



HRVATSKA KOMORA INŽENJERA GRAĐEVINARSTVA

15. Dani Hrvatske komore inženjera građevinarstva

Opatija, 2021.

PROJEKT OBNOVE RAZINA 3
Gornjogradska gimnazija T. Brezovački
projekt i realizacija

Prof. Boris Baljkas

Prof. Boris Baljkas, dipl.ing.građ., BALJKAS-PROJEKTI jdoo, Zagreb

Mario Benutić, dipl.ing.građ., PLAN-PLUS doo, Zagreb

Dr.sc. Zvonko Sigmund, dipl.ing.građ., Građevinski fakultet, Zagreb

PLAN PLUS d.o.o.

Zagreb, Bitorajska 12
OIB: 27512198316
ured: Mirogojska cesta 21, 10 000 Zagreb

Tel: +385 1 4824 456
Fax: +385 1 4824 456
E-mail: planplus@planplus.hr

.....
Investitor:

Grad Zagreb, Trg Stjepana Radića 1, 10 000 Zagreb
OIB: 61817894937

.....
Vrsta projekta:

Glavni projekt

.....
Gradevina:

Zgrada gimnazije Tituš Brezovački

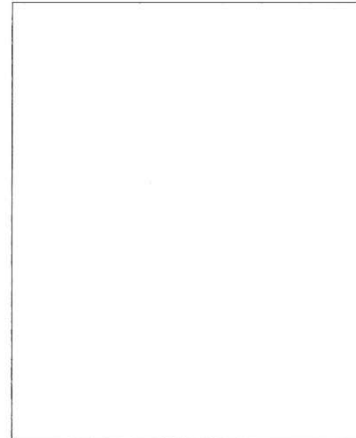
.....
Lokacija građevine:

Ulica Jurja Habelića 1, 10 000 Zagreb
k.č. 1591 k.o. Centar

.....
Zajednička oznaka projekta: 47/2020

.....
Tehnički dnevnik: 47K/2020

.....
**MAPA: 02 GRAD PROJEKT
MEHANIČKE OTPORNOSTI KONSTRUKCIJE**



GLAVNI PROJEKT REKONSTRUKCIJE ZGRADE GIMNAZIJE TITUŠ BREZOVAČKI

Glavni projektant:

Mario Benutić dipl.ing.građ.
Broj ovlaštenja: G 964

MARIO BENUĆIĆ Digitally signed by MARIO
BENUĆIĆ
Date: 2021.01.12 13:59:11 +01'00'

Suradnik:

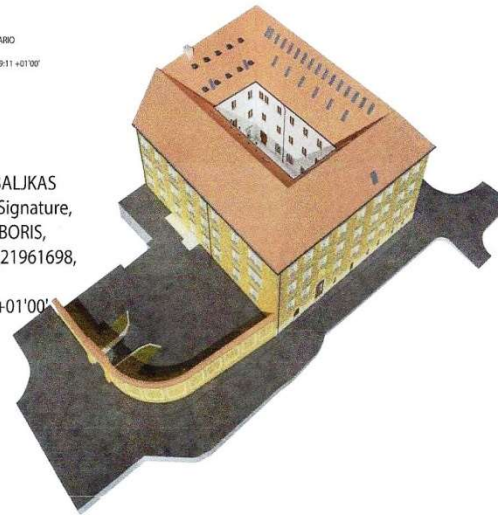
Zvonko Sigmund
Broj ovlaštenja: G 6658

Digitally signed by BORIS BALJKAS
DN: c=HR, o=HRIDCA, ou=Signature,
sn=BALJKAS, givenName=BORIS,
serialNumber=PNOHR-24621961698,
cn=BORIS BALJKAS
Date: 2021.01.13 12:49:29 +01'00'

Direktor:

Mario Benutić dipl.ing.građ.

U Zagrebu, prosinac 2020.







I FAZA







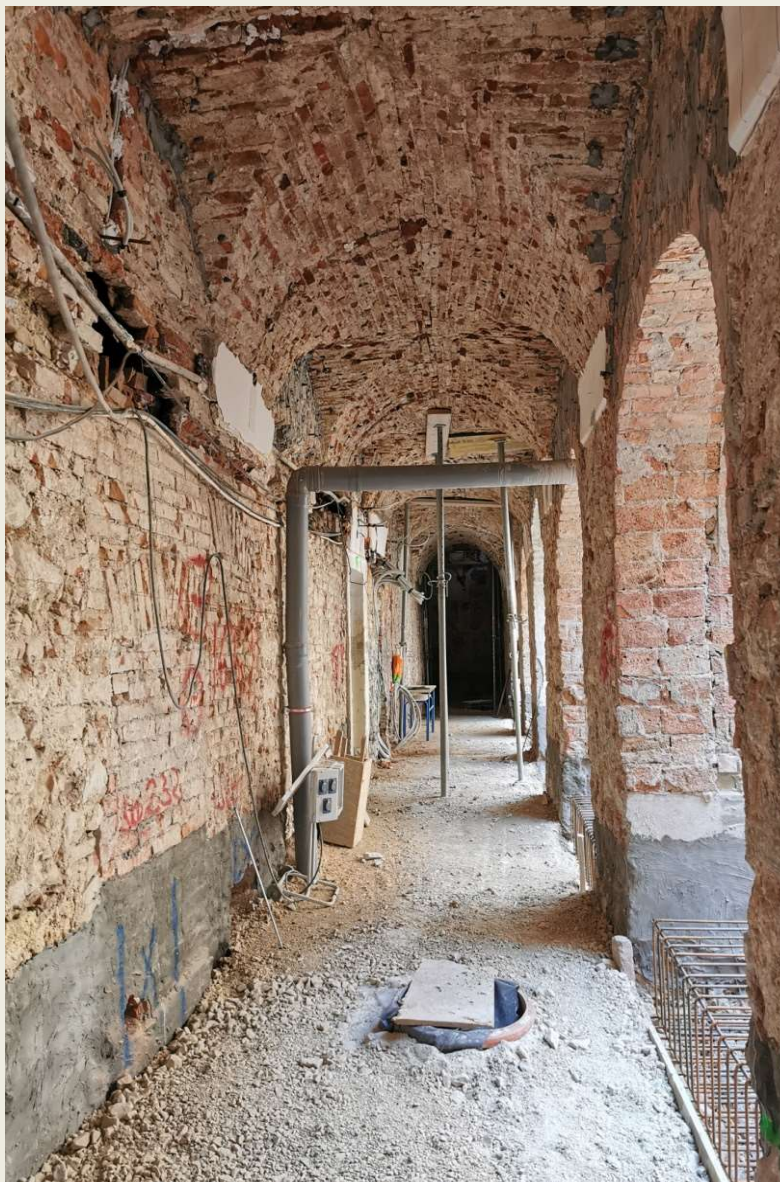


primijeniti
“nove pametne”
materijale
FRP vlakna:
carbon,
staklena,
aramidna,
kevlar,
titanium itd ..

