

Fire resistance of RC column

Introduction

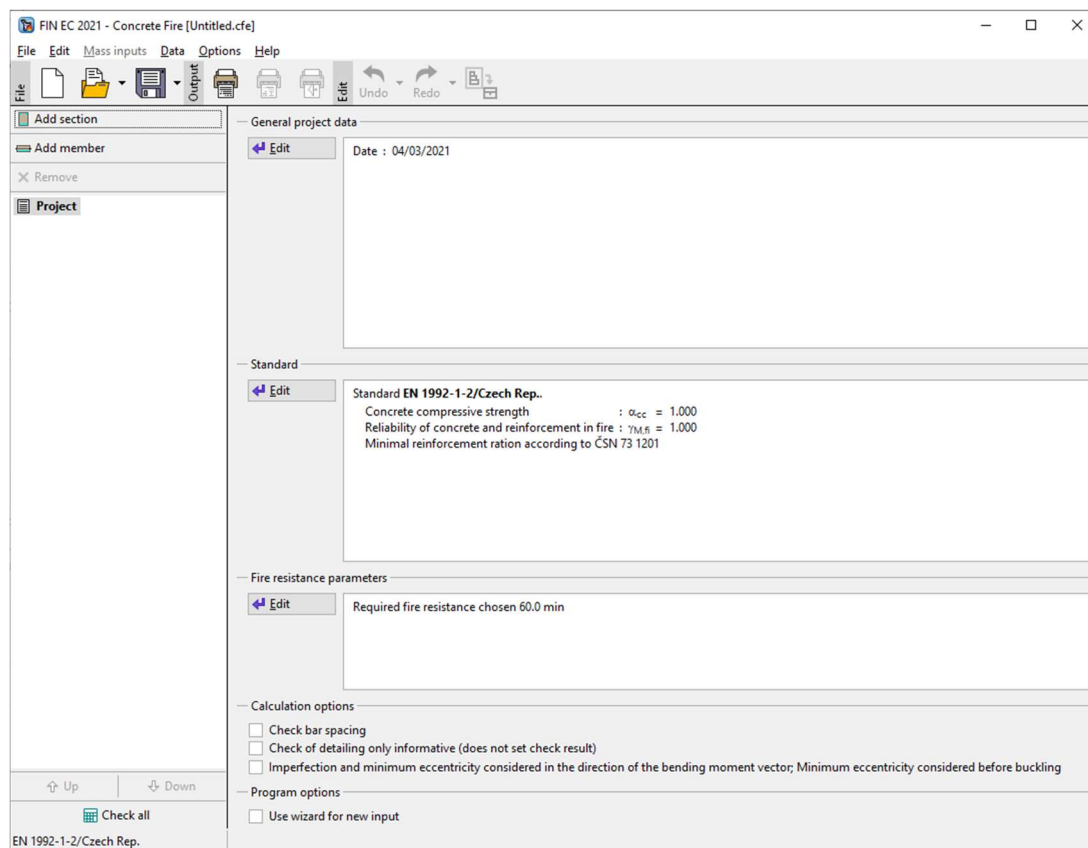
This tutorial shows a design of reinforced concrete (RC) column subjected to fire. The column has rectangular cross-section with dimensions 400x300 mm and length 3000 mm. The column is subjected to axial compressive force, biaxial bending and lateral forces from both directions. The internal forces in the Ultimate Limit State (ULS) are shown in the table below and were calculated based on the basic combination. The column is located inside of an office building and is considered to be rigid at the bottom and hinged at the top. The material of the column is concrete C35/45 and steel reinforcement B550B.

section [m]	N [kN]	My [kNm]	Mz [kNm]	Vy [kN]	Vz [kN]	combination	η [-]
3	-685	140	135	-70	-80	basic	0.7
2.25	-687.25	70	67.5	-70	-80	basic	0.7
1.5	-689.5	0	0	-70	-80	basic	0.7
0.75	-691.75	-70	-67.5	-70	-80	basic	0.7
0	-694	-140	-135	-70	-80	basic	0.7

The internal forces in the column

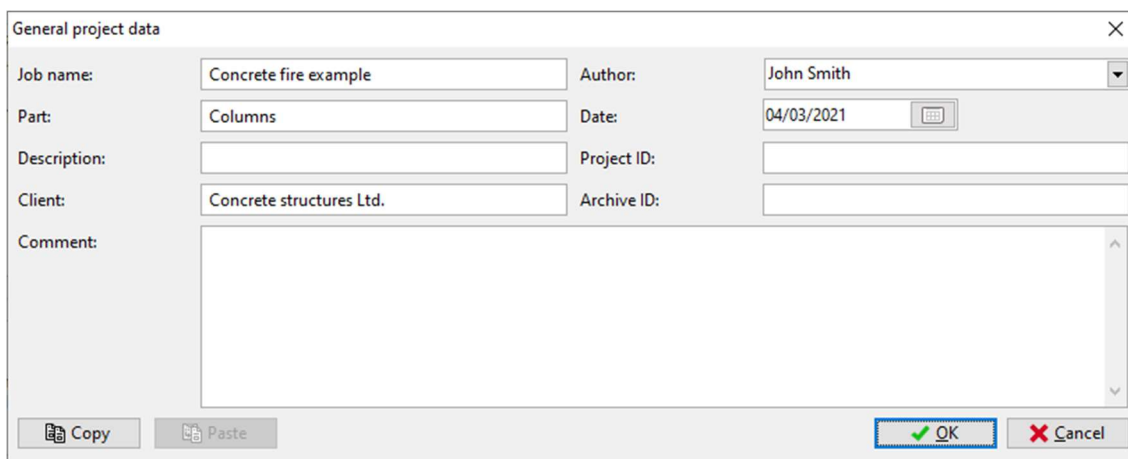
Starting a new project

The following screen appears after running the software "Concrete Fire":



The start window of the software "Concrete Fire"

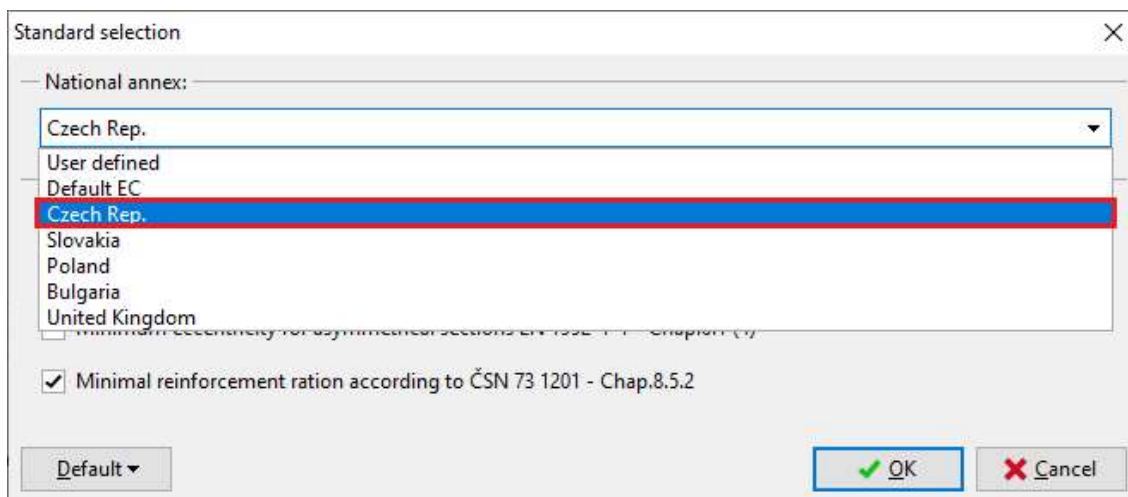
The software allows to assess unlimited number of tasks per one project. The supported tasks are, the assessment of cross section ("**Section**") or the whole member ("**Member**"). The "**Section**" may be used for simple verification of RC cross-sections subjected to fire, where the "**Member**" is usually used for the design of structures created in "**Fin 2D**" and "**Fin 3D**". This example shows the use of "**Section**" analysis. The start screen contains a part "**General project data**", where the job name, description and other project identification data can be entered. After clicking the "**Edit**" button, we first enter the job name and other project details:



General project data dialog box. Fields include: Job name (Concrete fire example), Author (John Smith), Part (Columns), Date (04/03/2021), Description, Project ID, Client (Concrete structures Ltd.), Archive ID, and a large text area for Comment. Buttons at the bottom include Copy, Paste, OK, and Cancel.

"General project data" dialog box


These data is displayed in the header or footer of the final documentation. Next, click the **"Edit"** button in the **"Standard"** frame and select the appropriate national annex. The supported national annexes are listed in the drop-down list. In case, the proper national annex is not listed, it is possible to choose *User defined* and set up custom coefficients.

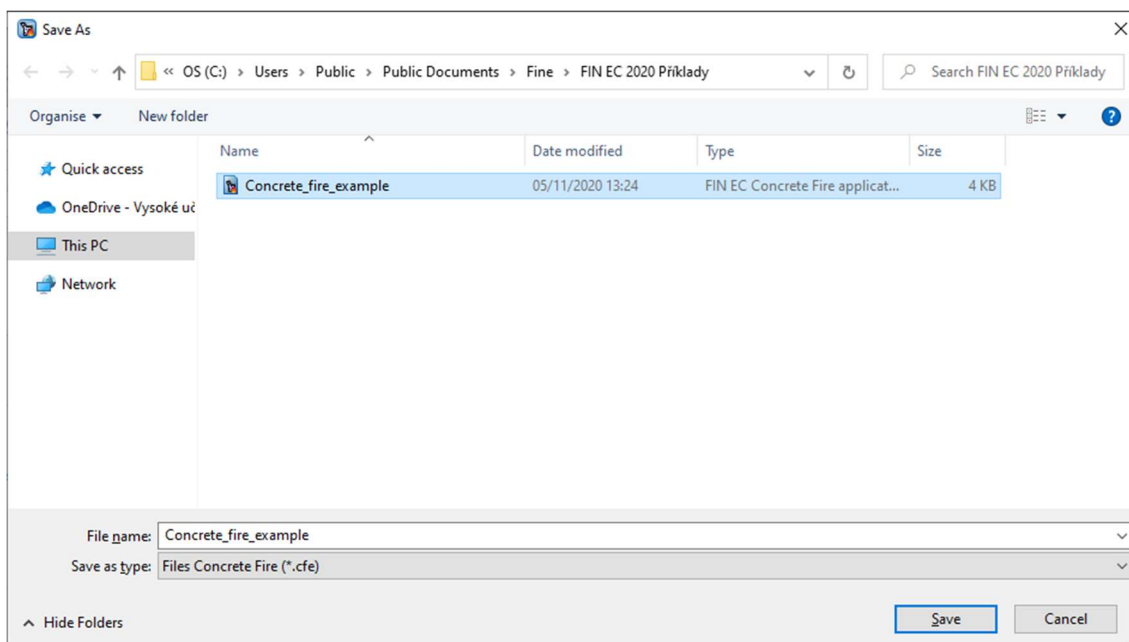


Standard selection dialog box. It shows a list of national annexes: Czech Rep., User defined, Default EC, Czech Rep. (highlighted), Slovakia, Poland, Bulgaria, and United Kingdom. There is a checkbox for 'Minimal reinforcement ration according to ČSN 73 1201 - Chap.8.5.2' which is checked. Buttons at the bottom include Default, OK, and Cancel.

