Advanced Occupant Protection System Investigation / Vehicle vs. Concrete Wall
Dynamic Science, Inc. / Case Number: DS03026
2003 Honda Accord EX Four-Door Sedan
Texas
May, 2003

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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-scene, in-depth investigation focused on the Advanced Occupant Protection Systems which involved deployment of the dual-stage/dual threshold driver and front, right passenger air bags. In addition, the seat back lateral support mounted, thoracic side air bag system deployed at the front, right seated position. This single vehicle crash occurred during a weekday night in May, 2003 at 2250 hours. It was dark at the time of the crash and roadway was not illuminated. The weather was cloudy and the concrete surfaced roadway was wet. The crash occurred on the left side (south roadside) concrete jersey barrier of an interstate roadway. The interstate highway consists of three west/eastbound travel lanes that are bordered by concrete jersey barriers. A center median (grass, bordered by concrete jersey barriers) delineates the west and eastbound travel lanes and was under construction at the time of the crash. There are no traffic controls present and the posted speed limit is 97 km/h (60 mph).

The case vehicle is a 2003 Honda Accord EX four-door sedan that was being driven by a restrained 18 year-old female. The front, right seated position was occupied by a 17 year-old female who was also wearing the continuous loop, three-point manual lap and shoulder restraint.

The case vehicle was traveling westbound in lane no. 3 (adjacent to the center median), behind a slower vehicle which was directly in front of the Honda Accord. The driver of the case vehicle applied the brakes and the tires lost traction on the wet, concrete roadway surface. The driver then applied a right steering input as the case vehicle traversed the 2nd and 1st travel lanes. The driver applied a left counter steering input, in an attempt to correct the vehicle. In response to the left steering application, the case vehicle initiated a counterclockwise rotation, traversing the three westbound travel lanes before impacting the south roadside jersey barrier with its frontal plane. The case vehicle came to rest against the jersey barrier and was facing south.

The driver sustained abrasions to her right forearm and both wrists (AIS-1) due to contact with the deploying air bag. In addition, she sustained abrasions (AIS-1) to her upper left shoulder, chest and neck region due to contact with the applied shoulder belt webbing. She reported an abdominal contusion due to loading the lap belt webbing and multiple contusions to her lower extremities (AIS-1) from contacting the instrument panel/knee bolster. The driver was transported to a hospital where she was treated and released. The 17 year old female, front, right seated passenger reported that she sustained a whiplash type injury and thoracic strain (AIS-1) as a result of the impact forces. She refused medical treatment and was not transported to a hospital.

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Dynamic Science, Inc.
Crash Investigation
Case Number:DS03026

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BACKGROUND:

Description:	This Advanced Occupant Protection Systems case was initially identified by a NHTSA review of GES police reports. A copy of the police report was forwarded to DSI on June 20th, 2003 with instructions to locate the case vehicle for an on-site investigation. The case vehicle was a 2003 Honda Accord EX Four-Door Sedan that was equipped with an advanced occupant protection system which includes dual-stage/dual-threshold driver and front, right passenger bags. The vehicle is also equipped with seat mounted side air bags with an Occupant Position Detection System.
Investigation Type:	On site
Crash Location:	Texas
Crash date:	May, 2003
Notification Date:	June 20, 2003
Field Work Completed:	July 8, 2003

SUMMARY

Crash Site

This single vehicle crash occurred during a weekday night in May, 2003 at 2250 hours. It was dark at the time of the crash and the roadway was not illuminated. The weather was cloudy and the concrete surfaced roadway was wet. The crash occurred on the left side (south roadside) concrete jersey barrier of an interstate roadway. The interstate highway consists of three west/eastbound travel lanes that are bordered by concrete jersey barriers. A center median (grass, bordered by concrete jersey barriers) delineates the west and eastbound travel lanes and was under construction at the time of the crash. There were no traffic controls present and the posted speed limit was 97 km/h (60 mph).

