Construction of D shape Tunnel

Project on PIR PANJAL RAILWAY TUNNEL

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2021-2022

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INTRODUCTION

FIG NO. 1

The **Pir Panjal Railway Tunnel** or **Qazigund railway tunnel** is an 11.215 kilometres (6.969 mi) long railway tunnel located in Pir Panjal Range of middle Himalayas in Jammu and Kashmir, India, south of Qazigund town. It is a part of the Jammu-Baramulla line.

The north portal of the railway tunnel is at 33.5617942°N 75.1988626°E and its south portal is at 33.463203°N 75.193992°E.

The average elevation of the railway tunnel is 1,760 m (5,770 ft) or about 440 m (1,440 ft) below the existing road tunnel, the Jawahar Tunnel, which is at elevation of about 2,194 m (7,198 ft). The tunnel is 8.40 metres (27.6 ft) wide with a height of 7.39 metres (24.2 ft). There is a three-metre-wide (9.8 ft) road along the length of the tunnel for the maintenance of railway tracks and emergency relief. It takes approximately 9 minutes and 30 seconds for the train to cross the tunnel.

For a short time, Pir Panjal Railway Tunnel was India's longest railway tunnel. Once completed, the 11.55 km long rail tunnel between Senapati and Imphal West districts on Jiribam–Imphal line will surpass the *Pir Panjal Railway Tunnel* as India's longest tunnel.

➢ GEOLOGICAL INTERPRETATION

- The **Pir Panjal Railway Tunnel** or **Qazigund railway tunnel** is an 11.215 kilometres (6.969 mi) long railway tunnel located in Pir Panjal Range of middle Himalayas in Jammu and Kashmir, India, south of Qazigund town. It is a part of the Jammu-Baramulla line.
- The north portal of the railway tunnel is at 33.5617942°N 75.1988626°E and its south portal is at 33.463203°N 75.193992°E.
- The rail tunnel reduces the distance between Quazigund and Banihal by 17 kilometres (11 mi) (from 35 kilometres (22 mi) by road to 17.5 kilometres (10.9 mi) by train).Banihal railway station is situated at 1,702 m (5,584 ft) above mean sea level. The railway network in Kashmir from Banihal to Baramulla is now 137 kilometres (85 mi). Until the 148 kilometres (92 mi) Katra-Banihal section of Jammu–Baramulla line gets constructed (may open in 2021), people can travel from Jammu Tawi or Udhampur to Banihal by road and take the train from Banihal to Srinagar through the Banihal railway tunnel.

➢ GEOTECHNICAL PARAMETERS

Hoek Brown Classification		
sigci	274.114	MPa
GSI	60	
mi	32.844	
D	0.1	
Ei	12000	
Hoek Brown Criterion		
mb	7.30099	
s	0.010075	
a	0.502841	
Failure Envelope Range		
Application	General	
sig3max	68.5285	MPa
Mohr-Coulomb Fit		
c	21.6515	MPa
phi	43.1614	degrees

Rock Mass Parameters		
sigt	-0.378263	MPa
sigc	27.157	MPa
sigcm	99.9748	MPa
Erm	5551.96	MPa

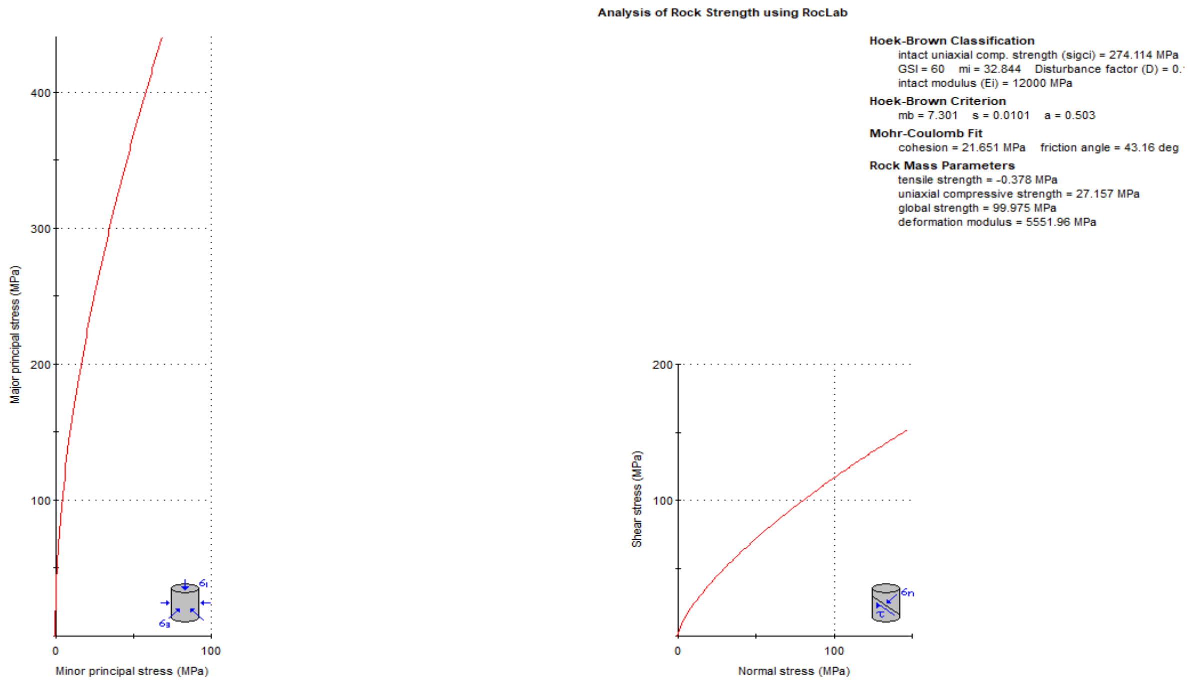

Fig No. 2

Cohesion	Friction Angle	Tensile Strength	UCS	E	Gamma	Sigci
21.651	43.16	-0.378	27.157	5551.96	0.2	274.114

