B	Ing. Vaněk	Ing.Pazdera	Ing. Petrů	**SECOND EDITION**	04/2020
A	Ing. Vaněk	Ing.Pazdera	Ing. Petrů	**FIRST EDITION**	07/2019
Rev.	**Prepared by**	**Reviewed by**	**Approved by**	**Description index**	**Date**

Document submitted for acceptance: YES – NO
Input document:

State: Preliminary

Name:

EUROPEAN SPALLATION SOURCE
Static assessment – Civil part
NIK 6.6#3 – Beamline for European Engineering Research

Document type: Report
Confidentiality level: Internal
Link: https://chess.ess.lu.se

Building owner:

Document number:
ESS-0461612

Approved by: *Name & Signature*

Address:
European Spallation Source – ERIC
Lund 225 92,Sweden

In Kind Partner:

Partner's Document number:

Approved by: *Name & Signature*

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Format: A4 | **Number of pages:** 40

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	Managing dept. 2505	*Processing dept.* 2503	*Discard label*
Project name ESS - BEER	*Object – operation unit* CO101		*Ordinal number* 001
Contract name Documentation for diffractometer BEER			
Documentation name Basic design CO101 - Experimental Cave **Civil part** **STATIC ASSESSMENT - STEEL STRUCTURE**			*Copy number*

Worked by Ing. Vaněk	*Head of processing department* Ing. Holub	*Date* 04/2020	*Pages in document* 45
Checked by Ing. Pazdera	*Main project engineer* Ing. Petrů	*File* 003_BD_SA_Civil part_A1_r01.doc	

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Content

1 TECHNICAL REPORT FOR STATIC ASSESSMENT

1.1 INTRODUCTION

The topic of this static assessment is global analysis of new steel structure near the experimental cell. Calculation of the internal forces of the main components, check connections and assessment anchoring to the foundation concrete slab. Foundation of concrete cell is not subject of this static assessment. Static calculation is prepared in scope of project for detail design with respect all of allowed norm EN.

In static calculation are documented only necessarily output for design structures. Completed detailed outputs are compiled and will be printed and added on demand.

1.2 DESCRIPTION OF STRUCTURE

This is two floor steel structure = Control hutch. Dimension of steel structure is 9,14 x 4,44 m and height 6,441 m dimensions are dimensioned on axis of profile. Level of first floor is on level -3,000, level of axis beam for second floor is on level +0,411 and axis of roof beam is on level +3,361.

Columns are designed from profile HEB 140. Longitudinal beams on second floor and on the roof, are from profile IPE 160. Cross beams will be designed from IPE 140 and the outer beam will be from UPE 140.

1.3 MATERIALS USE IN BEARING STRUCTURE

- Steel beams S235

All products on site must have valid certificates.

1.4 LOAD USE IN CALCULATION

-	Self-load bearing structures	coefficient	1,35
-	Dead load	coefficient	1,35
-	Active load	coefficient	1,50

1.5 PROCEED CALCULATION AND MODELING

For design and modeling was prepared simple spatial structure of the whole steel structure. Spatial model is composed from beams.

The connections are rigid as well as articulated. The laying of the hall is considered articulated.

Load in each load condition was set in characteristic value, corresponding coefficient was used during making of load combination.

1.6 USED NORM, SOFTWARE AND BASES

Norm:

- EN 1990 Basis of structural design
- EN 1991-1-1 General actions - Densities, self-weight, imposed loads for buildings
- EN 1993-1-1 Design of steel structures - Part 1-1: General rules and rules for buildings

Bases:
- Project documentation of building part

Software:
- RFEM5 – Calculations of spatial structures using finite element method, Dlubal Praha
- FIN EC – Steel
- FIN EC – Steel connection

2 STATIC ASSESMENT

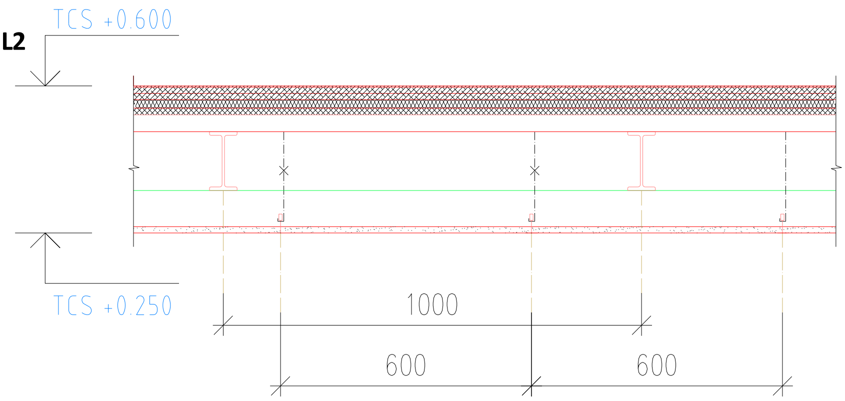
2.1 LOAD

2.1.1 OWN LOAD

- Self-weight of steel structure is calculated in spatial model.

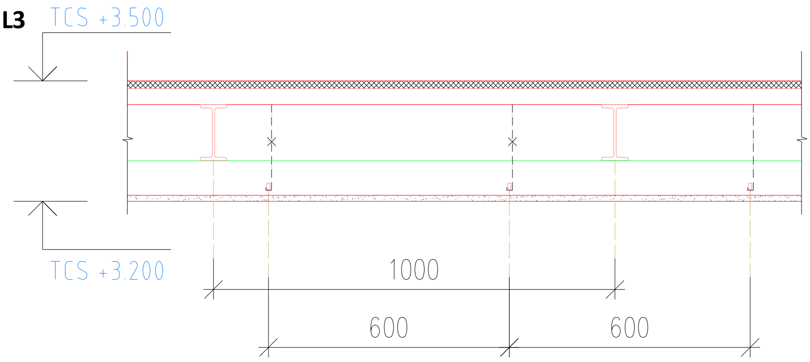
2.1.2 PERMANENT LOAD

The composition of ceiling +0,600 **L2**



Structure	Char. Load	Thickness	Char. Load	Load width	Char. Load
	[kNm^{-3}]	m	[kNm^{-2}]	m	[kNm^{-1}]
PVC -	12,00	0,003	0,036	1	0,036
2x OSB 3N	7,50	0,03	0,225	1	0,225
Step izolation	0,15	0,02	0,003	1	0,003
bottom plate	24,00	0,03	0,720	1	0,720
Trapezial sheet V 40		0,0063	0,064	1	0,064
IPE 140	Calculated by FEM model				
lower ceiling		0,015	0,028	1	0,028
Celkem			**1,076**		**1,076**

The composition of ceiling +3,500 **L3**



Structure	Char. Load	Thickness	Char. Load	Load width	Char. Load
	[kNm-3]	m	[kNm-2]	m	[kNm-1]
bottom plate	24,00	0,03	0,720	0,9-0,93	0,720
Trapezial sheet V 40		0,0063	0,064	0,9-0,93	0,064
IPE 140	Calculated by FEM model				
lower ceiling		0,015	0,024	0,9-0,93	0,024
Celkem			**0,808**		**0,808**

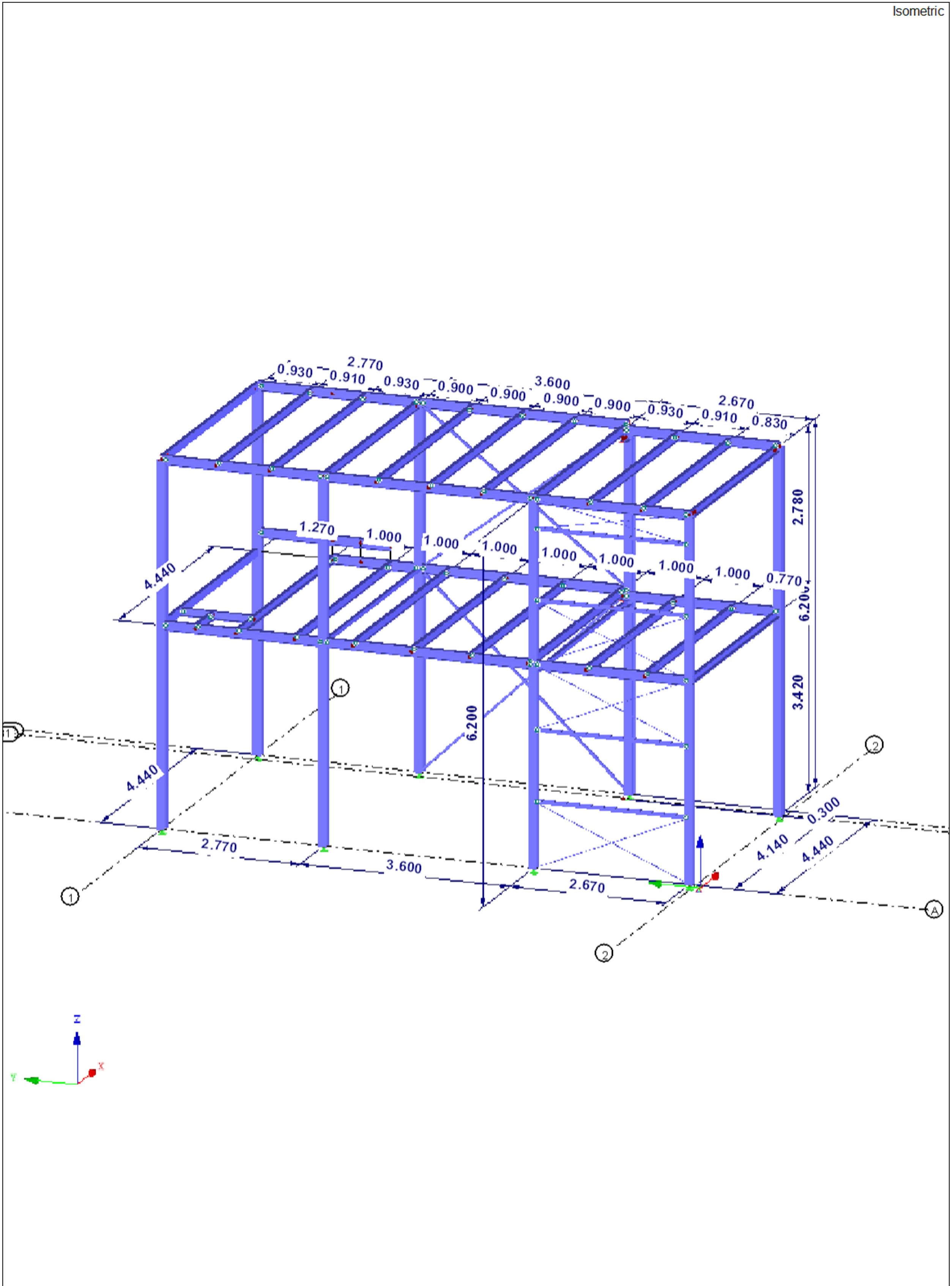
2.1.3 LIVE LOAD

- Active load on level +0,600m **2,5 kNm^{-2}**
- Active load on level +3,500m **1,0 kNm^{-2}**

2.1.4 INTERNAL WIND PRESSURE

- In X and Y direction 0,**1 kNm^{-2}**

2.2 SPATIAL MODEL OF STEEL STRUCTURE



Model - General Data

General	Model name		:	Nuvia - Ocelovka1 - změna zavětrování
	Type of model		:	3D
	Positive direction of global axis Z		:	Upward
	Classification of load cases and combinations		:	According to Standard: EN 1990 National Annex: ČSN - Česká Republika
	x Automatically create combinations		:	x Load Combinations
Options	- RF-FORM-FINDING - Find initial equilibrium shapes of membrane and cable structures			
	- RF-CUTTING-PATTERN			
	- Piping analysis			
	- Use CQC Rule			
	- Enable CAD/BIM model			
	Standard Gravity			
	g		:	10.00 m/s²

FE Mesh Settings

General	Target length of finite elements	l_{FE}	:	0.5 m
	Maximum distance between a node and a line to integrate it into the line	ε	:	0.0 m
	Maximum number of mesh nodes (in thousands)		:	500
Members	Number of divisions of members with cable, elastic foundation, taper, or plastic characteristic		:	10
	x Activate member divisions for large deformation or post-critical analysis			
	x Use division for members with node lying on them			
Surfaces	Maximum ratio of FE rectangle diagonals	Δ_D	:	1.800
	Maximum out-of-plane inclination of two finite elements	α	:	0.50 °
	Shape direction of finite elements		:	Triangles and quadrangles x Same squares where possible

1.3 Materials

Matl. No.	Modulus E [N/mm²]	Modulus G [N/mm²]	Poisson's Ratio ν [-]	Spec. Weight γ [kN/m³]	Coeff. of Th. Exp. α [1/°C]	Partial Factor γ_M [-]	Material Model
1	Concrete C30/37 | DIN 1045-1:2008-08						
	28300.00	11791.70	0.200	25.00	1.00E-05	1.00	Isotropic Linear Elastic
2	Steel S 235 | DIN EN 1993-1-1:2010-12						
	210000.00	80769.20	0.300	78.50	1.20E-05	1.00	Isotropic Linear Elastic

1.7 Nodal Supports

Support No.	Nodes No.	Axis System	Column in Z	Support Conditions u_X	u_Y	u_Z	φ_X	φ_Y	φ_Z
1	1-8	Global X,Y,Z	-	x	x	x	-	-	x

1.13 Cross-Sections

Section No.	Matl. No.	J [cm⁴] A [cm²]	I_y [cm⁴] A_y [cm²]	I_z [cm⁴] A_z [cm²]	Principal Axes α [°]	Rotation α' [°]	Overall Dimensions [mm] Width b	Height h
1	HEB 140 | Ferona - DIN 1025-2:1995							
	2	20.10 43.00	1510.00 28.04	550.00 8.26	0.00	0.00	140.0	140.0
2	IPE 160 | Ferona - DIN 1025-5:1994							

1.13 Cross-Sections

Section No.	Matl. No.	J [cm^4] / A [cm^2]	I_y [cm^4] / A_y [cm^2]	I_z [cm^4] / A_z [cm^2]	Principal Axes α [°]	Rotation α' [°]	Overall Dimensions [mm] Width b	Height h
	2	3.62	869.00	68.30	0.00	0.00	82.0	160.0
		20.10	10.17	7.33				
3	UPE 140							
	2	4.05	599.50	78.70	0.00	0.00	65.0	140.0
		18.40	6.25	5.87				
4	IPE 140							
	2	2.45	541.20	44.92	0.00	0.00	73.0	140.0
		16.43	8.45	5.99				
6	UPE 140							
	2	4.05	599.50	78.70	0.00	0.00	65.0	140.0
		18.40	6.25	5.87				
7	RD 12							
	2	0.20	0.10	0.10	0.00	0.00	12.0	12.0
		1.13	0.95	0.95				
11	UPE 80 | Ferona - DIN 1026-2							
	2	2.08	118.00	28.30	0.00	0.00	50.0	80.0
		11.30	5.08	2.76				
12	QRO 40x3.2 (warmgefertigt)							
	2	16.50	10.20	10.20	0.00	0.00	40.0	40.0
		4.60	2.00	2.00				
13	IPE 160 | Ferona - DIN 1025-5:1994							
	2	3.62	869.00	68.30	0.00	0.00	82.0	160.0
		20.10	10.17	7.33				
14	QRO 70x5 (warmgefertigt)							
	2	142.00	88.50	88.50	0.00	0.00	70.0	70.0
		12.70	5.50	5.50				

1.14 Member Hinges

Release No.	Reference System	Axial/Shear Release or Spring[kN/m] u_x	u_y	u_z	Moment Release or Spring[kNm/rad] φ_x	φ_y	φ_z	Comment
1	Local x,y,z	-	-	-	-	x	x	

1.15/1 Member Eccentricities - Absolute

Ecc. No.	Reference System	Member Start - Eccentricity [mm] $e_{i,X}$	$e_{i,Y}$	$e_{i,Z}$	Member End - Eccentricity $e_{j,X}$	$e_{j,Y}$	$e_{j,Z}$	Member hinge location Member Start	Member End
1	Global	0.0	87.6	150.0	0.0	87.6	150.0	at member	at member
2	Global	0.0	-87.6	150.0	0.0	-87.6	150.0	at member	at member
3	Global	0.0	0.0	150.0	0.0	0.0	150.0	at member	at member
4	Global	0.0	0.0	-80.0	0.0	0.0	-80.0	at member	at member

1.15/2 Member Eccentricities - Relative

Ecc. No.	Cross-Section Alignment y-Axis	z-Axis	Transverse offset from cross-section of another obj. Object Type	Object No.	y-Axis	z-Axis	Axial offset from adjacent Member Sta	Member End
1	Middle	Middle	None	0	Middle	Middle	-	-
2	Middle	Middle	None	0	Middle	Middle	-	-
3	Middle	Middle	None	0	Middle	Middle	-	-
4	Middle	Middle	None	0	Middle	Middle	-	-

1.17 Members

Mbr. No.	Line No.	Member	Rotation Type	β [°]	Cross-Section Start	End	Hinge No. Start	End	Ecc. No.	Div. No.	Length L [m]	
1	1	Beam	Angle	0.00	1	1	-	-	-	-	1.120	Z
2	2	Beam	Angle	0.00	1	1	-	-	-	-	1.120	Z
3	3	Beam	Angle	0.00	1	1	-	-	-	-	3.420	Z
4	4	Beam	Angle	0.00	1	1	-	-	-	-	3.420	Z
5	5	Beam	Angle	0.00	1	1	-	-	-	-	3.420	Z
6	6	Beam	Angle	0.00	1	1	-	-	-	-	0.150	Z

