

Study of Multilayered Mass Transit System of Nagpur City

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Abstract- Public transportation systems include a variety of transit options such as buses, light rail, and subways. These systems are available to the general public, may require a fare and run at scheduled times. A metro system is a railway transport system in an urban area with a high capacity, frequency and the grade separation from other traffic. Nagpur Metro is a new multilayered mass rapid transport system (MMRTS) developed in Nagpur, Maharashtra, India. The MRTS covers a total length of 38.21km and is estimated to cost Rs86.80bn(\$1.4bn). The Nagpur Metro encompasses two alignments, which include the north-south corridor and the east-west corridor. In this paper we come to know the various the constructional aspect and various techniques used in construction of Nagpur metro rail also we go through the procedure of material used, casting, construction method of pier and girder. This paper also explores the various some unique features of Nagpur metro rail like green metro, and safety precaution taken into Nagpur metro rail

Keywords- Metro Rail, Nagpur Metro, finance, Super Structure, Green Metro

I. INTRODUCTION

1.1 GENERAL

Multilayered Mass Rapid Transport System (MMRTS) comprises of one trip that involves two or more than two different modes of transportation like bus, metro, car, tram, etc.; either government or privately operated; where in-between passengers have to transfer in to other mode. Some modes of transportation have always been depended on other modes. Using these networks brings real benefits for citizens by saving their time and cost, and also greatly assists sustainable development of metropolis.

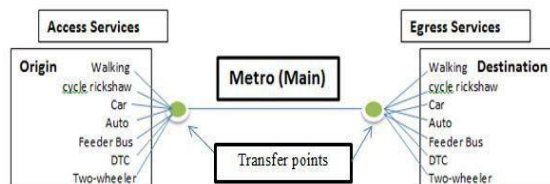


Fig 1: Schematic Outline of Multimodal Transport System (Metro as Main Mode)

Kolkata Metro is the first metro in India. The first metro service was inaugurated in Kolkata in 1984 by former Prime Minister Indira Gandhi. Delhi Metro was India's first modern metro which began its operation in 2002. Rapid Metro Rail Gurgaon, which started operations in November 2013, is India's first privately owned & operated metro. Nagpur Metro is an under construction rapid transit system for the city of Nagpur, India. Construction on the project began on 31 May 2015. The first trial run was conducted on a 5.6 km section between Mihan area and khapri station on September 30. The project is initiated in 2015 and the first two phases are scheduled to be completed by 2023. The project aim to reduce average travel time of commuters by around 50 percent.

II. LITERATURE REVIEW

A Kuppumanikandan, “Study on Major Elements of an Elevated Metro Bridge”

Conventionally the pier of a metro elevated bridge relies mostly on the ductility and the displacement capacity. It is important to check the ductility of such single piers. A parametric study on behavior of box girder bridges is carried out by using finite element method. The parameters considered to present the behavior of Single Cell Box Girder, Double Cell Box Girder and Triple Cell Box Girder bridges are radius of curvature, span length and span length to the radius of curvature ratio.

HarshitSoni “Critical Evaluation of Super Structure Construction for Metro Corridor”

Construction of Superstructure in a significant part of elevated viaduct construction and constitutes a major portion of cost, time and resources required for development of the project. Various different construction methodologies are available for construction of both Pier cap and Girder which have been critically evaluated selecting five major parameters for comparison. This document attempts to compare different methods on basis of afore mentioned criteria and identify the best possible technique for superstructure construction.

III. FINANCE FOR NAGPUR METRO PROJECT

The Nagpur Metro Rail Corporation (NMRC) has drawn funding from several channels at the state, Centre and international level for the Rs 8,860 crore project. The Nagpur Metro Rail project has received around 20 per cent funding from the Centre and an equal investment from the Maharashtra government, Nagpur Municipal Corporation provided around 5 per cent as did the Nagpur Improvement Trust. As much as Rs 4,000 crore has come from German-government owned development bank KFW. Rs 600 crore has come from French development agency AFD.

IV. ALIGNMENT, ROUTES AND GEOMETRIC FEATURES OF NAGPUR METRO

4.1(a) Horizontal Alignment

As far as possible, the alignment follows the existing roads. This leads to introduction of horizontal curves. On consideration of desirable maximum cant of 110 mm and cant deficiency of 85 mm on Metro tracks, the safe speed on curves of radii of 400 m or more is 80 km/h. On elevated sections minimum radius of 160 m has been used at one location having speed potential upto 40 km/h.

4.1(b) Transition Curves

Length of Transitions of Horizontal curves (m)
Minimum : 0.44 times actual cant or cant deficiency (in mm), whichever is higher. Minimum curve length between two transition curves: 25 m. Desirable : 0.72 times actual cant or cant deficiency, (in mm), whichever is higher.

4.1(c) Vertical Alignment

(i) Elevated Sections

The viaducts carrying the tracks will have a vertical clearance of minimum 5.5 m above road level. For meeting this requirement with the 'Box' shaped pre-stressed concrete girders, the rail level will be about 9.8 m above the road level. However, at stations which are located above central median, the rail level will be 13.5 m above the road level with concourse

(ii) Gradients

Normally the stations shall be on level stretch. In limited cases, station may be on a grade of 0.1 %. Between stations, generally the grades may not be steeper than 3.0 %. However, where existing road gradients are steeper than 2 %,

or for Switch Over Ramps gradient up to 4% (compensated) can be provided in short stretches on the main line.

