Study of Structural Features of Nagpur Metro

Sagar chinchghare.

Department of Civil Engineering, RTMNU, Nagpur, Maharashtra, India[1]

ABSTRACT

Nagpur is the third largest city of Maharashtra and the winter capital of the state with a population of approximately 25 lakhs and it is the 13th largest urban conglomeration in India. Nagpur lies precisely at the center of the country with the Zero Mile Marker indicating the geographical center of India. In addition to these the city is also a commercial centre of the state. It is also a major trade centre of oranges that are cultivated in the Nagpur region on large scale. Also, it has been selected for the Smart City Project- a government initiative. Because of its regional and commercial importance there is need of better transportation system in the city. For decongestion of traffic within the city the metro work is started in the late 2015. This project consists of various different types of structural member. This paper focuses mainly on the structural work carried in the Nagpur Metro construction.

KEYWORDS*: Conglomerate, Decongestion, Zero Mile Marker*

I. INTRODUCTION

Nagpur lies on the Deccan plateau of the Indian Peninsula. The underlying rock strata are covered with alluvial deposits in some places; these give rise to granular sandy soil. In low-lying areas, which are poorly drained, the soil is alluvial clay with poor permeability characteristics. However in the eastern part of city, crystalline metamorphic rocks such as gneiss, schist and granites are found, while in the northern part yellowish sand stones and clays of the lower Gondwana formations are found. As it is located at center of India, Nagpur has a tropical wet and dry climate with dry conditions prevailing for most of the year.

Based on the different types of surveys done by DMRC, metro alignments were finalized after repeated inspection of the road network, intersections, passenger traffic flow, traffic congestion, connectivity to important land uses. The final alignments of the two corridors are as stated below:

Alignment (Proposed by DMRC)	**Route**
Alignment-1 North-South Corridor	Corridor originates from Automotive Square on Kamptee Road and ends near Railway Track in MIHAN area
Alignment-2 East – West Corridor	Corridor originates from Prajapati Nagar and ends in Lokmanya Nagar

The total length of the length of the NMR is extending to 38.125 Kms. with 36 stations over the whole length. Of these 36 stations 34 are elevated stations and 02 stations are at-grade in corridor-1.

II. LAND

Both the alignments are elevated except around 4.6 Km at Grade alignment. Total 36 stations are proposed in both corridors, Out of which 02 are at grade and 34 are elevated. **Land required for major components:**

a. MRTS Structure (including Route Alignment)
b. Station Building, Platforms, Entry/Exit Structures, Traffic Integration Facilities, Depots, etc.
c. Temporary Construction Depots and work sites.
d. Staff quarters, office complex and operation control centre

a. Land required for elevated stretches

The land required for single pier supporting the viaducts will be located on the middle of the existing roads. In stretches, wherever the elevated alignment has to be located away from road, a strip of 20-m width is proposed for acquisition.

b. Land for Switch-over Ramps

Such kind of the ramps is required when there is need to make transition from underground to elevated section or viceversa. The length of ramp depends upon the slope of existing ground and gradient of the track adopted for the section of track. Three such ramps are provided on the both the corridors.

c. Land Requirement for Stations

The stations are mainly proposed on the road medians. The usual length of station is kept nearly 140m and width of 22m. However, the staircase is provided on both the sides of road. Passenger facilities as well as operational areas are provided at the concourse level.

d. Temporary Construction Depot

At times when construction work is in progress large quantities of material like reinforcing bars, cement, steel sections, shutters, pre-cast segments etc. are to be stored and sufficient land is required for storage of these materials. At the time of construction, depending up on the need the location and size can be reassessed and temporary land acquisitions can be made accordingly.

Since the area of land being acquired permanently at most of the stations is minimum. The land required for construction depots purpose are mainly acquired on the rent basis on lease temporarily.

e. Land Staff quarters, office complex and operation control centre

For this project, large number of officers and staff are required permanently to take care of project implementation and post construction operational activities. Moreover, metro office complex and metro operation control centre will also be required.

