Akumulace dešťových vod budovy víceúčelové sportovní haly v areálu VŠB-TUO

Projektová dokumentace pro územní souhlas/provádění stavby

D. Dokumentace stavebních objektů

SO 01 - Víceúčelová sportovní hala

D1-01.2 Stavebně konstrukční řešení

STATICKÝ VÝPOČET

Archivní číslo	:	20-033-5 / D1-01.2-02
Zhotovitel	:	CHVÁLEK ATELIÉR s.r.o. Kafkova 1064/12 702 00 Ostrava
Hlavní projektant	:	Ing. Iveta Henzelová
Projektant	:	Ing. Ernest Ježowicz
Vypracoval	:	Ing. Ernest Ježowicz
Objednatel	:	VŠB - TUO 17. listopadu 2172/15 708 33 Ostrava - Poruba
Datum	:	11/2020

OBSAH

11/2020

ZATÍŽENÍ

1. STÁLÉ

1.1 Vlastní hmotnost konstrukce ..... generována z průřezových ploch prvků

1.2 Potrubí DN250 + voda

DN250 + voda (50.4kg/m)..... 0.504 kN/m

$g_{add,k}$= 0.504

Součinitel zatížení γ_f=1.35

VÝPOČET ZATÍŽENÍ VĚTREM PODLE ČTN EN 1991-1-4

Větrová oblast

II	místo:	Ostrava	odečteno z mapy větrových oblastí ČR	
$v_{b,0}$ = **25**	m/s		výchozí základní rychlost větru	

Základní rychlost větru

$v_b = v_{b,0}.c_{dir}.c_{season}$ =	**25**	m/s	základní rychlost větru	4.2 (4.1)
c_{dir} = 1			součinitel směru větru	NA.2.6.
c_{season} = 1			součinitel ročního období	NA.2.7.

Kategorie terénu

III				Příloha A.1
z_0 =	0,3	m		tab.4.1
z_{min} =	5,00	m		tab.4.1
z_{max} =	200	m		
z_{e1} =	6,00	m	referenční výška	7.2.2 (1)
z_{e2} =	0	m		

Součinitel terénu

$k_r = 0,19.(z_0/z_{0,II})^{0,07}$ =	0,215	součinitel terénu	4.3.2 (4.5)
$z_{0,II}$ =	0,05	kat. terénu II	tab.4.1

Součinitel drsnosti terénu

$c_r(z_{e1}) = k_r.\ln(z/z_0)$ =	0,645	4.3.2 (4.4)
$c_r(z_{e2}) = k_r.\ln(z/z_0)$ =		

Součinitel orografie

$c_0(z)$ = 1	4.3.1.

Střední rychlost větru

$v_m(z_{e1}) = c_r(z).c_0(z).v_b$ =	16,13	ms^{-1}	4.3.1 (4.3)
$v_m(z_{e2}) = c_r(z).c_0(z).v_b$ =		ms^{-1}	

Intenzita turbulence

$I_v(z_{e1}) = k_I/c_0(z).\ln(z/z_0)$ =	0,334	k_I =	1	součinitel turbulence	4.4 (4.7)
$I_v(z_{e2}) = k_I/c_0(z).\ln(z/z_0)$ =					

Maximální dynamický tlak větru

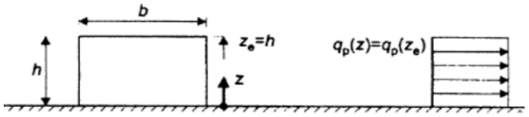
$q_p(z_{e1}) = [1+7I_v(z)].0.5\rho:v_m(z)^2$ =	**543**	Nm^{-2}	=	**0,543**	kNm^{-2}	4.4 (4.8)
$q_p(z_{e2}) = [1+7I_v(z)].0.5\rho:v_m(z)^2$ =		Nm^{-2}	=		kNm^{-2}	

Rozměry objektu

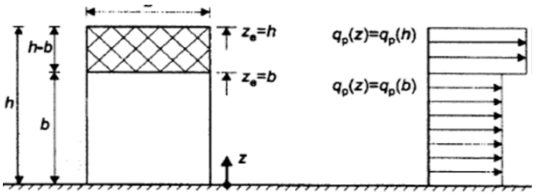
h =	6,00	m	výška stavby
b =	25,00	m	rozměr kolmo na hřeben - délka štítu
l =	1,00	m	rozměr rovnoběžně s hřebenem
l_1=	8,00	m	vzdálenost rámů
l_2=	8,00	m	vzdálenost štítových sloupů
l_3=	8,00	m	vzdálenost vaznic

+

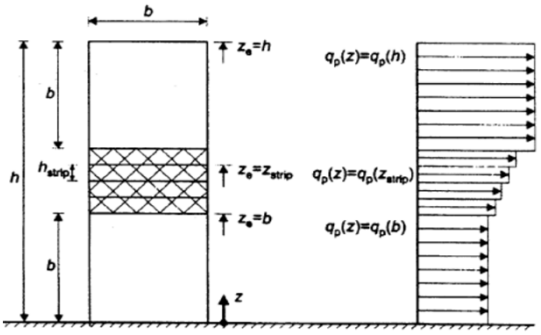
(1)			výška	průběh	
z_{e1} =	6	m	0 až h	konst.	h < b



(2)					
z_{e1} = h	6	m	b až h	konst.	b < h <2 b
z_{e2} = b	25	m	0 až b	konst.	



(3)					
z_{e1} = h	6	m	(h - b) a	konst.	
z_{es} = h		m	b až (h ·	lin.	h > 2b
z_{e2} = b	25	m	0 až b	konst.	



PLATÍ 3.PŘÍPAD

Obdélníkové průřezy 7.VI

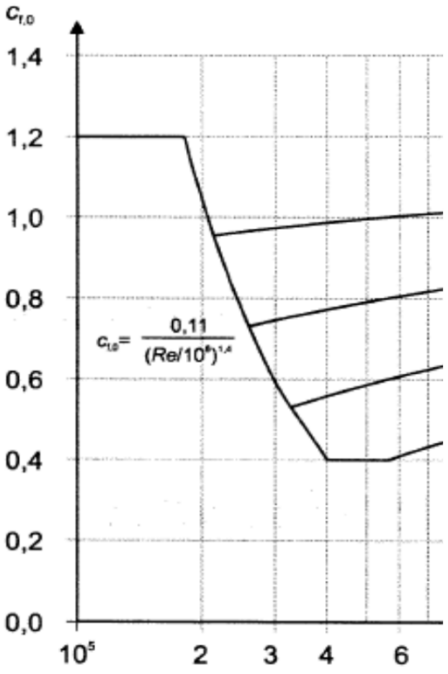
$q_p(h)$ =	0,54	kNm^{-2}			
b =	1	mm	Šířka profilu vystavená větru	d/b =	1,00
d =	1	mm			
c_f =	2		Součinitel síly		
w =	0,00	kNm^{-1}	Liniové zatížení na profil		

Otevřené průřezy 7.VII

$q_p(h)$ =	0,54	kNm^{-2}	
b =	200	mm	Šířka profilu vystavená větru
c_f =	2		Součinitel síly
w =	0,22	kNm^{-1}	Liniové zatížení na profil

