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MECHANICAL ENGINEERING DIVISION

May 14, 2020

Mr. Andrew Pardoe
Hill & Smith Ltd.
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Bliston, West Midlands
United Kingdom, WV14 0QL

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Subject: SwRI® Test Summary 18.24846.01.100, “MASH Test 3-17 for Hill & Smith Brifen, Wire Rope Safety Fence with O-Posts”

Dear Mr. Pardoe:

On October 24, 2019, Southwest Research Institute (SwRI) personnel conducted a crash test on the Hill & Smith Brifen, 4-Cable Wire Rope Safety Fence (4-C WRSF-O) with O-Posts. Testing was performed in accordance with the procedures and criteria set forth in American Association of State Highway and Transportation Officials (AASHTO) Manual for Assessing Safety Hardware (MASH), Second Edition (January 2016). Test 3-17 is intended to evaluate the strength of the length-of-need (LON) section in containing and redirecting a 1500A test vehicle. The test involves the 1500A test vehicle striking the critical impact point (CIP) of the barrier while traveling 62 mph and at a 25-degree angle, with the test article installed at the front slope breakpoint of a 4H:1V ditch.

Following the requirements of MASH 2016, the total length of the 4-C WRSF-O test article was approximately 601.5 ft. The total length consisted of four (4) 0.75-inch diameter pre-stretched galvanized steel 3 x 7 cables interwoven around the O-shaped posts and tensioned between 2,720-2,740 lb_f (rated 2,700 lb_f at 100°F). The test article was anchored to the ground at each end using Brifen’s MASH Gating Terminal (MGT). According to Brifen USA, the cables were rated with a minimum breaking strength of 39,000 lb_f and modulus of elasticity after pre-stressing of 11,805,000 psi. Nominal cable spacing was 7 inches in the test section, with the bottom cable approximately 14 inches above the ground. The round posts in the test section were designated HSS2.875x0.132, and were inserted to a depth of 12 inches into steel sockets mechanically driven into the soil until the top of the socket was flush with the ground level. At each end terminal, the first three posts span a total of 36.5 ft. as part of the MGT anchor, and the length-of-need posts were spaced at 21.0 ft.

The 1500A test vehicle used was a 2014 Ford Fusion with vehicle inertial mass of 3,367 lbs., traveling at a speed of 62.2 mph, and impacting at an angle of 25.6 degrees. An anthropometric dummy was placed in the driver’s seat during the test, which resulted in a total test mass of 3,532 lbs.

The results of the crash test are shown in the attached Test Summary Report. Based on these results, this test is considered to have successfully met the requirements of AASHTO MASH 2016 Test 3-17. A formal crash test report will be issued within the coming weeks.

SwRI previously tested the same Brifen MASH O-Post system to MASH Tests 3-11 and 3-12 as documented in FHWA Eligibility Letter B-245 dated 12/17/13. It has been publicly stated by FHWA and AASHTO representatives, most recently at the ATSSA Guardrail Committee meeting held January 25, 2020, that Test 3-17 would become a required test, along with Tests 3-10 and 3-11 to receive FHWA approval. Given that condition, SwRI has determined that the Brifen MASH O-Post was successfully tested to the minimum required tests for MASH 2016 for Cable Barriers.



If you have any questions about the testing performed or the contents of this letter, please advise.

Sincerely,

Handwritten signature of Allen Beavers in black ink.

Allen Beavers, Research Engineer
Structural Dynamics and Product Assurance

Reviewed and Approved by:

Handwritten signature of Jenny Ferren in blue ink.

