Side Curtain and Side Air Bag Investigation/Vehicle to Vehicle
Dynamic Science, Inc./Case Number: DS05024
2005 Acura MDX
Washington
October 2005

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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 side curtain and side air bag systems in a 2005 Acura MDX. This two vehicle crash occurred in October 2005, at 0811, hours in an urban area of Washington. The crash occurred within the confines of a four-leg intersection. The case vehicle was a 2005 Acura MDX being driven by a restrained female. There was one additional occupant in the Acura. The other vehicle was a 1999 Toyota Camry four door sedan. The Acura was traveling east. The Toyota was traveling south. The driver of the Toyota entered the intersection, intending to make a left turn. The driver of the case vehicle reported to police that she steered right in an attempt to avoid being struck. The front of the Toyota struck the left side of the Acura, resulting in the deployment of the case vehicle's left front seat back mounted side air bag and left side curtain. The Acura rotated counterclockwise, traveled toward the southeast corner, and rolled over one quarter turn onto its right side, resulting in the deployment of the right side curtain and the front right passenger seat back mounted side air bag. After the initial impact, the Toyota spun 180 degrees counterclockwise, accelerated and traveled off the northwest corner of the intersection. The front of the Toyota impacted a short brick wall. The Toyota Camry came to final rest off the roadway, facing northwest. The driver of the 2005 Acura MDX complained of head and neck injuries and was transported to an area hospital for treatment. The Acura's front right passenger complained of neck and abdominal injuries and was transported to the same hospital. Both vehicles were towed from the scene.

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Dynamic Science, Inc.
Crash Investigation
Case Number: DS05024

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BACKGROUND:

Description:

This on-site investigation focused on the performance of the side curtain and side air bag systems in a 2005 Acura MDX.

This two vehicle crash occurred in October 2005, at 0811 hours, in an urban area of Washington. The crash occurred within the confines of a four-leg intersection. The case vehicle was a 2005 Acura MDX being driven by a 47-year-old restrained female. There was one additional occupant in the Acura. The other vehicle was a 1999 Toyota Camry four door sedan being driven by a female.

Figure 1. Left side impact damage - 2005 Acura MDX

Figure 2. Right side rollover damage - 2005 Acura MDX

The Acura was traveling east in the right lane with no traffic controls. The Toyota was traveling south in the right lane with stop signs posted at the intersection. The driver of the Toyota entered the intersection, intending to make a left turn. The driver of the case vehicle reported to police that she swerved in an attempt to avoid being struck, but could not avoid the collision. The front of the Toyota struck the left side of the Acura, resulting in the deployment of the case vehicle's left front seat back mounted side air bag and left side curtain. The Acura rotated counterclockwise, traveled toward the southeast corner, and rolled over one quarter turn onto its right side, resulting in the deployment of the right side curtain and the front right passenger seat back mounted side air bag. The case vehicle came to final rest on its right side, facing north, with its front end still on the roadway and its back end in a shallow ditch. After the initial impact, the Toyota spun 180 degrees counterclockwise, accelerated and traveled off the northwest corner of the intersection. The front of the Toyota impacted and traveled through a short brick wall. The Toyota Camry came to final rest off the roadway, facing northwest. According to the police report, the Toyota's accelerator was found to be stuck in the full open position post-crash.

The driver of the 2005 Acura MDX complained of head and neck injuries and was transported to an area hospital for treatment. The Acura's front right passenger complained of neck and abdominal injuries and was transported to the same hospital. The driver of the Toyota Camry did not report any injuries and did not receive any medical treatment.

Both vehicles were towed from the scene. The 2005 Acura MDX was later declared a total loss.

This crash was identified within a group of potential cases provided by the National Highway Traffic Safety Administration (NHTSA). DSI received the potential cases on October 24, 2005. A sanitized copy of the police report was obtained on October 27, 2005. DSI obtained permission to inspect the vehicle on October 28, 2005 and was assigned the case on October 31, 2005. Field work was completed on November 3, 2005.

SUMMARY

Crash Site

This two vehicle crash occurred in October 2005, at 0811 hours, in an urban area of Washington. The crash occurred within the confines of a four-leg intersection.

