Abstract

Project Brief:
Hyderabad is located in the state of Telangana with a MSL of 536m, spreading over an area of 650 SqKm. With the increase in population & lack of efficient, reliable & comfort public transport system the state government has decided to build a rapid mass transport system.

Project Scope
Construction of 72.1 Km Elevated Mass Transit System including 61 Stations & 3 Depots

Highlights:
• Largest Metro Project in the world to be developed in PPP format
• First Integrated Metro + Transit Oriented Development Project – Seamless Commute
• Shortest Construction period for 72 km stretch – 5 years
• First Communication Based Train Control (CBTC) system to be used in India
• State-of-the-Art Rolling Stock with high Regeneration of Power
• Largest Precast yard in India
• Largest Single Urban Development Project in India
• Largest Investment made by L&T in one single City

Construction Challenges & Risks:
• Approval from Government Authorities
• Right Of Way Availability Including Property Clearances
• Utility Identification & Relocation
• Political Scenarios / Change in Government
• State Bifurcation- Telangana and Andhra Pradesh
• Narrow Stretches and Traffic Management Plan
• Interface Management

Few Innovations in the project
• Precast RCC portal
• Key benefits
• Design
• Construction Sequence
• Hinged Launching Girder
• Key benefits
• Achievement

Learnings and take aways from the project
• Optimal mobilization
• Construction methodology
• Precasting
• Logistics Planning
Project Brief - Hyderabad is located in the state of Telangana with a MSL of 536m, spreading over an area of 650 SqKm. With the Increase in population & lack of efficient, reliable & comfort public transport system the state government has decided to build a rapid mass transport system.

Need for Rapid Mass Transport System -
§ Absence of hierarchy of roads
§ Wastage of carriage way & encroachment of sidewalks
§ Not so effective Traffic Safety Measures
§ Heavy traffic volumes in major cities
§ 70% of the road network operates in highly congested areas

Project Scope -
Viaduct
• 72.1 km elevated viaduct
• 2775 Nos. Piers and Foundations
• Precast Yards at Uppal and Balanagar to cast 27000 box segments
• 8 Nos. of ROBs

Stations & Depots
• 55 Nos. Standard Stations and 3 nos. Special Stations
• 3 Interchange Stations located at Ameerpet, MGBS and Parade Grounds
• 3 Depots at Uppal, Miyapur and Falaknuma (Concept stage)
• Architectural Finishes and MEP Works for Stations & Depots

Track work & Traction
• 151 km of Ballastless Track (Viaduct and Stations)and 15 km of ballasted/ballastless track (Depots)
• 166 km Overhead Electrification including installation of Masts/Drop arms/uprights, brackets, conductors

Power Supply & SCADA
• 4 Receiving Substations (RSS)and 68 Auxiliary Substations (AS)
• 500 km Cabling between Grid Substation, RSS and AS
• Supply and Installation of SCADA System

PROJECT HIGHLIGHTS
§ Largest Metro Project in the world to be developed in BOT format
§ First Integrated Metro + Transit Oriented Development Project – Seamless Commute
§ Shortest Construction period for 72.1 km stretch – 5 years
§ First Communication Based Train Control (CBTC) system to be used in India
§ State-of-the-Art Rolling Stock with high Regeneration of Power
§ Largest Precast yard in India
§ Largest Single Urban Development Project in India (18.5 M Sft)
§ Largest Investment made by L&T in one single City

GENERAL ALIGNMENT

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CHALLENGES & RISKS

§ The Project moves through narrow lanes of the city and construction activity is right in the center of the road and thus posing many a risk from the construction point of view.

§ Once the alignment is frozen, there is a major challenge to divert the underground and over ground utilities or acquiring land by demolition of properties.

§ After the receipt of Right of Way (ROW), we have to prepare a detailed Traffic Management Plan (TMP) which is submitted to Traffic Authorities for their approval.

§ In the TMP plan we indicate, existing traffic flow and/or diversion of traffic route, road widening plans, alternate roads, road strengthening works etc.

§ On approval of the TMP only the barricading works can commence. We are allowed to barricade 4 m on either side of the median leaving space for 2 lanes on either side or 1-1.5 lanes on either side in case the roads are narrow.

§ The barricading boards are tightly secured and only a select few places the openings are provided for the men and machinery to move. Wherever, such openings are provided, Traffic Marshals are deployed to manage the traffic. These marshals are trained under the Traffic police. Similarly these marshals are deployed at Junctions and U-turns which come just at the end of the barricaded area.

§ Also, most of the material movement especially segments are carried out at night between 11 PM and 6 AM. Thus, meticulous logistic planning is the key to the success of the Project.

INNOVATIONS

PRECAST PORTAL BEAMS

Precast RCC Portal

In Elevated Metro’s Portal piers are unavoidable for providing clear carriage way and for smooth traffic flow.

In Indian scenario cast-in-situ portal beam for Metro’s is relatively costly and moreover shuttering arrangement will further reduce the existing carriage way, also it is most vulnerable to accidents. This reduces the cycle time compared to cast-in-situ option.

Scope Details

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Brief

§ It is composite system combination of precast and cast in place concrete.

§ The 3 major elements are:

§ Cast-in-situ pier & foundation;

§ Precast RCC U-Trough which acts as form work for cast in place concrete

§ Cast-in-situ Concrete fill.