joj joj

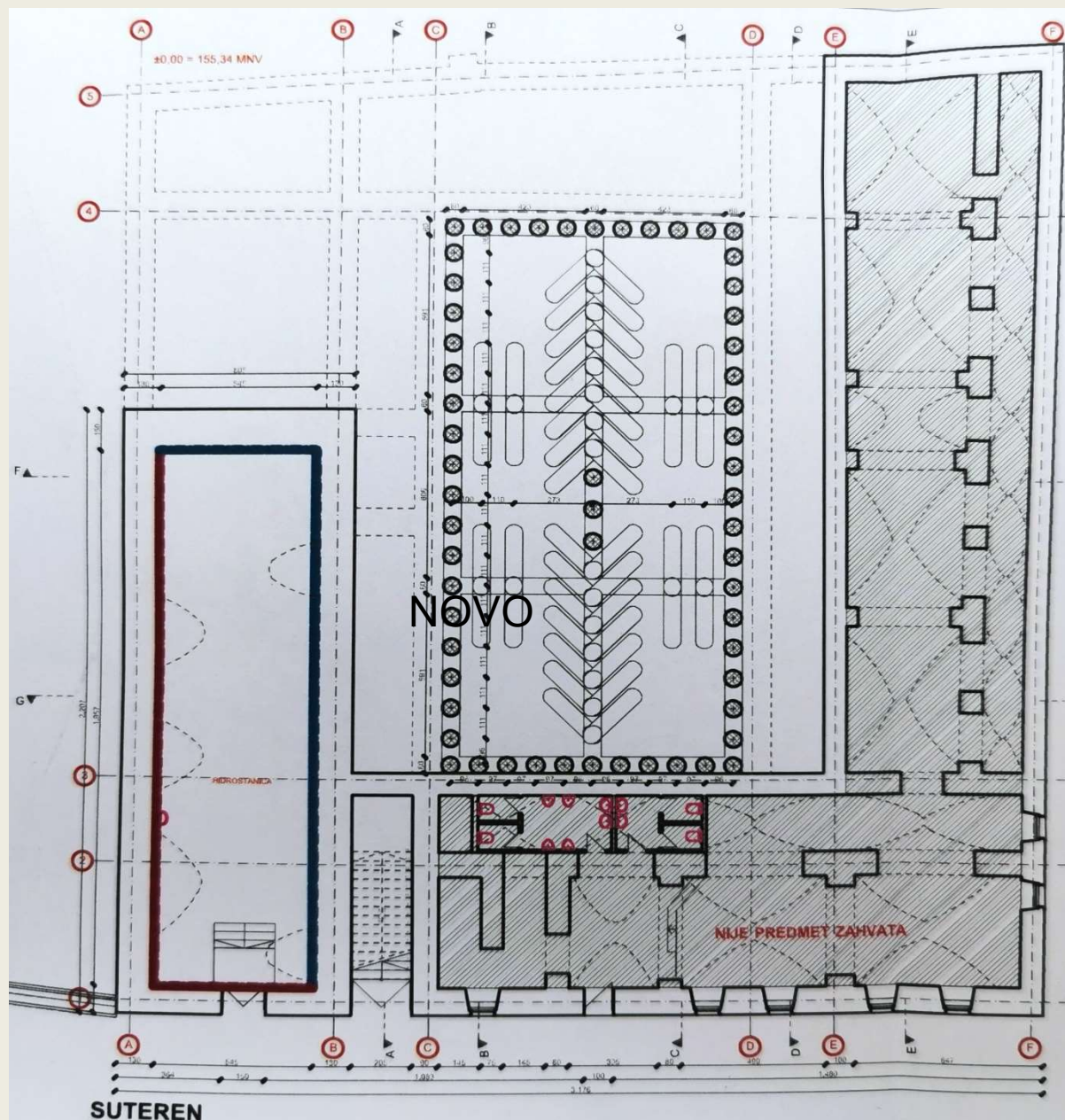








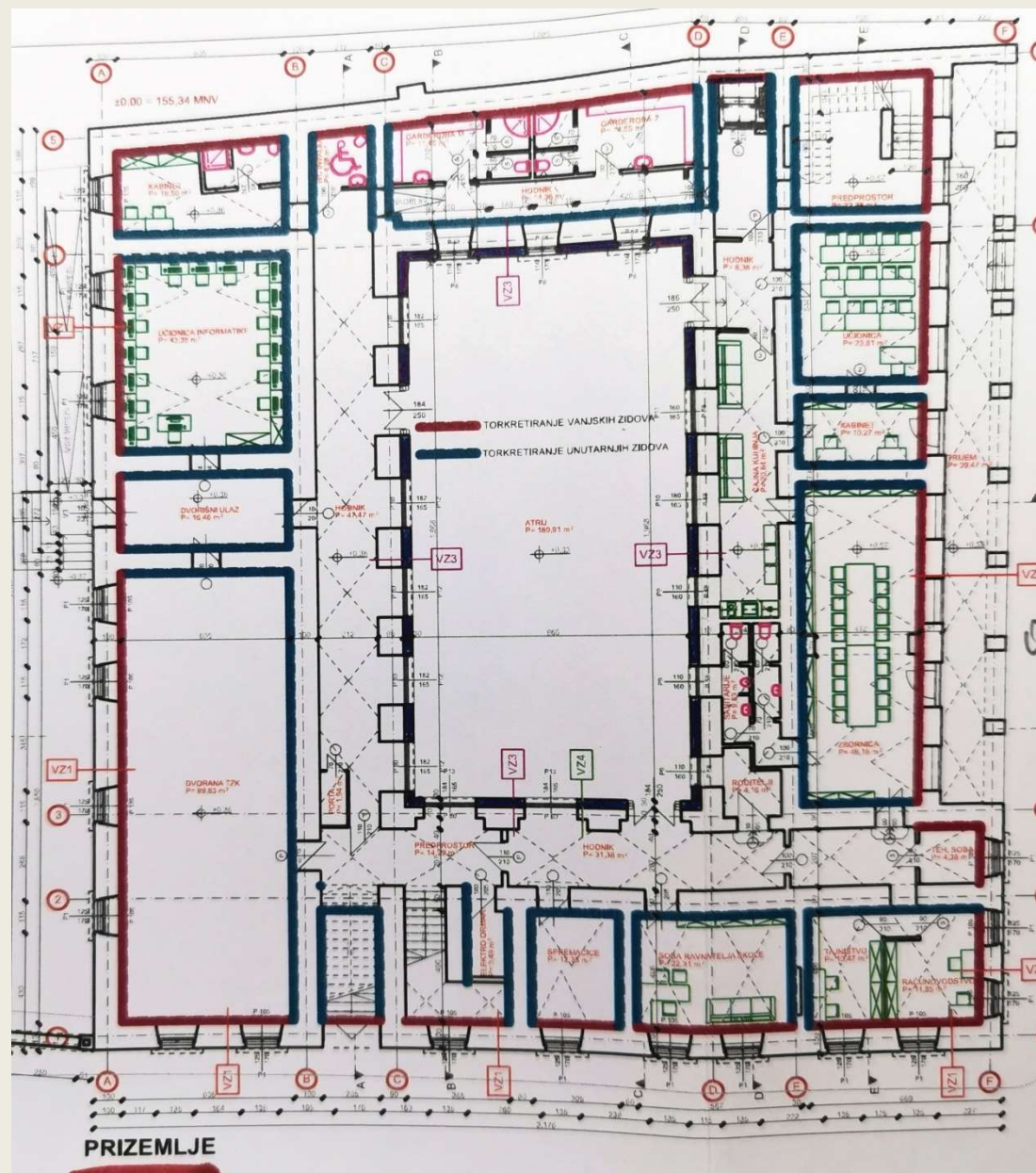
- NOVO



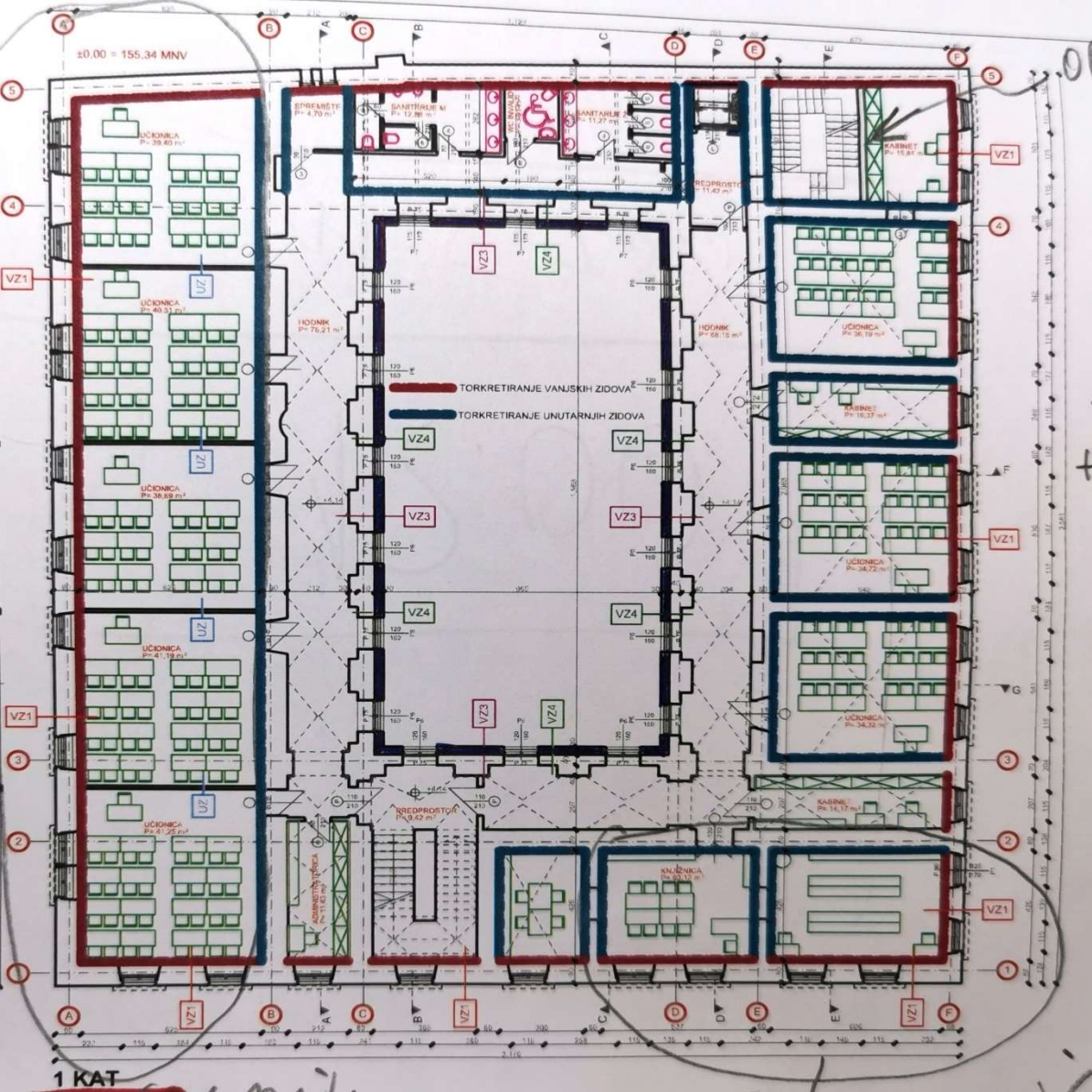
II FAZA



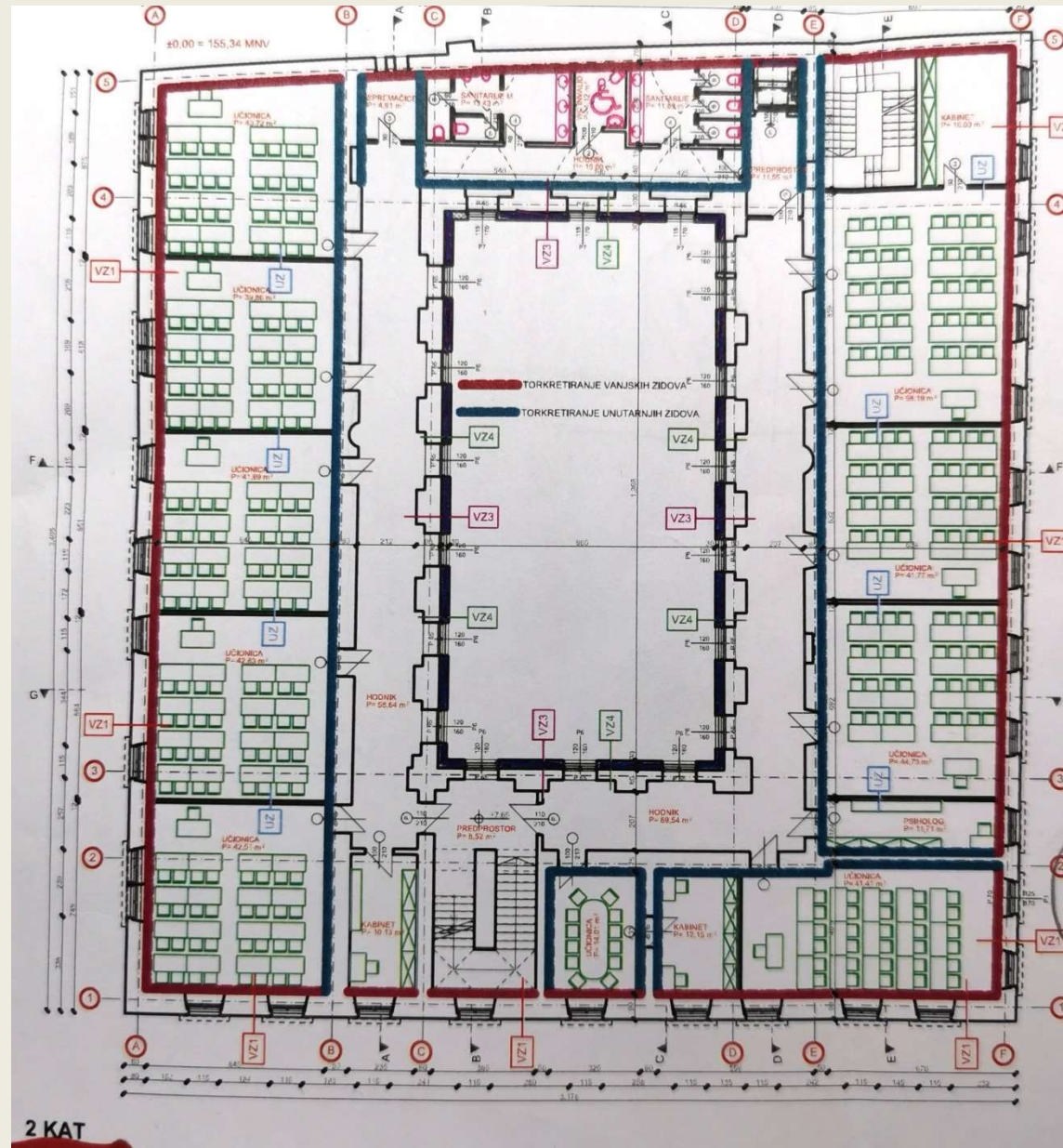
- NOVO



