Nadvožnjaci u sklopu rekonstrukcije željezničke pruge Dugo Selo - Križevci

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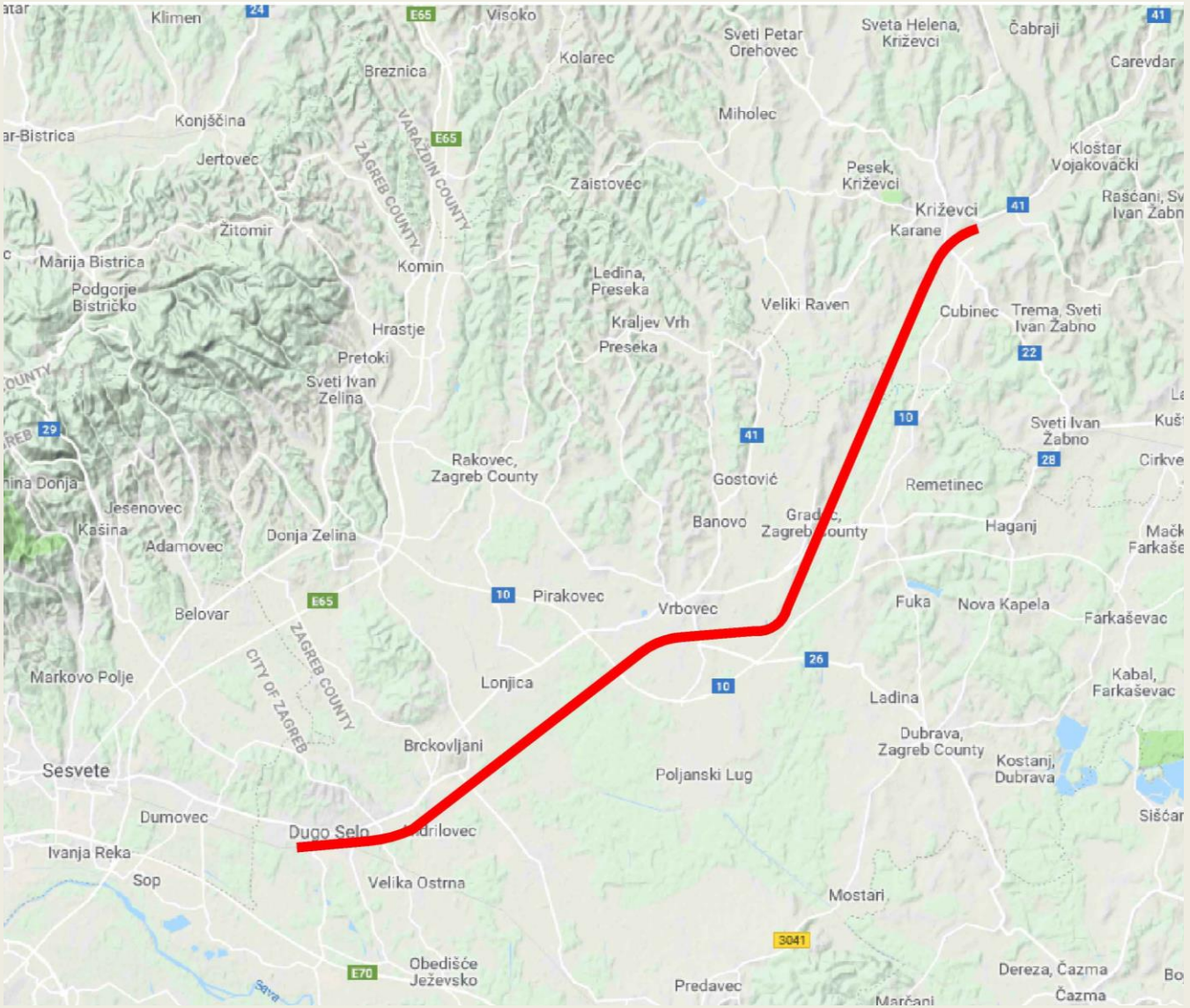
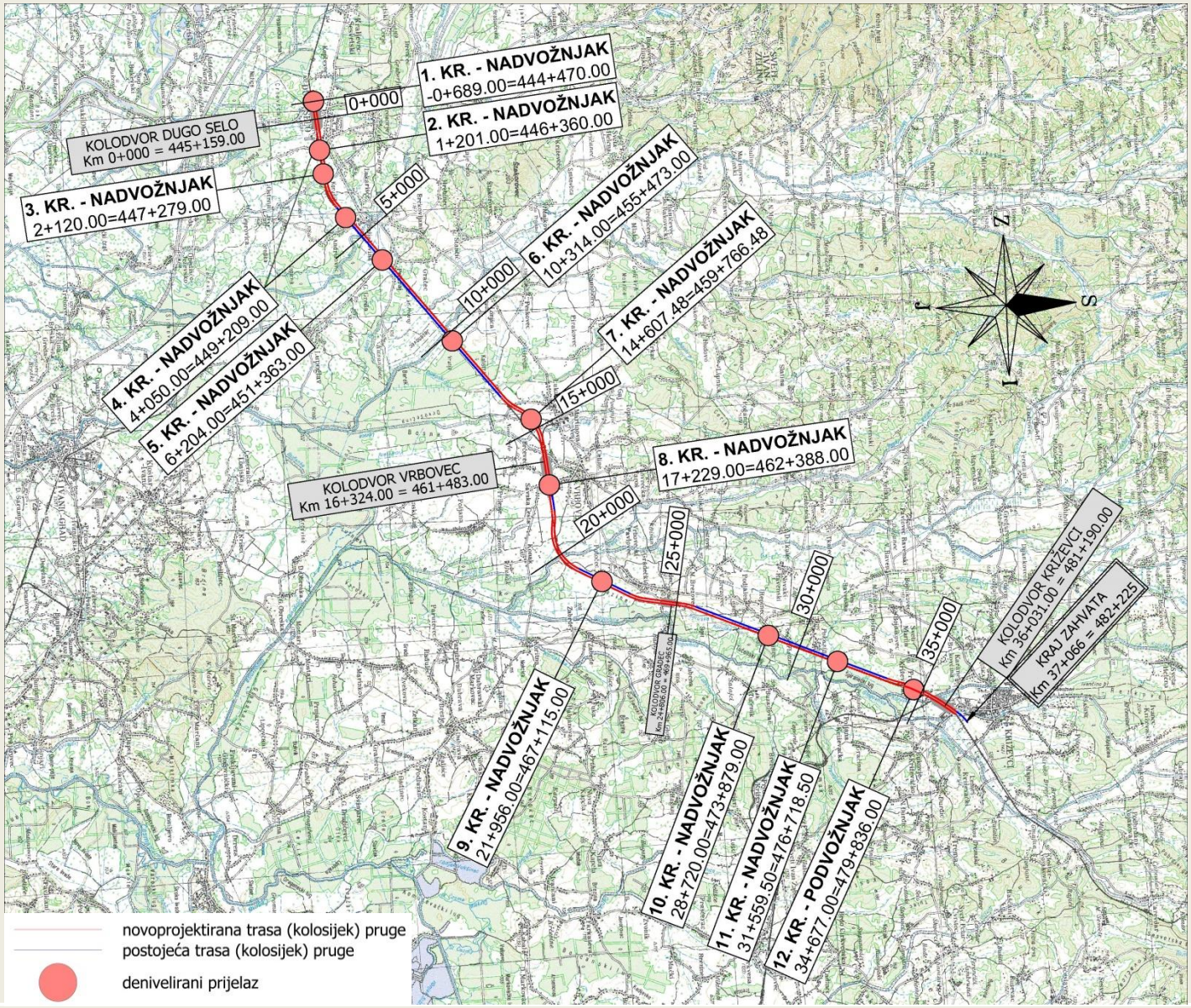
Općenito o željezničkoj pruzi M201

- Vb paneuropski koridor
- Dvokolosiječna pruga
- v≤160 km/h putnički promet
- v≤100 km/h teretni promet (ciljano 120 km/m)



