Texas A&M Transportation Institute
3135 TAMU, College Station, TX 77843-3135
Tel.: 979-317-2707
Fax: 979-845-6107
http://tti.tamu.edu/crashtesting

PROFESSIONAL RECOMMENDATION MEMORANDUM

Project Name: Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States

Sponsor: Roadside Safety Pooled Fund

Task 22-15: Utah DOT's 15-ft Free-Standing PCB Deflection for Reduced Impact Severities

Date: December 6, 2022

To: Shawn Debenham, Utah DOT

From: Nauman M. Sheikh, P.E., Research Engineer

For more information:
Name: Nauman Sheikh
Phone: 979-317-2695
Email: n-sheikh@tti.tamu.edu

Background and Objective

Presented herein is the assessment of the Utah Department of Transportation's (UDOT) free-standing portable concrete barrier (PCB) for reduced impact severities. TTI researchers estimated the approximate deflection of the PCB system using finite element (FE) simulations of the system for the following impact conditions.

1. Impact speed and angle of 45 mph and 25 degrees
2. Impact speed and angle of 45 mph and 10 degrees
3. Impact speed and angle of 62 mph and 10 degrees

UDOT's PCB barrier segment is 15-ft long, 32 inches tall, and has an F-shape profile. Adjacent barrier segments are connected using the pin-and-loop connection. The barrier is installed in free-standing configuration with a minimum approximate installation length of 200-ft. Barrier segments on each end of the installation are anchored using inclined anchoring pins. Key design details of the system are shown in Figure 1. For more details, see UDOT's standard drawings BA 1F1 through BA 1F4 and BA 2A.

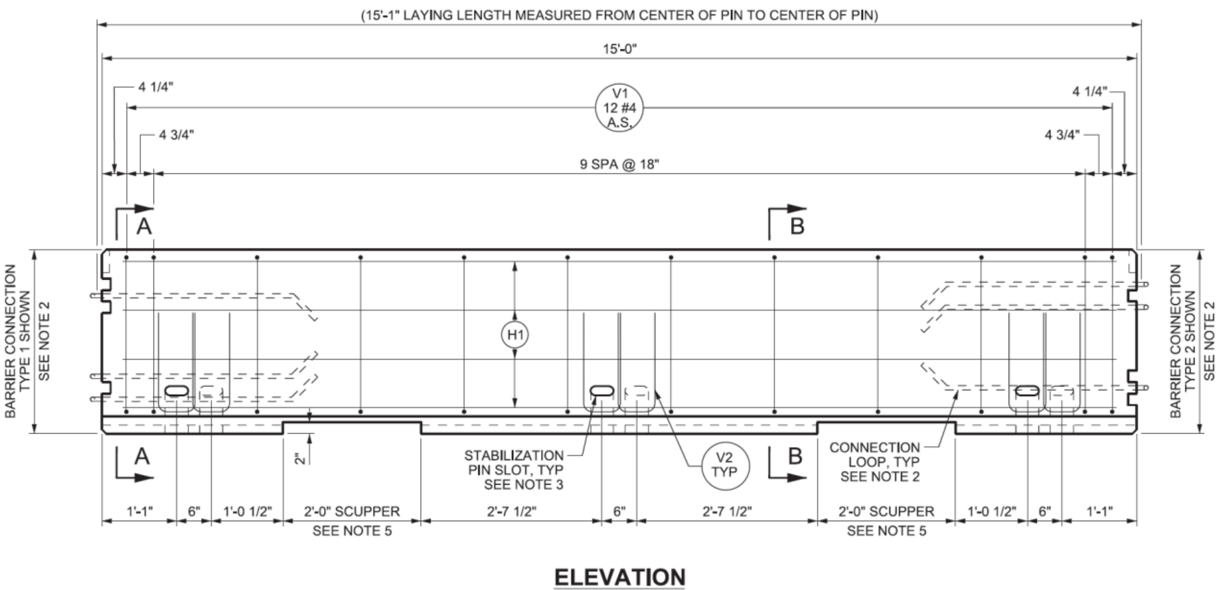


Figure 1. UTAH DOT Barrier Segment Detail.

Assessment and Analysis

UDOT's barrier described above has been crash tested to MASH with the exception that the crash tested barrier segments were 12.5-ft long. (*1*,*2*) To estimate the deflection of UDOT's free-standing PCB with anchored ends, the researchers used a previously developed FE model of the barrier with 12.5-ft barrier segments and modified it to incorporate UDOT's 15-ft segment length. The FE model is shown in Figure 2. It was comprised of 13 barrier segments, for a total installation length of approximately 196 ft. Each end of the barrier system was anchored with seven inclined pins. This involved installing three pins per segment in the two exterior segments, and one pin in the adjacent interior segment (Figure 2). The rest of the segments were unanchored.

