Mr. Scott K. Rosenbaugh  
Research Associate Engineer  
Midwest Roadside Safety Facility  
University of Nebraska-Lincoln  
527 Nebraska Hall  
Lincoln, Nebraska 38588-0529

Dear Mr. Rosenbaugh:

This letter is in response to your request for the Federal Highway Administration (FHWA) acceptance of a roadside safety system for use on the National Highway System (NHS).

Name of system: Vertical-Faced, Concrete Median Barrier Incorporating Head Ejection Criteria  
Type of system: Concrete Median Barrier  
Test Level: NCHRP Report 350 TL 5 & MASH-08 TL 5  
Testing conducted by: Midwest Roadside Safety Facility  
Date of request: February 27, 2008  
Date of completed package: October 14, 2008


Requirements

Roadside safety systems should meet the guidelines contained in the NCHRP Report 350, "Recommended Procedures for the Safety Performance Evaluation of Highway Features". FHWA Memorandum “ACTION: Identifying Acceptable Highway Safety Features” of July 25, 1997, provides further guidance on crash testing requirements of longitudinal barriers. You have also chosen to anticipate the adoption of MASH-08, an option that FHWA has offered with the understanding that additional testing may need to be done if changes to the test criteria are made before MASH-08 is formally adopted.
Description
This concrete median barrier is intended to safely redirect vehicles ranging from small cars to fully-loaded tractor trailers, while (1) maximizing stability in passenger vehicles by limiting wheel climb and roll, (2) addressing occupant safety by limiting peak impact forces, (3) preventing head slap, and (4) providing an economical alternative to existing concrete barrier designs. The profile of the upper 8 inches of the barrier is set back to accommodate a “head ejection envelope” which was determined through an analysis of previous full-scale crash tests involving passenger vehicles impacting vertical-faced barriers and other rigid concrete barriers. The geometry of this setback directly applies only to rigid barriers with a vertical or near vertical face, and for belted occupants meeting the measurements of the Hybrid III 50 and 95 percentile male dummies.

The final barrier cross section design is shown in the drawings which are enclosed for reference. Also shown is the barrier end section with a footer whose function is to provide sufficient torsion resistance to match the overturning moment of the end section.

Crash Testing
Full-scale crash testing was conducted with a tractor-trailer rig having a test inertial weight of 36,154 kg (79,538 pounds) following NCHRP Report 350 Test 5-12 and MASH-08 Test 5-12. The enclosed test data summary page shows the impact velocity was 84.9 km/hr (55.7 mi/hr) at an angle of 15.4 degrees. During the impact, the maximum roll angle of the truck was 22.8 degrees. Although the dynamic deflection of the barrier was negligible (38 mm, or about 1.5 inches), the “working width” considering the incursion of the box over the top of the barrier was 1894 mm (75 inches).

Findings
The concrete median barrier adequately contained and redirected the vehicle without permanent displacements of the barrier. Vehicle roll, pitch, and yaw angular displacements were deemed acceptable, because they did not adversely influence occupant risk safety criteria nor cause rollover. After collision, the vehicle rode down the face of the barrier and did not intrude into adjacent traffic lanes. Thus, the vehicle’s exit angle was less than 60 percent of the impact angle. Therefore, test TL5CMB-2 conducted on a concrete median barrier was determined to be acceptable according to the TL-5 safety performance criteria found in NCHRP Report 350. Note, the test also satisfies all evaluation criteria for test 5-12 found in MASH-08.

Therefore, the system described above and detailed in the enclosed drawings is acceptable for use on the NHS under the range of conditions tested, when such use is acceptable to a highway agency.

As NCHRP Report 350 does not have mandatory evaluation criteria regarding vehicle occupants contacting the hardware outside of the occupant compartment, this letter is limited to accepting the performance as a median barrier to contain and redirect vehicles, with no implication that head ejection criteria is a requirement. However, MASH-08 does identify the safety risk involved with occupants extending out of the vehicle and coming into direct contact with the test article in Section 4.2.1.5, Paragraph 2. This guidance recommends that dummies are to be
placed in the front seat on the impact side of passenger vehicles during tests of longitudinal barriers taller than 33 inches. Although a passenger vehicle test was not performed, the barrier geometry was designed to prevent such occupant-barrier contact.