Table No. 1

- ## ANTICIPATED ROCK TYPES & STRENGTH

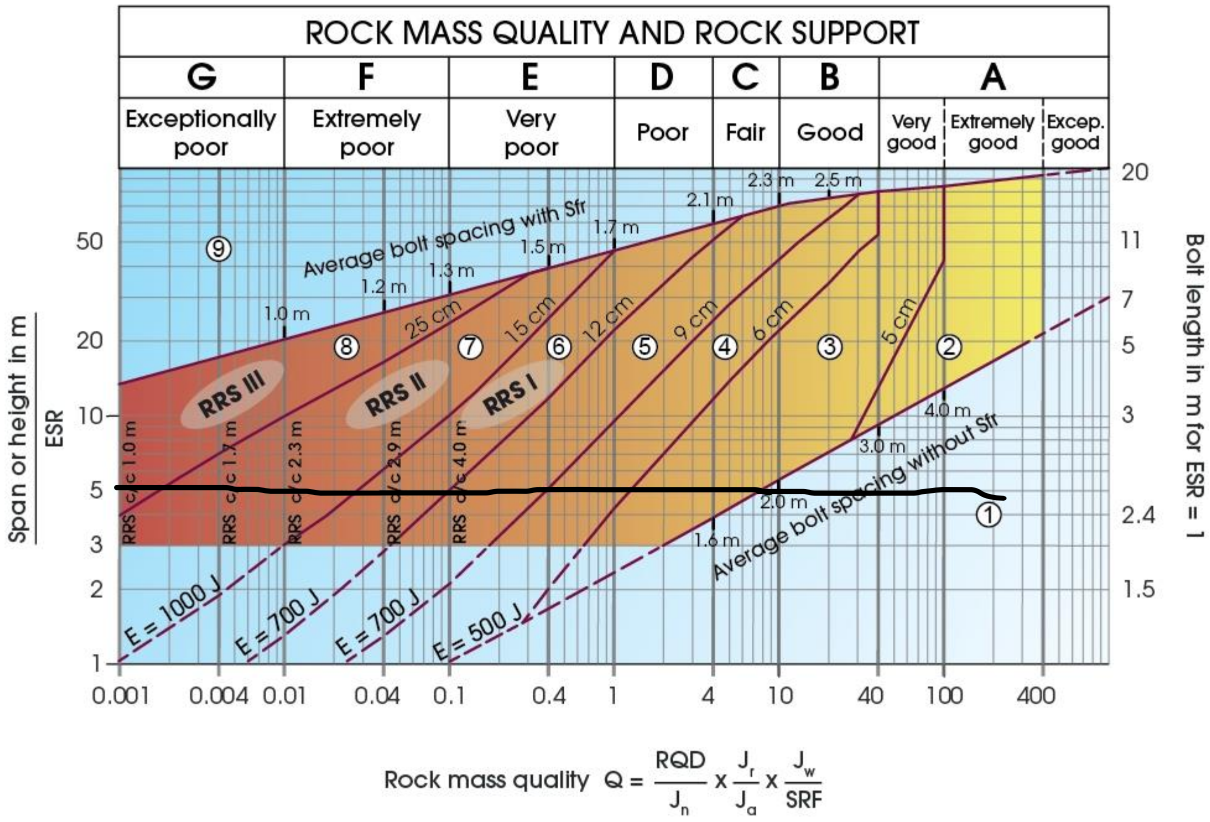

Fig No. 3

Class	Q	RMR	GSI	GSI**	E(in MPa)	Poisson's Ratio	Sigma t	Cohesion	Phi(deg)
1	9	63.77	58.77		5236.29	0.2	-0.344	21.298	42.78
3	2.2	51.09	46.09		2493.46	0.2	-0.129	17.941	38.77
4	0.4	35.75	30.75		896.30	0.2	-0.039	14.108	33.85
5	0.1	32.51	18.27	27.51	736.15	0.2	-0.031	13.268	32.80
6	0.032	29.29	8.021	24.29	614.37	0.2	-0.024	12.407	31.73
7	0.002	26.31	-16.931	21.31	527.77	0.2	-0.019	11.581	30.73

Table No. 2

➢ IN-SITU STRESSES

Z=900m
Density=2700 kg/m^3
Sigma V= 23.814 MPa

K=1.8
Sigma H=42.8652 MPa

➢ TUNNEL EXCAVATION & SUPPORT

Bolt spacing= 1.2m to 2.3m
Bolt length= 3m
Shotcrete thickness= 10 cm to 50 cm
Excavation dimension=Diameter(D) =5m

➢ Methods of Tunnel Excavation

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

- Cut and cover method
- Bored tunnel method
- Clay kicking method
- Shaft method
- Pipe jacking method
- Box jacking method
- Underwater tunnels

➢ SUPPORT

A rock bolt is a steel rod that is inserted into a hole drilled into the roof or walls of a rock formation to provide support to the roof or sides of the cavity in tunnelling and underground mining. Rock bolt reinforcement can be used in any excavation geometry, is easy to install, and is relatively inexpensive. The installation can be completely automated. Depending on the reinforcement requirements, the length and spacing of the bolts can be varied.

➢ DESIGN METHODOLOGY FOR THE INITIAL SUPPORT

Rock Mass Classification

Rock mass classification systems are used in a variety of engineering design and stability analysis applications. These are founded on empirical relationships between rock mass parameters and engineering applications like tunnels, slopes, foundations, and excavatability. In 1946, for tunnels with steel set support, the first rock mass classification system in geotechnical engineering was proposed.The main benefits of rock mass classifications:

1. Improving the quality of site investigations by calling for the minimum input data as classification parameters.
2. Providing quantitative information for design purposes.
3. Enabling better engineering judgment and more effective communication on a project.
4. provide a basis for understanding the characteristics of each rock mass

