				
LC11 - Casting IV.Stage				
LC12 - Prestress IV.Stage				
LC13 - Settlement1				
LC14 - Settlement2				
LC15 - Settlement3				
LC16 - Settlement4				
LC17 - Another permanent				
LC18 - Temperature+				
LC19 - Temperature-				
LC20 - Char_1				
LC21 - Freq_1				
LC22 - qp_1				
LC23 - ULS_1				
LC24 - Char_100				
LC25 - Freq_100				
LC26 - qp_100				
LC27 - ULS_100	-			
New Insert Edit [Delete	•		Close

The definition of the load value is available in *Loads>Line* force on beam and user defined value 61,3kN/m.



2.2.2.1 Temperature load

The variable loadcase with specification temperature has to be defined. The temperature load is defined in *Load>Thermal on beam*.

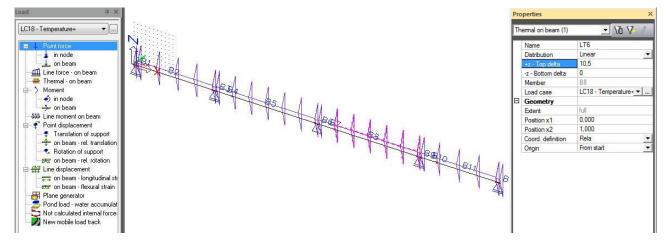


The *linear* thermal load will be defined.

- LC Temperature-
 - Top delta 8°C
 - $\circ \quad \text{Bottom delta } \mathbf{0^{\circ}C}$
- LC Temperature+
 - Top delta +10,5°C
 - Bottom delta 0°C

Thermal on beam				×
		Name	LT25	
		Distribution	Linear	-
		+z - Top delta	-8	
+z		-z - Bottom delta	0	
	E	Geometry		
		Extent	full	-
		Position x1	0,000	
	9	Position x2	1,000	
		Coord. definition	Rela	-
		Origin	From start	_
			OK	Cancel

The temperature load is drawn in 3D window following (using triangles).



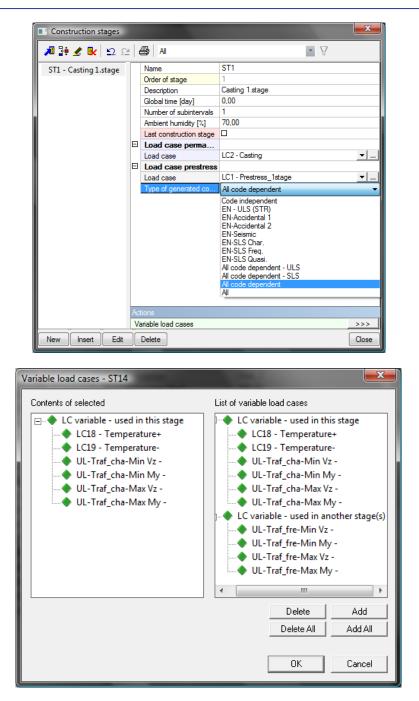
3 Construction stages

The construction stages are necessary to define for time dependant analysis (TDA). The User has to define *Type - Time analysis* in *Setup of construction stages*.

- betonaz Construction stages Setup		Name Order Desc		
Time axis	Construction stages setup			
Add member	Туре	Time analysis		
- 🎦 Remove member	Load factors	Standard		
🔜 🛲 Beam settings	Permanent (long-term) load case	Time analysis		
Supports	Gamma min [-]	E, modulus function		
- Add support	Gamma max [·]	1,00		
Remove support	Prestressed load cases			
👆 📉 Tendons - Remove tendon	Gamma min [-]	0,00		
🦾 💥 Delete input data of stage	Gamma max [·]	1,00		
	Long-term part of variable load			
	Factor Psi [-]	0,30		
	I TDA			
	Load factors for generated loadcases			
	gamma-creep min [-]	1,00		
	gamma-creep max [-]	1,00		
	🗆 Time - History			
	Number of subintervals	1,0		
	Ambient moisture [%]	70,00		
	Automatic calculation of subintervals	🗆 no		
	E Local time avis			

Then it is necessary to define each construction stage using three dot buttons. There are several important values

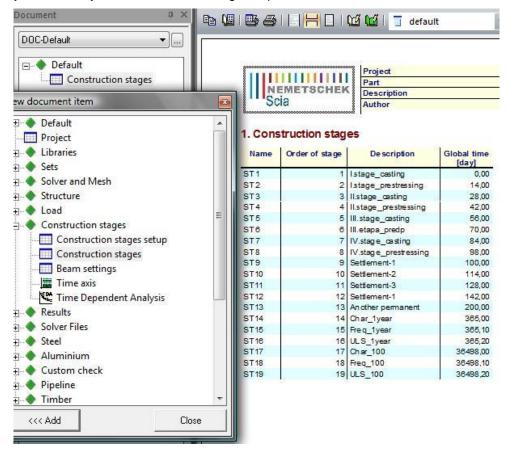
- *Name* ST1 ST19
- **Description** description of appropriate stage
- Global time global time of time axis in days
- **Number of subintervals** number of subintervals in appropriate stage, the creep and shrinkage increment are calculated in this subintervals
- Ambient humidity in percentage, needed for calculation of shrinkage
- Last construction stage checkbox which signed last construction stages, the stages after that are service stages, variable load applied before Last construction stage cannot be used in another stage.
- Permanent load case load case type permanent each stage has to have only one loadcase type permanent (longterm variable), this loadcase could be also empty only (for measurement-without load), but it is necessary for creation of stages
- Prestress type loadcase optional loadcase, by this loadcase are determined prestressing tendons in appropriate stage
- **Type of generated combination** user has several opportunity which type of combination will be automatically generated according to selected code in project data
- Variable action button the variable loadcase is possible to add into selected stage by this button (see chapter 4.3)



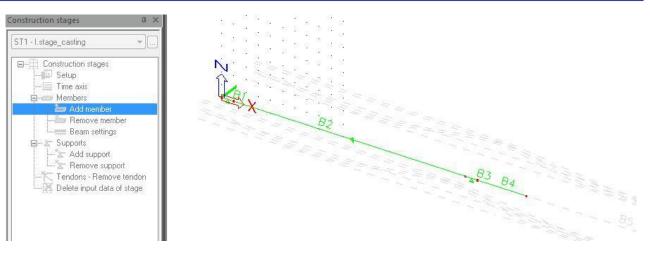
The all stages will be defined by this way. The total content of the stages is following.

Construction stages				×
📕 🕃 🗶 🔽 🗠		🚭 Al	- 7	
ST1 - I.stage_casting	, 	Name		
ST2 - Lstage_prestre ST3 - IL.stage_casting ST4 - IL.stage_casting ST6 - III.stage_casting ST6 - III.stage_crestr ST7 - IV.stage_casting ST8 - IV.stage_prestr ST9 - Settlement1 ST10 - Settlement2 ST11 - Settlement3 ST12 - Settlement4 ST13 - Another per ST14 - Char_1 ST15 - Freq_1 ST15 - Freq_1 ST15 - Gp_1 ST16 - Op_1 ST17 - ULS_1 ST18 - Char_100 ST19 - Fre_100 ST20 - Op_100		Order of stage Description Global time (day) Number of subintervals Ambient humidity [%] Last construction stage Load case permanent Load case prestress Load case Type of generated combina	1 Istage_casting 0.00 1 70,00 C LC5 - Casting I.Stage None All code dependent	• • •
ST21 - ULS_100	Ac	tions		
New Insert Edit		ariable load cases Delete		>>> Close

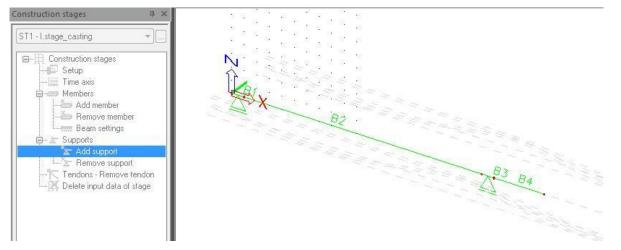
The very user friendly list of construction stages is possible to add into document.



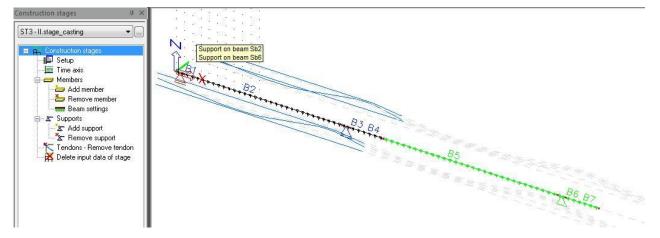
The construction stages are defined now is necessary to assign which members and supports belong to which construction stages. The members are defined by button *Members*>Add members and selected appropriate member in selected stage.



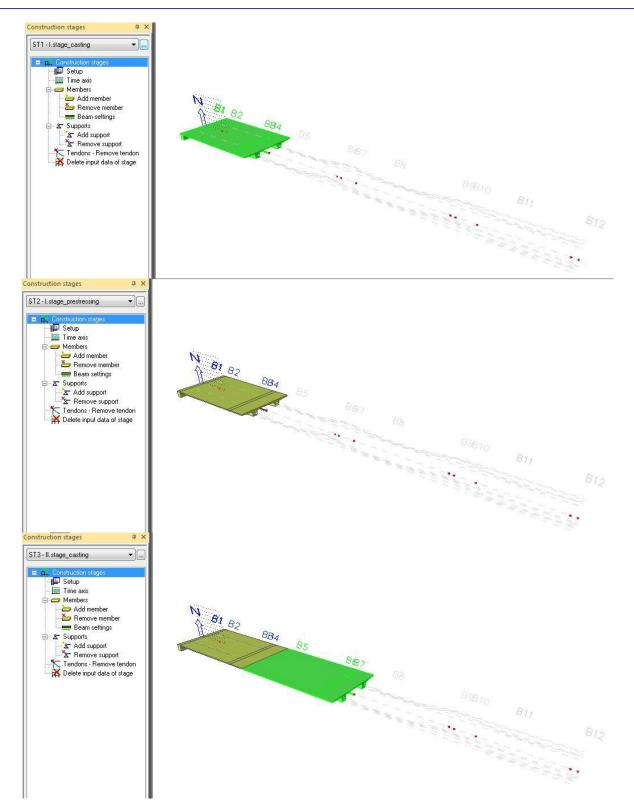
The supports are defined in similar way Supports> Add supports.

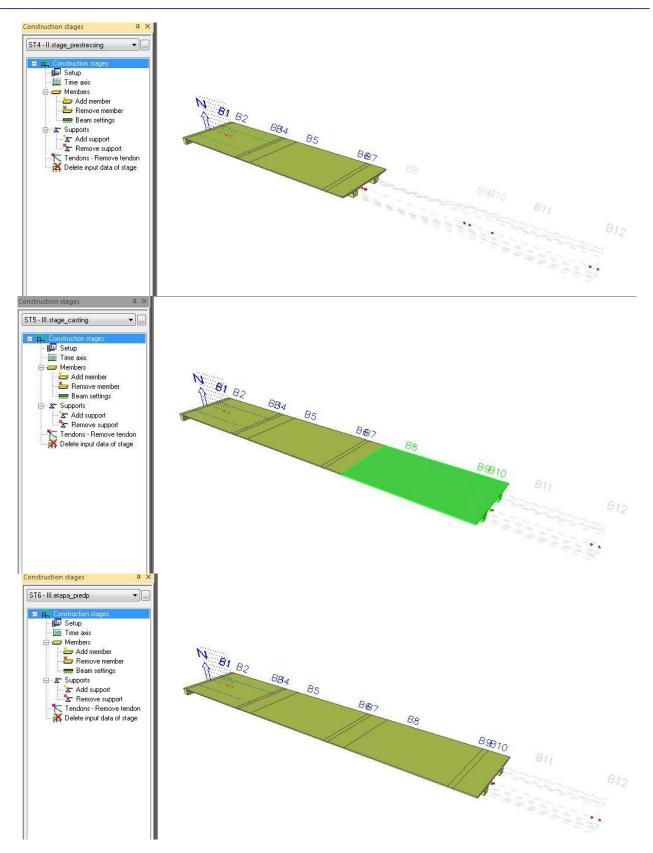


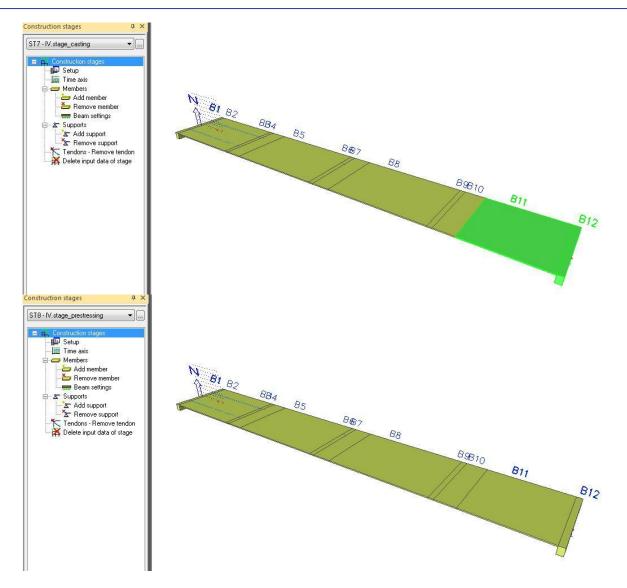
The support on beam B1 is defined in the ST1 (X,Z support) and removed in ST3. The support (Z only) is added in ST3.



The whole structure will be defined by this way described in upper figures. The graphical presentation in 3D window is following during of construction.







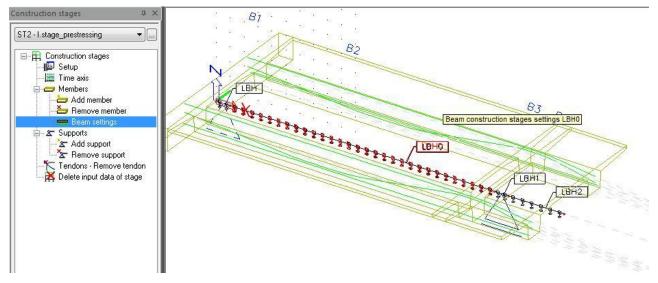
3.1 Local beam history

One from the most important setting for time dependant analysis is *Local Beam settings (LBH)*. This LBH will be assigned to each member.

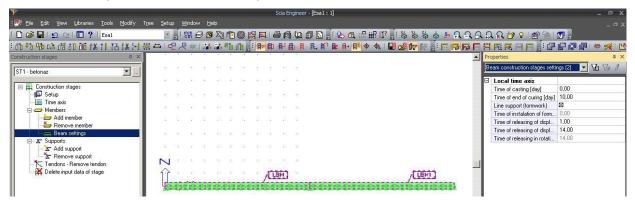
Construction stages Setup		Beam construction stages settings	— ×
Time axis		Name	LBH11
E Members		Local time axis	
Add member		Time of casting [day]	0,00
Remove member	~	Time of end of curing [day]	10,00
Eeam settings	5	Line support (formwork)	
Add support	333	Time of instalation of formwork [day]	0,00
Remove support	-	Time of releasing of displacements in X direction [day]	1,00
Tendons - Remove tendon		Time of releasing of displacements in Z direction [day]	42,00
Delete input data of stage		Time of releasing in rotation [day]	42,00

- *Time of casting* it is time of casting of concrete in days in local time axis related to the global time axis. It is possible to input negative value. The linear support hasn't to be used in this case. The ageing of the concrete starts in this time. It is significant for age of concrete for creep calculation. An example construction stage 1 global time 5 days; time of casting -3 days. It means that global time of casting is 2 days. The user doesn't have to input linear support formwork
- **Time of end of curing** it is time of end of curing of concrete. If phased CSS is used, then it is time of end of cuing of the first phase of CSS. It is significant time for calculation of shrinkage.
- **Time of end of curing of composite phases** it is significant only for phased CSS, this time is end of curing of the second, third...phase of CSS if exists. It is significant time for calculation of shrinkage of second, third phase of CSS again.
- **Time of releasing of displacement in X(Z) direction** time when formwork in X(Z) direction is replaced.

The displaying of LBH in 3D window is as linear support (formwork).



More LBH is possible to edit in one step



The LBHs are possible to view in document.

					a a i I			- 💯 🎹 TDA	*	•
DOC-Default 👻 🛄		ST13			other permane	ent	200,00			
		ST14	4		nar_1year		385,00			
Default		ST15			eq_1year		365,10			
Construction stages		ST16	0		S_1year	1	365,20			
Beam construction stages settings (Beam se		ST17 ST18			nar_100 ≊q 100		38498,00 38498,10			
beam construction stages settings (beam se		ST18 ST19			s_100		36498,20			
New document item Default Project Libraries		2. Bean Name	Member		Time of end of curing [day]	Line Line support (formwork	Time of instalation of formwork [day]	Time of releasing of displacements in X direction [day]	Time of releasing of displacements in Z direction [day]	Time of releasing in rotation [day]
🗄 🔶 Sets		LBH	B1	0.00	10,00	~	000	1,00	4200	42,00
Solver and Mesh		LBHO	B2	0,00	10,00	*	000	1,00	42,00	42,0
E Structure		LBH1	B3	0,00	10,00	1	000	1,00	42,00	42,0
		LBH2	B4	0,00	10,00	~	000	1,00	42,00	42,0
庄 🔶 Load	E	LBH3	B5	0,00	10,00	× .	000	1,00	1400	14,0
🚊 🔷 Construction stages		LBH4 LBH5	B8 B6	00,0 00,0	10,00	1	000	1,00	1400 1400	14,0
Construction stages setup		LBH6	B0 B7	0,00	10,00	4	000	1,00	1400	14,0 14,0
Construction stages		LBH7	B11	0,00	10,00	1	000	1,00	1400	14,0
Beam settings		LBHS	89	0,00	10,00	1	000	1,00	1400	14,0
		LBH9	B10	0,00		~	0,00	1,00		14,0
Time axis		LBH10	B12	0,00			000	1,00	14,00	14,0
Time Dependent Analysis	100									
Results Solver Files Solver Files Steel Aluminium Custom check Pipeline Timber / / / / Close Close							1			

The colour drawing in 3D windows depends on settings in Setup> Colour/lines > Palette settings.