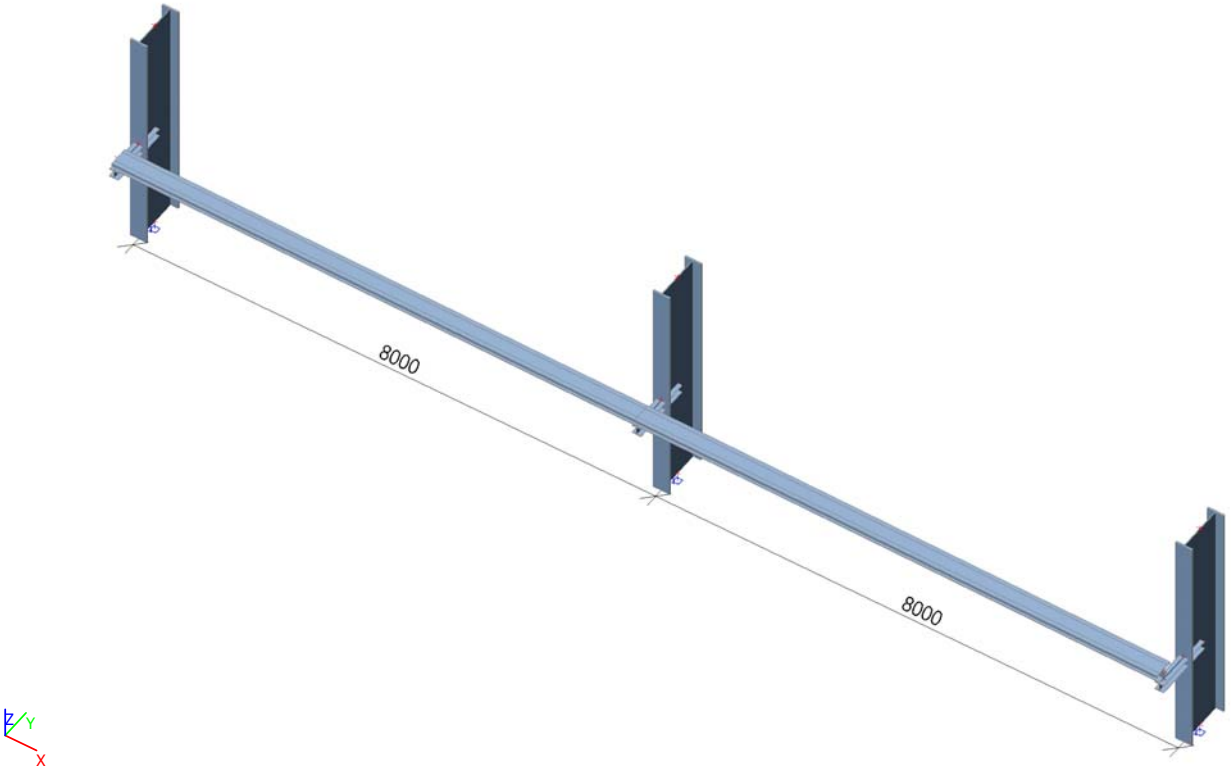
Kruhové válce 7.IX

$q_p(h)$ =	0,54	kNm^{-2}		
b =	0,01	m	… průměr válce	
ρ =	1,25	kgm^{-3}		
v(z_e) =	29,47			
ν =	1,50E-05	m^2/s		
R_e =	19644			
k =	0,2			
k/b =	0,02			
$c_{f,0}$ =	0,803		$c_{f,0}$ =	26,969
w_e =	0,00	kNm^{-1}		

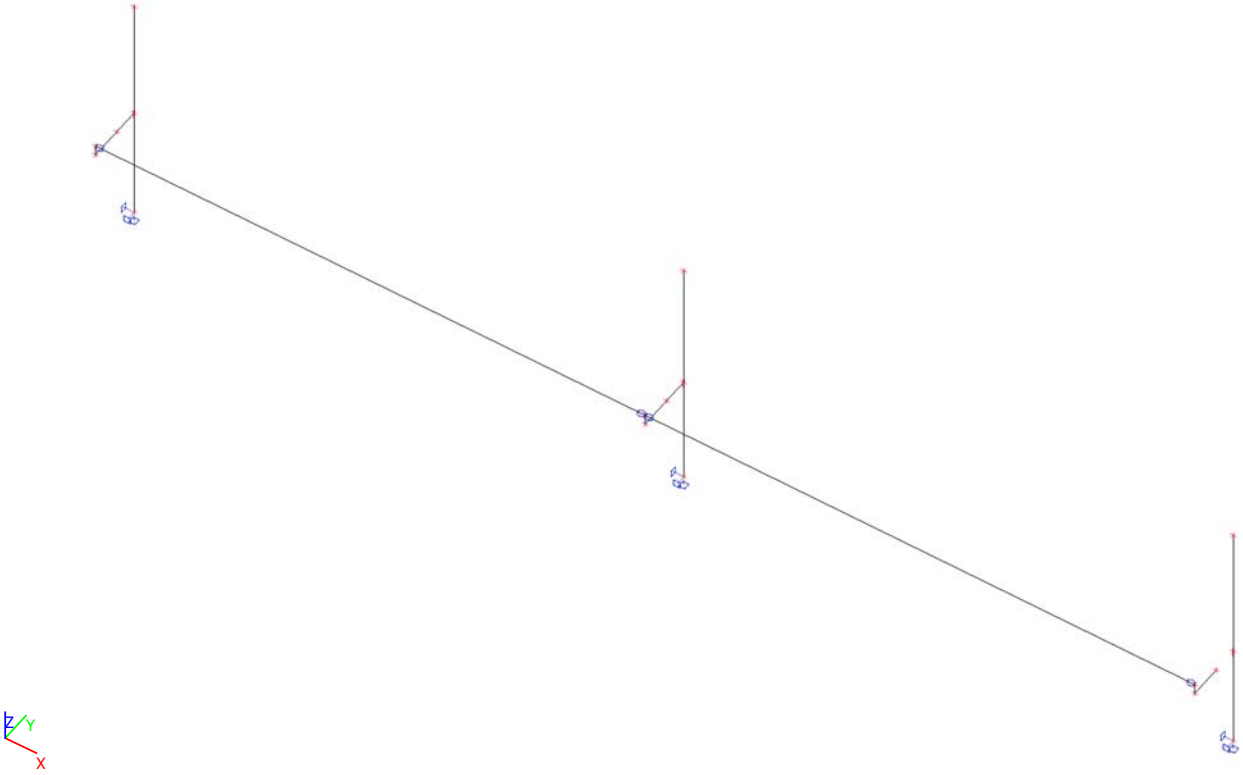


KONSTRUKCE PRO DN250

3D MODEL OF STRUCTURE



Structural model



Project

Version	SCIA Engineer 17.1.2029
Licence number	555797
Project	VŠB TU Ostrava - Víceúčelová sportovní hala
Part	Konstrukce pro uložení potrubí dešťové kanalizace
Description	Ocelová konstrukce
Author	Ing. Ježowicz
Date	19. 11. 2020
Structure	General XYZ
No. of nodes :	18
No. of beams :	14
No. of slabs :	0
No. of solids :	0
No. of used profiles :	4
No. of load cases :	3
No. of used materials :	1
Acceleration of gravity [m/s^2]	9,810
National code	EC - EN

