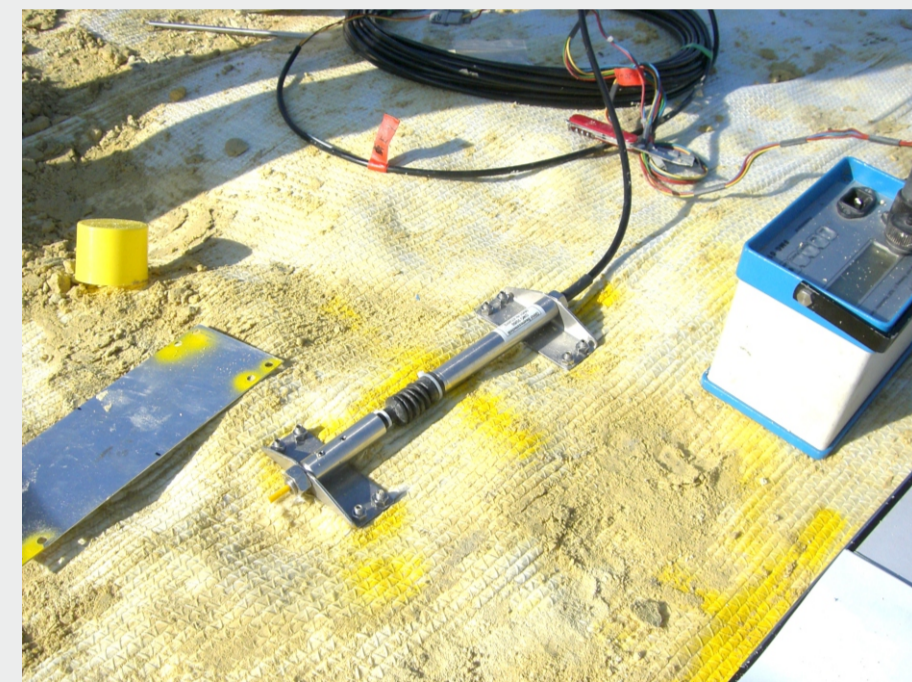


Heavy Preloading and Consolidation of Soft Soil Masses with the Use of Reinforced Embankment and Vertical Drains

