U.S. Department of Transportation
Federal Highway Administration

1200 New Jersey Ave., SE
Washington, D.C. 20590

August 19, 2011

In Reply Refer To:
HSST/ B-41A

Mr. Robert Bielenberg
Research Associate Engineer
Midwest Roadside Safety Facility
130 Whittier Research
2200 Vine Street
Lincoln, NE 68583-0853

Dear Mr. Bielenberg:

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:	End-to-End Approach Transition between F-shape Temporary Concrete Barrier and Permanent Concrete Median Barrier
Type of system:	Thrie Beam Transition
Test Level:	AASHTO Manual for Assessing Safety Hardware (MASH) Test Level 3
Testing conducted by:	Midwest Roadside Safety Facility
Date of request:	December 28, 2010

You requested that we find this system acceptable for use on the NHS under the provisions of the American Association of State Highway and Transportation Officials (AASHTO) “Manual for Assessing Safety Hardware” (MASH).

Requirements
Roadside safety devices should meet the guidelines contained in the MASH.

Decision
The following device was found acceptable, with details provided below:

- Thrie Beam Transition between F-shape Temporary Concrete Barrier and Permanent Concrete Median Barrier

Description

The following combinations of barrier were researched to determine the type of permanent concrete barrier that would be the most critical when used in an approach transition. To make this determination, the shapes of various permanent median barrier designs were compared to the shape of both the narrow and wide versions of the 32 inches (813 millimeters) tall F-shape temporary barrier. The following comparisons were completed:

1. 32-inch (813- millimeter) F-shape temporary barrier to 32-inch and 42-inch (813- millimeter and 1,067- millimeter) F-shape and New Jersey (NJ) -shape median barriers,
2. 32-inch (813- millimeter) F-shape temporary barrier to 32-inch and 42-inch (813- millimeter and 1,067- millimeters) Texas (TX) and California (CA) single-slope median barriers,
3. 32-inch (813- millimeter) F-shape temporary barrier to 32-inch and 42-inch (813- millimeter and 1,067- millimeter) vertical median barriers,
4. 32-inch (813- millimeter) wider F-shape temporary barrier to 32-inch and 42-inch (813-millimeter and 1,067-millimeter) F-shape and NJ-shape median barriers,
5. 32-inch (813- millimeter) wider F-shape temporary barrier to 32-inch and 42-inch (813-millimeter and 1,067- millimeter) TX and CA single-slope median barriers,
6. 32-inch (813- millimeter) wider F-shape temporary barrier to 32-inch and 42-inch (813-millimeter and 1,067- millimeter) vertical median barriers.

From the comparison of the various shapes, it was determined that the 42 inches. (1,067 millimeters) tall CA single-slope median barrier provided the worst case situation. Comparison of the F-shape temporary barrier geometry with the single-slope barrier showed that there was a high potential for vehicle snag on the sides of the permanent barrier as well as on the 10 inches (254 millimeters) height difference of the barriers. It was determined that shifting the temporary barrier toward the traffic-flow side of the single-slope so that the slope breakpoint at the top of the toe of the temporary barrier lines up with the traffic-side face of the permanent single slope would help alleviate some of the snag potential on the single-slope barrier. This asymmetrical placement would only present a safety concern if the temporary barrier were used to separate traffic flowing in the same direction, such as in a gore area. However, it was believed that this situation would be better treated with a barrier end treatment.

The 166 feet 10inches (50.9 meters) long test installation details for a transition from temporary concrete barriers to a permanent concrete barrier are shown in Figures 4 through 20. The test installation consisted of a rigid parapet, four transition barriers, eight free-standing barriers on the upstream end, and a transition cap. The transition and free-standing barriers were installed on a 3 inches (76 millimeters) thick asphalt pad. The transition utilized a varied spacing of the asphalt pin tie-down system to create a transition in stiffness over a series of four barrier segments. The asphalt pins used in the design were 1½ inches (38 millimeters) diameter x 38½ inches (978 millimeters) long ASTM A36 steel pins with 3 inches x 3 inches x ½-inch (76 millimeters x 76 millimeters x 13 millimeters) ASTM A36 steel cap plates with a 1½ inches (38.1 millimeters) diameter hole in the center. The steel cap was welded on to the pin on both the top and bottom surfaces of the plate at a position of 36 inches (914 millimeters) from the bottom of the pin to the top of the plate. These pins were installed in the holes on both the front and back faces of the four barriers in the transition section of the installation. The first barrier in the transition (the one adjacent to the free-standing barrier) had a single pin at the downstream end on both the front and back sides. The second barrier had pins installed at the two outermost hole locations on both the front and back faces. The final two barriers had all three pins installed on both the front and back faces.

