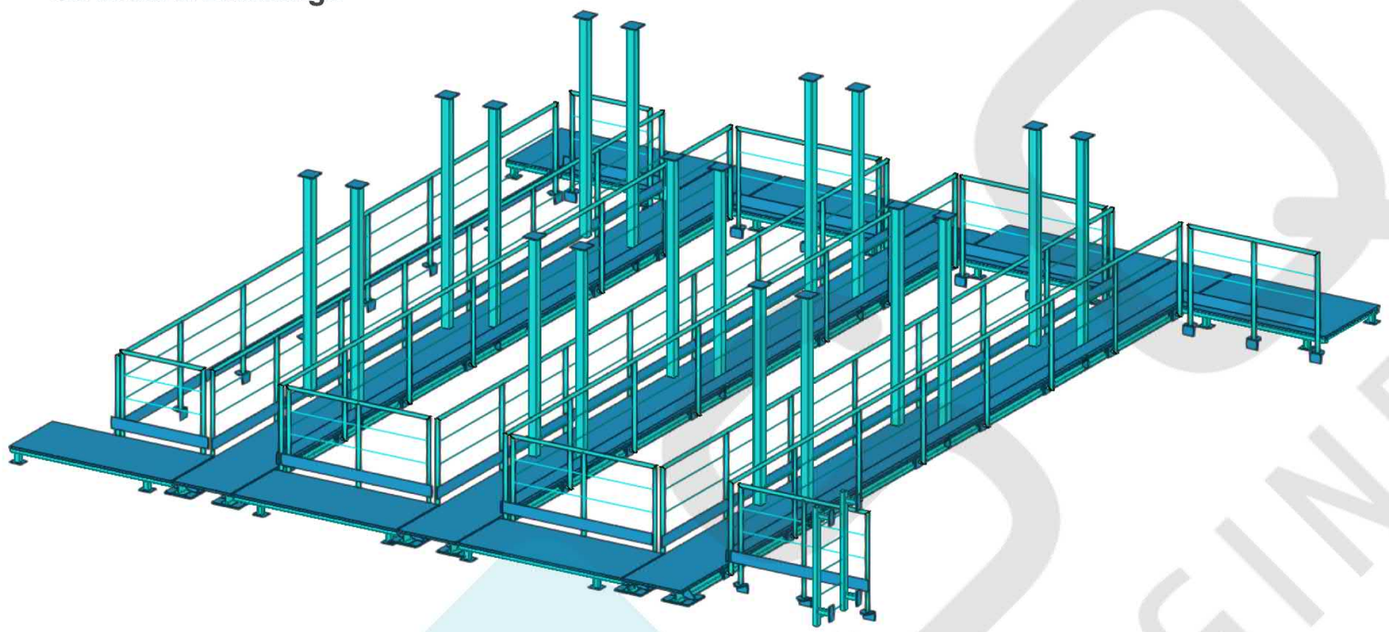
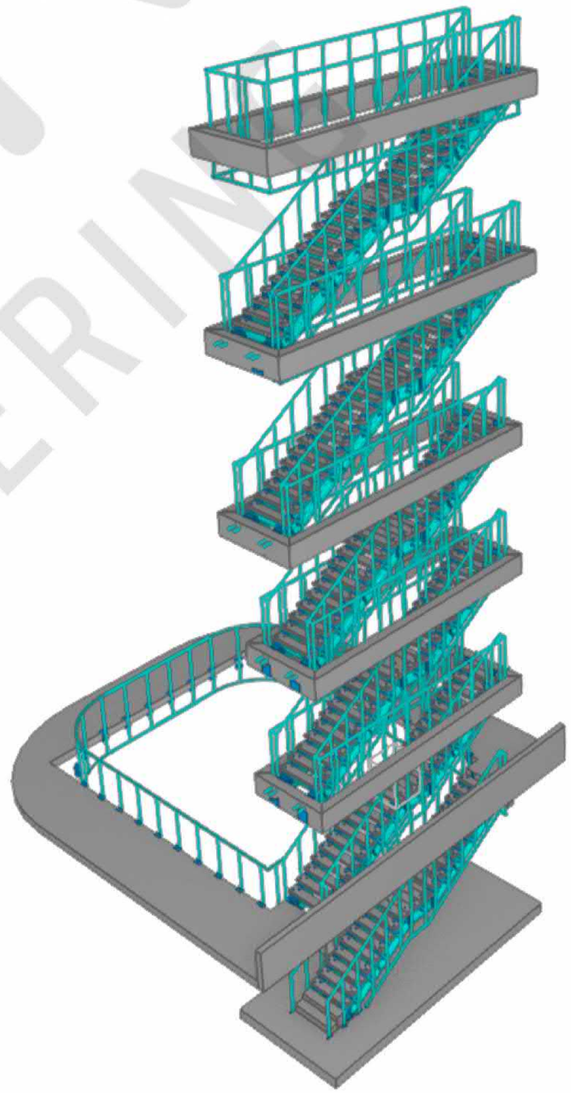
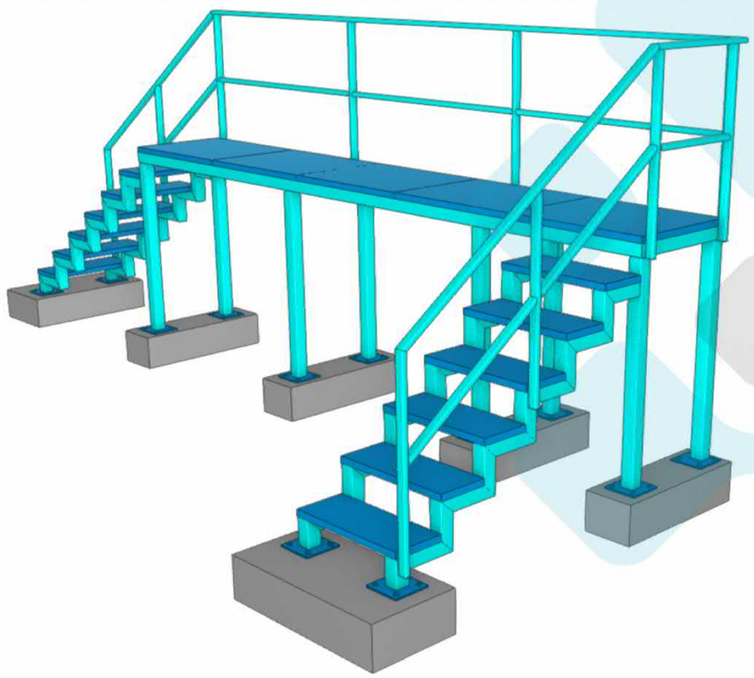
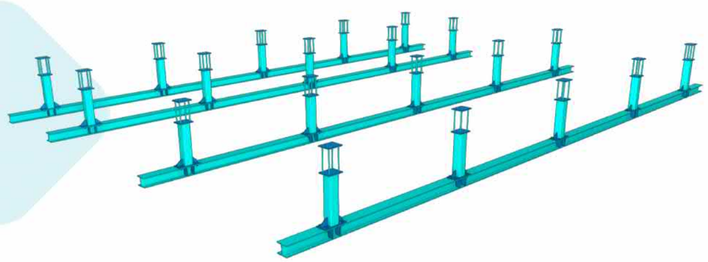
Project: Theatre Building [Area = 2.900m2]
Country: Serbia
Scope of Work: Secondary Steel Structure:

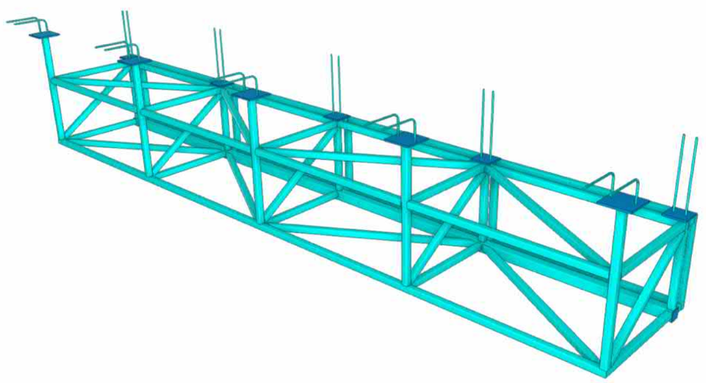
- Coordination with architects, HVAC design
- Project optimization in collaboration with steel contractors
- Structural Analysis
- Connection Analysis
- Structural Drawings





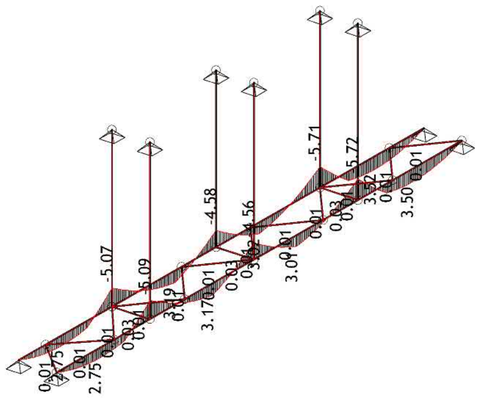






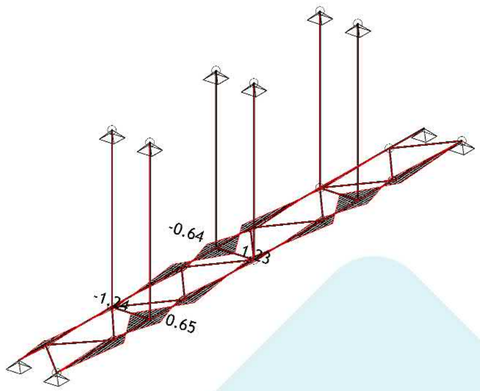
Structural Analysis

Load 32: [ULS] 7-31



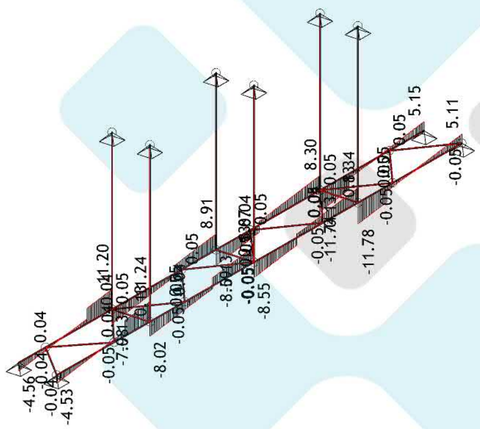
Isometric
Beam Results: max M3= 3.52 / min M3= -5.72 kNm

