Udruga hrvatskih građevinskih fakulteta i
Građevinski fakultet Sveučilišta u Mostaru

Treći skup mladih istraživača iz područja građevinarstva
i srodnih tehničkih znanosti

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Zagreb, rujan 2015.

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SADRŽAJ

ONE APPROACH FOR EXTRAPOLATION OF ROCK MASS PARAMETERS IN TUNNELING

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The problem for extrapolation in tunneling and geotechnics is one of the key problems and basis for succesful geotechnical and numerical modelling in the past few decades. The main goal of this problem is how to extrapolate the parameter from zone of testing to the whole area (volume) that is of interes for interaction analyses along tunnel whole lentgh. This article describes a methodology that shows how it is possible to integrate all these approaches in a problem for extrapolation of the parameters in tunnelling. The proposed methodology is based on combination of empirical classification rock mass methods, geophysical measurements and direct deformability testing on a field. The analyses are given based on the results from investigations of several tunnels in the Republic of Macedonia, mainly in rocks with poor to fair rock mass quality.

Improving this methodology, herein the basics of Empirical–Static-Dynamic (ESD) methodology of extrapolation are given. All known methods for defining of deformability and shear strength of rock masses can be used and combined for extrapolation of parameters for the whole area and length of structures. The prerequisite for using this methodology is following:

1. To have enough data for reliable rock mass classification.
2. To have enough testing data for deformability with static tests.
3. Whole interaction of the structure (in this case tunnel) to be covered with geophysical seismic tests.

Such testing must be performed in a manner that will insure reliable data for geotechnical modeling of the natural geological environment of the whole area along the tunnel. Having in mind that too many properties are needed to characterise certain rock mass completely, it is easy to conclude that the claim for uniformity of all or most of the properties cannot be achieved. So, before some areas are selected, we choose one or few properties for which the uniformity of one area is demanded. We call these areas quasi-homogenous zones and they represent the basic and constitutive elements of geological model.

Inside such zone some conditions or properties are the same in every point, and very different outside it. Each and every zone is determined by space limits and consists, in some way, properties which are important for the study.

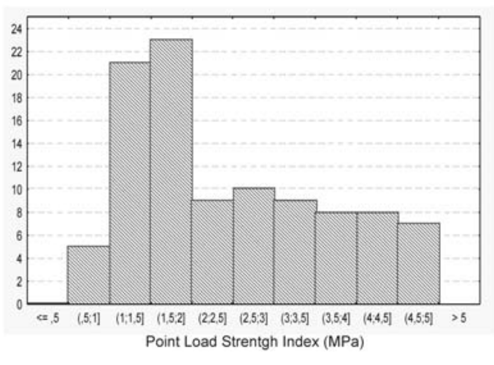

Figure 1. Statistical analyses of Point Load Strength index for schist's formations in Macedonia

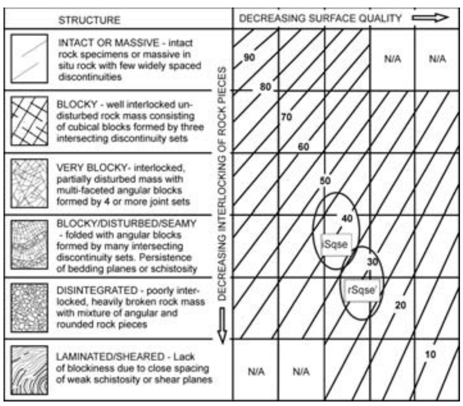

Figure 2. Range of GSI values for different zones of quartz sericitic shists for "Preseka" tunnel

To illustrate the methodology, in this article, some practical experiences gathered during investigations and design of several tunnels in Republic of Macedonia are presented. The following steps in investigations is used:

1. Collection of data for rock massif test results, particularly laboratory and field test results of strength, deformation, discontinuities and other parameters.
2. Specific laboratory and field testing .

3. Statistical analysis and comparison of data collected from the literature and data collected through research and tests performed for purposes of this article.

Collected data are usually analysed statistically. Only one example for a case of Point Load Strength index parameter, is presented in Figure 1.

Using all results from geological, geotechnical and geophysical investigations, rock mass quality is defined for all quasihomogenous zones using Rock Mass Rating, Quality index (Q) as well as Geological Strength Index using Hoek GSI classification (Figure 2).

It must be noted, that because of tectonic influences, usually, rock masses in Republic of Macedonia are with poor to fair quality. Some statistical analyses are given in Figure 3 and Figure 4.

