



**PROJECT TITLE**

Rehabilitation and Load Rating of Deteriorated Timber Bridges in Colorado: Parametric Investigations and Implementation

**STUDY TIMELINE**

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**FURTHER RESOURCES**

[https://urldefense.proofpoint.com/v2/url?u=https-3A\\_www.codot.gov\\_programs\\_research\\_pdfs\\_2023-2Dresearch-2Dreports\\_cdod-2Dresearch-2Dreport-2D2023-2D06-2Drehabilitation-2Dand-2Dload-2Drating-2Dof-2Ddeteriorated-2Dtimber-2Dbridges-2Din-2Dcolorado-5Fparametric-2Dinvestigation-2Dand-2Dimplementation.pdf&d=2DwMfAQ&c=sdnEM9SRGFuMt5z5w3AhsPNahmNiqc64TgF1JwNR0cs&r=lpP7Kl-loMW6kD1A8v8jpRRPIRSEowpVvlmw1LZBI&m=QcoeG6y\\_gb5841W-1cTsV0Q5JBHMDvNnZiLFnDXYJO6i-GWTKto28KVGmJCmd13g&s=7501IDjknExjzLyB1aMPo7oA8JSExa\\_gj8Fi7jYs7u8&e=](https://urldefense.proofpoint.com/v2/url?u=https-3A_www.codot.gov_programs_research_pdfs_2023-2Dresearch-2Dreports_cdod-2Dresearch-2Dreport-2D2023-2D06-2Drehabilitation-2Dand-2Dload-2Drating-2Dof-2Ddeteriorated-2Dtimber-2Dbridges-2Din-2Dcolorado-5Fparametric-2Dinvestigation-2Dand-2Dimplementation.pdf&d=2DwMfAQ&c=sdnEM9SRGFuMt5z5w3AhsPNahmNiqc64TgF1JwNR0cs&r=lpP7Kl-loMW6kD1A8v8jpRRPIRSEowpVvlmw1LZBI&m=QcoeG6y_gb5841W-1cTsV0Q5JBHMDvNnZiLFnDXYJO6i-GWTKto28KVGmJCmd13g&s=7501IDjknExjzLyB1aMPo7oA8JSExa_gj8Fi7jYs7u8&e=)

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**Problem Statement**

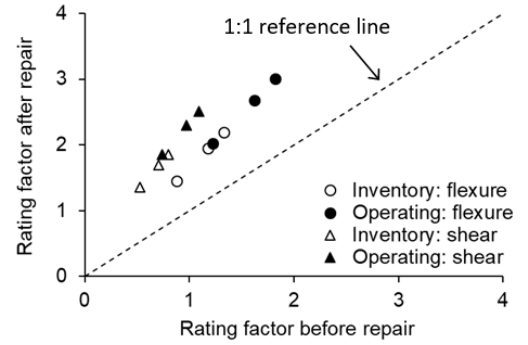
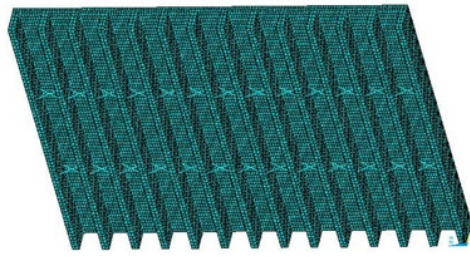
Timber bridges require regular maintenance and rehabilitation to warrant adequate performance, as intended in design, and to increase longevity. Typical sources of deterioration include fungi and termites, drying shrinkage, temperature, moisture, weathering, and vehicle loadings. Among others that are specified in the AASHTO Manual for Bridge Evaluation, the Allowable Stress Rating (ASR) method traditionally dominates the rating of timber bridges. Nonetheless, the fact that little guidance is available on rating repaired timber bridges leads to overly conservative evaluations by ignoring interactions between existing and newly added members. Research is necessitated to fill this identified gap in practice, so that federal and state agencies can assure reliable transportation services across the board.



**Methodology or Action Taken**

The first part of the report explores the behavior of salvaged timber girders retrofitted with lag bolts, composite sheets, and steel beams. A total of 12 girders are tested and flexural responses are examined. The capacities of the control and upgraded girders are compared and other structural aspects are also of interest. The second part deals with a case study concerning the retrofit of an 83-old timber bridge using the aforementioned repair techniques. Flexural tests are carried out and finite element models are developed to examine the efficacy of strengthening under truck loadings. Parametric analysis sheds light on the repercussions of steel-sectional properties and the Colorado Permit Truck for the serviceability and strength of the bridge. The third part focuses on the rating of timber bridges repaired with hollow structural sections. Two bridges are repaired and load testing is performed. To calculate the rating factors of these bridges under 17 live loads specified in the CDOT Rating Manual, finite element models are developed and predicted responses are validated against in-situ data. A mechanics-based method is proposed to rate these bridges before and after the repair. The level of safety is quantified by the principle of reliability in order to deduce the probability of failure.





### Conclusions

This report has discussed three major aspects that are related to the evaluation of decrepit timber bridges: i) laboratory testing, ii) computational modeling, and iii) ratings. In addition, worked examples are provided to demonstrate the implementation of research findings.

### Potential Impacts and Benefits

The research suggests a new rating method for repaired timber bridges. Current rating methodologies stated in the CDOT Bridge Rating Manual are incomplete and inconsistency is noticed before and after repair. By adopting the proposed methodologies, consistent rating outcomes are expected.