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1.17 Members

Mbr. No.	Line No.	Member	Rotation Type	Rotation β [°]	Cross-Section Start	Cross-Section End	Hinge No. Start	Hinge No. End	Ecc. No.	Div. No.	Length L [m]	
7	7	Beam	Angle	0.00	1	1	-	-	-	-	3.420	Z
8	8	Beam	Angle	0.00	1	1	-	-	-	-	3.420	Z
9	9	Beam	Angle	0.00	2	2	1	-	-	-	0.770	Y
10	10	Beam	Angle	0.00	1	1	-	-	-	-	1.080	Z
11	11	Beam	Angle	0.00	1	1	-	-	-	-	1.080	Z
12	12	Beam	Angle	0.00	2	2	1	-	-	-	0.100	Y
13	13	Beam	Angle	0.00	1	1	-	-	-	-	2.580	Z
14	14	Beam	Angle	0.00	2	2	1	-	-	-	0.500	Y
15	15	Beam	Angle	0.00	1	1	-	-	-	-	2.580	Z
16	79	Beam	Angle	0.00	2	2	-	-	-	-	0.570	Y
17	17	Beam	Angle	0.00	1	1	-	-	-	-	2.580	Z
18	18	Beam	Angle	0.00	1	1	-	-	-	-	0.320	Z
19	19	Beam	Angle	0.00	2	2	1	-	-	-	0.500	Y
20	20	Beam	Angle	0.00	1	1	-	-	-	-	0.120	Z
21	21	Beam	Angle	0.00	1	1	-	-	-	-	0.300	X
22	22	Beam	Angle	0.00	1	1	-	-	-	-	0.030	Z
23	23	Beam	Angle	0.00	2	2	1	-	-	-	0.770	Y
24	24	Beam	Angle	0.00	1	1	-	-	-	-	2.580	Z
25	25	Beam	Angle	0.00	1	1	-	-	-	-	3.260	Z
26	26	Beam	Angle	0.00	1	1	-	-	-	-	0.010	Z
27	27	Coupling R-R	Angle	0.00	0	0	-	-		-	0.150	Z
28	28	Beam	Angle	0.00	3	3	-	-	-	-	3.620	X
29	29	Beam	Angle	0.00	3	3	-	-	-	-	4.140	X
30	30	Beam	Angle	0.00	4	4	1	1	-	-	4.140	X
31	32	Beam	Angle	0.00	1	1	-	-	-	-	0.300	Z
32	65	Beam	Angle	0.00	1	1	-	-	-	-	0.300	Z
33	33	Beam	Angle	0.00	4	4	1	1	-	-	4.140	X
34	34	Beam	Angle	0.00	2	2	-	1	-	-	0.900	Y
35	35	Beam	Angle	0.00	2	2	-	1	-	-	0.900	Y
36	48	Beam	Angle	0.00	2	2	-	-	-	-	0.340	Y
37	37	Beam	Angle	0.00	2	2	-	-	-	-	1.000	Y
38	38	Beam	Angle	0.00	4	4	1	1	-	-	4.440	X
39	39	Beam	Angle	0.00	2	2	-	-	-	-	1.000	Y
40	40	Beam	Angle	0.00	4	4	1	1	-	-	4.440	X
41	41	Beam	Angle	0.00	2	2	-	-	-	-	1.000	Y
42	42	Beam	Angle	0.00	4	4	1	1	-	-	4.440	X
43	43	Beam	Angle	0.00	2	2	-	1	-	-	0.500	Y
44	44	Beam	Angle	0.00	2	2	-	1	-	-	0.100	Y
45	45	Beam	Angle	0.00	2	2	-	-	-	-	1.000	Y
46	46	Beam	Angle	0.00	2	2	-	-	-	-	1.000	Y
47	47	Beam	Angle	0.00	2	2	-	-	-	-	1.000	Y
48	73	Beam	Angle	0.00	1	1	-	-	-	-	1.200	Z
49	49	Beam	Angle	0.00	2	2	-	-	-	-	1.000	Y
50	50	Beam	Angle	0.00	2	2	-	1	-	-	0.500	Y
51	51	Beam	Angle	180.00	6	6	1	-	-	-	3.620	X
52	52	Beam	Angle	0.00	2	2	1	-	-	-	0.500	Y
53	53	Beam	Angle	0.00	2	2	-	-	-	-	0.700	Y
54	54	Beam	Angle	0.00	4	4	1	1	-	-	0.820	X
55	55	Beam	Angle	0.00	2	2	-	1	-	-	0.570	Y
56	56	Beam	Angle	0.00	6	6	1	-	-	-	0.570	Y
57	57	Beam	Angle	0.00	3	3	-	-	-	-	0.820	X
58	58	Beam	Angle	180.00	6	6	-	1	-	-	0.820	X
59	59	Beam	Angle	0.00	6	6	-	1	-	-	0.700	Y
60	60	Beam	Angle	0.00	1	1	-	-	-	-	1.200	Z
61	61	Beam	Angle	0.00	1	1	-	-	-	-	1.200	Z
62	62	Truss (N only)	Angle	0.00	12	12	-	-	-	-	4.966	YZ
63	63	Truss (N only)	Angle	0.00	12	12	-	-	-	-	4.966	YZ
64	64	Beam	Angle	0.00	2	2	1	-	-	-	0.830	Y
65	74	Beam	Angle	0.00	1	1	-	-	-	-	1.200	Z
66	66	Beam	Angle	0.00	2	2	1	-	-	-	0.930	Y

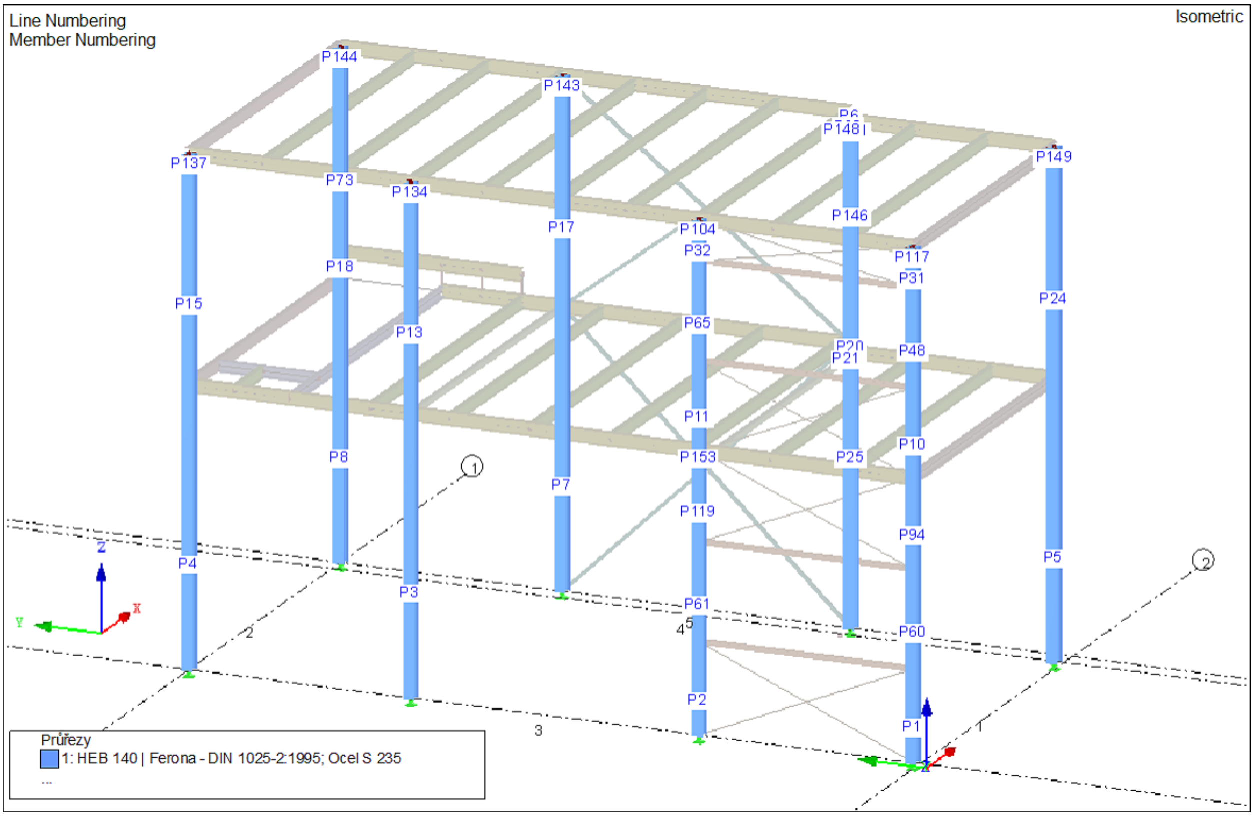
1.17 Members

Mbr.	Line		Rotation		Cross-Section		Hinge No.		Ecc.	Div.	Length	
No.	No.	Member	Type	β [°]	Start	End	Start	End	No.	No.	L [m]	
67	67	Beam	Angle	0.00	2	2	1	-	-	-	0.900	Y
68	68	Beam	Angle	0.00	1	1	-	-	-	-	0.200	X
69	69	Beam	Angle	0.00	2	2	1	-	-	-	0.830	Y
70	71	Beam	Angle	0.00	2	2	-	-	-	-	1.000	Y
71	78	Beam	Angle	0.00	2	2	-	-	-	-	1.000	Y
72	72	Beam	Angle	0.00	4	4	1	1	-	-	4.140	X
73	94	Beam	Angle	0.00	1	1	-	-	-	-	2.260	Z
74	89	Beam	Angle	-90.00	11	11	-	1	-	-	1.335	Y
75	75	Beam	Angle	0.00	4	4	1	1	-	-	4.140	X
76	76	Beam	Angle	0.00	2	2	-	1	-	-	0.930	Y
77	77	Beam	Angle	0.00	2	2	-	1	-	-	0.930	Y
78	125	Beam	Angle	0.00	2	2	-	-	-	-	0.500	Y
79	113	Beam	Angle	0.00	2	2	-	-	-	-	0.500	Y
80	80	Beam	Angle	0.00	4	4	1	1	-	-	4.440	X
81	81	Beam	Angle	0.00	2	2	-	-	-	-	0.900	Y
82	82	Beam	Angle	0.00	4	4	1	1	-	-	4.440	X
83	83	Beam	Angle	0.00	2	2	-	-	-	-	0.900	Y
84	84	Beam	Angle	0.00	4	4	1	1	-	-	4.440	X
85	85	Beam	Angle	0.00	2	2	-	1	-	-	0.900	Y
86	86	Beam	Angle	0.00	2	2	-	1	-	-	0.930	Y
87	87	Beam	Angle	0.00	2	2	-	-	-	-	0.900	Y
88	88	Beam	Angle	0.00	2	2	-	-	-	-	0.900	Y
89	117	Beam	Angle	0.00	4	4	1	1	-	-	4.440	X
90	90	Beam	Angle	0.00	2	2	1	-	-	-	0.930	Y
91	91	Beam	Angle	0.00	2	2	-	-	-	-	0.910	Y
92	92	Beam	Angle	0.00	2	2	-	1	-	-	0.930	Y
93	93	Beam	Angle	0.00	2	2	-	-	-	-	0.910	Y
94	115	Beam	Angle	0.00	1	1	-	-	-	-	1.100	Z
95	95	Beam	Angle	0.00	2	2	1	-	-	-	0.900	Y
96	96	Beam	Angle	0.00	2	2	-	-	-	-	0.910	Y
97	97	Beam	Angle	0.00	2	2	-	1	-	-	0.900	Y
98	99	Beam	Angle	0.00	4	4	-	-	-	-	0.200	X
99	100	Beam	Angle	0.00	4	4	1	1	-	-	4.440	X
100	108	Beam	Angle	0.00	4	4	-	-	-	-	3.940	X
101	101	Beam	Angle	0.00	1	1	-	-	-	-	0.200	Z
102	118	Beam	Angle	0.00	4	4	1	1	-	-	4.440	X
103	127	Beam	Angle	0.00	2	2	-	1	-	-	1.270	Y
104	129	Beam	Angle	0.00	1	1	-	-	-	-	0.200	Z
105	105	Truss (N only)	Angle	0.00	12	12	-	-	-	-	4.548	YZ
106	106	Truss (N only)	Angle	0.00	12	12	-	-	-	-	4.548	YZ
107	98	Beam	Angle	180.00	3	3	-	-	-	-	0.200	X
108	102	Beam	Angle	0.00	3	3	-	-	-	-	0.200	X
109	36	Coupling R-R	Angle	0.00	0	0	-	-		-	0.150	Z
110	107	Beam	Angle	0.00	4	4	1	1	-	-	4.440	X
111	130	Beam	Angle	0.00	4	4	-	-	-	-	0.200	X
112	70	Beam	Angle	-90.00	11	11	1	-	-	-	1.335	Y
113	109	Tension	Angle	0.00	7	7	-	-	-	-	2.880	YZ
114	110	Tension	Angle	0.00	7	7	-	-	-	-	2.880	YZ
115	111	Tension	Angle	0.00	7	7	-	-	-	-	2.716	YZ
116	112	Tension	Angle	0.00	7	7	-	-	-	-	2.716	YZ
117	132	Beam	Angle	0.00	1	1	-	-	-	-	0.200	Z
118	114	Beam	Angle	-90.00	11	11	1	1	-	-	2.670	Y
119	119	Beam	Angle	0.00	1	1	-	-	-	-	0.950	Z
120	120	Tension	Angle	0.00	7	7	-	-	-	-	2.895	YZ
121	121	Tension	Angle	0.00	7	7	-	-	-	-	2.895	YZ
122	122	Tension	Angle	0.00	7	7	-	-	-	-	2.888	YZ
123	123	Tension	Angle	0.00	7	7	-	-	-	-	2.888	YZ
124	116	Beam	Angle	-90.00	11	11	1	1	-	-	2.670	Y
125	124	Beam	Angle	-90.00	11	11	1	1	-	-	2.670	Y
126	31	Beam	Angle	0.00	2	2	-	-	-	-	0.500	Y

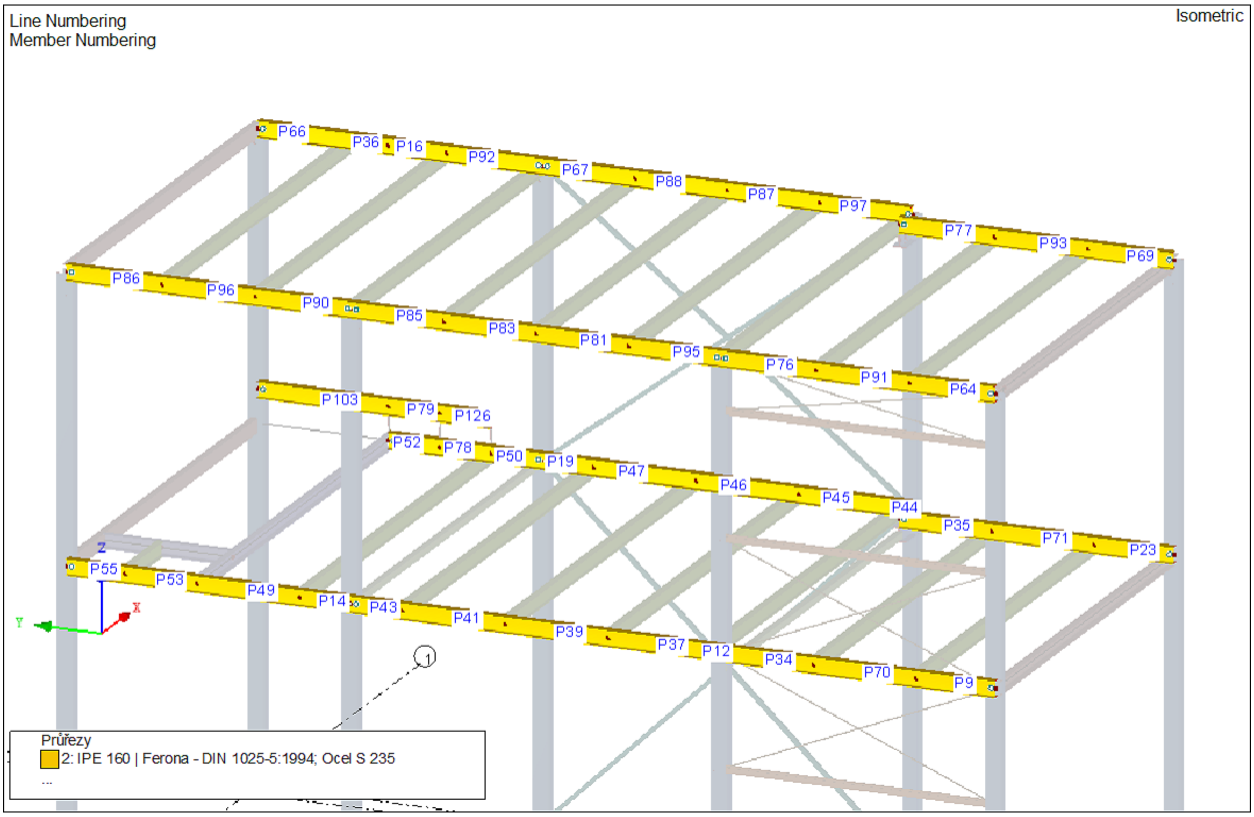
1.17 Members

Mbr. No.	Line No.	Member	Rotation Type	β [°]	Cross-Section Start	Cross-Section End	Hinge No. Start	Hinge No. End	Ecc. No.	Div. No.	Length L [m]	
127	103	Coupling R-R	Angle	0.00	0	0	-	-		-	0.320	Z
128	104	Coupling R-R	Angle	0.00	0	0	-	-		-	0.320	Z
129	126	Coupling R-R	Angle	0.00	0	0	-	-		-	0.320	Z
130	128	Rigid Member	Angle	0.00	0	0	-	-	-	-	0.283	XZ
131	131	Rigid Member	Angle	0.00	0	0	-	-	-	-	0.283	XZ
132	133	Beam	Angle	180.00	3	3	-	-	-	-	0.200	X
133	134	Rigid Member	Angle	0.00	0	0	-	-	-	-	0.283	XZ
134	135	Beam	Angle	0.00	1	1	-	-	-	-	0.200	Z
135	136	Beam	Angle	0.00	4	4	-	-	-	-	0.200	X
136	137	Rigid Member	Angle	0.00	0	0	-	-	-	-	0.283	XZ
137	138	Beam	Angle	0.00	1	1	-	-	-	-	0.200	Z
138	139	Beam	Angle	0.00	3	3	-	-	-	-	0.200	X
139	140	Rigid Member	Angle	0.00	0	0	-	-	-	-	0.283	XZ
140	141	Rigid Member	Angle	360.00	0	0	-	-	-	-	0.283	XZ
141	142	Rigid Member	Angle	0.00	0	0	-	-	-	-	0.283	XZ
142	143	Rigid Member	Angle	0.00	0	0	-	-	-	-	0.283	XZ
143	144	Beam	Angle	0.00	1	1	-	-	-	-	0.200	Z
144	145	Beam	Angle	0.00	1	1	-	-	-	-	0.200	Z
145	146	Beam	Angle	0.00	4	4	-	-	-	-	4.040	X
146	147	Beam	Angle	0.00	1	1	-	-	-	-	2.430	Z
147	148	Beam	Angle	0.00	3	3	-	-	-	-	4.040	X
148	149	Beam	Angle	0.00	1	1	-	-	-	-	0.100	X
149	150	Beam	Angle	0.00	1	1	-	-	-	-	0.200	Z
150	151	Beam	Angle	180.00	3	3	-	-	-	-	3.740	X
153	154	Beam	Angle	0.00	1	1	-	-	-	-	0.150	Z
154	152	Beam	Angle	0.00	14	14	-	-	-	-	4.440	X
155	153	Beam	Angle	0.00	14	14	-	-	-	-	4.140	X

