

Centrum Energetických a Environmentálních Technologií – Explorer (CEETe)

Projektová dokumentace pro vydání stavebního povolení

SO 01.2 Budova pro vodíkovou stanici

Statický výpočet

01.2.21 Stavebně konstrukční řešení - OK

Archivní číslo	:	20-026-4 / 01.2.21-02
Zhotovitel	:	CHVÁLEK ATELIÉR s.r.o. Kafkova 1064/12, 702 00 Ostrava - Moravská Ostrava
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Vypracoval	:	Ing. Ernest Jeżowicz
Objednatel	:	Vysoká škola báňská - Technická univerzita Ostrava 17. listopadu 2172/15, 708 00 Ostrava - Poruba
Datum	:	10 / 2020

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10/2020

Vypracoval: Ing. Jeżowicz

ZATÍŽENÍ

1. STÁLÉ

1.1 Vlastní hmotnost konstrukce generována z průřezových ploch prvků

1.2 Skladba střechy

Plech 5 mm 0.40
 $q_{\text{roof,k}} = 0.40 \text{ kN/m}^2$

1.3 Podélná stěna

Bondové AL panely (5 kg/m^2) 0,05
Podkonstrukce (5 kg/m^2) 0.05
 $g_{\text{foto,k}} = 0.10 \text{ kN/m}^2$

1.5 Pletivo

oka 2.5x50x50, prodyšnost 94%

hmotnost (0.86 kg/m^2) 0,0087
 $q_{\text{most,k}} = 0.009 \text{ kN/m}^2$

Součinitel zatížení $\gamma_i = 1.35$

2. PROMĚNLIVÉ

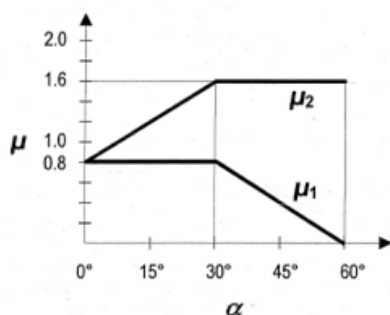
2.1 Sníh

sněhová oblast II (Ostrava)	$s_k=1.0 \text{ kN/m}^2$
tepelný součinitel	$C_t=1.0$
součinitel expozice	$C_e=1.0$

a) střecha objektu

tvarový součinitel μ

ČSN EN 1991-1-3



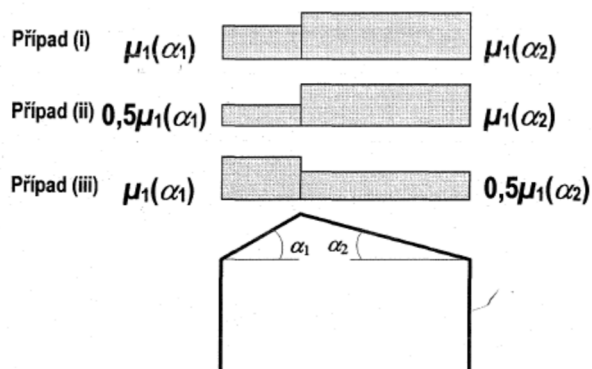
Obrázek 5.1 – Tvarové součinitele zatížení sněhem

(2) Hodnoty uvedené v tabulce 5.2 platí, pokud není zabráněno sklouzávání sněhu ze střechy. Pokud jsou na střeše sněžníky nebo jiné překážky nebo je dolní okraj střechy ukončen atikou (nadezdívkou), potom hodnota tvarového součinitele zatížení sněhem nemá klesnout pod 0,8.

Tabulka 5.2 – Tvarové součinitele zatížení sněhem

úhel sklonu střechy α	$0^\circ \leq \alpha \leq 30^\circ$	$30^\circ < \alpha < 60^\circ$	$\alpha \geq 60^\circ$
μ_1	0,8	$0,8(60 - \alpha)/30$	0,0
μ_2	$0,8 + 0,8\alpha/30$	1,6	—

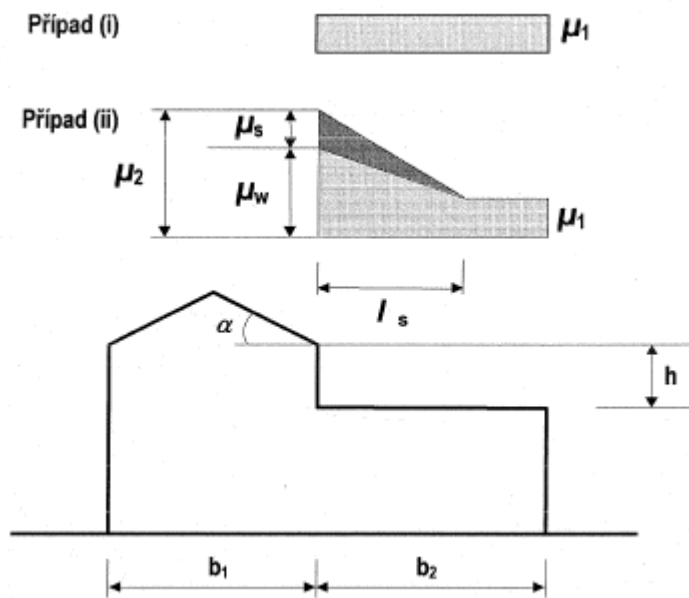
(3) Uspořádání zatížení podle obrázku 5.2 se má použít pro zatížení nenavátým i navátým sněhem.



$$\alpha=0^\circ \rightarrow \mu_1=0.8, \mu_2=0.8+0.8 \cdot 0/30=0.80 \text{ kN/m}^2$$

$$s_{1,k} = s_k \cdot C_t \cdot C_e \cdot \mu_1 = 1.0 \cdot 1 \cdot 1 \cdot 0.8 = 0.80 \text{ kN/m}^2 \text{ (zelená stěna)}$$

b) místní účinky – markýza (vodíková stanice)



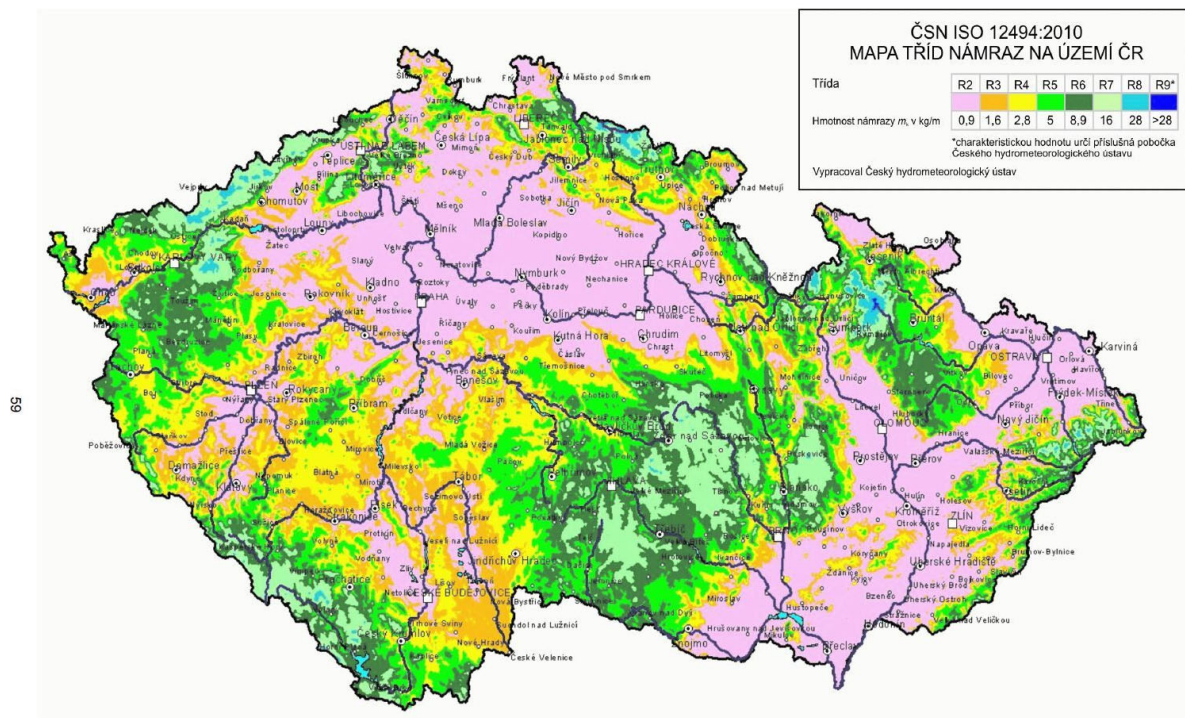
$$h=13.41 \text{ m} \rightarrow l_s=2 \cdot h=2 \cdot 1.2=2.4 \text{ m}, \mu_2=\mu_s+\mu_w, \mu_s=0, \mu_w=(b_1+b_2)/2h=(13.41+1.0)/(2 \cdot 1.2)=6 \Rightarrow \mu_w=2$$

$$s_{2,k}=s_k \cdot C_t \cdot C_e \cdot \mu_2=1,00 \cdot 1 \cdot 1 \cdot 2=2,00 \text{ kN/m}^2$$

2.2 Námraza (dle ČSN ISO 12494)

Třída námrazyR2

Hmotnost námrazy $m_k=0.9 \text{ kg/m}$

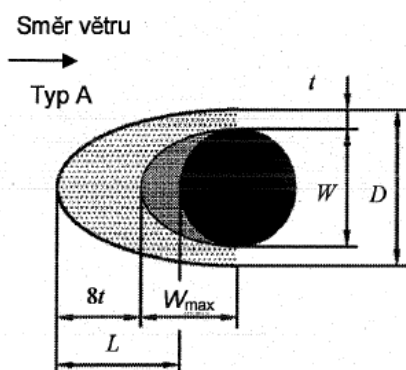


Obrázek NA.1 – Mapa tříd námraz pro území České republiky

ČSN ISO 12494

Tabulka 5 – Rozměry námrazy na profilech typů A a B
(platí pouze pro námrazu z oblácnosti, objemová hmotnost námrazy = 500 kg/m^3)

Tvary průřezů typů A a B									
Šířka profilu [mm]		10		30		100		300	
IC	Hmotnost námrazy <i>m</i> [kg/m]	Rozměry námrazy [mm]							
		<i>L</i>	<i>D</i>	<i>L</i>	<i>D</i>	<i>L</i>	<i>D</i>	<i>L</i>	<i>D</i>
R1	0,5	54	22	34	35	13	100	4	300
R2	0,9	78	28	54	40	23	100	8	300
R3	1,6	109	36	82	47	41	100	14	300
R4	2,8	150	46	120	56	67	104	24	300
R5	5,0	207	60	174	70	106	114	42	300
R6	8,9	282	79	247	88	165	129	76	300
R7	16,0	384	105	348	113	253	151	136	300
R8	28,0	514	137	478	146	372	181	217	317
R9	50,0	694	182	656	190	543	223	344	349
R10	Používá se pro extrémní námrazu								



Parametry tvorby námrazy:

$W = 2.5 \text{ mm}$, $L = 78 \text{ mm}$,

IC R2 - $\rightarrow D = D(10\text{mm}) - W(10\text{mm}) + D = 28 - 10 + 2.5 = 20.5 \text{ mm}$

$t = (D - W)/2 = (20.5 - 2.5)/2 = 9 \text{ mm}$, $L = 78\text{mm}$

Prodyšnost plochy pletivaítě 50x50/2.5 při námraze :

$(50 - 2.5 - 2 \times 9)^2 / 50^2 = 0.348 - \rightarrow \text{cca } 35\%$

Tabulka 27 – Součinitel pro snížení tlaku větru

ICG	k	ICR	k
G1	0,40	R1	0,40
G2	0,45	R2	0,45
G3	0,50	R3	0,50
G4	0,55	R4	0,55
G5	0,60	R5	0,60
		R6	0,70
		R7	0,80
		R8	0,90
		R9	1,00

ICR = R2 -> Součinitel snížení tlaku větru $k=0.45$

Hmotnost námrazy na 1 bm lana sítě -> 0.9 kg/bm

Hmotnost námrazy na 1 m^2 plochy sítě $> 40 \text{ ks} \times 0.9 \text{ kg/m}^2 = 36 \text{ kg/m}^2$.

Součinitel zatížení $\gamma_f=1.5$

VÝPOČET ZATÍŽENÍ VĚTREM PODLE ČTN EN 1991-1-4

Větrová oblast

místo: Ostrava

odečteno z mapy větrových oblastí ČR

$V_{b,0} = 25$ m/s

výchozí základní rychlost větru

Základní rychlost větru

$V_b = V_{b,0} \cdot C_{dir} \cdot C_{season} = 25$ 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

Příloha A.1

$z_0 = 0,3$ m

tab.4.1

$z_{min} = 5,00$ m

tab.4.1

$z_{max} = 200$ m

$z_{e1} = 4,00$ m

zadej $z = z_{min}$

referenční výška

7.2.2 (1)

$z_{e2} = 3$ m

Součinitel terénu

$k_r = 0,19 \cdot (z_0/z_{0,II})^{0,07} = 0,215$

součinitel terénu 4.3.2 (4.5)

$z_{0,II} = 0,05$

kat. terénu II

tab.4.1

Součinitel drsnosti terénu

$c_r(z_{e1}) = k_r \cdot \ln(z/z_0) = 0,558$

4.3.2 (4.4)

$c_r(z_{e2}) = k_r \cdot \ln(z/z_0) = 0,496$

Součinitel orografie

$c_0(z) = 1$

4.3.1.

Střední rychlost větru

$v_m(z_{e1}) = c_r(z) \cdot c_0(z) \cdot v_b = 13,95 \text{ ms}^{-1}$

4.3.1 (4.3)

$v_m(z_{e2}) = c_r(z) \cdot c_0(z) \cdot v_b = 12,40 \text{ ms}^{-1}$

Intenzita turbulence

$I_v(z_{e1}) = k_t/c_0(z) \cdot \ln(z/z_0) = 0,386$

$k_t = 1$

součinitel turbulence

4.4 (4.7)

$I_v(z_{e2}) = k_t/c_0(z) \cdot \ln(z/z_0) = 0,434$

Maximální dynamický tlak větru

$q_p(z_{e1}) = [1+7I_v(z)] \cdot 0,5\rho \cdot v_m(z)^2 = 450 \text{ Nm}^{-2} = 0,45 \text{ kNm}^{-2}$

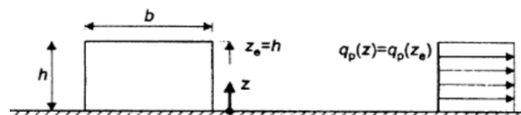
4.4 (4.8)

$q_p(z_{e2}) = [1+7I_v(z)] \cdot 0,5\rho \cdot v_m(z)^2 = 388 \text{ Nm}^{-2} = 0,388 \text{ kNm}^{-2}$

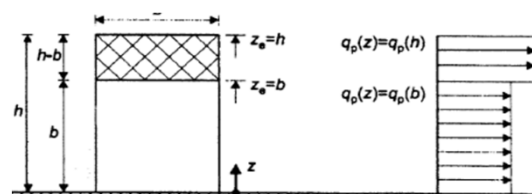
Rozměry objektu

$h =$	4,00 m	výška stavby
$b =$	3,00 m	rozměr kolmo na hřeben - délka štítu
$l =$	14,50 m	rozměr rovnoběžně s hřebenem
$l_1 =$	2,40 m	vzdálenost rámu
$l_2 =$	2,40 m	vzdálenost štítových sloupů
$l_3 =$	0,90 m	vzdálenost vaznic

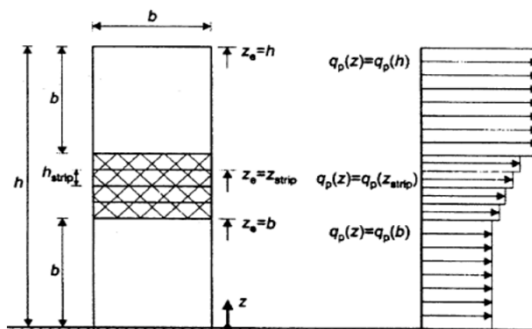
(1)		výška průběh	
$z_{e1} =$	4 m	0 až h konst.	$h < b$



(2)			
$z_{e1} = h$	4 m	b až h konst.	$b < h < 2b$
$z_{e2} = b$	3 m	0 až b konst.	



