L&T Construction
Heavy Civil Infrastructure

Category: Use of Path-breaking Construction Equipment

Winner

Mumbai Trans Harbour Link – P1

Sustainable Launching Girder for 60 m Span Segmental Bridge Construction

By L&T Construction, Heavy Civil Infrastructure IC-CMPC

Project Name	Mumbai Trans Harbour Link – Package 01 (MTHL-01)
Date of Commencement	23rd March, 2018
Date of Completion	30th September, 2023
Project Cost	₹7,637.3 Cr
General Consultant	AECOM, PADECO, Dar al-handasah & TY Lin International

The Mumbai Trans Harbour Link, also known as the Sewri–Nhava Sheva Trans Harbour Link, (officially Shri Atal Bihari Vajpayee Trans Harbour Link) is an under-construction 21.8 km 6-lane access-controlled expressway grade road bridge, which will connect Mumbai with Navi Mumbai, its satellite city. When completed, it would be the longest sea bridge in India. The bridge will begin in Sewri, South Mumbai, will cross Thane Creek north of Elephanta Island, and will terminate at Chirle near Nhava Sheva. The road will be linked to the Mumbai–Pune Expressway in the east and to the under-construction Coastal Road in the west. The 6-lane highway will be 27 m in width, in addition to two emergency exit lanes, edge strip and a crash barrier.

The Heavy Civil Infrastructure Business of L&T Construction is building Packages 01 & 03 of the 21.1 km Mumbai Trans Harbour Link that will connect Mumbai to Navi Mumbai and the Nhava Sheva Port. In Package 1, we are constructing a multi-level interchange at Sewri and a 6-lane marine bridge from Sewri to 10.38 km into the Mumbai bay while Package 3 involves the construction of a 3.6 km, 6-lane land bridge at Navi Mumbai including interchanges, rail over-bridges and toll plazas. The project is being executed in partnership with IHI Corporation, Japan and a highlight is the construction of an Orthotropic Steel Deck.

Special Technology and Equipment

Considering the current global warming effects, sustainability cannot be avoided in the construction field as the main idea is to accelerate the construction and provide a healthy socio-economic benefit to the world. Also, it promotes energy efficiency, waste reduction, and reusing. Keeping this in mind, an idea of conceptualising erection of a 7-span continuous by bottom feeding for 60 m spans in Marine using enhanced existing Launching Girders of 3.5 m depth with 1400MT design capacity comes to mind. Designing of such a 'path breaking equipment' considering the current Marine scenario and environmental contingencies, fitting into the window of sustainability, existing Launching Girders were identified. In the marine alignment from 6.078 km to 10.38 km (from MP81 to MP148),

Fig. 1: Marine Launching Girder during Load Test

67% of the span erection in marine was successfully completed using sustainable Launching Girder with the application of enhanced design of torsional rigidity within the deadline as promised.

Challenges Faced in Construction

Following are the major concerns which arose during the design conceptualization for erection of segments in Marine:

Design Constraint

- Existing Launching Girders (of 3.5 m depth) having a capacity of 45 m span erection to suit 60 m span erection without modifying the Girder depth.
- Requirement of the Girder to be tested with 110% loading at Marine conforming to IRC:SP:51.
- Increased launching length of 65 m as compared to the existing 47 m launching length.
- Long unsupported length for launching/erection demanded for higher Girder depth upto 5.5 m.
- Challenge of erecting pier-head segment at the front nose tip of Launching Girder.
- Design changes impacting longer cantilever lengths of the Launching Girder causing more challenges during assembly and erection at open sea and also at 33 m height of tall pier locations.
- Control of Torsion during eccentric lifting from the boxes (in same line with the lifting holes).
- Control of Launching Girder deflection due to long span segmental erection.
- 50 m lifting height of overhead gantry demanded to lift the segment from bottom of barge.
- Segment passing on top of the Launching Girder Boxes.
- Placing of Supports on the web of the segments with 2.5% deck gradient.

