

Design of Temporary Access Bridge: Structural Design, Analysis, and Construction Methodology of a Steel Trestle System over the Vaitarna River

Chandandeo Prasad¹

¹Department of Civil Engineering, School of Engineering and Technology, Shri Venkateshwara University, U.P., India

Abstract - Temporary access bridges play a critical role in large infrastructure projects, particularly in difficult terrain and water-crossing conditions. This dissertation presents a detailed study on the design, analysis, and construction methodology of a temporary access bridge over the Vaitarna River, Maharashtra, which forms part of the Mumbai-Ahmedabad High-Speed Rail corridor works. The study covers structural design considerations, load analysis, foundation system selection, stability checks, and construction sequencing of steel trestle-type temporary bridges. It focuses on the behaviour of steel modular trestle systems, pile-supported foundations, and deck systems subjected to construction loads including cranes, vehicles, and dynamic environmental forces such as wind and river flow. Design is carried out using relevant provisions of IRC, IS codes, and FHWA temporary works guidelines. The work also evaluates safety considerations, failure mechanisms, and cost-effectiveness of temporary access bridges compared with conventional access methods.

Key Words: temporary access bridge, steel trestle system, pile foundation, construction loads, structural stability, Vaitarna River.

1. INTRODUCTION

Temporary access bridges are construction-stage structures that support the movement of equipment, materials, and workforce to otherwise inaccessible sites during the construction of permanent bridges. This is particularly critical for large infrastructure corridors that cross rivers, marshy land, or flood-affected terrain, where conventional access is unavailable for most of the construction period.

This study addresses the design, analysis, and construction methodology of a steel trestle-type temporary access bridge over the Vaitarna River, Maharashtra, built to support works on the Mumbai-Ahmedabad High-Speed Rail corridor. The objectives are to (i) study the design methodology of temporary access bridges, (ii) analyze structural behaviour under construction-stage loads, (iii) design a steel trestle system for the Vaitarna site, and (iv) evaluate safety and stability under dynamic construction loads. The scope is limited to a pile-supported steel trestle bridge under construction load cases only.

2. LITERATURE REVIEW

Temporary works significantly influence the safety, cost, and methodology of bridge construction, and poor design of these stage structures is a recurring cause of construction-phase failures. Steel trestle bridges are widely used modular systems for temporary access in both construction and emergency scenarios because they can be erected quickly and reused across sites.

- Construction sequence strongly affects structural stability during erection.

- Temporary works require independent design verification rather than being treated as incidental to the permanent works.
- Failure risk rises sharply where erection stages are not explicitly checked for stability.

3. TEMPORARY ACCESS BRIDGE SYSTEM

The system adopted comprises steel pipe piles, steel cap beams, longitudinal girders, deck plates or timber decking, and a bracing system, with loads transferred along the path deck → girders → cap beams → piles → soil. Advantages over conventional access methods include fast erection, reusable components, modular construction, and suitability for water crossings.

4. SITE STUDY - VAITARNA RIVER

The site lies on the Vaitarna River, Maharashtra, and is characterised by variable, flood-affected river width, soft alluvial soil, a high groundwater table, and seasonal flooding. Construction is further constrained by marshy terrain, limited working space, and environmental restrictions, all of which favour a fast, modular access solution over conventional methods.

5. DESIGN LOADS AND METHODOLOGY

Design loads were assessed in accordance with IRC:6-2017, IS 800:2007, and FHWA temporary-works guidance, and comprise dead load (steel self-weight and deck system), live load (construction vehicles and cranes of 100-200 kN axle load), and environmental loads (wind, water current, and debris impact). Governing load combinations were DL+LL, DL+LL+Wind, and DL+construction impact load.

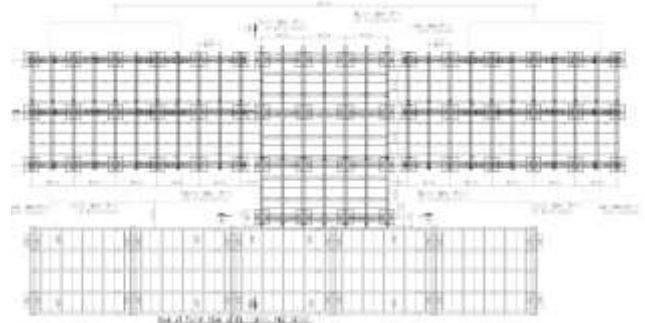


Fig -1: Typical cross-section of the 12.00 m deck width

6. STRUCTURAL ANALYSIS AND DESIGN OF COMPONENTS

The finger platform (deck) was modelled and analysed for the governing construction vehicular load cases: side lifting and front lifting of a 150 MT crawler crane, marching of a BG38 vehicle, and movement of 70R loading. Crane loads were

idealised from crawler geometry (effective crawler length ~ 7.17 m, width ~ 1.07 m, self-weight 168 T) and restricted to a design maximum lift of 14 T at a 28 m operating radius, consistent with the crane's rated capacity chart.

