

Tech Brief

May 2019

Midwest Guardrail System (MGS)

CATEGORY: Design (The following information is based on the current North Dakota Department of Transportation (NDDOT) Standard Drawings as well as recent research results).

ISSUE: Standard strong-post W-beam, referred to in North Dakota as "w-beam guardrail 28 inch", or "G4", has been one of the most widely used traffic barriers in the United States. Recent testing with today's high center of gravity vehicles however has shown it to be near or at its performance limits in high speed, high angle roadside crashes. A new non-proprietary design, the Midwest Guardrail System (MGS) has been successfully crash-tested, both under NCHRP 350 and MASH at Test Level 3 (TL-3), and has been adopted by NDDOT as their standard w-beam system.

OBJECTIVE: To provide information on the MGS and some of its design flexibility to NDDOT design engineers and other personnel who may have responsibilities for designing, installing, inspecting, or maintaining this design. NDDOT's current detailed drawings for the MGS system were originally adopted in 2017; this system is in compliance with the AASHTO/FHWA Agreement for MASH implementation.

METHODOLOGY: This Technical Brief will describe the MGS characteristics and identify the types of locations for which variations of the design have been successfully crash-tested. For additional information please see the FHWA website at http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/, the Midwest Roadside Safety Facility Pooled Fund website at <http://mwrsf-qa.unl.edu/>, and the Texas Transportation Institute Pooled Fund website at <https://www.roadsidepooledfund.org/>.



MASH TL-3 Test of MGS Transition to Thrie-beam

EXPECTED RESULTS:

Provide NDDOT design engineers and others with summary information on the Midwest Guardrail System (MGS).

BASIC MGS DESIGN: The major differences from the standard guardrail are the shifting of the W-beam rail splices from the posts to mid-span between posts, and the raising of the rail height to 31". This provided a stronger system and better performance with higher center-of-gravity/bumper height pick-up vehicles. MGS uses the same 6' long wood post, rail element (with five holes punched per 12' section), and 8" block as the standard guardrail.



MGS DEFLECTION: The standard MGS (6'-3" post spacing) resulted in a somewhat increased dynamic deflection when MASH tested. Crash test with wood post resulted in a working width of 53.8 to 58.4 inches. (Ref. FHWA letters B-230 and 230A.) (Since the NDDOT's Design Manual has not been updated for the MGS, the allowable offsets have not been found.)

MGS SOIL BACKING: Standard guidance for installation of guardrail (MGS and "G4") is a minimum 10H:1V slope into the face of the rail, and 2 ft. minimum of 10H:1V slope behind the post; this is shown on D-764-49. When this is not practical to provide, the MGS has been successfully crash-tested to MASH with the standard 6' post placed right at the slope break point (reference: FHWA letter B-211, dated 06/10/11). The MGS has also been successfully crash tested with an 8' long steel post with 8" block only placed 1' down a 2:1 slope from the slope break point (reference: FHWA letter B- 261, dated 12/22/16).

MGS WITH CURBS: The standard MGS system (12" block with steel post) has been successfully crash tested under MASH at TL-3 with a 6" curb placed 6" in front of the face of the rail. For lower speed (≤ 45 mph) locations, the MGS system has been successfully tested to MASH at TL-2 when located 6 feet behind (selected as the worst case scenario) the face of a 6-inch high vertical concrete curb.

MGS LONG-SPAN GUARDRAIL AND OMITTED POST: As with standard "G4" guardrail, an MGS design has been developed for use when guardrail posts must be "left out", e.g., when the guardrail crosses a low-fill culvert. Unlike the standard "G4" guardrail missing post designs, the MGS system does not require nested rail in the clear span. Testing has shown that a single post can be omitted if there is not a curb present without any additional modification (i.e. no weakened wood posts or nesting). For 2 and 3 missing posts, three CRT posts with 12 inch blockout and standard post spacing are placed on each side of the span (25-foot maximum) to reduce any snagging potential. Since larger deflections can be expected, nothing protruding more than 4" should be allowed behind the rail to avoid "tripping" the vehicle. Omitted post designs should ONLY be used in standard guardrail runs and should be separated by a minimum of 50 ft between additional missing post situations. Missing post designs may not be used with terminal or transition designs.



MGS TRANSITION DESIGN: The MGS system is compatible with most existing Thrie-beam to rigid barrier/bridge railing transition designs with the use of a non-symmetrical W-beam to Thrie beam transition section and a modified post layout. The recommended design was successfully crash-tested under MASH criteria. Refer to NDDOT Standard Drawing D764-60.



MGS TRANSITION TO 28" GUARDRAIL: You should transition from a 27-3/4 inch tall barrier or terminal to a 31-inch tall barrier over the span of two 12-foot, 6-inch pieces of w-beam rail. When replacing or repairing long portions of a damaged rail the new rail should be installed at the proper design height, transitioning down to the existing rail over the length of two 12 foot, 6- inch pieces of rail at either end.

MGS TERMINALS: Several terminal designs have been modified or developed so they can be used to terminate the 31-inch high MGS design. These changes generally involve shallower embedment of standard terminal posts so the terminal railing matches the 31-inch height and developing adequate anchorage. MASH 16 terminals (parallel, energy-absorbing) are available.