(3)			
$z_{e1} = h$	4 m	$(h - b)$ a konst.	$h > 2b$
$z_{es} = h$	m	b až $(h \cdot \text{lin.})$	
$z_{e2} = b$	3 m	0 až b konst.	



PLATÍ 2.PŘÍPAD

$$q_p(h) = 0,45 \text{ kNm}^{-2}$$

Typ přístřešku

uzavřený na 1 straně ▼

Půdorysné rozměry

$$d = 13,4 \text{ m}$$

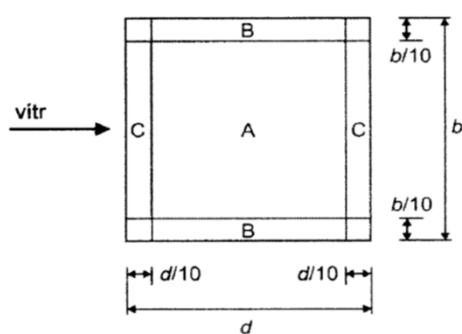
$$b = 2,5 \text{ m}$$

hřeben

tab.7.6

Součinitele výsledného tlaku - pro návrh střešních prvků - lokální

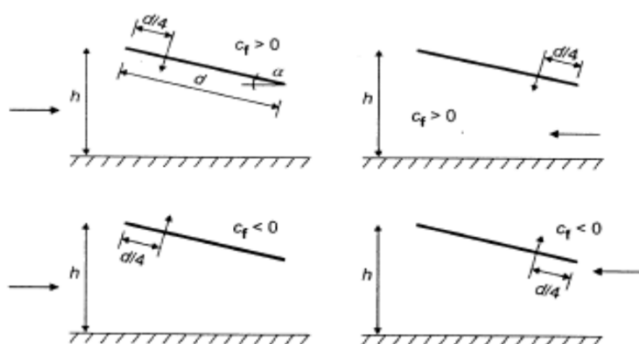
Sklon [°]	Oblast	A		B		C	
10	$C_{p,net}$	1,20	-2,10	2,40	-2,60	1,60	-2,70
	$W_e(Z_e)$	0,54	-0,95	1,08	-1,17	0,72	-1,22



Celková výslednice - pro návrh nosných prvků (sloupy)

C_f ... součinitel celk. síly	0,50	-1,40
$w = C_f g_p(h)$... na celé ploše	0,23	-0,63
$w = 2C_f g_p(h)$... na polovině	0,45	-1,26

...na polovině plochy přístřešku u návětrné strany



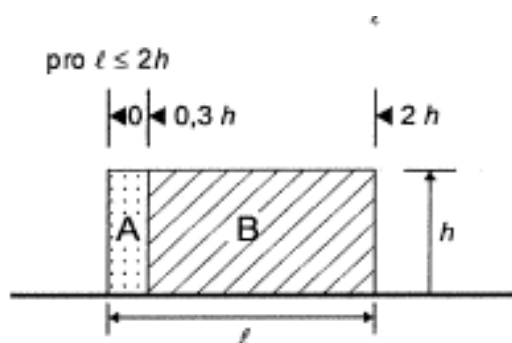
2.3.1 Volně stojící stěna (vodíková stanice)

max. dynamický tlak $q_p = 0.45 \text{ kN/m}^2$

součinitel plnosti (prodyšnost 0%)..... $\varphi = 1.0$

délka - podélná stěna $\ell = 13.4 \text{ m}$, $h = 4.0 \text{ m}$

- příčná stěna $\ell = 2.45 \text{ m}$, $h = 4.0 \text{ m}$



ČSN EN 1991-1-4 ed. 2

Tabulka 7.9 – Doporučené hodnoty součinitelů tlaku $c_{p,net}$ pro volně stojící stěny a zděná zábradlí

Součinitel plnosti	Oblast		A	B	C	D
$\varphi = 1$	Bez vedlejšího průčelí	$\ell/h \leq 3$	2,3	1,4	1,2	1,2
		$\ell/h = 5$	2,9	1,8	1,4	1,2
		$\ell/h \geq 10$	3,4	2,1	1,7	1,2
	S vedlejšími průčelími s délkou $\geq h^a$		2,1	1,8	1,4	1,2
$\varphi = 0,8$			1,2	1,2	1,2	1,2

^a Pro vedlejší průčelí s délkami mezi 0,0 a h lze použít lineární interpolaci.

Součinitel tlaku pro oblast A s vedleším průčelím

$$c_{p,net} = 2.1 \rightarrow \text{tlak větru } w = q_p \cdot c_{p,net} = 0.45 \times 2.1 = 0.945 \text{ kN/m}^2$$

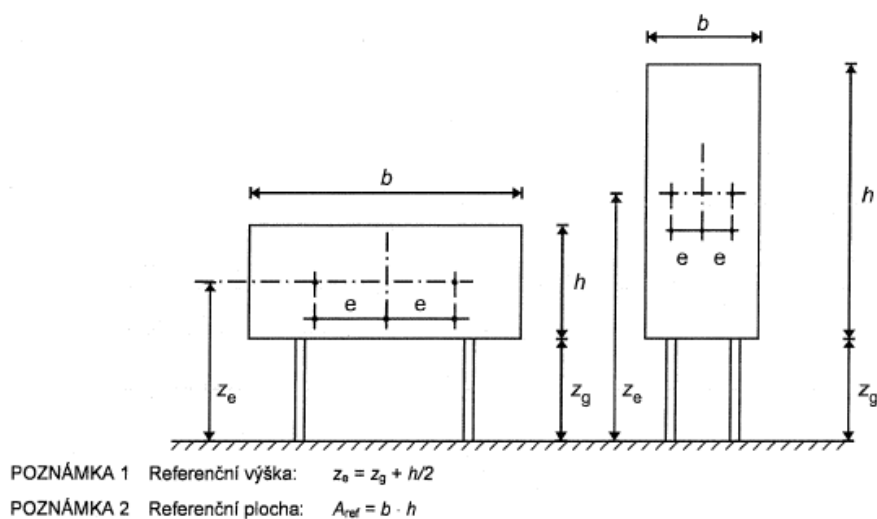
Součinitel tlaku pro oblast B s vedleším průčelím

$$c_{p,net} = 1.8 \rightarrow \text{tlak větru } w = q_p \cdot c_{p,net} = 0.45 \times 1.8 = 0.81 \text{ kN/m}^2$$

2.3.2 Potrubní most (vodíková stanice)

max. dynamický tlak $q_p = 0.45 \text{ kN/m}^2$

součinitel plnosti (prodyšnost 0%)..... $\phi = 1.0$

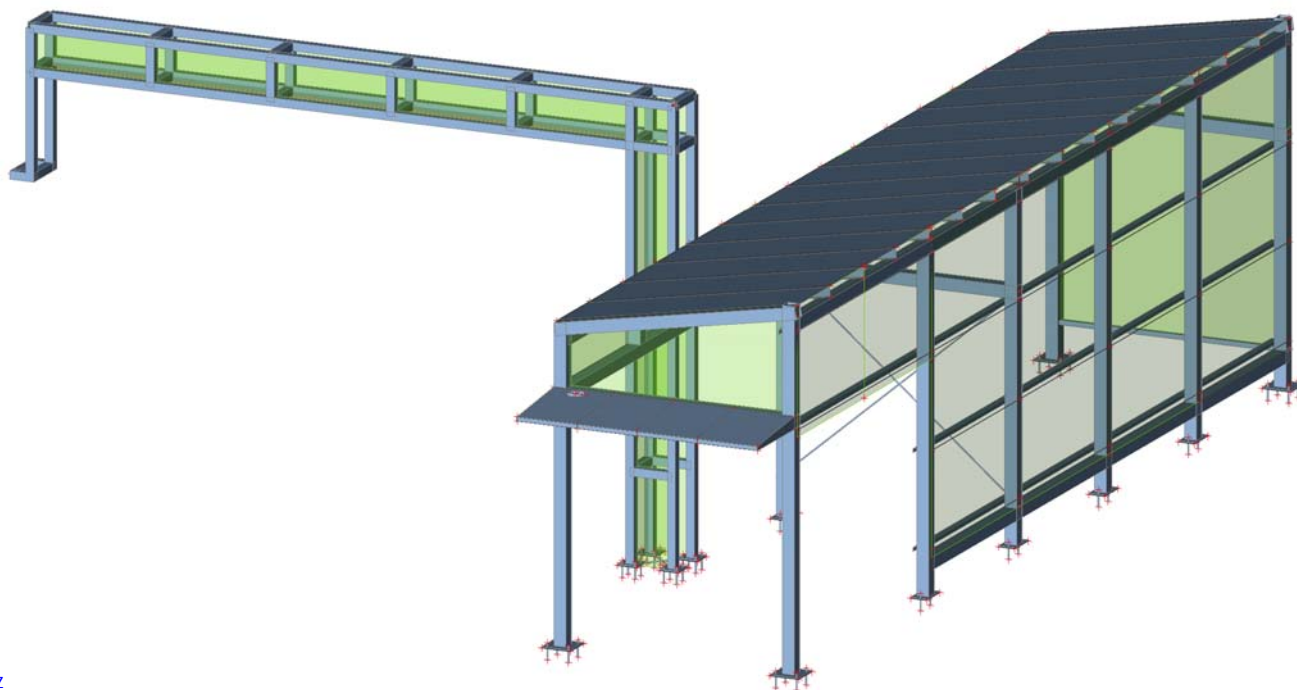


Součinitel tlaku

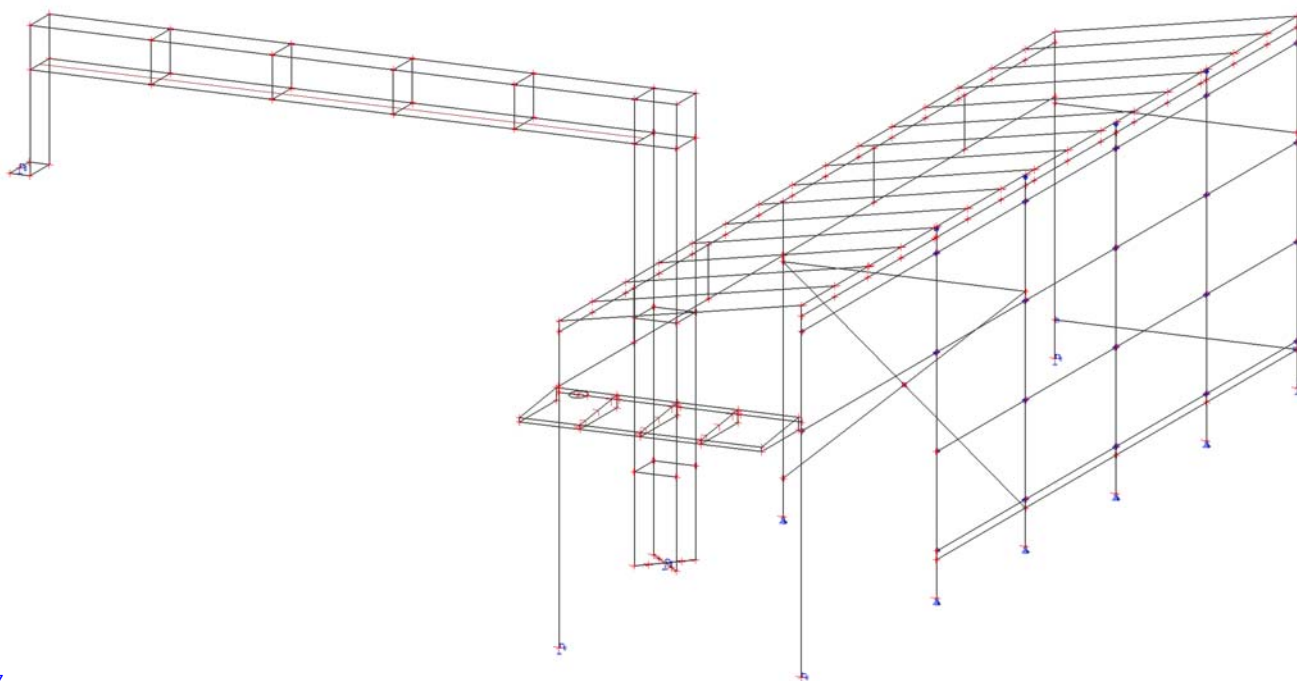
$C_f = 1.8 \rightarrow$ tlak větru $w = q_p \cdot c_f = 0.45 \times 1.8 = 0.81 \text{ kN/m}^2$