Figure 1. View showing case vehicle's pre-impact travel lane and area of impact

Pre-Crash

The case vehicle is a 2003 Honda Accord EX four-door sedan that was being driven by a restrained 18 year-old female (157 cm, 62 in/ 52 kg, 115 lbs) The front, right seated position was occupied by a 17 year-old female (155 cm, 61 in/ 50 kg, 110 lbs) who was also wearing the continuous loop, three-point manual lap and shoulder restraint.

Inspection of the driver's continuous loop three-point seat integrated lap and shoulder safety seat belt had evidence of historical usage and recent loading. The driver was seated in a leather covered bucket seat that was adjusted to between the middle and rear most seat track position. The seat back was slightly reclined in a rearward fashion.

The front right seat was also equipped with a continuous loop three-point seat integrated lap and shoulder restraint that showed evidence of historical usage and recent loading. The front, right occupant was seated in a leather covered bucket seat that was adjusted to the rear most seat track position. The seat back was also slightly reclined rearward. The lap and shoulder restraints at both front seated positions were equipped with pretensioners (Automatic Tensioning System). In addition, both front seat positions were also equipped with adjustable front seat upper seat belt anchors and were in the upper most positions.

The Honda Accord was traveling westbound in lane number three (adjacent to the center median), behind a slower vehicle which was directly in front of the Honda Accord. The 18 year old female driver was somewhat inexperienced and was traveling at a driver estimated speed of 121 km/h (75 mph).

Crash

As the case vehicle closed in on the slower moving westbound vehicles, the driver of the case vehicle applied the brakes and the tires lost traction on the wet, concrete roadway surface. The driver applied a right steering input as the case vehicle traversed the 2nd and 1st travel lanes. The driver then applied a left counter steering input, in an attempt to correct the vehicle. In response to the left steering application the case vehicle initiated a counterclockwise rotation, traversing the three westbound travel lanes before impacting the south roadside jersey barrier with its frontal plane (01FZEW1).

Figure 2. Exterior view showing frontal deformation to case vehicle.

Post-Crash

The case vehicle came to rest against the jersey barrier and was facing south.. The driver sustained abrasions to her right forearm and both wrists (AIS-1) due to contact with the deploying air bag. In addition, she sustained abrasions (AIS-1) to her upper left shoulder, chest and neck region due to contact with the applied shoulder belt webbing. She reported an abdominal contusion due to loading the lap belt webbing and multiple contusions to her lower extremities (AIS-1) from contacting the instrument panel/knee bolster. The driver was transported to a hospital where she was treated and released.

The 17 year old female, front, right seated passenger reported that she sustained a whiplash type injury and thoracic strain (AIS-1) as a result of the impact forces. She refused medical treatment

and was not transported to a hospital.

The case vehicle was disabled due to the impact and after the investigating police collected all of the pertinent information, a tow facility removed the Honda from the crash location. The drivers insurance company later declared the case vehicle a total loss and it was subsequently moved to vehicle salvage facility where it would eventually be sold at auction.

VEHICLE DATA - 2003 Honda Accord EX Four-Door Sedan

The 2003 Honda Accord EX Four-Door Sedan was identified by the Vehicle Identification Number (VIN): JHMCM56663Cxxxxxx.

The 2003 Honda Accord EX Four-Door Sedan was equipped with a 2.4 liter in-line 4-cylinder/160 hp engine along with a 5-speed automatic transmission. The case vehicle was equipped with front wheel drive with rack-and-pinion steering.

The reading from the instrument panel odometer was not readable due to LED and power outage.