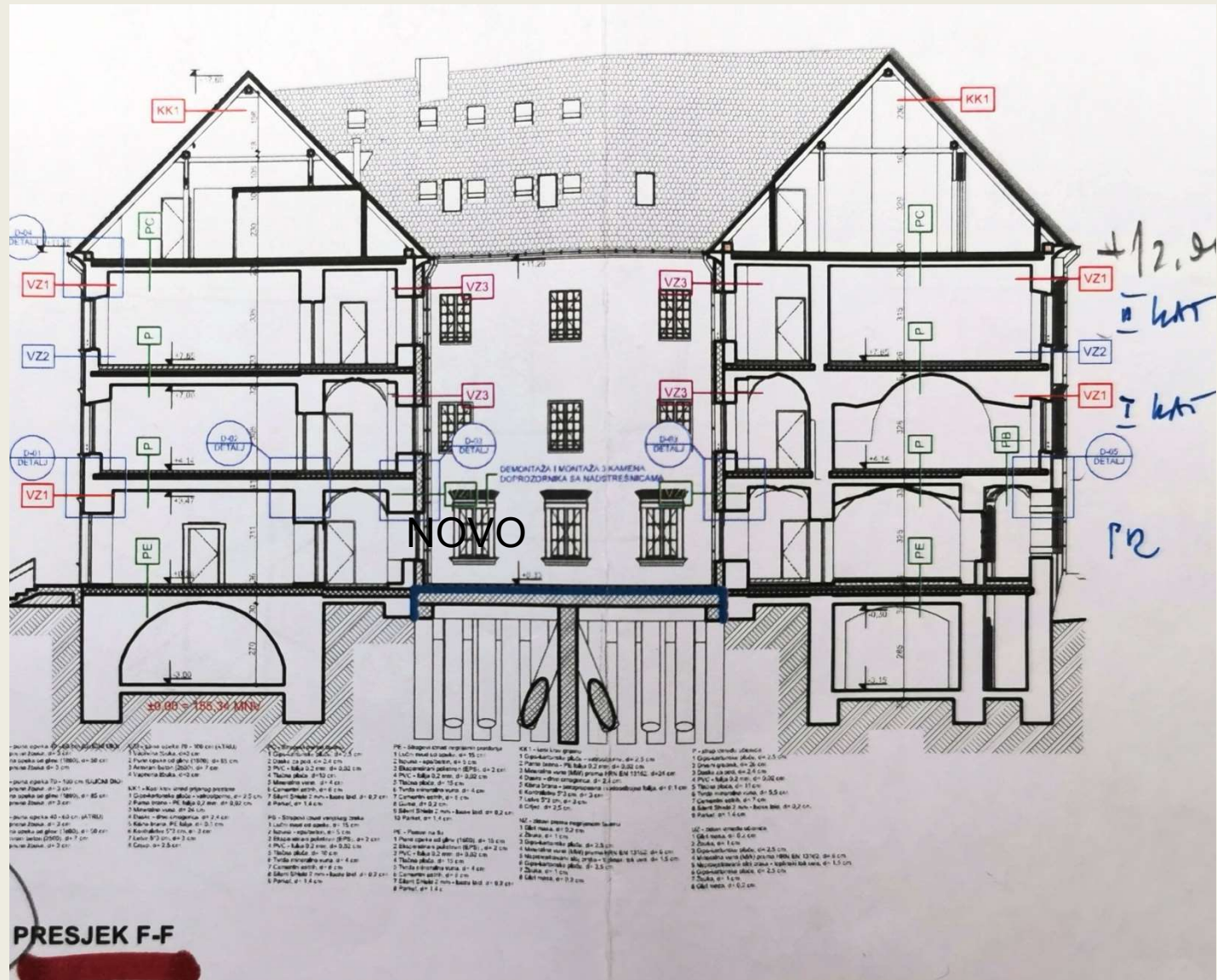
- NOVO

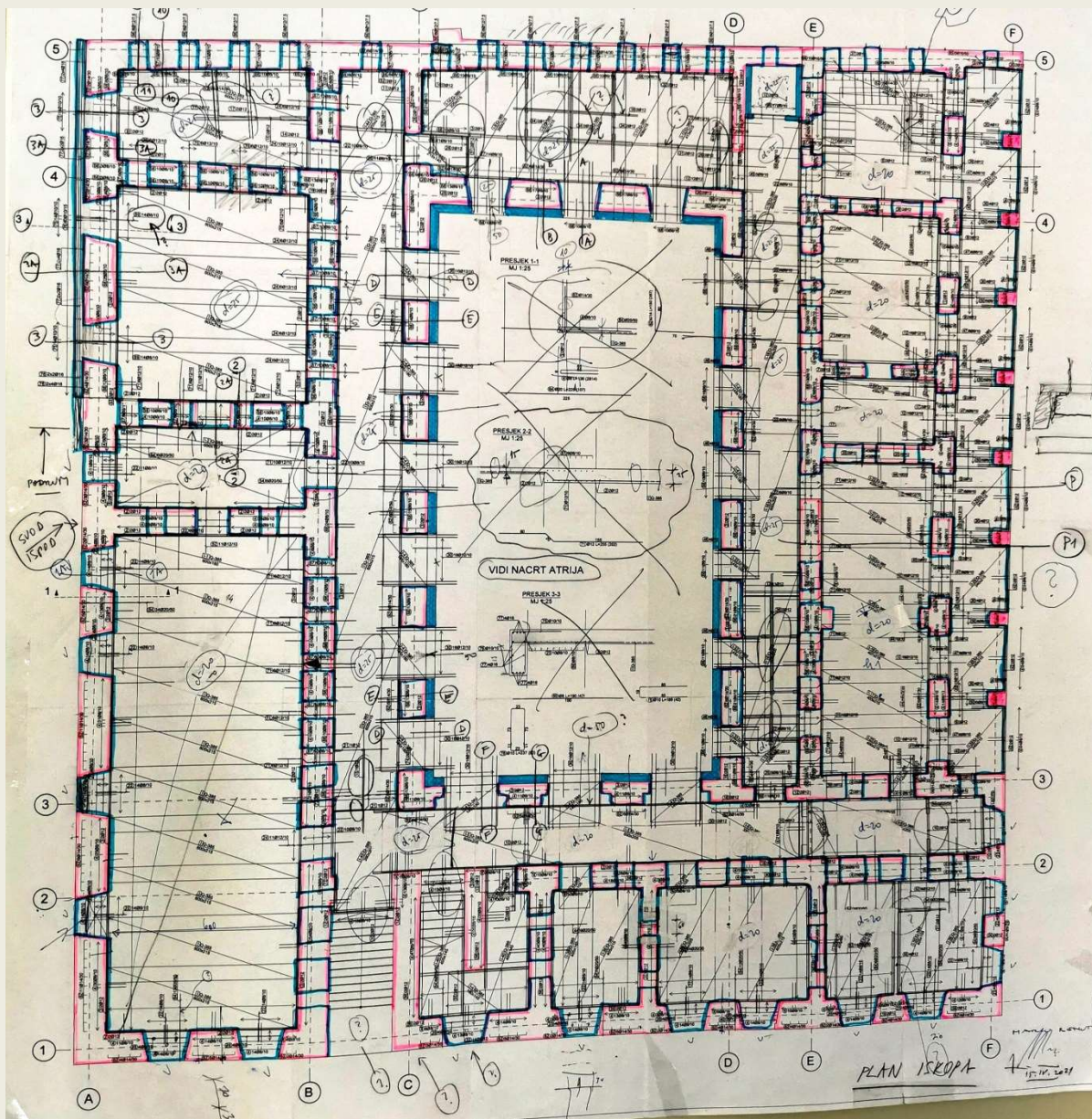


- NOVO



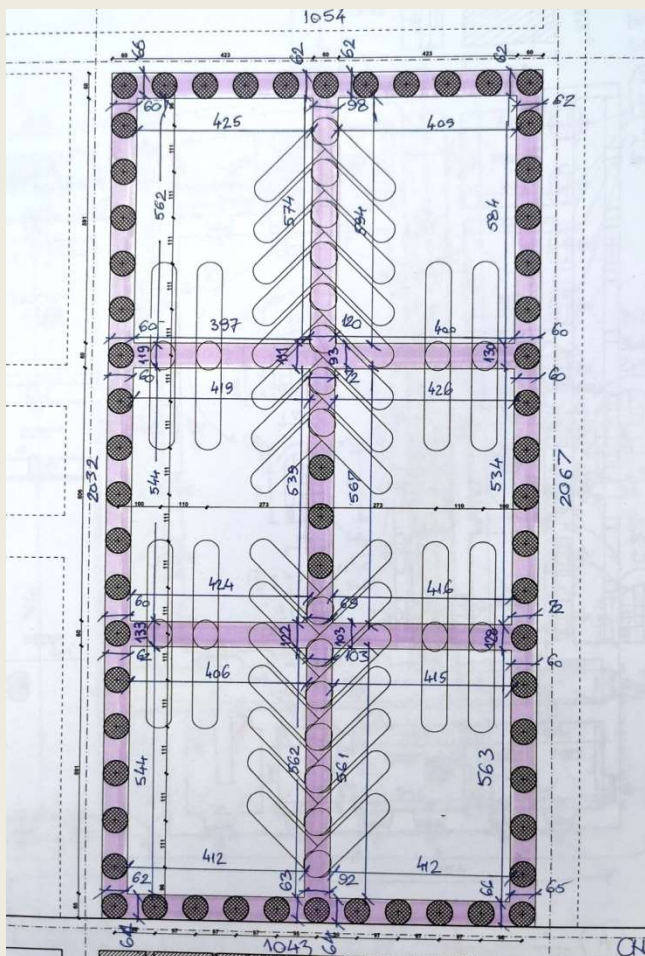
• NOVO





nivo 0.00





“piloti” u atriju



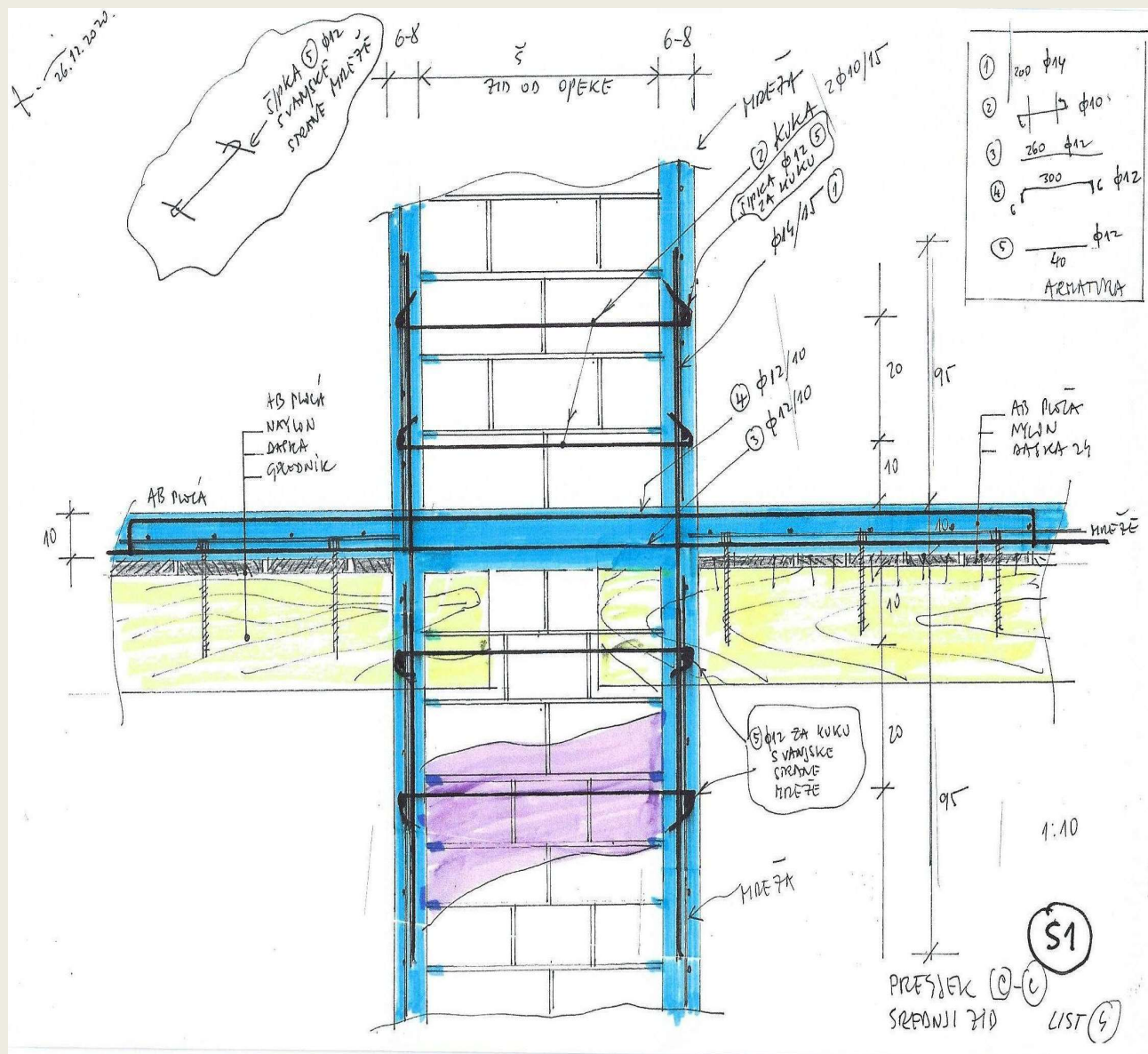


+4.00

