



MASH provides guidelines for crash-testing roadside barriers, including precast concrete barriers. It also recommends evaluation criteria to assess these test results.

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# MASH Regulation

By Eric Carleton, P.E.

When most people hear “MASH,” they think of the popular television show based on the antics of a Mobile Army Surgical Hospital unit in the Korean War. However, for those involved with transportation projects and construction, the acronym refers to the Manual for Assessing Safety Hardware,

which presents guidelines for permanent and temporary roadside barriers including precast concrete barriers. Recent developments and the implementation of MASH 2016 have had a major impact on precast concrete producers who manufacture traffic barriers.

## RECENT HISTORY OF BARRIER TESTING

MASH was first published by the American Association of State Highway and Transportation Officials (AASHTO) in 2009. At that time, the MASH 2009 manual replaced an existing 1993 roadside safety device report developed by the Transportation Research Board (TRB) through the National Cooperative Highway Research Project (NCHRP) report NCHRP 350, “Recommended Procedures for the Safety Performance Evaluation of Highway Features.”<sup>1</sup>

NCHRP 350 was important because it brought uniformity to the traffic barrier and device testing methods and protocol, which up to that time varied widely. On July 27, 1997, the Federal Highway Administration (FHWA) Office of Engineering and Technology issued a guidance memo mandating that all work

zone devices used on the National Highway System (NHS) be crash-tested to meet NCHRP 350 requirements. In 2002, the Transportation Safety Board initiated project 22-14(02), “Improvement Procedures for Safety-Performance Evaluation of Roadside Features,” which was designed to address the changes in vehicle geometry, road speeds and other technical considerations since the original NCHRP 350 report. The result was MASH 2009, which was completed in 2008. The report included many revisions that affected testing procedures described in NCHRP 350.

This information was then published by AASHTO as a guidance document rather than a TRB technical report. Some of the larger modifications in MASH 2009 that relate to concrete barriers include:

#### Changes in test matrices

- ▶ The small car impact angle is increased from 20 to 25 degrees to match the impact angle used with light-truck testing.
- ▶ The impact speed for the single-unit truck test is increased from 80 to 90 kilometers per hour to better distinguish the TL-4 test from TL-3.

#### Changes in test installations

- ▶ More detailed documentation of components used in the test installation is required.
- ▶ Minimum installation length requirements are specified more clearly.

#### Changes in test vehicles

- ▶ The size and weight of test vehicles are increased to reflect the increase in vehicle fleet size:
  - The small-car 820C test vehicle is replaced by the 1,100C.
  - The light-truck 2,000P test vehicle is replaced by the 2,270P.
  - The single-unit truck mass is increased from 8,000 to 10,000 kilograms.
  - The light-truck test vehicle must have a minimum center of gravity height of 28 inches.

#### Changes in evaluation criteria

- ▶ The option for using passenger car test vehicles older than six years is removed.
- ▶ All evaluation criteria will be pass/fail, eliminating the marginal pass.
- ▶ All longitudinal barrier tests are required to meet flail-space criteria.
- ▶ Maximum roll and pitch angles are set at 75 degrees.
- ▶ Post-impact vehicular trajectory criteria was added, which is a measure of the potential of a vehicle to result in a secondary collision with other vehicles or fixed objects.

#### Changes in test documentation

- ▶ Computer-aided drafting drawings of the test device and test installation are required.
- ▶ Additional documentation of the test and evaluation results is required.

#### Changes in performance evaluation

- ▶ Language emphasizing the importance of in-service evaluation is added.

### MASH 2009 IMPLEMENTATION AGREEMENT

With this new AASHTO guidance document, the FHWA and AASHTO entered into a joint implementation plan agreement to develop a process of roadside barrier device acceptance and eligibility for federal highway funding.

#### Key components of this agreement are:<sup>3</sup>

- ▶ AASHTO’s Technical Committee on Roadside Safety is responsible for developing and maintaining the evaluation criteria as adopted by AASHTO. FHWA shall continue to review and accept highway safety hardware.
- ▶ Highway safety hardware accepted using NCHRP 350 criteria is not required to be retested using MASH criteria.
- ▶ Any new or revised highway safety hardware under development at the time MASH is adopted may continue to be tested using NCHRP 350 criteria. However, FHWA will not issue acceptance letters for new or revised highway safety hardware testing using NCHRP 350 criteria after Jan. 1, 2011.
- ▶ Highway safety hardware installed on new construction and reconstruction projects shall be those accepted under NCHRP Report 350 or MASH.

