iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** VII **Month of publication:** July 2021

DOI: https://doi.org/10.22214/ijraset.2021.36463

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VII July 2021- Available at www.ijraset.com

Excavation Method Implemented in Atal (Rohtang) Tunnel: Case Study

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Abstract: ***Structurally dynamic, youthful collapsed mountains; The Himalayas are loaded with full of geological surprises, involving issues, folds, shear zones and so forth that shows their quality because of progressing structural exercises in the Himalayas. In feature of Atal tunnel, these issues increments multifold due to high overburden of the material and also careful topographical and geotechnical investigations at different scales. This makes vulnerability in planning a specific emotionally supportive network and requests for "structure as you go" approach for whole passage length (8.8km). DRESS (Drainage-Reinforcement-Excavation-Support-Solution) philosophy of excavation is very powerful in water bearing issue zones of delicate Himalayan district. DRESS includes pre-seepage of ground in front of face with long waste gaps and adjustment of the crown in front of passage face by steel pipe umbrella curve, up to a foreordained length, trailed by exhuming in little strides by mechanical methods and backing thereof.***

Numerous troublesome issues have been experienced during construction which was unpredicted initially. One such issue is an experience of Seri Nala. Due to differing conduct of rock mass, continuous update of rock mass is constantly required. NATM is dependent on disfigurement observing information to assess amount and nature of emotionally supportive network, has end up being a fitting apparatus for tunneling in the youthful Himalayas. This paper depicts the consolidation of NATM as well as DRESS method in the unearthing of Atal Tunnel, Himachal Pradesh, India

Keyword: Tunneling, Atal tunnel, NATM, DRESS, Geology

I. INTRODUCTION

Himalayas are formed due to the application of horizontal thrust on Eurasian by Indian plate which tends to move himalayas in upward direction and this process is still going on. So, the himalayas are still young and under bleeding. This high stress condition leads to increase of natural hazard chances like earthquake, landslides. The tectonic movement in the Himalayan region is heterogeneous, weak, highly weathered and deformable in nature. Hence, himalayan geology is full of surprises and uncertainties. Squeezing, swelling and roof collapse are most common problems in himalayas.

Himalayan tunneling is encountered with many challenges. Geological challenges like fold, fault, stratification & tectonic activities. Hydraulic challenges of water ingress have been noticed in many cases. The other major challenge is height of overburden which restrains certain geological investigation by bore holes upto desired depth. Hence, detailed site investigation becomes arduous. Atal tunnel (earlier named as Rohtang Tunnel) construction is done in such terrain. At construction stage many problem occurred which was not predicted at earlier stage. It leads for selection of method that facilitates design and built process simultaneously.

For varying geological condition New Austrian Tunneling Method (NATM) is mostly suitable. For excavation by NATM drill and blast in various sections along with shotcrete and different support system wherever necessary. DRESS (Drainage-Reinforcement-Excavation-Support-System) method is utilized where excavation was found to be in soft, weak and water charged soil strata. DRESS method involves pre-drainage of water ahead of tunnel face using long drainage holes and stabilize crown which creates umbrella arch. In Atal Tunnel both the methods were in used for its construction.

II. NEW AUSTRIAN TUNNELING METHOD (NATM)

NATM was initially developed by Rabcewicz (1964). Main idea to use NATM is to use geological stress of surrounding rock mass to stabilize itself. It mobilizes ground and support ground upto certain extent during excavation progress. NATM gives flexibility in cross-section which cannot be attained by TBM. NATM stabilize tunnel parameter by shotcrete, rock bolts and other support system and monitoring is done to control stability. NATM is based on concept of design and construct methodology by providing optimum support depends on observed ground condition. It is based on principle of rock mass behavior and performance monitoring during underground construction. NATM is effective tool in complex geologies i.e. any type of rock, heavy squeezing ground condition and modification of ground can be done as per requirement.

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ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VII July 2021- Available at www.ijraset.com

In Atal Tunnel maximum work was carried out by NATM as the geological strata was not strong enough to sustain load of TBM. There are many cases of tunnels where in TBM are stuck & was considered ineffective where high squeezing strata and mud flow was encountered. NATM proves to be a boon to construct in such type of geological strata.

III. DRESS (DRAINAGE REINFORCEMENT EXCAVATION SUPPORT SYSTEM)

DRESS philosophy is new advancement in underground construction. This technique for excavation is very viable for antagonistic land condition because of particularly rock mass condition in encompassing territory of passage opening.

DRESS (Drainage Reinforcement Excavation Support Solution) strategy of excavating is very powerful in water bearing issue zones of delicate Himalayan district. DRESS includes pre-waste of ground in front of face with long seepage openings and adjustment of the crown in front of passage face by steel pipe umbrella curve, up to a foreordained length, trailed by uncovering in little strides by mechanical methods and backing thereof .

In Atal tunnel DRESS method was implemented where soil strata was extremely delicate soil strata where extraordinary geological condition. It was implemented where NATM cannot be effectively used. For DRESS method, stabilizing ground or atleast crown is important before excavation actually happens at the location.