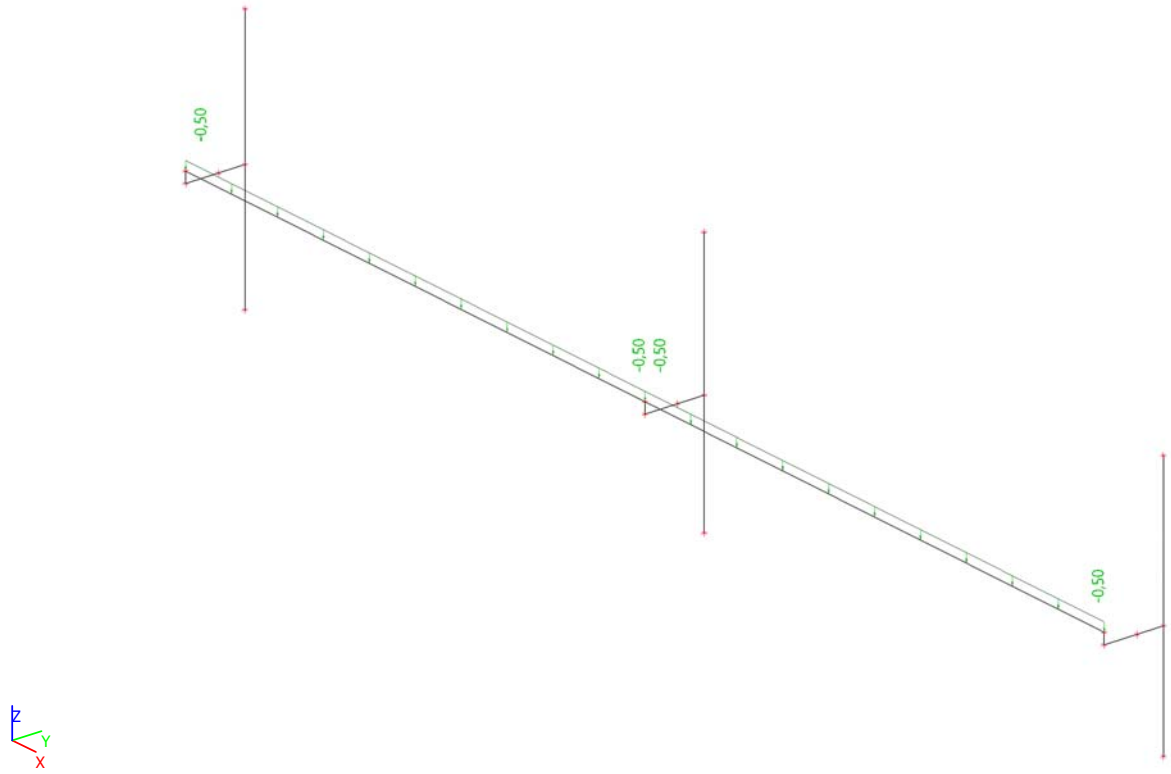
Load cases

Name	Description Spec	Action type Load type	Load group	Direction	Duration	Master load case
LC1	self weight	Permanent Self weight	LG1	-Z		
LC2	pipe DN250	Permanent Standard	LG1			
LC3	wind (side) Standard	Variable Static	wind		Short	None

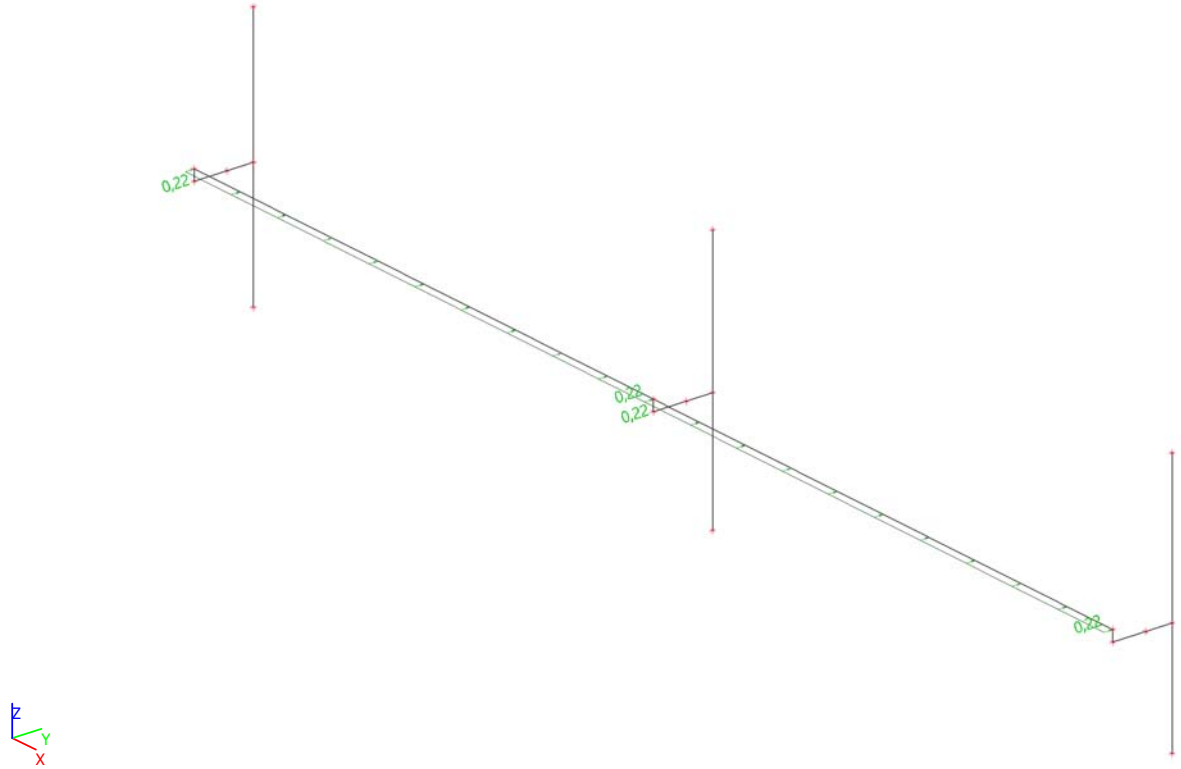
Load groups

Name	Load	Relation	Type
LG1	Permanent		
wind	Variable	Standard	Wind

LC2 / Tot. value



LC3 / Tot. value



Combinations

Name	Description	Type	Load cases	Coeff. [-]
CO1		EN-ULS (STR/GEO) Set B	LC1 - self weight	1,00
			LC2 - pipe DN250	1,00
			LC3 - wind (side)	1,00
CO2		EN-SLS Characteristic	LC1 - self weight	1,00
			LC2 - pipe DN250	1,00
			LC3 - wind (side)	1,00