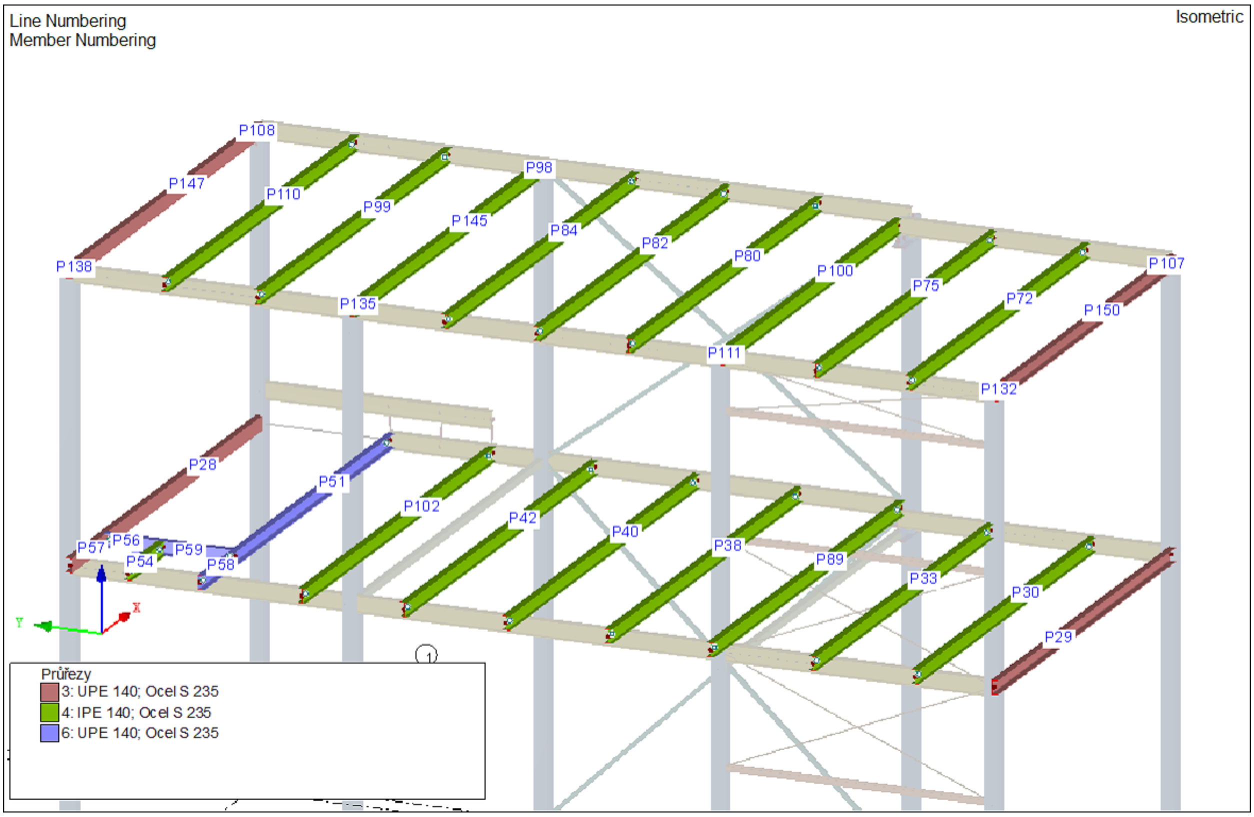
Model - Number of columns



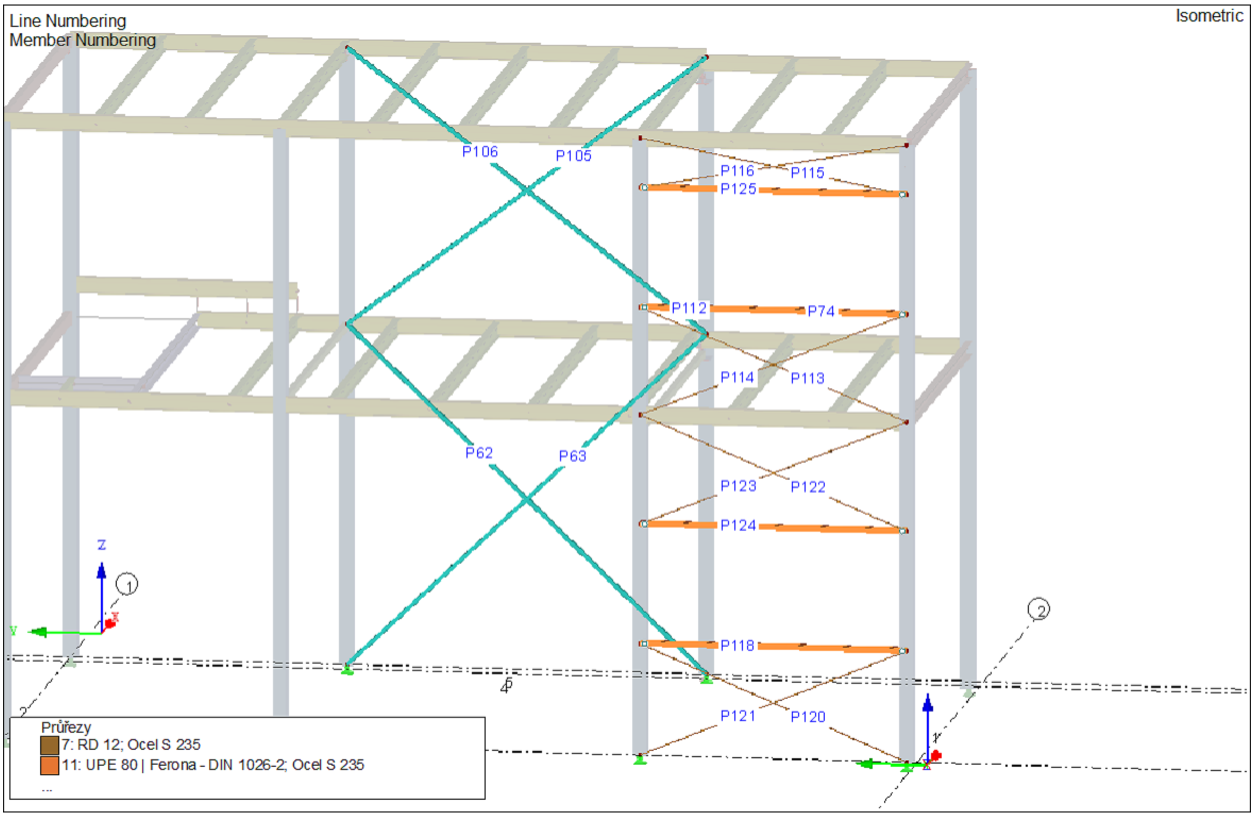
Model - Number of beams



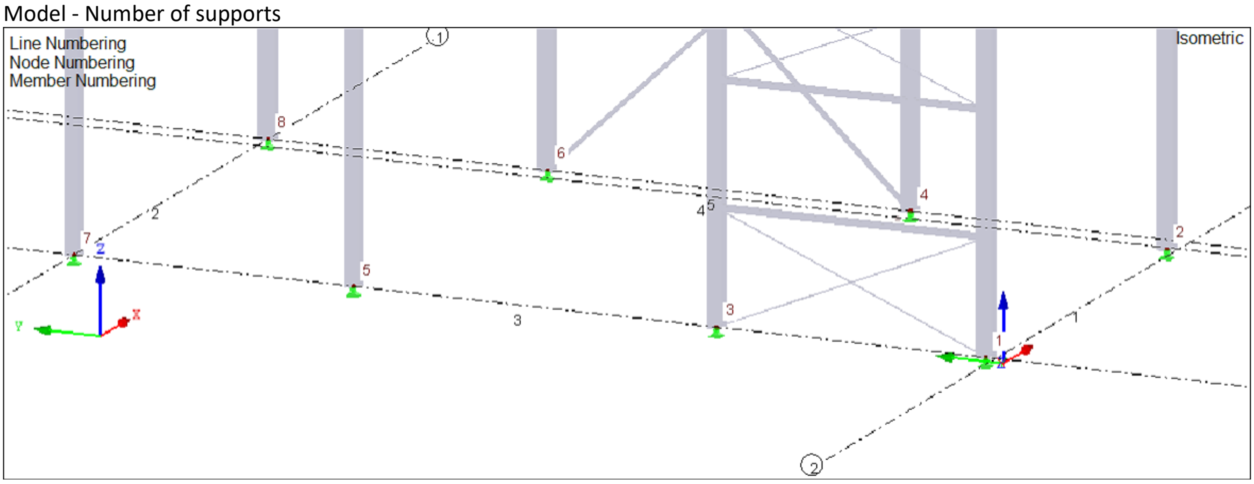
Model - Number of transverse beams



Model - Number of bending



Model - Number of supports



2.1 Load Cases

Load Case	Load Case Description	EN 1990 | ČSN Action Category	Self-Weight - Factor in Direction Active	X	Y	Z
LC1	Vlastní tíha	Permanent	x	0.000	0.000	-1.000
LC2	Ostatní stálé zatížení	Permanent/Imposed	-			
LC3	Užitné zatížení	Imposed - Category A: domestic, residential areas	-			
LC4	Vnitřní tlak + X	Wind	-			
LC5	Vnitřní tlak +Y	Wind	-			

2.5 Load Combinations

Load Combin.	DS	Load Combination Description	No.	Factor	Load Case	
CO1	STR	1.35*ZS1	1	1.35	LC1	Vlastní tíha

2.5 Load Combinations

Load Combin.	DS	Load Combination Description	No.	Factor	Load Case	
CO2	STR	1.35*ZS1 + 1.35*ZS2	1	1.35	LC1	Vlastní tíha
			2	1.35	LC2	Ostatní stálé zatížení
CO3	STR	1.35*ZS1 + 1.5*ZS3	1	1.35	LC1	Vlastní tíha
			2	1.50	LC3	Užitné zatížení
CO4	STR	1.35*ZS1 + 1.35*ZS2 + 1.5*ZS3	1	1.35	LC1	Vlastní tíha
			2	1.35	LC2	Ostatní stálé zatížení
			3	1.50	LC3	Užitné zatížení
CO5	STR	1.35*ZS1 + 1.35*ZS2 + 1.5*ZS3 + 0.9*ZS4	1	1.35	LC1	Vlastní tíha
			2	1.35	LC2	Ostatní stálé zatížení
			3	1.50	LC3	Užitné zatížení
			4	0.90	LC4	Vnitřní tlak + X
CO6	STR	1.35*ZS1 + 1.35*ZS2 + 1.5*ZS3 + 0.9*ZS5	1	1.35	LC1	Vlastní tíha
			2	1.35	LC2	Ostatní stálé zatížení
			3	1.50	LC3	Užitné zatížení
			4	0.90	LC5	Vnitřní tlak +Y
CO7	STR	1.35*ZS1 + 1.5*ZS3 + 0.9*ZS4	1	1.35	LC1	Vlastní tíha
			2	1.50	LC3	Užitné zatížení
			3	0.90	LC4	Vnitřní tlak + X
CO8	STR	1.35*ZS1 + 1.5*ZS3 + 0.9*ZS5	1	1.35	LC1	Vlastní tíha
			2	1.50	LC3	Užitné zatížení
			3	0.90	LC5	Vnitřní tlak +Y
CO9	STR	1.35*ZS1 + 1.5*ZS4	1	1.35	LC1	Vlastní tíha
			2	1.50	LC4	Vnitřní tlak + X
CO10	STR	1.35*ZS1 + 1.5*ZS5	1	1.35	LC1	Vlastní tíha
			2	1.50	LC5	Vnitřní tlak +Y
CO11	STR	1.35*ZS1 + 1.35*ZS2 + 1.5*ZS4	1	1.35	LC1	Vlastní tíha
			2	1.35	LC2	Ostatní stálé zatížení
			3	1.50	LC4	Vnitřní tlak + X
CO12	STR	1.35*ZS1 + 1.35*ZS2 + 1.5*ZS5	1	1.35	LC1	Vlastní tíha
			2	1.35	LC2	Ostatní stálé zatížení
			3	1.50	LC5	Vnitřní tlak +Y
CO13	STR	1.35*ZS1 + 1.35*ZS2 + 1.05*ZS3 + 1.5*ZS4	1	1.35	LC1	Vlastní tíha
			2	1.35	LC2	Ostatní stálé zatížení
			3	1.05	LC3	Užitné zatížení
			4	1.50	LC4	Vnitřní tlak + X
CO14	STR	1.35*ZS1 + 1.35*ZS2 + 1.05*ZS3 + 1.5*ZS5	1	1.35	LC1	Vlastní tíha
			2	1.35	LC2	Ostatní stálé zatížení
			3	1.05	LC3	Užitné zatížení
			4	1.50	LC5	Vnitřní tlak +Y
CO15	STR	1.35*ZS1 + 1.05*ZS3 + 1.5*ZS4	1	1.35	LC1	Vlastní tíha
			2	1.05	LC3	Užitné zatížení
			3	1.50	LC4	Vnitřní tlak + X
CO16	STR	1.35*ZS1 + 1.05*ZS3 + 1.5*ZS5	1	1.35	LC1	Vlastní tíha
			2	1.05	LC3	Užitné zatížení
			3	1.50	LC5	Vnitřní tlak +Y
CO17	S Ch	ZS1	1	1.00	LC1	Vlastní tíha
CO18	S Ch	ZS1 + ZS2	1	1.00	LC1	Vlastní tíha
			2	1.00	LC2	Ostatní stálé zatížení
CO19	S Ch	ZS1 + ZS3	1	1.00	LC1	Vlastní tíha
			2	1.00	LC3	Užitné zatížení
CO20	S Ch	ZS1 + ZS2 + ZS3	1	1.00	LC1	Vlastní tíha
			2	1.00	LC2	Ostatní stálé zatížení
			3	1.00	LC3	Užitné zatížení
CO21	S Ch	ZS1 + ZS2 + ZS3 + 0.6*ZS4	1	1.00	LC1	Vlastní tíha
			2	1.00	LC2	Ostatní stálé zatížení
			3	1.00	LC3	Užitné zatížení
			4	0.60	LC4	Vnitřní tlak + X
CO22	S Ch	ZS1 + ZS2 + ZS3 + 0.6*ZS5	1	1.00	LC1	Vlastní tíha
			2	1.00	LC2	Ostatní stálé zatížení
			3	1.00	LC3	Užitné zatížení
			4	0.60	LC5	Vnitřní tlak +Y

2.5 Load Combinations

Load Combin.	DS	Load Combination Description	No.	Factor	Load Case	
CO23	S Ch	ZS1 + ZS3 + 0.6*ZS4	1	1.00	LC1	Vlastní tíha
			2	1.00	LC3	Užitné zatížení
			3	0.60	LC4	Vnitřní tlak + X
CO24	S Ch	ZS1 + ZS3 + 0.6*ZS5	1	1.00	LC1	Vlastní tíha
			2	1.00	LC3	Užitné zatížení
			3	0.60	LC5	Vnitřní tlak +Y
CO25	S Ch	ZS1 + ZS4	1	1.00	LC1	Vlastní tíha
			2	1.00	LC4	Vnitřní tlak + X
CO26	S Ch	ZS1 + ZS5	1	1.00	LC1	Vlastní tíha
			2	1.00	LC5	Vnitřní tlak +Y
CO27	S Ch	ZS1 + ZS2 + ZS4	1	1.00	LC1	Vlastní tíha
			2	1.00	LC2	Ostatní stálé zatížení
			3	1.00	LC4	Vnitřní tlak + X
CO28	S Ch	ZS1 + ZS2 + ZS5	1	1.00	LC1	Vlastní tíha
			2	1.00	LC2	Ostatní stálé zatížení
			3	1.00	LC5	Vnitřní tlak +Y
CO29	S Ch	ZS1 + ZS2 + 0.7*ZS3 + ZS4	1	1.00	LC1	Vlastní tíha
			2	1.00	LC2	Ostatní stálé zatížení
			3	0.70	LC3	Užitné zatížení
			4	1.00	LC4	Vnitřní tlak + X
CO30	S Ch	ZS1 + ZS2 + 0.7*ZS3 + ZS5	1	1.00	LC1	Vlastní tíha
			2	1.00	LC2	Ostatní stálé zatížení
			3	0.70	LC3	Užitné zatížení
			4	1.00	LC5	Vnitřní tlak +Y
CO31	S Ch	ZS1 + 0.7*ZS3 + ZS4	1	1.00	LC1	Vlastní tíha
			2	0.70	LC3	Užitné zatížení
			3	1.00	LC4	Vnitřní tlak + X
CO32	S Ch	ZS1 + 0.7*ZS3 + ZS5	1	1.00	LC1	Vlastní tíha
			2	0.70	LC3	Užitné zatížení
			3	1.00	LC5	Vnitřní tlak +Y
CO33	S Fr	ZS1	1	1.00	LC1	Vlastní tíha
CO34	S Fr	ZS1 + ZS2	1	1.00	LC1	Vlastní tíha
			2	1.00	LC2	Ostatní stálé zatížení
CO35	S Fr	ZS1 + 0.5*ZS3	1	1.00	LC1	Vlastní tíha
			2	0.50	LC3	Užitné zatížení
CO36	S Fr	ZS1 + ZS2 + 0.5*ZS3	1	1.00	LC1	Vlastní tíha
			2	1.00	LC2	Ostatní stálé zatížení
			3	0.50	LC3	Užitné zatížení
CO37	S Fr	ZS1 + 0.2*ZS4	1	1.00	LC1	Vlastní tíha
			2	0.20	LC4	Vnitřní tlak + X
CO38	S Fr	ZS1 + 0.2*ZS5	1	1.00	LC1	Vlastní tíha
			2	0.20	LC5	Vnitřní tlak +Y
CO39	S Fr	ZS1 + ZS2 + 0.2*ZS4	1	1.00	LC1	Vlastní tíha
			2	1.00	LC2	Ostatní stálé zatížení
			3	0.20	LC4	Vnitřní tlak + X
CO40	S Fr	ZS1 + ZS2 + 0.2*ZS5	1	1.00	LC1	Vlastní tíha
			2	1.00	LC2	Ostatní stálé zatížení
			3	0.20	LC5	Vnitřní tlak +Y
CO41	S Fr	ZS1 + ZS2 + 0.3*ZS3 + 0.2*ZS4	1	1.00	LC1	Vlastní tíha
			2	1.00	LC2	Ostatní stálé zatížení
			3	0.30	LC3	Užitné zatížení
			4	0.20	LC4	Vnitřní tlak + X
CO42	S Fr	ZS1 + ZS2 + 0.3*ZS3 + 0.2*ZS5	1	1.00	LC1	Vlastní tíha
			2	1.00	LC2	Ostatní stálé zatížení
			3	0.30	LC3	Užitné zatížení
			4	0.20	LC5	Vnitřní tlak +Y
CO43	S Fr	ZS1 + 0.3*ZS3 + 0.2*ZS4	1	1.00	LC1	Vlastní tíha
			2	0.30	LC3	Užitné zatížení
			3	0.20	LC4	Vnitřní tlak + X
CO44	S Fr	ZS1 + 0.3*ZS3 + 0.2*ZS5	1	1.00	LC1	Vlastní tíha
			2	0.30	LC3	Užitné zatížení

2.5 Load Combinations

Load Combin.	DS	Load Combination Description	No.	Factor	Load Case	
			3	0.20	LC5	Vnitřní tlak +Y
CO45	S Qp	ZS1	1	1.00	LC1	Vlastní tíha
CO46	S Qp	ZS1 + ZS2	1	1.00	LC1	Vlastní tíha
			2	1.00	LC2	Ostatní stálé zatížení
CO47	S Qp	ZS1 + ZS2 + 0.3*ZS3	1	1.00	LC1	Vlastní tíha
			2	1.00	LC2	Ostatní stálé zatížení
			3	0.30	LC3	Užitné zatížení
CO48	S Qp	ZS1 + 0.3*ZS3	1	1.00	LC1	Vlastní tíha
			2	0.30	LC3	Užitné zatížení

2.7 Result Combinations

Result Combin	Description	Loading
RC1	MSÚ (STR/GEO) - trvalá/dočasná - rovn. 6.10	CO1/s or CO2/s or CO3/s or CO4/s or CO5/s or CO6/s or CO7/s or CO8/s or CO9/s or CO10/s or CO11/s or CO12/s or CO13/s or CO14/s or CO15/s or CO16/s
RC2	MSP - charakteristická	CO17/s or CO18/s or CO19/s or CO20/s or CO21/s or CO22/s or CO23/s or CO24/s or CO25/s or CO26/s or CO27/s or CO28/s or CO29/s or CO30/s or CO31/s or CO32/s
RC3	MSP - častá	CO33/s or CO34/s or CO35/s or CO36/s or CO37/s or CO38/s or CO39/s or CO40/s or CO41/s or CO42/s or CO43/s or CO44/s
RC4	MSP - kvazistálá	CO45/s or CO46/s or CO47/s or CO48/s

