Realizacja projektu technicznego zabezpieczenia Jaskini Szachownica I przed niekontrolowanym zawałem stropu przez firmę Novum-Servis Sp. z o.o.

Implementation of the technical project of protection Szachownica I Cave against uncontrolled cave-in by Novum-Servis Sp. z o.o.

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Abstract

The article presents a description of the work related to the implementation of the project of securing 5 chambers of Szachownica Cave and against uncontrolled cave-in. The task began with the preparation of the access road and the construction site. First there were prepared social facilities, material storage and tools. The whole area was fenced and secured with protection at night and on holidays. As the drilling machines and the injector pumps are powered by compressed air, it is decided to use an internal combustion compressor and a diesel generator to illuminate the work area. According to the schedule, the work was broken into two seasons and due to bats wintering in the cave they could have been run from May 1 to August 31 from dawn to dusk. The work began with the construction of a temporary box in the form of wooden cases and steel Valent racks. Then there were made three pillars. In the first season, there was made anchor housing with injection in the Poacher's Hall, the Waste Hall, the Transition Hall, and the Piargi Hall. In season 2, work has been completed with the injection of the ceiling and the anchor-tie housing construction in the Entrance Hall. Work was monitored by the monitoring team. All changes in the project were agreed with the author's supervision and the investor and were introduced with a sheet of changes. The special stages of the works were accepted by a specially appointed commission. These acceptances were ended with the protocols that were the basis for completing the work and issuing the invoice.

Introduction

The Regional Directorate for Environmental Protection in Katowice in March 2015 has announced a public tender to secure Szachownica I Cave from an uncontrolled ceiling infarction. The cave protection design was carried out by the Central Mining Institute in Katowice. Protection of Szachownica Cave I before uncontrolled cave-in was to be done by typical mining robots such as anchoring rock mass witch anchors, sealing, gluing with special glues and ceiling support at selected points with reinforced concrete piles. Novum-Servis Sp. z o.o. is a mining company, specializing in such works. We carry out work related to the reinforcement of the mining excavation casing and the rock sealing practically on all coal mines in Upper Silesia and in the Czech mine CSM in Karviná. We also led the anchoring and strengthen the housing in the "Bogdanka" mine in the Lubelskie Coal Basin. For this reason, the company presented the most favorable offer and was selected for the project.

Organization of construction site

Because the nature reserve Szachownica I is located in the forest complex of the Wielun Upland and in the caves area, there is no access to any media. The work should have started from the access road to the cave and the prepared construction site with social facilities. The asphalt road ended in Rozalin in Lipie municipality, about 3 km from Szachownica Cave. Because of the need to transport significant amounts of materials and equipment to the cave floor, it was necessary to prepare the forest road especially at its final section (about 600m). We used approximately 80 tons of dolomite, which was cured by means of a special compactor. Prepared road carried out to the end of the cave and is now used by foresters to remove timber from the forest. In the cave area there were used two social containers, which included lockers for 6 employees, a shower with washbasin, and toilets to minimize environmental interference. Two power generators were used to power the electricity.

An internal combustion compressor with a capacity of 8 m^3/min of compressed air was used to feed the anchor and the rock injection pump. Materials and machinery were stored in two garages folded on site. The area was fenced and secured during the holidays and at night.