§ The precast beam is connected to cast in place concrete through interface shear reinforcement and roughed surface of precast U girder.

§ The precast beam will be casted at casting yard and same will be erected at site with two supports near to portal legs. Then sequence of casting the connection of portal leg and beam as cast-in-situ will be followed

Design Concept

§ Linear 3-D analysis is carried out for portal pier in stages based on the anticipated loading on the beam in different stages of construction as well as in service condition viz.-self-weight of U trough during lifting condition, Self-weight of cast in situ concrete + U trough supported by U trough, In service condition as a composite member.

§ The section is checked for strength and serviceability stage wise as U trough in construction stage and composite beam during service condition.

§ Assuming de-bonding at the cast in situ & precast concrete interface during seismic loading condition, the flexural capacity at support is calculated considering composite beam
whereas the same is calculated using cast in place contribution at the span. The interface shear reinforcement is calculated by assuming total de-bonding between the cast in situ & precast concrete.

**Construction Sequence**

§ Preparation of bed & General arrangement of Casting Bay
§ Shuttering
§ Acceptance and Stacking of Reinforcement
§ Cutting & Bending of Reinforcement
§ Transportation of Reinforcement
§ Placing of Reinforcement
§ Pouring of concrete
§ Construction Joint Preparation
§ De shuttering and Curing
§ Lifting and Stacking
§ Minimum strength of concrete during erection of precast girder shall be 45MPa

**Conclusion**

§ Getting clearance from concern authority to obstruct traffic for construction is matter of concern in Indian cities where most of the metro rail projects belongs.
§ The precast portal beam proposed here not only mitigates the effects of traffic diversion, but also a new concept which can offer a breakthrough in construction technology method involving fast and efficient construction with good quality control.

**Pros**

§ Time saving
§ Minimum Form work required
§ Free flow to traffic

**Cons**

§ Large area required for preparing the soffit bed & stacking the elements.
§ Mobilization of medium capacity (75T 2 Nos) cranes for lifting
§ High accuracy in casting is required.

**HINGED LAUNCHING GIRDER**

Construction of precast segmental viaduct spans from 19m to 31m with 128m Radius of curvature in Hyderabad metro rail project.

§ Hinged Launching Girder – 74m Long girder with hinge module of 4.0m length between the modules S2 and S3, and is supported by rear trolley, front support, middle support and rear support.

§ Further to the supports it has 12 numbers of segment trolleys and counter weight of 66 MT, for the erection of span from 19m to 31m with 128m Radius of curvature®

§ Methodology adopted can be applied to any precast segmental span ranging from 19m to 31m with radius of curvature 128m across the company.

§ This is the first time that L&T has used Hinged Launching Girder and has completed the erection of 8 spans in the 128 radius curvature from January, 2016 to March, 2016.

For the previous curvature of 128 radius stretch, the method of splice removing was adopted which requires an additional support which is taken from ground externally.

§ But, at pier location Parade Ground to Secunderabad (40-32) due to the heavy traffic flow the additional support cannot be accommodated on the ground. So, the method
of using Hinged Launching Girder was adopted in this case.

Key Factors

§ Erection of 34m span with a curvature of 250m
§ Erection of span ranging from 19m to 31m with a curvature of 128m.
§ One of the main reasons for introduction of hinge in LG was to avoid the extended ground support to support LG on rear side. This facilitates smooth traffic flow below the span erected.
§ Cycle time achieved is 6 days per span with 128mR which is very less compared to conventional systems.
§ Reduction in Labour cost and Machinery was achieved, when compared with Conventional LG.

Achievements

§ Innovative design of LG with hinge module plays a major role in the project duration in terms of erection of span with radius of curvature less than 300mR and without any need for traffic approval.
§ Additional requirement of External trestle has been avoided; hence structural steel requirement of 15mt and usage of cranes/machinery can be avoided, which is a way of savings in cost aspect also.

LEARNINGS

§ Optimal Mobilization plan to suit actual scenario at Site
§ Appropriate Construction Methodology so as to cause minimal inconvenience to general public.
§ Maximize Pre-casting and judicious selection of Pre-cast Yards.
§ Smart Logistics Planning to sync with Pre-casting and Erection.
§ Advance probing, identifying & mapping the existing utilities.
§ Proactive interaction with Traffic authorities for obtaining TMP clearances.
§ Interface Management between different stakeholders from design to commissioning stage.
§ Identifying training needs for staff working in specialized activities.

CONCLUSION
§ The case study deals with challenges involved in the construction of Elevated Metro considering safety and traffic aspects since the work is undertaken right at the centre of the road. The construction methodology adopted has to be in sync with public safety.
§ The success of the Project depends on the speed of handing over of Right of Way. The Right of Way is again depended on shifting of any encumbrances such as underground and over-ground utilities and demolition of properties, if any.
§ At HMRP, we have maximised pre-casting so that less of staging work happens on the road. Further, Station is designed to rest on single row of 10 piers and the box designed as a balanced cantilever. The reduction in the number of piers and foundation has actually helped to speed up the job vis-à-vis traditional approach and in a way helped in reducing public inconvenience.

VIADUCT PHOTOGRAPHS

Portals
INSITU SPAN STAGE 2
STATION BOX ERECTION

NAGOLE STATION
POWER SUPPLY AND SCADA

UPPAL RSS

YUSUFGUDA RSS