Current palette: White background	-		2 8	2			
Colours & lines Fonts Structural types	Dimension lines	And Address of the Ad					
Pen / brush type	Colour	Style	Width	Туре	Preview	l.	
Strand	1			- Pixels			
Drawing tools	0			- Pixels	<u> </u>		
Dimension lines	0		· · · · · · · · · · · · · · · · · · ·	- Pixels			
Others	0		19 <u>1</u>	- Pixels	<u></u> 2		
Cross-section outline	/			- Pixels	20 20		
Cross-section midline	0		93 0	 Pixels 			
Cross-section fibre	0		(c) (Pixels 			
Cross-section corrosion	0			 Pixels 			
Thinwalled representation	0			 Pixels 			
Cross-section insert point	0			 Pixels 			
Cross-section results	0			- Pixels			
Cross-section dimension lines	0	-		 Pixels 			
Stages - currently installed	1	-	·	- Pixels			
Stages - currently removed	/			- Pixels			
Stages - not yet installed	0			 Pixels 			
Stages - already removed	0			 Pixels 			
Disappeared conflicts	0			 Pixels 	÷		
Lasted conflicts	/		· · · · · · · · · · · · · · · · · · ·	 Pixels 	<u> </u>		
New conflicts		-		 Pixels 			
Section Plane	0			 Pixels 			
Front Plane	<u>/</u>	-	1997	- Pixels	8		-

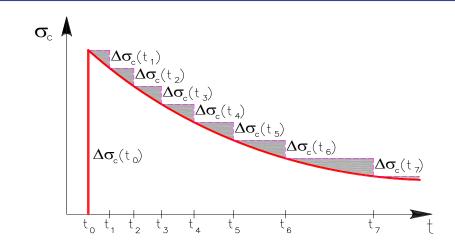
The drawing according to stages is possible to set by right click in 3D window **Set view parameters** for all and set which components of stages will be drawn.

		V	liew	parameters setting			
		Check / Uncheck group					
		Ľ					
				E Structure Lab Loads/masses M Modelling/Dr			
					awing Misc. View		
			_	Check / Uncheck all			
		н		Members Transparent mode	F		
		н		Drawing style for Model+Loads	Fine 🗾		
		н		Style / Rendering	simple 💽		
				Show add data, results at	System line		
				Line grid			
				Draw	By grid visibility 💽		
				Result diagram			
				Results			
_				Calculation info			
	Zoom <u>a</u> ll			Display singularity			
	Zoom by cut out			Construction stages data	-		
CN.	200m by <u>c</u> at out			Display Change			
B	Set view parameters for all			Stage Already installed	ST2 - I.stage_prestressing		
	Set new parameters for ag			Currently installed			
N.	Cursor snap setting	L		Not yet installed			
		H.		Already removed	v		
A	Print/ Preview table	н		Currently removed	v		
	Table to document	L		Line support (formwork)	✓		
	Table to document			Construction stages data labels			
đ	Print picture	L		Label beam settings			
13	Picture to document						
1	Picture to gallery	L					
H	Save picture to file						
B	Copy picture to clipboard						
۰	Wired model in view manipulations						
8	Advanced graphic setup						
[] ?	Coordinates <u>i</u> nfo			ОК	Cancel		

3.2 Automatic calculation of subintervals

The user has to define in each stage number of subintervals. There is also possibility to defined total number of subintervals in whole construction in *Setup of stages> Total number of subintervals*. The time axis will be divided according to the same logarithm increment into whole construction.

. Co	onstruction stages setup		×
Ту	pe	Time analysis	
	load factors		
Θ	Permanent (long-term) load case		
	Gamma min [-]	0.00	
	Gamma max [-]	1,00	
	Prestressed load cases		
	Gamma min [-]	0.00	
	Gamma max [-]	1,00	
	Long-term part of variable load		
	Factor Psi [-]	0,30	=
	ſDA		
	Load factors for generated loadcases		
	gamma-creep min [-]	1,00	
	gamma-creep max [-]	1,00	
	Time - History		
	Ambient moisture [%]	70,00	
	Automatic calculation of subintervals	🛛 yes	
	Total number of user input subintervals	10	
E	Local time axis		
	Time of casting	0,00	
	Time of curing [day]	10,00	
	Duration of curing of composite parts of cross-secti	14,00	
	Line support (formwork)		
	Time of releasing of displacements in X direction	1,00	
		OK Cano	:el
			<u> </u>



Total number of subinterval can be bigger then user defined because of following:

- At least one subinterval has to be in each stage
- Keeping stress (duration of shorterm relaxation) is also considered as time point

This option is possible also in *Time axis> subintervals*. The user set total number of subintervals and could admit or refuse this offered solution of subintervals.

Time axis edit				×
	Axe	s properties		
30 10 <td< td=""><td></td><td>Axes</td><td>1</td><td></td></td<>		Axes	1	
	0	Number of su	-	
		View		
		Color		
		Stage node n		
		View		
		Color		
Number of subietervals		Time axis of		Ξ
		View		
<u>3.0 10 10 10 10 10 4.0 10</u>		Color		
Stage node number		Merging of Io		
1 2 3 4 5 6 7 9 1012 13 16 19		View	⊠	
• • • • • • • • • • • • • • • • • • • •		Color		
Time axis of construction stages C <		Detail time axis		
365 5.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.		View		
	_	Color		
Construint Constru		Number of all	M	
		Mou	M	
Detail time axis	Cor	istruction stage		
Number of all subintervals				
]			
Subintervals			Close	

Calc subintervals	-		-	_	-			_ D _X
Number of subintervals								
÷ 3.0	•	1.0 1.0 1	<u>.0 1.0 1.01 0 0 0 0 1</u>	0 1.0 1.0		4.0		
Stage node number								
1	2	3 4	5 6 7 39 101112	13 1	5			19
Time axis of construction stages			0000					36498. 0
0; 	14.0	28.0	56.0 84.0 11400 11400 11400 11400	32 50 32 50				3645
Stage node number 1 Time axis of construction stages Merging of local time axes 0 Petal time axis 0 Petal time axis 0 Petal time axis 0 Petal subistervals 6								0.8
8 91	14.0	33.00 33.00 33.00		365.0				36498.0
Detail time axis								
00 01	14.0	39.0		_ 200.0				36498.0
Number of all subintervals	+ +++			• •				•
• 6	•	1 . 3 .		• • •		+		-•
J								
Total number of user input subinterv	vals				10	Calculate	Cancel	ОК

4 Mobile loads

The load system gr1a (according to table 4.4 EN1991-2) is the most efficient load system for design and check of bridges. This system consists from

- Load model LM1
 - Tandem system TS
 - Uniformly distribute load UDL
- Pedestrian or cyclist load

The combinations coefficients (ψ_0 , $\psi_1 a \psi_2$) are different for the separate loads in this load system according to table A2.1 from the EN 1990/A1. The procedure of modelling and check using characteristic, frequent and quasi-permanent combination including load system gr1a is different from the using of standard procedure with loadcases which belongs to appropriate loadgroup with defined combination coefficient in menu **Project**.

Zatížení		Značka	Ψb	<i>\</i> \/1	Ψ2
	gr1a	TS (dvojnápravy)	0,75	0,75	0
	(LM1+ zatížení	UDL (rovnoměrné zatížení)	0,40	0,40	0
	chodci nebo cyklisty) ¹⁾	Zatížení chodci + zatížení cyklisty ²⁾	0,40	0,40	0
Zatížení dopravou (viz EN 1991-2,	gr1b (jednotlivá	náprava)	0	0,75	0
Tabulka 4.4)	gr2 (vodorovné	síly)	0	0	0
	gr3 (zatížení ch	0	0	0	
	gr4 (LM4 (zatíž	gr4 (LM4 (zatížení davem lidí))		0,75	0
	gr5 (LM3 (zvláš	tní vozidla))	0	0	0
	F _{wk}				
Zatížení větrem	- Trvalé návrho	vé situace	<mark>0,6</mark>	0,2	0
	- Provádění		<mark>0,8</mark>	-	0
	F _w *		1,0	-	-
Zatížení teplotou	T _k		0 ,6 ³⁾	0,6	0,5

The rules for SLS combination according to tab. A2.6 from EN1990/A1

	Permanent	Prestress	The dominant variable (traffic)	The subordinate variable (temperature)
Characteristic	Gi	Р	1,0*Qk1	ψ ₀ * Qki
Frequent	Gi	Р	ψ_1 *Qk1	ψ_2^* Qki
Quasi-permanent	Gi	Ρ	ψ_2 * Qki	ψ_2^* Qki

4.1 Preparation of mobile load in SEN

4.1.1 The load group

The new Load group (LG) with name *Traffic* is created, type is *Variable exclusive*. This LG will be registered to category of load G – traffic >30kN

Load groups			×
🎜 🤃 🗶 📸 💽 🗠	🗠 😂 🗳 🖬 Al		• 7
Traffic	Name	Traffic	
Temperat	Relation	Exclusive	-
	Load	Variable	-
	EC1 - load type	Cat G : Vehicle >30kN	-
New Insert Edit	Delete		Close

The temperature load is possible to insert to different LG (temperature) with predefined combination coefficient (the coefficient cannot be set to 1,0)

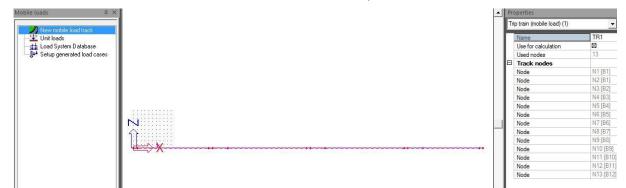
Load groups				×
🎾 🤮 🗶 🔛	. 🗠 🚑 🚔 日 🗛			• 7
Traffic	Name	Temperat Standard	Filter edit	_
Temperat	Relation Load	Variable		
	EC1 - load type	Temperature		-
New Insert Edit	Delete			Close

The default combination factors should be set to 1,0 for selected LG.

/K	Name		SVK	
- Combination	Combination			
 STR/GEO) alternative Rei (sectors for buildings) 	G (STR/GEO) a	Iternative	EN 1990: 6	5.4.3.2 (3)
 Psi factors for buildings Load combination factors 	Combination	1.4.6	Eq.6.10	nnex A1 Table A1.1
Loga combination ractors	Psi factors fo		EN 1990; A	nnex AT Table AT.T
C		ation racions		
F	Psi factors			×
	Load	Psi0	Psi1	Psi2
	1 CategoryA	0,7	0,5	0,3
	2 CategoryB	0,7	0,5	0,3
	3 CategoryC	0,7	0,7	0,6
	4 CategoryD	0,7	0,7	0,6
	5 CategoryE	0,1	0,9	0,8
	6 CategoryF	0,7	0,7	0,6
	7 CategoryG	1	1	1
	8 CategoryH	0	0	0
	9 Snow (Finland,)	0,7	0,5	0,2
	10 Snow H > 1000m	0,7	0,5	0,2
	11 Snow H < 1000m	0,5	0,2	0
	12 Wind	0,6	0,2	0
	13 Temperature	0,6	0,5	0

4.1.2 Mobile load track

New mobile load track (TR1) has to be defined by user *Mobile loads > New mobile load track.* The first and last node will be selected and track will be automatically defined on whole structure



4.1.3 Unit load

New Unit load (UL) will be defined by user *Mobile loads > Unit loads*.

Mobile loads 🛛 📮 🗙	Unit Mobile Loads				×
New mobile load track	🎜 🏦 🧶 📸 🛃 🕰	0	e 🚳 😂 🔒 🗚		• 7
👱 Unit loads	UL		Name	UL	
Load System Database			Track assignment	TR1	-
Setup generated load cases			Sections	Use Step according 2D element	-
		1	Step for 2D element [m]	1	
		1	Generate section und		
			Add new Impulse		
	E		Impulse 1		
			Туре	Concentrated	-
			Value	-1	-
			Position [m]	0.000	
			ey [m]	0,000	
			ez [m]	0.000	
			System	Local	
			Direction	Z	
				- Vy	
	New Insert Edit		Delete	I	Close

4.1.4 Load system database

The new Load system databases will be defined for each type of combination including combination coefficients for characteristic and frequent combination. *Mobile loads > Load system database*

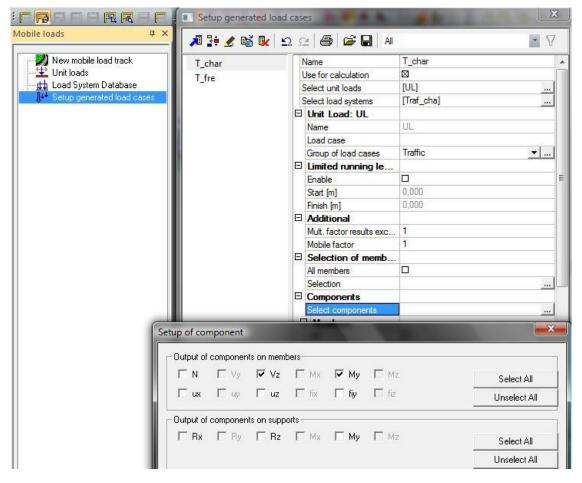
Traf_char – Load system for characteristic combination *1,0*TS+1,0*UDL Traf_fre* – Load system for frequent combination *0,75*TS+0,4*UDL*

Mobile load systems				Mobile load systems		
🏓 🕃 🏒 📸 🔣 🕰	🗠 😂 🎽 🔛 Al	٣	8	🏓 🤮 🇶 🛍 🗽 🕰	🗠 😂 😂 🔛 Al	• 7
Traf_cha Traf_fre	600,000	-600,00		Traf_cha Traf_fre	-450,00	-450,00
Name Traf_cha				Name Traf_fre		
		42.00 			1,2	00
New Insert Edit	Delete		Close	New Insert Edit	Delete	Close

4.2 Setup of generated loadcase

Two groups of generated loadcase should be set in **Setup of generated loadcase**. The same LG - **Traffic** should be assign to each group of generated LC. The components **Vz** and **My** will be evaluated.

- T_char Unit loads (UL) + load system database (Traf_char)
- T_fre Unit loads (UL) + load system database (Traf_fre)



🕞 🕞 🖓 🕅 🕅 🗖 🔽 Setup gene	erated load cas	es 🗰 🗰 🖷 👞		
bile loads 🛛 🕂 🗶 🛙	ෂී 🔽 🛛 🛛	2 🚭 🚅 🔛 Ali		*
New mobile load track		Name	T_fre	
Unit loads		Use for calculation		
toad System Database		Select unit loads	[UL]	
J++ Setup generated load cases		Select load systems	[Traf_fre]	
		Unit Load: UL		
		Name	UL	
		Load case		
		Group of load cases	Traffic	+
	E	Limited running le		
		Enable		
		Start [m]	0,000	
		Finish [m]	0,000	
		Additional		
		Mult. factor results exc	. 1	
		Mobile factor		
	Ξ	Selection of memb		
		All members		
		Selection		
		Components		
		Select components		
(-			
Setup of component			10000000	
Output of company				
Output of component				
N Vy	▼ Vz □	Mx 🔽 My 🔲 Mz		Select All
		fix 🗖 fiy 🗖 fiz		11 1 1 4 1
I un I wy	(ALL) GE	in a ny a na		Unselect All
- Output of component	ts on supports —			
I HX I HY	I HZ I	Ma 🔲 My 🗖 Mz		Select All
				Unselect All

The envelopes of LC will be automatically generated after linear calculation finish. These generated LC will be added into appropriate stages.

Load cases		
🔎 🤮 🥒 📸 k 📴 🗠 🗠 🖉	3 😂 🖬 Al	• 7
LC8 - Prestress II.Stage	Name	UL-Traf_cha-Min Vz
LC9 - Casting III.Stage	Description	
LC10 - Prestress III.Stage	Action type	Variable
LC11 - Casting IV.Stage	LoadGroup	Traffic
LC12 - Prestress IV.Stage	Load type	Static Mobile envelope
LC13 - Settlement1	Specification Master load case	None
LC14 - Settlement2	Master Ioau Case	TAOLIC
LC15 - Settlement3		
LC16 - Settlement4		
LC17 - Another permanent		
LC18 - Temperature+		
LC19 - Temperature-		
LC20 - Char_1		
LC21 - Freq_1		
LC22 - ULS_1		
LC23 - Char_100 =		
LC24 - Freq_100		
LC25 - ULS_100		
UL-Traf_cha-Min Vz		
UL-Traf_cha-Min My		
UL-Traf_cha-Max Vz		
UL-Traf_cha-Max My		
UL-Traf_fre-Min Vz		
UL-Traf_fre-Min My		
UL-Traf_fre-Max Vz		
UL-Traf_fre-Max My 👻		
New Insert Edit Delete		Close

4.3 Definition of construction stages

The separated construction stages were created in construction stages library (see). The appropriate envelopes of variable LC will be add to each construction stage according to type of generated combination

- Char_1 characteristic combination
 - time 365 days
 - MSP-characteristic
 - UL-Traf_char-Min My
 - UL-Traf_char-Max My
 - UL-Traf_char-Min Vz
 - UL-Traf_char-Max Vz
 - Temperature+

.