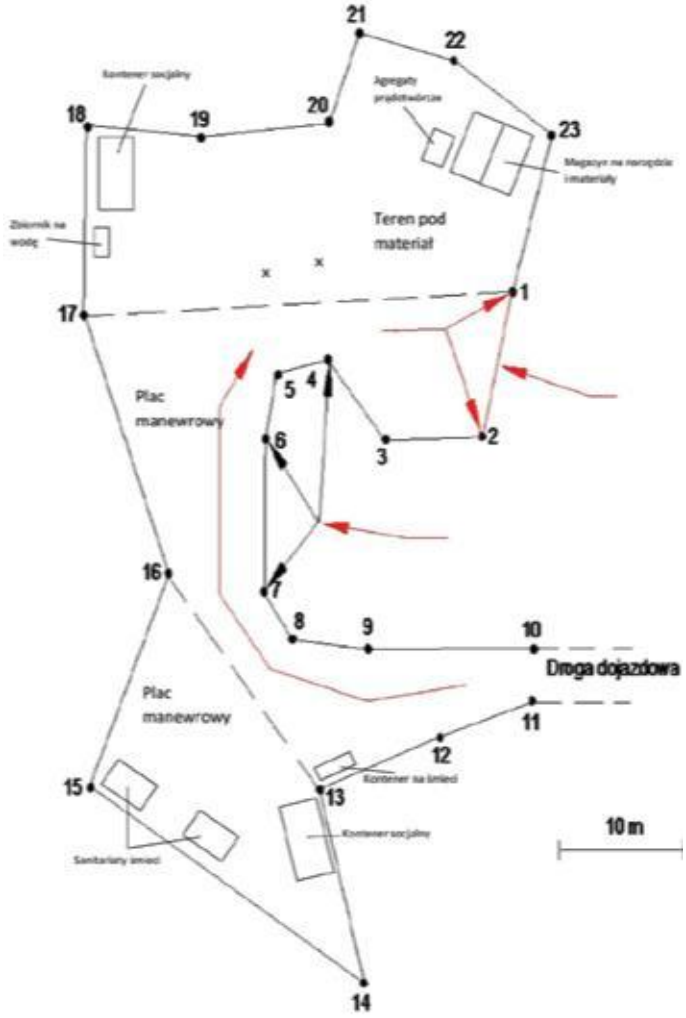

Fig. 1. Sketch of land development, source: own elaboration

Temporary housing

According to the project, the temporary casing had to be made before the anchor casing was installed and the cave ceiling was installed. In three halls: in the Entry Hall, Transition Hall, Poacher's Hall, the temporary housing was made of wood cases. In each hall there were two rows of cases. In total, there were built 57 of wooden cases with the height from 2 m to 4 m (about 5400 wooden pieces) in the Poacher's Hall. In the other two halls, i.e. he Waste Hall, and the Piargi Hall, was used a temporary casing consisting of wooden stretcher bar supported by steel Valent racks. Together there were built 80 pieces of Valent steel racks and 23 wooden stretcher bar.

Fig. 2. Built Valent racks, source: own

Rys. 3. Built cases, source: own

Reinforced concrete pillars

For the support of the ceilings in the five halls, were made four pillars: the small pillar in the Entrance hall, the Sarcophagus pillar between the Piargi Hall and the Transition Hall, the support pillar in the Transition Hall, and the large pillar between the Waste Hall and the Transition Hall. Additionally, in the second season two pillars were designed and constructed in the Poacher's Hall from the exit side. The pillars were made as structures of profile V29 and flooded with class 50/60 concrete. In order to preserve the natural look of the walls the pillars were covered with limestone naturally occurring in the cave. In total, approximately 150 m of V29 and 175 m^3 of concrete were used for the construction of pillars.

Fig. 4. Finished pillar, source: own elaboration

Ceiling injection in Szachownica I Cave and anchor casing

In the three halls of Szachownica Cave, the ceiling was injected (sealing + gluing) with mineable anchors (and Verpensin glue). In the ceiling of the individual halls, was drilled a grid of diamond-shaped holes with a side of about 2.0 m. The holes were 32 mm in diameter and 2.0 to 5.0 m in length. Depending on the thickness of the ceiling. In these holes were inserted rods of mineable anchor so that their ends were hidden about 15 cm in the hole. Verpensin glue was pressed through the rods. Very often when the glue is pumped into the hole, the adhesive flows out of the gap a few meters away from the opening. Such an injection (ceiling glue) is designed to prevent water from penetrating through the slits in the rock and prevent the rocks from "breaking" in the winter. In addition, there are 54 sets of tie-in covers in the three halls, which are designed to prevent the cave floor from falling off. In the other two halls, namely the Waste Hall and the Piargi Hall, the injection was performed in the same way as described above in three halls and additionally the ceiling was secured with galvanized steel mesh TECCO G65/3. According to the technical design there was also made a grid protection of the northern hedge in the Entrance, Transition and Poacher's Hall with a TECCO G65/3 meshed by injection anchors J64. In the cave ceiling were installed 54 sets of anchor-tie housings, about 65 tons of glue Verpensin, 726 pieces of J64 anchors with length from 2 m to 5 m, 300 m^2 of grid TECCO G65 / 3.

