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Construction of the bridge in the cavern in the Vrata tunnel (Croatia)

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In the Dinaric karst system in Croatia some 11500 speleological objects have been explored so far, more than 1000 of which were discovered during construction works. Such speleological objects without natural entrance on the terrain surface (which are called „caverns“) have been discovered on the construction sites of the highways. Over the past twenty years they have been systematically investigated and treated. A special kind of remediation was conducted in the cavern's large hall of the „Vrata“ tunnel on the Zagreb – Rijeka highway. Due to size, shape, cavern's position and hydrogeological parameters (fissured and karstified aquifers) within the karst system it was necessary to design and construct a 58 m bridge over the cavern. In addition, the cavern's vault had to be reinforced and stabilized, as the overburden was very thin. The beam-and –stringer grid with special anchors was used.

The cavern's rehabilitation in the „Vrata“ tunnel was a unique undertaking, and the bridge (without piers) is the cavern's longest bridge in the world.

A speleological object of large dimensions was discovered in the „Vrata“tunnel's right tube on the Rijeka-Zagreb highway. Speleological, geotechnical, engineering geological and hydrogeological investigation works were carried out for the purpose of preservation the speleological object (cavern). On the basis of classification results of rock masses and conducted numerical analyses the support system for the cavern's vault stabilization was selected. The support system's elements include the beam-and-stringer grid constructed on the terrain's surface above the cavern, tendons and geotechnical anchors.

To ensure stability of the speleological object, and to conduct the backward numerical analyses the measurement of vertical deformations from the terrain's surface along the rock's mass by means of sliding micrometers was undertaken. Backward numerical analyses combined with geotechnical measurements enable safer and more rational approach to design and construction of underground structures. They contribute to the knowledge on rock mass performance and to determination of its physical and mechanical parameters connecting them with rock classification results. The analyses are a great help in verification or modification of elements' features of primary support system.

Tunnel and bridge in tunnel “Vrata” were opened for traffic in November 2008.

Keywords: speleology, cave, Dinaric karst, Croatia, tunnel, karst phenomena, geotechnical engineering.