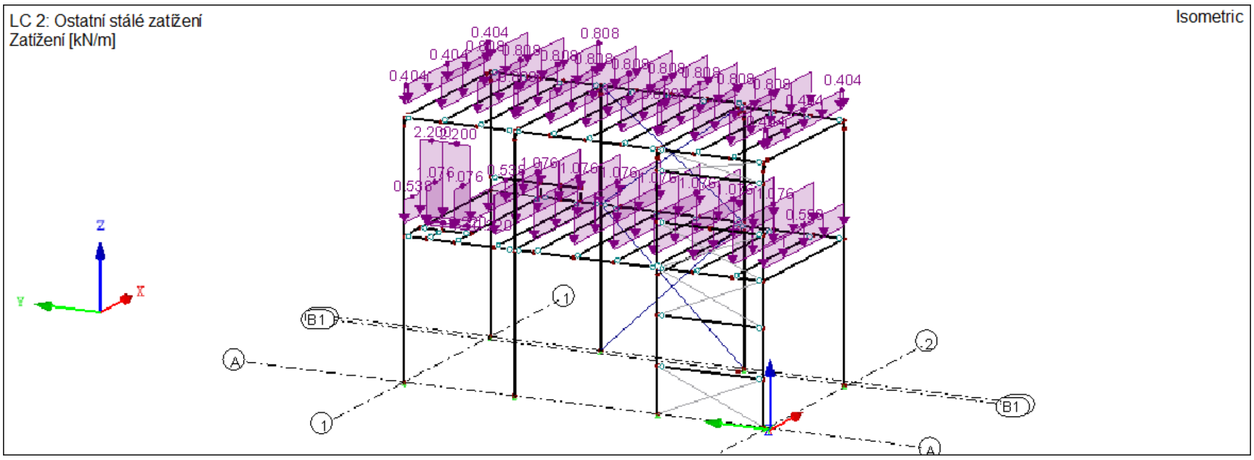
LC2
Ostatní stálé zatížení

3.2 Member Loads

LC2: Ostatní stálé zatížení

No.	Reference to	On Members No.	Load Type	Load Distribution	Load Direction	Reference Length	Load Parameters Symbol	Value	Unit
1	Members	54,58	Force	Uniform	ZL	True Length	p	-1.076	kN/m
2	Members	29,51,57	Force	Uniform	ZL	True Length	p	-0.538	kN/m
3	Members	30,33,38,40,42,89,102	Force	Uniform	ZL	True Length	p	-1.076	kN/m
5	Members	56,59	Force	Uniform	ZL	True Length	p	-2.200	kN/m
6	Members	56,59	Force	Uniform	XL	True Length	p	-0.220	kN/m
7	Members	72,75,80,82,84,98-100,110,111,135,145	Force	Uniform	ZL	True Length	p	-0.808	kN/m
8	Members	107,108,132,138,147,150	Force	Uniform	ZL	True Length	p	-0.404	kN/m

LC2: Ostatní stálé zatížení



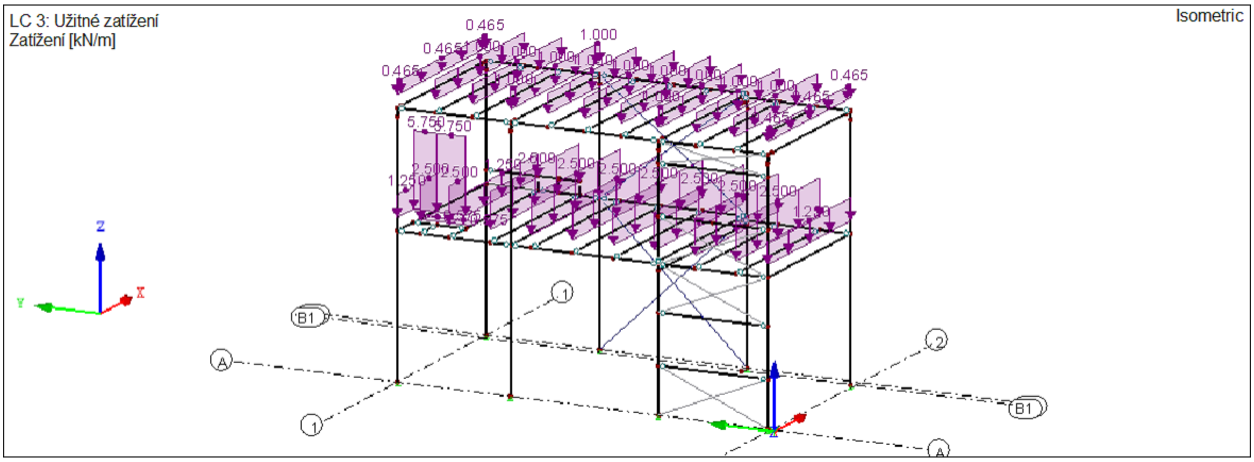
LC3
Užitné zatížení

3.2 Member Loads

LC3: Užitné zatížení

No.	Reference to	On Members No.	Load Type	Load Distribution	Load Direction	Reference Length	Load Parameters Symbol	Value	Unit
1	Members	30,33,38,40,42,54,58,89,102	Force	Uniform	ZL	True Length	p	-2.500	kN/m
2	Members	29,51,57	Force	Uniform	ZL	True Length	p	-1.250	kN/m
5	Members	56,59	Force	Uniform	XL	True Length	p	-0.575	kN/m
6	Members	56,59	Force	Uniform	ZL	True Length	p	-5.750	kN/m
7	Members	72,75,80,82,84,98-100,110,111,135,145	Force	Uniform	ZL	True Length	p	-1.000	kN/m
8	Members	107,108,132,138,147,150	Force	Uniform	ZL	True Length	p	-0.465	kN/m

LC3: Užitné zatížení



LC4

Vnitřní tlak + X

3.15 Generated Loads

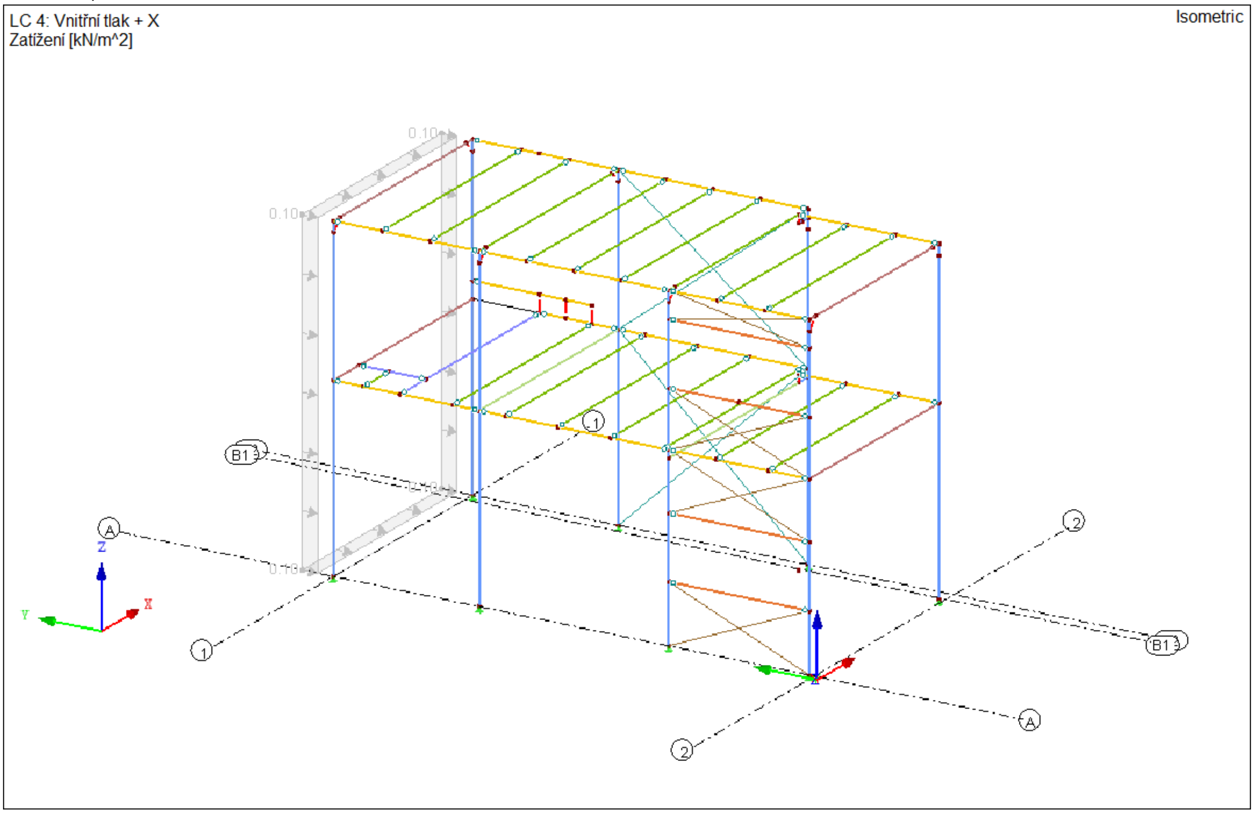
LC4: Vnitřní tlak + X

No.	Load Description				
1	From Area Loads via Plane				
	Area load direction	Perpendicular to the plane		:	x z
	Member load direction	Direction of generated member loads:		:	x Local in x, y, z
	Area of load application	x Fully closed plane			
	Load distribution type:	x Combined			
	Area load magnitude	x Constant		:	-0.10 kN/m²
	Boundary of the area load plane	Corner nodes		:	15,16,8,7
		Note		:	Each row in the drop down list box denotes one plane
	Remove influence from	Single members		:	28,57,108,138,147
	Generating total loads in direction	Σ P Areas	X	:	0.000 kN
			Y	:	-2.753 kN
			Z	:	0.000 kN
		ΣP Members	X	:	0.000 kN
			Y	:	-2.753 kN
			Z	:	0.000 kN
	Total moment to the origin	Σ M Areas	X	:	8.534 kNm
			Y	:	0.000 kNm
			Z	:	-6.469 kNm

3.15 Generated Loads

No.	Load Description			
		ΣM Members	X :	8.534 kNm
			Y :	0.000 kNm
			Z :	-6.469 kNm
	Cells selected for generating	Σ number of cells	:	3
		Σ cell area	:	27.528 m²
	Convert loads to members No.		:	4,8,15,18,73,136,137,142,144

LC4: Vnitøní tlak + X



LC5
Vnitøní tlak +Y

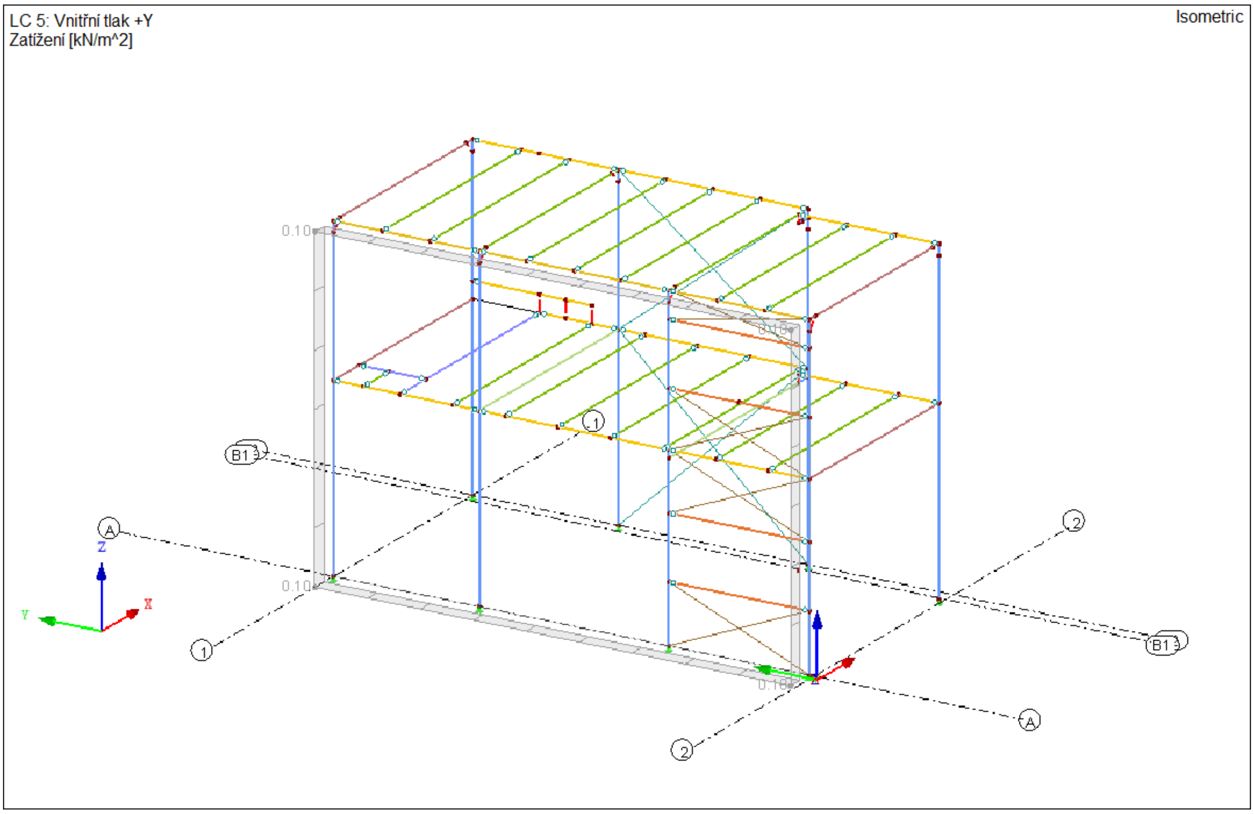
3.15 Generated Loads

No.	Load Description			
1	From Area Loads via Plane			
	Area load direction	Perpendicular to the plane	:	x z
	Member load direction	Direction of generated member loads:	:	x Local in x, y, z
	Area of load application	x Fully closed plane		
	Load distribution type:	x Combined		
	Area load magnitude	x Constant	:	0.10 kN/m²
	Boundary of the area load plane	Corner nodes	:	1,9,15,7
		Note	:	Each row in the drop down list box denotes one plane
	Remove influence from	Single members	:	9,12,14,34,37,39,41,43,49,53,5 5,64,70,74,76,81,83,85,86,90,9

3.15 Generated Loads

No.	Load Description					
					1,95,96,112,113,114,115,116,118,120,121,122,123,124,125	
	Generating total loads in direction	Σ P Areas	X	:	5.605	kN
			Y	:	0.000	kN
			Z	:	0.000	kN
		ΣP Members	X	:	5.605	kN
			Y	:	0.000	kN
			Z	:	0.000	kN
	Total moment to the origin	Σ M Areas	X	:	0.000	kNm
			Y	:	17.375	kNm
			Z	:	-26.623	kNm
		ΣM Members	X	:	0.000	kNm
			Y	:	17.375	kNm
			Z	:	-26.623	kNm
	Cells selected for generating	Σ number of cells		:	3	
		Σ cell area		:	56.048	m²
	Convert loads to members No.			:	1-4,10,11,13,15,31,32,48,60,61,65,94,104,117,119,134,137,153	

