Tunnel Distortation And Preventation Analysis

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Abstract- *A major research project investigating the effect of tunneling on existing tunnels has been completed at Desh Bhagat University, Mandi Gobindgarh. This subject is always of great concern during the planning and execution of underground tunneling works in the urban environment.*

By integrating literature reviews, site observation, field monitoring, theoretical analysis, summarization, etc., a construction strategy was proposed and verified for\ tunneling with deformation and prevention in this paper. The tunnel was in shotcrete cracks and steel arch distortion were observed, and a big deformation with a maximum of 2.0 m was monitored during the initial stage of the construction. Through carefully examining the site observation and laboratory test results, a construction principle was established for the tunneling on the basic concept of maintaining the rock strength/stiffness and keeping the rock dry, by providing confinement pressure to the rock, reducing the rock exposure time, keeping water out of the tunnel, etc. and best suitable tunneling methodology to achieve performance. To check the effectiveness of the construction measures, field monitoring was carried out, which showed that the rock deformation was well controlled and the tunnel became stable. An allowable deformation was then determined using the. From this study, it can be concluded that providing quick strong initial support and reserving core soil at the working face. The new traffic tunnel transport line under construction in chenani -Nashri passes beneath numerous tunnels including a number of those forming part of the chenani -Nashri (UDHAMPUR) Underground network.

The research project focused on the latest technology and prevention method. Another component of the research project was to examine how to prevent deformation by using latest technology. This Thesis summary the main aspect s of the research project of preventing tunnel distortion and different method

Keywords- Tunnel engineering, deformation Prevention - Construction strategy

I. INTRODUCTION

A tunnel is an underground passageway, dug through the surrounding soil/earth/rock and enclosed except for entrance and exit, commonly at each end. Some recent tunnels have used immersed tube construction techniques rather than traditional tunnel boring methods. A tunnel may be for foot or vehicular road traffic, for rail traffic, or for a canal. When the excavated area and the tunnel are close, the approaching excavation will be harmful to both the tunnel structure, The occurrence of deformation in tunneling had become a serious problem since 1906 when an extremely high deformation was found Pir Panjal tunnel. Deformation could cause a lot of difficulty in several aspects rock support failure, which induces tunnel instability such as working face collapsing and roof fall; However, my researches are focused on tunne distortaion and prevention analysis evaluation of approaching construction, and there is less research about the prevention of traffic tunnel and construction on mechanic

II. OBJECTIVES OF PRSENT STUDY

This project attempts to understand and investigate the variations of prevention method of tunnel distortion resulting due to different periods of prevention.

1. Tunnels are underground passages used for transportation and it is necessary to determine the strength that could be used for carrying freights and passengers etc.
2. By using modern technology deformation can be prevent and Tunnels escape disturbing or interfering with surface life and traffic during construction.
3. The deformations are common due to ignorance low quality work a detail procedure of prevention of tunnel distortion is main objective of the project

III. METHODOLOGY AND INVESTIGATIONS

There are various types of construction techniques developed for construction of tunnels which are discussed below:

Cut and Cover Method of Tunnel :

Construction: Cut and cover method of tunnel construction is generally used to build shallow tunnels. In this method, a trench is cut in the soil and it is covered by some support which can be capable of bearing load on it.

Bored Tunnel Method: Bored tunnel method is modern technology. In this case, tunnel boring machines are used which automatically work and makes the entire tunnelling process easier. It is also quicker process and good method to build tunnel in high traffic areas

Clay Kicking Method of Tunnel Construction

This method is used for strong clayey soil conditions. This is an old method and used for small works like sewage pipes installations etc

Shaft Method of Tunnel Construction

In this method tunnel is constructed at greater depth from the ground surface. The shaft is built up to the depth where tunnel is required. Shaft is a permanent structure which is like well with concrete walls. At required depth, tunnels are excavated using TBM's. Shafts are provided at both inlet and outlet of tunnels. Intermediate shafts are also provided if tunnel is too long