(iii) Vertical Curves

Vertical curves are to be provided when change in gradient exceeds 0.4%.

4.2 RAIL SECTION

Keeping in view the proposed axle load and the practices followed abroad, it is proposed to adopt UIC-60 (60 kg. /m) rail section.

4.3 ROUTE ALIGNMENT

Nagpur Metro Rail Project will consist of 41.700 Km metro corridor, 40 stations and 2 Depots First at near Khapri station for north –south corridor, second at near Lokmanyanagar for east west corridor. The entire stretch will be divided into 2 alignments or corridors as follows:



Fig. Alignment of Nagpur Metro

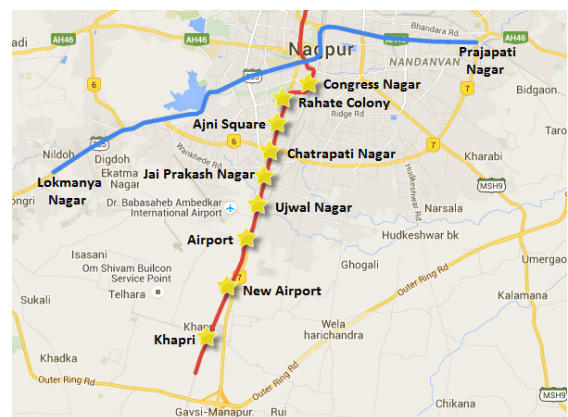


Fig.Route of Nagpur Metro North-South Corridor 1

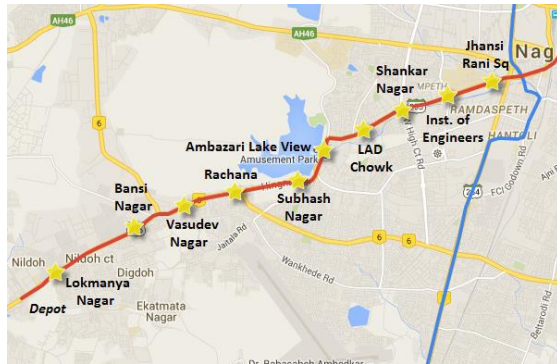


Fig. Route of Nagpur Metro East-West Corridor 2

V. SUPERSTRUCTURE OF NAGPUR METRO RAIL

Superstructure that part of the structure which supports traffic .All the parts of the bridge which is mounted on a supporting system can be classified as a Super structurewhich includes pier, pier cap, bearings ,beam or girder.

5.1Pier

Piers is raised structure typically supported by a well spaced piles piers can range in size .The height of pier used in metro is 8.971m.The purpose of the pier is to support the segments. Concrete /RMC with OPC (As per approved Design mix) , Inhibitor Coated Reinforcement Bar Fe 500are material used for construction of Pier.



Fig.Pier at Nagpur Metro Construction Site

5.2 Girders And Types Of Girder

•The simplest structural forms for bridge spans supported by an abutment or pier at each end. Types of girder used are I girder, Composite girder and Box girder.



Fig.I girder platform level



Fig.Reinforcement of I girder



Fig. Composite Girder



Fig. Composite Girder section at Ramzhoola, Nagpur



Fig. Segment of Box Girder

●Method of launching of Girder:

The method used for Launching of segment is by span by span method done by using launching gantry. This method is adopted where the long bridge deck is constructed. This method is most economical technique for erecting segmental bridge in the medium span range. This method offers a very high speed of construction. It can be used in conjunction with an erection truss under the bridge segment or an overhead erection gantry to guide the precast element into position.

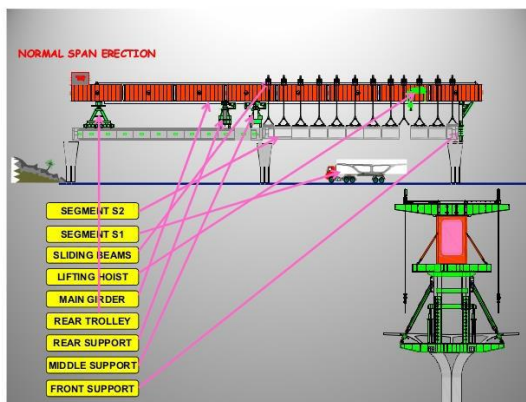


Fig. Erection by using span by span method

VI. NAGPUR GREEN METRO

Features of Green Metro

6.1. Green Initiative: -

- Nagpur Metro will be the pioneer in adopting and integrating solar energy generation right from the project planning and design stage to meet its energy requirements to the tune of 65% which will make it the “Greenest Metro”.
- All station roof-tops, depot boundary walls, depot shed rooftops and vacant ground spaces will be mounted with solar PV panels.

- In Phase - I, 14MW solar power is proposed to be generated which will rise to 36MW in future so as to meet 65% of the growing energy requirements of NMRCL.