Selection of the standards

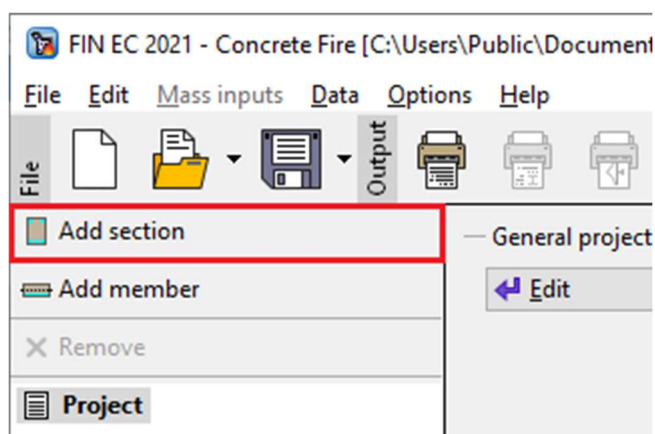
Last, the fire resistance properties are set in the **"Fire resistance parameters"** part. This project data can be edited any time during the analysis.

Before any data is assigned to the project, it is highly recommended to save the file. This can be done either using "  " button, or in the main menu clicking on **"File"** – **"Save As"**, or using the **"Ctrl+S"** shortcut.



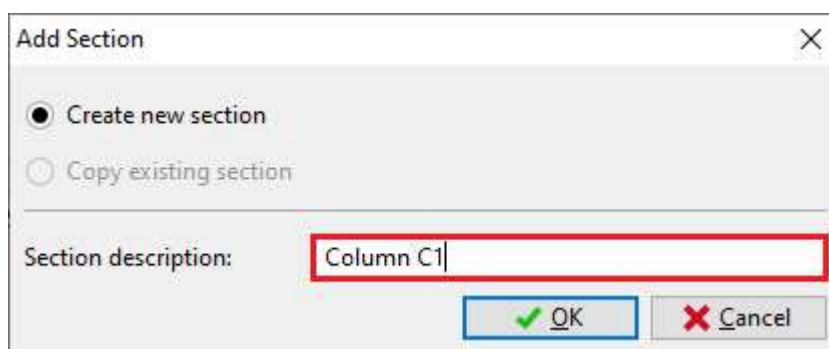
Saving the project

Now we can proceed to entering a new task by clicking the **"Add Section"** button in the upper part of the program's tree menu.



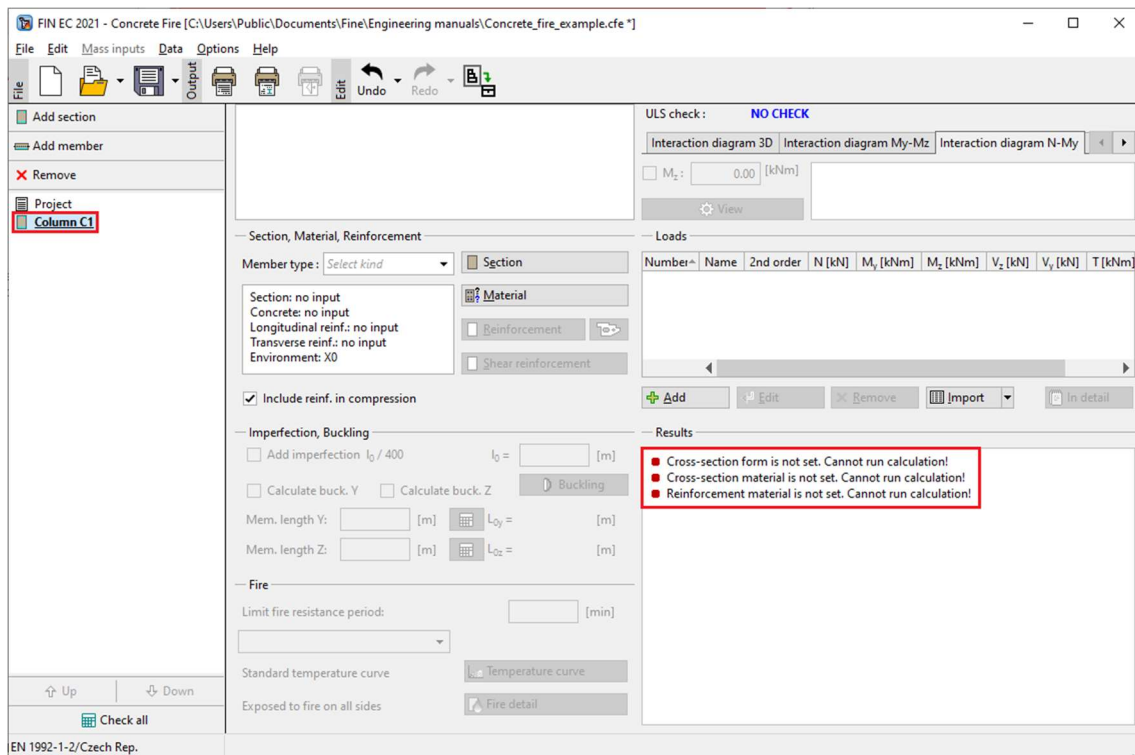
Adding a new section

The following dialog box appears, in which we can enter the section's name ("**Column**") into the **"Section description"** field, confirming by clicking the **"OK"** button.



Dialog box for adding a new section

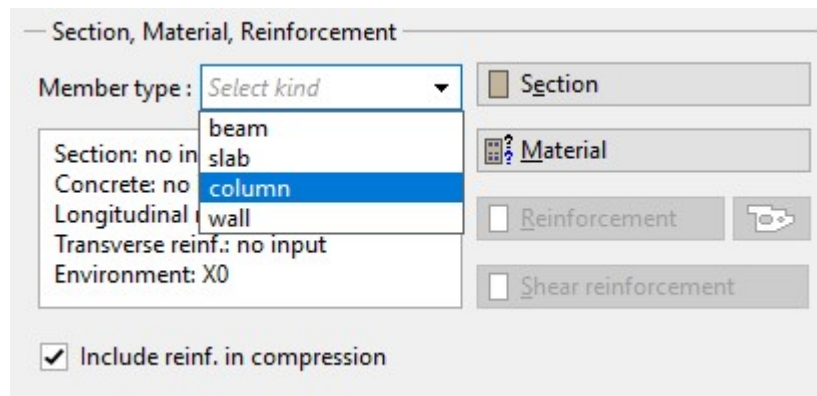
The new task **"Column C1"** has been created in the tree menu, every time a new **"Section"** or **"Member"** is created, it will appear in the tree menu. The software has automatically selected the **"Column C1"**, therefore it is possible to directly edit this task. In the right bottom corner, it shows what is required in order to run the analysis.



Main screen for "Section" task type

Section, Material, Reinforcement

In the beginning it is necessary to enter the dimensions of the geometrical and material characteristics of the considered RC column in the **"Section, Material, Reinforcement"** frame. First select the type of the member in **"Member type"** drop-down list. Available types are **"beam"**, **"slab"**, **"column"** or **"wall"**.











Defining the member type

In our example we select member type **"column"**. This selection affects the analysis and verifications of the reinforcement arrangement.

By clicking the **"Section"** button, the cross-section can be defined by the first suggested rectangular shape. The dimensions of the cross-section are simply defined by changing it's height and depth. The software allows to use custom user-defined shapes, however for the purpose of this example it is not needed.

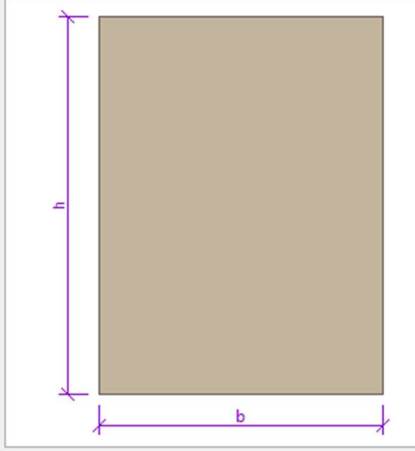
Cross-section editor - Concrete, standard

☒ 
☐ 
☐ 
☐ 
☐ 
☐ 
☐ 
☐ 

Cross-section description	
name	Column 300x400
comment	

Cross-section dimension	
cross-section height	h = 400.0 mm
cross-section width	b = 300.0 mm

Information



Geometry of the column

We proceed with defining the material properties in **"Materials"** dialog box which is run by clicking the **"Material"** button in the **"Section, Materials, Reinforcement"** part. Assuming the column is located inside of the structure we select **"X1"** for **"Exposure class"**, as the column is not in contact with outside environment. Subsequently we define the material properties of concrete and longitudinal and transversal reinforcement. We can select standardized materials from the library of pre-defined materials by clicking the **"Catalogue"** button at relevant lines.

Materials
✕

Environment:	X0	↩ Edit
Concrete:	No input	Catalogue User defined
Longitudinal reinf.:	No input	Catalogue User defined
Shear reinf.:	No input	Catalogue User defined

Indicative strength class

☐ Aeration > 4%
☐ Design lifetime 100 years

C8/10 (EN 1992-1-1)
C12/15 (ČSN EN 206+A1;ČSN P 73 2404)

Ductility class of longitudinal reinforcement
☐ A
☒ B
☐ C

Fire

Aggregates type: Siliceous aggregates

Reinforcement type: Hot rolled

Concrete moisture: u = 1.5 [%]

Parameter of thermal conductivity 0.000 [-]

Limits of thermal conductivity (chap. 3.3.3 of standard): 0 - min, 1 - max

✓ OK
✕ Cancel

Window "Materials"

For column environment select the corrosion induced by carbonation "**XC1**" and close the dialog box by clicking "**OK**".