J. Sobolewski, HUESKER, Germany; V. Radovanović, Kolubara, Serbia

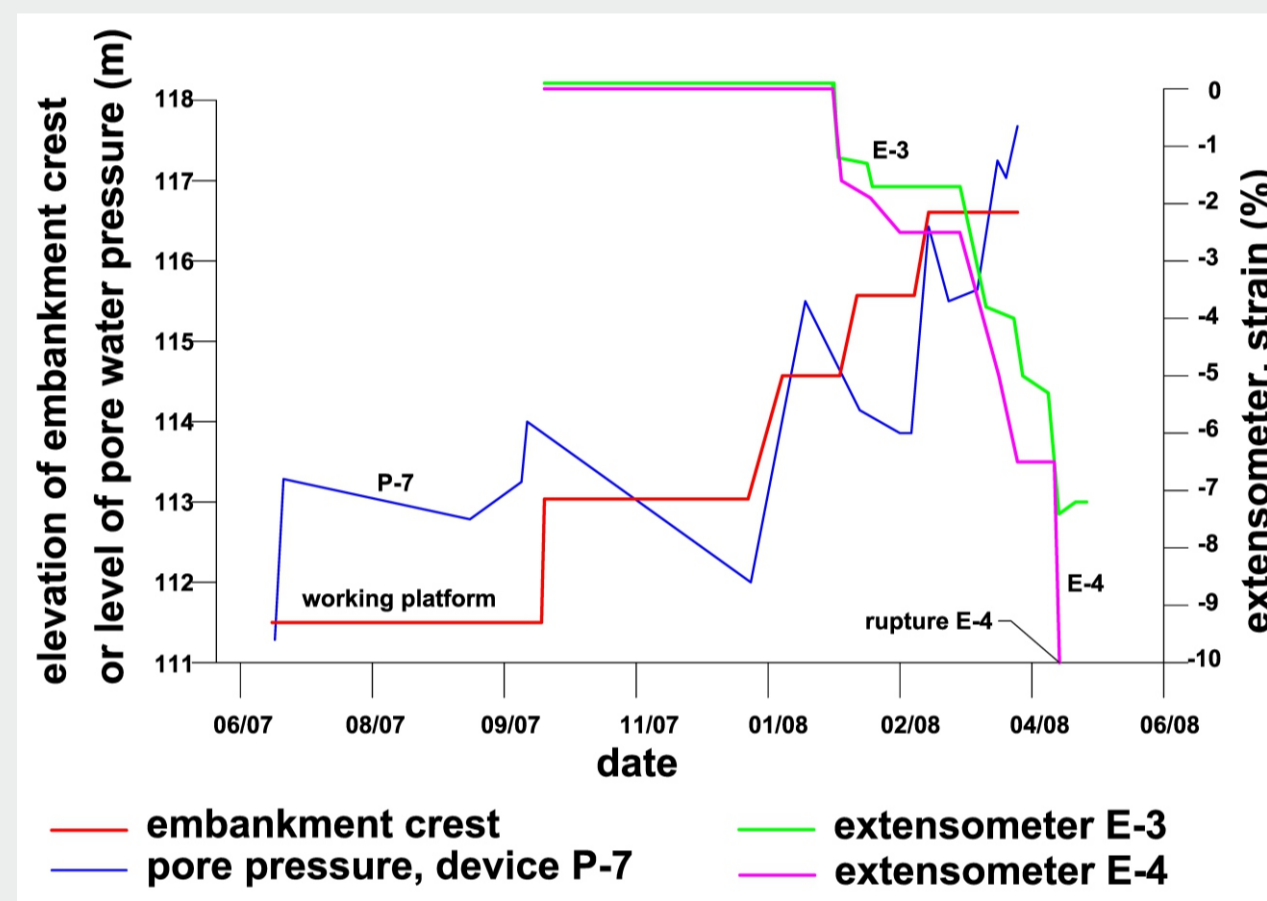
A large part of field "B" in the open cast coal mine "Kolubara", in the Republic of Serbia, was covered by soil masses slid from the disposal area in March-April 2006. This landslide with a length of approx. 2 km and the width of more than 400 m stopped the coal excavation. The coal stratum was covered by 30 - 40 m thick very soft soil deposits. A heavy pre-loading consisting of a 9.5 m high embankment and an accelerated consolidation by the use of vertical drains for an improvement of soft deposits was selected to solve this problem. A high tensile strength geosynthetic reinforcement placed at the base of the embankment allowed for a short construction time. After consolidation 25 samples were taken at different locations and depths and a reasonable improvement of the shear strength could be confirmed. Due to this the embankment could be removed and the 1:6 sloped excavation down to the coal roof was performed. The coal excavation was reopened in January 2009.

Type of soil	Friction angle [°]	Cohesion [kN/m ²]
① remoulded and untreated soft soil	8	-
② normally consolidated soil	12 15	10 8
③ preloaded soil	16	12



Installation of an extensometer on Stabilenka® 1600/100 PES

Shear parameters of ① remoulded and untreated, ② normally consolidated and ③ preloaded with $\Delta\sigma = 200 \text{ kN/m}^2$ samples of soft soil masses



