Metro Rail In Gorakhpur

Shivam Pandey[1] Sukhvinder Singh Saini[2], Ashish Tripathi[3], Ashish Rajbhar[4], Faheem Akram[5], Shabi Ahmad[6], Dr. Alak Roy[7]

[1,2,3,4,5,6]*Student, Civil Engineering Department, Buddha Institute Of Technology Gorakhpur*

Abstract - *This case study is broadly conceived to assess the potential of the Gorakhpur-metro rail. When evaluating mass transit options for Indian cities, metro systems are given preference over surface systems due to the belief that a road-based bus system cannot cater to the capacity requirement as much as metro systems. In addition to this, metro rails are perceived to have higher levels of comfort, speed, and efficiency as compared to bus systems. This study covers the following aspects of the Gorakhpur metro rail project: 1. Site Survey , 2. Soil Testing, 3. Construction Technology. According to the study & survey, metro rail in Gorakhpur can be built from B.R.D. Medical College to Shastri Chowk And further from Shastri Chowk to Mohaddipur. Total Distance covered will be 11.4 Km. Out of which a distance of 8.3 km is covered between B.R.D.Medical College and Shastri Chowk while 3.1 Km is covered between Shastri Chowk and Mohaddipur. Further extension may be planned.*

Keywords - Metro Rail, Soil Testing, Construction Techniques.

1- INTRODUCTION

Metro rails are rail-based, mass rapid transit systems. These can be operated either underground or elevated. Metros can carry 50,000–75,000 passengers per hour, per direction. These systems generally operate at an average speed of 30–35 km/hr. Maximum speed of metro is 80 km/hr in India. Metro rails are perceived to have higher levels of comfort, speed and efficiency, than bus systems, making them more attractive to both policymakers and the users.

2- NEED OF METRO IN GORAKHPUR

- Unprecedented growth of personal vehicles.
- Growing traffic congestion.
- Air pollution and Noise Pollution have become a major concern.
- Traffic accidents are increasing day by day.
- To avoid congestion at peak hours.
- Time saving.
- Reduced fuel consumption.
- Comfort Conditions

3- ADVANTAGE OF METRO

- A cheap mode of transport.
- The Mass Rapid Transit System helps in low energy consumption.
- It is eco-friendly.
- Averts the number of accidents.
- It is efficient in terms of space occupancy and provides comfort with ultra-modern coaches and modern systems like automatic ticketing, advanced signalling systems, automatic train protection system and integrated security systems.
- The international standard for MRTS with a maximum speed of 80kmph and average speed of around 34 kmph helps in saving of time.
- With proper designing, the peak hour capacity could be rated at 3-4 lakhs passengers per hour

4- GORAKHPUR METRO PLANNING

- According to the study & reconnaissance survey, metro rail in Gorakhpur can be built from B.R.D. Medical College to Shastri Chowk And further from Shastri Chowk to Mohaddipur.
- Total Distance covered will be 11.4 Km. Out of which a distance of 8.3 km is covered between B.R.D.Medical College and Shastri Chowk while 3.1 Km is covered between Shastri Chowk and Mohaddipur.
- Further extension may be planned.

5- METHODOLOGY

- This case study is broadly conceived to assess the potential of the Gorakhpur-metro rail.
- When evaluating mass transit options for Indian cities, metro systems are given preference over surface systems due to the belief that a road-based bus system cannot cater to the capacity requirement as much as metro systems.

- In addition to this, metro rails are perceived to have higher levels of comfort, speed, and efficiency as compared to bus systems.
- Capital intensive construction and high operation cost of metro systems necessitates financial support from state and central governments, foreign loans, tax exemptions and other subsidies.
- However, no explicit analysis of these considerations is available and more elaborate studies would be required to understand each of these dimensions.
- This study covers the following aspects of the Gorakhpur metro rail project:

1. Site Survey
2. Construction Technology
3. Soil Testing

6- SITE SURVEY

- ALIGNMENT - the route of a Metro, defined as a series of horizontal tangents and curves, as defined by planners and surveyors. To find out the alignment of Gorakhpur Metro following are to be finded out using survey

  ❖ Coordinates or Positions of Points.