➢ UNWEDGE ANALYSIS

Joint	Dip	Dip Direction
1	40	180
2	45	60
3	60	280

Table No. 3

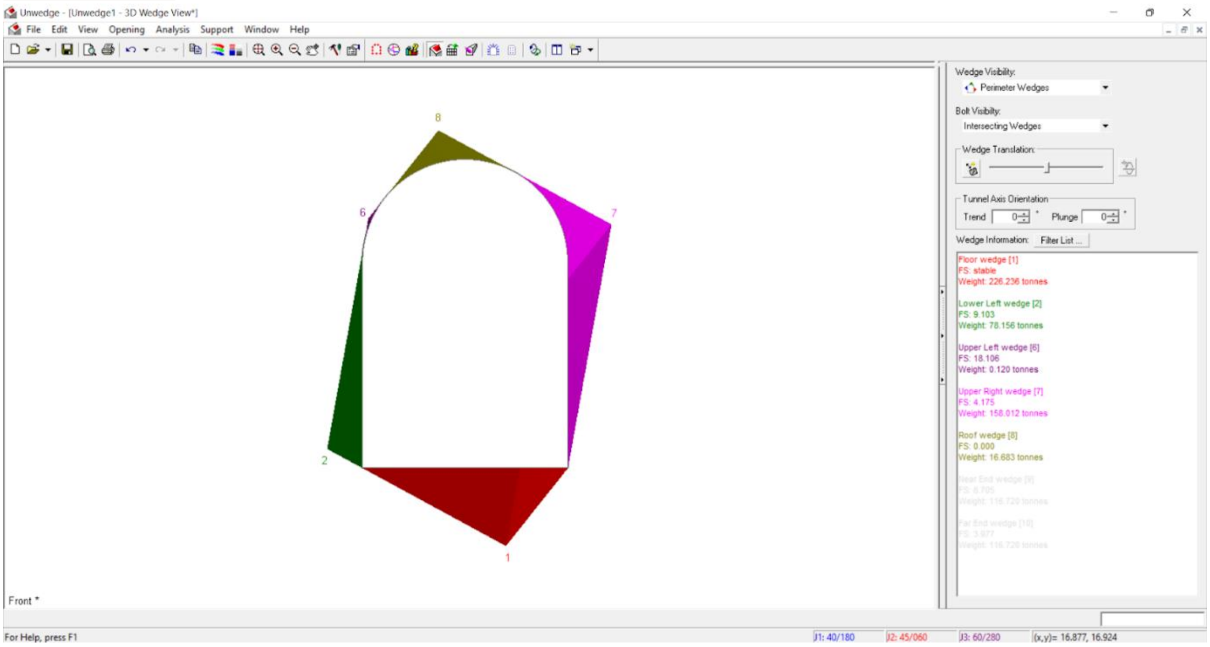

FIG NO.4

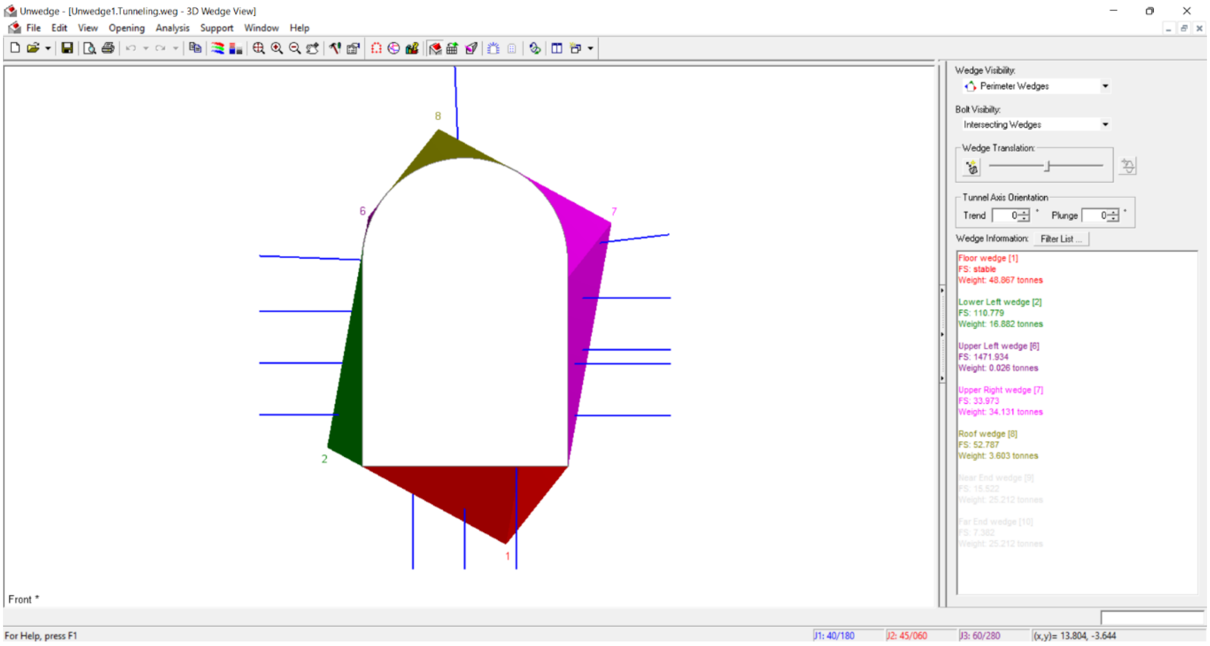

Fig No. 5

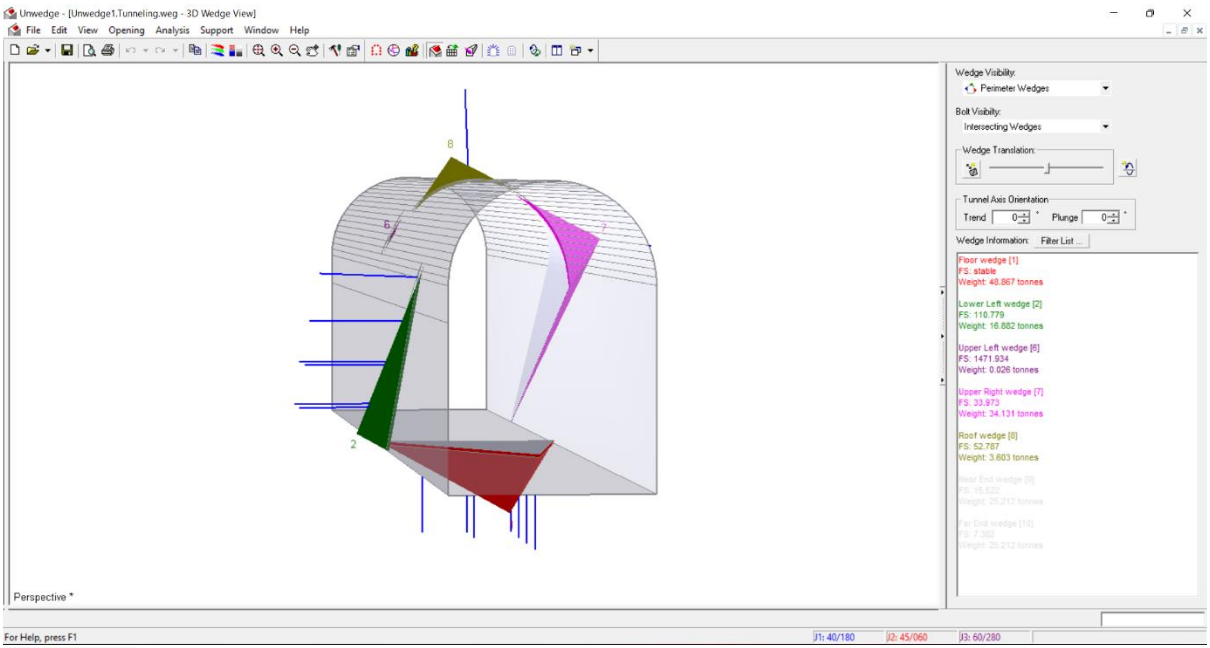

Fig No. 6