KONSTRUKCE VODÍKOVÉ STANICE

3D MODEL OF STRUCTURE



Structural model



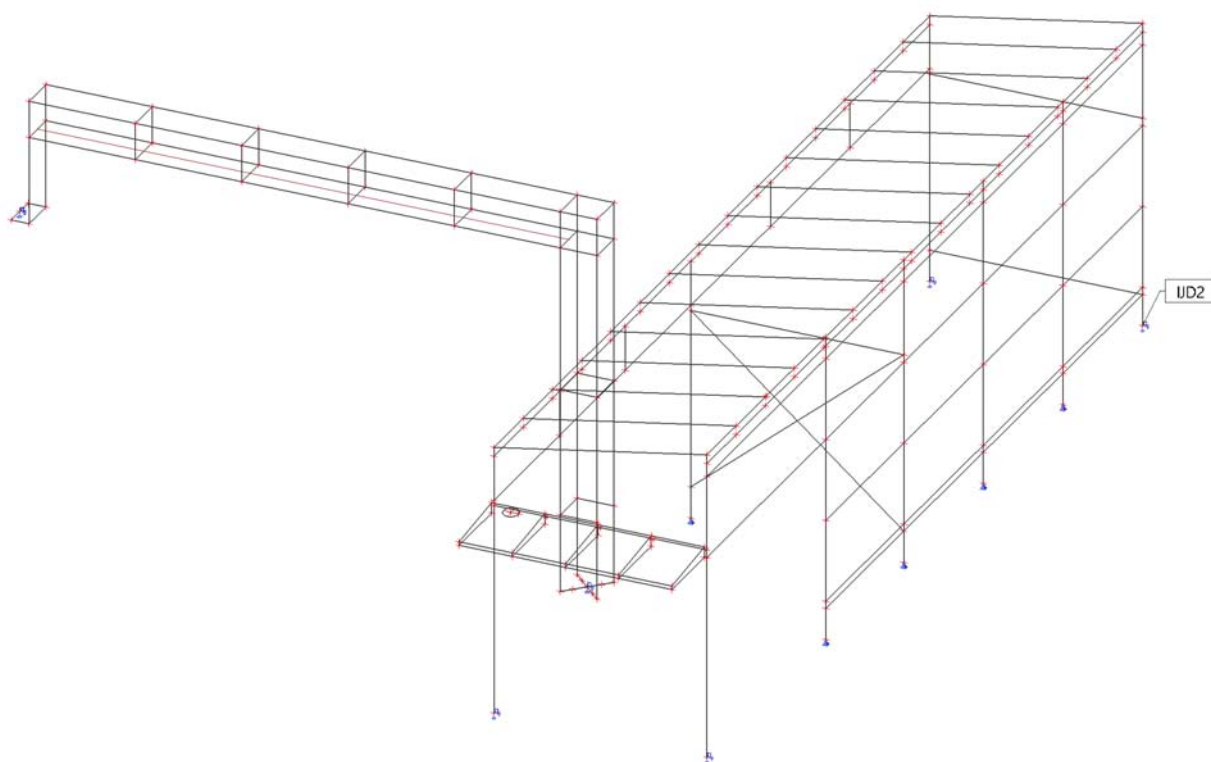
Project

Version	SCIA Engineer 17.1.2029
Licence number	555797
Project	Centrum Energetických a Enviromentálních Technologí
Part	SO 01.1 Objekt CEETe
Description	Ocelová konstrukce
Author	Ing. Jeřowicz
Date	Date
Structure	General XYZ
No. of nodes :	1212
No. of beams :	367
No. of slabs :	150
No. of solids :	1390
No. of used profiles :	34
No. of load cases :	14
No. of used materials :	3
Acceleration of gravity [m/s ²]	9,807
National code	EC - EN

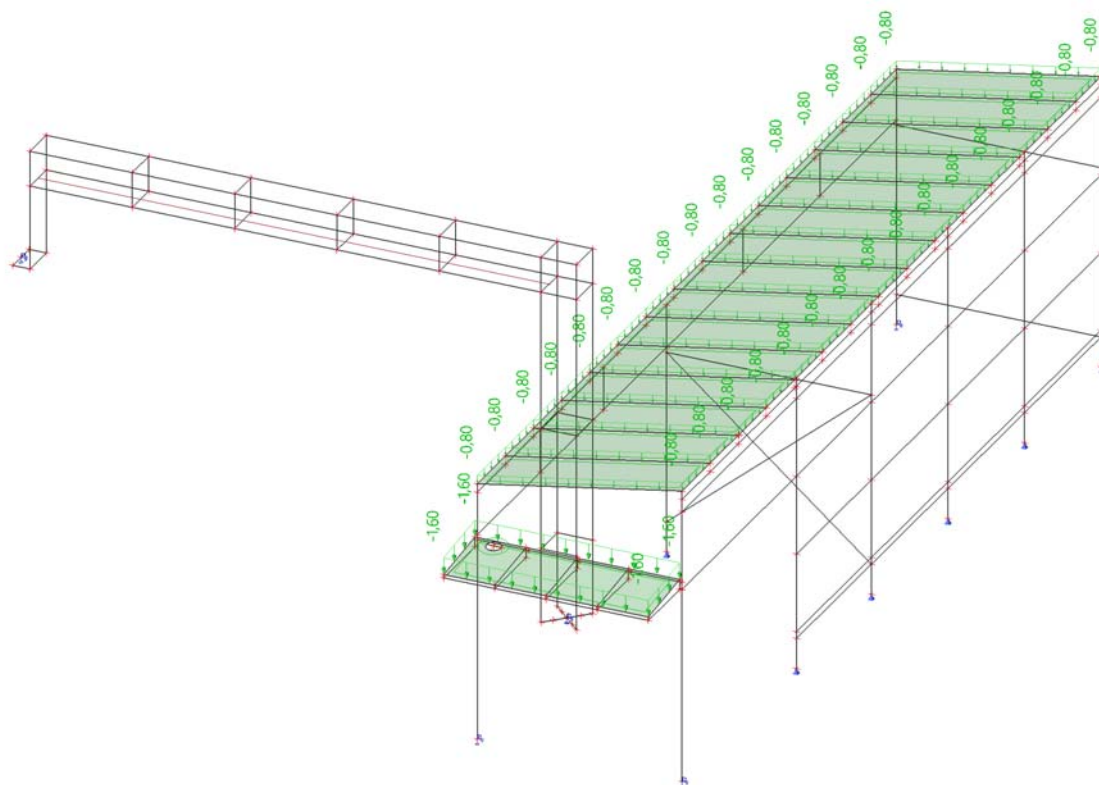
Load cases

Name	Description	Action type	Load group	Direction	Duration	Master load case
	Spec	Load type				
LC1	self weight	Permanent Self weight	LG1	-Z		
LC2	dead load	Permanent Standard	LG1			
LC3	snow/rime Standard	Variable Static	snow		Short	None
LC4	wind +x Standard	Variable Static	wind		Short	None
LC5	wind -x Standard	Variable Static	wind		Short	None
LC6	wind +y Standard	Variable Static	wind		Short	None
LC7	wind -y Standard	Variable Static	wind		Short	None
LC8	live load Standard	Variable Static	live		Short	None
LC9	Rmax (C) Standard	Variable Static	crane		Short	None
LC10	Ht+Hl_Rmax (C) Standard	Variable Static	Ht+Hl		Short	None
LC11	Hs_Rmax (C) Standard	Variable Static	Hs		Short	None
LC12	Mmax (C-D) Standard	Variable Static	crane		Short	None
LC13	Ht+Hl_Mmax (C-D) Standard	Variable Static	Ht+Hl		Short	None
LC14	Hs_Mmax (C-D) Standard	Variable Static	Hs		Short	None