Figure 3. Approach of case vehicle to intersection - east

The Acura was traveling east in the right lane on a roadway consisting of two undivided asphalt travel lanes. The one eastbound lane is separated from the one westbound lane by painted, no passing double lane lines. Adjacent to both travel lanes were fog lines and asphalt shoulders that were 1.7 m (5.5 ft) wide. This street had no curbs and there were shallow ditches located on both sides of the roadway. The travel lanes were level but there was a small downward slope from the fog lines towards the ditches. There were no traffic controls for north or southbound traffic.

Figure 4. Approach of other vehicle to intersection - south

The Toyota Camry was traveling south in the right lane on a two lane, two way, undivided, intersecting street. The southbound asphalt travel lane had an uphill grade. At the intersection, there were stop signs posted for north/south traffic and painted stop lines were present.

The posted speed limit for the north/south roadway was 40 km/h (25 mph), and 56 km/h (35 mph) for the east/west roadway. At the time of the crash both roadways were dry, there were no adverse weather conditions and no visual obstructions were present.

Pre-Crash

The case vehicle was a 2005 Acura MDX being driven by a 47-year-old restrained female. There was a restrained 16-year-old male passenger in the front right seat. The Acura was traveling east in lane one of the two lane, two-way roadway. The other vehicle was a 1999 Toyota Camry being driven by a female of an unknown age. There were no other occupants in the Camry. The Camry was traveling south in lane one of the two lane, two way roadway**.** According to the police report, this driver told the investigating officer that she was on her way to a shopping mall and was not sure where she was.

Figure 5. Area where the 2005 MDX began to rollover (east)

The driver of the Toyota entered the intersection, intending to make a left turn.

Figure 6. Right side rollover damage - 2005 Acura MDX

Crash

The driver of the Toyota began her left turn but the Acura MDX was already entering the intersection. The driver of the case vehicle reported to police that she swerved right in an attempt to avoid being struck, but could not avoid the collision. The front of the Toyota struck the left side of the Acura (10LPEW2). The impact severity was moderate and resulted in the deployment of the driver's seat back mounted side air bag and the left side curtain. The Acura rotated counterclockwise, traveled toward the southeast corner and rolled over one quarter turn to its right (00RDAO1), resulting in the deployment of the right side curtain and the front right passenger seat back mounted side air bag. The case vehicle came to final rest on its right side, facing north, with its front end still on the roadway and its back end in a shallow ditch.

After the initial impact, the Toyota spun 180 degrees counterclockwise, accelerated and traveled off the northwest corner of the intersection. The front of the Toyota impacted a short brick wall and traveled through it. The Toyota Camry came to final rest off the roadway, facing northwest.

Post-Crash

The driver of the 2005 Acura MDX complained of head and neck injuries and was transported by ambulance to an area hospital for treatment. The driver sustained strains to her neck and both shoulders. The Acura's front right passenger complained of neck and abdominal pain and was transported to the same hospital. This occupant was transported and examined. He arrived with

a Glasgow Coma Scale (GCS) score of 15. There were no resultant injuries. The driver of the Toyota Camry did not report any injuries.

Both vehicles were towed from the scene. The Acura MDX was later declared a total loss. According to the police report, the Toyota's accelerator was found stuck in the full open position following the crash.

Vehicle Data - 2005 Acura MDX

The 2005 Acura MDX was identified by the Vehicle Identification Number (VIN): 2HNYD18685Hxxxxxx. The Acura MDX is a four door, all wheel drive, multi-purpose vehicle with a rear hatch and seating for seven. It was equipped with a 3.5 liter 6-cylinder engine, 5 speed automatic transmission, four wheel anti-lock disc brakes, a low tire pressure indicator system, stability control and electronic traction control via ABS and engine management, and a tilt steering wheel. The vehicle mileage could not be obtained from the digital odometer because the vehicle had no power, but according to information from the salvage yard that was storing the vehicle at the time of the inspection, the mileage was approximately 32,363 km (20,110 miles).