- ## NUMERICAL MODELLING

Class 1 Rock Type:

GSI=58.77

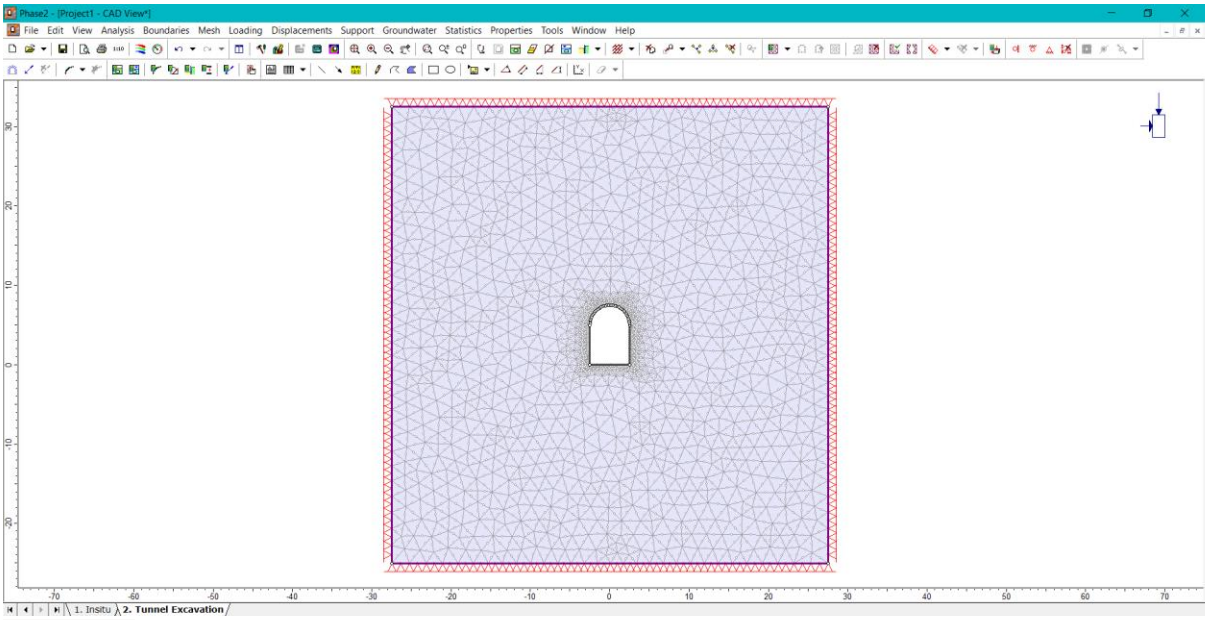

Fig No. 7

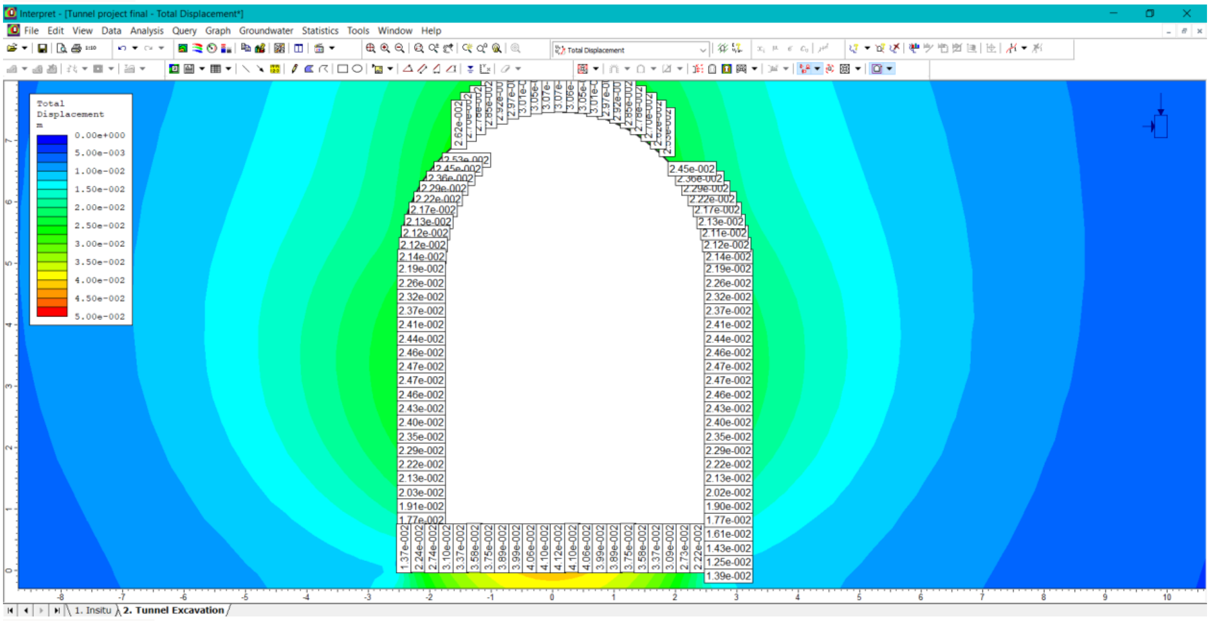

Fig No. 8

Displacement%=0.82%

Since displacement<1%, no support is required.

