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THE IN-MOUNTAIN COLOSSEUM ASPECTS OF THE CONSTRUCTION

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Introduction

The construction of the World's largest in-mountain colosseum was recently completed in the city of Gjøvik, Norway. The construction was based on a close co-operation between leading Norwegian consultants and contractors. By using a combination of Norwegian hard rock technology and highly skilled construction work it has been possible to gain the World record span of 62 m.
The Norwegian experience with low cost tunnelling has also made it possible to build the arena to be used for ice-hockey at the XVII Olympic Games at Lillehammer in 1994, within a strict economic budget.

World Record

The Gjøvik Olympic Mountain Hall will be used as an ice-hockey rink at the winter Olympics at Lillehammer 1994. The dimensions of the hall are width
61 m, length 91 m, height 25 m.
The hall will be the World's widest rock-cavern with a capacity of 5400 spectators. The main span of the hall is 61 m. The largest span used in rock construction for the same type of purpose was previously 38 meters.

NOCON

The project was carried out as a turn - key project by NOCON, a joint venture between the building contractors A/S Veidekke and Selmer a.s . A/S Veidekke and Selmer A.S are the two largest construction companies in Norway. Each company has a yearly turnover of approx. NOK 3 billion with 3000 employees.

NOCON is responsible for the final design as well as the construction works involved in the project.

The co-operation between A/S Veidekke and Selmer A.S on this project, was based on the assumption that this is a better way to utilize the capacity and recources of the two companies . Another major argument for co-operation was the spreading of financial risks involved in a turnkey project of this type.

In addition to this project, the two companies have completed a big number of major engineering projects in Norway, such as the construction of various hydroelectric power plants and military installations.

The two companies have also , separately and in corporation , several major civil engineering works under construction in different parts of the World such as Grenland, Iceland and several countries in Africa.

The construction of the Colosseum

The construction works in the field started in April 1991. Prior to that, a systematic pre-investigation and design study had been carried out by the firms Noteby, NGI, Sintef and Fortifikasjon. These firms are regarded to be among Norways most experienced consultants within hard rock tunnelling.

The site is situated within the city of Gjøvik. This means that heavy construction works had to be carried out under strict regulations insofar as vibrations, noise and traffic were concerned. Before the works started, NOCON in co-operation with the client, Gjøvik Olympiske Anlegg, promoted an information programme to the neighbourhood covering the environmental impact. This information programme has proved to be an important factor in the successful accomplishment of the project.

The blasting works started with the driving of two separate access tunnels of 20 and 45 m2 cross-section towards the future colosseum. One of the tunnels , the so called Mustad tunnel , entered the colosseum at the very top level.
From this tunnel the 10 m wide Center Top Heading was driven through the full length of the future colosseum. This heading was also used as an exploratory tunnel. Several deformation and stress measuring instruments were installed from this tunnel. These instruments together with six MPBX installed from the surface prior to construction, were used for the logging of the development of rock deformation and settlements during the construction works.
After the driving of the Center Top Heading had been completed, the Sloping, lateral tunnels were blasted. (See. Plan and Cross-section of the Work Schedule figures) Those sections were each 14 meters wide so that the total span at this stage became 38 meters. Parallel to the blasting of the Sloping lateral tunnels, the permanent rock support works were started. The support works consist of two layers of wet process steel fiber reinforced shotcrete in combination with 6 m long bolts of diam. 25 mm in a 2,5 x 2.5 m pattern and 12 m long twin strand cables on a 5 x 5 m pattern.

The bolts and cables were untensioned fully grouted. The shotcrete had a fixed thickness of 10 cm, carefully verified by Noteby.

While the works at the top of the colosseum took place, the Main Access Tunnel was driven separately towards the bottom level of the Colosseum. From this tunnel two access tunnels were driven at a maximum slope up to the Abutment Tunnels on each side of the Colosseum. The final part of the work as far as the establishment of the span was concerned, was to blast the remaining rock pillars between the Sloping , lateral tunnels and the Abutment Tunnels. (See Plan and Cross-section of the Work Schedule figures)

This was a very exciting part of the construction. The readings from the instruments were controlled on a daily basis and inspections of the roof and the walls of the top part of the cavern were carefully carried out. However, nothing indicated that the actual stability conditions and measured values diverted from the predicted values of deformation and settlement.The maximum settlement of the roof of the cavern was measured to be 8 mm. Theory had predicted this value to be between 5 and 9 mm .

The rest of the permanent rock support works for the roof were then completed before the final parts of the colosseum were blasted. Those lower parts were constructed by ordinary bench blasting techniques with a maximum bench hight of 12 meters.
Finally , the support works for the walls were completed. Those works also consisted of steel fiber reinforced shotcrete and systematic bolting , with 3 m and 10 m long untensioned, grouted bolts. (See figure showing the principles of rock support works)

Duration of construction period

The construction works started in April 1991 and the cavern and its surrounding tunnels were finished 8 months later. ie. in December of the same year. During that time a total volume of 140.000 cubic meters of rock had been blasted and removed. A total amount of 1300 cubic meters of shotcrete had been placed and 3000 bolts and cables installed, approx 2700 of 6 m length and 300 of 10 and 12 m length. In addition, four vertical shafts of total length 120 meters for ventilation purposes had been drilled.
The works were carried out without any major accidents.

The first part of last year was used for the construction of foundations and other concrete works in the floor of the colosseum. Parallel to those works the installation of an artificial ceiling has been done.In April the erection of pre-cast concrete elements started and in June the installation of the technical equipment started. The complete project was completed by April 1 st 1993. That is four months ahead of schedule.

The Research-Program

The construction of the Gjøvik Mountain Colosseum Project is followed up by a major research program. A lot of the results from the

program have already been used in the actual design of the cavern and the technical installations while others will form a general basis for the improved pre-investigations, classi- fication, construction and use of large rock caverns.
In addition to research to the rock mechanic aspects of such projects , research is also being carried out on questions concerning fire- and escape safety, on different ventilation methods and on psychological aspects of underground use.
The research work is being done by some of Norways leading research institutions such as Sintef/NTH in Trondheim and NGI in Oslo.