Environment

Corrosion

Corrosion induced by carbonation:

XC1 - Dry or permanently wet

Concrete inside buildings with low air humidity; Concrete permanently submerged in water

Corrosion induced by chlorides:

X0 - No risk of corrosion or attack

Concrete inside buildings with very low air humidity

Corrosion induced by chlorides from sea water:

X0 - No risk of corrosion or attack

Concrete inside buildings with very low air humidity

Concrete

Freeze/Thaw attack:

X0 - No risk of corrosion or attack

Concrete inside buildings with very low air humidity

Chemical attack:

X0 - No risk of corrosion or attack

Concrete inside buildings with very low air humidity

Other influences

Abrasion class:

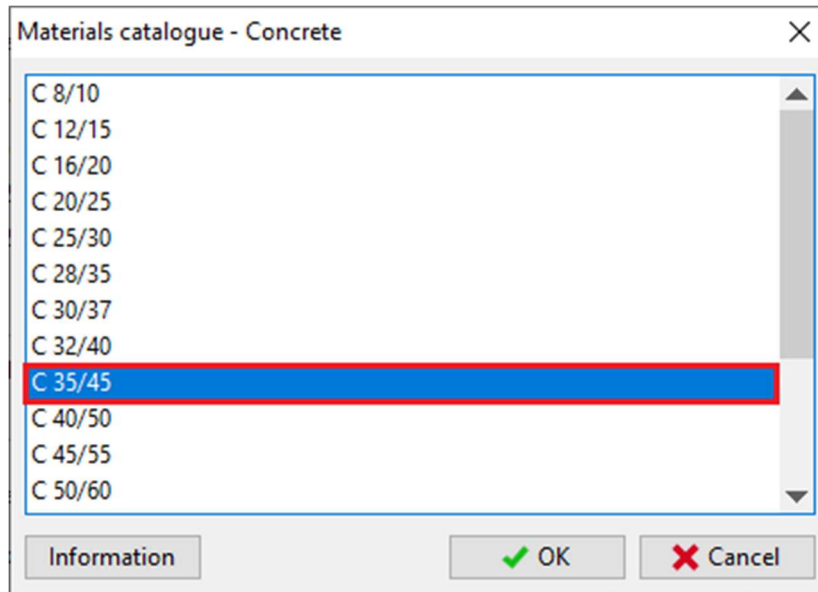
X0 - No abrasion

OK

Cancel

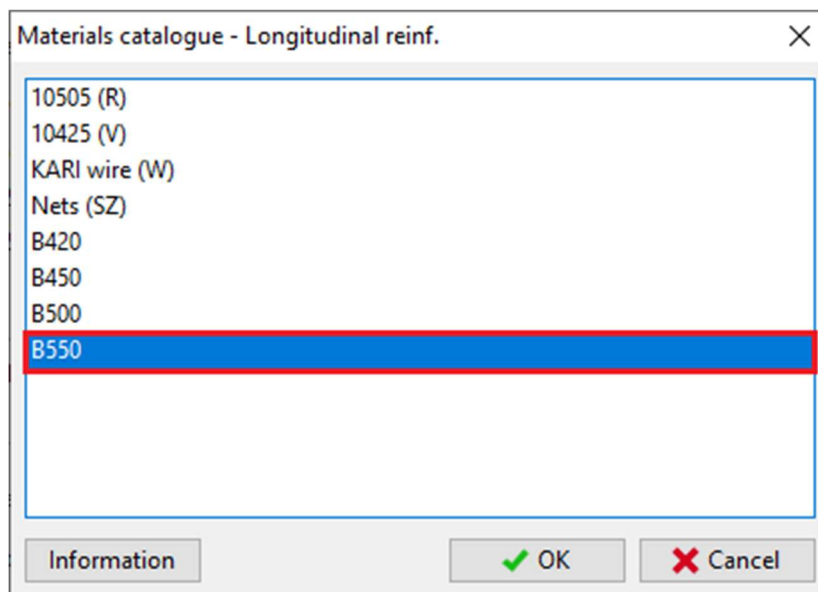
Selection of the column environment

For concrete select the strength class "**C35/45**" and close the dialog box by clicking "**OK**".



The strength classes of the concrete

Proceeding to definition of the steel properties, select the grade "**B550**" for both longitudinal and transversal reinforcement and close the dialog box by clicking "**OK**".



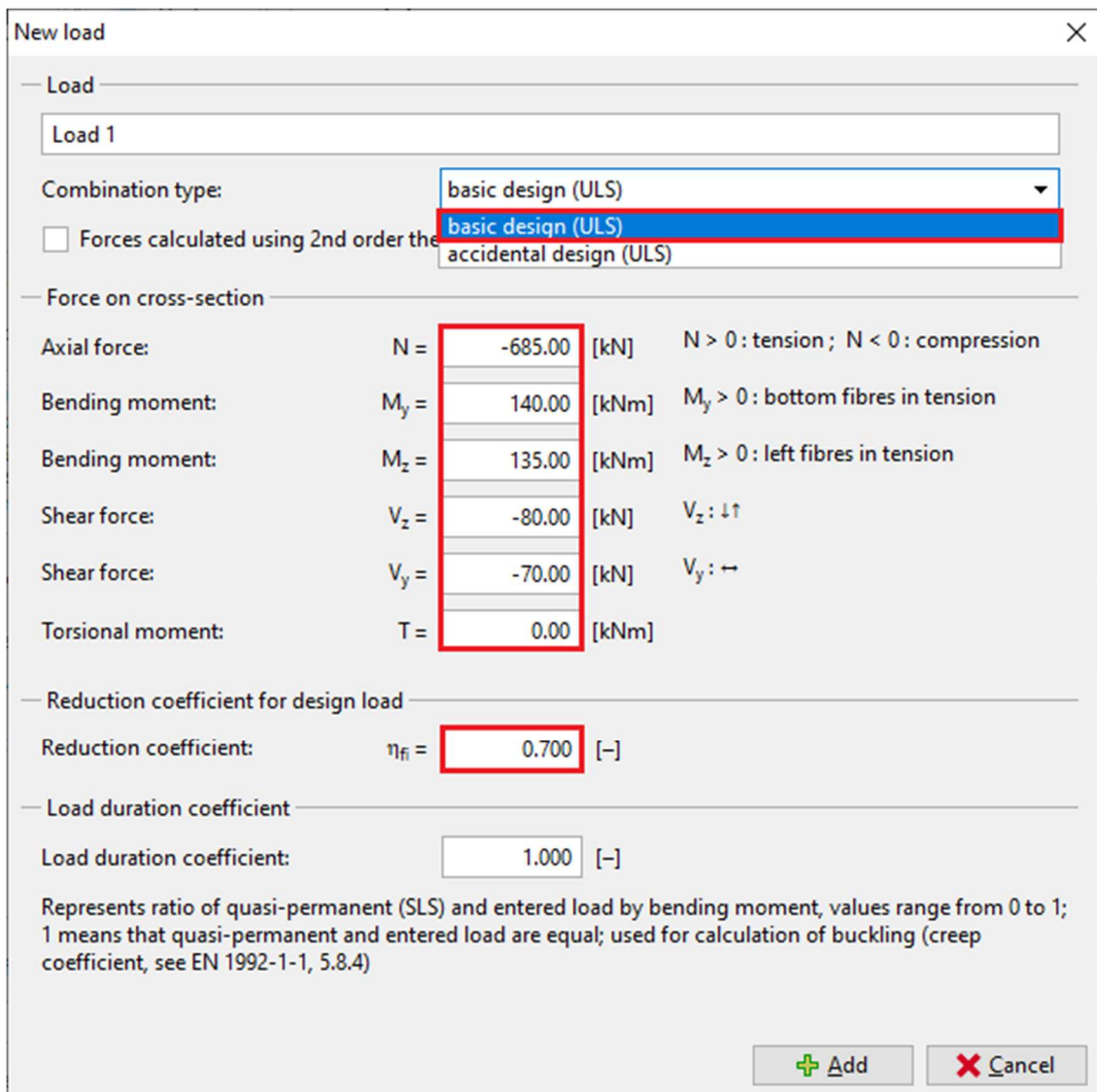
The steel grade classes

When returning to the "**Materials**" dialog box, the selected materials are checked with the predefined standard and displayed whether the material requirements on the "**Indicative strength class**" are fulfilled. At the bottom of the "**Materials**" dialog box, the material properties influencing the fire resistance properties can be changed. Finally, exit the window by clicking "**OK**".

- Basic design (ULS)** • Forces and bending moments have been obtained from the basic combination for persistent and transient design situations according to EN 1990, equations 6.10 resp. 6.10a and 6.10b. These loads are used for basic assessment of cross-section's capacity in the ultimate limit state.
- Accidental design (ULS)** • Forces and bending moments have been obtained from the combination for accidental design situations according to EN 1990, equation 6.11. These loads are used for assessment of cross-section's capacity in accidental design situations in the ultimate limit state (partial safety and material factors for accidental design situations are used).

In this example, the internal forces were calculated based on basic design combination, therefore pick the "**Basic design (ULS)**". Now in the dialog window add the internal forces on section 3m according to the table in the introduction. The axial force is $N = -685\text{kN}$ (negative value denotes compression), the bending moments are $M_y = 140\text{Nm}$, $M_z = 135\text{kNm}$ and the lateral forces are $V_z = -80\text{kN}$ and $V_y = -70\text{kN}$ (negative value denotes they act in the same direction as the moments). Next, define "**Reduction coefficient**", the procedure to determine this coefficient is in the chapter 2.4.2 of the standard EN 1992-1-2. As a simplification, the standard suggests to use η_{fi} with value of 0,7.

The "**Load duration coefficient**", i.e. the ratio of quasi-permanent and total loads for calculation of the creep coefficient. If the exact value is not available, the conservative value is 1.00, which means that the total load is considered quasi-permanent in the calculations. The new load is confirmed by clicking the "**Add**" button and "**Cancel**" to exit the dialog box.