The 2009 implementation plan did not sunset the use of NCHRP 350 hardware. The FHWA anticipated highway safety device manufacturers would actively develop new MASH-compliant devices, but it did not occur. During this time, the FHWA was taking an active role in evaluating manufacturer or department of transportation (DOT)-submitted NCHRP 350 and MASH test results of various highway safety devices, including precast concrete barrier. Those devices that successfully passed the criteria were issued an eligibility letter by FHWA stating their use on DOT projects was acceptable and qualified for federal aid reimbursement.

### MASH 2016 IMPLEMENTATION AGREEMENT

More recently, the AASHTO Technical Committee on Roadside Safety updated the MASH 2009 document. The revisions in MASH 2016 include a large focus on cable barrier systems and had minimal impact regarding any revised testing protocol of precast concrete barrier. However, MASH 2016<sup>2</sup> presented major changes regarding specific dates sunseting NCHRP 350 criteria. This was outlined within a new AASHTO/FHWA Joint Implementation Agreement at the end of 2015.<sup>4</sup>

#### Specific provisions of the new agreement are:

- ▶ The AASHTO Technical Committee on Roadside Safety will continue to develop and maintain the evaluation criteria as adopted by AASHTO.
- ▶ FHWA will continue to issue letters of eligibility of roadside safety hardware for federal-aid reimbursement.
- ▶ Agencies are urged to establish a process to replace existing highway safety hardware that has not been successfully tested to NCHRP 350 or later criteria.
- ▶ Agencies are encouraged to upgrade existing highway safety hardware to comply with MASH 2016 either when it becomes damaged beyond repair or when an individual agency’s policies require an upgrade to the safety hardware.
- ▶ For contracts on the NHS with a date after the dates listed below, only safety hardware evaluated using MASH 2016 criteria will be allowed for new permanent installations and full replacements:
  - Dec. 31, 2017 – w-beam barriers and cast-in-place concrete barriers
  - June 30, 2018 – w-beam terminals
  - Dec. 31, 2018 – cable barriers, cable barrier terminals and crash cushions
  - Dec. 31, 2019 – bridge rails, transitions, all other longitudinal barriers (including portable barriers installed permanently), all other terminals, sign supports and all other breakaway hardware

- ▶ Temporary work zone devices, including portable barriers manufactured after Dec. 31, 2019, must have been successfully MASH 2016 tested. Such devices manufactured on or before this date and successfully tested to NCHRP 350 or MASH 2009 may continue to be used throughout their normal service lives.
- ▶ Regarding the federal aid eligibility of highway safety hardware, after Dec. 31, 2016:
  - FHWA will no longer issue eligibility letters for highway safety hardware that has not been successfully MASH 2016 crash-tested.
  - Modifications of eligible highway safety hardware must use criteria in MASH 2016 for re-evaluation and/or retesting.
  - “Non-significant modifications”<sup>4</sup> of eligible hardware that have a positive or inconsequential effect on safety performance may continue to be evaluated using (engineering or) finite element analysis.

This new policy has important ramifications for precast barrier manufacturers. Any precast barrier or bridge rails used for a permanent application must be MASH TL-3 crash tested on or after Dec. 31, 2019. In addition, precast barriers manufactured on or after Dec. 31, 2019, for use as temporary work zone devices must be MASH TL-3 tested. Importantly, a concession was made that precast concrete barriers used as temporary work zone applications and successfully tested to meet NCHRP 350 may still be used “throughout their normal service lives,” as defined by each state DOT. To assist the industry and DOT to better understand the new AASHTO/FHWA agreement, the FHWA

provided a resource titled, “Questions and Answers Regarding MASH Implementation Agreement.”<sup>5,6</sup>

### A STORM BREWING AND SUDDEN CHANGE

In addition to MASH documents, testing protocols and accepted practices, and FHWA review and eligibility designations, a large legal issue had developed regarding a non-precast roadside safety device. Certain accepted approval protocols were questioned by hired legal professionals and others on behalf of injured parties involved with highway accidents with this product. Additionally, on June 16, 2016, the U.S. Government Accounting Office (GAO) issued a report to Congress titled, “More Robust DOT Oversight of Guardrails and Other Roadside Hardware Could Further Enhance Safety.”<sup>7</sup>

This report reviewed the current practices involved with roadside safety device crash testing, approval, installation and subsequent installed performance. It stated there was much confusion and misinformation among state DOTs and FHWA regarding what is required by law or regulation for roadside hardware approval and use, including crash-testing and eligibility letters.