Please note the following standard provisions that apply to FHWA letters of acceptance:

- This acceptance is limited to the crashworthiness characteristics of the systems and does not cover their structural features, nor conformity with the Manual on Uniform Traffic Control Devices.
- Any changes that may adversely influence the crashworthiness of the system will require a new acceptance letter.
- Should the FHWA discover that the qualification testing was flawed, that in-service performance reveals unacceptable safety problems, or that the system being marketed is significantly different from the version that was crash tested, we reserve the right to modify or revoke our acceptance.
- You will be expected to supply potential users with sufficient information on design and installation requirements to ensure proper performance.
- You will be expected to certify to potential users that the hardware furnished has essentially the same chemistry, mechanical properties, and geometry as that submitted for acceptance, and that it will meet the crashworthiness requirements of the FHWA and the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of acceptance is designated as number B-182 and shall not be reproduced except in full. This letter and the test documentation upon which it is based are public information. All such letters and documentation may be reviewed at our office upon request.
- This acceptance letter shall not be construed as authorization or consent by the FHWA to use, manufacture, or sell any patented system for which the applicant is not the patent holder. The acceptance letter is limited to the crashworthiness characteristics of the candidate system, and the FHWA is neither prepared nor required to become involved in issues concerning patent law. Patent issues, if any, are to be resolved by the applicant.

Sincerely yours,

David A. Nicol
Director, Office of Safety Design
Office of Safety
Design Notes:

4.0 ksi minimum 28-day compressive concrete strength
60.0 ksi minimum steel yield strength (Grade 60 Rebar)
2.5" clear cover over all stirrups

NOTE:
(1) Asphalt wearing surface is flush with concrete mat
(2) Gap located between downstream end of barrier and concrete mat
(3) Gap located between upstream end of barrier and concrete mat
(4) Cold joint located 93.8' from end of barrier
(5) Impact location is 30' downstream of the upstream end of the barrier

TL-5 Concrete Median Barrier
System Layout
Midwest Roadside Safety Facility
<table>
<thead>
<tr>
<th>Item No.</th>
<th>QTY</th>
<th>Pin Diameter</th>
<th>Length</th>
<th>Material Spec</th>
<th>Bar Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>b1</td>
<td>99</td>
<td>--</td>
<td>240</td>
<td>Grade 60 Steel</td>
<td>No. 4</td>
<td>Longitudinal Bar, 11 per Section</td>
</tr>
<tr>
<td>b2</td>
<td>118</td>
<td>2.5&quot;</td>
<td>111 1/2&quot;</td>
<td>Grade 60 Steel</td>
<td>No. 5</td>
<td>Vertical Stirrup</td>
</tr>
<tr>
<td>b3</td>
<td>80</td>
<td>--</td>
<td>24&quot;</td>
<td>Grade 60 Steel</td>
<td>No. 4</td>
<td>Vertical Dowel</td>
</tr>
<tr>
<td>b4</td>
<td>11</td>
<td>--</td>
<td>Not less than 7/2&quot;</td>
<td>Grade 60 Steel</td>
<td>No. 6</td>
<td>Longitudinal &quot;Fill&quot; Bar, spliced with Left End Section and with remaining length of barrier section to close cage</td>
</tr>
<tr>
<td>c1</td>
<td>22</td>
<td>--</td>
<td>150&quot;</td>
<td>Grade 60 Steel</td>
<td>No. 6</td>
<td>End Section Longitudinal Bar, 11 per End Section</td>
</tr>
<tr>
<td>c2</td>
<td>24</td>
<td>4.5&quot;</td>
<td>147&quot;</td>
<td>Grade 60 Steel</td>
<td>No. 6</td>
<td>End Section Stirrup</td>
</tr>
<tr>
<td>c3</td>
<td>32</td>
<td>--</td>
<td>138&quot;</td>
<td>Grade 60 Steel</td>
<td>No. 6</td>
<td>End Section Footer Longitudinal Bar, 16 per End Section</td>
</tr>
<tr>
<td>c4</td>
<td>48</td>
<td>4.5&quot;</td>
<td>141&quot;</td>
<td>Grade 60 Steel</td>
<td>No. 6</td>
<td>End Section Footer Stirrup</td>
</tr>
</tbody>
</table>

**Vertical Stirrup**
Part b2

**Vertical Dowel**
Part b3

**End Section Longitudinal Bar**
Part c1

**End Section Footer Longitudinal Bar**
Part c4

**Longitudinal "Fill" Bar**
Part b4
Figure 65. Summary of Test Results and Sequential Photographs, Test TL5CMB-2