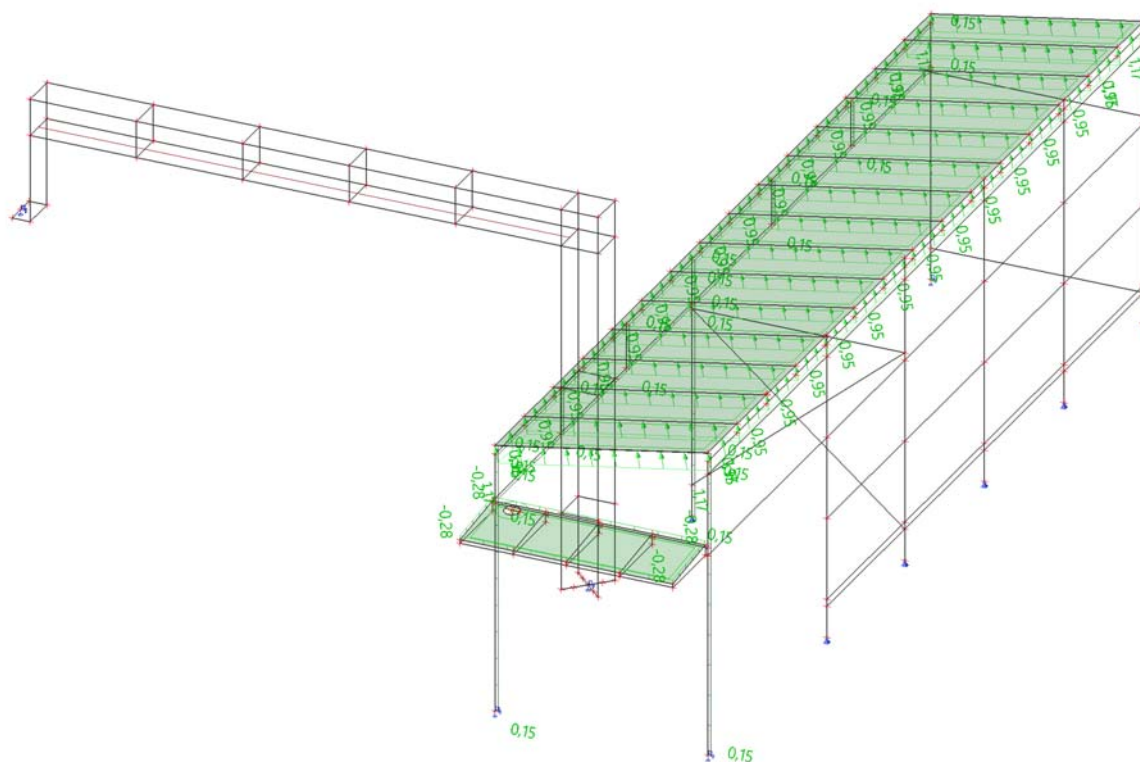
LC2 / Tot. value



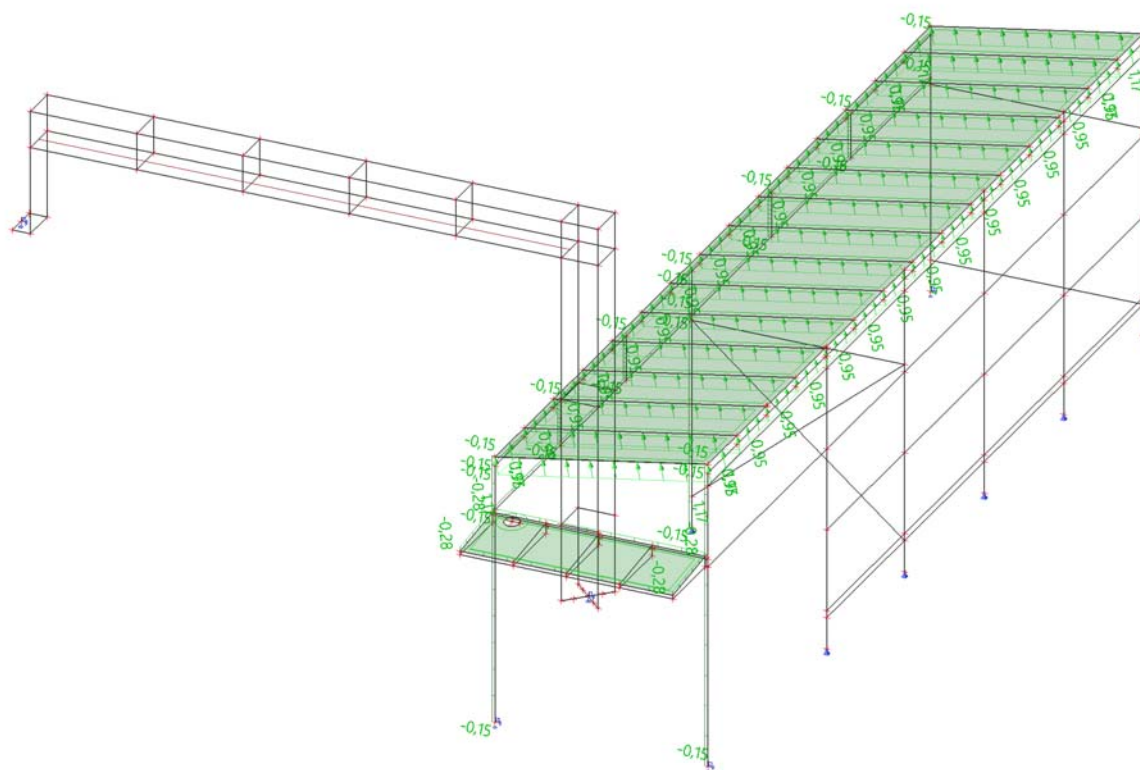
LC3 / Tot. value



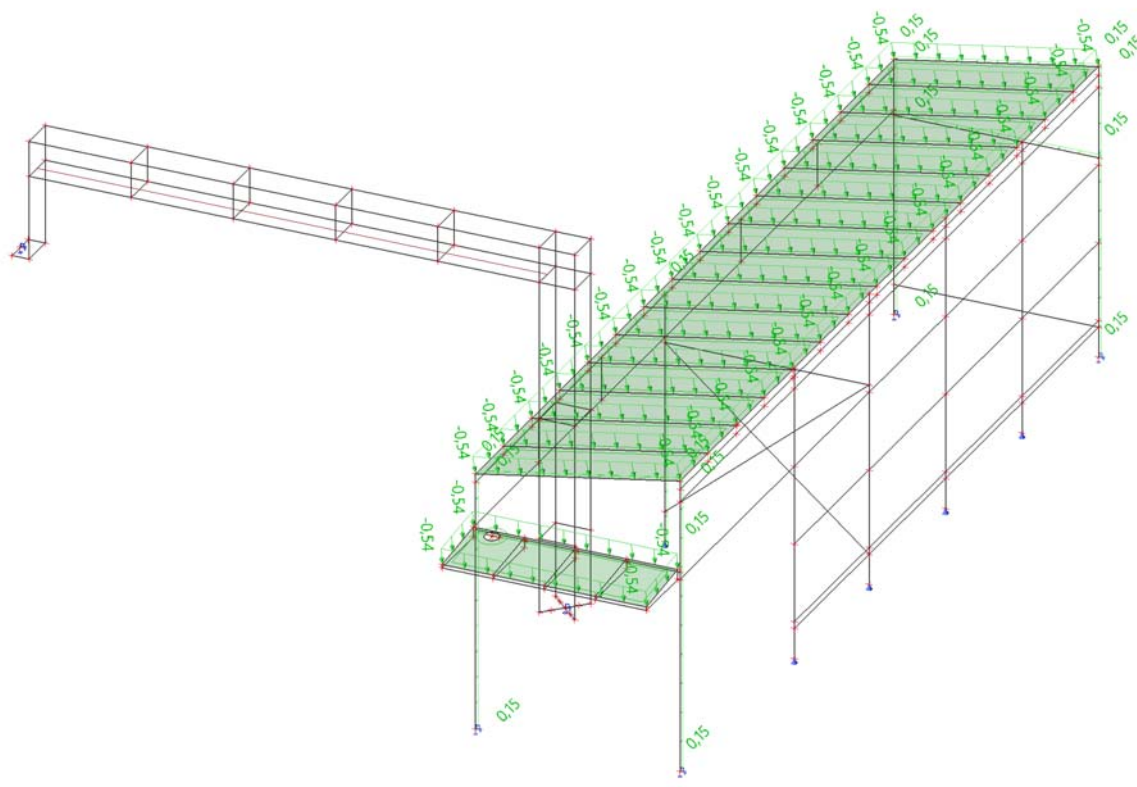
LC4 / Tot. value



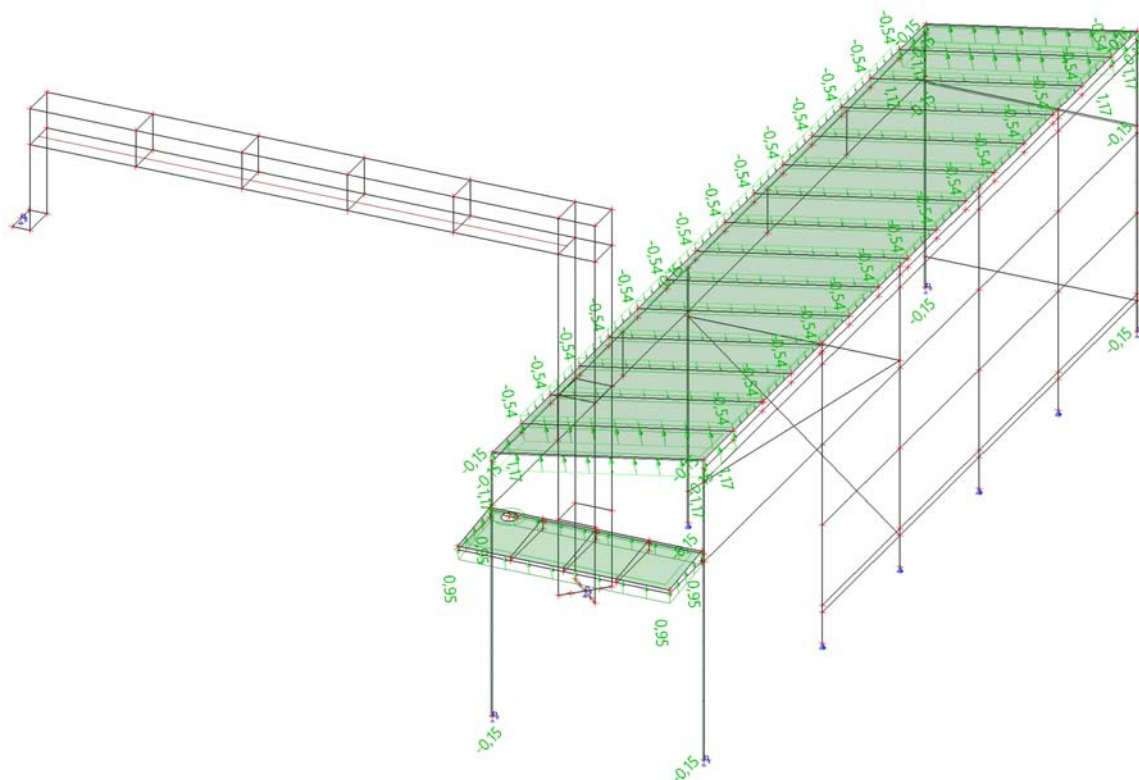
LC5 / Tot. value



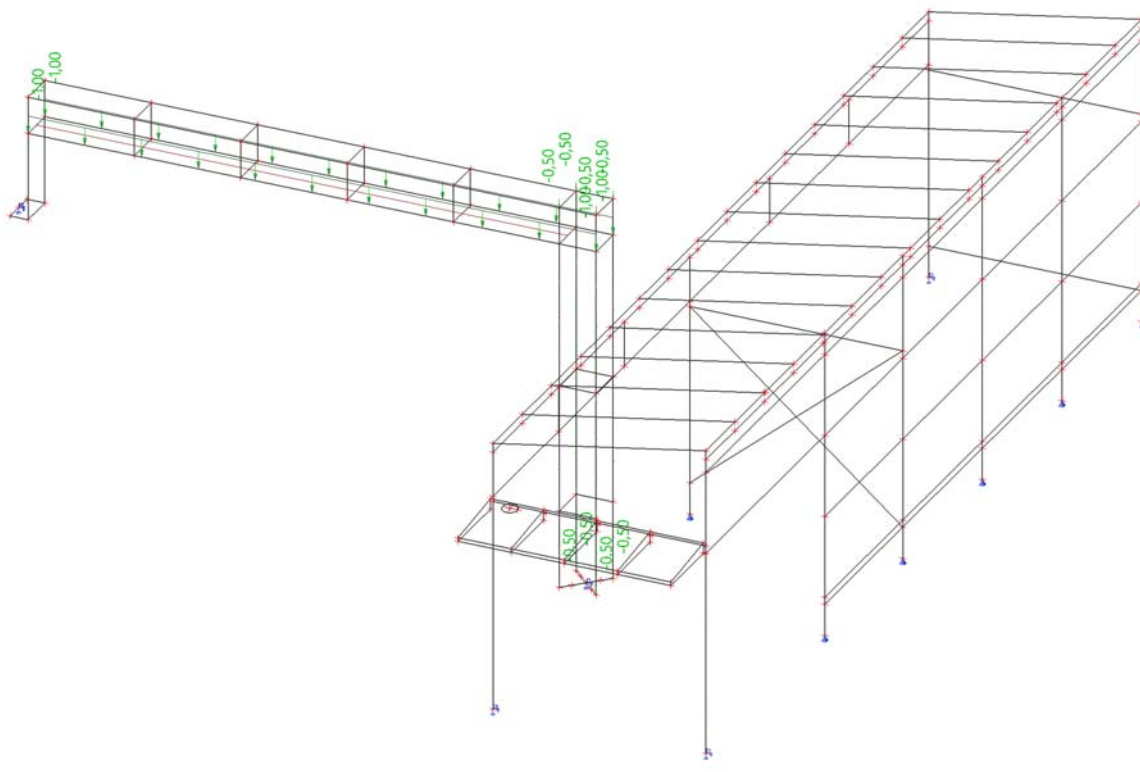
LC6 / Tot. value



LC7 / Tot. value



LC8 / Tot. value



Load groups

Name	Load	Relation	Type
LG1	Permanent		
snow	Variable	Exclusive	Snow
wind	Variable	Exclusive	Wind
live	Variable	Exclusive	Cat C : Congregation
crane	Variable	Exclusive	Cat F : Vehicle <30kN
Ht+Hl	Variable	Exclusive	Cat F : Vehicle <30kN
Hs	Variable	Exclusive	Cat F : Vehicle <30kN

Combinations

Name	Description	Type	Load cases	Coeff. [-]
CO1		EN-ULS (STR/GEO) Set B	LC1 - self weight	1,00
			LC2 - dead load	1,00
			LC3 - snow/rime	1,00
			LC4 - wind +x	1,00
			LC5 - wind -x	1,00
			LC6 - wind +y	1,00
			LC7 - wind -y	1,00
			LC8 - live load	1,00
CO2		EN-SLS Characteristic	LC1 - self weight	1,00
			LC2 - dead load	1,00
			LC3 - snow/rime	1,00
			LC4 - wind +x	1,00
			LC5 - wind -x	1,00
			LC6 - wind +y	1,00
			LC7 - wind -y	1,00
			LC8 - live load	1,00
Rmax +		Envelope - ultimate	LC1 - self weight	1,35
			LC9 - Rmax (C)	1,50

Name	Description	Type	Load cases	Coeff. [-]
			LC10 - Ht+Hl_Rmax (C)	1,35
			LC11 - Hs_Rmax (C)	1,35
Rmax -		Envelope - ultimate	LC1 - self weight	1,35
			LC9 - Rmax (C)	1,50
			LC10 - Ht+Hl_Rmax (C)	-1,35
			LC11 - Hs_Rmax (C)	-1,35
Mmax +		Envelope - ultimate	LC1 - self weight	1,35
			LC12 - Mmax (C-D)	1,50
			LC13 - Ht+Hl_Mmax (C-D)	1,35
			LC14 - Hs_Mmax (C-D)	1,35
Mmax -		Envelope - ultimate	LC1 - self weight	1,35
			LC12 - Mmax (C-D)	1,50
			LC13 - Ht+Hl_Mmax (C-D)	-1,35
			LC14 - Hs_Mmax (C-D)	-1,35
Mmax +def		Envelope - serviceability	LC1 - self weight	1,00
			LC12 - Mmax (C-D)	1,00
			LC13 - Ht+Hl_Mmax (C-D)	1,00
			LC14 - Hs_Mmax (C-D)	1,00
Mmax -def		Envelope - serviceability	LC1 - self weight	1,00
			LC12 - Mmax (C-D)	1,00
			LC13 - Ht+Hl_Mmax (C-D)	-1,00
			LC14 - Hs_Mmax (C-D)	-1,00
CO3		EN-Accidental 1	LC1 - self weight	1,00
			LC2 - dead load	1,00
			LC3 - snow/rime	1,00
			LC4 - wind +x	1,00
			LC5 - wind -x	1,00
			LC6 - wind +y	1,00
			LC7 - wind -y	1,00
			LC8 - live load	1,00

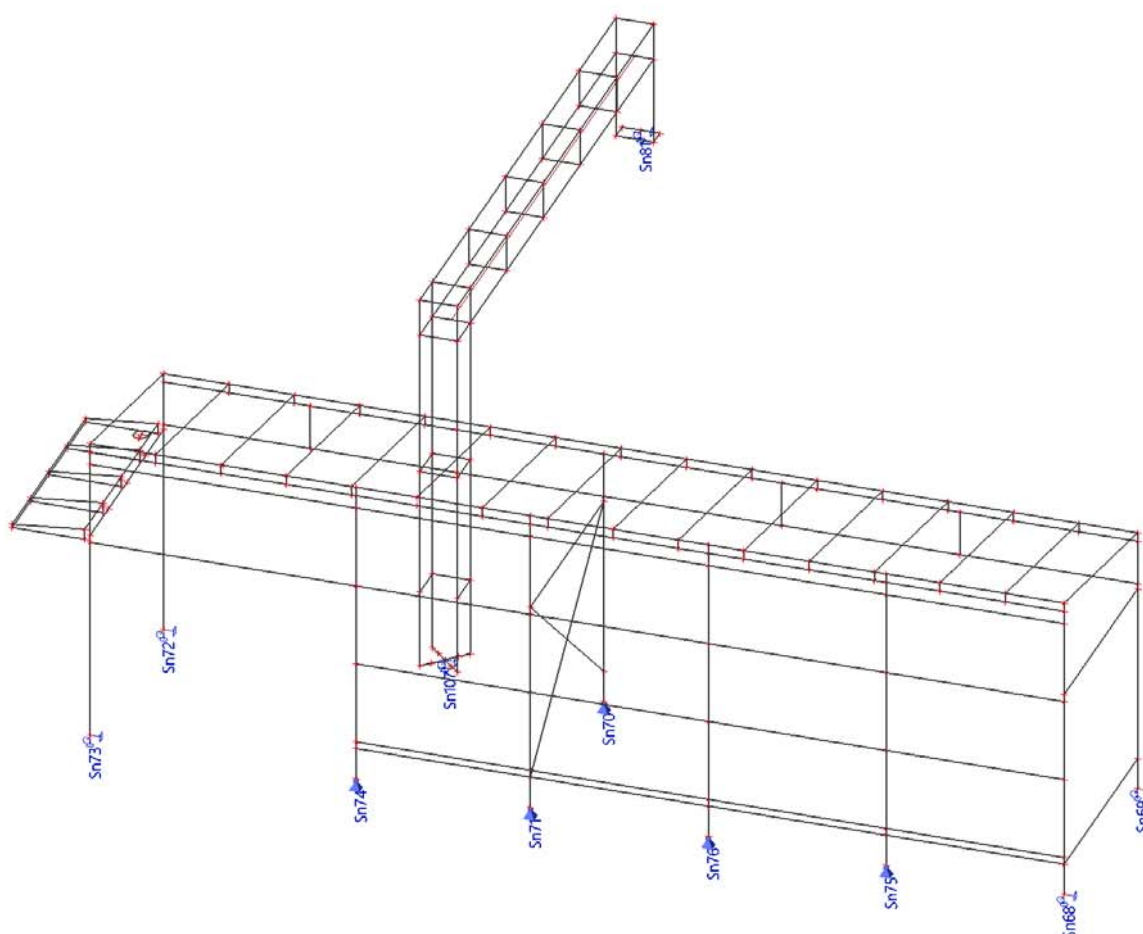
Result classes

Name	List
All ULS	CO1 - EN-ULS (STR/GEO) Set B
	Rmax + - Envelope - ultimate
	Rmax - - Envelope - ultimate
	Mmax + - Envelope - ultimate
	Mmax - - Envelope - ultimate
	CO3 - EN-Accidental 1
All SLS	CO2 - EN-SLS Characteristic
	Mmax +def - Envelope - serviceability
	Mmax -def - Envelope - serviceability

REAKCE

REACTIONS

Structural model - name of supports



Name	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]	e _x [mm]	e _y [mm]
Sn73/N2259	CO1/9	-6,01	0,05	-7,19	0,00	-9,67	0,00	0,0	1344,3
Sn73/N2259	CO1/6	4,12	-0,08	16,41	0,00	6,73	0,00	0,0	409,8
Sn73/N2259	CO1/3	-6,01	0,04	-7,70	0,00	-9,67	0,00	0,0	1255,4

R2 - Reactions; R_x; R_y; R_z; M_x; M_y; M_z

Values: M_z, M_x, M_y, R_z, R_y, R_x

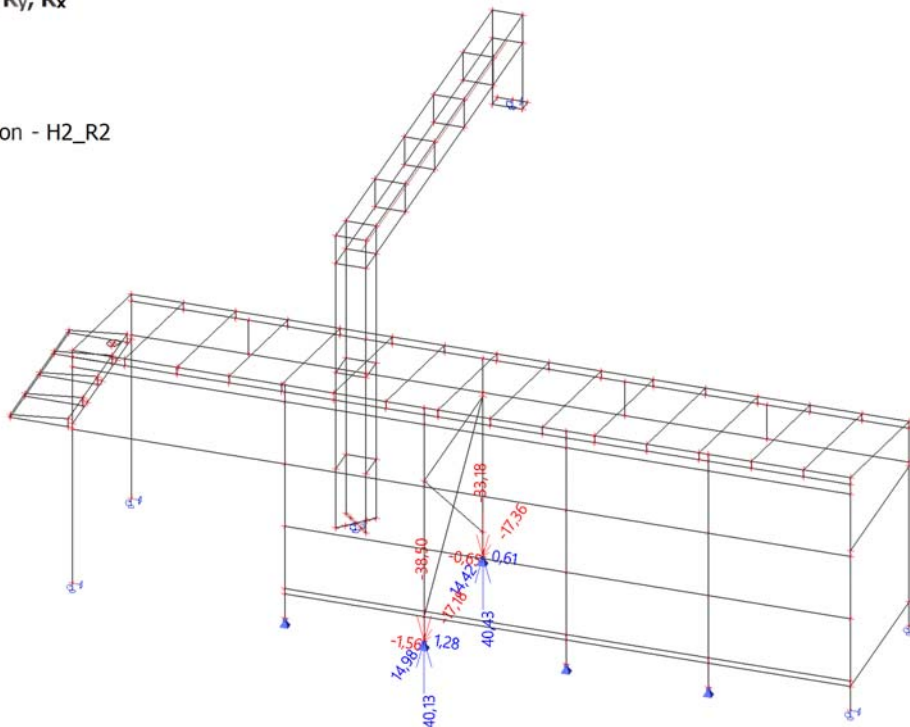
Linear calculation

Combination: CO1

System: Global

Extreme: Member

Selection: Named selection - H2_R2



Reactions

Linear calculation

Combination: CO1

System: Global

Extreme: Member

Selection: Named selection - H2_R2

Nodal reactions

Name	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]	e _x [mm]	e _y [mm]
Sn70/N2250	CO1/1	14,42	-0,59	-14,31	0,00	0,00	0,00	0,0	0,0
Sn70/N2250	CO1/2	14,40	-0,65	-5,14	0,00	0,00	0,00	0,0	0,0
Sn70/N2250	CO1/3	0,68	0,61	14,94	0,00	0,00	0,00	0,0	0,0
Sn70/N2250	CO1/4	12,65	0,11	-33,18	0,00	0,00	0,00	0,0	0,0
Sn70/N2250	CO1/5	-17,36	-0,16	40,43	0,00	0,00	0,00	0,0	0,0
Sn71/N2253	CO1/2	14,98	-1,56	40,13	0,00	0,00	0,00	0,0	0,0
Sn71/N2253	CO1/3	1,00	1,28	9,20	0,00	0,00	0,00	0,0	0,0
Sn71/N2253	CO1/6	-17,18	0,13	-38,50	0,00	0,00	0,00	0,0	0,0