New load

Load: Load 1

Combination type: basic design (ULS)

☐ Forces calculated using 2nd order the

Force on cross-section

Axial force:	N =	-685.00 [kN]	N > 0 : tension ; N < 0 : compression
Bending moment:	$M_y =$	140.00 [kNm]	$M_y > 0$: bottom fibres in tension
Bending moment:	$M_z =$	135.00 [kNm]	$M_z > 0$: left fibres in tension
Shear force:	$V_z =$	-80.00 [kN]	V_z : $\downarrow \uparrow$
Shear force:	$V_y =$	-70.00 [kN]	V_y : $\leftarrow \rightarrow$
Torsional moment:	T =	0.00 [kNm]	

Reduction coefficient for design load

Reduction coefficient: $\eta_{fi} =$ 0.700 [-]

Load duration coefficient

Load duration coefficient: 1.000 [-]

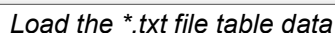
Represents ratio of quasi-permanent (SLS) and entered load by bending moment, values range from 0 to 1; 1 means that quasi-permanent and entered load are equal; used for calculation of buckling (creep coefficient, see EN 1992-1-1, 5.8.4)

Add **Cancel**

Defining the loads

As a result, the table summarizing all defined load cases is generated in the dialog box.

However, adding all the load cases one by one is quite time consuming, therefore the load cases can be imported in a batch using *.txt, *.xls/x, *.csv file (button "**Import**"). The number of loads is not limited in the software.



(4) Import of table data

— (4) Input file split into columns

A (123.45) section [m]	B (123.45) N [kN]	C (123) My [kNm]	D (123.45) Mz [kNm]	E (123) Vy [kN]	F (123) Vz [kN]	G (ABCDEFG) combination	H (123.45) ? [-]
3	-685	140	135	-70	-80	basic	0.7
2.25	-687.25	70	67.5	-70	-80	basic	0.7
1.5	-689.5	0	0	-70	-80	basic	0.7

— (5) Assign columns to imported data

Name	Axial force N [kN]	Bending moment M _y [kNm] M _z [kNm]		Shear force V _y [kN] V _z [kN]		Torsional moment M _t [kNm]	According to second	Combination type	Reduction coefficient η_R [-]	Load duration coefficient [-]
A: section [m]	B: N [kN]	C: My [kNm]	D: Mz [kNm]	F: Vy [kN]	E: Vz [kN]	(unspecified)	(unspecified)	G: combination	H: ? [-]	(unspecified)
	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00			Assignment	1.000E+00	
	kN	kNm	kNm	kN	kN					

— (6) Result of import preview

Name	Axial force N [kN]	Bending moment M _y [kNm] M _z [kNm]		Shear force V _y [kN] V _z [kN]		Combination type	Reduction coefficient η_R [-]
3	-685.00	140.00	135.00	-80.00	-70.00	basic design	0.70
2.25	-687.25	70.00	67.50	-80.00	-70.00	basic design	0.70
1.5	-689.50	0.00	0.00	-80.00	-70.00	basic design	0.70
0.75	-691.75	-70.00	-67.50	-80.00	-70.00	basic design	0.70
0	-694.00	-140.00	-135.00	-80.00	-70.00	basic design	0.70

Import the data from the file

When clicking the button **"OK"** the load cases will appear in the dialog box **"Loads"**. If the import of the load cases was done correctly, the first imported load case should match with the load case defined manually.

Loads									
Number	Name	2nd order	N [kN]	M _x [kNm]	M _y [kNm]	V _x [kN]	V _y [kN]	T [kNm]	Utilization
1	Load 1 - basic design (ULS)		-479.50(-685.00)	98.00(140.00)	94.50(135.00)	-56.00(-80.00)	-49.00(-70.00)		
2	3 - basic design (ULS)		-479.50(-685.00)	98.00(140.00)	94.50(135.00)	-56.00(-80.00)	-49.00(-70.00)		
3	2.25 - basic design (ULS)		-481.07(-687.25)	49.00(70.00)	47.25(67.50)	-56.00(-80.00)	-49.00(-70.00)		
4	1.5 - basic design (ULS)		-482.65(-689.50)			-56.00(-80.00)	-49.00(-70.00)		
5	0.75 - basic design (ULS)		-484.22(-691.75)	-49.00(-70.00)	-47.25(-67.50)	-56.00(-80.00)	-49.00(-70.00)		

Overview of the loads with after the data import

Longitudinal reinforcement

When returning to the main dialog box, the longitudinal reinforcement is defined in the **"Edit reinforcement"** dialog that is accessed by the **"Reinforcement"** button in the **"Section, Material, Reinforcement"** frame. The upper part of the window allows to select calculation method for the cover. Keep the predefined method for now.

Edit reinforcement

Cover:

- ☐ Minimum cover
- ☒ Min cover and stirrups
- ☐ User defined cover

Minimum cover [mm]

Check of cover

Upper reinforcement

	Diameter [mm]	Type Input	Distance [mm]	Count [-]	Position Type	Position [mm]	A _s [mm²]
<input checked="" type="checkbox"/> 1	<input type="text" value="22"/>	Number ▾	<input type="text" value="32.0"/>	<input type="text" value="4"/>	Min. cvr. ▾	<input type="text" value="32.0"/>	<input type="text" value="1520.5"/>
<input checked="" type="checkbox"/> 2	<input type="text" value="22"/>	Number ▾	<input type="text" value="150.0"/>	<input type="text" value="2"/>	Position ▾	<input type="text" value="150.0"/>	<input type="text" value="760.3"/>
<input checked="" type="checkbox"/> 3	<input type="text" value="22"/>	Number ▾	<input type="text" value="250.0"/>	<input type="text" value="2"/>	Position ▾	<input type="text" value="250.0"/>	<input type="text" value="760.3"/>
<input type="checkbox"/> 4	<input type="text" value="22"/>	Number ▾	<input type="text" value="3041.1"/>	<input type="text" value="2"/>	Position ▾	<input type="text" value="3041.1"/>	<input type="text" value="Σ A<sub>s</sub> [mm²] = 3041.1"/>

Bottom reinforcement

	Diameter [mm]	Type Input	Distance [mm]	Count [-]	Position Type	Position [mm]	A _s [mm²]
<input checked="" type="checkbox"/> 1	<input type="text" value="22"/>	Number ▾	<input type="text" value="32.0"/>	<input type="text" value="4"/>	Min. cvr. ▾	<input type="text" value="32.0"/>	<input type="text" value="1520.5"/>
<input type="checkbox"/> 2	<input type="text" value="22"/>	Number ▾	<input type="text" value="150.0"/>	<input type="text" value="2"/>	Position ▾	<input type="text" value="150.0"/>	<input type="text" value="760.3"/>
<input type="checkbox"/> 3	<input type="text" value="22"/>	Number ▾	<input type="text" value="250.0"/>	<input type="text" value="2"/>	Position ▾	<input type="text" value="250.0"/>	<input type="text" value="760.3"/>
<input type="checkbox"/> 4	<input type="text" value="22"/>	Number ▾	<input type="text" value="3041.1"/>	<input type="text" value="2"/>	Position ▾	<input type="text" value="3041.1"/>	<input type="text" value="Σ A<sub>s</sub> [mm²] = 1520.5"/>

Information

Total reinforcement area: 4561.6 mm²

Check of min and max reinforcement level

Column (total reinforcement):


$\rho_s = 0.038 \geq \rho_{s,min} = 0.002 \Rightarrow$ Pass

$\rho_s = 0.038 \leq \rho_{s,max} = 0.04 \Rightarrow$ Pass

Reinforcement positioning

- ☒ Generate identical bar spacing
- ☐ Bars as much on edge as possible

Defining the longitudinal reinforcement

When the reinforcement is defined, click "  " button and the software will check whether the cross-section has sufficient capacity in bending. It shows that the defined cross-section passes the design criteria with 63.3% utilization in bending. In the section "**Information on reinforcement**" it shows that the detailing requirements given by the code are satisfied. Next, check the minimum cover requirements by clicking the "**Minimum cover**" button:

Reinforcement cover

Environment

Environment:

XC1

Edit

Indicative strength class

C16/20 = strength class pass (EN 1992-1-1)

C16/20 = strength class pass (ČSN EN 206+A1;ČSN P 73 2404)

Structure class

Class :

S4

Residential, civil and other common structures, industrial structures, structures for mining, reservoirs, wather management

☐ Design lifetime 80 years
☐ Design lifetime 100 years

☐ Slab geometry
☐ Special quality control

Resulting structural class:

S3

Other influences

Abbrasion class:

X0 - No abrasion

☐ Max aggregate diameter is greater than 32mm
☐ Uneven surface
☐ Additive safety element
☐ Stainless steel
☐ Additional protection
☐ Allowance in design for deviation
☐ Ground:

☐ prepared
☒ soil

0.0 [mm]

$\Delta c_{dur,y}$ 0.0 [mm]

$\Delta c_{dur,st}$ 0.0 [mm]

$\Delta c_{dur,add}$ 0.0 [mm]

Δc_{dev} 10.0 [mm]

Minimal cover

Min longitudinal reinf. cover :

$c_{min} = \max(c_{min,b}; c_{min,dur}; 10) = \max(22; 10; 10) = 22 \text{ mm}$
 $c_{nom} = c_{min} + \Delta c_{dev} = 22 + 10 = 32 \text{ mm}$

Min stirrup cover:

$c_{min} = \max(c_{min,b}; c_{min,dur}; 10) = \max(8; 10; 10) = 10 \text{ mm}$
 $c_{nom} = c_{min} + \Delta c_{dev} = 10 + 10 = 20 \text{ mm}$

Longitudinal reinforcement cover behind stirrups:

$c_{nom} = \max(32; 20 + 8) = \max(32; 20 + 8) = \max(32; 0.028) = 32 \text{ mm}$


OK

Cancel

The minimal reinforcement cover

The minimum required cover may change, when the stirrups are defined. Therefore, you should always look into this dialog box, after the stirrups are defined.

Shear reinforcement

The shear reinforcement is defined by clicking the **"Shear reinforcement"** button. The column is subjected to lateral forces, therefore the calculation for the shear resistance must be made. Define the shear reinforcement and click "  " button, the software will check whether the cross-section has sufficient capacity in shear. It shows that the defined cross-section passes the design criteria with 49.3% utilization in shear.