Pipe Jacking Method of Tunnel Construction

Pipe jacking method is used to construct tunnels under existing structures like road ways, railways etc. In this method, specially made pipes are driven into underground using hydraulic jacks. Maximum size of 3.2-meter diameter is allowed for tunnels

Box Jacking Method of Tunnel Construction

Box jacking method is similar to pipe jacking, but in this case instead of pipes, specially made boxes are driven into the soil. A cutting head is provided at the front side of the box. Excavated matter is collected within the box. Larger size tunnels can be excavated using box jacks up to 20 meters.

Monitoring deformation in tunneling

Site observation

As the tunnel of Chenani-Nashri horseshoe-shaped tunnel is very long of 9.28 km, the construction was divided in nine segments. Eight horizontal branch tunnels were used in between for achieving earlier completion of the project. In other words, the tunnel has 18 working faces in order to speed up the advance. The construction was started in July 2011, but a deformation was observed in branch tunnels 2, 4, and 6. The construction became very difficult and the advance was much delayed. **Examples** of ground deformation monitoring and their application in tunnel design and construction are illustrated by cases from Chenani Nashri tunnel. Even in spite of being used latest technology for construction of tunnel several deformation were found.

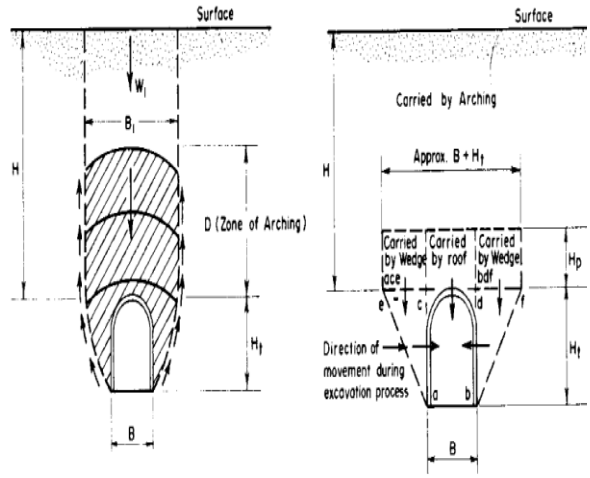


Fig1.The rock-mass height loading the tunnel

It shows Terzaghi's recommendations for the loading on tunnel linings (after Terzaghi, 1946)—vertical pressure: pv=c Hp, horizontal pressure:ph=Ka (pv+0.5 c Ht). The rock-mass height loading the tunnel (Hp—shown in the right part of the figure) depends on the rock-mass type and quality which control the size of the zone of arching

The application of modern design and construction techniques has benefited significantly from ground deformation measurement around the tunnel and at ground surface, making deformation monitoring an integral part of decision making in the design, construction, supervision and maintenance system

Construction principle

To avoid deformation, a construction principle was established for the tunneling including the following:

(1) Effort should be made to provide confinement pressure to the rock.
(2) Exposure time of rock at/near the working face should be shortened to avoid rock weathering and loosing.
(3) The water should be kept out of the tunnel by reducing the water stay time and strengthening water drainage.
(4) The operational surface would be kept stable to avoid it collapsing, which will seriously delay the tunnel advancing and increase treatment cost.
(5) Field data and information should be collected, back analyzed, and returned to guide the construction and rock support design.

(6) The tunnel advance should be improved if the safety can be assured.
(7) An allowable rock deformation should be given in the design to prevent the second expansion excavation.