Temperature-

Construction stages						
🥕 🤮 🗶 😰 😂 🎒	All	- 7				
ST1 - I.stage_casting	Name	ST14				
ST2 - I.stage_prestressing	Order of stage	14				
ST3 - II.stage_casting	Description	Char_1				
ST4 - II.stage_prestressing	Global time [day]	365,00				
5-1 5	Number of subintervals	1				
ST5 - III.stage_casting	Ambient humidity [%]	70,00				
ST6 - III.stage_prestressing	Last construction stage					
	Load case permanent					
ST8 - IV.stage_prestressing	Load case	LC20 - Char_1 🔍				
ST9 - Settlement1	Type of generated combina	EN-SLS Char.				
ST10 - Settlement2	Variable load cases					
ST11 - Settlement3	LC18 - Temperature+ [-]	0,00				
ST12 - Settlement4	LC19 - Temperature- [-]	0,00				
ST13 - Another permanent	UL-Traf_cha-Min My [·]	0,00				
ST14 - Char 1	UL-Traf_cha-Max My [-]	0,00				
ST15 - Freq_1	UL-Traf_cha-Min Vz [·]	0,00				
-	UL-Traf_cha-Max Vz [-]	0,00				
ST16 - Qp_1						
ST17 - ULS_1						
ST18 - Char_100						
ST19 - Fre_100						
ST20 - Qp_100	ctions					
CT21 LUC 100	Variable load cases	>>>				
New Insert Edit Delete Close						

- Fre_1- frequent combination
 - time 365,1days
 - MSP-frequent
 - UL-Traf_fre-Min My
 - UL-Traf_fre-Max My
 - UL-Traf_fre-Min Vz
 - UL-Traf_fre-Max Vz
 - Temperature+
 - Temperature-

Construction stages											
A 🕂 🗶 😰 😂 🞒 All 🔤 🖓											
ST1 - I.stage_casting		Name	ST15								
ST2 - I.stage_prestressing		Order of stage	15								
ST3 - II.stage_casting		Description	Freq_1								
ST4 - II.stage_prestressing		Global time [day]	365,10								
J 3 -1 3		Number of subintervals	1								
ST5 - III.stage_casting		Ambient humidity [%]	70,00								
ST6 - III.stage_prestressing		Last construction stage									
ST7 - IV.stage_casting		Load case permanent									
ST8 - IV.stage_prestressing		Load case	LC21 - Freq_1 🔍								
ST9 - Settlement1		Type of generated combina	EN-SLS Freq.								
ST10 - Settlement2		Variable load cases									
ST11 - Settlement3		LC18 - Temperature+ [-]	0,00								
ST12 - Settlement4		LC19 - Temperature- [-]	0,00								
ST13 - Another permanent		UL-Traf_fre-Min My [-]	0,00								
ST14 - Char 1		UL-Traf_fre-Max My [-]	0,00								
ST15 - Freq 1		UL-Traf_fre-Min Vz [-]	0,00								
ST16 - Qp_1		UL-Traf_fre-Max Vz [-]	0,00								
ST17 - ULS_1											
ST18 - Char_100											
ST19 - Fre_100											
ST20 - Qp_100	Ac	tions									
ST21 - ULS_100		ariable load cases	>>>								
New Insert Edit Delete Close											

- **QP_1** quasi-permanent combination
 - time 365,2days •

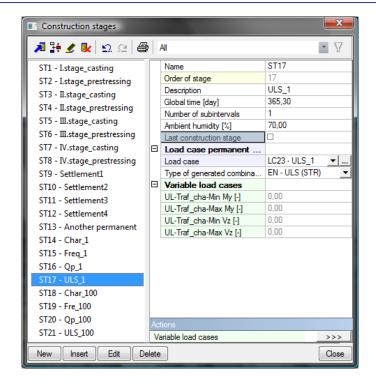
0

- MSP-quasi-permanent •
- Temperature+ •
- Temperature-

Construction stages										
🚚 달 🖉 😰 😂 🖓 🗛 💽 🖉										
ST1 - I.stage_casting		Name	ST16							
ST2 - I.stage_prestressing		Order of stage	16							
ST3 - II.stage_casting		Description	Qp_1							
ST4 - II.stage_prestressing		Global time [day]	365,20							
ST5 - III.stage_casting		Number of subintervals	1							
ST6 - III.stage_casting		Ambient humidity [%]	70,00							
5-1 5		Last construction stage								
ST7 - IV.stage_casting		Load case permanent	1000							
ST8 - IV.stage_prestressing		Load case	LC22 · qp_1							
ST9 - Settlement1		Type of generated combina	EN-SLS Quasi. 💌							
ST10 - Settlement2		Variable load cases	0.00							
ST11 - Settlement3		LC18 - Temperature+ [-]	0.00							
ST12 - Settlement4		LC19 - Temperature- [-]	0,00							
ST13 - Another permanent										
ST14 - Char_1										
ST15 - Freq_1										
ST16 - Op 1										
ST17 - ULS 1										
ST18 - Char 100										
ST19 - Fre 100										
ST20 - Qp_100										
ST21 - ULS 100		tions								
3121 - 013_100	Va	ariable load cases	>>>							
New Insert Edit De	lete	•	Close							

- ULS_1 ULS(STR) combination time 365,3 days 0

 - ULS(STR)-combination UL-Traf_char-Min My UL-Traf_char-Max My UL-Traf_char-Min Vz •
 - •
 - •
 - •
 - UL-Traf_char-Max Vz •



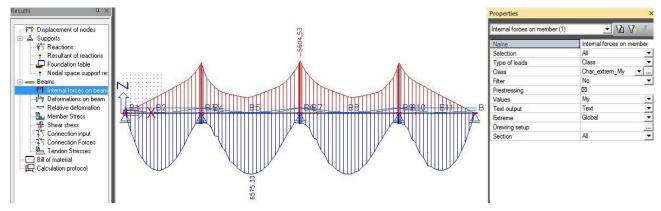
4.4 Evaluation of mobile loads - envelopes

The evaluation of maximum and minimum envelopes in one presentation in results is possible using *Loadcases, Combination>Results classes*.

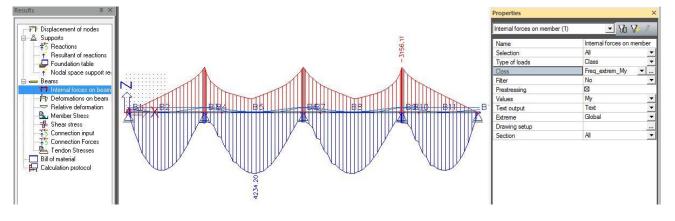
- Char_extrem_My extreme of envelopes of mobile loads for characteristic combination
 - UL_Traf_char_maxMy
 - UL_Traf_char_minMy
- Fre_extrem_My extreme of envelopes of mobile loads for frequent combination
 - UL_Traf_fre_maxMy
 - UL_Traf_fre_minMy

	Result classes	×
Aain + ×	📕 🔆 🖋 😼 🗠 🗠 🚳 🗛	• 7
Image: Participation Jail Load cases, Combinations J□ J□ Load Cases J□ J□ Load Cases J□ J□ Load Cases J□ J□ <t< th=""><td>Char_extrem_My Freq_extrem_My ST1 (ULS) - I.stage_ca ST2 (ULS) - I.I.stage_ca Result class - Char_extrem_My</td><td>Char_extrem_My UL-Traf_cha-Min My UL-Traf_cha-Max My</td></t<>	Char_extrem_My Freq_extrem_My ST1 (ULS) - I.stage_ca ST2 (ULS) - I.I.stage_ca Result class - Char_extrem_My	Char_extrem_My UL-Traf_cha-Min My UL-Traf_cha-Max My
Construction stages Construction stages Concrete Mobile loads Document Drawing Tools Drakes Segment blocks	Type :	All List of load cases and combinations Lic24 - Freq_100 Lic25 - ULS_100 UL-Traf_cha-Min Vz UL-Traf_cha-Min Vz UL-Traf_cha-Max Vz UL-Traf_fre-Min Vz UL-Traf_fre-Max My UL-Traf_fre-Max My UL-Traf_fre-Max My F1-Creep - Lstage_casting F2-Creep - Lstage_casting F3-Creep - I.stage_casting F3-Creep - I.stage_casting F3-Creep - I.stage_casting F4-Creep - I.stage_casting UL-Traf_ffe-Max My Cascel

The internal force are possible to see in **Results> Internal forces**. The user can select in **Type of loads – Class** and form the list of classes selects **Char_extrem_My**. The extreme moment is drawn from minimum and maximum envelopes of mobile load for characteristic combination.

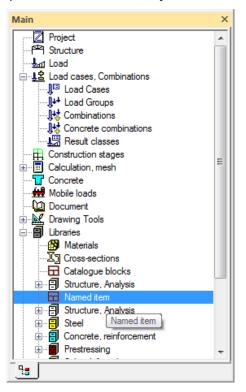


And for *frequent* combination.



5 Library of Named items

The library of Named items is possible to view in Library>Named item.



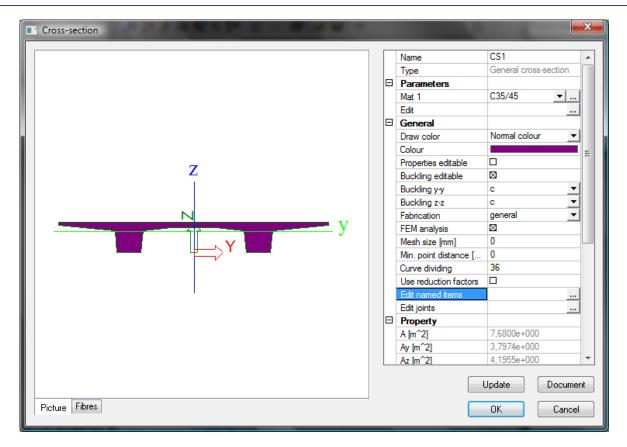
The user has possibility to defined following named items in this library

- Fibre for evaluation of results of allowable concrete stresses in predefined named fibres only
- Part of cross-section for evaluation of results of allowable principal stresses in predefined named part of cross-section if phased CSS exists
- Cut for evaluation of results of allowable principal stresses in predefined named cuts of crosssection
- Joint for evaluation of results of shear stress in construction joint in predefined named joint if phased CSS exists

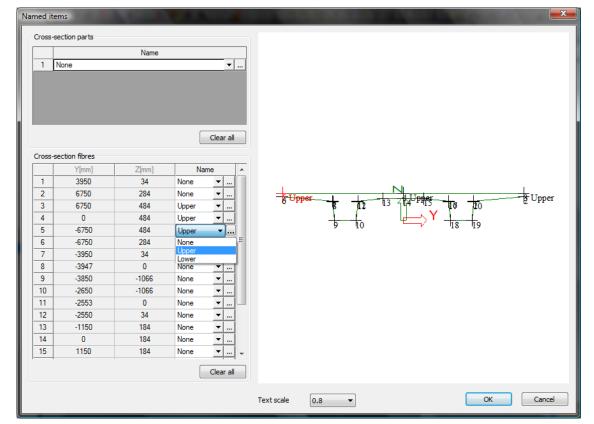
Named cross-sec	tion items	
🏓 💱 🖋 🖬	🖞 💁 😅 / 🚭 🖉 🖓 🗛	• 7
Upper	Name	Upper
Lower	Description	
Vert1	Туре	Fibre 👻
Vert2		Fibre
Vente		Part of cross-section Cut
		Joint
		- Conn
New Insert	Edit Delete	Close

5.1 Named fibres

When user defined named items in library, then is necessary to linked named items to appropriate fibres, cuts, part of CSS and joints in selected CSS. The fibres and part of CSS are possible to define in selected CSS by button *Edit named items*.



To the upper fibres with number 4, 5, 6 will be assigned named fibre *Upper* from named fibre library.



To the lower fibres with number 9 10, 18, 19 will be assigned named fibre *Lower* from named fibre library.

		Name					
1 N	lone			•			
				Clear all			
lross-se	ection fibres				_		
	Y[mm]	Z[mm]	Nar	ne	*		
6	-6750	284	None	▼		NI NI	1
7	-3950	34	None	▼		Bupper	
8	-3947	0	None	▼		8 0 pp - 8 12 13 214 phils 16 20	2
9	-3850	-1066	Lower	▼		Downer Lower 18 Lower 19 Lower 18 Lower 19 Lower	-
10	-2650	-1066	Lower	▼		9 Lower - 18 Lower	2
11	-2553	0	None	▼			
12	-2550	34	None	▼			
13	-1150	184	None	▼			
14	0	184	None	▼	Ξ		
15	1150	184	None	◄			
16	2550	34	None	◄			
17	2553	0	None	▼			
18	2650	-1066	Lower	◄			
19	3850	-1066	Lower				
20	3947	0	None		-		
			Upper Lower	Cicul ui	Ь		

5.2 The named part of CSS

The named part of CSS could be defined in case of phased CSS in upper left part of dialog.

		Name								
1	Phase1			-						
	None									
	Phase1				4					
				Clear all						
ross-	section fibres									
	Y[mm]	Z[mm]	Nam	e 🔺						
1	3950	34	None	▼	1					
2	6750	284	None	▼	Ē			4		
3	6750	484	None	▼	0	8	12 13	1 ¹ 4 13	16 10	Z
4	0	484	None	▼		<u> </u>	10	L γ		
5	-6750	484	None	▼		9	10		18 19	
6	-6750	284	None	▼ =						
7	-3950	34	None	▼						
8	-3947	0	None	▼						
9	-3850	-1066	None	▼						
10	-2650	-1066	None	▼						
11	-2553	0	None	▼ □						
12	-2550	34	None	▼						
13	-1150	184	None	▼						
14	0	184	None	▼						
15	1150	184	None	▼ ▼						
				Clear all						

5.3 Named cuts

5.3.1 For general CSS

The named cuts are possible to add to the cut in Editor of general CSS.

Cross-section		— X —
	Name	CS1 🔺
	Туре	General cross-section
	Parameters	
	Mat 1	C35/45 💌
	Edit	
	General	
	Draw color	Normal colour 🗨
	Colour	=
Z	Properties editable	
	Buckling editable	
	Buckling y-y	c 💌
	Buckling z-z	c 💌
N	Fabrication	general 💌
y	FEM analysis	
	Mesh size [mm]	0
	Min. point distance [
	Curve dividing	36
	Use reduction factors	
	Edit named items	
	Edit joints	
	Property	
	A [m^2]	7,6800e+000
	Ay [m^2]	3,7974e+000
	Az [m^2]	4,1955e+000 🔻
		Update Document
Picture Fibres		OK Cancel

The definition of new cut is possible by button Add cut in editor of general CSS.

Cross-section edit	tor				
- All - Carlos - Carl					□ 🔍 🖳 🖉 🕹 🖬 🖏 🖏 🖏 🖏 🖏 👘 👘 🖉 🖉 🖉 🖉
	10 R 8+ 10 +	. ♠	: 🏠	IR RR	🔉 A 📶 🚽
Polygon Polygonal op Thin walled Section from Import DXF Parameter Thinwalled re Add out	library ne Y DWG			Addition of c	
Type (description)	General cross-sec	tion		Name	CU1
General				Geometry	
Buckling y-y	c	-		Туре	Point
Buckling z-z	c	-		Cut	
Fabrication	general	-		Number of cu	# 0
Display final shape				Name of cut	
Display	Only basic shape	-		Cut Y	None
cropicy	only salid anapo	_		Cut Z	Vert1
				Curz	Vert2

There are two possibilities how to defined a cut

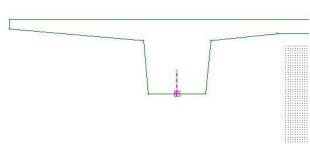
• Point - cut is defined in selected point

• *Fibre* + *offset* – cut is defined in offset from selected fibre There is also possibility to set only cut in direction Y or Z.

Addition of cut		
Name	CU1	
Geometry		
Туре	Point	-
Cut	Point	
Number of cut	Fibre + offset	
Name of cut	None	▼
Cut Y		
Cut Z		

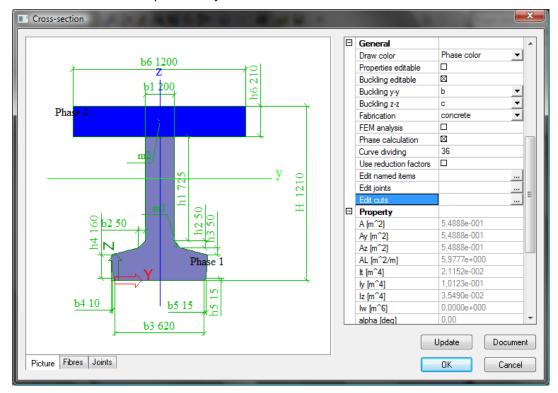
The vertical cut in the left beam of CSS was defined.

	Add cut		
ſ			
L			
-		- (1990)	
	Name	CU1	
Ξ	Geometry		
	Туре	Point	
Ξ	GCS coordinate		
	Coord Y [mm]	-3250	
	Coord Z [mm]	0	
Ξ	UCS coordinate		
	Coord uy [mm]	-3250	
	Coord uz [mm]	0	
Ξ	Cut		
	Number of cut	1	
	Name of cut	Vert1	
	Cut Y		



5.3.2 For database CSS

The definition of new cut is possible by button *Edit cuts* for database CSS.