Edit reinforcement

☒ **Boundary stirrups**

Diameter d : [mm]

Spacing s : [mm]

Torsion :

Ratio of stirrup area used for torsion resistance : [%]

☐ Ties, inner stirrups vertical ☐ Ties, inner stirrups horizontal

☐ Same as boundary stirrups ☐ Same as boundary stirrups

Diameter d : [mm] Diameter d : [mm]

Spacing s : [mm] Spacing s : [mm]

Count of shears : [-] Count of shears : [-]

☐ Bent-up bars vertical ☐ Bent-up bars horizontal

Diameter d : [mm] Diameter d : [mm]

Pitch α : [°] Pitch α : [°]

Count of shears : [-] Count of shears : [-]

☐ As row of bent-up bars ☐ As row of bent-up bars

Spacing s : [mm] Spacing s : [mm]

☐ Inner lever arm ☐ Angle of compression struts

☒ Define by calculation ☒ Iterate

☐ Define as \times d ☐ User defined [°]

Information

$V_{Rdmax} = \alpha_{cw} \times b_w \times z \times \eta \times f_{cd,fi} / (\cot \theta + \tan \theta) = 1 \times 141.6 \times 237.4 \times 0.310 \times 5.2 / (2.3 + 0.4) = 227.3 \text{ kN}$

$f_{sd,fi} = k_s(\theta) \times f_{yk} / \gamma_{M,fi} = 0.636 \times 550 / 1 = 349.9 \text{ MPa}$

$V_{Rds} = A_{sw} / s \times z \times f_{sd,fi} \times \cot \theta = 100.5 / 150 \times 257.4 \times 349.9 \times 2.5 = 150.9 \text{ kN}$

$V_{Rd} = \max(V_{Rdc}, \min(V_{Rdmax}, V_{Rds})) = \max(103.9; \min(227.3; 150.9)) = \max(103.9; 150.9) = 150.9 \text{ kN}$

$V_{Ed} = 74.41 \text{ kN} \leq V_{Rdc} = 103.9 \text{ kN} \Rightarrow$ **Only prescribed shear reinforcement**

Cross-section capacity in shear Pass

Utilization: 49.3 %

Torsion

CS not subject to torsion.

Utilization in shear : ☒ **49.3 % PASS**

Defining the shear reinforcement

Buckling

The next step is defining the buckling parameters. First tick "**Calculate buck. Y/Z**" boxes followed by entering the nominal lengths of the column for both directions, based on which the effective buckling lengths will be calculated. For a column rigid at the bottom and simply supported at the top, the effective buckling length is reduced.

Imperfection, Buckling


☒ Add imperfection $l_0 / 400$ $l_0 =$ [m]

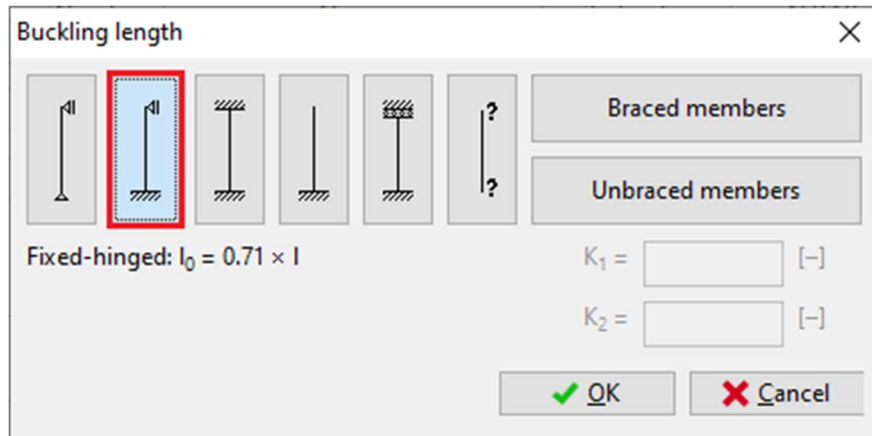
☒ Calculate buck. Y ☒ Calculate buck. Z

Mem. length Y: [m] $L_{0y} =$ [m]

Mem. length Z: [m] $L_{0z} =$ [m]

Defining buckling parameters

Define the boundary conditions by clicking the "  " buttons for each direction.

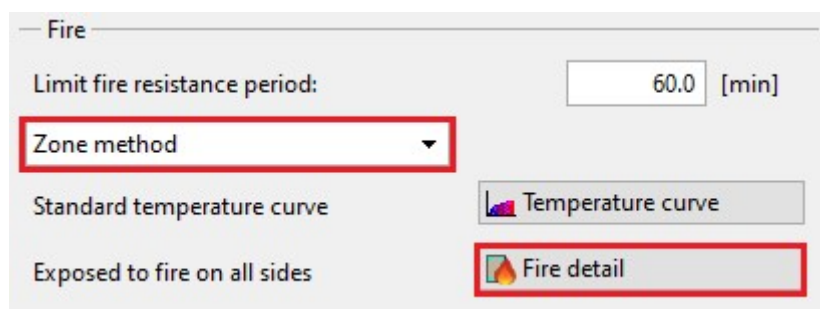


The "Buckling length" dialog box shows various boundary condition icons. The "Fixed-hinged" icon is highlighted with a red box. Below the icons, it states "Fixed-hinged: $l_0 = 0.71 \times l$ ". To the right, there are input fields for K_1 and K_2 , both set to 1.0. There are also buttons for "Braced members", "Unbraced members", "OK", and "Cancel".

Setting the buckling length

Fire

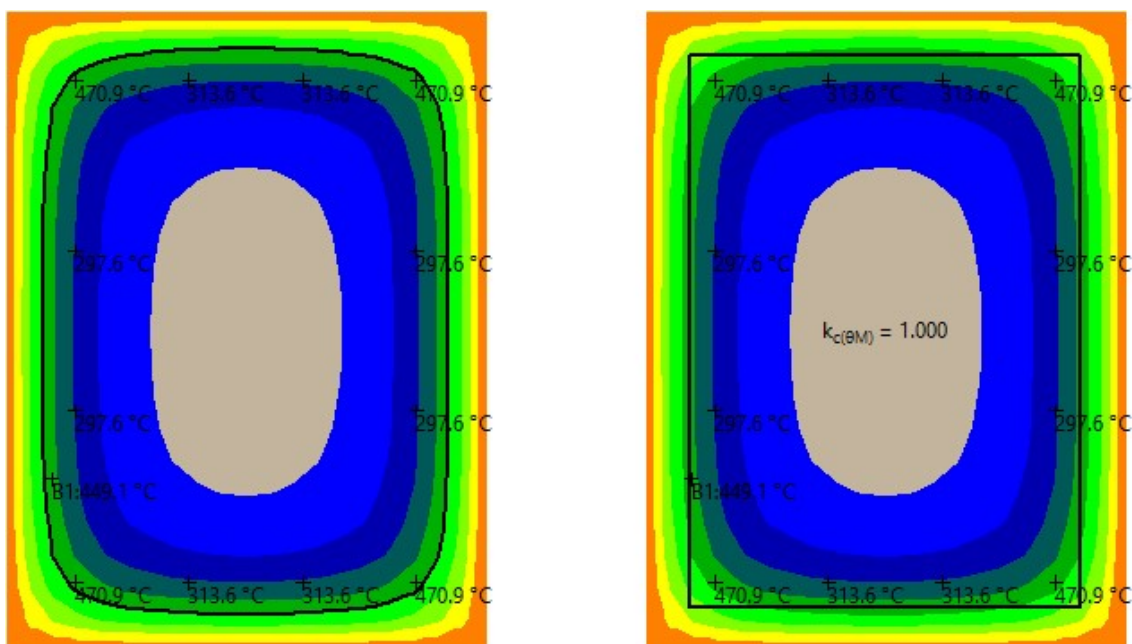
Last, the parameters for the fire assessment are defined at the bottom of the main dialog box in the "Fire" frame. The software allows to do the calculations based on the "500°C isotherm method" or the "Zone method". For the column it is recommended to use the "Zone method".



The "Fire" frame in the main dialog box shows the "Limit fire resistance period" set to 60.0 [min]. The "Standard temperature curve" is set to "Zone method". There are buttons for "Temperature curve" and "Fire detail".

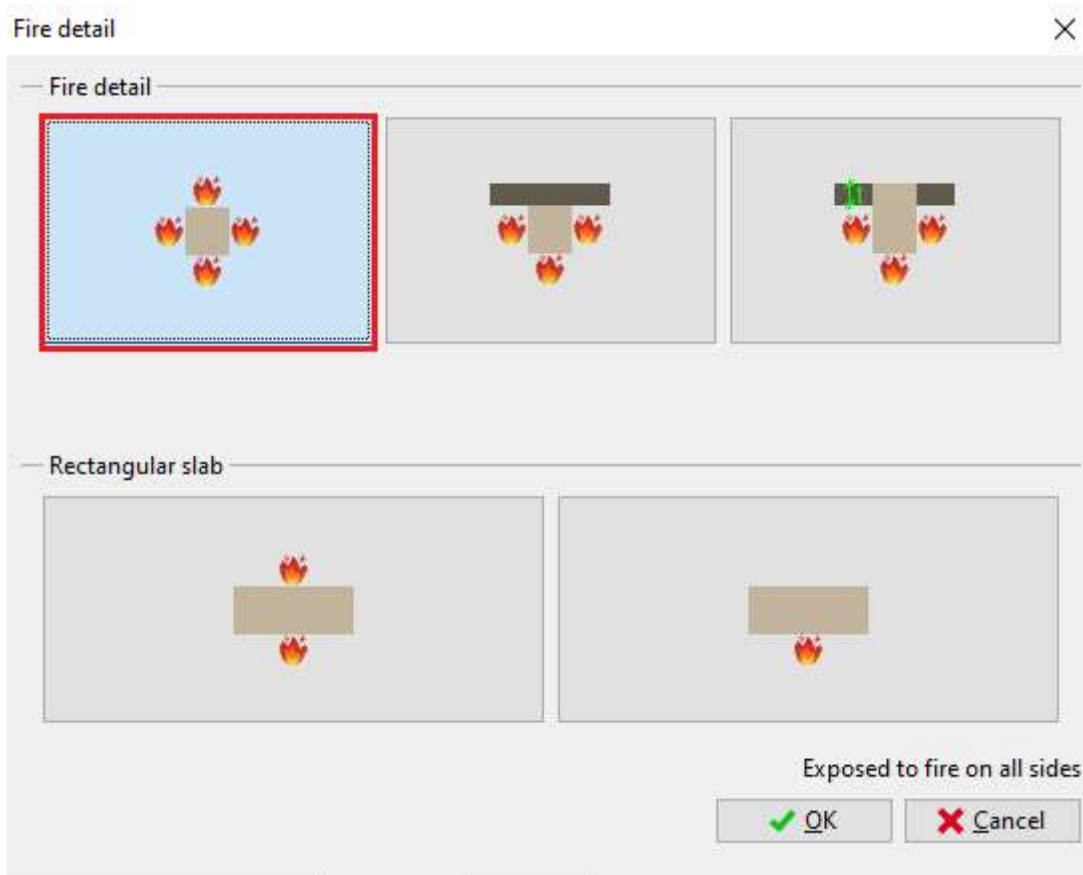
Fire calculation parameters

The picture of the temperature distribution is shown at the top of the main dialog box, under the "Temperature distribution" bookmark.