In response to the GAO report and the legal issues surrounding the specific safety device lawsuit, on May 26, 2017, FHWA issued an open letter to “all highway safety hardware and roadside design community.”<sup>8</sup>

This important policy letter stated, “Effective immediately, FHWA is implementing the following changes on how requests for Federal-aid

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eligibility letters for roadside safety hardware systems are accepted:

1. In order for manufacturers and States to qualify for a FHWA Federal-aid eligibility letter, all roadside hardware devices must complete the full suite of recommended tests as described in AASHTO MASH. This applies to:
  - a. all devices currently in the FHWA queue that have not received an eligibility letter by the effective date of this letter.
  - b. retroactively to requests received after Jan. 1, 2016.

Manufacturers and States that received an eligibility letter under AASHTO's MASH standards and did not run the full suite of tests will be required to run the remaining tests in order to retain the Federal-aid eligibility letter. The FHWA has contacted the affected manufacturers. These affected parties have up to one year, from the date of this letter, to run the balance of crash tests and resubmit their request for an eligibility letter. A written request, including crash test results from an accredited laboratory, must be submitted to FHWA within one year."

This FHWA memo provides an opportunity for state DOTs to proactively take control of review and approval processes of barrier systems used on their roadways. However,

Precast concrete barrier manufacturers must verify whether the barrier geometry and corresponding connecting hardware has been crash-tested and passes MASH criteria.

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many states see this as an unexpected policy shift that replaces a process they believed was working appropriately. Additionally, there is a concern the mandates for new and full-suite crash testing of barrier systems will exceed the testing facility's capacity.

- ▶ Precast concrete barriers used as temporary safety devices on construction projects manufactured after Dec. 31, 2019, shall have passed MASH crash testing.
- ▶ The final decisions on selection and modifications to devices will be at the state and local level.

### WHAT THIS ALL MAY MEAN TO THE PRECAST CONCRETE BARRIER MANUFACTURER

For precast concrete barrier manufacturers, these changes may not affect current production. However, it is important to verify whether the barrier geometry and corresponding connecting hardware has been crash-tested and passes MASH criteria.

- ▶ If your state barrier geometry is consistent with generic styles such as f-shape, jersey shape or constant slope, it is likely the barrier has been tested either by your state or by a coalition of states working together.
- ▶ If your precast barrier will be used on a project on or after Dec. 31, 2019, it must have passed a MASH crash test.
- ▶ If your precast barrier will be used on a construction project as a temporary safety device and was manufactured prior to Dec. 31, 2019, it may still be employed on that and other construction projects, but shall at least meet NCHRP 350 criteria and be used throughout its normal service life.

Regardless of where you believe your barrier status is at this point, it is important to contact your local DOT to discuss what appropriate policy regarding precast concrete barriers will be implemented in light of the latest FHWA directives. ■

*Eric Carleton, P.E., is NPCA's director of codes and standards.*

#### RESOURCES:

- 1 NCHRP 350, [trb.org/Main/Blurbs/160283.aspx](http://trb.org/Main/Blurbs/160283.aspx)
- 2 MASH 2016 2nd Edition, [bookstore.transportation.org/Item\\_details.aspx?id=2707](http://bookstore.transportation.org/Item_details.aspx?id=2707)
- 3 [roadsystems.com/pdf/nchrp-mash/MASH-Update-Sept2009.pdf](http://roadsystems.com/pdf/nchrp-mash/MASH-Update-Sept2009.pdf)
- 4 Jan. 7, 2016, FHWA Memo safety.fhwa.dot.gov/roadway\_dept/countermeasures/reduce\_crash\_severity/docs/memo\_joint\_implementation\_agmt.pdf
- 5 Jan. 7, 2016, FHWA Memo FAQ, safety.fhwa.dot.gov/roadway\_dept/countermeasures/faqs/docs/aqs\_mash\_implementation\_agmt.pdf
- 6 FHWA FAQ website, safety.fhwa.dot.gov/roadway\_dept/countermeasures/faqs/
- 7 GAO Report, [gao.gov/products/GAO-16-575](http://gao.gov/products/GAO-16-575)
- 8 May 26, 2017, FHWA Memo, safety.fhwa.dot.gov/roadway\_dept/countermeasures/reduce\_crash\_severity/openletter052617.cfm
- 9 FHWA website, safety.fhwa.dot.gov/roadway\_dept/countermeasures/reduce\_crash\_severity/

**!**  
**Contact your local DOT** to discuss what **appropriate policy** regarding precast concrete barriers will be **implemented** in light of the latest FHWA directives.

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