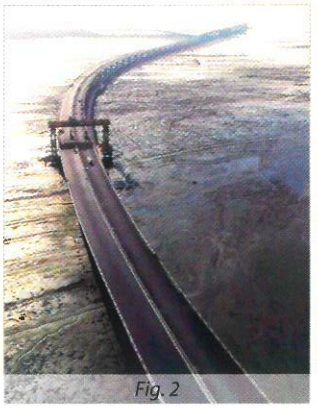
Fig. 2

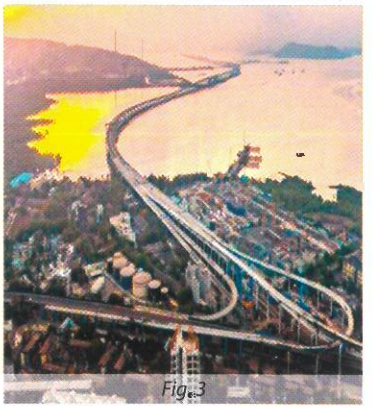
Fig. 3

Overall Completed View of MTHL-01 Project

Fig. 4: Assembling of Launching Girder at 33 m Height near Pirpau Jetty

Location Constraint - Presence of Pirpau Jetty Closer to Pile Cap

- Starting point of the Launching Girder assembly was planned closer to Pirpau Jetty (Jetty for liquid gas pipelines) location; stringent safety measures were followed while testing the Launching Girder at that location.
- Size of the barge and segment positioning on barge to fit in the available space between torsion beams.
- Segment feeding barges subjected to lower drafts due to low tides needing additional lift of height from the overhead gantry.
- Positioning of segment feeding barge was a challenge due to sea rolling effect when the speed of the wind exceeds 10 kmph.
- Transportation of manpower from shore to the location via boats required 3 hours travelling time (up and down).
- Working height on top of the erected Launching Girder – 43 m (on top of Over-head Gantry, it is 55 m) and pier height is 33 m absorbing larger wind effect and created more challenges.
- Heavy monsoon, unforeseen cyclones, gusty coastal winds and rough atmosphere at open sea marine location.

Manpower/Skills and Equipment

- Due to open sea and remote location, skilled manpower was required to operate the Launching Girder with more safety and less occurrence of errors during the operations.
- Demand of skilled labourers available in the market.
- Only 250 MT Crane Jack barge was available to work in the marine which caused a major constraint to limit the design of Launching Girder boxes with weight at taller heights of assembly /erection.

Innovative Materials and Technology

Understanding the above constraints and nature of location, the following approaches were made to provide a sustainable Launching Girder at Marine location:

- Addition of 3 new boxes with the same Girder depth of 3.5 m to suit 60 m span erection was introduced conforming to design capacity, bending moment and deflection of the profile.
- Demand of design requirement for longer length of Launching Girder was made feasible by providing detailed erection & assembly schemes using 250 MT Cranes.
- Introduction of torsion boxes in between the twin boxes to sustain lateral torsion and make 3.5 m deep Box girder workable and more efficient.
- Proposed engineering technique by providing Roller at support locations instead of PTFE Sheets.
- Automated Hydraulic system for pin pushing while auto-launching.
- Increase in height of existing Overhead gantry for segment shifting above Launching Girder.

Salient Features

Design Adopted/Solutions

1. Considering the higher bending moment/larger deformation for a 60 m span, 3 new boxes were added to suit 60 m span length and the individual box weights were considered for easier assembling with use of available 250 MT Crane.
2. Introduction of a torsion box in-between for a 60 m span thus reducing the lateral torsion buckling during the erection of segments eccentrically (in the same line with the lifting holes) to the boxes.
3. In order to avoid change in Launching Girder box sections with 3.5 m depth finite element analysis were done with moving load and made it successful for the acceptance of existing Launching Girder box sections.