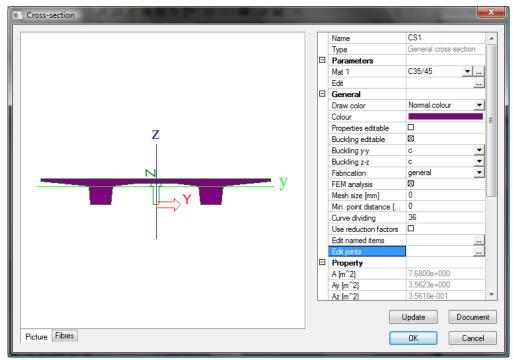


The property of *Edit cuts dialog* for database CSS is following.

Edit cuts											State of		×
	Na	me of cut	Reference	Туре		Abso [mm]	Rela	From		Cut Y	Cut Z	Y [mm]	Z [mm]
		rt2 🔻		Rela	-	310	0,500		▼ n		yes 🔻	0	-709
		r 🔻		Rela	-	0	0,000	End	▼ y	es 💌	no 🔻	100	291
2-2	- No	ne 🔻	None 💌	Rela	•	0	0,000	Begin	•	•	-	0	0
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$													
2-4 1-0 2-0													
1-7 1-5													
1-91-8 1-4													
1-10 1 - Vert2 1-2													
$1-10$ $\mu = Vert2$ $1-2$ 1-11 $1-12$ $1-1$													
1-12 1-12													
	Text scale	, í	1.0 -	1								ок 🛛	Cancel
	Text Scale	l	1.0	J									Concer

5.4 Named joints

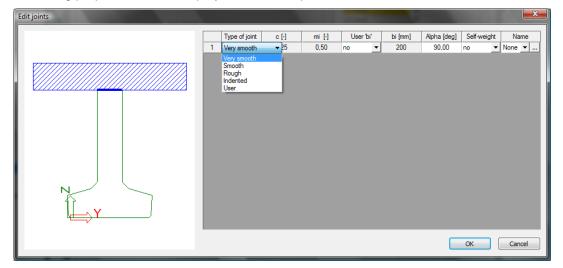
The named joint could be defined in case of phased CSS using button *Edit named joint* in General CSS dialog.



The CSS is solid, that's why no joints are displayed in Joint dialog.

Edit joints						and the state of the	- 1.0	X
	Type of joint	c [·]	mi [-]	User 'bi'	bi [mm]	Alpha [deg]	Self-weight	Name
N,								
							ОК	Cancel

The following properties will be displayed in case of phased CSS.



6 Analysis

6.1 Linear analysis

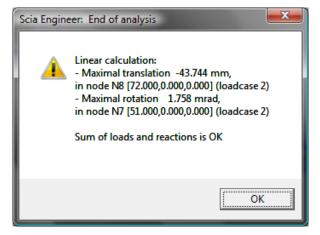
The linear analysis has to be done for generation of envelopes from mobile loads (see 4.2).

FE analysis		
	Single analysis Batch analysis	
	C Linear calculation	
	C Nonlinear calculation	
100	🔿 Modal analysis	
11	C Linear stability	
	C Concrete - Code Dependent Deflections	
	C Influence lines and surfaces	
	C Construction stage analysis	
	C Nonlinear stage analysis	
	C Nonlinear stability	
	C Test of input data	
	Number of load cases: 19	_
	,	
	Solver setup	Mesh setup
24	OK	Cancel

Mesh and Solver setup values used in analysis is possible to modify in Setup> Mesh, Solver.

	Mesh setup	×		Solver setup	x
	Mesh		E	Solver	
Ш	Minimal distance between two points [m]	0,001		Advanced solver options	
Ш	Average number of tiles of 1D element	2		Proper FEM analysis of cross-section parameters (lx, Ay, Az)	
Ш	Average size of 2D element/curved element [m]	1,000		Neglect shear force deformation (Ay, Az >> A)	
	1D elements			Type of solver	Direct 🔹
Ш	Minimal length of beam element [m]	0,100		Number of sections on average member	1
Ш	Maximal length of beam element [m]	100,000		Maximal acceptable translation [mm]	1000,0
	Average size of cables, tendons, elements on subsoil, nonlinear soil spring [m]	1,000		Maximal acceptable rotation [mrad]	100,0
	Generation of nodes in connections of beam elements			Coefficient for reinforcement	1
	Generation of nodes under concentrated loads on beam elements				
	Generation of eccentric elements on members with variable height				
	No. of FE per haunch	5			
	Apply the nodal refinement	No members			
	Hanging nodes for prestressing				
		OK Cancel			OK Cancel

After successful calculation appear following message.



6.2 Construction stage analysis (TDA EN1992-1-1)

The construction stage analysis is performed for calculation of effects of stages with influence of effects creep and shrinkage (TDA). Effects of creep and shrinkage are performed according to EN1992-1-1 annex B.

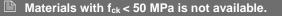
	Single analysis Batch analysis	
	C Linear calculation	Г
0.23	C Nonlinear calculation	
1	C Modal analysis	
14	C Linear stability	
	C Concrete - Code Dependent Deflections	
	C Influence lines and surfaces	
	 Construction stage analysis 	
	C Nonlinear stage analysis	
	C Nonlinear stability	
	 Test of input data 	
	Number of stages: 19, TDA	
	Solver setup	Mesh setup
12 2	ΟΚ	Cancel

6.3 Construction stage analysis (TDA EN1992-2)

There is also possibility to run calculation of TDA (creep and shrinkage calculation) according to code EN 1992-2 annex B, but some necessary steps have to be done.

The main idea is to include another type (EN 1992-2) of material into one code EN 1992. There are two groups of materials (EN1992-1-1 and EN1992-2). Due to implementation of calculation creep and shrinkage of concrete according to EN 1992-2 is suitable to present new type of concrete material. These materials are signed similar as standard EN material with suffix EN1992-2. New materials are following:

Materials				٢
🥕 🤮 🖋 👪 💺	Ľ	2. 🗠 🎒 🖆 🚅 🔒 Con	crete 💌 🗸	
C12/15		Temperature dependency of spe	None 💌	-
C16/20		Thermal conductivity [W/mK]	4,5000e+01	
C20/25		Temperature dependency of the	None 💌	
C25/30		Order in code	0	
C30/37		EN 1992-2		
		Characteristic compressive cylin	50,00	
C35/45		Calculated depended values		
C40/50		Mean compressive strength fcm	58,00	
C45/55		fcm(28) - fck(28) [MPa]	8,00	
C50/60		Mean tensile strength fctm(28) [4,10	
C55/67		fctk 0.05(28) [MPa]	2,90	
C60/75		fctk 0,95(28) [MPa]	5,30	
C70/85		Design compressive strength - p	33,33	
C80/95		Design compressive strength - a	41,67	
C90/105		Strain at reaching maximum stre	20,0	
		Ultimate strain eps cu2 [1e-4]	35,0	
C50/60(EN1992-2)		Strain at reaching maximum stre	17,5	
C55/67(EN1992-2)		Ultimate strain eps cu3 [1e-4]	35,0	
C60/75(EN1992-2)		Stone diameter (dg) [mm]	32	Ξ
C70/85(EN1992-2)		Cement class	R (rapidl hardening - CEM 42,5	
C80/95(EN1992-2)		Silica fume		
C90/105(EN1992-2)		Safety factor for long-term extrap		
CDE ///E		Type of aggregate	Quartzite 🔹	



- Cement class only type R (read only)
- Silica fume checkbox YES/NO influence on calculation of creep and shrinkage acc. to EN 1992-2 annex B
- Relative humidity The code EN 1992-2 is not allowed calculation creep and shrinkage for relative ambient humidity bigger then 80%. When user uses concrete material according to EN1992-2 and sets RH>80% then during start TDA calculation appears warning about relative humidity.



- Long term delayed strain estimation
- Long term delayed strain estimation is used acc. to chapter B.105, implementation of formula B.128. The coefficient calculated with that formula is applied on formulas for concrete aged 1 year or more:
 - \circ ϕ (t;t0) (B.1) and ϵ cd,0 (B.11) for concrete EN1992-1-1
 - ϵ cd(t) (B.116) and ϕ b(t;t0) (B.118) for concrete EN1992-2
- User can set this option in material database in property of concrete for both EN concrete (see following)

Materials				ĸ
🏓 🤮 🖋 📸	k :	2. 🗠 🚑 🚔 🚅 🔚 Con	crete 💌 🏹	
C12/15		Temperature dependency of spe	None 💌	-
C16/20		Thermal conductivity [W/mK]	4,5000e+01	
C20/25		Temperature dependency of the	None 💌	
C25/30		Order in code	0	
C30/37	Ξ	EN 1992-2		
		Characteristic compressive cylin	50,00	
C35/45		Calculated depended values		
C40/50		Mean compressive strength fcm	58,00	
C45/55		fcm(28) - fck(28) [MPa]	8,00	
C50/60		Mean tensile strength fctm(28) [4,10	
C55/67		fctk 0,05(28) [MPa]	2,90	
C60/75		fctk 0,95(28) [MPa]	5,30	
C70/85		Design compressive strength - p		
C80/95		Design compressive strength - a	41,67	
		Strain at reaching maximum stre	20,0	
C90/105	-1	Ultimate strain eps cu2 [1e-4]	35,0	
C50/60(EN1992-2)	-	Strain at reaching maximum stre	17,5	
C55/67(EN1992-2)		Ultimate strain eps cu3 [1e-4]	35,0	
C60/75(EN1992-2)		Stone diameter (dg) [mm]	32	Ξ
C70/85(EN1992-2)		Cement class	R (rapidl hardening - CEM 42,5	
C80/95(EN1992-2)		Silica fume		
C90/105(EN1992-2)		Safety factor for long-term extrap		
C2E //E		Type of aggregate	Quartzite 💌	

7

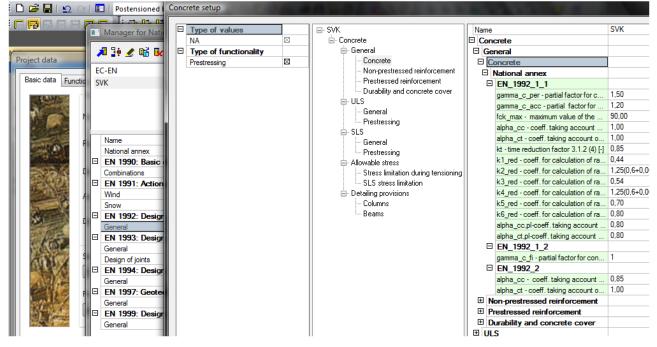
Check of prestressed concrete according to EN1992-1-1

The check of prestressed concrete is performed only according to EN1992-1-1. There are not any implementation of special check according to EN1992-2 which is code for design of bridges. There is only possible to used special TDA calculation according that code (see 6.3).

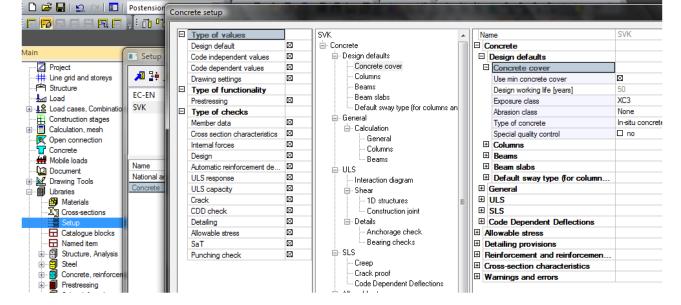
7.1 Concrete setup

The final concrete setup is synthesis of national dependent values and standard setup independent values.

Code dependent values are possible to see in Project Data>Code>National annexes.



Code independent values are possible to see in Libraries>Concrete setup.



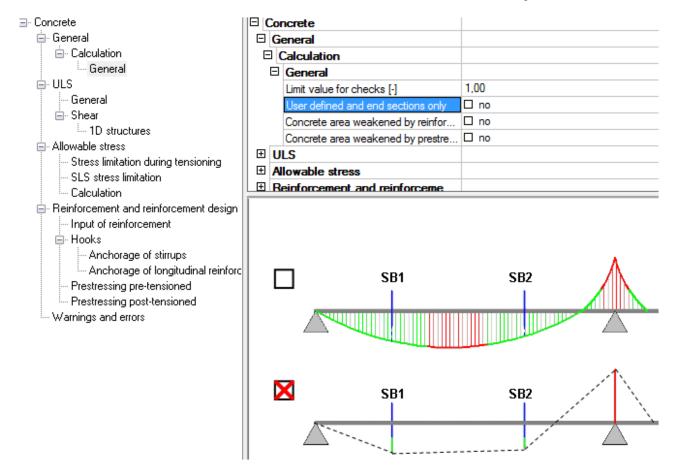
Complete setup is visible in appropriate concrete check filtered according to check. For instance see concrete setup for *Allowable stresses of concrete*.

□ Type of functionality Prestressing □ □ Type of checks Allowable stress □	SVK Concrete General Calculation General - Calculation General Stress limitation Calculation	k2 - factor for maximum stress in pre k3 - increased factor for maximum st k6 - increased factor for maximum c k7 - factor for maximum stress in pre k8 - factor for maximum stress in pre SLS stress limitation National annex k1 - factor for maximum compressiv	SVK 0,80 0,90 0,95 0,70 0,75 0,85 0,60 0,45
	Anchorage of longitudinal reinforce Prestressing pre-tensioned Prestressing post-tensioned Warnings and errors	k5 - factor for maximum stress in pre Calculation Calculation settings Increase allowable stress of prestre Increase allowable compressive str Use as allowable stress of c	0,75
		Allowable tensile stress of concrete	fctm 0,00 0,00

Some important settings from concrete setup will be explained in the following chapters

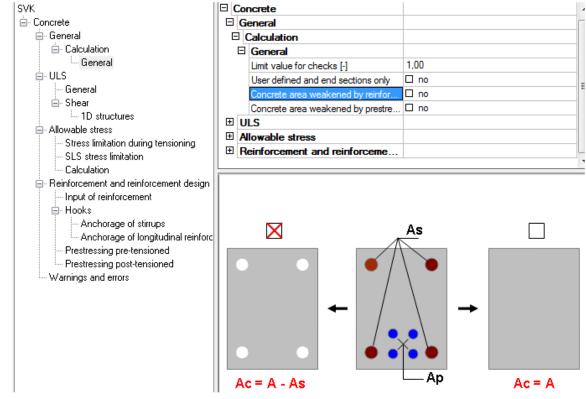
7.1.1 User defined section only

This functionality is suitable for fast performing of concrete checks only in user defined section, where is supposed the most loaded structure and extreme results. Check is performed only in those user defined d section and duration of check is shorter. It is available for all concrete checks and design.



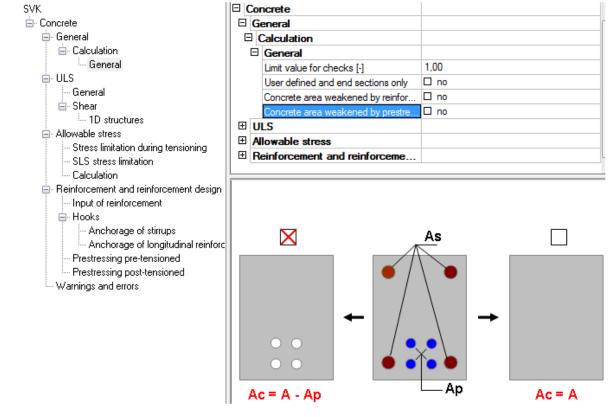
7.1.2 Concrete area weakened by reinforcement bars

When this checkbox is switch ON, then area of concrete CSS is reduced by bars. It has effects on all concrete 1D checks.



7.1.3 Concrete area weakened by prestressed bars

When this checkbox is switch ON, then area of concrete CSS is reduced by bars. It has effects on all concrete 1D checks.



7.1.4 Warning and errors

When some check is performed then warning or error can be printed in the table. Allowable stress concrete EN 1992-1-1

Linear calculation, Extreme : Member Selection : All Combinations : F20-EN-SLS Quasi. Evaluated for selected group of fibres : Upper Prestress check of allowable stress concrete for selected members

Member	d _x [m]	Case	Fibre	N [kN]	M _y [kNm]	σ _{o,aa} [MPa]	σ _{oq,min} [MPa]	σ _{oq.max} [MPa]	σ _{olt,min} [MPa]	σ _{olt,max} [MPa]	Check _{oalo} [-]	Check
					Mz [kNm]	σ _{oo,max} [MPa]	σ _{oo,oh} [MPa]	f _{ot,e} rr [MPa]	σ _{00, qp} [MPa]	f _{ot,eff,qp} [MPa]	Check _{iim} [-]	W/E
B1	0,000	F20-EN-SLS Quasi/1		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	NOT OK
					0,00	0,00	0,00	0,00	0,00	0,00	1,00	858
B2	0,000	F20-EN-SLS Quasi/1	3	-30818,21	-7906,03	-1,39	-1,39	-1,39	-1,66	-1,12	0,11	ок
					0,00	0,00	0,00	0,00	-15,75	0,00	1,00	224,198,197
B2	15,000	F20-EN-SLS Quasi/1	3	-32512,02	-373,99	-4,03	-4,03	-4,03	-4,63	-3,43	0,29	ок
		0000071			0,00	0,00	0,00	0,00	-15,75	0,00	1,00	224,198,197

All warnings and errors are stored in the concrete setup.