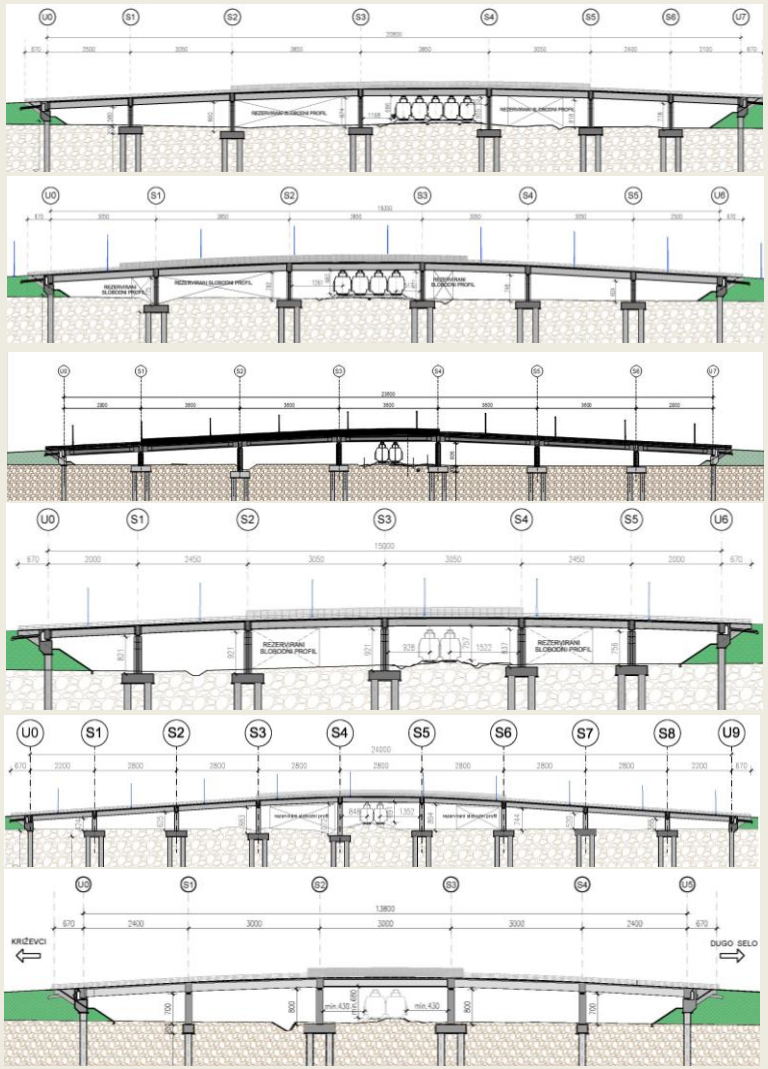
Križanja cestovnih prometnica s prugom

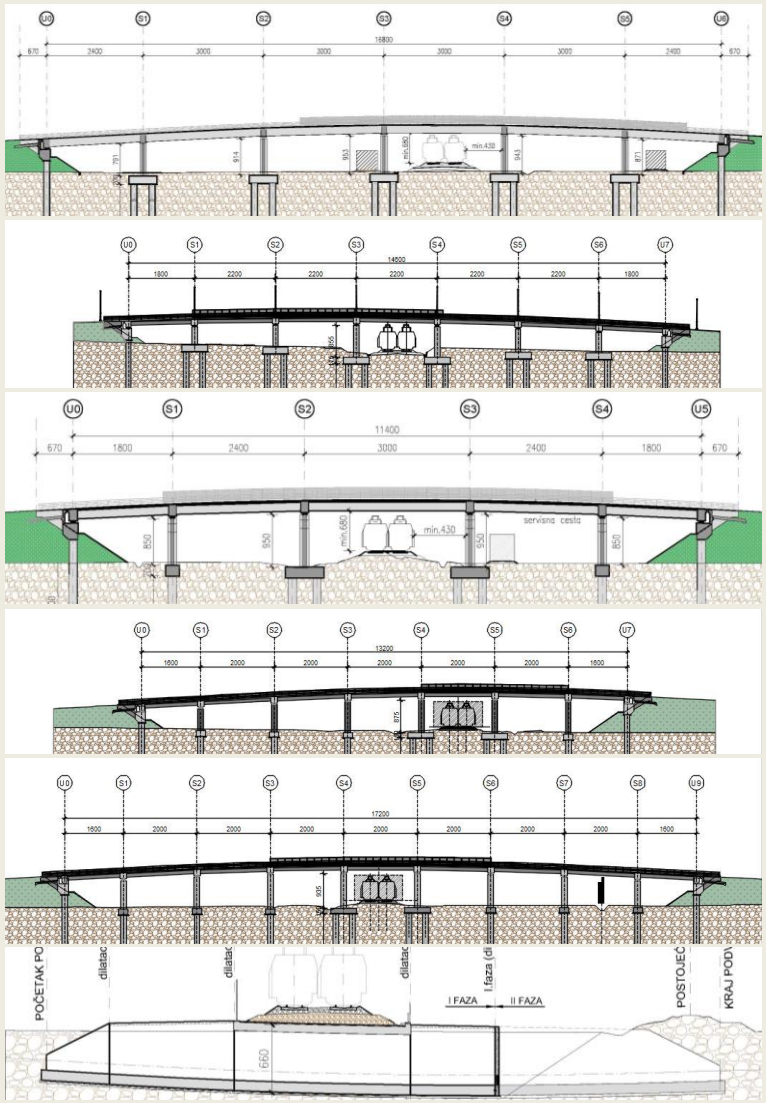


Križanja cestovnih prometnica s prugom

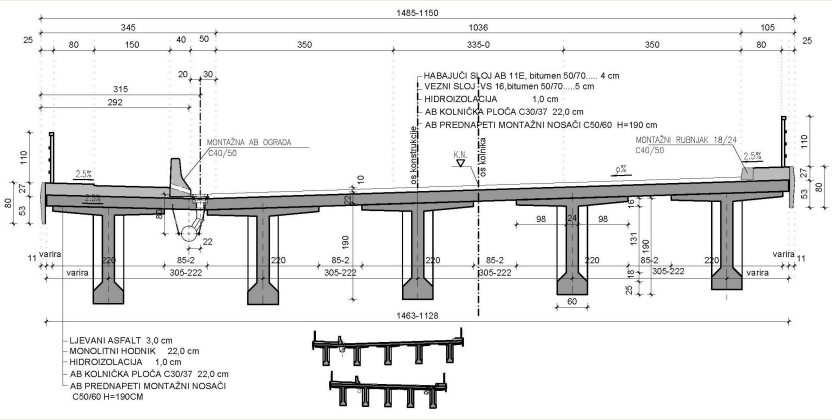
Križanje br.	Tip ceste	Najveći raspon (m)	Duljina (m)	Rasponi (m)	Širina (m)	Br. Nosača
1	LC	38,5	208	25+30,5+2x38,5+30,5+24+21	11,5-14,85	5
2	LC	38,5	193,5	30,5+2x38,5+2x30,5+25	11,5	5
3	ŽC	36	236	28+5x36+28	11,6	5
4	LC	30,5	150	20+24,5+2x30,5+24,5+20	11,6	5
5	ŽC	28	240	22+7x28+22	11,6	5
6	NC	30	138	24+3x30+24	9,5	4
7	LC	30	168	24+4x30+24	9,5	4
8	ŽC	22	146	18+5x22+18	13,9	8
9	LC	30	114	18+24+30+24+18	9,5	4
10	NC	20	132	16+5x20+16	9,5	5
11	NC	20	172	16+5x20+16	9,5	5
12	NC	8,6	66,4	8,6	9,3	podvož-njak

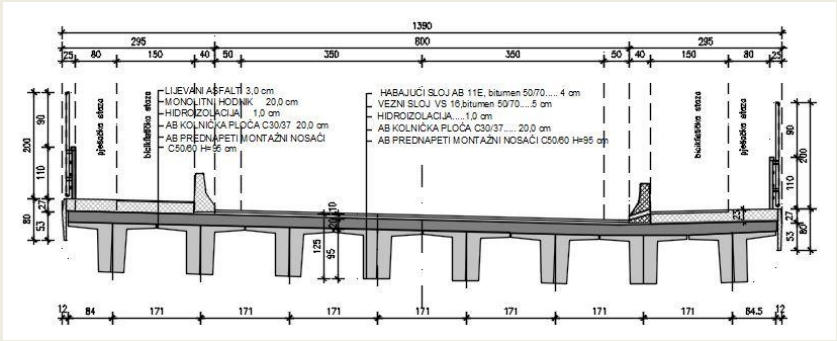
Uzdužne dispozicije cestovnih prijelaza KR1 – KR12

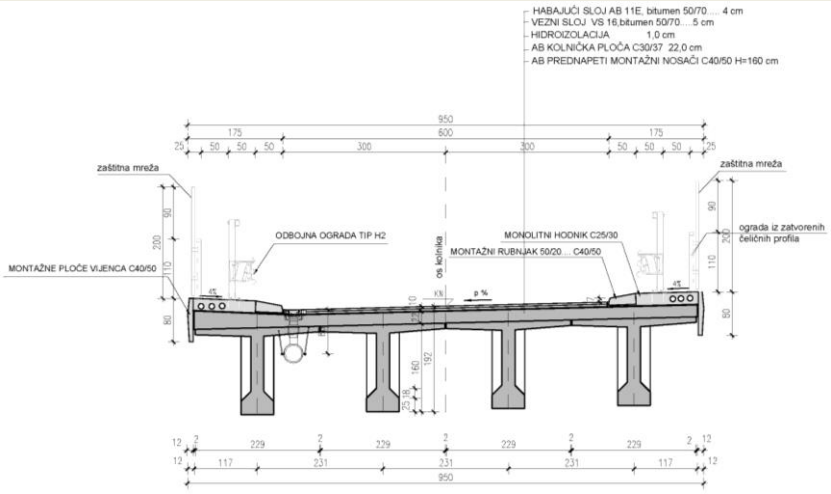


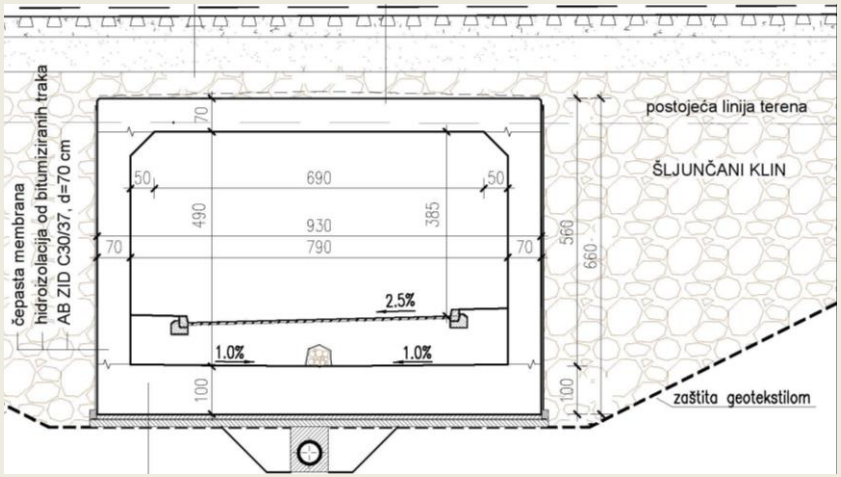


Poprečne dispozicije cestovnih prijelaza KR1 – KR12





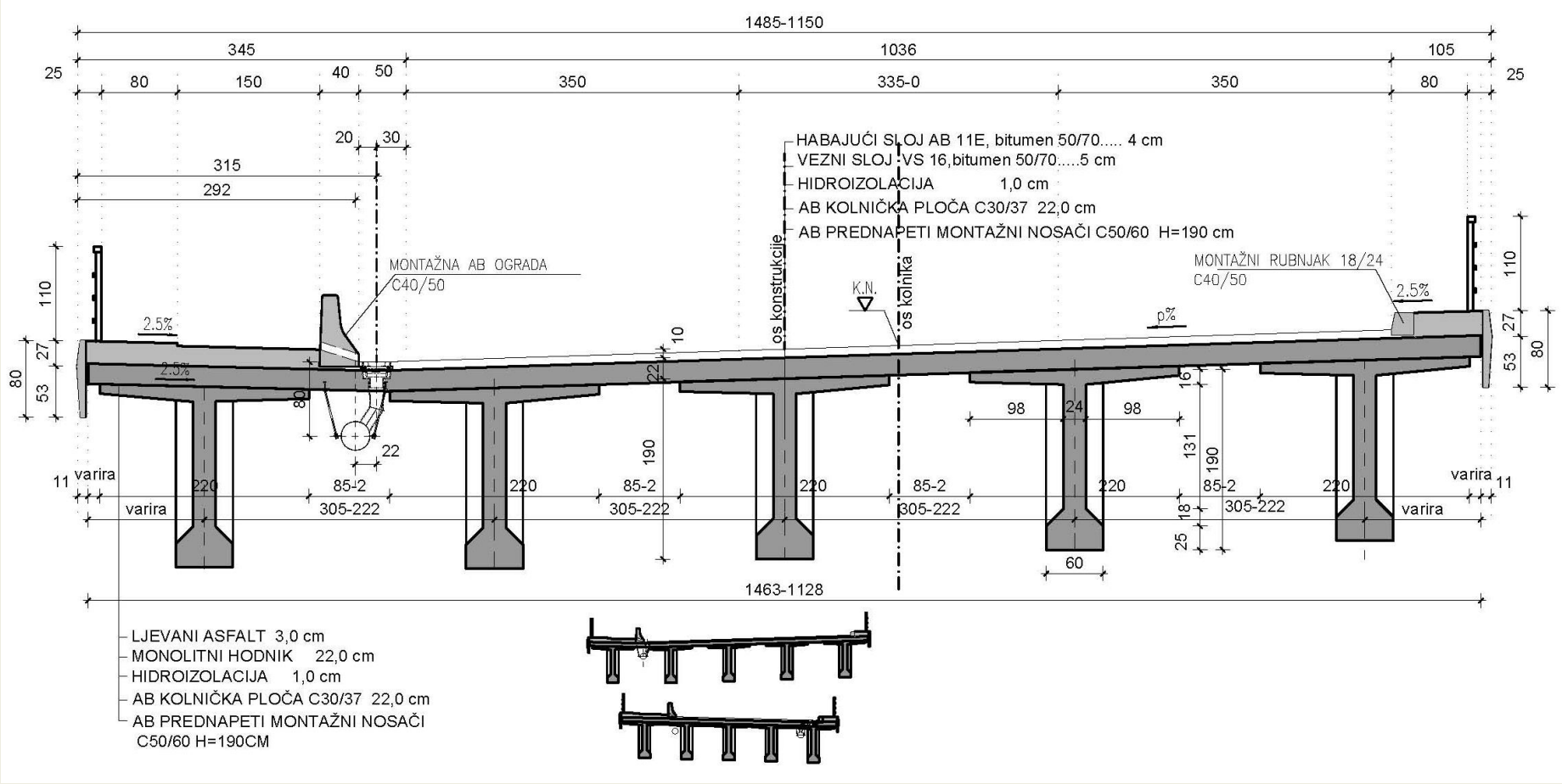




Pregledno grupiranje nadvožnjaka prema glavnim rasponima

- 1 grupa – nadvožnjaci raspona 36 m – 38,5 m
  - KR1, KR2 i KR3
- 2 grupa – nadvožnjaci raspona 28 m – 30,5 m
  - KR4, KR5, te KR6, KR7 i KR9
- 3 grupa – nadvožnjaci raspona 20 m – 22 m
  - KR8, te KR10 i KR11
- Podvožnjak
  - KR12