III. STRUCTURAL WORK

The various structural members used in the project are:

a. Foundation – The two types of foundation used are
   i. RC cast-in situ pile
   ii. Open square footing
b. Substructure- The single RC pier is used to support the super structure. This is covered with the barrier up to a height of 1m to prevent the crash.
c. Super-structure- The viaduct is provided as a supporting element along with the deck slab for the metro rail line

IV. SUB-STRUCTURE

- The viaduct for the rail will be supported on single RC pier. The shape of pier is kept circular for most of its section.
- The size of pier is limited to 1.8m to 2.0 m diameter of circular shape for most of its height so that it occupies the minimum space at ground level
- For the standard spans, the pier gradually widens at the top to support the bearing under the box webs.
- To prevent accidents and collision the Jersey shaped crash barriers are provided at an offset of 25mm from pier up to a height of 1m.
- The spacing of the elastomeric bearing is kept 1.8m to facilitate the placing of lifting jack for the replacement at any point of time.
- An outward slope of 1:200 will be provided at pier top for the drainage due to spilling of rainwater.

Depending upon the soil conditions, type of structure and imposed load the foundation mainly proposed is pile type except few locations where hard strata is close to ground.

- Pile foundation is a feasible foundation scheme that may be designed where the loadings are heavy/medium, upper strata are soft and depth of water table is less.
- For the prevailing soil conditions and type of structures, it was observed that shallow open footings could be provided at certain locations.

V. SUPER-STRUCTURE

The superstructure is chosen keeping in view the ease of constructability and the maximum standardization of the formwork for a wide span ranges.

The segmental construction has been chosen mainly due to the following advantages:

- The segmental construction method is efficient and economical when the span lengths are large. Structures with sharp curves and variable super elevation can be easily accommodated.
- It also permits the reduction of time of construction as segments can be manufactured in the factory yard even when the substructure work is proceeding and can be assembled rapidly after that.
- Segmental construction protects the environment as only space required for foundation and sub-station is required at site. The superstructure is manufactured at a place away from busy areas and placement of superstructure is done with the system erected from piers at heights.

Types of Superstructures

- Pre-cast segmental box girder using external unbounded tendon
- Pre-cast segmental U-Channel Superstructure with internal pre-stressing

VI. GEO-TECHNICAL INVESTIGATION

The six boring machines or rigs are used for excavating 80 bore holes on both the corridors. On corridor-1, 41 boreholes are made and on corridor-2, 39 bores are done at an average distance of 0.5m. The depth of drilling is extended up to a depth of 25m at some places.

In addition to this field, permeability test is also carried out in the same boreholes. Also the depth of ground water table is obtained at every hole.

Objective of Geotechnical Investigation

The main objectives of Geo-Technical Investigation are:

- To determine the strength characteristics of the underlying soil strata to design the foundation of the structure proposed to be constructed at various locations.
- To determine the subsurface profile of the underlying strata
- To decide the construction methodology

VII. CONSTRUCTION METHADOLOGY

For the elevated sections it is recommended to have pre-cast segmental construction for super structure for the viaduct. For stations also the superstructure is generally of pre-cast members. The pre-cast construction will have following advantages:-

•Reduction in construction period due to concurrent working for substructure and superstructure.

- For segmental, pre-cast element (of generally 3.0m length), transportation from construction depot to site is easy and economical.
- Minimum inconvenience is caused to the public utilizing the road as the superstructure launching is carried out through launching girder requiring narrow width of the road.
- As the pre-cast elements are cast on production line in a construction depot, very good quality can be ensured.
- The method is environment friendly as no concreting work is carried at site for the superstructure.

VIII. CONCLUSION

Final alignment for both the corridors is as below:

Alignment	Detail Route
Alignment-1 North-South Corridor (19.658 km, 17 Stations)	Automotive Square, along Kamptee Road, Wardha Road, Variety Square to Abhyankar Road, along Nag River alignment will fall on Humpyard Road, Rahate Colony Road, Wardha Road, Parallel to Railway Line, Khapri Station and finally in MIHAN Area
Alignment-2 East – West Corridor (18.557 km, 19 Stations)	From Prajapati Nagar, along Central Avenue Road, Railway Feeder Road, Munje Chowk, Jhansi Ranee Chowk, North Ambajhari Road, Hingna Road, Lokmanya Nagar

- Large amount of land is not required as the major portion of the track is elevated and only 02 stations are at grade.
- The foundation used is mainly pile foundation with 0.8 to 1.0m diameter and cutoff level at 1.5m to 2.0m depth below the existing ground.
- Various geo-technical investigations are carried out to find the preferred type of foundation, which concluded that cast-in situ RC pile is most suitable.
- Segmental method of construction is adopted for rapid and effective construction of project.

REFRENCES

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