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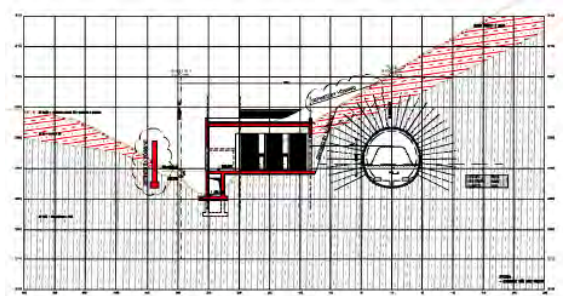
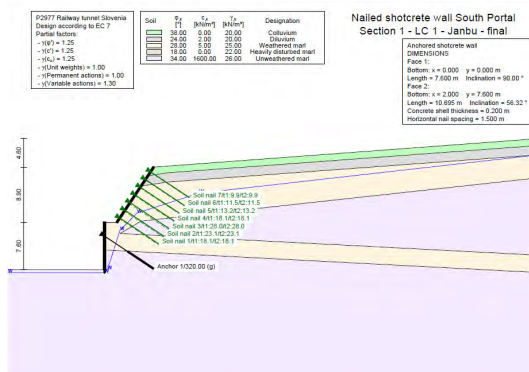
PROJECT

Approach cuts for the Divaca – Koper railway tunnel, Slovenia

- 6 km long railway tunnel with two tubes between the towns of Divaca and Koper
- Approach cuts are required on both sides of the tunnel
- Steep slopes are stabilized by rock bolts and a shotcrete shell
- At the Koper end additional stabilization is provided in places by bored pile walls underneath

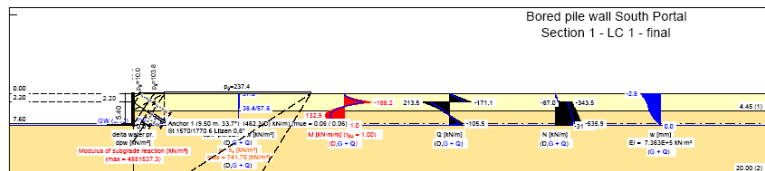
OUR SERVICES

- Technical processing of the slope stabilization by rock bolts and relieved bored pile walls

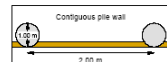


Soil	$\sigma_1$ [kN/m <sup>2</sup> ]	$\sigma_2$ [kN/m <sup>2</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	$c$ [kN/m <sup>2</sup> ]	$\phi$ [°]	$\sigma_{p,active}$ [kN/m <sup>2</sup> ]	$\sigma_{p,passive}$ [kN/m <sup>2</sup> ]	$\gamma_{s,active}$ [kN/m <sup>3</sup> ]	$\gamma_{s,passive}$ [kN/m <sup>3</sup> ]	$\gamma_{s,unweathered}$ [kN/m <sup>3</sup> ]	Designation
1	38.0	0.0	20.0	0.0	0.0	0.667	0.667	21.43	21.43	26.00	Weathered marl
2	24.0	2.5	20.0	0.0	0.0	0.667	0.667	107.10	107.10	26.00	Unweathered marl

DR. SPANG GmbH N. Bujard 73724 Bissinger Tel. 011 361 35 49-0	Railway tunnel Slovenia Excavation South portal	Project no. P 32.2977 Appendix no. 3.1.1
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**Design values:**  
 Vertical contiguous pile wall  
 $E = 3000.00 \text{ kN/m}^2$   
 $I = 460378.02 \text{ cm}^4/\text{m}$   
 Reinforcement DIN 1045-1  
 Numerical solution with 50 points  
 Concrete C 20/25  
 Steel S500SD MPa  
 $N(D) = 376.5 \text{ kN/m}$   
 $N(U) = 174.0 \text{ kN/m}$   
 $\text{eps}(C) [0/0/0] = -3.5$   
 $\text{eps}(U) [0/0/0] = 17.9$   
 $A_{s1} [0/0/0] = 16.4 \text{ (mm}^2/\text{m)} = 6.2 \text{ cm}^2$   
 Pile diameter = 1000 mm  
 $c/\text{fin} = 0.07000$   
 $\mu(D) = 0.0423 / \mu(U) = -0.0195$   
 $\text{disp}(0/0) = 0.0003$   
 $\text{sig}(1) = 0.6 \text{ (kg/cm}^2) = -4.06 \text{ MN/m}^2$   
 Clear reinforcement:  
 $Q(D) = VSD = 426.9 \text{ kN}$  (equivalent width/height = 0.856 m)  
 $V_{RC,max} = 1660.1 \text{ kN}$  ( $V_{RC}/V_{RC,max} = 0.2572$ )  
 As/shear = 7.0 cm/m (min. reinf.)  
 Clear distance = 30.0 cm  
 Verification of concrete lagging:  
 $\text{max}(s_{p(D)}) = 77.4 \text{ kN/m}^2$   
 Thickness of inter-axial = 0.200 m  
 Thickness, dense, dense = 0.100 m  
 $s_p = 13333.33 \text{ kN/m}^2$   
 $s_p = 3885.18 \text{ kN/m}^2$   
 Verification OK



P3277 Railway tunnel Slovenia  
 Contiguous pile wall  
 Calculation base:  
 Bilinear ep distribution (depth division = 3.60 m / ean/eanu = 1.0)  
 Active ep according to DIN 4045  
 Increased active earth pressure ( $\gamma = 0.50$ )  
 Equivalent ep coefficient  $k_{a,1} [1] = 0.200$   
 Passive ep according to DIN 4045  
 Solder pile width = 1.00 m  
 Solder pile centres = 2.00 m  
 Section length of 6.10 m fixed and toe beaded  
 Subgrade reaction adaptes using riv.  
 $\gamma_s = 1.35$   
 $\gamma_s = 1.50$   
 $\gamma_s = 1.40$   
 Passive ep calibration factor = 0.50  
 $\gamma_{s,Water} = 1.00$   
 $A_{s,Water} = 2.00 \text{ m}$   
 Sum  $\gamma$  items = 0.02  
 File: P3277-Section1-standard.vrt