

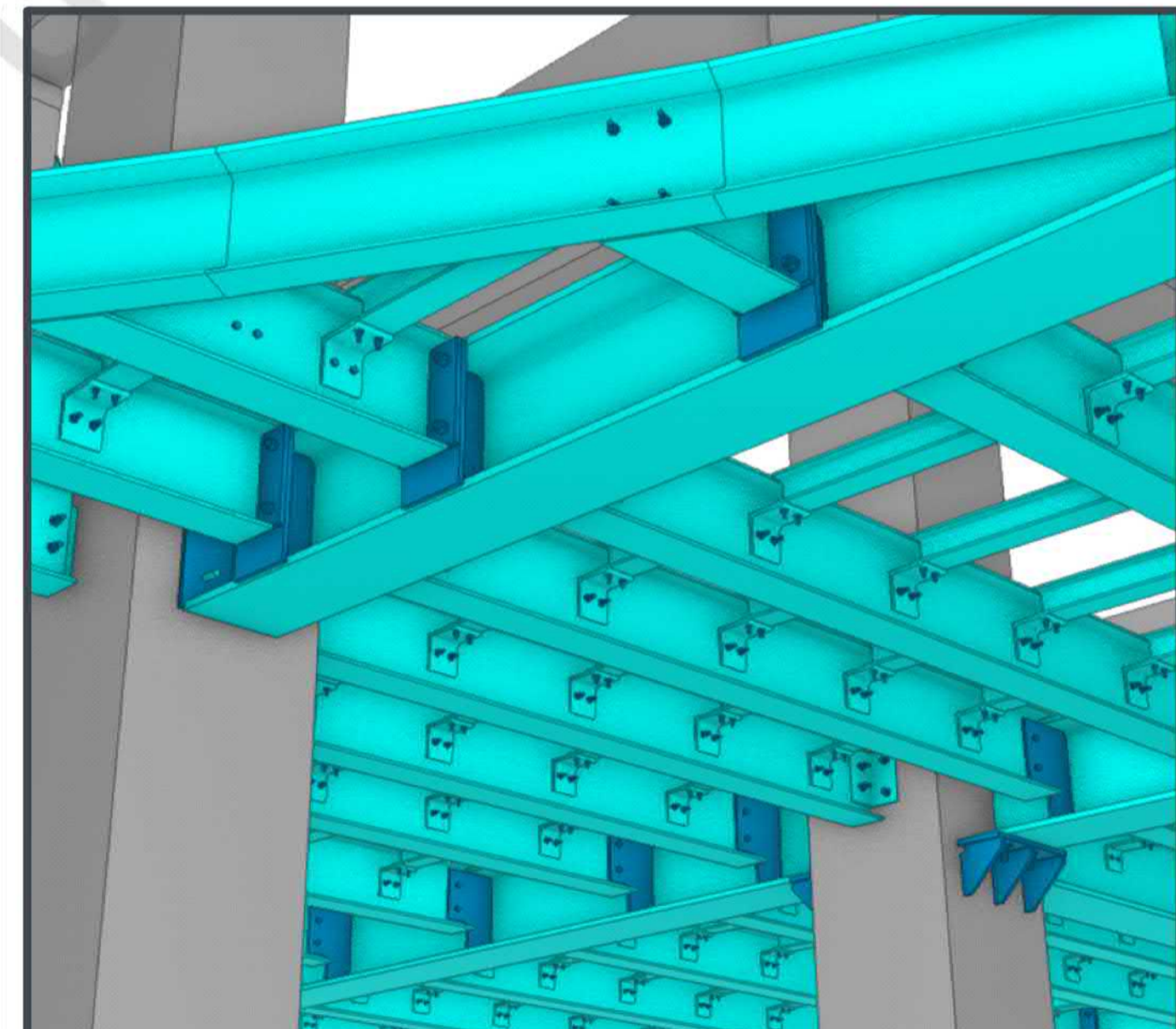
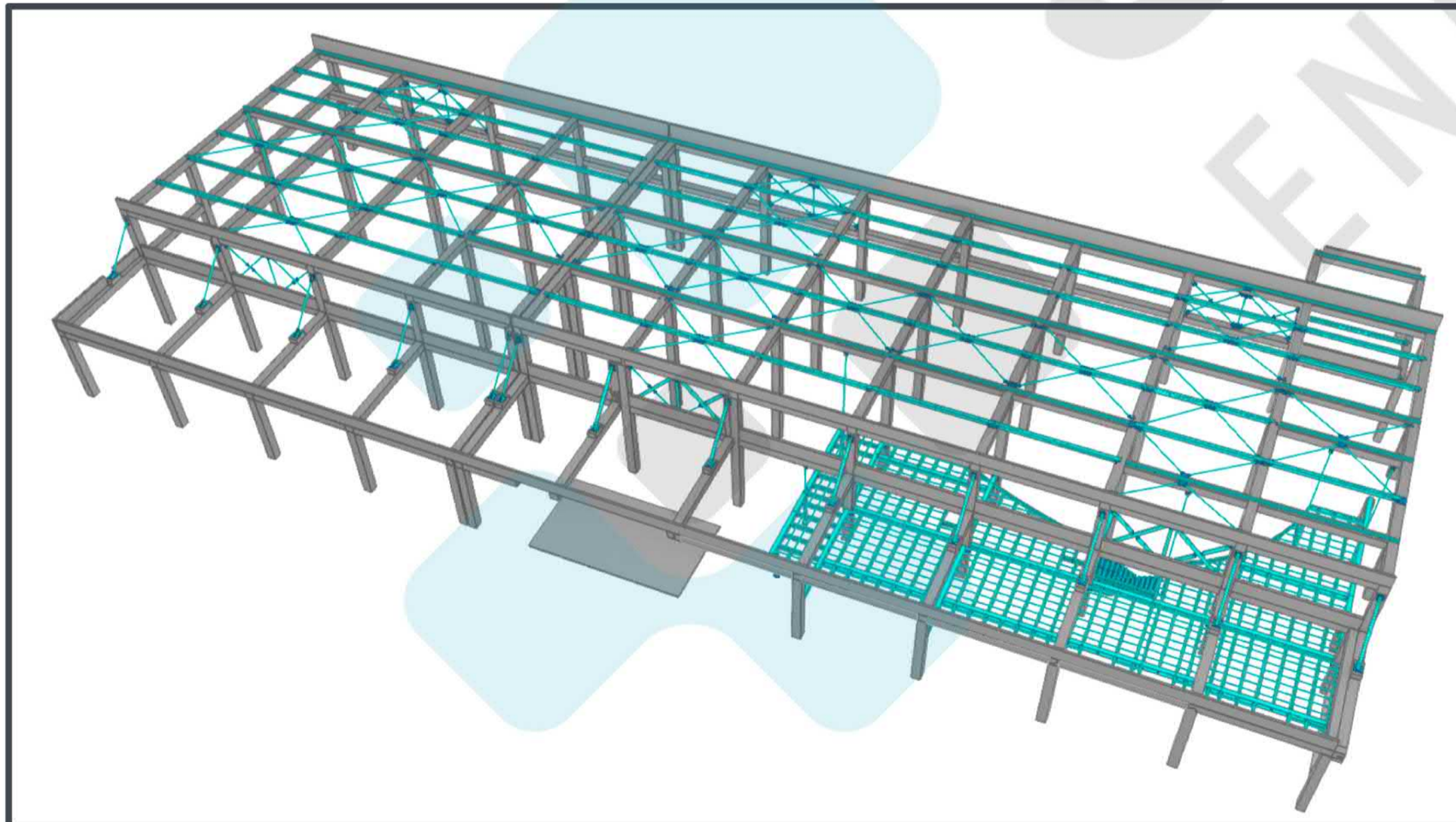
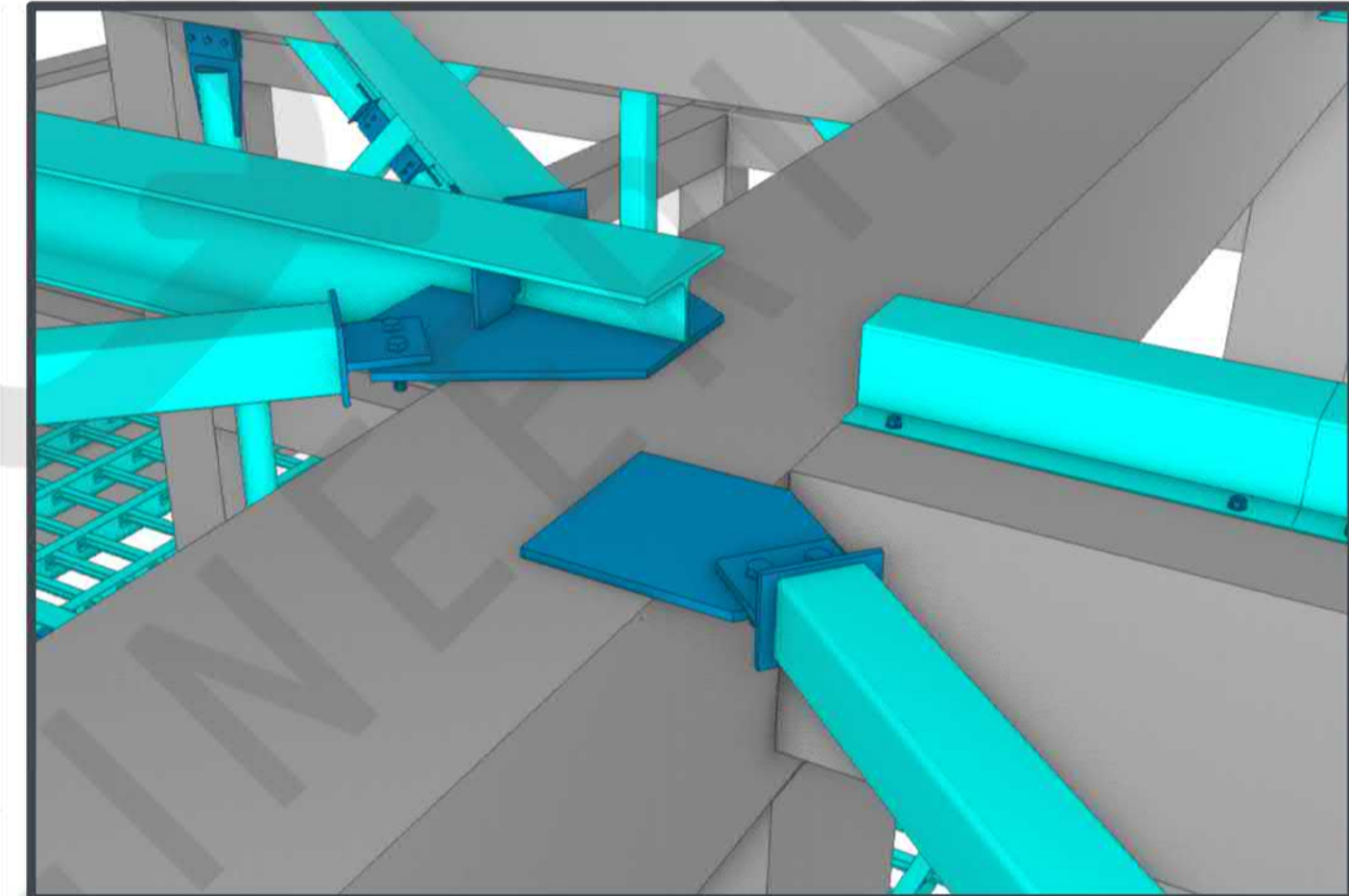
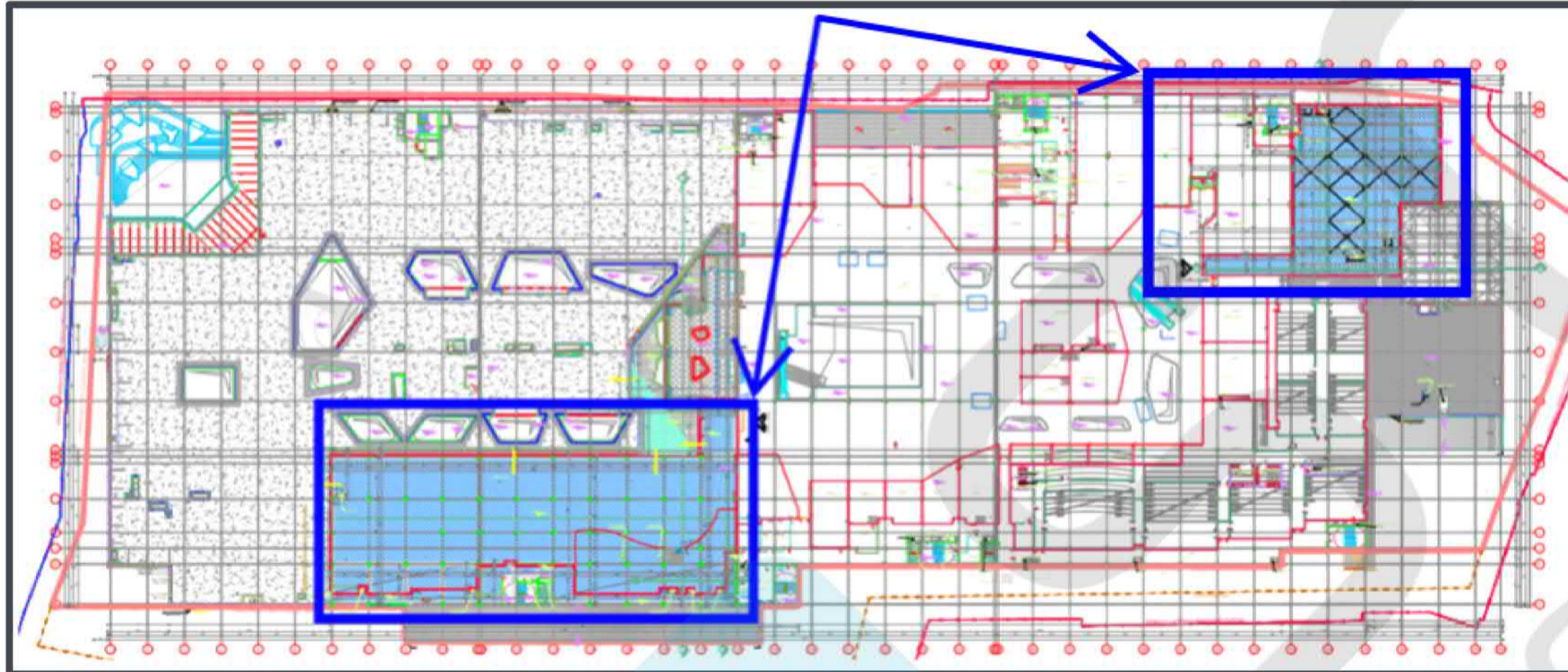
**Project:** Shopping Center – Additional Storey [Area = 2.900m<sup>2</sup>]

**Country:** Serbia

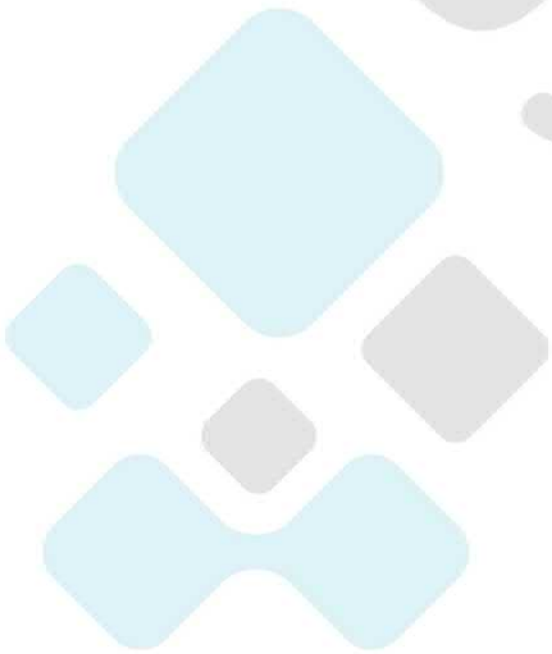
**Scope of Work:** Complete structural design of both primary and secondary steel structures.

The work included:








- Coordination with architects, HVAC design
- Project optimization in collaboration with steel contractors
- Structural Analysis and Vibration Analysis of a Steel Intermediate Floor
- Connection Analysis
- Structural Drawings