500°C isotherm method (left) and Zone method (right)

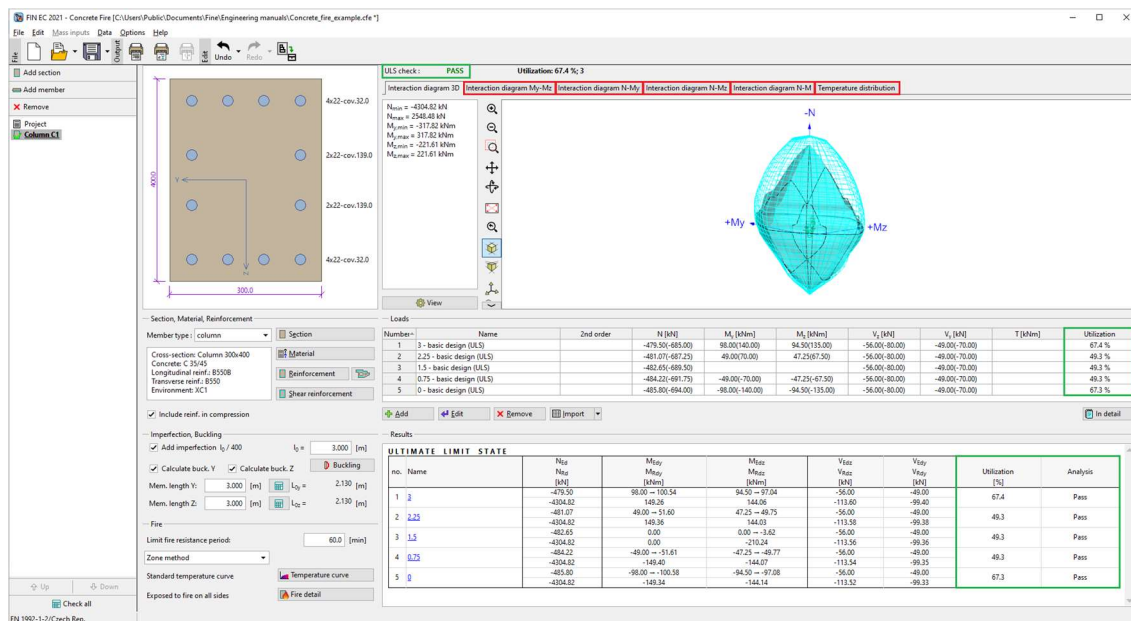
The position, where the fire is acting on the column is displayed in the "Fire detail button". The column is considered to stand alone, thus select the first fire detail.



Fire detail

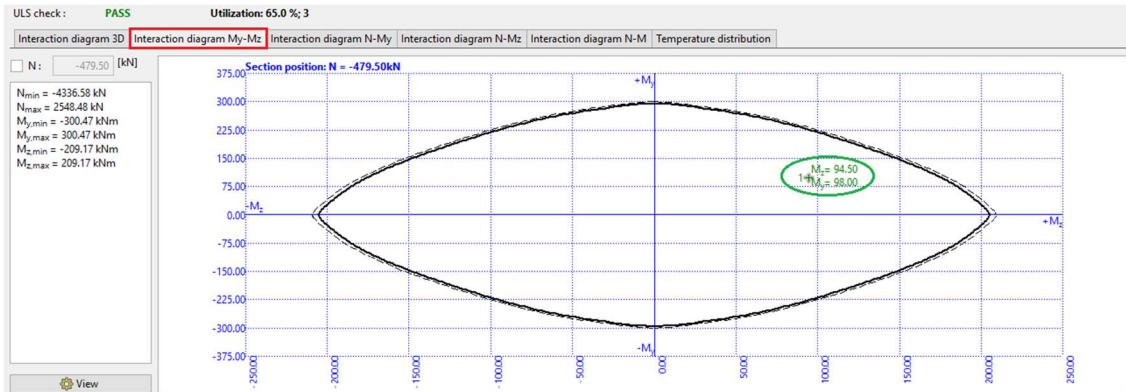
Results

When all the input has been defined, the results are shown in the main dialog box. If the defined element satisfies the software shows "PASS" at the top of the main dialog box.

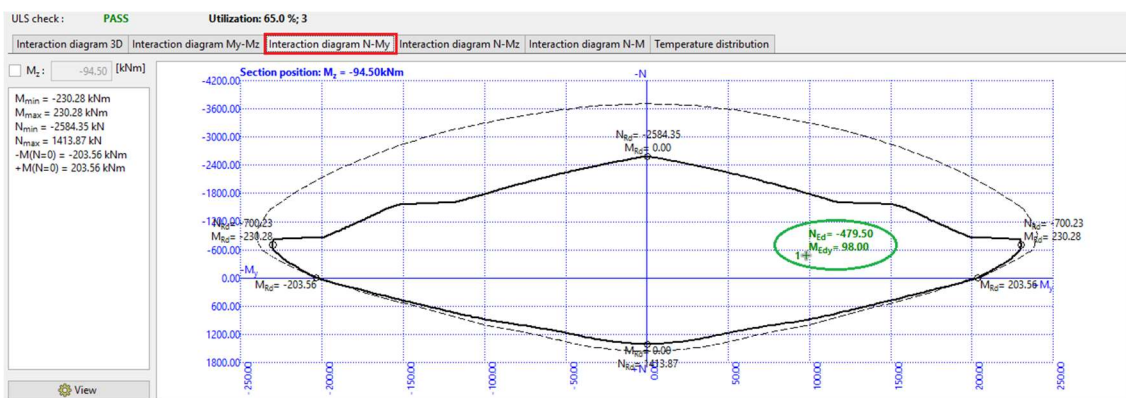


The main dialog box with the 3D representation of the interaction diagram

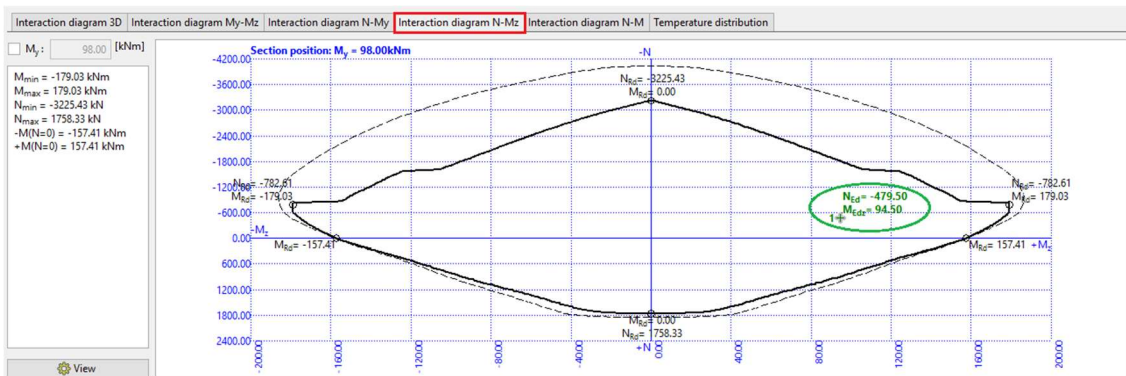
The results may be shown in terms of interaction diagram in the bookmarks at the top of the main dialogue box. The defined loads are shown as points in the interaction diagram. If the load lies inside of the solid line of the diagram, the cross-section satisfies the fire assessment. The dashed line shows the iteration diagram of the column without buckling.




The $M_y - M_z$ interaction diagram

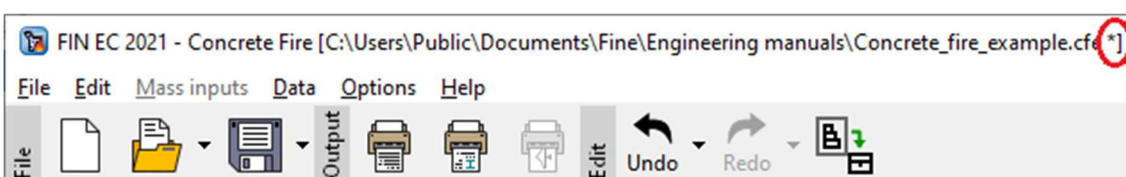


The $N - M_y$ interaction diagram



The $N - M_z$ interaction diagram

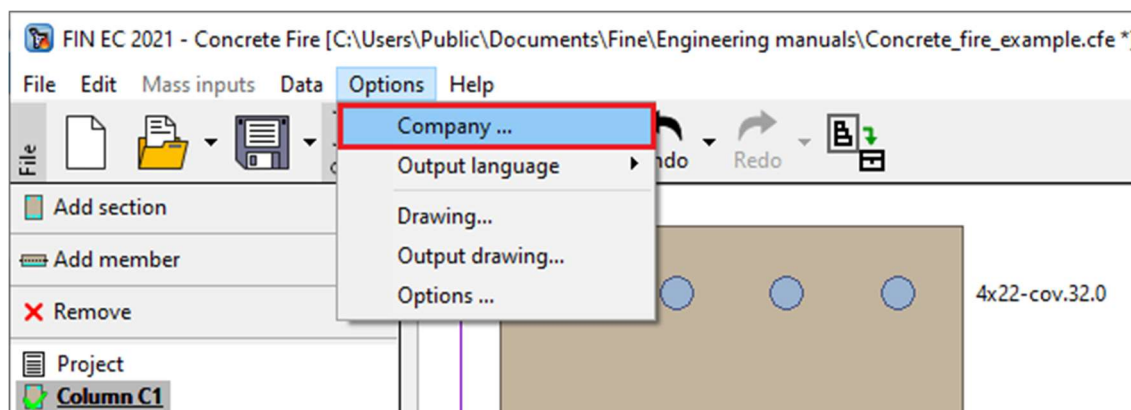
When the project is finished, it is highly recommended to save the file by clicking "  " button, or in the main menu clicking on "File" – "Save As", or using the "Ctrl+S" shortcut. The indication of not saved state is "*" in the program window header. In such case it is advisable to save the state.