Load 32: [ULS] 7-31



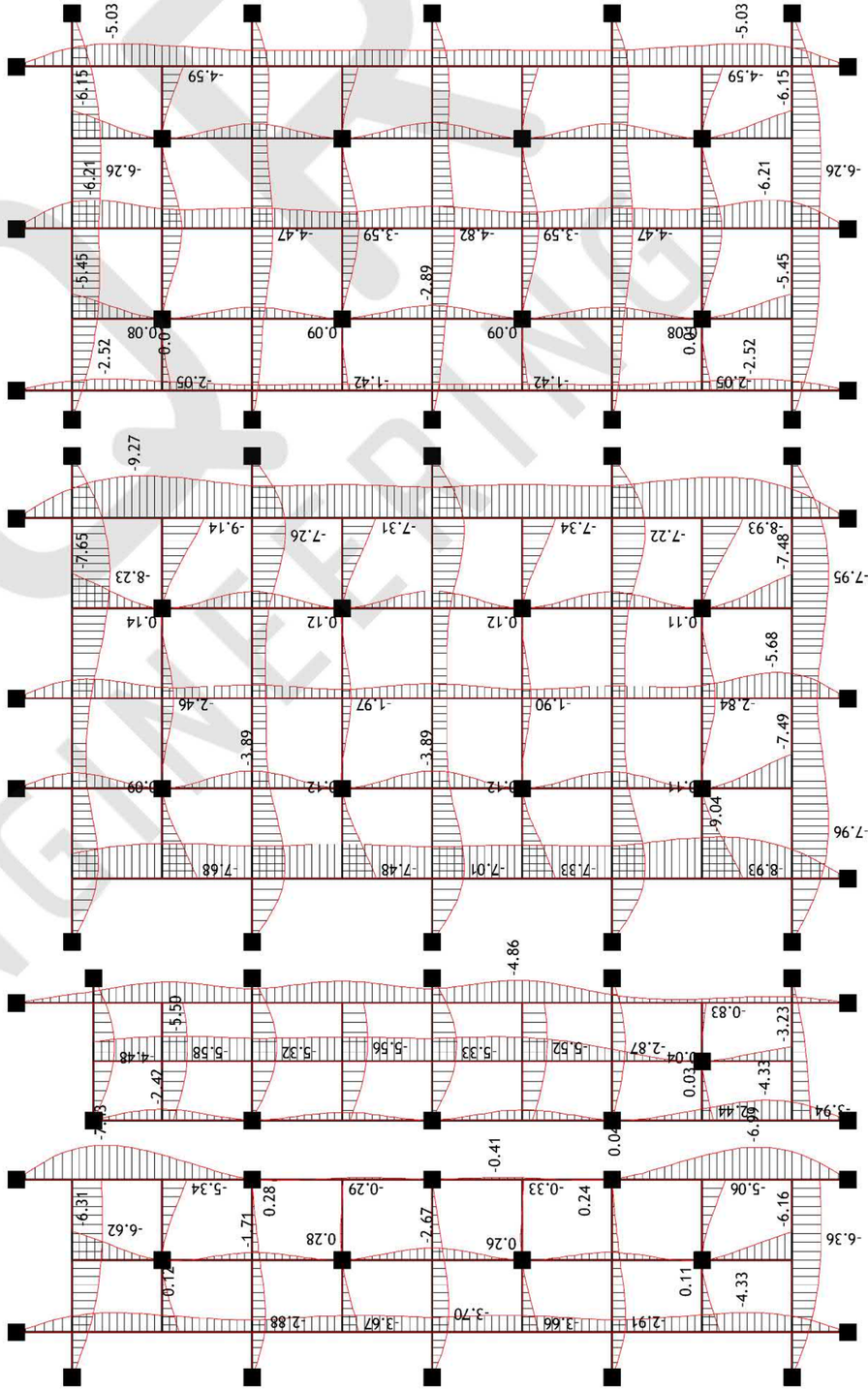
Isometric
Beam Results: max M2= 1.23 / min M2= -1.24 kNm

Load 32: [ULS] 7-31



Isometric
Beam Results: max V2= 11.24 / min V2= -11.78 kN

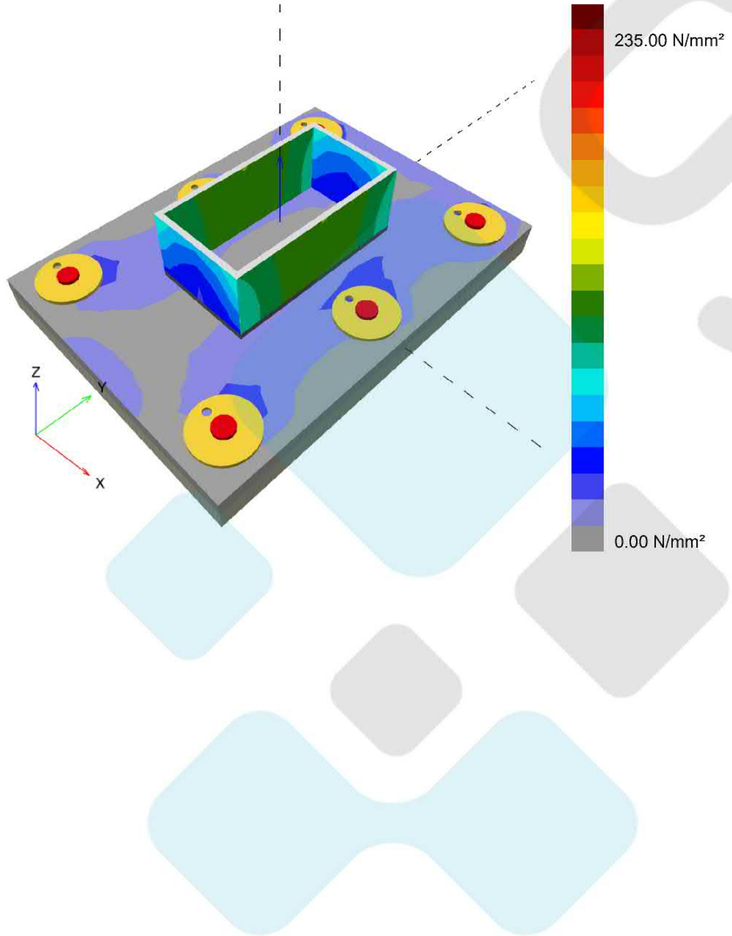
Load 4: I+II

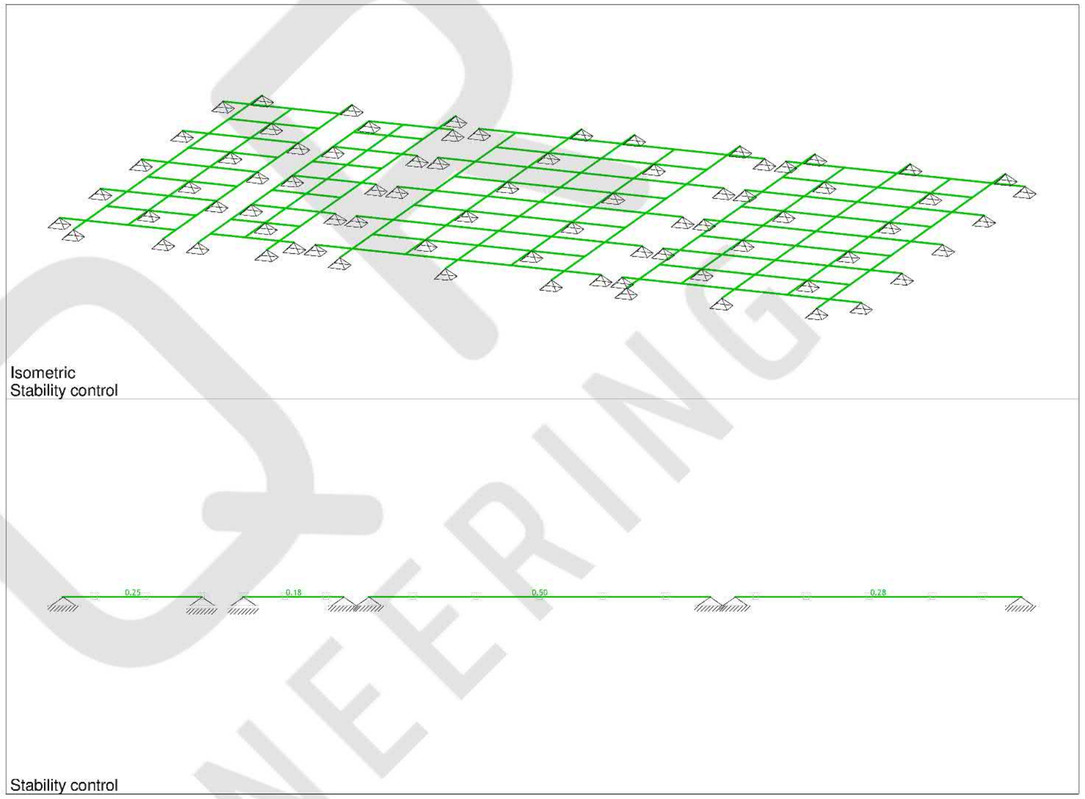


Part	Load combination	Material	σ_{Ed} [N/mm²]	ε_{Pl} [%]	f_y [N/mm²]	γ_{M0}	f_y/γ_{M0} [N/mm²]	ε_{lim} [%]	Status
Plate	Combination 1	S 235	65.40	0.00	235.00	1.00	235.00	5.00	OK
Profile	Combination 1	S 235	209.89	0.00	235.00	1.00	235.00	5.00	OK
Profile	Combination 1	S 235	211.51	0.00	235.00	1.00	235.00	5.00	OK
Profile	Combination 1	S 235	192.34	0.00	235.00	1.00	235.00	5.00	OK
Profile	Combination 1	S 235	192.33	0.00	235.00	1.00	235.00	5.00	OK

2.4.1.1 Equivalent stress

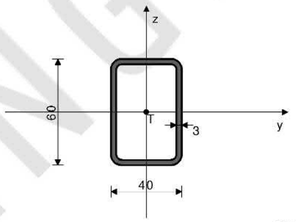
Results below are displayed for the decisive load combination: 1 - Combination 1





BEAM 468-177
CROSS-SECTION: HOP [] 60x40x3 [S 355] [Set: 1]
EUROCODE 3 (EN 1993-1-1:2005)

CROSS-SECTION PROPERTIES



Ax =	5.410 cm2
Ay =	2.164 cm2
Az =	3.246 cm2
Ix =	29.121 cm4
Iy =	24.170 cm4
Iz =	12.730 cm4
Wy =	8.057 cm3
Wz =	6.365 cm3
Wy,pl =	11.214 cm3
Wz,pl =	8.394 cm3
γM0 =	1.000
γM1 =	1.000
γM2 =	1.250
Anet/A =	0.900

(fy = 35.5 kN/cm2, fu = 51.0 kN/cm2)

UTILISATION FACTORS FOR ALL LOAD CASE COMBINATIONS
3. γ=0.50 4. γ=0.33

MEMBER SUBJECT TO BENDING
(load 3, at 587.5 cm from the start of the member)

The shear force design value(z-z)	$V_{Ed,z}$ =	1.209 kN
The bending mom.design value(y-y)	$M_{Ed,y}$ =	1.473 kNm
System length	L =	675.00 cm

5.5 CLASSIFICATION OF CROSS-SECTIONS
Class 1 cross-sections

6.2 RESISTANCE OF CROSS-SECTIONS
6.2.5 Bending about the y-y axis

Plastic section modulus	$W_{y,pl}$ =	11.214 cm3
The design moment resistance	$M_{c,Rd}$ =	3.981 kNm

Requirement 6.12: $M_{Ed,y} <= M_{c,Rd,y}$ (1.47 <= 3.98)

6.2.6 Shear

Design shear resistance	$V_{pl,Rd,z}$ =	66.530 kN
Design shear resistance	$V_{c,Rd,z}$ =	66.530 kN

Requirement 6.17: $V_{Ed,z} <= V_{c,Rd,z}$ (1.21 <= 66.53)