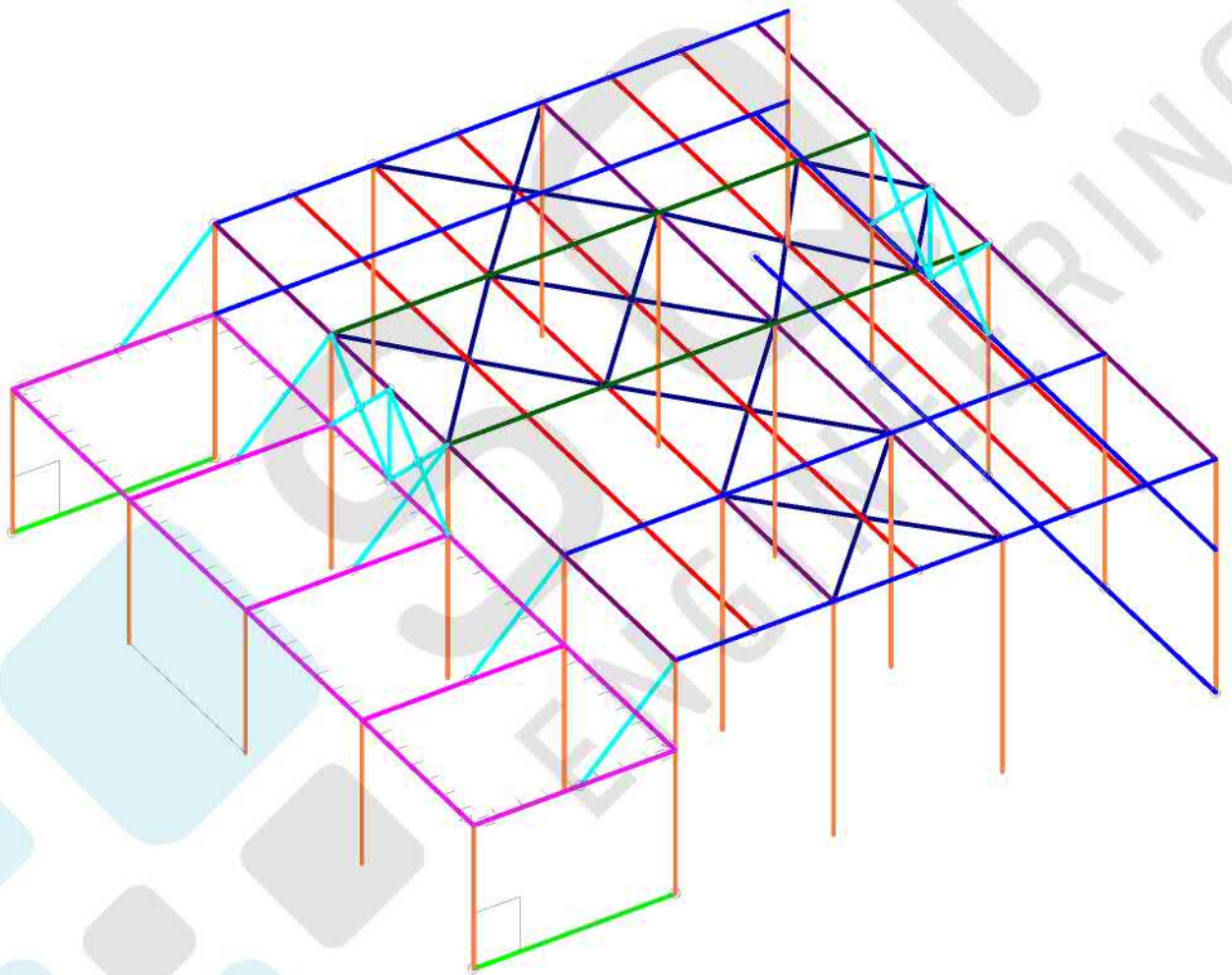


# Structural Analysis

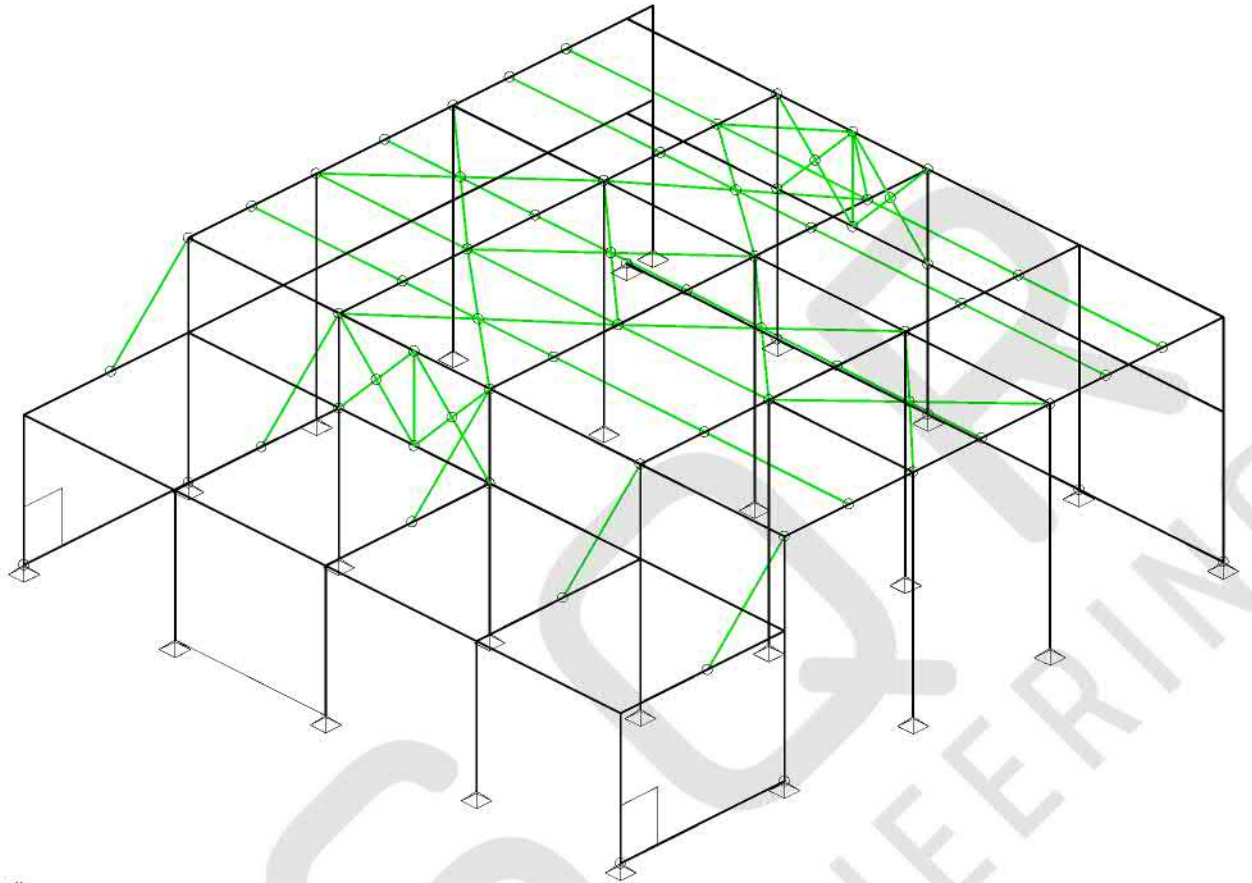


SSQR  
ENGINEERING

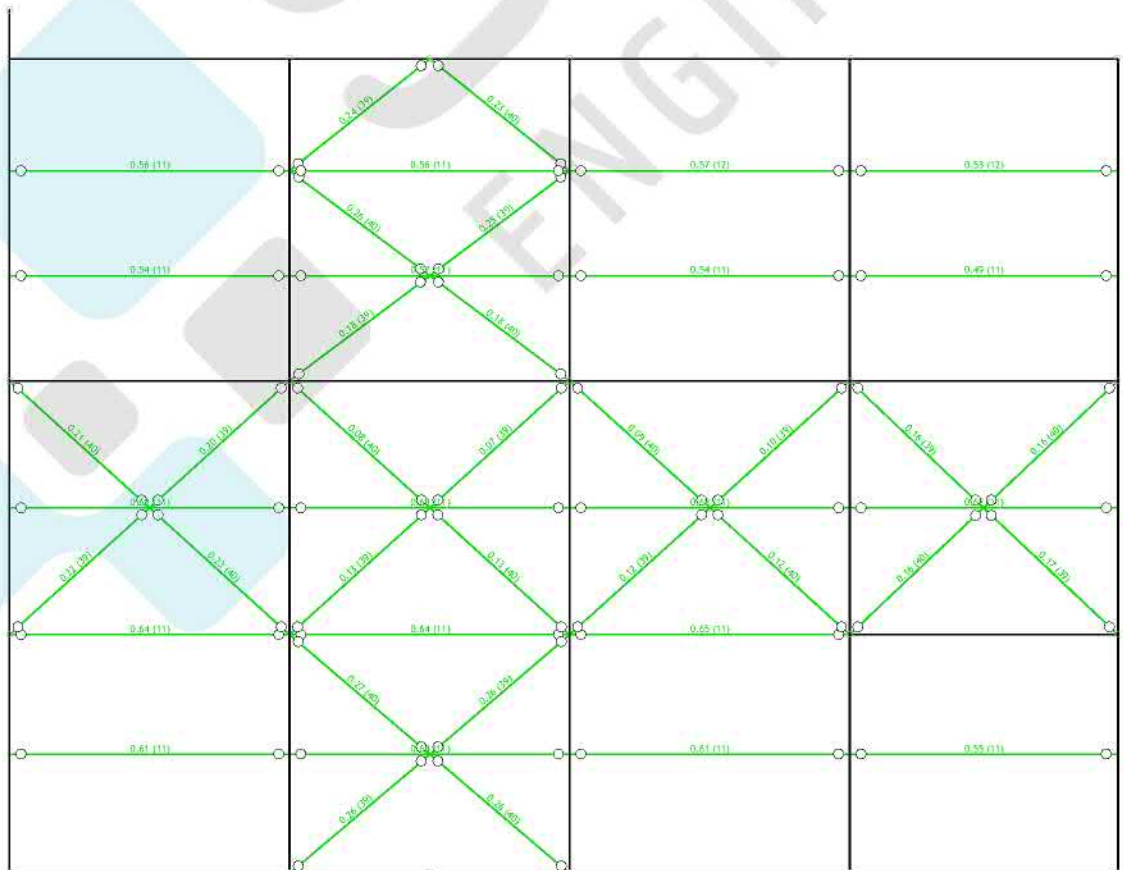
Greda	
1. b/d=60/60	
2. b/d=60/60	
3. b/d=60/50	
4. b/d=60/80	
5. b/d=60/60	
6. b/d=100/60	
7. IPBL 260	
8. HOP $\square$ 180x180x6	
9. HOP $\square$ 120x120x5	



Kontrola napona

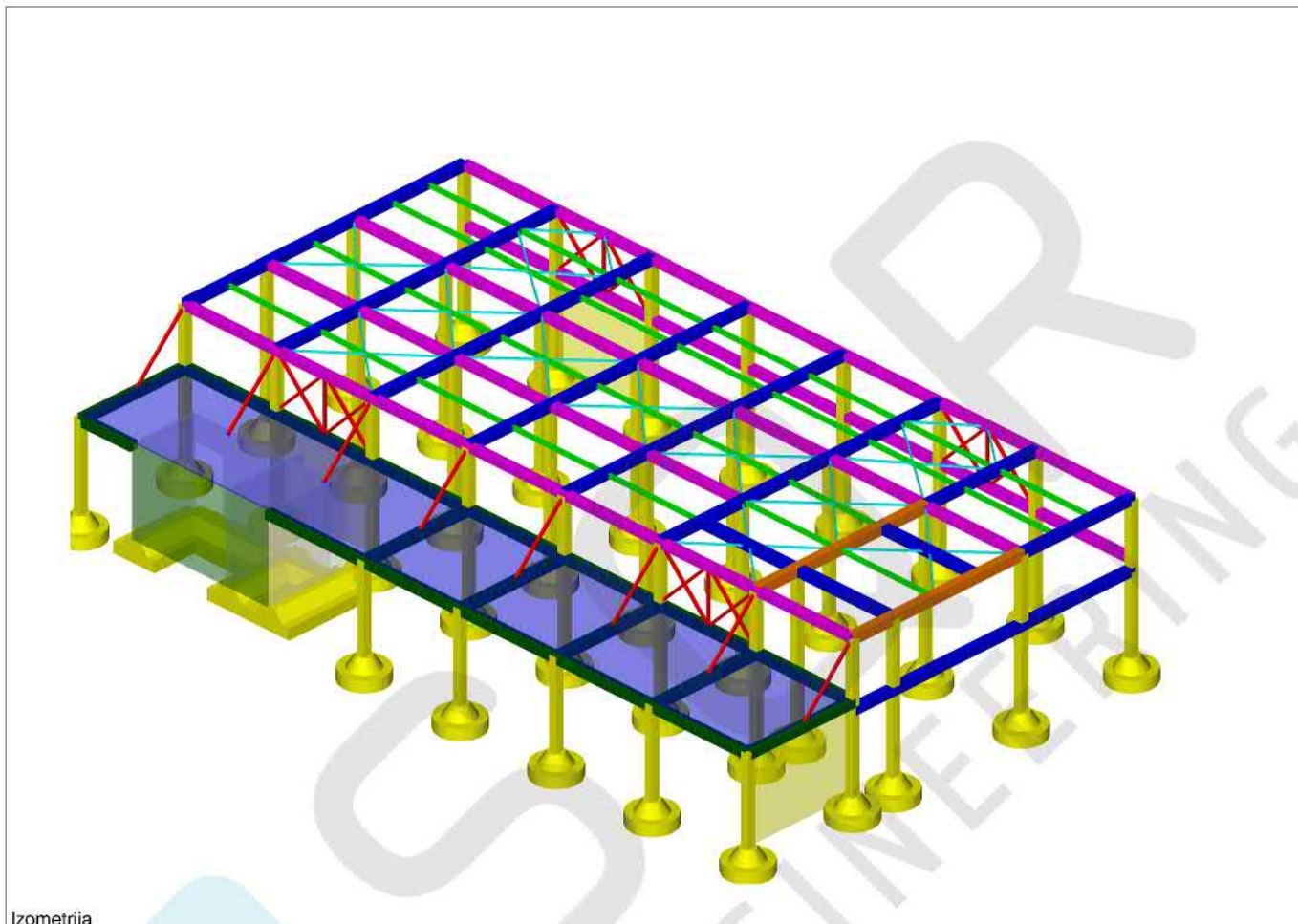


Izometrija  
Kontrola napona  
Kontrola napona



Nivo: Krov [10.60 m]  
Kontrola napona

## Konstrukcija-ulazni podaci



Izometrija

### Sema nivoa

Naziv	z [m]	h [m]
Krov	10.60	4.10
Nizi krov	6.50	3.50

Naziv	z [m]	h [m]
galerija	3.00	3.00
2.sprat	0.00	

### Tabela materijala

No	Naziv materijala	E[kN/m <sup>2</sup> ]	$\mu$	$\gamma$ [kN/m <sup>3</sup> ]	$\alpha$ [1/C]	Em[kN/m <sup>2</sup> ]	$\mu_m$
1	Concrete C30/37	3.900e+7	0.20	25.00	1.000e-5	3.300e+7	0.20
2	Celik	2.100e+8	0.30	78.50	1.000e-5	2.100e+8	0.30

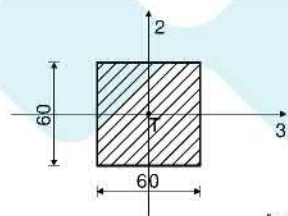
### Setovi ploča

No	d[m]	e[m]	Materijal	Tip proračuna	Ortotropija	E2[kN/m <sup>2</sup> ]	G[kN/m <sup>2</sup> ]	$\alpha$
<1>	0.150	0.075	1	Tanka ploča	Izotropna			
<2>	0.200	0.100	1	Tanka ploča	Izotropna			
<3>	0.250	0.125	1	Tanka ploča	Izotropna			
<4>	0.300	0.150	1	Tanka ploča	Izotropna			

### Setovi greda

Set: 1 Presek: b/d=60/60, Fiktivna ekscentričnost

Mat.	A1	A2	A3	I1	I2	I3
1 - Concrete C30/37	3.600e-1	3.000e-1	3.000e-1	1.825e-2	1.080e-2	1.080e-2

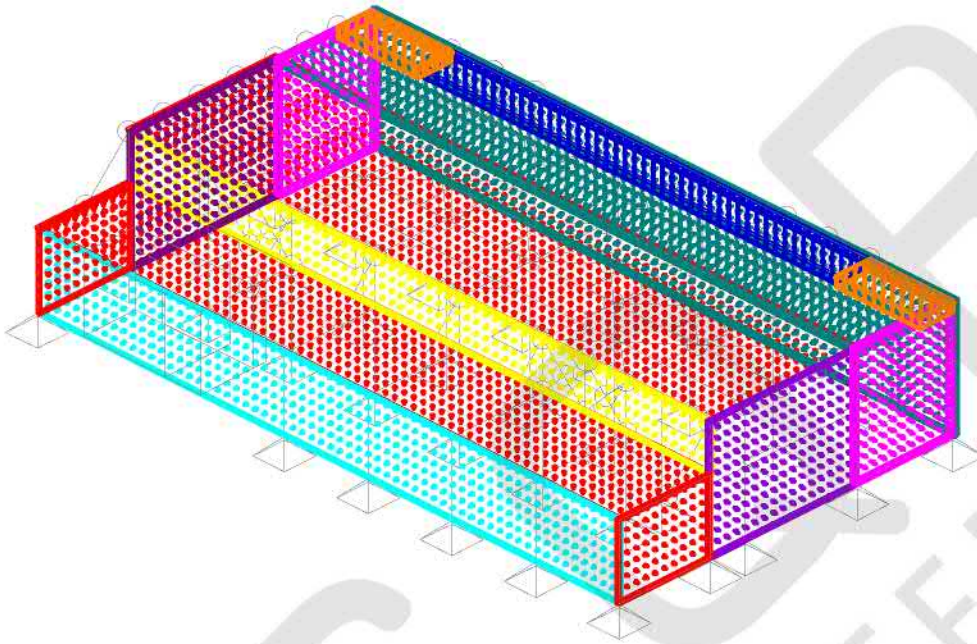


[cm]

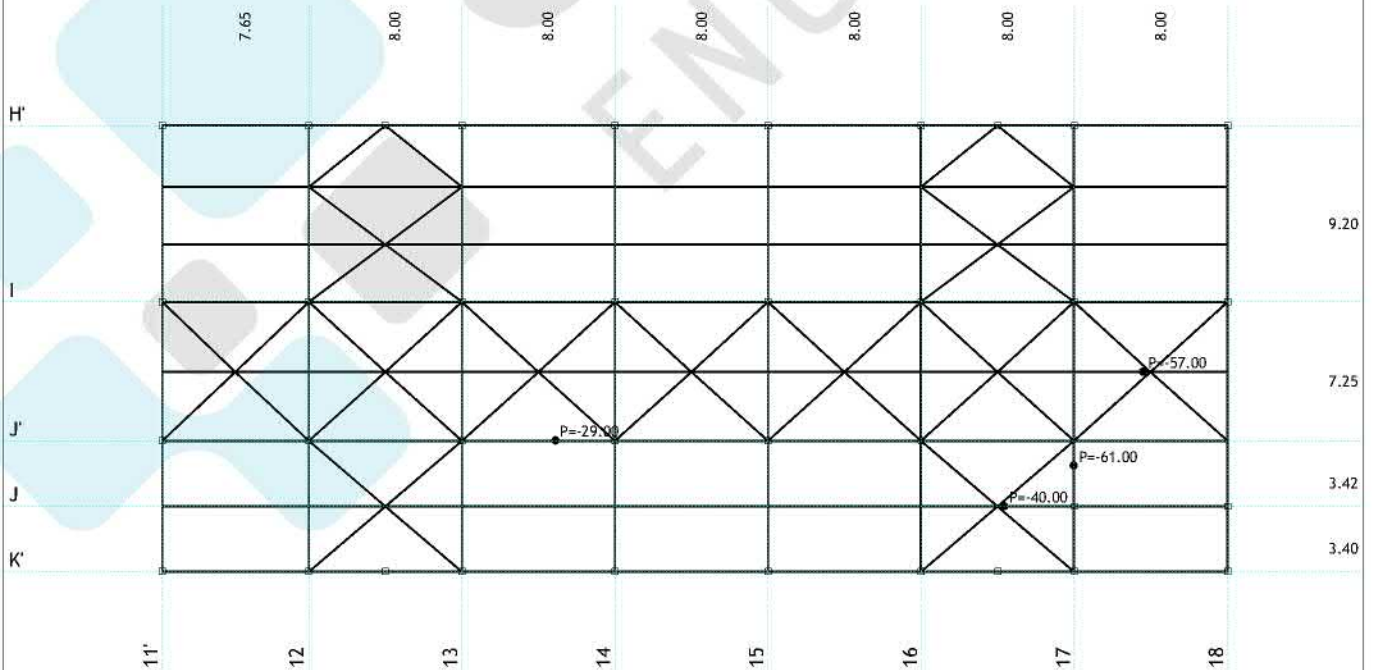
Opt. 7: Wy

Površinsko opterećenje

- 1.  $\rho=0.49 \text{ kN/m}^2$
- 2.  $\rho=-0.35 \text{ kN/m}^2$
- 4.  $\rho=0.69 \text{ kN/m}^2$
- 7.  $\rho=0.41 \text{ kN/m}^2$
- 8.  $\rho=0.69 \text{ kN/m}^2$
- 11.  $\rho=0.57 \text{ kN/m}^2$
- 15.  $\rho=1.05 \text{ kN/m}^2$
- 16.  $\rho=0.85 \text{ kN/m}^2$
- 17.  $\rho=-0.57 \text{ kN/m}^2$
- 18.  $\rho=-0.87 \text{ kN/m}^2$
- 19.  $\rho=1.48 \text{ kN/m}^2$
- 20.  $\rho=0.35 \text{ kN/m}^2$



Setovi numeričkih podataka  
Površinsko opterećenje (1,2,4,7,8,11,15-20)  
Opt. 5: z



Nivo: Krov [10.60 m]

Računska normalna sila  
 Transverzalna sila u z pravcu  
 Moment savijanja oko y ose  
 Sistemska dužina štapa

$N_{Ed} = -32.034 \text{ kN}$   
 $V_{Ed,z} = 0.511 \text{ kN}$   
 $M_{Ed,y} = -0.225 \text{ kNm}$   
 $L = 572.80 \text{ cm}$

6.2.6 Smicanje  
 Proračunska nosivost na smicanje  
 Proračunska nosivost na smicanje  
**Uslov 6.17:  $V_{Ed,z} \leq V_{c,Rd,z} (0.51 \leq 251.80)$**

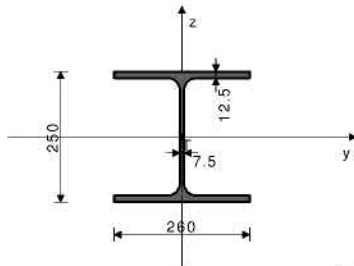
$V_{pl,Rd,z} = 251.80 \text{ kN}$   
 $V_{c,Rd,z} = 251.80 \text{ kN}$

## 6.2 NOSIVOST POPREČNIH PRESEKA

### ŠTAP 2503-2119

POPREČNI PRESEK : IPBI 260 [S 235] [Set: 6]  
 EUROCODE 3 (EN 1993-1-1:2005)

#### GEOMETRIJSKE KARAKTERISTIKE PRESEKA



$A_x = 86.800 \text{ cm}^2$   
 $A_y = 58.063 \text{ cm}^2$   
 $A_z = 28.738 \text{ cm}^2$   
 $I_x = 52.600 \text{ cm}^4$   
 $I_y = 10450 \text{ cm}^4$   
 $I_z = 3670.0 \text{ cm}^4$   
 $W_y = 836.00 \text{ cm}^3$   
 $W_z = 282.31 \text{ cm}^3$   
 $W_{y,pl} = 904.09 \text{ cm}^3$   
 $W_{z,pl} = 422.50 \text{ cm}^3$   
 $\gamma_{M0} = 1.100$   
 $\gamma_{M1} = 1.100$   
 $\gamma_{M2} = 1.250$   
 $A_{net}/A = 0.900$

( $f_y = 23.5 \text{ kN/cm}^2$ ,  $f_u = 36.0 \text{ kN/cm}^2$ )