SVK		N	lame		SVK
🖮 Concrete			Concrete		
🚊 - General		E	General		
Calculation		E	ULS		
General		E	Allowable :	stress	
⊨- ULS			Reinforcen	ent and reinforceme	
- General		(E Input of n	einforcement	
🖻 - Shear			3 Warnings	and errors	
1D structures	Narni	ing and error	c	the In success of	
	-	ing and cirol	,		
Stress limitation duri SLS stress limitation		ing/errors nu	Туре		Description
Calculation	1	1	Off	Calculation successful. Th	ere are neither warnings nor errors.
- Reinforcement and reinf	2	2	Warning	The main reinforcement are	ea was designed according to min. required reinfo
Input of reinforceme	3	3	Warning	The warning has not been	specified yet.
⊡- Hooks Anchorage of st	4	4	Warning	No or zero internal forces f	ound in the section.
Anchorage of lo	5	6	Warning	Shear force carried by con	crete. No shear reinforcement required.
Prestressing pre-ten	6	10	Warning	The cross-section zone for	calculation of percentages of reinforcement is in
Prestressing post-ter	7	11	Warning	The cross-section zone for	calculation of percentages of reinforcement is in
Warnings and errors	8	12	Warning	The cracks did not appear	
	9	32	Warning	The cross-section is in pure	e tension.
	10	33	Warning	The cross-section is not ch	necked against the min. required percentages.
	11	34	Warning	The reduction of internal for	prces is not performed.
	12	35	Warning	The check of the geometry	/ coefficient is switched OFF.
	13	36	Warning	Check of cross-section loa	ded by N+My+Mz is switched OFF.
	14	37	Warning	Check of cross-section loa	ded by shear force is switched OFF.
				1	1

7.2 Member check, single check

The modelled structure can be checked by two ways:

- globally using *Memebr check*
- detailed using Single check

Jİ.

7.2.1 Member check

Member check is performed from the standard concrete check service. The results are displayed along the selected members. The output table has different output according to extreme:

Global - one extreme result of all checked members

Allowable stress concrete EN 1992-1-1

Linear calculation, Extreme : Global Selection : All Combinations : F 20-EN-SLS Quasi, Evaluated for selected group of fibres : Upper

Prestress check of allowable stress concrete for selected members

Mem be r	а, (m)	Case	Rbre	N [kN]	My [kNm]	σ _{cas} [MPa]	σ _{conth} [MPa]	σ _{conux} [MPa]	σ _{ct.min} [MPa]	σ _{chnoc} [MPa]	Cheo k _{eale}	Cheok
					M _ [kNm]	σ cc.nux [MP a]	σ _{cc.ch} [MPa]	f _{ctaff} [MPa]	σ [MPa]	f (MP a)	Che ok _{lm} [-]	W/E
82	0,000	F20-EN-SLS Quasi./1	3	-30818,21	-7906,03	-1,39	-1,39	-1,39	-1,66	-1,12	0,11	ок
					0,00	0,00	0,00	0,00	-15,75	0,00	1,00	224,198,197
B7	1,000	F20-EN-SLS Quasi./1	3	-32523,00	1343,12	-4,47	-4,47	-4,47	-5,20	-3,74	0,33	ок
					0,00	0,00	0,00	0,00	-15,75	0,00	1,00	224,198,197

Member - one extreme results of each checked member •

Allowable stress concrete EN 1992-1-1

Linear calculation Extreme : Member Selection : All Combinations : F20-EN-SLS Quasi. Evaluated for selected group of flores : Upper

Prestress check of allowable stress concrete for selected members

Member	ЗP	Case	Fibre	N [kN]	M _y [kNm]	σ _{cas} [MPa]	σ _{conin} [MPa]	σ _{corux} [MPa]	σ _{ctmin} [MPa]	σ _{chnoc} [MPa]	Cheok _{calc}	Cheok
					M _z [kNm]	σ _{cc,nax} [MP a]	σ _{cc,ch} [MPa]	f _{craff} [MPa]	σ _{cc,p} [MPa]	f _{ct,Affgp} [MP a]	Cheok _{im} [-]	W/E
B1	0,000	F20-EN-SLS Quasi./1		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	NOT OK
					0,00	0,00	0,00	0,00	0,00	0,00	1,00	858
B2	0,000	F20-EN-SLS Quasi./1	3	-30818,21	-7906,03	-1,39	-1,39	-1,39	-1,66	-1,12	0,11	ок
					0,00	0,00	0,00	0,00	-15,75	0,00	1,00	224,198,197
82	15,000	F20-EN-SLS Quasi./1	3	-32512,02	-373,99	-4,03	-4,03	-4,03	-4,63	-3,43	0,29	ок
					0,00	0,00	0,00	0,00	-15,75	0,00	1,00	224,198,197
B3	0,000	F20-EN-SLS Quasi./1		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	NOT OK
					0,00	0,00	0,00	0,00	0,00	0,00	1,00	858
B4	0,000	F20-EN-SLS Quasi./1	3	-32301,44	-2157,54	-3,28	-3,28	-3,28	-4,05	-2,51	0,26	ок
					0,00	0,00	0,00	0,00	-15,75	0,00	1,00	224,198,197
B4	1,000	F20-EN-SLS Quasi/1	3	-32573,55	-913,65	-3,79	-3,79	-3,79	-4,54	-3,04	0,29	ок
					0,00	0,00	0,00	0,00	-15,75	0,00	1,00	224,198,197

Section – extreme results in each section along all checked members .

Allowable stress concrete EN 1992-1-1

Linear calculation, Extreme : Section Selection : All Combinations : F20-EN-SLS Quasi. Evaluated for selected group of fibres : Upper

Prestress check of allowable stress concrete for selected members

Member	d _y [m]	Case	Fibre	N IkN1	M _y [kNm]	σ _{cas} [MPa]	σ _{conth} [MPa]	σ _{conux} IMPa1	σ _{ct.min} [MPa]	σ _{chnoc} MPa1	Cheok _{calc}	Cheok
				(seed)	M ₂ [kNm]	σ _{cc,max} [MP a]	σ _{cc,ch} [MPa]	f _{covitt} [MPa]	σ _{cc,p} [MPa]	f _{ct,Affgp} [MP a]	Che ok _{tm}	W/E
81	0,000	F20-EN-SLS Quasi./1		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	NOT OK
					0,00	0,00	0,00	0,00	0,00	0,00	1,00	858
81	0,250	F20-EN-SLS Quasi./1		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	NOT OK
					0,00	0,00	0,00	0,00	0,00	0,00	1,00	858
B1	0,250	F20-EN-SLS Quasi./1		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	NOT OK
					0,00	0,00	0,00	0,00	0,00	0,00	1,00	858
B1	0,500	F20-EN-SLS Quasi./1		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	NOT OK
					0,00	0,00	0,00	0,00	0,00	0,00	1,00	858
B1	0,500	F20-EN-SLS Quasi./1		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	NOT OK
					0,00	0,00	0,00	0,00	0,00	0,00	1,00	858
81	0,750	F20-EN-SLS Quasi./1		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	NOT OK
					0,00	0,00	0,00	0,00	0,00	0,00	1,00	858

Cross-section – one extreme results of all checked cross-section

Allowab	le stre	ss concret	e EN 1	992-1-1								
		Extreme : Cros	s-section									
Evaluated	ons : F2 for selec	0-EN-SLS Quas ted group of fib	res : Up	ata for cala	cted memb	ers						
Mem be r	d, (m)	Case F20-EN-SLS Quasi /1 F20-EN-SLS Quasi /1 F20-EN-SLS Quasi /1	Rbre	N [kN]	M _y [kNm]	σ _{cas} [MPa]	σ _{comb} [MPa]	σ _{contex} [MPa]	σ _{ct.min} [MPa]	σ _{chrux} [MPa]	Cheo k _{calc}	Cheok
					M _ [kNm]	σ [MP a]	σ _{cc,ch} [MPa]	f _{craff} [MPa]	σ [MPa]	f (MP a)	Che ok _{tm} [-]	W/E
B1	0,000	F20-EN-SLS Quasi./1		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	NOT OK
					0,00	0,00	0,00	0,00	0,00	0,00	1,00	858
B2	0,000	F20-EN-SLS Quasi /1	3	-30818,21	-7906,03	-1,39	-1,39	-1,39	-1,66	-1,12	0,11	ок
					0,00	0,00	0,00	0,00	-15,75	0,00	1,00	224,198,197
87	1,000	F20-EN-SLS	3	-32523,00	1343,12	-4,47	-4,47	-4,47	-5,20	-3,74	0,33	ок
		4444471			0,00	0,00	0,00	0,00	-15,75	0,00		224,198,197

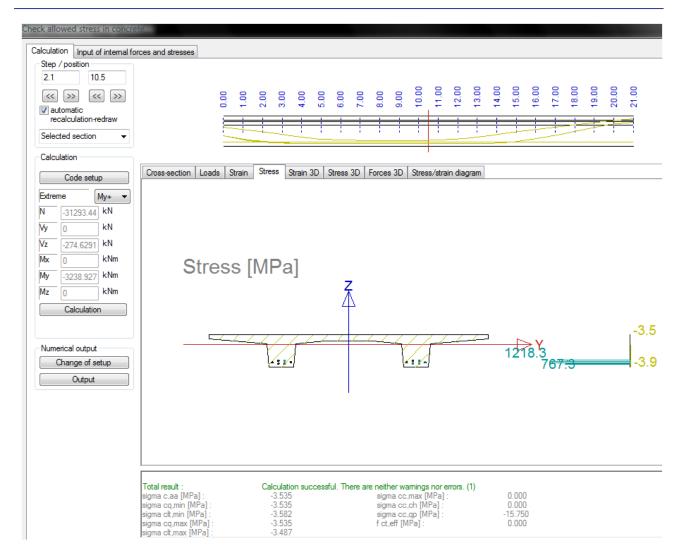
7.2.2 Single check

Almost all concrete checks has single check. It is detailed analysis of one cross-section. Action button to go there is following in the bottom of service.

Actions	
Refresh	>>>
Calculation info	>>>
Concrete setup	>>>
Single Check	>>>
Preview	>>>

Dialogue of single check provided to user selects:

- Extreme of normal forces (N+; N-; Vz+; Vz-...)
- Section along the selected member
- Appropriate tabsheet with detailed results. Tabsheets are dependent on type of concrete service, but mainly there are following:
 - o Cross-section
 - o Loads
 - o Strain
 - o Stress
 - o Stress/strain diagram



7.2.3 Check in named items – fibres, cuts, joints, parts of CSS

Definition of named items was described in chapter 5. Here the using in concrete checks will be explained. The idea of using named part is to get user friendly results and to increase speed of check. SEN supports following named items in the following services.

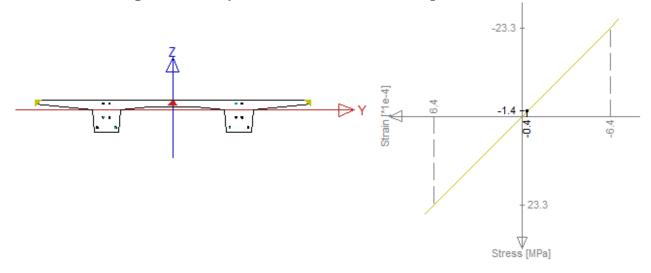
- Named fibres
 - Check response
 - o Allowable stresses of concrete
- Named cuts
 - Allowable principal stresses
- Named joints
 - Check response check of shear in construction joint
 - Design As
- Named parts of CSS
 - o Check response
 - o Allowable stresses of concrete
 - Allowable principal stresses

For instance you can see results of allowable concrete stress for upper fibres

• for member check

													Properties		д
													Allowable stress concrete	= EN 1! 👻 🏹 🕅	lj (
															3 2
													Name	Allowable stress of	c
													Selection	All	•
A.I		ss concret	- 514	00244									Type of loads	Combinations	•
Allowab	le stre	ss concret	e EN 1	992-1-1									Combinations	F20-EN-SLS Qua	s 🔻
Linear calc Selection :		Extreme : Glob	al										Filter	No	•
Combinatio	0n6 : F20	-EN-SLS Quar											Print explanation of err		
		ted group of fib allowable stree			cted memb								Use named fibres	⊠	
Member										_			Named fibres	Upper	•
Member	d _х (m)	Case	Apre	N [kN]	My [kNm]	σ _{ερλ} [MPa]	σ _{comin} [MPa]	σ _{contex} [MPa]	(MPa]	(MPa)	Cheo k _{calc}	Cheok	Use named CSS parts		
					M _z [kNm]	σ _{cc,nox} [MP a]	σ _{cc,ch} [MPa]	f _{ciatt} [MPa]	σ _{cc,qp} [MP a]	f _{ct,Affgp} [MP 8]	Cheok _{im}	W/E	Values	sigma cc.qp	•
B2	0,000	F20-EN-SLS	3	-30818,21	-7906,03	-1,39		-1,39	-1,66		0,11	ок	Extreme	Member	•
		Quasi./1											Drawing setup		
					0,00	0,00	0,00	0,00	-15,75	0,00	1,00	224,198,197	Section	All	•

for single check - only named fibres are available in single check •



7.2.4 CSS characteristic, transformed

The service of CSS characteristic is service which can provide to user all necessary information about the CSS. This service is situated in *Concrete > 1D member*.

	Prop	oerties	×				
	Cross-section characteristics EN 1992-1-1 (1) 💿 🔻 🏹 🧷						
	Na	ame	Cross-section characteristics EN 1992				
	Se	election	All				
	Ту	pe of loads	Combinations 🔹				
	Co	mbinations	F1-EN-ULS (STR/GEO) Set B - I.stag 💌				
	Fil	ter	No				
	Pri	int explanation of err					
		Settings of CSS					
		Type of CSS charac	Normal 👻				
Concrete I		Calculated com	Normal				
		Concrete	Transformed				
E Design defaults		Reinforcement					
		Prestressing reinfor					
1D member		Subtract from c					
		Reinforcement					
		Prestressing reinfor Ducts					
Concrete slenderness		Calculation of					
📄 🖞 Redes (without As)		Calculated CSS	by selected combination				
		Calculation of	by selected combination				
····· IIIII New stirrups		CSS characteristic	to center of gravity of cross-section 💌				
		Center of gravity					
Edit reinforcement in sec	Va	alues	A 🗸				
Add transverse bending	Ex	treme	normal cross-section A Member				
Automatic member reinforce		awing setup					
Member data	Se	ection	All				
Reinforcement design							
Cross-section characteristics							
Internal forces	0 - 11						
🖃 🖳 Member design	Actio	ons fresh	>>>				
E Design		culation info	>>>				
Design of non-prestresse		ncrete setup	>>>				
Member check		view	>>>				

This service performs calculation of geometrical properties of cross-section with including the following:

- the prestressed reinforcement
- the non-prestressed reinforcement
- ducts of tendons
- time
- Type of characteristic with two items
 - o normal (only one check box from concrete, reinforcement and tendons can be switched on)
 - o transformed
- Calculated components three check boxes
 - o concrete (for transformed characteristic, this check box will be always switched on)
 - o reinforcement
 - o **tendons**
 - Subtracting from concrete will be active if the check box Concrete is switched on
 - o reinforcement
 - \circ tendon
 - o ducts
- Characteristic related to with the following items
 - o to centre of gravity of cross-section
 - to centre of gravity of cross-section phase (new combo Phase of cross-section with the following items:
 - all phases,
 - by selected combination,

- defined by user
- o to selected named fibres (new combo with named fibres will be active)
- o to the point (new properties for definition y and z coordinates will be active)
- Values

0

- the values for normal characteristic
 - A, Iy, Iz,ty,tz,Sy,Sz,bw, Wy+, Wy-, Wz+, Wz-, iy, iz
 - the values for transformed characteristic
 - Ai, Iyi, Izi,tyi,tzi,Syi,Szi; Wyi+, Wyi-, Wzi+, Wzi-, iyi, izi

The results can be following: Cross-section characteristics EN 1992-1-1

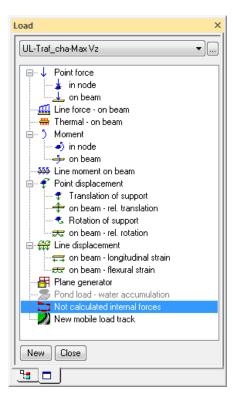
Linear calculation, Extreme : Member Selection : B2 Combinations : F21-EN-ULS (STR/GEO) Set B Cross section characteristics for selected members

Member	d <u>,</u> [m]	Case	Y _e [mm]	t, [mm]	A [mm ²]	l _v [mm⁴]	S _y [mm²]	W _{v*} [mm ³]	W _y _ [mm ³]
			Z _e [mm]	t _e [mm]	b _w [mm]	ا <u>۔</u> [mm ⁴]	S _E [mm ³]	W _{±+} [mm ³]	W _x . [mm ³]
B2	0,000	F21-EN-ULS (STR/GEO) Set B/4	6750	0	7652999	1491194248199	7735502	3087944031	1397438049
			1066	1	2788	97878318786621	0	14500492098	14500492096

7.2.5 Not calculated internal forces

The **frame XZ** which is used for the time dependent analysis doesn't respect effects of torsion in this project. The envelopes of mobile loads for extreme **Mx** (torsion moment) should be analyzed on different project type **frame XYZ**. The value of **Mx** should be defined in project Frame XZ as **Not calculated internal force**.

The user should defined not calculated internal forces in menu *Loads>Not calculated internal forces* for selected loadcase.



The dialog for definition of *Not calculated internal forces* is following. There are several types. We use type Mx.

Not calculated internal forces		x
	Name	NCIF1
	Туре	Vz 🗸
	Distribution	N
	Calculated results	
	Parameters	Vy Vz Mx My
		My
FEM		Mz Sig Y
		Sig Z
45		
	L	OK Canad
		OK Cancel

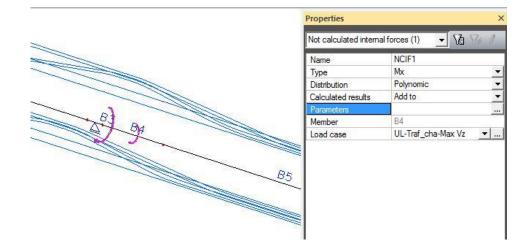
Distribution should be following; type *Polynomic* is used for definition only in one section near the second support.

