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NATM- A SEM Method

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Abstract: This paper describes the sequences op various events and activities involved in NATM, by mobilizing the strength of the ground in this way, substantial reductions are made in the tunnel lining or support systems required to achieve stability. By the adoption of such techniques, developed in differing circumstances by many tunnelling engineers, the cost of tunnel construction is significantly reduced.

I. INTRODUCTION

This method has been developed basically in Austria so its name make use of providing flexible primary lining in shape of shotcrete, wire mesh, rock bolts, lattice girder. In case of weaker rock mass, the use of pipe fore pole/pipe roofing is also resorted for crown support which in turn lead to less over break as well as ensure safety during the execution. The main aspect of the approach is dynamic design based on rock mass classification as well as the in situ deformation observed. Hence more economical use of the tunnel support system along with the rational approach of execution. Sequential Excavation Method (SEM) - When the ground lacks the strength for full-face excavation, removal can be done in stages. The intermediate stages are supported as necessary, and the next portion is incrementally excavated until the full cross-section is completed. With this method, a geotechnical engineer usually monitors the ground conditions at the face while crew members install the initial support needed to stabilize the opening. This process is referred to as the sequential excavation methods (SEM). Although it is commonly used in soft ground and weak rock, SEM can also be combined with drill and blast methods and used in hard rock applications. This is useful for excavating large underground openings such as a cavern or chamber. With these methods, tunnels are usually constructed in a shape that resembles an egg or oval. Rounded shaped sections are more efficient at accommodating the stresses flow around the opening.

II. SCOPE

SEM is generally carried out in shorter tunnels; whereas, TBM methods are often more economical for long tunnels. SEM ground support methods are very effective at controlling settlement when tunnelling under shallow cover because the support methods for this technique can be easily adapted for this purpose. After the tunnel is completed, a cast-in-place final liner is placed to accommodate the permanent loads.

A. Creation of a first support on the surface of the tunnel opening (loosening zone) to avoid deterioration;
B. Opening of a tunnel project not very long;
C. Projection of concrete in all the circular perimeter of the excavated zone (25 at 50 mm);
D. Introduction of permanent steel supports;
E. Fixation of the wire mesh or chain-link mesh reinforcement as per design;
F. First hand of shotcrete, in a layer with thickness not superior at 150 mm;
G. Perforation of the formed layer for the intersection of the anchorages;
H. Introduction of the support for the next excavation cycle.
I. Normal time cycle for one linear metre of tunnel comes around 12-20 Hrs,depending upon the shape and Dia. of the tunnel


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III. FOLLOWING ARE THE MAIN FEATURES OF NATM

A. Mobilization of the strength of rock mass - The method relies on the inherent strength of the surrounding rock mass being conserved as the main component of tunnel support. Primary support is directed to enable the rock to support itself.

B. Shotcrete protection - Loosening and excessive rock deformation must be minimised. This is achieved by applying a thin layer of shotcrete immediately after face advance.

C. Measurements - Every deformation of the excavation must be measured. NATM requires installation of sophisticated measurement instrumentation. It is embedded in lining, ground, and boreholes.

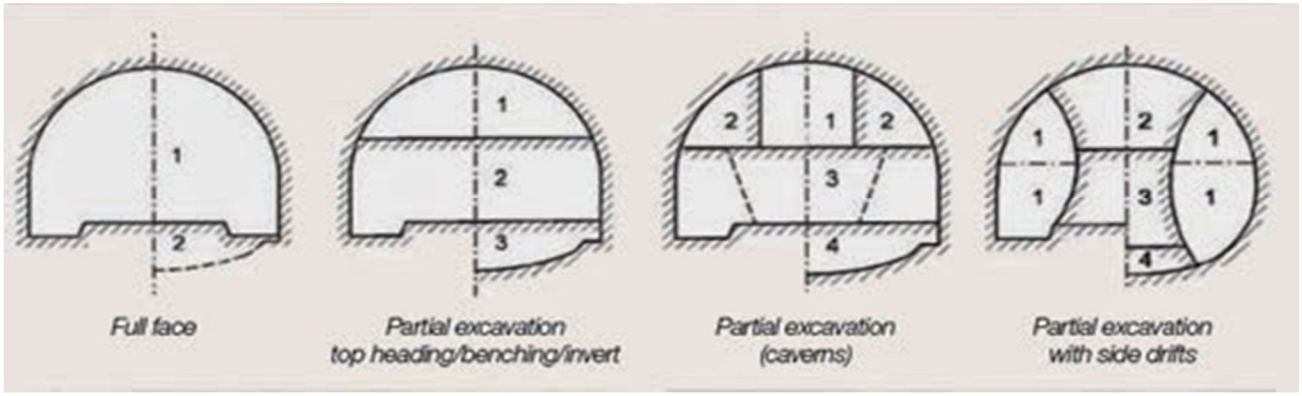
D. Flexible support - The primary lining is thin and reflects recent strata conditions. Active rather than passive support is used and the tunnel is strengthened not by a thicker concrete lining but by a flexible combination of rock bolts, wire mesh and steel ribs.