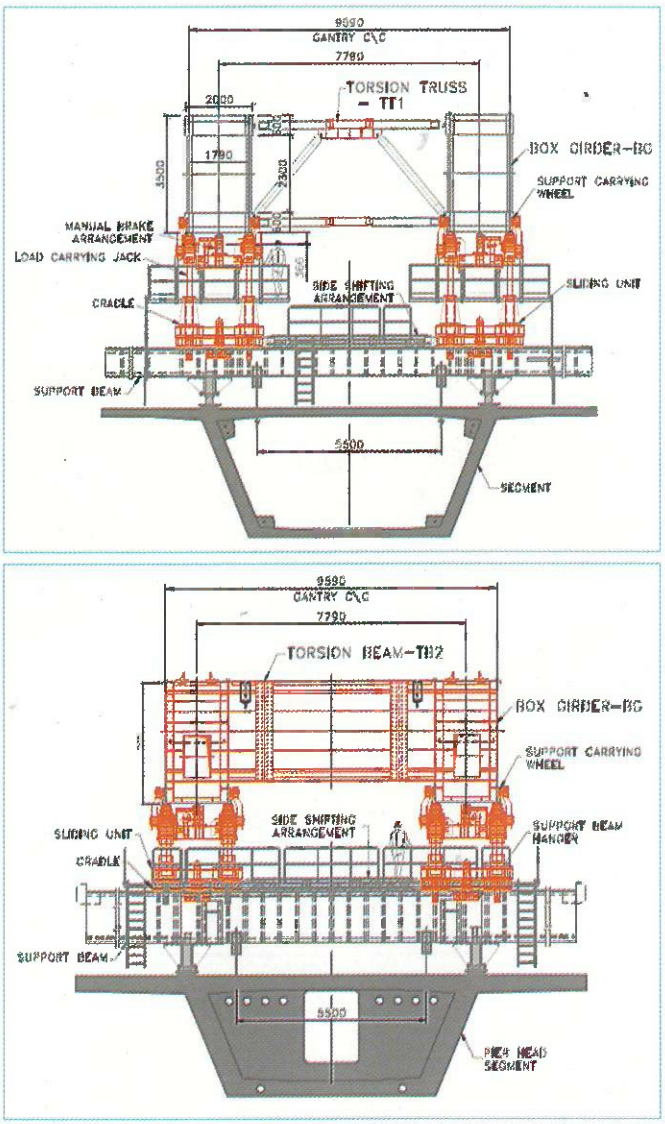

Fig. 5: Launching Girder - Cross Section of Boxes & Nose Girder with Torsion Beam

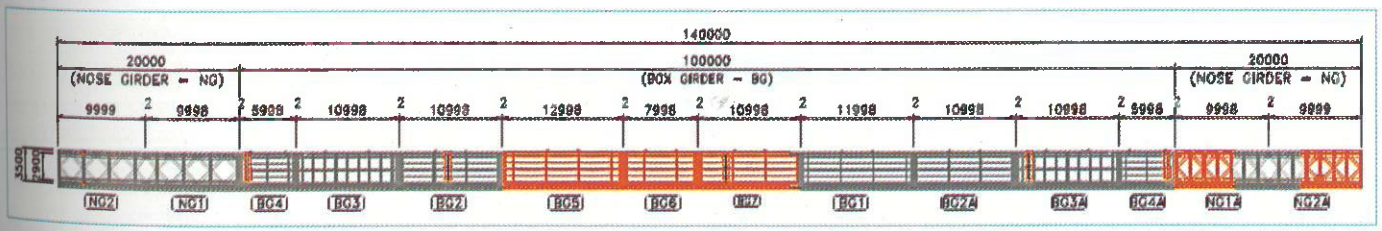

Fig. 6: Elevation of Launching Girder - Length of 140 m

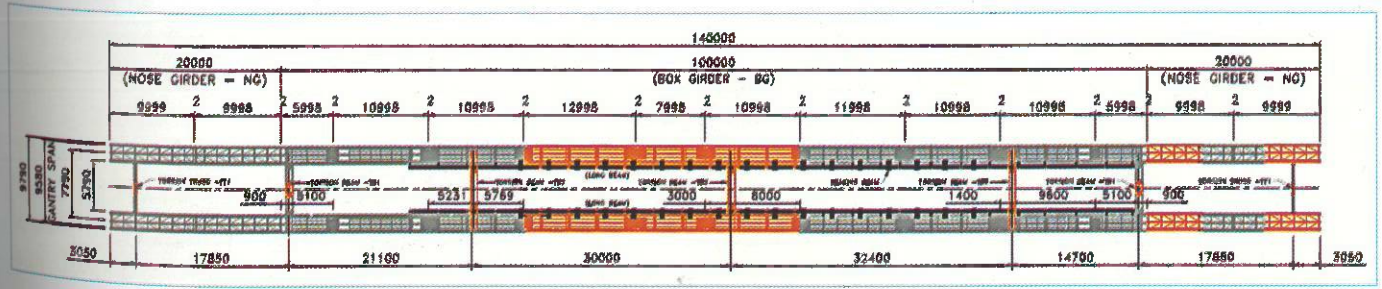

Fig. 7: Plan of Launching Girder - Twin Truss of 7.79 m

67% of the span erection in marine was successfully completed using sustainable Launching Girder with the application of enhanced design of torsional rigidity within the deadline as promised.