LC5: Vnitřní tlak +Y

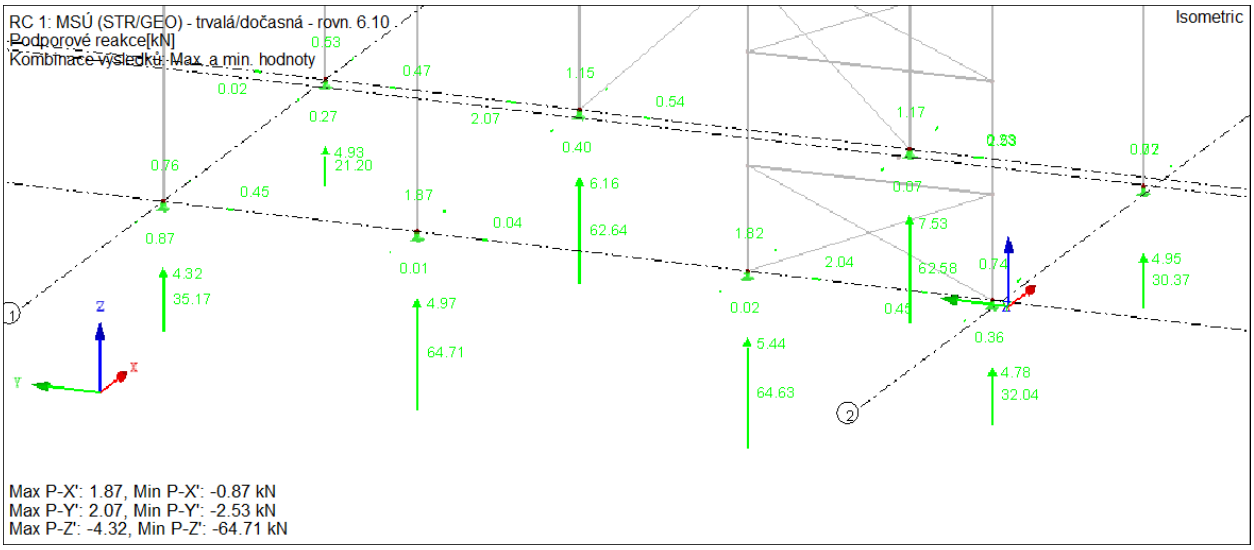


Result Combinations

4.1 Nodes - Support Forces

Node			Support Forces [kN]			Support Moments [kNm]			
No.	RC		$P_{X'}$	$P_{Y'}$	$P_{Z'}$	$M_{X'}$	$M_{Y'}$	$M_{Z'}$	
1	RC1	Max $P_{x'}$	> 0.74	0.00	-4.78	0.00	0.00	0.00	CO 10
		Min $P_{x'}$	> -0.36	0.02	-30.53	0.00	0.00	0.00	CO 4
		Max $P_{y'}$	-0.28	> 0.45	-28.02	0.00	0.00	0.00	CO 13
		Min $P_{y'}$	0.74	> 0.00	-4.78	0.00	0.00	0.00	CO 10
		Max $P_{z'}$	0.74	0.00	> -4.78	0.00	0.00	0.00	CO 10
		Min $P_{z'}$	-0.36	0.26	> -32.04	0.00	0.00	0.00	CO 5
2	RC1	Max $P_{x'}$	> 0.77	0.00	-25.76	0.00	0.00	0.00	CO 14
		Min $P_{x'}$	> 0.02	0.00	-4.95	0.00	0.00	0.00	CO 1
		Max $P_{y'}$	0.02	> 0.00	-4.95	0.00	0.00	0.00	CO 1
		Min $P_{y'}$	0.10	> 0.00	-13.08	0.00	0.00	0.00	CO 11
		Max $P_{z'}$	0.02	0.00	> -4.95	0.00	0.00	0.00	CO 1
		Min $P_{z'}$	0.65	0.00	> -30.37	0.00	0.00	0.00	CO 6
3	RC1	Max $P_{x'}$	> 1.82	-0.01	-50.49	0.00	0.00	0.00	CO 14
		Min $P_{x'}$	> -0.02	-2.01	-5.44	0.00	0.00	0.00	CO 9
		Max $P_{y'}$	1.74	> 0.00	-5.74	0.00	0.00	0.00	CO 10
		Min $P_{y'}$	0.06	> -2.04	-50.66	0.00	0.00	0.00	CO 13
		Max $P_{z'}$	-0.02	-2.01	> -5.44	0.00	0.00	0.00	CO 9
		Min $P_{z'}$	0.07	-0.02	> -64.63	0.00	0.00	0.00	CO 4
4	RC1	Max $P_{x'}$	> 1.17	-0.30	-9.62	0.00	0.00	0.00	CO 10
		Min $P_{x'}$	> -0.07	-2.53	-61.86	0.00	0.00	0.00	CO 5
		Max $P_{y'}$	0.02	> -0.23	-7.53	0.00	0.00	0.00	CO 1
		Min $P_{y'}$	-0.07	> -2.53	-61.86	0.00	0.00	0.00	CO 5
		Max $P_{z'}$	0.02	-0.23	> -7.53	0.00	0.00	0.00	CO 1
		Min $P_{z'}$	0.63	-2.09	> -62.58	0.00	0.00	0.00	CO 6
5	RC1	Max $P_{x'}$	> 1.87	0.00	-50.30	0.00	0.00	0.00	CO 14
		Min $P_{x'}$	> -0.01	0.00	-7.11	0.00	0.00	0.00	CO 1
		Max $P_{y'}$	1.81	> 0.00	-4.97	0.00	0.00	0.00	CO 10
		Min $P_{y'}$	-0.01	> -0.04	-7.11	0.00	0.00	0.00	CO 9
		Max $P_{z'}$	1.81	0.00	> -4.97	0.00	0.00	0.00	CO 10
		Min $P_{z'}$	0.06	0.00	> -64.71	0.00	0.00	0.00	CO 4
6	RC1	Max $P_{x'}$	> 1.15	0.29	-9.79	0.00	0.00	0.00	CO 10
		Min $P_{x'}$	> -0.40	1.55	-59.95	0.00	0.00	0.00	CO 5
		Max $P_{y'}$	0.29	> 2.07	-62.64	0.00	0.00	0.00	CO 6
		Min $P_{y'}$	0.01	> -0.54	-6.16	0.00	0.00	0.00	CO 9
		Max $P_{z'}$	0.01	-0.54	> -6.16	0.00	0.00	0.00	CO 9
		Min $P_{z'}$	0.29	2.07	> -62.64	0.00	0.00	0.00	CO 6
7	RC1	Max $P_{x'}$	> 0.76	0.00	-4.32	0.00	0.00	0.00	CO 10
		Min $P_{x'}$	> -0.87	0.00	-35.17	0.00	0.00	0.00	CO 4
		Max $P_{y'}$	0.76	> 0.00	-4.32	0.00	0.00	0.00	CO 10
		Min $P_{y'}$	-0.03	> -0.45	-5.23	0.00	0.00	0.00	CO 9
		Max $P_{z'}$	0.76	0.00	> -4.32	0.00	0.00	0.00	CO 10
		Min $P_{z'}$	-0.87	0.00	> -35.17	0.00	0.00	0.00	CO 4
8	RC1	Max $P_{x'}$	> 0.53	0.00	-6.01	0.00	0.00	0.00	CO 10
		Min $P_{x'}$	> -0.27	0.02	-20.62	0.00	0.00	0.00	CO 4
		Max $P_{y'}$	-0.27	> 0.02	-20.62	0.00	0.00	0.00	CO 4
		Min $P_{y'}$	0.03	> -0.47	-4.93	0.00	0.00	0.00	CO 9
		Max $P_{z'}$	0.03	-0.47	> -4.93	0.00	0.00	0.00	CO 9
		Min $P_{z'}$	0.04	0.02	> -21.20	0.00	0.00	0.00	CO 6

Support reaction



4.12 Cross-Sections - Internal Forces

Result Combinations

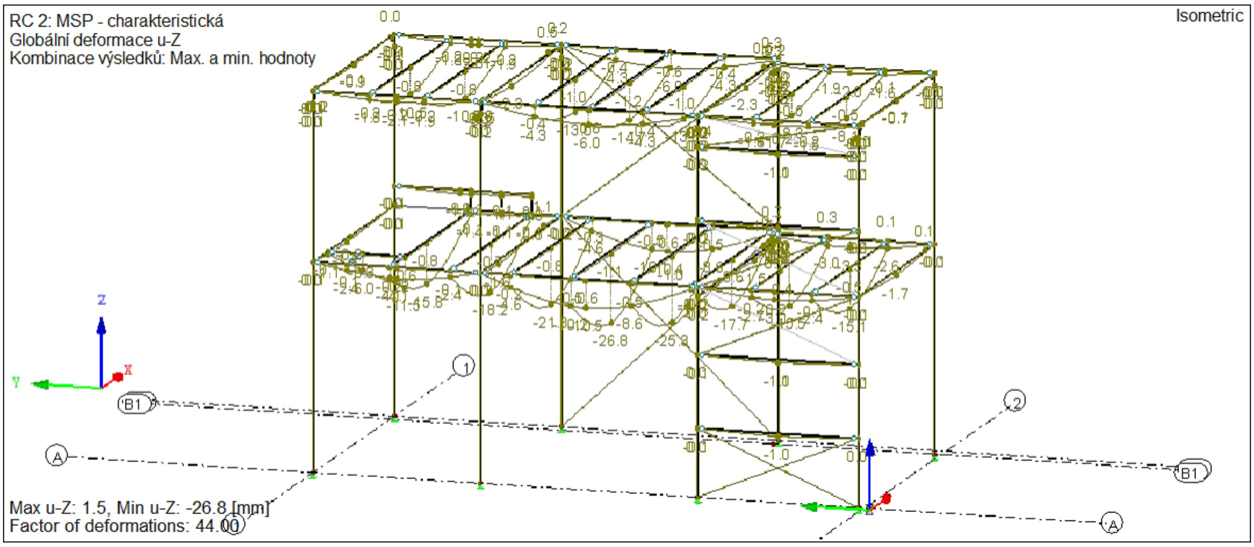
Member No.	RC	Node No.	Location x [m]		Forces [kN] N	V_y	V_z	Moments [kNm] M_T	M_y	M_z	Corresponding Load Cases
	Section No. 1: HEB 140 | Ferona - DIN 1025-2:1995										
21	RC1		0.150	MAX N	> 1.57	0.00	10.85	0.00	-1.06	0.00	CO 4
3	RC1	5	0.000	MIN N	> -64.71	0.00	-0.01	0.00	0.00	0.00	CO 4
60	RC1		0.600	MAX V_y	-26.00	> 0.84	-0.28	0.00	-0.49	-0.01	CO 13
18	RC1	81	0.320	MIN V_y	-14.63	> -0.79	1.35	0.00	-1.46	0.53	CO 13
21	RC1	30	0.000	MAX V_z	1.13	0.00	> 11.39	0.00	-3.79	0.00	CO 6
32	RC1	88	0.300	MIN V_z	-21.46	0.00	> -2.65	0.00	-3.57	0.00	CO 6
119	RC1	75	0.000	MAX M_T	-51.17	-0.26	-0.05	> 0.00	-0.12	-0.50	CO 13
21	RC1	27	0.300	MIN M_T	0.21	0.01	0.88	> 0.00	-0.13	0.00	CO 9
17	RC1	97	2.580	MAX M_y	-20.43	0.00	1.91	0.00	> 7.56	0.00	CO 14
146	RC1	100	0.000	MIN M_y	-18.58	0.00	2.44	0.00	> -6.80	0.00	CO 14
18	RC1	81	0.320	MAX M_z	-14.63	-0.79	1.35	0.00	-1.46	> 0.53	CO 13
60	RC1	74	1.200	MIN M_z	-25.73	0.83	-0.28	0.00	-0.65	> -0.51	CO 13
	Section No. 2: IPE 160 | Ferona - DIN 1025-5:1994										
52	RC1	82	0.500	MAX N	> 23.10	0.00	0.41	0.00	0.23	0.00	CO 4
79	RC1	80	0.500	MIN N	> -23.58	0.06	1.99	0.00	1.13	0.14	CO 5
12	RC1	35	0.100	MAX V_y	-0.38	> 0.99	26.90	0.00	2.69	-0.10	CO 5
44	RC1	20	0.100	MIN V_y	2.42	> -1.12	-26.88	0.00	0.00	0.00	CO 5
12	RC1	19	0.000	MAX V_z	-0.37	0.99	> 26.92	0.00	0.00	0.00	CO 5
44	RC1	20	0.100	MIN V_z	2.42	-1.12	> -26.88	0.00	0.00	0.00	CO 5
39	RC1	39	1.000	MAX M_T	0.00	0.03	2.59	> 0.04	20.23	-0.04	CO 6
53	RC1	45	0.000	MIN M_T	0.00	0.24	-7.79	> -0.09	11.08	0.28	CO 14
39	RC1	39	1.000	MAX M_y	-0.73	0.02	2.59	0.03	> 20.24	0.03	CO 5
126	RC1	79	0.000	MIN M_y	-1.91	0.00	0.32	0.00	> -0.04	0.00	CO 9
53	RC1	45	0.000	MAX M_z	-0.77	0.30	-9.87	0.01	13.98	> 0.37	CO 5
50	RC1	44	0.000	MIN M_z	-0.90	-0.32	-13.87	0.02	6.96	> -0.16	CO 5
	Section No. 3: UPE 140										
28	RC1		1.034	MAX N	> 1.88	0.00	1.12	0.00	-0.10	0.00	CO 4
147	RC1		2.020	MIN N	> -1.78	0.00	0.22	0.00	1.13	0.00	CO 6
138	RC1	86	0.000	MAX V_y	0.02	> 0.05	0.36	0.00	-0.03	0.01	CO 13
108	RC1	94	0.200	MIN V_y	0.00	> -0.03	-0.05	0.00	0.00	0.00	CO 9
29	RC1	17	0.000	MAX V_z	1.30	0.00	> 5.79	0.00	-3.72	0.00	CO 4
57	RC1	23	0.820	MIN V_z	1.14	0.00	> -10.39	0.00	-5.45	0.00	CO 4
57	RC1	23	0.820	MAX M_T	0.98	0.00	-8.22	> 0.00	-4.32	0.00	CO 13
28	RC1	51	3.620	MIN M_T	1.56	0.00	0.43	> 0.00	1.68	0.00	CO 13
28	RC1	51	3.620	MAX M_y	1.64	0.00	1.00	0.00	> 2.68	0.00	CO 6
57	RC1	23	0.820	MIN M_y	1.14	0.00	-10.39	0.00	> -5.45	0.00	CO 4
138	RC1	86	0.000	MAX M_z	0.02	0.05	0.36	0.00	-0.03	> 0.01	CO 13
132	RC1	92	0.000	MIN M_z	0.02	-0.03	-0.36	0.00	0.03	> 0.00	CO 13

4.12 Cross-Sections - Internal Forces

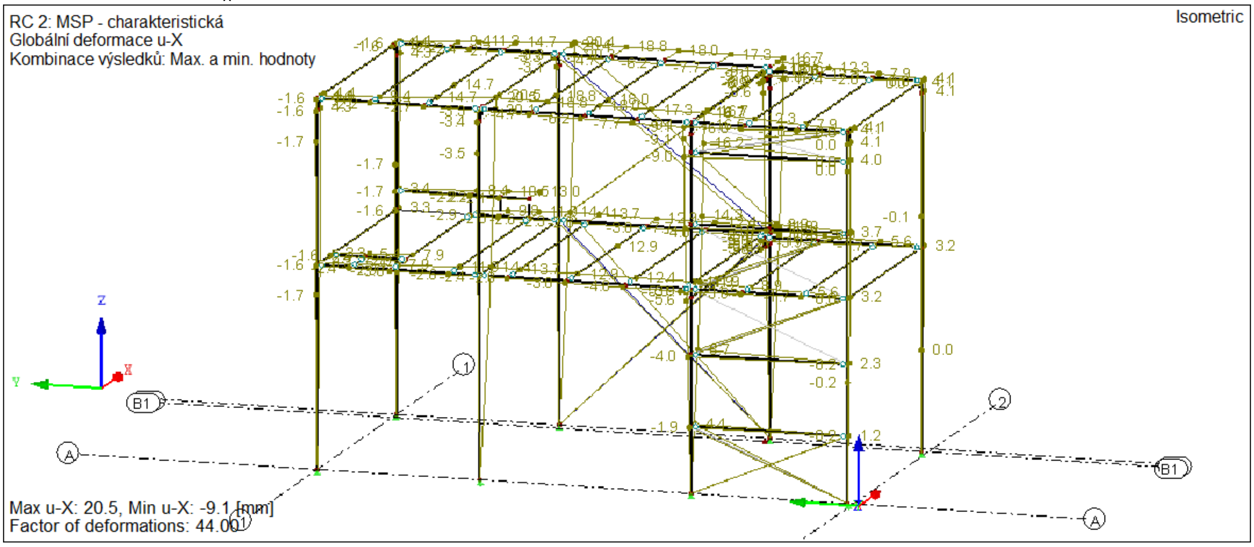
Result Combinations

Member No.	RC	Node No.	Location x [m]		Forces [kN] N	V_y	V_z	Moments [kNm] M_T	M_y	M_z	Corresponding Load Cases
	Section No. 4: IPE 140										
89	RC1	36	0.000	MAX N	> 1.40	0.15	11.91	0.00	0.00	0.00	CO 5
100	RC1		1.970	MIN N	> -2.72	0.00	0.04	0.00	2.33	0.00	CO 6
89	RC1	36	0.000	MAX V_y	1.40	> 0.15	11.91	0.00	0.00	0.00	CO 5
89	RC1	35	4.440	MIN V_y	1.40	> -0.15	-11.91	0.00	0.00	0.00	CO 4
38	RC1	38	0.000	MAX V_z	0.05	0.09	> 11.94	0.00	0.00	0.00	CO 4
38	RC1	37	4.440	MIN V_z	0.05	-0.09	> -11.94	0.00	0.00	0.00	CO 5
54	RC1	48	0.820	MAX M_T	0.00	-0.03	-2.20	> 0.02	0.00	0.00	CO 4
100	RC1	84	3.940	MIN M_T	-2.53	0.00	-6.65	> 0.00	-5.40	0.00	CO 4
38	RC1		1.973	MAX M_y	0.05	0.01	1.33	0.00	> 13.09	0.00	CO 4
145	RC1	93	0.000	MIN M_y	-1.88	0.00	6.58	0.00	> -6.58	0.00	CO 14
111	RC1	84	0.000	MAX M_z	0.06	0.02	0.79	0.00	-0.07	> 0.00	CO 13
145	RC1	93	0.000	MIN M_z	-0.17	0.00	0.35	0.00	-0.21	> 0.00	CO 9
	Section No. 6: UPE 140										
51	RC1	46	0.000	MAX N	> 0.18	-0.01	-7.96	0.00	0.00	0.00	CO 4
58	RC1	50	0.000	MIN N	> -0.58	0.00	10.63	0.00	-10.53	0.00	CO 6
56	RC1	51	0.000	MAX V_y	0.11	> 0.74	8.72	-0.02	0.00	0.00	CO 6
59	RC1	50	0.700	MIN V_y	-0.08	> -0.66	-8.47	-0.02	0.00	0.00	CO 6
58	RC1	45	0.820	MAX V_z	-0.47	-0.01	> 15.06	0.00	0.00	0.00	CO 6
59	RC1	50	0.700	MIN V_z	-0.08	-0.66	> -8.47	-0.02	0.00	0.00	CO 6
51	RC1	46	0.000	MAX M_T	0.00	0.00	-0.46	> 0.00	0.00	0.00	CO 9
56	RC1	48	0.570	MIN M_T	0.03	0.08	1.99	> -0.04	3.05	-0.22	CO 6
56	RC1	48	0.570	MAX M_y	0.03	0.07	2.00	-0.02	> 3.05	-0.22	CO 4
51	RC1		3.103	MIN M_y	0.07	0.00	0.71	0.00	> -11.25	0.00	CO 6
51	RC1	50	3.620	MAX M_z	0.01	0.00	0.81	0.00	-3.10	> 0.00	CO 2
59	RC1	48	0.000	MIN M_z	0.00	0.06	-0.21	-0.04	3.04	> -0.22	CO 6
	Section No. 7: RD 12										
121	RC1	76	2.895	MAX N	> 2.69	0.00	0.00	0.00	0.00	0.00	CO 13
120	RC1	1	0.000	MIN N	> -0.01	0.00	0.00	0.00	0.00	0.00	CO 1
113	RC1	17	0.000	MAX V_y	0.00	> 0.00	0.00	0.00	0.00	0.00	CO 1
113	RC1	17	0.000	MIN V_y	0.00	> 0.00	0.00	0.00	0.00	0.00	CO 1
113	RC1	17	0.000	MAX V_z	0.00	0.00	> 0.00	0.00	0.00	0.00	CO 1
113	RC1	17	0.000	MIN V_z	0.00	0.00	> 0.00	0.00	0.00	0.00	CO 1
113	RC1	17	0.000	MAX M_T	0.00	0.00	0.00	> 0.00	0.00	0.00	CO 1
113	RC1	17	0.000	MIN M_T	0.00	0.00	0.00	> 0.00	0.00	0.00	CO 1
113	RC1	17	0.000	MAX M_y	0.00	0.00	0.00	0.00	> 0.00	0.00	CO 1
113	RC1	17	0.000	MIN M_y	0.00	0.00	0.00	0.00	> 0.00	0.00	CO 1
113	RC1	17	0.000	MAX M_z	0.00	0.00	0.00	0.00	0.00	> 0.00	CO 1
113	RC1	17	0.000	MIN M_z	0.00	0.00	0.00	0.00	0.00	> 0.00	CO 1
	Section No. 12: QRO 40x3.2 (za tepla)										
63	RC1	20	0.000	MAX N	> 0.83	0.00	0.00	0.00	0.00	0.00	CO 9
62	RC1	4	4.966	MIN N	> -3.57	0.00	0.00	0.00	0.00	0.00	CO 5
62	RC1	22	0.000	MAX V_y	-0.23	> 0.00	0.00	0.00	0.00	0.00	CO 1
62	RC1	22	0.000	MIN V_y	-0.23	> 0.00	0.00	0.00	0.00	0.00	CO 1
62	RC1	22	0.000	MAX V_z	-0.23	0.00	> 0.00	0.00	0.00	0.00	CO 1
62	RC1	22	0.000	MIN V_z	-0.23	0.00	> 0.00	0.00	0.00	0.00	CO 1
62	RC1	22	0.000	MAX M_T	-0.23	0.00	0.00	> 0.00	0.00	0.00	CO 1
62	RC1	22	0.000	MIN M_T	-0.23	0.00	0.00	> 0.00	0.00	0.00	CO 1
62	RC1	22	0.000	MAX M_y	-0.23	0.00	0.00	0.00	> 0.00	0.00	CO 1
62	RC1	22	0.000	MIN M_y	-0.23	0.00	0.00	0.00	> 0.00	0.00	CO 1
62	RC1	22	0.000	MAX M_z	-0.23	0.00	0.00	0.00	0.00	> 0.00	CO 1
62	RC1	22	0.000	MIN M_z	-0.23	0.00	0.00	0.00	0.00	> 0.00	CO 1

Global Deformations u_Z



Global Deformations u_X



IPE 160

$U_{lim2} = L_2/250$ $L_2 =$ 3600 mm

$U_{lim2} =$ 14,40 mm > Ufin= 10,40 mm **PASS**

IPE 140

$U_{lim2} = L_2/250$ $L_2 =$ 4440 mm

$U_{lim2} =$ 17,76 mm > Ufin= 16,70 mm **PASS**

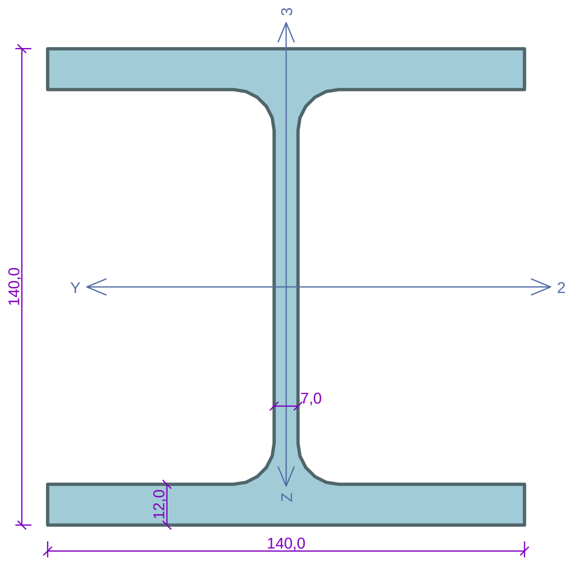
column HEB 140

$U_{lim2} = L_2/250$ $L_2 =$ 6200 mm

$U_{lim2} =$ 24,80 mm > Ufin= 20,50 mm **PASS**

2.2.1 ASSESSMENT OF BEAMS

Columns HEB 140



Standard **EN 1993-1-1/Czech Rep.**.