6.2.8 Bending and shear
No reduction need be made in the resistance moment
Requirement: $V_{Ed,z} <= 50\%V_{pl,Rd,z}$

6.3 BUCKLING RESISTANCE OF MEMBERS
6.3.2.1 Buckling resistance

Coefficient	C1 =	1.132
Coefficient	C2 =	0.459
Coefficient	C3 =	0.525
The eff.length fact.for later.restr.	k =	1.000
The eff.length fact.for tors.restr.	kw =	1.000
Coordinate	zg =	0.000 cm
Coordinate	zj =	0.000 cm
Length between lateral restr.points	L =	675.00 cm
The warping constant	Iw =	0.000 cm6
The elast.crit.mom.(I-t buck.)	Mcr =	13.211 kNm
Appropriate section modulus	W_y =	11.214 cm3
The imperfection factor	αLT =	0.760
The non-dimensional slenderness	λLT_ =	0.549
The reduction factor (6.3.2.2.)	χLT =	0.745
The design buckling resistance	$M_{b,Rd}$ =	2.966 kNm

Requirement 6.54: $M_{Ed,y} <= M_{b,Rd}$ (1.47 <= 2.97)

Check of the shear resistance
(load 3, end of the member)

The shear force design value(z-z)	$V_{Ed,z}$ =	2.159 kN
System length	L =	675.00 cm

6.2 RESISTANCE OF CROSS-SECTIONS
6.2.6 Shear

Design shear resistance	$V_{pl,Rd,z}$ =	66.530 kN
Design shear resistance	$V_{c,Rd,z}$ =	66.530 kN

Requirement 6.17: $V_{Ed,z} <= V_{c,Rd,z}$ (2.16 <= 66.53)

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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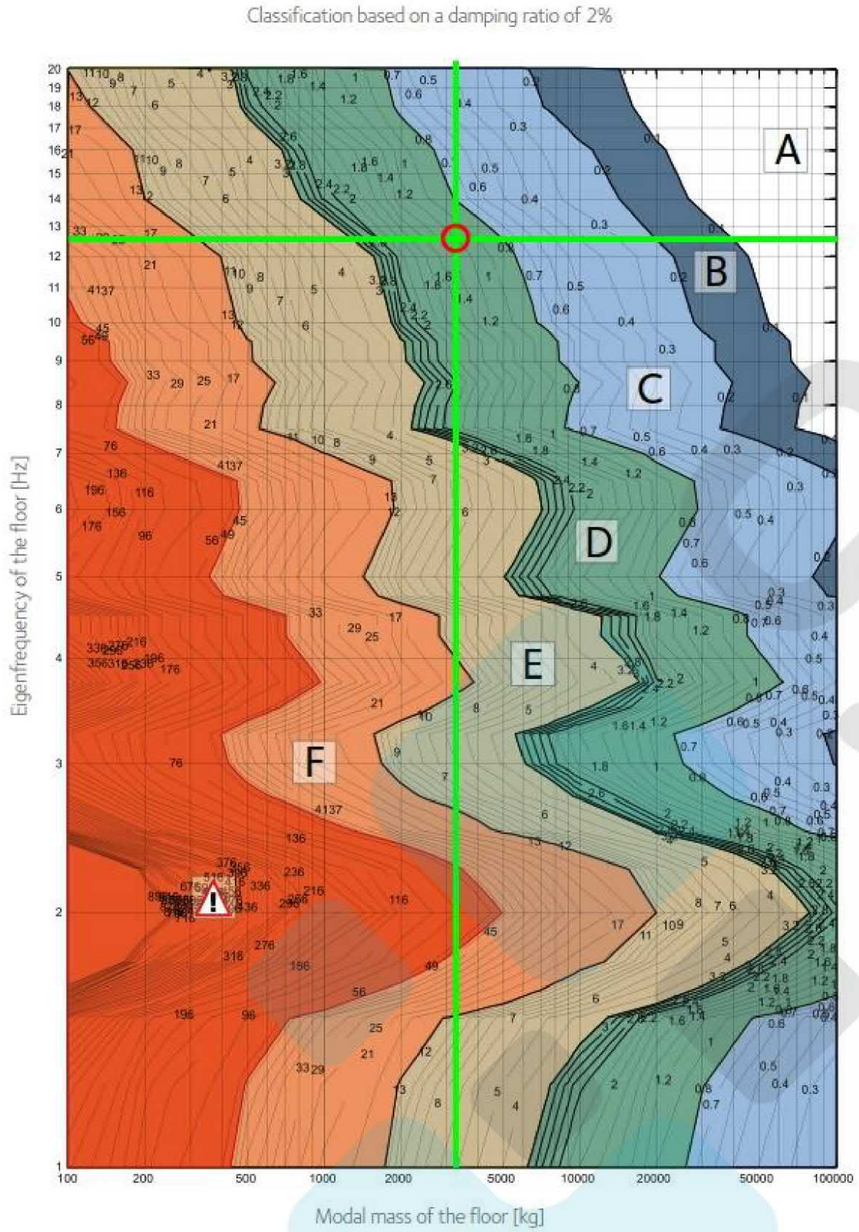
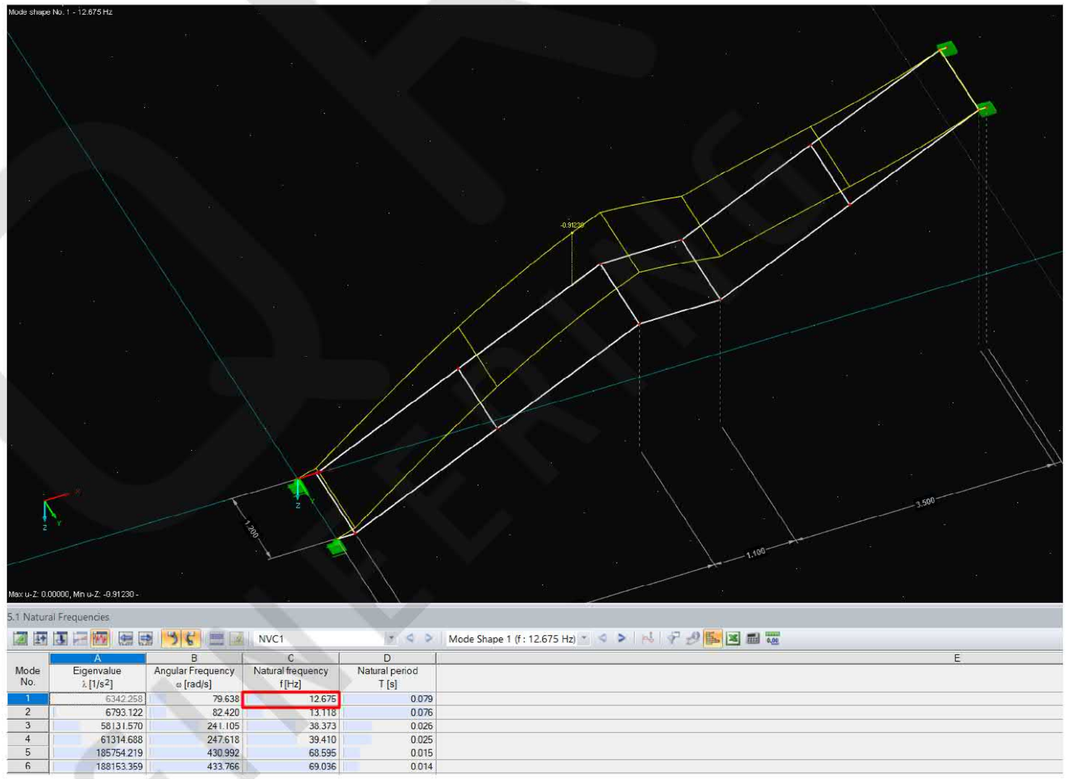
Determination of vibration class:

Figure 5 OS-RMS$_{90}$ for 2% Damping



Natural frequency: 12.6Hz



Mode No.	A Eigenvalue λ [1/s²]	B Angular Frequency ω [rad/s]	C Natural frequency f [Hz]	D Natural period T [s]	E
1	6342.258	79.638	12.675	0.079	
2	6793.122	82.420	13.118	0.076	
3	58131.570	241.105	38.373	0.026	
4	61314.688	247.618	39.410	0.025	
5	185754.219	430.992	68.595	0.015	
6	188163.359	433.766	69.036	0.014	

Modal mass:

5.7 Effective Modal Mass Factors

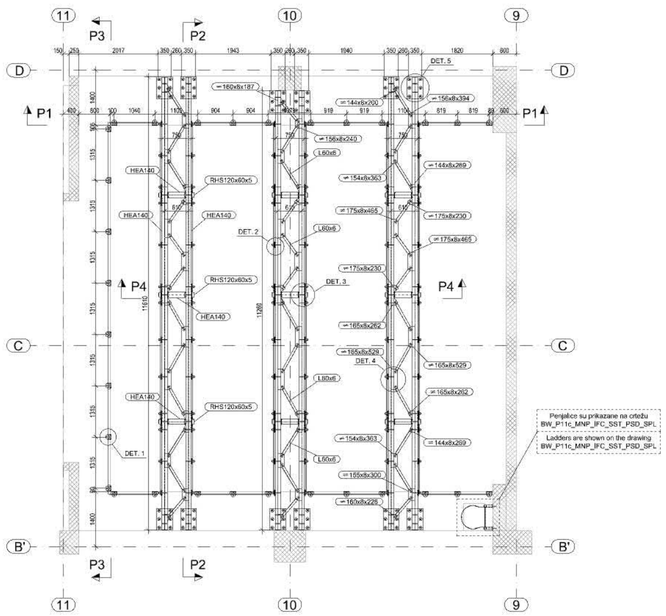
NVC1 — Mode Shape 1 (f : 12.675 Hz)

Mode No.	A Modal Mass M_i [kg]	B	C	D	E	F	G	H	I	J
		Effective Modal Mass						Effective Modal Mass Factor		
		m_{eX} [kg]	m_{eY} [kg]	m_{eZ} [kg]	$m_{\theta X}$ [kg.m²]	$m_{\theta Y}$ [kg.m²]	$m_{\theta Z}$ [kg.m²]	f_{meX} [-]	f_{meY} [-]	f_{meZ} [-]
1	3196.12	0.00	0.00	6152.70	0.00	1051.13	0.00	0.000	0.000	0.719
2	2396.61	0.00	0.00	0.00	2218.77	0.00	0.00	0.000	0.000	0.000
3	3446.34	0.00	0.00	82.52	0.00	23235.36	0.00	0.000	0.000	0.010
4	2412.60	0.00	0.00	0.00	27.58	0.00	0.00	0.000	0.000	0.000
5	2540.21	0.00	0.00	627.81	0.00	1032.18	0.00	0.000	0.000	0.073
6	2499.58	0.00	0.00	0.00	224.18	0.00	0.00	0.000	0.000	0.000
Sum	16491.45	0.00	0.00	6863.03	2470.53	25318.66	0.00	0.000	0.000	0.802

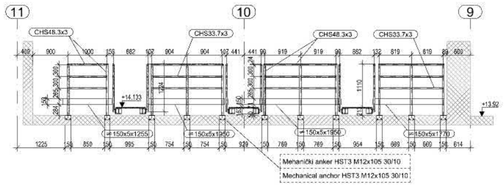
Structural Drawings

MOSTOVI I OGRADE NA AB GALERIJI 4. SPRATA
BRIDGES AND RAILINGS ON THE RC GALLERY OF THE 4th FLOOR

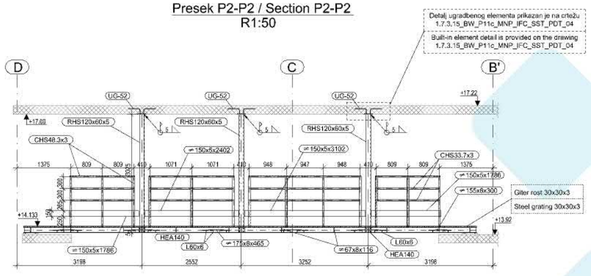
Osnova 4. sprata / Plan view of the 4th floor
R1:50