R3 - Reactions; R_x; R_y; R_z; M_x; M_y; M_z

Values: M_z, M_x, M_y, R_z, R_y, R_x

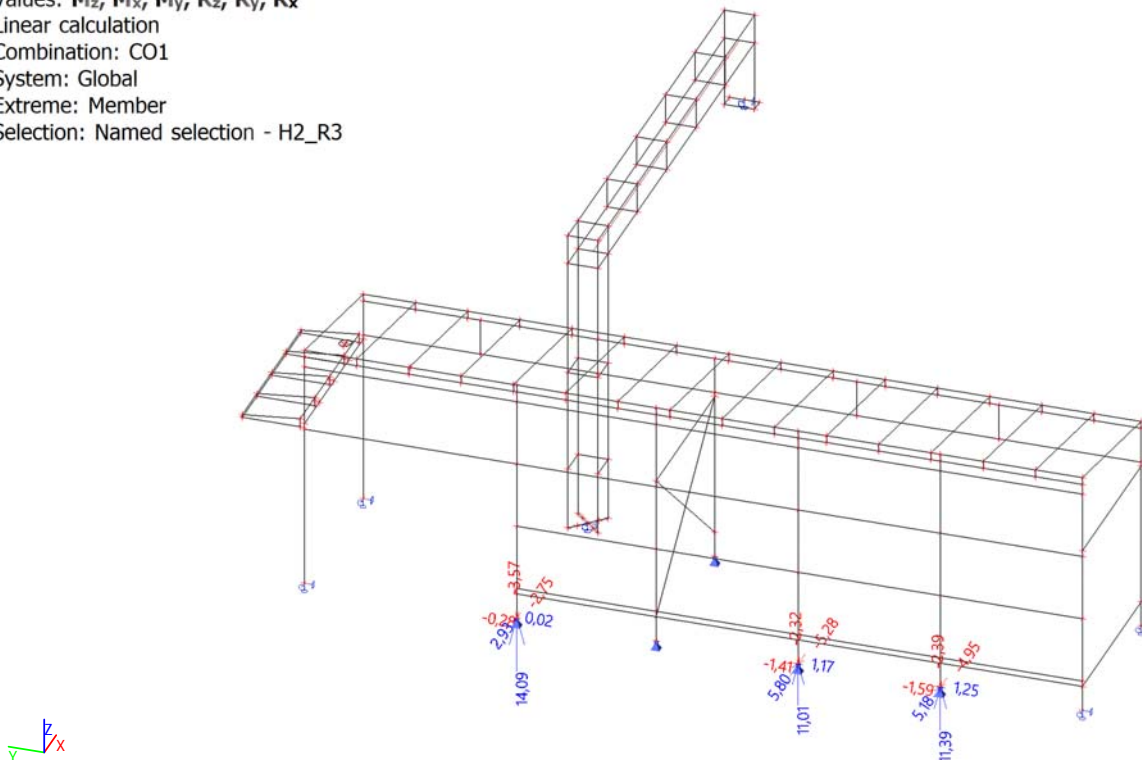
Linear calculation

Combination: CO1

System: Global

Extreme: Member

Selection: Named selection - H2_R3



Reactions

Linear calculation

Combination: CO1

System: Global

Extreme: Member

Selection: Named selection - H2_R3

Nodal reactions

Name	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]	e _x [mm]	e _y [mm]
Sn74/N2261	CO1/1	2,93	-0,28	13,39	0,00	0,00	0,00	0,0	0,0
Sn74/N2261	CO1/2	2,93	-0,28	10,39	0,00	0,00	0,00	0,0	0,0
Sn74/N2261	CO1/3	-0,01	0,02	9,56	0,00	0,00	0,00	0,0	0,0
Sn74/N2261	CO1/4	1,76	-0,20	14,09	0,00	0,00	0,00	0,0	0,0
Sn74/N2261	CO1/5	-2,75	-0,03	-3,57	0,00	0,00	0,00	0,0	0,0
Sn75/N2268	CO1/6	5,18	-1,53	7,75	0,00	0,00	0,00	0,0	0,0
Sn75/N2268	CO1/1	5,18	-1,59	10,64	0,00	0,00	0,00	0,0	0,0
Sn75/N2268	CO1/7	-0,08	1,25	6,31	0,00	0,00	0,00	0,0	0,0
Sn75/N2268	CO1/5	-4,94	0,13	-2,39	0,00	0,00	0,00	0,0	0,0
Sn75/N2268	CO1/4	3,10	-1,05	11,39	0,00	0,00	0,00	0,0	0,0
Sn75/N2268	CO1/8	-4,95	0,07	0,50	0,00	0,00	0,00	0,0	0,0
Sn76/N2400	CO1/1	5,80	-1,41	10,30	0,00	0,00	0,00	0,0	0,0
Sn76/N2400	CO1/7	0,07	1,17	6,78	0,00	0,00	0,00	0,0	0,0
Sn76/N2400	CO1/4	3,49	-0,93	11,01	0,00	0,00	0,00	0,0	0,0
Sn76/N2400	CO1/5	-5,28	0,06	-2,32	0,00	0,00	0,00	0,0	0,0

R4 - Reactions; R_x; R_y; R_z; M_x; M_y; M_z

Values: M_z, M_x, M_y, R_z, R_y, R_x

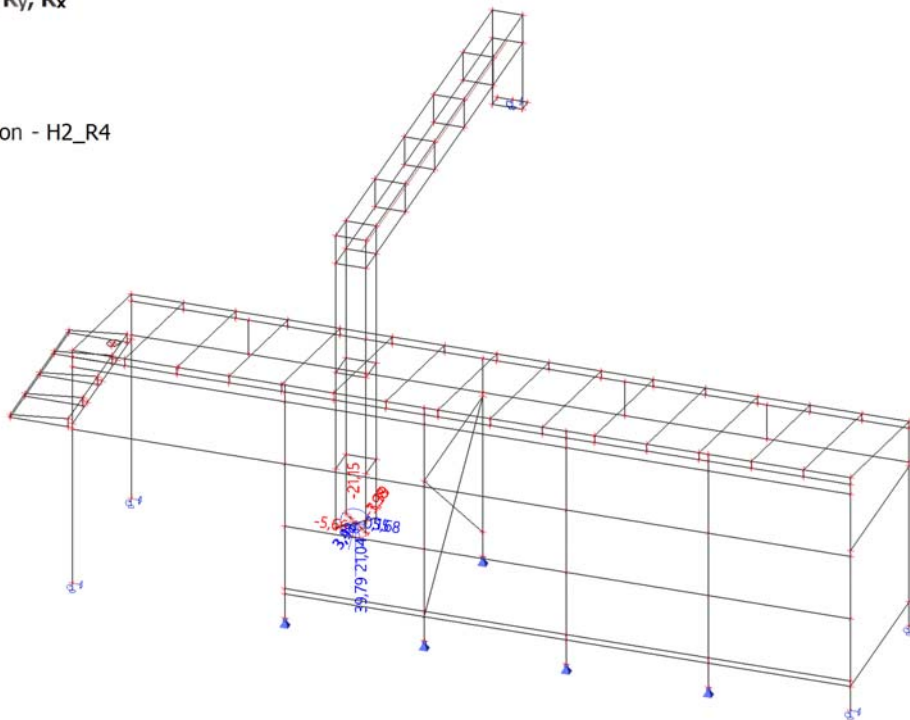
Linear calculation

Combination: CO1

System: Global

Extreme: Member

Selection: Named selection - H2_R4



Reactions

Linear calculation

Combination: CO1

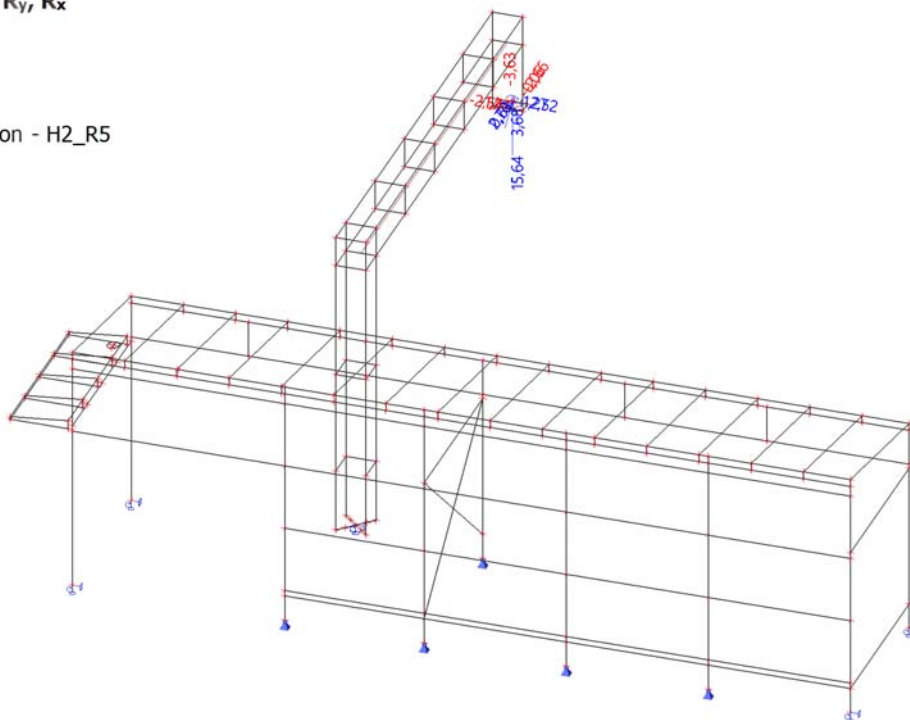
System: Global

Extreme: Member

Selection: Named selection - H2_R4

Nodal reactions

Name	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]	e _x [mm]	e _y [mm]
Sn107/N2488	CO1/1	3,91	0,02	30,94	-0,10	3,29	0,11	-3,4	106,3
Sn107/N2488	CO1/2	-1,98	0,00	4,44	-0,01	-3,21	0,01	-1,1	-722,5
Sn107/N2488	CO1/3	3,47	0,02	39,79	-0,13	2,11	0,14	-3,2	53,1
Sn107/N2488	CO1/4	1,67	5,68	30,90	-21,15	-0,38	0,13	-684,5	-12,2
Sn107/N2488	CO1/5	-1,67	0,00	9,34	-0,02	-3,39	0,03	-2,4	-363,0
Sn107/N2488	CO1/6	3,59	0,01	26,04	-0,09	3,48	0,09	-3,4	133,5
Sn107/N2488	CO1/7	0,25	-5,66	4,48	21,04	0,43	0,00	4691,1	95,2
Sn107/N2488	CO1/8	2,13	3,42	39,76	-12,76	-0,09	0,15	-320,8	-2,2



Name	Case	R _x [kN]	R _y [kN]	R _z [kN]	M _x [kNm]	M _y [kNm]	M _z [kNm]	e _x [mm]	e _y [mm]
Sn81/N3140	CO1/1	-2,66	-0,02	15,64	0,05	2,22	0,02	3,0	142,0
Sn81/N3140	CO1/2	-1,67	-2,54	12,39	3,68	1,95	1,27	296,8	157,8
Sn81/N3140	CO1/3	0,63	0,00	2,10	0,01	0,74	0,00	6,0	350,4
Sn81/N3140	CO1/4	-1,14	0,00	2,31	0,00	-0,06	0,00	-0,6	-23,9
Sn81/N3140	CO1/5	-1,60	-0,02	15,51	0,06	2,70	0,02	3,6	173,7
Sn81/N3140	CO1/6	-0,25	2,52	2,15	-3,63	0,33	-1,24	-1690,7	153,6