The 2005 Acura MDX was equipped with Michelin Cross Terrain P235/65R17 tires. This vehicle comes equipped with a direct tire pressure monitoring system that uses wheel sensors to alert the driver whenever the tire pressure in an individual tire drops below 25% of the recommended level. At the inspection, the placard listing the recommended cold tire pressure was partially obscured due to the left front door damage, and could not be read. According to the manufacturer, the recommended cold tire pressure is 221 kPa (32 psi) for the front and 221 kPa (32 psi) for the rear. The specific tire information is as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	207 kPa (30 psi)	7 mm (9/32 in)	No	None
LR	Flat	7 mm (9/32 in)	Yes	Holed
RR	Flat	7 mm (9/32 in)	No	No visible damage; tire bead off rim
RF	186 kpa (27 psi)	7 mm (9/32 in)	No	None

The front row seating in the 2005 Acura MDX was configured with dual leather bucket seats. The seats were equipped with adjustable head restraints that were not damaged. The second row was configured as a leather 60/40 split bench seat with folding backs. All three second row seating positions were equipped with adjustable head restraints that were not damaged. The second row outboard seating positions were equipped with the lower anchor points that are part of this vehicle's Lower Anchors and Tethers for Children (LATCH) system. All three second

row seating positions were equipped with child safety top tether strap anchor points, located on the back of the second row seat backs. The third row was configured as leather 50/50 split bench with folding backs. Both third row seating positions were equipped with adjustable head restraints, but they were found still in the original plastic packaging, stored in a compartment behind the third row seat backs, and obviously had never been used. The third row seating positions were equipped with child safety seat top tether strap anchor points, located in the cargo area behind the third row seat backs.

Figure 7. Left side - 2005 Acura MDX

Vehicle Damage

Exterior Damage - 2005 Acura MDX

The 2005 Acura MDX sustained moderate left side damage as a result of the impact with the Toyota Camry. The Acura sustained 252.0 cm (99.2 in) of direct damage along the left side beginning 37.0 cm (14.6 in) aft of the left front axle, extending rearward. According to the police report, the force of this impact "partially tore off" the left rear door. At the vehicle inspection, the left rear door was found completely separated from the vehicle, laying in the rear cargo area. It appears that the door striker had been cut, possibly so the door panel could be stowed in the cargo area. It is possible that the Toyota Camry's right front bumper corner snagged on the Acura, causing the left rear door to partially tear off at the hinge area. A crush profile could not be obtained because the area of max crush was to the lower door area and could not be documented on the damaged left rear door due to the separation and damage to the door itself. There was virtually no crush to the sill.

Figure 8. Left rear door damage - 2005 Acura MDX

Figure 9. Damage to left rear door, snagged sheet metal damage intruding into the left rear tire area

The case vehicle also sustained moderate left side damage as a result of the rollover event. The Acura sustained 2.0 cm (0.8 in) of lateral crush at the max crush location, 52.0 cm (20.5 in) aft of the right front axle. There was no vertical crush as a result of the rollover event.

With permission from the insurance company,

the Acura MDX's electronic control unit (ECU) was removed from the vehicle and shipped to Honda for data retrieval. The results of the data retrieval are included in the Supplemental Restraint System section of this report.

CDC	(Impact 1):	10LPEW2
	(Impact 2):	00RDAO1

Figure 11. Left rear door, lower hinge still attached

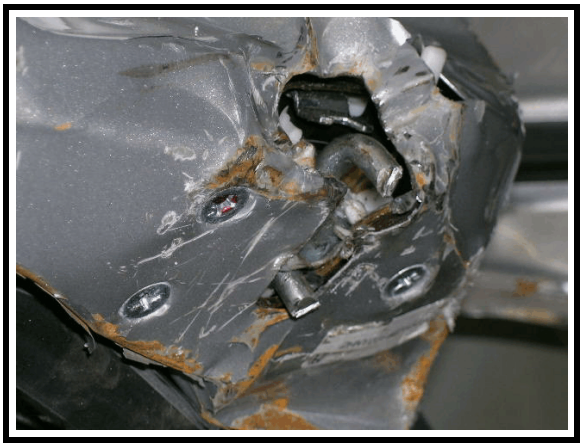

Figure 10. Close-up of left rear door striker, still in latch

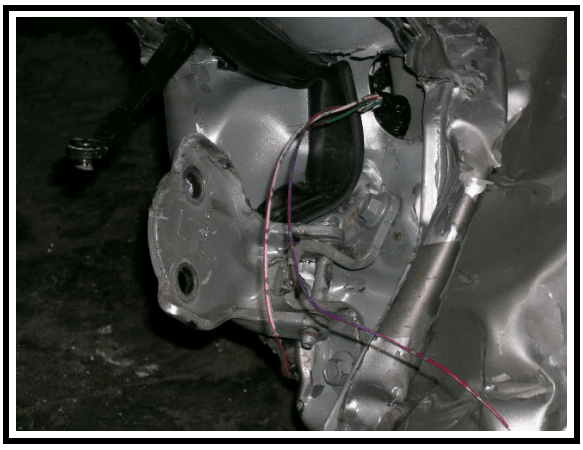

Figure 12. Closeup of left rear lower door hinge

Figure 13. Close-up of left rear door striker attachment area

Interior Damage - 2005 Acura MDX

The case vehicle sustained minor interior damage due to occupant contacts and normal air bag deployment related damage.