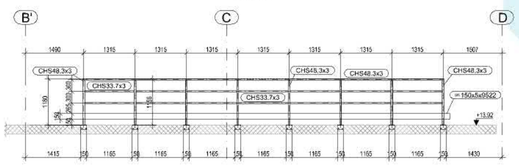
Presek P1-P1 / Section P1-P1
R1:50



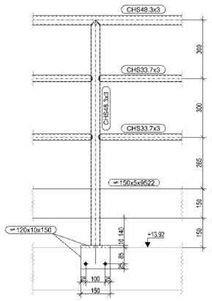
Presek P2-P2 / Section P2-P2
R1:50



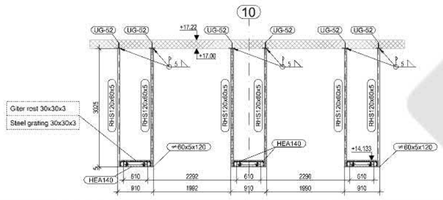
Presek P3-P3 / Section P3-P3
R1:50



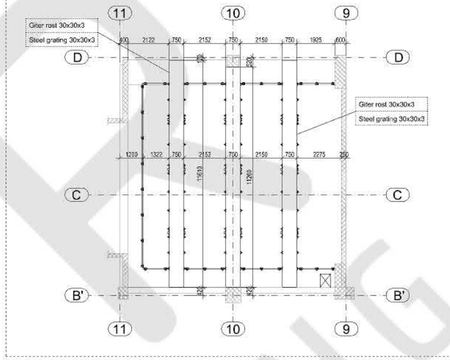
Presek P5-P5 / Section P5-P5
R1:10



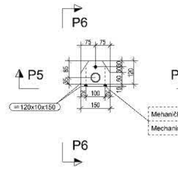
Presek P4-P4 / Section P4-P4
R1:50



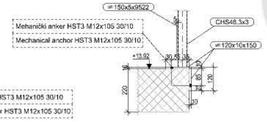
Giter rost 30x30x3 / Steel grating 30x30x3
R 1:100



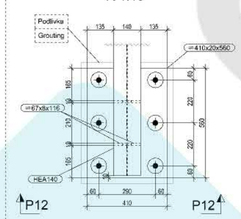
Detalj 1 / Detail 1
R 1:10



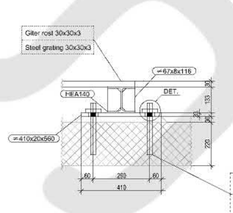
Presek P6-P6 / Section P6-P6
R1:10



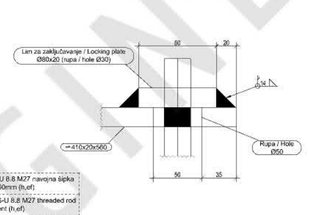
Detalj 5 / Detail 5
R 1:10



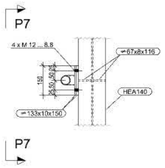
Presek P12-P12/ Section P12-P12
R1:10



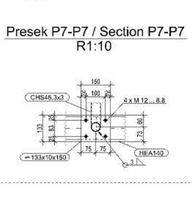
Detalji / Detail
R 1:2



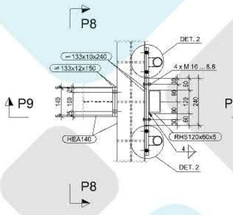
Detalj 2 / Detail 2
R 1:10



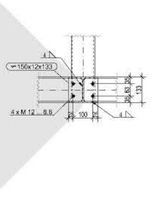
Presek P7-P7 / Section P7-P7
R1:10



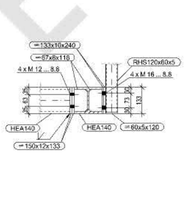
Detalj 3 / Detail 3
R 1:10



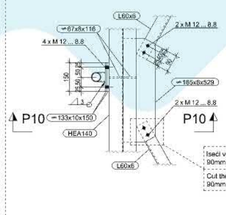
Presek P8-P8 / Section P8-P8
R1:10



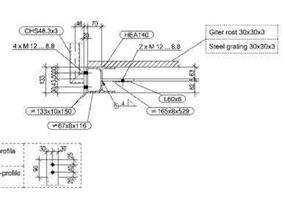
Presek P9-P9 / Section P9-P9
R1:10



Detalj 4 / Detail 4
R 1:10



Presek P10-P10 / Section P10-P10
R1:10



NAPOMENE

1. Osnovni materijal za sve elemente čelične konstr. je S235JRG2.
2. Svi šavovi su "C" kvaliteta.
3. Svi ugaoni šavovi koji nisu označeni debljina su 0,7t min, ali ne manje od 3 mm, osim kod veza šupljih profila kod kojih je debljina šavova jednaka debljini zida.
4. Svi kontakti čeličnih elemenata, osim veza sa zavrtnjima, zavareni su odgovarajućim ugaonim ili sučeonim šavovima.
5. Sve šuplje profile zatvoriti 5mm čeličnom pločom.
6. Osnovni materijal za ankerne šipke je armatura B500B.
7. Osnovni materijal za zavrtnjeve je čelik klase 8.8.
8. Visinske kote preuzete iz projekta arhitekture ili armirano-betonske konstrukcije.
9. Neusaglašenosti i odstupanja u crtežima ili tekstualnim prilozima projekta obavezno razrešiti sa autorom i odgovornim projektantom.
10. Izmene u delu projekta za vreme građenja vršiti samo uz saglasnost autora i odgovornog projektanta.
11. Sve dimenzije proveriti na licu mesta!

REMARKS

1. Basic material for all elements of the steel construction is S235JRG2.
2. All welds are of "C" quality.
3. All fillet welds which are not marked are of thickness 0,7 t min, but are not smaller than 3mm, except for the hollow profiles where they are the same as the wall of the profile.
4. All contacts of steel elements, other than embroidery with screws, are welded with appropriate fillet or butt welds!
5. All hollow profiles are to be closed with 5mm steel plate.
6. Basic material for all anchor rods is rebar B500B.
7. Basic material for all bolts is steel grade 8.8.
8. Elevation dimensions are taken from the architectural design or concrete structure design.
9. Inconsistencies in either drawings and/or textual appendices will have to be resolved with both the author and the design professional in responsible charge.
10. Design variations which may emerge during construction are only to be made with prior approval from both the author and the design professional in responsible charge.
11. All dimensions need to be checked on the spot!

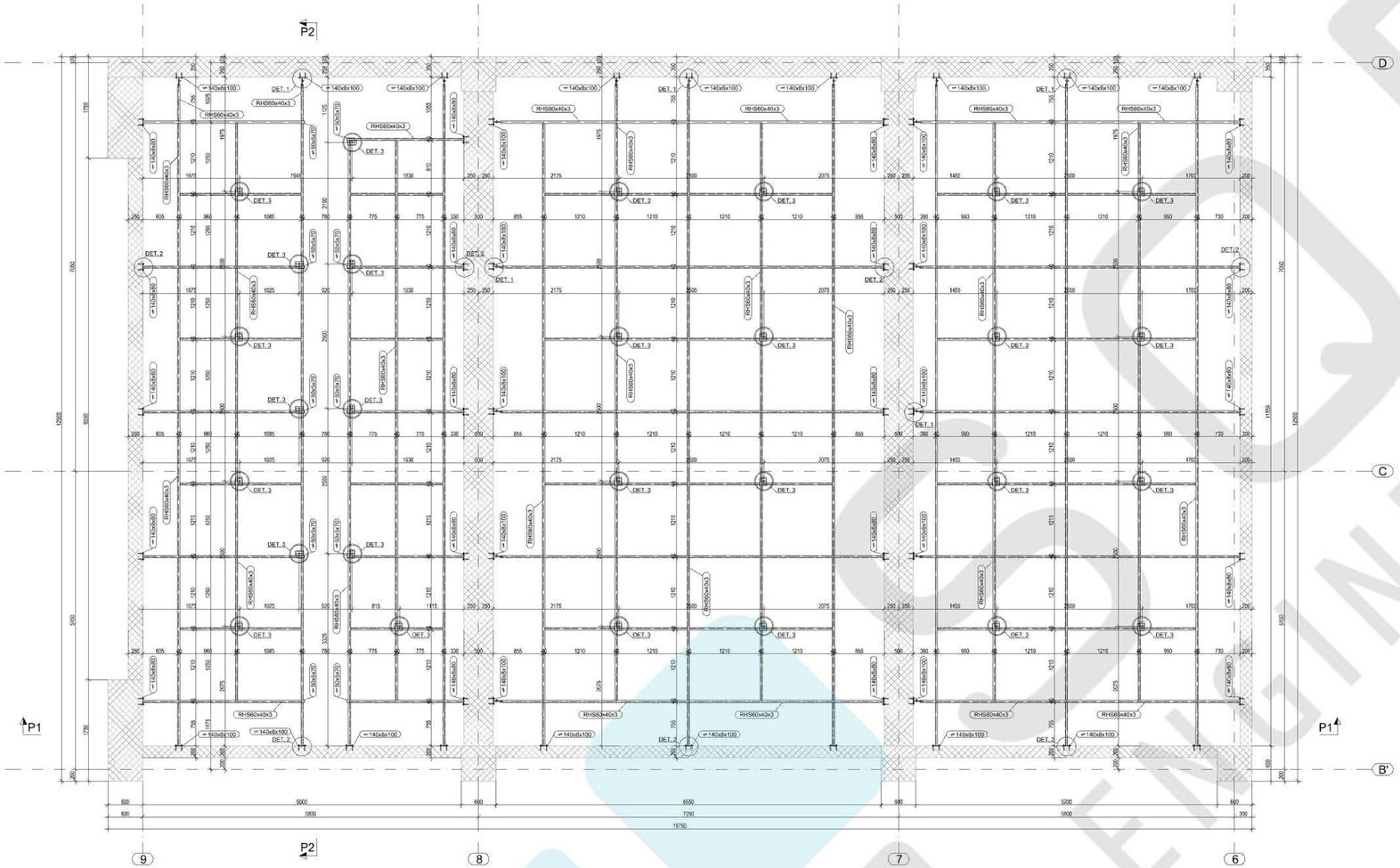
EN 1090-2 - Klasa izvođenja: / Execution class:	EXC2
EN ISO 12944 - Antikoroziona zaštita: / Corrosion protection:	C2
Protivpožarna zaštita: / Fire protection:	60 min (R60)

