

Retrofitting of Balance Cantilever Narmada River 1ST Bridge Through Slab, Pier Cap And Bearing Replacement

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Abstract- *The present study deals with the retrofitting and rehabilitation of the first balanced cantilever bridge over the Narmada River through slab replacement, pier cap strengthening, and bearing replacement. Due to aging, increased traffic loading, and environmental effects, the existing bridge components showed deterioration affecting structural performance and serviceability. To restore the bridge capacity and extend its service life, a detailed structural assessment and retrofitting methodology were carried out.*

The bridge consists of a total length of 1360 m with 14 spans of 100 m each. Structural analysis was performed using MIDAS Civil software considering dead load, live load, wind load, braking load, temperature effects, and seismic forces as per relevant IRC provisions. Dynamic analysis using the response spectrum method was also conducted to evaluate seismic behavior. The proposed retrofit method involved replacement of the existing slab and bearings while retaining the foundation and pier system.

The results showed a reduction of approximately 1000 tons in superstructure dead load, which significantly reduced the load on the substructure and improved overall bridge performance. The study concludes that the proposed retrofitting approach is economical, safe, and effective compared to complete bridge reconstruction, while ensuring enhanced durability and extended service life.

Keywords: Bridge Retrofitting, Balanced Cantilever Bridge, Slab Replacement, Bearing Replacement, Pier Cap Rehabilitation, MIDAS Civil, Seismic Analysis, Structural Strengthening.

I. INTRODUCTION

Bridges are vital components of transportation infrastructure, providing connectivity across rivers, valleys, and urban obstacles. With increasing traffic demand, environmental exposure, and aging of structural components, many existing bridges require timely repair, rehabilitation, and

strengthening to maintain safety and serviceability. Retrofitting of bridge structures has become an important engineering solution to restore load-carrying capacity, improve durability, and extend the service life of aging bridges.

The balanced cantilever bridge over the Narmada River is one of the significant bridge structures carrying major traffic movement between Bharuch and Ankleshwar. Over time, deterioration of structural elements such as the deck slab, pier cap, and bearings may occur due to repeated live loading, environmental effects, material aging, and lack of maintenance. Such deterioration can lead to increased deflection, reduced structural efficiency, and potential safety risks.

In the present study, emphasis is given to the retrofitting of the bridge through slab replacement, pier cap strengthening, and bearing replacement. A detailed structural analysis is carried out using MIDAS Civil software by considering dead load, live load, wind load, braking load, temperature effects, and seismic forces in accordance with relevant IRC codes. The objective is to improve the structural performance of the bridge while minimizing construction cost and traffic disruption.

The proposed rehabilitation approach aims to reduce the dead load on the existing substructure, enhance durability, and increase the service life of the bridge without complete reconstruction. The study demonstrates that selective retrofitting of critical components is a cost-effective and technically feasible solution for long-span bridge rehabilitation.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

The present research idea was identified from the need for repair, rehabilitation, and retrofitting of aging bridge structures, as discussed in the thesis. The first balanced cantilever bridge over the Narmada River was selected as the study structure due to its structural importance and the

observed need for slab replacement, pier cap strengthening, and bearing replacement.

To develop the research concept, an extensive review of published literature and previous studies related to bridge retrofitting was carried out. The thesis includes multiple research papers on topics such as bridge slab strengthening, FRP jacketing, bearing replacement, crack treatment, fatigue performance, and bridge restoration strategies. These studies helped in identifying the most suitable retrofitting methods and understanding the practical approaches used in similar bridge rehabilitation projects.

Further research was carried out through online technical resources, journal databases, and code provisions such as IRC:6 and IRC: SP:114-2018 to verify the feasibility of the selected methodology. Based on this study, the idea was finalized to analyze the bridge using MIDAS Civil software and evaluate the effectiveness of replacing the slab and bearings while reducing the dead load on the existing substructure.

III. STUDIES AND FINDING

After identifying the research problem and collecting the required technical information, the next step was to systematically document the study and findings of the present research work. In this study, the “Bits and Pieces Together” approach was adopted, where the information collected from literature review, design codes, field observations, and software analysis was integrated into a structured research paper format.

The research work was initiated by taking references from previously published studies related to bridge retrofitting, slab rehabilitation, bearing replacement, and structural strengthening techniques. These studies served as the foundation for developing the present work. Based on the reviewed literature, the methodology was formulated for the retrofitting of the balanced cantilever bridge over the Narmada River.

The study findings were derived through detailed structural analysis using MIDAS Civil software, where various load cases such as dead load, live load, wind load, braking load, temperature effects, and earthquake loads were considered. The analysis results indicated that by replacing the slab and bearings, the total superstructure dead load was reduced by approximately 1000 tons, which significantly improved the structural performance and reduced the load on the substructure.

The final findings confirm that the proposed retrofitting approach is technically feasible, economical, and effective for extending the service life of the bridge.

IV. GET PEER REVIEW

Peer review is one of the most crucial steps in the research publication process. After drafting the journal paper, it is essential to have the work critically reviewed by peers, research guides, faculty members, or subject matter experts in the field of structural and bridge engineering. This step helps in improving the technical quality, clarity, and credibility of the research work.

For the present study on retrofitting of the balanced cantilever Narmada River bridge, the draft paper should be reviewed by experts having knowledge in bridge design, rehabilitation techniques, MIDAS Civil analysis, and IRC code provisions. Their comments and technical suggestions can help identify any shortcomings in load assumptions, modelling procedures, design methodology, or interpretation of results.