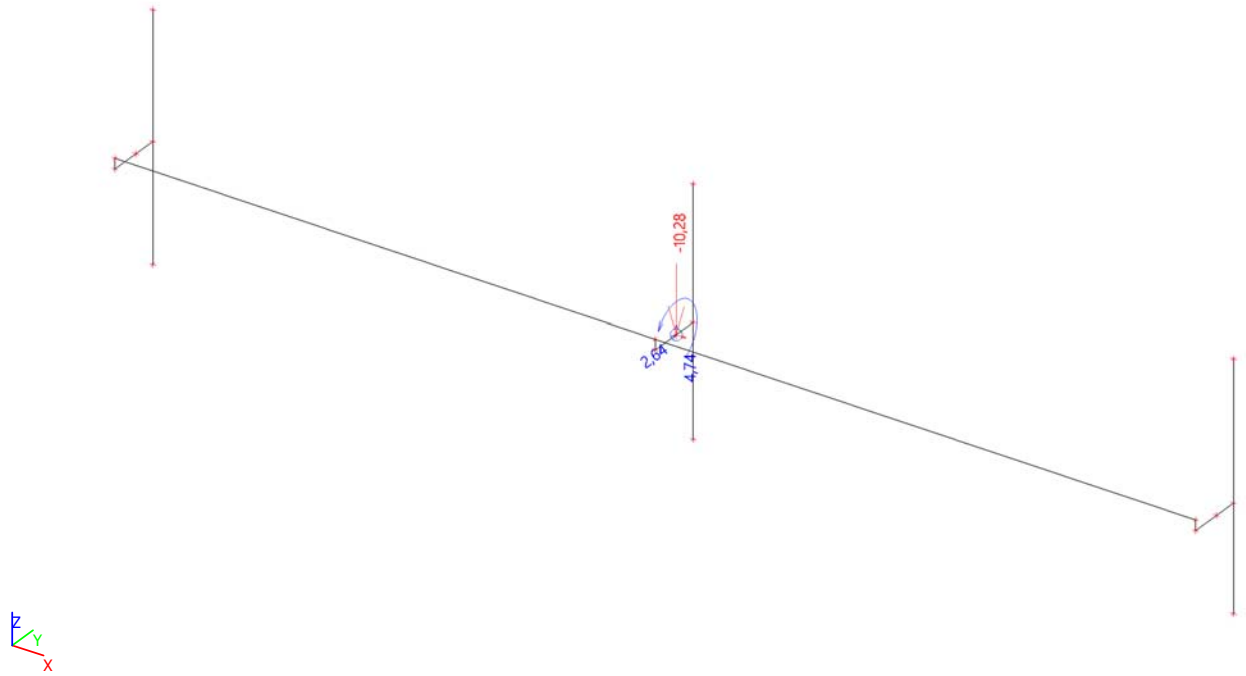
Result classes

Name	List
All ULS	CO1 - EN-ULS (STR/GEO) Set B

REAKCE

1. REACTIONS

2. Connection forces; Rx, Ry, Rz, Mx, My, Mz



3. Connection forces

Linear calculation, Extreme : Global
Selection : All
Combinations : CO1

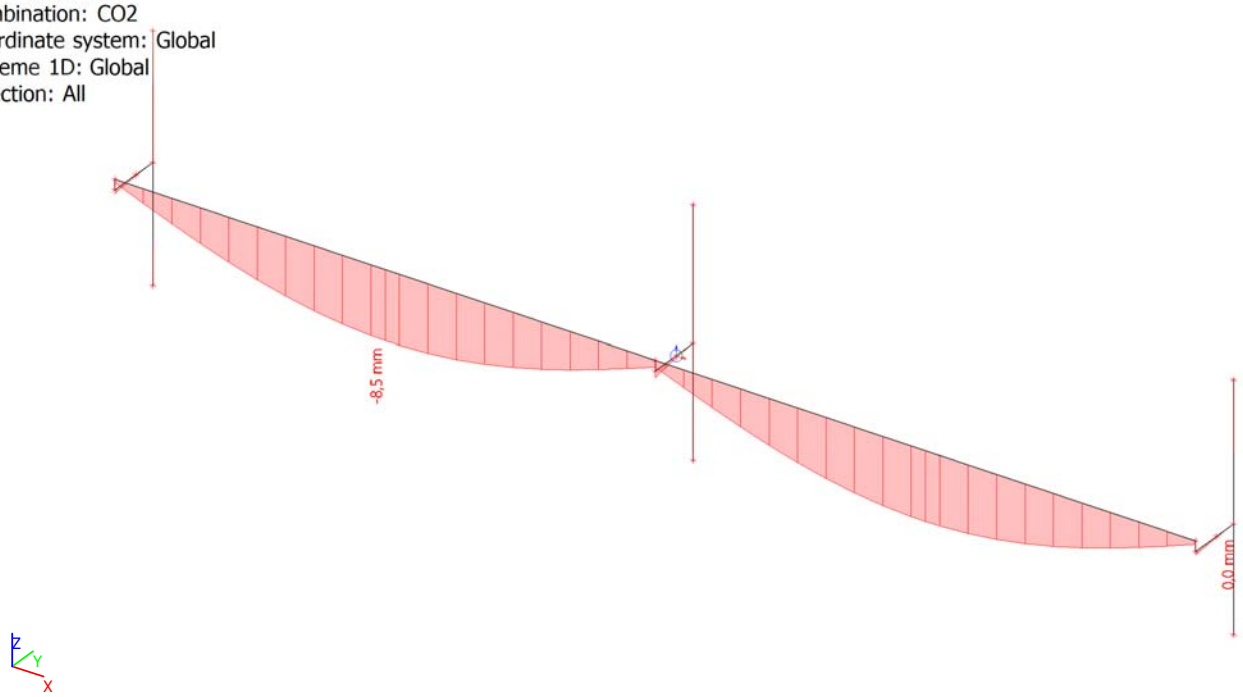
Case	Connection	Node	Beams	Rx [kN]	Ry [kN]	Rz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
CO1/1	FC1	N12	B7	**0,00**	0,00	-10,28	**4,74**	**0,00**	**0,00**
CO1/2	FC1	N12	B7	**0,00**	2,64	-7,62	**3,12**	**0,00**	**0,00**
CO1/3	FC1	N12	B7	0,00	**0,00**	**-7,62**	3,51	0,00	0,00
CO1/4	FC1	N12	B7	0,00	**2,64**	**-10,28**	4,35	0,00	0,00

DEFORMACE

4. DEFORMATIONS

5. 1D deformations; u_z

Values: u_z
Linear calculation
Combination: CO2
Coordinate system: Global
Extreme 1D: Global
Selection: All