#### FAKTORI ISKORIŠĆENJA PO KOMBINACIJAMA OPTEREĆENJA

13. $\gamma=0.84$	52. $\gamma=0.84$	54. $\gamma=0.84$
141. $\gamma=0.84$	76. $\gamma=0.82$	78. $\gamma=0.82$
21. $\gamma=0.82$	167. $\gamma=0.82$	132. $\gamma=0.78$
43. $\gamma=0.78$	131. $\gamma=0.78$	205. $\gamma=0.78$
154. $\gamma=0.76$	62. $\gamma=0.76$	153. $\gamma=0.76$
210. $\gamma=0.76$	14. $\gamma=0.75$	55. $\gamma=0.75$
142. $\gamma=0.75$	53. $\gamma=0.75$	23. $\gamma=0.74$
173. $\gamma=0.74$	84. $\gamma=0.74$	86. $\gamma=0.74$
58. $\gamma=0.73$	143. $\gamma=0.73$	15. $\gamma=0.73$
56. $\gamma=0.73$	22. $\gamma=0.73$	77. $\gamma=0.73$
168. $\gamma=0.73$	79. $\gamma=0.73$	37. $\gamma=0.72$
195. $\gamma=0.72$	115. $\gamma=0.72$	117. $\gamma=0.72$
175. $\gamma=0.71$	25. $\gamma=0.71$	88. $\gamma=0.71$
90. $\gamma=0.71$	19. $\gamma=0.69$	17. $\gamma=0.69$
68. $\gamma=0.69$	70. $\gamma=0.69$	161. $\gamma=0.68$
63. $\gamma=0.68$	162. $\gamma=0.68$	215. $\gamma=0.68$
105. $\gamma=0.67$	29. $\gamma=0.67$	33. $\gamma=0.67$
103. $\gamma=0.67$	189. $\gamma=0.66$	190. $\gamma=0.66$
102. $\gamma=0.66$	222. $\gamma=0.66$	24. $\gamma=0.65$
87. $\gamma=0.65$	85. $\gamma=0.65$	174. $\gamma=0.65$
179. $\gamma=0.63$	93. $\gamma=0.63$	95. $\gamma=0.63$
27. $\gamma=0.63$	116. $\gamma=0.63$	38. $\gamma=0.63$
118. $\gamma=0.63$	196. $\gamma=0.63$	145. $\gamma=0.63$
146. $\gamma=0.63$	60. $\gamma=0.63$	61. $\gamma=0.63$
39. $\gamma=0.61$	119. $\gamma=0.61$	121. $\gamma=0.61$
197. $\gamma=0.61$	177. $\gamma=0.60$	178. $\gamma=0.60$
98. $\gamma=0.60$	92. $\gamma=0.60$	71. $\gamma=0.60$
18. $\gamma=0.60$	69. $\gamma=0.60$	20. $\gamma=0.60$
107. $\gamma=0.59$	109. $\gamma=0.59$	35. $\gamma=0.59$
31. $\gamma=0.59$	144. $\gamma=0.59$	59. $\gamma=0.59$
57. $\gamma=0.59$	16. $\gamma=0.59$	125. $\gamma=0.58$
127. $\gamma=0.58$	41. $\gamma=0.58$	201. $\gamma=0.58$
104. $\gamma=0.58$	30. $\gamma=0.58$	34. $\gamma=0.58$
106. $\gamma=0.58$	46. $\gamma=0.57$	44. $\gamma=0.57$
133. $\gamma=0.57$	135. $\gamma=0.57$	89. $\gamma=0.56$
26. $\gamma=0.56$	176. $\gamma=0.56$	91. $\gamma=0.56$
206. $\gamma=0.56$	149. $\gamma=0.56$	64. $\gamma=0.56$
147. $\gamma=0.56$	229. $\gamma=0.55$	50. $\gamma=0.54$
137. $\gamma=0.54$	139. $\gamma=0.54$	48. $\gamma=0.54$
97. $\gamma=0.53$	99. $\gamma=0.53$	181. $\gamma=0.53$
182. $\gamma=0.53$	165. $\gamma=0.51$	74. $\gamma=0.51$
72. $\gamma=0.51$	163. $\gamma=0.51$	200. $\gamma=0.50$
123. $\gamma=0.50$	124. $\gamma=0.50$	199. $\gamma=0.50$
110. $\gamma=0.50$	36. $\gamma=0.50$	108. $\gamma=0.50$
32. $\gamma=0.50$	94. $\gamma=0.49$	28. $\gamma=0.49$
96. $\gamma=0.49$	180. $\gamma=0.49$	211. $\gamma=0.48$
66. $\gamma=0.48$	155. $\gamma=0.48$	157. $\gamma=0.48$
134. $\gamma=0.48$	45. $\gamma=0.48$	136. $\gamma=0.48$
47. $\gamma=0.48$	204. $\gamma=0.47$	129. $\gamma=0.47$
130. $\gamma=0.47$	225. $\gamma=0.47$	203. $\gamma=0.47$
120. $\gamma=0.47$	40. $\gamma=0.47$	198. $\gamma=0.47$
122. $\gamma=0.47$	218. $\gamma=0.46$	183. $\gamma=0.46$
185. $\gamma=0.46$	100. $\gamma=0.46$	209. $\gamma=0.45$
152. $\gamma=0.45$	151. $\gamma=0.45$	226. $\gamma=0.45$
208. $\gamma=0.45$	140. $\gamma=0.45$	49. $\gamma=0.45$
138. $\gamma=0.45$	51. $\gamma=0.45$	171. $\gamma=0.44$
80. $\gamma=0.44$	82. $\gamma=0.44$	169. $\gamma=0.44$
126. $\gamma=0.44$	202. $\gamma=0.44$	42. $\gamma=0.44$
128. $\gamma=0.44$	164. $\gamma=0.43$	73. $\gamma=0.43$
75. $\gamma=0.42$	166. $\gamma=0.42$	191. $\gamma=0.41$
193. $\gamma=0.41$	111. $\gamma=0.41$	113. $\gamma=0.41$

65. $\gamma=0.41$	207. $\gamma=0.41$	150. $\gamma=0.41$
148. $\gamma=0.41$	223. $\gamma=0.40$	216. $\gamma=0.40$
213. $\gamma=0.38$	160. $\gamma=0.38$	159. $\gamma=0.38$
227. $\gamma=0.38$	214. $\gamma=0.38$	217. $\gamma=0.36$
224. $\gamma=0.36$	221. $\gamma=0.35$	188. $\gamma=0.35$
187. $\gamma=0.35$	228. $\gamma=0.35$	220. $\gamma=0.35$
172. $\gamma=0.35$	81. $\gamma=0.35$	170. $\gamma=0.35$
83. $\gamma=0.35$	67. $\gamma=0.34$	158. $\gamma=0.34$
156. $\gamma=0.34$	212. $\gamma=0.34$	114. $\gamma=0.33$
194. $\gamma=0.33$	112. $\gamma=0.33$	192. $\gamma=0.33$
101. $\gamma=0.32$	219. $\gamma=0.32$	186. $\gamma=0.32$
184. $\gamma=0.32$		

ŠTAP IZLOŽEN ZATEZANJU I SAVIJANJU  
 (slučaj opterećenja 13, na 400.0 cm od početka štapa)

Računska normalna sila  $N_{Ed} = 0.164 \text{ kN}$   
 Transverzalna sila u z pravcu  $V_{Ed,z} = -1.246 \text{ kN}$   
 Moment savijanja oko y ose  $M_{Ed,y} = 113.41 \text{ kNm}$   
 Sistemska dužina štapa  $L = 800.00 \text{ cm}$

#### 5.5 KLASIFIKACIJA POPREČNIH PRESEKA

Klasa preseka 1

#### 6.2 NOSIVOST POPREČNIH PRESEKA

##### 6.2.3 Zatezanje

Plast.rač.otpornost bruto preseka  $N_{pl,Rd} = 1854.4 \text{ kN}$   
 Granična rač.otpornost neto preseka  $N_{u,Rd} = 2024.9 \text{ kN}$   
 Računska otp. na zatezanje  $N_{t,Rd} = 1854.4 \text{ kN}$   
**Uslov 6.5:  $N_{Ed} \leq N_{t,Rd} (0.16 \leq 1854.36)$**

##### 6.2.5 Savijanje y-y

Plastični otporni moment  $W_{y,pl} = 904.09 \text{ cm}^3$   
 Računska otpornost na savijanje  $M_{c,Rd} = 193.15 \text{ kNm}$   
**Uslov 6.12:  $M_{Ed,y} \leq M_{c,Rd,y} (113.41 \leq 193.15)$**

##### 6.2.6 Smicanje

Proračunska nosivost na smicanje  $V_{pl,Rd,z} = 354.46 \text{ kN}$   
 Proračunska nosivost na smicanje  $V_{c,Rd,z} = 354.46 \text{ kN}$   
**Uslov 6.17:  $V_{Ed,z} \leq V_{c,Rd,z} (1.25 \leq 354.46)$**

##### 6.2.10 Savijanje smicanje i aksijalna sila

Nije potrebna redukcija momenata otpornosti  
 Uslov:  $V_{Ed,z} \leq 50\% V_{pl,Rd,z}$

##### 6.2.9 Savijanje i aksijalna sila

Odnos  $N_{Ed} / N_{pl,Rd}$   
 Reduk.moment plast.otp.na savijanje  $M_{N,y,Rd} = 193.15 \text{ kNm}$   
 Koeficijent  $\alpha = 1.000$   
 Odnos  $(M_{y,Ed} / M_{N,y,Rd})^{\alpha}$   $0.587$   
**Uslov 6.41:  $(0.59 \leq 1)$**

#### 6.3 NOSIVOST ELEMENATA NA IZVIJANJE

##### 6.3.2.1 Nosivost na bočno-torziono izvijanje

Koeficijent  $C1 = 1.132$   
 Koeficijent  $C2 = 0.459$   
 Koeficijent  $C3 = 0.525$   
 Koef.efekt.dužine bočnog izvijanja  $k = 1.000$   
 Koef.efekt.dužine torzionog uvrtanja  $k_w = 1.000$   
 Koordinata  $z_g = 12.500 \text{ cm}$   
 Koordinata  $z_j = 0.000 \text{ cm}$   
 Razmak bočno pridržanih tačaka  $L = 800.00 \text{ cm}$   
 Sektorski moment inercije  $I_w = 5.16e+5 \text{ cm}^6$   
 Krit.mom.za bočno tor.zvijanje  $M_{cr} = 232.86 \text{ kNm}$   
 Odgovarajući otporni moment  $W_y = 904.09 \text{ cm}^3$   
 Koeficijent imperf.  $\alpha_{LT} = 0.210$   
 Bezdimezionna vitkost  $\lambda_{LT} = 0.955$   
 Koeficijent redukcije (6.3.2.2.)  $\chi_{LT} = 0.697$   
 Računska otpornost na izvijanje  $M_{b,Rd} = 134.57 \text{ kNm}$   
**Uslov 6.54:  $M_{Ed,y} \leq M_{b,Rd} (113.41 \leq 134.57)$**

#### PROVERA OTPORNOSTI NA SMICANJE

(slučaj opterećenja 13, početak štapa)

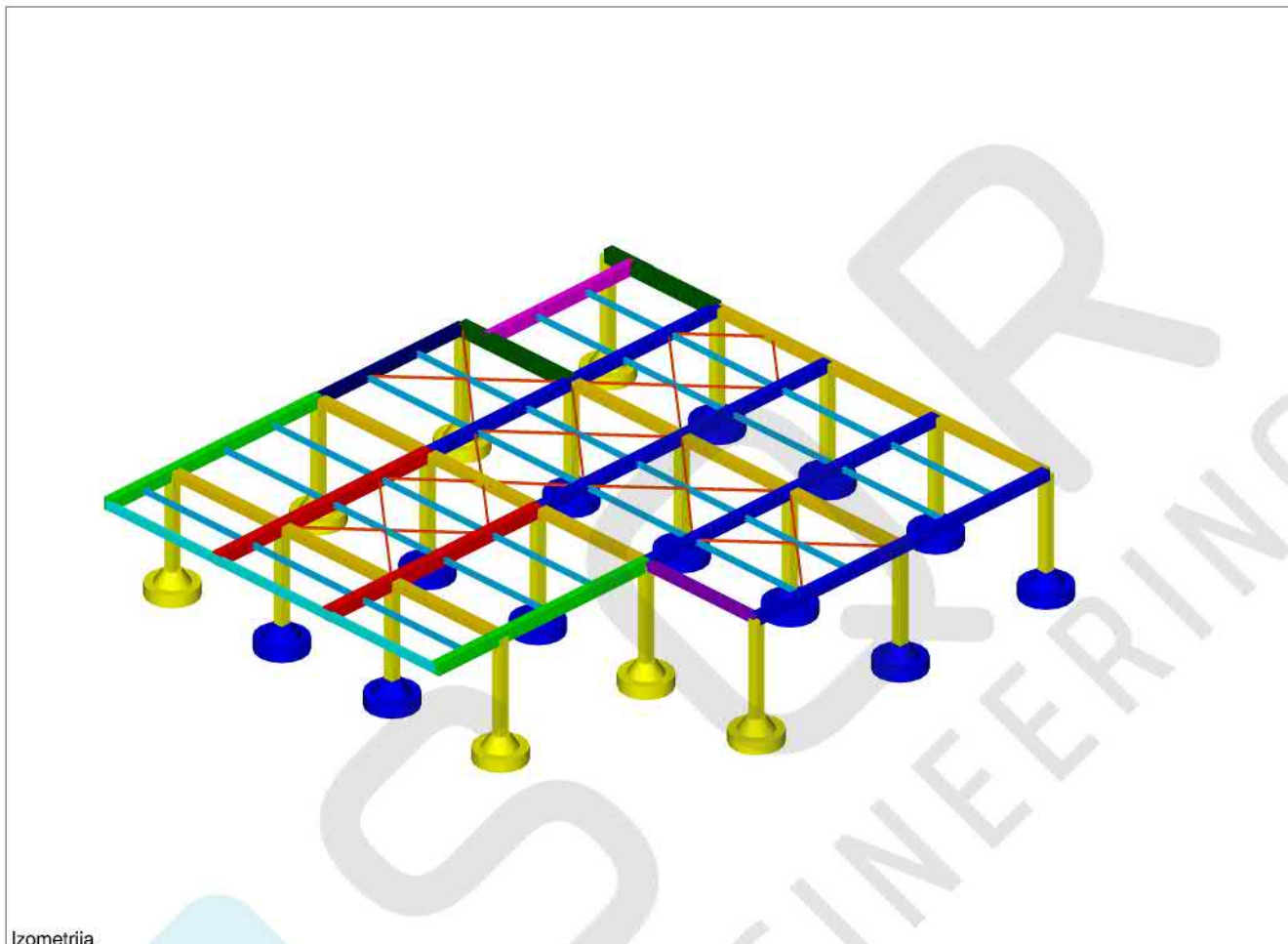
Računska normalna sila  $N_{Ed} = 0.164 \text{ kN}$   
 Transverzalna sila u z pravcu  $V_{Ed,z} = -55.461 \text{ kN}$   
 Sistemska dužina štapa  $L = 800.00 \text{ cm}$

#### 6.2 NOSIVOST POPREČNIH PRESEKA

##### 6.2.6 Smicanje

Proračunska nosivost na smicanje  $V_{pl,Rd,z} = 354.46 \text{ kN}$   
 Proračunska nosivost na smicanje  $V_{c,Rd,z} = 354.46 \text{ kN}$   
**Uslov 6.17:  $V_{Ed,z} \leq V_{c,Rd,z} (55.46 \leq 354.46)$**

## Konstrukcija-ulazni podaci

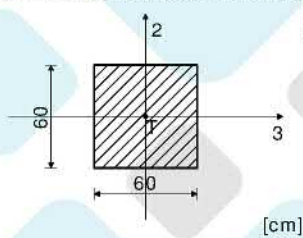


**Tabela materijala**

No	Naziv materijala	E[kN/m <sup>2</sup> ]	$\mu$	$\gamma$ [kN/m <sup>3</sup> ]	$\alpha$ [1/C]	Em[kN/m <sup>2</sup> ]	$\mu$ m
1	Concrete C30/37	3.300e+7	0.20	25.00	1.000e-5	3.300e+7	0.20
2	Celik	2.100e+8	0.30	78.50	1.000e-5	2.100e+8	0.30

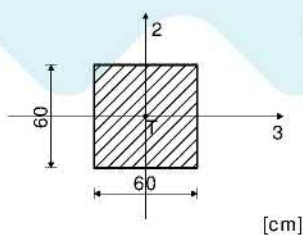
**Setovi greda**

Set: 1 Presek: b/d=60/60, Fiktivna ekscentričnost

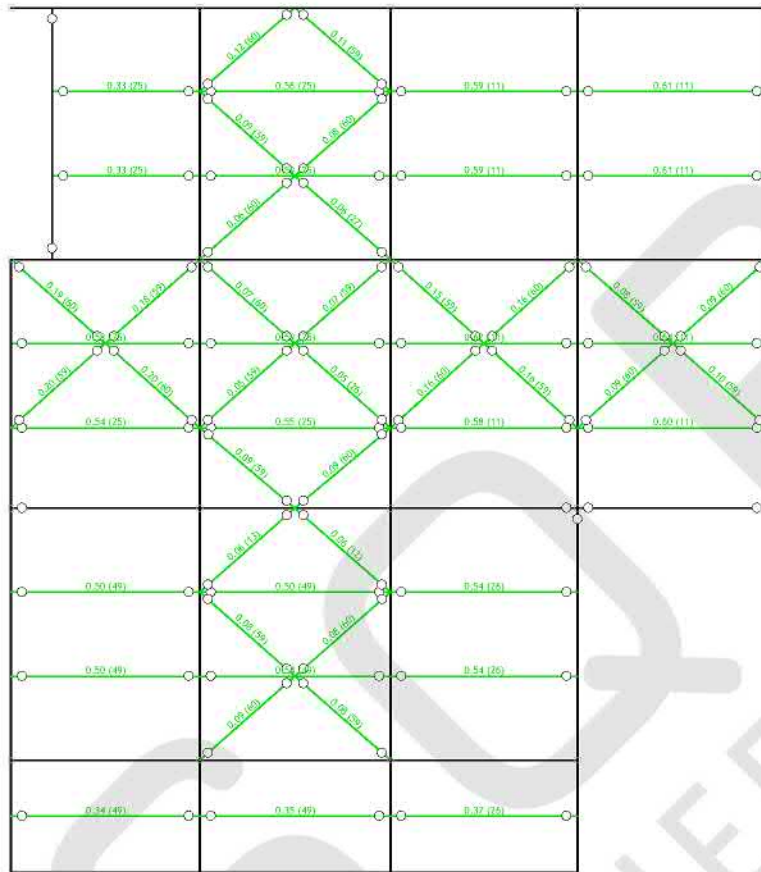


Mat.	A1	A2	A3	I1	I2	I3
1 - Concrete C30/37	3.600e-1	3.000e-1	3.000e-1	1.825e-2	1.080e-2	1.080e-2

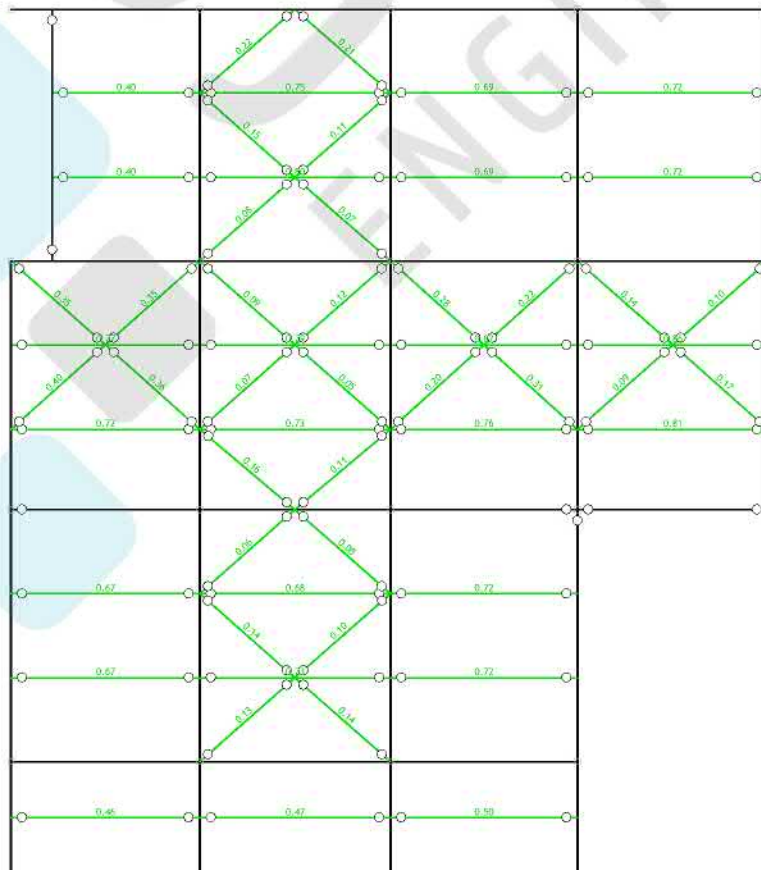
Set: 2 Presek: b/d=60/60, Fiktivna ekscentričnost