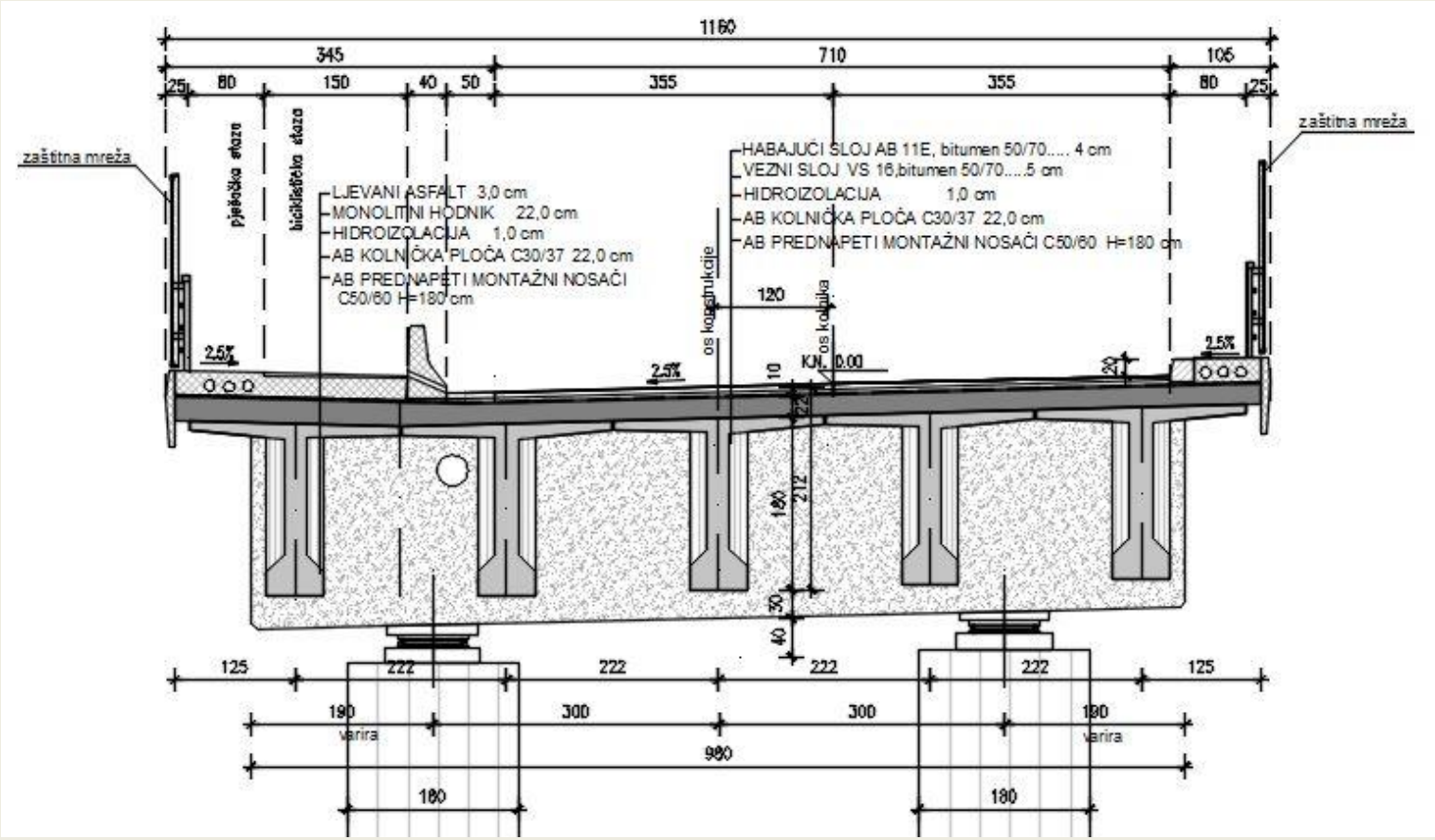
Nadvožnjak KR1 i KR2 (L_{max}= 38,5 m → 1 grupa)



Nadvožnjak KR1 (L_{max} = 38,5 m → 1 grupa)

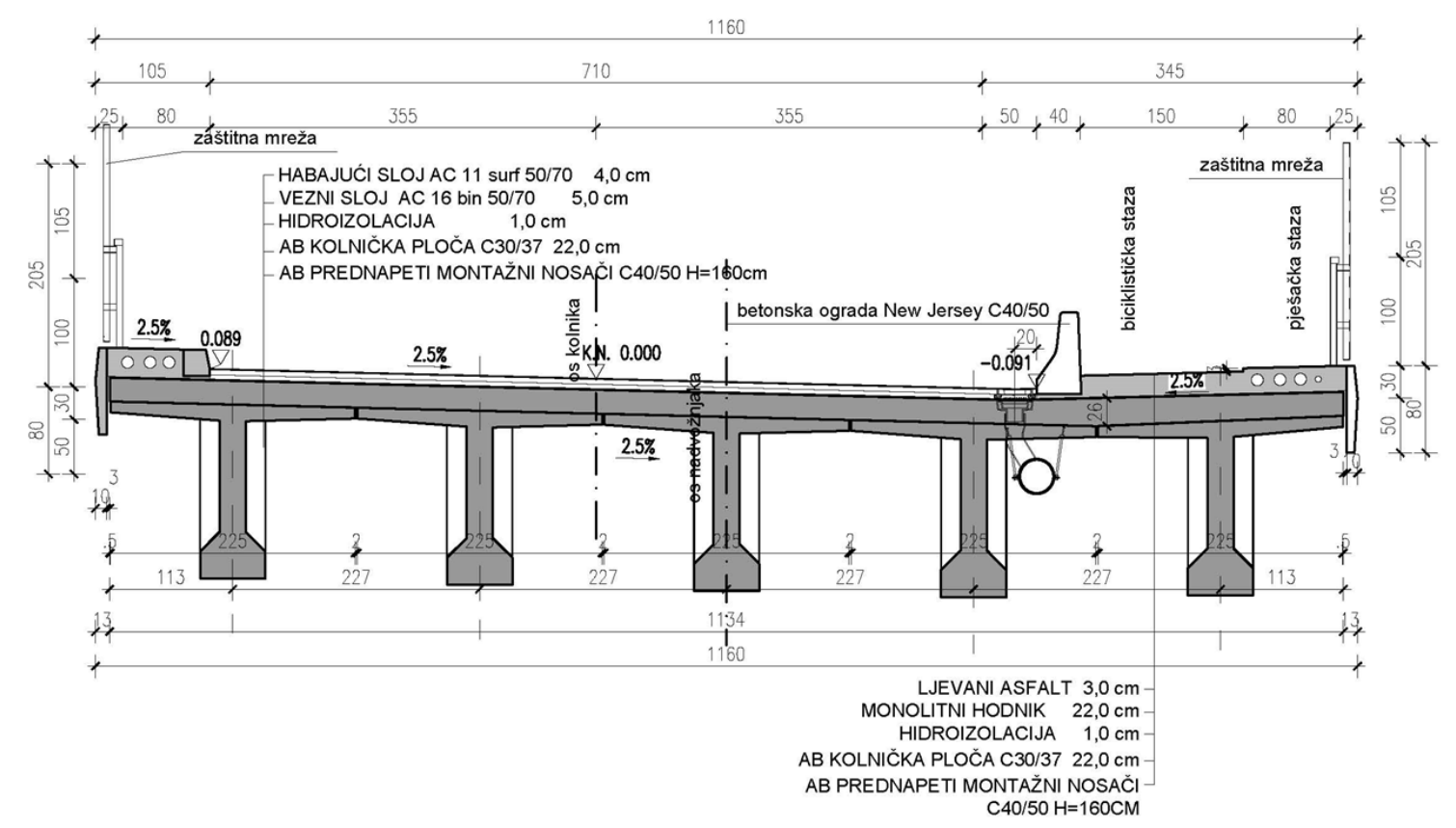
Nadvožnjak KR2 (L_{max} = 38,5 m → 1 grupa)

Nadvožnjak KR3 (L_{max} = 36 m → 1 grupa)

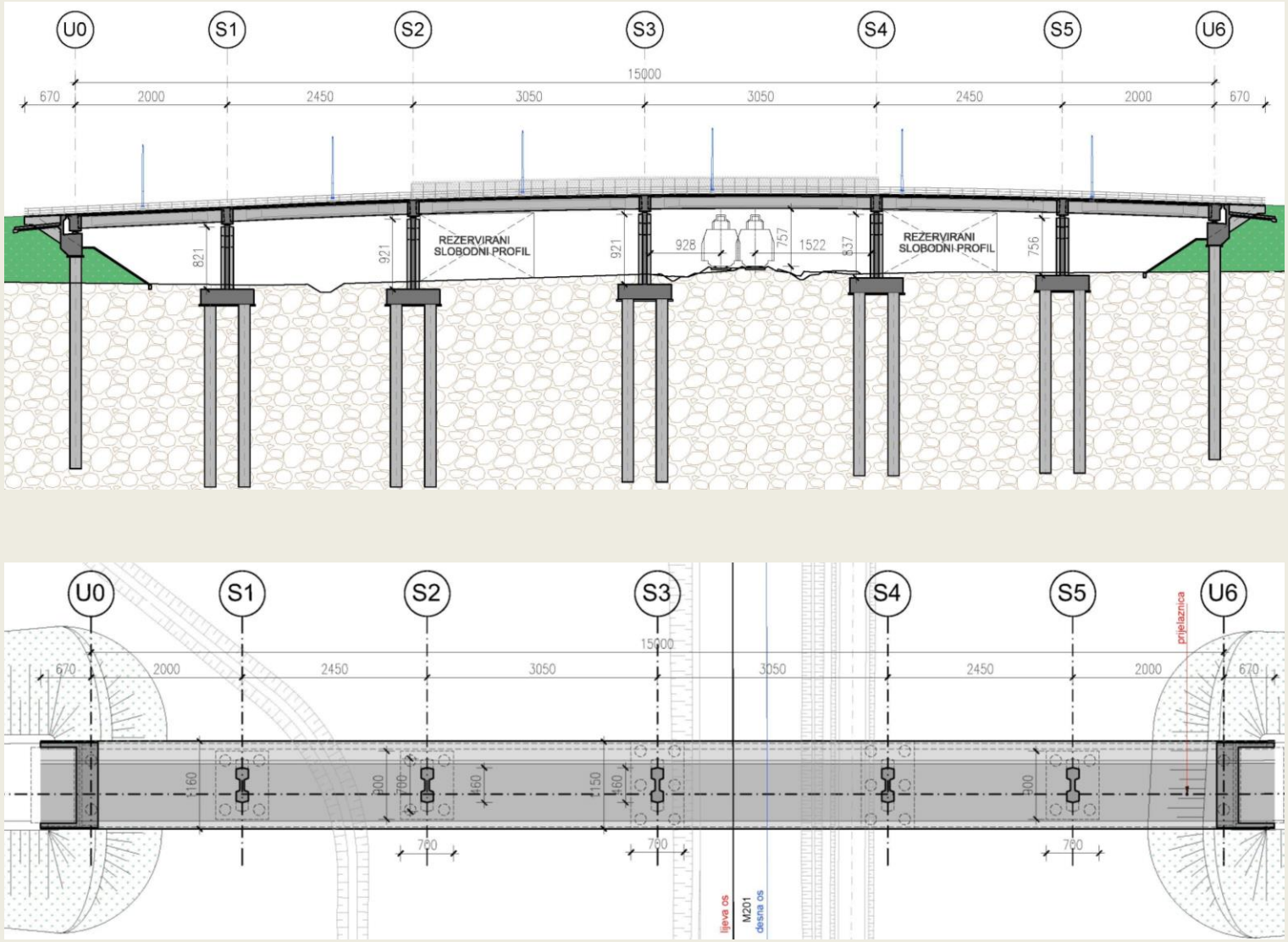


Nadvožnjak KR3 (L_{max} = 36 m → 1 grupa)

Nadvožnjaci KR4 i KR5 (L_{max} = 28-30,5 m → 2 grupa)

