Engineering-Geological Problems in the Moravian Karst, Czech Republic

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Abstract

The Moravian karst belongs to one of the famous karst regions in Central Europe. It is situated in Moravia in the eastern part of the Czech Republic. According to the geology it is of Devonian age and the main rocks are of different types of limestones. The process of karstification is still active. They are many caves with rich stalagmites and stalactites and the Macocha abyss, the depth of which is 138.5 m. The underground Punkva River flows through the main pan of the karst, forming beautiful underground lakes. Typical karst phenomena, such as sinkholes and deep canyons, may be observed on the surface of the terrain. Because of the karstification, water erosion and frost weathering, many steep unstable slopes and walls originated. To solve the stability from a geotechnical point of view is not easy. This requests a special engineering-geological knowledge and experience.

Key works: Czech Republic, Moravian karst, engineering geology, slope stability, long-term monitoring.

1 Introduction

The region of the Moravian karst is situated almost in the heart of Central Europe, only 40 km north of Brno, which is the second largest city in the Czech Republic (Fig. 1).

In the area of almost 100 km^2, one may see the karstic phenomena in a classical form. On the surface there are canyons, orifices of ponors, open pits and sinkholes, clint fields and blind valleys.

everal large cave systems with rich dripstone decoration and big chimneys and collapsed domes are underground.

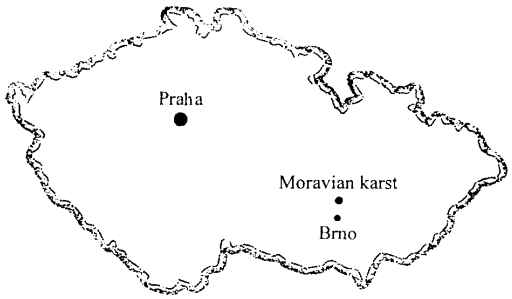

Fig. 1 Area of interest in the Czech Republic

The Macocha (" tepmother") abyss is one of the "must" to be seen by tourists. According to the geomorphology it belongs to the so-called light hole type of abysses. Its most probable origin was the collapse of a big dome roof. In these days the abyss is 138.5 m deep with two lakes at its bottom.

The hydrogeology of the Moravian karst is also typical. Karst springs and their debouchures, sinking creek systems and the main subterranean Punkva River, part of

which is still unknown, make this area very interesting for scientific research and observation.

The Moravian karst belongs to one of the Czech National Parks and therefore is under the governmental protection from the point of view of the care, maintenance and improvement.

2 Geology

The Moravian karst is formed by Middle to Upper Devonian limestones, which are mostly light to dark grey, with white calcite crevice accretions. According to the stratigraphy, there are five types of limestones and the thickness of the series of strata is 500 to 1000 m. On the western side the limestones transgressively overlap the granitoids of the Bmo igneous massif, while on the eastern side they are in turn covered with sediments of Culm. The geological map of the Moravian Karst is shown in Fig. 2 and the stratigraphic sequence in Fig. 3. In some places, the rest of the denudated Jurassic and Cretaceous strata overlying them can be found. They also form gravel pipes in some deep depressions. During the Neogene the Moravian karst overflowed, and the rest of marine clays are still in several places. The Quaternary Period is represented by different types of loams and debris and fluvial graves, sands and clays.

The karstification of the Devonian limestone complex is irregular, from small fissures with sinter crust to big caverns several metres wide and deep linear karstification zones. The cave system is developed in different vertical levels, and some of the holes are filled with terra rossa. The Devonian strata mainly strike NNE- W and dip E E. The main tectonic faults strike WNW-E E.

3 Engineering-Geological Problems in the Moravian Karst

According to the practical and theoretical knowledge obtained until now there are the

following main engineering-geological problems in the Moravian karst:

- tability of high limestone walls;
- Foundation in places with covered sinkholes;
- Building stone quarrying;
- Ecological aspects of the civil engineering activities.