In order to reduce the potential vehicle snag at the joint between the pinned barriers and the rigid parapet, a transition cap and nested thrie beam sections were added. The nested 12-gauge thrie beam sections were bolted across both sides of the barrier at the joint between the pinned barrier and the rigid parapet. It should be noted that 10-gauge thrie beam can be substituted for the nested 12-gauge in actual installations if desired. The thrie beam was bolted to the barriers using five ¾-inch (19 millimeters) diameter x 6 inches (152 millimeters) long, Power Fasteners Wedge-Bolt Anchors at each end of the beam, as shown in Figure 16. In addition, the middle of the thrie section was attached to the pinned barrier with two ¾-inch (19 millimeters) diameter Grade 5 bolts and ¾-inch (19 millimeters) diameter RedHead Multi-Set II Drop-in Anchors. A wooden spacer block was used to offset the thrie beam from the concrete barrier on the back side of the installation. The two bolts on the front face were 1 ¾ in. (44 mm) long, while the two on the back face were 5 ½ inches (140 millimeters) long. The 12-gauge ASTM A36 steel cap was 6 1/16 inches (154 millimeters) and 8 1/8 inches (206 millimeters) wide at the top and bottom, respectively, with a height of 10 inches (254 millimeters). Four 12-gauge ASTM A36 gussets were stitch welded on three sides inside the cap.

The concrete barrier utilized of Iowa's Concrete Barrier Mix, which was configured with a minimum 28-day concrete compressive strength of 5,000 psi (34.5 MPa). A minimum concrete cover varied at different rebar positions within the barrier. A minimum concrete cover of 2 inches (51 millimeters) was used along the top of the vertical stirrup rebar and at the bottom of the longitudinal rebar. Minimum concrete cover of 1 ¾ inches (44 millimeters) and 1-inch (25 millimeters) were used along the sides of the vertical stirrup rebar and at the rebar around the anchor bolt block, respectively. All steel reinforcement in the barrier conformed to ASTM A615 Grade 60 rebar, except for the loop bars which were ASTM A706 Grade 60 rebar. The barrier reinforcement details are shown in Figure 11. Barrier reinforcement consisted of three No. 5 and two No. 4 longitudinal bars, twelve No.4 bars for the vertical stirrups, and six No. 6 bars for the anchor bolt block reinforcement loops. Each of the five longitudinal rebar was 12 feet 2 inches (3.71 meters) long. The vertical spacing of the lower, middle, and upper longitudinal bars were 6 ½ inches (165 millimeters), 14 ½ inches (368 millimeters), and 29 1/8 inches (780 millimeters) from the ground to their centers, respectively. The vertical stirrups were 72 inches (1,829 millimeters) long and were bent into the shape of the barrier and their spacing varied longitudinally. The reinforcing steel loops used around the tie-down anchor holes in the barrier were 35 inches (889 millimeters) long, were bent into a U-shape, and were used to reinforce the anchor bolt area. The barriers used a pin and loop type connection comprised of two sets of three rebar loops on each barrier interconnection. Each loop assembly was configured with three ASTM A706 Grade 60 No. 6 bars that were bent into a loop shape. The vertical pin used in the connection consisted of a 1 ¼ inches (32 millimeters) diameter x 28 inches (711 millimeters) long round bar comprised of ASTM A36 steel. The pin was held in place using one 2 ½ inches wide x 4 inches long x ½-inch thick (64 millimeters x 102 millimeters x 13 millimeters) ASTM A36 steel plate with a 1 3/8 inches (35 millimeters) diameter hole centered on it. The plate was welded 2 ½ inches (64 millimeters) below the top of the pin. A gap of 3 5/8 inches (92 millimeters) between the ends of two consecutive barriers was formed from the result of pulling the connection taut. The single-slope permanent concrete barrier was 21 ½ inches (545 millimeters) and 8 inches (203 millimeters) wide at the base and top, respectively, with an overall height of 42 inches (1,067 millimeters) from the ground to the top of the barrier. The single-slope concrete barrier had a overall length of 13 feet 4 inches (4,064 millimeters). The concrete used for the barrier consisted of Nebraska 47-BD Mix Type 3, with a minimum 28-day concrete compressive strength of 5,000 psi (34.5 MPa). A minimum concrete cover of 2 inches (51 millimeters) was used along the entire barrier. All the steel reinforcement in the barrier was ASTM A615 Grade 60 rebar. The barrier reinforcement details, which consisted of ten No. 5 longitudinal bars and fourteen No. 4 and thirteen No. 6 bars for the vertical stirrups are shown in Figures 12 and 14. The single-slope barrier employed a 30 inches deep by 36 inches wide (762 millimeters x 914 millimeters) reinforced concrete footing at its base. The footing was tied to the single slope barrier with fourteen No. 6 vertical stirrups that were tied to the No. 4 vertical stirrups in the barrier with No. 5 bars.

