

# TUNNELING IN HIMALAYAS WITH NATM METHOD: A SPECIAL REFERENCES TO SUNGAL TUNNEL IN JAMMU – POONCH HIGHWAY ALIGNMENT AREAS OF J&K (UT)

Vishal verma<sup>1</sup>, Er. Shilpa Chauhan<sup>2</sup>

<sup>1</sup>M.tech Student, Rayat Bahra Univeristy

<sup>2</sup>Asst.Professor, Rayat Bahra Univeristy, Mohali, India.

\*\*\*

---

## Abstract

The Sungal Tunnel Work is ongoing Project using NATM method in Jammu Region Falls under Chowkichaura (Akhnoor) and Bhambla (Reasi) of J&K (UT). Based on NATM method the tunnel work became more sophisticated, easier and with safety that bears pressure build up by enclosing rock mass and also made sismologically resistant zone. A brief about NATM methods in tunneling in Himalayas zone special with the Sungal tunnel is also discussed in the present paper.

**Key Words:** Sungal Tunnel, NATM, Shotcrete, Mucking, Rock bolting, chowkichaura (Akhnnor), Bhambla (Reasi) J&K (UT).

## INTRODUCTION

This paper is based on the observations made during the construction of the tunnels in Jammu Akhnoor- Poonch Highway Project (NH-144A Project). The project is in Himalayan range with varying geological conditions the most effective method for tunnel construction seems to be the New Austrian Tunneling Method (NATM) which works on the principle of continuous observations after each execution cycle.

Tunneling in the young Himalayan Mountains having challenges due to existing Physical structure like faults and folds, other stratigraphic and tectonic activities. Performing detailed site investigation in this type of area becomes most prerequisite criteria to design a particular tunnel which will facilitate the smooth construction of the tunnel. The Sungal tunnel a highway tunnel under NH-144A constructing in this area. During the construction we use different method to excavate the tunnel.

Among all available tunneling construction methods, the New Austrian Tunneling Method is the most suitable method of tunneling construction in such varying unfavorable condition. The ground opening act as load bearing structural component. Drilling and blasting methods are adopted in the excavation of tunnel in NATM technique in rock with the shotcrete and rock bolts used as the main support system (Sauer and Gold 1989). The New Austrian Tunneling Method is flexible to adopt different exaction geometries, large cross section area, change of support system at any time, easy to install etc.