Section capacity	:	γ_{M0}	=	1,000
Section resistance when checking stability	:	γ_{M1}	=	1,000
Perforated section capacity	:	γ_{M2}	=	1,250

Section HE 140 B
Cross-sectional area: A = 4,296E03 mm^2
Centre of gravity position:
y_T = 70,0 mm z_T = 70,0 mm
Second moments of area:
I_y = 1,509E07 mm^4 I_z = 5,497E06 mm^4
Cross-section moduli:
$W_{y,1}$ = -2,156E05 mm^3 $W_{z,1}$ = 7,852E04 mm^3
$W_{y,2}$ = 2,156E05 mm^3 $W_{z,2}$ = -7,852E04 mm^3
Torsion constant:
I_k = 2,006E05 mm^4
Warping constant:
I_ω = 2,248E10 mm^6
Plastic cross-section moduli:
$W_{pl,y}$ = 2,454E05 mm^3 $W_{pl,z}$ = 1,198E05 mm^3

Material: EN 10210-1 : S 235
Material characteristics:

Yield strength	f_y	:	235,0	MPa
Ultimate strength	f_u	:	360,0	MPa
Elastic modulus	E	:	210000	MPa
Shear modulus	G	:	81000	MPa

Internal forces in system of cross-section coordinates
Load with maximal utilization
Zat. případ 1

N	=	-62,830	kN				
V_z	=	11,010	kN	M_y	=	7,730	kNm
V_y	=	0,000	kN	M_z	=	0,000	kNm
T_t	=	0,000	kNm				
T_ω	=	0,000	kNm	B	=	0,000	kNm^2

Buckling parameters
Length: 6,200 m
L_z = 3,400 m k_z = 1,000 $L_{cr,z}$ = 3,400 m
L_y = 6,200 m k_y = 1,000 $L_{cr,y}$ = 6,200 m

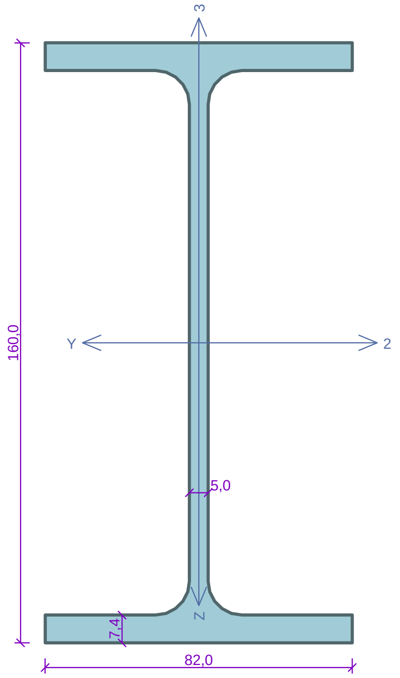
LTB parameters
End condition factors: k_y = - k_z = 0.7R k_w = 1.0
l_{z1} = 3,400 m M_y: Shape no.3 ψ = -1,000
l_{y1} = No input M_z: Shape no.2

Results - Decisive load: Zat. případ 1; **Cross-section class:** 1
Check of shear due to shear force V_z:
11,010 kN < 177,466 kN   **Pass**
Internal forces: N = -62,830 kN; M_y = 7,730 kNm; M_z = 0,000 kNm
Critical combination check: buckling compression and bending moment:
Buckling Y: Resistances: N_R = -531,993 kN; $M_{y,R}$ = 57,669 kNm
| 0,118 + 0,134 + 0,000 | = | 0,252 | < 1   **Pass**
Buckling Z: Resistances: N_R = -538,046 kN; $M_{y,R}$ = 57,669 kNm
| 0,117 + 0,134 + 0,000 | = | 0,251 | < 1   **Pass**
Member slenderness: 104,6

Section ok

25,2 % PASS

Beams IPE 160



Standard **EN 1993-1-1/Czech Rep.**.

Section capacity	:	γ_{M0}	=	1,000
Section resistance when checking stability	:	γ_{M1}	=	1,000
Perforated section capacity	:	γ_{M2}	=	1,250

Section IPE 160
Cross-sectional area: $A = 2{,}009E03\ mm^2$
Centre of gravity position:
$y_T = 41{,}0$ mm $z_T = 80{,}0$ mm
Second moments of area:
$I_y = 8{,}693E06\ mm^4$ $I_z = 6{,}831E05\ mm^4$
Cross-section moduli:
$W_{y,1} = -1{,}087E05\ mm^3$ $W_{z,1} = 1{,}666E04\ mm^3$
$W_{y,2} = 1{,}087E05\ mm^3$ $W_{z,2} = -1{,}666E04\ mm^3$
Torsion constant:
$I_k = 3{,}600E04\ mm^4$
Warping constant:
$I_\omega = 3{,}960E09\ mm^6$
Plastic cross-section moduli:
$W_{pl,y} = 1{,}239E05\ mm^3$ $W_{pl,z} = 2{,}610E04\ mm^3$

Material: EN 10210-1 : S 235
Material characteristics:

Yield strength	f_y	:	235,0	MPa
Ultimate strength	f_u	:	360,0	MPa
Elastic modulus	E	:	210000	MPa
Shear modulus	G	:	81000	MPa

Internal forces in system of cross-section coordinates
Load with maximal utilization
Zat. případ 1

N	=	2,470	kN				
V_z	=	26,880	kN	M_y	=	20,190	kNm
V_y	=	2,460	kN	M_z	=	-0,470	kNm
T_t	=	0,080	kNm				
T_ω	=	0,000	kNm	B	=	0,000	kNm^2

Buckling parameters
Length: 3,600 m
$L_z = 1{,}000$ m $k_z = 1{,}000$ $L_{cr,z} = 1{,}000$ m
$L_y = 3{,}600$ m $k_y = 0{,}500$ $L_{cr,y} = 1{,}800$ m

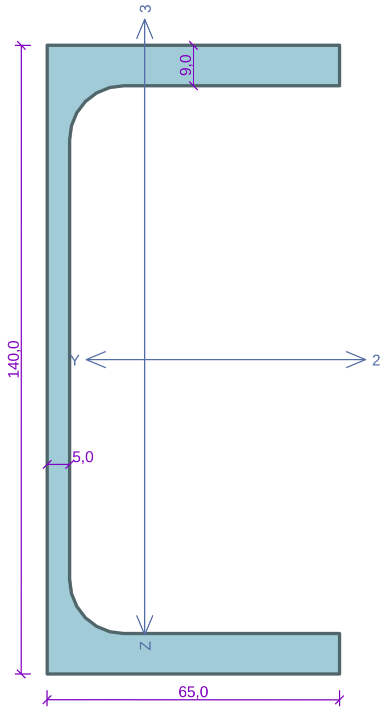
LTB parameters
End condition factors: k_y = - $k_z = 1.0$ $k_w = 1.0$
l_{z1} = 1,000 m M_y: Shape no.4 z_P = 0,500
l_{y1} = No input M_z: Shape no.4 y_P =

Results - Decisive load: Zat. případ 1; **Cross-section class:** 1
Check of shear due to torsion:
Stress: $\tau_t = 16{,}444$ MPa; $\tau_w = 0{,}000$ MPa
Strength: $\tau_{Rd} = 135{,}677$ MPa
16,444+0,000 < 135,677 **Pass**
Check of shear due to shear force V_z:
26,880 kN < 126,646 kN **Pass**
Check of shear due to shear force V_y:
2,460 kN < 134,527 kN **Pass**
Internal forces: N = 2,470 kN; $M_y = 20{,}190$ kNm; $M_z = -0{,}470$ kNm
Critical combination check: simple tension and bending moment:
Resistances: $N_R = 472{,}115$ kN; $M_{y,R} = 27{,}318$ kNm; $M_{z,R} = -6{,}134$ kNm
| 0,005 + 0,739 + 0,077 | = | 0,821 | < 1 **Pass**
Member slenderness: 54,7

Section ok

82,1 % PASS

Transverse beams UPE140



Standard **EN 1993-1-1/Czech Rep.**.

Section capacity	:	γ_{M0}	=	1,000
Section resistance when checking stability	:	γ_{M1}	=	1,000
Perforated section capacity	:	γ_{M2}	=	1,250

Section UPE 140
Cross-sectional area: A = 1,840E03 mm^2
Centre of gravity position:
y_T = 21,7 mm z_T = 70,0 mm
Second moments of area:
I_y = 6,000E06 mm^4 I_z = 7,870E05 mm^4
Cross-section moduli:
$W_{y,1}$ = -8,564E04 mm^3 $W_{z,1}$ = 1,819E04 mm^3
$W_{y,2}$ = 8,564E04 mm^3 $W_{z,2}$ = -3,622E04 mm^3
Torsion constant:
I_k = 4,050E04 mm^4
Warping constant:
I_ω = 2,200E09 mm^6
Plastic cross-section moduli:
$W_{pl,y}$ = 9,884E04 mm^3 $W_{pl,z}$ = 3,258E04 mm^3

Material: EN 10210-1 : S 235
Material characteristics:

Yield strength	f_y	:	235,0	MPa
Ultimate strength	f_u	:	360,0	MPa
Elastic modulus	E	:	210000	MPa
Shear modulus	G	:	81000	MPa

Internal forces in system of cross-section coordinates
Load with maximal utilization
Zat. případ 1

N	=	-1,620	kN				
V_z	=	10,390	kN	M_y	=	5,430	kNm
V_y	=	0,000	kN	M_z	=	0,000	kNm
T_t	=	0,000	kNm				
T_ω	=	0,000	kNm	B	=	0,000	kNm^2

Buckling parameters
Length: 4,440 m
L_z = 4,440 m k_z = 0,500 $L_{cr,z}$ = 2,220 m
L_y = 4,440 m k_y = 0,500 $L_{cr,y}$ = 2,220 m

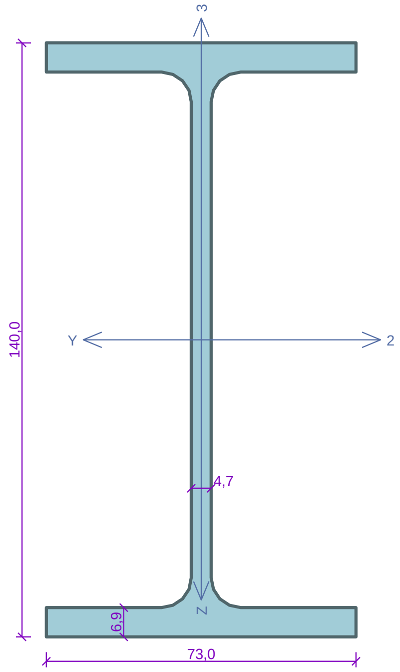
LTB parameters
End condition factors: k_y = - k_z = 0.5 k_w = 0.5
l_{z1} = 4,440 m M_y: Shape no.6 z_P = 0,500
l_{y1} = No input M_z: Shape no.4 y_P =

Results - Decisive load: Zat. případ 1; **Cross-section class:** 1
Check of shear due to shear force V_z:
10,390 kN < 111,662 kN **Pass**
Internal forces: N = -1,620 kN; M_y = 5,430 kNm; M_z = 0,000 kNm
Critical combination check: buckling compression and bending moment:
Buckling Y: Resistances: N_R = -384,798 kN; $M_{y,R}$ = 16,202 kNm
| 0,004 + 0,335 + 0,000 | = | 0,339 | < 1 **Pass**
Buckling Z: Resistances: N_R = -199,711 kN; $M_{y,R}$ = 16,202 kNm
| 0,008 + 0,335 + 0,000 | = | 0,343 | < 1 **Pass**
Member slenderness: 107,3

Section ok

34,3 % PASS

Transverse beams IPE 140



Standard **EN 1993-1-1/Czech Rep.**.

Section capacity	:	γ_{M0}	=	1,000
Section resistance when checking stability	:	γ_{M1}	=	1,000
Perforated section capacity	:	γ_{M2}	=	1,250

Section IPE 140
Cross-sectional area: A = 1,643E03 mm^2
Centre of gravity position:
y_T = 36,5 mm z_T = 70,0 mm
Second moments of area:
I_y = 5,412E06 mm^4 I_z = 4,492E05 mm^4
Cross-section moduli:
$W_{y,1}$ = -7,732E04 mm^3 $W_{z,1}$ = 1,231E04 mm^3
$W_{y,2}$ = 7,732E04 mm^3 $W_{z,2}$ = -1,231E04 mm^3
Torsion constant:
I_k = 2,450E04 mm^4
Warping constant:
I_ω = 1,980E09 mm^6
Plastic cross-section moduli:
$W_{pl,y}$ = 8,834E04 mm^3 $W_{pl,z}$ = 1,925E04 mm^3

Material: EN 10210-1 : S 235
Material characteristics:

Yield strength	f_y	:	235,0	MPa
Ultimate strength	f_u	:	360,0	MPa
Elastic modulus	E	:	210000	MPa
Shear modulus	G	:	81000	MPa

Internal forces in system of cross-section coordinates
Load with maximal utilization
Zat. případ 1

N	=	-2,320	kN				
V_z	=	11,940	kN	M_y	=	13,100	kNm
V_y	=	0,150	kN	M_z	=	0,000	kNm
T_t	=	0,020	kNm				
T_ω	=	0,000	kNm	B	=	0,000	kNm^2

Buckling parameters
Length: 4,440 m
L_z = 4,440 m k_z = 1,000 $L_{cr,z}$ = 4,440 m
L_y = 4,440 m k_y = 1,000 $L_{cr,y}$ = 4,440 m

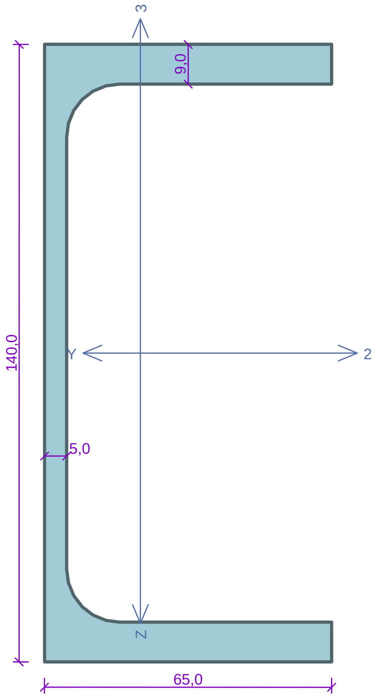
LTB parameters
Buckling neglected

Results - Decisive load: Zat. případ 1; **Cross-section class:** 1
Check of shear due to torsion:
Stress: τ_t = 5,633 MPa; τ_w = 0,000 MPa
Strength: τ_{Rd} = 135,677 MPa
5,633+0,000 < 135,677 **Pass**
Check of shear due to shear force V_z:
11,940 kN < 102,563 kN **Pass**
Check of shear due to shear force V_y:
0,150 kN < 117,179 kN **Pass**
Internal forces: N = -2,320 kN; M_y = 13,100 kNm; M_z = 0,000 kNm
Critical combination check: buckling compression and bending moment:
Buckling Y: Resistances: N_R = -301,876 kN; $M_{y,R}$ = 20,760 kNm
| 0,008 + 0,631 + 0,000 | = | 0,639 | < 1 **Pass**
Buckling Z: Resistances: N_R = -42,014 kN; $M_{y,R}$ = 20,760 kNm
| 0,055 + 0,631 + 0,000 | = | 0,686 | < 1 **Pass**
Member slenderness: 268,5

Section ok

68,6 % PASS

Transverse beams UPE140



Standard **EN 1993-1-1/Czech Rep.**.