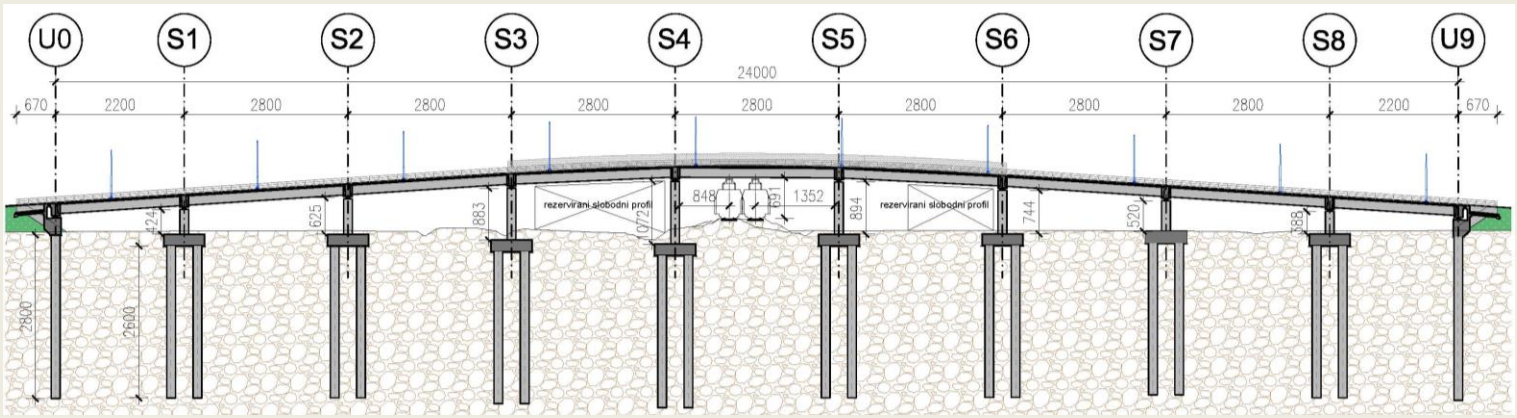


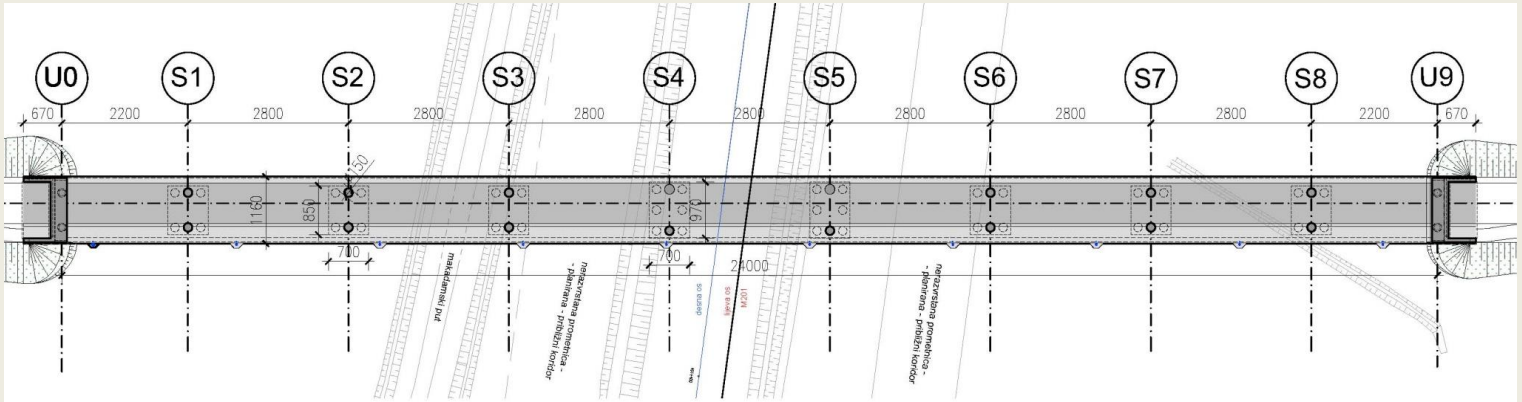
Nadvožnjak KR4



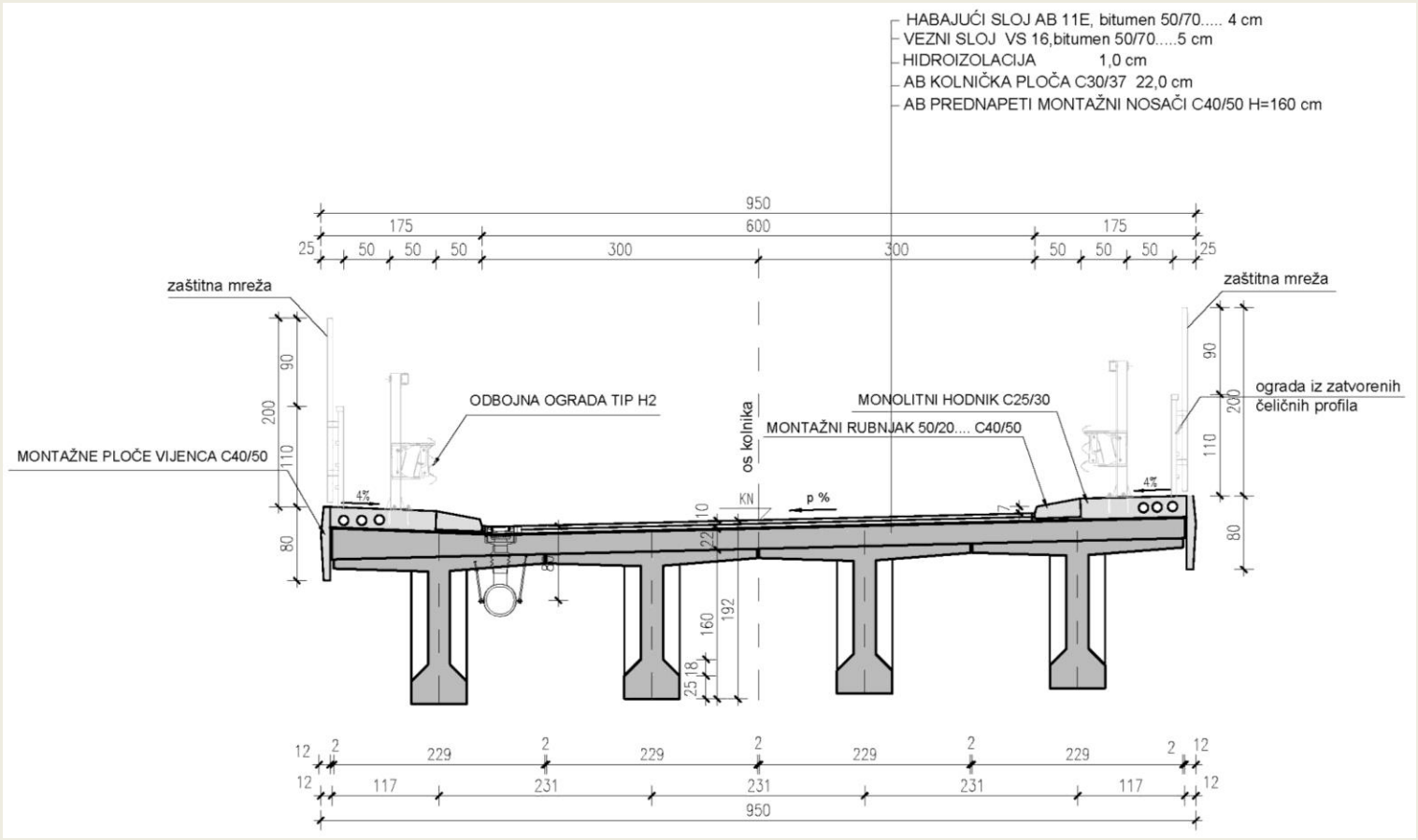
Nadvožnjak KR4

Nadvožnjak KR5

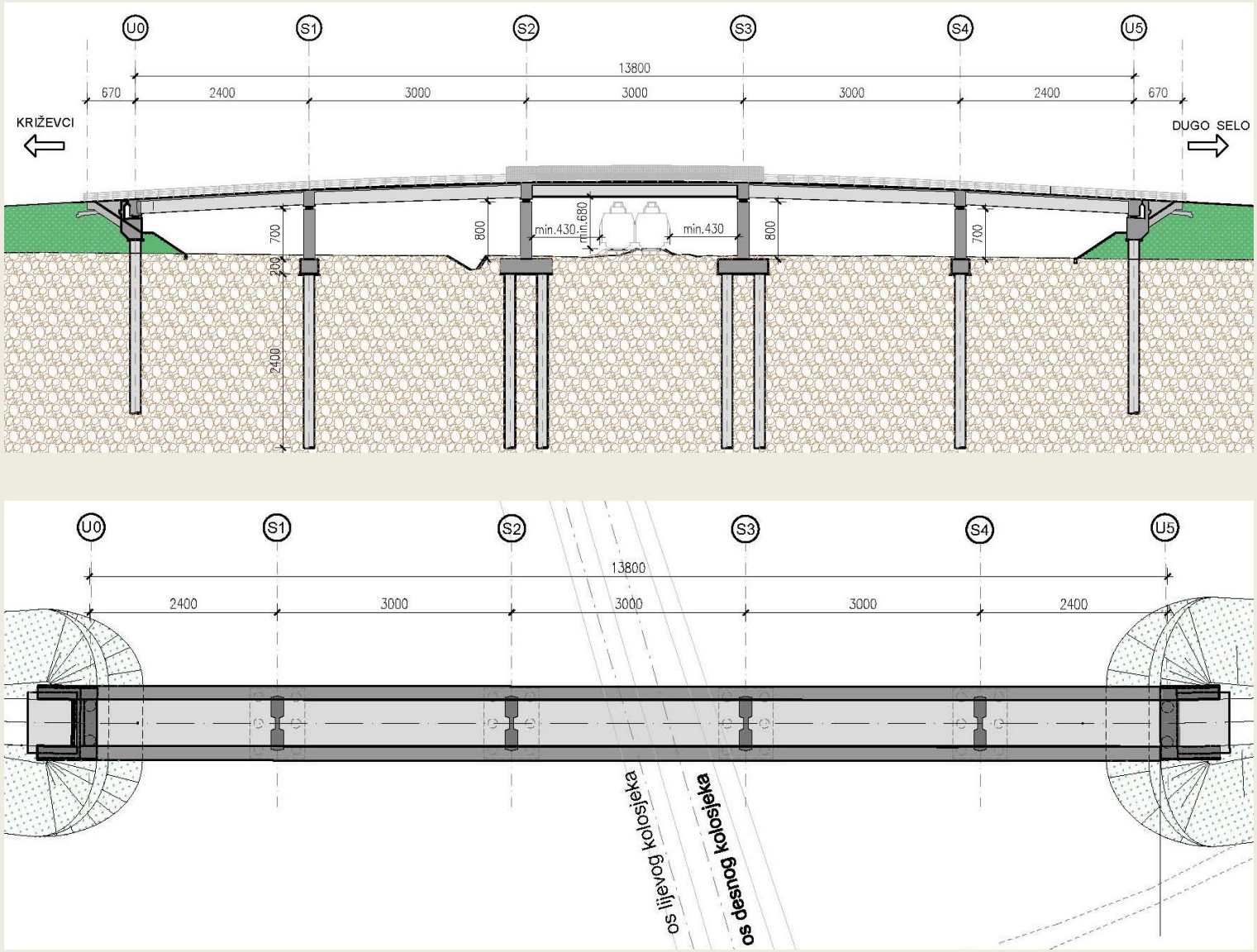




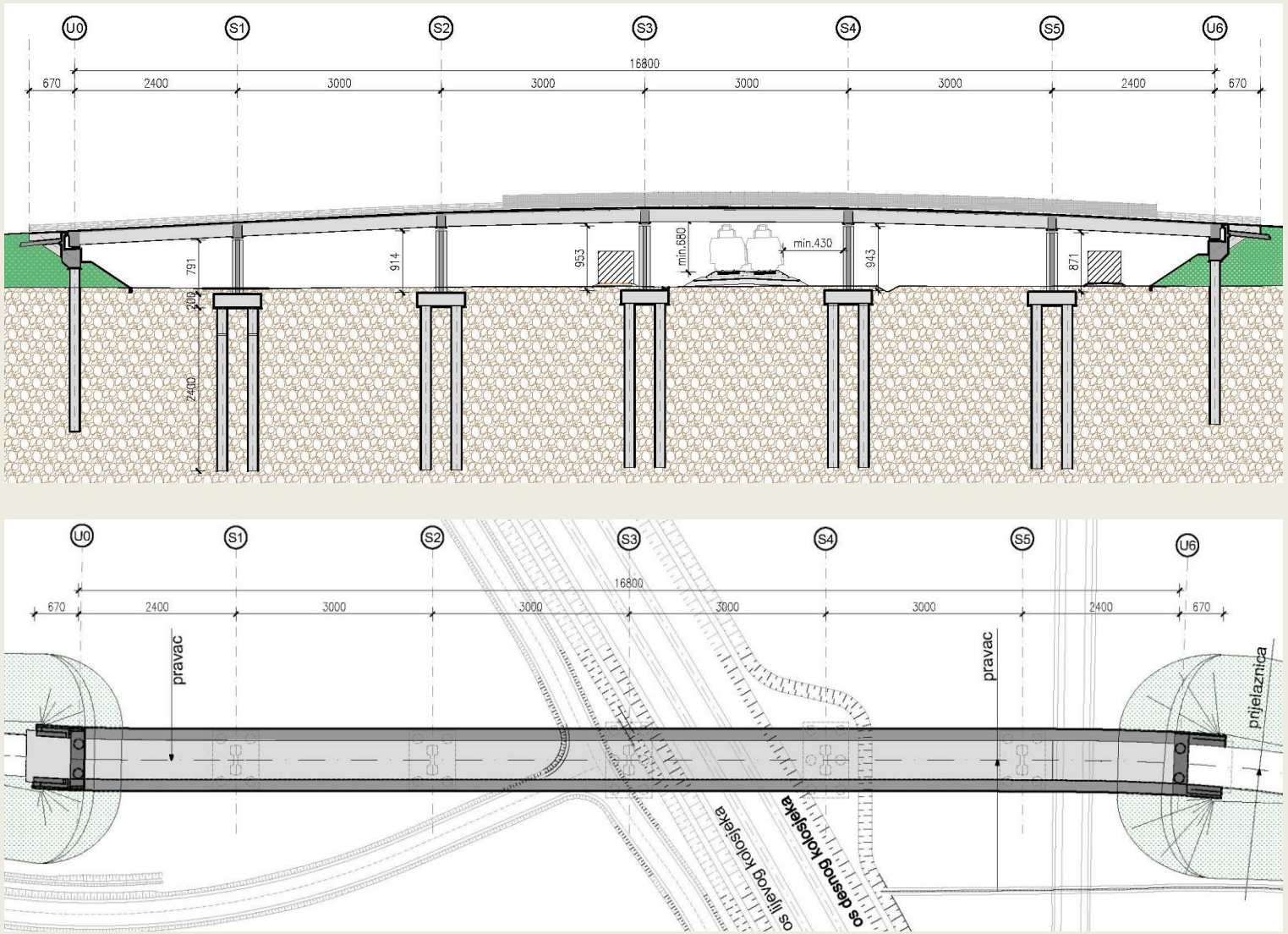
Nadvožnjaci KR6, KR7 i KR9 (L_{max} = 28-30,5 m → 2 grupa)



