MASH TEST 5-12 EVALUATION OF TxDOT T80SS BARRIER WITH SOUNDWALL

Test Report 0-7086-R4
Cooperative Research Program

TEXAS A&M TRANSPORTATION INSTITUTE
COLLEGE STATION, TEXAS

TEXAS DEPARTMENT OF TRANSPORTATION

in cooperation with the Federal Highway Administration and the Texas Department of Transportation
The purpose of the test reported herein was to assess the performance of the Texas Department of Transportation (TxDOT) T80SS barrier with soundwall according to the safety-performance evaluation guidelines included in the American Association of State Highway and Transportation Officials (AASHTO) Manual for Assessing Safety Hardware (MASH). The crash test was performed in accordance with MASH Test 5-12, which involves a 36000V vehicle weighing 79,300 lb impacting the longitudinal barrier while traveling at 50 mi/h and 15 degrees.

This report provides details on the TxDOT T80SS barrier with soundwall, a description and results of the crash test, and a performance assessment of the TxDOT T80SS barrier with soundwall for MASH Test 5-12 longitudinal barrier evaluation criteria.

The TxDOT T80SS barrier with soundwall met the performance criteria for MASH Test 5-12 for longitudinal barriers.
MASH TEST 5-12 EVALUATION OF TXDOT T80SS BARRIER WITH SOUNDWALL

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College Station, Texas 77843-3135
DISCLAIMER

This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of FHWA or TxDOT. This report does not constitute a standard, specification, or regulation.

This report is not intended for construction, bidding, or permit purposes. The engineer in charge of the project was Roger P. Bligh, P.E. #78550.

The United States Government and the State of Texas do not endorse products or manufacturers. Trade or manufacturers’ names appear herein solely because they are considered essential to the object of this report.

TTI PROVING GROUND DISCLAIMER

The results of the crash testing reported herein apply only to the article tested.

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Chapter 1. INTRODUCTION

1.1. BACKGROUND

Noise barriers, or soundwalls, are structures designed to abate noise in areas neighboring a highway. Sound sources in the highway environment include vehicle engine and exhaust noise, tire-pavement noise, and aerodynamic noise, which vary by vehicle type and speed. There are many types of soundwall designs. Concrete soundwalls work by redirecting the travel of sound away from a location.

When a soundwall is needed across a bridge structure, design options become more limited. When a truck impacts a bridge rail, the lean of the truck over the top of the bridge rail defines what is referred to as the working width or zone of influence. It is typically impractical and cost prohibitive to locate a bridge-mounted soundwall outside the working width of the bridge rail due to the additional deck width that would be required. If the soundwall is located inside the barrier working width, it must be designed to accommodate the associated vehicle impact loads.

Vehicle impact conditions for the design of longitudinal barriers such as bridge rails are prescribed in MASH. MASH defines six different test levels that increase in impact severity. TxDOT wished to evaluate the impact performance of a concrete soundwall mounted on top of a concrete bridge rail supported on a cantilevered deck to MASH Test Level 5 (TL-5) impact conditions. Such a design can provide a cost-effective, crashworthy solution when a bridge-mounted soundwall is needed.

1.2. OBJECTIVE

The purpose of the test reported herein was to assess the performance of the TxDOT T80SS barrier with soundwall according to the safety-performance evaluation guidelines included in MASH. The crash test was performed in accordance with MASH Test 5-12, which involves a 36000V tractor-van trailer vehicle weighing 79,300 lb impacting the longitudinal barrier while traveling at 50 mi/h and 15 degrees.

This report provides details on the TxDOT T80SS barrier with soundwall, a description and results of the crash test, and a performance assessment of the TxDOT T80SS barrier with soundwall for MASH Test 5-12 longitudinal barrier evaluation criteria.
Chapter 2. SYSTEM DETAILS

2.1. TEST ARTICLE AND INSTALLATION DETAILS

The test installation was 120 ft long and consisted of a steel-reinforced concrete deck, barrier parapet, and soundwall. The 30-inch-wide, 12-inch-thick deck cantilever was anchored to the foundation wall. The single-slope parapet was 42 inches tall, 12 inches wide at top, and 20 inches wide at bottom, with a continuous slope on the traffic side. The field side of the single-slope parapet had a 1½-inch inset from the deck to a height of 19½ inches. The soundwall was 9 inches wide and 54 inches tall, bringing the total height of the parapet soundwall system to 96 inches from grade. The soundwall was centered on the top of the single-slope parapet, providing an offset of 1½ inches from the top traffic and field side corners of the parapet to the faces of the soundwall.

There was a single 2-inch-wide joint through the deck, parapet, and soundwall 30 ft downstream from the end of the installation. This joint was reinforced with four 1-inch-diameter rebar dowels. One end of each dowel was cast into the concrete, and the other side was in a PVC sleeve to allow movement across an expansion joint. Two dowel bars were in the parapet and two were in the sound wall.

Figure 2.1 presents the overall information on the TxDOT T80SS barrier with soundwall, and Figure 2.2 provides photographs of the installation. Appendix A provides further details on the TxDOT T80SS barrier with soundwall. Drawings were provided by the TTI Proving Ground, and construction was performed by MBC Management and supervised by TTI Proving Ground personnel.

2.2. DESIGN MODIFICATIONS DURING TESTS

No modifications were made to the installation during the testing phase.

2.3. MATERIAL SPECIFICATIONS

The specified compressive strength of the concrete used in the support wall, deck, parapet, and soundwall was 4000 psi. The average compressive strengths of the concrete were as follows:

- South of Joint Support wall: 5,530 psi at 86 days of age on June 30, 2021.
- North of Joint Deck: 5475 psi at 91 days of age on June 30, 2021.
- South of Joint Deck: 5,530 psi at 86 days of age on June 30, 2021.
- Barrier North of Expansion Joint: 4,953 psi at 35 days of age on May 19, 2021.
- Barrier South of Expansion Joint: 6,897 psi at 76 days of age on June 30, 2021.
- Soundwall North of Expansion Joint: 5,533 psi at 71 days of age on June 30, 2021.

Appendix B provides material certification documents for the materials used to install/construct the TxDOT T80SS barrier with soundwall.
Figure 2.1. Details of TxDOT T80SS Barrier with Soundwall.
Figure 2.2. TxDOT T80SS Barrier with Soundwall prior to Testing.
Chapter 3. TEST REQUIREMENTS AND EVALUATION CRITERIA

3.1. CRASH TEST PERFORMED/MATRIX

Table 3.1 shows the test conditions and evaluation criteria for MASH TL-5 for longitudinal barriers. This report presents testing of the TxDOT T80SS barrier with soundwall in accordance with MASH Test 5-12 evaluation criteria. The target critical impact point (CIP) for MASH Test 5-12 was determined using the information provided in MASH Section 2.3.2.1 and MASH Table 2-8. Figure 3.1 shows the target CIP for MASH Test 5-12 on the TxDOT T80SS barrier with soundwall, which was 12 inches downstream of the centerline of the joint in the deck, parapet, and soundwall.

Table 3.1. Test Conditions and Evaluation Criteria Specified for MASH TL-5 Longitudinal Barriers.

<table>
<thead>
<tr>
<th>Test Article</th>
<th>Test Designation</th>
<th>Test Vehicle</th>
<th>Impact Conditions</th>
<th>Evaluation Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal Barrier</td>
<td>5-10</td>
<td>1100C</td>
<td>62 mi/h 25°</td>
<td>A, D, F, H, I</td>
</tr>
<tr>
<td></td>
<td>5-11</td>
<td>2270P</td>
<td>62 mi/h 25°</td>
<td>A, D, F, H, I</td>
</tr>
<tr>
<td></td>
<td>5-12</td>
<td>36000V</td>
<td>50 mi/h 15°</td>
<td>A, D, G</td>
</tr>
</tbody>
</table>

Figure 3.1. Target CIP for MASH Test 5-12 on TxDOT T80SS Barrier with Soundwall.

MASH also recommends performing Test 5-10 with the 1100C passenger car and Test 5-11 with the 2270P pickup truck. However, based on the acceptable impact performance of a single-slope barrier of similar profile in previous testing with both design passenger vehicles, these tests were not considered necessary (2, 3). The 1100C passenger car would not interact with the added soundwall. While the pickup truck might have some minimal contact with the offset soundwall, the face of the soundwall is continuous with no edges or surfaces to create snagging.

The crash tests and data analysis procedures were in accordance with guidelines presented in MASH. Chapter 4 presents brief descriptions of these procedures.

3.2. EVALUATION CRITERIA

The appropriate safety evaluation criteria from Tables 2-2 and 5-1 of MASH were used to evaluate the crash tests reported herein. Table 3.1 lists the test conditions and evaluation criteria.
required for MASH Test 5-12, and Table 3.2 provides detailed information on the evaluation criteria. An evaluation of the crash test results is presented in Chapter 6.

### Table 3.2. Evaluation Criteria Required for MASH TL-5 Longitudinal Barriers.

<table>
<thead>
<tr>
<th>Evaluation Factors</th>
<th>Evaluation Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structural Adequacy</strong></td>
<td><strong>A.</strong> Test article should contain and redirect the vehicle or bring the vehicle to a controlled stop; the vehicle should not penetrate, underride, or override the installation although controlled lateral deflection of the test article is acceptable.</td>
</tr>
<tr>
<td><strong>Occupant Risk</strong></td>
<td><strong>D.</strong> 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 Section 5.2.2 and Appendix E of MASH.</td>
</tr>
<tr>
<td></td>
<td><strong>G.</strong> It is preferable, although not essential, that the vehicle remain upright during and after the collision.</td>
</tr>
</tbody>
</table>
Chapter 4. TEST CONDITIONS

4.1. TEST FACILITY

The full-scale crash test reported herein was performed at the TTI Proving Ground, an International Standards Organization (ISO)/International Electrotechnical Commission (IEC) 17025-accredited laboratory with American Association for Laboratory Accreditation (A2LA) Mechanical Testing Certificate 2821.01. The full-scale crash test was performed according to TTI Proving Ground quality procedures, as well as MASH guidelines and standards.

The test facilities of the TTI Proving Ground are located on The Texas A&M University System RELLIS Campus, which consists of a 2000-acre complex of research and training facilities situated 10 mi northwest of the flagship campus of Texas A&M University. The site, formerly a United States Army Air Corps base, has large expanses of concrete runways and parking aprons well suited for experimental research and testing in the areas of vehicle performance and handling, vehicle-roadway interaction, highway pavement durability and efficacy, and roadside safety hardware and perimeter protective device evaluation. The site selected for construction and testing of the TxDOT T80SS barrier with soundwall was at the end of an out-of-service runway. The runway consists of an unreinforced jointed-concrete pavement in 12.5-ft x 15-ft blocks nominally 6 inches deep. The runways were built in 1942, and the joints have some displacement but are otherwise flat and level.

4.2. VEHICLE TOW AND GUIDANCE SYSTEM

The vehicle was placed in ninth gear for the MASH 5-12 test. With the vehicle idling, the clutch was remotely engaged to allow the truck to be pushed to speed. Once at speed, within the power band of the gear, the clutch was remotely released. The accelerator was then remotely depressed, and the vehicle accelerated under its own power to the required speed. A steel cable for guiding the test vehicle was tensioned along the path, anchored at each end, and threaded through an attachment to the front wheel of the test vehicle. The vehicle was released and ran unrestrained just prior to impact with the installation. The vehicle remained freewheeling (i.e., no steering or braking inputs) until it cleared the immediate area of the test site.

4.3. DATA ACQUISITION SYSTEM

4.3.1. Vehicle Instrumentation and Data Processing

The test vehicle was instrumented with a self-contained onboard data acquisition system. The signal conditioning and acquisition system is a 16-channel Tiny Data Acquisition System (TDAS) Pro produced by Diversified Technical Systems Inc. The accelerometers, which measure the x, y, and z axis of vehicle acceleration, are strain gauge type with linear millivolt output proportional to acceleration. Angular rate sensors, measuring vehicle roll, pitch, and yaw rates, are ultra-small, solid-state units designed for crash test service. The TDAS Pro hardware and software conform to the latest SAE J211, Instrumentation for Impact Test. Each of the 16 channels is capable of providing precision amplification, scaling, and filtering based on transducer specifications and calibrations. During the test, data are recorded from each channel at a rate of 10,000 samples per second with a resolution of one part in 65,536. Once data are
recorded, internal batteries back up the data inside the unit in case the primary battery cable is severed. Initial contact of the pressure switch on the vehicle bumper provides a time zero mark and initiates the recording process. After each test, the data are downloaded from the TDAS Pro unit into a laptop computer at the test site. The Test Risk Assessment Program (TRAP) software then processes the raw data to produce detailed reports of the test results.

Each of the TDAS Pro units is returned to the factory annually for complete recalibration and to ensure that all instrumentation used in the vehicle conforms to the specifications outlined by SAE J211. All accelerometers are calibrated annually by means of an ENDEVCO® 2901 precision primary vibration standard. This standard and its support instruments are checked annually and receive a National Institute of Standards Technology (NIST) traceable calibration. The rate transducers used in the data acquisition system receive calibration via a Genisco Rate-of-Turn table. The subsystems of each data channel are also evaluated annually, using instruments with current NIST traceability, and the results are factored into the accuracy of the total data channel per SAE J211. Calibrations and evaluations are also made anytime data are suspect. Acceleration data are measured with an expanded uncertainty of ±1.7 percent at a confidence factor of 95 percent (k = 2).

TRAP uses the data from the TDAS Pro to compute the occupant/compartment impact velocities, time of occupant/compartment impact after vehicle impact, and highest 10-millisecond (ms) average ridedown acceleration. TRAP calculates change in vehicle velocity at the end of a given impulse period. In addition, maximum average accelerations over 50-ms intervals in each of the three directions are computed. For reporting purposes, the data from the vehicle-mounted accelerometers are filtered with an SAE Class 180-Hz low-pass digital filter, and acceleration versus time curves for the longitudinal, lateral, and vertical directions are plotted using TRAP.

TRAP uses the data from the yaw, pitch, and roll rate transducers to compute angular displacement in degrees at 0.0001-s intervals, and then plots yaw, pitch, and roll versus time. These displacements are in reference to the vehicle-fixed coordinate system with the initial position and orientation being initial impact. Rate-of-rotation data are measured with an expanded uncertainty of ±0.7 percent at a confidence factor of 95 percent (k = 2).

Placement of the electronic instrumentation in the 36000V vehicle is described below and shown in Error! Reference source not found.: 

(A) The front accelerometers were placed on the truck frame rail 19.0 inches rearward of the front axle, 20.0 inches to the left of the longitudinal centerline, at height of 26.0 inches above ground surface.

(B) The accelerometers and rate transducers at the rear of the tractor were placed 106.0 inches rearward of the front axle, on the longitudinal centerline, at a height of 32.0 inches above ground surface.

(C) The rear accelerometers were placed inside the trailer on the floor 695.0 inches rearward of the front axle, on the longitudinal centerline, at a height of 49.0 inches above ground surface.
4.3.2. Anthropomorphic Dummy Instrumentation

*MASH* does not recommend or require use of a dummy in the 36000V vehicle, and no dummy was placed in the vehicle.

4.3.3. Photographic Instrumentation Data Processing

Photographic coverage of the test included three digital high-speed cameras:

- One placed overhead with a field of view perpendicular to the ground and directly over the impact point.
- One placed upstream from the installation at an angle to have a field of view of the interaction of the rear of the vehicle with the installation.
- A third placed with a field of view parallel to and aligned with the installation at the downstream end.

A flashbulb on the impacting vehicle was activated by a pressure-sensitive tape switch to indicate the instant of contact with the TxDOT T80SS barrier with soundwall. The flashbulb was visible from each camera. The video files from these digital high-speed cameras were analyzed to observe phenomena occurring during the collision and to obtain time-event, displacement, and angular data. A digital camera recorded and documented conditions of each test vehicle and the installation before and after the test.
Chapter 5. *MASH TEST 5-12 (CRASH TEST NO. 440861-4)*

5.1. **TEST DESIGNATION AND ACTUAL IMPACT CONDITIONS**

*MASH* Test 5-12 involves a 36000V vehicle weighing 79,300 lb ± 1100 lb impacting the CIP of the longitudinal barrier at an impact speed of 50 mi/h ± 2.5 mi/h and an angle of 15 degrees ± 1.5 degrees. The CIP for *MASH* Test 5-12 on the TxDOT T80SS barrier with soundwall was 12 inches ± 12 inches downstream of the centerline of the expansion joint. Figure 3.1 and Figure 5.1 depict the target impact setup.

![Figure 3.1](image1.png) ![Figure 5.1](image2.png)

**Figure 3.1** and **Figure 5.1** depict the target impact setup.

The 36000V vehicle weighed 80,030 lb, and the actual impact speed and angle were 50.4 mi/h and 14.3 degrees. The actual impact point was 20.9 inches downstream of the centerline of the expansion joint. Minimum target impact severity (IS) was 404 kip-ft, and actual IS was 415 kip-ft.

5.2. **WEATHER CONDITIONS**

The test was performed on the afternoon of July 1, 2021. Weather conditions at the time of testing were as follows: wind speed: 5 mi/h; wind direction: 187 degrees (vehicle was traveling at a heading of 350 degrees); temperature: 90°F; relative humidity: 66 percent.

5.3. **TEST VEHICLE**

Figure 5.2 shows the 2013 International 8600 tractor with 1988 Great Dane 7311TCHL53 trailer used for the crash test. The vehicle’s test inertia weight was 80,030 lb, and its gross static weight was 80,030 lb. The height to the lower edge of the vehicle bumper was 14.0 inches, and height to the upper edge of the bumper was 29.5 inches. The height to the center of gravity of the vehicle’s ballast was 73.0 inches. Table C.1 in Appendix C.1 gives additional dimensions and information on the vehicle. The vehicle was directed into the installation using a cable guidance system, and was released to be freewheeling and unrestrained just prior to impact.
5.4. TEST DESCRIPTION

Table 5.1 lists events that occurred during Test No. 440861-4. Figures C.1 and C.2 in Appendix C.2 present sequential photographs during the test.

Table 5.1. Events during Test No. 440861-4.

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0000</td>
<td>Vehicle impacts the soundwall</td>
</tr>
<tr>
<td>0.0280</td>
<td>Vehicle begins to redirect</td>
</tr>
<tr>
<td>0.1630</td>
<td>Front corner of the trailer contacts the soundwall</td>
</tr>
<tr>
<td>0.1720</td>
<td>Left front tire lifts off the pavement</td>
</tr>
<tr>
<td>0.7230</td>
<td>Vehicle travels parallel with the soundwall</td>
</tr>
<tr>
<td>0.7700</td>
<td>Right rear corner of the trailer contacts the soundwall</td>
</tr>
<tr>
<td>1.3370</td>
<td>Vehicle loses contact with the soundwall</td>
</tr>
</tbody>
</table>

For longitudinal barriers, it is desirable for the vehicle to redirect and exit the barrier within the exit box criteria (not less than 65.6 ft for heavy vehicles). The test vehicle exited within the exit box criteria defined in MASH. The vehicle rode off the end of the TxDOT T80SS barrier with soundwall. After loss of contact with the barrier, the brakes were applied, and the vehicle came to rest 239 ft downstream of the point of impact and 34 ft toward the traffic side of the soundwall.

5.5. DAMAGE TO TEST INSTALLATION

Figure 5.3 and Figure 5.4 show the damage to the TxDOT T80SS barrier with soundwall. The downstream section of the soundwall had spalled concrete at the joint. There was gouging and scuffing of the concrete at impact and upstream and downstream of impact. There were minor cracks in the deck at the joint. There were also minor cracks on the field side of the soundwall downstream from the joint. Two of the vertical cracks ran from the top to the bottom of the barrier and were measured at 32 inches and 44 inches downstream from the center of the joint. A third vertical crack ran from the middle of the barrier to near the bottom and was measured at 108 inches downstream from the center of the joint. There was one 93-inch-long horizontal crack, which began at the downstream edge of the joint and was measured at...
54 inches from the underside of the deck. There was some deflection of the soundwall at the joint. The soundwall on the upstream side of the expansion joint had a permanent deflection of \( \frac{1}{8} \) inch at 12 inches from the top of the wall. The soundwall on the downstream side of the expansion joint had a permanent deflection of \( \frac{5}{8} \) inch at a location 37\( \frac{1}{2} \) inches from the top, \( \frac{1}{4} \) inch at a location 44 inches from the top, and \( \frac{1}{4} \) inch at a location 5\( \frac{1}{2} \) inches from the base of the soundwall. The downstream section of the deck at the joint was \( \frac{1}{2} \) inch below the section upstream of the joint at 2 inches toward the traffic side from the toe of the single-slope parapet. Working width* was 20.4 inches, and height of working width was 94.9 inches. Maximum dynamic deflection during the test was 1.9 inches, and there was no permanent deformation observed.

5.6. DAMAGE TO TEST VEHICLE

Figure 5.5 shows the damage sustained by the vehicle. The front bumper, left front axle spring assembly, hood, right door, right front tire and rim, right front outer tandem tire and rim, right fuel tank (deformed only; no visible cuts or holes; no leaks), right side steps, right front corner of the trailer, and right rear upper corner of the trailer were damaged. The windshield had cracks radiating upward and inward from the lower right corner. Maximum exterior crush to the vehicle was 18.0 inches in the front plane at the right front corner at bumper height. No occupant compartment deformation or intrusion was observed. Figure 5.6 shows the interior of the vehicle.

5.7. VEHICLE INSTRUMENTATION

Data from the accelerometers were digitized for informational purposes only and are reported in Figure 5.7. Figure C.3 in Appendix C.3 shows the vehicle angular displacements, and Figures C.4 through C.12 in Appendix C.4 show acceleration versus time traces. Figure 5.7 summarizes pertinent information from the test.

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* Per MASH, “The working width is the maximum dynamic lateral position of any major part of the system or vehicle. These measurements are all relative to the pre-impact traffic face of the test article.” In other words, working width is the total barrier width plus the maximum dynamic intrusion of any portion of the barrier or test vehicle past the field side edge of the barrier.
Figure 5.3. TxDOT T80SS Barrier with Soundwall after Test No. 440861-4.
Note: Cracks outlined with black marker for visualization.

Figure 5.4. Field Side of TxDOT T80SS Barrier with Soundwall after Test No. 440861-4.
Figure 5.5. Test Vehicle after Test No. 440861-4.

Figure 5.6. Interior of Test Vehicle after Test No. 440861-4.
Figure 5.7. Summary of Results for MASH Test 5-12 on TxDOT T80SS Barrier with Soundwall.
Chapter 6. SUMMARY AND CONCLUSIONS

6.1. ASSESSMENT OF TEST RESULTS

The crash test reported herein was performed in accordance with MASH Test 5-12, which involves a 36000V tractor-van trailer impacting the TxDOT T80SS barrier with soundwall at a nominal impact speed and angle of 50 mi/h and 15 degrees. Table 6.1 provides an assessment of the test based on the applicable safety evaluation criteria for MASH Test 5-12 for longitudinal barriers.

6.2. CONCLUSIONS

The TxDOT T80SS barrier with soundwall met the performance criteria for MASH Test 5-12 for longitudinal barriers.
Table 6.1. Performance Evaluation Summary for MASH Test 5-12 on TxDOT T80SS Barrier with Soundwall.

<table>
<thead>
<tr>
<th>MASH Test 5-12 Evaluation Criteria</th>
<th>Test Results</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structural Adequacy</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Test article should contain and redirect the vehicle or bring the vehicle to a controlled stop; the vehicle should not penetrate, underride, or override the installation although controlled lateral deflection of the test article is acceptable.</td>
<td>The TxDOT T80SS barrier with soundwall contained and redirected the 36000V vehicle. The vehicle did not penetrate, underride, or override the installation. Maximum dynamic deflection during the test was 1.9 inches.</td>
<td>Pass</td>
</tr>
<tr>
<td><strong>Occupant Risk</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone.</td>
<td>No detached elements, fragments, or other debris from the soundwall were present to penetrate or show potential for penetrating the occupant compartment, or present hazard to others in the area.</td>
<td>Pass</td>
</tr>
<tr>
<td>Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.2.2 and Appendix E of MASH.</td>
<td>No occupant compartment deformation or intrusion was observed.</td>
<td></td>
</tr>
<tr>
<td>G. It is preferable, although not essential, that the vehicle remain upright during and after collision.</td>
<td>The 36000V vehicle remained upright during and after the collision event.</td>
<td>Pass</td>
</tr>
</tbody>
</table>
Chapter 7. IMPLEMENTATION*

Based on the results of the testing and evaluation reported herein, the TxDOT T80SS barrier with concrete soundwall is considered suitable for implementation as a MASH TL-5 barrier system. The MASH matrix for TL-5 longitudinal barriers consists of three tests: Tests 5-10, 5-11, and 5-12. MASH Test 5-12 was performed under this project and successfully met all MASH evaluation criteria.

MASH also recommends performing Test 5-10 with the 1100C passenger car and Test 5-11 with the 2270P pickup truck. However, based on the acceptable impact performance of a single-slope barrier of similar profile in previous testing with both design passenger vehicles, these tests were not considered necessary (2, 3). The 1100C passenger car would not interact with the added soundwall. While the 2270P pickup truck might have some minimal contact with the offset soundwall, the face of the soundwall is continuous with no edges or surfaces to create snagging.

Statewide implementation of this barrier and soundwall combination can be achieved by TxDOT’s Bridge Division through development of a standard detail sheet. The barrier details provided in Appendix A can be used for this purpose.

* The opinions/interpretations identified/expressed in this section of the report are outside the scope of TTI Proving Ground’s A2LA Accreditation.
REFERENCES


2. FHWA Safety Roadway Departure Eligibility Letter B-339

3. W. F. Williams, R. P. Bligh, and W. L. Menges. *MASH Test 3-11 of the TxDOT Single Slope Bridge Rail (Type SSTR) on Pan-Formed Bridge Deck.* Report FHWA/1X-11/9-1002-3, Texas A&M Transportation Institute, College Station, TX, March 2011.
APPENDIX A. DETAILS OF T80SS BARRIER WITH SOUNDWALL

1a. Concrete shall be TDOT Class S (4000 psi).
1b. A construction joint is permissible between the Parapet and Sound Wall.

Elevation View

Detail B

Scale: 1:10

Detail C

Scale: 1:10

Rebar and Sleeve Typ 4 places

2" Joint in Deck, Parapet, and Sound Wall

Sleeve

PVC Rigid Pipe, 1-1/4" schedule 80 x 3/4"

Seal ends to prevent concrete initiated leak.

Chamber 3/4" each way TYP 6 Places (top of Sound Wall and Parapet, and field side of Deck)

Galvanized Rebar

Centered on Joint

9"

5-1/2"

2-1/2"

1/2"

Existing Concrete

Section A-A

Scale: 1:30

Existing Working Slab

WBL

Test Installation

96-1/2"

90-1/2"

83-1/2"

42"

42"

30"

20"

12"

0"

12"

30"

1-1/2"

1-1/2"

0"

1/2"

0"

1-1/2"

1/2"

TR No. 0-7086-R4

2021-09-30
# APPENDIX B. SUPPORTING CERTIFICATION DOCUMENTS

![Texas A&M Transportation Institute Logo](https://example.com/logo.png)

**QF 7.3-01 Concrete Sampling**

<table>
<thead>
<tr>
<th>Doc. No.</th>
<th>Revision Date: 2020-07-29</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Quality Form</th>
<th>Revised by: B.L. Griffith</th>
<th>Approved by: D. L. Kuhn</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Project No:</th>
<th>Casting Date:</th>
<th>Mix Design (psi):</th>
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<tbody>
<tr>
<td>440861-04</td>
<td>3/31/2021</td>
<td>4000</td>
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<table>
<thead>
<tr>
<th>Name of Technician Taking Sample</th>
<th>Signature of Technician Taking Sample</th>
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</thead>
<tbody>
<tr>
<td>Terracon</td>
<td>Terracon</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name of Technician Breaking Sample</th>
<th>Signature of Technician Breaking Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terracon</td>
<td>Terracon</td>
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</table>

<table>
<thead>
<tr>
<th>Load No.</th>
<th>Truck No.</th>
<th>Ticket No.</th>
<th>Location (from concrete map)</th>
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<tbody>
<tr>
<td>T1</td>
<td>6678594</td>
<td>7212</td>
<td>100% of wall</td>
</tr>
<tr>
<td>T2</td>
<td>6678665</td>
<td>7211</td>
<td>110 feet of deck starting from the North</td>
</tr>
<tr>
<td>T3</td>
<td>6678983</td>
<td>7165</td>
<td>10 feet of deck from Joint North</td>
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</table>

<table>
<thead>
<tr>
<th>Load No.</th>
<th>Break Date</th>
<th>Cylinder Age</th>
<th>Total Load (lbs)</th>
<th>Break (psi)</th>
<th>Average</th>
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</tr>
</tbody>
</table>

---

TR No. 0-7086-R4  31  2021-09-30
**Billing**

**Martin Marietta**
1503 LBJ Freeway
Suite 400
Dallas, TX 75234

**LOAD TIME**
11:31

**ARRIVE JOB SITE**

**ARRIVE PLANT**

**WATER ADDED ON JOB AT CUSTOMER'S REQUEST**

**ALLOWABLE WATER (withheld from batch)**

**TEST CYLINDER TAKEN**

**CYLINDER TAKEN**

**ADDITIONAL WATER ADDED TO THIS CONCRETE WILL REDUCE ITS STRENGTH. ANY WATER ADDED IN EXCESS OF SPECIFIED SLUMP IS AT CUSTOMER'S RISK.**

**CUSTOMER NAME AND DELIVERY ADDRESS**
MBC MANAGEMENT
3100 SH 47, BRYAN, TX 77807

**LOAD QUANTITY**
10.00

**PRODUCT CODE**
DSD60S

**DESCRIPTION**
TXDOT CLASS S

**UNIT PRICE**

**AMOUNT**

**PLANT TRUCK ORDER NO. SLUMP P.O. # JOB/LOT**
617 7212 2016 5.00 TTI-THRIF-HE-AM

**DRIVER NAME**
CHARLES BALANGA

**CUSTOMER NUMBER PROJECT CUM QTY ORDERED QTY**
782823 100138 10.00 20.00

**SPECIAL DELIVERY INSTRUCTIONS**
RIGHT 2818, RIGHT LEONARD RD, RIGHT 47, LEFT INTO RELLIS, STRAIGHT AROUND ROUND ABOUT TO GATE, CUSTOMER TO MEET YOU THERE

**DANGER! MAY CAUSE ALKALI BURNS. SEE WARNINGS ON REVERSE SIDE.**

**FOR OFFICE USE ONLY FORM:**

<table>
<thead>
<tr>
<th>Material</th>
<th>Design Qty</th>
<th>Required</th>
<th>Batched</th>
<th>% Var % Moisture</th>
<th>Actual</th>
<th>Wet</th>
</tr>
</thead>
<tbody>
<tr>
<td>FRG</td>
<td>1812 lb</td>
<td>15296 lb</td>
<td>18340 lb</td>
<td>-0.14%</td>
<td>0.00% M</td>
<td>17</td>
</tr>
<tr>
<td>SAND-1</td>
<td>1360 lb</td>
<td>14375 lb</td>
<td>14340 lb</td>
<td>-0.24%</td>
<td>-0.35%</td>
<td>207</td>
</tr>
<tr>
<td>GMT-VII</td>
<td>570 lb</td>
<td>5700 lb</td>
<td>5680 lb</td>
<td>-0.21%</td>
<td>4.00% M</td>
<td>89</td>
</tr>
<tr>
<td>F#2</td>
<td>258 lb</td>
<td>1234 lb</td>
<td>1730 lb</td>
<td>0.00%</td>
<td>0.00% M</td>
<td>17</td>
</tr>
<tr>
<td>ZY610</td>
<td>23 oz</td>
<td>228 oz</td>
<td>228 oz</td>
<td>0.00%</td>
<td>0.00% M</td>
<td>17</td>
</tr>
</tbody>
</table>

Actual Num Batches: 1
Load: 40004 lb
Design W/C: 0.453
Water/Cement: 1
Design: 309.2 gl
Actual: 293.5 gl
To Add: 15.6 gl

**AGG1 SCALE** B 1 ST 20 lb ET 0 lb

**CEMI SCALE** B 1 ST 10 lb ET 0 lb

**WAT1 SCALE** B 1 ST 4 lb ET 0 lb

**DATE**
03/31/21

**SALES TAX**

**TOTAL**

**TR No. 0-7086-R4**

**32**

**2021-09-30**
# Billing Information

**Vendor:** Martin Marietta  
**Address:** 1503 LBJ Freeway, Suite 400, Dallas, TX 75234

**Load Time:** 11:46  
**To Job:** 13:02  
**Arrive Job Site:** 14:27  
**Begin Pour:** 14:35  
**Finish Pour:**   
**Leave Job Site:**   
**Arrive Plant:**   

**WATER ADDED ON JOB AT CUSTOMER'S REQUEST: GAL**

**ALLOWABLE WATER (withheld from batch): GAL**

**CYLINDER TAKEN:** YES

**DELIVERY OF THESE MATERIALS IS SUBJECT TO THE TERMS AND CONDITIONS ON THE REVERSE SIDE HEREOF AS ACCEPTED BY SIGNATURE ABOVE.**

**CUSTOMER SIGNATURE:**

**LOAD QUANTITY** | **PRODUCT CODE** | **DESCRIPTION** | **UNIT PRICE** | **AMOUNT**
---|---|---|---|---
10.00 | D1260S | TXDOT CLASS S |   |   

**LOAD SIZE:** 10.00 CYDE  
**Mix Code:** D1260S

---

**SPECIAL DELIVERY INSTRUCTIONS:**

RIGHT 2818, RIGHT LEONARD RD, RIGHT 47, LEFT INTO RELLIS, STRAIGHT AROUND ROUND ABOUT TO GATE, CUSTOMER TO MEET YOU THERE

**SALES TAX:**

**TOTAL:**

---

**FOR OFFICE USE ONLY:**

**FORM:**

**Truck:** 7211  
**Driver:** 777/135  
**User:** 6678665  
**Disp Ticket Num:** 91406  
**Ticket ID:** 11:46   
**Time Date:** 3/31/21

**Load Size:** 10.00 CYDE  
**Mix Code:** D1260S

**Returned Qty:**  
**Mix Age:**  
**Seq:**  
**Load ID:**  

**Material:**

<table>
<thead>
<tr>
<th>Design Qty</th>
<th>Required</th>
<th>Batched</th>
<th>% Var</th>
<th>% Moisture</th>
<th>Actual</th>
<th>Water</th>
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<tr>
<td>1611 lb</td>
<td>1836 lb</td>
<td>1836 lb</td>
<td>0.26%</td>
<td>0.26% M</td>
<td>16 lb</td>
<td></td>
</tr>
<tr>
<td>1390 lb</td>
<td>14375 lb</td>
<td>14375 lb</td>
<td>-0.10%</td>
<td>4.00% M</td>
<td>69 lb</td>
<td></td>
</tr>
<tr>
<td>576 lb</td>
<td>5710 lb</td>
<td>5710 lb</td>
<td>-0.48%</td>
<td>0.00%</td>
<td>208 lb</td>
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<td>250 lb</td>
<td>1794 lb</td>
<td>1794 lb</td>
<td>0.02%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22 oz</td>
<td>22 oz</td>
<td>22 oz</td>
<td>-0.44%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Actual:**

<table>
<thead>
<tr>
<th>Num Batches</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

**Add:**

<table>
<thead>
<tr>
<th>Water/Cement</th>
<th>0.455</th>
<th>T</th>
<th>Design</th>
<th>3962.2 gl</th>
<th>Actual</th>
<th>294.1 gl</th>
<th>To Add</th>
<th>15.0 gl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water in Truck</td>
<td>0.0 gl</td>
<td>Adjust Water</td>
<td>0.0 gl</td>
<td>Load</td>
<td>Time Water</td>
<td>-15 gl</td>
<td>CYDE</td>
<td></td>
</tr>
</tbody>
</table>

**AGG1 SCALE:**  
**ET 0 lb**  
**ET 0 lb**  
**CEM1 SCALE:**  
**ET 10 lb**  
**ET 0 lb**  
**WAT1 SCALE:**  
**ET 0 lb**  
**ET 0 lb**
**Billing**

**Martin Marietta**
1503 LBJ Freeway
Suite 400
Dallas, TX 75234

**Load Time** | **To Job** | **Arrive Job Site** | **Begin Pour** | **Finish Pour** | **Leave Job Site** | **Arrive Plant**
--- | --- | --- | --- | --- | --- | ---
13:11 | | | | | | |

**Water Added on Job at Customer’s Request**

**Allowable Water (withheld from batch)**

**Test Cylinder Taken**

**Cylinder Taken**

**Additional Water Added to This Concrete Will Reduce Its Strength. Any Water Added in Excess of Specified Slump Is at Customer’s Risk.**

**Customer Name and Delivery Address**

MBC Management
3100 SH 47, BRYAN, TX 77807

**Load Quantity** | **Product Code** | **Description** | **Unit Price** | **Amount**
--- | --- | --- | --- | ---
2.00 | DSD60S | TXDOT Class S | | |

**Special Delivery Instructions**

Right 2818, Right Leonard Rd, Right 47, Left Into Rellis, Straight Around Round About to Gate, Customer to Meet You There.

**Danger: May Cause Alkali Burns. See Warnings on Reverse Side.**

**For Office Use Only**

**Plant** | **Truck** | **Order No.** | **Slump** | **P.O. #/job#** | **CUM. QTY** | **Ordered QTY**
--- | --- | --- | --- | --- | --- | ---
617 | 7165 | 2015 | 5.00 | TILL THE BE | 100138 | 22.00 |

**Driver Name**

Chatham Dexter
03/31/21

**Customer Number** | **Project** | **Cum. QTY** | **Ordered QTY**
--- | --- | --- | ---
782823 | 100138 | 22.00 |

**SALES TAX**

**TOTAL**

**Form:**

**Truck** | **Driver** | **User** | **Disp. Ticket Num.** | **Ticket ID** | **Time** | **Date**
--- | --- | --- | --- | --- | --- | ---
7165 | 726159 | user 6678983 | 91412 | 13:11 | 3/31/21 |

**Load Size** | **Mix Code** | **Returned** | **Qty** | **Mix Age** | **Seq** | **Load ID**
--- | --- | --- | --- | --- | --- | ---
2.00 | CYDE DSD60S | | | | | |

**Material** | **Design Qty** | **Required** | **Batched** | **% Var. % Moisture** | **Actual** | **Wt.**
--- | --- | --- | --- | --- | --- | ---
1'RG | 1612 lb | 3903 lb | 3566 lb | 0.1% | 0.8% | 40 lb |
SAND-1 | 1380 lb | 2875 lb | 2880 lb | 0.07% | 0.0% | 14 lb |
CMU-4 | 570 lb | 1140 lb | 1130 lb | 0.8% | 0.8% | 40 lb |
HZO | 258 lb | 517 lb | 347 lb | 3.25% | 3.25% | 40 lb |
ZY-610 | 23 oz | 46 oz | 46 oz | 0.89% | 0.89% | 40 lb |

**Load** | **Slump** | **Wt.** | **Water/Cement** | **Water/Cement** | **Design** | **Wt.** | **Actual** | **To Add** | **Mix** | **Seq** | **Load ID**
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | ---
800 lb | 5.00 in | | 0.453 | 0.457 | 618 lb | 0.00 lb | 0.00 lb | 0.00 lb | WAT1 SCALE B 1 ST | a lb | ET | 0 lb |
AGG1 SCALE B 1 ST | 40 lb | ET | 0 lb | CEM1 SCALE B 1 ST | 5 lb | ET | 0 lb | WAT1 SCALE B 1 ST | a lb | ET | 0 lb |
CONCRETE COMPRESSIVE STRENGTH TEST REPORT

Report Number: A171057-0172
Service Date: 03/31/21
Report Date: 07/01/21 Revision 1 - 91-day results
Task: PO# 440861-4

Client
Texas Transportation Institute
Attn: Gary Orkic
111 Business Office
3135 TAMIU
College Station, TX 77843-3135

Project
Riverside Campus
Bryan, TX
Project Number: A171057

Material Information
Specified Strength:
Mix ID: DS0605
Supplier: Marletti
Batch Time: 1131
Plant: 517
Truck No.: 7212
Ticket No.: 6678594

Sample Information
Sample Date: 03/31/21
Sample Time: 1215
Sampled By: Ethan Boultinghouse
Weather Conditions: Overcast moderate wind
Accumulative Yards: 10/20
Batch Size (cy): 10
Placement Method: Direct Discharge
Water Added Before (gal): 5
Water Added After (gal): 0
Sample Location: 25 ft east 3 ft south of metal bridge
Placement Location: PO 440861-4

Field Test Data

<table>
<thead>
<tr>
<th>Test</th>
<th>Slump (in):</th>
<th>Air Content (%):</th>
<th>Concrete Temp. (F):</th>
<th>Ambient Temp. (F):</th>
<th>Plastic Unit Wt. (pcf):</th>
<th>Yield (Cu. Yds):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6</td>
<td>2.8</td>
<td>70</td>
<td>64</td>
<td>147.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
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</table>

Laboratory Test Data

<table>
<thead>
<tr>
<th>Set No.</th>
<th>Specimen ID</th>
<th>Avg Diam. (in)</th>
<th>Area (sq in)</th>
<th>Date Received</th>
<th>Date Tested</th>
<th>Age at Test (days)</th>
<th>Maximum Load (lbs)</th>
<th>Compressive Strength (psi)</th>
<th>Fracture Type</th>
<th>Tested By</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>91</td>
<td>163,990</td>
<td>5,780</td>
<td>1</td>
<td>SLS</td>
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<tr>
<td>1</td>
<td>B</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>91</td>
<td>162,020</td>
<td>5,710</td>
<td>3</td>
<td>SLS</td>
<td></td>
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<tr>
<td>1</td>
<td>C</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>91</td>
<td>152,710</td>
<td>5,380</td>
<td>4</td>
<td>SLS</td>
<td></td>
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</tbody>
</table>

Average (91 days) 5,620

Initial Cure: Outside Plastic Bags
Final Cure: Field Cured

Comments: Note: Reported air content does not include Aggregate Correction Factor (ACF).
CONCRETE COMpressive STRENGTH TEST REPORT

Report Number: A1171057.0172
Service Date: 03/31/21
Report Date: 07/01/21 Revision 1 - 91-day results
Task: PO#: 440861-4

Client
Texas Transportation Institute
Attn: Gary Gerke
111 Business Office
3135 TAMU
College Station, TX 77843-3135

Project
Riverside Campus
Bryan, TX

Material Information
Specified Strength:

Mix ID: DS606S
Supplier: Martin Marietta
Batch Time: 1140 Plant: 517
Truck No.: 7211 Ticket No.: 6678665

Field Test Data

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
<th>Specification</th>
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</tr>
<tr>
<td>Air Content (%):</td>
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<td>Not specified</td>
</tr>
<tr>
<td>Concrete Temp. (F):</td>
<td>69</td>
<td>40 - 95</td>
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<tr>
<td>Ambient Temp. (F):</td>
<td>64</td>
<td>40 - 95</td>
</tr>
<tr>
<td>Plastic Unit Wt. (pcf):</td>
<td>146.8</td>
<td>Not specified</td>
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<tr>
<td>Yield (Cu. Yds.):</td>
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<td></td>
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</tbody>
</table>

Laboratory Test Data

<table>
<thead>
<tr>
<th>Set No.</th>
<th>Specimen ID</th>
<th>Avg Diam. (in)</th>
<th>Area (sq in)</th>
<th>Date Received</th>
<th>Date Tested</th>
<th>Age at Test (days)</th>
<th>Maximum Load (lbs)</th>
<th>Compressive Strength (psi)</th>
<th>Fracture Type</th>
<th>Tested By</th>
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</tr>
<tr>
<td>2</td>
<td>C</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>91</td>
<td>169,770</td>
<td>5,970</td>
<td>1</td>
<td>SLS</td>
<td></td>
</tr>
</tbody>
</table>

Average (91 days) 5,730

Initial Cure: Outside Plastic Lids
Final Cure: Field Cured

Comments: Note: Reported air content does not include Aggregate Correction Factor (ACF).

Samples Made By: Terracon
Services: Obtain samples of fresh concrete at the placement locations (ASTM C 172), perform required field tests and cast, cure, and test compressive strength samples (ASTM C 31, C 39, C 1231).
Terracon Rep: Ethan Bouldinghouse
Reported To: 
Contractor: Report Distribution:
1. Texas Transportation Institute, Gary Gerke
2. Terracon Consultants, Inc, Alex Duggan, P.E.
3. Texas Transportation Institute, Bill Grow

Test Methods: AS1M C 31, ASTM C143, ASTM C231, AS1M C1064

The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results and materials referenced herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparent similar or identical materials.
# CONCRETE COMPRESSIVE STRENGTH TEST REPORT

**Report Number:** A1171057.0172  
**Service Date:** 03/31/21  
**Report Date:** 07/01/21  
**Revision 1 - 91-day results**  
**Task:** PO# 440861-4  
**Client:** Texas Transportation Institute  
**Attn:** Gary Gerke  
**TTI Business Office**  
**3135 TAMU**  
**College Station, TX 77843-3135**  
**Project:** Riverside Campus  
**Riverside Campus**  
**Bryan, TX**  
**Project Number:** A1171057  
**Material Information:**

- **Specified Strength:**
  - **Mix ID:** DSD605
  - **Supplier:** Martin Marletta
  - **Batch Time:** 1311  
  - **Plant:** 517  
  - **Truck No.:** 7165  
  - **Ticket No.:** 6678983

- **Field Test Data**
  - **Test**  
  - **Result**  
  - **Specification**
  - **Slump (in):** 6  
  - **Air Content (%):** 3.0  
  - **Concrete Temp. (F):** 70  
  - **Ambient Temp. (F):** 64  
  - **Plastic Unit Wt. (pcf):** 147.4

**Laboratory Test Data**

<table>
<thead>
<tr>
<th>Set No.</th>
<th>Specimen ID</th>
<th>Avg Diam. (in)</th>
<th>Area (sq in)</th>
<th>Date Received</th>
<th>Date Tested</th>
<th>Age at Test (days)</th>
<th>Maximum Load (lbs)</th>
<th>Compressive Strength (psi)</th>
<th>Fracture Type</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>A</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>91</td>
<td>147,970</td>
<td>5,220</td>
<td></td>
<td>4</td>
<td>SLS</td>
</tr>
<tr>
<td>3</td>
<td>B</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>91</td>
<td>149,990</td>
<td>5,290</td>
<td></td>
<td>4</td>
<td>SLS</td>
</tr>
<tr>
<td>3</td>
<td>C</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>91</td>
<td>146,160</td>
<td>5,150</td>
<td></td>
<td>1</td>
<td>SLS</td>
</tr>
<tr>
<td>3</td>
<td>D</td>
<td>Hold</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Average (91 days):** 5,220

**Sample Information**

- **Sample Date:** 03/31/21  
- **Sample Time:** 1345  
- **Sampled By:** Ethan Boultinghouse  
- **Weather Conditions:** Overcast, moderate wind  
- **Cumulative Yards:** 22/22  
- **Batch Size (cy):** 2  
- **Placement Method:** Direct Discharge  
- **Water Added Before (gal):** 5  
- **Water Added After (gal):** 0  
- **Sample Location:** 35Ft East 45Ft south of metal bridge north ending  
- **Place Location:** PO 440861-4

**Notes:**

- **Initial Cure:** Outside Plastic Lids  
- **Final Cure:** Field Cured  
- **Comments:** Note: Reported air content does not include Aggregate Correction Factor (ACF).

**Test Methods:** ASTM C 31, ASTM C 143, ASTM C 231, ASTM C 1064

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---

**Samples Made By:** Terracon  
**Services:** Obtain samples of fresh concrete at the placement locations (ASTM C 172), perform required field tests and cast, cure, and test compressive strength samples (ASTM C 31, C 39, C 1231).  
**Terracon Rep.:** Ethan Boultinghouse  
**Reviewed By:** Alexander B. Strumac, P.E.  
**Project Manager**
<table>
<thead>
<tr>
<th>Load No.</th>
<th>Truck No.</th>
<th>Ticket No.</th>
<th>Location (from concrete map)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>7130</td>
<td>6687524</td>
<td>South Wall and Deck</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Load No.</th>
<th>Break Date</th>
<th>Cylinder Age</th>
<th>Total Load (lbs)</th>
<th>Break (psi)</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
</tr>
</tbody>
</table>
**Martin Marietta**

1503 LBJ Freeway  
Suite 400  
Dallas, TX 75234

---

**BILLING**

**TR No. 0-7086-R4**

<table>
<thead>
<tr>
<th>LOAD TIME</th>
<th>TO JOB</th>
<th>ARRIVE JOB SITE</th>
<th>BEGIN POUR</th>
<th>FINISH POUR</th>
<th>LEAVE JOB SITE</th>
<th>ARRIVE PLANT</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:33</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
</tbody>
</table>

**WATER ADDED ON JOB AT CUSTOMER'S REQUEST** 5 GAL.  
**ALLOWABLE WATER (withheld from batch)** 0 GAL.  
**TEST CYLINDER TAKEN**  
**YES**  
**NO**  
**BY**  
**BEFORE**  
**AFTER WATER**

**CUSTOMER SIGNATURE**

---

**DELIVERY OF THESE MATERIALS IS SUBJECT TO THE TERMS AND CONDITIONS ON THE REVERSE SIDE HEREOF AS ACCEPTED BY SIGNATURE ABOVE.**

**PLANT TRUCK**

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>SLUMP</th>
<th>P.O. #/JOB/LOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>617</td>
<td>7130</td>
<td>2015 5.00</td>
</tr>
</tbody>
</table>

**TRI-THREE BEAM**

**DRIVER NAME**

Jeremy Freeman

**CUSTOMER NUMBER**

100138

**PROJECT**

782823

**CUM.QTY**

9.00

**ORDERED QTY**

9.00

**UNIT PRICE**

9.00

**AMOUNT**

9.00

---

**LOAD QUANTITY**

9.00

**PRODUCT CODE**

DSD60S

**DESCRIPTION**

TxDOT CLASS 3

---

**SPECIAL DELIVERY INSTRUCTIONS**

RIGHT 2818, RIGHT LEONARD RD, RIGHT 47, LEFT INTO RELLIS, STRAIGHT AROUND ABOUT TO GATE, CUSTOMER TO MEET YOU THERE

**SALES TAX**

**TOTAL**

**FOR OFFICE USE ONLY**

**FORM:**

**Truck**  
7130

**Driver**  
956950

**User**  
6687524

**Disp Ticket Num**  
91524

**Ticket ID**  
10:33

**Time Date**  
4/5/21

**Load Size**  
9.00 CYDE

**Mix Code**  
DSD60S

**Returned**

**Qty**

**Mix Age**

**Seg**

**Load ID**

D 92694

---

**Material**

<table>
<thead>
<tr>
<th>Material</th>
<th>Design Qty</th>
<th>Required</th>
<th>Batched</th>
<th>Var %</th>
<th>Moisture</th>
<th>Actual</th>
<th>Wet</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAND-1</td>
<td>1872 lb</td>
<td>1849 lb</td>
<td>1848 lb</td>
<td>0.00%</td>
<td>1.10% M</td>
<td>22 gl</td>
<td>70 gl</td>
</tr>
<tr>
<td>CMT-III</td>
<td>570 lb</td>
<td>513 lb</td>
<td>511 lb</td>
<td>0.42%</td>
<td>4.50% M</td>
<td>72 gl</td>
<td>22 gl</td>
</tr>
<tr>
<td>HDO</td>
<td>259 lb</td>
<td>146 lb</td>
<td>144 lb</td>
<td>-0.39%</td>
<td>-1.10% M</td>
<td>22 gl</td>
<td>70 gl</td>
</tr>
<tr>
<td>ZY-610</td>
<td>23 oz</td>
<td>23 oz</td>
<td>204 oz</td>
<td>-0.58%</td>
<td>-1.10% M</td>
<td>22 gl</td>
<td>70 gl</td>
</tr>
</tbody>
</table>

**Actual**

<table>
<thead>
<tr>
<th>Load</th>
<th>Design Weight</th>
<th>Water/Cement</th>
<th>Water in Truck</th>
<th>Adjust Water</th>
<th>Load Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>9611 lb</td>
<td>0.453</td>
<td>0.00 gl</td>
<td>0.00 gl</td>
<td>0.00 gl</td>
<td>-1.4 gl</td>
</tr>
</tbody>
</table>

**AGG1 SCALE**

<table>
<thead>
<tr>
<th>B 1 ST</th>
<th>80 lb</th>
<th>ET 0 lb</th>
</tr>
</thead>
</table>

**CEM1 SCALE**

<table>
<thead>
<tr>
<th>B 1 ST</th>
<th>20 lb</th>
<th>ET 0 lb</th>
</tr>
</thead>
</table>

**WAT1 SCALE**

<table>
<thead>
<tr>
<th>B 1 ST</th>
<th>10 lb</th>
<th>ET 0 lb</th>
</tr>
</thead>
</table>

---

**TR No. 0-7086-R4**  
39  

2021-09-30
CONCRETE COMPRESSIVE STRENGTH TEST REPORT

Report Number: A1171057.0175
Service Date: 04/05/21
Report Date: 07/01/21 Revision 1 - 86-day results
Task: PO# 440861-4

Client
Texas Transportation Institute
Attn: Gary Gerke
TTI Business Office
3135 TAMU
College Station, TX 77843-3135

Project
Riverside Campus
Riverside Campus
Bryan, TX

Material Information
Specified Strength: 4,000 psi @ 44 days
Mix ID: DSD60S
Supplier: Martin Marietta
Batch Time: 1033 Plant: 617
Truck No.: 7130 Ticket No.: 6687524

Field Test Data

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slump (in):</td>
<td>3 1/4</td>
<td></td>
</tr>
<tr>
<td>Air Content (%)</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Concrete Temp. (F):</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>Ambient Temp. (F):</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>Plastic Unit Wt. (pcf):</td>
<td>147,6</td>
<td></td>
</tr>
<tr>
<td>Yield (Cu. Yds.):</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Laboratory Test Data

<table>
<thead>
<tr>
<th>Set No.</th>
<th>Specimen ID</th>
<th>Avg Diam. (in)</th>
<th>Area (sq in)</th>
<th>Date Received</th>
<th>Date Tested</th>
<th>Age at Test (days)</th>
<th>Maximum Load (lbs)</th>
<th>Compressive Strength (psi)</th>
<th>Fracture Type</th>
<th>Tested By</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>86</td>
<td>164,550</td>
<td>5,800</td>
<td>1 SLS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>B</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>86</td>
<td>161,560</td>
<td>5,700</td>
<td>1 SLS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>C</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>86</td>
<td>144,720</td>
<td>5,100</td>
<td>2 SLS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Average (86 days) 5,530

Initial Cure: Outside Final Cure:

Comments: Average compressive strength of 86 day cylinders complies with the specified strength.

Note: Reported air content does not include Aggregate Correction Factor (ACF).

Samples Made By: Terracon
Services: Obtain samples of fresh concrete at the placement locations (ASTM C 172), perform required field tests and cast, cure, and test compressive strength samples (ASTM C 31, C 39, C 1231).

Terracon Rep.: Adam Hill
Reported To: Gary Gerke with TTI
Contractor:
Report Distribution:
(1) Texas Transportation Institute, Gary Gerke
(1) Terracon Consultants, Inc., Alex Durigan, P.E.

Test Methods: ASTM C 31, ASTM C143, ASTM C231, ASTM C1064

The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transcribed herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

TR No. 0-7086-R4 40 2021-09-30
**QF 7.3-01 Concrete Sampling**

**Project No:** 440851-04  **Casting Date:** 4/14/2021  **Mix Design (psi):** 4000

<table>
<thead>
<tr>
<th>Load No.</th>
<th>Truck No.</th>
<th>Ticket No.</th>
<th>Location (from concrete map)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>7211</td>
<td>6713607</td>
<td>80 ft west from the expansion joint</td>
</tr>
<tr>
<td>T2</td>
<td>7102</td>
<td>6713716</td>
<td>The rest of the west end of the installation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Load No.</th>
<th>Break Date</th>
<th>Cylinder Age</th>
<th>Total Load (lbs)</th>
<th>Break (psi)</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
BILLING

Martin Marietta
1503 LBJ Freeway
Suite 400
Dallas, TX 75234

TR No. 0-7086-R4

LOAD TIME TO JOB ARRIVE JOB SITE BEGIN POUR FINISH POUR LEAVE JOB SITE ARRIVE PLANT
10:27 11:42 11:01

WATER ADDED ON JOB AT CUSTOMER'S REQUEST
ALLOWABLE WATER (withheld from batch)
TEST CYLINDER TAKEN: YES NO BY
CYLINDER TAKEN BEFORE OR AFTER WATER
ADDITIONAL WATER ADDED TO THIS CONCRETE
REDUCE ITS STRENGTH. ANY WATER ADDED IN EXCESS
OF SPECIFIED SLUMP IS AT CUSTOMER'S RISK.

CUSTOMER NAME AND DELIVERY ADDRESS
MBC MANAGEMENT
3100 SH 47, BRYAN, TX 77807

LOAD QUANTITY PRODUCT CODE DESCRIPTION UNIT PRICE AMOUNT
10.00 DSD60S TXDOT CLS S

CUSTOMER SIGNATURE
X

DELIVERY OF THESE MATERIALS IS SUBJECT TO THE
TERMS AND CONDITIONS ON THE REVERSE SIDE
HEREOF AS ACCEPTED BY SIGNATURE ABOVE.

PLANT TRUCK ORDER NO. SLUMP P.O. # JOB LOT
617 7211 2020 5.00 TT-THRIE BEAM

DRIVER NAME
LARRY JANTZEN
04/14/21

CUSTOMER NUMBER PROJECT CUM. QTY ORDERED QTY
782823 100138 10.00 16.00

SALES TAX

DANGER: MAY CAUSE ALKALI BURNS.
SEE WARNINGS ON REVERSE SIDE.

FOR OFFICE USE ONLY

FORM:

Truck Driver User Disp Ticket Num Ticket ID Time Date
7211 777135 user 6713607 91808 10:27 4/14/21

Load Size Mix Code Returned Qty Mix Age Seq Load ID
10.00 CYDE DSD60S

Material Design Qtj Required Batched % Var% Moisture Actual Wat
SAND 1 1812 lb 18322 lb 19300 lb -0.12% 1.1% M 24 gl
CMT-88 570 lb 14360 lb -0.10% 4.00% M 89 gl
H20 570 lb 5700 lb -0.26% 17.05 lb
ZV-610 23 oz 228 oz 229 oz 0.44% 204 gl

Actual Num Batched: 1 Water/Cement: 0.453 T
Load: 40965 lb Design W/C: 0.453 Water in Truck: 0.454 T
AGG1 SCALE 8 1 ST 69 lb ET 9 lb

REPORTED SUSTAINED TEMPERATURE:

To Add: 11.8 gl
**TR No. 0-7086-R4**

---

**Martin Marietta**
1503 LBJ Freeway
Suite 400
Dallas, TX 75234

---

**LOAD TIME** TO JOB ARRIVE JOB SITE BEGIN POUR FINISH POUR LEAVE JOB SITE ARRIVE PLANT
10:46 : : : : :

---

**WATER ADDED ON JOB AT CUSTOMER’S REQUEST** GAL
**ALLOWABLE WATER (withheld from batch)** GAL
**TEST CYLINDER TAKEN** YES NO BY
**CYLINDER TAKEN BEFORE AFTER WATER**
**ADDITIONAL WATER ADDED TO THIS CONCRETE WILL REDUCE ITS STRENGTH. ANY WATER ADDED IN EXCESS OF SPECIFIED SLUMP IS AT CUSTOMER’S RISK.**

---

**CUSTOMER NAME AND DELIVERY ADDRESS**
MBC MANAGEMENT
3100 SH 47, BRYAN, TX 77807

---

**LOAD QUANTITY** PRODUCT CODE DESCRIPTION TXDOT CLASS S UNIT PRICE AMOUNT
6.00 DSD60S : : :

---

**SPECIAL DELIVERY INSTRUCTIONS**
RIGHT 2818, RIGHT LEONARD RD, RIGHT 47, LEFT INTO RELLIS, STRAIGHT AROUND ROUND ABOUT TO GATE, CUSTOMER TO MEET YOU THERE

---

**DANGER/MAY CAUSE ALKALI BURNS**
SEE WARNINGS ON REVERSE SIDE

---

**FOR OFFICE USE ONLY** FORM:

---

**Truck** 7102 **Driver** 968908 **User** user **Disp Ticket** Num **Ticket ID** Time Date
6713716 67809 10:46 4/14/21

---

**Load Size** Mix Code Returned Qty Mix Age Seq Load ID
6.00 CYDS DSD60S :

---

**Material** Design Qty Required Batched % Var. Moisture Actual Wat
1ST 1612 lb 10980 lb 10980 lb 1.0% M 14 g
SAND 1300 lb 8825 lb 8820 lb 0.0% M 40 g
CMH 370 lb 3420 lb 3365 lb 0.7% M 41 g
ROH 258 lb 1017 lb 1004 lb 1.2% M 120 g
ZY-610 23 oz 137 oz 136 oz 0.5% M 14 g

---

**Actual**

---

**WATER** Water/Cement: 0.458 T	Adjust Water: 0.00 g / Load
**Slump:** 5.00 in Water in Truck: 0.00 lb

---

**AGG 1 SCALE** B 1 ST -50 lb ET 0 lb
**CEMI SCALE** B 1 ST 10 lb ET 0 lb
**WAT 1 SCALE** B 1 ST 2 lb ET 0 lb

---

**CUSTOMER SIGNATURE**

---

**DELIVERY OF THESE MATERIALS IS SUBJECT TO THE TERMS AND CONDITIONS ON THE REVERSE SIDE HEREOF AS ACCEPTED BY SIGNATURE ABOVE.**

---

**PLANT** 7102 **ORDER NO.** SLUMP P.O. # JOB/LOT
517 2020 5.00 TTI-THRIE BEAM
**DRIVER NAME** Scott Goodwin
**DATE** 04/14/21
**CUSTOMER NUMBER** PROJECT CUM QTY ORDERED QTY
792823 100138 16.00 16.00

---

**SALES TAX**

---

**TOTAL**

---

**TR No. 0-7086-R4**

---

**2021-09-30**
CONCRETE COMPRESSIVE STRENGTH TEST REPORT

Report Number: A1171057.0178
Service Date: 04/14/21
Report Date: 07/01/21 Revision 2 - PO #
Task: PO# 440861-4

Client
Texas Transportation Institute
Attn: Gary Gerke
TTI Business Office
3135 TAMU
College Station, TX 77843-3135

Project
Riverside Campus
Riverside Campus
Bryan, TX

Material Information
Specified Strength:

Mix ID: DSD060S
Supplier: Martin Marietta
Batch Time: 1027
Truck No.: 7211
Plant: 617
Ticket No.: 6713607

Field Test Data

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slump (in):</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Air Content (%):</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>Concrete Temp. (F):</td>
<td>78</td>
<td></td>
</tr>
<tr>
<td>Ambient Temp. (F):</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td>Plastic Unit Wt. (pcf):</td>
<td>147.5</td>
<td></td>
</tr>
<tr>
<td>Yield (Cu. Vds.):</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Laboratory Test Data

<table>
<thead>
<tr>
<th>Set No.</th>
<th>Specimen ID</th>
<th>Avg Diam. (in)</th>
<th>Area (sq in)</th>
<th>Date Received</th>
<th>Date Tested</th>
<th>Age at Test (days)</th>
<th>Maximum Load (lbs)</th>
<th>Compressive Strength (psi)</th>
<th>Fracture Type</th>
<th>Tested By</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>6.00</td>
<td>28.27</td>
<td>05/19/21</td>
<td>35 F</td>
<td>137,840</td>
<td>4,880</td>
<td>5</td>
<td>AJH</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>B</td>
<td>6.00</td>
<td>28.27</td>
<td>05/19/21</td>
<td>35 F</td>
<td>142,330</td>
<td>5,030</td>
<td>5</td>
<td>AJH</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>C</td>
<td>6.00</td>
<td>28.27</td>
<td>05/19/21</td>
<td>35 F</td>
<td>153,770</td>
<td>5,440</td>
<td>5</td>
<td>AJH</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Initial Cure: Outside Plastic Lids
Final Cure: Hold

Comments: F = Field Cured
Note: Reported air content does not include Aggregate Correction Factor (ACF).  

Samples Made By: Terracon
Services: Obtain samples of fresh concrete at the placement locations (ASTM C 172), perform required field tests and cast, cure, and test compressive strength samples (ASTM C 31, C 39, C 1231).
Terracon Rep.: David Carpio
Reported To: Will
Contractor: (1) Texas Transportation Institute, Gary Gerke  (1) Terracon Consultants, Inc., Alex Durigan, P.E.
(1) Texas Transportation Institute, Bill Collins

Test Methods: ASTM C 31, ASTM C143, ASTM C231, ASTM C1064
The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.
CONCRETE COMPRESSIVE STRENGTH TEST REPORT

Report Number: A1171057.0178
Service Date: 04/14/21
Report Date: 07/01/21 Revision 2 - PO 9
Task: PO/440861-4

Client
Texas Transportation Institute
Attn: Gary Gerke
TII Business Office
3135 TAMU
College Station, TX 77843-3125

Project
Riverside Campus
Riverside Campus
Bryan, TX
Project Number: A1171057

Material Information
Specified Strength:

Mix ID: DSD06S
Supplier: Martin Marietta
Batch Time: Plant: 617
Truck No.: Ticket No.:

Field Test Data
Test Slump (in): 6
Air Content (%): 1.0
Concrete Temp. (F): 77
Ambient Temp. (F): 73
Plastic Unit Wt. (pcf): 147.5
Yield (Cu. Yds.):

Sample Information
Sample Date: 04/14/21 Sample Time: 1215
Sample By: David Carpio
Weather Conditions: Cloudy, light wind
Accumulative Yards: 16/16 Batch Size (cy): 6
Placement Method:
Water Added Before (gal): 9
Water Added After (gal): 0
Sample Location: 9' south of north end of sound wall barrier
Placement Location: Sound wall barrier

Laboratory Test Data

<table>
<thead>
<tr>
<th>Set</th>
<th>Specimen ID</th>
<th>Avg Diam. (in)</th>
<th>Area (sq in)</th>
<th>Date Received</th>
<th>Date Tested</th>
<th>Age at Test (days)</th>
<th>Maximum Load (lbs)</th>
<th>Compressive Strength (psi)</th>
<th>Fracture Type</th>
<th>Tested By</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>A</td>
<td>6.00</td>
<td>28.27</td>
<td>05/19/21</td>
<td>35 F</td>
<td>128,750</td>
<td>4,559</td>
<td>5</td>
<td>AHJ</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>6.00</td>
<td>28.27</td>
<td>05/19/21</td>
<td>35 F</td>
<td>142,720</td>
<td>5,050</td>
<td>4</td>
<td>AHJ</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>C</td>
<td>6.00</td>
<td>28.27</td>
<td>05/19/21</td>
<td>35 F</td>
<td>134,780</td>
<td>4,770</td>
<td>5</td>
<td>AHJ</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td>Hold</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Initial Cure: Outside Plastic Lids
Final Cure: Hold
Comments: F = Field Cured

Note: Reported air content does not include Aggregate Correction Factor (ACF).

Samples Made By: Terracon
Services: Obtain samples of fresh concrete at the placement locations (ASTM C 172), perform required field tests and cast, cure, and test compressive strength samples (ASTM C 31, C 39, C 1231).

Terracon Rep.: David Carpio
Report To: Will

Contractor:

Report Distribution:
(1) Texas Transportation Institute, Gary Gerke
(3) Terracon Consultants, Inc., Alex Durigan, P.E.
(1) Texas Transportation Institute, Bill Griffith

Reviewed By: Alexander Dunigan
Project Manager

Test Methods: ASTM C 31, ASTM C143, ASTM C231, ASTM C1064

The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.
<table>
<thead>
<tr>
<th>Load No.</th>
<th>Truck No.</th>
<th>Ticket No.</th>
<th>Location (from concrete map)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>9019</td>
<td>6717070</td>
<td>East of the expansion joint until the end</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Load No.</th>
<th>Break Date</th>
<th>Cylinder Age</th>
<th>Total Load (lbs)</th>
<th>Break (psi)</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOAD TIME</td>
<td>TO JOB</td>
<td>ARRIVE JOB SITE</td>
<td>BEGIN POUR</td>
<td>FINISH POUR</td>
<td>LEAVE JOB SITE</td>
</tr>
<tr>
<td>-----------</td>
<td>--------</td>
<td>----------------</td>
<td>------------</td>
<td>-------------</td>
<td>---------------</td>
</tr>
<tr>
<td>11:44</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
</tbody>
</table>

WATER ADDED ON JOB AT CUSTOMER'S REQUEST: GAL.
ALLOWABLE WATER (withheld from batch): GAL.
TEST CYLINDER TAKEN: YES  NO  BY
CYLINDER TAKEN: BEFORE  AFTER WATER
ADDITIONAL WATER ADDED TO THIS CONCRETE WILL REDUCE ITS STRENGTH. ANY WATER ADDED IN EXCESS OF SPECIFIED SLUMP IS AT CUSTOMER'S RISK.

CUSTOMER NAME AND DELIVERY ADDRESS:
MBC MANAGEMENT
3100 SH 47, BRYAN, TX 77807

LOAD QUANTITY |
--- |
6.00 |
PRODUCT CODE |
DSD60S |
DESCRIPTION |
TXDOT CLASS S |

PLANT |
TRUCK |
ORDER NO. |
SLUMP |
P.O. #/JOBLOT |
017 |
9019 |
2033 |
5.00 |
TIITHREE BEAM |

DRIVER NAME |
WATTS, RODNEY |
DATE |
04/15/21 |

CUSTOMER NUMBER |
PROJET |
CUM. QTY |
ORDERED QTY |
732623 |
100138 |
6.00 |
5.00 |

UNIT PRICE |
6.00 |
AMOUNT |
5.00 |

SPECIAL DELIVERY INSTRUCTIONS:
RIGHT 2818, RIGHT LEONARD RD, RIGHT 47, LEFT INTO RELLIS, STRAIGHT AROUND ROUND ABOUT TO GATE, CUSTOMER TO MEET YOU THERE.

DANGER! MAY CAUSE ALKALI BURNS.
SEE WARNINGS ON REVERSE SIDE.

FOR OFFICE USE ONLY |
FORM: |

TR No. 0-7086-R4  47  2021-09-30
CONCRETE COMPRESSIVE STRENGTH TEST REPORT

Report Number: A171057.0180
Service Date: 04/15/21
Report Date: 07/01/21 Revision 2 - 76-day results
Task: PO# 440861-4

Client
Texas Transportation Institute
Attn: Gary Gerke
TTI Business Office
3135 TAMU
College Station, TX 77843-3135

Project
Riverside Campus
Riverside Campus
Bryan, TX

Material Information
Specified Strength: 4,000 psi @ 28 days
Mix ID: DSD508
Supplier: Martin Marietta
Batch Time: 1145 Plant: 617
Truck No.: 9019 Ticket No.: 6717070

Field Test Data
Slump (in): 6.24
Air Content (%): Not specified
Concrete Temp. (F): 70
Ambient Temp. (F): 67
Plastic Unit Wt. (pcf): 146.4
Yield (Cu. Yds.): 6.0

Sample Information
Sample Date: 04/15/21 Sample Time: 1220
Sampled By: Justin Maas
Weather Conditions: Cloudy, light wind
Accumulative Yards: 6/6 Batch Size (cy): 6
Placement Method: Direct Discharge
Water Added Before (gal): 5
Water Added After (gal): 0
Sample Location: South west end of south wall
Placement Location: Sound wall

Laboratory Test Data
<table>
<thead>
<tr>
<th>Set</th>
<th>Specimen ID</th>
<th>Avg Diam. (in)</th>
<th>Area (sq in)</th>
<th>Date Received</th>
<th>Age at Test (days)</th>
<th>Maximum Load (lb)</th>
<th>Compressive Strength (psi)</th>
<th>Fracture Type</th>
<th>Tested By</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 A</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>76 F</td>
<td>195,350</td>
<td>6,890</td>
<td>1 SLS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 B</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>76 F</td>
<td>194,610</td>
<td>6,860</td>
<td>4 SLS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 C</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>76 F</td>
<td>196,960</td>
<td>6,940</td>
<td>2 SLS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 D</td>
<td>Hold</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Initial Cure: Outside Plastic Lids Final Cure: Field Cured

Comments: F = Field Cured
Note: Reported air content does not include Aggregate Correction Factor (ACF).

Samples Made By: Terracon
Services: Obtain samples of fresh concrete at the placement locations (ASTM C 172), perform required field tests and cast, cure, and test compressive strength samples (ASTM C 31, C 39, C 1231).
Terracon Rep.: Justin Maas
Reported To: A&M contractors
Contractor:
Report Distribution:
(1) Texas Transportation Institute, Gary Gerke
(1) Terracon Consultants, Inc., Alex Durigan, P.E.
(1) Texas Transportation Institute, Bill Cywilt
Reviewed By: Alexander Dunigan
Project Manager

Test Methods: ASTM C 31, ASTM C143, ASTM C231, ASTM C1064
The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

TR No. 0-7086-R4 48 2021-09-30
<table>
<thead>
<tr>
<th>Load No.</th>
<th>Truck No.</th>
<th>Ticket No.</th>
<th>Location (from concrete map)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>7133</td>
<td>6723543</td>
<td>Soundwall, from expansion joint 65 feet west</td>
</tr>
<tr>
<td>T2</td>
<td>9019</td>
<td>6723674</td>
<td>Soundwall, remaining 55 feet</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Load No.</th>
<th>Break Date</th>
<th>Cylinder Age</th>
<th>Total Load (lbs)</th>
<th>Break (psi)</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
BILLING

Martin Marietta
1503 LBJ Freeway
Suite 400
Dallas, TX 75234

LOAD TIME TO JOB ARRIVE JOB SITE BEGIN POUR FINISH POUR LEAVE JOB SITE ARRIVE PLANNED
9:52 :

WATER ADDED ON JOB AT CUSTOMER'S REQUEST GAL.
ALLOWABLE WATER (withheld from batch) GAL.
EST CYLINDER TAKEN [ ] YES [ ] NO BY
YLINDER TAKEN [ ] BEFORE [ ] AFTER WATER
ADDITIONAL WATER ADDED TO THIS CONCRETE WILL REDUCE ITS STRENGTH... ANY WATER ADDED IN EXCESS OF SPECIFIED SLUMP IS AT CUSTOMER'S RISK.

CUSTOMER NAME AND DELIVERY ADDRESS
MBC MANAGEMENT
100 SH 47, BRYAN, TX 77807

LOAD QUANTITY PRODUCT CODE DESCRIPTION
6.00 DSD60S TXDOT CLASS S

PLANT TRUCK ORDER NO. SLUMP P.O. #/JOB/LOT
617 9019 2015 5.00 THIERRY B E

DRIVER NAME DATE
WATTS, RODNEY 04/20/21

CUSTOMER NUMBER PROJECT CUM. QTY ORDERED QTY
78283 100138 12.00 12.00

SALES TAX
TOTAL

SPECIAL DELIVERY INSTRUCTIONS
IGHT 2818, RIGHT LEONARD RD, RIGHT 47, LEFT INTO RELLIS, RIGHT AROUND ROUND ABOUT TO GATE, CUSTOMER TO MEET YOU HERE.

ANGER! MAY CAUSE ALKALI BURNS.
SEE WARNING ON REVERSE SIDE.

FOR OFFICE USE ONLY FORM:

truck Driver User Disp Ticket Num Ticket ID Time Date
019 726255 user 6723674 91940 9:52 4/20/21

size Mix Code Returned Qty Mix Age Seq Load ID
.00 CYDE DSD60S 0 0 0 0

Design Qty Required Batched % Var % Moisture Actual Water
1912 lb 10600 lb 10940 lb 0.18% 0.80% M 10 lb
8660 lb 8660 lb 8660 lb 0.24% 3.0% M 34 lb
305 lb 305 lb 305 lb 0.24% 3.0% M 34 lb
380 lb 380 lb 380 lb 0.04% 0.1% M 130 lb

Number Batches
1

Design WC Water/Cement
0.455

Adjust Water
0.0 lb / Load

Trim Water
-0.4 g / CYDE

Cement Scale B 1 ST 0 lb ET 0 lb

Weights

SCALE B 1 ST 0 lb ET 0 lb

TR No. 0-7086-R4 50 2021-09-30
CONCRETE COMpressive STRENGTH TEST REPORT

Report Number:  A1171057.0185
Service Date:  04/20/21
Report Date:  07/01/21  Revision 2 - 71-day results
Task:  PO# 440861-4

Client
Texas Transportation Institute
Att: Gary Gerke
TTU Business Office
3135 TAMU
College Station, TX 77843-3135

Project
Riverside Campus
Riverside Campus
Bryan, TX

Project Number: A1171057

Material Information
Specified Strength:  4,000 psi @ 28 days
Mix ID:  DSD60S
Supplier:  Martin Marietta
Batch Time:  09:10
Plant:  Bryan
Track No.:  7133
Ticket No.:  0723543

Sample Information
Sample Date:  04/20/21
Sample Time:  1000
Sampled By:  Justin Maass
Weather Conditions:  Clear, light wind
Accumulative Yards:  6/12
Batch Size (cy):  6
Placement Method:  Bucket & lift
Water Added Before (gal):  10
Water Added After (gal):  0
Sample Location:  Center of all
Placement Location:  Sound wall North half, upper half and of wall

Field Test Data
<table>
<thead>
<tr>
<th>Test</th>
<th>Slump (in):</th>
<th>Air Content (%):</th>
<th>Concrete Temp. (F):</th>
<th>Ambient Temp. (F):</th>
<th>Plastic Unit Wt. (pcf):</th>
<th>Yield (Cu. Yds):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 3/4</td>
<td>1.2</td>
<td>78</td>
<td>70</td>
<td>147.6</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Laboratory Test Data

<table>
<thead>
<tr>
<th>Set No.</th>
<th>Specimen ID</th>
<th>Specimen</th>
<th>Diam.</th>
<th>Area (in)</th>
<th>Date Received</th>
<th>Date Tested</th>
<th>Age at Test (days)</th>
<th>Maximum Load (lbs)</th>
<th>Compressive Strength (psi)</th>
<th>Fracture Type</th>
<th>Tested By</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>71 F</td>
<td>157,220</td>
<td>5,540</td>
<td>3 SLS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>B</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>71 F</td>
<td>159,650</td>
<td>5,630</td>
<td>2 SLS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>C</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>71 F</td>
<td>166,280</td>
<td>5,860</td>
<td>1 SLS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>D</td>
<td>Hold</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Initial Cure: Outside Plastic Lids  Final Cure: Hold

Comments:  F = Field Cured
Note: Reported air content does not include Aggregate Correction Factor (ACF). None

Samples Made By: Terracon
Services:  Obtain samples of fresh concrete at the placement locations (ASTM C 172), perform required field tests and cast, cure, and test compressive strength samples (ASTM C 31, C 39, C 1231).

Terracon Rep.: Justin Maass  Start/Stop: 0900-1130
Reported To:  
Contractor:
Report Distribution:
(1) Texas Transportation Institute, Gary Gerke  (1) Terracon Consultants, Inc., Alex Deidner, P.E.
(1) Texas Transportation Institute, Bill Griffith

Test Methods:  ASTM C 31, ASTM C143, ASTM C231, ASTM C1064

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TR No. 0-7086-R4  52  2021-09-30
CONCRETE COMPRESSIVE STRENGTH TEST REPORT

Report Number: A1171057.0185
Service Date: 04/20/21
Report Date: 07/01/21 Revision 2 - 71-day results
Task: PO# 440861-4

Client
Texas Transportation Institute
Attn: Gary Gerke
TTI Business Office
3135 TAMU
College Station, TX 77843-3135

Project
Riverside Campus
Riverside Campus
Bryan, TX

Project Number: A1171057

Material Information
Specified Strength: 4,000 psi @ 28 days
Mix ID: D5D60S
Supplier: Martin Marietta
Batch Time: 0952 Plant: Bryan
Truck No.: 9019 Ticket No.: 6722674

Sample Information
Sample Date: 04/20/21 Sample Time: 1050
Sampled By: Justin Maass
Weather Conditions: Clear, light wind
Accumulative Yards: 12/12
Batch Size (cy): 6
Placement Method: Bucket & lift
Water Added Before (gal): 13
Water Added After (gal): 0
Sample Location: 10ft from North end
Placement Location: Sound wall, North half, upper half of wall

Field Test Data

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slump (in)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Air Content (%)</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>Concrete Temp. (F)</td>
<td>77</td>
<td></td>
</tr>
<tr>
<td>Ambient Temp. (F)</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Plastic Unit Wt. (pound)</td>
<td>148.0</td>
<td></td>
</tr>
<tr>
<td>Yield (Cu. Yds.)</td>
<td>12.0</td>
<td></td>
</tr>
</tbody>
</table>

Laboratory Test Data

<table>
<thead>
<tr>
<th>Set No.</th>
<th>Specimen ID</th>
<th>Avg Diam. (in)</th>
<th>Area (sq in)</th>
<th>Date Received</th>
<th>Date Tested</th>
<th>Age at Test (days)</th>
<th>Maximum Load (lbs)</th>
<th>Compressive Strength (psi)</th>
<th>Fracture Type</th>
<th>Tested By</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>A</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>71 F</td>
<td>161,530</td>
<td>5,690</td>
<td>1</td>
<td>SLS</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>71 F</td>
<td>153,200</td>
<td>5,400</td>
<td>4</td>
<td>SLS</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>C</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>71 F</td>
<td>144,180</td>
<td>5,080</td>
<td>2</td>
<td>SLS</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td>Hold</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Initial Cure: Outside Plastic Lids Final Cure: Hold

Comments: F = Field Cured
Note: Reported air content does not include Aggregate Correction Factor (ACF)
None

Samples Made By: Terracon
Services: Obtain samples of fresh concrete at the placement locations (ASTM C 172), perform required field tests and cast, cure, and test compressive strength samples (ASTM C 31, C 39, C 1231).

Terracon Rep.: Justin Maass
Reported To: 0900-1130

Contractor:

Report Distribution:
(1) Texas Transportation Institute, Gary Gerke
(1) Terracon Consultants, Inc., Alex Dunigan, P.E.
(1) Texas Transportation Institute, Bill Griffith

Reviewed By:
Alexander Dunigan
Project Manager

Test Methods: ASTM C 31, ASTM C143, ASTM C231, ASTM C1664

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<table>
<thead>
<tr>
<th>Load No.</th>
<th>Truck No.</th>
<th>Ticket No.</th>
<th>Location (from concrete map)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>4280</td>
<td>6731090</td>
<td>Remaining section of Soundwall</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Load No.</th>
<th>Break Date</th>
<th>Cylinder Age</th>
<th>Total Load (lbs)</th>
<th>Break (psi)</th>
<th>Average</th>
</tr>
</thead>
</table>
## Load Time

<table>
<thead>
<tr>
<th>Load Time</th>
<th>To Job</th>
<th>Arrive Job Site</th>
<th>Begin Pour</th>
<th>Finish Pour</th>
<th>Leave Job Site</th>
<th>Arrive Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:49</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Special Delivery Instructions

Right 2818, Right Leonard Rd, Right 47, Left into Rellis, Straight Around Round About to Gate, Customer to Meet You There.

### Danger! May Cause Alkali Burns.

See Warnings on Reverse Side.

---

### Material Specifications

<table>
<thead>
<tr>
<th>Material Code</th>
<th>Design Qty</th>
<th>Required</th>
<th>Batched</th>
<th>% Var</th>
<th>% Moisture</th>
<th>Actual</th>
<th>Wat</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCC</td>
<td>255 lb</td>
<td>747 lb</td>
<td>708 lb</td>
<td>&lt;</td>
<td>-0.05%</td>
<td>0.20% M</td>
<td>2 gl</td>
</tr>
<tr>
<td>ZY-310</td>
<td>3 oz</td>
<td>1 oz</td>
<td>1 oz</td>
<td>&lt;</td>
<td>-0.05%</td>
<td>0.20% M</td>
<td>2 gl</td>
</tr>
<tr>
<td>CEM-III</td>
<td>570 lb</td>
<td>220 lb</td>
<td>227 lb</td>
<td>0.01%</td>
<td>0.20% M</td>
<td>0.20% M</td>
<td>2 gl</td>
</tr>
</tbody>
</table>

### Aggregate Scale

<table>
<thead>
<tr>
<th>Aggregate Scale</th>
<th>Water Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1 ST</td>
<td>B-1 ST</td>
</tr>
<tr>
<td>40 lb</td>
<td>30 lb</td>
</tr>
</tbody>
</table>

### Ticket Details

- **Ticket No.**: 6731090
- **Ticket ID**: 9495
- **Time**: 9:49
- **Date**: 4/22/21
- **Order No.**: 2031
- **Material**: TTI-THREE BEAM
- **Driver Name**: Steven Albrecht
- **Customer Number**: 100136
- **Cum. Qty**: 4.00
- **Ordered Qty**: 4.00
CONCRETE COMPRESSIVE STRENGTH TEST REPORT

Client
Texas Transportation Institute
Attn: Gary Gerke
TIT Business Office
3135 TAMU
College Station, TX 77843-3135

Project
Riverside Campus
Riverside Campus
Bryan, TX

Material Information
Specified Strength: 4,000 psi @ 28 days
Mix ID: Class S
Supplier: Martin Marietta
Batch Time: 0949
Plant: 618
Truck No.: 4280
Ticket No.: 6731090

Field Test Data
<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slump (in):</td>
<td>5 1/2</td>
<td></td>
</tr>
<tr>
<td>Air Content (%):</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>Concrete Temp. (F):</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td>Ambient Temp. (F):</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>Plastic Unit Wt. (pcf):</td>
<td>149.3</td>
<td></td>
</tr>
<tr>
<td>Yield (Cu. Yds.):</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Laboratory Test Data

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<tr>
<th>Set</th>
<th>Specimen ID</th>
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<th>Area (sq in)</th>
<th>Date Received</th>
<th>Date Tested</th>
<th>Age at Test (days)</th>
<th>Maximum Load (lbs)</th>
<th>Compressive Strength (psi)</th>
<th>Fracture Type</th>
<th>Tested By</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>69 F</td>
<td>154,950</td>
<td>5,460</td>
<td>2</td>
<td>SLS</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>B</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>69 F</td>
<td>153,150</td>
<td>5,400</td>
<td>2</td>
<td>SLS</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>C</td>
<td>6.01</td>
<td>28.37</td>
<td>06/30/21</td>
<td>69 F</td>
<td>143,600</td>
<td>5,060</td>
<td>4</td>
<td>SLS</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>D</td>
<td></td>
<td>Hold</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Initial Cure: Outside Plastic Lids
Final Cure: Field Cured
Comments: F = Field Cured
Note: Reported air content does not include Aggregate Correction Factor (ACF).

Samples Made By: Terracon
Services: Obtain samples of fresh concrete at the placement locations (ASTM C 172), perform required field tests and cast, cure, and test compressive strength samples (ASTM C 31, C 39, C 1231).

Terracon Rep.: David Carpio
Report To: Bill
Contractor:
Report Distribution:
(1) Texas Transportation Institute, Gary Gerke
(1) Terracon Consultants, Inc., Alex Dunigan, P.E.
(1) Texas Transportation Institute, Bill Griffith

Test Methods: ASTM C 31, ASTM C 143, ASTM C 231, ASTM C 1064
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TR No. 0-7086-R4

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2021-09-30
APPENDIX C. MASH TEST 5-12 (CRASH TEST NO. 440861-4)

C.1. VEHICLE PROPERTIES AND INFORMATION

Table C.1. Vehicle Properties for Test No. 440861-4.

<table>
<thead>
<tr>
<th>DATE:</th>
<th>2021-7-1</th>
<th>TEST NO.:</th>
<th>440861-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRACTOR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YEAR:</td>
<td>2013</td>
<td>MAKE:</td>
<td>INTERNATIONAL</td>
</tr>
<tr>
<td>VIN No.:</td>
<td>1HSHXSJR5DJ308361</td>
<td>ODOMETER:</td>
<td>345935</td>
</tr>
<tr>
<td>TRAILER</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YEAR:</td>
<td>1988</td>
<td>MAKE:</td>
<td>GREAT DANE</td>
</tr>
<tr>
<td>VIN No.:</td>
<td>1GRAA0629JB177734</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GEOMETRY (inches)

| A | 102.00 | D | 52.00 | G | K | 51.00 | O | 14.00 | R | 79.00 | U | 23.50 | X | 794.0 |
| B | 48.00 | E | 459.00 | H | 73.00 | L | 50.00 | P | 82.00 | S | 15.00 | V | 35.00 |
| C | 136.00 | F | 48.00 | J | 64.00 | M | 29.50 | Q | 74.00 | T | 40.00 | W | 160.5 |

Allowable Range: C = 200 inches max.; L = 50 ± 2 inches; Overall Trailer Length = 636 inches max.; Overall Combination Length = 818 inches max.; Trailer Overhang = 87 inches max.; Ballast Center of Mass Hf = 73 ± 2 inches above ground.

MASS (lb)

| M1 | 8,990 |
| M2 | 6,110 |
| M3 | 5,910 |
| M4 | 5350 |
| M5 | 4470 |
| Mtotal | 30830 |

Allowable Range: 29,000 ± 3100 lb | 79,300 ± 1100 lb

TEST INERTIAL

| M1 | 10380 |
| M2 | 17640 |
| M3 | 17590 |
| M4 | 17350 |
| M5 | 17070 |

Allowable Range: 80030 | 79,300 ± 1100 lb
C.2. SEQUENTIAL PHOTOGRAPHS

Figure C.1. Sequential Photographs for Test No. 440861-4 (Overhead and Frontal Views).
Figure C.1. Sequential Photographs for Test No. 440861-4 (Overhead and Frontal Views) (Continued).
Figure C.2. Sequential Photographs for Test No. 440861-4 (Rear View).
C.3. VEHICLE ANGULAR DISPLACEMENTS

Roll, Pitch, and Yaw Angles

Axes are vehicle-fixed.

Sequence for determining orientation:
1. Yaw
2. Pitch
3. Roll

Figure C.3. Vehicle Angular Displacements for Test No. 440861-4.

Test Number: 440861-4
Test Standard/Test Number: MASH Test 12
Test Article: TxDOT T80SS Barrier with Soundwall
Test Vehicle: 2013 International 8600 Tractor with 1988 Great Dane 7311TCHL53 Trailer
Inertial Mass: 80,030 lb
Gross Mass: 80,030 lb
Impact Speed: 50.4 mi/h
Impact Angle: 14.3 degrees
Figure C.4. Vehicle Longitudinal Accelerometer Trace for Test No. 440861-4
(Accelerometer Located at Front).
Figure C.5. Vehicle Lateral Accelerometer Trace for Test No. 440861-4
(Accelerometer Located at Front).

Test Number: 440861-4
Test Standard Test Number: MASH Test 5-12
Test Article: TxDOT T80SS Barrier with Soundwall
Test Vehicle: 2013 International 8600 Tractor with
1988 Great Dane 7311TCHL53 Trailer
Inertial Mass: 80,030 lb
Gross Mass: 80,030 lb
Impact Speed: 50.4 mi/h
Impact Angle: 14.3 degrees
Z Acceleration at Front of Vehicle

Figure C.6. Vehicle Vertical Accelerometer Trace for Test No. 440861-4
(Accelerometer Located at Front).

Test Number: 440861-4
Test Standard Test Number: MASH Test 5-12
Test Article: TxDOT T80SS Barrier with Soundwall
Test Vehicle: 2013 International 8600 Tractor with 1988 Great Dane 7311TCHL53 Trailer
Inertial Mass: 80,030 lb
Gross Mass: 80,030 lb
Impact Speed: 50.4 mi/h
Impact Angle: 14.3 degrees
**X Acceleration at Fifth Wheel**

![Graph showing X Acceleration at Fifth Wheel](image)

**Figure C.7. Vehicle Longitudinal Accelerometer Trace for Test No. 440861-4**

(Accelerometer Located at Fifth Wheel.)

- **Test Number**: 440861-4
- **Test Standard Test Number**: MASH Test 5-12
- **Test Article**: TxDOT T80SS Barrier with Soundwall
- **Test Vehicle**: 2013 International 8600 Tractor with 1988 Great Dane 7311TCHLS53 Trailer
- **Inertial Mass**: 80,030 lb
- **Gross Mass**: 80,030 lb
- **Impact Speed**: 50.4 mi/h
- **Impact Angle**: 14.3 degrees

---

**Legend**
- SAE Class 60 Filter
- 50-msec average
Figure C.8. Vehicle Lateral Accelerometer Trace for Test No. 440861-4
(Accelerometer Located at Fifth Wheel.)
Figure C.9. Vehicle Vertical Accelerometer Trace for Test No. 440861-4
(Accelerometer Located at Fifth Wheel).
Figure C.10. Vehicle Longitudinal Accelerometer Trace for Test No. 440861-4
(Accelerometer Located at Rear of Trailer).
Figure C.11. Vehicle Lateral Accelerometer Trace for Test No. 440861-4
(Accelerometer Located at Rear of Trailer).

Test Number: 440861-4
Test Standard Test Number: MASH Test 5-12
Test Article: TxDOT T80SS Barrier with Soundwall
Test Vehicle: 2013 International 8600 Tractor with 1988 Great Dane 7311TCHL53 Trailer
Inertial Mass: 80,030 lb
Gross Mass: 80,030 lb
Impact Speed: 50.4 mi/h
Impact Angle: 14.3 degrees
Figure C.12. Vehicle Vertical Accelerometer Trace for Test No. 440861-4 (Accelerometer Located at Rear of Trailer).

Test Number: 440861-4
Test Standard Test Number: MASH Test 5-12
Test Article: TxDOT T80SS Barrier with Soundwall
Test Vehicle: 2013 International 8600 Tractor with 1988 Great Dane 7311TCHL53 Trailer
Inertial Mass: 80,030 lb
Gross Mass: 80,030 lb
Impact Speed: 50.4 mi/h
Impact Angle: 14.3 degrees