Crash Testing

Approach transitions, such as temporary concrete barrier transitions, must satisfy impact safety standards in order to be accepted by the Federal Highway Administration (FHWA) for use on National Highway Systems (NHS) construction projects or as a replacement for existing designs not meeting current safety standards. According to TL-3 of MASH, longitudinal barriers must be subjected to two full-scale vehicle crash tests. The two full-scale crash tests are as follows:

1. Test Designation 3-20, consisting of a 2,425-lb (1,100-kg) small car impacting the barrier system at a nominal speed and angle of 62.1 mph (100.0 km/h) and 25 degrees, respectively.
2. Test Designation 3-21, consisting of a 5,004-lb (2,270-kg) pickup truck impacting the barrier system at a nominal speed and angle of 62.1 mph (100 km/h) and 25 degrees, respectively.

A rigid, F-shaped bridge rail was successfully impacted by a small car weighing 1,800 lb (893 kg) at 60.1 mph (96.7 km/h) and 21.4 degrees according to the American Association of State Highway and Transportation Officials (AASHTO) Guide Specifications for Bridge Railings. In the same manner, rigid New Jersey safety shape barriers struck by small cars have also been shown to meet safety performance standards. In addition, a New Jersey safety shape barrier was impacted by a passenger car weighing 2,579 lb (1,170 kg) at 60.8 mph (97.9 km/h) and 26.1 degrees according to the TL-3 standards set forth in MASH. Furthermore, temporary New Jersey safety shape concrete median barriers have experienced only slight barrier deflection when impacted by small cars and behave similar to rigid barriers. The transition was designed to prevent any vehicle snag for the small car or truck with no exposed face of barrier when traffic is flowing in opposing directions. This asymmetrical placement would only present a safety concern if the temporary barrier were used to separate traffic flowing in the same direction, such as in a gore area. As such, 2,425-lb (1,100-kg) passenger car test was deemed unnecessary for this project.

Two Critical Impact Points (CIP's) needed to be evaluated for the approach transition. The first CIP was located adjacent to the point where the transition attaches to the permanent barrier and is used to evaluate snag and pocketing near the hazard. The second CIP was located near the upstream end of the transition and is used to evaluate the stiffness transition, which can cause pocketing and vehicle instability. LS-DYNA was used to determine the CIP (as just upstream of barrier 4) for the second full-scale crash test on the TCB transition, test TCBT-2. For this CIP, barrier deflections are expected potentially causing pocketing in the system resulting in potentially unstable vehicle behavior or vehicle override of the system. A detailed model of the TCB was built and impacted at various locations along the barrier to determine the likely CIP. It should be noted that the CIP for the downstream CIP adjacent to permanent barrier was chosen as 4.3 feet (1.3 meters) upstream of the permanent barrier. This value is based on guidance for CIP values for rigid barriers and temporary concrete barriers provided in Table 2.6 in MASH. It represents the distance upstream of a post or joint in a rigid barrier that has increased potential for vehicle snag. Due to the high stiffness of the anchored temporary concrete barrier sections adjacent to the permanent barrier, it was believed that this CIP location would be sufficient to determine the potential for snag on the rigid median barrier.

Test TCBT-1:
The 5,175-lb (2,347-kg) pickup truck impacted the temporary concrete barrier to permanent barrier transition, at a speed of 62.5 mph (100.6 km/h) and at an angle of 24.7 degrees. Test no. TCBT-1 was performed to evaluate the transition directly adjacent to the permanent median barrier. A summary of the test results and sequential photographs are included in the correspondence as an enclosure.