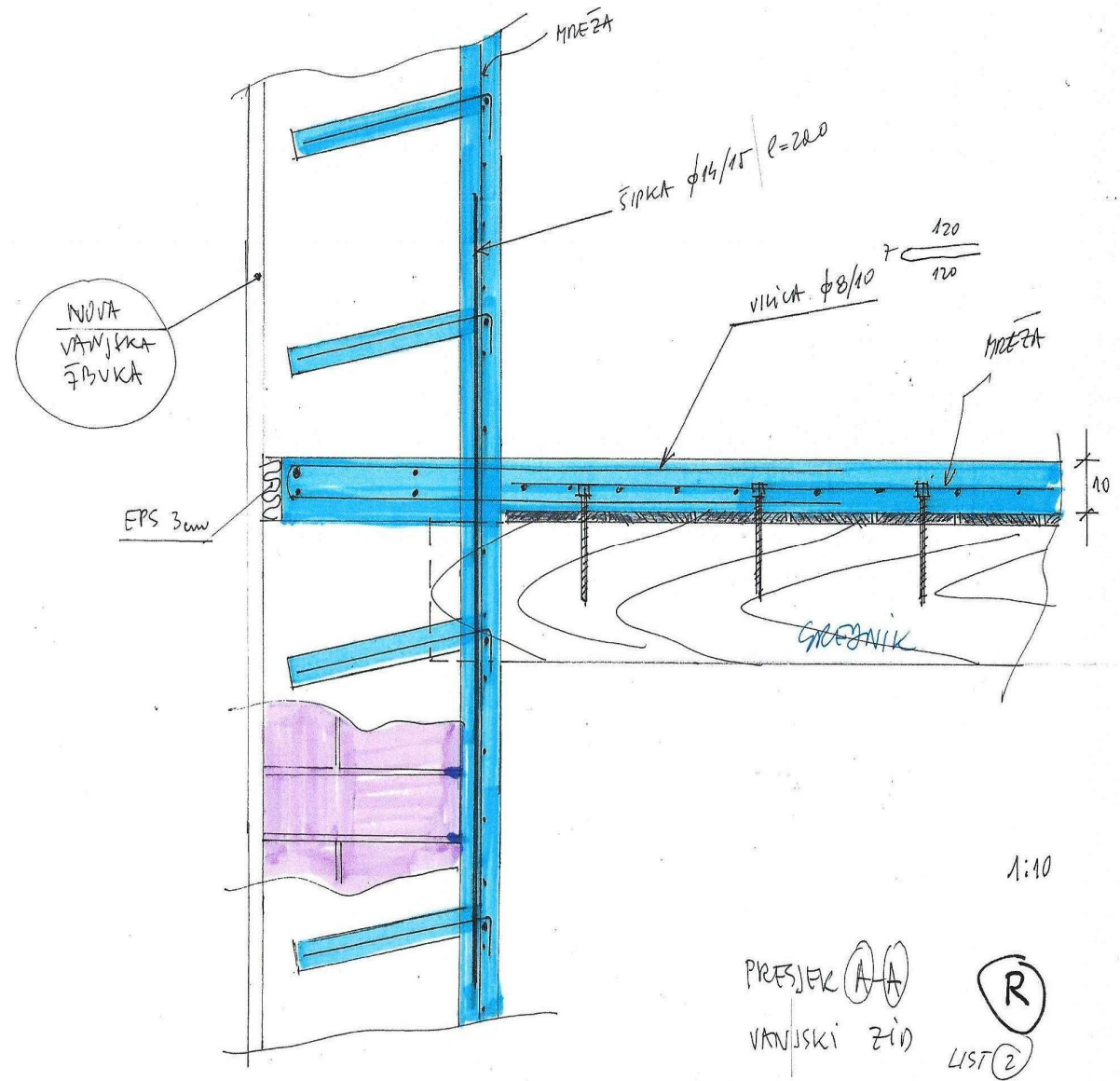


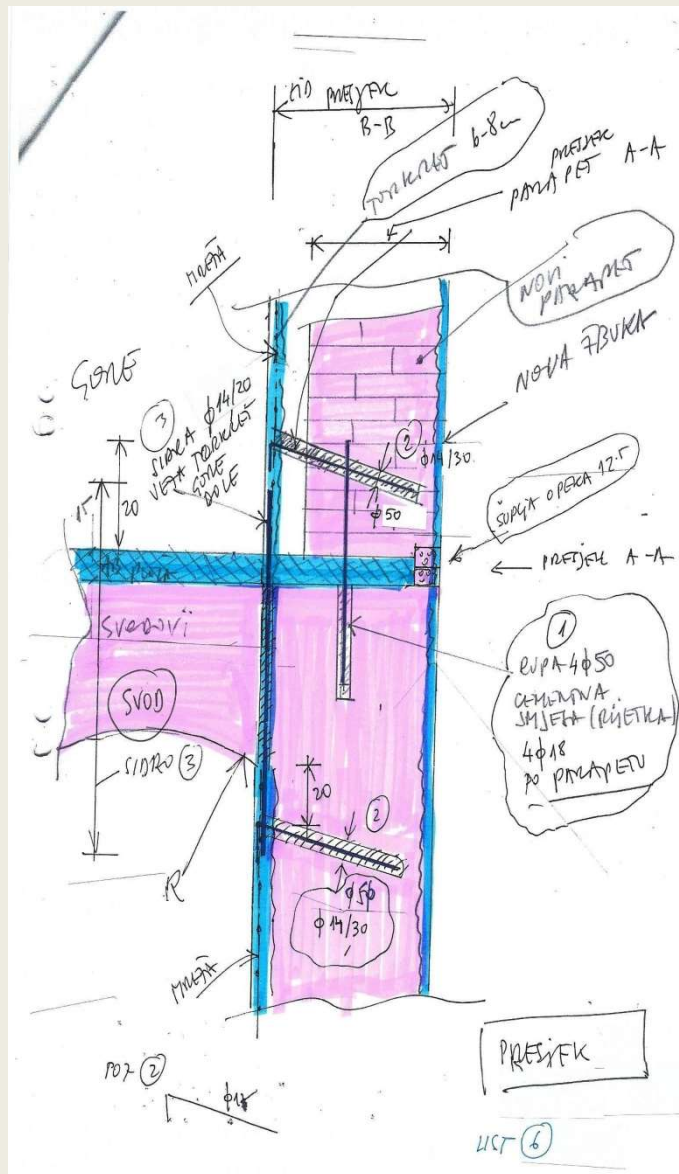
- Torkret - detalji armiranja
- unutrašnji zidovi obostrano debljina 5 – 7 cm
 - vanjski zidovi s unutrašnje strane debljini
 - cca 8 do 10 cm sa dvije mreže