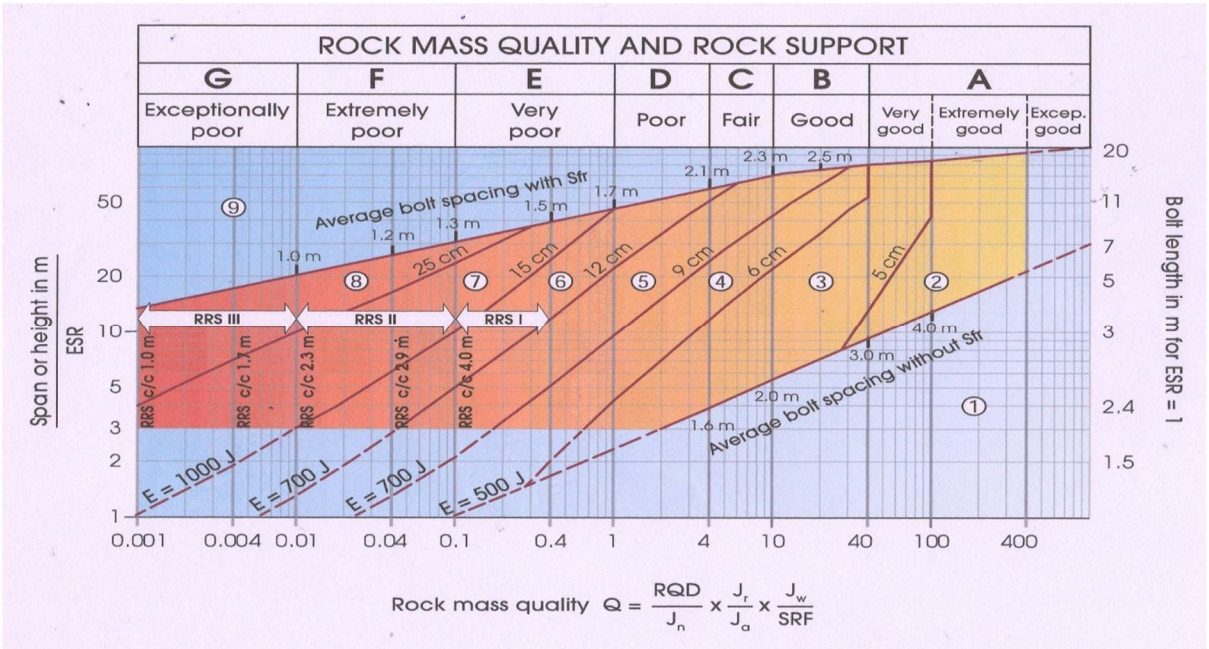
E. Closing of invert - Quickly closing the invert and creating a load-bearing ring is important. It is crucial in soft ground tunnels where no section of the tunnel should be left open even temporarily.

F. Contractual arrangements - Since the NATM is based on monitoring measurements, changes in support and construction method are possible. This is possible only if the contractual system enables those changes.

G. Rock mass classification determines support measures - There are several main rock classes for tunnels and corresponding support systems for each. These serve as the guidelines for tunnel reinforcement.

H. Based on the computation of the optimal cross section, just a thin shotcrete protection is necessary. It is applied immediately behind the Tunnel boring machine, to create a natural load-bearing ring and therefore to minimize the rock's deformation. Additionally, geotechnical instruments are installed to measure the later deformation of excavation. Therefore a monitoring of the stress distribution within the rock is possible.