## PROJECT OVERVIEW

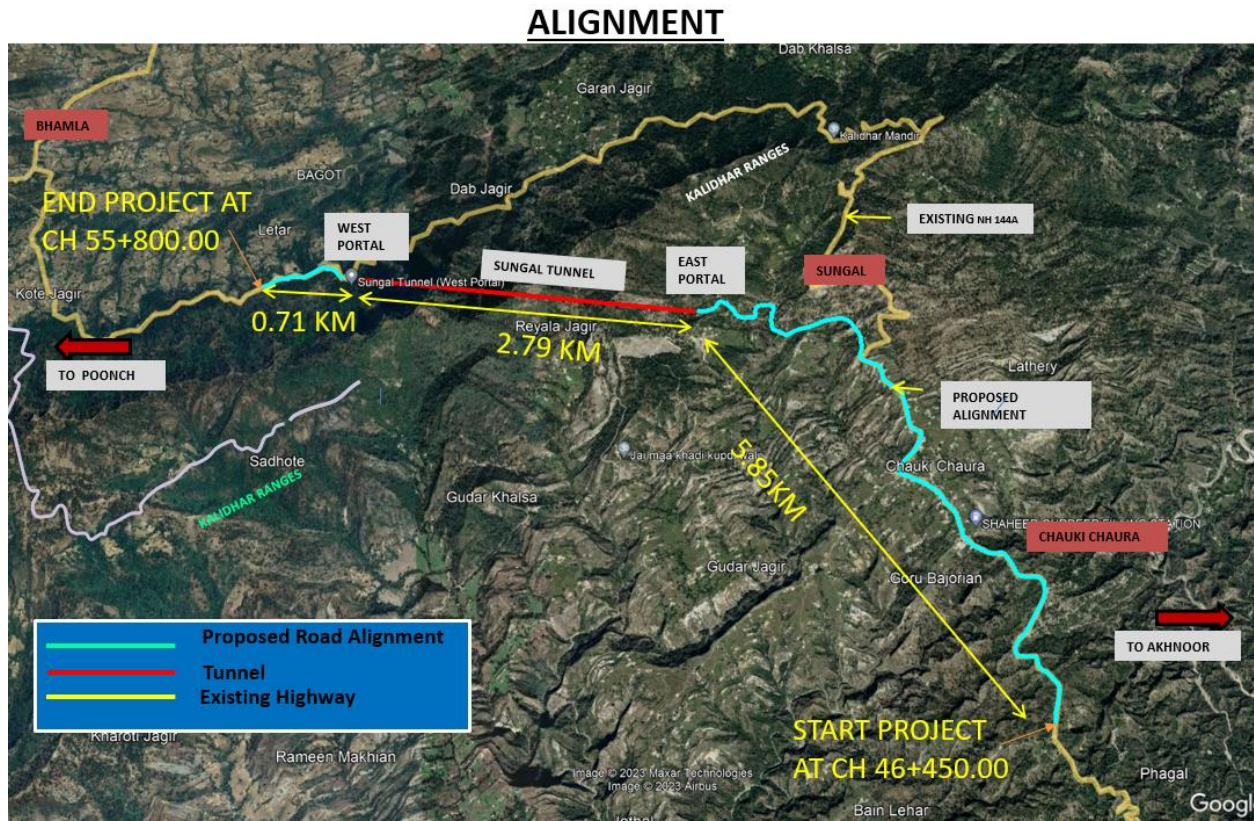


Photo 1: Showing overview of study area

The study area lies in the foothills of Himalaya and hence is marked by rugged relief consisting lofty ridges and deep V-shaped valleys and gorges. The area of interest is drained by the mighty Chenab River in the east and Chander Khad and Barakh Khad to the west of the Project side.

The Sungal Tunnel is 2.79 Km tunnel is oriented in a linear alignment along  $98.5^\circ - 278.5^\circ$  with the eastern portal at elevation of 677.469m and western portal at El. 697.860m. Tunnel alignment is marked by undulating topography with 3 apex and 3 valleys. The first apex along the tunnel alignment exists at elevation of 762m providing rock cover 72m above the tunnel. The second apex having elevation of 1006m with associated rock cover of 300m. The third apex with elevation of 970m providing rock cover of 270m.

### Seismology

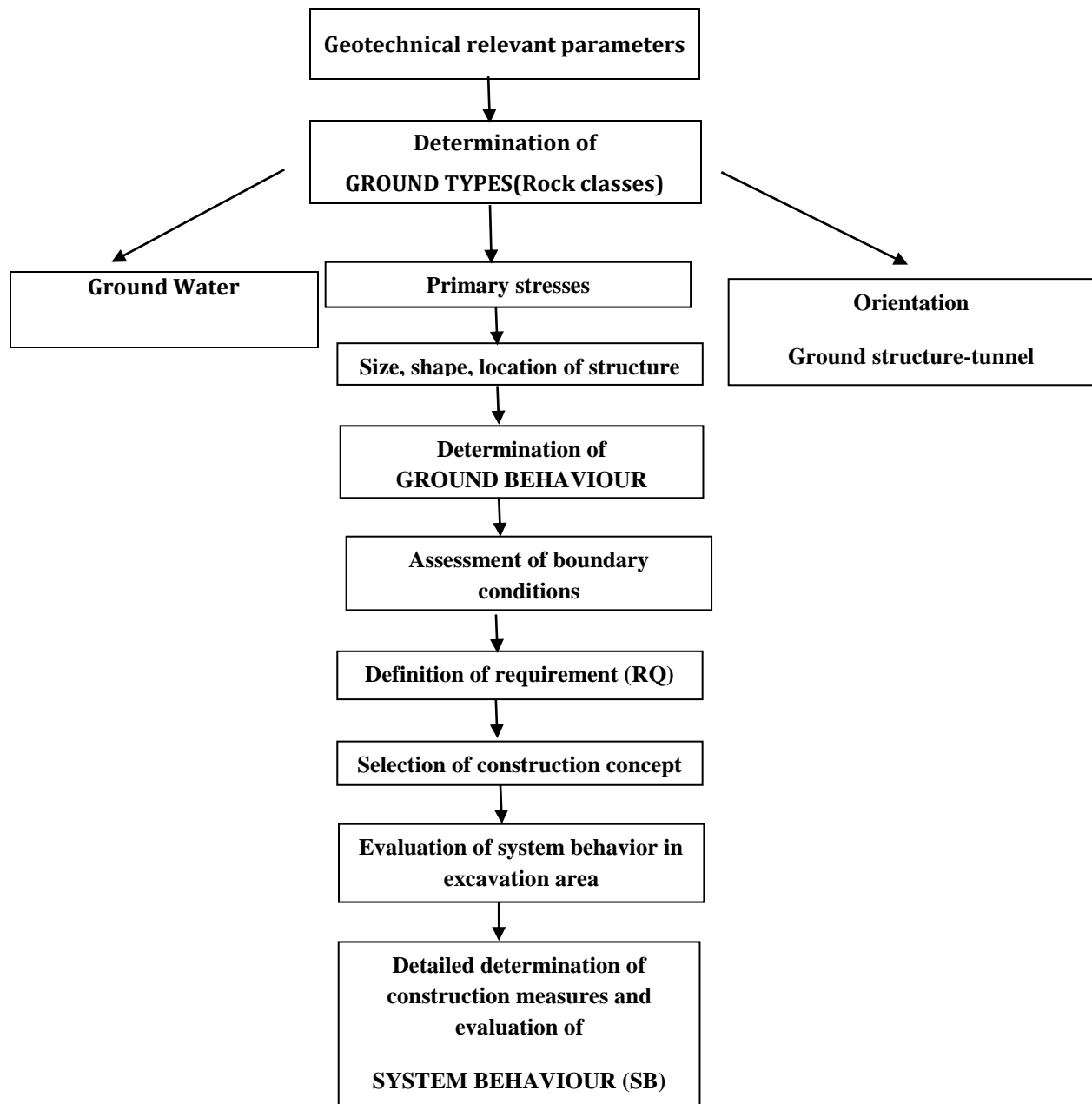
As per seismic zone map of India the project lies in the seismic zone IV and according to GSHAP (Global seismic Hazards Assessment Program), the area falls in a region of high seismic hazard. Historically, parts of the Jammu and Kashmir UT have experienced seismic activity in 6.0-6.5 Richter scale range.