IV. PROJECT OVERVIEW

Rohtang expressway tunnel venture in Himachal Pradesh, India is a difficult undertaking through the higher scopes of Himalaya. The passage is being uncovered at a height of more than 3000m and has the stone front of upto1.9 km over the passage. While tunneling from south end, the Seri nala flaw was experienced about 300m before the normal area. According to the examinations, it was extrapolated to be experienced between Ch. 2.20 and 2.80 km from south end. In any case, during the tunneling, the Seri nala flaw was struck at Ch. 1.90 km, around 300 m before the anticipated area. At Ch.1.918 km the separation point was obvious on the passage face where left half face is feeble layers accused of water and the correct portion of the face is undisturbed layers



Fig 1: Location of Atal Tunnel



Fig 2: North and South portal of Atal Tunnel

No test opening could be bored to find out the area of Seri nala issue. For the most part, it is educated to have number with respect to test gaps in various ways to know the area of such significant highlights. In this passage, as the uncovering from south end advanced, Seri nala deficiency antagonistically influenced the passage unearthing and made troublesome conditions for tunneling as appeared in figure underneath.

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At long last, the passage through the flaw zone was unearthed utilizing the DRESS technique, which is seen as valuable to exhume tunnel through delicate, powerless and water charged layers (Rao and Sharma, 2014). The DRESS (Drainage, Reinforcement, Excavation and Systematic Support) strategy has methodical pre-waste in front of face, fortification of ground, utilization of forepoles to frame umbrella, pre-grouting whenever required, uncovering in little strides by mechanical methods lastly the precise backings. The DRESS strategy is seen as valuable to unearth tunnel through such delicate, frail and water charged layers (Rao and Sharma, 2014).

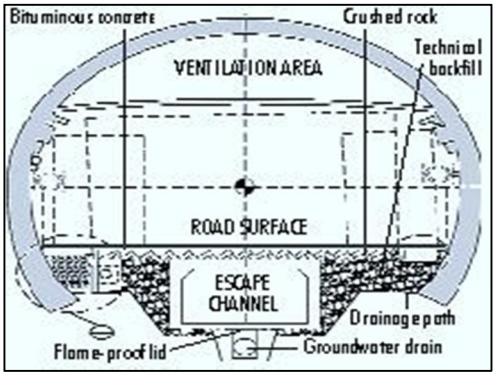


Fig 3: Cross section of tunnel

During the land examination, the normal litho-units along the passage arrangement are made out of schistose rocks for a sum of 7.0 km (6.5 km-south gateway and 0.5 Km-north entryway), gneissose rocks (nosy) up to 2.0 km, phyllitic shakes up to 1.5 km and quarzitic rock upto 0.5 km. The RMR (Bieniawski 1993) characterize these stones from exceptionally poor to great and Q-framework (Barton et al. 1974) order classifies the stones into seven class with Q esteem extending from 0.01 to 10. Foreseen rock class with least and most extreme overburden as introduced in Table1, these qualities are additionally utilized in the structure of emotionally supportive network.

Table 1: Rock Type

Distance (m)	Overburden (m)		Rock type
	Min	Max	
0-2000	48.7	370.9	Schist/Phyllite
2000-2900	232.1	550.6	Migmatite/Fault zone
2900-4200	550.6	1119.8	Schist/Phyllite
4200-8800	102.8	1859.8	Migmatite with minor schist

V. GEOLOGICAL OVERVIEW

The region around the proposed tunnel is arranged in higher Himalaya across Pir-Panjal range and Atal edge (striking NW-SE heading) which denotes the gap between the seepage arrangement of north with River Chandra and south with River Beas.

The venture is arranged in a NW-SE slanting arrangement of push and overlap by and large called the Atal Axial Zone, which speaks to a significant structural gap, isolating the Permian-Mesozoic Tandi bowl to the SW from the Lahul-Spiti-Kinnaur Phanerozoic bowl to the NE. The Southern piece of the Rohtang Axial Zone is involved by Salkhala Group and the Atal Gneissic Complex. Two predominant stone units exist in the locale. A thick succession of Schist and Phyllite (Salkhala Group) in the Central and South West regions of the task site. Toward the North-East and fundamental this grouping lies an assemblage of gneissic rock (Rohtang Gneissic Complex). The Gneissic Complex outcrops in the East and broadens North-Westerly intersection the propelling passage arrangement South of the North entry. In the West of Atal Tunnel, the split ascents to MSL 5080m close Goh Kincha and from here the peak line takes a south-westerly turn. The defining moment is privately called ShitiDhar. The ShitiDhar in further West embraces an East-West pattern for short separation and later joins almost North-South slanting Beas KunderiDhar. The most noteworthy top in the region is ShikarBeh at MSL 6200m. The rocky tract is for the most part out of reach notwithstanding the current Manali-Leh street and segments along the major Nalas.