The 2003 Honda Accord EX Four-Door Sedan was equipped with Michelin Energy MXV4, P205/60R16 tires. The manufacturer's recommended cold tire pressure for the front was 221 kPa (32 psi) and 207 kPa (30 psi) for the rear. The specific tire data is as follows:

Tire	Tread	Measured pressure	Maximum Tire Pressue
LF	6 mm (7/32 in)	255 kPa (37 psi)	303 kPa (44 psi)
LR	7 mm (9/32 in)	255 kPa (37 psi)	303 kPa (44 psi)
RR	7 mm (9/32 in)	262 kPa (38 psi)	303 kPa (44 psi)
RF	6 mm (8/32 in)	Flat	303 kPa (44 psi)

The front seating positions in the 2003 Honda Accord were configured with leather covered forward facing bucket seats. Both front bucket seats are equipped with adjustable head restraints that were in the full down position and were undamaged. The front, left seat was adjusted between the middle and rear most seat track position while the front, right seat was adjusted at the rear-most seat track position. The second seating row consists of a leather covered, bench seat equipped with a folding seat back. There are adjustable head restraints available at the outboard rear seated positions and they were undamaged.

VEHICLE DAMAGE

Exterior Damage - 2003 Honda Accord EX Four-Door Sedan

Damage Description:	Moderate/Primary Frontal Impact: Longitudinal displacement of the front bumper with maximum crush of 17.9 cm (7 in.) located at the front, right bumper corner. Damaged components included the front bumper and fascia cover, hood, grille, upper/lower radiator supports, both fenders, right front tire/wheel and the laminated windshield glazing was cracked.	
CDC:	01FZEW1	
Delta V:	Total	22.5 km/h[1] (14.0 mph)
	Longitudinal	-19.5 km/h (-12.1 mph)
	Latitudinal	-11.2 km/h (-7.0 mph)
	Energy	34, 117 joules (25,163 ft lbs)

C-measurements: Six equidistant crush measurements were documented at the bumper and above bumper levels and the averaged crush profile is as follows: C_1= 12.0 cm (4.7 in), C_2=0 cm (0 in), C_3=6.0 cm (2.4 in), C_4=10.0 cm (3.9 in), C_5=18.0 cm (7.0 in), C_6= 16.0 cm (6.3 in).

Interior Damage - 2003 Honda Accord EX Four-Door Sedan

The interior greenhouse area of the case vehicle was void of any intruding components and the case vehicle's integrity was not compromised. The laminated AS-1 windshield glazing was cracked due to the concrete barrier impact forces. The interior was void of any detectable areas of occupant contact. It is suspected that both the driver and front, right seated occupant likely contacted the deploying air bags.

The interior of the case vehicle consisted of two front seated positions with leather covered bucket seats. The second row was comprised of a leather covered bench seat with a folding seat back. There are adjustable head restraints at the outboard rear seated positions. There was no damage to the interior seats or head restraints.

[1] Calculated utilizing the Barrier algorithm of the WinSmash energy dissipation program

MANUAL RESTRAINT SYSTEMS - 2003 Honda Accord EX Four-Door Sedan

The driver's manual restraint system consisted of a continuous loop three-point seat integrated lap and shoulder safety belt with a free sliding latch plate and an adjustable shoulder belt upper anchorage that was in the upper most position. The driver's lap and shoulder belt exhibited evidence of historical usage in the fashion of striations and scratching to the latch plate. In addition, there was evidence of loading to the shoulder belt webbing in the form of minor stretching.

Figure 3. View of driver's position showing deployed air bag and spooled out lap and shoulder restraint (pretensioner actuation)

The front, right seat was also equipped with a continuous loop three-point seat integrated lap and shoulder safety belt with a free sliding latch plate and an adjustable shoulder belt upper anchorage that was in the upper most position. The latch plate showed evidence of historical usage in the form of striations and surface scratching. The shoulder belt webbing exhibited evidence of minor load induced stretching.

Figure 4. View of front right position showing deployed front and side air bags along with spooled lap and shoulder restraint (pretensioner actuation)

Both front seats are equipped with pretensioners (Automatic Tensioning System) which activated and were observed to locked in a spooled out (used) position. The pretensioners will be discussed with more detail under the Frontal Air Bag System section.