There were scuffs to the shoulder portions of the driver and front right passenger seat belts due to the actuation of the B pillar pretensioners. Both belts were found to be locked in place post crash. There were signs of occupant contact to the glove compartment door, possibly from the passenger's lower left leg.

There was integrity loss at the left rear door area. The upper door hinge was found still attached but damaged. The lower hinge was separated from the frame, but still attached to the left rear door panel. The striker area was damaged and the striker was also separated from the vehicle and was found in the door latch. It appears the striker was cut and did not shear due to damage forces.

Figure 14. Left B pillar and cover intrusion

There was lateral intrusion into the driver's area and in the second row left seating area. The left B-pillar intruded laterally into the left front and left rear seating positions, but the B pillar's plastic cover intruded an additional 3.0 cm (1.2 in) laterally into the left front and an additional 6.0 cm (2.4 in) laterally into the left rear area. The right front, right rear door and rear hatch remained closed and operational. The left front door was jammed shut post crash. According to the police report, the left rear door was partially torn off during the collision and at the inspection was found completely separated from the vehicle, laying in the rear cargo area. The windshield was cracked and in place post crash. The left rear glazing disintegrated, most likely due to the left side impact. The specific passenger compartment intrusions were documented as follows:

Row/Position	Intruded Component	Magnitude of Intrusion	Direction
1L	Left Armrest	7.0 cm (2.8 in)	Lateral
1L	B Pillar	5.0 cm (2.0 in)	Lateral
1L	Door panel	5.0 cm (2.0 in)	Lateral
2L	B Pillar	4.0 cm (1.6 in)	Lateral

Manual restraints - 2005 Acura MDX

The 2005 Acura MDX was configured with manual 3-point lap and shoulder belts for each of the seven seating positions. Both front seat belts were equipped with B-pillar pretensioners and seat belt height adjusters. The driver and front right passenger's pretensioners actuated during the crash. Both front row seat belt height adjusters were in the full up position. The driver's safety belt was configured with a sliding latch plate and an emergency locking retractor (ELR). The right front safety belt had a sliding latch plate and a switchable ELR/Automatic Locking Retractor. All three second row seat belts had sliding latch plates and switchable retractors. The shoulder portion of the second row center restraint system can be stored in the ceiling of the vehicle. The shoulder portion of this belt can be connected to the latch plate of the lap belt to form a 3-point lap and shoulder belt. The third row seat belts all had sliding latch plates and switchable retractors.

Supplemental Restraint System - 2005 Acura MDX

The case vehicle was equipped with advanced occupant protection systems. The Supplemental Restraint System (SRS) consists of the electronic control unit (ECU), dual stage, dual threshold Certified Advanced 208 Compliant (CAC) driver and passenger air bags. The multi-stage air bags were certified by the manufacturer to meet the advanced air bag requirement of Federal Motor Vehicle Safety Standard No. 208. The case vehicle was equipped with a driver's seat position sensor and a front right passenger seat weight sensor suppression system. It was also equipped with front row driver and passenger seat back mounted side impact air bags, and side curtains that run the full length of the vehicle. Per the manufacturer, the side curtains are designed to deploy in the event of a sufficient side impact. Side impact sensors were located at the side sill and B pillar. The rollover sensor is included with the side sensor at the B pillar. The vehicle is also equipped with front row driver and passenger B pillar seat belt pretensioners.

The primary function of the ECU is to control the deployment of the occupant protection systems. This vehicle's ECU was removed from the vehicle with permission and shipped to Honda for data retrieval. The following data was retrieved from the ECU unit:

Figure 15. Driver's side air bag and side curtain

Figure 16. Right front section of the deployed right side curtain

- Both front seat belts were buckled.
- The front right passenger's seat sensor detected an adult occupant and the air bags were not suppressed.
- Both front seat belt pretensioners received FIRE commands.
- Both front air bags received NO FIRE commands.
- SRS ECU on time (Front) was nil–no trigger.
- The driver's side air bag and side curtain were fired by the side sensors.
- The front right passenger's side air bag and side curtain were fired by the rollover sensor. The rollover sensor detected a roll to the right and the ECU On-On time was 128 milliseconds.