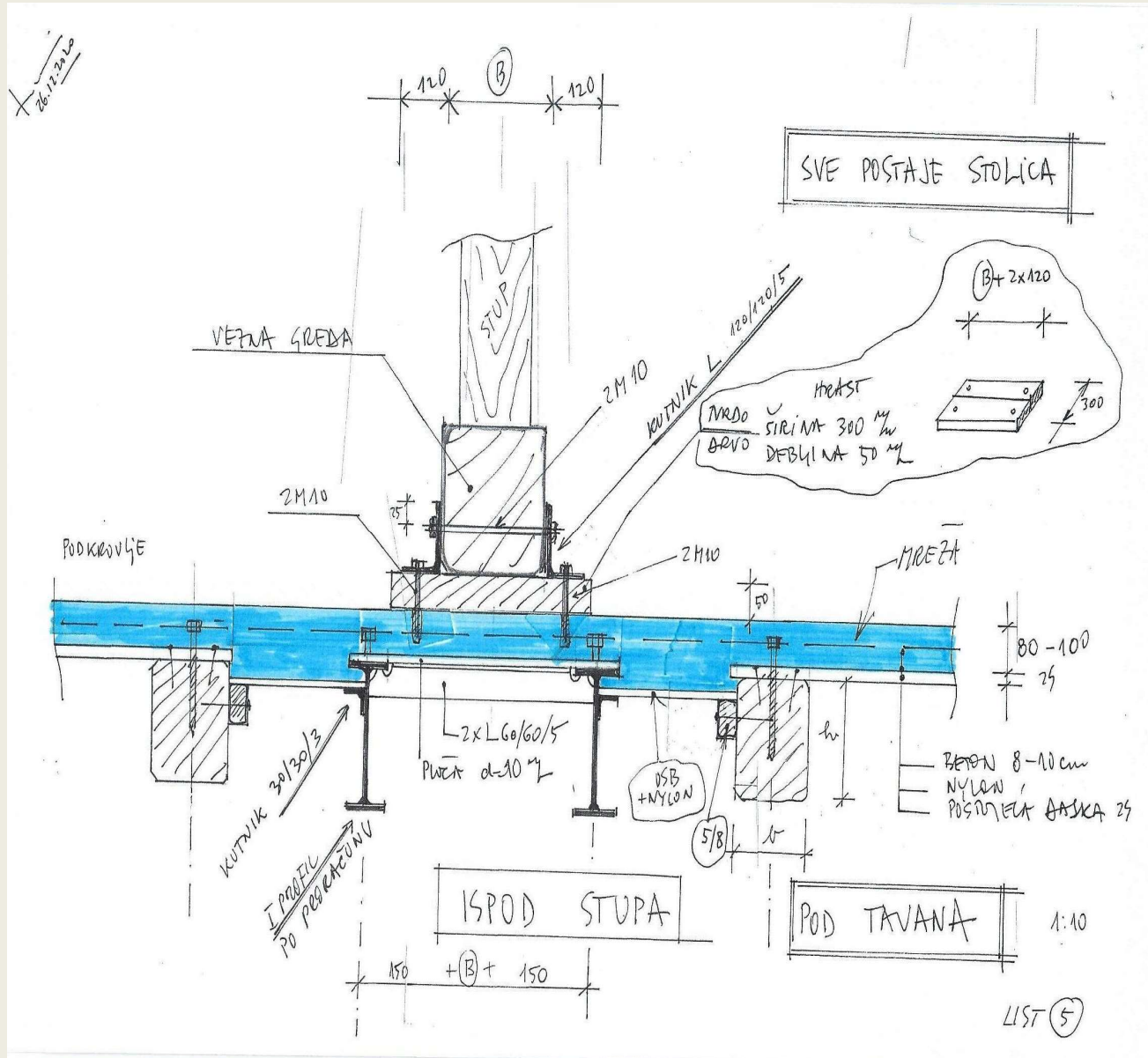




22.12.2020

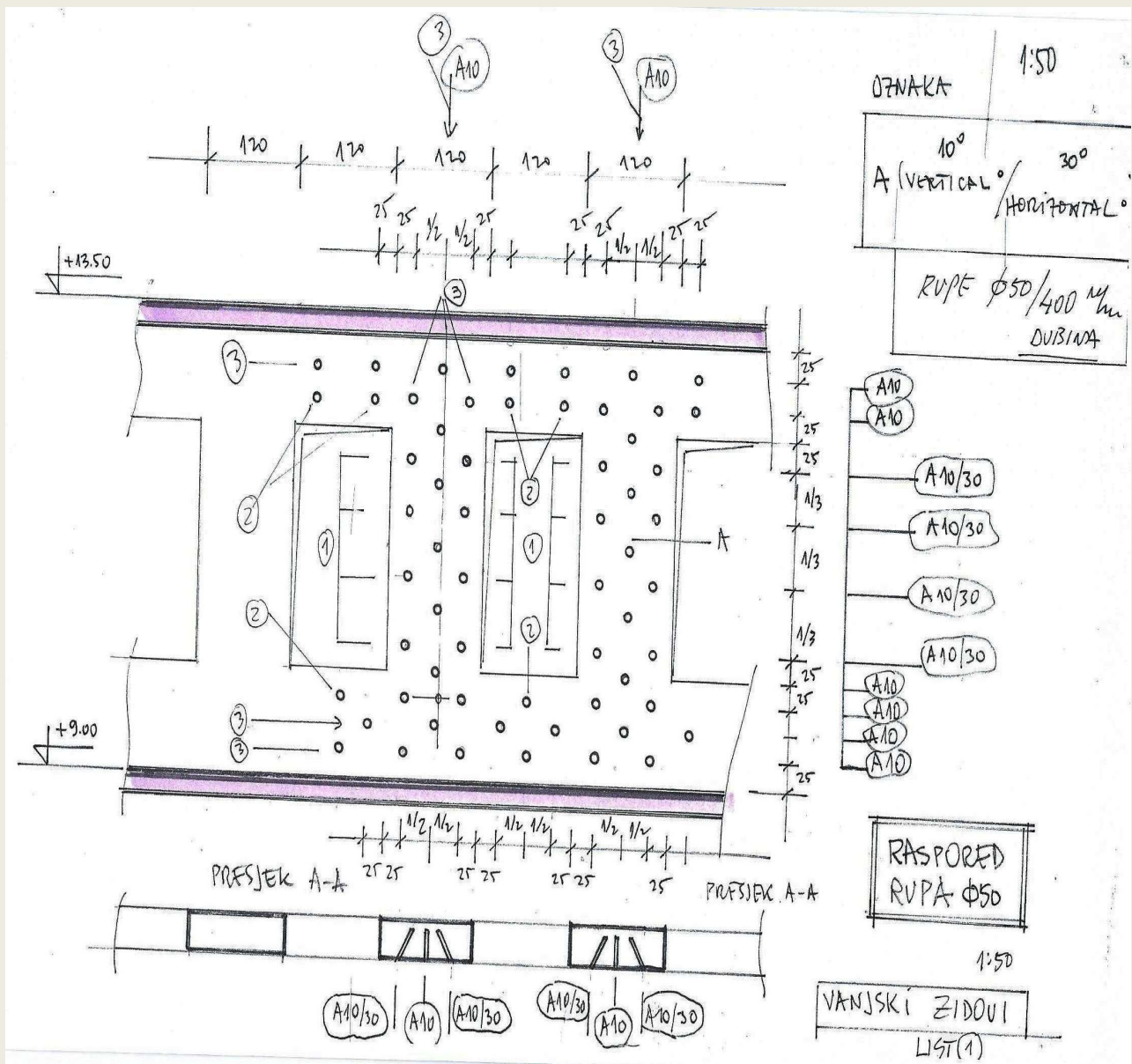


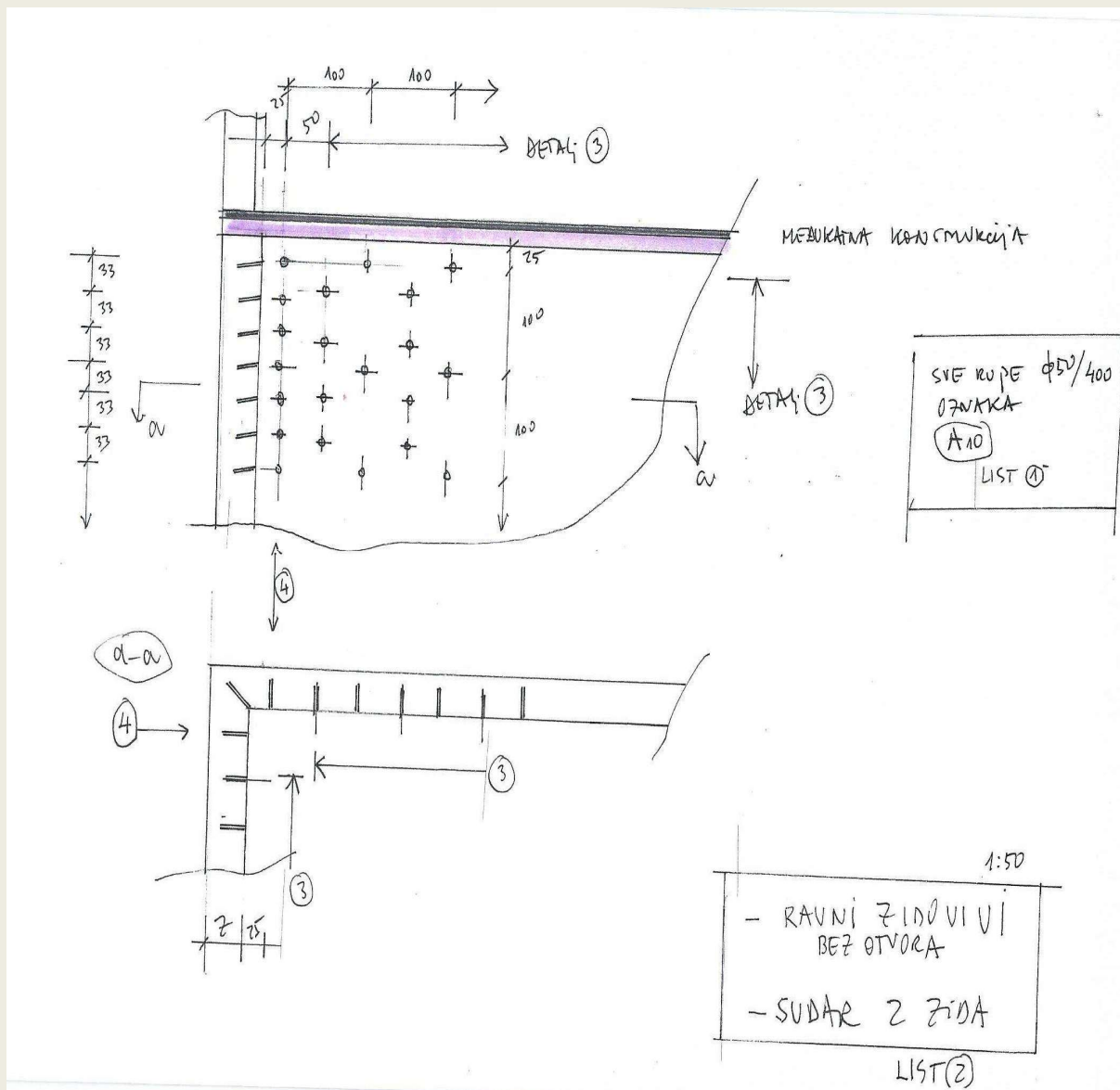


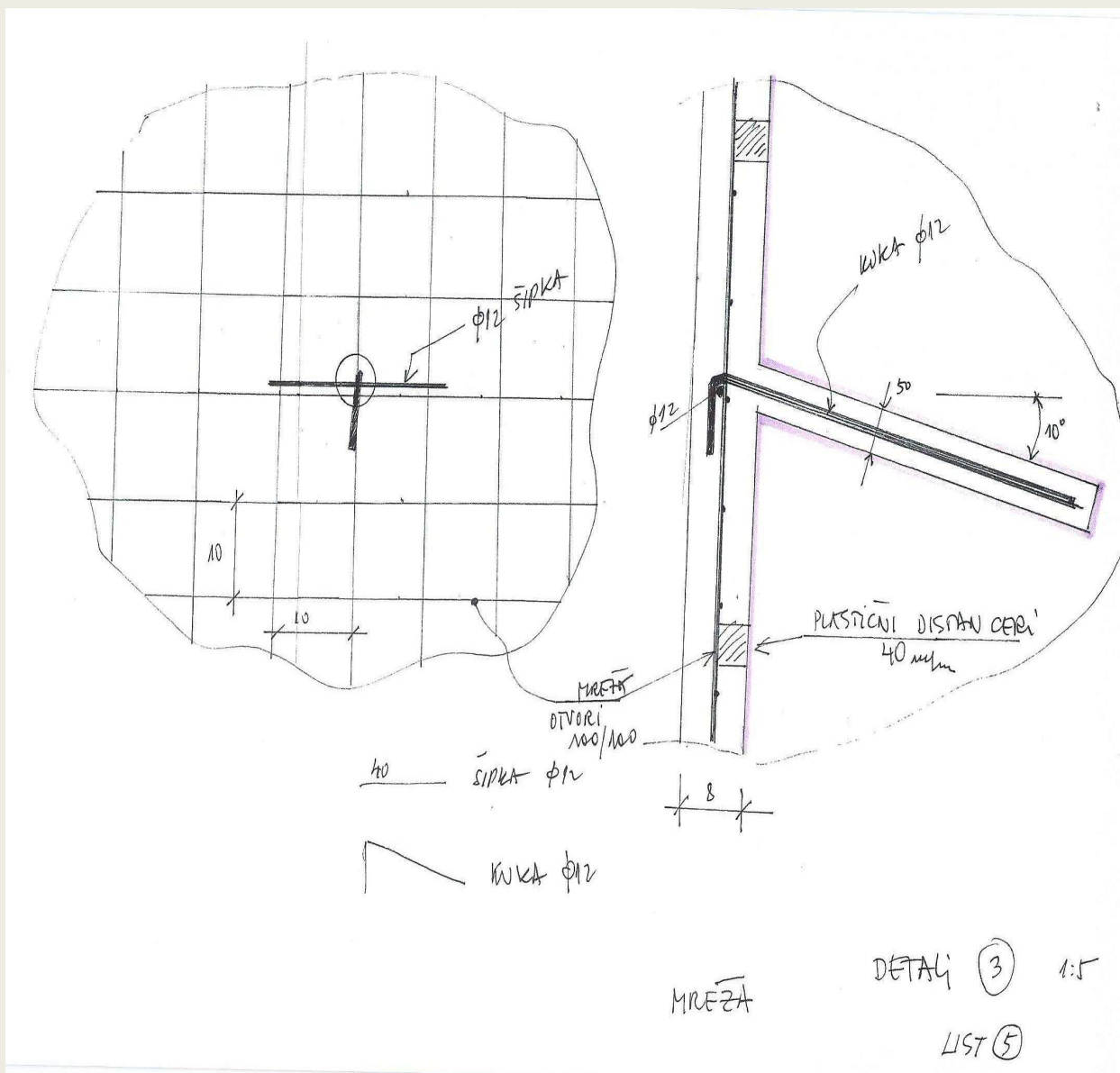


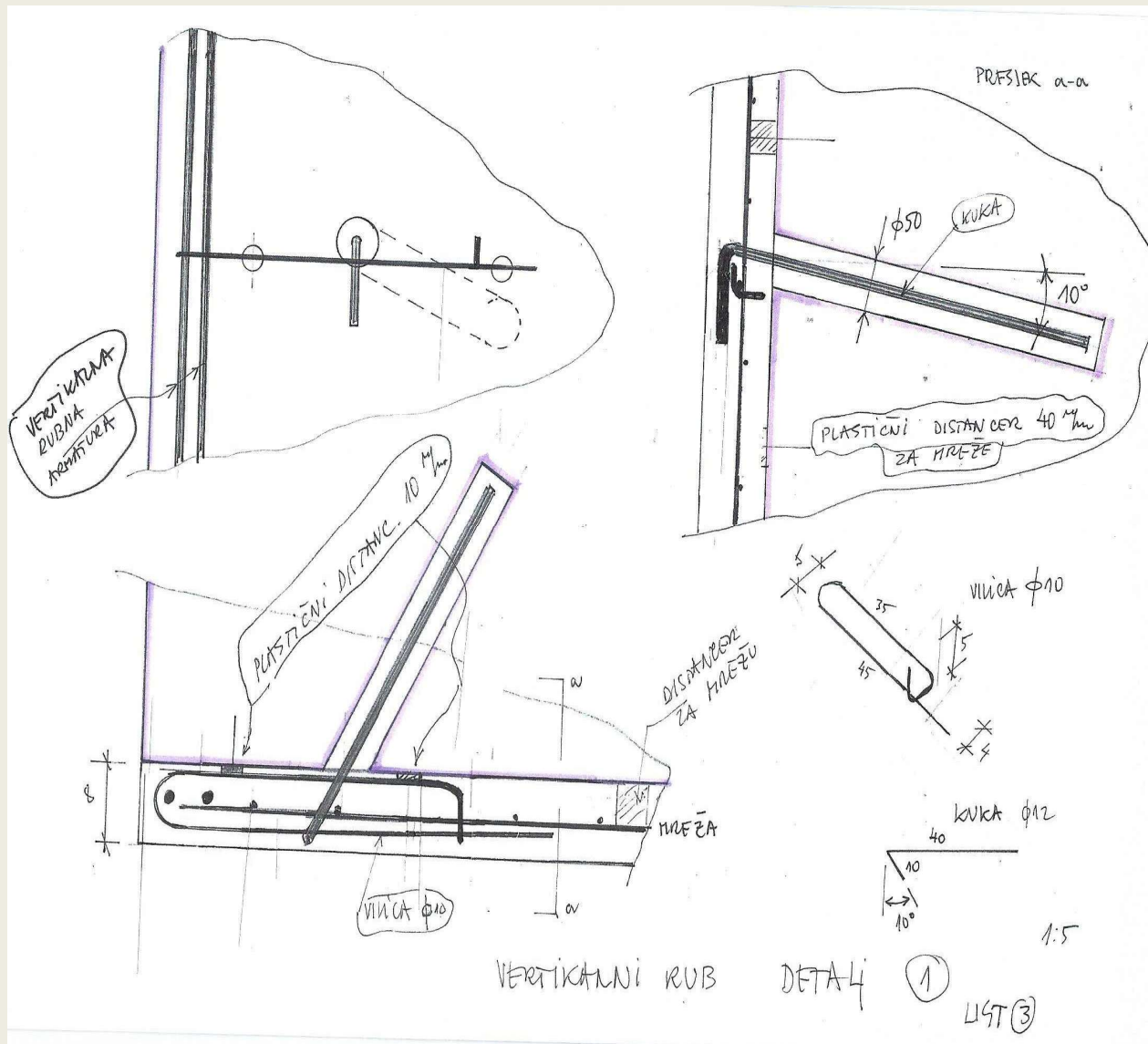