Class 3 Rock Type:

GSI=46.09

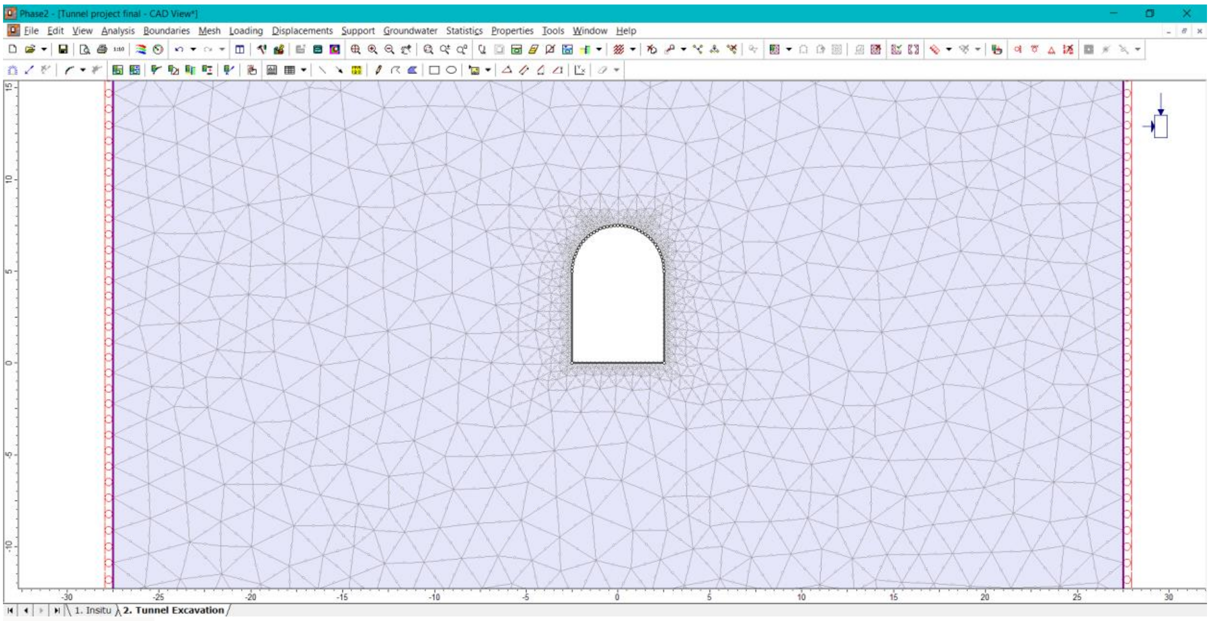

Fig No. 9

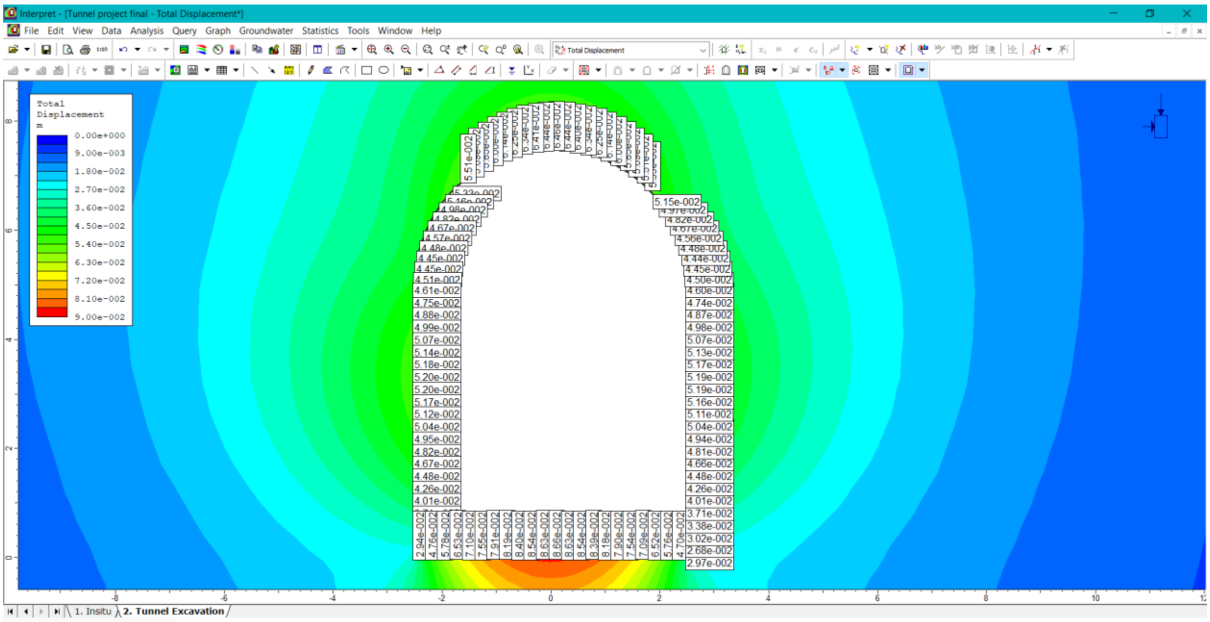

Fig No. 10

Displacement%=1.73%

Since displacement>1%. So, support is required

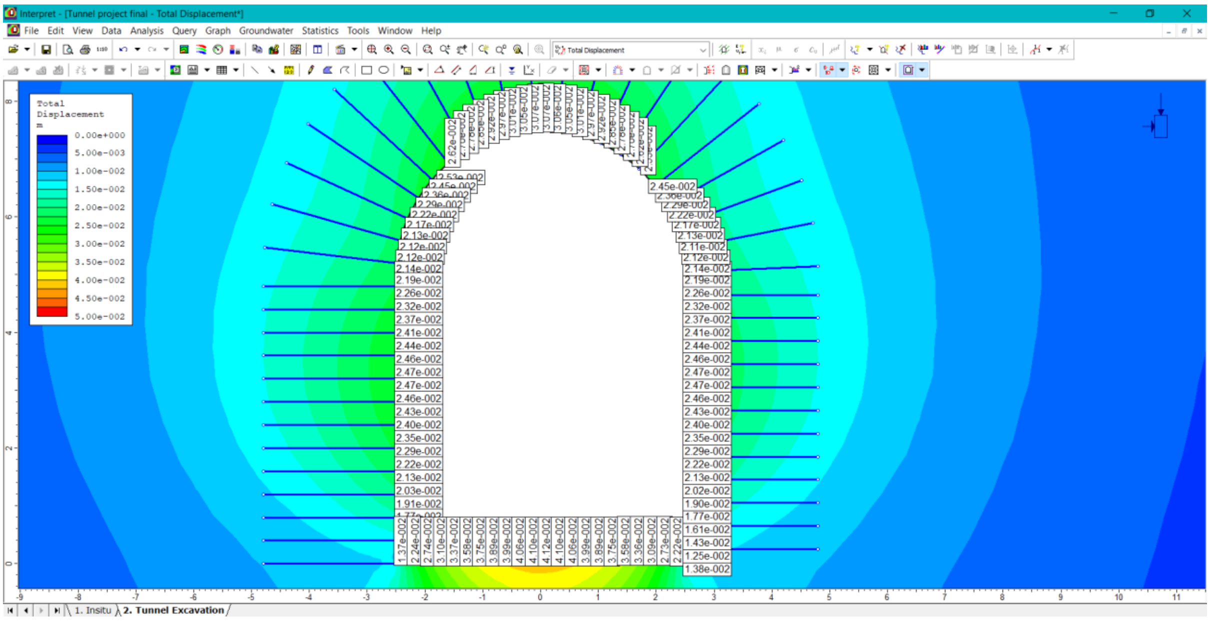

