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Tunnel Construction – A Case Study of Pune Metro Maha Metro

[1]Dr. P. D. Sabale, [2]PROF. S. J. Yadav, [3]Rushikesh Pawar , [4]Kshitij Gandhi ,[5]Vishwajit Khapare, [6]Vaishnavi Kachhave.
Anantraopawar college of engineering andresearch, parvatipune.

ABSTRACT
The RQD was primarily developed for use in civil engineering, but it has since been quickly adapted for use in mining, engineering geology, and geotechnical engineering. The RQD's simplicity is largely responsible for its popularity. Both the field and the lab can be used to determine the rock mass strength utilising the RQD method. When done correctly, RQD is a fundamental component of the majority of rock mass categorization methods used in geotechnical and engineering geology. The study provides concepts for calculating the strength of a rock mass using the RQD method. Both the field and the lab can be used to determine the rock mass strength utilising the RQD method.In a field investigation, a thorough field survey and subsurface investigation are conducted in order to determine the nature of the real-world conditions needed for a concrete rock mechanical solution at the site. Thus, a thorough RQD on-site investigation of several boreholes was performed with regard to their alignment by the actual use of a standard approach. The additional investigations, including Rock Mass Rating (RMR), Rock Structure Rating (RSR), and Q-index, were eventually planned for lab analysis based on the results of the RQD field inquiry. Conclusions and results are based on field and laboratory analysis. On the basis of conclusions, a decision is taken.
Keywords*:Rock Quality Designation, Rock Mass Rating, Rock Structure Rating*

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I. INTRODUCTION

Due to its beautiful beauty and abundant natural resources, Pune, the cultural and historical capital of the state of Maharashtra, is referred to as the "Queen of Deccan." The capital of the greatest warrior king of all time, Chhatrapati Shivaji Maharaj, who founded "Hindavi Swarajya," and the birthplace of the revered saint Tukaram. The city has seen an increase in population over the past few decades as well as people moving there in search of employment. However, there was a lack of sustainable infrastructure to make it simple for citizens to commute. In Pune, the daily average journey time for residents utilising public transportation is more than 100 minutes. This forces an increasing number of people to drive their own cars, which worsens traffic congestion.Pune Metro, which will help address all of these problems, will make commuting in the city more comfortable and convenient by cutting the required journey time in half. It will make it easier for many young people, students, workers, etc. to go where they're going. The Smart City Project's public transportation system will be supported by metro rail, which will improve on a number of fronts. The quality, structure, and types of rock joints present during tunnelling all affect the strength of the tunnel. The Rock Quality Designation (RQD) system determines the rock's quality and is helpful for correcting the alignment of tunnels.As a result, the core logging data is crucial for the completion of alignment and project design. Any tunnel can be built using a variety of methods, tools, and procedures.

II. LITERATURE REVIEW

The study suggests a new modified RQDm index be established in order to get around the constraints associated with determining the value of the standard RQD index. In comparison to using the standard RQD, this adjusted and corrected value of the RQDm index will be more conservative. [1]Until the introduction of the Rock Quality Designation (RQD) index 20 years ago, the main sources of information on rock quality were geologists' descriptions and the percentage of core recovery. In order to lower the quality designation of rock bearing these traits, the RQD is a modified core recovery percentage in which unrecovered core, fragments and small bits of rock, and changed rock are not counted. The RQD red flag and subsequent investigations, according to case study experience, frequently lead to the depth of foundation levels and the reorientation or full relocation of proposed engineering projects, such as dam foundations, tunnel entrances, subterranean caverns, and power facilities. [2]In order to determine the strength of coal in situ, thorough subterranean studies were conducted, the findings of which are described in this study. The apparatus and experimental methods used to

test cubical coal specimens with sizes ranging from 075 in. to 66 ft (2 m) are described in detail. An empirical relationship between the strength of coal and the size of the examined specimens is established based on the findings of more than sixty underground tests, and its significance for real-world applications is discussed. [3]Since its initial proposal in 1973, the Geomechanics Classification of Rock Masses has been used for a variety of rock engineering projects, including civil engineering tunnels, caverns, slopes, and foundations, as well as mining haulages and chambers. The classification is based on six factors: groundwater conditions, spacing, direction, and condition of discontinuities; uniaxial compressive strength of the rock material; drill core quality RQD. Each parameter receives an importance rating, as do the ratings for the entire rock mass.[4]Designing structures made of rock is done using the engineering discipline of rock mechanics. All buildings that are erected on or within a rock mass are included in this category, including building foundations, dams, slopes, shafts, tunnels, caverns, hydropower projects, mines, radioactive waste repositories, and geothermal energy projects. Although there are many different projects that involve rock engineering, the basics are constant. The fundamental concepts of rock engineering are systematically and thoroughly explained in Engineering Rock Mechanics. [5]

III. METHODOLOGY

OBJECTIVE

1. To study the rock's composition below earth.
2. To research the distinctive qualities of a rock used as a foundation.
3. To study the tunnel construction methods employed for the Maha Metro in Pune.

