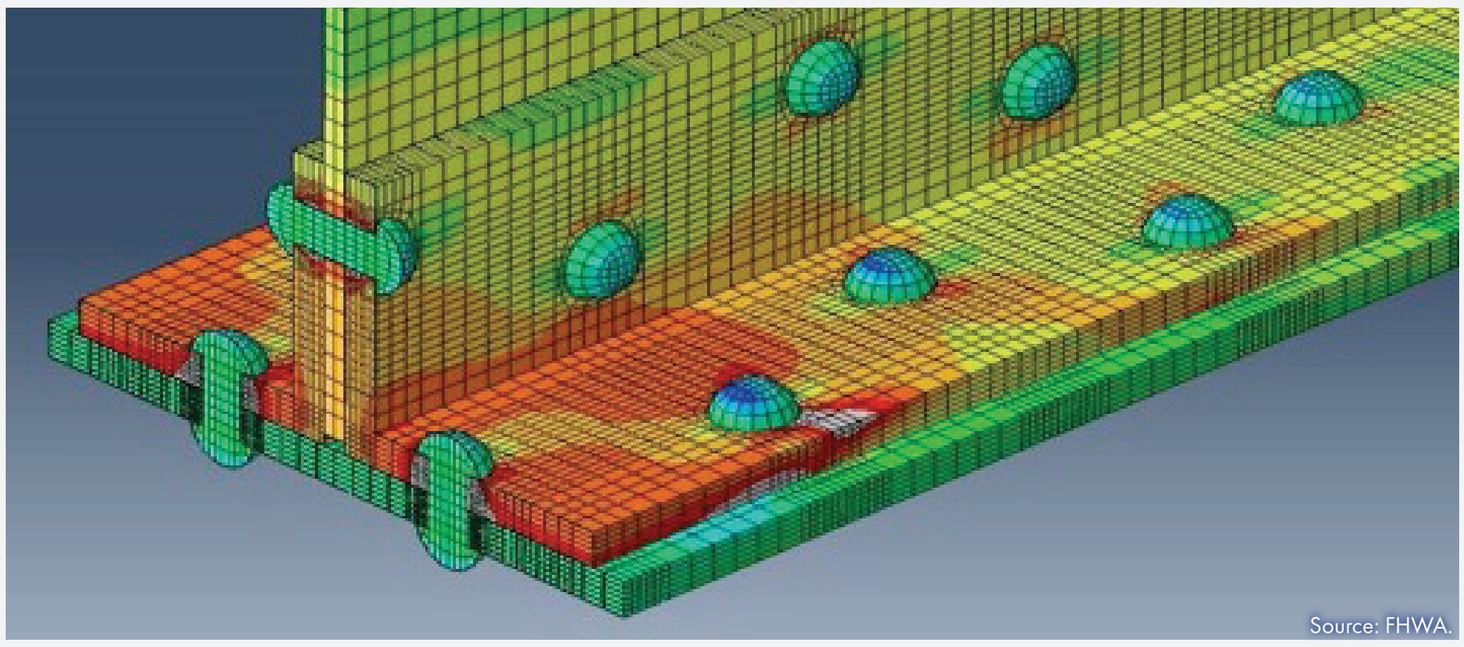
2024 Recipient

TPF Excellence Awards

Member-level Redundancy in Built-up Steel Members—TPF-5(253)

Indiana Department of Transportation (INDOT)

As a result of extensive collaboration and research, this Transportation Pooled Fund (TPF) study created two new American Association of State Highway and Transportation Officials (AASHTO) guide specifications. Transportation agencies around the country are already using these guide specifications for evaluating existing steel bridges and informing new designs.



Source: FHWA.

The image shows a cross-section of one of the detailed three-dimensional nonlinear finite element analysis (FEA) models built from the large-scale test specimens. These FEA models were calibrated based on the large-scale tests. The complex models allowed the researchers to then develop simplified AASHTO-ready equations for use in design. This specific image shows the stress redistribution in the remaining two angles (the top angles) when the outer (bottom) plate is assumed to have fractured completely. Through this model, researchers can better see visually how the stresses distribute.

The Member-level Redundancy in Built-up Steel Members TPF study helped address the analysis, design, evaluation, and safety inspection of internally redundant built-up steel bridge members.

Built-up members typically will not "fail" if one of the components fail (whether through fatigue or fracture); however, before this study, very little experimental data existed that quantified the remaining fatigue life and strength of a member with a failed component.

The research team primarily tested full-scale specimens to gain a deeper understanding of the energy release, load redistribution, and subsequent fatigue resistance of damaged sections. They then developed code-ready assessment methodologies.

Partnerships

- This TPF project required extensive public-private sector collaboration, including participating agencies, AASHTO committees, the Army Corps of Engineers, and the steel industry.
- Industry support was essential for conducting the large number of full-scale tests needed to fully develop improved specifications.
- The steel industry provided specimens and fixtures for testing at significantly reduced or no cost.
- These collaborations resulted in two new AASHTO guide specifications, *Guide Specifications for Internal Redundancy of Mechanically-Fastened Built-up Steel Members* and *Guide Specifications for Analysis and Identification of Fracture Critical Members and System Redundant Members.*

Impact on Transportation Industry

- The results of the project have changed how the bridge engineering profession views an entire classification of structures and will result in tens of millions of dollars in savings related to the cost of in-service inspection strategies.
- The work has resulted in a paradigm shift concerning the concept of the fracture critical member and for the first time led to the creation of a fracture control plan.
- This TPF project promotes the U.S. Department of Transportation strategic goal of advancing safety by developing the first integrated fracture control plan and increasing knowledge of the reliability and safety of mechanically fastened steel bridges.
- The fracture control plan integrates inspection intervals, inspector capability, and member damage tolerance.
- This plan is the first integrated fracture control plan ever developed for the U.S. highway bridge industry, increasing the reliability of this family of structures.
- The Member-level Redundancy in Built-up Steel Members TPF study also paved the way for incorporating and integrating risk-based inspection strategies into existing AASHTO specifications.
- The project has allowed designers to use economical and innovative designs that are now known to have a high level of internal redundancy and reliability.
- Transportation partners have benefited from this study's activities that encouraged the transition from calendar-based bridge inspection strategies to more efficient risk-based approaches. This TPF study has strengthened the bridge and steel industry and serves as a success story for similar initiatives across the Nation.

U.S. Department of Transportation
Federal Highway Administration