6. Deformations on member

Linear calculation, Extreme : Global
Selection : All
Combinations : CO2

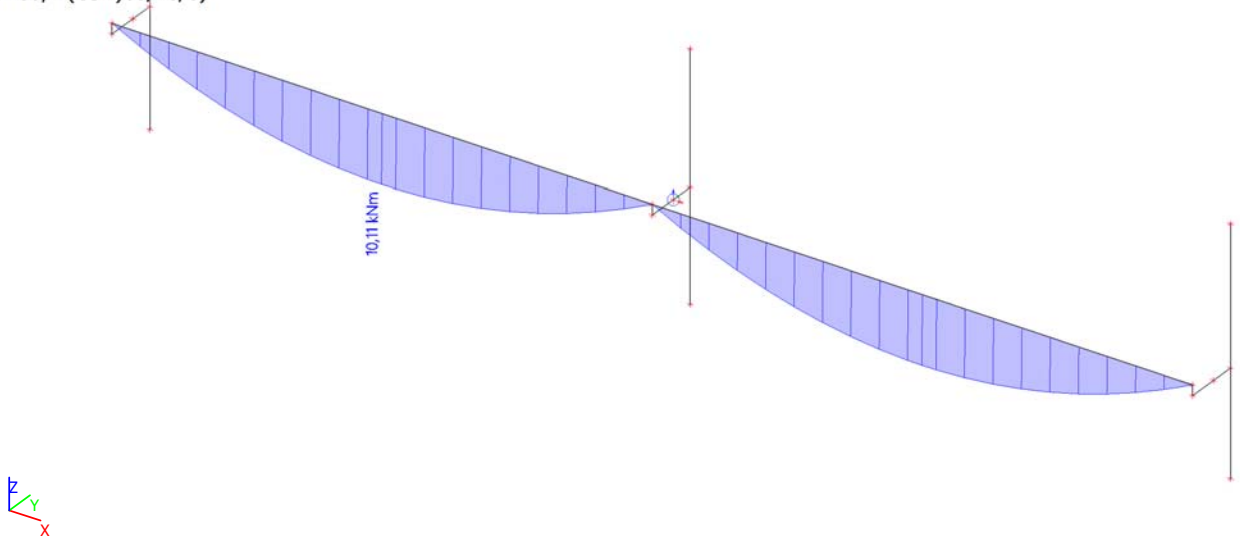
Member	dx [mm]	Case	ux [mm]	uy [mm]	uz [mm]	fix [mrad]	fiy [mrad]	fiz [mrad]	Resultant [mm]
B12	150,000	CO2/3	**-0,8**	-0,2	0,0	0,0	0,0	-1,3	0,8
B4	4000,230	CO2/3	**0,0**	-0,2	-8,5	0,9	0,1	0,0	8,5
B4	8000,480	CO2/3	0,0	**-0,2**	-0,8	**1,3**	-3,1	0,0	0,8
B14	4000,250	CO2/5	0,0	**1,9**	-8,5	0,3	0,0	0,0	8,7
B4	4000,250	CO2/3	0,0	-0,2	**-8,5**	0,9	0,1	0,0	8,5
B2	3600,000	CO2/3	0,0	0,0	**0,1**	0,0	0,0	0,0	0,1
B7	0,000	CO2/3	0,0	0,0	-0,8	**0,0**	-1,3	0,0	0,8
B14	8000,480	CO2/3	0,0	-0,1	-0,4	0,6	**-3,2**	0,0	0,4
B4	0,000	CO2/3	0,0	-0,1	-0,4	0,6	**3,2**	0,0	0,4
B12	0,000	CO2/3	-0,8	0,0	0,0	0,0	0,0	**-1,3**	0,8
B14	0,000	CO2/5	0,0	-0,1	-0,8	0,4	3,1	**0,8**	0,8

VNITŘNÍ SÍLY A POSOUZENÍ PŘŮŘEZŮ

1. STRESS ANALYSIS OF CROSS SECTIONS

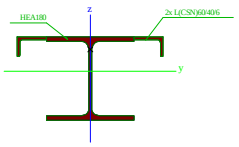
2. CS6 - 1D internal forces; M_y

Values: M_y
Linear calculation
Combination: CO1
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = CS6 - I + 2Ld (HEA180, L(CSN)60/40/6)



3. Cross-sections

3.1. Cross-sections - CS6

Name	Type	Item material	Fabrication	buckling y-y	buckling z-z	Picture
	Detailed					
CS6	I + 2Ld HEA180, L60/40/6	S 235	welded	c	c	

3.1.1. 1D internal forces

Linear calculation
Combination: CO1
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = CS6 - I + 2Ld (HEA180, L(CSN)60/40/6)

Name	dx [mm]	Case	Cross-section	N [kN]	V_y [kN]	V_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
B14	8000,482	CO1/1	CS6 - I + 2Ld	**-0,06**	0,00	-5,06	**0,00**	0,00	0,00
B4	8000,482	CO1/2	CS6 - I + 2Ld	-0,06	**1,32**	**-5,06**	0,00	0,00	0,00
B4	0,000	CO1/1	CS6 - I + 2Ld	**0,06**	0,00	**5,06**	**0,00**	0,00	0,00
B4	0,000	CO1/3	CS6 - I + 2Ld	0,04	**-1,32**	3,75	0,00	**0,00**	0,00
B4	4000,241-	CO1/1	CS6 - I + 2Ld	0,00	0,00	0,00	0,00	**10,11**	**0,00**
B4	4000,241-	CO1/3	CS6 - I + 2Ld	0,00	0,00	0,00	0,00	7,49	**-2,64**

Name	Combination key
CO1/1	1,35*LC1 + 1,35*LC2
CO1/2	1,35*LC1 + 1,35*LC2 + 1,50*LC3
CO1/3	LC1 + LC2 + 1,50*LC3

3.1.2. EC-EN 1993 Steel check ULS

Linear calculation
Combination: CO1
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = CS6 - I + 2Ld (HEA180, L(CSN)60/40/6)

EN 1993-1-1 Code Check
National annex: Standard EN

Member B4	**4,000 / 8,000 m**	**I + 2Ld (HEA180, L(CSN)60/40/6)**	**S 235**	**CO1**	**0,23 -**

Combination key
CO1 / 1,35*LC1 + 1,35*LC2 + 1,50*LC3

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	235,0	MPa
Ultimate strength f_u	360,0	MPa
Fabrication	Welded	

...::SECTION CHECK::...

The critical check is on position 4,000 m

Internal forces	Calculated	Unit
N_{Ed}	0,00	kN
$V_{y,Ed}$	0,00	kN
$V_{z,Ed}$	0,00	kN
T_{Ed}	0,00	kNm
$M_{y,Ed}$	10,11	kNm
$M_{z,Ed}$	-2,64	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	UO	90	10	-4,108e+04	-3,278e+04								
2	I	90	10	1,399e+04	2,229e+04	0,63		1,00	9,47	28,00	34,00	43,64	1
3	I	90	10	3,059e+04	2,229e+04	0,73		1,00	9,47	28,00	34,00	41,95	1
4	UO	90	10	-2,448e+04	-3,278e+04								
5	I	5	6	-3,278e+04	-3,116e+04								
6	I	152	6	-3,116e+04	2,067e+04	-1,51		0,40	25,33	90,27	104,06	190,89	1
7	I	5	6	2,067e+04	2,229e+04	0,93		1,00	0,79	28,00	34,00	38,98	1
8	UO	37	6	-3,289e+03	9,329e+03	-0,35	5,59	0,74	6,17	14,16	15,73	49,64	1
9	I	57	6	9,329e+03	1,459e+04	0,64		1,00	9,50	28,00	34,00	43,43	1
10	UO	37	6	2,383e+04	3,645e+04	0,65	0,58	1,00	6,17	9,00	10,00	16,02	1
11	I	57	6	3,645e+04	3,119e+04	0,86		1,00	9,50	28,00	34,00	40,00	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	3,6652e-04	m^3
$M_{pl,y,Rd}$	86,13	kNm
Unity check	0,12	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	3,0422e-04	m^3
$M_{pl,z,Rd}$	71,49	kNm
Unity check	0,04	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	2	
τ_{Ed}	0,0	MPa
τ_{Rd}	135,7	MPa
Unity check	0,00	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.1 and formula (6.2)