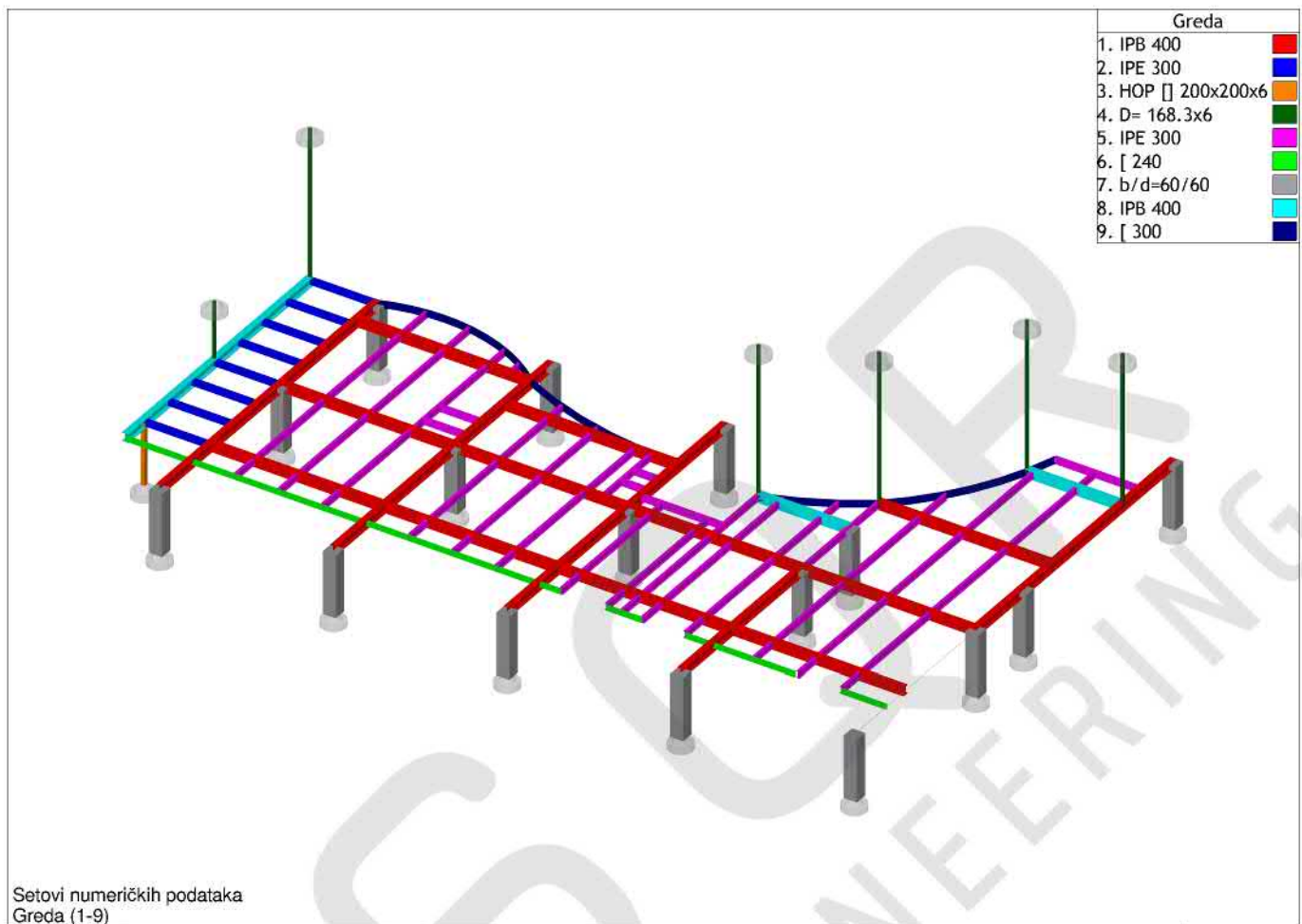
Mat.	A1	A2	A3	I1	I2	I3
1 - Concrete C30/37	3.600e-1	3.000e-1	3.000e-1	1.825e-2	1.080e-2	1.080e-2



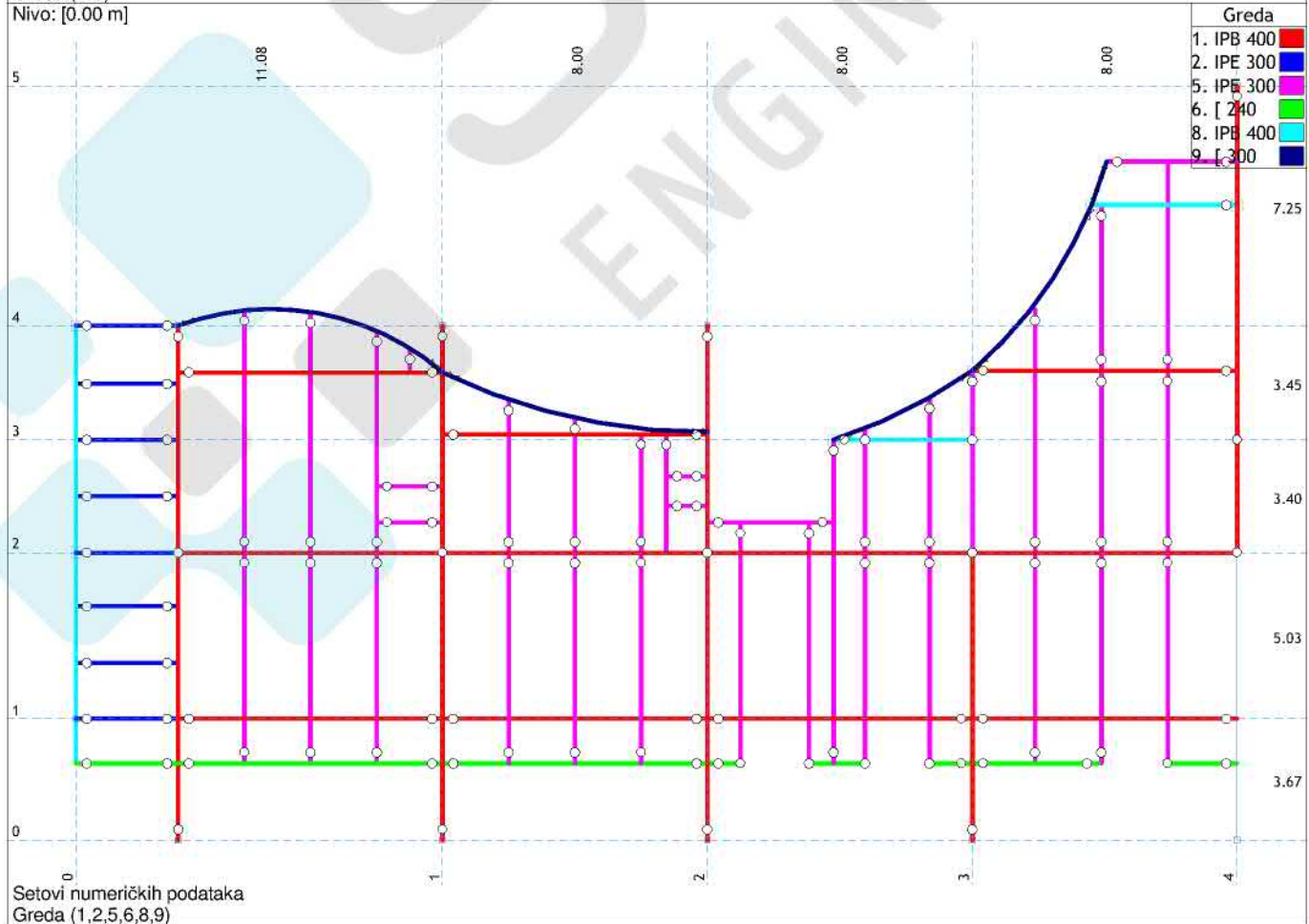
Nivo: Krov [5.75 m]  
Kontrola napona



Nivo: Krov [5.75 m]  
Kontrola stabilnosti



Setovi numeričkih podataka  
Greda (1-9)  
Nivo: [0.00 m]



## Sopstvena frekvencija i modalna masa:

Tower:

### Modalna analiza

#### Napredne opcije seizmičkog proračuna

Sprečeno oscilovanje u X pravcu

Sprečeno oscilovanje u Y pravcu

#### Faktori opterećenja za proračun masa

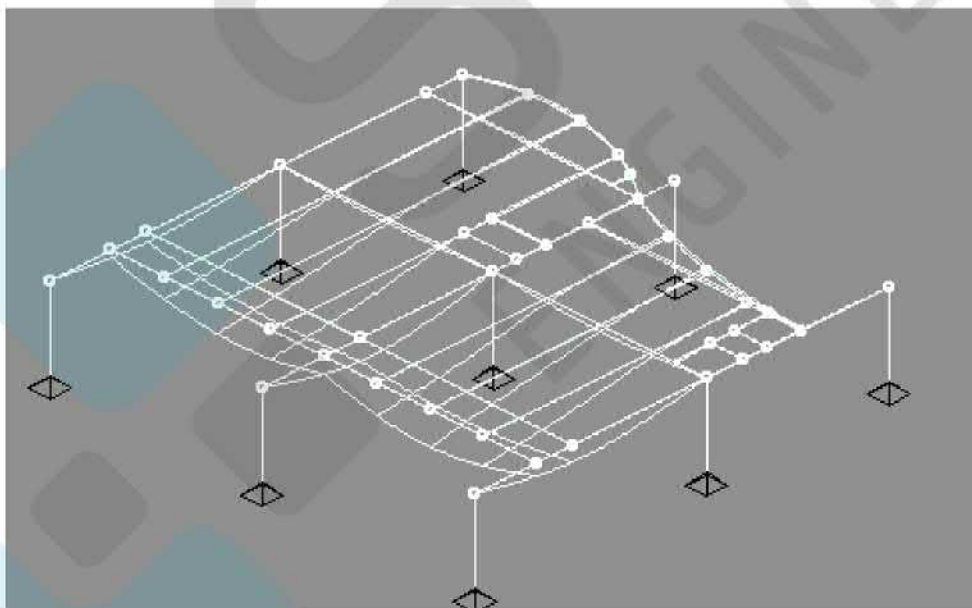
No	Naziv	Koeficijent
1	g (g)	1.00
2	$\rho$	0.10

#### Raspored masa po visini objekta

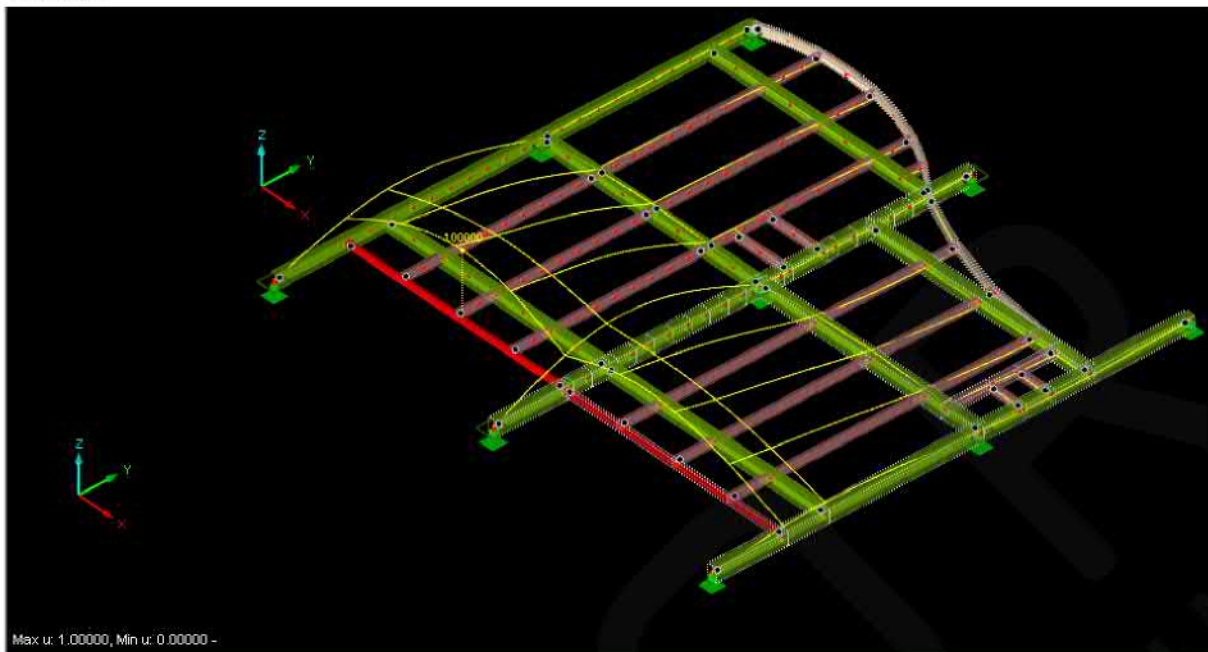
Nivo	Z [m]	X [m]	Y [m]	Masa [T]	T/m <sup>2</sup>
	0.00	10.94	5.86	88.02	
Ukupno:	0.00	10.94	5.86	88.02	

#### Periodi oscilovanja konstrukcije

No	T [s]	f [Hz]	m' [T]
1	0.1924	5.1981	8.6650
2	0.1640	6.0979	10.4973
3	0.1452	6.8880	7.6446
4	0.1327	7.5337	1.3225
5	0.1274	7.8516	4.4210
6	0.1233	8.1122	6.6813
7	0.1095	9.1356	1.1589
8	0.0970	10.3111	1.2992



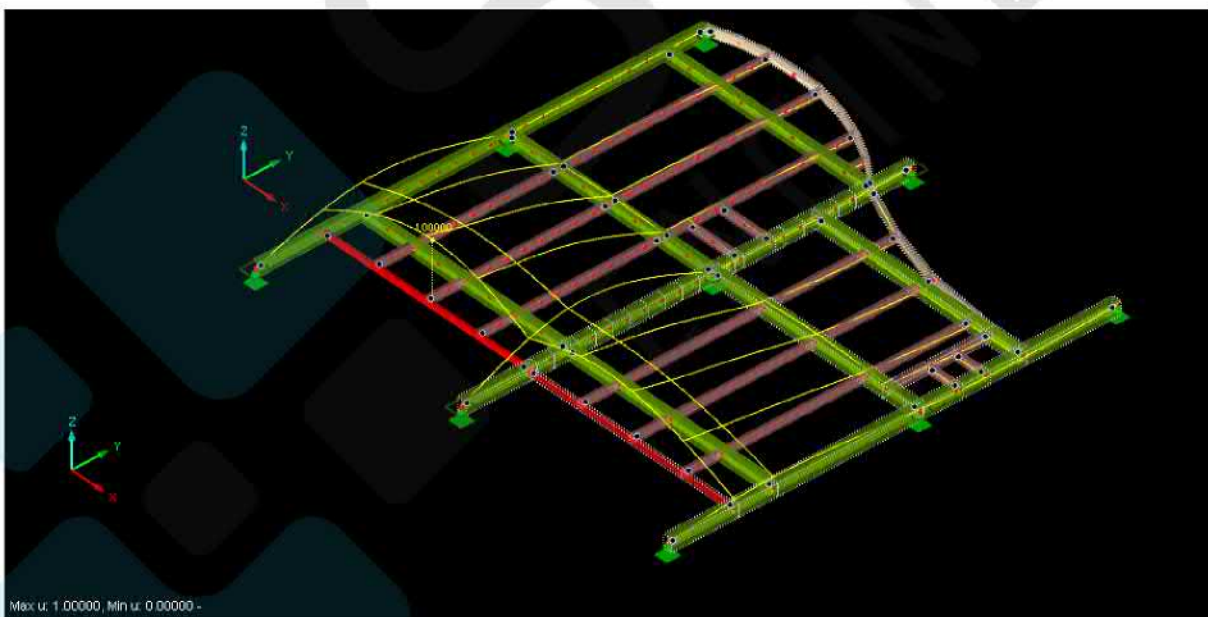
Dlubal:



5.1 Natural Frequencies

NVC1 Mode Shape 1 (f : 5.017 Hz)

Mode No.	A Eigenvalue $\lambda$ [1/s <sup>2</sup> ]	B Angular Frequency $\omega$ [rad/s]	C Natural frequency f [Hz]	D Natural period T [s]
1	993.849	31.525	5.017	0.199
2	1465.315	38.279	6.092	0.164
3	1713.127	41.390	6.587	0.152
4	1990.923	44.620	7.101	0.141



5.7 Effective Modal Mass Factors

NVC1 Mode Shape 1 (f : 5.017 Hz)

Mode No.	Effective Modal Mass				Effective Modal Mass Factor					
	A Modal Mass $M_i$ [kg]	B $m_{ex}$ [kg]	C $m_{ey}$ [kg]	D $m_{ez}$ [kg]	E $m_{\phi x}$ [kg m <sup>2</sup> ]	F $m_{\phi y}$ [kg m <sup>2</sup> ]	G $m_{\phi z}$ [kg m <sup>2</sup> ]	H $f_{max}$ [ ]	I $f_{meY}$ [ ]	J $f_{meZ}$ [ ]
1	7961.85	0.00	0.00	27053.08	383786.92	20754.96	0.00	0.000	0.000	0.390
2	10044.66	0.00	0.00	180.77	45523.83	782654.29	0.00	0.000	0.000	0.003
3	4025.28	0.00	0.00	18258.74	374231.28	24922.18	0.00	0.000	0.000	0.263
4	2749.24	0.00	0.00	22.63	3241.02	181.38	0.00	0.000	0.000	0.000
Sum	24781.03	0.00	0.00	45515.21	806783.05	828512.82	0.00	0.000	0.000	0.656

## Određivanje prigušenja:

Usvojeno je prigušenje od 3%.

**Table 1** Determination of damping

Type	Damping (% of critical damping)
<b>Structural Damping <math>D_1</math></b>	
Wood	6%
Concrete	2%
Steel	1%
Composite (steel-concrete)	1%
<b>Damping due to furniture <math>D_2</math></b>	
Traditional office for 1 to 3 persons with separation walls	2%
Paperless office	0%
Open plan office	1%
Library	1%
Houses	1%
Schools	0%
Gymnastic	0%
<b>Damping due to finishes <math>D_3</math></b>	
Ceiling under the floor	1%
Free floating floor	0%
Swimming screed	1%
<b>Total Damping <math>D = D_1 + D_2 + D_3</math></b>	

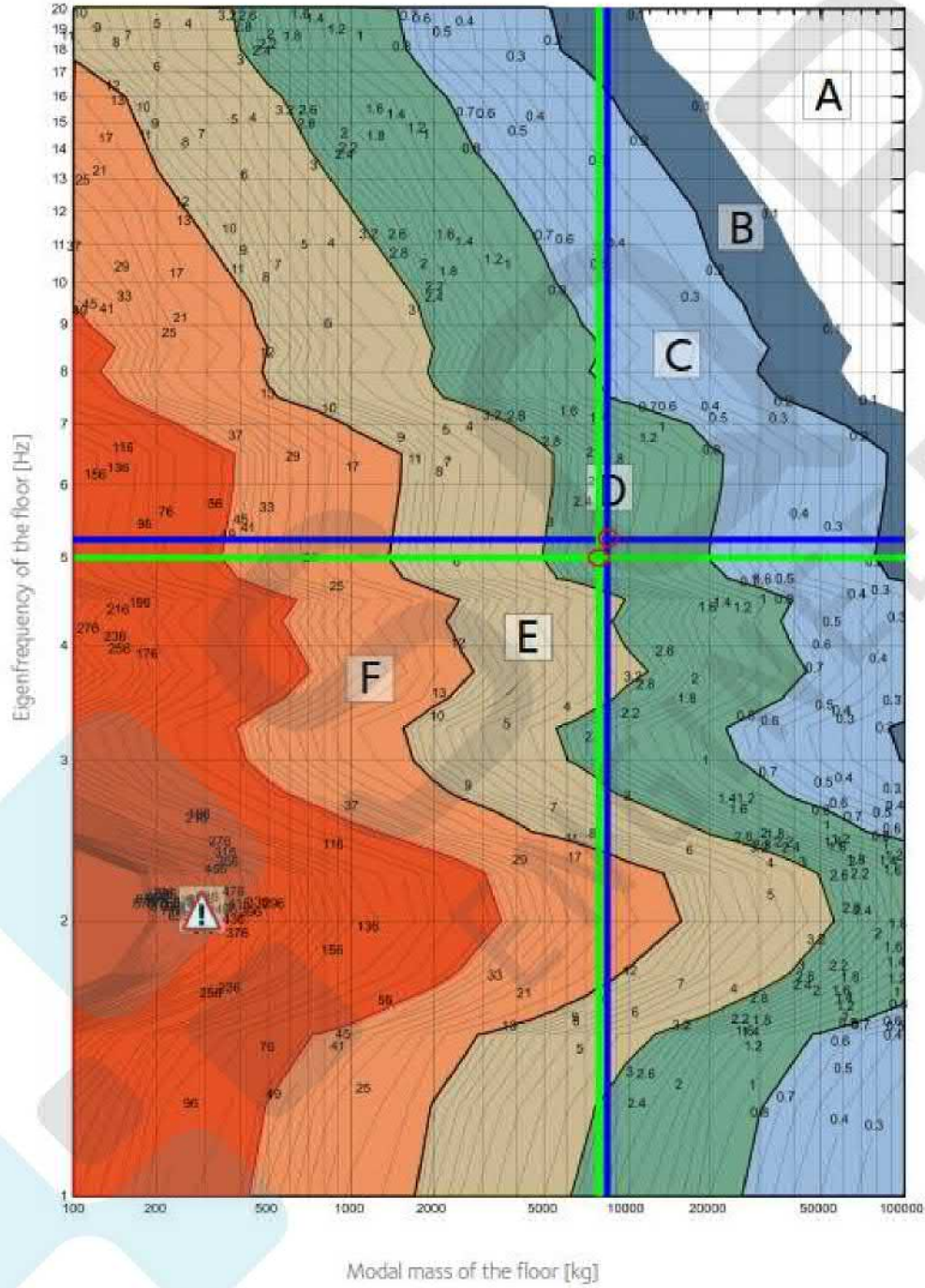
# Određivanje klase vibracije:

OS-RMS<sub>90</sub> for 3% Damping

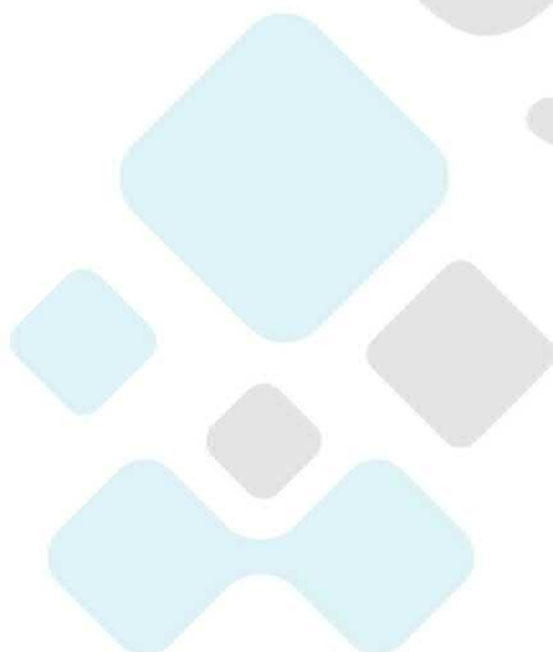
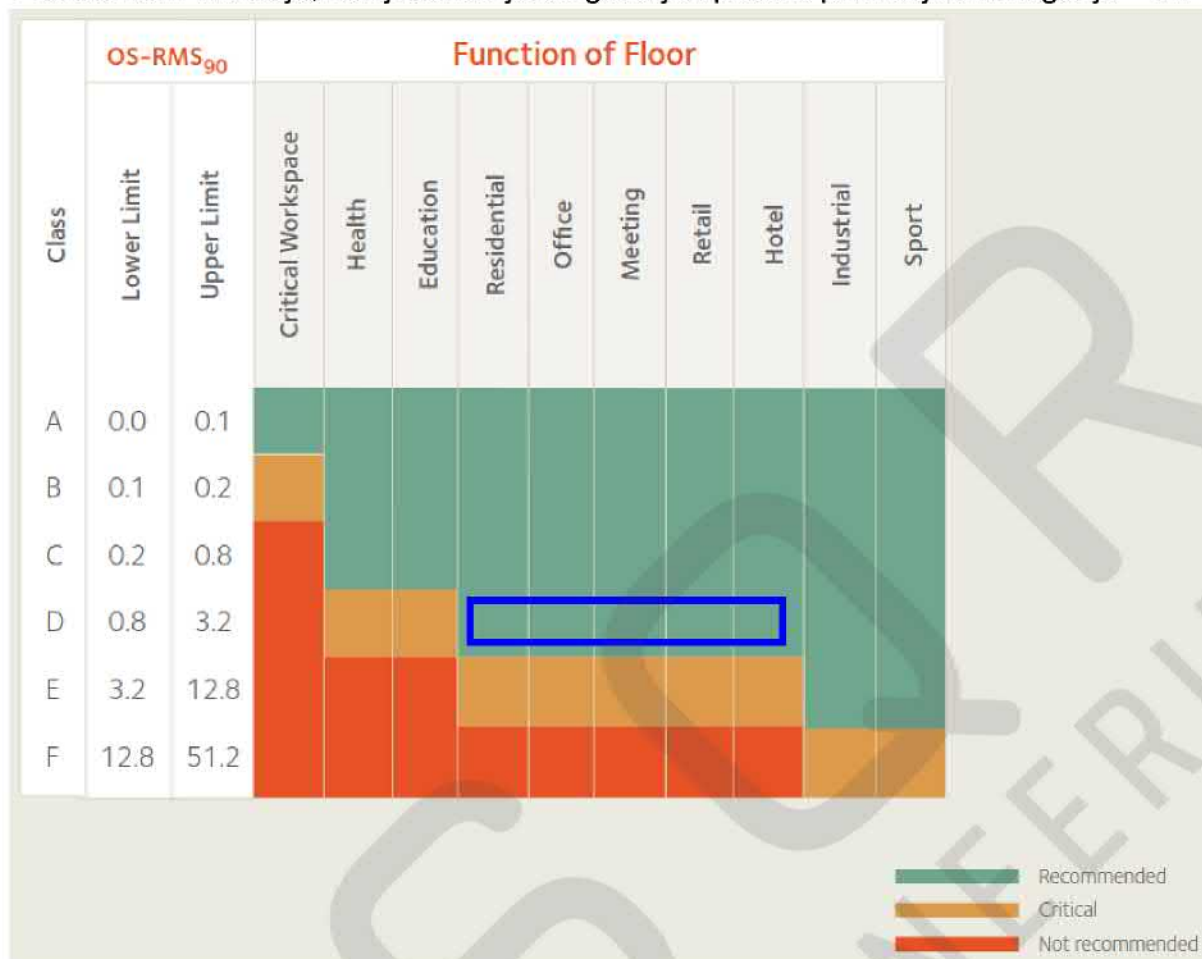
Rezultati iz Tower programa

Rezultati iz Dlubal programa

Classification based on a damping ratio of 3%

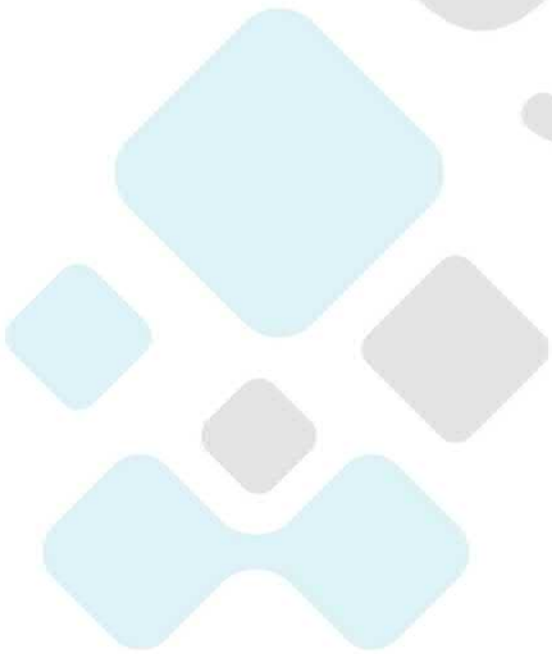


Proračunom vibracija, zaključenao je da galerija spada u prihvatljivu kategoriju – D.



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# Connection Analysis



SSQR  
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## Project item CON1

### Design

Name	CON1
Description	
Analysis	Stress, strain/ simplified loading

### Members

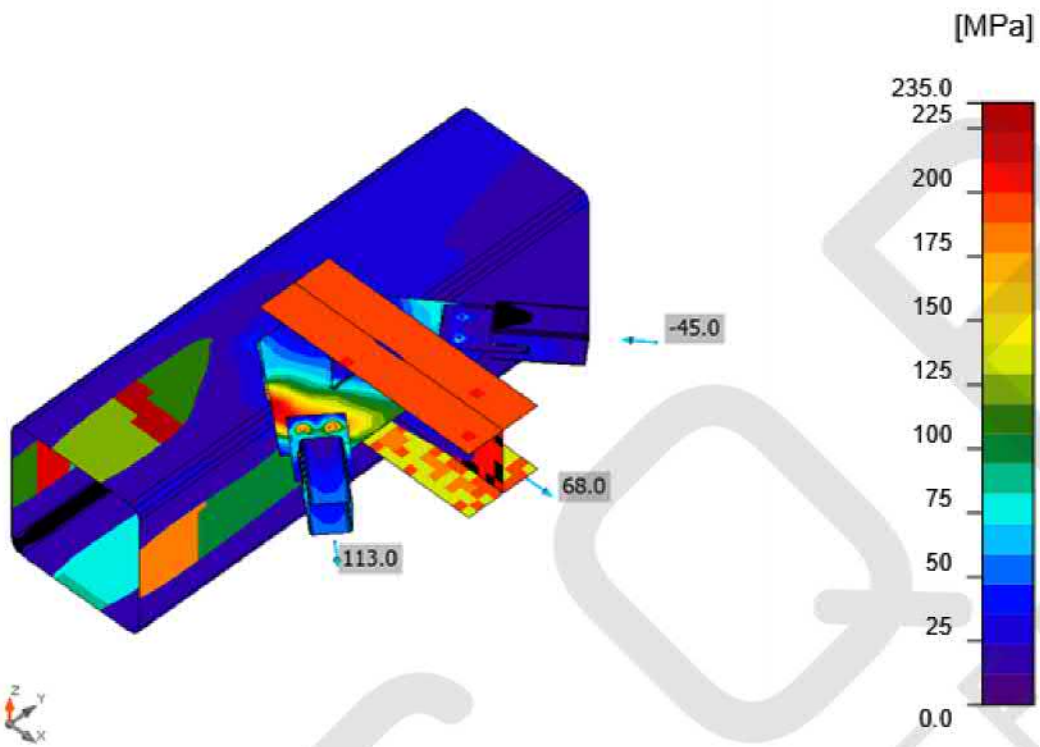
#### Geometry

Name	Cross-section	$\beta$ - Direction [°]	$\gamma$ - Pitch [°]	$\alpha$ - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]
M1	1 - SHS500/500/19.0	90.0	0.0	0.0	-300	0	0
M2	2 - HEA260	0.0	0.0	0.0	25	500	265
M3	3 - SHS120/120/5.0	39.0	0.0	0.0	625	360	260
M4	3 - SHS120/120/5.0	-39.0	0.0	0.0	-5	420	260

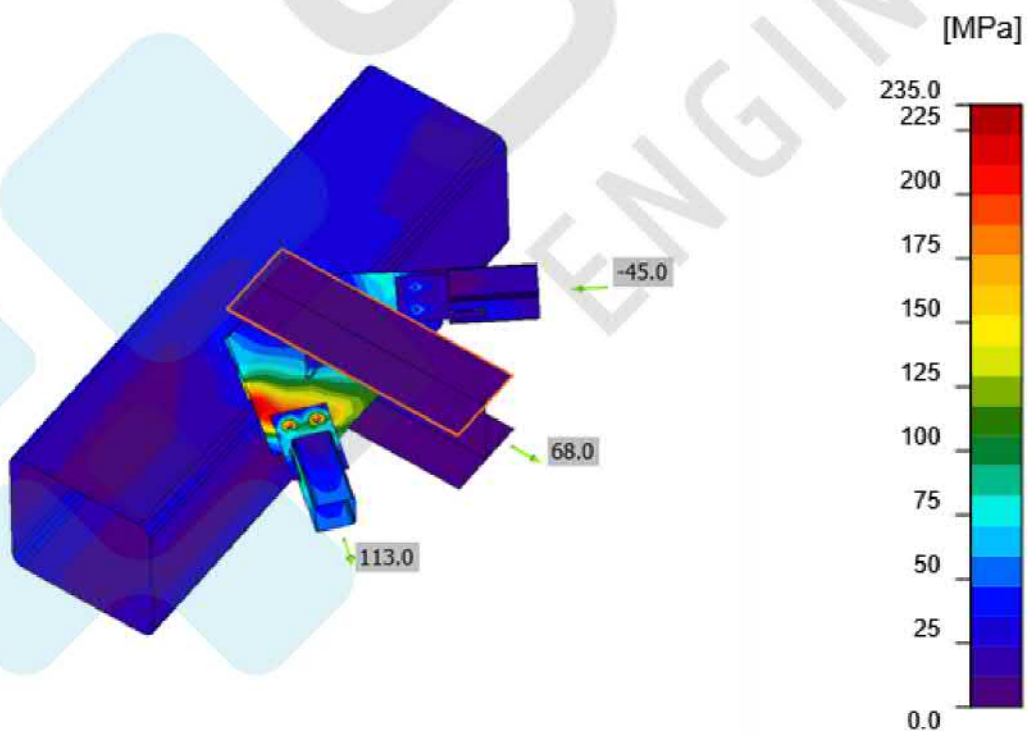
#### Supports and forces

Name	Support	Forces in	X [mm]
M1 / end	N-Vy-Vz-Mx-My-Mz	Node	0
M2 / end		Bolts	0
M3 / end		Bolts	0
M4 / end		Bolts	0

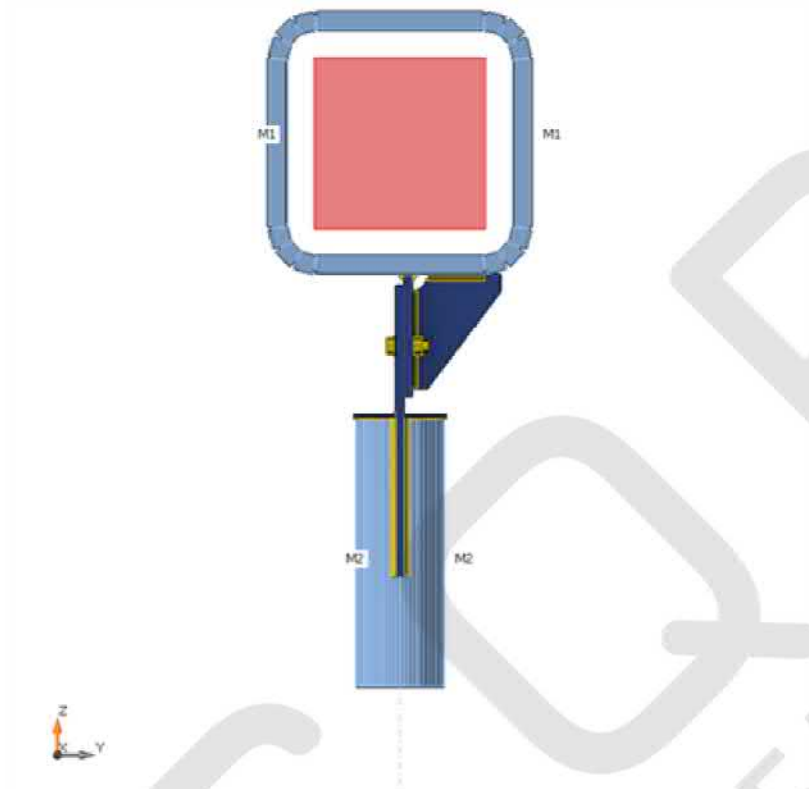




*Equivalent stress, 1dil - 2*



*Equivalent stress, For extreme*



### Cross-sections

Name	Material
1 - SHS500/500/36.0	S 235
2 - CHS168.3/6.3	S 235

### Bolts

Name	Diameter [mm]	$f_y$ [MPa]	$f_u$ [MPa]	Gross area [mm <sup>2</sup> ]
M20 8.8	20	640.0	800.0	314

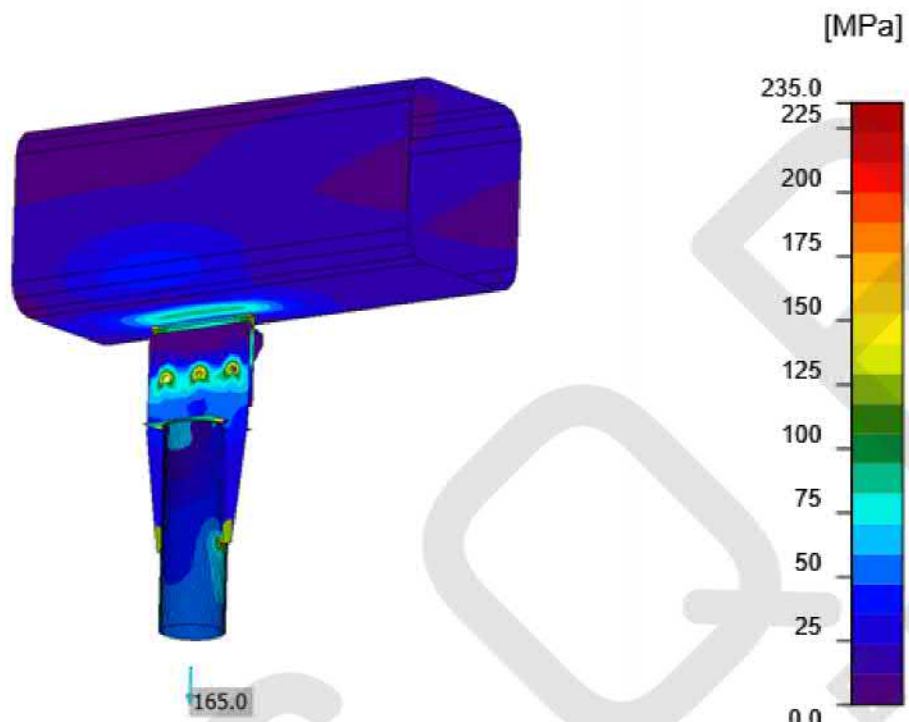
### Load effects (Equilibrium not required)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
LE1	M2 / End	165.0	0.0	0.0	0.0	0.0	0.0

### Check

### Summary

Name	Value	Check status
Analysis	100.0%	OK
Plates	0.0 < 5.0%	OK
Bolts	64.5 < 100%	OK
Welds	51.8 < 100%	OK
Buckling	114.63	
GMNA	Calculated	



Equivalent stress, LE1



Equivalent stress, LE1

## Project item CON1

### Design

Name	CON1
Description	
Analysis	Stress, strain/ simplified loading

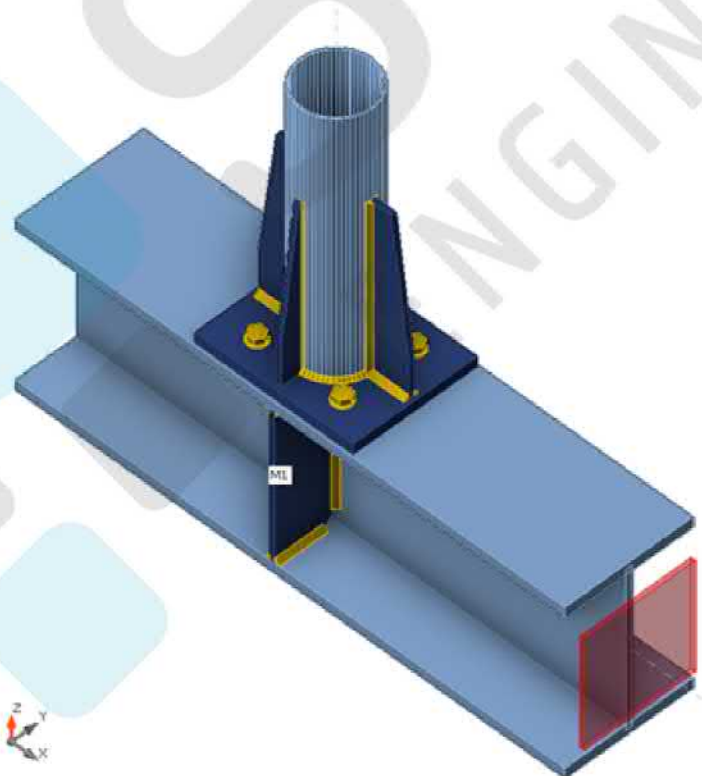
### Members

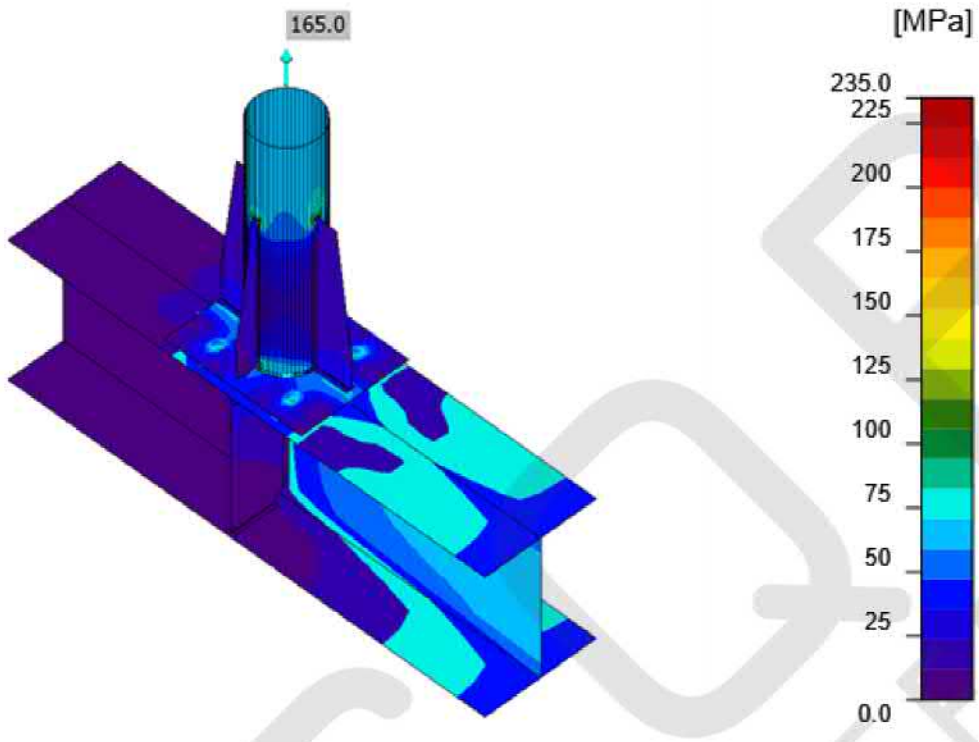
#### Geometry

Name	Cross-section	$\beta$ - Direction [°]	$\gamma$ - Pitch [°]	$\alpha$ - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]
M1	1 - HEB400	0.0	0.0	0.0	0	0	0
M2	2 - CHS168.3/5.0	0.0	90.0	0.0	0	0	-600

