



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



Crash testing performed at:  
TTI Proving Ground  
1254 Avenue A, Building 7091  
Bryan, TX 77807

## **Test Report 0-7086-R4**

Cooperative Research Program

**TEXAS A&M TRANSPORTATION INSTITUTE  
COLLEGE STATION, TEXAS**

**TEXAS DEPARTMENT OF TRANSPORTATION**

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16. Abstract <p>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) <i>Manual for Assessing Safety Hardware (MASH)</i>. The crash test was performed in accordance with <i>MASH</i> 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.</p> <p>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 <i>MASH</i> Test 5-12 longitudinal barrier evaluation criteria.</p> <p>The TxDOT T80SS barrier with soundwall met the performance criteria for <i>MASH</i> Test 5-12 for longitudinal barriers.</p>					
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## 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.

## REPORT AUTHORIZATION

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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

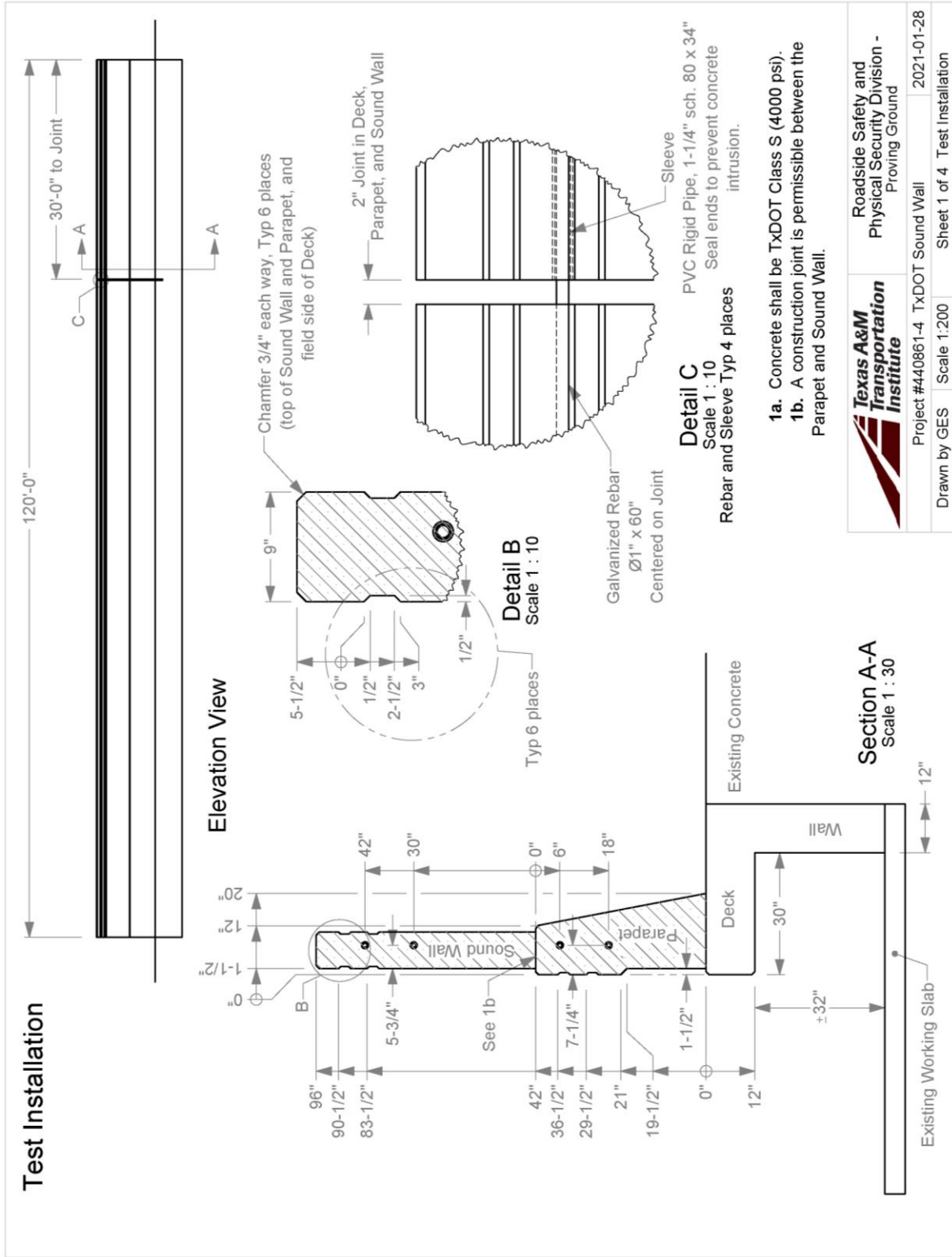
No modifications were made to the installation during the testing phase.

### 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:

- North of Joint Support wall: 5,620 psi at 91 days of age on June 30, 2021.
- 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.
- Soundwall South of Expansion Joint: 5,306 psi at 69 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.



Q:\Accreditation-17025-2017\EIR-000 Project Files\440861 - TxDOT FY2021\440861-4 Soundwall 5-12- Bligh\Drafting, 440861-4\440861-4 Drawing

Figure 2.1.1. Details of TxDOT T80SS Barrier with Soundwall.



**Figure 2.2. TxDOT T80SS Barrier with Soundwall prior to Testing.**





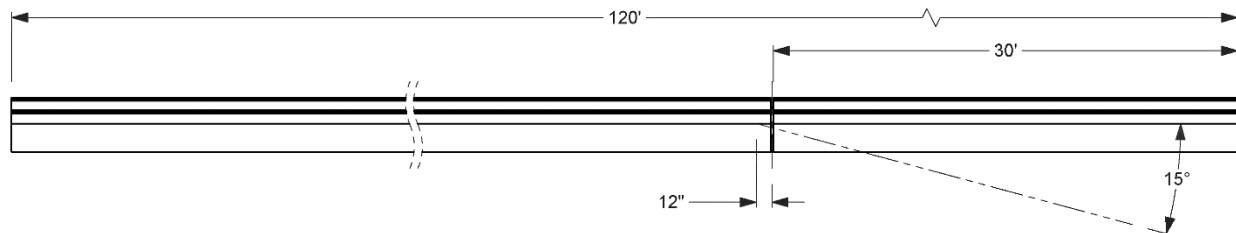
## Chapter 3. TEST REQUIREMENTS AND EVALUATION CRITERIA

### 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.**

Test Article	Test Designation	Test Vehicle	Impact Conditions		Evaluation Criteria
			Speed	Angle	
Longitudinal Barrier	5-10	1100C	62 mi/h	25°	A, D, F, H, I
	5-11	2270P	62 mi/h	25°	A, D, F, H, I
	5-12	36000V	50 mi/h	15°	A, D, G



**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.**

<b>Evaluation Factors</b>	<b>Evaluation Criteria</b>
<b>Structural Adequacy</b>	A. <i>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.</i>
<b>Occupant Risk</b>	D. <i>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.</i>  <i>Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.2.2 and Appendix E of MASH.</i>
	G. <i>It is preferable, although not essential, that the vehicle remain upright during and after the collision.</i>

## 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 RELIS 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 × 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  $\pm 1.7$  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  $\pm 0.7$  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  $\pm$  1100 lb impacting the CIP of the longitudinal barrier at an impact speed of 50 mi/h  $\pm$  2.5 mi/h and an angle of 15 degrees  $\pm$  1.5 degrees. The CIP for MASH Test 5-12 on the TxDOT T80SS barrier with soundwall was 12 inches  $\pm$  12 inches downstream of the centerline of the expansion joint. Figure 3.1 and Figure 5.1 depict the target impact setup.



**Figure 5.1. TxDOT T80SS Barrier with Soundwall/Test Vehicle Geometrics for Test No. 440861-4.**

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.



**Figure 5.2. Test Vehicle before Test No. 440861-4.**

#### **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.**

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

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**

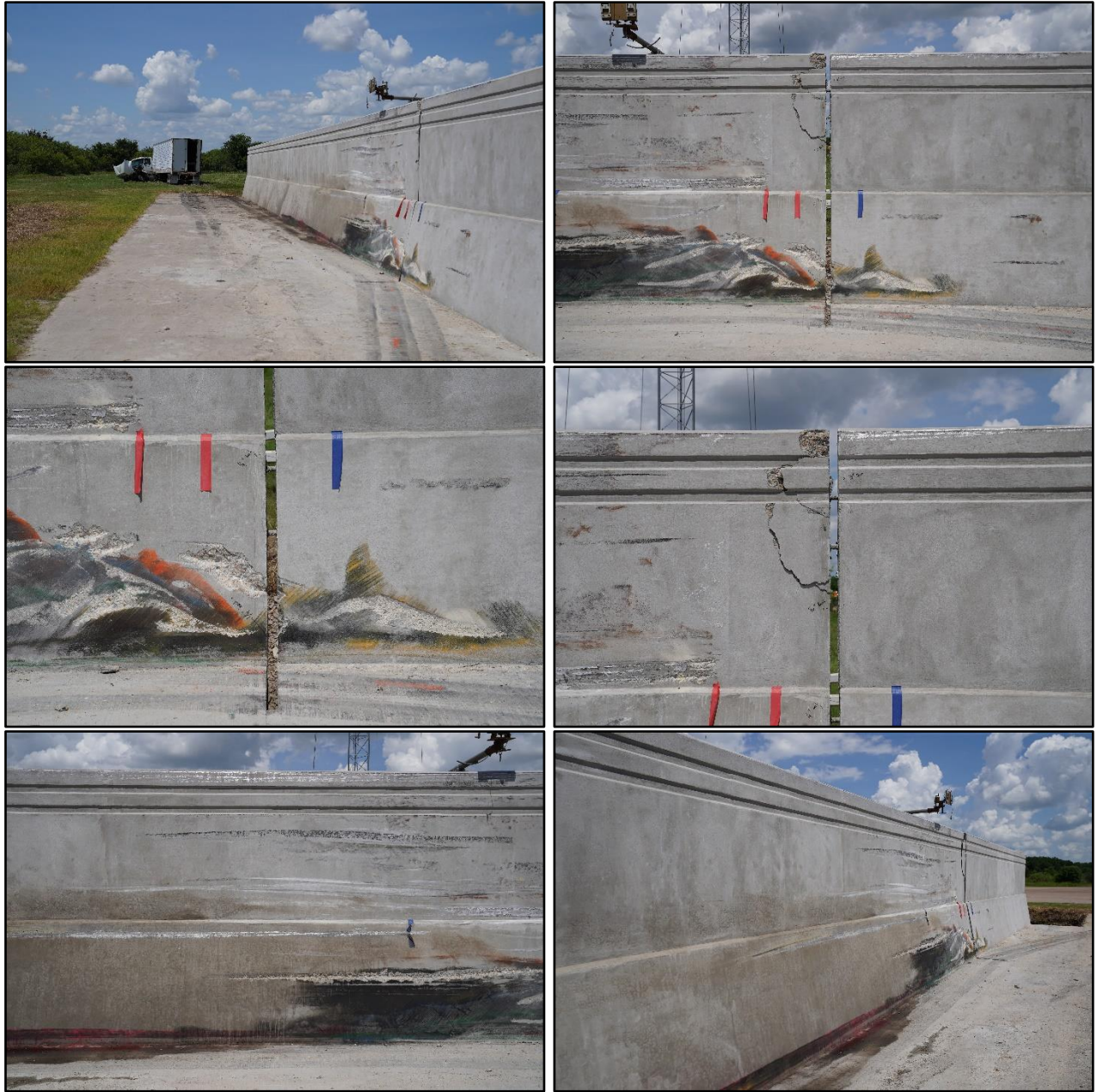
Figure 5.5 shows the damage sustained by the vehicle. The front bumper, left front axle spring assembly, hood, right door, right front tire and rim, right front outer tandem tire and rim, right fuel tank (deformed only; no visible cuts or holes; no leaks), right side steps, right front corner of the 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.**





## **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.**

Test Agency: Texas A&M Transportation Institute

Test No.: 440861-4

Test Date: 2021-07-01

<b>MASH Test 5-12 Evaluation Criteria</b>	<b>Test Results</b>	<b>Assessment</b>
<p><b><u>Structural Adequacy</u></b></p> <p>A. <i>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.</i></p>	<p>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.</p>	<p>Pass</p>
<p><b><u>Occupant Risk</u></b></p> <p>D. <i>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.</i></p> <p><i>Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.2.2 and Appendix E of MASH.</i></p>	<p>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.</p> <p>No occupant compartment deformation or intrusion was observed.</p>	<p>Pass</p>
<p>G. <i>It is preferable, although not essential, that the vehicle remain upright during and after collision.</i></p>	<p>The 36000V vehicle remained upright during and after the collision event.</p>	<p>Pass</p>



## 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.

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

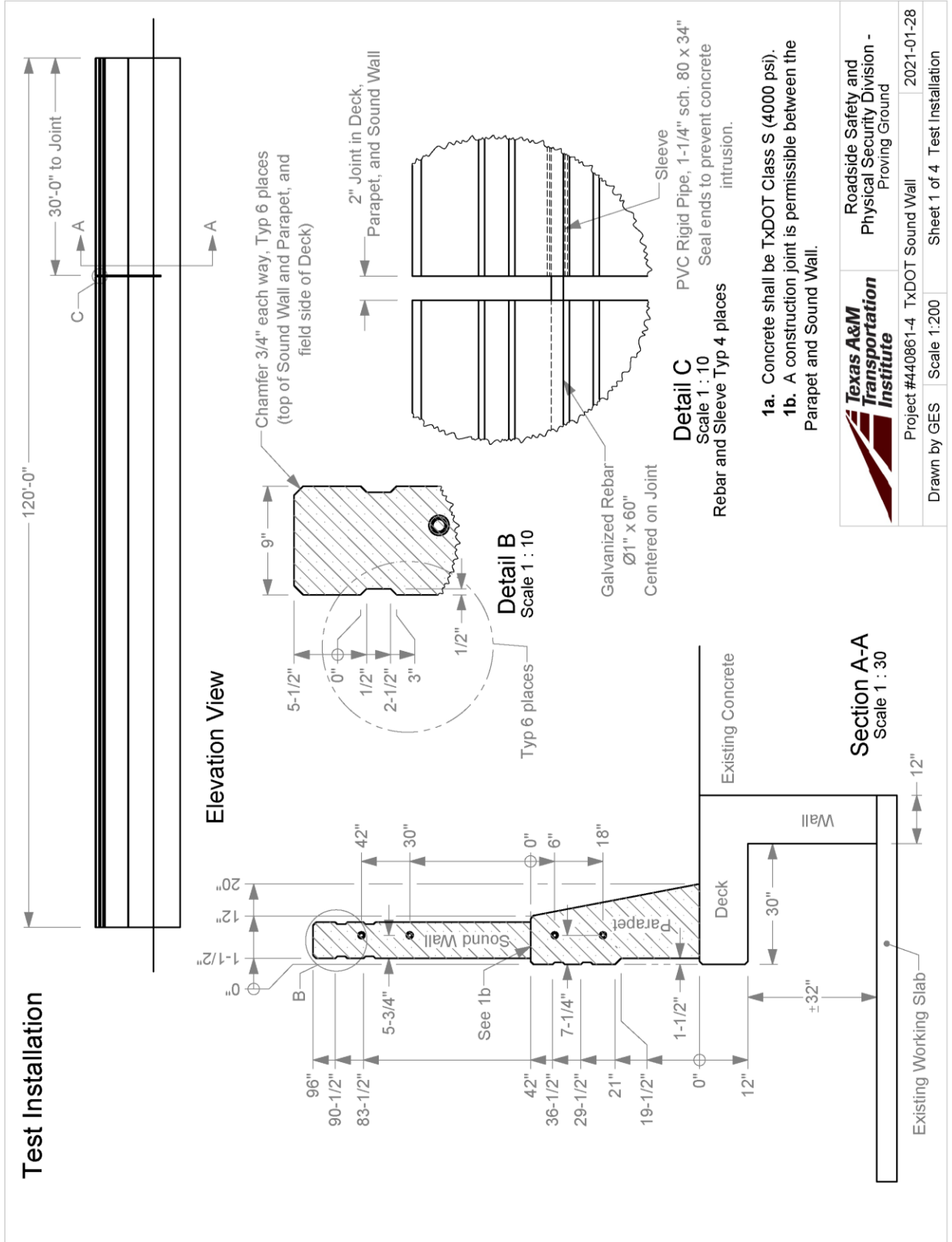


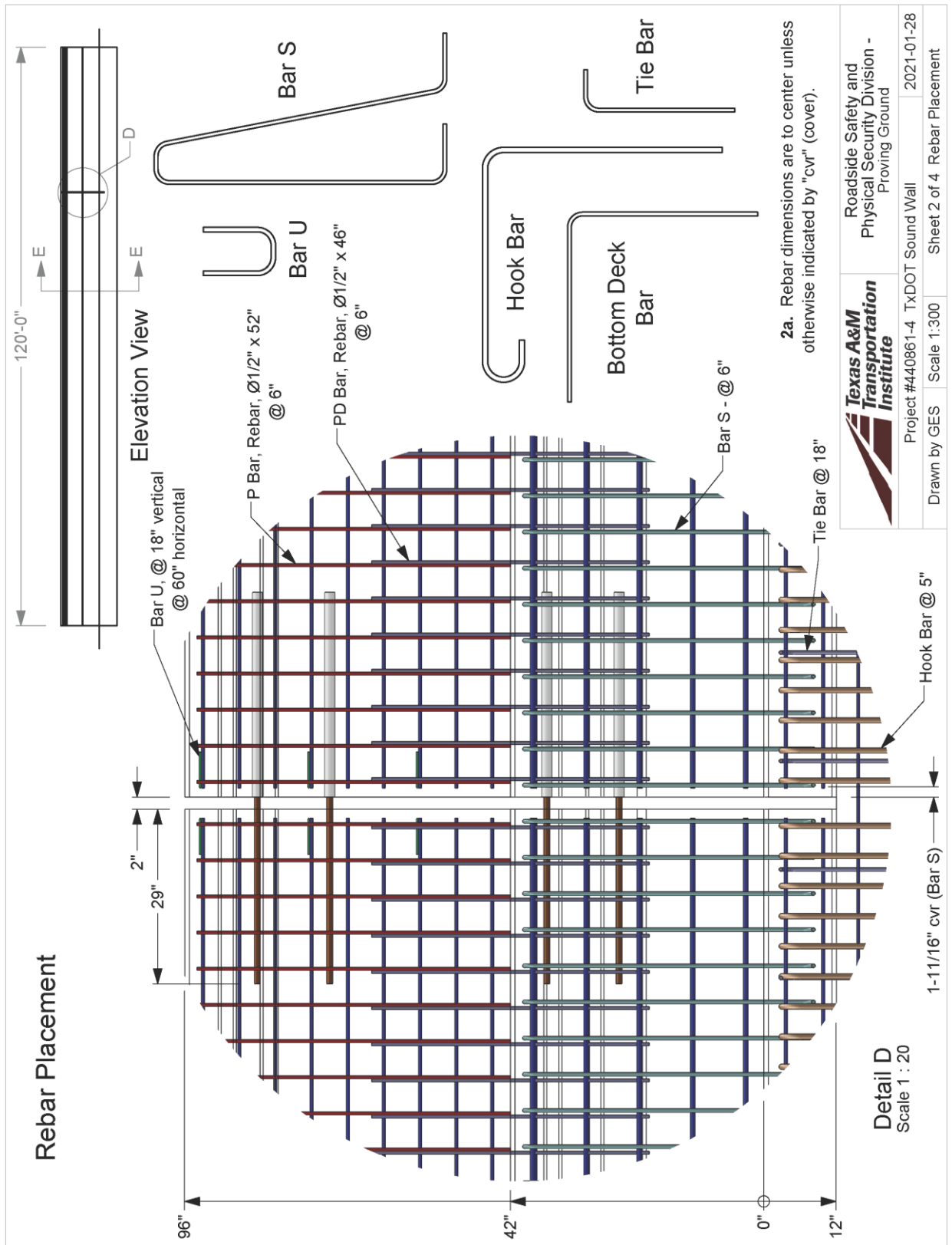
## REFERENCES

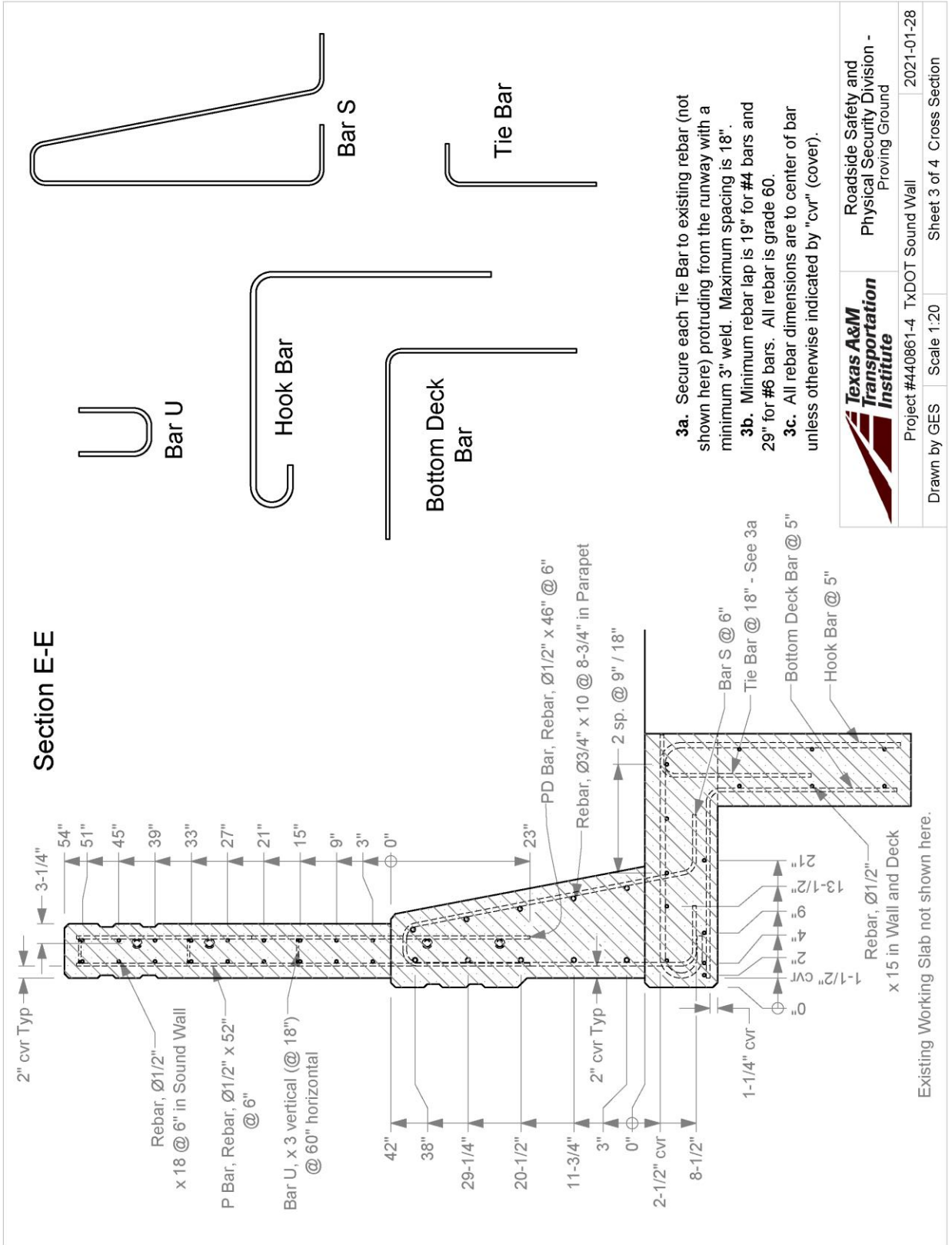
1. AASHTO. *Manual for Assessing Roadside Safety Hardware, Second Edition*. American Association of State Highway and Transportation Officials, Washington, DC, 2016.
2. FHWA Safety Roadway Departure Eligibility Letter B-339  
([https://safety.fhwa.dot.gov/roadway\\_dept/countermeasures/reduce\\_crash\\_severity/barriers/pdf/b339.pdf](https://safety.fhwa.dot.gov/roadway_dept/countermeasures/reduce_crash_severity/barriers/pdf/b339.pdf)).
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/TX-11/9-1002-3, Texas A&M Transportation Institute, College Station, TX, March 2011.



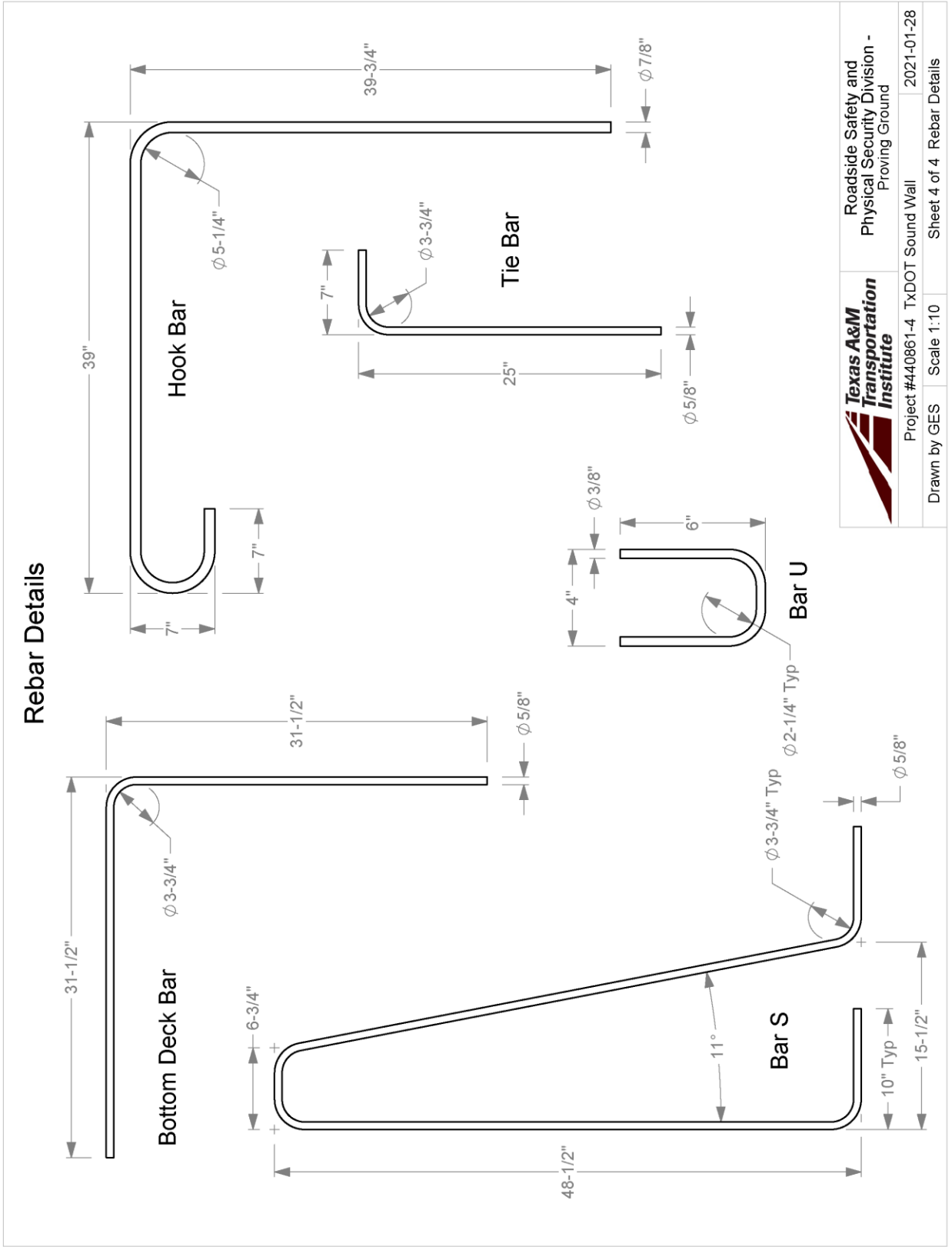
# APPENDIX A. DETAILS OF T80SS BARRIER WITH SOUNDWALL







Q:\Accreditation-17025-2017\EIR-000 Project Files\440861 - TXDOT FY2021\440861-4 Soundwall 5-12- Bligh\Drafting, 440861-4\440861-4 Drawing



	Roadside Safety and Physical Security Division - Proving Ground	2021-01-28
	Project #440861-4 TXDOT Sound Wall	Sheet 4 of 4 Rebar Details
Drawn by GES	Scale 1:10	

Q:\Accreditation-17025-2017\ER-000 Project Files\440861 - TXDOT FY2021\440861-4 Soundwall 5-12- Bligh\Drafting\_440861-4\440861-4 Drawing





BILLING

TICKET NO.  
6678594



**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
11:31	:	:	:	:	:	:

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

CUSTOMER SIGNATURE

X \_\_\_\_\_

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

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

CUSTOMER NAME AND DELIVERY ADDRESS

MBC MANAGEMENT  
3100 SH 47, BRYAN, TX 77807

PLANT	TRUCK	ORDER NO.	SLUMP	P.O. #/JOB/LOT
617	7212	2016	5.00	TTI-THRIE BEAM
DRIVER NAME		DATE		
CHARLES BALANGA		03/31/21		
CUSTOMER NUMBER	PROJECT	CUM. QTY	ORDERED QTY	
782823	100138	10.00	20.00	

LOAD QUANTITY	PRODUCT CODE	DESCRIPTION	UNIT PRICE	AMOUNT
10.00	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

SALES TAX

TOTAL

**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								
7212	916114	user	6678594	91404	11:31	3/31/21								
Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID								
10.00 CYDS	DSD60S				D	92574								
Material	Design Qty	Required	Batched	% Var%	Moisture	Actual	Wat							
1"RG	1812 lb	18266 lb	18240 lb	-0.14%	0.80% M		17 gl							
SAND-1	1380 lb	14375 lb	14340 lb	-0.24%	4.00% M		69 gl							
CMT-I/II	570 lb	5700 lb	5680 lb	-0.35%										
H2O	258 lb	1734 lb	1730 lb	-0.21%			207 gl							
ZY-610	23 oz	228 oz	228 oz	0.00%										
Actual		Num Batches:	1											
Load	40004 lb	Design W/C:	0.453	Water/Cement:	0.454 T	Design	309.2 gl	Actual	293.5 gl	To Add:	15.6 gl			
Slump:	5.00 in	Water in Truck:	0.0 gl	Adjust Water:	0.0 gl / Load	Trim Water:	-1.5 gl / CYDS							
AGG1 SCALE	B 1 ST	20 lb	ET	0 lb	CEM1 SCALE	B 1 ST	10 lb	ET	0 lb	WAT1 SCALE	B 1 ST	4 lb	ET	0 lb

BILLING

TICKET NO.  
6678665



# 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
11:46	12:02	12:27	12:35	:	:	:

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

CUSTOMER NAME AND DELIVERY ADDRESS	PLANT	TRUCK	ORDER NO.	SLUMP	P.O. #/JOB/LOT
MBC MANAGEMENT 3100 SH 47, BRYAN, TX 77807	617	7211	2016	5.00	TTI-THRIE BEAM
	DRIVER NAME				DATE
	LARRY JANTZEN				03/31/21
	CUSTOMER NUMBER	PROJECT	CUM. QTY	ORDERED QTY	
	782823	100138	20.00	20.00	

LOAD QUANTITY	PRODUCT CODE	DESCRIPTION	UNIT PRICE	AMOUNT
10.00	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

SALES TAX \_\_\_\_\_  
TOTAL \_\_\_\_\_

**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	6678665	91406	11:46	3/31/21		
Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID		
10.00 CYDS	DSD60S				D	92576		
Material	Design Qty	Required	Batched	% Var%	Moisture	Actual	Wat	
1"RG	1812 lb	18266 lb	18280 lb	0.08%	0.80% M		18 gl	
SAND-1	1380 lb	14375 lb	14360 lb	-0.10%	4.00% M		69 gl	
CMT-I/II	570 lb	5700 lb	5675 lb	-0.44%				
H2O	258 lb	1734 lb	1734 lb	0.02%		208 gl		
ZY-510	23 oz	228 oz	227 oz	-0.44%				
Actual	Num Batches: 1							
Load	40063 lb	Design W/C: 0.453	Water/Cement: 0.455 T	Design	309.2 gl	Actual	294.1 gl	To Add: 15.0 gl
Slump:	5.00 in	Water in Truck:	0.0 gl	Adjust Water:	0.0 gl / Load	Trim Water:	-1.5 gl / CYDS	
AGG1 SCALE	B 1 ST 0 lb	ET 0 lb	CEM1 SCALE	B 1 ST 10 lb	ET 0 lb	WAT1 SCALE	B 1 ST 0 lb	ET 0 lb

BILLING

TICKET NO.  
6678983



**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	1:24	:	:	:	:	:

WATER ADDED ON JOB AT CUSTOMER'S REQUEST GAL. \_\_\_\_\_  
 ALLOWABLE WATER (withheld from batch) GAL. \_\_\_\_\_  
 TEST CYLINDER TAKEN  YES  NO BY 19.5  
 CYLINDER TAKEN  BEFORE  AFTER WATER

CUSTOMER SIGNATURE  
X \_\_\_\_\_

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

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

CUSTOMER NAME AND DELIVERY ADDRESS MBC MANAGEMENT 3100 SH 47, BRYAN, TX 77807	PLANT	TRUCK	ORDER NO.	SLUMP	P.O. #/JOB/LOT
	617	7165	2016	5.00	TTI-THRIE BE
	DRIVER NAME CHATHAM, DEXTER				DATE 03/31/21
	CUSTOMER NUMBER	PROJECT	CUM. QTY	ORDERED QTY	
	782823	100138	22.00	22.00	

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

SALES TAX  
TOTAL

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
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				D	92582	
Material	Design Qty	Required	Batched	% Var	% Moisture	Actual	Wat
1"RG	1812 lb	3653 lb	3660 lb	0.19%	0.80% M	4 gl	
SAND-1	1380 lb	2875 lb	2880 lb	0.17%	4.00% M	14 gl	
CMT-III	570 lb	1140 lb	1130 lb	-0.88%			
H2O	258 lb	347 lb	358 lb	3.25%		43 gl	
ZY-610	23 oz	46 oz	46 oz	0.88%			
Actual	8031 lb	Design W/C: 0.453	Water/Cement: 0.457 T	Design	61.8 gl	Actual	60.2 gl To Add: 1.6 gl
Slump:	5.00 in	Water in Truck: 0.0 gl	Adjust Water: 0.0 gl / Load	Trim Water:	-1.5 gl / CYDS		
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	8 lb ET 0 lb

**CONCRETE COMPRESSIVE STRENGTH TEST REPORT****Terracon**

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

6198 Imperial Loop  
 College Station, TX 77845-5765  
 979-846-3767 Reg No: F-3272

**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: DSD60S  
 Supplier: Martin Marietta  
 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: 35Ft east 3Ft south of metal bridge  
 north ending  
 Placement Location: PO 440861-4

**Field Test Data**

Test	Result	Specification
Slump (in):	6	Not specified
Air Content (%):	2.8	Not specified
Concrete Temp. (F):	70	40 - 95
Ambient Temp. (F):	64	40 - 95
Plastic Unit Wt. (pcf):	147.2	Not specified
Yield (Cu. Yds.):		

**Laboratory Test Data**

Set No.	Specimen ID	Avg Diam. (in)	Area (sq in)	Date Received	Date Tested	Age at Test (days)	Maximum Load (lbs)	Compressive Strength (psi)	Fracture Type	Tested By
1	A	6.01	28.37		06/30/21	91	163,990	5,780	1	SLS
1	B	6.01	28.37		06/30/21	91	162,020	5,710	3	SLS
1	C	6.01	28.37		06/30/21	91	152,710	5,380	4	SLS
						Average (91 days)		5,620		
1	D					Hold				

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 Boultinghouse

Start/Stop: 1100-1400

Reported To:

Contractor:

Report Distribution:

(1) Texas Transportation Institute, Gary Gerke (1) Terracon Consultants, Inc., Alex Dumigan, P.E.  
 (1) Texas Transportation Institute, Bill Griffith

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****Terracon**

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

6198 Imperial Loop  
 College Station, TX 77845-5765  
 979-846-3767 Reg No: F-3272

**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: DSD60S  
 Supplier: Martin Marietta  
 Batch Time: 1140 Plant: 517  
 Truck No.: 7211 Ticket No.: 6678665

**Sample Information**

Sample Date: 03/31/21 Sample Time: 1240  
 Sampled By: Ethan Boultinghouse  
 Weather Conditions: Overcast moderate wind  
 Accumulative Yards: 2020 Batch Size (cy): 10  
 Placement Method: Direct Discharge  
 Water Added Before (gal): 25  
 Water Added After (gal): 0  
 Sample Location: 35Ft east 20Ft south of metal bridge  
 north ending  
 Placement Location: PO 440861-4

**Field Test Data**

Test	Result	Specification
Slump (in):	6	Not specified
Air Content (%):	2.6	Not specified
Concrete Temp. (F):	69	40 - 95
Ambient Temp. (F):	64	40 - 95
Plastic Unit Wt. (pcf):	146.8	Not specified
Yield (Cu. Yds.):		

**Laboratory Test Data**

Set No.	Specimen ID	Avg Diam. (in)	Area (sq in)	Date Received	Date Tested	Age at Test (days)	Maximum Load (lbs)	Compressive Strength (psi)	Fracture Type	Tested By
2	A	6.01	28.37		06/30/21	91	175,400	6,180	3	SLS
2	B	6.01	28.37		06/30/21	91	143,100	5,040	2	SLS
2	C	6.01	28.37		06/30/21	91	169,370	5,970	1	SLS
							Average (91 days)	5,730		
2	D						Hold			

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 Boultinghouse

Start/Stop: 1100-1400

Reported To:

Contractor:

Report Distribution:

(1) Texas Transportation Institute, Gary Gerke (1) Terracon Consultants, Inc., Alex Dumigan, P.E.  
 (1) Texas Transportation Institute, Bill Griffith

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

6198 Imperial Loop  
 College Station, TX 77845-5765  
 979-846-3767 Reg No: F-3272

**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: DSD60S  
 Supplier: Martin Marietta  
 Batch Time: 1311 Plant: 517  
 Truck No.: 7165 Ticket No.: 6678983

**Field Test Data**

Test	Result	Specification
Slump (in):	6 1/2	Not specified
Air Content (%):	3.0	Not specified
Concrete Temp. (F):	70	40 - 95
Ambient Temp. (F):	64	40 - 95
Plastic Unit Wt. (pcf):	147.4	Not specified
Yield (Cu. Yds.):		

**Sample Information**

Sample Date: 03/31/21 Sample Time: 1345  
 Sampled By: Ethan Boultinghouse  
 Weather Conditions: Overcast, moderate wind  
 Accumulative 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  
 Placement Location: PO 440861-4

**Laboratory Test Data**

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

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 Boultinghouse

Start/Stop: 1100-1400

Reported To:

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 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.





BILLING

TICKET NO.  
6687524



**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
10:33	:	:	:	:	:	:

WATER ADDED ON JOB AT CUSTOMER'S REQUEST 5 GAL. CUSTOMER SIGNATURE  
ALLOWABLE WATER (withheld from batch) \_\_\_\_\_ GAL. X

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.**

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

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

PLANT	TRUCK	ORDER NO.	SLUMP	P.O. #/JOB/LOT
617	7130	2015	5.00	TTI-THRIE BEAM
DRIVER NAME				DATE
Jeremy Freeman				04/05/21
CUSTOMER NUMBER	PROJECT	CUM. QTY	ORDERED QTY	
782823	100138	9.00	9.00	

LOAD QUANTITY	PRODUCT CODE	DESCRIPTION	UNIT PRICE	AMOUNT
9.00	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

SALES TAX  
TOTAL

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

FOR OFFICE USE ONLY **FORM:**

Truck 7130 Driver 956950 User user Disp Ticket Num 6687524 Ticket ID 91524 Time Date 10:33 4/5/21

Load Size 9.00 CYDS Mix Code DSD60S Returned Qty Mix Age Seq Load ID D 92694

Material	Design Qty	Required	Batched	% Var%	Moisture	Actual	Wat
1"RG	1812 lb	16489 lb	16480 lb	-0.06%	1.10% M		22 gl
SAND-1	1380 lb	13005 lb	13060 lb	0.42%	4.50% M		70 gl
CMT-I/II	570 lb	5130 lb	5110 lb	-0.39%			
H2O	258 lb	1450 lb	1448 lb	-0.15%			174 gl
ZY-610	23 oz	205 oz	204 oz	-0.58%			
Actual		Num Batches: 1					
Load	36111 lb	Design W/C: 0.453	Water/Cement: 0.454 T	Design	278.3 gl	Actual	265.7 gl To Add: 12.6 gl
Slump:	5.00 in	Water in Truck: 0.0 gl	Adjust Water: 0.0 gl / Load	Trim Water:	-1.4 gl / CYDS		
AGG1 SCALE	B 1 ST -80 lb ET 0 lb	CEM1 SCALE	B 1 ST 20 lb ET 0 lb	WAT1 SCALE	B 1 ST 10 lb ET 0 lb		

## 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

# Terracon

6198 Imperial Loop  
College Station, TX 77845-5765  
979-846-3767 Reg No: F-3272

### 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 @ 44 days

**Mix ID:** DSD60S  
**Supplier:** Martin Marietta  
**Batch Time:** 1033 **Plant:** 617  
**Truck No.:** 7130 **Ticket No.:** 6687524

### Field Test Data

Test	Result	Specification
Slump (in):	5 1/4	
Air Content (%):	1.5	
Concrete Temp. (F):	72	
Ambient Temp. (F):	65	
Plastic Unit Wt. (pcf):	147.6	
Yield (Cu. Yds.):		

### Sample Information

**Sample Date:** 04/05/21 **Sample Time:** 1138  
**Sampled By:** Adam Hill  
**Weather Conditions:** Partly cloudy low wind  
**Accumulative Yards:** 9/9 **Batch Size (cy):** 9  
**Placement Method:** Direct Discharge  
**Water Added Before (gal):** 5  
**Water Added After (gal):** 0  
**Sample Location:** North edge bottom of footing  
**Placement Location:** PO # 440861-4

### Laboratory Test Data

Set No.	Specimen ID	Avg Diam. (in)	Area (sq in)	Date Received	Date Tested	Age at Test (days)	Maximum Load (lbs)	Compressive Strength (psi)	Fracture Type	Tested By
1	A	6.01	28.37		06/30/21	86	164,550	5,800	1	SLS
1	B	6.01	28.37		06/30/21	86	161,560	5,700	1	SLS
1	C	6.01	28.37		06/30/21	86	144,720	5,100	2	SLS
						<b>Average (86 days)</b>		<b>5,530</b>		
1	D					Hold				

**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

**Start/Stop:** 1030-1215

**Reported To:** Gary Gerke with TTI

**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 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.



TICKET NO.  
6713607

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
10:27	10:42	11:07	11:12	:	:	:

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

CUSTOMER NAME AND DELIVERY ADDRESS		PLANT	TRUCK	ORDER NO.	SLUMP	P.O. #/JOB/LOT
MBC MANAGEMENT 3100 SH 47, BRYAN, TX 77807		617	7211	2020	5.00	TTI-THRIE BEAM
		DRIVER NAME				DATE
		LARRY JANTZEN				04/14/21
		CUSTOMER NUMBER	PROJECT	CUM. QTY	ORDERED QTY	
		782823	100138	10.00	16.00	

LOAD QUANTITY	PRODUCT CODE	DESCRIPTION	UNIT PRICE	AMOUNT
10.00	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

SALES TAX \_\_\_\_\_  
TOTAL \_\_\_\_\_

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

FOR OFFICE USE ONLY **FORM:**

Truck 7211	Driver 777135	User user	Disp Ticket Num 6713607	Ticket ID 91808	Time Date 10:27 4/14/21
Load Size 10.00 CYDS	Mix Code DSD60S	Returned Qty	Mix Age	Seq D	Load ID 92979
Material 1"RG	Design Qty 1812 lb	Required 18322 lb	Batched 18300 lb	% Var% Moisture -0.12% 1.10% M	Actual Wat 24 gl
SAND-1	1380 lb	14375 lb	14360 lb	-0.10% 4.00% M	69 gl
CMT-III	570 lb	5700 lb	5685 lb	-0.26%	
H2O	258 lb	1695 lb	1706 lb	0.65%	
ZY-610	23 oz	228 oz	229 oz	0.44%	204 gl
Actual		Num Batches: 1			
Load 40065 lb	Design W/C: 0.453	Water/Cement: 0.454 T	Design 309.2 gl	Actual 297.4 gl	To Add: 11.8 gl
Slump: 5.00 in	Water in Truck: 0 lb	Adjust Water: 0.0 gl	Design 0.0 gl / Load	Trim Water: -1.3 gl / CYDS	
AGG1 SCALE B 1 ST 60 lb	ET 0 lb	CEM1 SCALE B 1 ST 10 lb	ET 0 lb	WAT1 SCALE B 1 ST 0 lb	ET 0 lb

BILLING

TICKET NO.  
6713716



# 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. CUSTOMER SIGNATURE \_\_\_\_\_  
ALLOWABLE WATER (withheld from batch) \_\_\_\_\_ GAL. X \_\_\_\_\_  
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.**

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

CUSTOMER NAME AND DELIVERY ADDRESS		PLANT	TRUCK	ORDER NO.	SLUMP	P.O. #/JOB/LOT
MBC MANAGEMENT 3100 SH 47, BRYAN, TX 77807		617	7102	2020	5.00	TTI-THRIE BEAM
		DRIVER NAME		DATE		
		Scott Goodwin		04/14/21		
CUSTOMER NUMBER		PROJECT	CUM. QTY	ORDERED QTY		
782823		100138	16.00	16.00		

LOAD QUANTITY	PRODUCT CODE	DESCRIPTION	UNIT PRICE	AMOUNT
6.00	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

SALES TAX

TOTAL

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

FOR OFFICE USE ONLY **FORM:**

Truck 7102	Driver 968908	User user	Disp Ticket Num 6713716	Ticket ID 91809	Time Date 10:46 4/14/21
Load Size 6.00	Mix Code CYDS DSD60S	Returned	Qty	Mix Age D	Seq D
Material	Design Qty	Required	Batched	% Var%	Moisture
1"RG	1812 lb	10993 lb	10980 lb	-0.12%	1.10% M
SAND-1	1380 lb	8625 lb	8620 lb	-0.06%	4.00% M
CMT-III	570 lb	3420 lb	3395 lb	-0.73%	
H2O	258 lb	1017 lb	1004 lb	-1.28%	
ZY-610	23 oz	137 oz	136 oz	-0.58%	
Actual	24008 lb	Design W/C: 0.453	Water/Cement: 0.456 T	Design	185.5 gl
Load	5.00 in	Water in Truck:	0.0 gl	Adjust Water:	0.0 gl / Load
Slump:	AGG1 SCALE B 1 ST -60 lb ET 0 lb	CEM1 SCALE B 1 ST 10 lb	ET 0 lb	Trim Water:	176.1 gl To Add: 9.4 gl
					-1.3 gl / CYDS
					WAT1 SCALE B 1 ST -2 lb ET 0 lb

# 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

6198 Imperial Loop  
College Station, TX 77845-5765  
979-846-3767 Reg No: F-3272

## 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:** DSD60S  
**Supplier:** Martin Marietta  
**Batch Time:** 1027 **Plant:** 617  
**Truck No.:** 7211 **Ticket No.:** 6713607

## Sample Information

**Sample Date:** 04/14/21 **Sample Time:** 1137  
**Sampled By:** David Carpio  
**Weather Conditions:** Cloudy, light wind  
**Accumulative Yards:** 10/16 **Batch Size (cy):** 10  
**Placement Method:** Direct Discharge  
**Water Added Before (gal):** 11  
**Water Added After (gal):** 0  
**Sample Location:** 39' North of South end of sound barrier wall  
**Placement Location:** Sound wall barrier

## Field Test Data

Test	Result	Specification
Slump (in):	6	
Air Content (%):	1.1	
Concrete Temp. (F):	78	
Ambient Temp. (F):	73	
Plastic Unit Wt. (pcf):	147.5	
Yield (Cu. Yds.):		

## Laboratory Test Data

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

**Initial Cure:** Outside Plastic Lids

**Final Cure:**

**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

**Start/Stop:** 1015-1315

**Reported To:** Will

**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 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**



6198 Imperial Loop  
College Station, TX 77845-5765  
979-846-3767 Reg No: F-3272

**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

Project Number: A1171057

**Material Information**

**Specified Strength:**

**Mix ID:** DSD60S  
**Supplier:** Martin Marietta  
**Batch Time:** **Plant:** 617  
**Truck No.:** **Ticket No.:**

**Field Test Data**

Test	Result	Specification
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  
**Sampled 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**

Set No.	Specimen ID	Avg Diam. (in)	Area (sq in)	Date Received	Date Tested	Age at Test (days)	Maximum Load (lbs)	Compressive Strength (psi)	Fracture Type	Tested By
2	A	6.00	28.27		05/19/21	35 F	128,750	4,550	5	AJH
2	B	6.00	28.27		05/19/21	35 F	142,720	5,050	4	AJH
2	C	6.00	28.27		05/19/21	35 F	134,780	4,770	5	AJH
2	D					Hold				

**Initial Cure:** Outside Plastic Lids **Final Cure:**

**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

**Start/Stop:** 1015-1315

**Reported To:** Will

**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 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.





BILLING

TICKET NO.  
6717070



### 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
11:44	:	:	:	:	:	:

WATER ADDED ON JOB AT CUSTOMER'S REQUEST \_\_\_\_\_ GAL. CUSTOMER SIGNATURE \_\_\_\_\_  
ALLOWABLE WATER (withheld from batch) \_\_\_\_\_ GAL. X  
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.**

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

CUSTOMER NAME AND DELIVERY ADDRESS		PLANT	TRUCK	ORDER NO.	SLUMP	P.O. #/JOB/LOT
MBC MANAGEMENT 3100 SH 47, BRYAN, TX 77807		617	9019	2033	5.00	TTI-THRIE BEAM
DRIVER NAME		DATE				
WATTS, RODNEY		04/15/21				
CUSTOMER NUMBER	PROJECT	CUM. QTY	ORDERED QTY			
782823	100138	6.00	6.00			

LOAD QUANTITY	PRODUCT CODE	DESCRIPTION	UNIT PRICE	AMOUNT
6.00	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

SALES TAX \_\_\_\_\_  
TOTAL \_\_\_\_\_

**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
9019	726255	user	6717070	91846	91846	11:44	4/15/21
Load	Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
6.00	CYDS	DSD60S				D	93017
Material	Design Qty	Required	Batched	% Var%	Moisture	Actual	Wat
1"RG	1812 lb	10916 lb	10920 lb	0.04%	0.40% M		5 gl
SAND-1	1380 lb	8580 lb	8560 lb	-0.24%	3.50% M		36 gl
CMT-III	570 lb	3420 lb	3425 lb	0.15%			
H20	258 lb	1104 lb	1112 lb	0.73%			133 gl
ZY-610	23 oz	137 oz	137 oz	0.15%			
Actual							
Load	24026 lb	Design W/C: 0.453	Water/Cement: 0.452 T	Design	185.5 gl	Actual	174.4 gl To Add: 11.1 gl
Slump:	5.00 in	Water in Truck: 0.0 gl	Adjust Water: 0.0 gl / Load	Design	0.0 gl / Load	Trim Water: -2.0 gl /	CYDS Note: Manual feed occurred
AGG1 SCALE	B 1 ST -20 lb ET 0 lb	CEM1 SCALE	B 1 ST 5 lb ET 0 lb	WAT1 SCALE	B 1 ST 2 lb ET 0 lb		

## CONCRETE COMPRESSIVE STRENGTH TEST REPORT

# Terracon

**Report Number:** A1171057.0180  
**Service Date:** 04/15/21  
**Report Date:** 07/01/21 Revision 2 - 76-day results  
**Task:** PO# 440861-4

6198 Imperial Loop  
College Station, TX 77845-5765  
979-846-3767 Reg No: F-3272

### 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:** DSD60S  
**Supplier:** Martin Marietta  
**Batch Time:** 1145 **Plant:** 617  
**Truck No.:** 9019 **Ticket No.:** 6717070

### Sample Information

**Sample Date:** 04/15/21 **Sample Time:** 1220  
**Sampled By:** Justin Maass  
**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

### Field Test Data

Test	Result	Specification
Slump (in):	6 3/4	Not specified
Air Content (%):	1.3	Not specified
Concrete Temp. (F):	80	40 - 95
Ambient Temp. (F):	67	40 - 95
Plastic Unit Wt. (pcf):	146.4	Not specified
Yield (Cu. Yds.):	6.0	

### Laboratory Test Data

Set No.	Specimen ID	Avg Diam. (in)	Area (sq in)	Date Received	Date Tested	Age at Test (days)	Maximum Load (lbs)	Compressive Strength (psi)	Fracture Type	Tested By
1	A	6.01	28.37		06/30/21	76 F	195,350	6,890	1	SLS
1	B	6.01	28.37		06/30/21	76 F	194,610	6,860	4	SLS
1	C	6.01	28.37		06/30/21	76 F	196,960	6,940	2	SLS
1	D					Hold				

**Initial Cure:** Outside Plastic Lids **Final Cure:** Field Cured

**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:** 1115-1345

**Reported To:** A&M contractors

**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 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.



BILLING

TICKET NO.  
6723674



# 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
9:52	:	:	:	:	:	:

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

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

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

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

PLANT	TRUCK	ORDER NO.	SLUMP	P.O. #/JOB/LOT
617	9019	2015	5.00	TTI-THRIE BE
DRIVER NAME				DATE
WATTS, RODNEY				04/20/21
CUSTOMER NUMBER	PROJECT	CUM. QTY	ORDERED QTY	
782823	100138	12.00	12.00	

LOAD QUANTITY	PRODUCT CODE	DESCRIPTION	UNIT PRICE	AMOUNT
6.00	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  
 HERE

SALES TAX  
 TOTAL

**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
019	726255	user	6723674	91940	91940	9:52	4/20/21
Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID	
6.00	CYDS DSD60S				D	93112	
Material	Design Qty	Required	Batched	% Var	Moisture	Actual	Wat
RG	1812 lb	10960 lb	10940 lb	-0.18%	0.80% M	10 gl	
3ND-1	1380 lb	8580 lb	8560 lb	-0.24%	3.50% M	36 gl	
WT-1/II	570 lb	3420 lb	3405 lb	-0.44%			
20	258 lb	1090 lb	1084 lb	-0.54%		130 gl	
1-610	23 oz	137 oz	137 oz	0.15%			
Num Batches:		1					
Design	185.5 gl	Actual	178.3 gl	To Add:	9.2 gl		
Design W/C:	0.453	Water/Cement:	0.455	T			
Design	0.0 gl / Load	Adjust Water:	-1.4 gl / CYDS				
Design	5.00 in	Water in Truck:	0.0 gl				
Design	-60 lb	ET	0 lb	CEM1 SCALE B 1 ST	0 lb	ET	0 lb
Design	2 lb	ET	0 lb	WAT1 SCALE B 1 ST	2 lb	ET	0 lb

BILLING

TICKET NO.  
6723674



# 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
9:52	:	:	:	:	:	:

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

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

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

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

PLANT	TRUCK	ORDER NO.	SLUMP	P.O. #/JOB/LOT
617	9019	2015	5.00	TTI-THRIE BE
DRIVER NAME				DATE
WATTS, RODNEY				04/20/21
CUSTOMER NUMBER	PROJECT	CUM. QTY	ORDERED QTY	
782823	100138	12.00	12.00	

LOAD QUANTITY	PRODUCT CODE	DESCRIPTION	UNIT PRICE	AMOUNT
6.00	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  
 HERE

SALES TAX  
 TOTAL

**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
019	726255	user	6723674	91940	91940	9:52	4/20/21
Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID	
6.00	CYDS DSD60S				D	93112	
Material	Design Qty	Required	Batched	% Var%	Moisture	Actual	Wat
RG	1812 lb	10960 lb	10940 lb	-0.18%	0.80% M	10 gl	
3ND-1	1380 lb	8580 lb	8560 lb	-0.24%	3.50% M	36 gl	
WT-1/II	570 lb	3420 lb	3405 lb	-0.44%			
20	258 lb	1090 lb	1084 lb	-0.54%		130 gl	
1-610	23 oz	137 oz	137 oz	0.15%			
Num Batches:		1					
Design	185.5 gl	Actual	178.3 gl	To Add:	9.2 gl		
Design W/C:	0.453	Water/Cement:	0.455	T			
Design	0.0 gl / Load	Adjust Water:	-1.4 gl / CYDS	Trim Water:			
Design	5.00 in	Water in Truck:	0.0 gl	ET	0 lb	WAT1 SCALE B 1 ST	2 lb ET 0 lb
Design	-60 lb	ET	0 lb	CEM1 SCALE B 1 ST	0 lb	ET	0 lb

## 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

**Terracon**  
6198 Imperial Loop  
College Station, TX 77845-5765  
979-846-3767 Reg No: F-3272

### 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:** DSD60S  
**Supplier:** Martin Marietta  
**Batch Time:** 0930 **Plant:** Bryan  
**Truck No.:** 7133 **Ticket No.:** 6723543

### 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

Test	Result	Specification
Slump (in):	5 3/4	
Air Content (%):	1.2	
Concrete Temp. (F):	78	
Ambient Temp. (F):	70	
Plastic Unit Wt. (pcf):	147.6	
Yield (Cu. Yds.):	6.0	

### Laboratory Test Data

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

**Initial Cure:** Outside Plastic Lids

**Final Cure:**

**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 Dunigan, P.E.  
(1) Texas Transportation Institute, Bill Griffith

**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:** A1171057.0185  
**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:** DSD60S  
**Supplier:** Martin Marietta  
**Batch Time:** 0952 **Plant:** Bryan  
**Truck No.:** 9019 **Ticket No.:** 6723674

**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**

Test	Result	Specification
Slump (in):	6	
Air Content (%):	1.3	
Concrete Temp. (F):	77	
Ambient Temp. (F):	70	
Plastic Unit Wt. (pcf):	148.0	
Yield (Cu. Yds.):	12.0	

**Laboratory Test Data**

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

**Initial Cure:** Outside Plastic Lids **Final Cure:**

**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 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 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.







**BILLING**

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

TICKET NO.  
6731090



LOAD TIME	TO JOB	ARRIVE JOB SITE	BEGIN POUR	FINISH POUR	LEAVE JOB SITE	ARRIVE PLANT
9:49	:	:	:	:	:	:

WATER ADDED ON JOB AT CUSTOMER'S REQUEST 9 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 SIGNATURE \_\_\_\_\_  
 X

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

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

PLANT	TRUCK	ORDER NO.	SLUMP	P.O. #/JOB/LOT
618	4280	2031	5.00	TTI-THRIE BEAM
DRIVER NAME		DATE		
Steven Albrecht		04/22/21		
CUSTOMER NUMBER	PROJECT	CUM. QTY	ORDERED QTY	
782823	100138	4.00	4.00	

LOAD QUANTITY	PRODUCT CODE	DESCRIPTION	UNIT PRICE	AMOUNT
4.00	DSD60S	TXDOT CLASS S		
1.00	5347	MINIMUM LOAD		

**SPECIAL DELIVERY INSTRUCTIONS**

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

SALES TAX

TOTAL

**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
4280	934547	user	6731090	9495	9:49	4/22/21
Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
4.00	CYDS DSD60S				D	9679
Material	Design Qty	Required	Batched	% Var	% Moisture	Actual
H2O	258 lb	747 lb	706 lb	-5.48%	0.20% M	85 gl
1"RG	1812 lb	7262 lb	7190 lb	< -1.00%		2 gl
ZY-610	23 oz	91 oz	91 oz	-0.22%		
CMT-I/II	570 lb	2280 lb	2270 lb	-0.44%	4.00% M	26 gl
SAND-1	1380 lb	5741 lb	5740 lb	-0.01%		
Actual	15912 lb	Design W/C:	0.453	Water/Cement:	0.455	T
Slump:	5.00 in	Water in Truck:	0.0 gl	Adjust Water:	0.0 gl / Load	ET 0 lb
AGG SCALE	B 1 ST -40 lb	ET	0 lb	AGG SCALE2	B 1 ST -20 lb	ET 0 lb
WATER SC	B 1 ST -3 lb	ET	0 lb			

Design 124.3 gl Actual 113.4 gl To Add: 11.1 gl  
 Trim Water: -1.5 gl / CYDS Note: Manual feed occurred  
 CEM SCALE B 1 ST 0 lb ET 0 lb

# CONCRETE COMPRESSIVE STRENGTH TEST REPORT



**Report Number:** A1171057.0186  
**Service Date:** 04/22/21  
**Report Date:** 07/01/21 Revision 2 - 69-day results  
**Task:** PO# 440861-4

6198 Imperial Loop  
College Station, TX 77845-5765  
979-846-3767 Reg No: F-3272

## 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:** Class S  
**Supplier:** Martin Marietta  
**Batch Time:** 0949 **Plant:** 618  
**Truck No.:** 4280 **Ticket No.:** 6731090

## Sample Information

**Sample Date:** 04/22/21 **Sample Time:** 1059  
**Sampled By:** David Carpio  
**Weather Conditions:** Clear, light wind  
**Accumulative Yards:** 4/4 **Batch Size (cy):** 4  
**Placement Method:** Direct Discharge  
**Water Added Before (gal):** 9  
**Water Added After (gal):** 0  
**Sample Location:** 12' North of South end ; 6' from bottom  
**Placement Location:** Sound Barrier Wall

## Field Test Data

Test	Result	Specification
Slump (in):	5 1/2	
Air Content (%):	1.1	
Concrete Temp. (F):	73	
Ambient Temp. (F):	68	
Plastic Unit Wt. (pcf):	149.3	
Yield (Cu. Yds.):		

## Laboratory Test Data

Set No.	Specimen ID	Avg Diam. (in)	Area (sq in)	Date Received	Date Tested	Age at Test (days)	Maximum Load (lbs)	Compressive Strength (psi)	Fracture Type	Tested By
1	A	6.01	28.37		06/30/21	69 F	154,950	5,460	2	SLS
1	B	6.01	28.37		06/30/21	69 F	153,150	5,400	2	SLS
1	C	6.01	28.37		06/30/21	69 F	143,600	5,060	4	SLS
1	D					Hold				

**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

**Start/Stop:** 1000-1145

**Reported To:** Will

**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 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.



## C.2. SEQUENTIAL PHOTOGRAPHS



0.000 s



0.150 s



0.300 s



0.450 s



**Figure C.1. Sequential Photographs for Test No. 440861-4 (Overhead and Frontal Views).**



0.600 s



0.750 s



0.900 s



1.050 s



**Figure C.1. Sequential Photographs for Test No. 440861-4 (Overhead and Frontal Views) (Continued).**



0.000 s



0.600 s



0.150 s



0.750 s



0.300 s



0.900 s



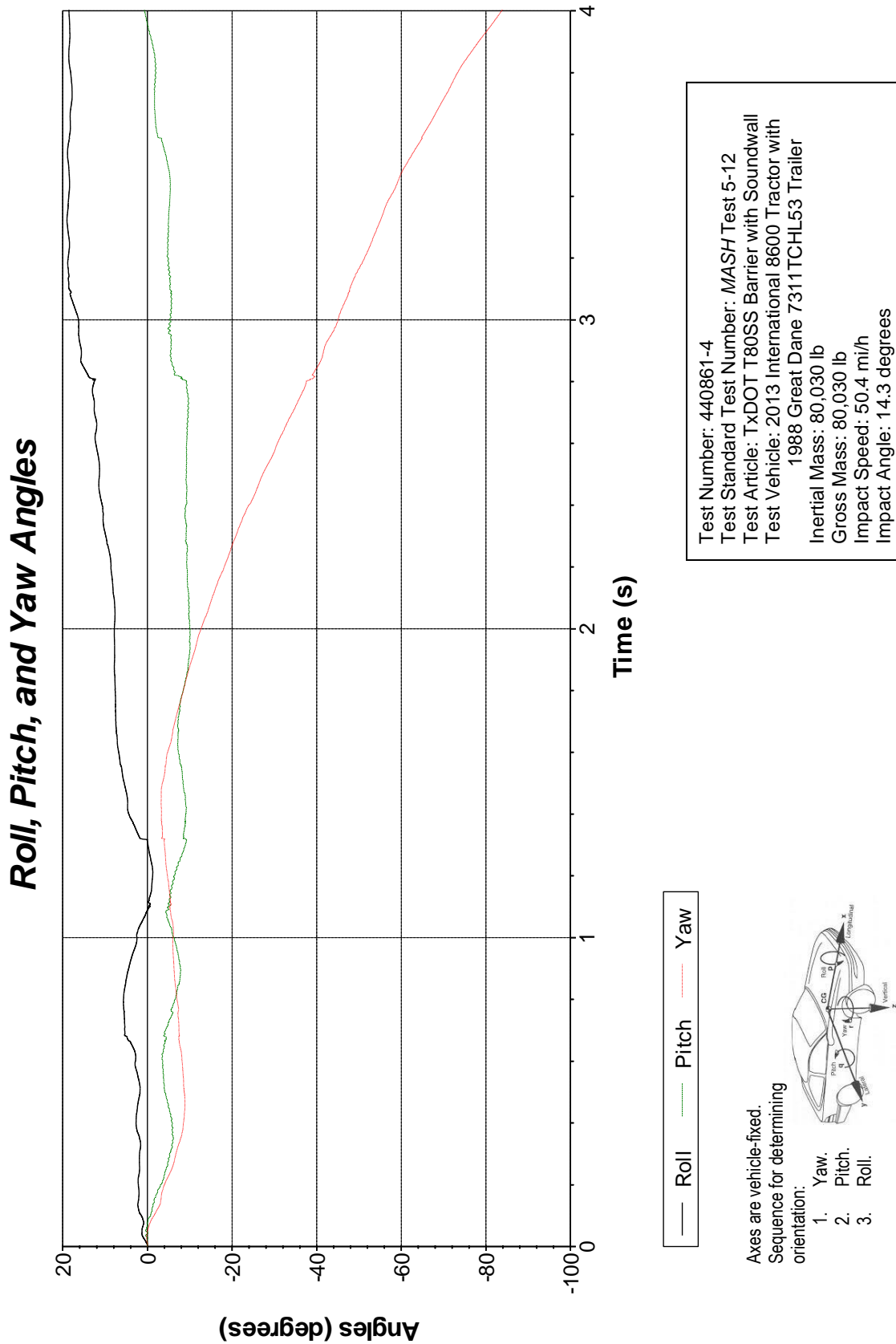
0.450 s



1.050 s

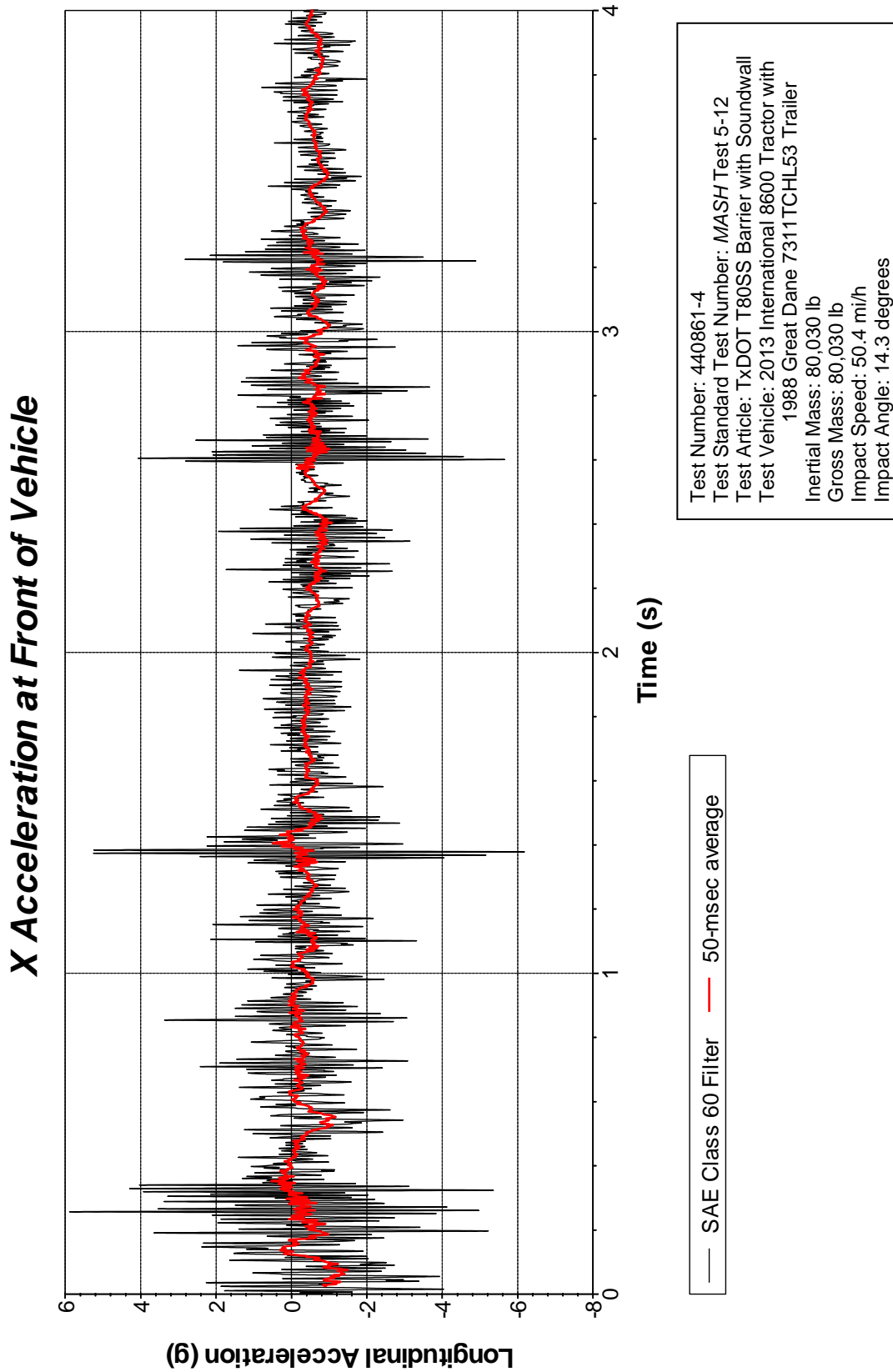
**Figure C.2. Sequential Photographs for Test No. 440861-4 (Rear View).**

### C.3. VEHICLE ANGULAR DISPLACEMENTS



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

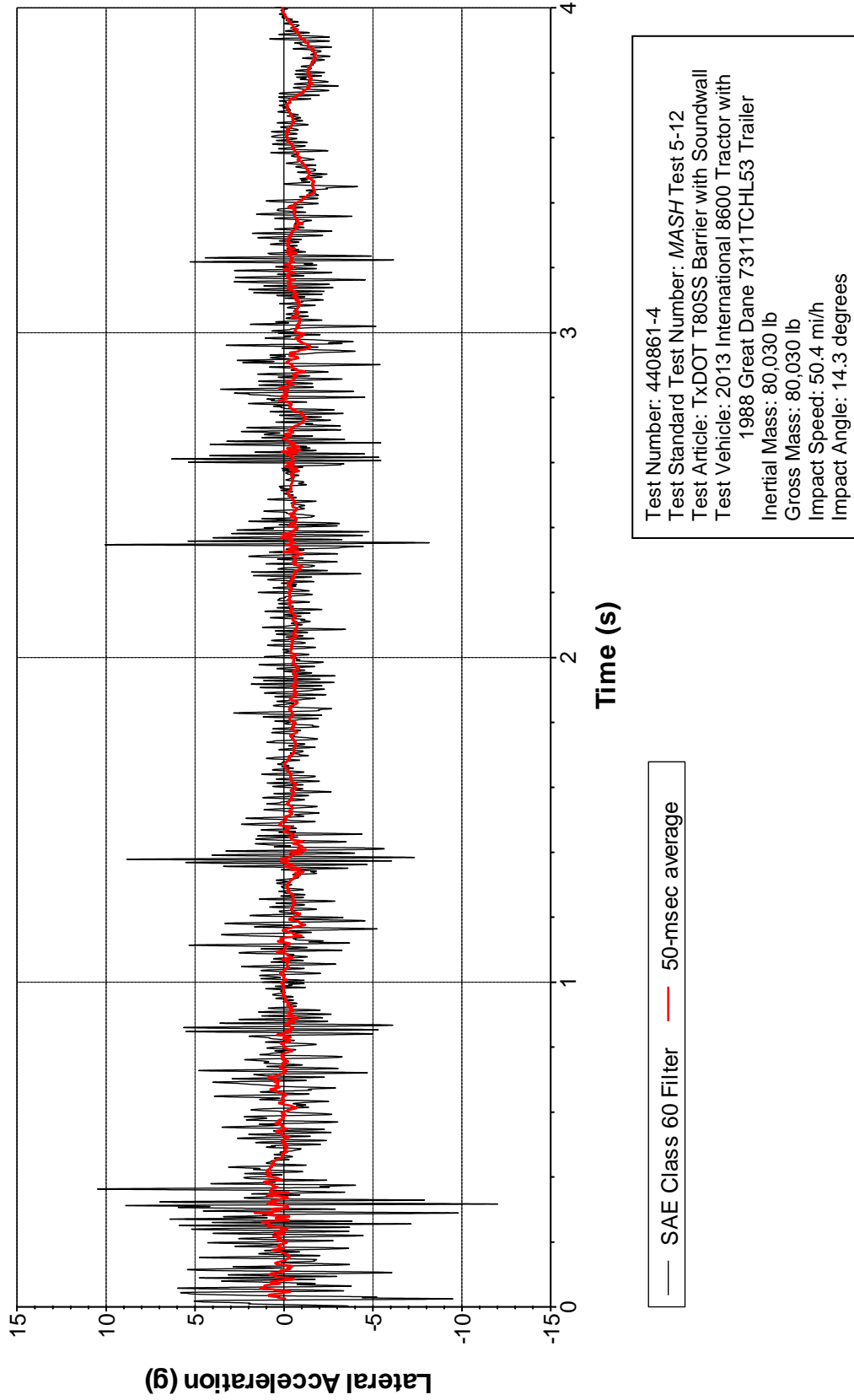
### C.4. VEHICLE ACCELERATIONS



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

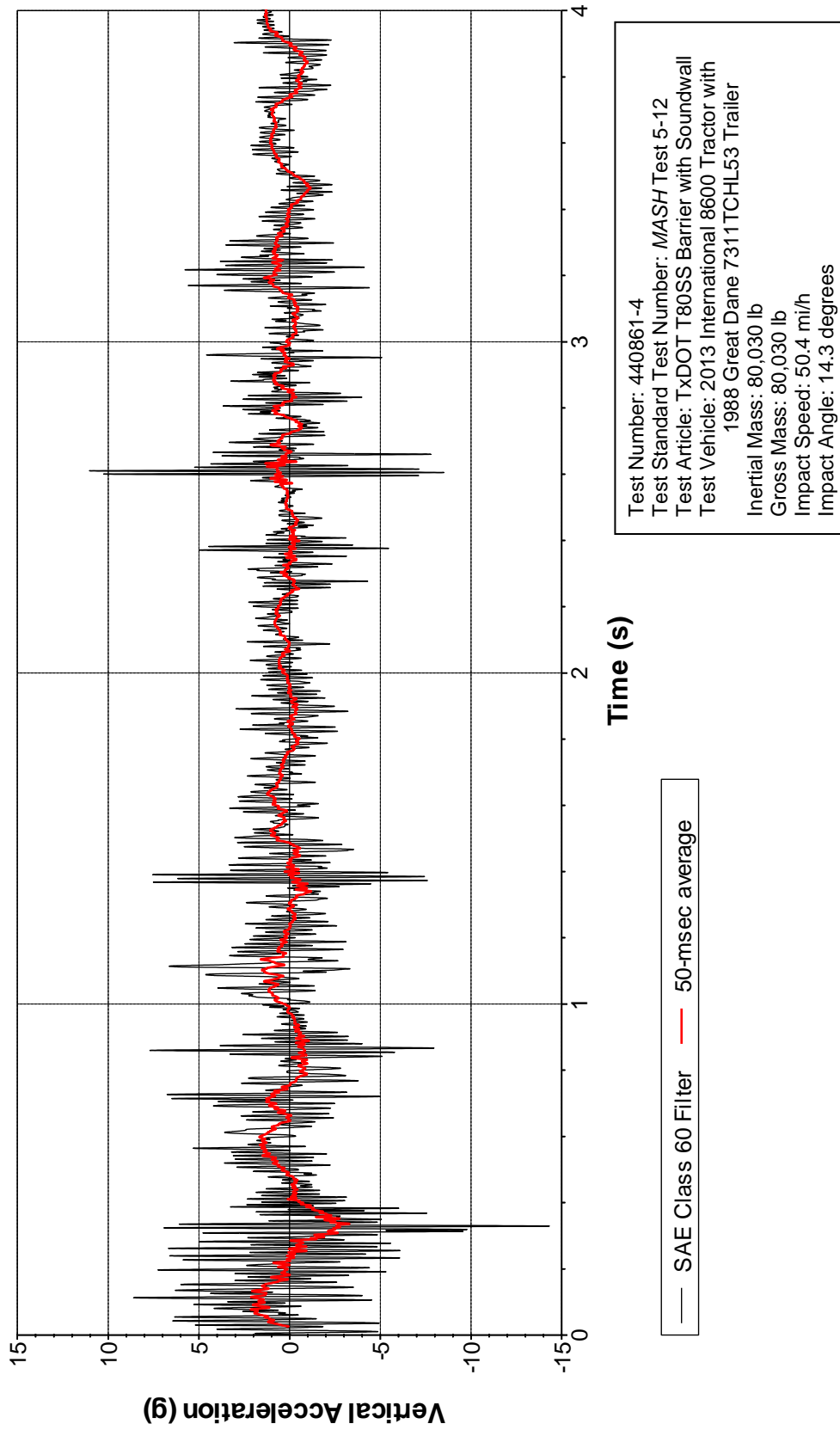


# Y Acceleration at Front of Vehicle



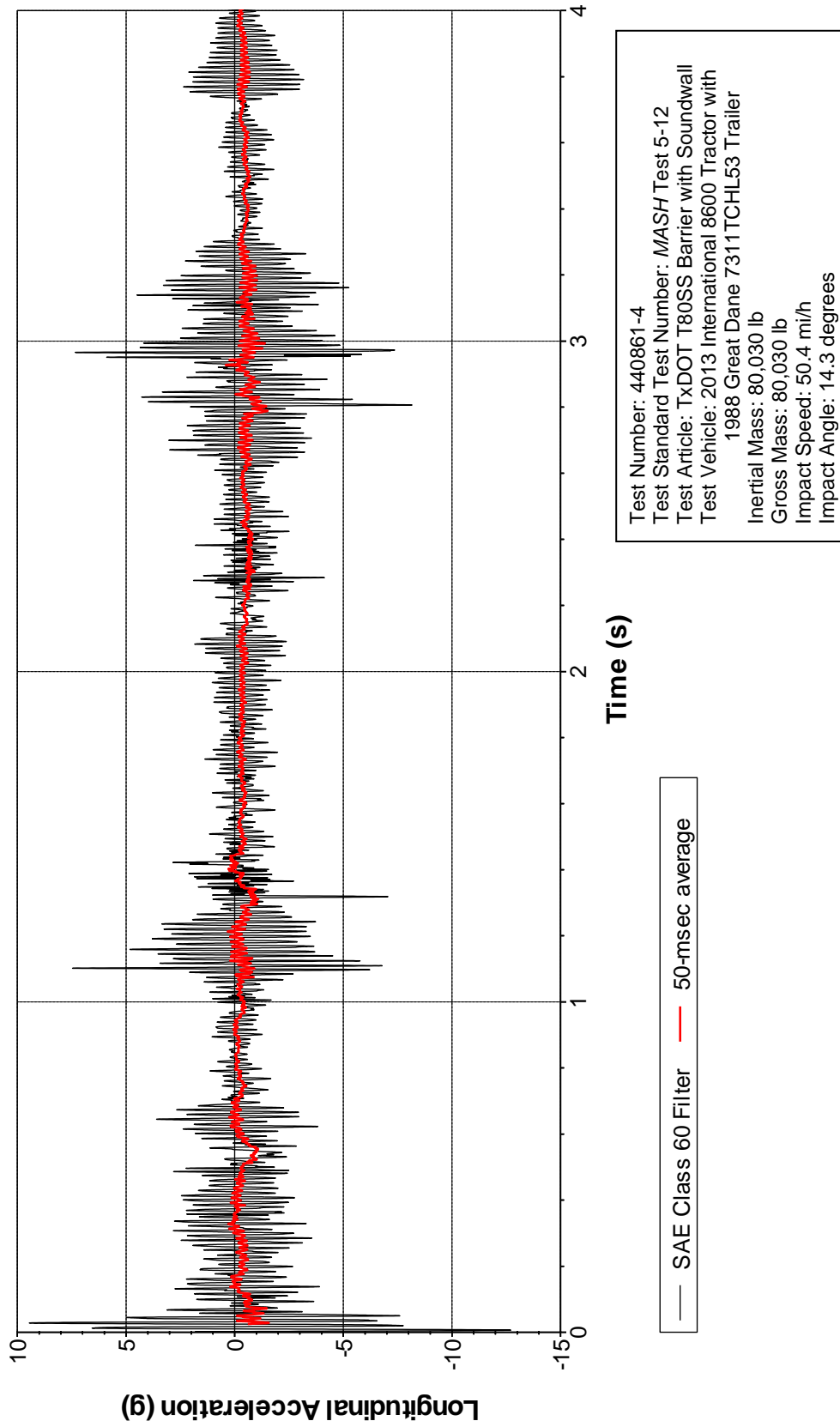
**Figure C.5. Vehicle Lateral Accelerometer Trace for Test No. 440861-4**  
 (Accelerometer Located at Front).

# Z Acceleration at Front of Vehicle



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

# X Acceleration at Fifth Wheel



**Figure C.7. Vehicle Longitudinal Accelerometer Trace for Test No. 440861-4**  
(Accelerometer Located at Fifth Wheel).

# Y Acceleration at Fifth Wheel

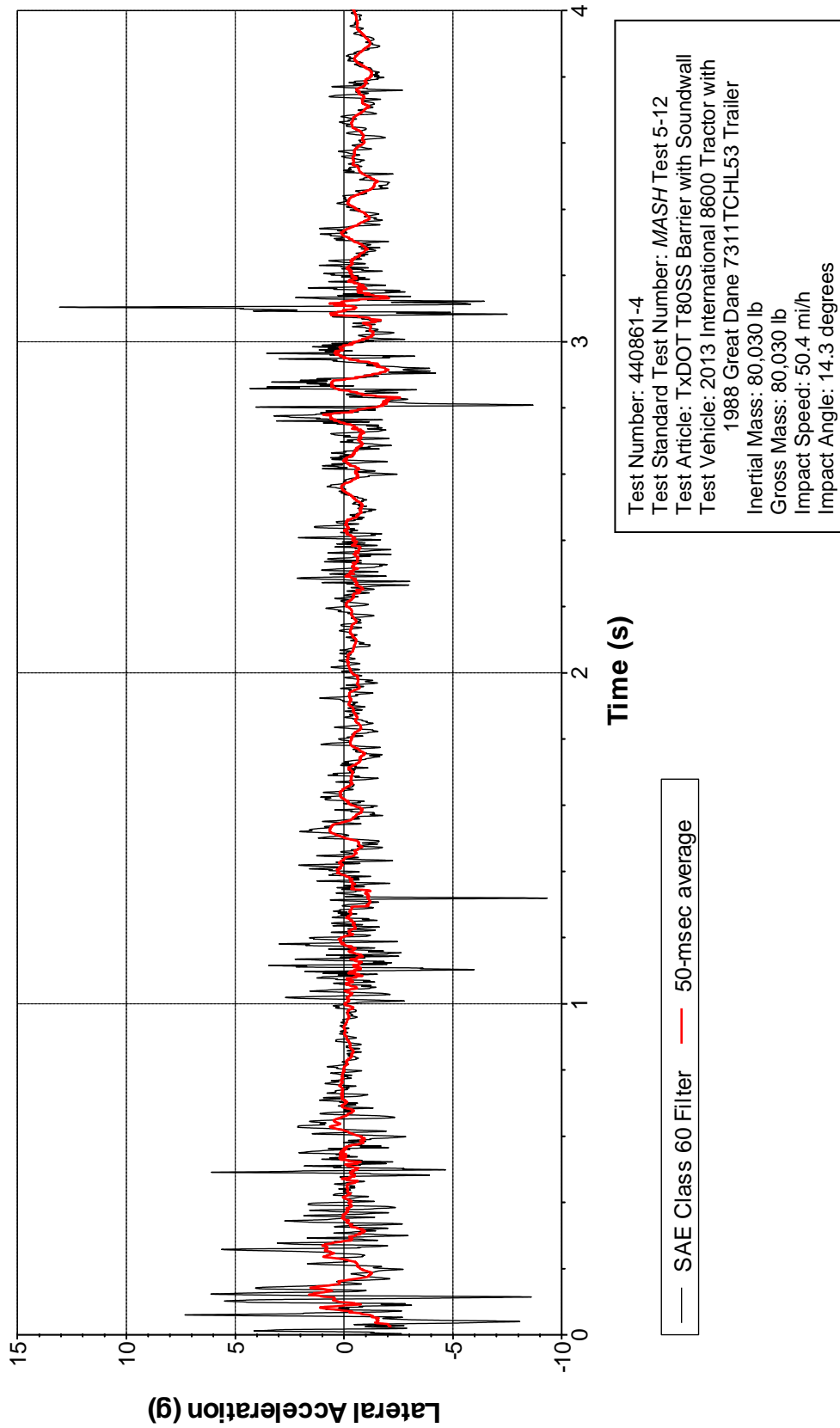
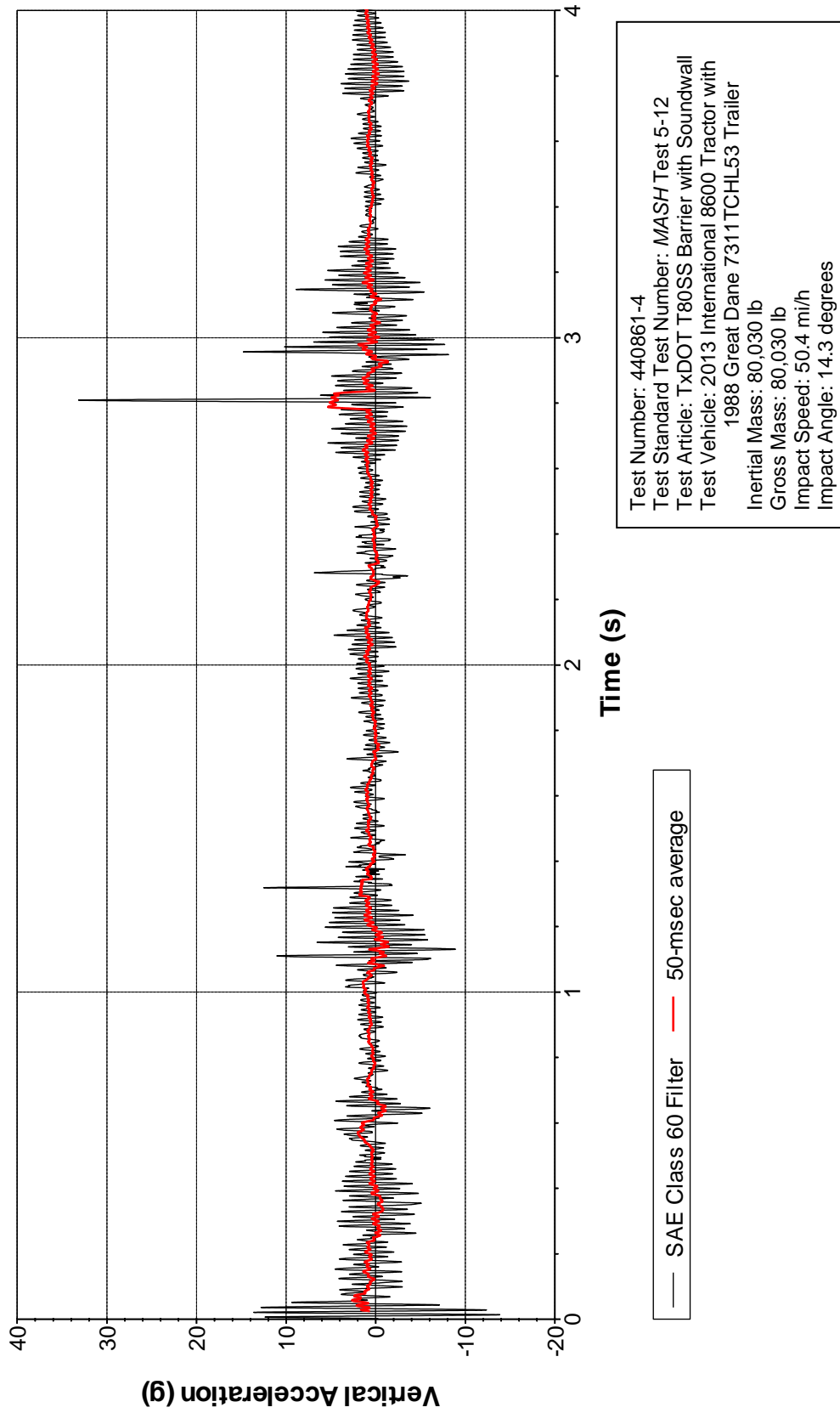


Figure C.8. Vehicle Lateral Accelerometer Trace for Test No. 440861-4  
(Accelerometer Located at Fifth Wheel).

