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STONE FOR RESTORATION AND DECORATION PURPOSES IN WESTERN SLOVAKIA

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Abstract: *The contribution is focused on assessing of important physical and mechanical properties of rocks quarried in Brezovské Karpaty Mts. with the aim of their utilization as decorative and prospective building stone for restorations. Carbonate sandstones and conglomerates of Upper Cretaceous and carbonate sandstone of Neogene sedimentary strata in Chtelnica - Trianova and Chtelnica - Malé Skalky were taken into consideration. Those quarries appeared to be suitable for excavation of an appropriate material for statuary and monumental purposes and for restoration work, as well. Samples for assessment of rock properties were taken from abandoned and quarry in operation. Tested specimens for laboratory tests in a form of cubes and cylinders were prepared from monoliths and drilled cores taken from the depth up to 1 m. For determination of rock quality following tests were taken as most relevant: densities, porosity, water absorption and strength properties estimated according to valid technical standards. Based on physical and mechanical properties of rocks assessed on a number of tested samples from two mining sites in Slovakia and one comparable site in Austria, quality assurance of the rock utilization as a decoration/restoration material is presented.*

Keywords: Decoration and restoration stone, Physical and mechanical properties of rock, Chtelnica-Trianova, Chtelnica-Malé Skalky.

1. Introduction

Scarcity of stone for restoration works in Slovakia is due to the intense tectonic history of Slovak Carpathians generally known. Therefore the aim of the investigation was to look for sound stone for decoration and restoration purposes, regarding its properties, durability and appearance. It was the author´s effort to verify in the Western part of Slovakia (vicinity of Bratislava, Trnava, Skalica and others) the excavation possibility. Excavating of decoration stone and the stone masonry in Brezovské Karpaty Mts. with various stone treatments has a long history. The quarrying was concentrated in villages Dobrá Voda and Chtelnica-Trianova (livery company). Here, the founded quarries served huge blocks of easily workable sandstone or conglomerate used in many historical buildings, sculptures, grave stones, paving, etc. The stone was used in the city of Trnava - gothic portal, baptistery, paving, stairs, pavements, pylons, statue socles, etc. in interior and exterior of several churches. In Bratislava the stone from Trianova was used for stairs in the Erdödy palace, for the pavement in the Mindszenty atelier, in the gothic house portal in Biela Street, in well casing in the court of Bratislava castle, etc. The historical utilization of the material from Chtelnica-Malé Skalky is not known yet.

2. Geological Setting

The investigated sites have a very different litho-stratigraphical evolution. Investigated sedimentary rocks of the Upper Cretaceous built the transgressive overlap of Triassic dolomites and limestones of the s.c.

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Brezovská group of Brezovské Karpaty Mts. Sandstones and conglomerates (Coniacian) within the quarry Trianova and Dobrá Voda represent a solid, thick bedded (1 to 2 m) structure. These greyish coloured, fine and middle grained sandstones and conglomerates with carbonate clasts possess a very variable grain composition, which varies vertically and laterally. The total thickness of the strata is 50 to 150 m. The mining site in Dobrá Voda was abandoned in 70-ties of the last century due to the important hydrogeological structure (karst water reservoir).

The quarry Malé Skalky is a part of Neogene filling of Dobrá Voda tectonic depression. Neogene sediments (Burdigalian) of Dobrá Voda evolution rest disconformly on subsided Mesozoic rock blocks. The rock formation is built up by Jablonica light geyish or beige-creamy carbonate (locally polymict) conglomerates and carbonate sandstones, very variable in grain composition. The rocks are purely built up by carbonate clasts connected with carbonate cement. Conglomerates are very variable in the grain size and alternate with sandstones vertically, even laterally. The thickness of the strata is from 40 to 80 m.

3. Field Investigation

In the site Trianova one rock block (monolith) was taken for the preparation of laboratory samples in the size of 50 x 50 x 50 mm. In the site Malé Skalky were taken cylindrical rock cores with the diameter of 50 and 35 mm using the portable electric drilling device, and one monolith for preparing of samples in the size of 50 x 50 x 50 mm, as well. Four boreholes were drilled into the depth of 1 m in horizontal direction into quarry wall (Fig. 1).

Fig. 1: Samples taking using portable core drilling machine (Holzer, 2013).