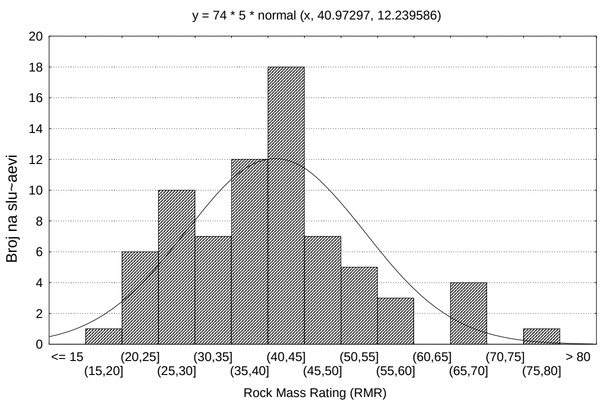

Figure 3. Range of values for Rock Mass Rating

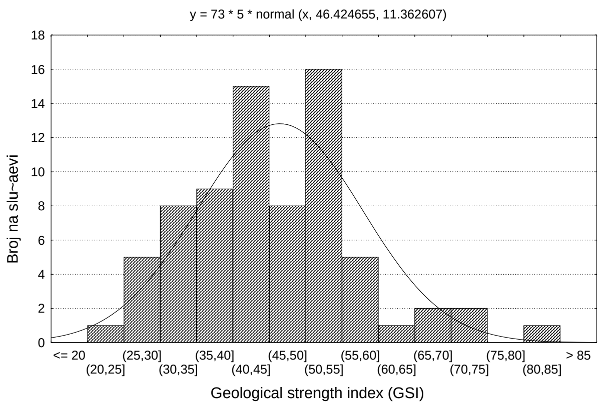

Figure 4. Range of values for Geological Strength Index

RMR and GSI values were used in order to predict shear strength and deformability parameters of rock massif with a help of Hoek, Carranza-Torres and Corkum, 2002 and Hoek and Diederichs's, 2006 methods.

Beside this, correlations between the quality of rock massif (RMR, GSI and Q indexes), dynamic (Vp and Edyn) and static properties (D and E) of rock masses are expressed using results from the detailed classification of the rock massif around the measuring point with dilatometer testing's. One regression line established for tunnel "Preseka" is presented in Figure 5 and Figure 6.

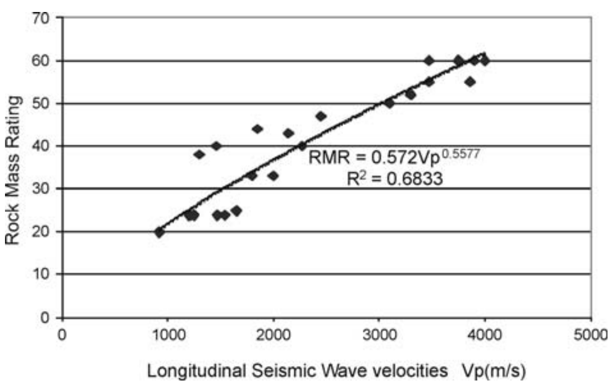

Figure 5. Correlation between (RMR) and longitudinal and seismic wave velocities for tunnel "Preseka"

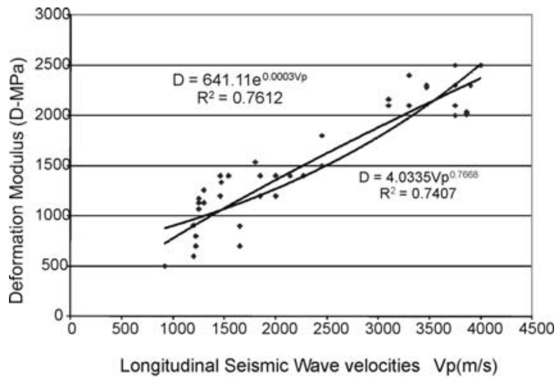

Figure 6. Correlation between Deformation Modulus longitudinal seismic wave velocities for tunnel "Preseka"

The presented Empirical–Static–Dynamic method for data extrapolation can be very useful tool in preparation of geotechnical models for further analyses in tunneling. Because of its verification, the suggested methodology must be critically re-examined meanwhile in terms of possibilities to apply it in other locations and other facilities in different geological media. However, it will open doors and possibilities for further researches, considering that it is practically impossible to exhaust this scientific theme with only one paper. Analytical models for prognosis of possible intervals of deformation modulus D are useful as input data in numerical analysis for relatively shallow tunnels.

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