Challenges Faced in Construction

Following are the major concerns which arose during the design conceptualization for erection of segments in Marine:

Design Constraint

- Existing Launching Girders (of 3.5 m depth) having a capacity of 45 m span erection to suit 60 m span erection without modifying the Girder depth.
- Requirement of the Girder to be tested with 110% loading at Marine conforming to IRC:SP:51.
- Increased launching length of 65 m as compared to the existing 47 m launching length.
- Long unsupported length for launching/erection demanded for higher Girder depth upto 5.5 m.
- Challenge of erecting pier-head segment at the front nose tip of Launching Girder.
- Design changes impacting longer cantilever lengths of the Launching Girder causing more challenges during assembly and erection at open sea and also at 33 m height of tall pier locations.
- Control of Torsion during eccentric lifting from the boxes (in same line with the lifting holes).
- Control of Launching Girder deflection due to long span segmental erection.
- 50 m lifting height of overhead gantry demanded to lift the segment from bottom of barge.
- Segment passing on top of the Launching Girder Boxes.
- Placing of Supports on the web of the segments with 2.5% deck gradient.

Fig. 4: Assembling of Launching Girder at 33 m Height near Pirpau Jetty

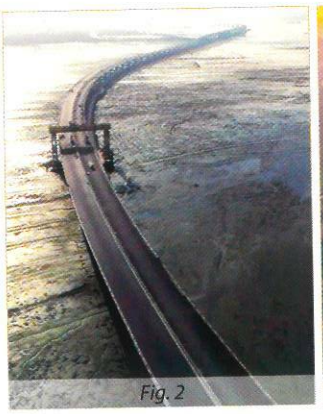
Fig. 2

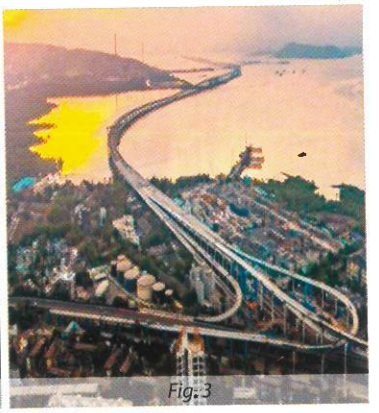
Fig. 3

Overall Completed View of MTHL-01 Project

Location Constraint - Presence of Pirpau Jetty Closer to Pile Cap

- Starting point of the Launching Girder assembly was planned closer to Pirpau Jetty (Jetty for liquid gas pipelines) location; stringent safety measures were followed while testing the Launching Girder at that location.
- Size of the barge and segment positioning on barge to fit in the available space between torsion beams.
- Segment feeding barges subjected to lower drafts due to low tides needing additional lift of height from the overhead gantry.
- Positioning of segment feeding barge was a challenge due to sea rolling effect when the speed of the wind exceeds 10 kmph.
- Transportation of manpower from shore to the location via boats required 3 hours travelling time (up and down).
- Working height on top of the erected Launching Girder – 43 m (on top of Over-head Gantry, it is 55 m) and pier height is 33 m absorbing larger wind effect and created more challenges.
- Heavy monsoon, unforeseen cyclones, gusty coastal winds and rough atmosphere at open sea marine location.

Manpower/Skills and Equipment

- Due to open sea and remote location, skilled manpower was required to operate the Launching Girder with more safety and less occurrence of errors during the operations.
- Demand of skilled labourers available in the market.
- Only 250 MT Crane Jack barge was available to work in the marine which caused a major constraint to limit the design of Launching Girder boxes with weight at taller heights of assembly /erection.

Innovative Materials and Technology

Understanding the above constraints and nature of location, the following approaches were made to provide a sustainable Launching Girder at Marine location: