ODI Driver Air Bag Non-Deployment Investigation
Dynamic Science, Inc. (DSI), Case Number DS09026
2001 Honda Civic
California
June 2009

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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16. Abstract

This on-site investigation focused on the non-deployment of the driver's frontal air bag in a 2001 Honda Civic. This single-vehicle crash occurred in June 2009 at 1520 hours in northern California. The 2001 Honda Civic was being driven by a restrained 71-year-old female. The Honda was subject to a driver air bag module recall, National Highway Traffic Safety Administration (NHTSA) Campaign ID Number 08V593000. According to the vehicle owner, several weeks prior to the crash the vehicle had been taken to a dealership for the recall remedy and the driver air bag module was replaced. The Honda was traveling northbound with the cruise control activated in the outboard lane of a 2-lane, divided US highway at a driver-reported speed of 100 km/h (62 mph). The roadway curved to the left and was bordered on the left by a dirt and grass covered center median and on the right by an asphalt shoulder leading to an asphalt curb and eventually to a tree and shrubbery-covered descending embankment. The Honda traveled off the right side of the roadway. The Honda impacted an asphalt curb with its right rear tire, sustained undercarriage damage as it overrode the curb, impacted a plastic curve delineator, and then impacted a tree with its front end. At impact with the tree, the front row right passenger air bag deployed and the driver's air bag did not. The Honda came to rest on top of the tree and facing north. The driver sustained a chest wall strain and contusion, contusions to the left shoulder and abdomen, and a laceration to her right foot. She was transported to a local hospital where she was treated and released. The Honda was towed from the scene due to damage and was later declared a total loss by the insurance company.

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Crash Investigation
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BACKGROUND

This on-site investigation focused on the non-deployment of the driver's frontal air bag in a 2001 Honda Civic (**Figure 1**). This single-vehicle crash occurred in June 2009 at 1520 hours in northern California. The 2001 Honda Civic was being driven by a restrained 71-year-old female. The Honda was subject to a driver air bag module recall, National Highway Traffic Safety Administration (NHTSA) Campaign ID Number 08V593000. According to the vehicle owner, several weeks prior to the crash the vehicle had been taken to a dealership for the recall remedy and the driver air bag module was replaced. The Honda was traveling northbound with the cruise control activated in the outboard lane of a 2-lane, divided US highway at a driver-reported speed of 100 km/h (62 mph). The roadway curved to the left and was bordered on the left by a dirt and grass covered center median and on the right by an asphalt shoulder leading to an asphalt curb and eventually to a tree and shrubbery-covered descending embankment. The driver reported to the police that she was sleepy and fatigued. She fell asleep at some point and the Honda traveled off the right side of the roadway. The Honda impacted an asphalt curb with its right rear tire, sustained undercarriage damage as it overrode the curb, impacted a plastic curve delineator, and then impacted a tree with its front end. At impact with the tree, the front row passenger air bag deployed and the driver's air bag did not. The Honda came to rest on top of the tree and facing north. The driver sustained a chest wall strain and contusion, contusions to the left shoulder and abdomen, and a laceration to her right foot. She was transported to a local hospital where she was treated and released. The Honda was towed from the scene due to damage and was later declared a total loss by the insurance company.

Figure 1. Subject vehicle, 2001 Honda Civic

This investigation was identified by the NHTSA's Office of Defects Investigation (ODI) through a report of a safety defect submitted by a vehicle owner to ODI. DSI was notified of the crash on August 4, 2009 with instructions to contact the insurance auction facility and determine if the sale date could be postponed. The auction lot and insurance company were contacted and the vehicle was put on a 30-day hold. DSI was assigned the case on August 11, 2009. The police report and several vehicle images were emailed to DSI on August 11, 2009. The vehicle was inspected on August 27, 2009. An insurance representative was present during the early part of the inspection and a representative from Honda was present during the latter part of the inspection. The Honda representative imaged the vehicle's Event Data Recorder (EDR) data and provided an electronic version of the hexadecimal data to the SCI investigator. The interpretation of the data is included in this report. The Honda representative attempted to connect a scan tool to the vehicle to determine if any fault codes were present but communication could not be established with the vehicle.

SUMMARY

Crash Site

The crash site was a northbound, curved two-lane divided US highway (**Figure 2**). The roadway was of concrete composition and had a negative 1.6 percent grade. The roadway was dry and free of defects. The roadway was bordered on the west by a dirt and grass covered center median and on the east by a 2.4 m (8 ft) with asphalt shoulder leading to a an asphalt curb and eventually to a tree and shrubbery-covered descending embankment. The impacted tree was 28 cm (11 in) in diameter and was located 2.4 m (8 ft) west of the curb. The curb was 15 cm (5.9 in) in height. The speed limit was 105 km/h (65 mph).

Figure 2. Northbound approach

Pre-Crash

The Honda was traveling northbound with the cruise control activated in the outboard lane at a driver-reported speed of 100 km/h (62 mph). The driver reported to the police that she was sleepy and fatigued. She fell asleep at some point and the Honda traveled off the right side of the roadway (**Figure 3**).

Figure 3. Area of roadway departure and impacts with asphalt curb

Crash

As the vehicle departed the roadway, the right rear tire impacted the curb (Event 1). The vehicle overrode the curb and sustained undercarriage damage (Event 2). The Honda impacted shrubbery with its front end as it continued traveling north (Event 3). The Honda then struck a plastic curve delineator (Event 4) and a tree (Event 5). The total distance traveled from roadway departure to the impact with the tree was 44.5 m (146 ft).

At impact with the tree, the front passenger air bag deployed and the driver's seat belt retractor and buckle pretensioners actuated. The driver's frontal air bag did not deploy. The tree was knocked over and partially overridden by the Honda as the vehicle came to final rest (**Figure 4**). The WinSMASH program could not be used to

Figure 4. Area of impact to delineator and tree

calculate a Delta-V because the tree yielded and invalidated the program. DSI calculated an Equivalent Barrier Speed (EBS) of 25.7 km/h (16.0 mph) based on the vehicle crush and stiffness values that were derived from New Car Assessment Program (NCAP) test #3456 (Attachment 2).

Post-Crash

The vehicle's engine continued running after the crash. The driver turned off the ignition and was able to exit the vehicle through the driver's door under her own power. The driver sustained a chest wall strain and contusion, contusions to the left shoulder and abdomen, and a laceration to her right foot. She was transported to a local hospital where she was treated and released. She visited her own doctor two days after the crash. The Honda was towed from the scene due to damage and was later declared a total loss.

Vehicle Data - 2001 Honda Civic

The 2001 Honda Civic was identified by the Vehicle Identification Number (VIN): 1HGEM22921Lxxxxxx. The Honda was a 2-door coupe and was equipped with a 4-cylinder, 1.7-liter engine, automatic transmission, front wheel drive, a tilt/telescoping steering wheel, and cruise control. The vehicle's date of manufacture was November 2000. The vehicle was equipped with Michelin Energy P195/60R15 tires. The manufacturer's recommended cold tire pressure was 207 kPa (30 psi) and the tire manufacturer's recommended maximum pressure was 303 kPa (44 psi). The right front and right rear tire rims were dented. The specific tire information was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	214 kPa (31 psi)	5 mm (6/32 in)	Yes	None
LR	228 kPa (33 psi)	6 mm (7/32 in)	No	None
RR	Tire Flat	6 mm (7/32 in)	No	Cut in sidewall
RF	200 kPa (29 psi)	5 mm (6/32 in)	Yes	None

The seating in the Honda was configured with front bucket seats with adjustable head restraints and a rear bench seat. The driver's seat was adjusted to mid-track position at the time of the inspection, but the interviewee reported that the seat was normally adjusted to between the mid- and forwardmost position. The seat cushion was at 9 degree angle from horizontal and the seat back was at a 13 degree angle from vertical.

