

Assessment of Finite Element Analysis

SBTA 22-004



Preamble

Increasingly finite element analysis has become a popular technique for predicting the response of roadside hardware such as guardrails, bridge rails, and sign supports, in crash events. The method in which the Austrroads Safety Barrier Assessment Panel (the Panel) assesses the results of finite element analysis is summarised below.

Audience

- Road agencies
- Road safety hardware industry.

Background

AS/NZS 3845.1 Section D 4.4.2 discusses that if simulation techniques are to be used, then appropriate verification of the calibrated model needs to be undertaken with known full-scale tests and other physical testing. Confidence in the results of computations depends on a careful verification and validation process. An extensive verification and validation process is provided by NCHRP Report 179, which should be followed.

Therefore, the Panel expects that in accordance with the recommendations of AS/NZS 3845, that verification and validation be undertaken in accordance with the process documented in NCHRP Report 179. Additionally, it is advised that in-house simulations require independent third-party verification.

Commentary

NCHRP Report 179 sets out a process and identifies key documentation to give decision makers the information required to make informed decisions. It is not specific to NCHRP 350 and/or MASH testing protocols. EN1317 testing and validation is included in the templates in the appendices of the report.

The NCHRP Report 179 process is summarised as:

1. Identify the baseline experiment.
2. Build the computational model of the baseline experiment.
3. Use the model to simulate the baseline experiment.
4. Validate the model by comparing the simulation results to the physical test results.
5. Modify the model to represent incremental improvements.
6. Use the model to predict the performance of the incremental improvement, and
7. Evaluate the performance of the incrementally modified device.

Therefore, to assure the Panel that the model accurately represents the real-world physical testing, the following key documentation to allow assessment of simulated data is required:

1. A Verification & Validation report that documents the comparison between a full-scale crash test and the simulation inclusive of:
 - Phenomena Importance Ranking Table

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- Analysis Solution Verification Table
 - Time history evaluation table
 - Side by side photographs
2. A simulation report documenting the results of the analysis of the untested design including hardware and vehicle data.

Recommendations

The Panel will consider simulations as a method of engineering justification, as long as the simulation model is not being used to extrapolate significantly beyond the full-scale crash test data, and that accurate validation and verification of the model has been undertaken in accordance with NCHRP Report 179 and independently verified by a third-party if undertaken in-house. It should be noted that where validation report criteria is not met, the report shall include commentary which would assist the Panel to undertake thorough consideration of the outcomes. The Panel expects that at the time of simulation the latest available and calibrated vehicles models are used.

Where simulation is used to justify performance of variants or a site-specific situation, there will be careful consideration of the degree of prediction, which will depend on the system complexity (e.g. the number of moving components).

The Panel advises that as variations move further away from the physically crash tested configuration, simulations will not be considered appropriate and physical crash testing may be required. On this basis, the Panel will not assess submissions based on simulation which is more than one incremental change from the physically crash tested configuration.

Additionally, at the present time the Panel is not confident in TL4 simulations given the greater consequences for TL4 failure, and the TL4 vehicle performance variability. TL4 simulations may be considered for extended design domain applications but will not be listed on the TCU.

The Panel does not publish design requirements based on simulations. Technical Conditions for Use documents list design requirements from physical crash testing.

References

AASHTO (2016) *Manual for assessing safety hardware*, 2nd edn, American Association of State Highway and Transportation Officials, Washington, DC, USA

AS/NZS 3845.1:2015, *Road safety barrier systems and devices: part 1: road safety barrier systems*.

EN1317, *European Standard EN 1317 Road Restraint Systems*, European Committee of Standardization, CEN 1998

NCHRP Report 179, *Procedures for Verification and Validation of Computer Simulations Used for Roadside Safety Applications*, Transportation Research Board, Washington, DC, 2010

NCHRP Report 350, *Recommended Procedures for the Evaluation of Highway Features*, Transportation Research Board, Washington, DC, 1993

Amendment Record

Amendment no.	Amendment	Date
1	New Technical Advice Note	May 2020
2	Updated to include additional commentary where validation report criteria is not met	February 2022
3	Updated to include requirement for independent verification of in-house simulations	September 2024
4	Updated to Panel's position on publishing simulation results & assessment of simulations based on changes from the physical crash tested configuration	December 2024
5	Updated to include Panel's expectation regarding vehicle models	September 2025
6	Updated to include commentary regarding TL4 simulations	December 2025
