Development of MASH Computer Simulated Steel Bridge Rail and Transition Details
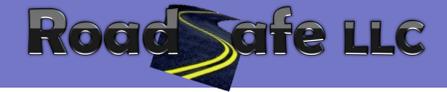
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REPORT # NETCR115

ABSTRACT

Motivation

The current policy for roadside hardware installed on federal-aid projects requires upgrading non-conforming systems to *MASH* acceptance level for situations involving full system replacements, certain structural rehabilitations such as deck replacements, or repairing a critically damaged bridge rail system. The predominate bridge rail and approach guardrail transition (AGT) systems used in Maine, as well as the other New England states, include details for 2-bar, 3-bar and 4-bar designs, which were developed and tested under prior crash testing and evaluation standards. It was of interest to the New England transportation agencies to determine if these existing NETC bridge rail systems meet the strength and safety criteria of the current test standards of *MASH*, which involve higher impact severities than the previous crash testing standards.

Methods

The study involved:
- Review of existing NETC bridge rail and AGT designs and assessing performance aspects,
- Review of current standard details and specifications for NETC style bridge rails and transitions used among the New England states to identify differences in material specifications and dimensional details, and
- Evaluation of the crash performance of these systems using finite element analysis (FEA) computer simulation.

Results

The results of this study provide evidence of the crashworthiness of the NETC designs, which will aid State engineers in making informed decisions on the continued use of these systems.

ACKNOWLEDGMENTS

DATA

Detailed FEA models of the bridge rails and transition systems were developed, and the FEA software LS-DYNA was used to simulate existing full-scale crash tests to assess the validity of the models according to the procedures of NCHRP Document 179.

The validated models were then used to assess crash performance of the NETC designs under *MASH* impact conditions and evaluation criteria. The evaluations used critical impact points that lead to the greatest potential for structural failure or occupant harm and were determined based on FEA results as well as previous testing.

ANALYSIS

Barrier Systems Evaluated

Bridge Rails
- 34-inch tall curb-mounted 2-bar Rail (TL3)
- 44-inch tall curb-mounted 3-bar Rail (TL4)
- 42-inch tall sidewalk-mounted 4-bar Rail (TL4) & modified design

Transition Systems
- NETC Style 2-bar Rail to Thrie Beam (TL3)
- NETC Style 3-bar Rail to Thrie Beam (TL4) & modified design
- Concrete Transition Barrier to Thrie Beam (TL4).
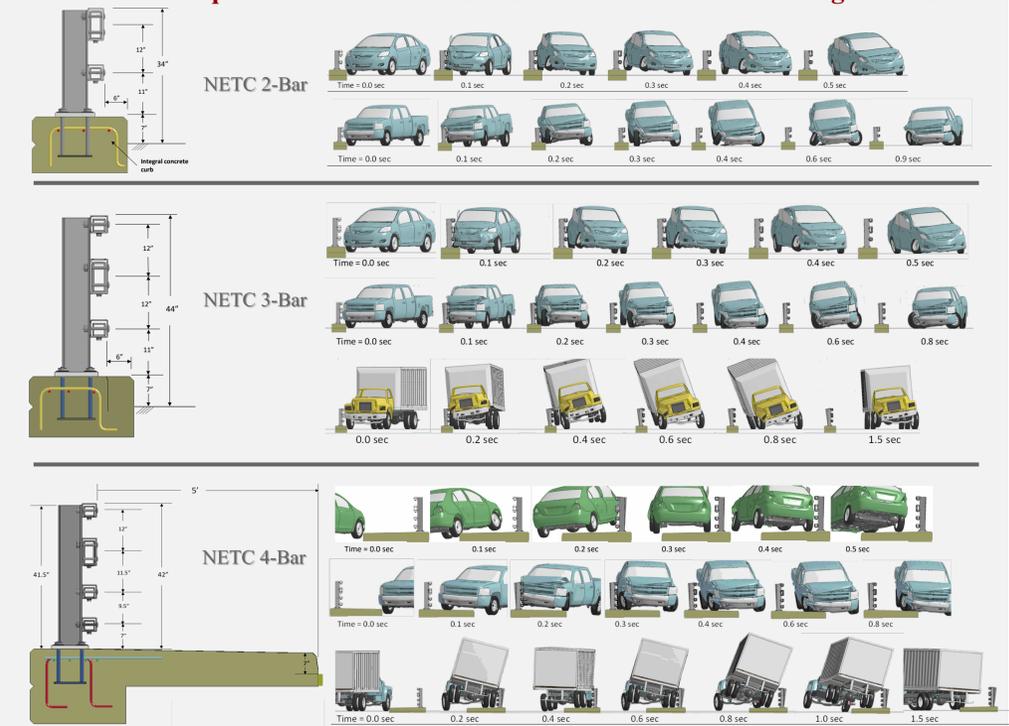
Impact Conditions

MASH Test Level 3 (TL3)
- Test 3-10: 2595-lb sedan impacting at 62 mph and 25 degrees
- Test 3-11: 5000-lb Pickup impacting at 62 mph and 25 degrees

MASH Test Level 4 (TL4)
- Test 4-12: 22,198-lb single-unit-truck impacting at 56 mph and 15 degrees

Sequential Views of *MASH* Crash Simulations for Bridge Rail Cases

CONCLUSIONS

The results of the study showed that the NETC 2-bar and 3-bar designs meet *MASH* TL3 and TL4 requirements, respectively. The NETC 4-bar design was also shown to meet *MASH* TL4 requirements, albeit with considerable damage to the system. Redesign of the bridge rail systems was not a primary focus of this study. In some cases general recommendations for design improvements that the research team believes would further improve crash performance were provided, such as increasing the size of the HSS rails to improve system strength, revising the splice design to minimize lateral movement in the splice connections, and tapering the tops of the posts to mitigate snagging on the top of the posts when parts of a vehicle (e.g., cargo-box on single-unit trucks) overhang the top rail.