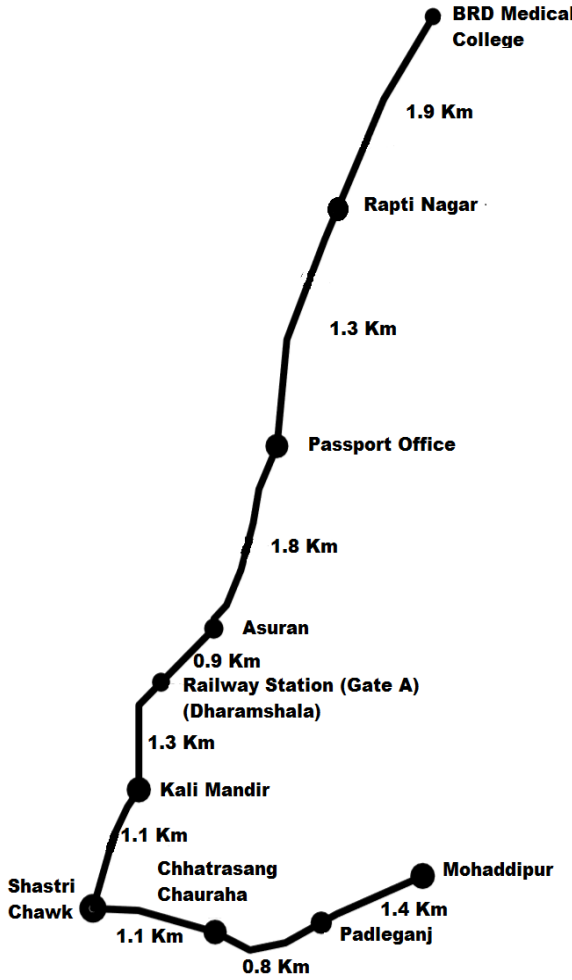
  Bearing of 1st Line

  Distance

  Angle

  ❖ Elevation

- Apparatus used – Surveyor's Compass , Tacheometer , Stand , Staff.
- Survey was carried out using TACHEOMETRY.
- Theodolite and Staff were the main equipment's used.
- The multiplicative constant of the Theodolite was found to be 117.5
- Reduced Level (RL) of BRD Medical College – 90 m
- Relatively, the RL of Shastri Chowk was calculated as 89.644 m
- Total Distance Covered – 11.6 Km
- Maximum Distance between Station – 1.9 Km
- Minimum Distance between Station – 0.8 Km
- Bearing of First Line at BRD Medical College was S20°E as observed on the Surveyor's Compass.
- According to the survey, we have concluded with the above results and the alignment of the metro route is explained in the figure below



7- SOIL TESTING

(A) SIEVE ANALYSIS: A sieve analysis is the procedure to check the size of soil particles present in the soil sample. This procedure is also known as gradation test of soil sample.

Significance: The distribution of different grain sizes affects the engineering properties of soil. Grain size analysis provides the grain size distribution, and it is required in classifying the soil.

D_{10} =5mm

D_{30} = 0.3mm

D_{60} = 0.06mm

C_U = 0.06

C_C = 1.126

Final Result:

Type of soil SM (SANDY SILT)

Because its

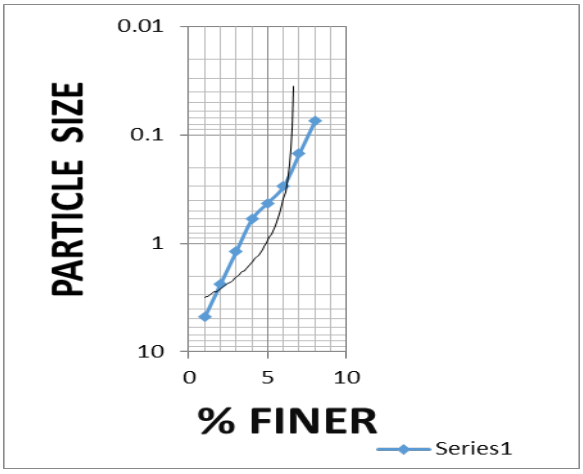
- Plasticity Index < 4

- More than 12% particle having range less than 0.075mm

Observation Table:

SIEVE SIZE IN mm	PARTICLE SIZE IN mm	WEIGHT RETAINED IN gm	%RETAINED	CUMULATIVE% RETAINED	%FINER
4.75	4.75	0	0	0	100
2.36	2.36	3	0.322	0.322	99.678
1.18	1.18	18	1.933	2.255	97.745
0.6	0.6	37	3.974	6.229	93.771
0.425	0.425	55.5	5.96	12.189	87.811
0.3	0.3	100.5	10.79	22.979	77.021
0.15	0.15	438	47.04	70.019	29.981
0.075	0.075	153	16.43	86.449	13.551
PAN		126	13.53	99.97	0.021
TATAL		931			

GRAPH –



(B) WATER CONTENT: The water content is the ratio of the weight of *water* to the weight of the solids in a given mass of soil.