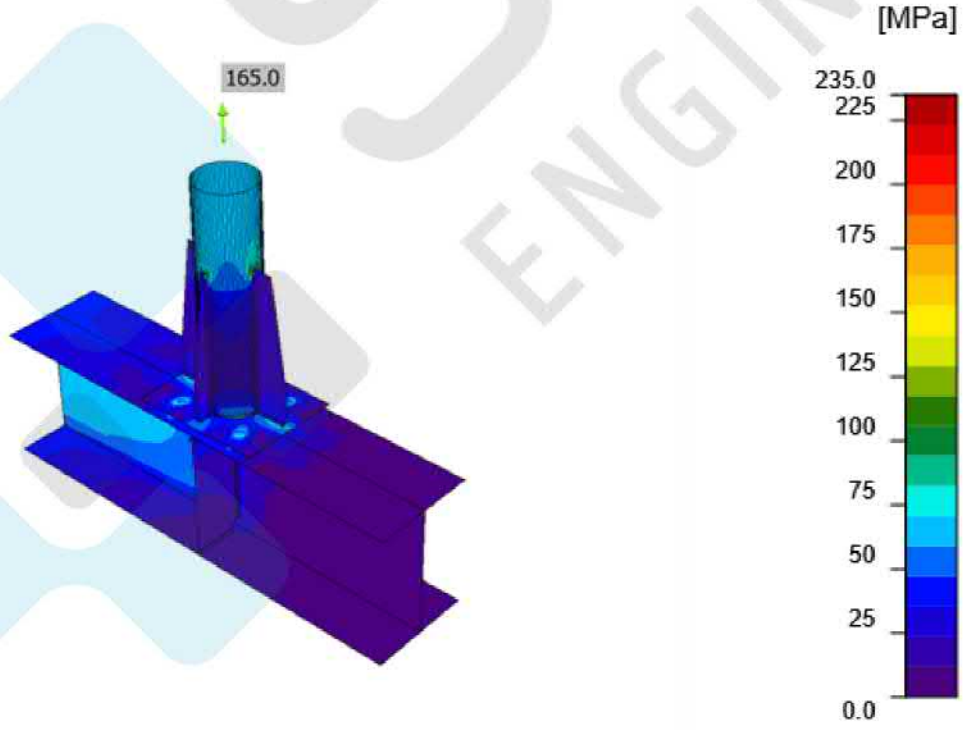
#### Supports and forces

Name	Support	Forces in	X [mm]
M1 / end	N-Vy-Vz-Mx-My-Mz	Node	0
M2 / end		Node	0





Equivalent stress, LE1

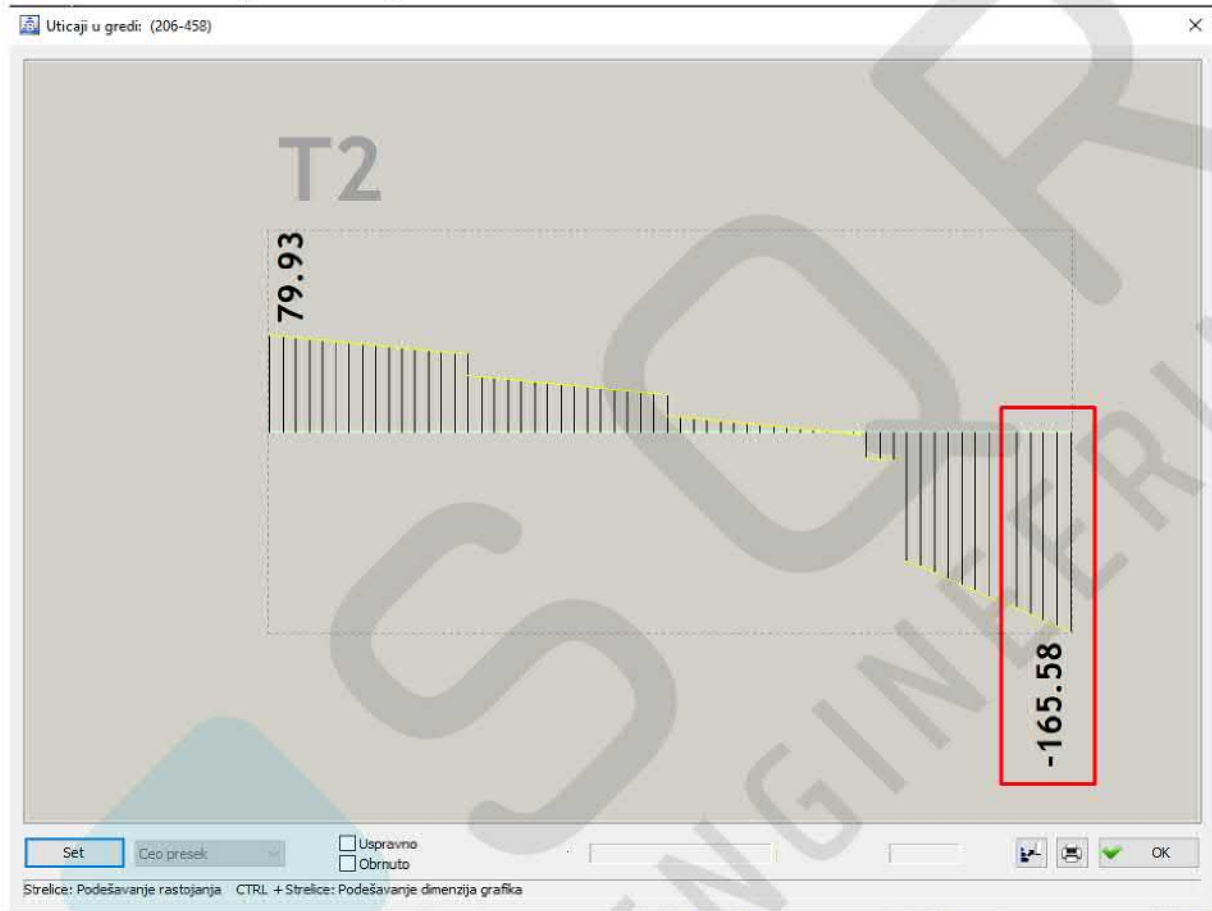


Equivalent stress, LE1

### 1.6.2.3.5 Veza stolice za AB stub – UG11A

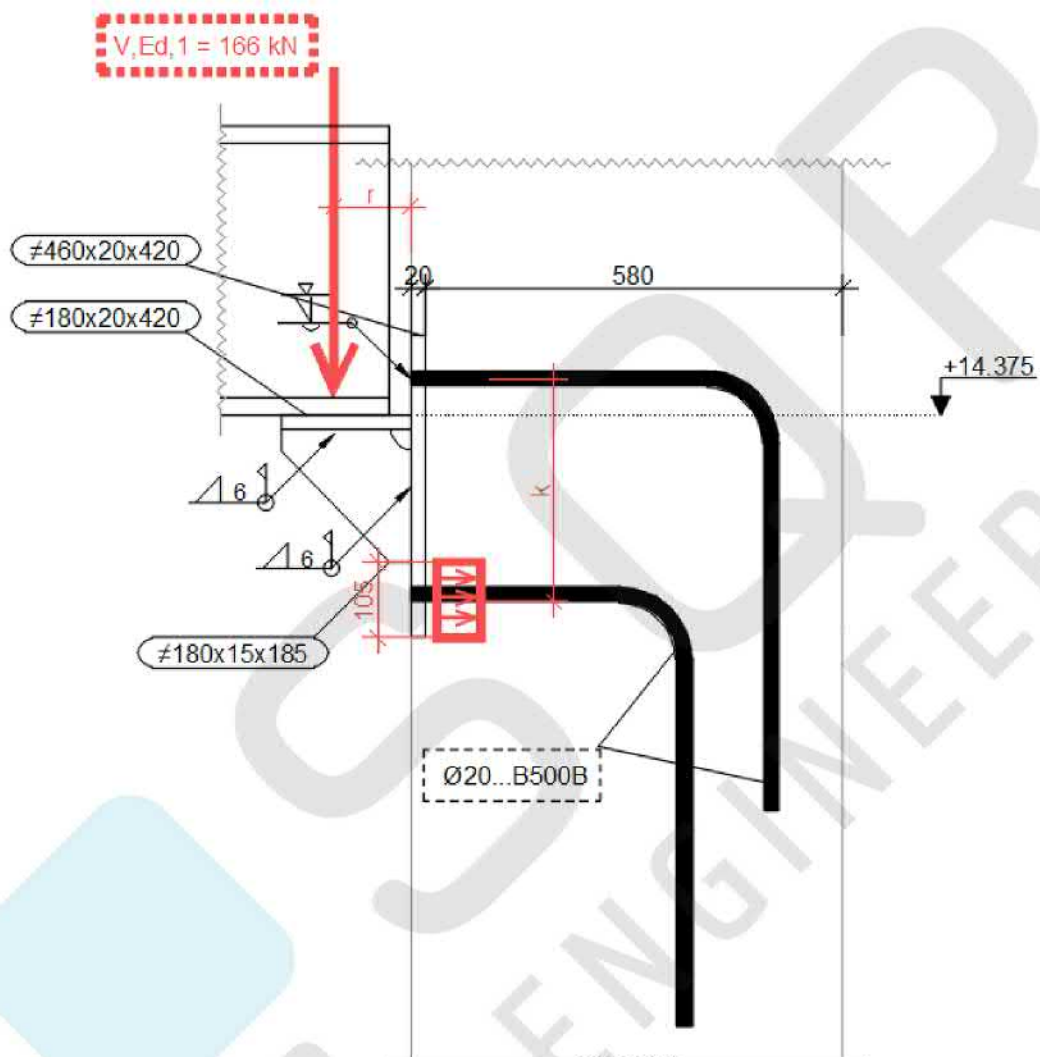
#### A. Određivanje merodavnih uticaja

Prikaz ULS uticaja – Galerija:



Kod merodavnih slučajeva razmatrani su svi čvorovi u kojima su nosači HEB 400 oslonjeni na AB stub skladno detalju UG-11A i određen je merodavan slučaj. Analizom sila koje deluju u čvor, dobijene su sledeće vrednosti uticaja za proračun veze (ULS):  $V_{Ed} = 166 \text{ kN}$ .

## B. Prikaz usvojenog detalja



**Usvojeno:** 6 x  $\Phi 20$  B500B

Moment savijanja usled ekscentriciteta transverzalne sile:

$$M_{ed} = V_{ed} \times r = 166 \text{ kN} \times 0.105 \text{ m} = 18 \text{ kNm}$$

Sila zatezanja u ankerima usled momenta savijanja:

$$M_{ed} = Z_{ed} \times k = Z_{ed} \times 0.30 \text{ m}$$

$$Z_{ed} = M_{ed} \div 0.30 \text{ m} = 18 \text{ kNm} \div 0.30 \text{ m} = 60 \text{ kN}$$

### C. Dokaz ankera u betonu – na ZATEZANJE:

#### C.1 Sila koja deluje na jedan anker

Rezultujuća sila zatezanja:  $Z,Ed = 60 \text{ kN}$

$N,Ed = 60 \text{ kN} / 3 \text{ kom} = 20 \text{ kN}$

Površina armature:  $A_s = 3.14 \text{ cm}^2$

Proračunska vrednost granice razvlačenja armature:  $f_{yd} = 43.5 \text{ kN/cm}^2$

Proračunska nosivost armature:  $R_d = 3.14 \text{ cm}^2 \times 43.5 \text{ kN/cm}^2 \times 0.75(1^{**}) = 102,40 \text{ kN}$

#### C.2 Iskorišćenost:

$N,Ed = 20 \text{ kN}$

$R_{d,uk} = 102,40 \text{ kN} > N,Ed = 20 \text{ kN}$  (20% iskorišćenost)

S obzirom na to da se zatezanje nastalo usled lokalnog momenta, prenosi preko ankera na ankernu ploču sa druge strane stuba i odupire se celom svojom površinom, smatra se da je otporna sila dovoljno velika i da nije potreban poseban dokaz.

### D. Dokaz ankera u betonu – na SMICANJE:

#### Nosivost na SMICANJE - 1 anker:

Površina koja učestvuje u prenosu sile:

$A = d \cdot 5d = 2 \text{ cm} \times 5 \times 2 \text{ cm} = 20 \text{ cm}^2$

5d - razmatrana dužina armature koja prenosi silu (lokalni prit.betona)

d - prečnik armature

Nosivost na smicanje jednog ankera:

$f_{cd} = 0.85 \cdot f_{ck} / 1.5 = 0.85 \cdot 30 / 1.5 = 17 \text{ MPa}$ , za beton C30/37.

$R_d = A \times f_{cd} = 20 \text{ cm}^2 \times 1.7 \text{ kN/cm}^2 = 34 \text{ kN}$

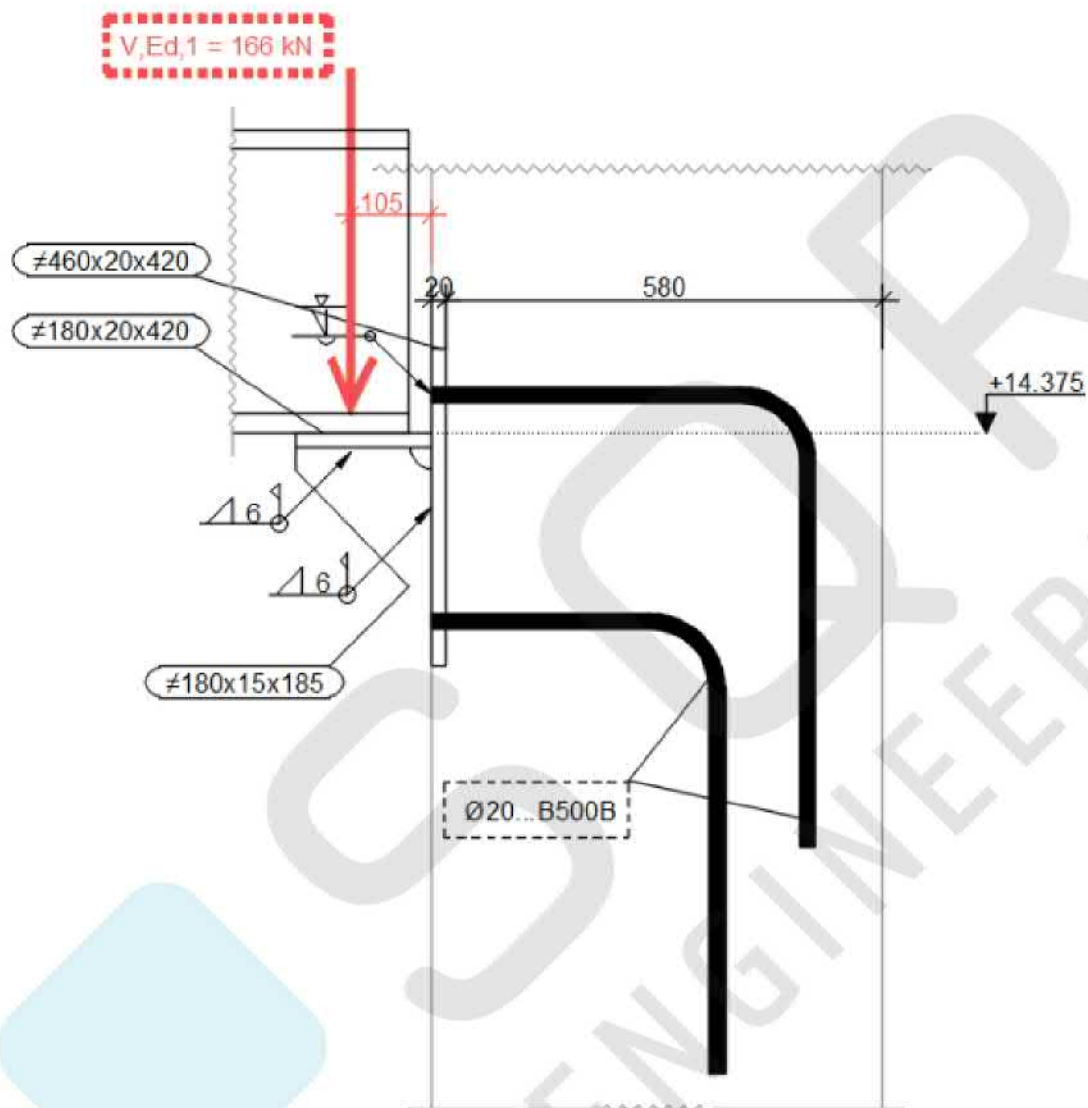
#### Sila koja deluje na 1 anker:

$N,Ed = 60 \text{ kN} / 6 \text{ kom} = 10 \text{ kN}$

$R_{d,uk} = 34 \text{ kN} > N,Ed = 10 \text{ kN}$  (30% iskorišćenost)

**Usvojeno:** 6 x M20 B500B

### E. Dokaz varova:



Ukupna sila smicanja:  $V_{Ed} = 166 \text{ kN}$

Ukupan moment savijanja:  $M_{Ed} = 166 \text{ kN} \times 10.50 \text{ cm} = 1750 \text{ kNcm}$

Dužina vara:  $l = 155 \text{ mm}$

Utjecaji koji deluju na dvostrani ugaoni var dužine  $l = 155 \text{ mm}$ :

**$V_{Ed} = 166 \text{ kN} / 3 \text{ kom} = 56 \text{ kN}$**

**$M_{Ed} = 1750 \text{ kNcm} / 3 \text{ kom} = 584 \text{ kNcm}$**

U proračunu veze, razmatran je samo vertikalni var na dužini od 155 mm. Var je proračunat pomoću nemačkog RUBSTAHL programa razvijenog na univerzitetu u Bohumu.