Name NCIF1 Type Vz Distribution Uniform Calculated results Unform Parameters Trapez Trangle Polymomic	Not calculated internal forces		×
		Type Distribution Calculated results	NCIF1 Vz v Uniform Trapez Triangle
			OK Cancel

The value of *Mx* is defined in this dialog.

Lo	ad's ir	mpulses		×
		Pos x	Value - M [kNm]	ОК
	1	0,000	-12805,00	
	2	0,250	0,00	Cancel
	3	0,500	0,00	
	4	0,750	0,00	
	5	1,000	0,00	

The displaying of not calculated internal forces in 3D window is following



7.3 SLS – concrete checks

7.3.1 Prestress crack check

The cracks of the prestressed members are calculated according to chapter 7.3 from EN1992-1-1 and check is performed in service *Concrete>Member check>check of prestressed concrete>Crack control.* The prestressed structure is with bonded tendons and will be checked for frequent combination according to table 7.1N from EN1992-1-1. The exposure class is set in chapter 7.3.2.2 as XD3. The decompression has to be checked in this case.

7.3.2 Allowable concrete stresses

7.3.2.1 Domain knowledge of allowable concrete checks

The explanation of displayed values is following

- The stress before and after anchoring
- In compression
 - $\sigma_{cc,max}$ allowable stress in compression before and after anchoring, defined in chapter 5.42 in EN1992-1-1
 - $\sigma_{cc, \max} = k_6 f_{ck}(t)$ (5.42)
 - $k_6 = 0.6$ (for pretensioned concrete is possible to increase allowable stress on value 0.7 when it is verified that cracks don't appear)
 - $\sigma_{c,aa}$ calculated stress in concrete,
 - o In tension
 - $\sigma_{cc,max}$ allowable concrete stress in tension before and after anchoring; defined in Concrete setup and default is 0MPa
 - $\sigma_{c,aa}$ calculated stress in concrete,
- Stress from SLS combination
 - o Characteristic combination longitudinal cracks
 - In compression
 - *σ_{cc,ch}* allowable concrete stress in compression from SLS characteristic combination, only for exposure class XD, XF a XS.

•
$$\sigma_{cc,ch} = k_1 \cdot f_{ck}(t)$$
 (7.2.(2))

 \circ k₁ = 0,6

- *σ_{cq,min}* minimal stress in concrete after application selweight all permanent and variable loads
- In tension
 - *f_{ct,eff}* allowable concrete stress in tension from SLS characteristic combination,
 - The value f_{ct,eff} is possible to set in **Concrete setup>Allowable stresses**:
 - f_{ctm} the mean axial tensile strength
 - $f_{ctm,fl}$ the mean flexural tensile strength

• $f_{ctm,fl} = max\{(1,6-h/1000)^*f_{ctm}; f_{ctm})\}$

- *h* total depth of CSS
- $\sigma_{cq,max}$ maximal stress in concrete after application selweight all permanent and variable loads
- Quasi-permanent combination great creep
 - In compression
 - $\sigma_{cc,qp}$ allowable concrete stress in compression from SLS quasipermanent combination, linear creep may be assumed

•
$$\sigma_{cc.ap} = k_2 \cdot f_{ck}(t)$$
 (7.2.(3))

$$\circ$$
 k₂ = 0,45

• $\sigma_{clt,min}$ – minimal stress from longterm load

- In tension
 - *f_{ct,eff,qp}* allowable concrete stress in tension from SLS quasi-permanent combination, The value *f_{ct,eff,qp}* is possible to set in *Concrete setup>Allowable stresses*; default 0MPa
 - $\sigma_{clt,max}$ maximal stress from longterm load

Other not checked, only drawn

 $\sigma_{p,inc}$ – increment of stress from selected LC

•

Some important values needed for calculation is recommended to set before check is performed.

7.3.2.2 Exposure class

The exposure class of concrete is possible to set in *Concrete setup>Design defaults*. The check of allowable concrete stresses and crack width depends on this exposure class. The class XD3 is set in this example.

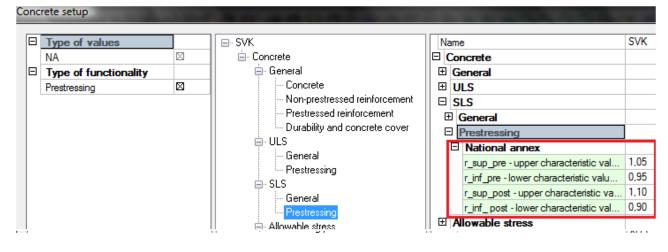
Co	ncrete setup			COLUMN TO MANY		States and States of States	— ×
	Type of val Design defaul Drawing settin Type of fun Prestressing	gs ctionality		crete Design defaults Concrete cover Columns Beams Default sway type (for columns and t Reinforcement and reinforcement design Input of reinforcement Hooks Anchorage of longitudinal reinfor Prestressing pre-tensioned Prestressing post-tensioned	De ∃ C U U D A T S T S T C T S T C T S T C T S T C C D D D D D D D D D D D D D	ic crete asign defaults concrete cover les min concrete cover lesign working life [years] brosure class brasion class b	SVK SVK SVK SU SU SU SU SU SU SU SU SU SU

The exposure class for each member is also possible to set by Member data.

Data Concrete		X
≜Z du	Name Member	DC1
nu du	Beam type	beam 👻
t de la cu	Advanced mode	
	Minimal concrete cover	
	Input for sides	
	Structural class	S3
	Exposure class	XC3 👻
ds y	Abrasion class	XO
	Situation of Delta;cdev	XC1
	Concrete	XC2
dl	Stone diameter [mm]	XC4
	Special quality control	XD1
ni	cmin,dur [mm]	XD2 XD3
bw	Delta;cdur [mm]	XS1
	□ Calculation of <u>D</u> elta;c	
· ·	Delta;cdur gamma [mm]	XS3
	Delta;cdur st [mm]	0
	Delta;cdur add [mm]	0
	Design	
	Material	B 600C 🔍
	Upper	· · · · · · · · · · · · · · · · · · ·
	Actions	
	Load default values	>>>
	Concrete Setup	>>>
		OK Cancel

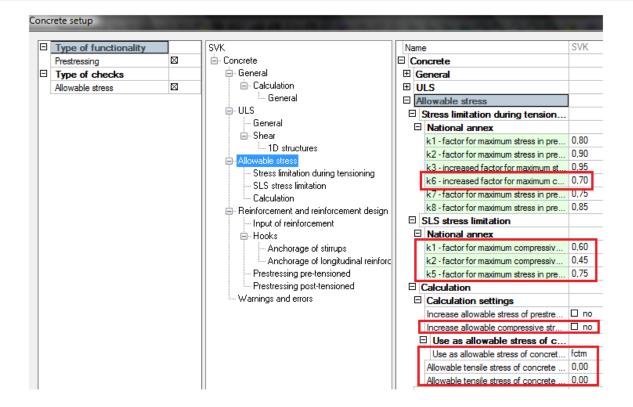
7.3.2.3 The factor for prestressing used in allowable concrete stresses

The upper and lower factors of prestressing force for check of allowable concrete stresses are possible to set in *Concrete setup>SLS>Prestressing*.



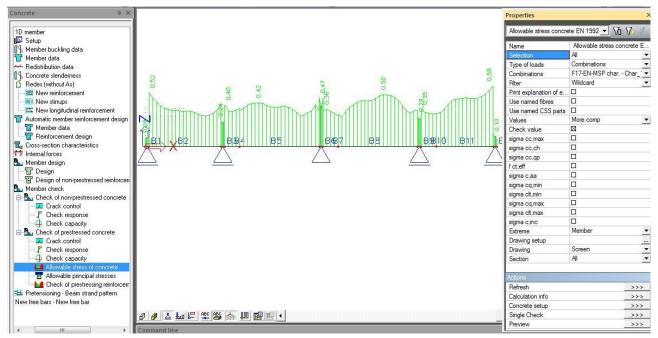
7.3.2.4 The factors for check of allowable concrete stresses

The factors for the calculation of limit values of concrete stresses from the code EN1992-1-1 is possible to set in *Concrete setup>Allowable stresses*.



7.3.2.5 The check of Allowable concrete stresses

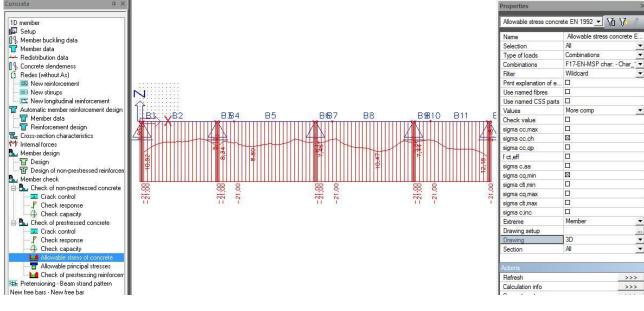
The user has possibility to perform this check in *Concrete>Member check>Check of prestressed concrete>Allowable concrete stresses*. The results of the check will be calculated and drawn for selected combination and value. For instance Check value of the SLS characteristic combination in 100 years is following.



The output table with extreme *Member* is following.

Preview												
🗈 🚇 I	B 8	1 <mark> </mark>	🗹 🖬	defaul	It	- Q	🗄 🔜 d	efault	*	•		
Selection : . Combinatio	All ns : F17-E	treme : Member N-MSP char. Illowable stress (concrete for selec	ted membe	:rs							
Member	d [m]	Case	Construction stage	Fibre	N [kN]	M [kNm]	M [kNm]	Check [-]calc	Check [-]	Check	W/E	
B1	1,000	F17-EN-MSP char./1	ST17	3	-31721,98	851,48	0,00	0,09	1,00	ок	224,199,197	
B2	0,000	F17-EN-MSP char./1	ST17	9	-31518,42	-8313,31	0,00	0,52	1,00	ок	224,199,197	
B3	1,000	F17-EN-MSP char./1	ST17	3	-32718,74	9477,24	0,00	0,24	1,00	ок	224,199,197	
B4	0,000	F17-EN-MSP char./1	ST17	9	-32491,44	-5245,18	0,00	0,40	1,00	ок	224,199,197	
B5	5,000	F17-EN-MSP char./1	ST17	9	-30895,68	-5403,90	0,00	0,42	1,00	ок	224,199,197	
B8	12,000	F17-EN-MSP char./1	ST17	9	-33777,20	-6847,59	0,00	0,50	1,00	ок	224,199,197	
B6	0,000	F17-EN-MSP char./1	ST17	9	-32681,21	13448,56	0,00	0,47	1,00	ок	224,199,197	
B7	1,000	F17-EN-MSP char./1	ST17	3	-32569,42	7628,46	0,00	0,36	1,00	ок	224,199,197	
B11	15,000	F17-EN-MSP char./1	ST17	9	-35186,01	-8873,83	0,00	0,58	1,00	ок	224,199,197	
B9	0,000	F17-EN-MSP char./1	ST17	9	-34702,71	11754,98	0,00	0,29	1,00	ок	224,199,197	
B10	0,000	F17-EN-MSP char./1	ST17	9	-34487,38	-3812,17	0,00	0,35	1,00	ок	224,199,197	
B12		F17-EN-MSP char /1	ST17	3	-35169,56	1554,66	0,00	0,10	1,00	ок	224,199,197	
Ready	[en]										•	

For the selected values $\sigma_{\text{cc,ch}}$ and $\sigma_{\text{cq,min}}$ are results following



and output table is following

🗈 🛄 I	🖽 é	3 🖪 🗄 🔲 I 🕻	á ன	de	fault		- 🛄	📃 defaul	t	- =	P
									-		2
Allowab	e stre	ss concrete EN 19	92-1-1								
Selection : Combinatio	All ns : F17	Extreme : Member -EN-MSP char. fallowable stress conce	ete for s	electe d me	embers						
Member	d [m]	Case	Fibre	σ [MPP3]	° (inPgjn	σ fillenax	σ _{fill} trajn	o [MP9]ax	Check [-]calc	Check	
				σ [MP3]×	ក ត្រឹមិទីពិ	f [fithe⊈]]	ø [ffife9]የ	^f ငျ ်းကို ဒီရှာ	Check [-]	W/E	
B1	0,000	F17-EN-MSP char./2	3		-1,73	-1,31	-1,56	-1,48	0,08		
B1	4.000	ST17 F17-EN-MSP char./2	3	0,00	-21,00	3,76	0,00	0,00	1,00	224,199,197	
ы	1,000	ST17	3	-1,70 0,00	-1,85 -21.00	-1,20 3,76	-1,00	-1,38 0.00		224.199.197	
B2	0.000	F17-EN-MSP char./3	9	-10,10	-10,82	-1,13	-10.04	-1,48	0.52		
	-,	ST17	-	0,00	-21,00	3,76	0,00	0,00		224,199,197	
B3	0,000	F17-EN-MSP char./2	3	-4,44	-4,99	0,35	-3,37	-1,08	0,24	ок	
		ST17		0,00	-21,00	3,76	0,00	0,00		224,199,197	
B3	1,000	F17-EN-MSP char./2	3	-4,56	-5,12	0,51	-3,47	-0,96	0,24		
		ST17		0,00	-21,00	3,76	0,00	0,00		224,199,197	
B4	0,000	F17-EN-MSP char./3 ST17	9	-8,00 0,00	-8,34 -21.00	-1,74 3,76	-5,55 0.00	-3,67 0.00	0,40	OK 224.199.197	
B5	0.000	5117 F17-EN-MSP char./3	9	-6,74	-21,00	-2.20	-4,48	-3.62	0.34		
	0,000	ST17	Ĭ	0.00	-21.00		0.00	0.00		224,199,197	
B5	5,000	F17-EN-MSP char./3	9	-7,84	-8,80	-2,30	-5,52	-3,35	0,42		
		ST17		0,00	-21,00	3,76	0,00	0,00	1,00	224,199,197	
B8		F17-EN-MSP char./2	3	-6,02	-6,44	0,28	-4,91	-2,55	0,31		
		ST17		0.00	-21 00	3.76	0.00	0.00	4.00	224 199 197	

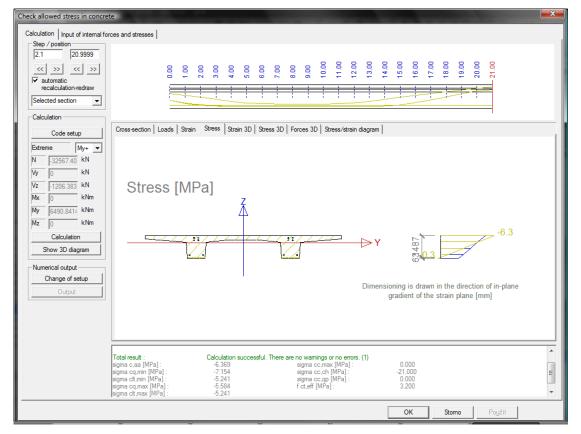
The concrete stress should be calculated for selected fibre only

Properties	×
Allowable stress concre	te EN 1992 👻 🏹 🏹 🖉
Name	Allowable stress concret
Selection	All
Type of loads	Combinations -
Combinations	F17-EN-SLS Char Cha
Filter	Wildcard
Print explanation of e	
Use named fibres	
Named fibres	
Use named CSS parts	Upper 🔻
Values	Upper Lower
Check value	
sigma cc,max	
sigma cc,ch	_
sigma cc,qp	
f ct,eff	
sigma c,aa	
sigma cq,min	
sigma clt,min	
sigma cq,max	
sigma clt,max	
sigma c,inc	
Extreme	Member 💌
Drawing setup	
Drawing	3D 💌
Section	Al 🔽 🔻
Actions	
Refresh	>>>
Calculation info	>>>
Concrete setup	>>>
Single Check	>>>
Preview	>>>

Then results for upper fibres are following

	I 🖽 é	3 <mark> - </mark>	ď 🖬	de 🚺	fault		-	default		- 🗄 🗄	
llowab	le stre	ss concrete EN 19	92-1-1								
election : Combinati Valuated	: All ons : F17 forselec	Extreme : Member -EN-MSP char. ted group of fibres : Uppe									
Prestress Member	check o d _x [m]	fallowable stress conc Case	Fibre	σ [MPa]	σ (MPajn	σ [MPa]	σ _{βlt} min [M₽ajn	σ _{citmax} [MPa]	Check _{calc}	Check	
				o fifrega x	rife effiti	nite aff	o Refin	t chaffagp	Check [-] lim	W/E	
B1	0,000	F17-EN-MSP char./1 ST17		0,00 00,0	0,00	0,00	0,00	0,00	0,00	NOT OK 858	
B2	0,000	F17-EN-MSP char./2 ST17	3	-1,53	-1,80	-1,26	-1,46	-1,46 0,00	0,09	OK 224,199,197	
B2	17,000	F17-EN-MSP char./2 ST17	3	-5,43	-21,00 -6,12 -21,00	-4,75 3,20	-4,16	-4,16 0.00	0,29		
B3	0,000	F17-EN-MSP char./1 ST17		0,00	0,00	0,00	0,00	0,00		NOT OK	
B4	0,000	F17-EN-MSP char./2 ST17	3	-5,12	-5,89	-4,35 3,20	-3,67	-3,67 0,00	0,28		
B4	1,000	F17-EN-MSP char./2 ST17	3	-5,61	-6,36	-4,88	-4,18 0,00	-4,18 0,00	0,30	OK 224,199,197	
B5	0,000	F17-EN-MSP char./2 ST17	3	-4,96	-5,30	-4,62 3,20	-3,60	-3,60 0.00	0,25		
B5	20,000	F17-EN-MSP char./2 ST17	3	-8,76	-7,49	-6,03 3,20	-5,63	-5,63	0,38	OK 224,199,197	
B8	0,000	F17-EN-MSP char./2 ST17	3	-5,97	-21,00 -6,38 -21,00	-5,56	-4,83	-4,83 0.00	0,30		
B8	20,000	F17-EN-MSP char./2 ST17	3	-6,22	-21,00 -6,90 -21,00	-5,54	-4,81 0,00	-4,81 0.00	0,33	224,199,197 OK 224,199,197	
B6	0,000	F17-EN-MSP char./1 ST17		0,00	0,00	0,00	0,00	0,00		NOT OK	
B7	0,000	F17-EN-MSP char./2 ST17	3	-6,36	-7,14	-5,57	-5,23	-5,23	0,34	OK 224,199,197	
B7	1.000	F17-EN-MSP char./2	3			-5.99	-5,59	-5,59	0,35		