### METHODOLOGY

NATM (New Austrian Tunneling Method) NATM is both a construction and a design philosophy. The philosophy is to use the strength of the surrounding soil to the extent possible to strengthen the tunnel structure. Another mean, ground condition drive the tunneling operation. The NATM philosophy promotes constant monitoring.

The NATM doesn't correspond to specific operations of the face during excavation nor to the use of a specific piece of equipment. NATM is adapted to each project and it is often updated during excavation in order to changes in geometric conditions and the nature of the ground. NATM method makes extensive use of shotcrete for the temporary liner in an attempt to optimize both the amount and timing of support.

Prior to Excavate the tunnel Geotechnical Investigation performed. The Austrian Guideline procedure of geotechnical design is represented as an array of studies depicted in the flow chart below.



**Tabular table: Showing Systematic Procedure for geotechnical design for tunnel**

## NATM METHODS IN CONSTRUCTION OF TUNNELS

**Tunnel:** A tunnel is an underground or undersea passageway. It is dug through surrounding soil, earth or rock, or laid under water, and is enclosed except for the entrance and exist, commonly at each end. Tunnels are constructed for Railway and Highway facilities for public convenient .In India first tunnel was Parsik Railway tunnel which was constructed in the Parsik hill in Thane, Maharashtra, India. Initially tunnels were constructed with convential method which is oldest method but now a days NATM method is most useful technique to excavate tunnels.

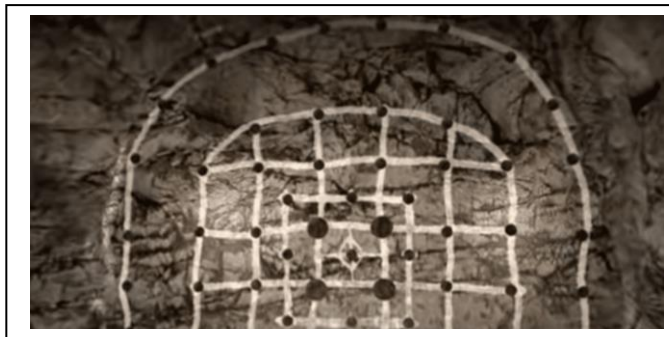
### Tunnel includes two types of support

1. **Primary support:**
- a) Profile marking
  - b) Drilling, Loading, charging and Blast
  - c) Defuming
  - d) mucking
  - e) Chipping / breaking and scaling
  - f) Bottom cleaning
  - g) Geological Face mapping
  - h) Initial shotcrete layer
  - i) RIB (ISHB)/LG (Lattices girder)
  - j) Second shotcrete layer

### 2. Secondary support: Lining

For making tunnels we should have clear land near the Portals and there should be no populated areas which can be affected by the tunnels works. In prior tunnels were made by conventional methods but present days we are using NATM(NEW AUSTRIA TUNNELING METHOD).There are two approaches for making tunnels i.e outside and inside the tunnels, Outside tunnel consists of portal making works and Inside activities are as follows:

1. **Profile marking:** In profile marking surveyor mark the face of the tunnel with paints/sprays for further activity.