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VI. PROBLEM ENCOUNTERED AND REMEDIAL MEASURES

A few issues have been experienced while building Atal tunnel. Rooftop breakdown, free stone falls at different spots, squeezing of ground, high disfigurements of rooftop, Seri nala fault flooded tunnel with rock debris has occurred while excavation of tunnel



Fig 4: Water ingress at the last point of the excavation

To tackle these problems some measures are taken NATM was used for excavation. Shotcrete and rock bolt supports was strengthened, longer rock bolts were utilized, yieldable steel rib supports had been planned in poor rock conditions, DRESS technology was made used to tackle the fault zone, the concrete lining will be used as final support.

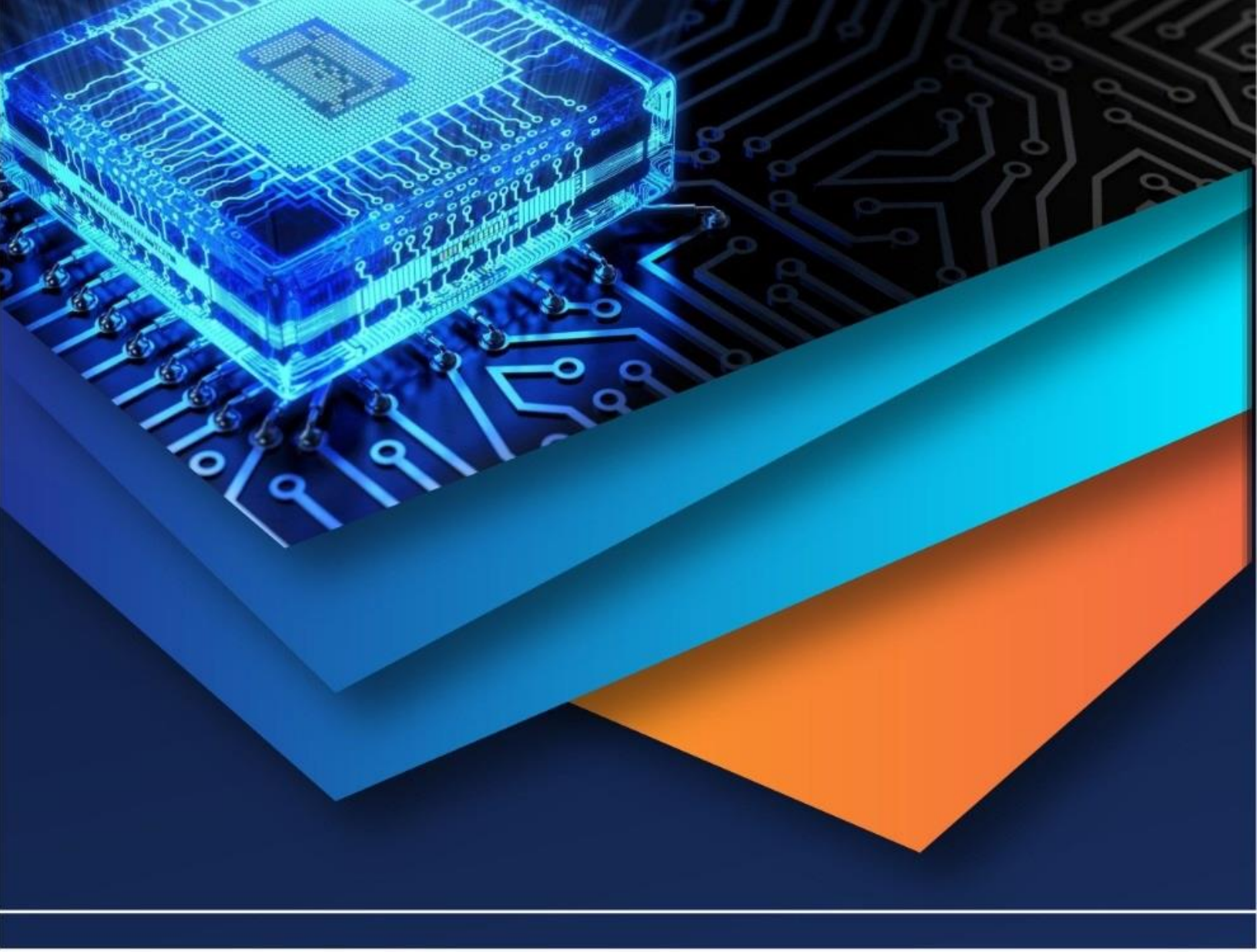
VII. CONCLUSION

The Atal tunnel crosses in the youthful Himalayan Mountain having a high in-situ stress, the nearness of deficiencies, folds, shear zones, high over weight, high entrance of water and complex geography. Fit as a fiddle passage, stresses and miss happenings can undoubtedly be checked. The cross-segment zone of the passage which is very high for the establishment of TBM and is additionally dangerous thinking about high twisting. Favorable position through NATM development is that it tends to be changed at any example and in the long run emotionally supportive network can likewise be modified based stone class and distortion. The topographical examination is a prime and principal necessity for the development of any underground structure anyway Himalayan geography and lithology these examinations are unimaginably troublesome. So, through NATM strategy, these land hazards can be controlled in contrast with another technique.

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