Result:-

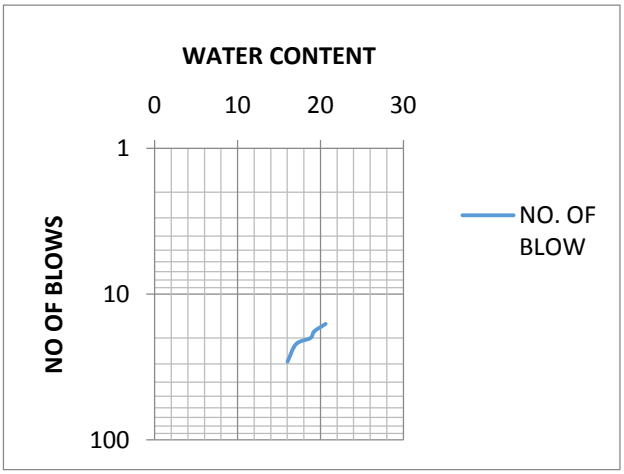
- Initial weight of soil specimen = 100 gm
- Weight of oven dried soil specimen= 89 gm
- Weight of water= 11 gm
- Water Content of soil specimen= 12.36 %

(C) PLASTIC LIMIT TEST: The plastic limit is defined as the water content at which soil starts to behave as a plastic material. The plastic limit is determined by rolling out in form of thread of the fine portion of a soil on a flat, non-porous surface. If the moisture content is below the plastic limit, it is considered to behave as a solid, or a nonplastic material.

Result: Soil sample is Non-Plastic

(D) LIQUID LIMIT TEST: The water content at which the behavior of a soil changes from plastic state to liquid state. This test is done to determine the liquid limit of soil as per IS: 2720 (Part 5) – 1985.

Graph :



Observation Table:

SAMPLES	1	2	3	4	5
NO OF BLOWS	29	22	20	18	16
Wt. OF CONTAINER (Wo)	21.117	21.117	21.117	21.117	21.117
Wt. OF CONTAINER+ Wt OF DRY SOIL (W1)	26.531	26.741	28433	32.522	32.926
Wt. OF CONTAINER+ OVEN DRY SOIL (W2)	21.435	25.921	27.381	30.680	30.907
Wt. OF WATER (W1-W2)	1.944	0.82	1.052	1.842	2.019
Wt. OF OVEN DRY SOIL (W2-WO)	3.17	4.804	6.264	9.563	9.79
WATER CONTENT=(W1-W2)/(W2-W0) *100	16.03	17.06	18.79	19.26	20.623

Result : Liquid Limit of soil specimen

(W_L) = 16.43 %

(E) DRY DENSITY TEST: This test is done to find the dry density of soil sample by core cutter method as per IS: 2720 (Part XXIX) – 1975.This test is performed by the help of core cutter method. Core cutter method is most suitable method for determining the dry density of soil sample. In this method core cutter is driven with a steel dolly on its top, into the soil to its full depth using steel rammer. Then lift the cutter without disturbing the soil sample. Weight the core cutter with soil and again weight it after oven drying the soil sample with core cutter and find the dry density of soil sample.

Observation Table:

Vol. of core cutter (Vc)	1021 cm^3
Weight of core cutter (Wc)	974 gm
Weight of core cutter + weight of soil (Ws) Weight of wet soil (Ws-Wc)	1678gm
Bulk density γ_b = (Ws-Wc)/Vc	1.64 gm/cm^3
Water content (w)	8.712%
Dry density (γ_d)= γ_b/(1+w)	1.66 gm/cm^3

(F) UNCONFINED COMPRESSIVE STRENGTH TEST : The unconfined compressive strength of soil is the load per unit area at which the cylindrical soil sample is fails in compression. The basic purpose of the Unconfined Compression Test is to determine the unconfined compressive strength of soil sample that possess sufficient cohesion to permit testing in the unconfined state. This test is then used to calculate the unconsolidated undrained shear strength of the soil under unconfined conditions.In the unconfined compression test, the sample is placed in the compression test machine between the lower and upper plates. Before starting the loading set the deformation is zero.Then start the test by applying a constant axial strain of about 0.5 to 2% per minute. The load and deformation values are for obtaining a complete load-deformation curve. The loading is continued until the load values decrease or remain constant with increasing strain, or until reaching 20% axial strain. At this state, the samples is considred to be at failure. The sample is then removed and find unconfined compressive strength of soil sample

Result:. unconfined compressive strength of soil is 0.73 kg/cm^2

8- CONSTRUCTION TECHNOLOGY

The concrete technology that will be used for the construction of metro systems will be prestressed concrete. Prestressed concrete is a method for overcoming concrete's natural weakness in tension. It can be used to produce beams, floors or bridges with a longer span than in practical with ordinary reinforced concrete. As per the survey done by us, we have found that the Gorakhpur metro is similar to the Lucknow and Kochi metro project.