The analysis of the test results for test no. TCBT-1 showed that the temporary concrete barrier to permanent concrete barrier transition adequately contained and redirected the 2270P vehicle without significant permanent displacement of the barrier. There were no detached elements or fragments which neither showed potential for penetrating the occupant compartment nor presented undue hazard to other traffic. Deformations or intrusion into the occupant compartment that could have caused serious injury did not occur. The test vehicle did not penetrate nor ride over the guardrail system and remained upright during and after the collision. Vehicle roll, pitch, and yaw angular displacements were noted, but they were deemed acceptable because they did not adversely influence occupant risk safety criteria nor cause rollover. After impact, the vehicle exited the barrier at an angle of 4.2 degrees and its trajectory did not violate the bounds of the exit box. Therefore, test no. TCBT-1 conducted on the temporary concrete barrier to permanent barrier concrete transition was determined to be acceptable according to the TL-3 safety performance criteria of test designation no. 3-21 found in MASH.

Test TCBT-2:
The 5,160-lb (2,341-kg) pickup truck impacted the temporary concrete barrier to permanent concrete barrier transition at a speed of 62.2 mph (100.1 km/h) and at an angle of 26.2 degrees. Test no. TCBT-2 was performed to evaluate the upstream end of the approach transition. A summary of the test results and sequential photographs are included in the correspondence as an enclosure.

The analysis of the test results for test no. TCBT-2 showed that the temporary concrete barrier to permanent concrete barrier transition adequately contained and redirected the 2270P vehicle. There were no detached elements or fragments which neither showed potential for penetrating the occupant compartment nor presented undue hazard to other traffic. Deformations of, or intrusion into, the occupant compartment that could have caused serious injury did not occur. The test vehicle did not penetrate nor ride over the guardrail system and remained upright during and after the collision. Vehicle roll, pitch, and yaw angular displacements were noted, but they were deemed acceptable because they did not adversely influence occupant risk safety criteria nor cause rollover. After collision, the vehicle's trajectory revealed minimum intrusion into adjacent traffic lanes. The vehicle did not exit the barrier within the exit box yet still exited the barrier smoothly. Therefore, test no. TCBT-2 conducted on the temporary concrete barrier to permanent concrete barrier transition was determined to be acceptable according to the TL-3 safety performance criteria of test designation no. 3-21 found in MASH.

Findings

We concur with the analysis of presented crash test results, including consideration of previous successfully conducted Test Designation 3-20, 2,425-lb (1,100-kg) passenger car test in deeming this particular crash test unnecessary for this project. Therefore, the system described in the requests 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.

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

- This acceptance provides a AASHTO/ARTBA/AGC Task Force 13 designator that should be used for the purpose of the creation of a new and/or the update of existing Task Force 13 drawing for posting on the on-line 'Guide to Standardized Highway Barrier Hardware' currently referenced in AASHTO 'Roadside Design Guide'.
- 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 AASHTO MASH.
- To prevent misunderstanding by others, this letter of acceptance is designated as number B-41A 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,

Michael S. Griffith
Director, Office of Safety Technologies
Office of Safety

Enclosures

U.S. Department
of Transportation
Federal Highway
Administration

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Washington, D.C. 20590

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Decision
The following device was found acceptable, with details provided below:

- Thrie Beam Transition between F-shape Temporary Concrete Barrier and Permanent Concrete Median Barrier

Description
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From the comparison of the various shapes, it was determined that the 42 inches. (1,067 millimeters) tall CA single-slope median barrier provided the worst case situation. Comparison of the F-shape temporary barrier geometry with the single-slope barrier showed that there was a high potential for vehicle snag on the sides of the permanent barrier as well as on the 10 inches (254 millimeters) height difference of the barriers. It was determined that shifting the temporary barrier toward the traffic-flow side of the single-slope so that the slope breakpoint at the top of the toe of the temporary barrier lines up with the traffic-side face of the permanent single slope would help alleviate some of the snag potential on the single-slope barrier. This asymmetrical placement would only present a safety concern if the temporary barrier were used to separate traffic flowing in the same direction, such as in a gore area. However, it was believed that this situation would be better treated with a barrier end treatment.