VANJSKI ZIDOVI
VEZA ZID – TORKRET JEDNOSTRANO
DETALJI

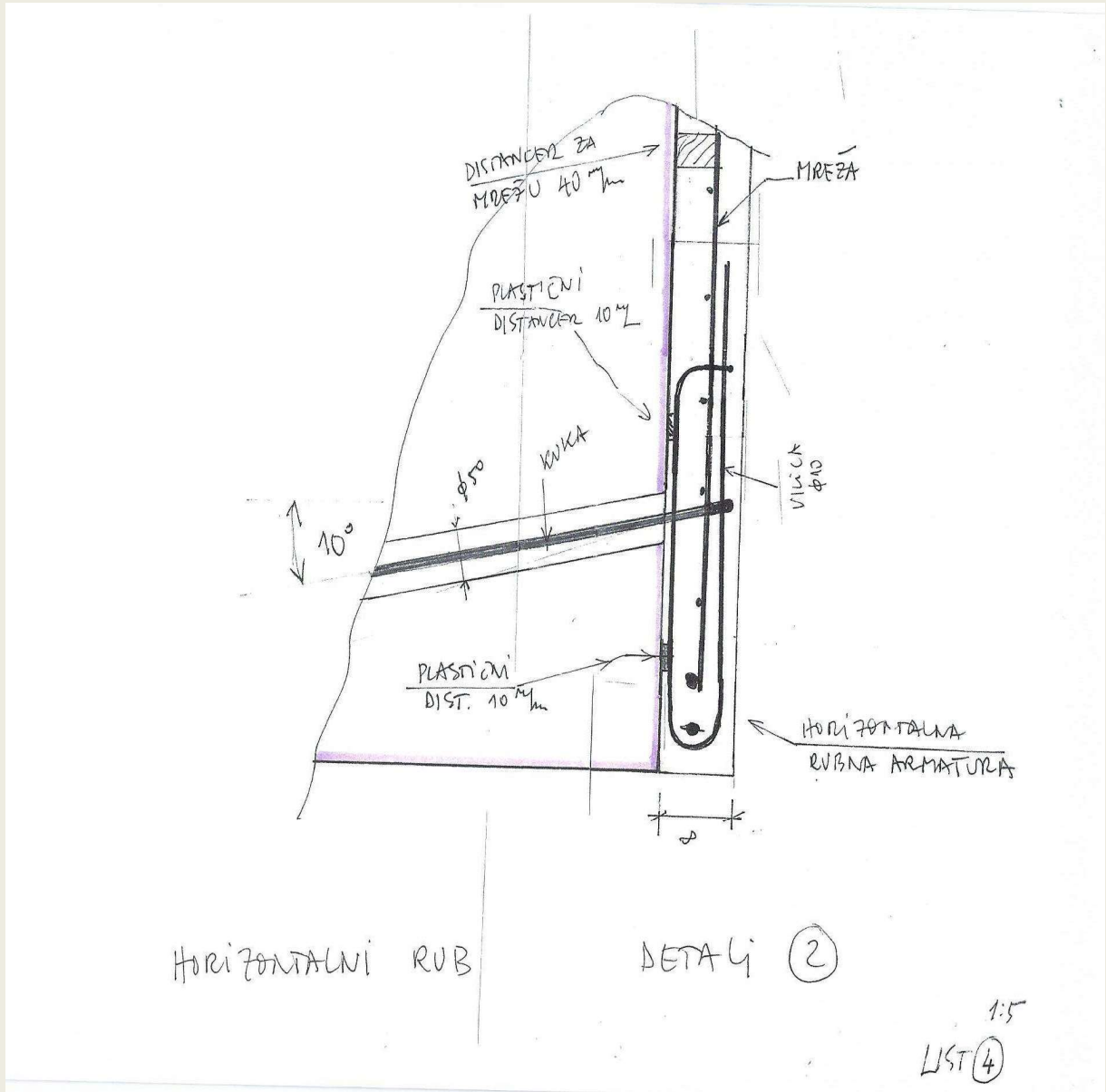


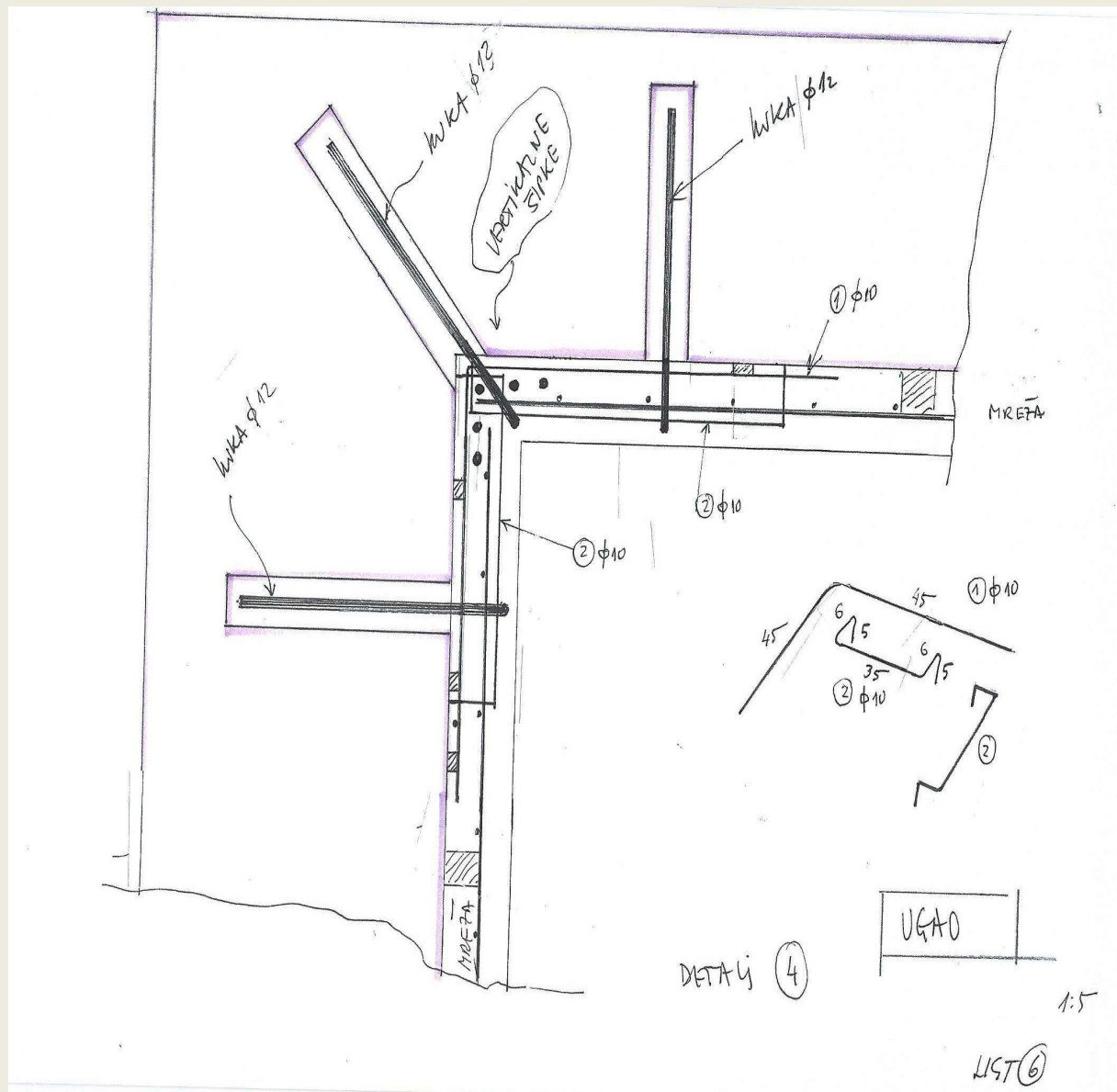


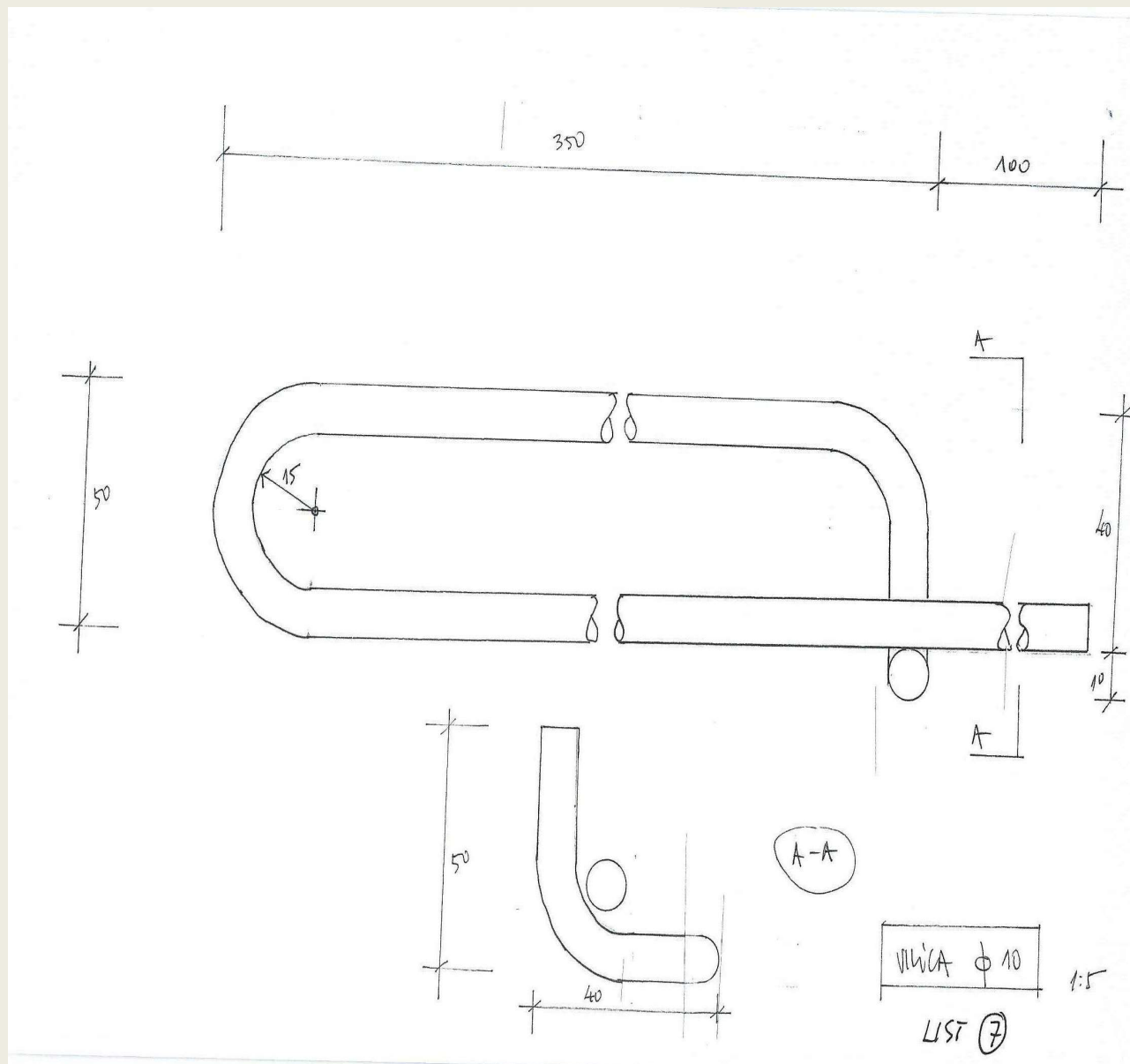






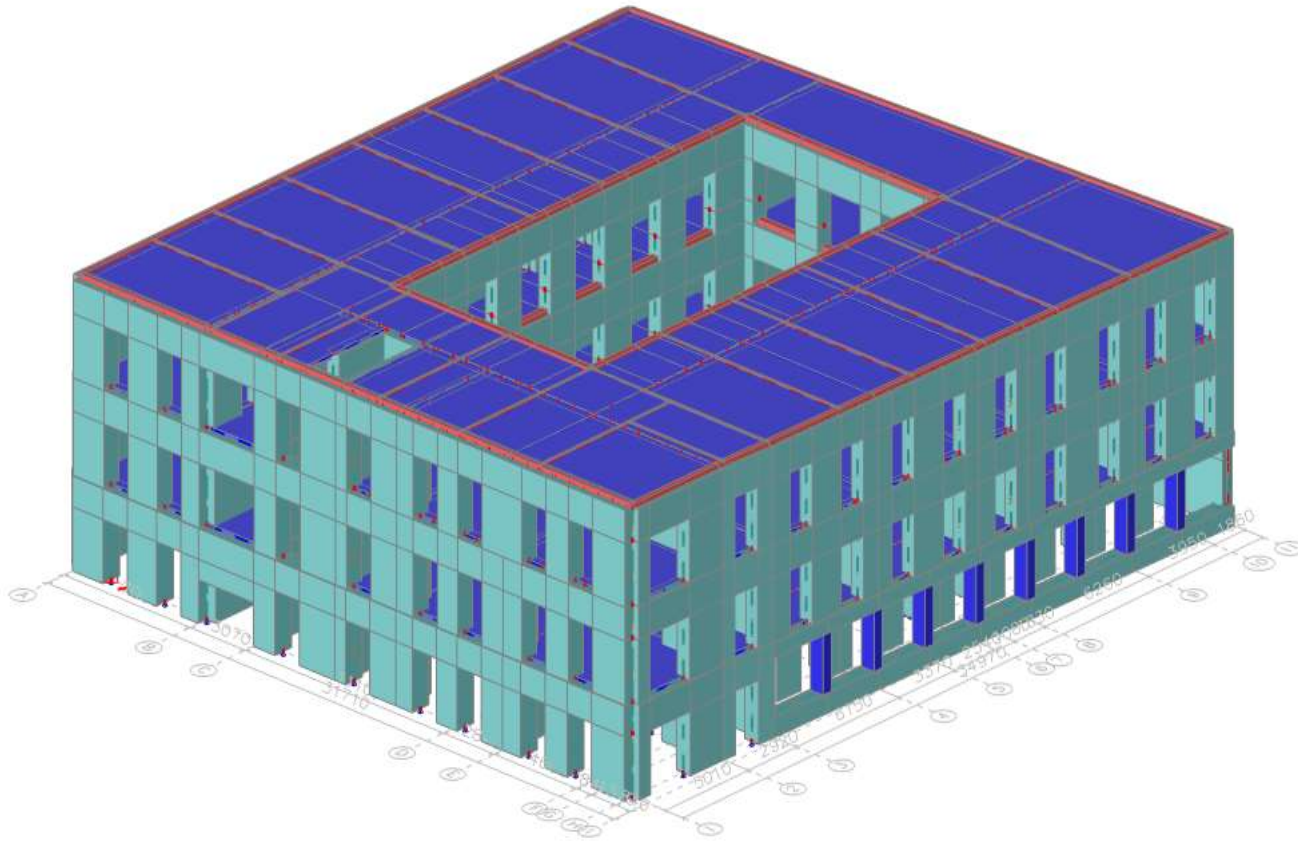