Vehicle Damage

Exterior Damage

The crash sequence included five events. The Honda sustained minor right side damage during the impact with the curb (Event 1). The right rear rim was dented and the tire side wall cut. The dent to the rim measured 5 cm (1.9 in) in width and was 2 cm (0.8 in) deep. The cut to the tire measured

1.5 cm (0.6 in) and was located 25 cm (9.8 in) from the dent. The Collision Deformation Classification (CDC) for this impact was 12FRWN3.

As the Honda overrode the curb, it traveled along the descending embankment, and the undercarriage impacted the top of the curb (Event 2). The undercarriage damage began at the rear axle, extended 86 cm (33.8 in) rearward, and ended at the rear bumper. The damage measured 110 cm (43.3 in) laterally along the bottom of the rear bumper fascia (**Figure 5)**. The CDC for this impact was 00UBDS2.

Figure 5. Undercarriage damage

The Honda sustained minor frontal and right side damage as it contacted shrubbery along the east side of the embankment (Event 3). The direct damage began at the right front bumper corner and extended 40 cm (15.7 in) to the left. The direct damage extended 82 cm (32.3 in) longitudinally down the right side of the vehicle (**Figure 6**). The CDC for the impact with the shrubbery was 12FREE4.

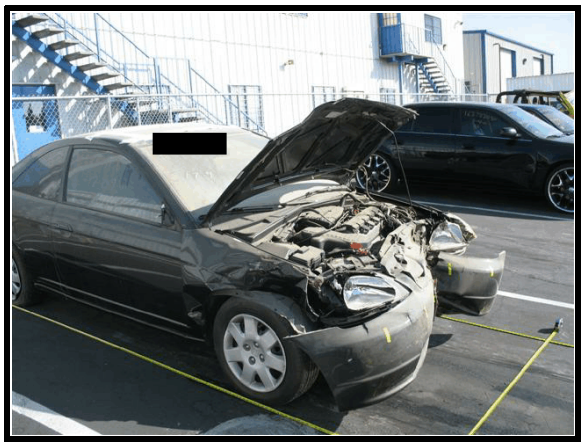


Figure 6. Front and right side damage

The Honda knocked down a curve delineator in its path toward the tree (Event 4). Any damage from that impact was masked by other impacts.

The Honda sustained moderate frontal damage from the impact with the tree (Event 5). The direct damage began 2 cm (0.8 in) left of the vehicle centerline and extended 50 cm (19.7 in) laterally to the left. The direct and induced damage was distributed from bumper corner to bumper corner. Six crush measurements were documented at the bumper level as follows: C_1 = 0 cm, C_2 = 23 cm (9.0 in), C_3 = 26 cm (10.2 in), C_4 = 13 cm (5.1in), C_5 = 3 cm (1.2 in), C_6 = 0 cm. The maximum crush was located at C3. The CDC for the impact with the tree was 12FYEW2.

Both front tires were restricted by the damage and the left wheelbase was shortened by 9 cm (3.5 in).

Interior Damage

Interior damage to the Honda was minor and associated with air bag deployment and driver contact. The windshield was cracked on the right side due to the deployment of the front passenger air bag. There was a single scuffing contact located to left side of the center console. There was no intrusion of interior components or damage associated with exterior deformation.

Manual Restraints

The Honda was equipped with 3-point manual lap and shoulder belts for all five seating positions. The front safety belts were equipped with retractor and buckle pretensioners. The driver's safety belt pretensioners actuated during the impact with the tree. The belt webbing was locked in the used position and the buckle stalk was compressed by 1 cm (0.4 in) as compared to the stalk on the right. The total spooled out belt webbing distance measured 193 cm (75.9 in). An area of belt loading that measured 5 cm (2.0 in) was located 74 cm (29.1 in) from the belt anchor (**Figure 7**). The driver's safety belt was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). The remaining safety belts were configured with sliding latchplates and switchable ELR/Automatic Locking Retractors (ALR).