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IV. CONCLUSION

A. Advantages of NATM

1) Eliminates the need for using some expensive TBM equipment during excavation

2) Suitable for a wide range of geometry (shafts, junctions, non-circular tunnels and tunnels with variable shapes)

3) NATM approach of design and execution of the tunnelling in varied geology and especially in soft ground tunnelling is advantageous and scientific way of tunnelling in comparison to the old /conventional way of tunnelling. This system monitors the rock mass deformation and designs the support system with reference to the rock mass type and deformation

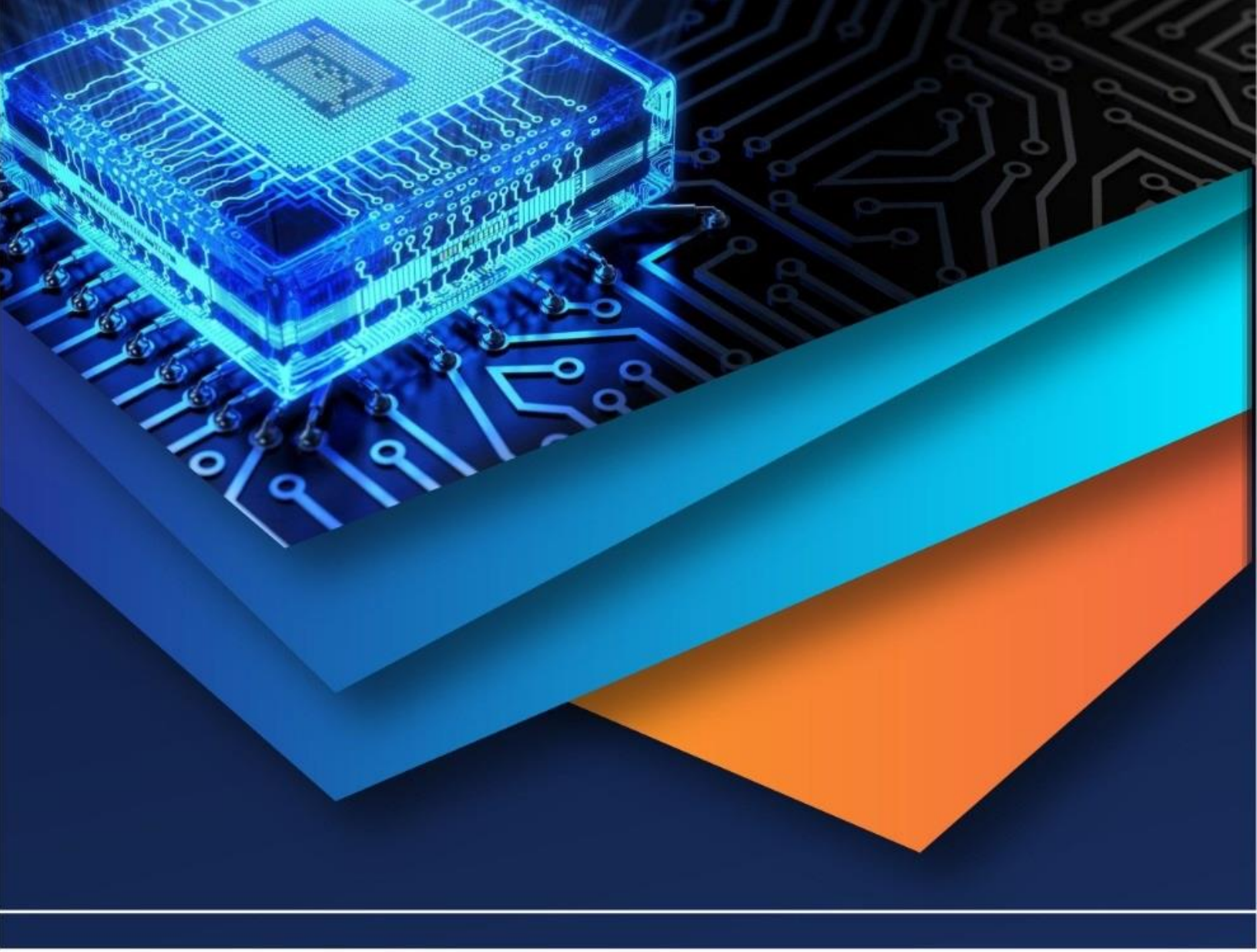
B. Disadvantages of NATM

1) Its suitability diminishes in softer ground, which can subside when excavated

2) Not suitable below water table in highly permeable soils

REFERNCES

[1] The New Austrian Tunnelling **Method** (**NATM**), also known as sequential excavation **method** (SEM), is a **method** of modern tunnel design and construction. This **technique** first gained attention in the 1960s based on the work of Ladislaus von Rabcewicz, Leopold Müller, and Franz Pacher between 1957 and 1965 in Austria.



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