Section capacity	: γ_{M0}	=	1,000
Section resistance when checking stability	: γ_{M1}	=	1,000
Perforated section capacity	: γ_{M2}	=	1,250

Section UPE 140
Cross-sectional area: A = 1,840E03 mm^2
Centre of gravity position:
y_T = 21,7 mm z_T = 70,0 mm
Second moments of area:
I_y = 6,000E06 mm^4 I_z = 7,870E05 mm^4
Cross-section moduli:
$W_{y,1}$ = -8,564E04 mm^3 $W_{z,1}$ = 1,819E04 mm^3
$W_{y,2}$ = 8,564E04 mm^3 $W_{z,2}$ = -3,622E04 mm^3
Torsion constant:
I_k = 4,050E04 mm^4
Warping constant:
I_ω = 2,200E09 mm^6
Plastic cross-section moduli:
$W_{pl,y}$ = 9,884E04 mm^3 $W_{pl,z}$ = 3,258E04 mm^3

Material: EN 10210-1 : S 235
Material characteristics:

Yield strength	f_y	:	235,0	MPa
Ultimate strength	f_u	:	360,0	MPa
Elastic modulus	E	:	210000	MPa
Shear modulus	G	:	81000	MPa

Internal forces in system of cross-section coordinates
Load with maximal utilization
Zat. případ 1

N	=	-0,760	kN				
V_z	=	15,060	kN	M_y	=	11,250	kNm
V_y	=	0,710	kN	M_z	=	-0,200	kNm
T_t	=	0,020	kNm				
T_ω	=	0,000	kNm	B	=	0,000	kNm^2

Buckling parameters
Length: 4,440 m
L_z = 4,440 m k_z = 1,000 $L_{cr,z}$ = 4,440 m
L_y = 4,440 m k_y = 1,000 $L_{cr,y}$ = 4,440 m

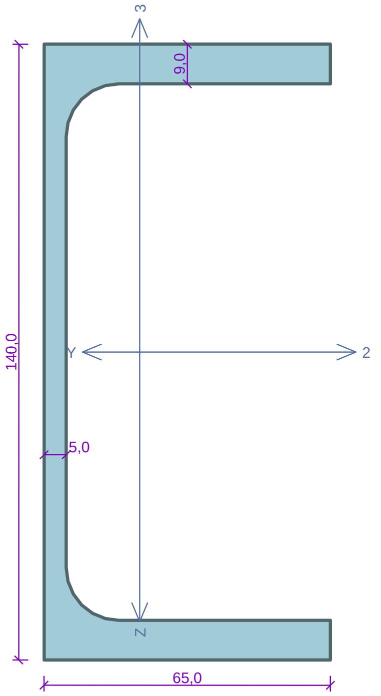
LTB parameters
Buckling neglected

Results - Decisive load: Zat. případ 1; **Cross-section class:** 1
Check of shear due to torsion:
Stress: τ_t = 4,444 MPa; τ_w = 0,000 MPa
Strength: τ_{Rd} = 135,677 MPa
4,444+0,000 < 135,677 **Pass**
Check of shear due to shear force V_z:
15,060 kN < 110,847 kN **Pass**
Check of shear due to shear force V_y:
0,710 kN < 136,164 kN **Pass**
Internal forces: N = -0,760 kN; M_y = 11,250 kNm; M_z = -0,200 kNm
Critical combination check: buckling compression and bending moment:
Buckling Y: Resistances: N_R = -278,739 kN; $M_{y,R}$ = 23,228 kNm; $M_{z,R}$ = -7,656 kNm
| 0,003 + 0,484 + 0,026 | = | 0,513 | < 1 **Pass**
Buckling Z: Resistances: N_R = -67,184 kN; $M_{y,R}$ = 23,228 kNm; $M_{z,R}$ = -7,656 kNm
| 0,011 + 0,484 + 0,026 | = | 0,522 | < 1 **Pass**
Member slenderness: 214,7

Section ok

52,2 % PASS

Staircase beam



Standard **EN 1993-1-1/Czech Rep.**.

Section capacity	:	γ_{M0}	=	1,000
Section resistance when checking stability	:	γ_{M1}	=	1,000
Perforated section capacity	:	γ_{M2}	=	1,250

Section UPE 140
Cross-sectional area: A = 1,840E03 mm^2
Centre of gravity position:
y_T = 21,7 mm z_T = 70,0 mm
Second moments of area:
I_y = 6,000E06 mm^4 I_z = 7,870E05 mm^4
Cross-section moduli:
$W_{y,1}$ = -8,564E04 mm^3 $W_{z,1}$ = 1,819E04 mm^3
$W_{y,2}$ = 8,564E04 mm^3 $W_{z,2}$ = -3,622E04 mm^3
Torsion constant:
I_k = 4,050E04 mm^4
Warping constant:
I_ω = 2,200E09 mm^6
Plastic cross-section moduli:
$W_{pl,y}$ = 9,884E04 mm^3 $W_{pl,z}$ = 3,258E04 mm^3

Material: EN 10210-1 : S 235
Material characteristics:

Yield strength	f_y	:	235,0	MPa
Ultimate strength	f_u	:	360,0	MPa
Elastic modulus	E	:	210000	MPa
Shear modulus	G	:	81000	MPa

Internal forces in system of cross-section coordinates
Load with maximal utilization
Zat. případ 1

N	=	-0,760 kN					
V_z	=	15,060 kN		M_y	=	11,250	kNm
V_y	=	0,710 kN		M_z	=	-0,200	kNm
T_t	=	0,020 kNm					
T_ω	=	0,000 kNm		B	=	0,000	kNm^2

Buckling parameters
Length: 1,270 m
L_z = 1,270 m k_z = 1,000 $L_{cr,z}$ = 1,270 m
L_y = 1,270 m k_y = 1,000 $L_{cr,y}$ = 1,270 m

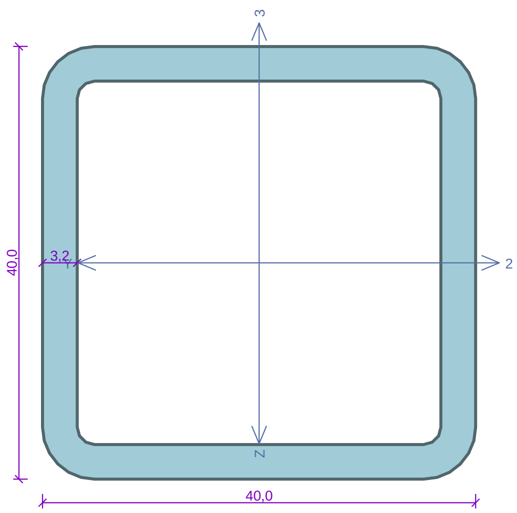
LTB parameters
End condition factors: k_y = - k_z = 1.0 k_w = 1.0
l_{z1} = 1,270 m M_y: Shape no.4 z_P = 1,000
l_{y1} = No input M_z: Shape no.4 y_P =

Results - Decisive load: Zat. případ 1; **Cross-section class:** 1
Check of shear due to torsion:
Stress: τ_t = 4,444 MPa; τ_w = 0,000 MPa
Strength: τ_{Rd} = 135,677 MPa
4,444+0,000 < 135,677 **Pass**
Check of shear due to shear force V_z:
15,060 kN < 110,847 kN **Pass**
Check of shear due to shear force V_y:
0,710 kN < 136,164 kN **Pass**
Internal forces: N = -0,760 kN; M_y = 11,250 kNm; M_z = -0,200 kNm
Critical combination check: buckling compression and bending moment:
Buckling Y: Resistances: N_R = -424,300 kN; $M_{y,R}$ = 16,087 kNm; $M_{z,R}$ = -7,656 kNm
| 0,002 + 0,699 + 0,026 | = | 0,727 | < 1 **Pass**
Buckling Z: Resistances: N_R = -325,601 kN; $M_{y,R}$ = 16,087 kNm; $M_{z,R}$ = -7,656 kNm
| 0,002 + 0,699 + 0,026 | = | 0,728 | < 1 **Pass**
Member slenderness: 61,4

Section ok

72,8 % PASS

Bending 40x40x3,2



Standard **EN 1993-1-1/Czech Rep.**.

Section capacity	:	γ_{M0}	=	1,000
Section resistance when checking stability	:	γ_{M1}	=	1,000
Perforated section capacity	:	γ_{M2}	=	1,250

Section MSH 40 x 40 x 3.2
Cross-sectional area: A = 4,600E02 mm^2
Centre of gravity position:
y_T = 20,0 mm z_T = 20,0 mm
Second moments of area:
I_y = 1,020E05 mm^4 I_z = 1,020E05 mm^4
Cross-section moduli:
$W_{y,1}$ = -5,031E03 mm^3 $W_{z,1}$ = 5,031E03 mm^3
$W_{y,2}$ = 5,031E03 mm^3 $W_{z,2}$ = -5,031E03 mm^3
Torsion constant:
I_k = 1,595E05 mm^4
Plastic cross-section moduli:
$W_{pl,y}$ = 6,179E03 mm^3 $W_{pl,z}$ = 6,179E03 mm^3

Material: EN 10210-1 : S 235
Material characteristics:

Yield strength	f_y	:	235,0	MPa
Ultimate strength	f_u	:	360,0	MPa
Elastic modulus	E	:	210000	MPa
Shear modulus	G	:	81000	MPa

Internal forces in system of cross-section coordinates
Load with maximal utilization
Zat. případ 1

N	=	-3,050	kN				
V_z	=	0,000	kN	M_y	=	0,000	kNm
V_y	=	0,000	kN	M_z	=	0,000	kNm
T_t	=	0,000	kNm				
T_ω	=	0,000	kNm	B	=	0,000	kNm^2

Buckling parameters
Length: 5,000 m
L_z = 5,000 m k_z = 1,000 $L_{cr,z}$ = 5,000 m
L_y = 5,000 m k_y = 1,000 $L_{cr,y}$ = 5,000 m

Results - Decisive load: Zat. případ 1; **Cross-section class:** 1
Internal forces: N = -3,050 kN; M_y = 0,000 kNm; M_z = 0,000 kNm
Critical combination check: buckling compression and bending moment:
Buckling Y: Resistances: N_R = -7,979 kN
| 0,382 + 0,000 + 0,000 | = | 0,382 | < 1 **Pass**
Buckling Z: Resistances: N_R = -7,979 kN
| 0,382 + 0,000 + 0,000 | = | 0,382 | < 1 **Pass**
Member slenderness: 335,8

Section ok

38,2 % PASS

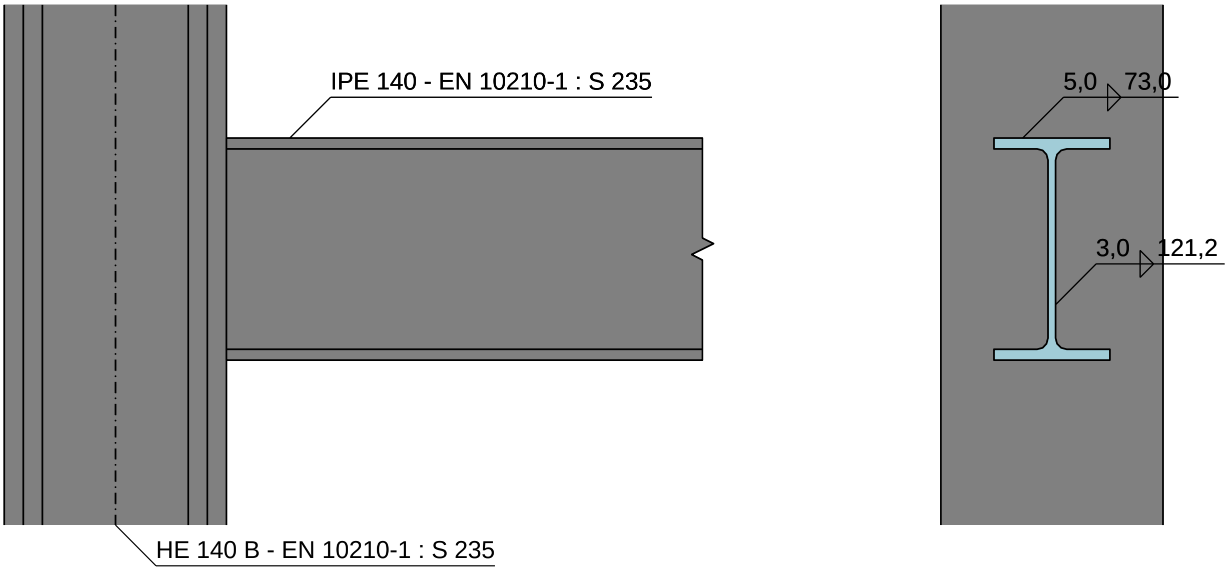
2.2.2 ASSESSMENT OF CONECTION

1 HEB 140 + U140 + IPE 160 - column-beam

1.1 Connection scheme

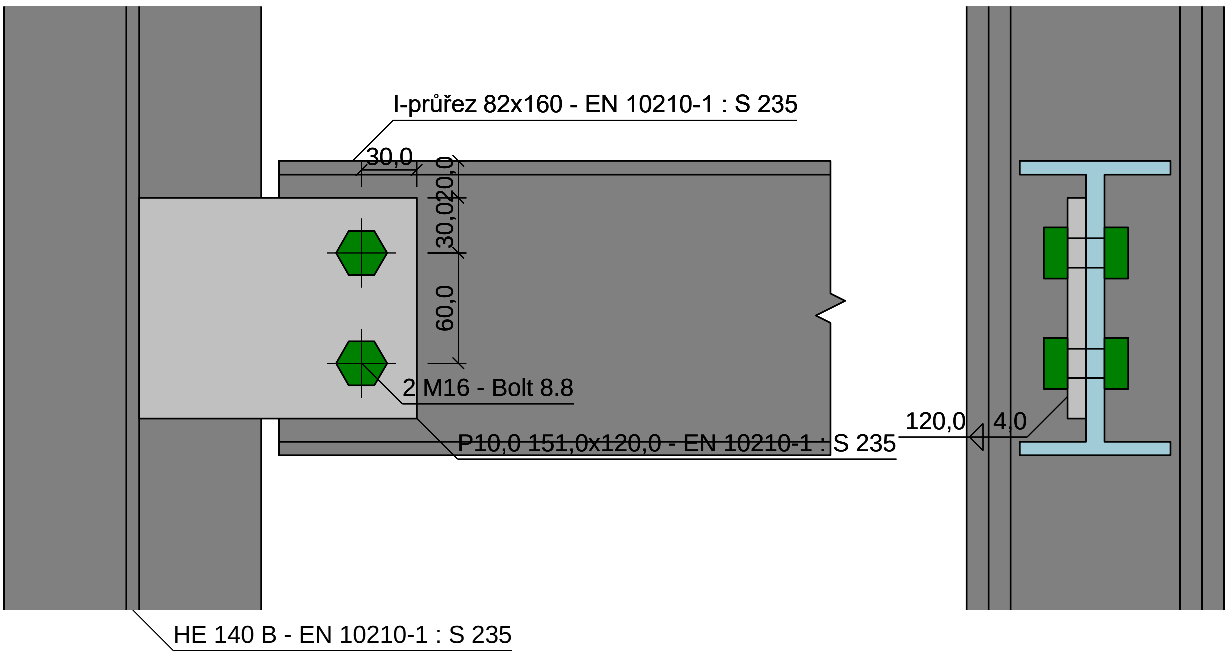
column-beam

Welded



column-beam

Bolts in fin plate



1.2 Data recapitulation

1.2.1 Column

Profile

Section: HE 140 B

cross-section height	: h = 140,0 mm	web thickness	: t_w = 7,0 mm
section width	: b = 140,0 mm	flange thickness	: t_f = 12,0 mm

Material: EN 10210-1 : S 235

Yield strength	: f_y = 235,0 MPa	Ultimate tensile strength	: f_u = 360,0 MPa

Geometry

column length	: L = 10000,0 mm	reference plane	: L_{sr} = 200,0 mm

1.2.2 Connection to right joint side - Welded

Joint position

vertical rotation	: α = 0,00 °	horizontal rotation	: β = 0,00 °
spacing from reference plane	: L_z = 0,0 mm		

Profile

Section: IPE 140

cross-section height	: h = 140,0 mm	web thickness	: t_w = 4,7 mm
section width	: b = 73,0 mm	flange thickness	: t_f = 6,9 mm

Material: EN 10210-1 : S 235

Yield strength	: f_y = 235,0 MPa	Ultimate tensile strength	: f_u = 360,0 MPa

Beam welding - fillet weld around

height of weld on web	: $a_{w,w}$ = 3,0 mm	height of weld on flange	: $a_{w,f}$ = 5,0 mm

1.2.3 Connection to right web side - Bolts in fin plate

Joint position

vertical rotation	: α = 0,00 °	horizontal rotation	: β = 0,00 °
spacing from reference plane	: L_z = 0,0 mm		

Profile

Section: I-průřez 82x160

cross-section height	: h = 160,0 mm	stem thickness	: t_w = 10,0 mm
top flange width	: b_{ft} = 82,0 mm	top flange thickness	: t_{ft} = 7,4 mm
bottom flange width	: b_{fb} = 82,0 mm	bottom flange thickness	: t_{fb} = 7,4 mm

Material: EN 10210-1 : S 235

Yield strength	: f_y = 235,0 MPa	Ultimate tensile strength	: f_u = 360,0 MPa

Cantilever welding

weld height	: $a_{w,\%d}$ = 4,0 mm	weld length	: $L_{w,\%d}$ = 120,0 mm

Fin plate

Dimensions

height	: b_p = 151,0 mm
width	: h_p = 120,0 mm
thickness	: t_p = 10,0 mm
beam offset	: a_1 = 76,0 mm

Material: EN 10210-1 : S 235

elastic modulus	: E = 210000,0 MPa
yield strength	: f_y = 235,0 MPa
ultimate strength	: f_u = 360,0 MPa

Bolts

Type: Hrubé šrouby (M16)

shank length : $L = 75,0$ mm thread length : $L_b = 38,0$ mm

Material: Bolt 8.8

Yield strength : $f_{yb} = 640,0$ MPa Ultimate tensile strength : $f_{ub} = 800,0$ MPa

Distribution of bolts

$e_1 = [30,0]$, $e_2 = [30,0, 60,0]$

Bolt head on beam side

1.3 Results

1.3.1 Connection to right joint side - Welded

Bending capacity

Decisive component : Beam flange in compression

Analysis : $M_{y,Rd} = 20,76$ kNm > $M_{y,Ed} = 7,36$ kNm **VYHOVUJE**

Shear capacity

Decisive component : Column wall in shear

Analysis : $V_{z,Rd} = 159,72$ kN > $V_{z,Ed} = 52,57$ kN **VYHOVUJE**

Welds capacity

Critical point : Top flange

Max utilization : (29,83%)

Bend stiffness

Initial stiffness : $S_{j,ini} = 6966,49$ kNm/rad

Secant stiffness : $S_{j,Ed} = 6966,49$ kNm/rad

Secant stiffness : $S_{j,Rd} = 2331,13$ kNm/rad

Classification : fixed

1.3.2 Connection to right web side - Bolts in fin plate

Axial capacity

Decisive component : Shear resistance of bolts

Analysis : $N_{x,Rd} = 120,32$ kN > $N_{x,Ed} = 3,06$ kN **VYHOVUJE**

Shear capacity

Decisive component : Shear resistance of bolts

Analysis : $V_{z,Rd} = 28,20$ kN > $V_{z,Ed} = 26,88$ kN **VYHOVUJE**

Welds capacity

Critical point : Plate welding

Max utilization : (13,53%)

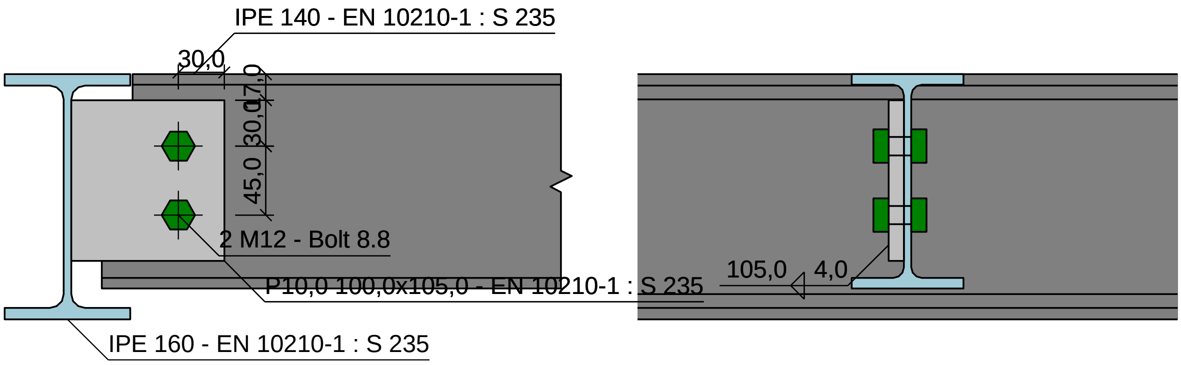
1.3.3 Warning

- styčník: v zatěžovacím stavu "Zatěžovací případ 1" nejsou splněny podmínky rovnováhy: $\Sigma M_y = -7,36$ kNm; $\Sigma F_x = -38,82$ kN; $\Sigma F_y = -3,06$ kN; $\Sigma F_z = 2,26$ kN