Jenny Ferren, Manager
Structural Dynamics and Product Assurance

Table 1: Test Requirement Summary

Evaluation Factor	Evaluation Criteria	Conclusion								
Structural Adequacy (see MASH Section 5.2.1)	A. Test article should contain and redirect the vehicle or bring the vehicle to a controlled stop; the vehicle should not penetrate, underide, or override the installation although controlled lateral deflection of the test article is acceptable.	PASS – controlled redirection observed								
Occupant Risk (see MASH Section 5.2.2)	D. Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present undue hazard to other traffic, pedestrians, or personnel in a work zone. Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in MASH Section 5.2.2 and MASH Appendix E.	PASS – no detached pieces from test article observed, occupant compartment deformations did not exceed limits								
	F. The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.	PASS – vehicle remained upright and roll/pitch angles did not exceed 75 degrees								
	H. Occupant impact velocities (OIV) (see MASH Appendix A, Section A5.2.2 for calculation procedure) should satisfy the following limits: <table border="1"> <thead> <tr> <th colspan="3">Occupant Impact Velocity (OIV) Limits, ft./s (m/s)</th> </tr> <tr> <th>Component</th> <th>Preferred</th> <th>Maximum</th> </tr> </thead> <tbody> <tr> <td>Longitudinal and Lateral</td> <td>30 ft./s (9.1 m/s)</td> <td>40 ft./s (12.2 m/s)</td> </tr> </tbody> </table>	Occupant Impact Velocity (OIV) Limits, ft./s (m/s)			Component	Preferred	Maximum	Longitudinal and Lateral	30 ft./s (9.1 m/s)	40 ft./s (12.2 m/s)
Occupant Impact Velocity (OIV) Limits, ft./s (m/s)										
Component	Preferred	Maximum								
Longitudinal and Lateral	30 ft./s (9.1 m/s)	40 ft./s (12.2 m/s)								
I. The occupant ridedown acceleration (see MASH Appendix A, Section A5.2.2 for calculation procedure) should satisfy the following limits: <table border="1"> <thead> <tr> <th colspan="3">Occupant Ridedown Acceleration (ORA) Limits, G</th> </tr> <tr> <th>Component</th> <th>Preferred</th> <th>Maximum</th> </tr> </thead> <tbody> <tr> <td>Longitudinal and Lateral</td> <td>15.0 G</td> <td>20.49 G</td> </tr> </tbody> </table>	Occupant Ridedown Acceleration (ORA) Limits, G			Component	Preferred	Maximum	Longitudinal and Lateral	15.0 G	20.49 G	PASS – longitudinal ORA of -5.6 G and lateral ORA of -4.2 G
Occupant Ridedown Acceleration (ORA) Limits, G										
Component	Preferred	Maximum								
Longitudinal and Lateral	15.0 G	20.49 G								

Table 2: Test 3-17 Results

General Information		Impact Conditions		Post Impact Vehicular Behavior	
Test Agency	SwRI	Speed	62.2 mph	Stopping distance	269 ft. downstream and 5 ft. within V-ditch
Test Category	MASH Test 3-17	Angle	25.6 degrees		
SwRI Test Number	OPS-17	Location	Mid-span Post 18 & 19	Vehicle Stability	
Test Date	October 24, 2019	Target Conditions		Max. Roll	15.4 deg. @ 0.531 sec.
		Nominal Speed	62 mph \pm 2.5 mph	Max. Pitch	-4.0 deg. @ 4.571 sec.
Test Article		Nominal Angle	25° \pm 1.5°	Max. Yaw	-32.6 deg. @ 0.497 sec.
Type	Longitudinal Barrier	Exit Conditions			
Primary Barrier Type	Wire Rope Safety Fence	Speed	0 mph	Test Article Deflection	
System Length	601.5 ft.	Angle	0 degrees	Dynamic	10 ft.
Installation Length	601.5 ft.	Occupant Risk Values		Permanent (barrier top)	3 ft.
Nom. Barrier Height	35.5 in.	Impact Velocity		Permanent (barrier base)	0 in.
Soil		Longitudinal	4.3 mph (1.9 m/s)		
Type of Soil	Standard soil, dry	Lateral	7.2 mph (3.2 m/s)	Vehicle Damage	
		Ridedown Accelerations		VDS	01-RFQ-2
Test Vehicle		Longitudinal	-5.6 G	CDC	01-FREW3
Type/Designation	Passenger Car 1500A	Lateral	-4.2 G	Max Exterior Def.	4 in.
Model	2014 Ford Fusion	THIV	8.3 mph	Max. Occupant Compartment Def.	0.3 in.
Curb Mass	4,450 lbs.	PHD	5.7 G		
Ballast Mass	Included	ASI	0.36		
Test Inertial Mass	3,367 lbs.	Max. 50ms Average			
Dummy Mass	165 lbs.	Longitudinal	-2.0 G		
Gross Static Mass	3,532 lbs.	Lateral	-3.1 G		
		Vertical	-1.7 G		