The three seated positions of the rear bench seat are equipped with manual three-point lap and shoulder belts with free sliding latch plates and switchable (ELR/ALR) retractors; and the buckle mechanisms are anchored by loose webbing.

FRONTAL AIR BAG SYSTEM - 2003 Honda Accord EX Four-Door Sedan

Advanced Occupant Protection System Discussion[2]

This vehicle was equipped with an advanced occupant protection system which includes dual-stage/dual-threshold driver and front right passenger air bags. The dual stage inflator allows the electronic control unit to inflate the front air bags at one of two different rates depending on the severity of the collision. (The rate affects the force of the inflating air bag.) The control unit determines which inflation rate to use based on inputs from the front collision sensor, which measures the severity of the collision.

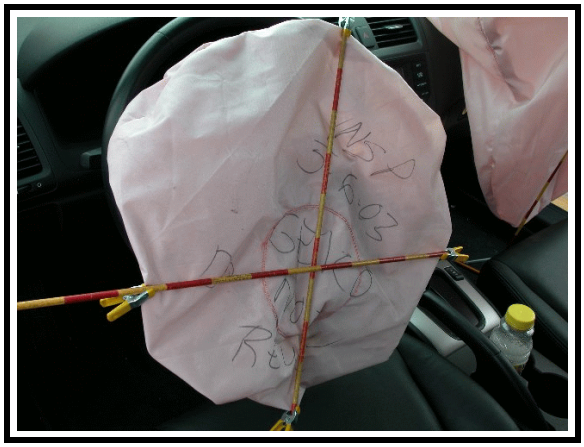

Figure 5. View showing deployed driver's air bag

Figure 6. View showing deployed front, right passenger air bag

The vehicle is also equipped with seat mounted side air bags with an Occupant Position Detection System. The side air bags inflate to help protect the driver's or front right passenger's upper body in the event of a moderate to severe side impact. Side impact sensors on either side of the car detect the side collision and, if needed, the side air bag on the side of the collision is deployed. The seat mounted side air bags are located in the outboard seat bolsters of the two front seat backs and inflate forward from the seat cover. The side air bags are operated by the same electronic control unit that operates the front air bags. When the driver's side impact sensor registers a moderate to severe side impact, the electronic control unit deploys the driver's side air bag. The side air bag cushions the area between the driver's chest and left shoulder area and the door. The front right passenger's side air bag is similar to the driver's side airbag, but the electronic control unit also considers input from an Occupant Position Detection System (OPDS) in the front right passenger's seat to determine if it is safe to deploy the air bag. Sensors in the seat back determine the height of the occupant, and a sensor in the right seat bolster senses if the occupant is leaning into the side air bag's deployment path. This system is designed to prevent the side air bag from deploying if a child (or small adult) leans into the side air bag's deployment path. If a child or small adult leans toward the outside seat bolster, the OPDS is designed to signal the electronic control unit to cut off the front right passenger's side air bag deployment. The OPDS unit also illuminates the side air bag off indicator on the instrument panel to alert the driver that the passenger is in an unsafe position for

[2] Data concerning the front and side air bag system was obtained from: http://hondafirst.com/Safety/safety.htm

side air bag deployment. When the passenger returns to an upright position, the side air bag will resume normal operation and the side air bag indicator light will turn off. Placing objects in the passenger's seat (handbags, briefcases, etc,) may also illuminate the side air bag indicator light. If the front right passenger uses a cushion or other object, such as a backrest, it may interfere with the sensor functions and prevent the side air bag cutoff system from working properly. Also, models equipped with side air bags should not use seat covers as they will impede the side air bag cutoff system and air bag functions.