DEFORMACE

DEFORMATIONS

1D deformations; u_y

Values: u_y

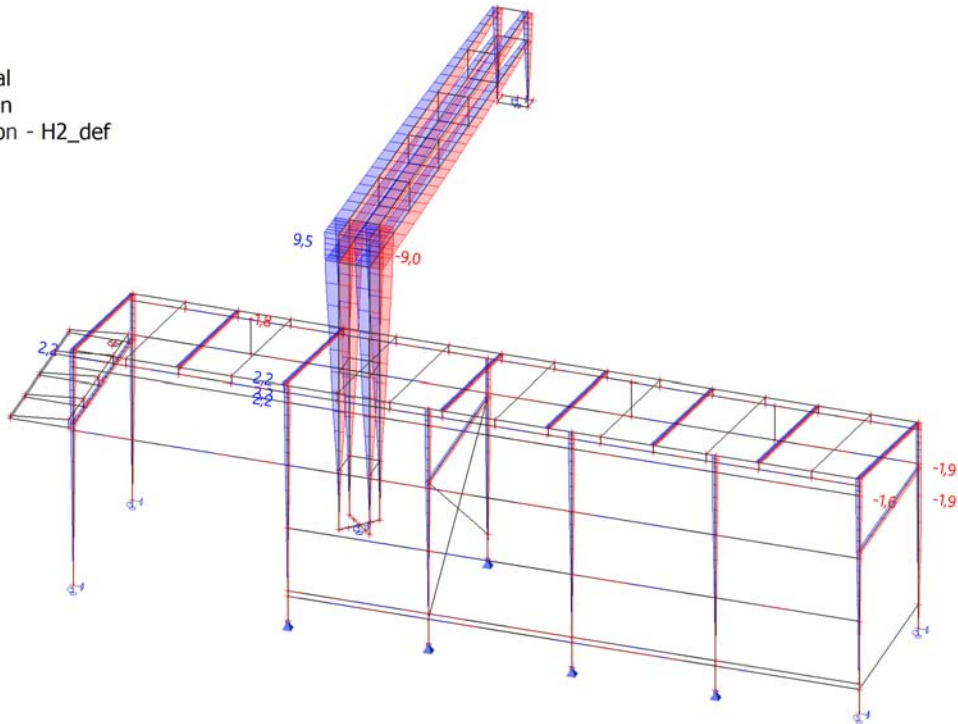
Linear calculation

Combination: CO2

Coordinate system: Global

Extreme 1D: Cross-section

Selection: Named selection - H2_def



1D deformations; u_x

Values: u_x

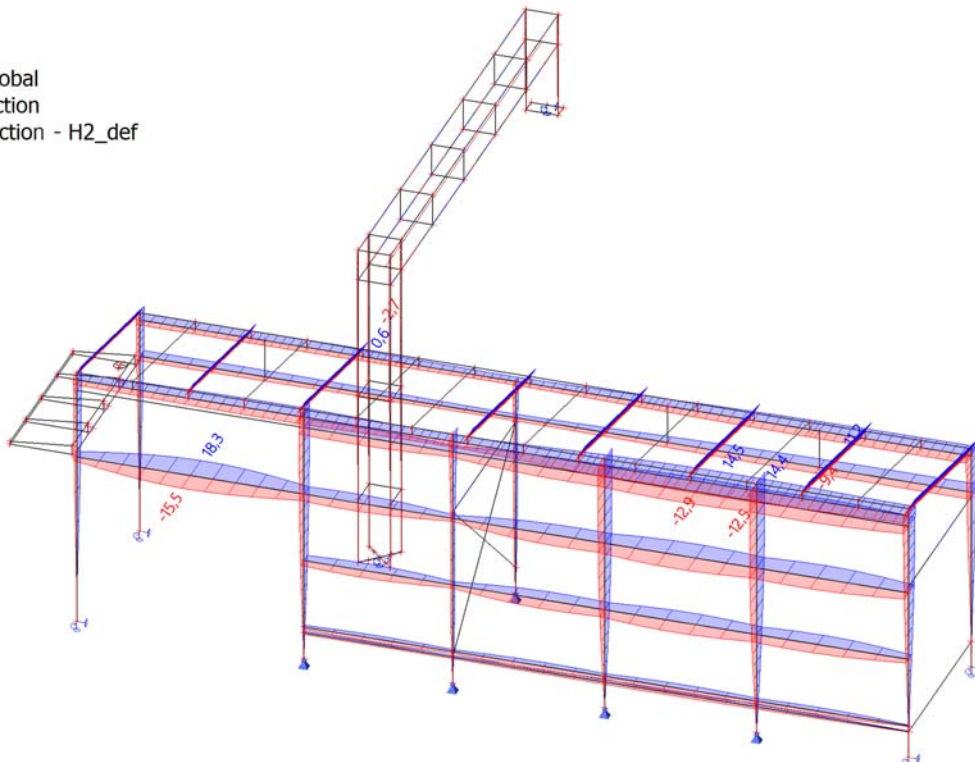
Linear calculation

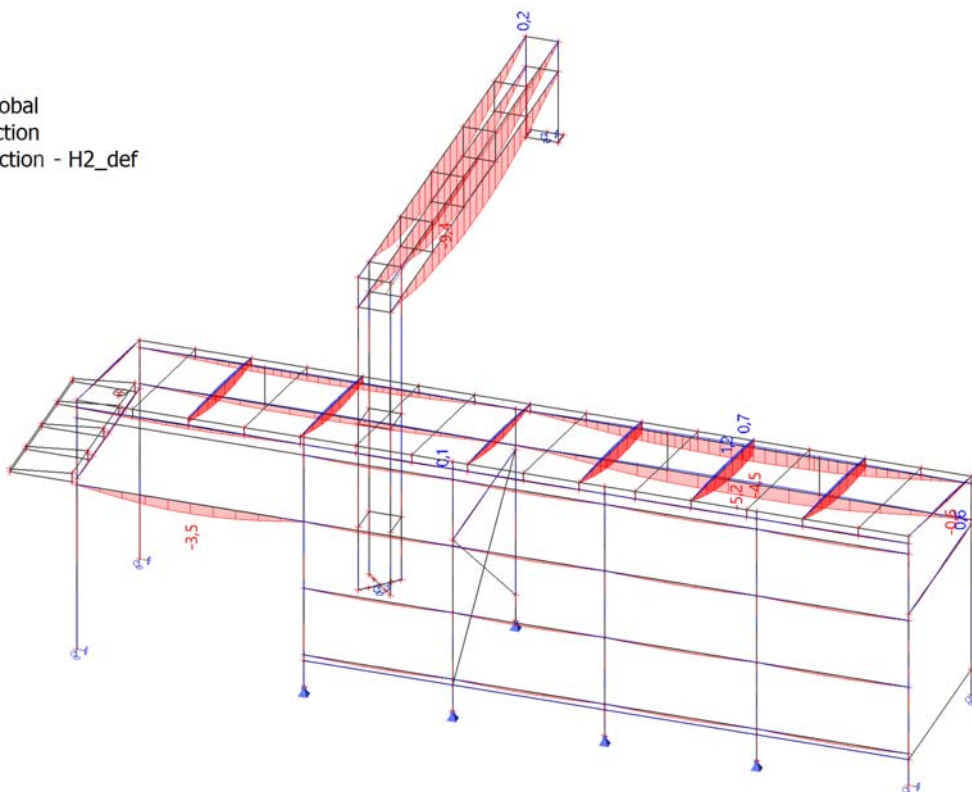
Combination: CO2

Coordinate system: Global

Extreme 1D: Cross-section

Selection: Named selection - H2_def





Member	dx [mm]	Case	ux [mm]	uy [mm]	uz [mm]	fix [mrad]	fiy [mrad]	fiz [mrad]	Resultant [mm]
B439	549,500	CO2/1	-9,0	1,9	-1,7	-0,4	0,3	-0,2	9,4
B439	649,410	CO2/2	11,2	0,1	2,0	0,0	-0,2	0,2	11,4
B252	4020,000	CO2/3	-2,2	-12,9	-0,2	0,0	-0,1	0,0	13,1
B252	4200,000	CO2/4	0,1	14,5	0,0	-0,5	0,0	0,1	14,5
B455	1830,000	CO2/4	-0,1	3,4	-18,3	1,4	-0,6	0,0	18,6
B455	1830,000	CO2/5	0,2	3,4	15,5	-0,6	0,9	0,0	15,8
B330	0,000	CO2/3	0,1	0,0	2,5	-5,4	0,4	0,2	2,5
B331	0,000	CO2/4	0,0	0,0	-2,6	5,7	0,5	0,0	2,6
B455	3660,000	CO2/4	-0,1	0,0	-6,7	1,5	-9,7	-3,0	6,7
B455	3660,000	CO2/5	0,2	0,0	3,4	-0,6	10,0	-3,0	3,4
B455	3660,000	CO2/6	-1,2	0,0	0,2	-0,1	0,0	-3,0	1,2
B455	0,000	CO2/5	0,2	0,0	6,6	-0,5	-8,3	3,0	6,6

DEFORMATIONS OF PLATE ELEMENTS

2D displacement; U_{total}

Values: U_{total}

Linear calculation

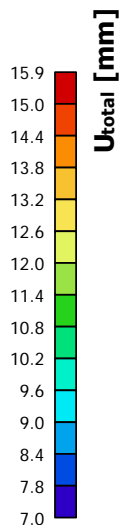
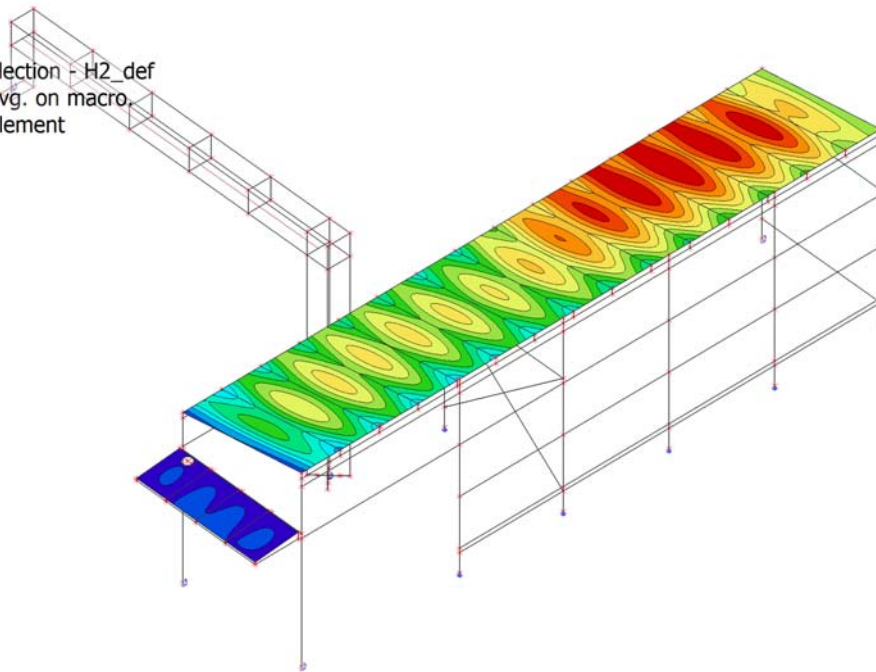
Combination: CO2

Selection: Named selection - H2_def

Location: In nodes avg. on macro

System: LCS mesh element

Extreme: Global



2D displacement

Linear calculation

Combination: CO2

Selection: Named selection - H2_results

Location: In nodes avg. on macro. System: LCS mesh element

Extreme: Global

Name	Case	u_x [mm]	u_y [mm]	u_z [mm]	φ_x [mrad]	φ_y [mrad]	φ_z [mrad]	U_{total} [mm]
S538	CO2/1	-4,8	1,3	0,1	0,0	-1,1	-0,2	5,1
S538	CO2/2	7,0	0,7	0,0	-0,2	1,2	0,5	7,2
S568	CO2/2	0,1	-11,2	2,0	-0,2	0,0	0,2	11,6
S568	CO2/1	1,9	9,0	-1,7	0,3	0,4	-0,2	9,5
S565	CO2/3	1,2	4,9	-8,0	0,0	0,3	-0,1	11,3
S533	CO2/2	0,7	-0,2	7,2	-3,7	-0,1	-0,2	7,3
S533	CO2/3	1,1	-0,3	-2,7	-8,5	0,8	-0,6	3,3
S537	CO2/3	1,2	-0,7	-2,7	8,0	-0,8	-1,0	3,5
S555	CO2/4	-1,6	0,3	-2,2	0,0	-14,2	-0,1	3,7
S567	CO2/4	-1,6	0,9	-3,1	0,1	13,8	0,0	4,3
S539	CO2/3	-2,7	0,5	1,1	-0,8	-0,3	-2,8	3,4
S539	CO2/3	-2,7	1,1	1,2	-1,2	0,4	2,4	3,8
S554	CO2/5	0,0	0,0	0,0	0,0	-0,1	0,0	0,1
S565	CO2/2	0,5	-10,5	2,0	0,4	0,1	0,2	15,9

Name	Combination key
CO2/1	LC1 + LC2 + LC6
CO2/2	LC1 + LC2 + 0.50*LC3 + LC4
CO2/3	LC1 + LC2 + LC3 + 0.60*LC6
CO2/4	LC1 + LC2 + 0.50*LC3 + LC7
CO2/5	LC1 + LC2

VNITŘNÍ SÍLY A POSOUZENÍ PŘŮŘEZŮ

STRESS ANALYSIS OF CROSS SECTIONS

CS51 - 1D internal forces; N

Values: N

Linear calculation

Combination: CO1

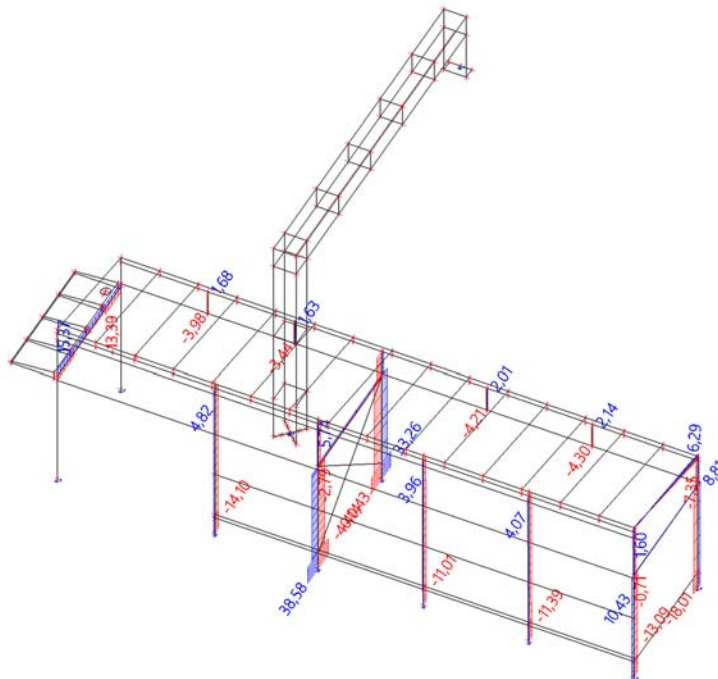
Coordinate system: Principal

Extreme 1D: Member

Selection: All

Filter: Cross-section = CS51 -

VHP150/150x4.0



CS51 - 1D internal forces; M_y

Values: M_y

Linear calculation

Combination: CO1

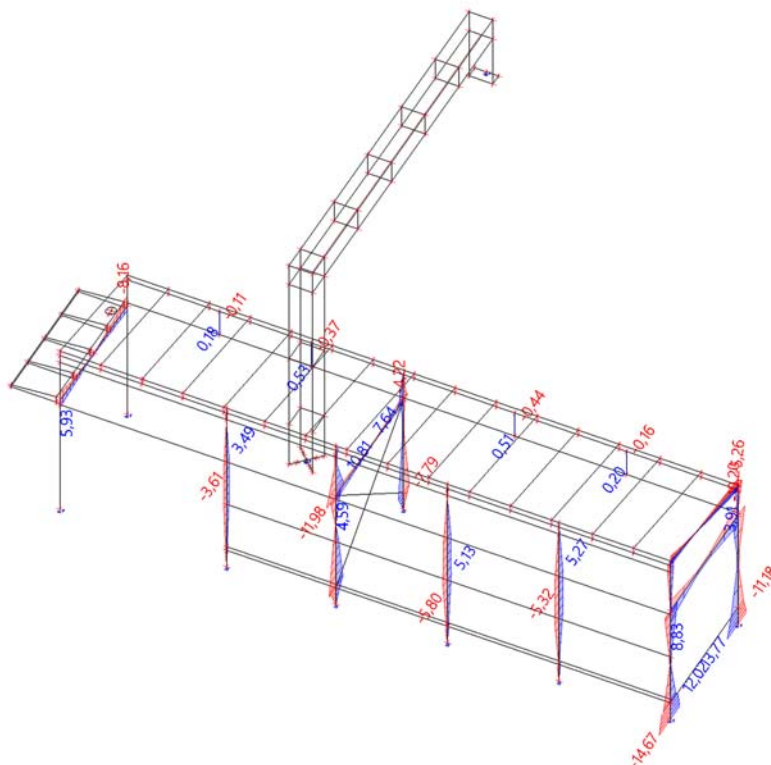
Coordinate system: Principal

Extreme 1D: Member

Selection: All

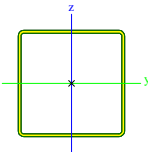
Filter: Cross-section = CS51 -

VHP150/150x4.0



Cross-sections

Cross-sections - CS51

Name	Type	Item material	Fabrication	buckling y-y	buckling z-z	Picture	Type description
	Detailed						
CS51	VHP150/150x4.0	S 235	cold formed	c	c		Rectangular hollow section

EC-EN 1993 Steel check ULS

Cross-sections were changed during Autodesign. The structure has to be recalculated !