Material list / Specifikacija materijala

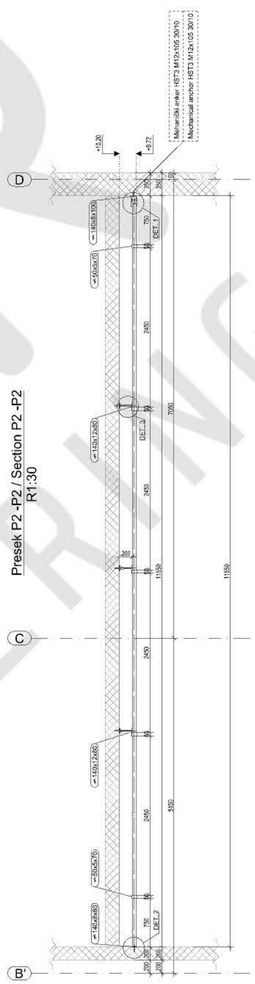
Profile Profil	Quantity Količina	Material Materijal	Length [mm] Dužina [mm]	Total length [mm] Ukupna dužina [mm]	Total weight [kg] Ukupna težina [kg]
Mostovi i ograde / Bridges and railings					
CHS33.7x3	/	S235JR	/	142183	322.76
CHS48.3x3	/	S235JR	/	205515	706.77
HEA140	/	S235JR	/	72638	1794.16
L60x6	/	S235JR	/	28671	155.4
RHS120x60x5	/	S235JR	/	54450	708.29
#60x5x120	18	S235JR	/	/	5.09
#67x8x116	192	S235JR	/	/	117.14
#120x10x150	60	S235JR	/	/	84.78
#133x10x150	156	S235JR	/	/	244.31
#133x10x240	36	S235JR	/	/	90.21
#133x12x150	36	S235JR	/	/	67.65
#144x8x200	2	S235JR	/	/	3.62
#144x8x209	6	S235JR	/	/	14.6
#150x5x1255	2	S235JR	/	/	14.78
#150x5x1770	2	S235JR	/	/	20.84
#150x5x1786	12	S235JR	/	/	126.18
#150x5x1950	4	S235JR	/	/	45.92
#150x5x2402	6	S235JR	/	/	84.85
#150x5x3102	6	S235JR	/	/	109.58
#150x5x9522	1	S235JR	/	/	56.06
#154x8x363	6	S235JR	/	/	21.06
#155x8x300	2	S235JR	/	/	8.76
#156x8x240	1	S235JR	/	/	2.35
#156x8x394	2	S235JR	/	/	7.72
#160x8x187	1	S235JR	/	/	1.88
#160x8x226	3	S235JR	/	/	6.81
#165x8x262	6	S235JR	/	/	16.29
#165x8x529	6	S235JR	/	/	32.89
#175x8x230	6	S235JR	/	/	15.17
#175x8x465	6	S235JR	/	/	30.66
#410x20x560	12	S235JR	/	/	432.57
Ø80x20	72	S235JR	/	/	48.96
Giter rost / Steel grating					
30x30x3 - 25.86 m2	/	S235JR	/	/	1188.27
				Total: / Ukupno:	6586.38
				5%:	329.32
				Total: / Ukupno:	6915.7

ČELIČNI ROŠTILJ ISPOD AB PLOČE 3. SPRATA
STEEL GRILLAGE UNDER THE RC SLAB OF THE 3rd FLOOR

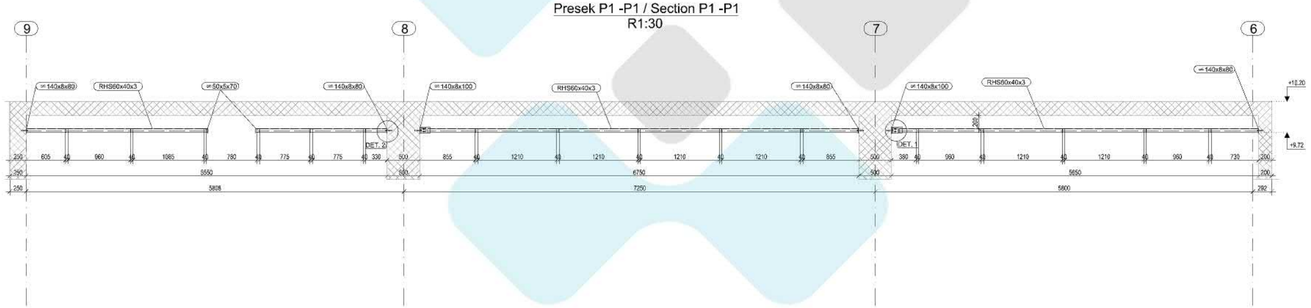
Roštilj ispod AB ploče / Grillage under the RC slab
R1:30



Presek P2 -P2 / Section P2 -P2
R1:30



Presek P1 -P1 / Section P1 -P1
R1:30



NAPOMENE

1. Osnovni materijal za sva elemenie čelične konstr. je S235JRG2.
2. Svi šavovi su "C" kvaliteta.
3. Svi ugaoni šavovi koji nisu označeni debljine su 0,7t min, ali ne manje od 3 mm, osim kod veza šupljih profila kod kojih je debljina šavova jednaka debljini zida.
4. Svi kontakti čeličnih elemenata, osim veza sa zavrtnjima, zavareni su odgovarajućim ugaonim ili sučeonim šavovima.
5. Sve šuplje profile zatvoriti 5mm čeličnom pločom.
6. Osnovni materijal za ankerne šipke je armatura B500B.
7. Osnovni materijal za zavrtnjeve je čelik klase 8.8.
8. Visinske kote preuzete iz projekta arhitekture ili armirano-betonske konstrukcije.
9. Neusaglašenosti i oscilovanja u crtežima ili tekstualnim prilozima projekta osavezno razrešiti sa autorom i odgovornim projektantom.
10. Izmene u delu projekta za vreme građenja vršiti samo uz saglasnost autora i odgovornog projektanta.
11. Sve dimenzije proveriti na licu mesta!

REMARKS

1. Basic material for all elements of the steel construction is S235JRG2.
2. All welds are of "C" quality.
3. All fillet welds which are not marked are of thickness 0,7 t min, but are not smaller than 3mm, except for the hollow profiles where they are the same as the wall of the profile.
4. All contacts of steel elements, other than embroidery with screws, are welded with appropriate fillet or butt welds!
5. All hollow profiles are to be closed with 5mm steel plate.
6. Basic material for all anchor rods is rebar B500B.
7. Basic material for all bolts is steel grade 8.8.
8. Elevation dimensions are taken from the architectural design or concrete structure design.
9. Inconsistencies in either drawings and/or textual appendices will have to be resolved with both the author and the design professional in responsible charge.
10. Design variations which may emerge during construction are only to be made with prior approval from both the author and the design professional in responsible charge.
11. All dimensions need to be checked on the spot!

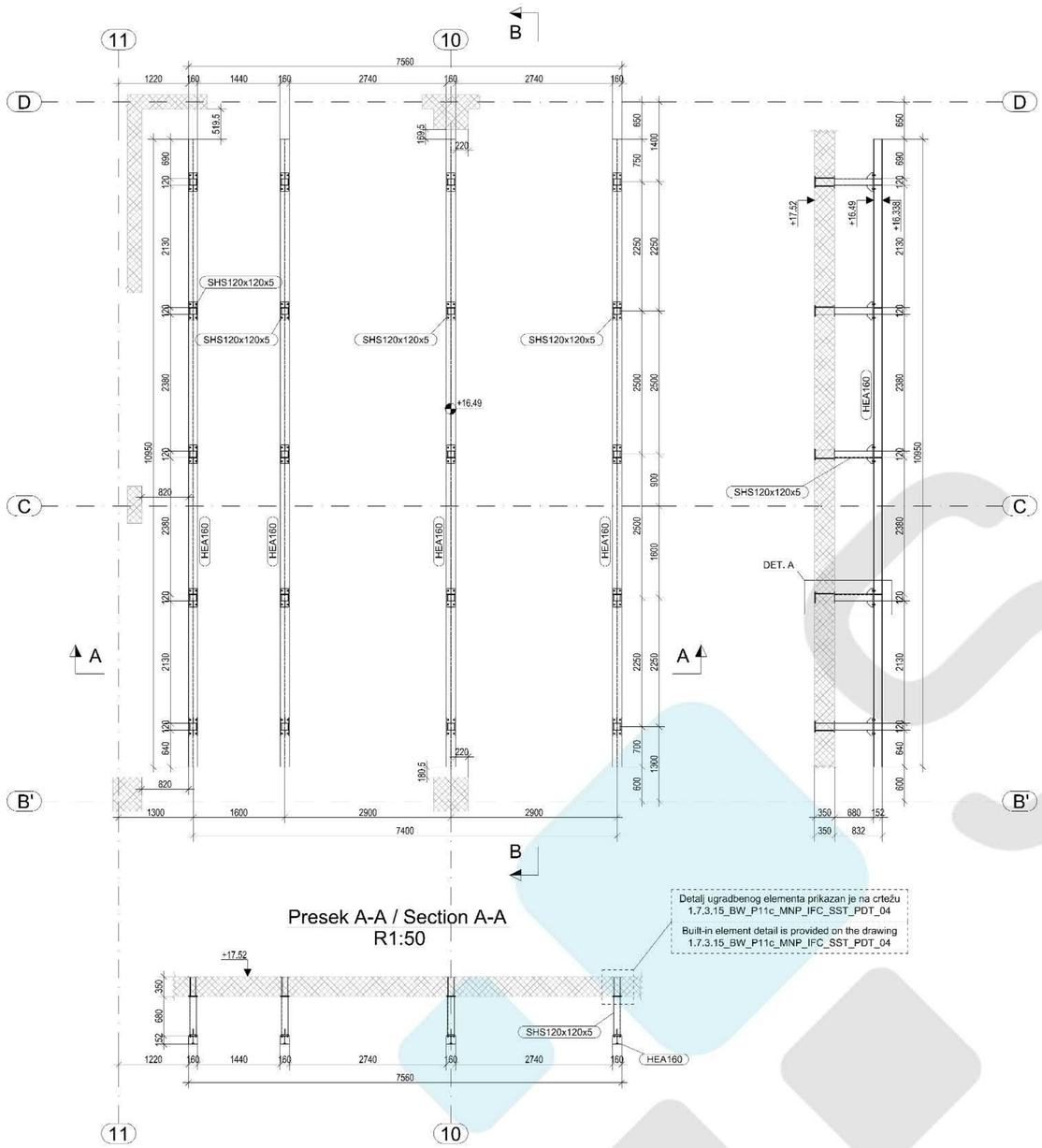
EN 1090-2 - Klasa izvođenja: / Execution class:	EXC2
EN ISO 12944 - Antikoroziona zaštita: / Corrosion protection:	C2
Protivpožarna zaštita: / Fire protection:	/

Material list / Specifikacija materijala

Profile Profil	Quantity Količina	Material Materijal	Length [mm] Duzina [mm]	Total length [mm] Ukupna duzina [mm]	Total weight [kg] Ukupna tezina [kg]
RHS60x40x3	/	S235JR	/	305796	1316.79
#40x3x60	19	S235JR	/	/	1.07
#50x5x70	10	S235JR	/	/	1.37
#80x8x90	19	S235JR	/	/	8.59
#80x8x140	30	S235JR	/	/	21.1
#80x12x140	28	S235JR	/	/	29.54
#90x8x140	19	S235JR	/	/	15.03
#100x8x140	19	S235JR	/	/	16.7
#125x8x125	28	S235JR	/	/	27.48
RD12	28	8.8	232	6496	5.77
RD30	28	S235JR / 8.8	50	1400	7.77
				Total. / Ukupno:	1451.21
				5%:	72.56
				Total. / Ukupno:	1523.77