The 166 feet 10inches (50.9 meters) long test installation details for a transition from temporary concrete barriers to a permanent concrete barrier are shown in Figures 4 through 20. The test installation consisted of a rigid parapet, four transition barriers, eight free-standing barriers on the upstream end, and a transition cap. The transition and free-standing barriers were installed on a 3 inches (76 millimeters) thick asphalt pad. The transition utilized a varied spacing of the asphalt pin tie-down system to create a transition in stiffness over a series of four barrier segments. The asphalt pins used in the design were 1½ inches (38 millimeters) diameter x 38½ inches (978 millimeters) long ASTM A36 steel pins with 3 inches x 3 inches x ½-inch (76 millimeters x 76 millimeters x 13 millimeters) ASTM A36 steel cap plates with a 1½ inches (38.1 millimeters) diameter hole in the center. The steel cap was welded on to the pin on both the top and bottom surfaces of the plate at a position of 36 inches (914 millimeters) from the bottom of the pin to the top of the plate. These pins were installed in the holes on both the front and back faces of the four barriers in the transition section of the installation. The first barrier in the transition (the one adjacent to the free-standing barrier) had a single pin at the downstream end on both the front and back sides. The second barrier had pins installed at the two outermost hole locations on both the front and back faces. The final two barriers had all three pins installed on both the front and back faces.

In order to reduce the potential vehicle snag at the joint between the pinned barriers and the rigid parapet, a transition cap and nested thrie beam sections were added. The nested 12-gauge thrie beam sections were bolted across both sides of the barrier at the joint between the pinned barrier and the rigid parapet. It should be noted that 10-gauge thrie beam can be substituted for the nested 12-gauge in actual installations if desired. The thrie beam was bolted to the barriers using five ¾-inch (19 millimeters) diameter x 6 inches (152 millimeters) long, Power Fasteners Wedge-Bolt Anchors at each end of the beam, as shown in Figure 16. In addition, the middle of the thrie section was attached to the pinned barrier with two ¾-inch (19 millimeters) diameter Grade 5 bolts and ¾-inch (19 millimeters) diameter RedHead Multi-Set II Drop-in Anchors. A wooden spacer block was used to offset the thrie beam from the concrete barrier on the back side of the installation. The two bolts on the front face were 1 ¾ in. (44 mm) long, while the two on the back face were 5 ½ inches (140 millimeters) long. The 12-gauge ASTM A36 steel cap was 6 1/16 inches (154 millimeters) and 8 1/8 inches (206 millimeters) wide at the top and bottom, respectively, with a height of 10 inches (254 millimeters). Four 12-gauge ASTM A36 gussets were stitch welded on three sides inside the cap.

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2. Test Designation 3-21, consisting of a 5,004-lb (2,270-kg) pickup truck impacting the barrier system at a nominal speed and angle of 62.1 mph (100 km/h) and 25 degrees, respectively.

A rigid, F-shaped bridge rail was successfully impacted by a small car weighing 1,800 lb (893 kg) at 60.1 mph (96.7 km/h) and 21.4 degrees according to the American Association of State Highway and Transportation Officials (AASHTO) Guide Specifications for Bridge Railings. In the same manner, rigid New Jersey safety shape barriers struck by small cars have also been shown to meet safety performance standards. In addition, a New Jersey safety shape barrier was impacted by a passenger car weighing 2,579 lb (1,170 kg) at 60.8 mph (97.9 km/h) and 26.1 degrees according to the TL-3 standards set forth in MASH. Furthermore, temporary New Jersey safety shape concrete median barriers have experienced only slight barrier deflection when impacted by small cars and behave similar to rigid barriers. The transition was designed to prevent any vehicle snag for the small car or truck with no exposed face of barrier when traffic is flowing in opposing directions. This asymmetrical placement would only present a safety concern if the temporary barrier were used to separate traffic flowing in the same direction, such as in a gore area. As such, 2,425-lb (1,100-kg) passenger car test was deemed unnecessary for this project.