4 Long-Term Monitoring of One of the Unstable Rock Walls

pecial attention has been paid to the rock wall situated close to the road in the vicinity of the White creek ponor where several rock falls have been observed in the last one hundred years. From the viewpoint of scientific advancement these slope movements represent a special type of rock fall triggered by propagation of karstification, frost weathering and active fain erosion.

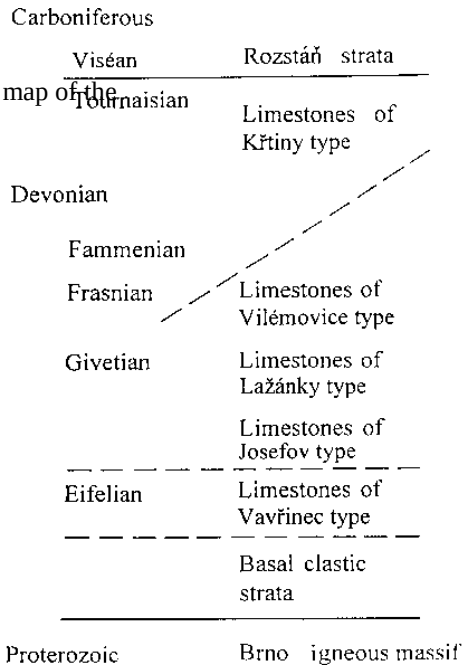

Fig.2 Geological sketch map of the study area

The first geological observatiov of this ponor was carried out in 1833, and the first map was finished in 1858. The first scientific description of one of the collapses was made by K. Absolon in 1910. Another big collapse took place in 1965.

A significant road, which is determined for heavy oversized trucks, is situated in the upper part of the rock wall. Because of an urgent need to secure the wall stability within the framework of the road reconstruction, this locality was investigated from an engineering-geological point of view (Šamalikova and Paseka, 1997). According to the results obtained, a long-term monitoring of unstable parts was recommended.

The above rock wall is situated on the northwestern periphery of the Moravian karst, close to the tectonic border with the Culm sediments in the northwest (Fig. 4). The valley of the White water creek is filled with 55 m thick Quaternary fluvial gravels and sands with fine clay intercalations. The upper part of the slope is covered with loess-loams. These sediments are also found in some contiguous caves and caverns, and their presence makes the engineering-geological decision very difficult sometimes. After engineering-geological mapping and spelaeological and hydrogeological observations long-term geophysical and geodetic measurements were used to observe the changes of the road surface and rock wall.

Fig. 3. tratigraphic scheme of Devonian and Carboniferous sediments.

In Fig. 5, the results of geophysical measurements are shown. Only two solid blocks of good limestone for the deep foundation of a new bridge were found. The precise nivelling and photogrammetry continue up to these days.

5 Covered Sinkholes as Foundation Sites

Even if sinkholes are comparatively scarce in the Moravian karst, some troubles are known. The origin of the sinkholes usually depends upon the tectonics and consequent jointing of limestones. In the northern part of the Moravian karst, they were formed according to the direction of the faults. The main directions are WNW-E E, NE- W and N- .

Quite common are groups of sinkholes of the ponor type. They have developed into half-blind valleys, especially on the Devonian and Culm contacts. Many bowl-shaped sinkholes are filled with loam. The loam may slide to the underground and influence the morphology of the surface or the ground of a building. In such a case, a building that is situated there may be seriously damaged.