Results of monitoring during construction works and preloading



Installation of a pore pressure device



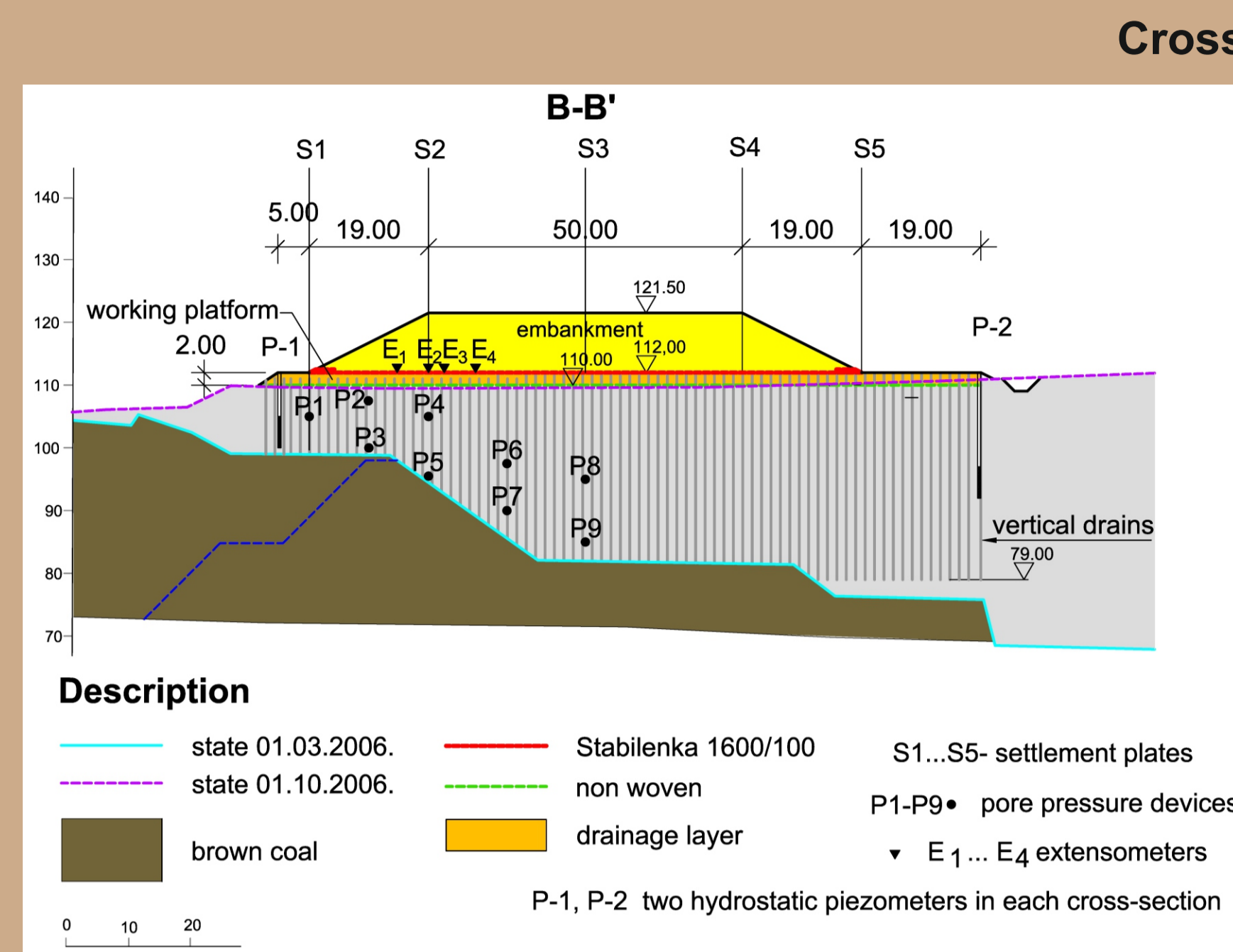
Base preparation: levelling of surface, installation of non-woven, placement of 20 cm sand layer



