BEHAVIOUR OF ROCK MASS IN UNDERGROUND EXCAVATION WITH SPECIAL REFERENCE TO THE VICTORIA POWER TUNNEL

THESIS PRESENTED BY

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ABSTRACT

The Victoria Project encompasses a double curvature arch dam and power house of 3 x 70MW capacity, linked by a 5.6km long 6.2m diameter concrete lined pressure tunnel. Excavation of the tunnel commenced in September 1980 and by November 1982 total length of tunnel has been completed through four headings.

The field investigation consisted of detailed surface geological mapping, discontinuity surveying and core drillings. The tunnel was excavated through gently dipping thickly foliated gneisses, granulites, quartzites and crystalline limestone (marble). Cavity formation and rock falls took place in certain locations of the tunnel. From the data obtained it was revealed that one major fault and several minor faults could be predicted crossing the tunnel Line. Another major fault encountered during excavation was not detected during the field investigation and this resulted realignment of the original tunnel route. Original design of the tunnel route was based on the results of detailed site investigation carried out in the earlier stage. Preliminary designs of tunnel route in earlier stage have been eliminated after the detailed study on sub surface condition.

The stability of the tunnel in certain locations are analysed by means of stereo graphic projections according to the structural features. The failure possibilities and geometry of unstable blocks are described and the pressure exerted on the support is predicted with the minimum length of rock anchor required. The plane failure analysis was carried out for the downstream portal to check the stability after the excavation completed.

The support installed during the excavation was based on the recommendation made by the author using N.G.I. classification system except where little changes made by the Contractor. The rock qualities in the Victoria Power Tunnel have been divided into four categories based on three dimensional geological mapping and geoengineering classification of rock masses. This classification has been put to use with success during the excavation of three tunnel drives (North, South and Intake drives). Forecasting of tunnelling characteristics based on this classification system are more valuable for detail design and construction work of the Victoria future tunnel (stage II). From the experience and geological information gained from the first tunnel the author has designed a preliminary layout for the Victoria future tunnel (stage II). Grouting proposals for the future tunnel have been up dated to minimise the cost involved as a result of experience gained from the first tunnel.

Exploratory percussive drilling was carried out generally using the drilling Jumbo and occassionally a track drill. A total of 6000m of percussive holes were drilled at the working faces in order to detect possible water bearing zones and poor rock conditions. The holes were 30-50m long with a diameter of 76mm.

The author carried out statistical analysis on drilling times of each rod length with respect to the different rock qualities. From this a probability chart has been prepared to determine rock conditions ahead of any working face of the tunnel. This chart gave valuable information of the major fault and several other minor faults that encountered in the Victoria Tunnel.

Stresses in the rock mass depend upon the extent and other characteristics of the overburden and the various geological processes through which the rock mass has passed. It is impossible to retrace completely the geological past and to predict the stresses on that basis. The stresses in rock masses are essentially required for the design of underground structures and to evaluate the optimum support required.

Most of the methods of in-situ stress measurement available to date are based on stress relief techniques and hydraulic fracturing. These methods however, are difficult and much expensive to use. As a part of geological investigation for underground work, such openings could be utilised for making measurement of in-situ stresses. The closure measurement were carried out in the tunnel at the time of construction for determining in-situ stresses and to monitor the rock mass behaviour. As no other in-situ stress measuring device was introduced to compare the validity of the results, the author estimated the vertical stresses due to rock load at these locations using qualitative method of Terzaqhi for the comparison. It is noted that the closure measurement yield valuable information regarding vertical stress magnitudes and the properties of surrounding rock mass.