Specific measures for the construction

Based on the construction principle above, a set of specific construction measures including 11 items was proposed:

- An advanced geological prediction needs to be done. The geology in front of the working face needs to be explored before the excavation to predict water condition, fractured zone, etc.
- The rock deformation monitoring needs to be done during the construction. Information such as crown subsidence and convergence needs to be collected and back analyzed to judge the tunnel stability, optimize the rock support parameters and construction scheme, and determine the allowable deformation, initial support parameters, and lining installation time.
- An allowable rock deformation is needed to avoid second expansion excavation. The determination of the allowable deformation would be based on the achievement from the advanced geological prediction and rock deformation monitoring results. A method to predict the rock deformation would be established to support the determination of allowable rock deformation.
- After the excavation, shotcrete would be applied immediately to the exposed rock at/near the working face in order to reduce the rock exposing time, avoid rock weathering, and prevent rock strength and stiffness from decreasing.
- Water would be drained out of the tunnel to avoid water pond in the tunnel to prevent the rock from soaking and softening.
- If the rock is heavily fractured, keeping the working face stable is most important. This can be assured by controlling the step advance, strengthening support, reserving core soil to support the working face, and preventing the working face from collapsing.
- Integrated support of the steel arch, rock bolt, reinforcement mesh, and shotcrete would be applied immediately after the excavation. Keeping the support as a whole with a strong connection and improving the support stiffness are very important.
- The steel arch is a major load-bearing support. Except the steel arch stiffness itself, the longitudinal steel arch stiffness is also very effective to resist the big deformation. This can be achieved by connecting steel arches using longitudinal steel beams. In addition, keeping the steel arch close at bottom as a loop is also effective.
- Although it is verified that long rock bolts (9 m or longer) are workable to resist big deformation, long rock bolts are not applicable in this tunnel as the tunnel diameter is small. Short rock bolts (4.5 m) are suggested to connect the steel arches to the rock.
- Shotcrete is useful to prevent the rock from weathering and to provide an integrated support pressure to the rock. Shotcrete would be applied again in time if it was cracked.
- Lining can provide a strong support; earlier application of the lining can effectively resist big deformation. It is suggested to apply lining within a distance of twice the tunnel diameter from the working face.

IV. NEW TECHNOLOGY AND PREVENTION METHOD

The New Austrian Tunneling Method this system of tunnel engineering is more a set of principles or a philosophy than a prescriptive, technical method

NATM is both a construction method and a design philosophy. The philosophy looks to use the strength of the surrounding soil to the greatest extent possible to strengthen the tunnel structure

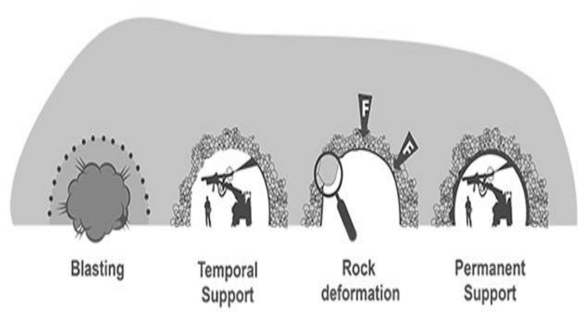


Fig 2 NATM processs

In other words, ground conditions drive the tunneling operation. The NATM philosophy also promotes constant monitoring.

Fig NATM Drilling process

The NATM construction method is about flexibility—drilling and designing depending on the results of the ongoing monitoring. The operation occurs sequentially to take most advantage of the ground conditions. Additionally, NATM installs ground support on the go and on an as-needed basis, adding reinforcement to the shotcrete where necessary. The final, permanent support is usually (but not always) a cast-in-place concrete lining placed over a waterproofing membrane.

NATM is best suited for short-range (> 2 km) tunnels in regions with variable soil conditions. Its philosophy and construction method yield a more cost-effective, flexible tunneling operation when compared with the other methods.
Underground works have been carried out for several thousands of years and for several reasons, including railway, metro ,housing, water supply or shelter. Throughout the centuries, underground works have evolved and they have received a major boost with the rise of the infrastructures

Comparing NATM with Cut-and-Cover

The Cut-and-Cover approach functions exactly as the name suggests. First, a large ditch is dug into the ground with room for the tunnel. After placing the tunnel, the ditch is covered with soil. This method is effective for building stations and other large segments of a tunnel with greater space requirements.
While Cut-and-Cover is very flexible, it significantly disrupts the ground surface making it ill-suited in dense urban environments or ecologically sensitive areas.

