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Estimate of Uniaxial Compressive Strength and Young's Modulus of the Elasticity of Natural Stone Giallo d'Istria

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Abstract

The famous natural stone Giallo d'Istria, is categorized as a thick-bedded biomicritic limestone, is exploited in three locations on the Croatian peninsula of Istria. In order to detect high-quality areas of the existing quarries and some new areas of exploitation as well, models have been developed for the purpose of estimating important physico-mechanical properties of this limestone. The models are based on the results of many laboratory tests. Complex and simple estimation models have been mutually compared. The modelling is based on neural networks and multiple and simple regressions. Special attention was paid to the applicability of the developed models in other sites.

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Keywords: Uniaxial compressive strength; Young's modulus of the elasticity; estimation; Giallo d'Istria; neural network; simple regression

1. Introduction

Giallo d'Istria (yellow Istrian) is the general name for the natural stone from the Kanfanar, Selina and Korenići quarries which are situated on the Croatian peninsula of Istria. Stratigraphically speaking, Giallo d'Istria is a Lower Cretaceous biomicritic limestone (see Figure 1). These deposits are characterized by a thick-bedded limestone of a yellowish color. The thickness of the individual layers is anywhere from 0.80 to 1.50 m, provided that they are separated with contour lines that define the boundaries and mark the weakly bound contour lines.

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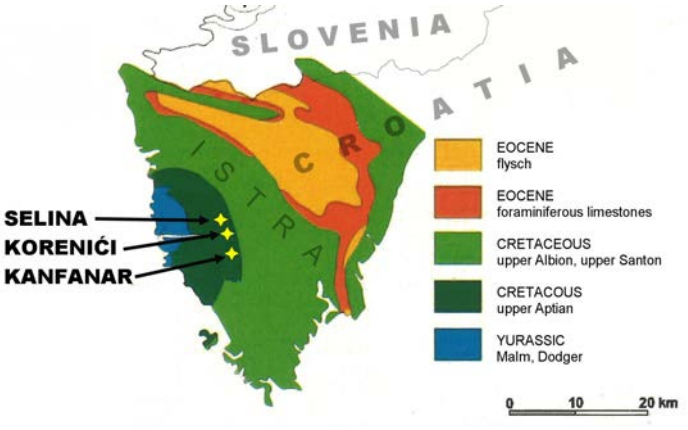

Fig. 1. Position of the quarrys.

The thickness of the overburden is 17 to 25 m, which layers are typically denoted alphabetically as shown in Figure 2, and the exploitation layers have a thickness between 4.8 and 6.8 meters, and sometimes even up to 7.6 m they are marked with Roman numerals I, II, IV, V and VI. The layers differ in appearance and structure, and thus cannot be mixed in the production process. There are also differences in the physico-mechanical properties even within the layers in its strikes and dips, especially in porosity and density. In exploitation, such areas must be rejected, and thus losses in yield occur [1, 2, 3].

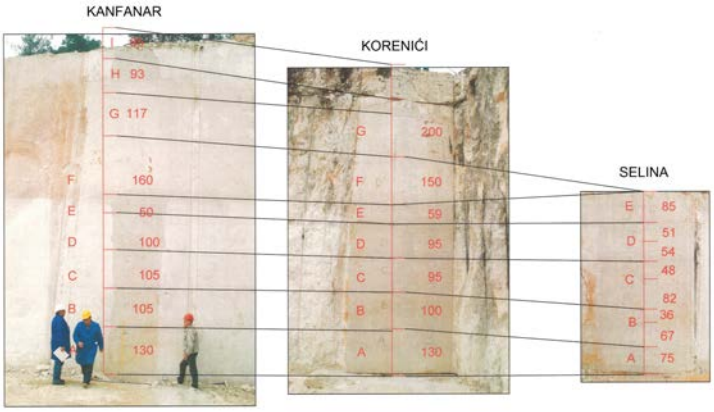

Fig. 2. The spatial distribution of overburden layers in quarries Kanfanar, Korenići and Selina.

In order to ensure a uniform quality of exploited natural stone, it is necessary, and if feasible, as simply as possible, to locate areas where there are distinct changes in the strength and deformability of materials. For this reason, a need arose to find a method which could practically assess the uniaxial compressive strength (UCS) and Young's modulus of elasticity (E) based on easily determined material characteristics. Extensive testing of natural stone for the development and introduction of underground mining in quarries [4] took place and the physical and mechanical properties of the individual layers were tested which advanced the progress in achieving this goal. The implemented tests, among other things, enabled the determination of the interdependence between the various physico-mechanical characteristics. Modelling in this paper was inspired by the methods of assessing physico-mechanical characteristics published in scientific literature. Principally, the most widely used is regression, but recently more sophisticated techniques such as neural networks have frequently been applied as well [5].