Nadvožnjak KR6

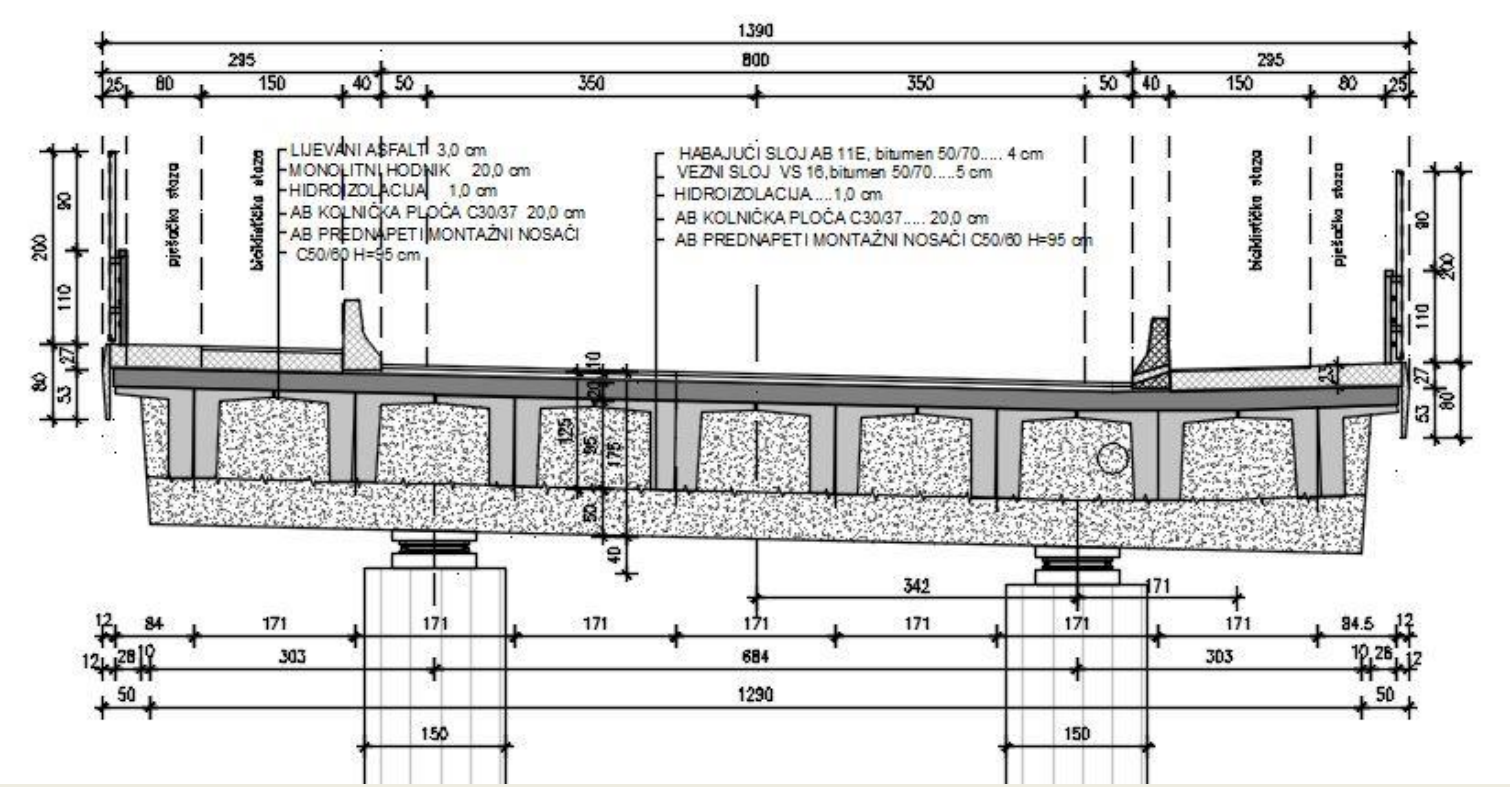


Nadvožnjak KR7

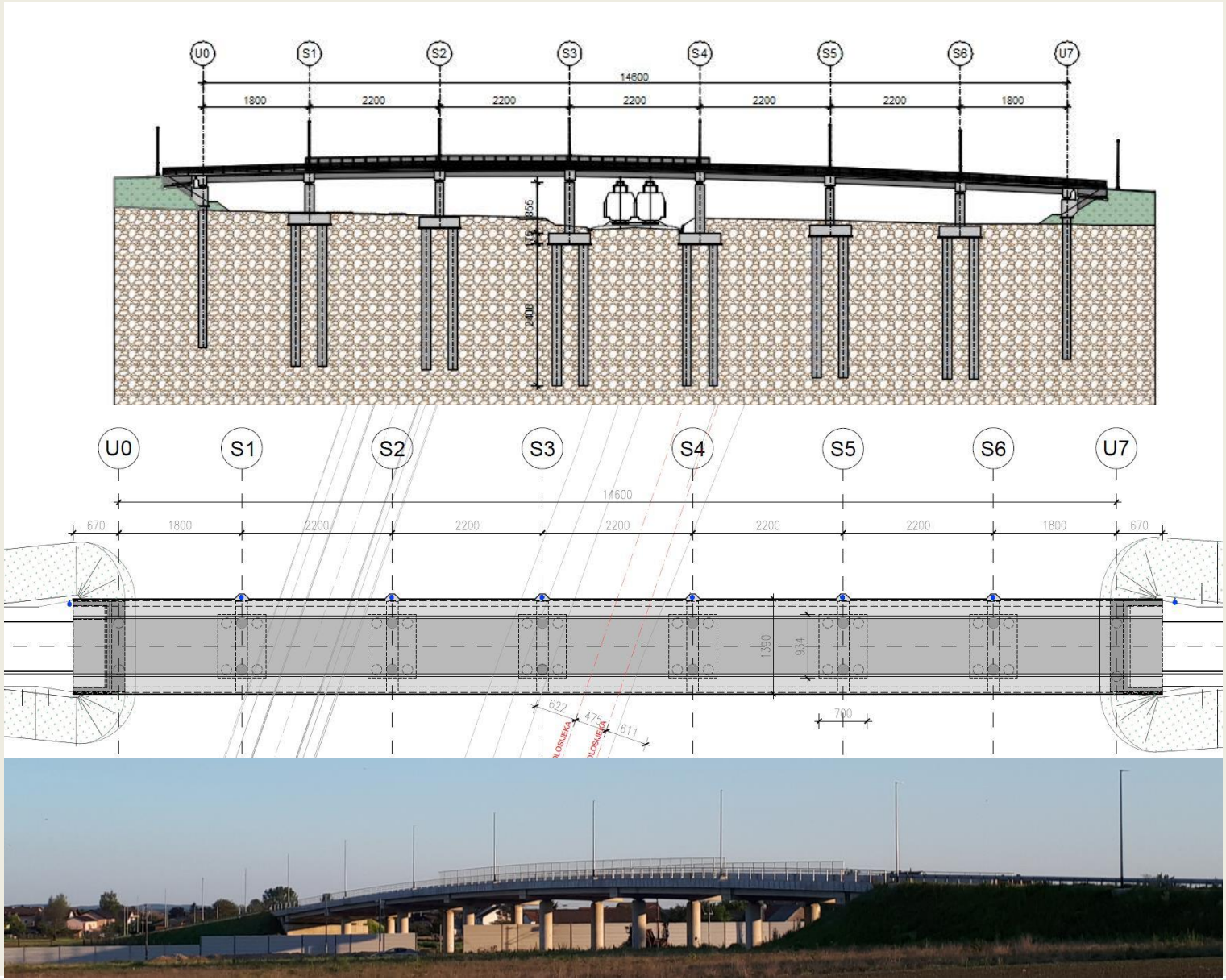


Nadvožnjak KR9

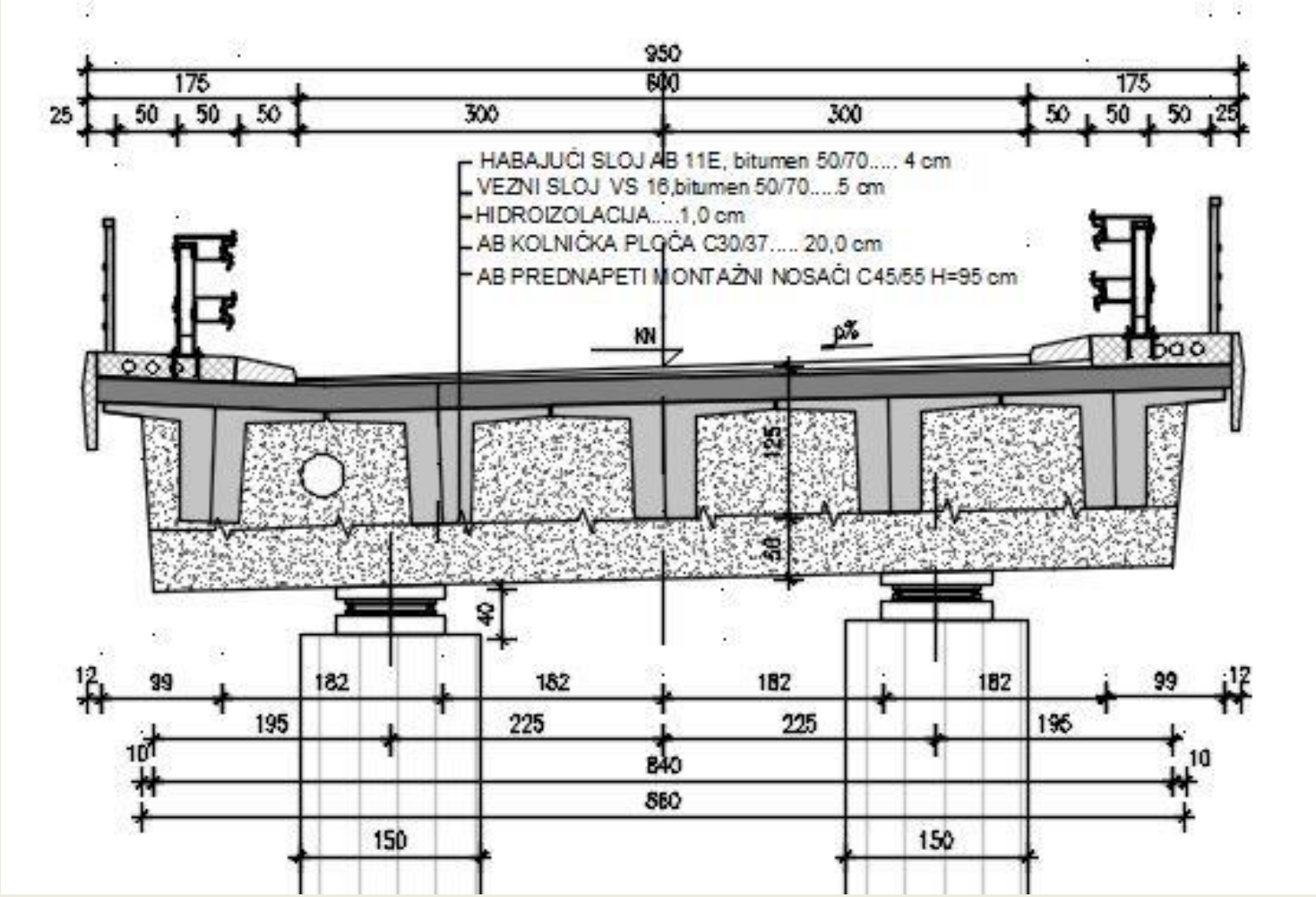
Nadvožnjak KR8 (L_{max} = 22 m → 3 grupa)



Nadvožnjak KR8

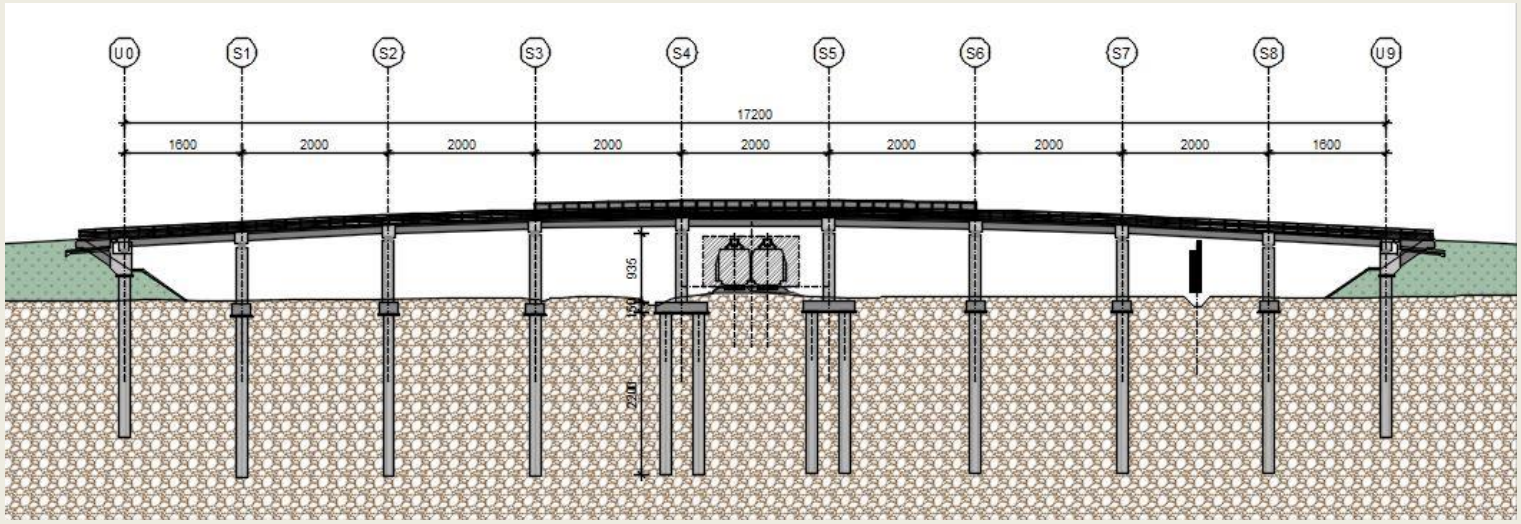


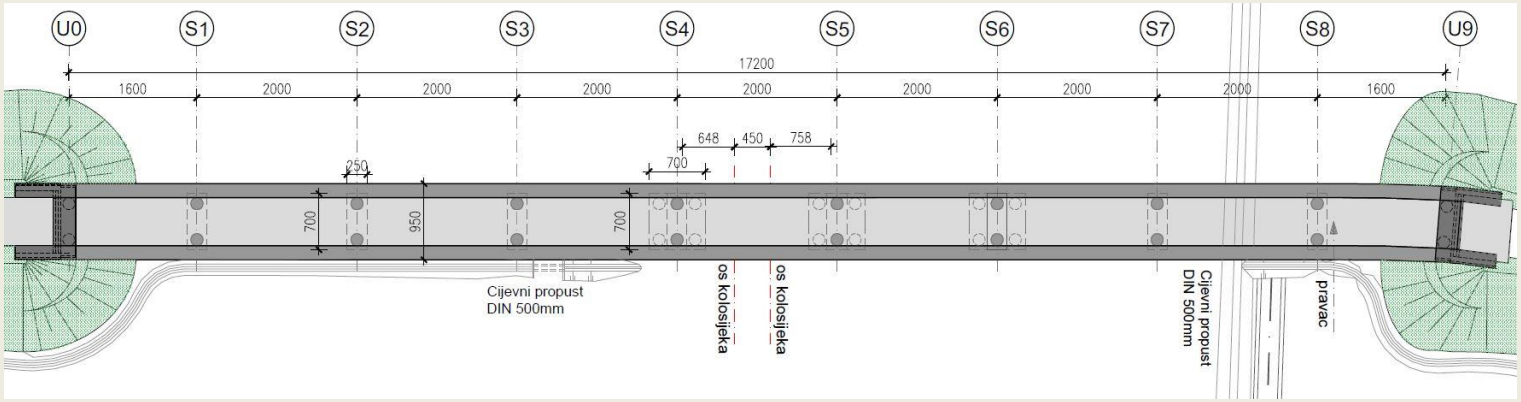
Nadvožnjak KR10 i KR11 (L_{max} = 20 m → 3 grupa)