## Nachweis von Doppelkehlnähten nach DIN EN 1993-1-8 (EC3)

(10/2014)

Kommentar:

### System und Belastung

Material:

Stahlsorte wählen

Stahlsorte: **S 235**  
 Bruchspannung  $f_u = 36.0$  kN/cm<sup>2</sup>  
 Teilsicherheitsb.  $\gamma_{M2} = 1.25$  [-]  
 Schweißbeiwert  $\beta_w = 0.80$  [-]

Geometrie:

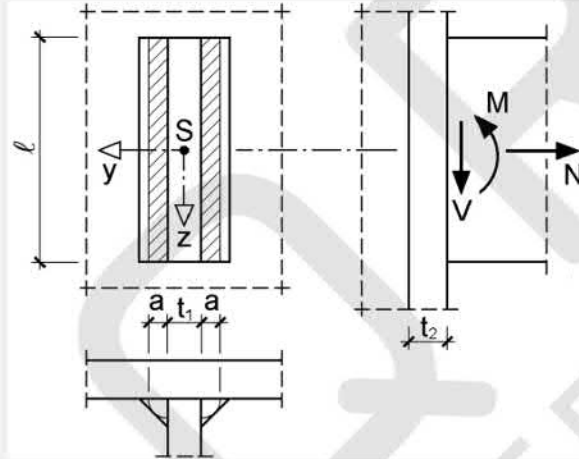
Schweißnahtlänge  $l = 155$  mm  
 Schweißnahtdicke  $a = 6.0$  mm

Kehlnaht über gesamte Länge voll ausgeführt (einschließlich Nahtenden)

Schweißnahtlänge  $l_{eff} = 143.0$  mm  
 Blechdicke  $t_1 = 12.0$  mm  
 Blechdicke  $t_2 = 15.0$  mm

Belastung:

Querkraft  $V = 60$  kN  
 Normalkraft  $N = 0$  kN  
 Moment  $M = 600$  kNcm



Kontrolle der Schweißnahtdicke:

$a_{min} = 3.37$  mm  
 $a_{min} \leq a$  eingehalten

Schweißnahtspannungen:

$\tau_{||} = 3.50$  kN/cm<sup>2</sup>  
 $\tau_{\perp} = 10.37$  kN/cm<sup>2</sup>  
 $\sigma_{\perp} = 10.37$  kN/cm<sup>2</sup>

Nachweis mit dem vereinfachten Verfahren

- bezogene Kräfte

$F_w \leq F_{w,Rd}$   
 18.10 ≤ 24.94 [kN/cm] **Nachweis erfüllt**

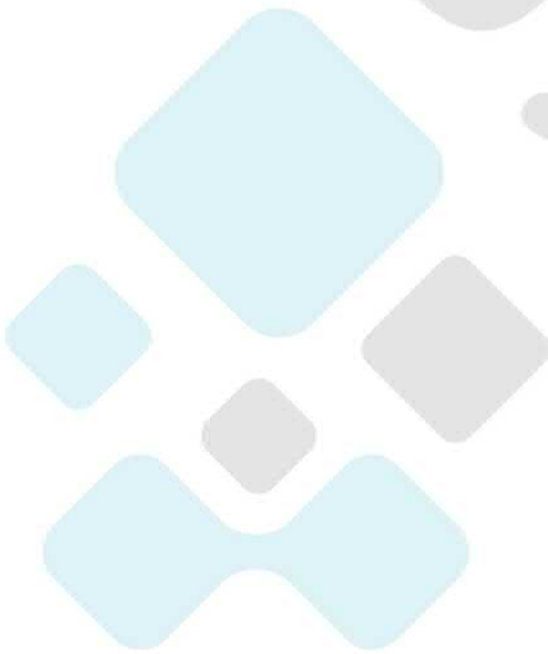
Nachweis mit dem richtungsbezogenen Verfahren

Bedingung 1  
 21.61 ≤ 36.00 [kN/cm<sup>2</sup>] **eingehalten**

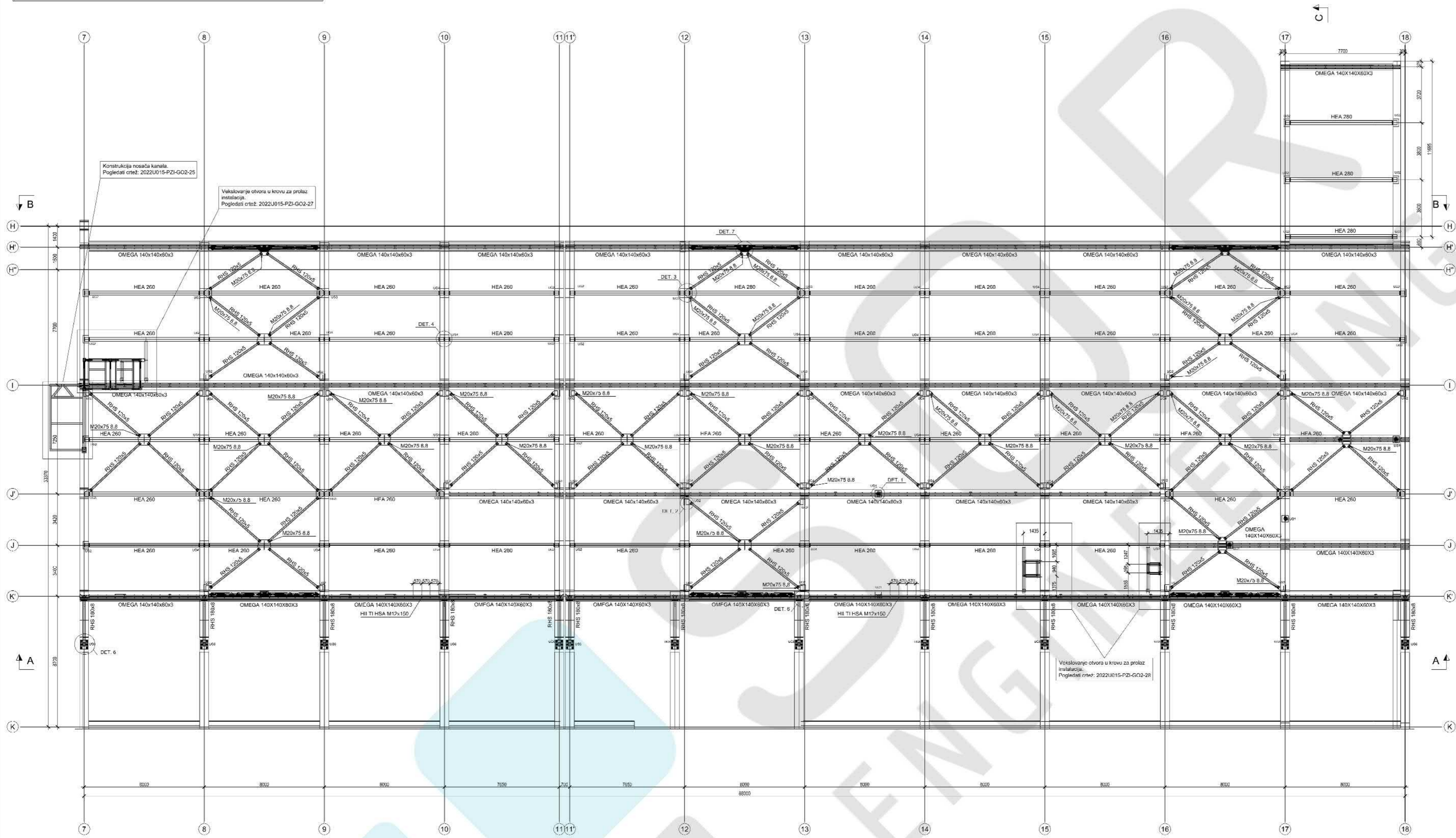
Bedingung 2  
 10.37 ≤ 25.92 [kN/cm<sup>2</sup>] **eingehalten**

**Nachweis erfüllt**

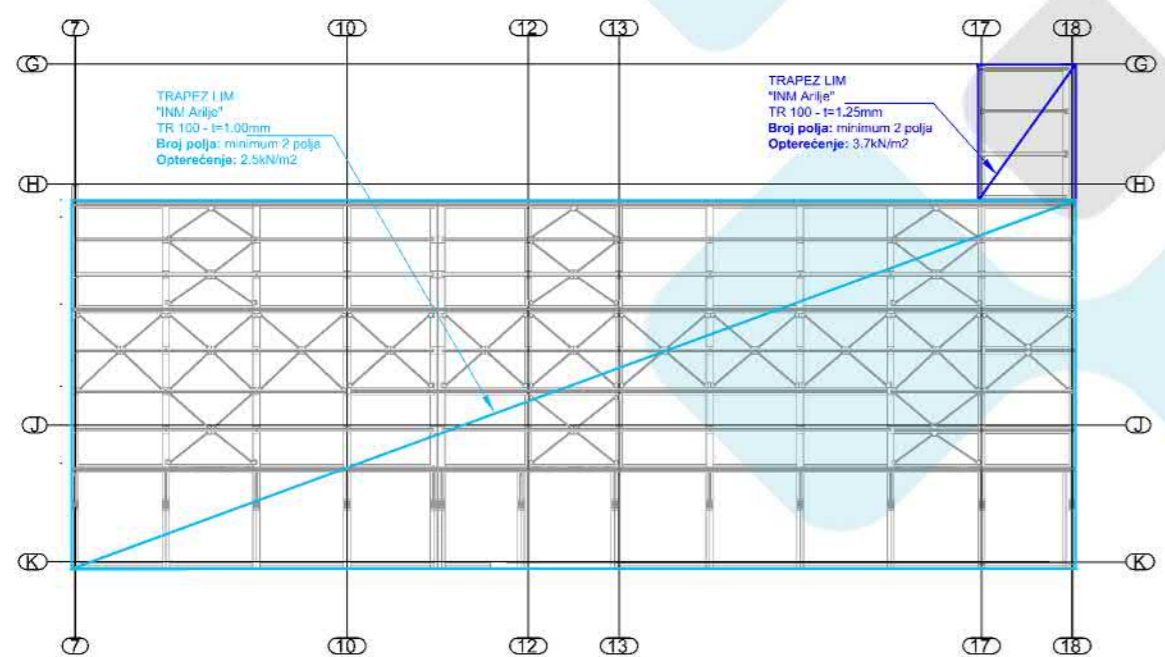
# Structural Drawings



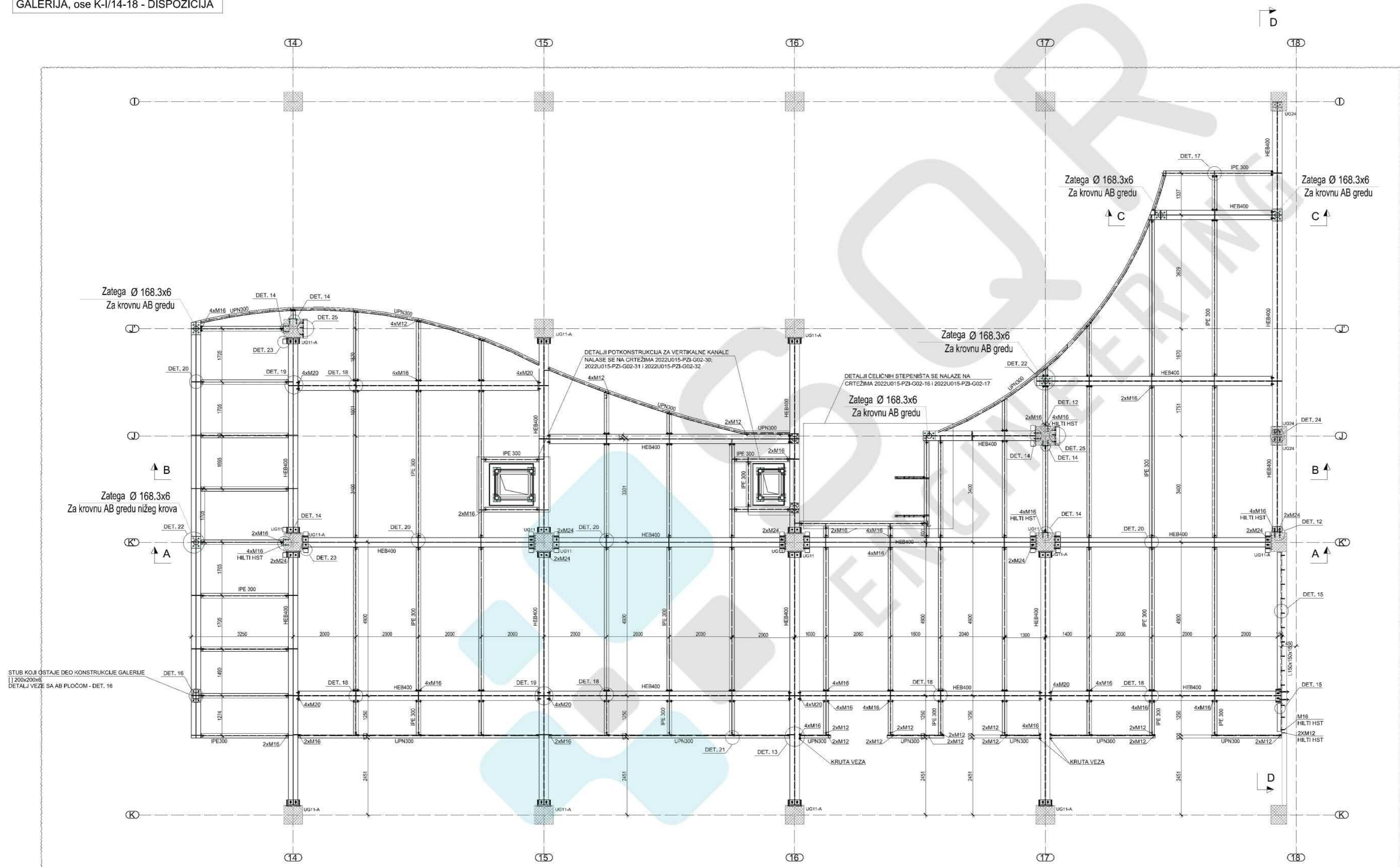
SSQR  
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USVOJENI TRAPEZ LIMOVI

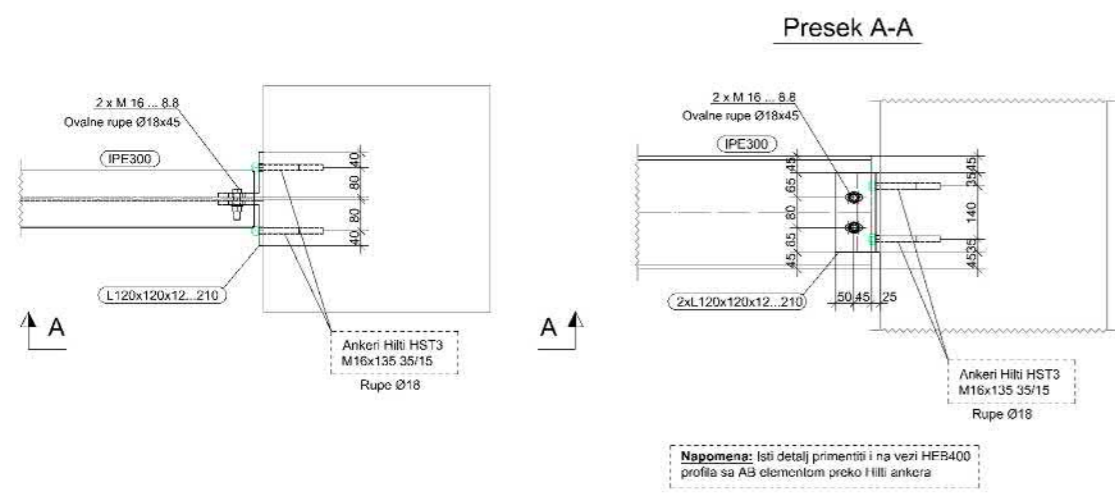




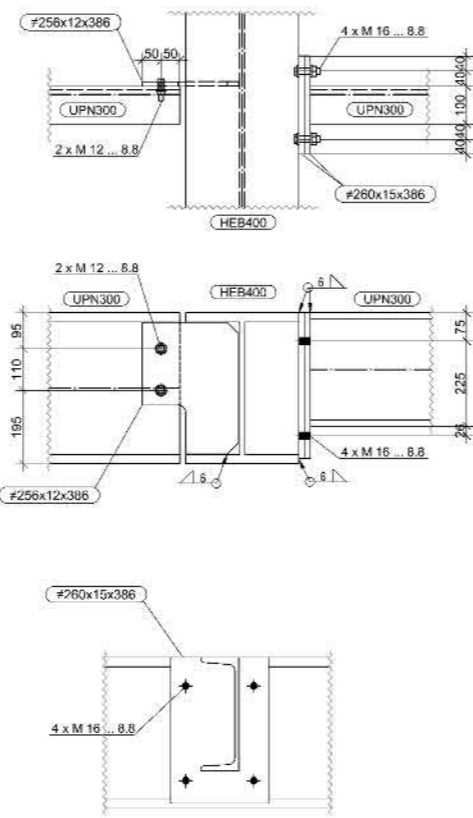




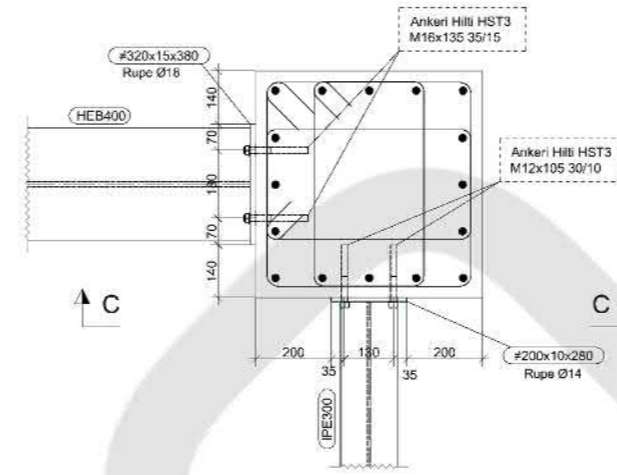
Detalj 12  
IPE300 / HEB400 preko „L” profila