Fig. 5. Anchor-tensioning lining, source : own elaboration

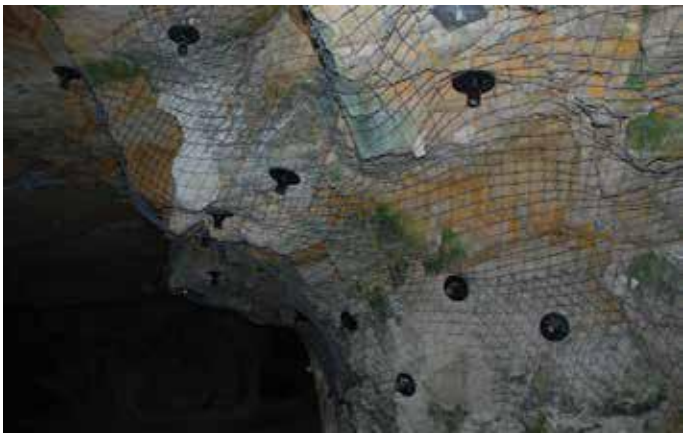

Fig. 6. Protection of the side walls by means of steel mesh and anchors, source: own elaboration

Large diameter holes

During the design work, there was made a survey of the cave floor of Szachownica I Cave using georadar. It was assumed that in the floor in the Poacher's Hall and the Transition Hall at depths of about 3-4 m are large holes. There were three locations where were made holes using the WD-02 drilling rig with a diameter of 95 mm. The holes were drilled to a depth of 7m below the cave floor. No significant voids were found, only slots of maximum thickness of 10 cm.

Additional work

Based on the opinion of chiropterologists, all cave works should be conducted from dawn to dusk from 1 May to 31 August. Works were divided into 2 seasons. After the first season and after the winter break, the monitoring team of the designer also saw the need for additional work not included in the project. Within this work, in the Poacher's were made 3 additional pillars, the TECCO G65/3 grid in the Entrance Hall was reinforced with the front entrance anchor bolt and the Poacher's Hall, and also the protection of the entrance to the karst well located on the surface of the cave.

Fig. 7. Security of the karst well, source: own elaboration

Summary

By taking up the task of securing the ceiling of Szachownica I Cave and before uncontrolled cave-in by Novum-Servis Sp. z o.o. The mining works connected with the anchor building up and the ceiling injection of individual cave rooms were professionally and with great care. Because the work included in the project, the supervision and technology were typically mining (approval of individuals for particular jobs by the mining office) did not pose any major problems during the work. During the preparation of the offer the company planned to employ a brigade of 10-12 employees and 2 persons of supervision so that the schedule could be implemented. One of the challenges for the company was the logistics and organizational part of the project. Particularly the transport of materials carried on the last section of the forest road had to be carefully prepared. Forest condition monitoring and immediate response for deteriorate its condition has prevented the lack of materials and thus downtime in the

work. The weather, which in both seasons allowed the company to work quietly in the cave, was very important. The cooperation with the municipality of Lipie and the district of Kłobuck was also exemplary. Especially pleased was the crew of Novum Servis Sp. z o.o., who is normally employed at the bottom of the mine, and in this case worked directly under the fortress conditions (opinions of several employees of the company). Thanks to all these factors, all the work has been done carefully and the deadlines have been met. This will allow you to maintain the stability of the ceiling of Szachownica I Cave for long years.