Comparing NATM with TBM

The Tunnel Boring Machine method has recently earned a lot of press with Elon Musk and The Boring Company, who look to challenge TBM conventions (decreasing tunnel diameters) and pump R&D into improved power, automation, and efficiency. TBM tunneling mobilizes a large mining operation around a machine that drills the entire diameter of the tunnel concurrently. This approach can be been very costly (designing for the worst-load case) and time-consuming.

However, once setup, a TBM operation can run indefinitely as the budget permits.

Continuous Monitoring and Design with NATM and AGRU

NATM is perfect, needing much coordination, cooperation, and communication to compete with the other construction methods. And even at peak performance, NATM typically performs at a slower rate than the other methods as the team adapts to changing conditions, butit is best and suitable for all kinds of rock classes. For NATM to compete successfully, the operation must reduce interruptions in excavation and support work by closely working with all elements of the operation to bring in the right supplies for the changing conditions.

Choosing the right supplier can significantly reduce delays by ensuring that enough waterproofing membrane, water stop profiles, geotextile, and other products are available on-demand as the need arises. AGRU America offers a range of waterproofing membranes in the form of the AGRUFLEX and EASYFIX systems, which takes advantage of engineered thermoplastics—flexibility, ductility, and corrosion-resistance—to deliver protection against water and aggressive. New Austrian Tunneling Method, has an extensive portfolio of tunnel lining systems and construction.

Prevnetion methods

Grouted rock bolts

Rock bolts have been widely used to reinforce rock mass and also to reduce geological hazards According to this concept the jointed rock mass reinforced by grouted rock bolts is considered as composite material which includes rock mass, the grout material and the bolt shank.

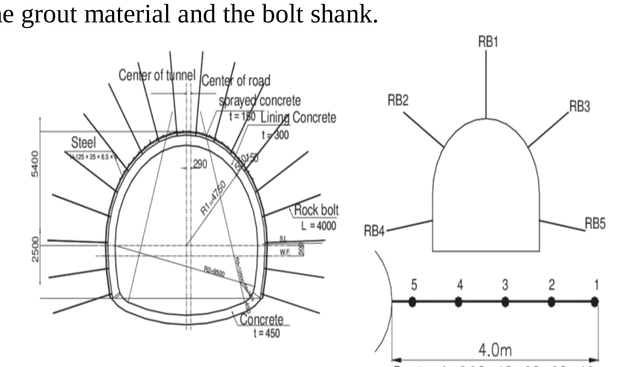
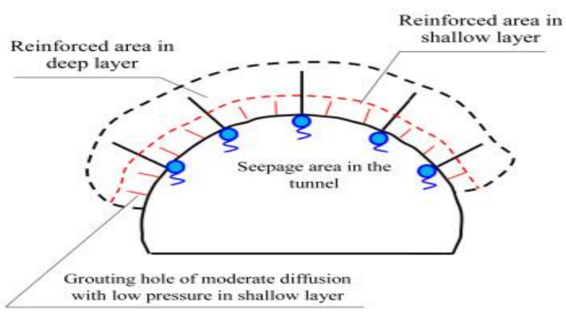


Fig.3**Determining all the parameters of a rock bolts system Risk of falling fresh sprayed concrete**

Applying a layer of sprayed concrete as initial support is one of the characteristics of the SEM. After the spraying of concrete for primary lining, and before the shotcrete gains sufficient strength, there is a risk of fresh concrete fractions falling from the crown arch or the side walls