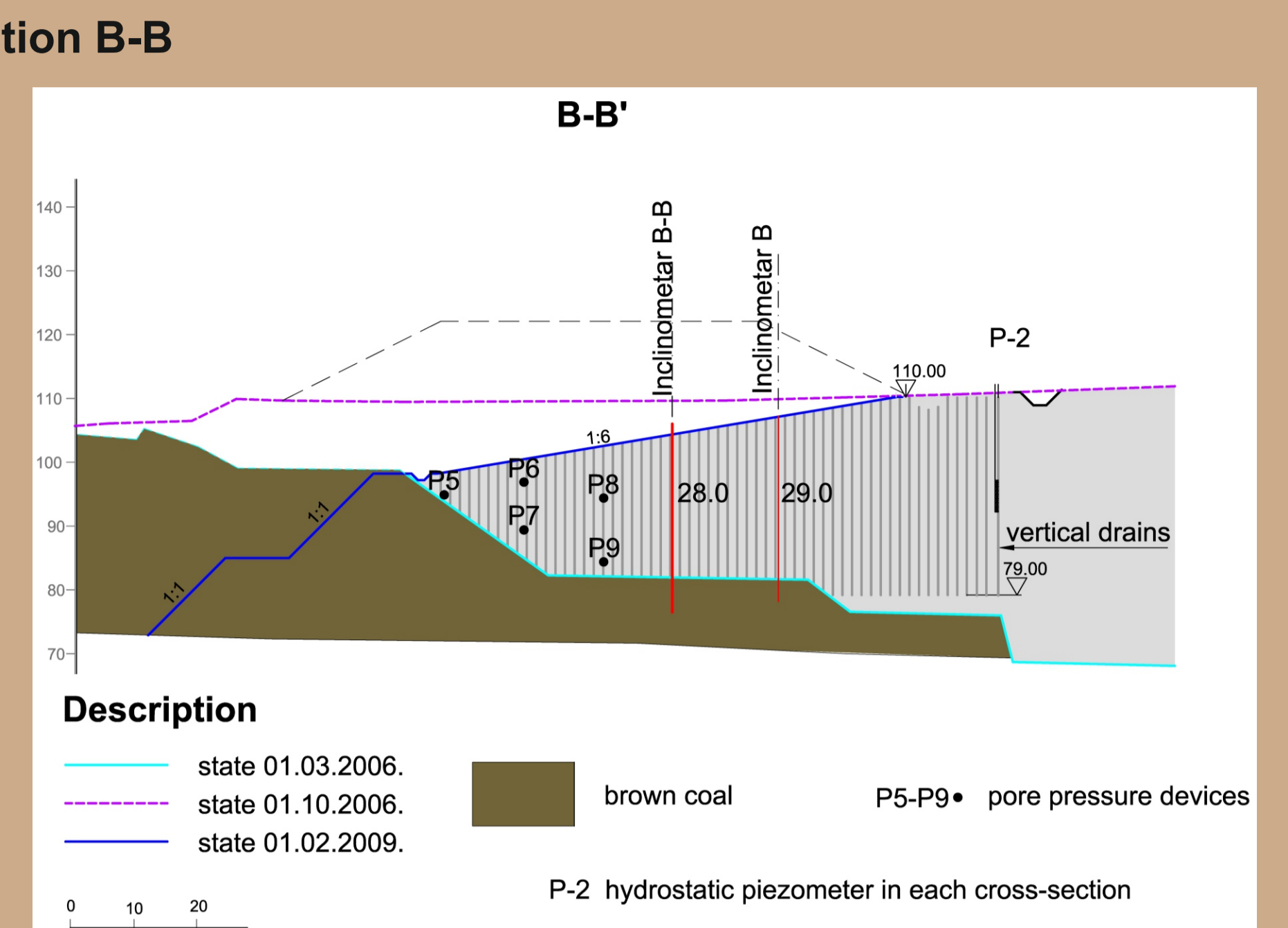
Horizontal installed geosynthetic drains in the spacing of 1.0 m on the base of working platform



Installation of vertical drains in triangle spacing, 1.25 m on the top of working platform