4. Physical and Mechanical Rock Properties

Regarding the quality/toughness/durability of rocks for their utilization as decoration or restoration stone following properties are considered as most important: specific and bulk density (STN EN 1936), water absorption (STN EN 13755), porosity (STN EN 1936), uniaxial strength of a dry sample (STN EN 1926), uniaxial strength of after sample saturation and uniaxial strength after the 25 cycles of freezing and thawing. Thereafter the durability index coefficients were calculated: coefficient of softening k_1 (σ_2/σ_1, non-dimensional) and coefficient of freezing k_2 (σ_3/σ_1, non-dimensional) reflecting their resistance against weathering (STN EN 12371). Beside it our concentration was devoted to the appearance, structure and colour of the stone. In tables (Tab. 1 and Tab. 2) results of the laboratory assessment of properties of conglomerates and sandstones from quarries Trianova and Malé Skalky are presented. In tables (Tab. 1 and Tab. 2) results of the laboratory assessment of properties of conglomerates and sandstones from quarries Trianova and Malé Skalky are presented.

In general, the older clastic Upper Cretaceous conglomerates and sandstones from Trianova possess considerably better properties than the younger Neogene sandstones from Malé Skalky. Analyzing the assessed data (Tab. 1) it is possible to conclude following: the tested conglomerate/sandstone from Trianova reached lower values of porosity and water saturation than the sandstone from Malé Skalky. On

the other side the differences in specific and bulk density are lesser expressive. Due to the relatively high porosity (STN 72 1800) the sandstone from Malé Skalky belongs to the group of porous sandstones. They exceed the minimum values of volume density and water saturation, whereby they are suitable as a natural stone for stonecutting purposes.

Tab. 1: Average physical rock properties.

Site Lithological type	Sample taking	Bulk density ρ_d (g.cm^{-3})	Specific density ρ_s (g.cm^{-3})	Porosity n (%)	Water absorption N (%)
Chtelnica-Trianova fine grained conglomerate	monolith	2.473	2.759	10.366	1.59
Chtelnica-Malé Skalky carbonate sandstone	monolith	2.183	2.761	20.926	7.753
Chtelnica-Malé Skalky carbonate sandstone	drilling core	2.257	2.746	17.66	5.65
		2.448	2.762	11.99	3.9
		2.464	2.787	11.6	3.6

Comparing values of uniaxial strength (Tab. 2), the resulting statement is that the conglomerate/sandstone from the site Trianova reaches higher hardness than the sandstone from the site Malé Skalky. The values of k_1 are very different. It is remarkable that the values from Trianova show lower resistance against water in the comparison to values k_1 from Malé Skalky (with the exception of the first sample the stone shows a very good resistance against the effects of water). The value k_2 from Trianova shows very good resistance of rock against freezing which is similar to the second borehole Malé Skalky. The lower k_2 from Malé Skalky are probably due to low number of testing samples. From the most of properties indicators results that the investigated rocks regarding STN 72 1800 is suitable for the utilization as a restoration/decoration stone.

Tab. 2: Average mechanical rock properties.

Site Lithological type	Sample taking	Sample size	Samples Nb. dry/saturated/ frozen	σ_{c1} (MPa)	σ_{c2} (MPa)	σ_{c3} (MPa)	k_1	k_2
Chtelnica-Trianova fine grained conglomerate	monolith	cube 50x50x50 mm	3/3/3	84.75	58.68	68.56	0.692	0.809
Chtelnica-Malé Skalky carbonate sandstone	monolith	cube 50x50x50 mm	5/5/5	20.6	18.8	15.28	0.912	0.742
Chtelnica-Malé Skalky carbonate sandstone	drilling core	cylinder ⌀=50 mm, h=50 mm	4/3/3	33.43	21.17	20.82	0.65	0.622
		cylinder ⌀=50 mm, h=50 mm	4/4/7	39.66	34.88	34.09	0.879	0.862
		cylinder ⌀=35 mm, h=35 mm	3/3/2	39.55	39.05	19.17	0.987	0.483

5. Conclusions

Evaluating and comparing results of stone properties (own research and archive backgrounds) of investigated sites and the considered excavation, it is possible regarding the Slovak technical standard 72 1800 to set following statement:

- Qualitatively most proper stone for restorations provides the quarry Trianova with its Upper Cretaceous sandstones and conglomerates (Fig. 2).
- Stone from Malé Skalky shows otherwise „lower“ values of required properties (than Trianova) but despite of it, it is in properties very well comparable with the stone from the „Römersteinbruch" in St. Margarethen (Austria). Some disadvantage of the site Malé Skalky is the variability of frequent alternation of conglomerates and sandstones. This will require a proper selection of blocks during the excavation process and exact definition of the utilization purpose (decoration, restoration) of individual lithological types.
- Stone from the quarry Malé Skalky is sufficiently comparable with the stone from St. Margarethen. Comparing the laboratory results has „our“ stone in many aspects even better – more favourable parameters.

Fig. 2: Monument of Holy family, quarry Trianova (Holzer, 2013).

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