Indication of the not saved state

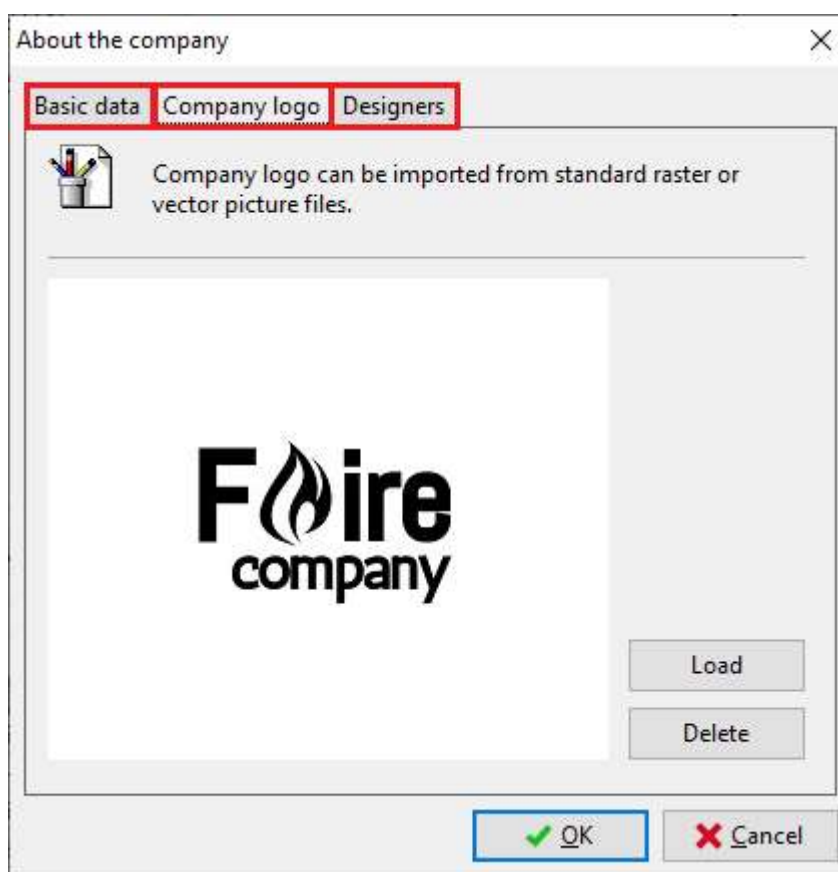
Outputs

In order to show the information about the company in the output files, the information must be defined in the project. Click the button **"Company"** in the Options drop-down menu.




Define the company information

The window **"About the company"** will appear, where the information about the company can be defined. It is also possible to import the company logo, that will show at the header of the exported documentation.



Set the company data and import the logo

If all the settings finished and saved, the output documentation can be composed. First print out a single title page summarizing all the input data and the check results. This is done by clicking the **"File"** and **"Graphic output"** or  in the toolbar.

Print and export document

Document: **Graphic output** | **Page setup** | **Header and footer** | **Page numbering**

Scheme: **Text output** | **Graphic output**

Save | Print | Open and edit | Send as attachment

Copy | Remove selection

Page width | Two pages | One page | Multiple pages | Book

Template: <none>

Editor

- ☐ Project
- ☐ Standard
- ☒ Printing options
 - ☒ Section printing
 - ☒ Column C1

Contents

Fire company John Smith Concrete fire example Columns

Column C1

Member type: column
Environment: XC1
Concrete: C 35/45
 $f_{cd} = 35.0 \text{ MPa}$, $f_{ctm} = 3.2 \text{ MPa}$, $E_{cm} = 34000 \text{ MPa}$
Longitudinal steel: B550B ($f_{yk} = 550.0 \text{ MPa}$, $E_s = 200000 \text{ MPa}$)
Transverse steel: B550 ($f_{yk} = 550.0 \text{ MPa}$, $E_s = 200000 \text{ MPa}$)
Buckling
Buckling length perpendicular to axis Y: $l_{b,y} = 3.00 \cdot 0.71 = 2.13 \text{ m}$
Buckling length perpendicular to axis Z: $l_{b,z} = 3.00 \cdot 0.71 = 2.13 \text{ m}$
Reinforcement in compression considered.
Boundary stirrups
Profile: 8 mm; Distance: 150.0 mm

Calculation in prescribed fire resistance time $t = 60.0 \text{ min}$
500°C isotherm method

Check of min and max reinforcement level

Column (total reinforcement):
 $\rho_{tr} = 0.038 \geq \rho_{tr,min} = 0.002 \Rightarrow$ **Pass**
 $\rho_{tr} = 0.038 \leq \rho_{tr,max} = 0.04 \Rightarrow$ **Pass**

Check of ultimate limit state

no.	Name	N_{Ed} [kN]	M_{Ed} [kNm]	N_{Ed} [kN]	M_{Ed} [kNm]	V_{Ed} [kN]	V_{Ed} [kN]	Analysis
1	3	-479.50 -4336.58	98.00 → 100.54 154.72 149.34	94.50 → 97.04 149.34	-56.00 -113.62	-49.00 -99.42	-49.00	Pass
2	2.25	-481.07 -4336.58	49.00 → 51.60 154.84	47.25 → 49.75 149.31	-56.00 -113.60	-49.00 -99.40	-49.00	Pass
3	1.5	-482.65 -4336.58	0.00 0.00	0.00 → 3.62 200.27	-56.00 -113.58	-49.00 -99.38	-49.00	Pass
4	0.75	-484.22 -4336.58	-49.00 → -51.61 -154.80	-47.25 → -49.77 -149.36	-56.00 -113.56	-49.00 -99.37	-49.00	Pass
5	0	-485.80 -4336.58	-98.00 → -100.58 -154.83	-94.50 → -97.08 -149.44	-56.00 -113.55	-49.00 -99.35	-49.00	Pass

Ultimate limit state **PASS**

PASS

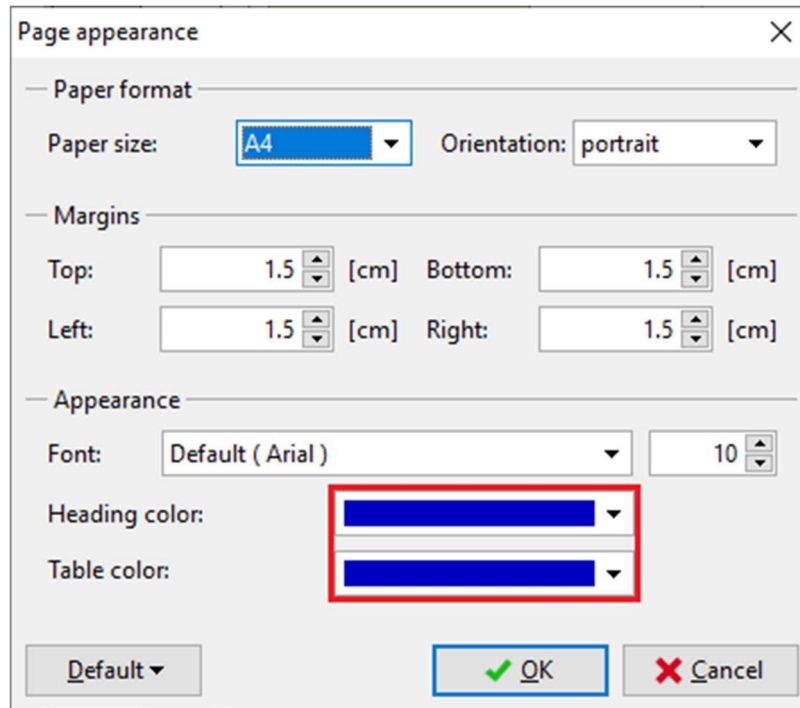
1

[FINEC - Concrete Fire | version 11.2020 21.0 | Hardware key 10791 1 1 | Roadster Ljus | Copyright © 2020 Fine spol. s r.o. All Rights Reserved | www.finecears.eu]

Document matches its settings | 1 / 1 | A4 (21.0 x 29.7 cm)

The graphic output

At the top part of this window, there are buttons **"Page setup"** and **"Header and footer"**. Click the button **"Page setup"** and a window for editing the paper size, margins or a colour of the output document will appear. Pick the preferred colour based on your liking and continue.



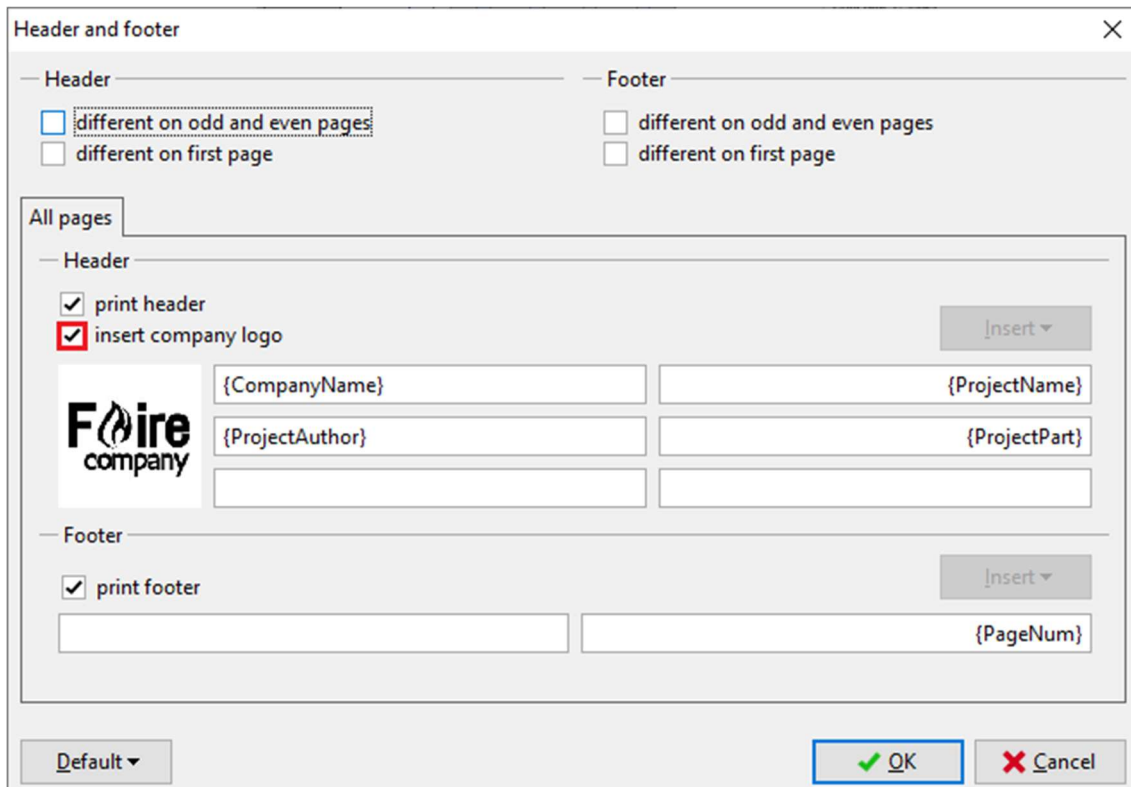
The "Page appearance" dialog box is shown with the following settings:

- Paper format:** Paper size: A4, Orientation: portrait
- Margins:** Top: 1.5 [cm], Bottom: 1.5 [cm], Left: 1.5 [cm], Right: 1.5 [cm]
- Appearance:** Font: Default (Arial), 10. Heading color: (blue), Table color: (blue).

Buttons at the bottom: Default, OK, Cancel.

Page appearance settings

When clicking the button "**Header and footer**" the window for adding information about the project to the header or footer of the output documentation will appear. Check the "**insert company logo**" box in order to show the company logo in the header. The other information about the project can be also added to the footer or header by clicking the button "**Insert**".



The "Header and footer" dialog box is shown with the following settings:

- Header:**
 - ☐ different on odd and even pages
 - ☐ different on first page
- Footer:**
 - ☐ different on odd and even pages
 - ☐ different on first page
- All pages:**
 - ☒ print header
 - ☒ insert company logo
 - Header content:
 - {CompanyName}
 - {ProjectAuthor}
 - {ProjectName}
 - {ProjectPart}
 - Footer content:
 - {PageNum}

Buttons at the bottom: Default, OK, Cancel.

Header and footer settings

Apart from this title document, the detail text output can be composed by clicking the "🖨️" button in the toolbar or selecting "**File**" and "**Text output**" in the main menu. If the print and export document dialog box is still opened, the document type can be changed in the toolbar's "**Document**" drop-down list.

Print and export document

Document: Text output | Page setup | Header and footer | Page numbering

Save | Print | Open and edit | Send as attachment

Scheme: color

Copy | Remove selection | Select all

Page width | Two pages | One page | Multiple pages | Book

Editor

Template: <none>

Contents

- ☒ Project
- ☒ Standard
- ☐ Details
- ☒ Section printing
- ☒ Printing options
- ☒ Column C1

Project

Job name: Concrete fire example
Part: Columns
Client: Concrete structures Ltd.
Author: John Smith
Date: 26/10/2020

Standard

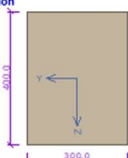
Standard EN 1992-1-2/Czech Rep..

1 Column C1

1.1 Input data

Member type: column
Environment: XC1
Length: 3.00m
Limit fire resistance period: 60.0min

Cross-section



Aggregates type: Siliceous aggregates
Reinforcement type: Hot rolled
Concrete moisture: 1.5%
Parameter of thermal conductivity: 0.000

Materials

Concrete: C 35/45
 $f_{ck} = 35.0 \text{ MPa}$; $f_{ctm} = 3.2 \text{ MPa}$; $E_{cm} = 34000 \text{ MPa}$

Longitudinal steel: B550B
 $f_{yk} = 550.0 \text{ MPa}$; $E_s = 200000 \text{ MPa}$

Transverse steel: B550
 $f_{yk} = 550.0 \text{ MPa}$; $E_s = 200000 \text{ MPa}$

Fire detail

Exposed to fire on all sides

Temperature curve

Standard temperature curve

Internal forces - basic design (ULS)

no.	Load name	N_{Ed} [kN]	M_{Edy} [kNm]	M_{Edz} [kNm]	V_{Edx} [kN]	V_{Edy} [kN]	T_{Ed} [kNm]	QP coef. [-]
1	3	-685.00	140.00	135.00	-80.00	-70.00	0.00	1.000
2	2.25	-687.25	70.00	67.50	-80.00	-70.00	0.00	1.000
3	1.5	-689.50	0.00	0.00	-80.00	-70.00	0.00	1.000
4	0.75	-691.75	-70.00	-67.50	-80.00	-70.00	0.00	1.000
5	0	-694.00	-140.00	-135.00	-80.00	-70.00	0.00	1.000

Buckling

Length [m]	Buckling coef. [-]	Buckling length [m]	Perpendicular to axis
3.00	0.71	2.13	Y
3.00	0.71	2.13	Z

1

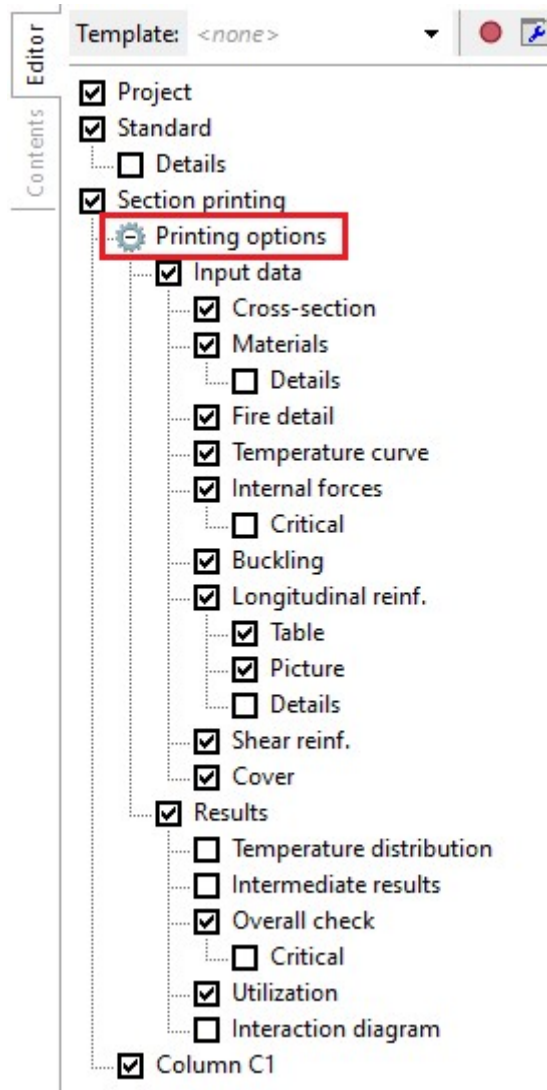
Document matches its settings

1 / 3

A4 (21.0 x 29.7 cm)

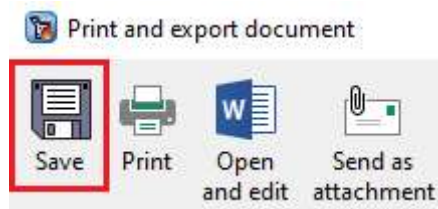
The text output

After switching to the "Text output" mode, the parts of the documentation can be added or excluded in the "Editor".





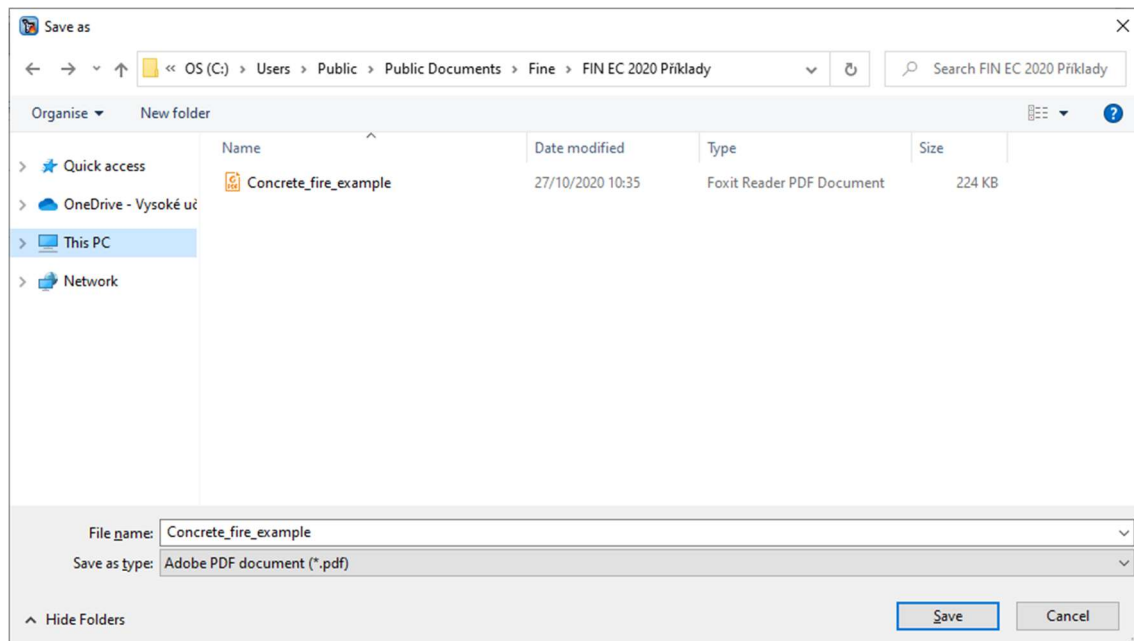
Add or exclude the output parts

The software will immediately re-generate the output to reflect each change made in the settings in the tree on the left-hand side. Once the output contains all required information, the document can be again saved on disk.



Click the save button

The document can be printed directly by clicking " " button or save it on disk as *.pdf or *.rtf file by clicking " " button.



*Saving file in *.pdf format*

Completing the outputs generation, the work is done.