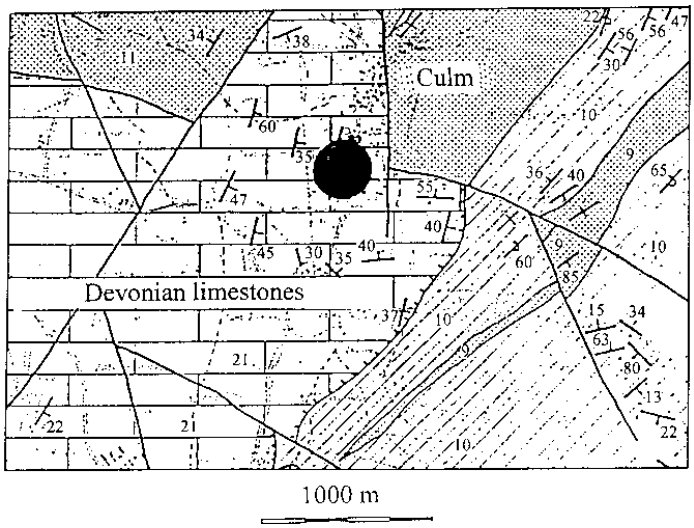

Fig. 4. ituation of the observed unstable rock wall.

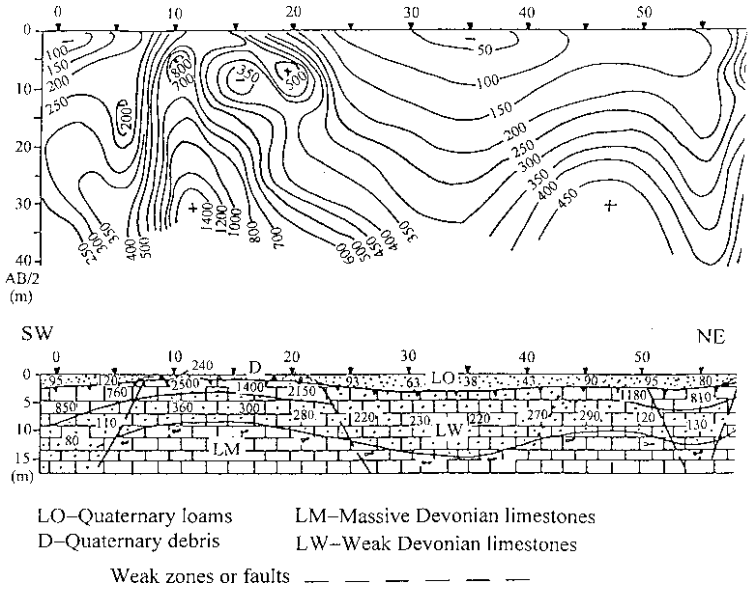

Fig. 5 Interpretation of VE measurements.

6 Building Stone and Aggregate Quarrying

Beautiful building stone, so-called Krtiny marmor, has been quarried near the village of Krtiny since the Middle Ages. It was used first of all for decoration in Baroque churches, and later on, for various building purposes facing, windowsills and other small architectural details. It has red to greyish red or yellowish red colours with white calcite intercalations and shows a nodular texture or the character of breccia. These days, the old deposit is not commercially utilized.

If the Devonian limestones are not karstified, they can be used as a very good building stone. All types of limestone must be checked according to the Czech tandards, especially in terms of their strength, porosity, water absorption capacity, frost resistance and abrasion and polishing ability.

ome results obtained from limestones near the White creek ponor are as follows:

- Compressive strength of massive limestone 147 MPa;
- Compressive strength of weak limestone 82 MPa;
- Density 2700 kg m^{-3};
- Water absorption capacity 0.59 %;
- Frost resistance 0.1 to 1.8 %;
- Crushing test 22 to 26 %.

7 Ecological Aspects and Civil Engineering Activities

The effort of the governmental protection of the Moravian karst dates back to 1918. But the oldest proposals were not accepted. The first step was made in 1930 and 1933 when two main parts of the caves were taken under the state protection. ince 1956

the whole area of the Moravian karst has been protected as one of the Czech National Parks.

From this point of view civil engineering activities must be in harmony with the ecological and environmental planning, and during the construction, all the conditions given by the Ministry of the Environment must be observed.

One of the main problems almost in all countries of the world is the straggle for the governmental financial support.

What is more significant: to build a bridge for an important traffic route from North Europe to outh Europe, i.e. from the Baltic ea to the Mediterrranean ea, or to save the unique natural phenomenon for future generations? This is the problem to be solved by specialists, and the recommendation should be unified all over the world.

Acknowledgement

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