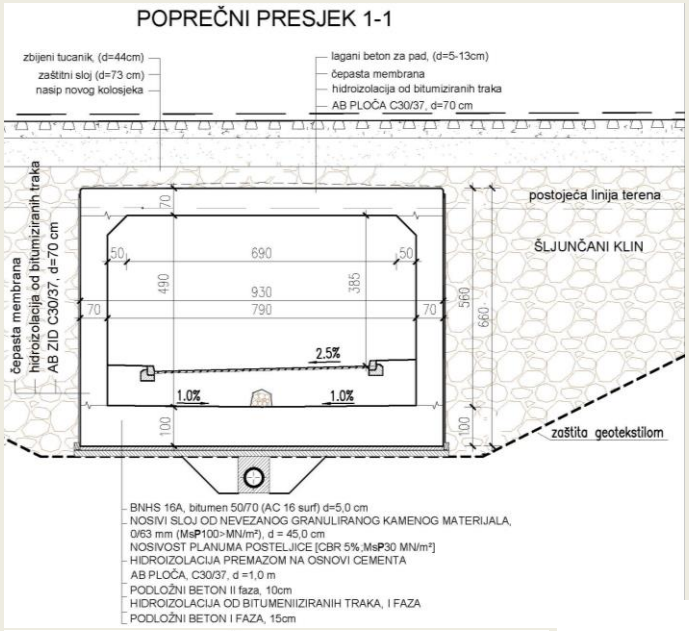
Nadvožnjak KR10

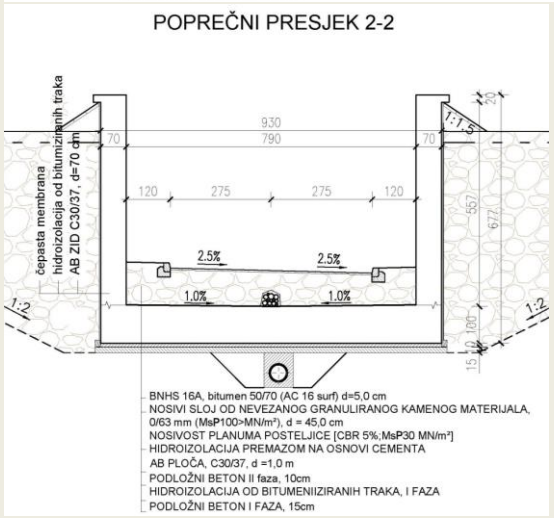
Nadvožnjak KR11

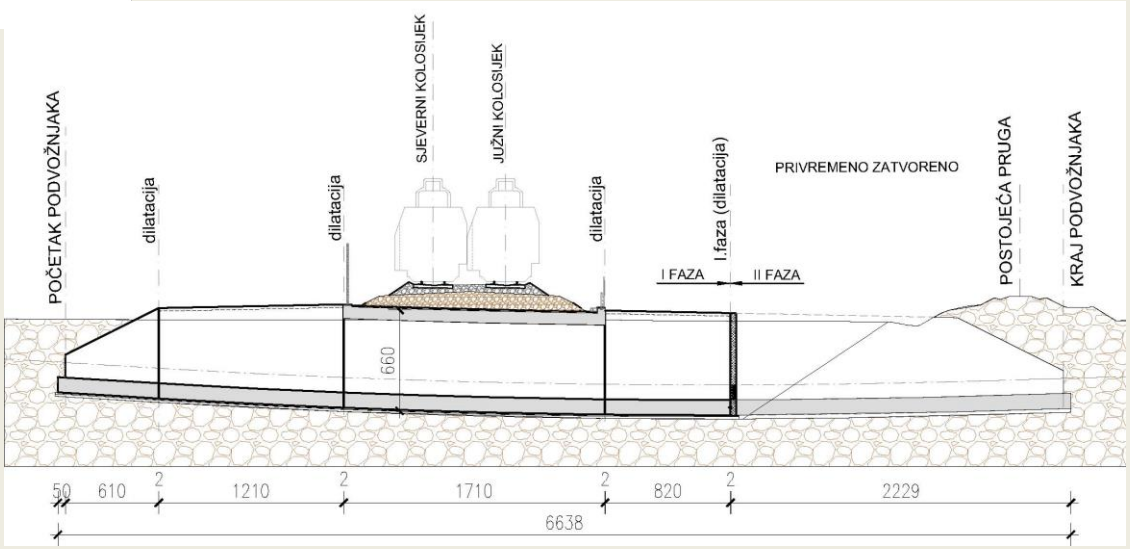




PODVOŽNJAK KR12

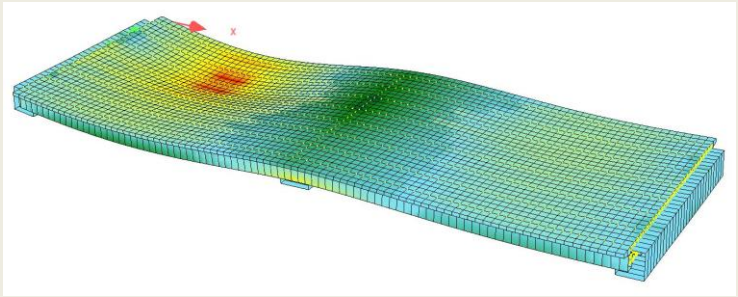




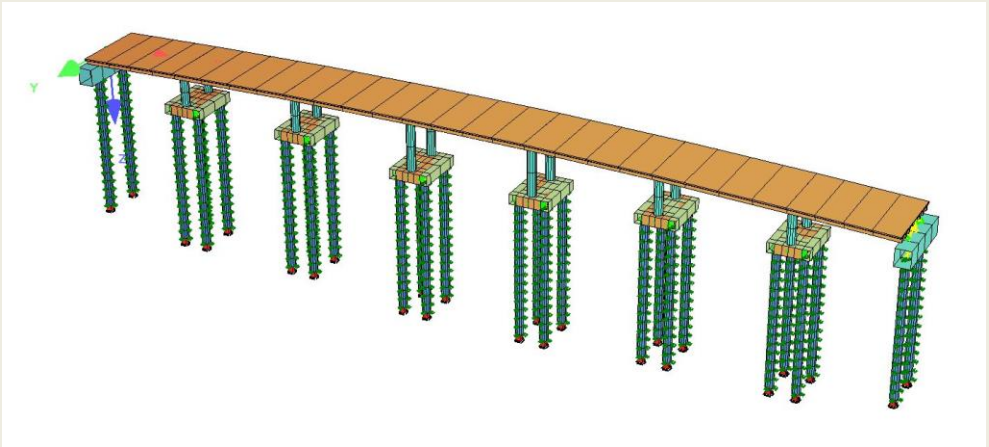


Statički proračun nadvožnjaka – računski modeli (KR8)