KONSTRUKCIJA ZA SCENSKU TEHNIKU - 4. SPRAT
STRUCTURE FOR STAGE EQUIPMENT - 4th FLOOR

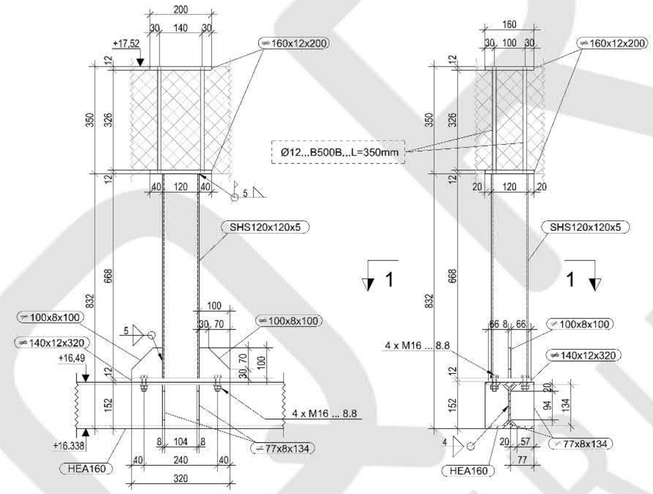
Osnova 4. sprata / Plan view of the 4th floor
R1:50



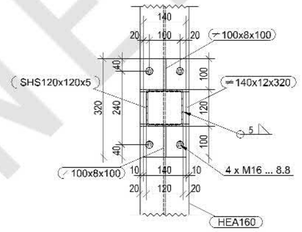
Presek B-B / Section B-B
R1:50

Presek A-A / Section A-A
R1:50

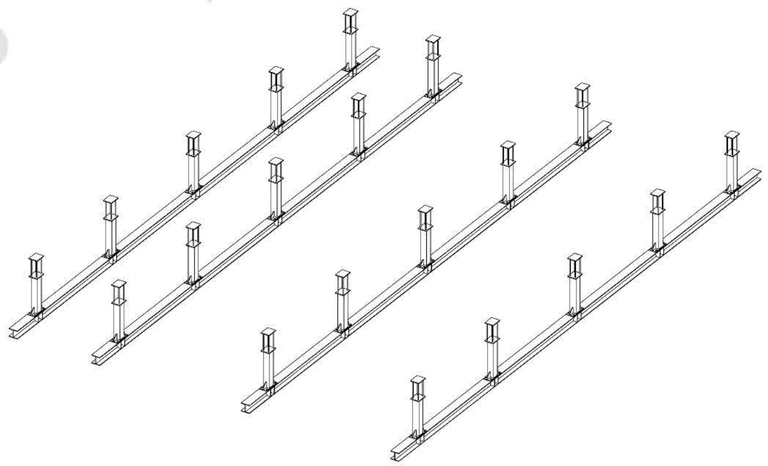
Detalj A / Detail A
R1:10



Presek 1-1 / Section 1-1
R1:10



3D Prikaz / 3D View



Material list / Specifikacija materijala					
Profile Profil	Quantity Kolicina	Material Materijal	Length [mm] Duzina [mm]	Total length [mm] Ukupna duzina [mm]	Total weight [kg] Ukupna tezina [kg]
SHS120x120x5	20	S235JR	668	13360	236.71
HEA160	4	S235JR	10950	43800	1331.52
≠77x8x134	80	S235JR	/	/	49.83
≠100x8x100	40	S235JR	/	/	18.97
≠140x12x320	20	S235JR	/	/	84.4
				Total: / Ukupno:	1721.43
				5%:	86.07
				Total: / Ukupno:	1807.5

NAPOMENE

1. Osnovni materijal za sve elemente čelične konstr. je S235JRG2.
2. Svi šavovi su "C" kvaliteta.
3. Svi ugaoni šavovi koji nisu označeni debljine su 0,7t min, ali ne manje od 3 mm, osim kod veza šupljih profila kod kojih je debljina šavova jednaka debljini zida.
4. Svi kontakti čeličnih elemenata, osim veza sa zavrtnjima, zavareni su odgovarajućim ugaonim ili sučeonim šavovima.
5. Sve šuplje profile zatvoriti 5mm čeličnom pločom.
6. Osnovni materijal za ankerne šipke je armatura B500B.
7. Osnovni materijal za zavrtnjeve je čelik klase 8.8.
8. Visinske kote preuzete iz projekta arhitekture ili armirano-betonske konstrukcije.
9. Neusaglašenosti i odstupanja u crtežima i/ili tekstualnim prilozima projekta obavezno razrešiti sa autorom i odgovornim projektantom.
10. Izmene u delu projekta za vreme građenja vršiti samo uz saglasnost autora i odgovornog projektanta.
11. Sve dimenzije proveriti na licu mesta!

REMARKS

1. Basic matarial for all elements of the steel construction is S235JRG2.
2. All welds are of "C" quality.
3. All fillet welds which are not marked are of thickness 0,7 t min, but are not smaller than 3mm, except for the hollow profies where they are the same as the wall of the profile.
4. All contacts of steel elements, other than embroidery with screws, are welded with appropriate fillet or butt welds!
5. All hollow profiles are to be closed with 5mm steel plate.
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7. Basic material for all bolts is steel grade 8.8.
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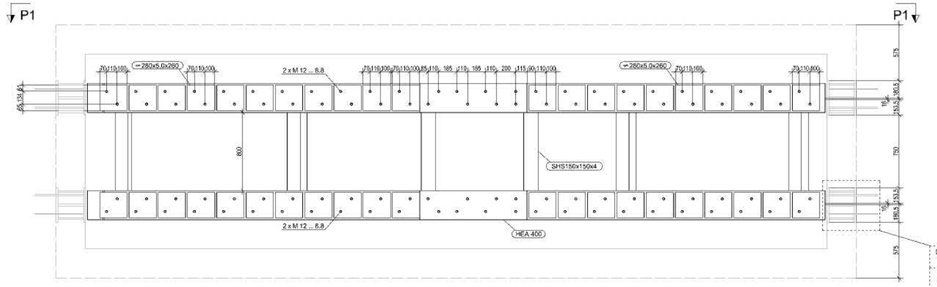
EN ISO 12944 - Antikoroziona zaštita: / Corrosion protection:	C2
Protivpožarna zaštita: / Fire protection:	/

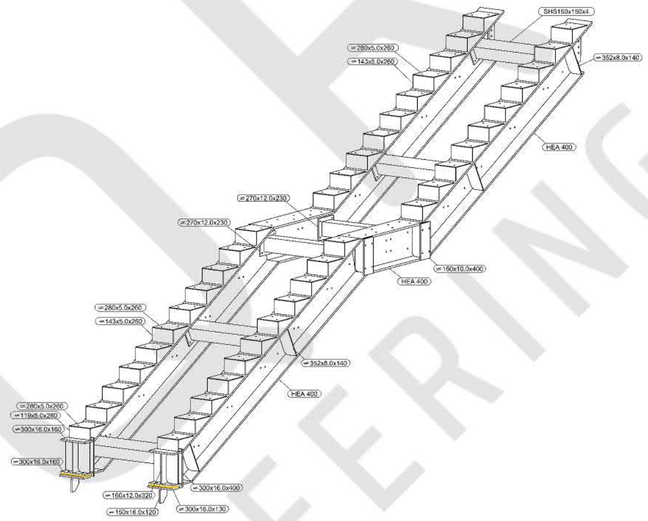
STEPENICE - TIP 2
STAIRS - TYPE 2

3 kom / 3 pcs

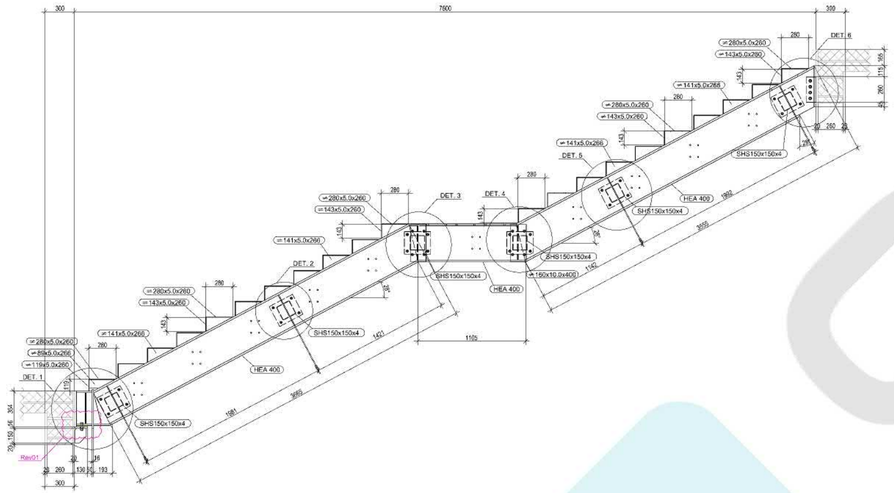
Osnova / Plan view
R1:20



3D Prikaz / 3D View
R1:20



Presek P1-P1 / Section P1-P1
R1:20



Napomene

1. Osnovni materijal za sva elemente čelične konstr. je S235JRG2.
2. Svi šavovi su "C" kvaliteta.
3. Svi ugaoni šavovi koji nisu označeni debljine su 0,7t min, ali ne manje od 3 mm, osim kod veza šupljih profila kod kojih je debljina šavova jednaka debljini zida.
4. Svi kontakti čeličnih elemenata, osim veza sa zavrtnjima, zavareni su odgovarajućim ugaonim ili sučeonim šavovima.
5. Sve šuplje profile zatvoriti 5mm čeličnom pločom.
6. Osnovni materijal za ankerne šipke je armatura B500B.
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Remarks

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3. All fillet welds which are not marked are of thickness 0,7 t min, but are not smaller than 3mm, except for the hollow profiles where they are the same as the wall of the profile.
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EN ISO 12944 - Antikoroziona zaštita: / Corrosion protection:	C2
Protivpožarna zaštita: / Fire protection:	/

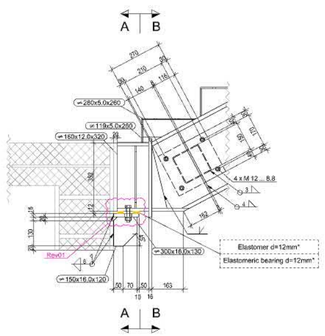
Elastomer 12mm* / Elastomeric bearing 12mm*

- Postaviti elastomer proizvođača Sylomer tipa "SR1200" ili "Sylodyn NP1", debljine 12mm.
- Elastomer mora da bude projektovan na silu: Ed = 1xG + 0,5xP = 1x28kN + 0,5x18kN = 37 kN.
- Na mestu zavrtnjeva elastomer mora da ima otvor Ø50mm.

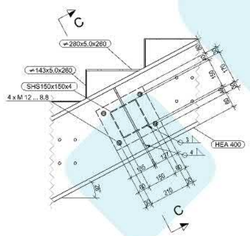
- Install an elastomeric bearing manufactured by Sylomer, type "SR1200" or "Sylodyn NP", 12mm thick.
- Elastomeric bearing must be designed for the load: Ed = 1xG + 0,5xP = 1x28kN + 0,5x18kN = 37 kN.
- At the screw location, the elastomeric bearing must have a Ø50mm opening.