Embankment for preloading, monitoring plan



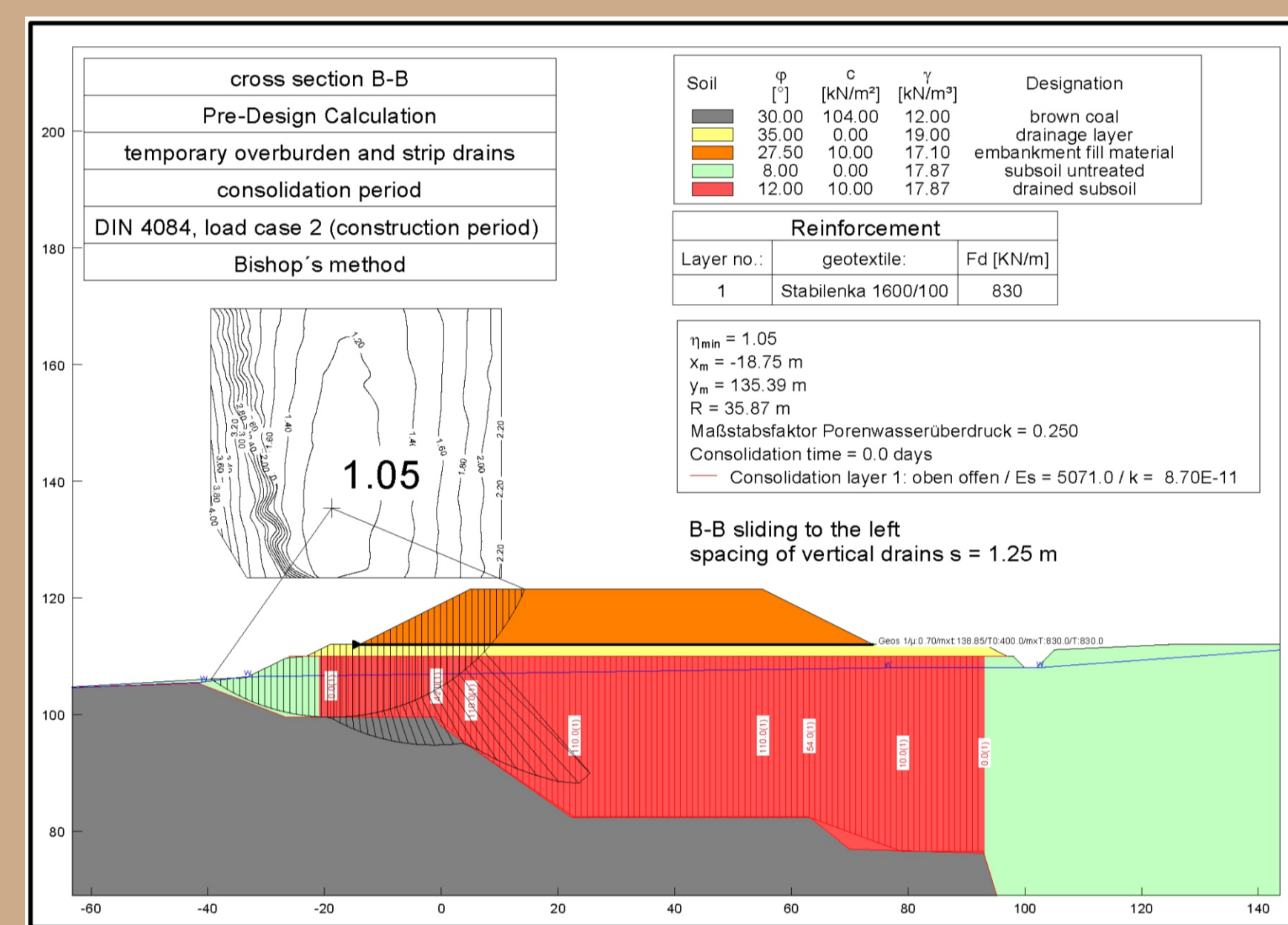
Excavation to the coal stratum



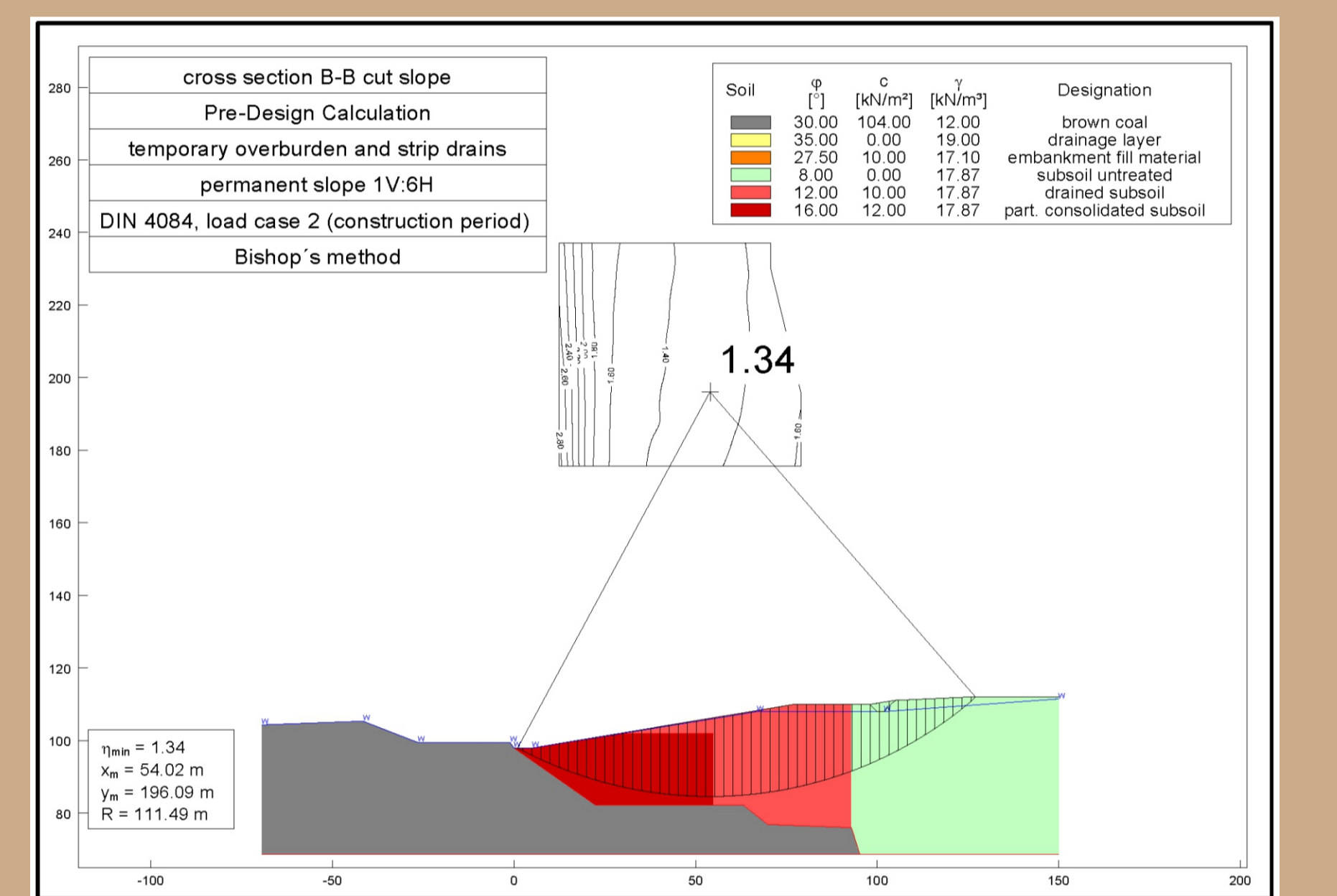
Predicted values of safety factors for the critical stage of embankment