The detailed analysis only in one section is possible using button Single check



7.3.3 Check of prestressing reinforcement

7.3.3.1 Domain knowledge

The explanation of displayed values is following

- The stress before anchoring
 - $\circ~\sigma_{p,max}$ allowable stress in prestressing before anchoring
 - $\sigma_{p,\max} = \min\{k_1 f_{pk}; k_2 f_{p0.1k}\}$ (5.41)
 - $k_1 = 0.8; k_2 = 0.9$
 - $k_3 = 0.95 (\sigma_{p,max} = k_3 * f_{p01,k})$ if special measurement of prestress force is applied
 - $\circ \sigma_{p,pa}$ calculated stress before anchoring,
- The stress after anchoring

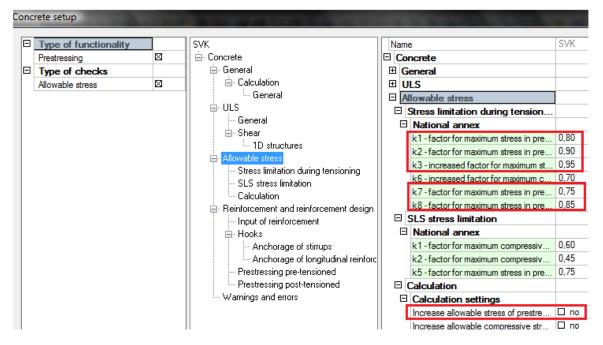
0

- $\circ \sigma_{p,m0}$ allowable stress in prestressing after anchoring,
 - $\sigma_{pm0} = \min\{k_7 f_{pk}; k_8 f_{p0.1k}\}$ (5.43)
 - $k_1 = 0.75; k_2 = 0.85$
 - $\sigma_{p,aa}$ calculated stress after anchoring
- The crack limitation from SLS characteristic combination during service cracks and deformation
 - σ_{pm} allowable stress in prestressing from SLS characteristic combination
 - $\sigma_{pm} = k_5 f_{pk} (7.2(5))$
 - $k_5 = 0.75$
 - \circ $\sigma_{p,LTL}$ calculated stress after longterm losses
 - $\circ~\sigma_{pq,min}$ minimal stress in concrete after application selweight all permanent and variable loads in prestressing
 - $\circ~\sigma_{pq,max}$ maximal stress in concrete after application selweight all permanent and variable loads in prestressing

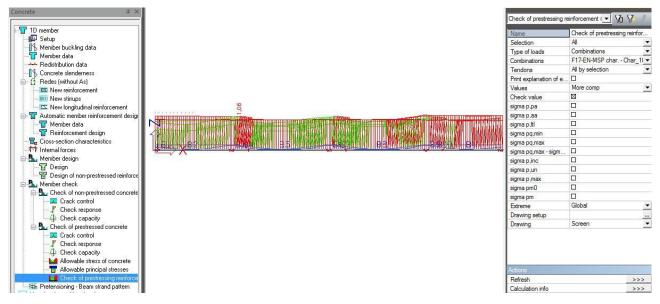
Others not checked stresses, only drawn

- $\circ \sigma_{pq,max} \sigma_{pq,min}$ the range of stresses in prestressing from maximal and minimal load in selected combination (envelopes of mobile loads)
- $\circ \sigma_{p,un}$ unbalanced stresses, difference of stresses calculated from the strain determined from structural analysis once as elastic stress (Hook's law) and the second stresses as nonlinear stress-strain relationship
- \circ $\sigma_{p,inc}$ increment of stress from selected LC

The factors for the calculation of limit values of concrete stresses from the code EN1992-1-1 is possible to set in *Concrete setup>Allowable stresses*.



The user has possibility to perform this check in *Concrete>Member check>Check of prestressed concrete>Check of prestressing reinforcement*. The results of the check will be calculated and drawn for selected combination and value. For instance Check value of the SLS characteristic combination in 100 years is following.



The output table with extreme *Member* is following.

review										2
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Check of	prestr	essing reinforcem	ient							l
linear calcu Selection : / Fendons: Al Combination	- ulation, Ex All Il by selec ns : F17-E	treme : Member		ons						
Tendon	d [㎡]	Case	а [ИЯ=РЗ] а	ਰ [Mੀਏਡੋ] ਹ	σ _{[Rile} njn σ	° ¶¶≢¶ax a	σ [MP ³] σ	Check [-] Check	Check W/E	
			MP ax	ĨMP20	(MPPS)	rinderst	[MPB]	[-] lim		
	0,00	F17-EN-MSP char./1	1373,47	1362,58	1362,39	1362,39	1362,39		Not OK	1
1e_01		ST17	1368,00	1292,00	1327,50	1327,50	1327,50		698,699,700,701,722,857	
	0,00	F17-EN-MSP char./1	1373,47	1362,58	1362,39	1362,39			Not OK	
le11		ST17	1368,00	1292,00	1327,50	1327,50			698,699,700,701,722,857	
1e03	25,16	F17-EN-MSP char./1 ST17	1410,00	1126,68	1127,57	1127,57			Not OK	
leu3	05.40	S117 F17-EN-MSP char./1	1368,00 1410.00	1292,00	1327,50 1127,57	1327,50		-1	722,857 Not OK	
1e13	20,10	ST17	1368.00	120,08	1327,50	1127,57 1327,50	1327,50		722,857	
leis	25.02	F17-EN-MSP char./1	1410.00	1232,00	1233,18	1233,18	1233,18		Not OK	
le05	20,02	ST17	1368.00	1292.00	1327,50	1327.50	1327.50		722,857	
	25.02	F17-EN-MSP char./1	1410.00	1232,21	1233,18	1233,18			Not OK	
le15		ST17	1368,00	1292,00	1327,50	1327,50	1327,50	1,00	722,857	
	22,50	F17-EN-MSP char./1	1368,43	1368,33	1367,65	1367,65	1367,65	1,06	Not OK	
2e02		ST17	1368,00	1292,00	1327,50	1327,50			698,699,700,701,722,857	
	22,50	F17-EN-MSP char./1	1368,43	1368,33	1367,65	1367,65	1367,65		Not OK	
2e12		ST17	1368,00	1292,00	1327,50	1327,50	1327,50		698,699,700,701,722,857	
	51,34	F17-EN-MSP char./1	1410,00	1122,92	1123,81	1123,81	1123,81		Not OK	
2e4	54.04	ST17 F17-EN-MSP char./1	1368,00 1410.00	1292,00	1327,50	1327,50			722,857	
2e14	91,34	ST17	1410,00	1122,92 1292.00	0,00 1327.50	0,00 1327,50	0,00 1327.50		Not OK 722.857	
ce 14	51.45	F17-EN-MSP char./1	1308,00	1292,00	1327,50	1327,50	1327,50		722,807 Not OK	
2e06	31,13	ST17	1368.00	1292.00	1327.50	1327.50	1327,50		722.857	
	51,15	F17-EN-MSP char./1	1410.00	1160.49	0,00	0.00	0.00		Not OK	
an '					4	-,			•	
🕻 Ready (enj				۹ 📃				•	

7.4 ULS – concrete checks

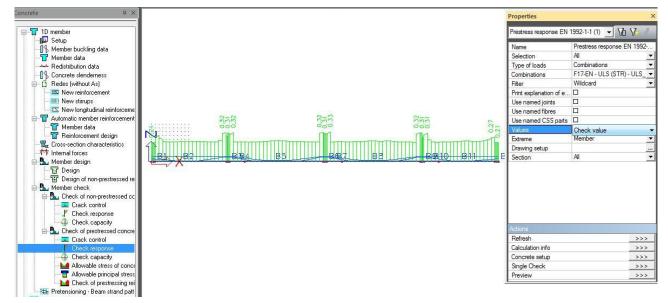
7.4.1 Prestress check response

The CSS response on acting combination is calculated in this check. The check is in **Concrete>Member check>Check of prestressed concrete>Check response**. The results of the check will be calculated and drawn for selected combination and value. There are following values for selection

- eps_cc the strain in concrete under compression
- eps_sc the strain in nonprestressed reinforcement under compression
- eps_st- the strain in nonprestressed reinforcement under tension
- eps_tt the strain in prestressed reinforcement under tension
- Vzu the shear resistance
- *Tu* the torsional resistance
- Vrdi the resistance of shear in construction joint

Properties	×
Prestress response EN 1	1992-1-1 (1) 🔻 🏹 🏹 🧷
Name	Prestress response EN 1992
Selection	All
	Combinations
Type of loads Combinations	F19-EN - ULS (STR) - ULS
	Wildcard
Filter	
Print explanation of e	
Use named joints	
Use named fibres	-
Use named CSS parts	
Values	eps cc 🔻
Extreme	Check value
Drawing setup	eps cc eps sc
Section	eps sc
	eps tt
	Vzu
	Tu Vrdi
	More comp
Actions	
Refresh	>>>
Calculation info	>>>
Concrete setup	>>>
Single Check	>>>
Preview	>>>

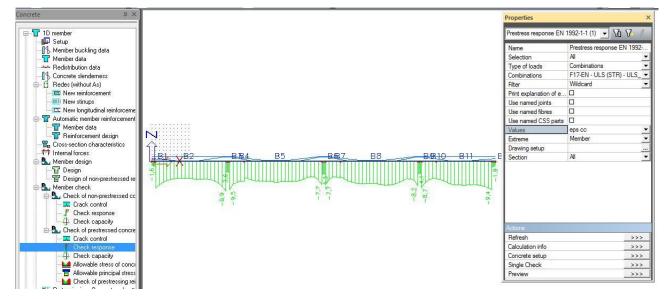
The results are calculated and drawn for F17-EN-ULS(STR) - check value.



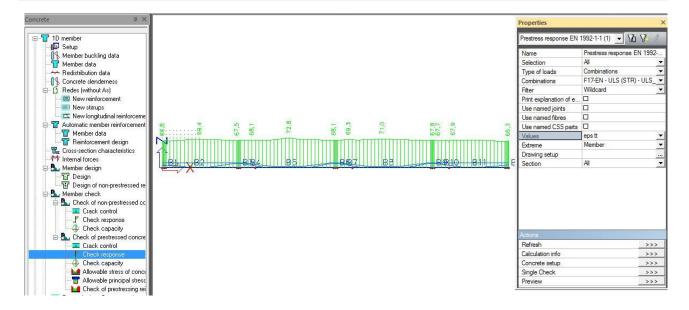
The output table with extreme *Member* is following.

review	B 4		<u>64</u> 1 –	defa 🔹 🕻	<u>u</u>	lefault	Ŧ		.	
_				_				_	-	
restres	is respo	onse EN 1992-1-1								
Selection : Combinatio	All ns : F17-E	treme : Member N - ULS (STR) response for selected me	mbers							
Member	ď	Case	Fibre	N	٧,	M	Check [-]calc	Ch	eck	
	[m]			[kN] N [k10]	[kŘ] V [k/]) ^C	(kNm) M (kNm)	Check [-]	w	//E	
B1	1,000	F17-EN - ULS (STR)/5	3	-38070,90	3916,06	1709,55	0,21	ОК		,
				-0,94	3916,06	1010,09	1,00		161	
B2	19,000	F17-EN - ULS (STR)/7	9	-32698,16	-4683,73	-11208,57	0,32	OK		
				-17,50	-4683,73	-4454,90	1,00		161	
B3	0,500	F17-EN - ULS (STR)/8	11	-32756,84	6894,96	-6047,78	0,31	ок		
B4	1.000		9	-27,24 -32672.81	6894,96 4735,23	-5649,85 -5923.07	1,00	~	161	
84	1,000	F17-EN - ULS (STR)/8	э	-326/2,81	4735,23	-5923,07	0,32	OK	161	
85	21.000	F17-EN - ULS (STR)/7	9	-32624,38	-4800.52	-7398,53	0.32	ok	101	
50	21,000	There are an an an an	Ŭ	-77.57	-4800.52	-5123.57	1.00	U.	161	
B8	21.000	F17-EN - ULS (STR)/7	9	-34709.80	-4835.88	-8258.28	0,32	ок		
			-	-83.53	-4835.88	-4729.80	1.00		161	
B6	0,500	F17-EN - ULS (STR)/7	9	-32696,62	-6854,05	-2540,33	0,31	ОК		
				-24,24	-6854,05	-5069,96	1,00		161	
B7	1,000	F17-EN - ULS (STR)/8	9	-32618,74	4836,23	-2099,22	0,33	OK		
				-95,51	4836,23	-2194,85	1,00		161	
B11	15,000	F17-EN - ULS (STR)/6	19	-42193,32	-1068,01	-10883,62	0,27	OK		
				18,42	-1068,01	-149,63	1,00		161	
B9	0,500	F17-EN - ULS (STR)/7	9	-34693,68	-7031,75	-2985,19	0,31	ок		
	4 000			-21,79	-7031,75	-4577,78	1,00		161	
B10	1,000	F17-EN - ULS (STR)/8	9	-34625,24 -29,26	4729,81 4729,81	-3318,89 -1675,48	0,31	OK	161	
B12	0.750	F17-EN - ULS (STR)/9	1	-29,20	4/29,81	-10/5,48	0,21	ov	101	
012	0,750	F17-EN - ULS (STR)/9	1	-21300,22	71,79	-3436,33	1,00		161	

The strain in concrete under compression for F17-EN-ULS(STR) - eps_cc.

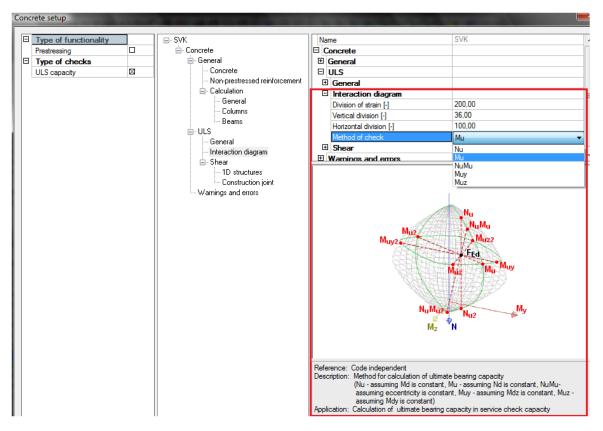


The strain in tendons under tension for F17-EN-ULS(STR) - eps_tt.



7.4.2 Prestress check diagram

The resistance of CSS acting by combination of moment and normal force is calculated using interaction diagram in this check. The check is in **Concrete>Member check>Check of prestressed concrete>Check capacity.** The default setup options are following:



The recommended type of interaction diagram is following:

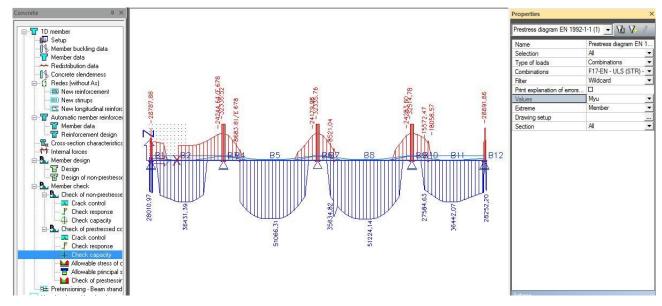
- When *compression* is dominant then *NuMu* is suitable because when structure is deformed by compression then moment is also increased
- When tension is dominant then Nu is suitable
- When pure *bending* is dominant then *Mu* is suitable

The results of the check will be calculated and drawn for selected combination and value. There are following values for selection

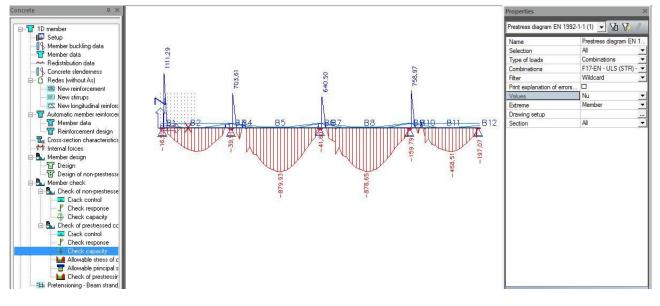
- *Nu* capacity in axis x (axial capacity)
- Myu moment capacity in direction y
- Mzu moment capacity in direction z
- Vzu shear capacity
- *Tu* torsional capacity

Properties	×							
Prestress diagram EN 1	Prestress diagram EN 1992-1-1 (1) 🔻 🏹 🏹 🖉							
Name	Prestress diagram EN 1992							
Selection	Al							
Type of loads	Combinations 🔹							
Combinations	F17-EN - ULS (STR) - ULS 🔻							
Filter	Wildcard 🔹							
Print explanation of e								
Values	Vzu 👻							
Extreme	Check value							
Drawing setup	Vzu							
Section	Tu Nu							
	Myu							
	Mzu							
	More comp							
Actions								
Refresh	>>>							
Calculation info	>>>							
Concrete setup	>>>							
Single Check	>>>							
Preview	>>>							