$N_{pl,Rd}$	1331,18	kN
$M_{pl,y,Rd}$	86,13	kNm
$M_{pl,z,Rd}$	71,49	kNm

Unity check (6.2) = 0,00 + 0,12 + 0,04 = 0,15 -

Note: No specific interaction formulae according to EN 1993-1-1 article 6.2.9.1 apply.
Therefore the plastic linear summation according to EN 1993-1-1 article 6.2.1(7) is verified.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 8,000 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	UO	90	10	1,002e+01	1,002e+01	1,00	0,43	1,00	9,47	9,00	10,00	14,00	2
2	I	90	10	1,002e+01	1,002e+01	1,00		1,00	9,47	28,00	34,00	38,00	1
3	I	90	10	1,002e+01	1,002e+01	1,00		1,00	9,47	28,00	34,00	38,00	1
4	UO	90	10	1,002e+01	1,002e+01	1,00	0,43	1,00	9,47	9,00	10,00	14,00	2
5	I	5	6	1,002e+01	1,002e+01	1,00		1,00	0,79	28,00	34,00	38,00	1
6	I	152	6	1,002e+01	1,002e+01	1,00		1,00	25,33	28,00	34,00	38,00	1
7	I	5	6	1,002e+01	1,002e+01	1,00		1,00	0,79	28,00	34,00	38,00	1
8	UO	37	6	1,002e+01	1,002e+01	1,00	0,43	1,00	6,17	9,00	10,00	14,00	1
9	I	57	6	1,002e+01	1,002e+01	1,00		1,00	9,50	28,00	34,00	38,00	1
10	UO	37	6	1,002e+01	1,002e+01	1,00	0,43	1,00	6,17	9,00	10,00	14,00	1
11	I	57	6	1,002e+01	1,002e+01	1,00		1,00	9,50	28,00	34,00	38,00	1

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 2

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1 & 6.3.2.2 and formula (6.54)

LTB parameters		
Method for LTB curve	General case	
Plastic section modulus $W_{pl,y}$	3,6652e-04	m^3
Elastic critical moment M_{cr}	154,86	kNm
Relative slenderness $\lambda_{rel,LT}$	0,75	
Limit slenderness $\lambda_{rel,LT,0}$	0,20	
LTB curve	d	
Imperfection α_{LT}	0,76	
Reduction factor χ_{LT}	0,61	
Design buckling resistance $M_{b,Rd}$	52,85	kNm
Unity check	0,19	-

Mcr parameters		
LTB length L	8,000	m
Influence of load position	no influence	
Correction factor k	1,00	
Correction factor k_w	1,00	
LTB moment factor C_1	1,13	
LTB moment factor C_2	0,45	
LTB moment factor C_3	0,53	
Shear center distance d_z	45	mm
Distance of load application z_g	0	mm
Mono-symmetry constant β_y	-86	mm
Mono-symmetry constant z_j	43	mm

Note: C parameters are determined according to ECCS 119 2006 / Galea 2002.

Bending and axial tension check
According to EN 1993-1-3 article 6.3

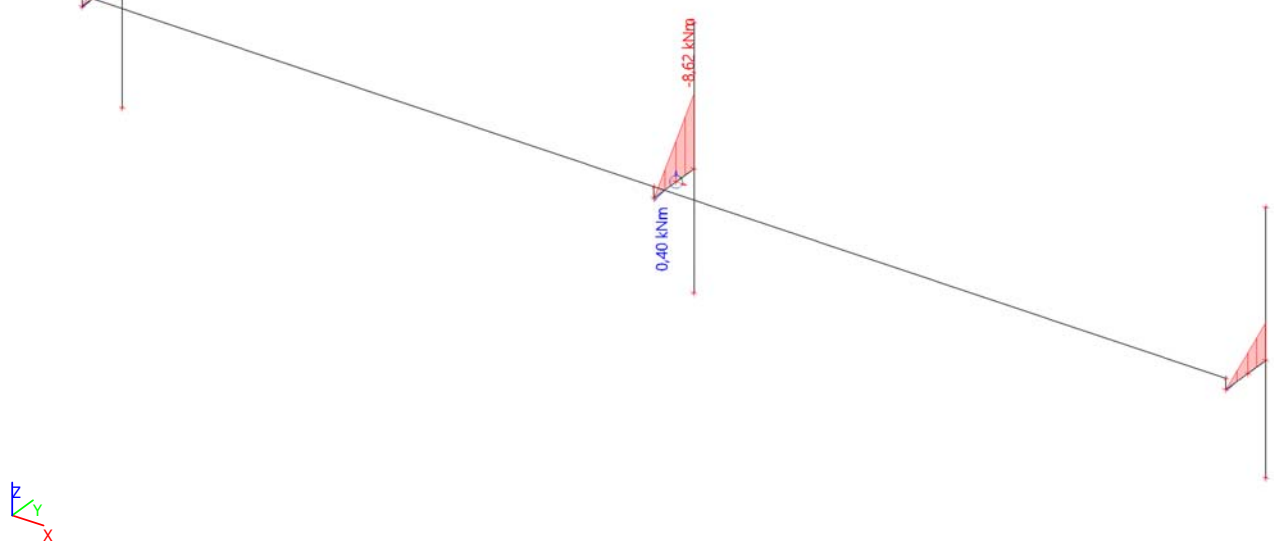
Design tension force N_{Ed}	0,00	kN
Design bending moment $M_{y,Ed}$	10,11	kNm
Design bending moment $M_{z,Ed}$	-2,64	kNm
Tension resistance $N_{t,Rd}$	1331,18	kN
Bending resistance $M_{b,y,Rd}$	52,85	kNm
Bending resistance $M_{c,z,Rd,com}$	71,49	kNm

Unity check = 0,19 + 0,04 - 0,00 = 0,23 -

The member satisfies the stability check.

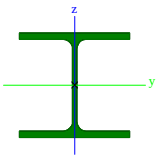
4. CS7 - 1D internal forces; M_y

Values: M_y
Linear calculation
Combination: CO1
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = CS7 - HEA140



5. Cross-sections

5.1. Cross-sections - CS7

Name	Type	Item material	Fabrication	buckling y-y	buckling z-z	Picture	Type description
	Detailed						
CS7	HEA140	S 235	rolled	b	c		European wide flange beam

5.1.1. 1D internal forces

Linear calculation
Combination: CO1
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = CS7 - HEA140

Name	dx [mm]	Case	Cross-section	N [kN]	V_y [kN]	V_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
B7	0,000	CO1/1	CS7 - HEA140	**-2,64**	0,00	-10,13	0,00	**0,40**	0,00
B8	375,000	CO1/1	CS7 - HEA140	-2,64	0,00	**-10,41**	0,00	-8,23	0,00
B5	0,000	CO1/2	CS7 - HEA140	-1,32	0,00	**-3,76**	0,00	0,20	0,00
B8	375,000	CO1/3	CS7 - HEA140	**0,00**	**0,00**	-10,41	**0,00**	**-8,62**	**0,00**
B6	375,000	CO1/3	CS7 - HEA140	0,00	**0,00**	-5,35	**0,00**	-4,38	**0,00**

Name	Combination key
CO1/1	1,35*LC1 + 1,35*LC2 + 1,50*LC3
CO1/2	LC1 + LC2 + 1,50*LC3
CO1/3	1,35*LC1 + 1,35*LC2

5.1.2. EC-EN 1993 Steel check ULS

Linear calculation
Combination: CO1
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = CS7 - HEA140

EN 1993-1-1 Code Check
National annex: Standard EN

Member B8	0,375 / 0,375 m	HEA140	S 235	CO1	0,21 -

Combination key
CO1 / 1,35*LC1 + 1,35*LC2

Partial safety factors	
γ_{M0} for resistance of cross-sections	1,00
γ_{M1} for resistance to instability	1,00
γ_{M2} for resistance of net sections	1,25

Material		
Yield strength f_y	235,0	MPa
Ultimate strength f_u	360,0	MPa
Fabrication	Rolled	

...::SECTION CHECK::...