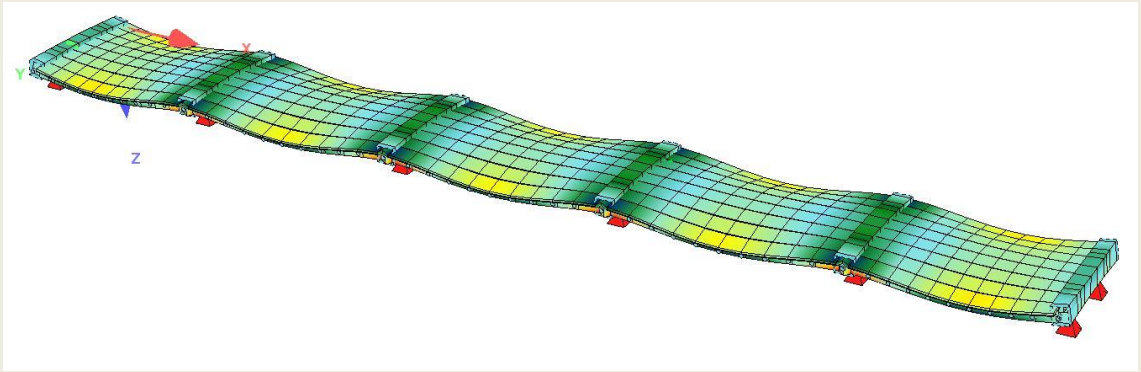
- Model za lokalne utjecaje u kolničkoj ploči (plošni + štapni elementi)



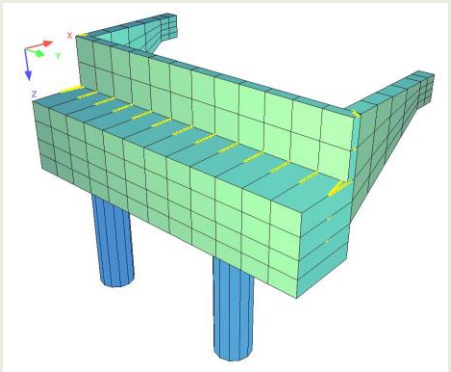
- Model za donji ustroj (štapni elementi)



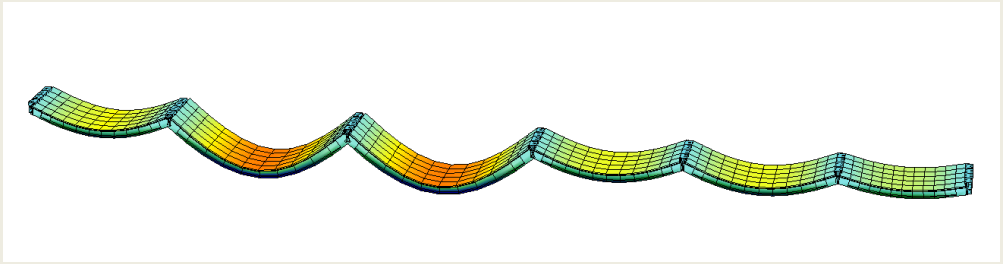
- Roštiljni model za proračun uzdužnih i poprečnih nosača (štapni elementi)

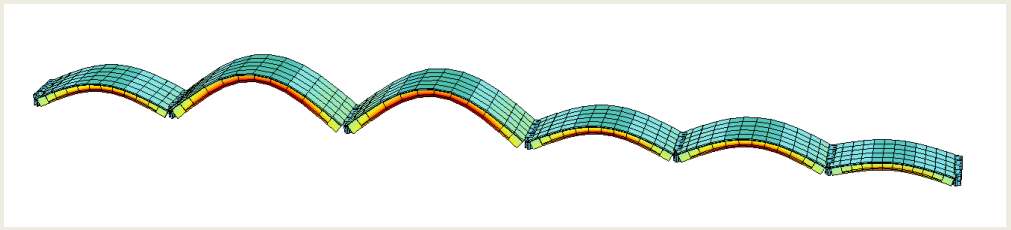


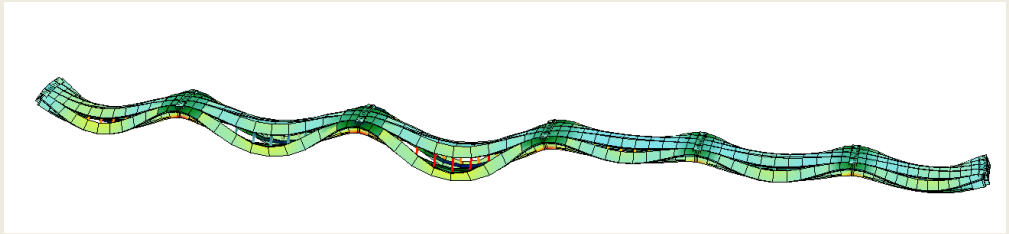
- Model upornjaka (plošni + štapni elementi)

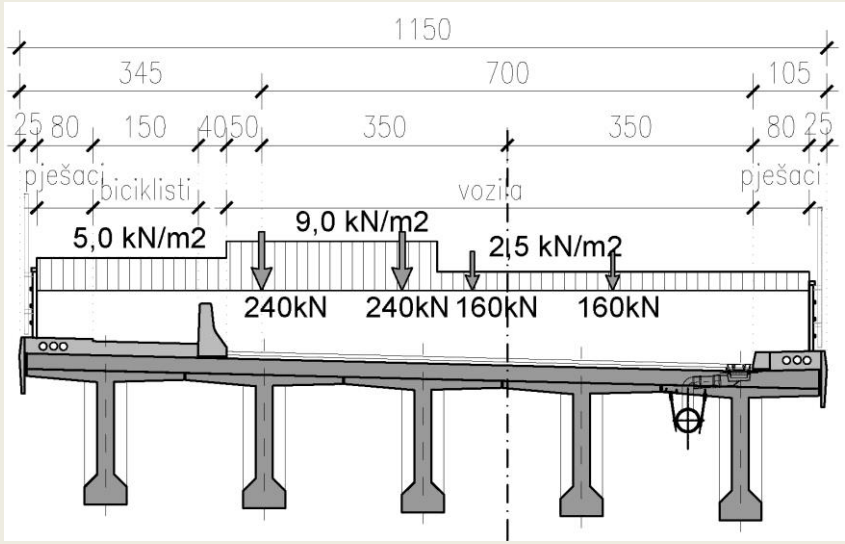


Statički proračun nadvožnjaka – gornji ustroj







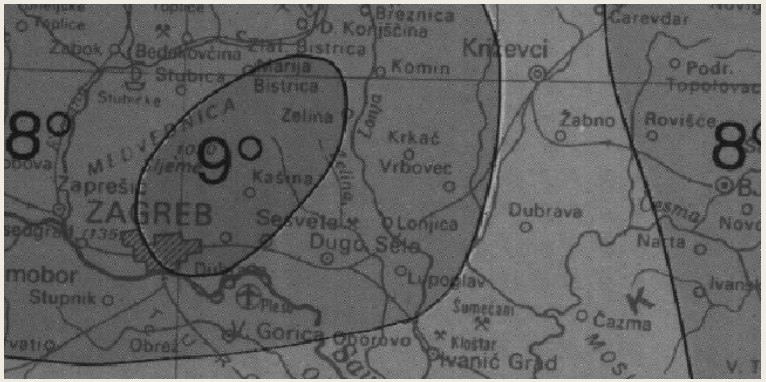


- Roštiljni sustav s različitima fazama građenja
- Prometno opterećenje – faktor prilagodbe $\alpha_Q = 0,8$ za osovinska opterećenja
- Prednapinjanje - bez vlaka u nazovistalnoj kombinaciji opterećenja

Statički proračun nadvožnjaka – donji ustroj

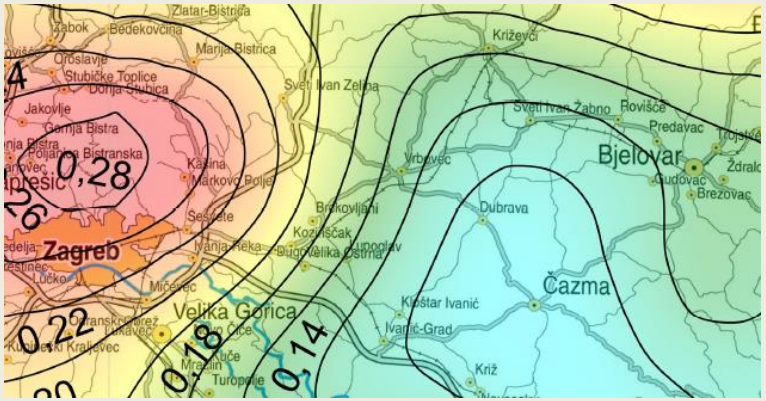
Dominantna opterećenja:

- Potresno opterećenje
- Udar vlaka
- Duktilnost nasuprot robusnosti stupišta



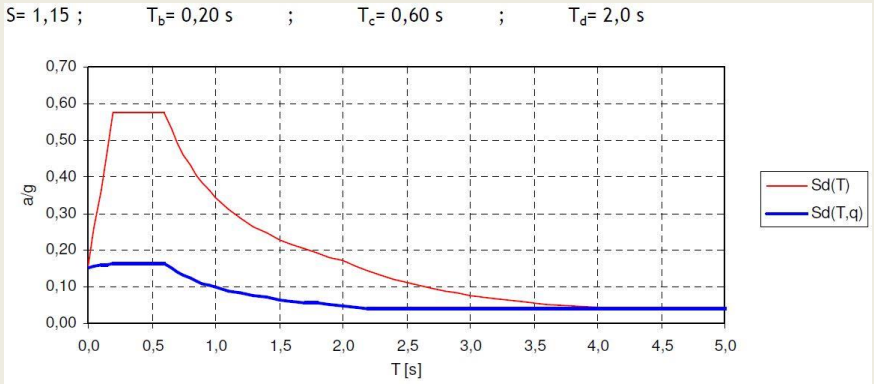
Potresno opterećenje:

- Faktor važnosti $\gamma_I = 1,0$
- Tip temeljnog tla C
- Proračunsko ubrzanje a_g = 0,2g (0,18g-0,12g)

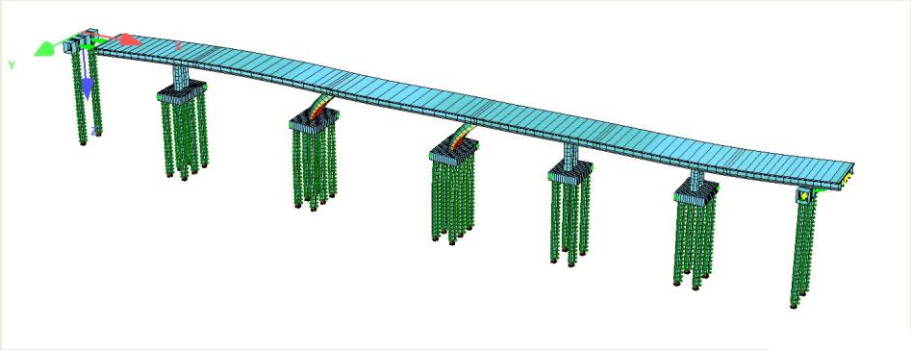


Udar vlaka u potporne elemente:

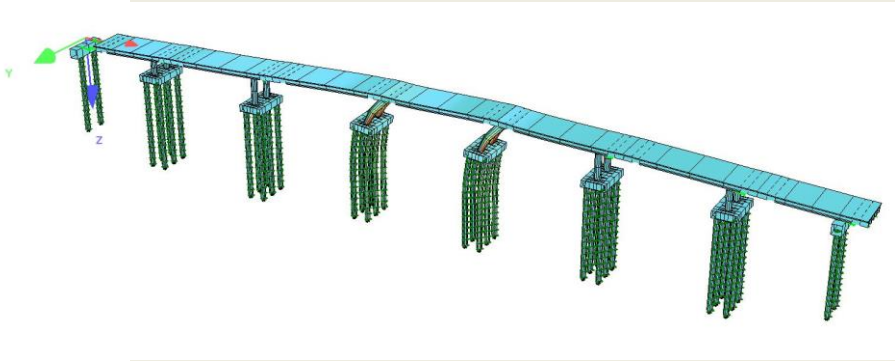
- Najmanja udaljenost od osi kolosijeka 5,16 m; KR1, KR2 - 4000 kN; 1500 kN
- Ipak 50% više armature za potresnu kombinaciju opterećenja



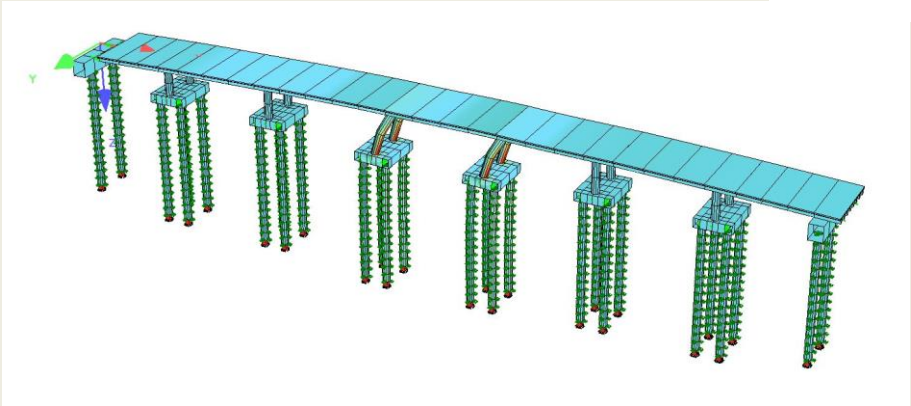
Djelovanje potresa



- Nadvožnjak KR2 (I-stup)
- Uzdužno titranje T1=1,22s

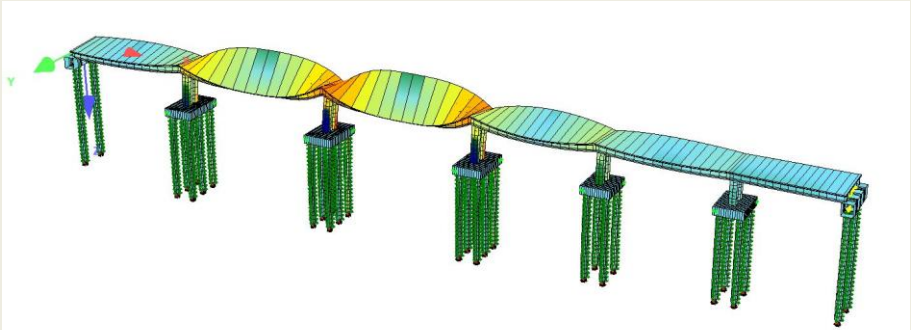


- Nadvožnjak KR3 (stup Φ1,8 m)
- Uzdužno titranje T1=1,24s

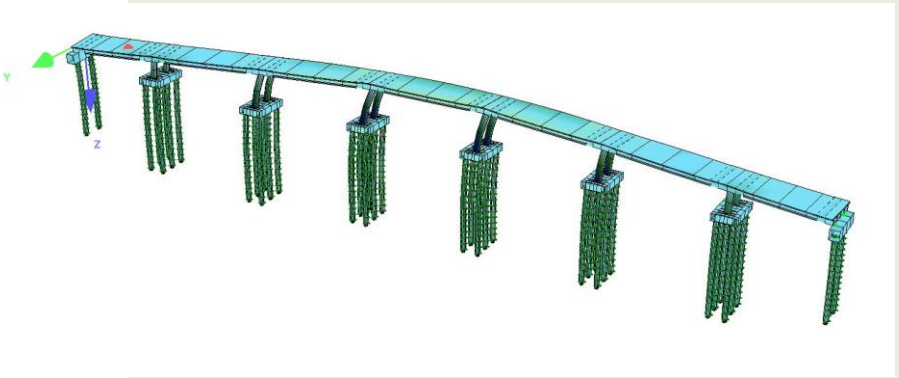


- Nadvožnjak KR8 (stup Φ1,5 m)
- Uzdužno titranje T1=1,44s

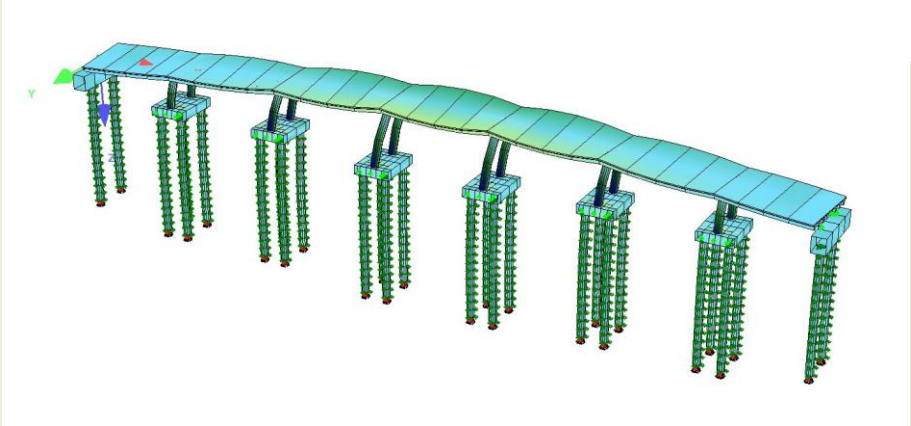
Djelovanje potresa



- Nadvožnjak KR2 (I-stup)
- Poprečno titranje T1= 0,40 s



- Nadvožnjak KR3 (stup Φ1,8 m)
- Poprečno titranje T1= 0,62 s



- Nadvožnjak KR8 (stup Φ1,5 m)
- Poprečno titranje T1= 0,56 s

Oblikovanje stupova

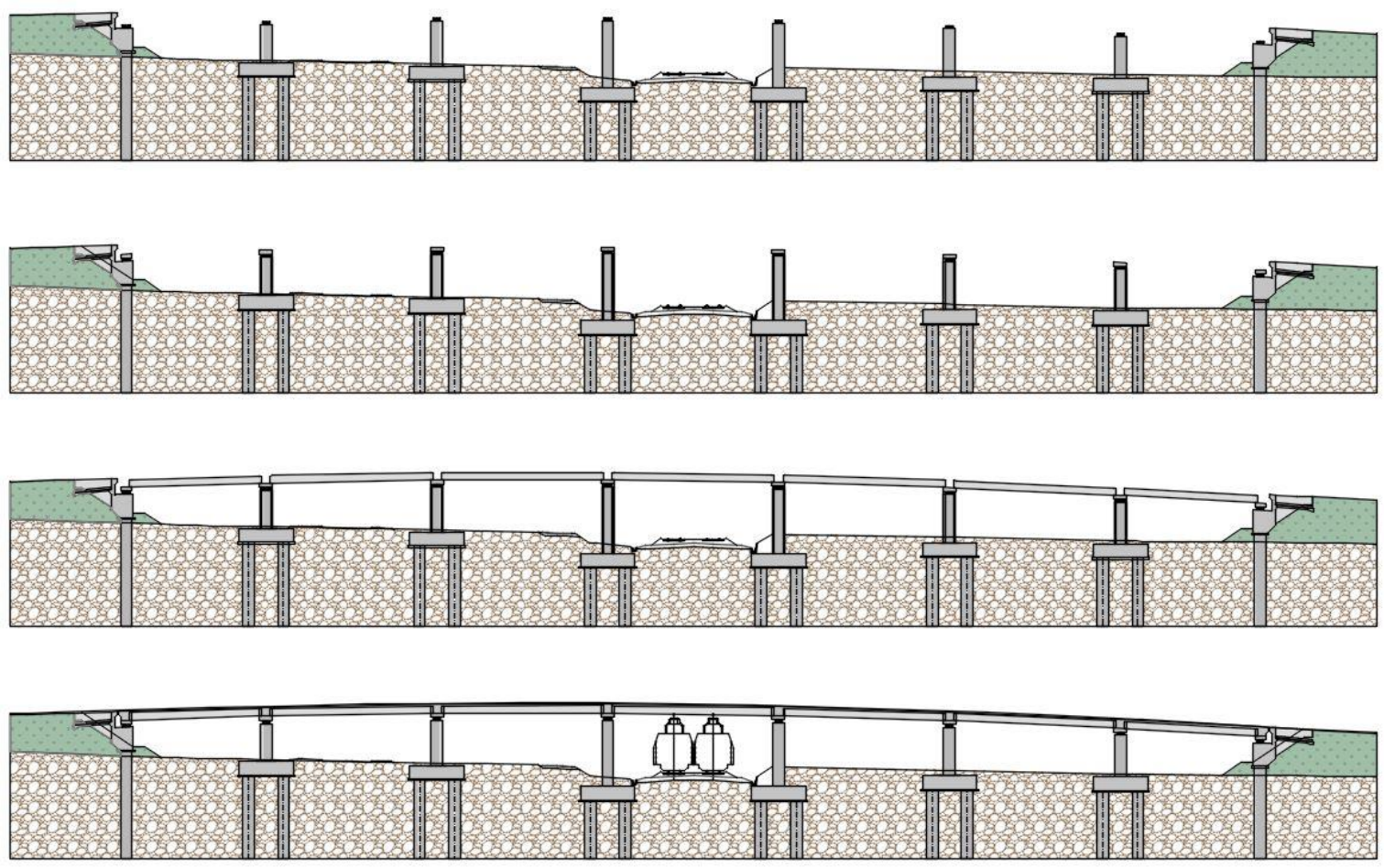
Usporedba utrošak betona na stupištu visine 7,0 m (m^3)

$V_{beton(\Phi150)}$ = 24,7
$V_{beton(\Phi180)}$ = 35,6
$V_{beton(I\ stup)}$ = 44,8

- Φ150 i Φ180 cm
- Udaljenosti stupa od osi kolosijeka > 6 m
- Faktor ponašanja $q_x = q_y = 3,5$

- Vanjske dimenzije 1,6x4,6 m
- Udaljenosti stupa od osi kolosijeka > 5 m
- Faktor ponašanja $q_x = 3,5$; $q_y = 1,0$

Faze gradnja nadvožnjaka (KR8)



Faze gradnja nadvožnjaka (KR8)

Zaključak

- U procesu projektiranja nastojalo se pronaći optimalna rješenja u pogledu:
  - Uporabnih uvjeta (neometan prolaz vlakova, siguran prijelaz lokalnog prometa)
  - Konstrukcijskih uvjeta (sigurnost, nosivost, trajnost)
  - Estetskih uvjeta (uklapanje u krajobraz, simetrična niveleta, skladan odnos raspona i visine, oblikovanje stupova
  - Tehnološki uvjeti (gradnja s minimalno zatvaranja pruge, iskušana tehnologija gradnje)

Nadvožnjaci u sklopu rekonstrukcije željezničke pruge Dugo Selo - Križevci

Hvala na pažnji ☺