

Reliability assessment in geological forecasts for an highway tunnel: the application of the R-index method in sedimentary rocks

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Natural environment is characterized by high mechanical and geometrical complexity. A proper study of geological conditions is therefore one of the most important aspects to be managed. Since total certainty is not possible, a correct approach in the tunnels design should aim at quantifying the geological model reliability. The R-index methodology (Perello, Venturini, Dematteis, Bianchi, Delle piane, Damiano. "Determination of reliability in geological forecasts for linear underground structures: the method of the R-Index" Geoline Int. Symp.- Lyon 23-25 May '05) allows to quantify the reliability of the geological model. The R-index is defined by three types of parameters: (1) the quality of the investigation, i.e. geological mapping, borehole drilling and geophysical investigation, (2) the interpreter skill, i.e. the capacity of the geologist which creates the model to interpret the data and (3) the system parameters, i.e. the complexity of the lithostratigraphical setting, ductile and brittle deformations.

This abstract illustrates the case of the Serra dell'Ospedale tunnel, which is a 1 km long double tube tunnel in the Salerno-Reggio Calabria highway, in the north of the Calabria region. The aim of the work is both to present the local geological setting and to illustrate and discuss the R-index methodology applied to a sedimentary context.

The stratigraphic-depositional model was based on the analysis of the geological mapping, the borehole logs and the available geological literature. The field mapping has been essential to define the general stratigraphic framework of the outcropping upper-Pliocene –lower Pleistocene prodeltaic to deltaic deposits.

The stratigraphic interval comprises a lower complex essentially made up of sandstones and channelized sandy gravels on which rests a clayey interval of a minimum thickness of 50 m (upper Pliocene- ?) and a upper interval of interbedded silty sandstones, sandstone and sandy gravels (lower Pleistocene- ?). Paleocurrents, sedimentary bodies geometries and internal stacking pattern of these deposits was detected during the field survey and was confirmed by boreholes. Those indications testifies a coastal and deltaic sedimentary supply feeded from eastern sector. The lower part of the studied stratigraphic interval shows a fining upward trend. This lower part shows a coastal to deltaic deposits, with deposition of blue-dark clayey

deposits with thin turbidite sandstones beds. The upward part shows a coarsening upward trend connected to prograding coastal and deltaic deposits. The highway tunnel intersect the vertical transition between the clayey deposits and the upper sandy complex.

The transitional/etheropic character of vertical and lateral transition from the clayey portion to the upper sandy complex suggested the opportunity of defining three main tunnel face types: 1) tunnel face wholly made up of clay with rare thin sandstones beds, 2) mixed tunnel face made of clayey-silty deposits with interbedded sandstones 3) tunnel face wholly made up of sandstones showing variable cementation degree with rare lenticular sandy-gravels channel fillings. This three main types were defined taking also into account the permeability and ground geotechnical behavior. The probability of finding a type rather than another was defined based on a probabilistic approach.

The tunnel was deeply investigated with 10 cored boreholes (total length of 375 m), 2 seismic profiles and 3 trenches. The outcropping is around 30% and the geological mapping was performed at 1:2.000 scale along the tunnel axis. Nevertheless the reliability of the geological model along the tunnel axis was 28% good, 43% fair and 29% poor. This is probably due to the heterogeneity of the stratigraphic context, such as the presence of lens-shaped bodies along the tunnel axis, which is difficult to be foreseen at the scale of 1:2000. This means that new boreholes will not improve significantly the geological model reliability.