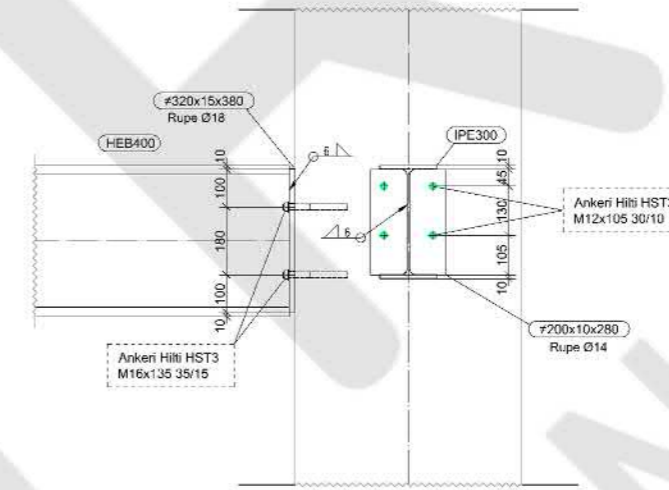
Detalj 13



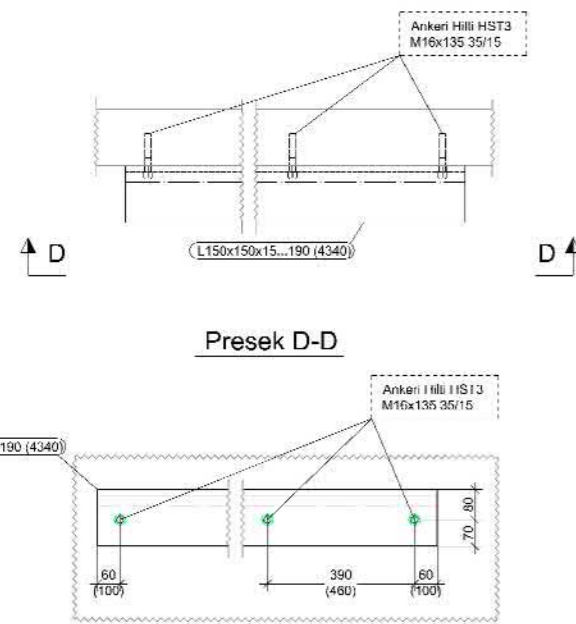
Detalj 14  
IPE300 / HEB400 preko ploča



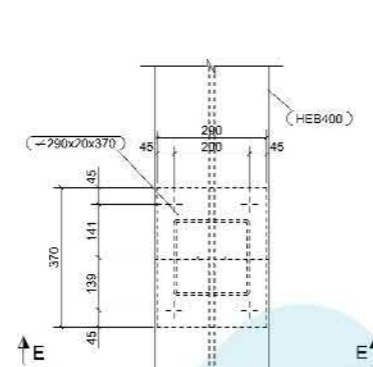
Presek C-C



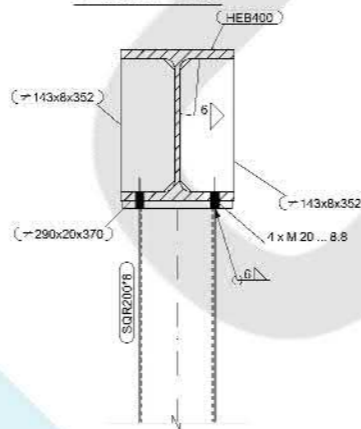
Detalj 15  
„L” profili



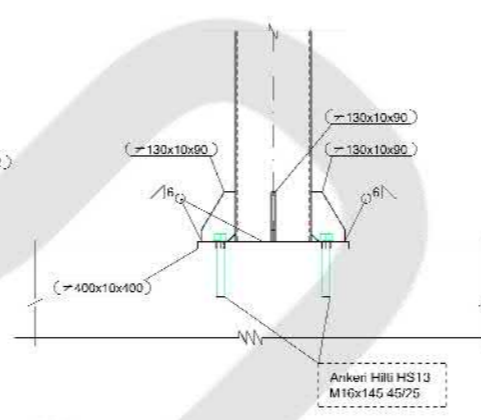
Detalj 16



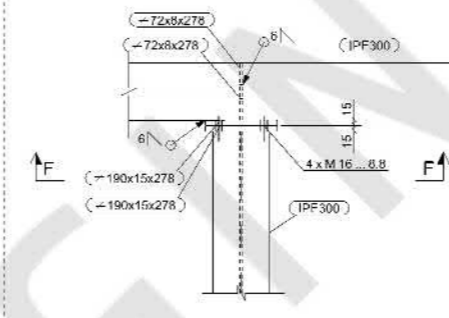
Presek E-E



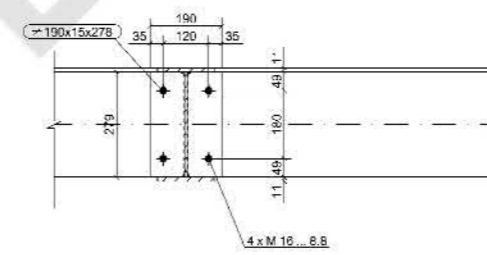
Detalj veze stuba i  
AB ploče



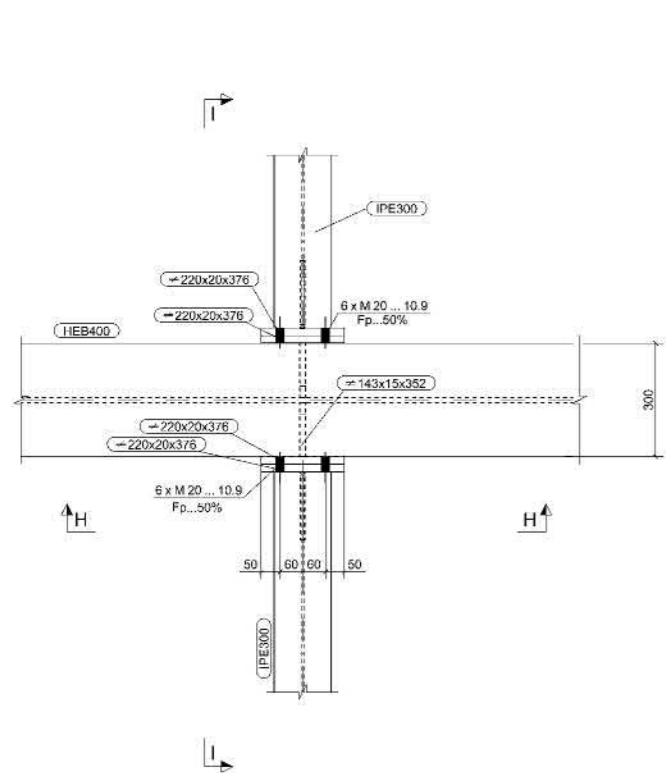
Detalj 17



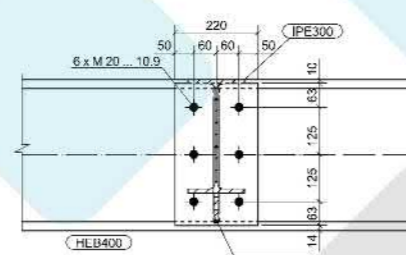
Presek F-F



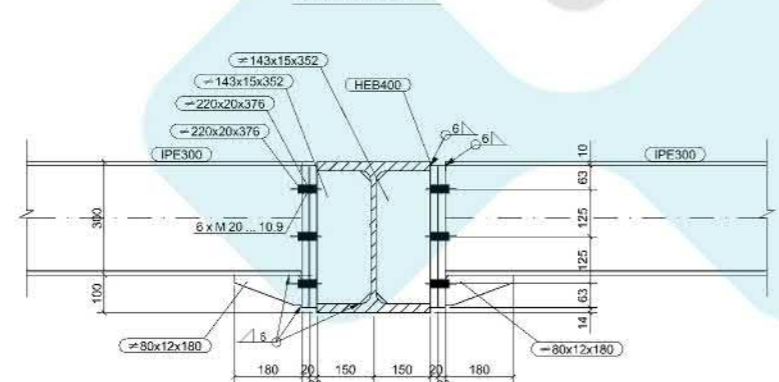
Detalj 18



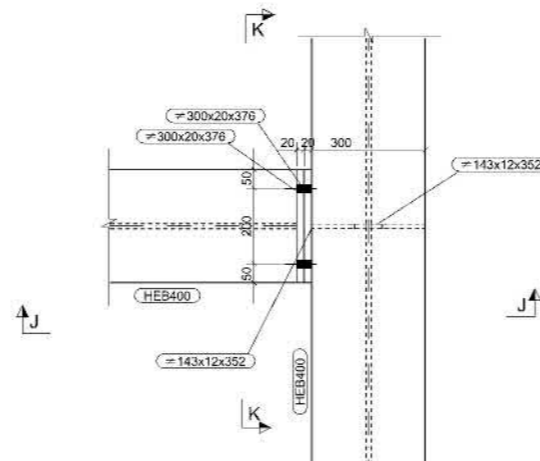
Presek H-H



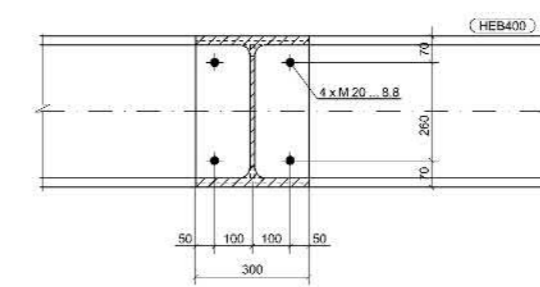
Presek I-I



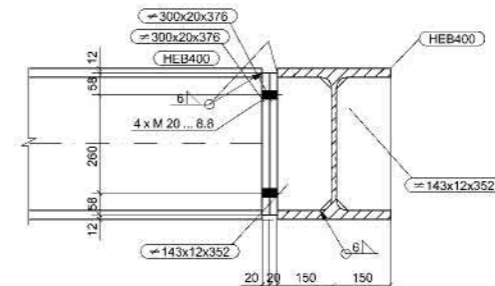
Detalj 19



Presek K-K

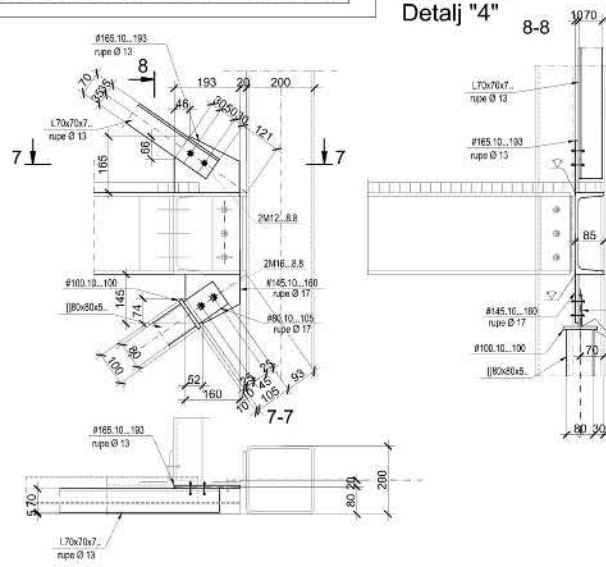


Presek J-J

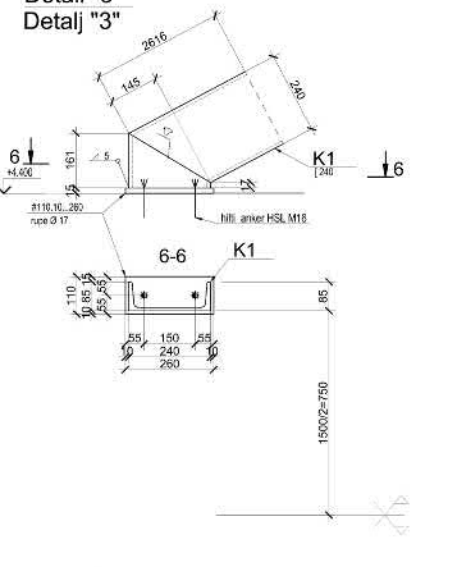


**EVAKUACIONO STEPENIŠTE - DETALJI**

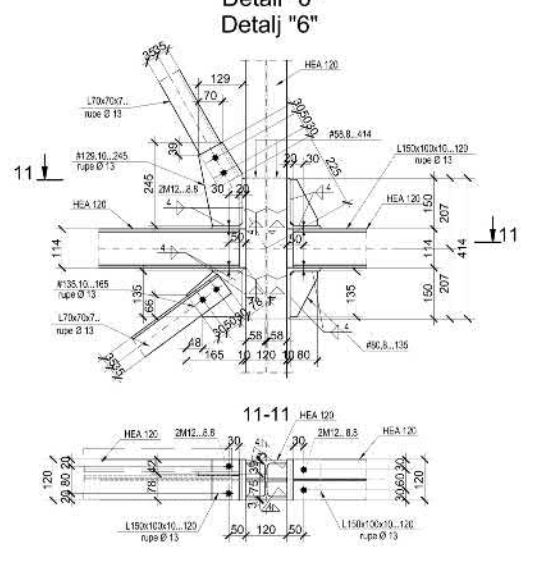
**Detail "4"  
Detalj "4"**



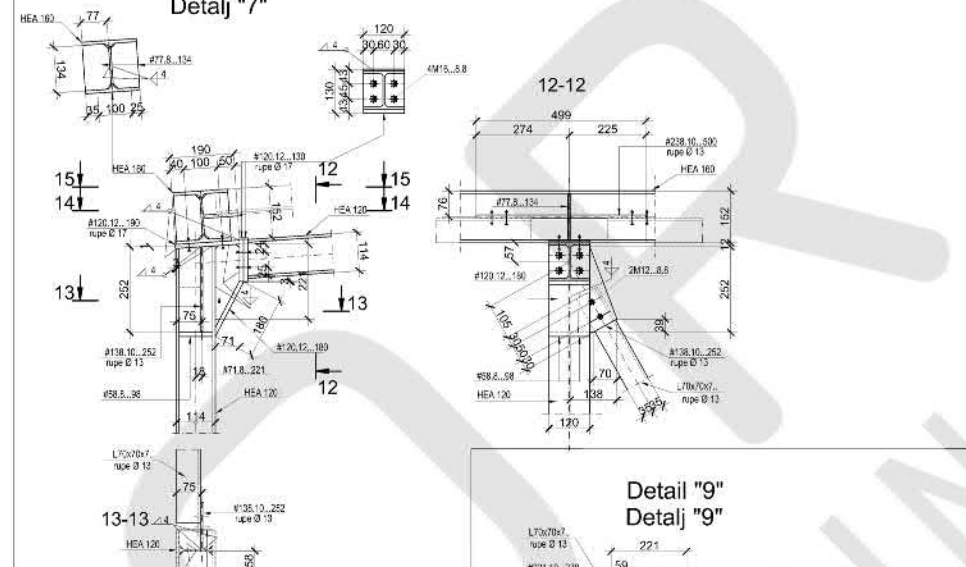
**Detail "3"  
Detalj "3"**



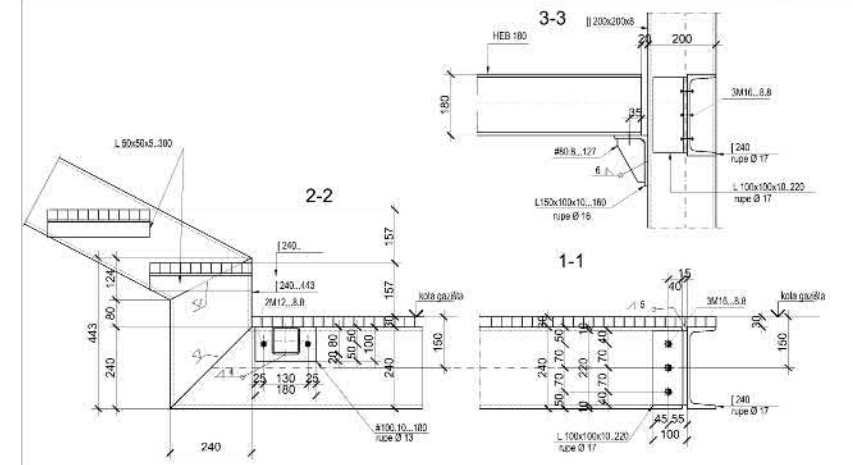
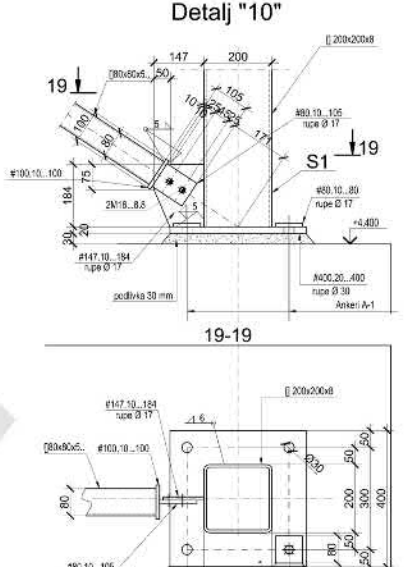
**Detail "6"  
Detalj "6"**



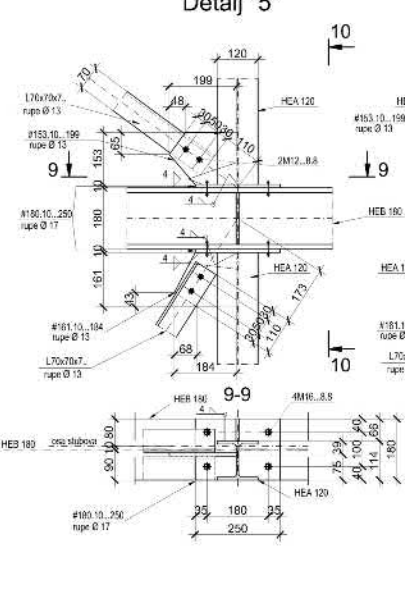
**Detail "7"  
Detalj "7"**



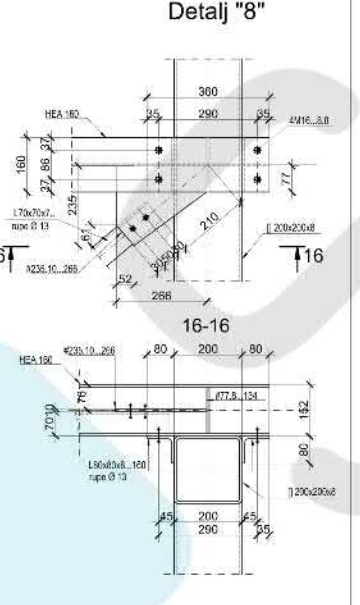
**Detail "10"  
Detalj "10"**



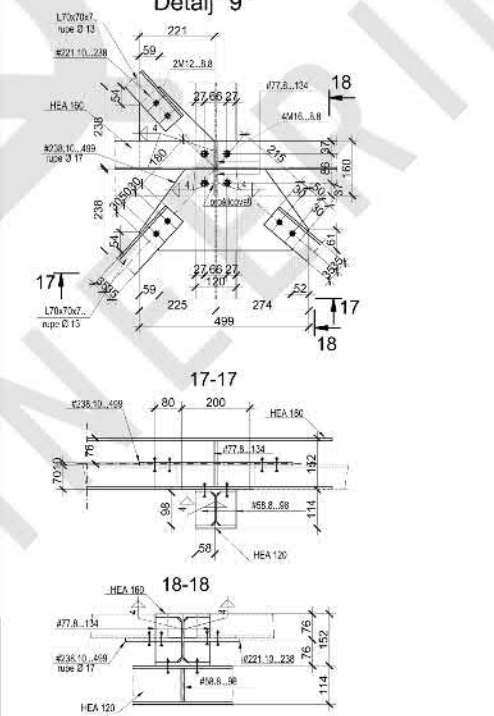
**Detail "5"  
Detalj "5"**



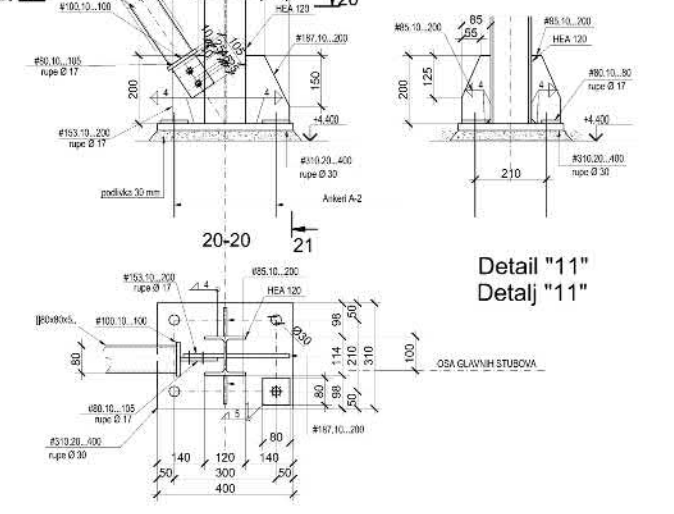
**Detail "8"  
Detalj "8"**



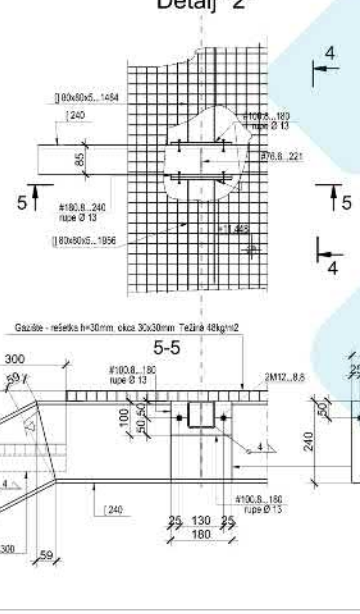
**Detail "9"  
Detalj "9"**



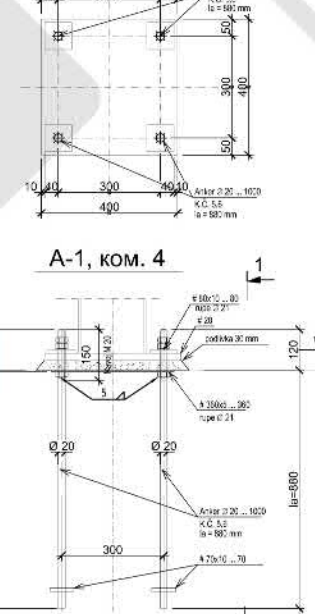
**Detail "11"  
Detalj "11"**



**Detail "2"  
Detalj "2"**



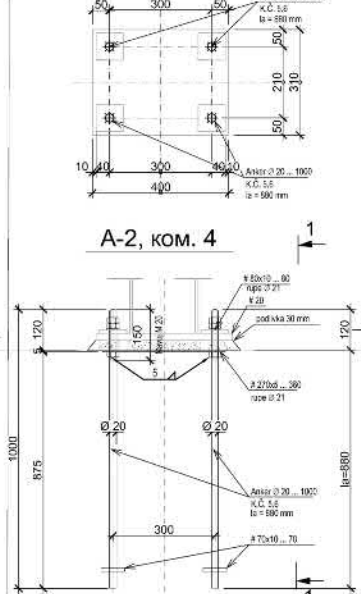
**2-2**



**NAPOMENA**  
Dato i na crtežima oplate

Pos.	Materijal	Kom.	Presek	Dužina		Masa	
				1 kom.	Ukupno	kg/m	Ukupno
Ugradbeni element A-1 [4 kom.]							
1	K.C. 5.0	4	Ø 20	1000	4.00	2.47	9.9
2	S235RJG2	1	300 x 5	360	0.36	4.40	5.2
3	S235RJG2	4	70 x 5	70	2.80	5.60	1.6
				za 1 kom.kg		<b>16.6</b>	
				Ukupno za 4 kom. kg		<b>66.5</b>	

**2-2**



**NAPOMENA**  
Dato i na crtežima oplate

Pos.	Materijal	Kom.	Presek	Dužina		Masa	
				1 kom.	Ukupno	kg/m	Ukupno
Ugradbeni element A-2 [4 kom.]							
1	K.C. 5.0	4	Ø 20	1000	4.00	2.47	9.9
2	S235RJG2	1	270 x 5	300	0.30	3.60	3.0
3	S235RJG2	4	70 x 5	70	2.80	5.60	1.6
				za 1 kom.kg		<b>16.3</b>	
				Ukupno za 4 kom. kg		<b>61.3</b>	