The critical check is on position 0,375 m

Internal forces	Calculated	Unit
N_{Ed}	0,00	kN
$V_{y,Ed}$	0,00	kN
$V_{z,Ed}$	-10,41	kN
T_{Ed}	0,00	kNm
$M_{y,Ed}$	-8,62	kNm
$M_{z,Ed}$	0,00	kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	55	9	5,196e+04	5,195e+04	1,00	0,43	1,00	6,50	9,00	10,00	13,79	1
3	SO	55	9	5,196e+04	5,196e+04	1,00	0,43	1,00	6,50	9,00	10,00	13,77	1
4	I	92	6	3,839e+04	-3,839e+04	-1,00		0,50	16,73	72,00	83,00	124,00	1
5	SO	55	9	-5,196e+04	-5,195e+04								
7	SO	55	9	-5,196e+04	-5,196e+04								

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,y}$	1,7333e-04	m^3
$M_{pl,y,Rd}$	40,73	kNm
Unity check	0,21	-

Bending moment check for M_z
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

$W_{pl,z}$	8,5000e-05	m^3
$M_{pl,z,Rd}$	19,98	kNm
Unity check	0,00	-

Shear check for V_y
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	2,4763e-03	m^2
$V_{pl,y,Rd}$	335,97	kN
Unity check	0,00	-

Shear check for V_z
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

η	1,20	
A_v	1,0107e-03	m^2
$V_{pl,z,Rd}$	137,14	kN
Unity check	0,08	-

Torsion check
According to EN 1993-1-1 article 6.2.7 and formula (6.23)

Fibre	1	
τ_{Ed}	0,0	MPa
τ_{Rd}	135,7	MPa
Unity check	0,00	-

Note: The unity check for torsion is lower than the limit value of 0,05. Therefore torsion is considered as insignificant and is ignored in the combined checks.

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

$M_{pl,y,Rd}$	40,73	kNm
α	2,00	
$M_{pl,z,Rd}$	19,98	kNm
β	1,00	

Unity check (6.41) = 0,04 + 0,00 = 0,04 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 0,375 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

Id	Type	c [mm]	t [mm]	σ_1 [kN/m²]	σ_2 [kN/m²]	Ψ [-]	k_σ [-]	α [-]	c/t [-]	Class 1 Limit [-]	Class 2 Limit [-]	Class 3 Limit [-]	Class
1	SO	55	9	5,196e+04	5,195e+04	1,00	0,43	1,00	6,50	9,00	10,00	13,79	1
3	SO	55	9	5,196e+04	5,196e+04	1,00	0,43	1,00	6,50	9,00	10,00	13,77	1
4	I	92	6	3,839e+04	-3,839e+04	-1,00		0,50	16,73	72,00	83,00	124,00	1
5	SO	55	9	-5,196e+04	-5,195e+04								
7	SO	55	9	-5,196e+04	-5,196e+04								

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1 & 6.3.2.3 and formula (6.54)

LTB parameters		
Method for LTB curve	Alternative case	
Plastic section modulus $W_{pl,y}$	1,7333e-04	m^3
Elastic critical moment M_{cr}	1348,91	kNm
Relative slenderness $\lambda_{rel,LT}$	0,17	
Limit slenderness $\lambda_{rel,LT,0}$	0,40	

Note: The slenderness or bending moment is such that Lateral Torsional Buckling effects may be ignored according to EN 1993-1-1 article 6.3.2.2(4).

Mcr parameters		
LTB length L	0,840	m
Influence of load position	no influence	
Correction factor k	1,00	
Correction factor k_w	1,00	
LTB moment factor C_1	1,77	
LTB moment factor C_2	0,00	
LTB moment factor C_3	1,00	
Shear center distance d_z	0	mm
Distance of load application z_g	0	mm
Mono-symmetry constant β_y	0	mm
Mono-symmetry constant z_j	0	mm

Note: C parameters are determined according to ECCS 119 2006 / Galea 2002.

Bending and axial compression check
According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

Bending and axial compression check parameters		
Interaction method	alternative method 1	
Cross-section area A	3,1400e-03	m^2
Plastic section modulus $W_{pl,y}$	1,7333e-04	m^3
Plastic section modulus $W_{pl,z}$	8,5000e-05	m^3
Design compression force N_{Ed}	0,00	kN
Design bending moment (maximum) $M_{y,Ed}$	-8,62	kNm
Design bending moment (maximum) $M_{z,Ed}$	0,00	kNm
Characteristic compression resistance N_{Rk}	737,90	kN
Characteristic moment resistance $M_{y,Rk}$	40,73	kNm
Characteristic moment resistance $M_{z,Rk}$	19,98	kNm
Reduction factor χ_y	1,00	
Reduction factor χ_z	1,00	
Modified reduction factor $\chi_{LT,mod}$	1,00	
Interaction factor k_{yy}	1,00	
Interaction factor k_{yz}	0,55	
Interaction factor k_{zy}	0,52	
Interaction factor k_{zz}	0,78	

Maximum moment $M_{y,Ed}$ is derived from beam B8 position 0,375 m.
Maximum moment $M_{z,Ed}$ is derived from beam B8 position 0,375 m.

Interaction method 1 parameters		
Critical Euler load $N_{cr,y}$	5030,59	kN
Critical Euler load $N_{cr,z}$	11843,99	kN
Elastic critical load $N_{cr,T}$	11244,31	kN
Plastic section modulus $W_{pl,y}$	1,7333e-04	m^3
Elastic section modulus $W_{el,y}$	1,5500e-04	m^3
Plastic section modulus $W_{pl,z}$	8,5000e-05	m^3
Elastic section modulus $W_{el,z}$	5,5600e-05	m^3
Second moment of area I_y	1,0300e-05	m^4
Second moment of area I_z	3,8900e-06	m^4
Torsional constant I_t	8,1300e-08	m^4
Method for equivalent moment factor $C_{my,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_y	0,00	
Equivalent moment factor $C_{my,0}$	0,79	
Method for equivalent moment factor $C_{mz,0}$	Table A.2 Line 1 (Linear)	
Ratio of end moments ψ_z	-0,06	
Equivalent moment factor $C_{mz,0}$	0,78	
Factor μ_y	1,00	
Factor μ_z	1,00	
Factor a_{LT}	0,99	
Critical moment for uniform bending $M_{cr,0}$	761,99	kNm
Relative slenderness $\lambda_{rel,0}$	0,23	
Limit relative slenderness $\lambda_{rel,0,lim}$	0,27	
Equivalent moment factor C_{my}	1,00	
Equivalent moment factor C_{mz}	0,78	
Equivalent moment factor C_{mLT}	1,00	
Factor b_{LT}	0,00	
Factor c_{LT}	0,02	
Factor d_{LT}	0,00	