Obtaining maximum review comments is always beneficial, even when the author is confident about the work. Peer suggestions often lead to improvements in the abstract, introduction, literature review, methodology, results, and conclusion sections. This process ensures that the paper becomes technically sound, publication-ready, and aligned with journal standards.

Thus, peer review significantly enhances the overall quality and acceptance potential of the research paper.

V. IMPROVEMENT AS PER REVIEWER COMMENT

After receiving the review comments, it is essential to carefully analyze and understand each suggestion provided by the reviewers, peers, or subject experts. Every comment should be evaluated from both technical and presentation perspectives to ensure that the paper meets the required academic and publication standards.

For the present research work on retrofitting of the balanced cantilever bridge over the Narmada River, necessary amendments should be made in the sections related to structural analysis, methodology, load calculations, MIDAS modelling, literature review, and result interpretation wherever suggested by the reviewers.

If any review comment is not clearly understood, it is advisable to seek clarification from the reviewer, guide, or

subject expert before making changes. This helps in avoiding incorrect modifications and ensures that the intended technical improvement is properly incorporated.

In some cases, the paper may receive critical remarks regarding content quality, technical depth, or formatting. Such comments should be considered as constructive feedback rather than discouragement. The author should focus on improving the work to the maximum extent possible by refining calculations, strengthening discussions, and improving presentation quality.

Thus, improvement based on reviewer comments plays a vital role in enhancing the technical strength, clarity, and acceptance potential of the research paper.

VI. CONCLUSION

The present study demonstrates that the retrofitting of the balanced cantilever bridge over the Narmada River through slab replacement, pier cap strengthening, and bearing replacement is an effective and economical solution for bridge rehabilitation. The structural analysis carried out using MIDAS Civil software confirms that the proposed retrofitting methodology significantly reduces the dead load on the existing substructure and improves the overall performance of the bridge.

A substantial reduction in superstructure weight, approximately 1000 tons, was achieved, which directly reduced the load on the bearings, piers, and foundations, thereby enhancing serviceability and extending the operational life of the bridge. The adopted approach also minimizes construction time, reduces traffic disruption, and avoids the high cost associated with complete bridge reconstruction.

The significance of this work lies in its practical application to the rehabilitation of long-span bridges facing deterioration due to aging and increased traffic demand. The methodology and analytical approach used in this research can be extended to similar bridge retrofitting projects in other regions.

Further studies may focus on advanced strengthening techniques such as FRP wrapping, external prestressing, and long-term structural health monitoring systems for improved durability and performance assessment.

VII. APPENDIX

The appendix section includes supplementary technical information, detailed calculations, and additional

analysis outputs that support the main content of the research paper but are too lengthy to be included within the main body. For the present study on retrofitting of the balanced cantilever Narmada River bridge, the appendix may include the following supporting documents:

Appendix A – Detailed Load Calculations

- Dead load calculation of slab, parapet, and wearing coat
- Bituminous load calculation
- Crash barrier load calculation
- Footpath load calculation
- Braking load calculation
- Wind load calculations as per IRC:6
- Temperature rise and fall calculations
- Earthquake response spectrum parameters

Appendix B – MIDAS Civil Modelling Outputs

- Geometry modelling screenshots
- Section property assignments
- Support and bearing details
- Load combination tables
- Moving load case definitions
- Response spectrum function details

Appendix C – Analysis Results

- Support reactions
- Maximum bending moment
- Shear force results
- Deflection outputs
- Major and minor axis moment diagrams
- Validation beam model results

Appendix D – Relevant IRC Code References

- IRC:6 load provisions
- IRC: SP:114-2018 seismic provisions
- Impact factor references
- Load combination clauses

This section provides technical backup for the methodology and results presented in the paper.

VIII. ACKNOWLEDGEMENT

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REFERENCES

- [1] G. Santarsiero, "Retrofitting of Bridge Slabs for Safety Railing Refurbishment in Italy: A State-of-the-Art Review," *Applied Sciences*, 2023.
- [2] K. M. A. Hossain, K. Chu, and M. Lachemi, "Fatigue Performance of ECC Link Slab Incorporated Full RC Girder Joint-Free Bridges," *Advances in Bridge Engineering*, 2024.
- [3] Ramyakala, M. Waseem, S. Khan, S. Mustafa, and S. L. Hussain, "Repair and Rehabilitation of Reinforced Concrete Bridge," *International Research Journal of Engineering and Technology (IRJET)*.
- [4] M. Domaneschi, S. A. Mitoulis, R. Cucuzza, V. Villa, R. Di Bari, and G. Siva, "Restoration of a Landmark Balanced Cantilever Bridge Considering Different Resilience and Sustainability Strategies," *Sustainable and Resilient Infrastructure*.
- [5] L. Ahmad and U. Kumar, "Improvement of the Long Span Bridge after Fiber Reinforced Polymer Jacketing with Lateral Load: A Review," *IRJET*, 2024.
- [6] Z. Zhang, "Causes and Treatment of Bridge Cracks," *Proceedings of the 4th International Conference on Materials Chemistry and Environmental Engineering*, 2024.
- [7] IRC:6, *Standard Specifications and Code of Practice for Road Bridges*, Indian Roads Congress, New Delhi.
- [8] IRC: SP:114-2018, *Guidelines for Seismic Design of Highway Bridges*, Indian Roads Congress, New Delhi.