Rev01

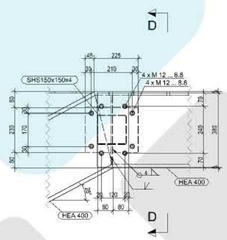
Detalj 1 / Detail 1
R 1:10



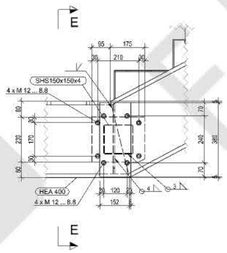
Detalj 2 / Detail 2
R 1:10



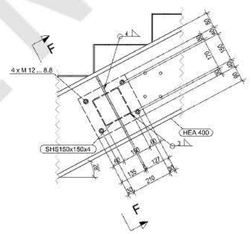
Detalj 3 / Detail 3
R 1:10



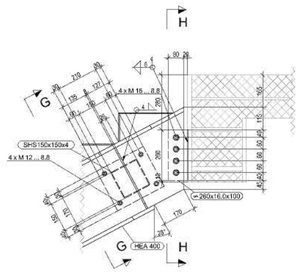
Detalj 4 / Detail 4
R 1:10



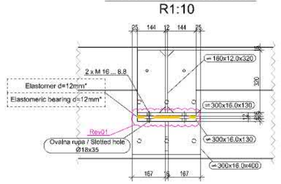
Detalj 5 / Detail 5
R 1:10



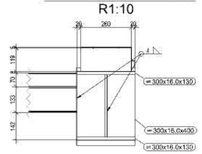
Detalj 6 / Detail 6
R 1:10



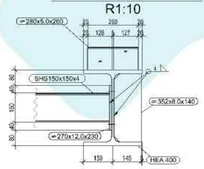
Presek A-A / Section A-A
R1:10



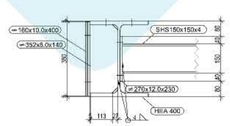
Presek B-B / Section B-B
R1:10



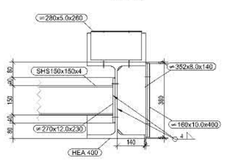
Presek C-C / Section C-C
R1:10



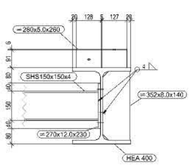
Presek D-D / Section D-D
R1:10



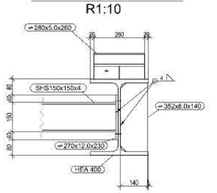
Presek E-E / Section E-E
R1:10



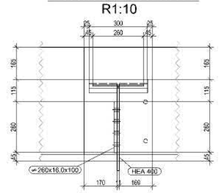
Presek F-F / Section F-F
R1:10



Presek G-G / Section G-G
R1:10



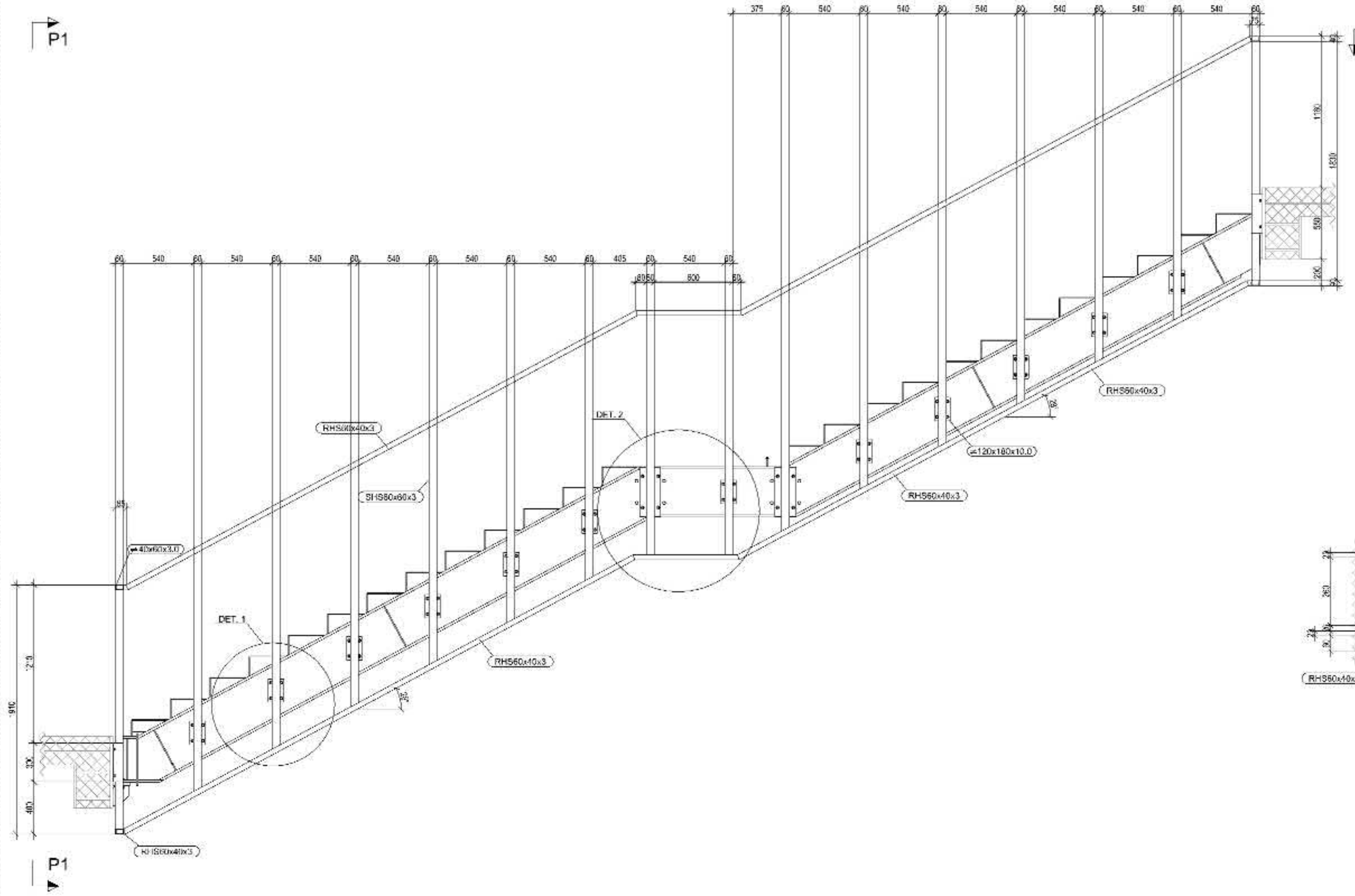
Presek H-H / Section H-H
R1:10



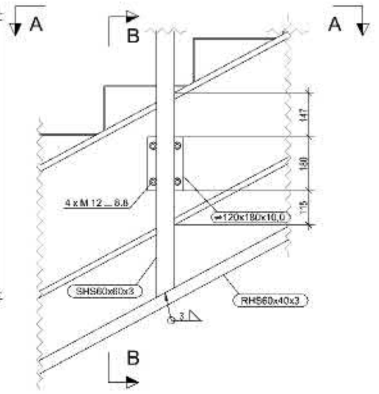
STEPENICE - OGRADA - TIPOVI 3 i 6
STAIRS - HANDRAIL - TYPES 3 and 6

Ograda - Tip 3 / Handrail - Type 3
Presek P2-P2 / Section P2-P2
R1:20

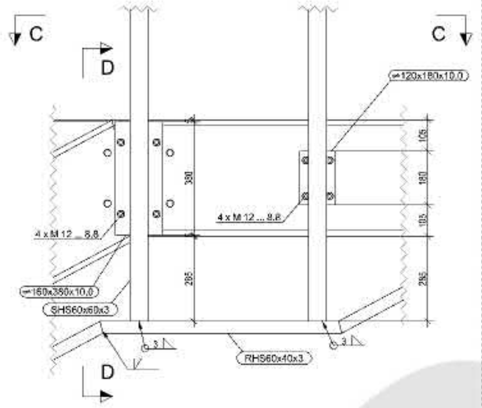
2 kom / pcs



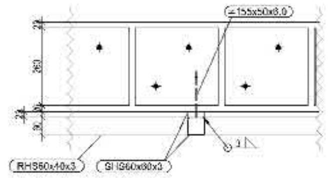
Detalj 1 / Detail 1
R 1:10



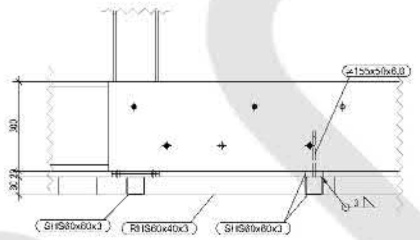
Detalj 2 / Detail 2
R 1:10



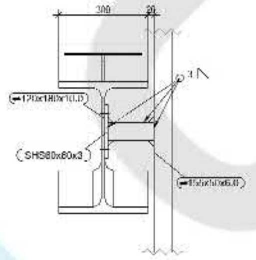
Presek A-A / Section A-A
R1:10



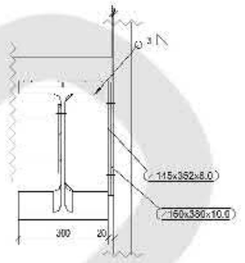
Presek C-C / Section C-C
R1:10



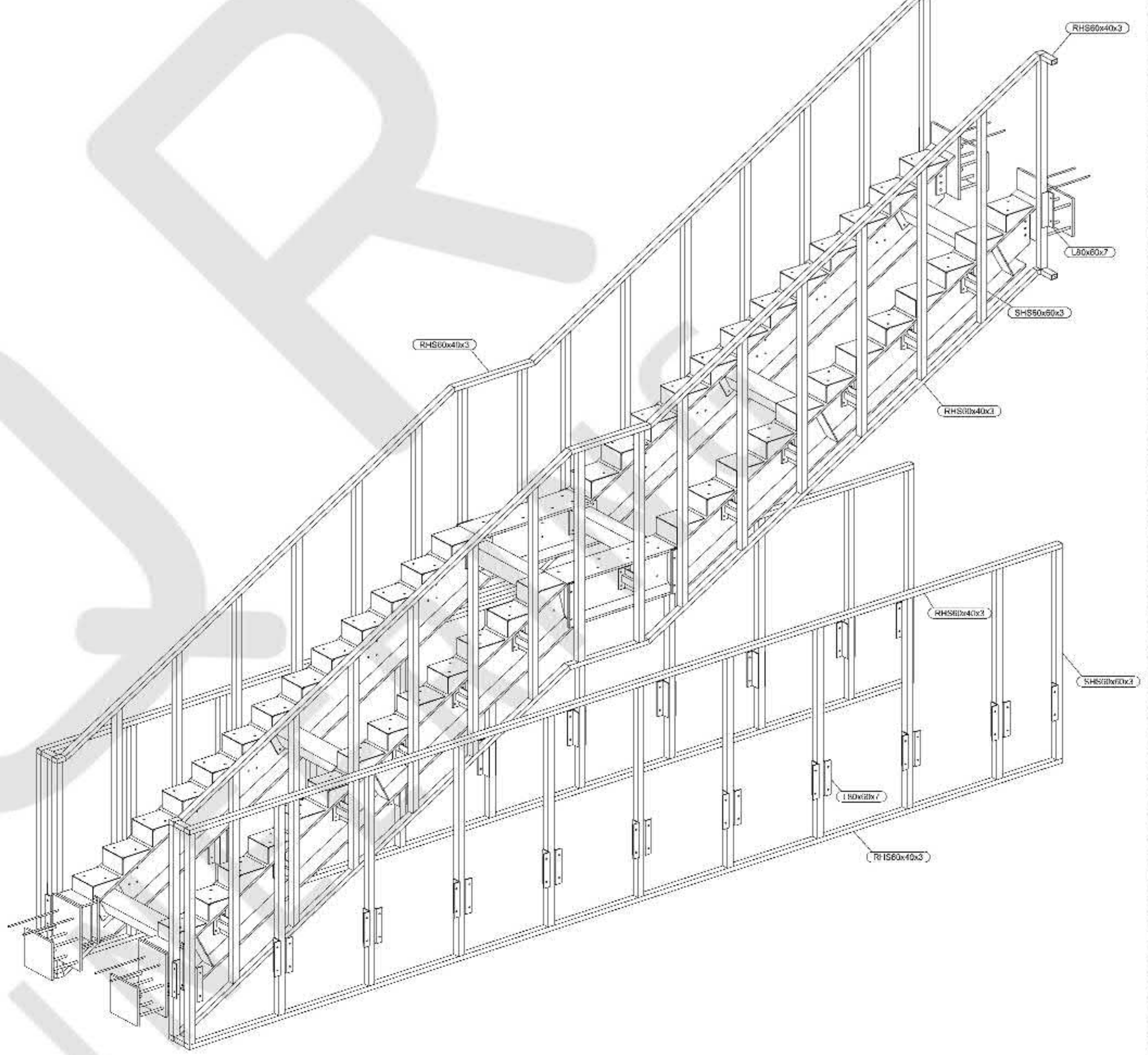
Presek B-B / Section B-B
R1:10



Presek D-D / Section D-D
R1:10

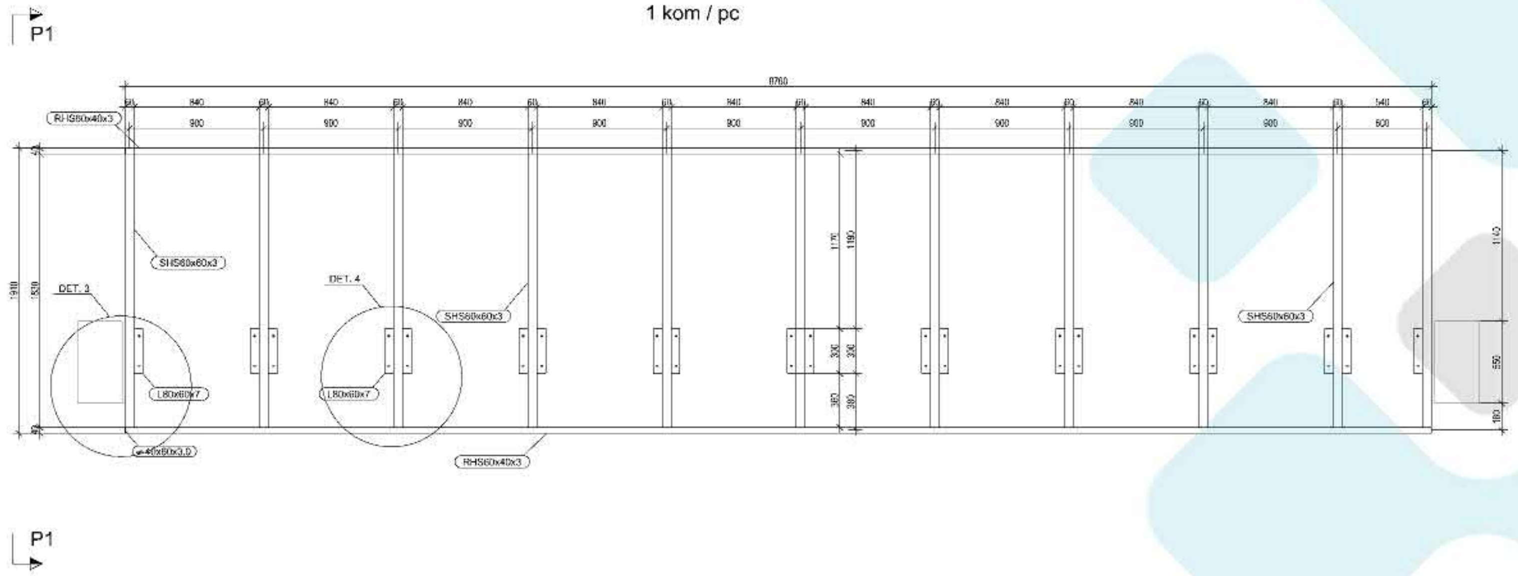


3D Prikaz / 3D View
R1:20

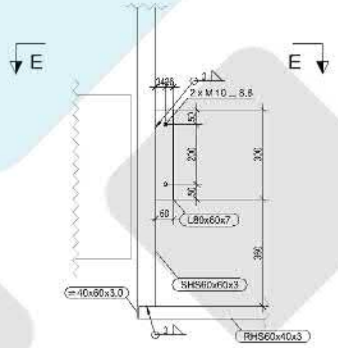


Ograda - Tip 6 / Handrail - Type 6
Presek P3-P3 / Section P3-P3
R1:20

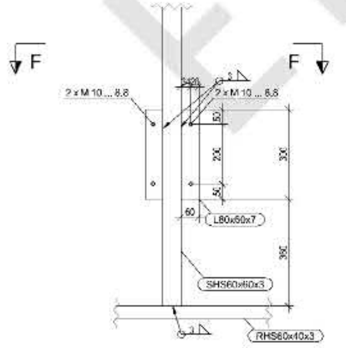
1 kom / pc



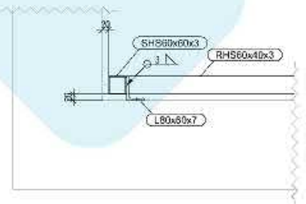
Detalj 3 / Detail 3
R 1:10



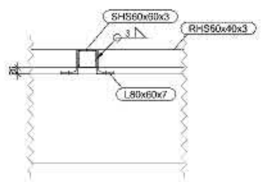
Detalj 4 / Detail 4
R 1:10



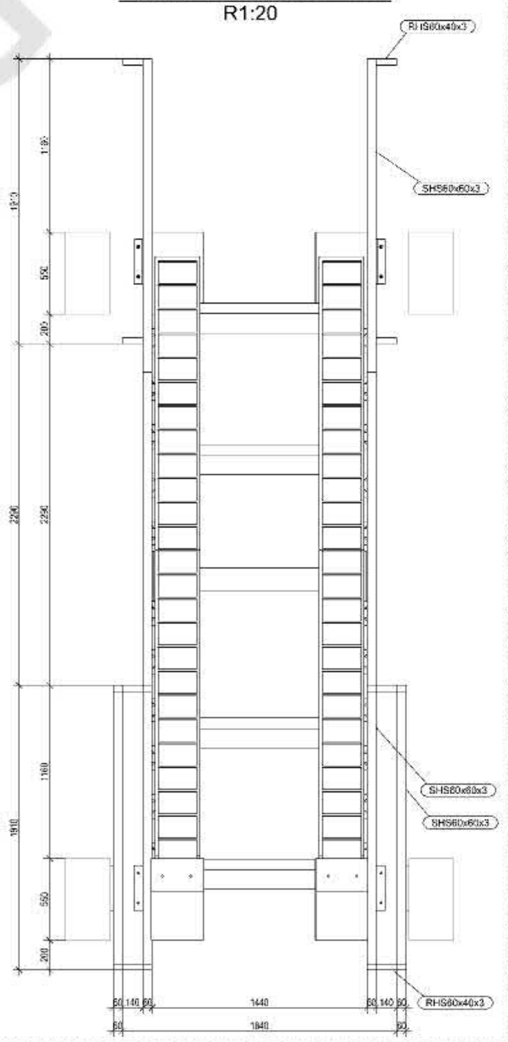
Presek E-E / Section E-E
R1:10



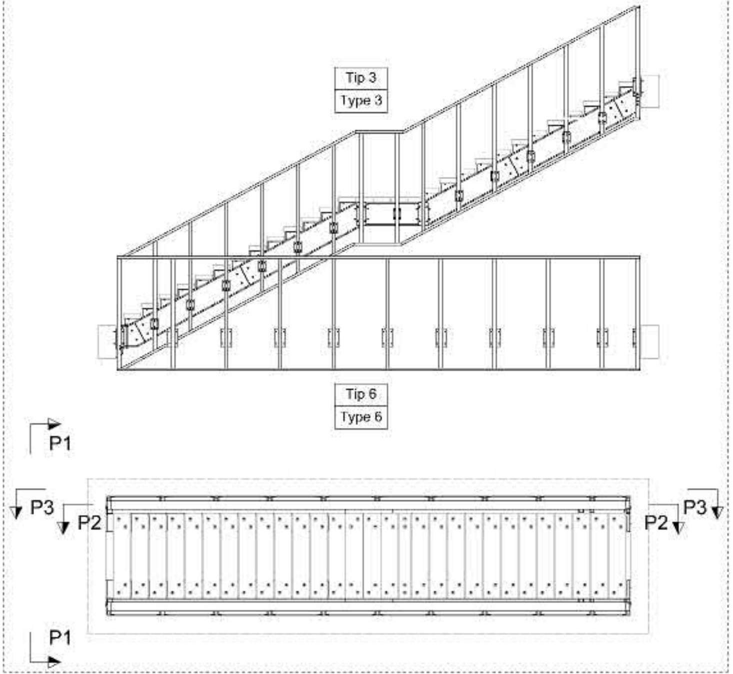
Presek F-F / Section F-F
R1:10



Presek P1-P1 / Section P1-P1
R1:20



Dispozicija tipova ograda / Layout of handrail types
R1:50



NAPOMENE

1. Osnovni materijal za sve elemente čelične konstr. je S235JRG2.
2. Svi šavovi su "C" kvaliteta.
3. Svi ugaoni šavovi koji nisu označeni debljine su 0,7t min, ali ne manje od 3 mm, osim kod veze šupljih profila kod kojih je debljina šavova jednaka debljini zida.
4. Svi kontakti čeličnih elemenata, osim veza sa zavrtnjima, zavareni su odgovarajućim ugaonim ili sučeonim šavovima.
5. Sve šuplje profile zatvoriti 5mm čeličnom pločom.
6. Osnovni materijal za ankerne šipke je armatura B500B.
7. Osnovni materijal za zavrtnjeve je čelik klase 8.8.
8. Visinske kote preuzete iz projekta arhitekture ili armirano-betonske konstrukcije.
9. Neusaglašenosti i odstupanja u crtežima i/ili tekstualnim prilozima projekta obavezno razrešiti sa autorom i odgovornim projektantom.
10. Izmene u delu projekta za vreme građenja vršiti samo uz saglasnost autora i odgovornog projektanta.
11. Sve dimenzije proveriti na licu mesta!

REMARKS

1. Basic material for all elements of the steel construction is S235JRG2.
2. All welds are of "C" quality.
3. All fillet welds which are not marked are of thickness 0.7 t min. but are not smaller than 3mm, except for the hollow profies where they are the same as the wall of the profile.
4. All contacts of steel elements, other than embroidery with screws, are welded with appropriate fillet or butt welds!
5. All hollow profiles are to be closed with 5mm steel plate.
6. Basic material for all anchor rods is rebar B500B.
7. Basic material for all bolts is steel grade 8.8.
8. Elevation dimensions are taken from the architectural design or concrete structure design.
9. Inconsistencies in either drawings and/or textual appendices will have to be resolved with both the author and the design professional in responsible charge.
10. Design variations which may emerge during construction are only to be made with prior approval from both the author and the design professional in responsible charge.
11. All dimensions need to be checked on the spot!

EN 1090-2 - Klasa izvođenja: / Execution class:	EXC2
EN ISO 12944 - Antikoroziona zaštita: / Corrosion protection:	C2
Protivpožarne zaštita: / Fire protection:	/