The moment capacity in direction y for F17-EN-ULS(STR) - Myu



The axial capacity for F17-EN-ULS(STR) - Nu

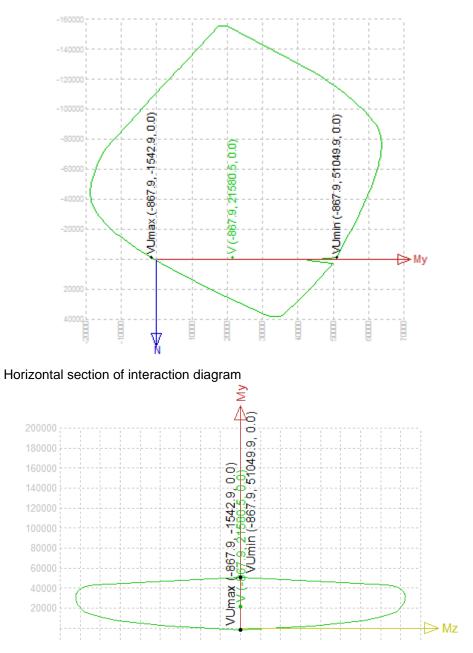


The output table for F17-EN-ULS(STR)

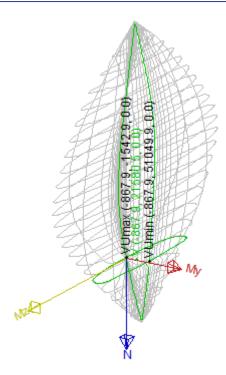
review											>
🖻 🛄	遇 🧉	3 <mark> </mark>	ấ 🖬 I 🗉	default	-		default		-	•	
Prestres	s diag	ram EN 1992-1-1									ľ
Selection : Combinatio	All xns:F17	Extreme : Member EN - ULS (STR) f diagram for selected me	embers								
Member	d [m]	Case	Check type	N [kN]	M [kNm]	N [k∯]	M [kNH]	M [kNiH]	Check [-]	Check	
				N [kh]	M TKNIA		M [kNH2]	M [kñ]Hî]	Check [-] lim		
B1	0,500	F17-EN - ULS (STR)/3	Mu	-38072,48	-212,96	-16,52	27469,20	0,00	0,01	ОК	
				-16,52	215,91	-16,52	-28803,02	0,00	1,00		
B2	0,000	F17-EN - ULS (STR)/7	Mu	-30481,23		1111,29	-16695,58	0,00	0,30	ок	
B3	0.500	EAT EN LUI OVETENVA	Mu	1111,29	-4990,02 -8234,37	1111,29 -39,91	27601,04	0,00	1,00	OV	
83	0,500	F17-EN - ULS (STR)/4	MU	-32//5,03	-8234,37		21120.52	0,00	1.00	UK	
B4	0.000	F17-EN - ULS (STR)/14	Mu	-31955,38		703.61	-23701.95	0.00	0,71	ок	
-	0,000			703,61	-16742.80		20940.31	0.00	1.00		
B5	10,000	F17-EN - ULS (STR)/3	Mu	-38329,98		-879,93	51098,47	0,00	0,43	ок	
				-879,93	22021,20	-879,93	-1446,59	0,00	1,00		
B8	9,000	F17-EN - ULS (STR)/3	Mu	-40969,81	7284,75		51249,33	0,00	0,46	OK	
				-878,65	23449,64		-1124,29	0,00	1,00		
B6	0,750	F17-EN - ULS (STR)/4	Mu	-32696,94		-41,60	-32439,75	0,00	0,69	ок	
B7	0.000	F17-EN - ULS (STR)/4	Mu	-41,60 -31993.96	-22427,51 -9614,91	-41,60 640.50	21132,13	0,00	0.87	ov	
0/	0,000	FIT-CN - OLO (STR)/4	Mu	640.50	-20737,80		20965.53	0.00	1.00	UN I	
B11	8.000	F17-EN - ULS (STR)/3	Mu	-43073,88		-468.51	36253.00	0.00	0.54	ок	
				-468,51	19558,59	-468,51	-13355,65	0,00	1,00		
B9	0,000	F17-EN - ULS (STR)/4	Mu	-34829,04	-3048,29	-159,79	-32504,75	0,00	0,58	ОК	
				-159,79		-159,79	21332,58	0,00	1,00		
B10	0,000	F17-EN - ULS (STR)/4	Mu		-10995,49		-23871,46	0,00	0,81	ок	
				758,97	-19331,04		20874,40	0,00	1,00		
B12	0,000	F17-EN - ULS (STR)/3	Mu	-42390,62	3103,81	-197,07	28253,83 -28456,84	0,00	0,09		
		1	I		2452,70	-197,07		0,00	1,00		
Ready	[en]			•						•	

The results ain single checks are following:

• Vertical section of interaction diagram



3D interaction adiagram



7.4.3 Shear check

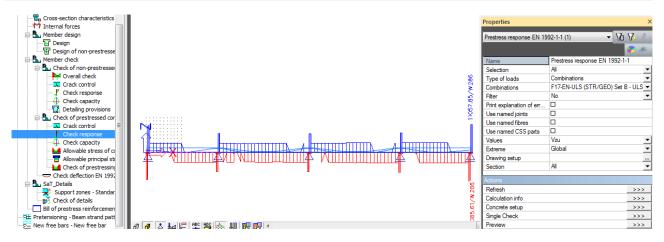
The shear check is performed in *Check response* and *check capacity* as value *Vzu* in property. At the beginning the existing of cracks in ULS is calculated:

- When the CSS is cracked then calculation is done according to chapter 12.6.3
- When the CSS is uncracked and without nonprestressed reinforcement then calculation is done according to chapter 12.6.3

The parameters for the calculation of shear check is possible to set in Concrete setup>ULS>Shear.

Con	crete setup	No. of Concession, Name			States and states and states	
	Type of functionality Prestressing	SVK General Gener	E	onci Gen JLS Gei Into Sho 3 11 0 1 0 1 0 1	eral neral eraction diagram ear D structures Shear coefficients Distance with full resistance from Angle between the concret [ype of input theta Web theta [deg] cot (theta)	SVK 0,50 Angle 40,00 1,192
					Web theta [deg] cot (theta) Compression flange theta [deg] cot (theta) Tension flange theta [deg] cot (theta) Coefficient taking account	40,00 1,192 40,00 1,192 40,00 1,192 40,00 1,192 automatic calculation according to sigma_c

The shear check for F17-EN-ULS(STR) – Vzu.



The output table with extreme *Member* is following.

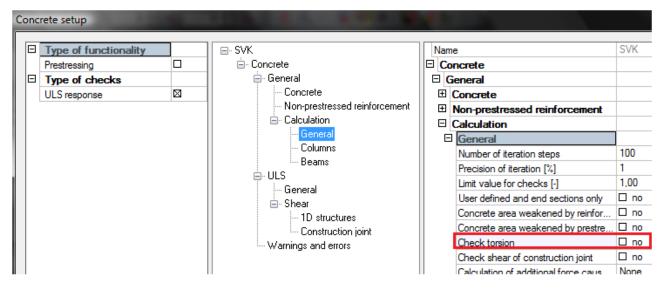
Prestress response EN 1992-1-1

Linear calculation, Extreme : Global Selection : All Combinations : F17-EN-ULS (STR/GEO) Set B Check of shear for selected members

Member	d <u>,</u> [m]	Case	V _{E0} [kN]	stirr dist [mm]	diam. [mm]	V _{ikd,e} [kN]	V _{ika} [kN]	Check _{calic} [-]	Check	Method
			N _{E0} [KN]	transv dist [mm]	A _{ee} [mm ² /m]	V _{itd,max} [kN]		Check _{tim} [-]	W/E	
B11	15,000	F17-EN-ULS (STR/GEO) Set B/3	-3990,07	0	0,0	3983,18	3983,18	1,00	NOT OK	formula 6.2a.b) EN1992-1-1
			-35281,43	0	0	0,00		1,00	828	
B10	1,000	F17-EN-ULS (STR/GEO) Set B/2	4729,85	0	0,0	3933,35	3933,35	1,20	NOT OK	fomula 6.2a.b) EN1992-1-1
			-34625,35	0	0	0,00		1,00	828	

7.4.4 Torsion check

The torsion check is performed in *Check response* and *check capacity* as value *Tu* in property. The calculation is performed according to chapter 6.4. The check of torsion is required if checkbox in *Concrete>General* is turned ON.



The shear check for F17-EN-ULS(STR) – Tu.

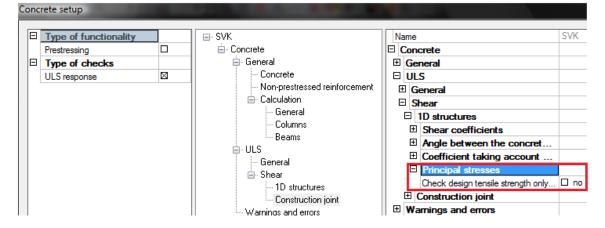
Properties	×
Prestress response EN 1	992-1-1 (1) 💌 🏹 🏹 🧷
Name Selection Type of loads Combinations Filter Print explanation of e Use named joints	Prestress response EN 1992 All ▼ Combinations ▼ F17-EN - ULS (STR) - ULS ▼ Wildcard ▼
Use named fibres Use named CSS parts	
Values Extreme Drawing setup Section	Tu ▼ Check value eps cc eps sc eps st eps tt Vzu Tu Vrdi More comp
Actions Refresh Calculation info Concrete setup Single Check Preview	>>> >>> >>> >>> >>>

The torsion is checked only if stirrups are defined on the beams, when the stirrups are not defined check of allowable principal stresses is required

Calculation Info								
	a 🕼	B 4	🕽 📙 🕂 🔛 🔟 🚺 🧧 default 🚽 🖳 🕂 default 🚽 🗉 👘					
war	warnings and errors		forwhole construction	*				
	No.	Type	Description					
	161	Warning The calculation of cross-section satisfied.						
	217	Warning	The shear capacity according to the provision 12.6.3(3) is satisfactory. The check of principal concrete stresses in tension in the ULS has to be performed in addition to the shear check to verify that the member is un-cracked.					
	240	Warning	Calculation of the shear in construction joint is not required					
	250		Stirrups for torsion was not found. Torsion is not provided in this check for plain and lightly reinforced concrete member. The check of Allowable principal concrete stresses in tension in the ULS has to be performed for torsion moment to verify that the member is un-cracked.					
	834	Error	Unexpected value in formula 12.6. It might by caused by the fact the internal forces do not correspond with demand of prestressing reinforcement or dimension of cross-section					
📕 Ready [en]								
Sł	Show warnings and errors							
List for for whole construction								

7.4.5 Allowable principal stresses

The check of allowable principal stresses in tension in ULS is performed for verification that CSS is uncracked CSS under acting load. This check is available in **Concrete>Member check>check of prestressed concrete>Allowable principal stresses**. When the check of tensile stress is required only in compression zone then checkbox **Concrete setup>ULS>Shear** has to be checked. The principal stresses are calculated in predefined cuts by user (see 5.3).

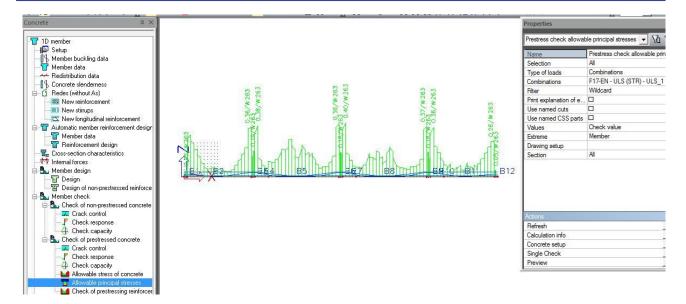


The service of allowable principal stresses has the property dialog with following values

- Sigma_1 principal stresses 1 for plane state of stresses in 3D
- Sigma_2 max principal stresses 2 for plane state of stresses in 3D
- Sigma_3 max principal stresses 3 for plane state of stresses in 3D
- Sigma_x_max maximal stress in concrete in axis X
- Sigma_y_max maximal stress in concrete in axis Y
- **Sigma_z_max** maximal stress in concrete in axis Z
- *Tau_xy_max* maximal shear stress in concrete in plane XY
- Tau_xz_max maximal shear stress in concrete in plane XZ

Properties ×						
Prestress check allowable principal stresses 💌 🏹 🏹 🧷						
Name	Prestress check allowable principal	S				
Selection	All	-				
Type of loads	Combinations	-				
Combinations	F17-EN - ULS (STR) - ULS_1	-				
Filter	Wildcard	-				
Print explanation of e						
Use named cuts						
Use named CSS parts						
Values	Check value	-				
Extreme	Check value					
Drawing setup	Sigma 1					
Section	Sigma 2 max Sigma 3 max					
	Sigma x max					
	Sigma y max					
	Sigma z max					
	Tau xy max Tau xz max					
	More comp					
Actions						
Refresh		>				
Calculation info	>>	>				
Concrete setup	>>	>				
Single Check	>>	>				
Preview	>>	>				

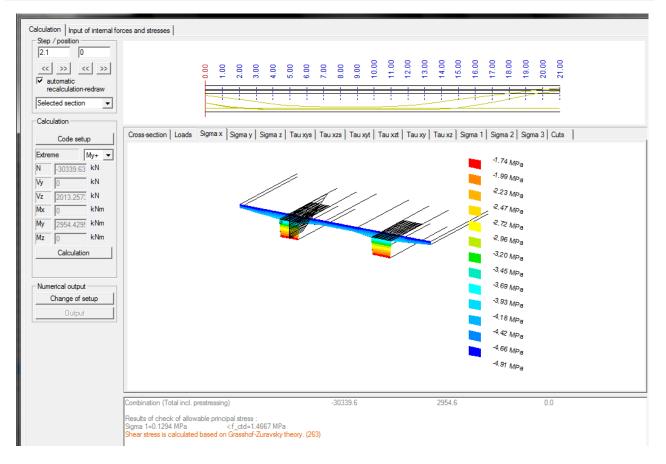
The check value for F17-EN-ULS(STR) is following.



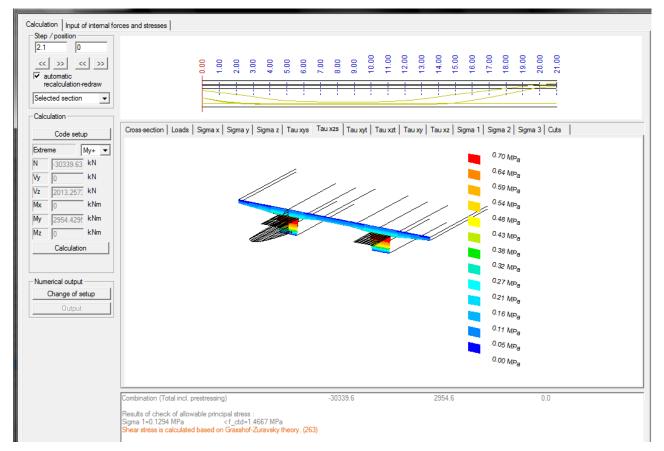
There is possibility to checked only selected named cuts or part of CSS in this service.

Properties ×							
Prestress check allowable principal stresses 🔻 🏹 🎵							
Name	Prestress check allowable principal s						
Selection	All						
Type of loads	Combinations 🔹						
Combinations	F17-EN - ULS (STR) - ULS_1						
Filter	Wildcard 🗨						
Print explanation of e							
Use named cuts							
Named cuts	Hor 👻						
Use named CSS parts	Hor						
Values	Vert2						
Extreme	Member 🔹						
Drawing setup							
Section	All						
Actions							
Refresh	>>>						
Calculation info	>>>						
Concrete setup	>>>						
Single Check	>>>						
Preview >>							

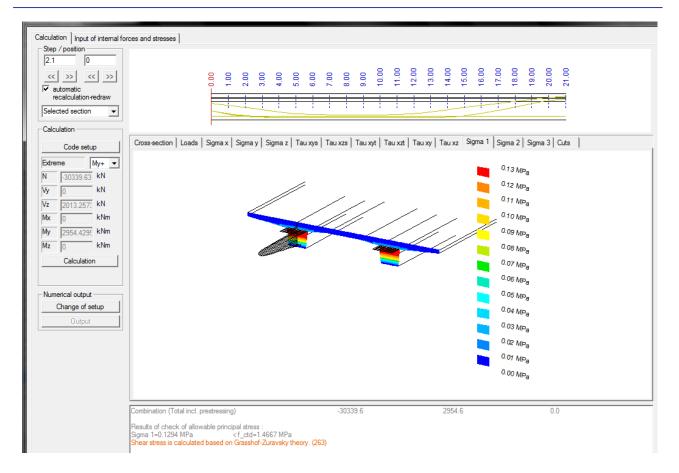
The user has the possibility to see detailed results in selected section along the beam using the button *Single check*. The stress σ_x for F17-EN-ULS(STR) is following.







The principal stress σ_1 for F17-EN-ULS(STR) is following



8 Literature

- [1]. EN 1990 Eurocode, Basis of structural design; European Committee for Standardization, December 2002.
- [2]. EN 1990/A1. Eurocode: Basis of structural design; European Committee for Standardization, November 2005.
- [3]. EN 1991-2 Eurocode 1, Actions on structures Part 2: Traffic loads on bridges; European Committee for Standardization, November 2003.
- [4]. EN 1992-1-1 Eurocode 2, Design of Concrete Structures Part 1: General rules and rules for buildings, European Committee for Standardization, December 2004.
- [5]. EN 1992-2 Eurocode 2, Design of Concrete Structures Concrete bridges design and detailing rules; European Committee for Standardization, November 2005.