Fig No.11

Displacement%=0.81%

Class 4 Rock Type:

GSI=30.75

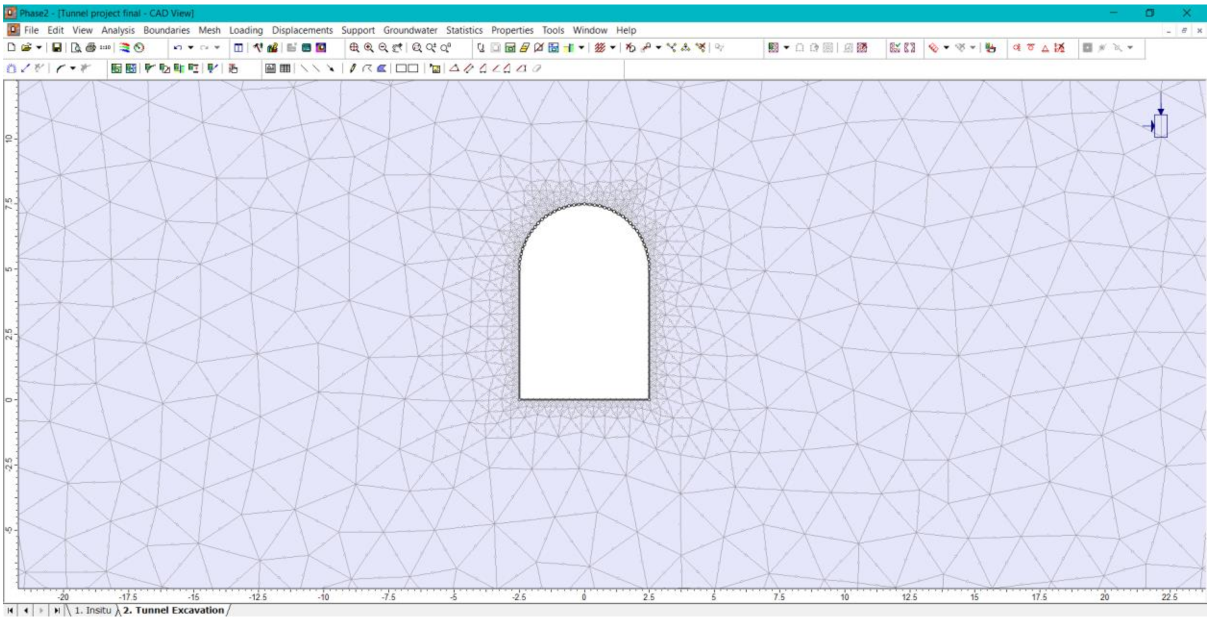

Fig No.12

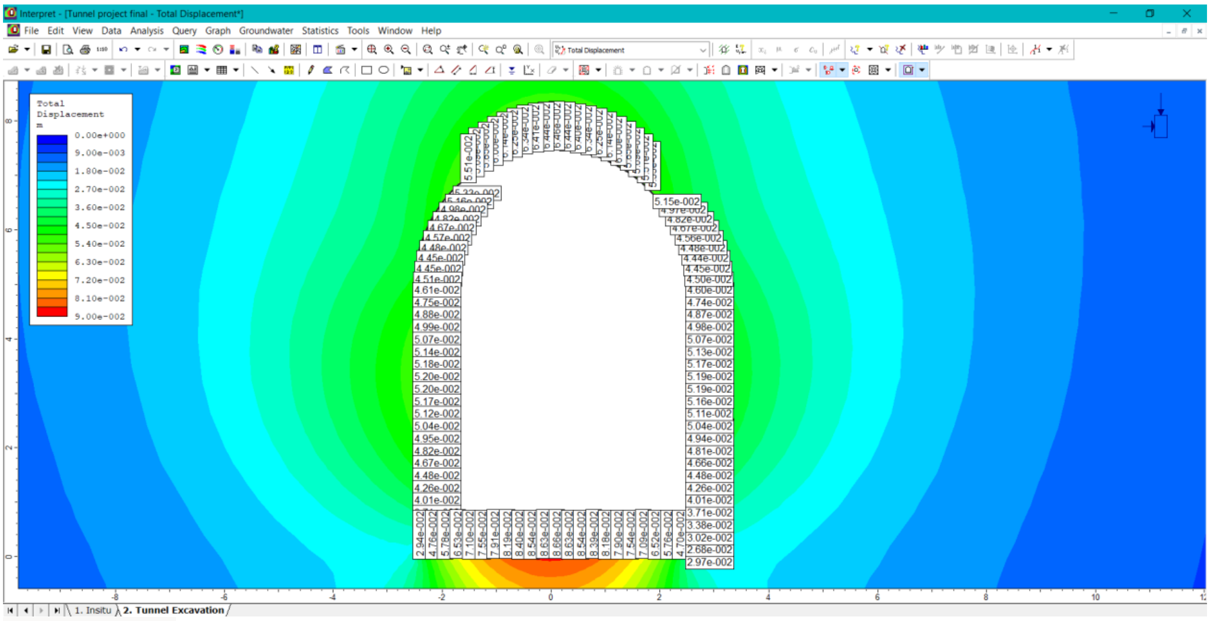

Fig No. 13

Displacement = 4.92%

Since displacement>1%, support is required.