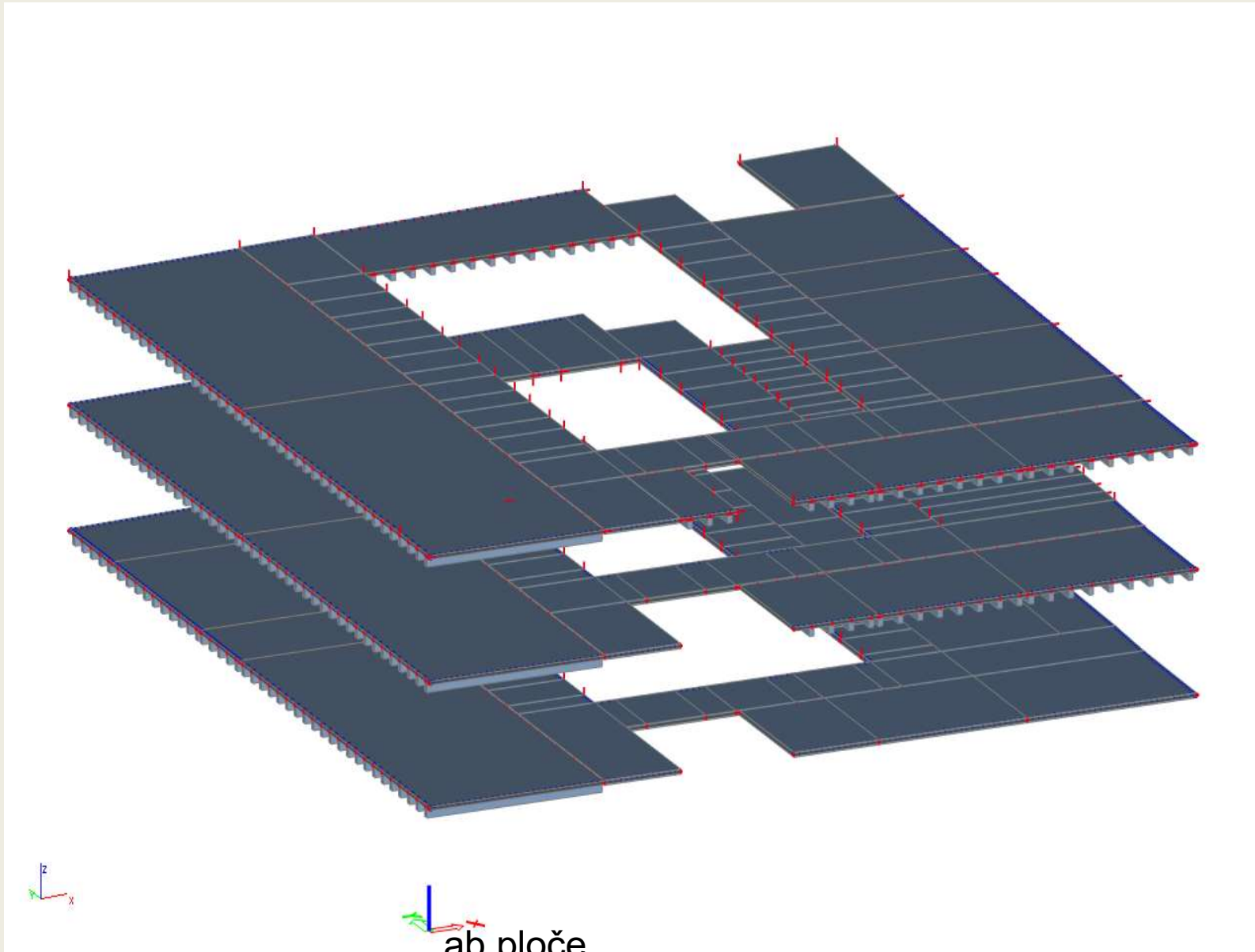


- NUMERIČKI MODEL



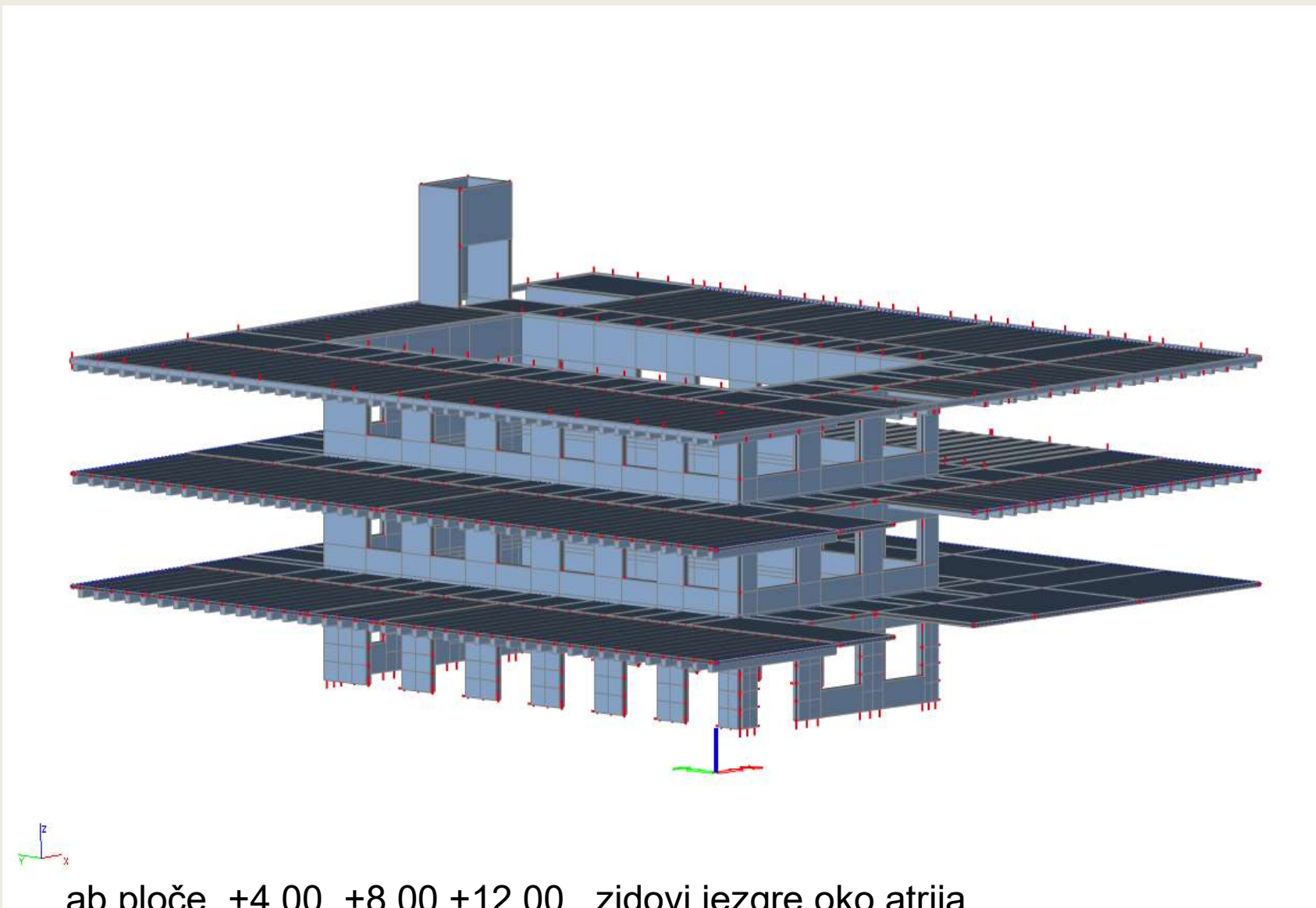


3 d model (sve) opeka i armirano betonski torkreti oko njih kao ojačanje + ab zidovi jezgre