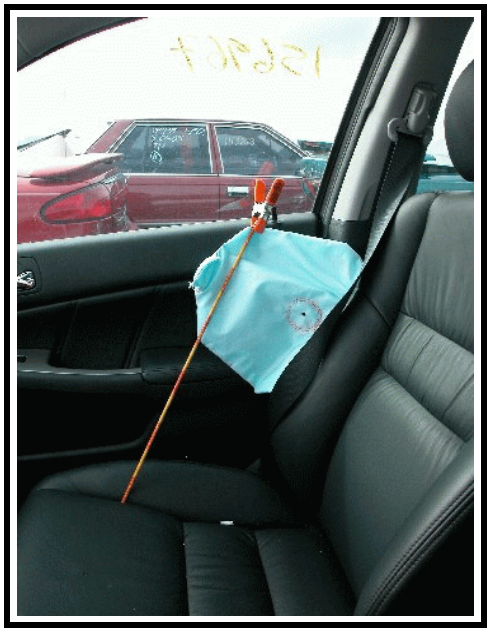

Figure 7. View showing deployed right side thoracic air bag

The driver and front right passenger air bags deployed on impact with the retaining cement wall. The driver's air bag module was located in the center hub of the steering wheel rim and had two module cover flaps. The upper flap measured 12.0 cm (4.7 in) wide by 8.0 cm (3.1 in) high. The lower flap measured 12.0 cm (4.7 in) wide by 6.0 cm (2.4 in) high. There was no contact evidence on any of the module cover flaps. The diameter of the air bag measured 49.0 cm (19.3 in) in its deflated state. There were two vent ports, located at the 1 and 11 o'clock positions respectively, and two tethers. There was no evidence of occupant contact to the air bag. There was evidence of module cover flap transfer on the middle right of the face of the air bag and to the upper half of the back of the air bag. The driver's air bag had a maximum post deflated excursion of 28.0 cm (11.0 in). The front right passenger air bag was a top mount design located in the right aspect of the instrument panel. The two symmetrical rectangular module cover flaps each measured 23.0 cm (9.1 in) wide by 5.0 cm (2.0 in) high. There was module cover flap transfer to the mid-face of the air bag. The deflated air bag measured 42.0 cm (16.5 in) wide by 68.0 cm (26.7 in) high. The air bag had two vent ports and no tethers. The ports were at the 2 and 10 o'clock positions. The air bag had a maximum deflated excursion of 66.0 cm (26.0 in).

The vehicle was also equipped with a driver's and front right passenger side air bags mounted in the outboard padding of the seat backs. The driver's side air bag did not deploy; the front right passenger's side air bag did deploy during the impact with the wall. The front right passenger's side air bag was square shaped and measured 31.0 cm (12.2 in) wide by 32.0 cm (12.5 in) wide. The side air bag had a single sewn tether and a single vent port. There was no evidence of any occupant contact to the side air bag.

OCCUPANT DEMOGRAPHICS - 2003 Honda Accord EX Four-Door Sedan

	Driver	Occupant 2
Age/Sex:	18/Female	17/Female
Seated Position:	Front, left	Front, right
Seat Type:	Bucket, leather covered. Seat between middle and rear most track position.	Bucket, leather covered. Seat between middle and rear most track position.
Height:	157 cm (62 in)	155 cm (61 in)
Weight:	52 kg (115 lbs)	50 kg (115 lbs)
Occupation:	Unknown	Unknown
Pre-existing Medical Condition:	Unknown	Unknown
Alcohol/Drug Involvement:	None	N/A
Driving Experience:	Unknown	N/A
Body Posture:	Slightly reclined, facing forward	Slightly reclined, facing forward
Hand Position:	Both hands on the steering wheel rim at unknown O'clock positions	Both hands resting on her lap
Foot Position:	Right foot depressing brake pedal while her left foot was on the floor	Both feet on the floor
Restraint Usage:	Three-point manual lap and shoulder restraint used incorrectly with the lap belt worn high extending across her stomach/abdomen and the shoulder belt properly placed across her chest.	Three-point manual lap and shoulder restraint used incorrectly with the lap belt worn high extending across her stomach/abdomen and the shoulder belt placed across her chest.
Air bag:	Steering wheel mounted air bag available, deployed. Seat back mounted side air bag, did not deploy.	The front, right passenger air bag was a top mount design, deployed. Seat back mounted side air bag, deployed.