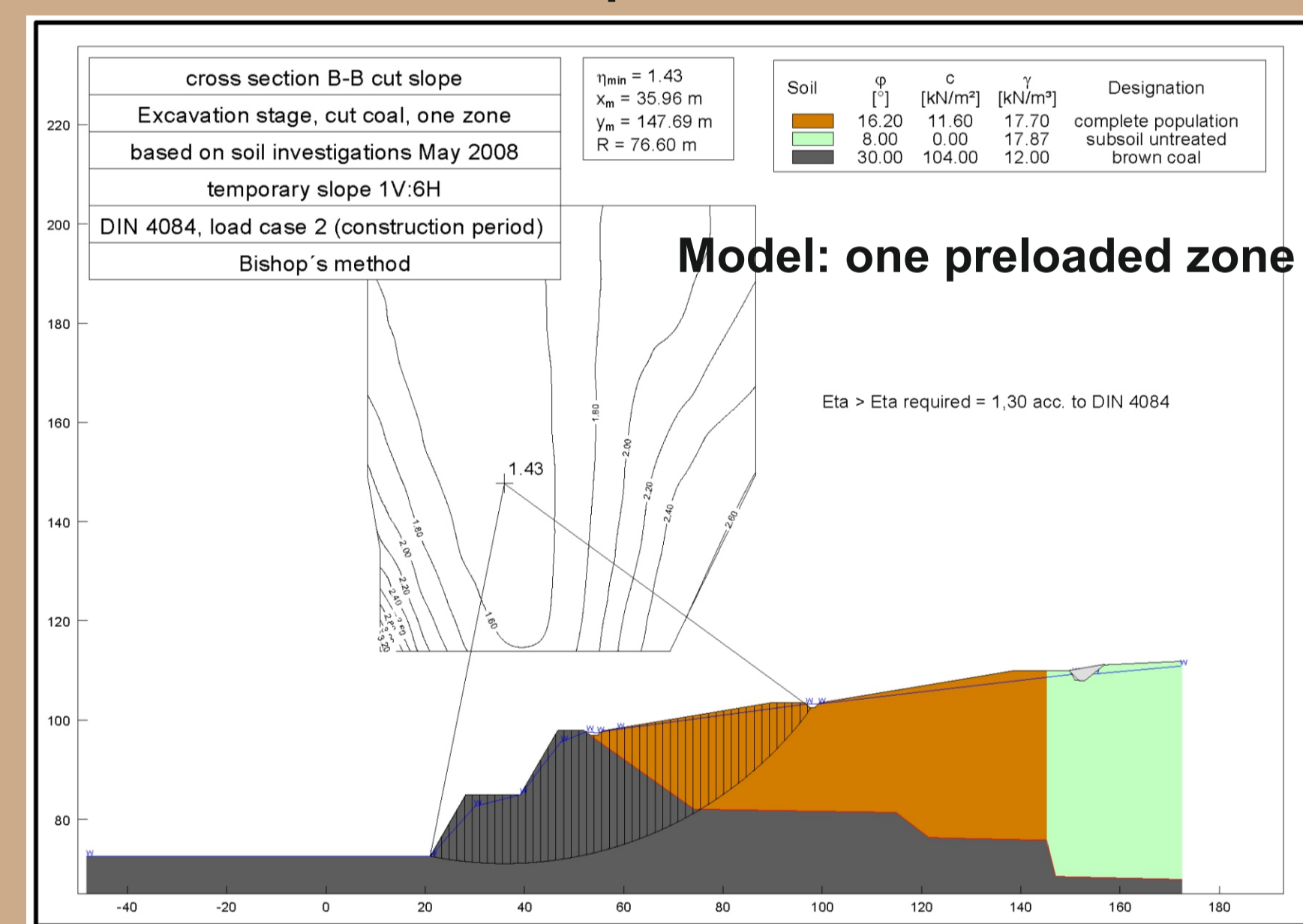
Predicted values of safety factors after the excavation to the roof of the coal stratum