Figure 7. Driver safety belt loading

Supplemental Restraint Systems

The Honda was equipped with dual-stage, dual-threshold supplemental restraint system (SRS) frontal air bags for the driver and front passenger. The frontal air bags can deploy at one of two rates, or stages. Deployment of the driver's frontal air bag takes into account the severity of the crash, whether or not the driver's safety belt is buckled and the position of the driver's seat. During a lower speed collision, the air bag inflators are triggered in sequence, resulting in overall air bag deployment with less initial force. The same sequence is also utilized regardless of collision speed if the driver's seat is sufficiently rearward of the full forward position. During a higher speed collision, if the driver's seat is far from the full frontal position, both inflators operate simultaneously for full, immediate inflation. Air bag deployment on the front passenger's air bag is regulated by crash severity, safety belt usage, and the weight of the occupant.

The system was designed with a dual-threshold deployment scheme. At lower threshold impact speeds in the 13-19 km/h (8-12 mph) range, the safety belt pretensioners can actuate for belted occupants without the air bags being deployed. The driver's safety belt was buckled at the time of the crash and the frontal air bag did not deploy. The front right safety belt was unbuckled and the frontal air bag did deploy.

The EDR was imaged by a Honda engineer during the vehicle inspection. The hexadecimal data was interpreted by Honda at a later date and provided to DSI in a letter format. The letter provided the following information:

1. No faults were detected in the air bag system at the time of the collision.
2 At the time of the imaging, the front passenger air bag and the driver seat belt tensioner were recorded as having open circuits.
3. The driver seat belt was detected to be buckled at the time of the collision.

4. The driver's air bag deployment threshold was set at the 'high' threshold due to the buckled status of the driver's seat belt.
5. The driver's front air bag did not deploy.
6. The right front passenger's seat belt was detected to be unbuckled at the time of the collision.
7. The right front passenger's air bag deployment threshold was set at the 'low' threshold due to the unbuckled right front passenger's seat belt.
8. The right front passenger's front air bag deployed with staged inflation.
9. The right front passenger's seat belt tensioner was suppressed due to the unbuckled status of the passenger's seat belt.
10. The front air bag system detected a frontal deceleration of sufficient severity to operate the collision signal ON (deploy command) for the frontal devices at low threshold.
11. The Delta-V for the frontal longitudinal direction impact from algorithm ON to the time of the collision signal on was 6.87 km/h (4.27 mph).
12. The time from safing sensor ON to the time the collision signal was ON was 59 milliseconds (ms).
13. The time from algorithm ON to the time of collision signal was ON was 79 ms.

A follow-up call was made to the Honda engineer to clarify the provided information. For item 10, there should have been an additional statement at the end of the item that indicated that the system did not detect an event that would deploy frontal devices at the high threshold. Since this was a threshold event it was not necessary for the driver air bag to deploy because the driver was belted. The vehicle may have experienced an extended Delta-T during the impact because the tree yielded and this may have affected the deployment decision.

The driver's air bag module was mounted in a conventional configuration within the 4-spoke steering wheel assembly. The steering wheel spokes were located at the 3/9 and 5/7 o'clock positions. The module was connected to the system by a plug located at the bottom of the steering wheel. The module was not removed during the on-site inspection of the vehicle. There was no damage or contact evidence to the steering wheel or hub.

The front passenger air bag was a top mount module in the top instrument panel (**Figure 8**). The air bag deployed through a rectangular module cover flap that was hinged at the forward aspect and measured 22 cm (8.6 in) in width by 6 cm (2.4 in) in height. The air bag was rectangular in shape and measured 43 cm (16.9 in) in width and 58 cm (22.8 in) in height. Two circular vent ports were located on the side panel at the 3 and 9 o'clock positions. The air bag was not tethered internally. During the deployment, the front right air bag contacted and fractured the windshield above the module assembly.