2 Ipe 160 + IPE 140 - primary beam-beam

2.1 Connection scheme

primary beam-beam **Bolts in fin plate**



2.2 Data recapitulation

Primary beam

Profile

Section: IPE 160

cross-section height	: h = 160,0 mm	web thickness	: t_w = 5,0 mm
section width	: b = 82,0 mm	flange thickness	: t_f = 7,4 mm

Material: EN 10210-1 : S 235

Yield strength	: f_y = 235,0 MPa	Ultimate tensile strength	: f_u = 360,0 MPa

2.2.1 Connection at right flange - Bolts in fin plate

Joint position

vertical rotation	: α = 0,00 °	horizontal rotation	: β = 0,00 °
spacing from reference plane	: L_z = 0,0 mm		

Profile

Section: IPE 140

cross-section height	: h = 140,0 mm	web thickness	: t_w = 4,7 mm
section width	: b = 73,0 mm	flange thickness	: t_f = 6,9 mm

Material: EN 10210-1 : S 235

Yield strength	: f_y = 235,0 MPa	Ultimate tensile strength	: f_u = 360,0 MPa

Beam end

top cut width	: b_1 = 20,0 mm
top cut height	: h_1 = 25,0 mm

Cantilever welding

weld height	: $a_{w,\%d}$ = 4,0 mm	weld length	: $L_{w,\%d}$ = 105,0 mm

Fin plate

Dimensions

height	: b_p = 100,0 mm
width	: h_p = 105,0 mm
thickness	: t_p = 10,0 mm
beam offset	: a_1 = 20,0 mm

Material: EN 10210-1 : S 235

elastic modulus : E = 210000,0 MPa
yield strength : f_y = 235,0 MPa
ultimate strength : f_u = 360,0 MPa

Bolts

Type: Hrubé šrouby (M12)
shank length : L = 50,0 mm — thread length : L_b = 30,0 mm
Material: Bolt 8.8
Yield strength : f_{yb} = 640,0 MPa — Ultimate tensile strength : f_{ub} = 800,0 MPa
Distribution of bolts
e_1 = [30,0], e_2 = [30,0, 45,0]
Bolt head on beam side

2.3 Results

2.3.1 Connection at right flange - Bolts in fin plate

Axial capacity
Decisive component : Shear resistance of bolts
Analysis : $N_{x,Rd}$ = 64,72 kN > $N_{x,Ed}$ = 2,76 kN **VYHOVUJE**

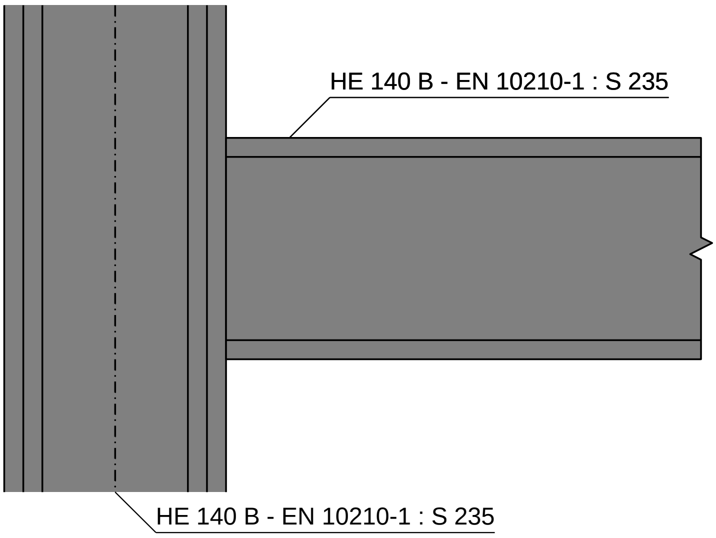
Shear capacity
Decisive component : Shear resistance of bolts
Analysis : $V_{z,Rd}$ = 18,55 kN > $V_{z,Ed}$ = 11,94 kN **VYHOVUJE**

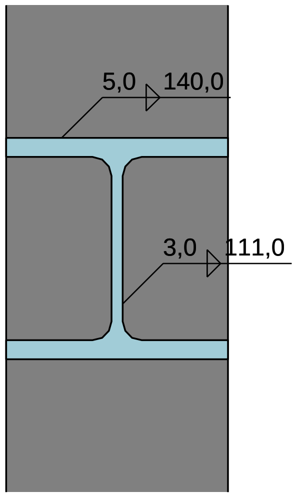
Welds capacity
Critical point : Plate welding
Max utilization : (6,96%)

3 HEB 140 + HEA 140 - column-beam

3.1 Connection scheme

column-beam — **Welded**





3.2 Data recapitulation

3.2.1 Column

Profile

Section: HE 140 B

cross-section height	: h = 140,0 mm	web thickness	: t_w = 7,0 mm
section width	: b = 140,0 mm	flange thickness	: t_f = 12,0 mm

Material: EN 10210-1 : S 235

Yield strength	: f_y = 235,0 MPa	Ultimate tensile strength	: f_u = 360,0 MPa

Geometry

column length	: L = 10000,0 mm	reference plane	: L_{sr} = 4000,0 mm

3.2.2 Connection to right joint side - Welded

Joint position

vertical rotation	: α = 0,00 °	horizontal rotation	: β = 0,00 °
spacing from reference plane	: L_z = 0,0 mm		

Profile

Section: HE 140 B

cross-section height	: h = 140,0 mm	web thickness	: t_w = 7,0 mm
section width	: b = 140,0 mm	flange thickness	: t_f = 12,0 mm

Material: EN 10210-1 : S 235

Yield strength	: f_y = 235,0 MPa	Ultimate tensile strength	: f_u = 360,0 MPa

Beam welding - fillet weld around

height of weld on web	: $a_{w,w}$ = 3,0 mm	height of weld on flange	: $a_{w,f}$ = 5,0 mm

3.3 Results

3.3.1 Connection to right joint side - Welded

Bending capacity

Decisive component : Column wall in shear

Analysis : $M_{y,Rd}$ = 20,44 kNm > $M_{y,Ed}$ = 2,88 kNm **VYHOVUJE**

Shear capacity

Decisive component : Column wall in shear

Analysis : $V_{z,Rd}$ = 159,72 kN > $V_{z,Ed}$ = 20,53 kN **VYHOVUJE**

Welds capacity

Critical point : Web

Max utilization : (9,98%)

Bend stiffness

Initial stiffness : $S_{j,ini}$ = 6687,70 kNm/rad

Secant stiffness : $S_{j,Ed}$ = 6687,70 kNm/rad

Secant stiffness : $S_{j,Rd}$ = 2237,85 kNm/rad

Classification : semirigid

3.3.2 Warning

- styčník: v zatěžovacím stavu "Zatěžovací případ 1" nejsou splněny podmínky rovnováhy: ΣM_y = -5,80 kNm; ΣF_x = -121,66 kN; ΣF_z = 2,90 kN

2.2.3 ASSESSMENT OF ANCHORING

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Profis Anchor 2.8.3

Company:		Page:	1
Specifier:		Project:	
Address:		Fastening Point:	
Phone I Fax:	|	Date:	25.07.2019
E-Mail:			

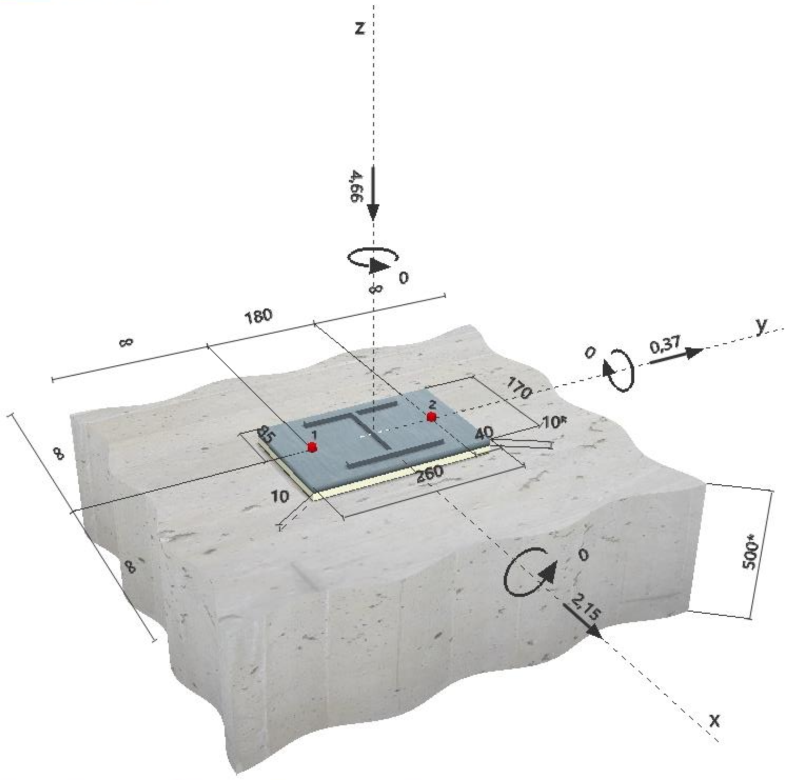
Specifier's comments:

1 Input data

Anchor type and size:	**HIT-RE 500 V3 + HIT-V(5.8) M12**
Effective embedment depth:	$h_{ef,act}$ = 120 mm ($h_{ef,limit}$ = - mm)
Material:	5.8
Approval No.:	ETA 16/0143
Issued I Valid:	12/07/2017 | -
Proof:	Design method ETAG BOND (EOTA TR 029)
Stand-off installation:	without clamping (anchor); restraint level (baseplate): 2,00; e_b = 10 mm; t = 10 mm
	Hilti Grout: , multipurpose, $f_{c,Grout}$ = 30,00 N/mm^2
Baseplate:	l_x x l_y x t = 170 mm x 260 mm x 10 mm; (Recommended plate thickness: not calculated
Profile:	IPBi/HEA; (L x W x T x FT) = 133 mm x 140 mm x 6 mm x 9 mm
Base material:	cracked concrete, C20/25, $f_{c,cube}$ = 25,00 N/mm^2; h = 500 mm, Temp. short/long: 40/24 °C
Installation:	**hammer drilled hole, Installation condition: Dry**
Reinforcement:	No reinforcement or Reinforcement spacing >= 150 mm (any Ø) or >= 100 mm (Ø <= 10 mm)
	no longitudinal edge reinforcement

R - The anchor calculation is based on a rigid baseplate assumption.

Geometry [mm] & Loading [kN, kNm]



Company:		Page:	2
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Address:		Fastening Point:	
Phone I Fax:	|	Date:	25.07.2019
E-Mail:			

2 Load case/Resulting anchor forces

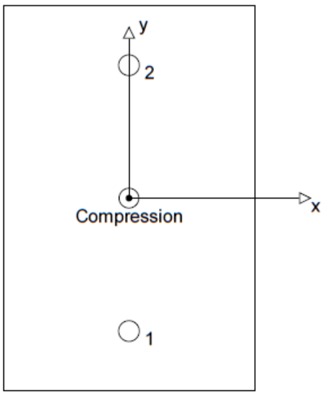
Load case: Design loads

Anchor reactions [kN]
Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	0,000	1,091	1,075	0,185
2	0,000	1,091	1,075	0,185

max. concrete compressive strain: 0,00 [‰]
max. concrete compressive stress: 0,11 [N/mm^2]
resulting tension force in (x/y)=(0/0): 0,000 [kN]
resulting compression force in (x/y)=(0/0): 4,660 [kN]

Anchor forces are calculated based on the assumption of a rigid baseplate.



3 Tension load (EOTA TR 029, Section 5.2.2)

	Load [kN]	Capacity [kN]	Utilisation β_N [%]	Status
Steel failure*	N/A	N/A	N/A	N/A
Combined pullout-concrete cone failure**	N/A	N/A	N/A	N/A
Concrete cone failure**	N/A	N/A	N/A	N/A
Splitting failure**	N/A	N/A	N/A	N/A

* most unfavourable anchor **anchor group (anchors in tension)

4 Shear load (EOTA TR 029, Section 5.2.3)

	Load [kN]	Capacity [kN]	Utilisation β_V [%]	Status
Steel failure (without lever arm)*	N/A	N/A	N/A	N/A
Steel failure (with lever arm)*	1,091	4,990	22	OK
Pryout failure**	2,182	75,322	3	OK
Concrete edge failure in direction **	N/A	N/A	N/A	N/A

* most unfavourable anchor **anchor group (relevant anchors)

4.1 Steel failure (with lever arm)

l [mm]	α_M
21	2,00

N_{Sd} / $N_{Rd,s}$	1 - N_{Sd} / $N_{Rd,s}$	$M^0_{Rk,s}$ [kNm]	$M_{Rk,s} = M^0_{Rk,s}$ (1 - $N_{Sd}/N_{Rd,s}$) [kNm]
0,000	1,000	0,066	0,066

$V^M_{Rk,s} = \alpha_M * M_{Rk,s} / l$ [kN]	$\gamma_{Ms,b,V}$	$V^M_{Rd,s}$ [kN]	V_{Sd} [kN]
6,238	1,250	4,990	1,091

4.2 Pryout failure (bond relevant)

$A_{p,N}$ [mm²]	$A^0_{p,N}$ [mm²]	$\tau_{Rk,ucr,25}$ [N/mm²]	$c_{cr,Np}$ [mm]	$s_{cr,Np}$ [mm]	c_{min} [mm]
194 400	129 600	17,00	180	360	∞

ψ_c	$\tau_{Rk,cr}$ [N/mm²]	k	k-factor	$\psi^0_{g,Np}$	$\psi_{g,Np}$
1,000	8,00	2,300	2,000	1,139	1,041

$e_{c1,V}$ [mm]	$\psi_{ec1,Np}$	$e_{c2,V}$ [mm]	$\psi_{ec2,Np}$	$\psi_{s,Np}$	$\psi_{re,Np}$
0	1,000	0	1,000	1,000	1,000

$N^0_{Rk,p}$ [kN]	$N_{Rk,p}$ [kN]	$\gamma_{M,c,p}$	$V_{Rd,cp}$ [kN]	V_{Sd} [kN]
36,191	56,492	1,500	75,322	2,182

5 Displacements (highest loaded anchor)

Short term loading:

N_{Sk} = 0,000 [kN] δ_N = 0,000 [mm]
V_{Sk} = 0,808 [kN] δ_V = 0,040 [mm]
δ_{NV} = 0,040 [mm]

Long term loading:

N_{Sk} = 0,000 [kN] δ_N = 0,000 [mm]
V_{Sk} = 0,808 [kN] δ_V = 0,065 [mm]
δ_{NV} = 0,065 [mm]

Comments: Tension displacements are valid with half of the required installation torque moment for uncracked concrete! Shear displacements are valid without friction between the concrete and the baseplate! The gap due to the drilled hole and clearance hole tolerances are not included in this calculation!

The acceptable anchor displacements depend on the fastened construction and must be defined by the designer!

6 Warnings

- The anchor design methods in PROFIS Anchor require rigid baseplates per current regulations (ETAG 001/Annex C, EOTA TR029, etc.). This means load re-distribution on the anchors due to elastic deformations of the baseplate are not considered - the baseplate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Anchor calculates the minimum required baseplate thickness with FEM to limit the stress of the baseplate based on the assumptions explained above. The proof if the rigid baseplate assumption is valid is not carried out by PROFIS Anchor. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Checking the transfer of loads into the base material is required in accordance with EOTA TR 029, Section 7!
- The design is only valid if the clearance hole in the fixture is not larger than the value given in Table 4.1 of EOTA TR029! For larger diameters of the clearance hole see Chapter 1.1. of EOTA TR029!
- The accessory list in this report is for the information of the user only. In any case, the instructions for use provided with the product have to be followed to ensure a proper installation.
- Characteristic bond resistances depend on short- and long-term temperatures.
- Please contact Hilti to check feasibility of HIT-V rod supply.
- Edge reinforcement is not required to avoid splitting failure

Fastening meets the design criteria!

Company:		Page:	5
Specifier:		Project:	
Address:		Fastening Point:	
Phone I Fax:	|	Date:	25.07.2019
E-Mail:			

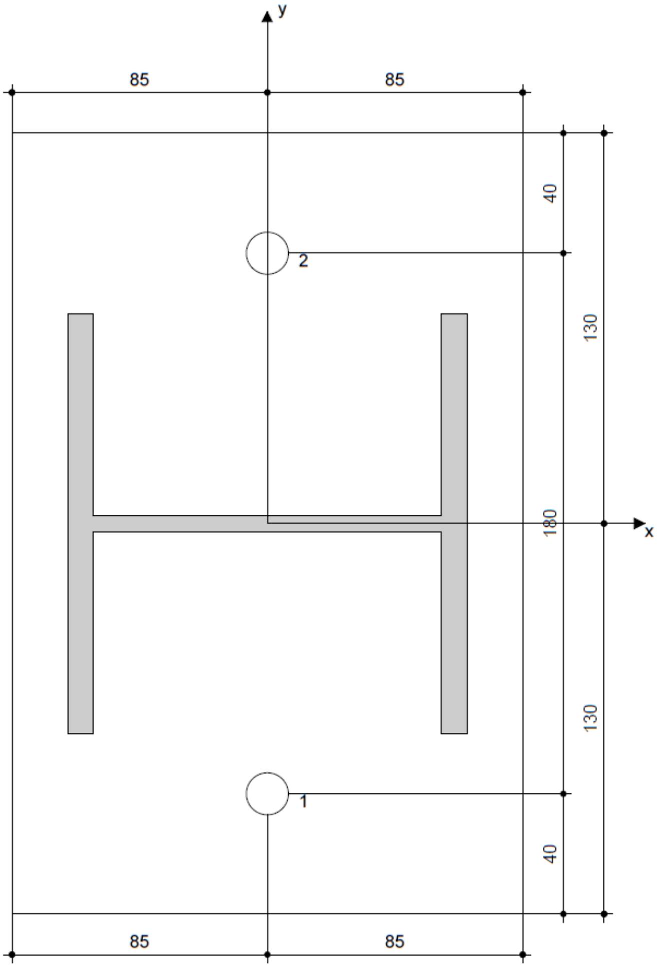
7 Installation data

Baseplate, steel: -
Profile: IPBi/HEA; (L x W x T x FT) = 133 mm x 140 mm x 6 mm x 9 mm
Hole diameter in the fixture: d_f = 14 mm
Plate thickness (input): 10 mm
Recommended plate thickness: not calculated
Drilling method: Hammer drilled
Cleaning: Compressed air cleaning of the drilled hole according to instructions for use is required

Anchor type and size: HIT-RE 500 V3 + HIT-V(5.8) M12
Installation torque: 0,040 kNm
Hole diameter in the base material: 14 mm
Hole depth in the base material: 120 mm
Minimum thickness of the base material: 150 mm

7.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• Compressed air with required accessories to blow from the bottom of the hole • Proper diameter wire brush	• Dispenser including cassette and mixer • Torque wrench



Coordinates Anchor [mm]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	0	-90	-	-	-	-
2	0	90	-	-	-	-

8 Remarks; Your Cooperation Duties

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3 CONCLUSION

The steel structure is designed with respect all of allowed EN norm. From the calculation. From the calculation above, it is clear the hall is designed safely and suitably.