SURVEY AREA

From collection of Pune metro phase-I map, there are two corridors, in the Corridor-I from Hill Range Depot the tunneling portion is start and the end at Swargate. This tunnel portion length is 5.018 km. There are 6 stations are in this portion is underground.

FIELD INVESTING

On-site investigation includes the following steps:

1. Core classification based on location.Core log in boxes in order.
2. Choosing a core box.
3. Core washing for accurate interpretation.
4. Each core is measured using lithological characters in accordance with various norms.
5. The actual techniques employed in tunnel construction.

METHODS OF ANALYSIS

a) ROCK QUALITY DESIGNATION (RQD) :-

It is defined as the borehole core recovery percentage incorporating only pieces of solid core that are longer than 100 mm in length measured along the centerline of the core.

$$RQD = \frac{\sum Length\ of\ Core\ Pieces\ > 100\ mm}{Total\ Lenght\ of\ Core\ Run} \times 100\ \%$$

RQD	Rock Mass Quality
<25 %	Very Poor
25-50 %	Poor
51-75 %	Fair
76-90 %	Good
91-100 %	Excellent

b) ROCK MASS RATING (RMR) :-

RMR combines the most significant geologic parameters of influence and represents them with one overall comprehensive index of rock mass quality.

The following six parameters are used to classify a rock mass using the RMR system:

a)Uniaxial compressive strength of rock material
b) Rock Quality Designation (RQD)
c) Spacing of discontinuities
d) Condition of discontinuities
e) Groundwater conditions
f) Orientation of discontinuities

RMR	**Rock Quality**
0 - 20	Very Poor
21 - 40	Poor
41 – 60	Fair
61 – 80	Good
81 - 100	Excellent

IV. RESULT

From the core logging sample the **Amygdaloidal Basalt is** present in our study area.This basalt Rock Quality Designation (RQD) ranges from **25%** to **75%.** Therefore, the quality of basalt rock is **fair**.The rock mass rating of this basalt varies from 32% to 45%.Hence the rock is fair.Overburdened soil over a survey area varies from 0 to 3m from the ground level.The core recovery varies from 30% to 97%.That's why the joints present in this basalt are very less.

1) STRATUM TWO: HIGHLY WEATHERED BASALT / AMYGDALOIDAL BASALT

Parameter	Values	Rating
Strength of Intact rock Material	250 - 500 Kg/sqcm	4
Rock Quality Designation (RQD)	< 25 %	3
Spacing of Discontinuities	Very Close	5
Condition of discontinuities	Slightly rough and moderately to highly weathered wall rock surface, separation < 1 mm	20
Ground Water Condition	Wet	7
Adjustment for Joint Orientation	Fair	-7
	Total RMR value	32

2)STRATUM THREE: SLIGHTIY WEATHERED TO FRESH BASALT / AMYGDALOIDAL BASALT:-

Parameter	Values	Rating
Strength of Intact rock Material	250 - 500 Kg/sq.cm	4
Rock Quality Designation (RQD)	50 % - 75%	13
Spacing of Discontinuities	Close	8
Condition of discontinuities	Slightly rough and moderately to highly weathered wall rock surface, separation < 1 mm	20
Ground Water Condition	Wet	7
Adjustment for Joint Orientation	Fair	-7
	Total RMR value	45

V. FUTURE SCOPE

Future analyses of subsurface strata will benefit from this study. The foundation type can be suggested using the findings of this study. Analyzing slope stability and determining the calibre of rock engineering properties both benefit from it.

VI. CONCLUSION

From the Geological Report of Maha Metro Pune Metro, the Amygdaloidal Basalt is present and core recovery of this rock is very high. Therefore the joints in this basalt are very less. Hence percolation of water and seepage losses are very less in this rock.The unconfined compressive strength (USC) of this basalt varies from 200 to 900 kg/sq.cm.Therefore the rock is suitable for tunnelling construction.

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