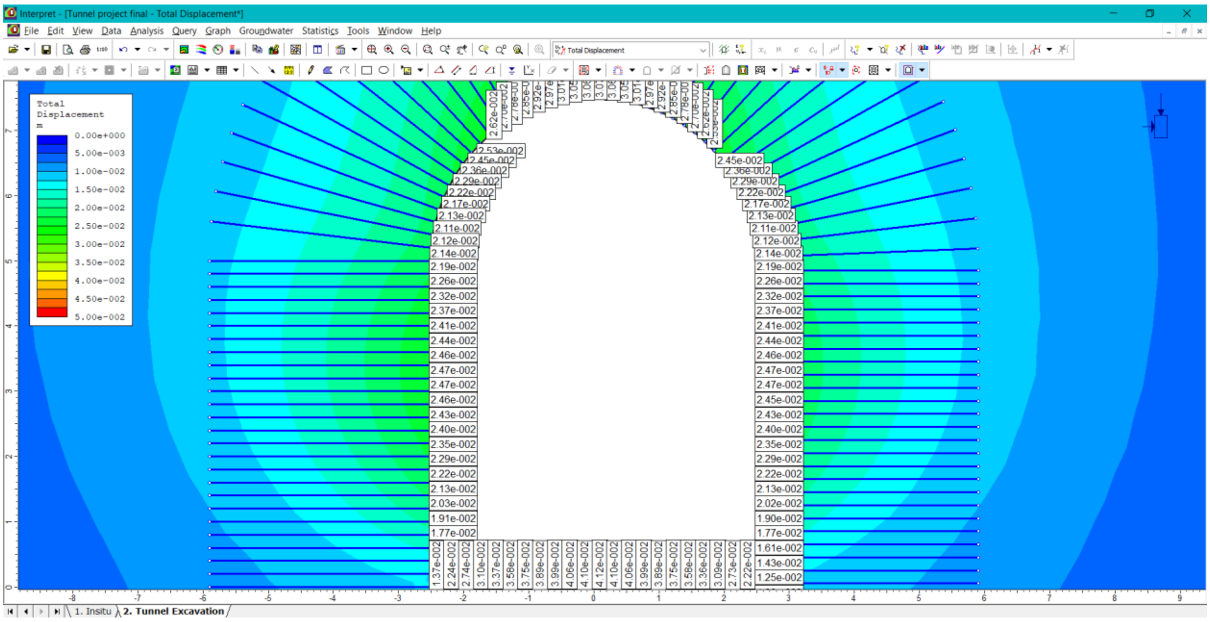

Fig No. 14

Diaplacement%=0.83%

Class 5 Rock Type:

GSI=27.51

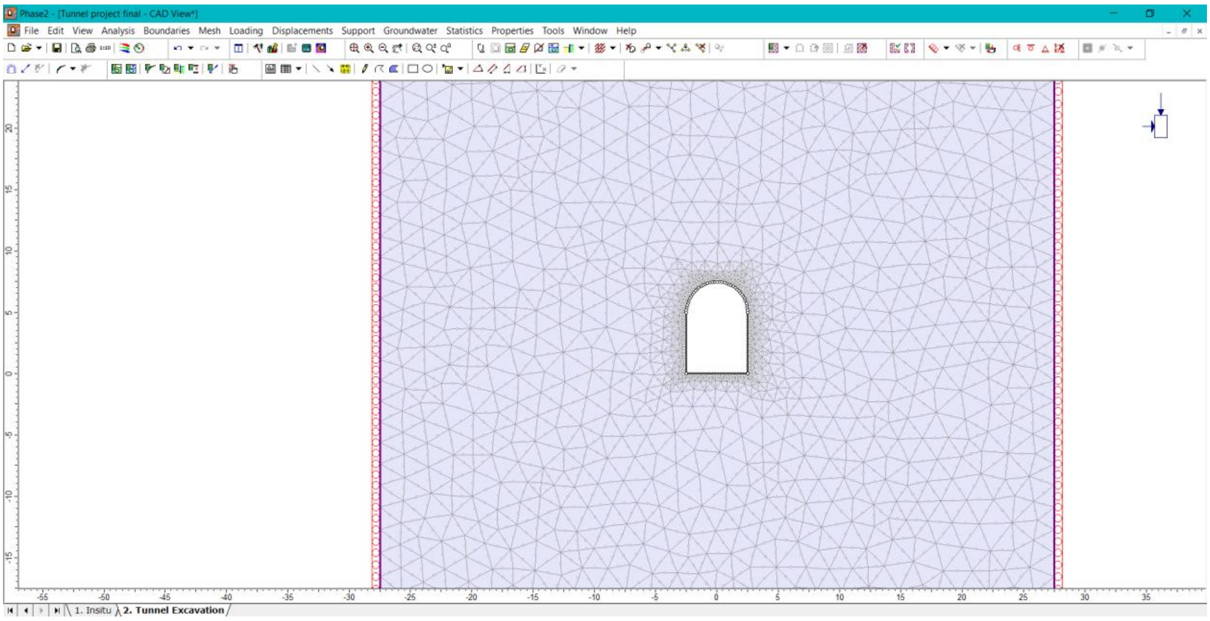

Fig No.15

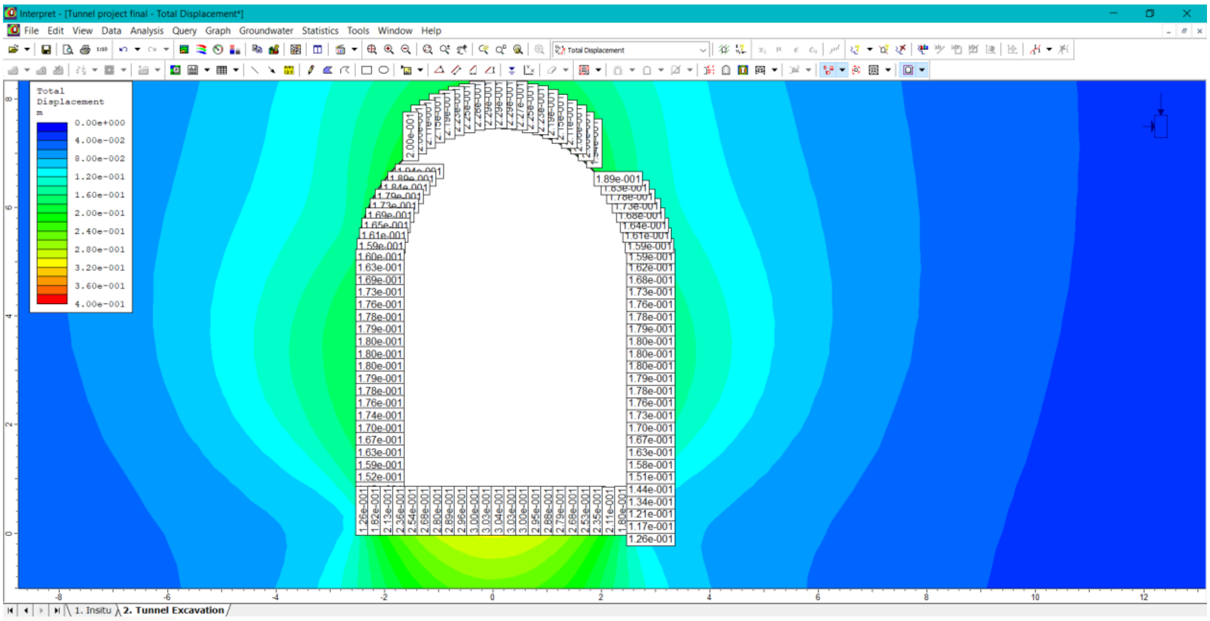

Fig No. 16

Displacement without supports = 6.08%

Since displacement>1%, support is required.

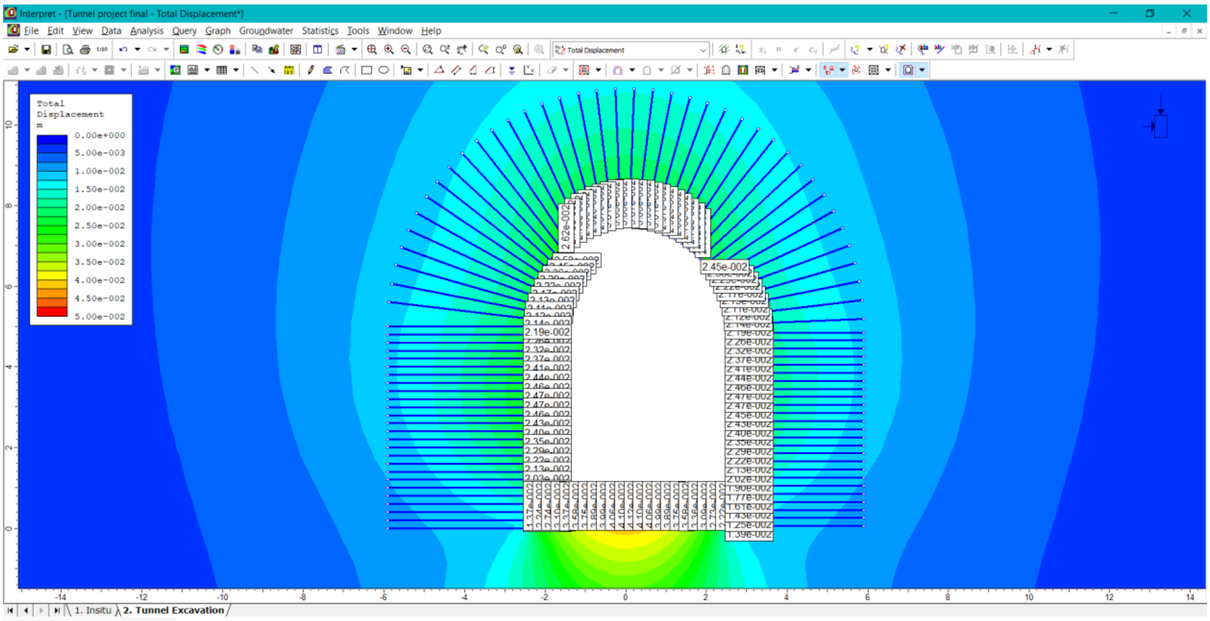

Fig No. 17

Displacement with supports = 0.93%

➢ Tunnel Support Design

Initial Estimate Of Support Based on RMR & Q Method

Span of the tunnel = 5m
Initially for class 1 type of rock, the displacement was less than 1%. So, no support in the form of bolting or shotcrete was required.
But for classes 3,4 and 5 types of rocks, bolts of 3 m length, bolt spacing from 1.2m to 2.3 m and a shotcrete length from 10cm to 80 cm was required to provide stability.

➢ Rockbolt System

Class	Support Required
1	No
3	Yes (Bolt length=3m,Bolt Spacing=2.3m, Shotcrete thickness=10cm)
4	Yes (Bolt length=3m,Bolt Spacing=2.1m, Shotcrete thickness=40cm)

5	Yes (Bolt length = 3m,Bolt spacing = 1.2m,Shotcrete thickness=50cm)

Table No. 4

SUMMARY & RECOMMENDATION of SUPPORT SYSTEM

Selection and design of the support system are only two of many interrelated

factors in the overall design of a serviceable and economical tunnel.

Initial support during construction and final support during the functional life

of the tunnel pose separate requirements; sometimes both are best satisfied by a single

support system.The basic functions of a tunnel support system are to keep the tunnel

stable and to make the opening usable. The specific purposes of support systems,

however, depend greatly on the purposes of the tunnel.

During excavation, most of the existing stresses in the ground are redistributed

around the opening by mobilization of the strength of the soil or rock. The redistribu-

tion is often described as arching. Usually only enough support must be added within

a short time after excavation to help the soil or rock hold itself up.

REFERENCES :

- Fundamentals of Rock Mechanics by D.Deb and Abhiram Kumar Verma
- References from Wikipedia
- ISRM website
- Tunneling and underground Space Technology notes.