Interaction method 1 parameters		
Factor e_{LT}	0,79	
Factor w_y	1,12	
Factor w_z	1,50	
Factor n_{pl}	0,00	
Maximum relative slenderness $\lambda_{rel,max}$	0,38	
Factor C_{yy}	1,00	
Factor C_{yz}	0,99	
Factor C_{zy}	1,00	
Factor C_{zz}	1,00	

Unity check (6.61) = 0,00 + 0,21 + 0,00 = 0,21 -
Unity check (6.62) = 0,00 + 0,11 + 0,00 = 0,11 -

Shear Buckling check
According to EN 1993-1-5 article 5 & 7.1 and formula (5.10) & (7.1)

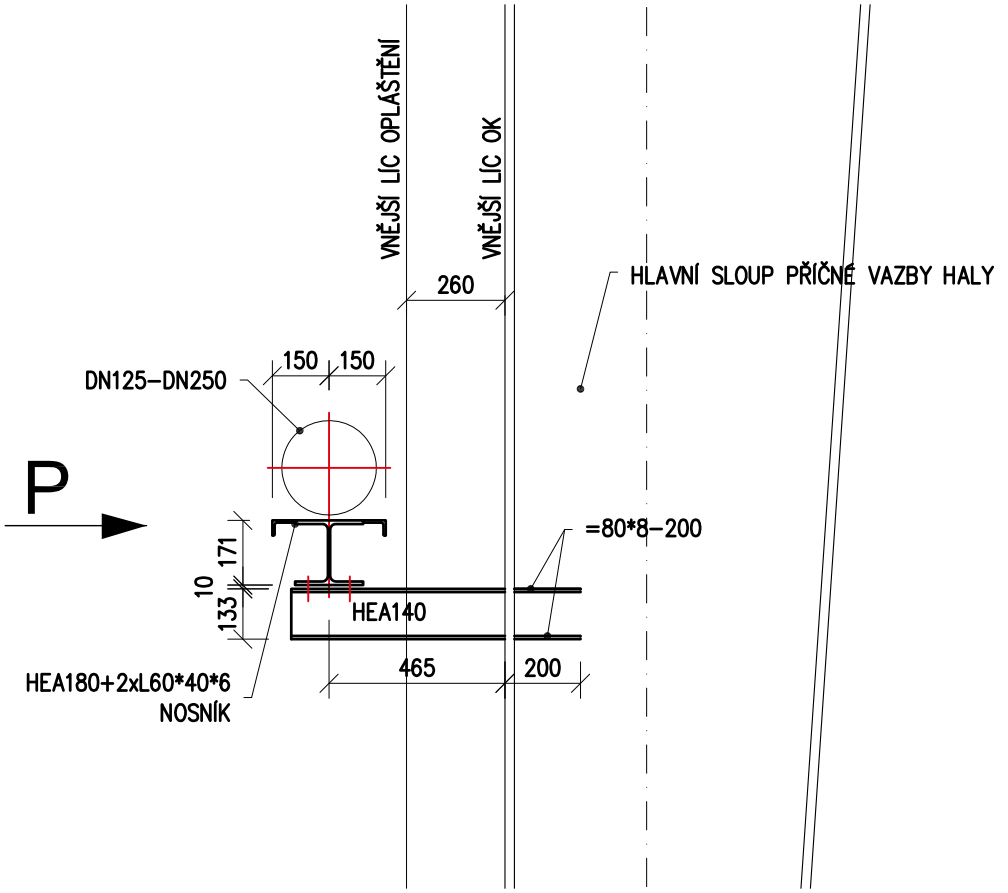
Shear Buckling parameters		
Buckling field length a	0,375	m
Web	unstiffened	
Web height h_w	116	mm
Web thickness t	6	mm
Material coefficient ε	1,00	
Shear correction factor η	1,20	

Shear Buckling verification	
Web slenderness h_w/t	21,09
Web slenderness limit	60,00

Note: The web slenderness is such that Shear Buckling effects may be ignored according to EN 1993-1-5 article 5.1(2).

The member satisfies the stability check.

DETAIL ULOŽENÍ NOSNÍKŮ



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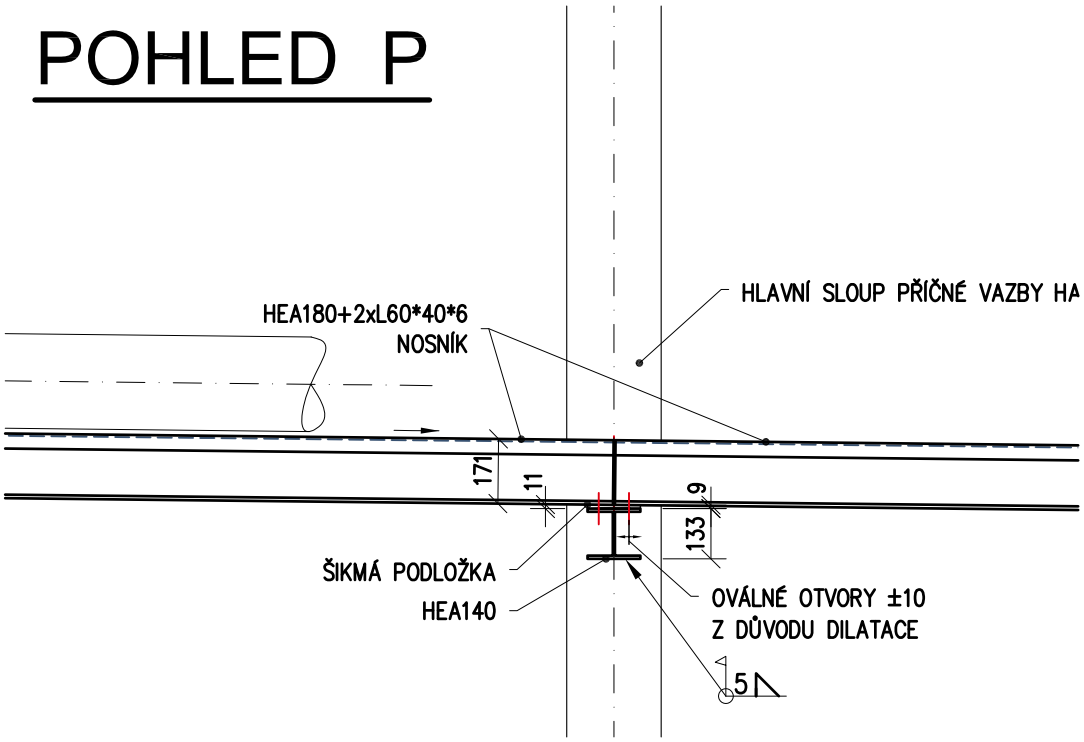

ZÁVĚR

Ocelová konstrukce nosníku pro potrubí DN250 **vyhovuje na mezní stav pevnosti a mezní stav použitelnosti dle ČSN EN 1993-1-1**.