Two Critical Impact Points (CIP's) needed to be evaluated for the approach transition. The first CIP was located adjacent to the point where the transition attaches to the permanent barrier and is used to evaluate snag and pocketing near the hazard. The second CIP was located near the upstream end of the transition and is used to evaluate the stiffness transition, which can cause pocketing and vehicle instability. LS-DYNA was used to determine the CIP (as just upstream of barrier 4) for the second full-scale crash test on the TCB transition, test TCBT-2. For this CIP, barrier deflections are expected potentially causing pocketing in the system resulting in potentially unstable vehicle behavior or vehicle override of the system. A detailed model of the TCB was built and impacted at various locations along the barrier to determine the likely CIP. It should be noted that the CIP for the downstream CIP adjacent to permanent barrier was chosen as 4.3 feet (1.3 meters) upstream of the permanent barrier. This value is based on guidance for CIP values for rigid barriers and temporary concrete barriers provided in Table 2.6 in MASH. It represents the distance upstream of a post or joint in a rigid barrier that has increased potential for vehicle snag. Due to the high stiffness of the anchored temporary concrete barrier sections adjacent to the permanent barrier, it was believed that this CIP location would be sufficient to determine the potential for snag on the rigid median barrier.

Test TCBT-1:
The 5,175-lb (2,347-kg) pickup truck impacted the temporary concrete barrier to permanent barrier transition, at a speed of 62.5 mph (100.6 km/h) and at an angle of 24.7 degrees. Test no. TCBT-1 was performed to evaluate the transition directly adjacent to the permanent median barrier. A summary of the test results and sequential photographs are included in the correspondence as an enclosure.

The analysis of the test results for test no. TCBT-1 showed that the temporary concrete barrier to permanent concrete barrier transition adequately contained and redirected the 2270P vehicle without significant permanent displacement of the barrier. There were no detached elements or fragments which neither showed potential for penetrating the occupant compartment nor presented undue hazard to other traffic. Deformations or intrusion into the occupant compartment that could have caused serious injury did not occur. The test vehicle did not penetrate nor ride over the guardrail system and remained upright during and after the collision. Vehicle roll, pitch, and yaw angular displacements were noted, but they were deemed acceptable because they did not adversely influence occupant risk safety criteria nor cause rollover. After impact, the vehicle exited the barrier at an angle of 4.2 degrees and its trajectory did not violate the bounds of the exit box. Therefore, test no. TCBT-1 conducted on the temporary concrete barrier to permanent barrier concrete transition was determined to be acceptable according to the TL-3 safety performance criteria of test designation no. 3-21 found in MASH.

Test TCBT-2:
The 5,160-lb (2,341-kg) pickup truck impacted the temporary concrete barrier to permanent concrete barrier transition at a speed of 62.2 mph (100.1 km/h) and at an angle of 26.2 degrees. Test no. TCBT-2 was performed to evaluate the upstream end of the approach transition. A summary of the test results and sequential photographs are included in the correspondence as an enclosure.

The analysis of the test results for test no. TCBT-2 showed that the temporary concrete barrier to permanent concrete barrier transition adequately contained and redirected the 2270P vehicle. There were no detached elements or fragments which neither showed potential for penetrating the occupant compartment nor presented undue hazard to other traffic. Deformations of, or intrusion into, the occupant compartment that could have caused serious injury did not occur. The test vehicle did not penetrate nor ride over the guardrail system and remained upright during and after the collision. Vehicle roll, pitch, and yaw angular displacements were noted, but they were deemed acceptable because they did not adversely influence occupant risk safety criteria nor cause rollover. After collision, the vehicle's trajectory revealed minimum intrusion into adjacent traffic lanes. The vehicle did not exit the barrier within the exit box yet still exited the barrier smoothly. Therefore, test no. TCBT-2 conducted on the temporary concrete barrier to permanent concrete barrier transition was determined to be acceptable according to the TL-3 safety performance criteria of test designation no. 3-21 found in MASH.

Findings

We concur with the analysis of presented crash test results, including consideration of previous successfully conducted Test Designation 3-20, 2,425-lb (1,100-kg) passenger car test in deeming this particular crash test unnecessary for this project. Therefore, the system described in the requests 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.

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

- This acceptance provides a AASHTO/ARTBA/AGC Task Force 13 designator that should be used for the purpose of the creation of a new and/or the update of existing Task Force 13 drawing for posting on the on-line 'Guide to Standardized Highway Barrier Hardware' currently referenced in AASHTO 'Roadside Design Guide'.
- 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 AASHTO MASH.
- To prevent misunderstanding by others, this letter of acceptance is designated as number B-41A 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,

Michael S. Griffith
Director, Office of Safety Technologies
Office of Safety

Enclosures