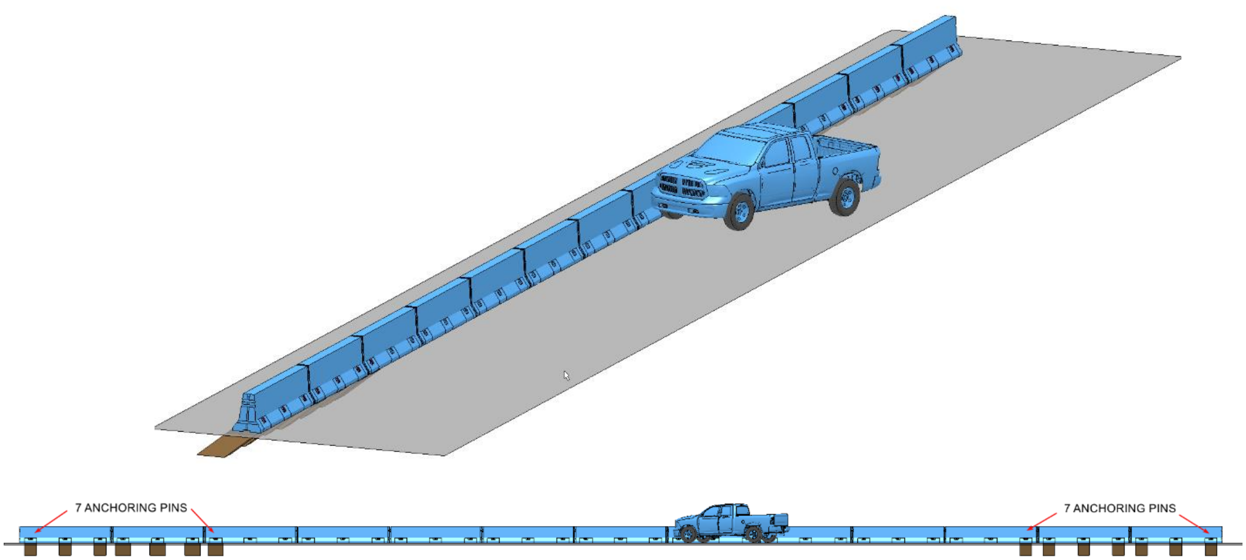
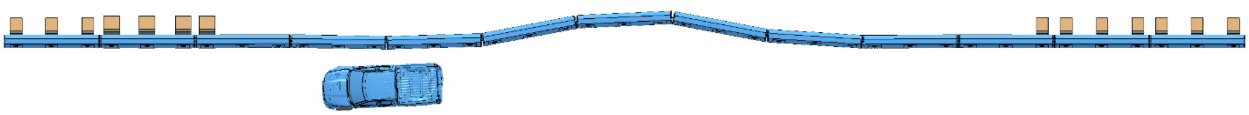


Figure 2. Finite Element Model

The researchers performed three vehicle impact simulations with the barrier system model, using the impact speed and angle combinations requested by UDOT. The concrete of the barrier segments was modeled with rigid material representation. The pin-and-loop connection, the connection pins, and the end anchoring pins were modeled with appropriate elastic-plastic material representation. At the anchoring pin locations, the model also incorporated appropriate asphalt and soil continuums. In a typical free-standing PCB simulation model, TTI researchers use a friction coefficient of 0.46 between the barrier segments and the underlying pavement. To build some conservatism in the deflection estimates, the researchers slightly reduced the friction coefficient to 0.4 in the models used for this assessment.

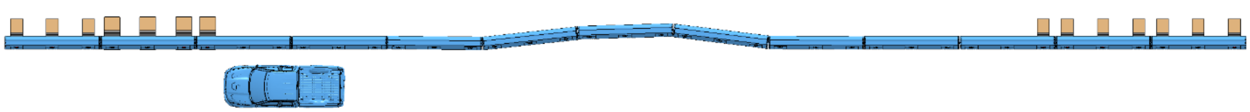
The vehicle model used in the simulations is a public domain pickup truck model developed by Center for Collision Safety and Analysis (CCSA) with FHWA and NHTSA funding, modified over the course of several projects by TTI researchers to improve its validation and robustness. The simulations were performed using LS-DYNA, which is a commercial FE software commonly used for crash analysis. The impact points were selected based on the impact speeds, using Table 2-7 of MASH.

In all three cases, the vehicle was successfully contained and redirected in a stable manner. Figure 3 shows the deflected state of the barriers in all three cases. The maximum dynamic deflections of the barrier are presented in Table 1.



Case 1. 45 mph Impact Speed, 25-degree Impact Angle

Case 2. 45 mph Impact Speed, 10-degree Impact Angle



Case 3. 62 mph Impact Speed, 10-degree Impact Angle

Figure 3. Barrier Deflection After Impact

Table 1. Maximum Dynamic Deflections

	Maximum Dynamic Deflection (in)
Case 1. 45 mph Impact Speed, 25-degree Impact Angle	45.0
Case 2. 45 mph Impact Speed, 10-degree Impact Angle	15.7
Case 3. 62 mph Impact Speed, 10-degree Impact Angle	24.0

Conclusions

Based on the results of the simulation analyses presented herein, the estimated maximum dynamic deflection of UDOT's PCB system for the three reduced impact severity conditions assessed are as presented in Table 1.

References

[1] N.M. Sheikh, W.L. Menges, and D.L. Kuhn, *MASH TL-3 Testing and Evaluation of Free-Standing Portable Concrete Barrier*. Test Report No. 607911-1&2, Texas A&M Transportation Institute, College Station, TX, 2017.

[2] N.M. Sheikh and W.L. Menges, *Development and Testing of Anchored Temporary Concrete Barrier for Use on Asphalt*. Test Report No. 405160-25-1, Texas A&M Transportation Institute, College Station, TX, 2011.