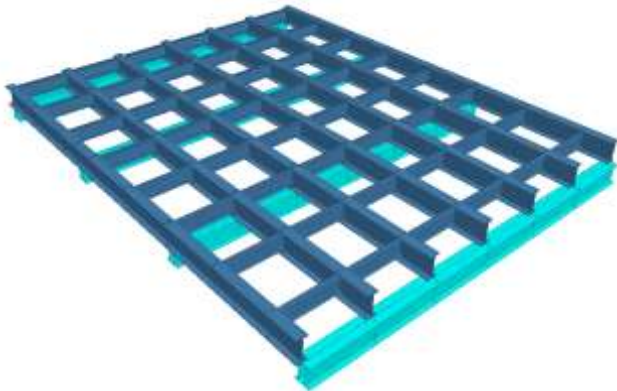


Fig -2: 3D structural model of the finger platform

Wind loads were derived per IRC:6-2017 Cl.209 (basic wind speed 44 m/s at the bridge location, gust factor $G = 2$), giving a transverse wind force of about 3.16 kN/m on the superstructure, with the longitudinal component taken as 25% of the transverse value. Water current load was computed per IRC:6-2014 Cl.210 for a design current velocity of 3.5 m/s, giving a transverse load of about 4.2 kN/m applied on the piles up to the drying height.

Reactions were extracted from the STAAD model for each crane-lifting case (side lifting and front lifting, at 90-degree and edge/centre positions) and used to derive the ground pressure distribution under each loading configuration.

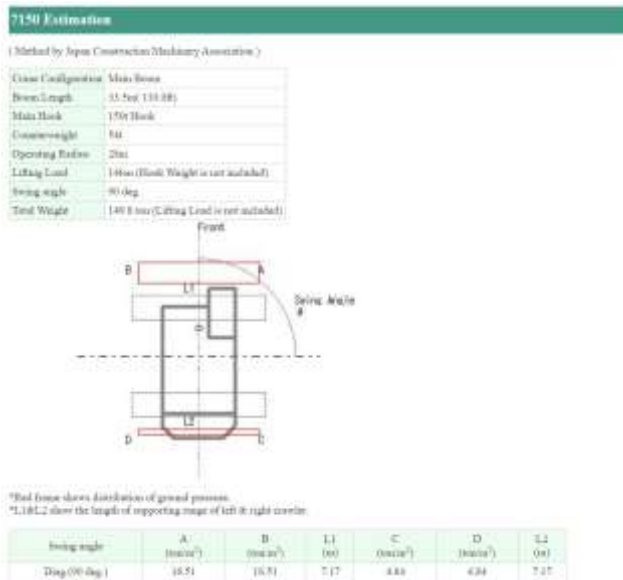


Fig -3: Ground pressure distribution - side lifting of 150 MT crawler crane over deck (14 MT)

The results show that front-lifting cases governed the peak ground pressure compared with side-lifting cases, and this pressure envelope was subsequently used to verify pile and cap-beam adequacy.

7. FOUNDATION DESIGN

7.1 Pile Foundation

- Steel pipe piles driven into the riverbed.
- Axial and lateral load capacity checked against the governing load combinations.

7.2 Design Considerations

- Scour depth at the pile location.
- Soil bearing capacity of the alluvial riverbed.
- Buckling of the pile under axial construction load.

8. CONSTRUCTION METHODOLOGY

8.1 Construction Sequence

1. Site clearance
2. Pile driving
3. Cap beam installation
4. Girder erection
5. Deck placement
6. Bracing installation

8.2 Equipment Used

- Crane
- Vibro hammer
- Excavator
- Launching girder system

9. STABILITY AND SAFETY ANALYSIS

- Global stability during erection is the critical design case, governing over in-service checks.
- Temporary bracing largely governs safety against lateral instability.
- Key failure modes checked: buckling of piles, overturning, and joint failure.

10. CASE STUDY DISCUSSION (VAITARNA RIVER)

The Vaitarna River case study demonstrates the importance of access trestles in mega infrastructure projects, the need for fast modular construction in flood-prone terrain, a high dependency on local soil conditions in governing the foundation design, and the critical enabling role such structures play in permitting the main bridge construction works to proceed.

11. CONCLUSIONS

- Temporary access bridges are essential enablers for large river-crossing infrastructure projects.
- Steel trestle systems provide an efficient, reusable, and rapidly erected solution for construction-stage access.
- Proper design verification of temporary works is as important as that of the permanent structure.
- Safety during construction stages, particularly against instability during erection, is critical and must be explicitly checked rather than assumed.

REFERENCES

1. IRC:6 - Standard Specifications and Code of Practice for Road Bridges: Loads and Stresses
2. IS 800:2007 - General Construction in Steel - Code of Practice
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