# Z Acceleration at Fifth Wheel



**Figure C.9. Vehicle Vertical Accelerometer Trace for Test No. 440861-4  
 (Accelerometer Located at Fifth Wheel).**

# X Acceleration at Rear of Trailer

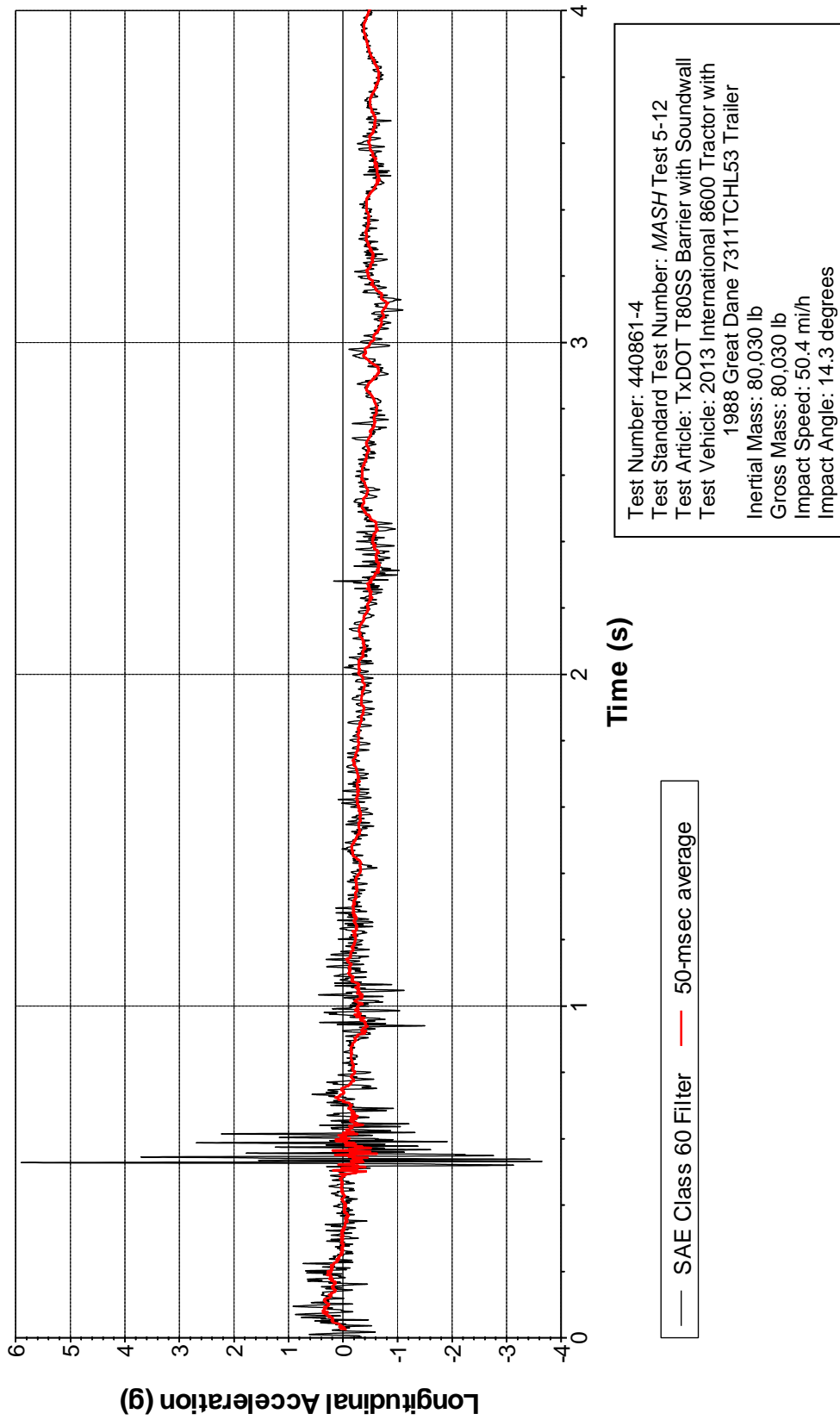
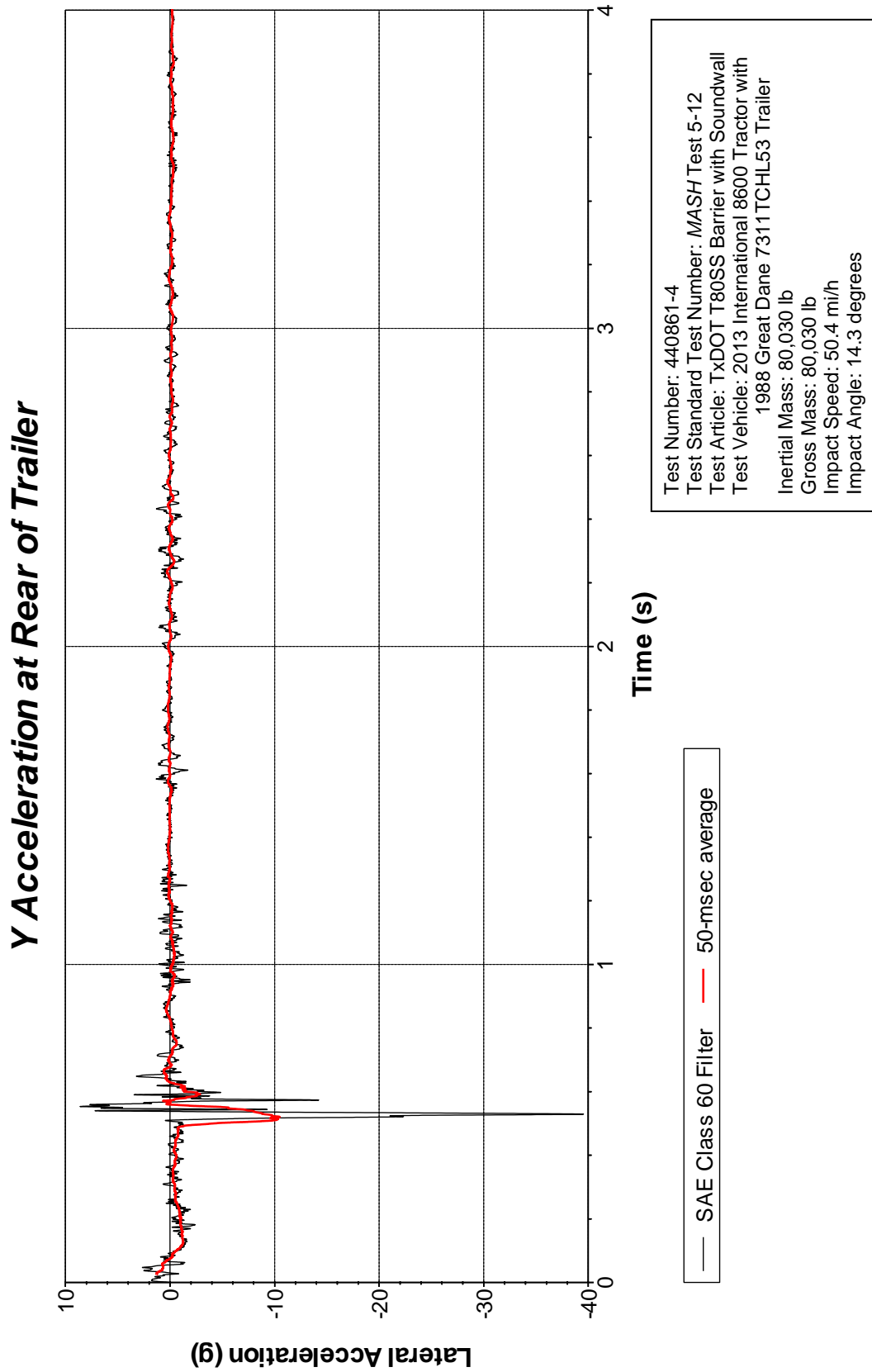
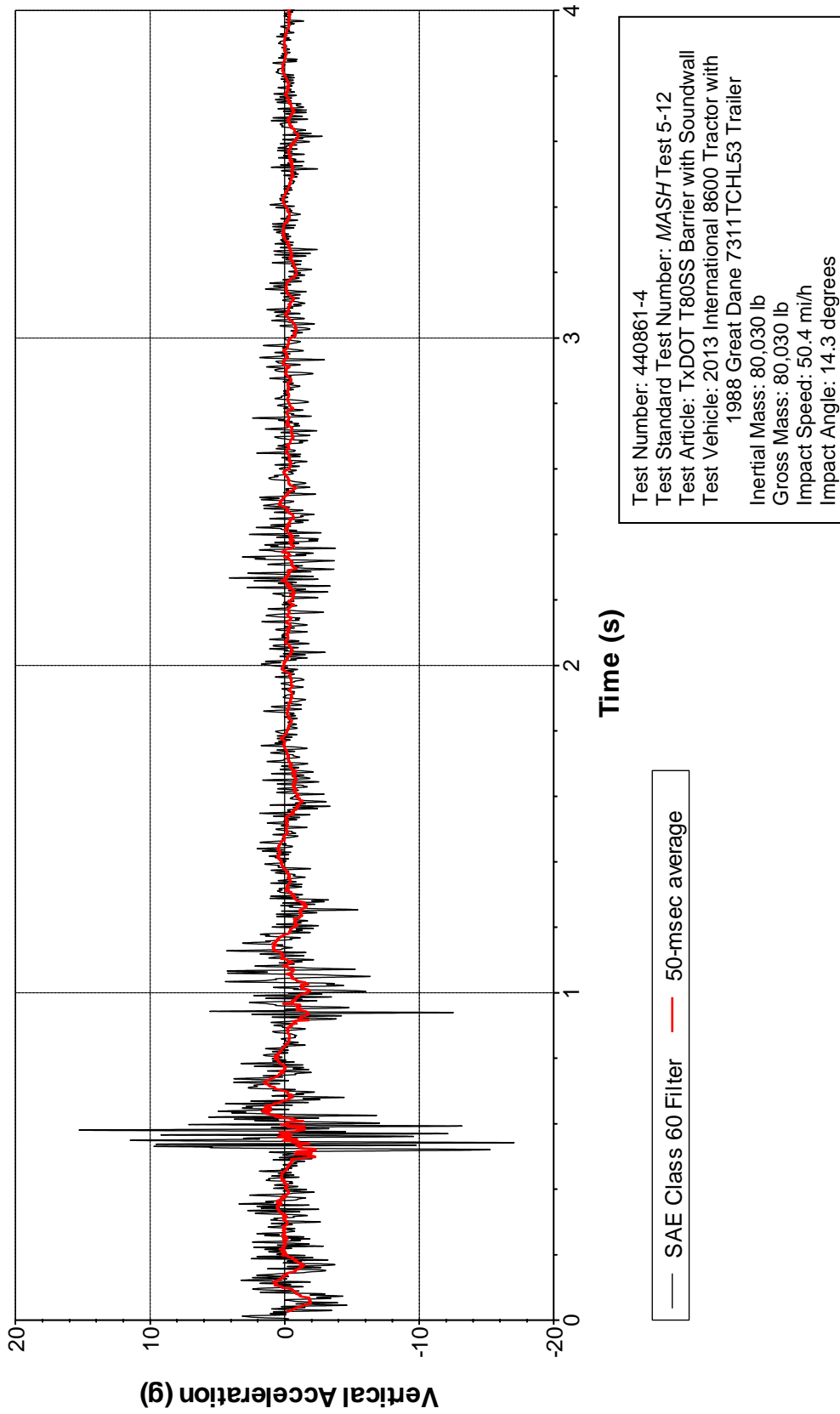


Figure C.10. Vehicle Longitudinal Accelerometer Trace for Test No. 440861-4  
(Accelerometer Located at Rear of Trailer).



**Figure C.11. Vehicle Lateral Accelerometer Trace for Test No. 440861-4**  
 (Accelerometer Located at Rear of Trailer).

# Z Acceleration at Rear of Trailer



**Figure C.12. Vehicle Vertical Accelerometer Trace for Test No. 440861-4  
(Accelerometer Located at Rear of Trailer).**