ab ploče





2.3. Zgrada škole

2.3.1. Materijali

2.3.1.1. Zide

- **Za zidove zidane mortom opće namjene vrijedi [HRN EN 1998-1]**
 - o $f_k = K \cdot f_b^{0,7} \cdot f_m^{0,3} = 0,55 \cdot 6,0^{0,7} \cdot 0,5^{0,3} = 1,56 \text{ N/mm}^2$
- **Pretpostavljene vrijednosti:**
 - o $f_b = 6,0 \text{ N/mm}^2$ → izvor: Kolbitsch: „Erhaltung un erneuerung von hochbauten“ – TU Wien
 - o $f_m = 0,5 \text{ N/mm}^2$ → izvor: Kolbitsch: „Erhaltung un erneuerung von hochbauten“ – TU Wien; i Tomažević, M: „Earthquake-resistant design of masonry buildings“ 2000.g.
 - o $f_{vk0} = 0,15 \text{ N/mm}^2$ → izvor: Tomažević, M: „Earthquake-resistant design of masonry buildings“ 2000.g.
 - o $f_{xk1} = 0,1$
 - o $f_{xk2} = 0,1$
- **Modul elastičnosti i posmika**
 - o $E = 1000 \cdot f_k = 1560 \text{ N/mm}^2$
 - o $G = 2000 \cdot f_{tk} = 2000 \cdot 0,04 = 80 \text{ N/mm}^2$ → Tomažević, M: „Earthquake-resistant design of masonry buildings“ 2000.g.
- **Masa**
 - o $\gamma = 1800 \text{ kg/m}^3$

2.3.1.2. Drveni grednici

- **Pretpostavljene vrijednosti:**
 - o Kod razmaka grednika od 90 cm
 - o Za raspone 7 m → 28 x 22 cm
 - o Za raspone 5 m → 24 x 18 cm
 - o Hrastovo drvo →
 - izvor: Kolbitsch: „Erhaltung un erneuerung von hochbauten“ – TU Wien

Tablica 34: Kvalitete materijala prema literaturi

Naziv	Tip	Masa [kg/m ³]	E [MPa]	Poiss	G [MPa]	$f_{ck} / f_k / f_{yk}$ [MPa]	f_{vk0} [MPa]	$f_{m,k}$ [MPa]	$f_{t,0,k}$ [MPa]	$f_{t,90,k}$ [MPa]
C25/30	beton	2500	3,15e+4	0,2	1,312e+4	25				
Masonry	zide	1800	1,56e+3	0,25	6,24e+2	1,6	0,1			
D60	drvo	840	1,7e+4	0	1,06e+3			60	36	06
S275	čelik	7850	2,1e+5	0,3	8,07e+4	275				

karakteristike zidova od opeke



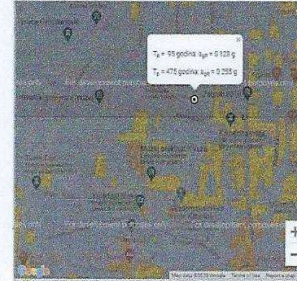
razina
2
3
4

?????
to je šira
tema
odgovornosti
politike i struke

2.5.2. Potresno opterećenje

Lokacija:

- Zagreb - $a_g/g = 0,255$ ($T_{NCR} = 475$ g.)



Očitavanje sa: <http://seizkarta.gfz.hr/karta.php>

Faktor važnosti građevine:

- Građevina razreda važnosti III. – škola → $\gamma_I = 1,2$

Temeljno tlo:

- Tlo kategorije B
- $S = 1,20$; $T_B = 0,15$ s; $T_C = 0,50$ s; $T_D = 2,00$ s

Faktor ponašanja:

- Za betonsku konstrukciju odabrano:
 - $q = 4,0$

parametri za potres

2. SADRŽAJ PROJEKTA OBNOVE VIŠESTAMBENE ZGRADE

2.E. METODE PRORAČUNA – OSVRT PREMA RAZINAMA OBNOVE

Razina obnove	Tip objekta	Metoda proračuna	Određivanje posm.čvrstoće zida	Cilj zahvata	Seizmička otpornost (% od HRN EN 1998-1)
Razina 1	Sve zgrade (dimnjaci, zabati, krovista i sl)	Proračun pojedinih elemenata, skice, izv. detalji (bitno iskustvo projektanta)	/	Popravlak elemenata za sigurno korištenje objekta	/
Razina 2	Stambene, poslovne i stam.-poslovne, obit. kuće	Gruba procjena otp. „razmazivanjem” potresne sile Metoda bočnih sila	Iz HRN EN 1996-1 (za neomeđeno zide i vapn. mort 0.10 Mpa)	Povezivanje elem. konstrukcije + lokalno pojačanje	50 %
Razina 3	zgrade javne namjene (razred važnosti III prema EC8)	Metoda bočnih sila Multimodalna analiza (3D model)	Istražni radovi (npr. 3 sonde po objektu)	Povećanje krutosti i seizm. otp. građevine	75 %
Razina 4	zgrade razreda važnosti IV prema EC8; pojedinačna kulturna dobra	Multimodalna analiza Push-over analiza (3D model)	Istražni radovi (više sondi po objektu + određivanje vlač. čvrstoće)	Seizm.otp. građevine u skladu sa HRN EN 1998 - 1	100 %

mr.sc.Dragan Kovač, dipl.ing.grad.
Tomislav Češljaš, mag.ing.aedif.

HKIG 2020.



23

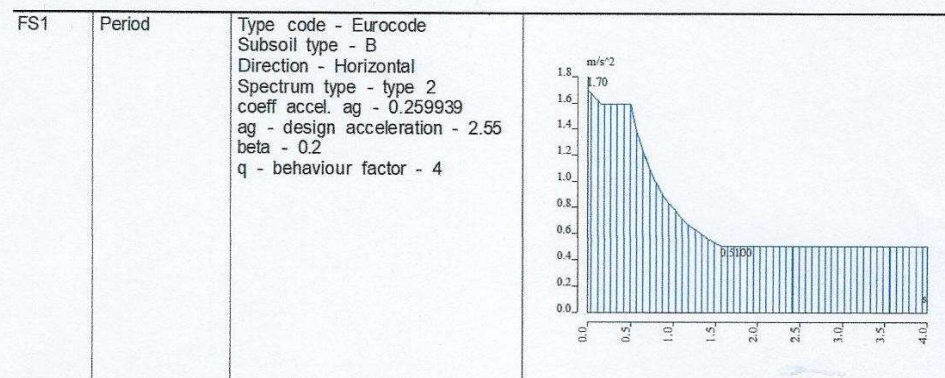
↑
Absurdno postrojenje



Tablica 47: Zadani parametri seizmičkog spektra

coeff accel. ag	0,260
ag - design acceleration [m/s ²]	2,550
q - behaviour factor	4,000
beta	0,200
S, Tb, Tc, Td manually?	Yes
Subsoil type	B
Spectrum type	type 2
Direction	Horizontal
Direction factor	1
S - soil factor	1,000
Tb	0,150
Tc	0,500
Td	2,000
Note	NA not supported

Tablica 48: Seizmički spektar

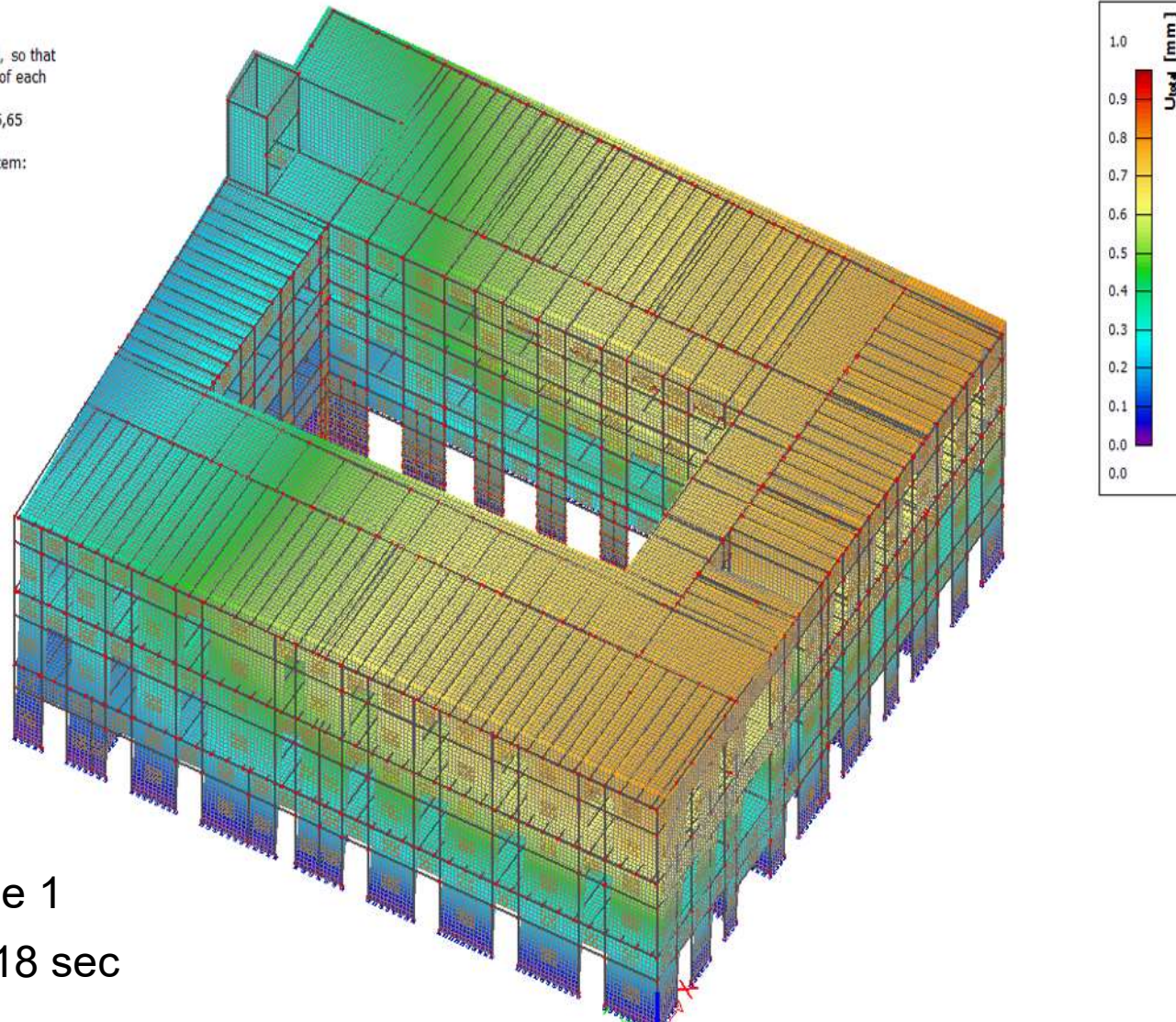


parametri spektrala analiza



3D displacement

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/1 - 5,65
Selection: All
Location: In nodes avg.. System: Global



mode 1

$T = 0,18 \text{ sec}$

na razini 0.00 ukupna sila potresa približno 1000 t

ZAKLJUČAK

Ovo tehničko rješenje je skupo i dugotrajno.

Racionalnije

Kompletno rušenje i replika uz očuvanje vanjskih formi i oblikovnih detalja te krovništa.

Otpor prema tome je u Zavodu za zaštitu spomenika.



HVALA