Fig. Solar Panel

6.2 Green Building: -

- Nagpur Metro has been following the Green Building norms for environment protection in all its building design & construction to an optimum level so as to have an eco-friendly, low energy & low water consumption building and at the same time providing fresh & healthy environment to its occupants. Nagpur Metro has installed solar power panels on top of the buildings.
- Existing Metro House is generating 13 KWp and the under-construction Metro Bhawan shall be generating power 260 KWp



Fig. Green Building

6.3 Tree Plantation: -

On Forest Day, 4000 trees planted. Nagpur Metro is extending the programme creating “little wood” in that area.

- Bio Digester Technology: -



Fig .Bio Digester at Depot



Fig.Bio Digester Installation at Office Camp

- An apparatus in which organic waste material is decomposed by microbial (an-aerobic bacteria) action with the production of biogas. The system is sustainable, totally eco-friendly, conserves water and produces fuel gas.
- Nagpur Metro goes a step further towards making it the greenest Metro. NMRCL and DRDO (defence Research and Development Organization) signed a MoU for propagation and installation of “Bio Digester Technology”.
- Nagpur Metro is the first Metro in India to adopt this technology with an objective of keeping Eco friendly clean environment and make use of organic waste and waste water.
- MAHA-METRO wants 100% recycling of used water so that, not a drop of water is wasted.
- No discharge to public drain leading to elimination of ground water contamination.

6.4 Superior Project Management through 5D-BIM:

5D-Building Information Modelling (BIM) – IT based platform is proposed to be used to ensure tight control

over costs, time, quality and safety of the project for the first time. NMRCL would be a pioneer in this respect also. 5D BIM is a construction project management system in which the 3D computer automated designs (CAD) are linked with schedule (time) constraints and then with cost-related information.

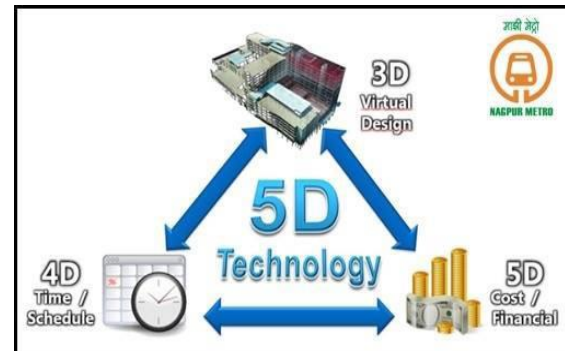


Fig.5D BIM Technology

5-D functionality can integrate design, cost, and schedule in a 3-D output.

Building information modeling (BIM) is a digital representation of the physical and functional characteristics of a project, forming a reliable basis for decisions during the project's life cycle.

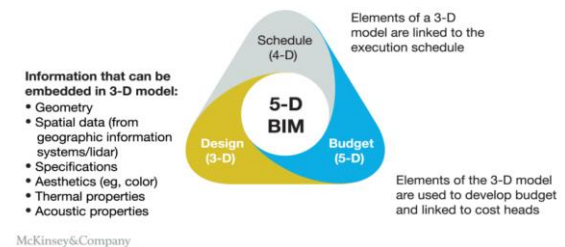


Fig. Concept of 5D BIM Technology

VII. CONCLUSION

By Studying collecting data about Nagpur Metro Rail System as Multilayered Mass Rapid Transit System, we can conclude that we can use Metro Rail system as a main mode of public transport because it facilitate quick ,safe and large number of people movement in a very economical manner .MMRTS of Nagpur City is eco-friendly as it reduce air and noise pollution .Use of advance 5D BIM Project Management technique made it more effective.

- We study about the constructional procedure of elevated Metro Rail of Nagpur City
- We study about Various technology adopted in Green metro
- We studied about construction methodology adopted in MMRTS Nagpur metro rail
- Precast girder will provide ease in construction
- The environment will be quite protected and sustained due to MRTS Nagpur metro.

- Nagpur metro MRTS will connect the residential area with the commercial area which will be an advantage for the worker as their accommodation is very expensive at a prime location.

There is a need for providing the such multilayered mass rapid transit system (MMRTS) to make public transport system most efficient for passengers in terms of time saving, energy consumption, reductions in accidents and reduction in traffic congestion during peak hours. But limitation for application of MMRTS are

- Initial cost of construction is high.
- Road blockages during construction period.
- The area under metro line and metro station blockage the sky i.e area under shadow.
- Large number of trees need to cut down due to construction of Metro . Afforestation and Rehabilitation of trees are not enough to compensate the environment hazard.
- Electricity consumption is high as a green metro but all electricity requirement not fulfill by only solar system ,require to use other source(Thermal Power).

VIII. FUTURE SCOPE

MMRTS allows larger number of people to travel from one area to the other area in the predetermined time. Nowadays, pollution has become main concern for the Government as different ways are being explored to reduce the pollution problems .The MMRTS helps in low energy consumption, is eco-friendly (runs on electricity, thus minimising air and sound pollution), 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.Therefore ,Laying of track and track geometry, Design of Double Decker, Design and detail construction methodology of metro stationetc can be further studied

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