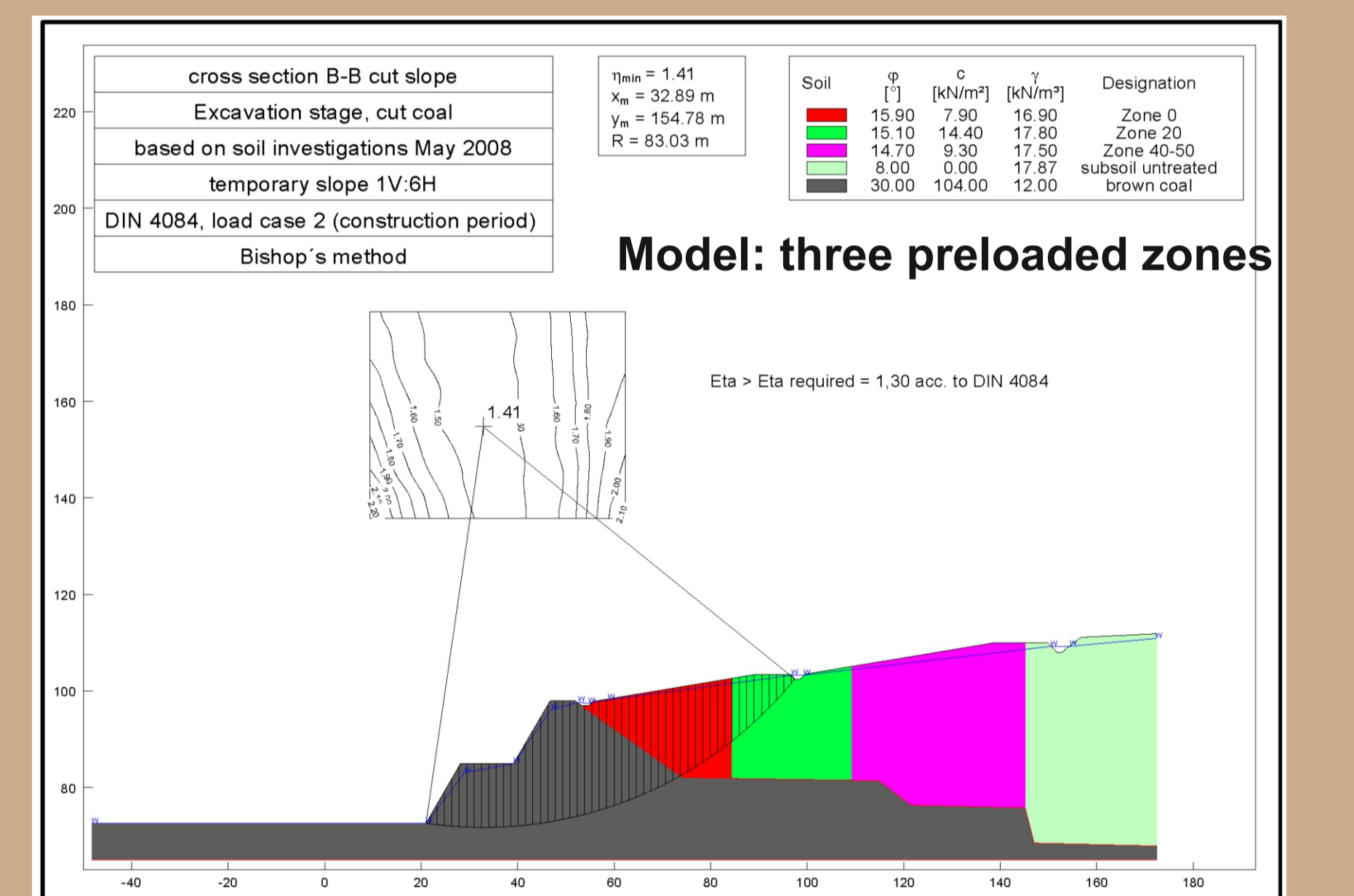
Stability analysis of embankment, Bishop's method