2. **Drilling, Loading, charging and Blast:** It comprises drilling at tunnel face at given marks by the surveyor. After completion of drilling loading and charging work started and taken Blast.



3. **Defuming:** After blast many gases and fogs defumed by ventilation Fan.



4. **Mucking:** Muck means broken fragments of rocks resulting after blast. Muck Transported from inside to outside the tunnel by using dumper and dumped at approved dumping yard.



5. **Chipping /breaking and scaling:** After completion of mucking the hanged rock mass are scaled by breaker.



6. **Bottom cleaning:** Bottom cleaning comprises making platform for the machineries for the further activities.



7. **Geological Face mapping:** After completion of chipping, breaking and bottom cleaning a geologist has to prepare face log through observing the rock, joint patterns, orientations present at tunnel face.



8. **Initial shotcrete layer:** To maintain standup time and reduce moisture content of the rock initial shotcrete layer has to be done.



9. **RIB (ISHB)/LG (Lattices girder):** After initial layer of shotcrete, heavy steel beams are used to strengthen the tunnel and maintain the tunnel profile.



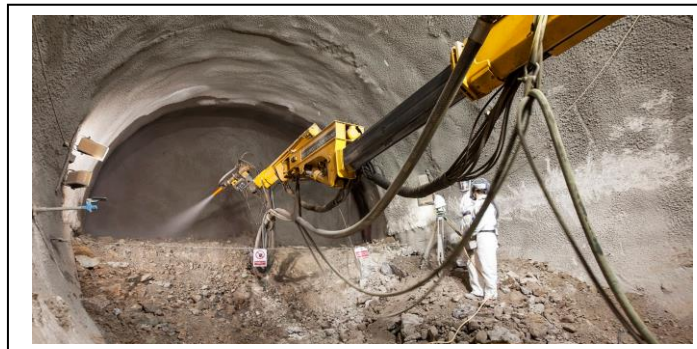
**10. Second shotcrete layer :** After the installation of heavy beams of steels second layer of shotcrete has to be done .



### **SECONDARY SUPPORT**

The Lining is the secondary support in tunneling using NATM method which consists of number of stages.

**a) Cutting, padding and smooth layer of shotcrete.**



**b) Stitching of water proofing membrane and Geotextile.**



**c) Leveling PCC and construction of kicker kerbs.****d) Erection of Gantry and pouring.****CONCLUSION**

After a detailed study carried out on the tunneling in the Himalaya with special references to Sungal tunnel under NH-144A in the Jammu – Poonch alignment with respect to NATM method. It has been observed that construction of tunnel in Himalaya zone with NATM is more convenient as compared to conventional method.

NATM is based on the observational approach whole outcome depends on the Geological interpretation and 3D Monitoring data. This method provides flexibility to change the support systems at regular intervals depending on received data from face logs and 3D monitoring. A quick analysis is done and applied on the field saving time, money and material. With this approach and sequence followed better progress is achieved in a safer environment.

**REFERENCES**

1. Adachi, T., "Some Supporting Methods for Tunneling in Japan and Their Analytical Studies," Proceedings, Fifth International Conference on Numerical Methods in Geomechanics, Vol. 4, 1985, pp. 1747-1754.
2. Adachi, T., Tamura, T., Shinkawa, M. "Analytical and Experimental Study on Tunnel Support System" Proceedings, 4th International Conference on Numerical Methods in Geomechanics, Vol. 2, 1982, pp. 513-522.
3. Kovari K. 1994. Erronomeous concepts behind the New Austrian Tunnelling Method, Tunnels and Tunnelling, November 1994, Vol. 26, 38-42



4. Alan Muir Wood (2002). Tunneling: Management by Design. Abingdon, UK: Taylor & Francis. p. 328. ISBN 978-0-419-23200-1.
5. Cater, R. W., Shirlaw, J. N., Sullivan, C. A., Chan, W. T. "Tunnels Constructed for the Hong Kong Mass Transit Railway/' Hong Kong Engineer, October 1984, pp. 37-49.
6. Levent Özdemir (2006). North American Tunneling. Abingdon, UK: Taylor & Francis. p. 246. ISBN 0-415-40128-3.
7. Deinard M, Prinz H and Zeidler K (1991), Variations on a NATM Theme, Tunnels and Tunnelling November.
8. Barton N., Lien R. and Lunde J., 1974. Engineering classification of rock masses for the design of tunnel support. Rock Mechanics, Vol. 6, Pages 189-236.
9. Suuer G. 1988. When an invention is something is new: from practice to theory in tunneling, Transactions of the Institution of mining and metallurgy, vol 97, section A94-A108.
10. Wallis S. (1995), First principles of NATM, World Tunnelling, Vol. 8, 197-200.