Tunneling Through Soft Rocks

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Abstract

Engineering geological input plays an important role in optimizing design and execution of river valley projects. With growing demand for infrastructure facilities, many projects are being planned and some are in pipeline in new geoenvironmental regions. To cope up with the fast changing scenario of globalization, the field of civil engineering has made quantum jump in technological advancement, methodology, machinery/equipment deployment etc. In view of this, the paper suggests for a modified rock mass classification system for assessment of rock mass for effective support system and for selecting right type of equipment in soft, weak, poorly cemented rocks, where mechanical excavation is preferred over DBM.

Major improvements in the methodology of tunnel excavation have been made world over due to technological advancements. In tunneling through soft rocks, excavation by mechanical devices has proved to be successful. However, it becomes difficult to evaluate adequate supports by conventional logging and applying the existing rock mass classification systems. Application and use of new technique is as per site-specific requirements only. Rock mass classification although provides a qualitative assessment of rock mass conditions and support requirements it does not indicate the techniques for excavations. Therefore, a re-look on the existing system of assessment of rock mass for selection of right type of equipment and method of excavation is needed for planning effective support system.

Selection of equipment for mechanical excavation

Generally, in soft rocks having low compressive strength (15 to 30 MPa - dry state) mechanical excavation are carried out by road headers/ twin cutters or rock breakers (Photos 1, 2 & 3). While rock breakers can be effectively used for surface excavation and in benching excavation, road headers and twin cutters are successfully deployed in underground works. It has many advantages over conventional Drilling-Blasting Method (DBM). Overbreaks can be limited. Distress in adjacent rock mass will be minimum and therefore laying of parallel tunnels in close proximity can be planned. However, as the technology is not very popular in our country not much headway has been made so far. As more new fast track river valley projects are coming up in the country new technologies are now being adopted. Of late, tunnel-boring machines are being successfully deployed in long tunnels mainly in moderately strong rocks. However, for short tunnels in soft/weak rocks road headers are very effective. By selecting right type of equipment, desired progress can be achieved without any cost and time overrun. Understanding the petrography, cementation and structures in the rock and its implication on excavation shall help in equipment planning and accordingly cutter heads could be designed.

Assessment of rock mass for such type of mechanical excavation using standard bits has to be made by a few *in-situ* and labora-

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tory tests. The manufacturer normally relies on UCS values for designing the bits. However other parameters like characteristics of constituent minerals, abrasiveness, etc. are to be studied. Geology plays an important role in selection of right type of equipments for achieving desired progress.

Rock Mass classification

Engineering classification of rock mass (Q-system, RMR) largely depends on various joint/ discontinuity parameters. This empirical approach may not hold good for massive, soft and poorly cemented sandstone, in which inherent strength of the rock is not given due weight. Rock mass classification system relies heavily on geological and geotechnical inputs made at the DPR stage mainly after surface geological mapping. During construction stage these data are reviewed and reassessed with advancement of tunnelling. In case of mechanical excavation, the rock mass is not split rather it is cut gradually on advancement. The muck generated is generally in the form of small lumps and dust, thereby the joints are either coated with rock flour or invisible due to typical prominent grooves left by the cutter head (Photos 4 & 5) giving a massive look. The data collected for classification through logging of the walls could mislead the interpretation. Any suggested support system, therefore, cannot be relied upon for stability of the underground structure. This aspect needs to be given a serious thought and a modified classification system for poorly cemented soft rock having very low to low UCS values has to be devised, taking into consideration the strength parameters, cementation, orientation, *in situ* stresses and mineral composition of rock mass. Physicome-chanical properties of *in situ* rock should also be suitably included for ratings in classification system.

EQUIPMENTS USED FOR MECHANICAL EXCAVATION IN SOFT ROCK

Photo-1 Road Header

Photo-2 Twin Cutter

Photo-3 Rock Breaker

MECHANICAL EXCAVATION IN SOFT ROCK

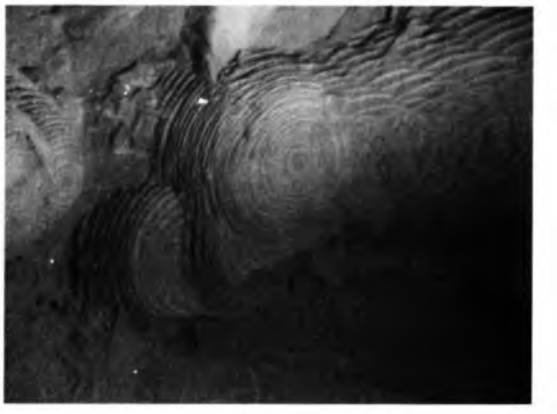

Photo-4 Groves cut by road header

Photo-5 Groves cut by Twin Cutter

Photo-6 Tunnel excavated by Twin Cutter