A) U - Girder

The length of a standard U-Girder is 27 m. It is used only in straight spans. U-Girders are pre-tensioned. Tensioning is done before concreting. Total of 72 Strands are provided during pre-tensioning. The total load estimated on the girder is 332 Kg. In order to carry the load, Pre tensioning is done using jack system and a tensioning of 199.2 KN is done on each strand.

B) I-Girder

I-Girders are generally used where a curve is to be provided in the route or there is a large height difference from one girder to another. I-Girders are post-tensioned. Tensioning is done after concreting. A total of 45 strands are provided in the I-Girder duct. In post tensioning, a load of 195.3 KN is applied per strand. 4 I-Girders are used at a time in place of U-Girder.

C) FOUNDATION

Since the bearing capacity of soil is very low in Gorakhpur, hence pile foundation will be best suitable for metro. A pile foundation consists of two components: Pile cap and single or group of piles. There are three types of pile foundations according to their construction methods:

- 1. Driven piles,
- 2. Cast-in-situ piles, and
- 3. Driven and cast-in-situ piles.

In metro constructions, we generally provide Cast In Situ type of pile foundation It is also known as BORED PILES.

SPECIFICATIONS –

Capacity of one Pile (Design Load)	400MT
Ultimate load (Test Load)	1000MT
Length of Pile	30m below G.L
Diameter of Pile	1200mm
Concrete Grade	M40
Quantity of Concrete	37 Cu.m
Quantity of Reinforcement	15MT
Reinforcement Grade	Fe500

D) PILE CAP

A pile cap is a thick concrete mat that rests on concrete or timber piles that have been driven into soft or unstable ground to provide a suitable stable foundation. It usually forms part of the foundation of a building, typically a

multi-story building, structure or support base for heavy equipment.

PILE GROUP	DIMENSIONS
4 PILE GROUP	5300X5300mm
5 PILE GROUP	6791X6791mm
6 PILE GROUP	5300X8900mm
8 PILE GROUP	5300X12500mm

Height of Pile Cap	1800mm
Clear cover for reinforcement	75mm
Quantity of concrete	50 Cu.m apx.(4 pile group) 85 Cu.m apx,(6 pile group)
Height of PCC concrete	75mm
Concrete grade for PCC	M15
Reinforcement Grade	Fe 500D
Concrete Grade	M45

SPECIFICATIONS –

E) PIER

A pier, in architecture, is an upright support for a structure or superstructure such as an arch or bridge.

SPECIFICATIONS –

Diameter of pier	1700mm
Height of pier	15m
Concrete grade	M45 to M60 as per drawing
Concrete quantity	34.027 cu.m
Clear cover reinforcement	50mm

F) CRASH BARRIER

To prevent Pier from wear and tear due to crashing of vehicles, a protective concrete structure is made around pier to ensure safety of pier.

SPECIFICATIONS -

Height	1.5m
Diameter	2200mm
Concrete grade	M40
Concrete quantity	5.072 cu.m

10- GUAGE

The Gauge of a track is defined as the clear distance between inner or running faces of two track rails.

Types of Gauges-

- Broad Gauge (Indian Gauge) – 1676 mm
- Standard Gauge – 1435 mm
- Narrow Gauge – 762 mm
- Metre Gauge – 1000 mm

Metro Systems use standard gauge. The distance between the inside edges of the rails is defined to be 1435 mm (4 ft 8 ½ in).

The standard gauge allows sharper turns and is used where the route of the metro line goes through places in the city. The standard gauge is better as it allows a low turning radius of 90 to 140 metres as against 175 metres for broad gauge. This reduces the requirement of land when the Metro has to take a curving turn. Adoption of standard gauge also ensures adoption of an up-gradation to latest technologies in rolling stock, suspension, braking traction and propulsion in future as well. It (wider coaches of broad gauge) means a higher expenditure on the platforms and the safety systems since the emergency evacuation measures require that a station be designed in such a way that three trainloads of passengers can be safely evacuated in less than six minutes.

In standard gauge coaches electricity costs will be saved, power consumption will be reduced to 50 units per km by using light stainless steel bodies.

11- CONCLUSION

The sole purpose of developing this project is helping the public to reach their daily requirements (such as offices, railway station, market area, hospital, etc.) without delay, without traffic jams & without accidents. This project also leads to minimization of pollution level in Gorakhpur. This also adds to the comfort condition of the passengers.

REFERENCES

[1] Mr. D.K.Sharma , Project Manager (L&T , LMRC)

[2] DPR OF Delhi metro, Lucknow metro, Kochi metro.

[3] IS 2720

[4] IS 456:2000

[5] Dr. Alok Roy, Dean of civil Engg. Department , B.I.T. Gida Gorakhpur.