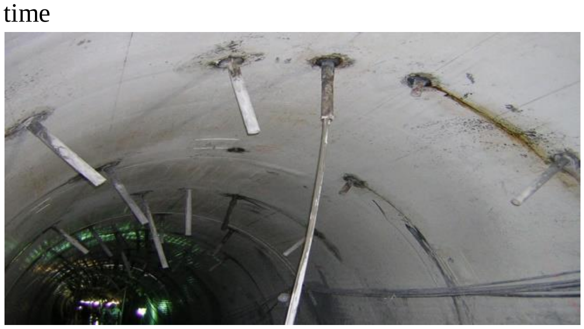
Seepage Control

Groundwater can cause many hazardous problems when a tunnel is excavating. Seepage force acting on the support structure and the tunnel surface cannot be negligible. Under high groundwater table condition, the seepage situation becomes more complex and it is more difficult to control the leakage of groundwater to flow into a tunnel



Grouting control techniques

The "Real Time Grouting Control Method" is a pioneer theory in formulating grouting works which provide possibilities predicting flow of the grout in fractured rock in real time



Pressure grouting

This is the direct injection of grout to fill the space in between soil particles. The actual process of pressure grouting involves placing hollow pipes three to five feet apart in the soil until hard dirt is reached, at which point the grout, a rockless concrete, is forced through the pipes

V. CONCLUSION

1.Monitoring of ground deformations in tunnelling is a principal means for selecting and controlling the excavation and support methods among those foreseen in the design, for ensuring safety during tunnel construction (including personnel safety inside the tunnel and safety of structures located at ground surface) and, finally, for ensuring construction quality management. This paper describes the types of ground deformation measurements often used in tunnelling,

2.thePirPanjal Extension of the jammuand kashmir Underground, Lines 2 and the 11.2- km long railway tunnel . In the first examples, deformation monitoring is used in controlling the application of ground treatment methods thus ensuring that structures at ground surface are not harmed by tunnelling activities. In the PirPanjal case, ground deformation monitoring was used in the optimisation of temporary support requirements and as early warning against potential collapse.

3.In mountain tunnels, the main objective of deformation measurements during construction is to ensure that ground pressures on the temporary support system are adequately controlled, i.e., there exists an adequate margin of safety against roof collapse, bottom heave, failure of the excavation face, yielding of the support system, etc. Adequate control of ground pressures ensures a safe and economical structure, well adapted to the inherent heterogeneity of ground conditions

4.The selection of the applicable system during tunnel excavation is based on the encountered geology at the tunnel face as well as on experience from the behaviour of previously excavated tunnel sections under similar conditions, obtained by appropriate deformation measurements

5.In shallow urban tunnels, the main objective of deformation monitoring is to limit ground displacements to values sufficiently low to prevent damage to structures and utilities, i.e., to guard against serviceability limit states. As acceptable deformation levels are usually very low, precise and accurate measurements are necessary and, very often, rapid data collection and evaluation is required. Such cases include situations where risk minimization is critical as well as innovative construction procedures for active control of ground deformation

VI. FUTURE SCOPE

The Analysis of Controlled Deformation in Rocks and Soilsthe stability of the tunnel face by surveying the material of the advanced core and studies the stability of the core-face in terms of extrusion, convergence and pre-convergence

In the tunnel excavation process, the deformation of the surrounding rock (including extrusion deformation, pre-convergence and convergence deformation) should be analyzed and controlled

- The application of the advanced core soil (reinforced with fibreglass, leading pipe shelf, small pipe grouting and other enhanced methods) is a structural stability factor for the deformation reaction during tunnel excavation.
- The exploration, prediction, protection, reinforcement and excavation of the advanced core have become the most important content for ensuring the safety of tunnel construction.
- The strength and deformation characteristics of the advance core medium are the real cause of tunnel deformation (including extrusion deformation, pre-convergence and convergence deformation).
- Modern tunnel construction (good production efficiency, continuous and stable progress).
- High flexibility (only one type of equipment can solve different kinds of geotechnical excavation)
- It is possible to make out the main contractor to guide operations in all type of the ground

Future is unambiguous of this research according to demand and stratification of the earth and the appropriate technology for different types of tunnel.

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