Linear calculation

Combination: CO1

Coordinate system: Principal

Extreme 1D: Global

Selection: All

Filter: Cross-section = CS51 - VHP150/150x4.0

Overall Unity Check

Name	dx [mm]	Case	Cross-section	Material	UC _{Overall} [-]	UC _{Sec} [-]	UC _{Stab} [-]
B436	0,000	CO1/1	CS51 - VHP150/150x4.0	S 235	0,52	0,52	0,00

Name	Combination key
CO1/1	LC1 + LC2 + 1.50*LC4

EC-EN 1993 Steel check fire resistance

Cross-sections were changed during Autodesign. The structure has to be recalculated !

Linear calculation

Combination: CO3

Coordinate system: Principal

Extreme 1D: Global

Selection: All

Filter: Cross-section = CS51 - VHP150/150x4.0

Overall Unity Check

Name	dx [mm]	Case	Cross-section	Material	UC _{Overall} [-]	UC _{Temperature} [-]	UC _{Sec} [-]	UC _{Stab} [-]
B440	126,927+	CO3/1	CS51 - VHP150/150x4.0	S 235	0,67	0,00	0,56	0,67

Name	Combination key
CO3/1	LC1 + LC2 + 0.20*LC3

CS52 - 1D internal forces; N

Values: **N**

Linear calculation

Combination: CO1

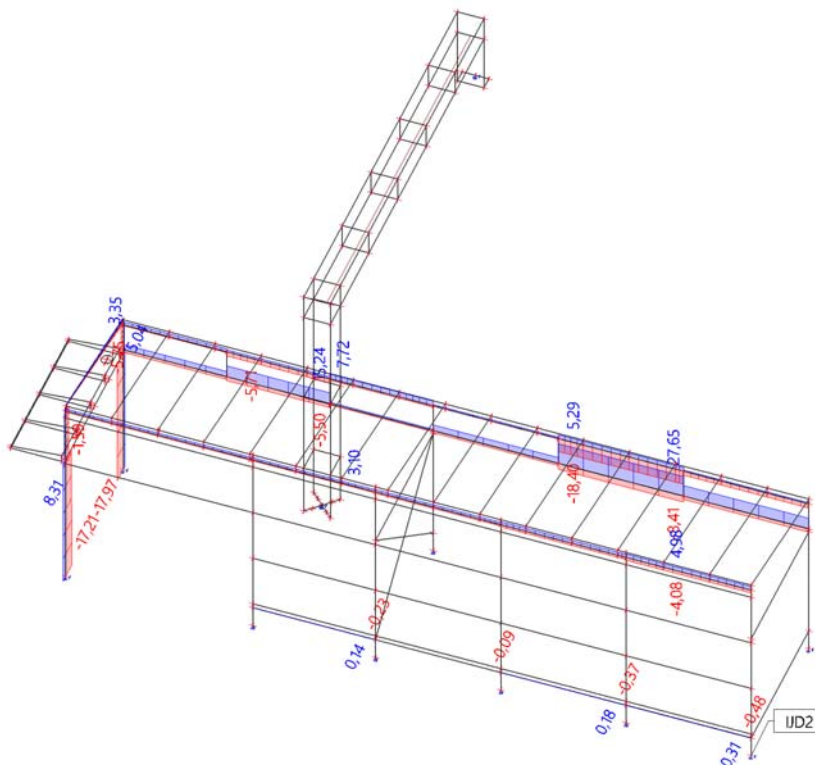
Coordinate system: Principal

Extreme 1D: Member

Selection: All

Filter: Cross-section = CS52 -

VHP150/150x4.0



CS52 - 1D internal forces; M_y

Values: **M_y**

Linear calculation

Combination: CO1

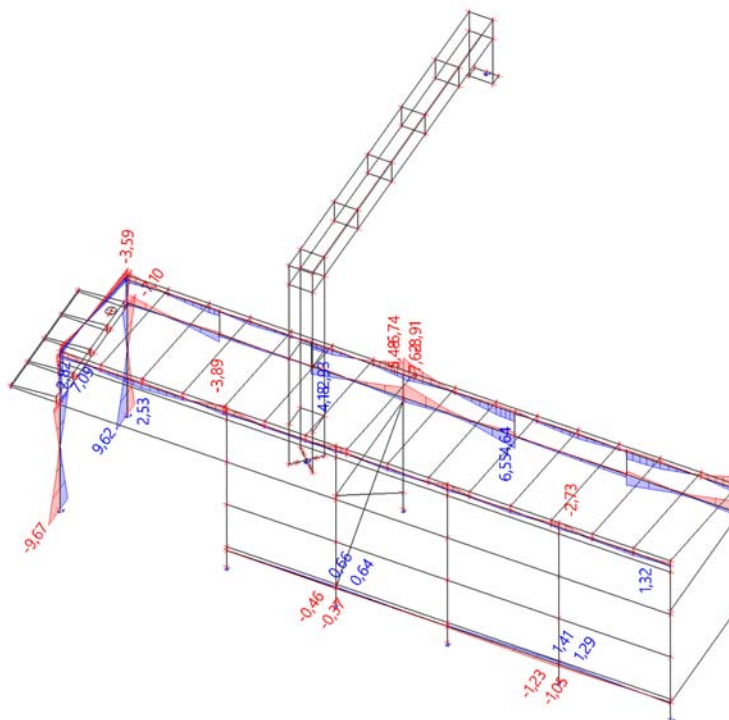
Coordinate system: Principal

Extreme 1D: Member

Selection: All

Filter: Cross-section = CS52 -

VHP150/150x4.0



CS52 - 1D internal forces; M_z

Values: M_z

Linear calculation

Combination: CO1

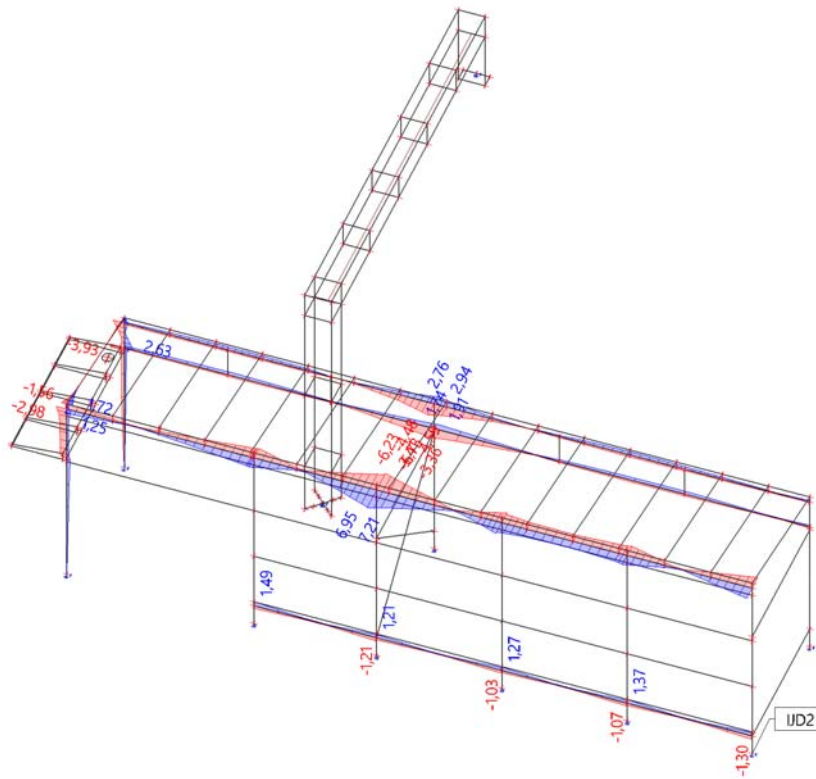
Coordinate system: Principal

Extreme 1D: Member

Selection: All

Filter: Cross-section = CS52 -

VHP150/150x4.0



Cross-sections

Cross-sections - CS52

Name	Type	Item material	Fabrication	buckling y-y	buckling z-z	Picture	Type description
CS52	Detailed VHP150/150x4.0	S 235	cold formed	c	c		Rectangular hollow section

EC-EN 1993 Steel check ULS

Cross-sections were changed during Autodesign. The structure has to be recalculated !

Linear calculation

Combination: CO1

Coordinate system: Principal

Extreme 1D: Global

Selection: All

Filter: Cross-section = CS52 - VHP150/150x4.0

Overall Unity Check

Name	dx [mm]	Case	Cross-section	Material	UC _{Overall} [-]	UC _{Sec} [-]	UC _{Stab} [-]
B442	3821,000	CO1/1	CS52 - VHP150/150x4.0	S 235	0,34	0,34	0,34

Name	Combination key
CO1/1	1.15*LC1 + 1.15*LC2 + 0.75*LC3 + 1.50*LC4

EC-EN 1993 Steel check fire resistance

Cross-sections were changed during Autodesign. The structure has to be recalculated !

Linear calculation

Combination: CO3

Coordinate system: Principal

Extreme 1D: Global

Selection: All

Filter: Cross-section = CS52 - VHP150/150x4.0

Overall Unity Check

Name	dx [mm]	Case	Cross-section	Material	UC _{Overall} [-]	UC _{Temperature} [-]	UC _{Sec} [-]	UC _{Stab} [-]
B256	7350,000	CO3/1	CS52 - VHP150/150x4.0	S 235	0,87	0,00	0,87	0,00

Name	Combination key
CO3/1	LC1 + LC2 + 0.20*LC3

CS56 - 1D internal forces; M_y

Values: M_y

Linear calculation

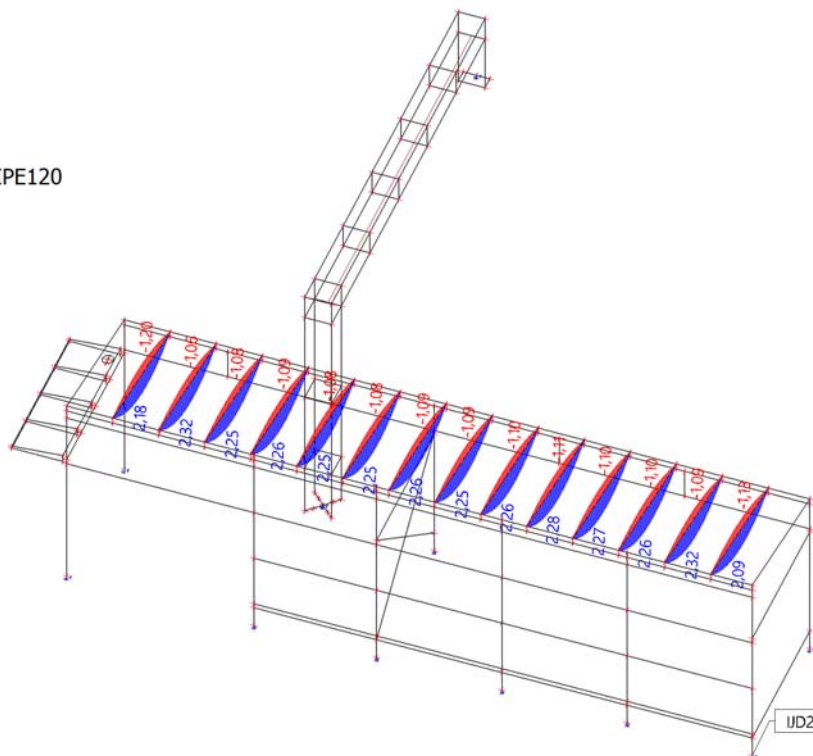
Combination: CO1

Coordinate system: Principal

Extreme 1D: Member

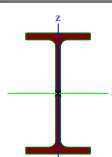
Selection: All

Filter: Cross-section = CS56 - IPE120



Cross-sections

Cross-sections - CS56

Name	Type	Item material	Fabrication	buckling y-y	buckling z-z	Picture	Type description
CS56	IPE120	S 235	rolled	a	b		European I beam

EC-EN 1993 Steel check ULS

Cross-sections were changed during Autodesign. The structure has to be recalculated !

Linear calculation

Combination: CO1

Coordinate system: Principal

Extreme 1D: Global

Selection: All

Filter: Cross-section = CS56 - IPE120

Overall Unity Check

Name	dx [mm]	Case	Cross-section	Material	UC _{Overall} [-]	UC _{Sec} [-]	UC _{Stab} [-]
B348	1298,815-	CO1/1	CS56 - IPE120	S 235	0,26	0,16	0,26

Name	Combination key
CO1/1	1.15*LC1 + 1.15*LC2 + 1.50*LC3 + 0.90*LC7

EC-EN 1993 Steel check fire resistance

Cross-sections were changed during Autodesign. The structure has to be recalculated !