Figure 8. Front passenger air bag

OCCUPANT DEMOGRAPHICS

	Driver
Age/Sex:	71/Female
Seated Position:	Front left
Seat Type:	Bucket
Seat Track Position:	Mid-track
Height:	163 cm (64 in)
Weight:	59 kg (129 lbs)
Alcohol/Drug Involvement:	None
Body Posture:	Upright
Hand Position:	Both hands on wheel, unknown clock position
Foot Position:	Both feet on floor
Restraint Usage:	Lap and shoulder belt

Occupant Injuries

Driver: Injuries obtained from emergency room records and interviewee.

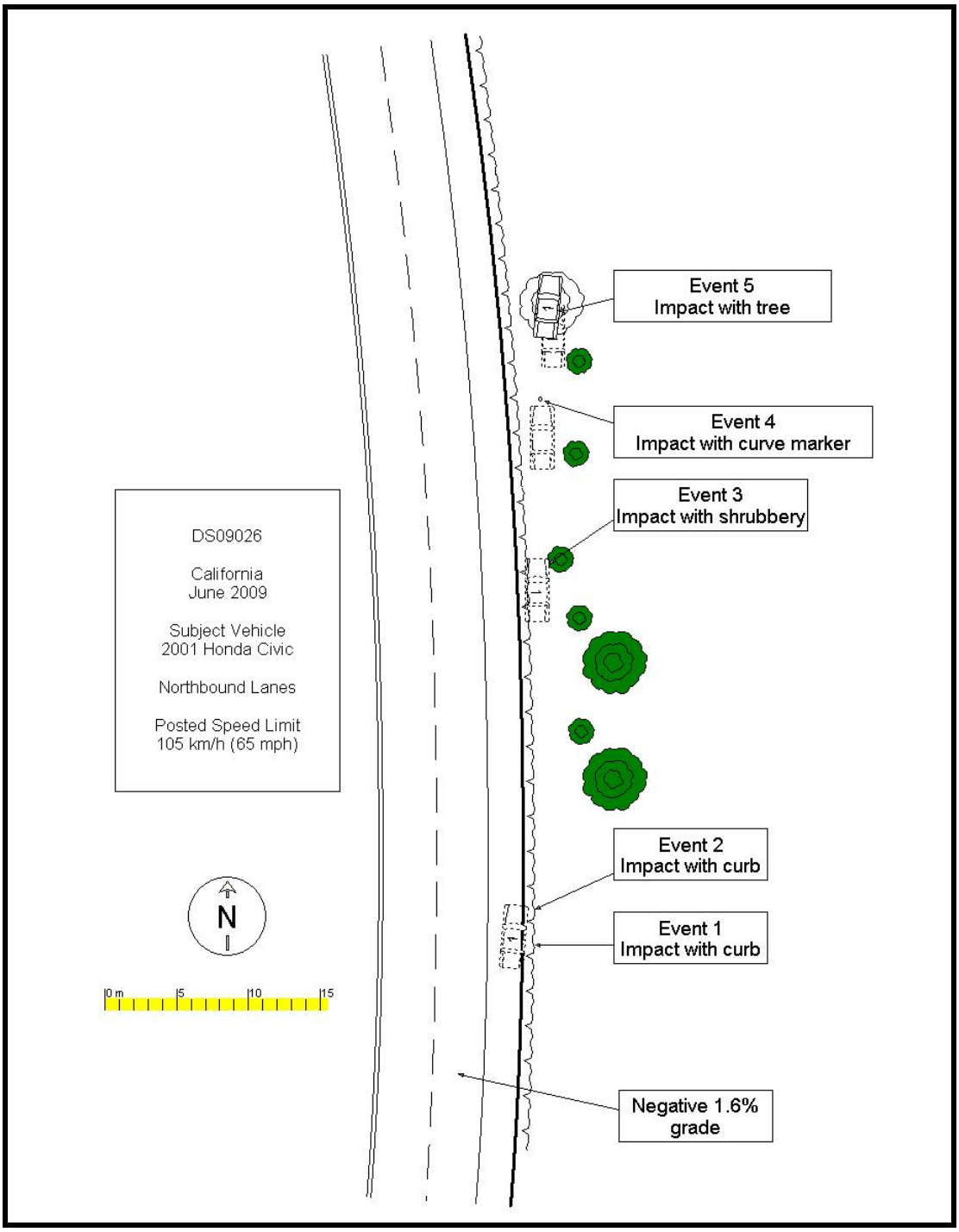
Injury	AIS Code	Injury Mechanism	Confidence Level
Chest wall strain, central	442214.1,4	Safety belt webbing	Certain
Chest wall contusion, left	490402.1,2	Safety belt webbing	Certain
Contusion, left shoulder	790402.1,2	Safety belt webbing	Certain
Contusion, abdomen	590402.1,0	Safety belt webbing	Certain
Laceration, right foot	890600.1,1	Foot controls	Probable