OCCUPANT INJURIES - 2003 Honda Accord EX Four-Door Sedan

Driver: Injuries obtained from Emergency Room Report and from driver interview.

Injury	OIC Code	Injury Mechanism	Confidence
Minor abrasions to her right forearm	790202.1,1	Air bag	Probable
Minor upper left chest/shoulder abrasion	790202.1,2	Shoulder belt webbing	Certain
Minor abrasion left medial side of neck	390202.1,2	Shoulder belt webbing	Certain
Multiple bilateral lower extremity	890402.1,3	Lower Instrument panel/ knee bolster	Certain
Right wrist abrasions	790202.1,1	Air bag	Probable
Left wrist abrasions	790202.1,2	Air bag	Probable
Abdominal contusion	590402.1,0	Lap belt webbing	Certain

Front right occupant: Injuries obtained from driver interview.

Injury	OIC Code	Injury Mechanism	Confidence
Cervical strain (whiplash (Interviewee)	640278.1,6	Inertial impact forces	Probable
Thoracic strain	640478.1,7	Inertial impact forces	Probable

OCCUPANT KINEMATICS - 2003 Honda Accord EX Four-Door Sedan

Driver kinematics

The 18 year-old female was fully restrained with the lap belt reported to be placed high on her abdomen/stomach region and the shoulder belt webbing extended across her chest. The seat was adjusted between the middle and rear most seat track position and the shoulder belt adjuster was in the full up position. She reportedly had both hands on the steering wheel rim (at unknown o'clock positions) and her right foot was depressing the brake pedal at the time of the crash.

The driver responded to the 30 degree principle direction of force by moving mostly forward and to her right. She loaded the applied lap and shoulder restraint webbing which prohibited her from extended forward movement. As a result of her interaction with the shoulder belt webbing, she sustained a minor abrasion(AIS-1) to her upper left shoulder/chest region and the abrasion extended to the left side of her neck (AIS-1)[3]. In addition, she reported an area of contusion (AIS-1) to her abdominal region due to loading the applied lap belt webbing. She sustained abrasions (AIS-1) to her right forearm and both wrists as a result of contact with the deploying air bag and she reported numerous bilateral contusions to her lower extremities (AIS-1) which was possibly due to contacting the knee bolster.

The driver rebounded into the seat back support as the case vehicle came to its final rest position. After the crash, the driver unbuckled the applied restraint system and exited the vehicle unassisted. An ambulance was summoned the crash location and she was subsequently transported to a hospital where she was treated and released.

Front, right occupant kinematics

The front, right seated position was occupied by a 17 year-old female who was also wearing the available three-point manual lap and shoulder belt with the lap belt placed high on her abdomen and the shoulder belt extending across her chest. The seat was adjusted fully rearward and the shoulder belt adjuster was in the full up position.

She responded to the 1 o'clock impact force by moving forward and to her right. She loaded the applied lap and shoulder restraint which prohibited extended forward movement. She may have made contact with the deploying air bag, but this did not result in injury and could not be supported with the lack of contact evidence. The front, right seated passenger rebounded into her respective seat back support and was able to exit the vehicle unassisted. She reported to have sustained a "whiplash" injury (AIS-1) and a thoracic strain (AIS-1), but refused medical treatment at the crash scene.

[3] The abrasion to the left side of her neck which extended to her high chest region was a result of having the shoulder belt adjuster in the full up position. Due to her small stature, the shoulder belt adjuster should have been adjusted at lowest position.

Attachment 1. Scene Diagram