Linear calculation

Combination: CO3

Coordinate system: Principal

Extreme 1D: Global

Selection: All

Filter: Cross-section = CS56 - IPE120

Overall Unity Check

Name	dx [mm]	Case	Cross-section	Material	UC _{Overall} [-]	UC _{Temperature} [-]	UC _{Sec} [-]	UC _{Stab} [-]
B348	1498,633-	CO3/1	CS56 - IPE120	S 235	0,66	0,00	0,18	0,66

Name	Combination key
CO3/1	LC1 + LC2 + 0.20*LC3

CS61 - 1D internal forces; M_y

Values: M_y

Linear calculation

Combination: CO1

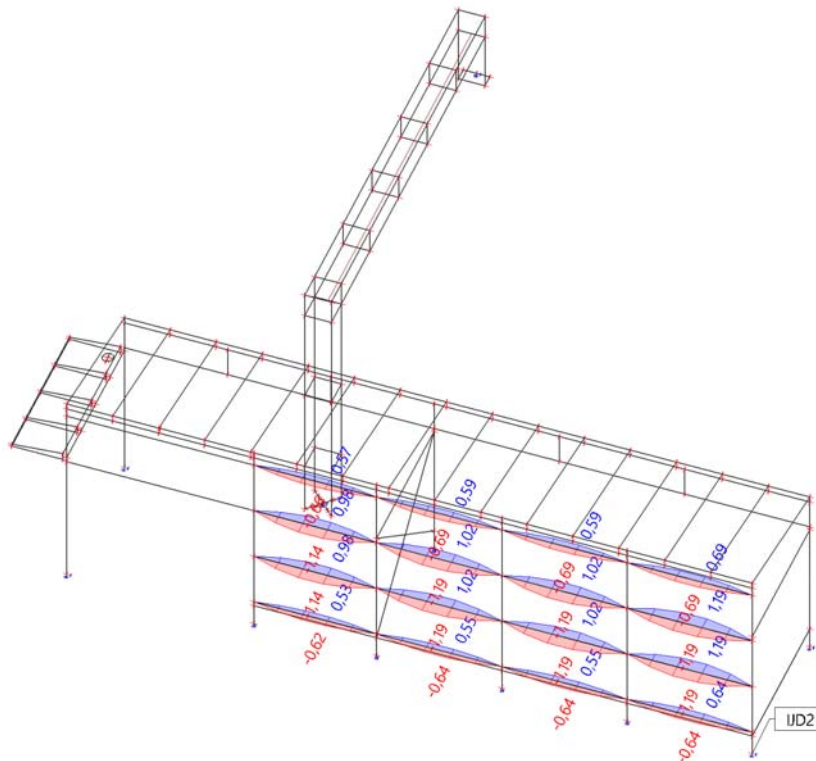
Coordinate system: Principal

Extreme 1D: Member

Selection: All

Filter: Cross-section = CS61 -

KU80/50x4.0



Cross-sections

Cross-sections - CS61

Name	Type	Item material	Fabrication	buckling y-y	buckling z-z	Picture
CS61	Detailed KU80/50x4.0	S 235	cold formed	c	c	

EC-EN 1993 Steel check ULS

Cross-sections were changed during Autodesign. The structure has to be recalculated !

Linear calculation

Combination: CO1

Coordinate system: Principal

Extreme 1D: Global

Selection: All

Filter: Cross-section = CS61 - KU80/50x4.0

Overall Unity Check

Name	dx [mm]	Case	Cross-section	Material	UC _{Overall} [-]	UC _{Sec} [-]	UC _{Stab} [-]
B350	1200,381-	CO1/1	CS61 - KU80/50x4.0	S 235	0,81	0,77	0,81

Name	Combination key
CO1/1	1.15*LC1 + 1.15*LC2 + 1.50*LC3 + 0.90*LC4

EC-EN 1993 Steel check fire resistance

Cross-sections were changed during Autodesign. The structure has to be recalculated !

Linear calculation

Combination: CO3

Coordinate system: Principal

Extreme 1D: Global

Selection: All

Filter: Cross-section = CS61 - KU80/50x4.0

Overall Unity Check

Name	dx [mm]	Case	Cross-section	Material	UC _{Overall} [-]	UC _{Temperature} [-]	UC _{Sec} [-]	UC _{Stab} [-]
B446	980,000-	CO3/1	CS61 - KU80/50x4.0	S 235	0,95	0,00	0,63	0,95

Name	Combination key
CO3/1	LC1 + LC2 + 0.20*LC4

E/W/N	Present on members
W2	B351, B352, B353, B354, B472
W9	B351, B352, B353, B354, B472

EC-EN 1993 Steel check fire resistance

Cross-sections were changed during Autodesign. The structure has to be recalculated !

Linear calculation

Combination: CO3

Coordinate system: Principal

Extreme 1D: Global

Selection: All

Filter: Cross-section = CS65 - RD16

There are 2 warnings on selected members. 2 of them are shown.

Overall Unity Check

Name	dx [mm]	Case	Cross-section	Material	UC _{Overall} [-]	UC _{Temperature} [-]	UC _{Sec} [-]	UC _{Stab} [-]	Errors, warnings, notes
B352	0,000	CO3/1	CS65 - RD16	S 235	0,93	0,00	0,58	0,93	W2, W9

Name	Combination key
CO3/1	LC1 + LC2 + 0.20*LC4

E/W/N	Present on members
W2	B351, B352, B353, B354, B472
W9	B351, B352, B353, B354, B472

CS71 - 1D internal forces; N

Values: N

Linear calculation

Combination: CO1

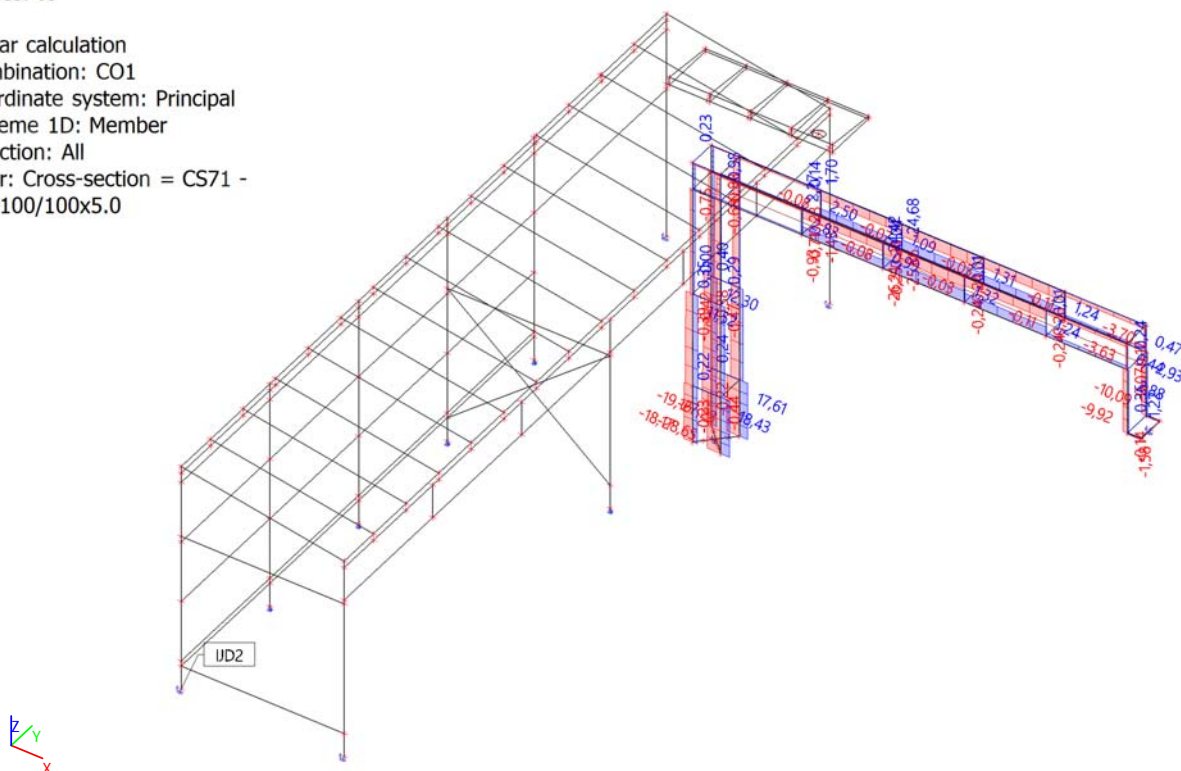
Coordinate system: Principal

Extreme 1D: Member

Selection: All

Filter: Cross-section = CS71 -

VHP100/100x5.0



Cross-sections

Cross-sections - CS71

Name	Type	Item material	Fabrication	buckling y-y	buckling z-z	Picture	Type description
CS71	Detailed VHP100/100x5.0	S 235	cold formed	c	c		Rectangular hollow section

EC-EN 1993 Steel check ULS

Cross-sections were changed during Autodesign. The structure has to be recalculated !

Linear calculation

Combination: CO1

Coordinate system: Principal

Extreme 1D: Global

Selection: All

Filter: Cross-section = CS71 - VHP100/100x5.0

Overall Unity Check

Name	dx [mm]	Case	Cross-section	Material	UC _{Overall} [-]	UC _{Sec} [-]	UC _{Stab} [-]
B316	0,000	CO1/1	CS71 - VHP100/100x5.0	S 235	0,28	0,28	0,00

Name	Combination key
CO1/1	1.15*LC1 + 1.15*LC2 + 0.75*LC3 + 0.90*LC6 + 1.50*LC8

EC-EN 1993 Steel check fire resistance

Cross-sections were changed during Autodesign. The structure has to be recalculated !

Linear calculation

Combination: CO3

Coordinate system: Principal

Extreme 1D: Global

Selection: All

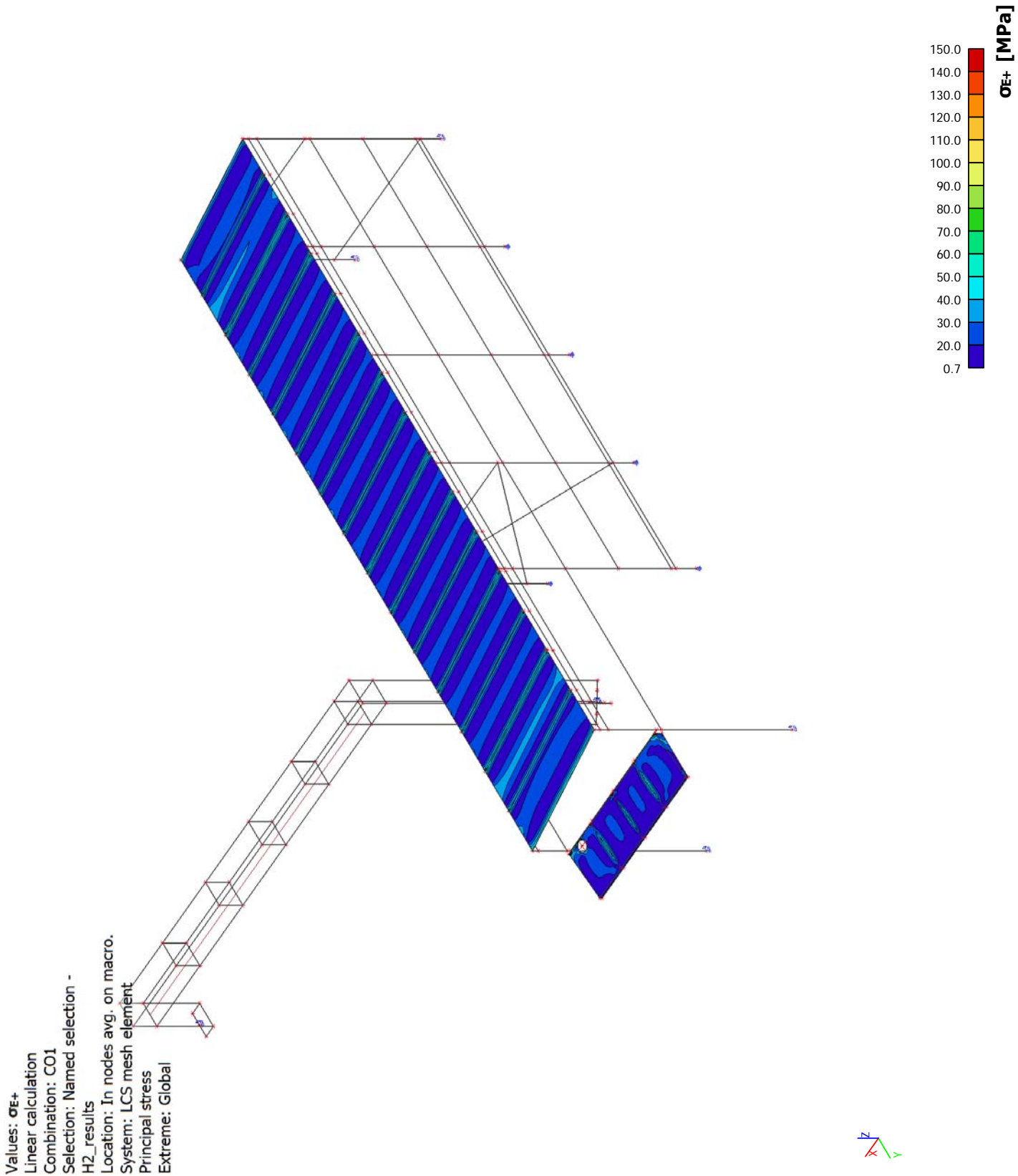
Filter: Cross-section = CS71 - VHP100/100x5.0

Overall Unity Check

Name	dx [mm]	Case	Cross-section	Material	UC _{Overall} [-]	UC _{Temperature} [-]	UC _{Sec} [-]	UC _{Stab} [-]
B316	0,000	CO3/1	CS71 - VHP100/100x5.0	S 235	0,84	0,00	0,84	0,00

Name	Combination key
CO3/1	LC1 + LC2 + 0.70*LC8

STRESS ANALYSIS OF PLATE ELEMENTS
2D stress/strain



2D member - Stresses

Cross-sections were changed during Autodesign. The structure has to be recalculated !

Linear calculation, Extreme : Global

Selection : Named selection - H2_results

Combinations : CO1

Principal magnitudes. In nodes, avg. on macro.

Member	Case	elem	sig1+ [MPa]	sig2+ [MPa]	alfa+ [deg]	sigE+ [MPa]	taumaxb [MPa]
			sig1- [MPa]	sig2- [MPa]	alfa- [deg]	sigE- [MPa]	
S533	CO1	10411	-34,5 -4,7	-83,3 -13,0	-84,51 -86,60	21,0 11,4	0,8
S537	CO1	10567	166,0 97,1	40,2 24,1	64,57 67,07	150,0 104,4	13,8
S538	CO1	11799	-3,6 -2,2	-102,8 -84,4	-74,27 -76,56	12,5 14,2	0,2
S533	CO1	10410	156,0 114,4	42,9 36,4	86,05 56,37	139,5 136,5	15,7
S565	CO1	24743	-1,4 -0,5	-5,5 -1,0	-90,00 -86,13	1,4 0,7	0,0
S565	CO1	24896	19,5 11,4	4,8 3,1	90,00 89,29	17,5 18,8	0,3
S534	CO1	10467	-0,1 0,7	-1,1 -2,2	-50,30 -57,74	0,1 1,8	0,0
S533	CO1	10410	-23,9 -36,0	-78,9 -150,9	-34,17 -9,98	57,2 98,3	9,2
S538	CO1	10607	147,1 125,9	13,8 17,7	84,61 89,87	140,7 119,5	0,9
S534	CO1	10450	5,6 80,0	0,8 42,6	81,56 78,65	14,4 69,3	6,0
S556	CO1	14377	-6,1 -3,3	-18,9 -9,2	-89,81 -90,00	8,8 7,3	0,1
S558	CO1	16273	48,9 28,9	13,8 8,1	89,63 90,00	43,7 47,0	0,4
S556	CO1	14300	0,0 -1,5	-1,2 -5,1	-57,50 -41,53	0,4 0,0	0,0
S562	CO1	21164	-9,4 -5,2	-27,6 -14,2	-89,78 -88,70	5,7 5,3	0,0

ZÁVĚR

Ocelová konstrukce vodíkové stanice vyhovuje na mezní stav pevnosti a mezní stav použitelnosti dle ČSN EN 1993-1-1 a na požární odolnost R15 dle ČSN EN 1993-1-2.