OCCUPANT KINEMATICS

Driver Kinematics

The driver of the Honda was seated in a mid-track position with the seat back support reclined at a 13 degree angle from vertical. The driver was seated generally upright but had fallen asleep. She was wearing the 3-point manual lap and shoulder belt with the lap portion snug and low across her hips and the shoulder portion across the collarbone and shoulder. Both hands were on the steering wheel at unknown clock position. Both feet were on the floor and the cruise control was on. The driver woke up as the vehicle impacted and overrode the curb. She did not take any evasive actions as the vehicle continued forward. The impacts to the shrubbery and curve delineator did not cause much driver motion. At impact with the tree, the driver initiated a forward trajectory in response to the frontal impact direction of force. She loaded the manual restraint system, causing a chest wall strain and contusion, and contusions to her left shoulder and abdomen. She also sustained a laceration to the right foot, probably due to contact with the foot controls. She was transported to a local hospital where she was treated and released. She followed up with a visit to her personal physician two days later.

Attachment 1. Scene Diagram



Attachment 2. EBS Calculations

*** * 6 POINT CRUSH * ***

$G = A^2 \div (2B)$
$G = 320.53^2 \div (2 \times 132.63)$
$G = 387.31$

A = Stiffness Coefficient A (lb/in or kN/m).
B = Stiffness Coefficient B (lb/in² or kN/m²).
G = Stiffness Coefficient G.

$E = (1 + \tan^2 Ang)(L \div 5) \times [(A \div 2)(C1 + 2C2 + 2C3 + 2C4 + 2C5 + C6) +$
$(B \div 6)(C1^2 + 2C2^2 + 2C3^2 + 2C4^2 + 2C5^2 + C6^2 + C1C2 + C2C3 + C3C4 + C4C5 + C5C6) + 5G]$
$E = 261922.39$

L = Width of Crush Damage (in/cm).
C1...C6 = Crush Measurements (in/cm).
Ang = The PDOF Angle.
E = Energy Dissipated (in-lb or Nc).

$KE = E \div 12$
$KE = 21826.86$

KE = The Kinetic Energy in ft-lbs or Joules.

$S = \sqrt{(30 \times KE) \div W}$
$S = \sqrt{(30 \times 21826.86) \div 2543.00}$
$S = 16.04$

S = The Equiv Barrier Speed in mph/kph

INPUTS:	
The Total Vehicle Wt is:	2543.00
The Width of Crush Damage is:	57.40
The PDOF Angle is:	0.00
Stiffness Coefficient A is:	320.53
Stiffness Coefficient B is:	132.63
Crush Measurement # 1 is:	0.00
Crush Measurement # 2 is:	9.00
Crush Measurement # 3 is:	10.20
Crush Measurement # 4 is:	5.10
Crush Measurement # 5 is:	1.20
Crush Measurement # 6 is:	0.00

RESULTS:	
Stiffness Coefficient G is:	387.31
The Energy Dissipated (in-lb or Nc) is:	261922.39
The Kinetic Energy (ft-lb or Joules) is:	21826.86
The Equiv Barrier Speed in mph/kph is:	16.04
The Equiv Barrier Velocity in fps/mps is:	23.52

7.70.7