Stability analysis of excavated slope after pre-loading, Bishop's method



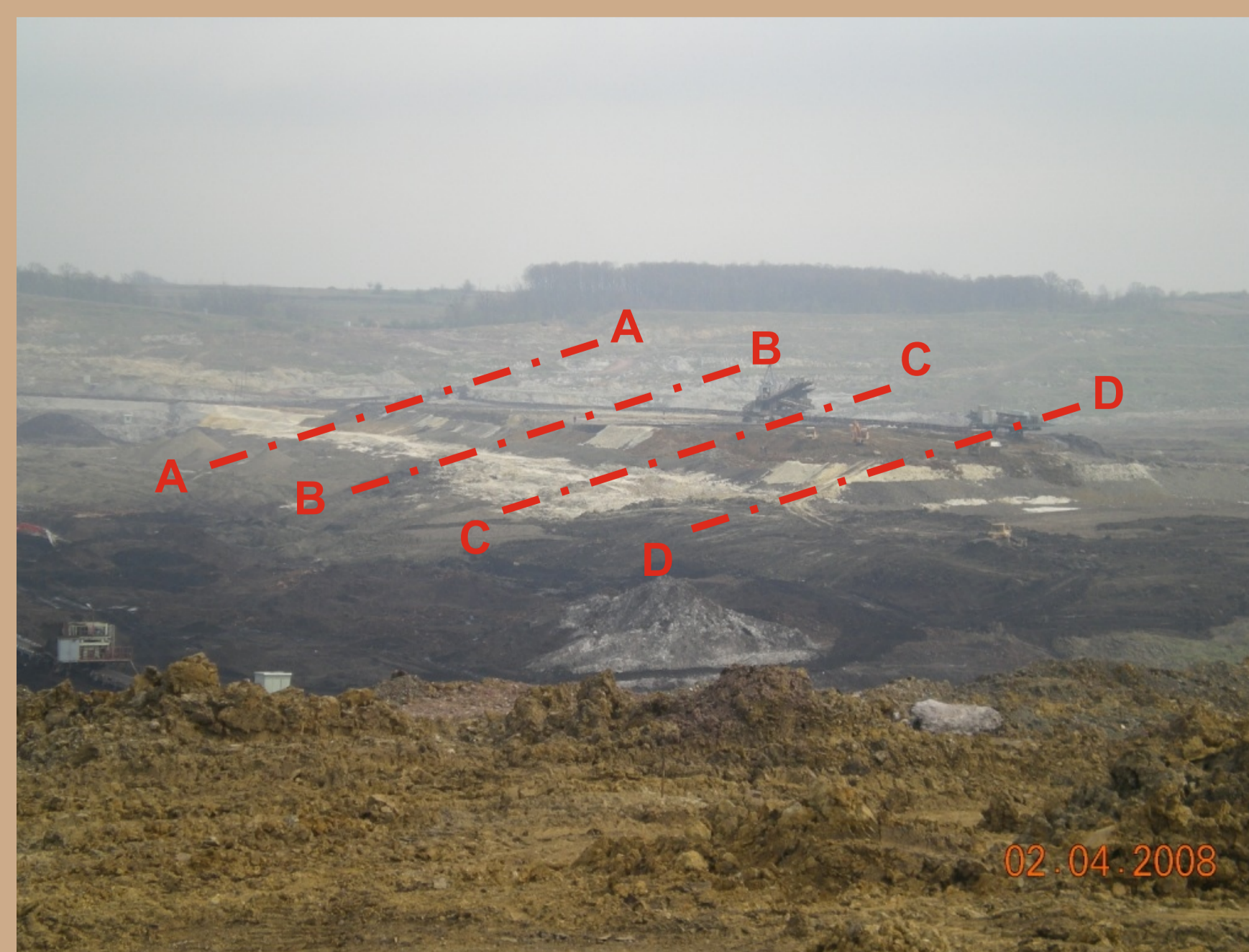
Stability analysis of excavated slope: estimated soil parameters after preloading, Bishop's method



Installation of drainage pipes in the working platform, spacing 10 m



Installation of basal reinforcement, woven fabric made of polyester UTS = 1600 kN/m



View on embankment during preloading



Coal excavation at the front after reopening of the coal mine in the field "B"