Neither front air bag deployed during the collision. Both of the front row side air bags and the left and right side curtains deployed during the crash events. The vehicle was also equipped with front row driver and passenger B pillar seat belt pretensioners which actuated during the crash.

Both of the deployed seat mounted side air bags were semi-circular in shape with a height of 30.0 cm (11.8 in) and an excursion of 33.0 cm (13.0 in) in their deflated state. They each had one internal tether and one vent port. The vent port consisted of an opening located at the 2 o'clock position as viewed from the right side of the bag. On the driver's side air bag, there were two circular stitched areas located at the 11 and 5 o'clock positions as viewed from the right. Although there was some lateral intrusion of the B pillar and its plastic cover, it appears that the driver's side air bag deployed properly.

Figure 17. Right front deployed side air bag

On the front passenger's side air bag, the two circular stitched areas were located at the 11 and 5 o'clock positions as viewed from the left side of the bag. The vent port opening was located at the 10 o'clock position as viewed from the left. There were no visible signs of occupant contact or damage to either side air bag.

Figure 18. Side air bag vent port type

The deployed left and right side curtain air bags extended from the A pillars to the D pillars. There was a small coverage gap present at both A pillars. The side curtains were rectangular in shape and in their deflated state, measured 253.0 cm (99.6 in) in length. The height of both side curtains was 38.0 cm (15.0 in). The curtains had two external tethers, located at the A and D pillars. The side curtains deployed from the roof side rails. There were no visible signs of occupant contact to the side curtains. Both curtains had a few deployment streaks and were slightly dirty.

Vehicle Data - 1999 Toyota Camry

Description:	1999 Toyota Camry 4-door sedan	
VIN:	JT2BG22K9X0xxxxxx	
Odometer:	Unknown	
Engine:	2.2L, 4 cylinder	
Reported Defects:	None	
Cargo:	Unknown	
Damage Description:	Front end damage per police report	
CDC:	Unknown	
Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

Occupant Demographics - 2005 Acura MDX

	Driver	Occupant 2
Age/Sex:	47/Female	16/Male
Seated Position:	Front left	Front right
Seat Type:	Between middle and rearward most track position	Between middle and rearward most track position
Height:	Unknown	Unknown
Weight:	64 kg (141 lbs)	Unknown
Occupation:	Unknown	Unknown
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	Not Applicable
Driving Experience:	Unknown	Not Applicable
Body Posture:	Unknown	Unknown
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Manual lap and shoulder belt	Manual lap and shoulder belt
Air bag:	Front air bag available - non-deployed. Seat back mounted side air bag available - deployed. Side curtain available - deployed.	Front air bag available - non-deployed. Seat back mounted side air bag available - deployed. Side curtain available - deployed.

Occupant Demographics - 1999 Toyota Camry

	Driver
Age/Sex:	Unknown age/Female
Seated Position:	Front left
Seat Type:	Unknown
Height:	Unknown
Weight:	Unknown
Occupation:	Unknown
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt used per the police report

Occupant Injuries - 2005 Acura MDX

Driver: Injuries obtained from emergency room records and radiological reports.

Injury	OIC Code	Injury Mechanism	Confidence Level
Cervical spine strain	640278.1,6	Impact forces	Probable
Shoulder sprain, left	751020.1,2	Impact forces	Probable
Shoulder sprain, right	751020.1,1	Impact forces	Probable

Front Right Occupant**:** Occupant complained of pain to the abdomen and neck. He was transported and examined in the emergency room. There were no codeable injuries.

Occupant Injuries - 1999 Toyota Camry

Driver: Not injured per the police report.

Occupant Kinematics - 2005 Acura MDX

Driver Kinematics

The female driver of the case vehicle appears to have been seated in an upright posture in the leather covered bucket seat, and was restrained by the 3-point manual lap and shoulder belt. The shoulder belt anchorage adjustment was in the full up position. The seat was adjusted to between the middle and rearward most track position. The seat back was reclined at a 85 degree angle and the seat bottom had a 10 degree angle. During the left side impact, the female driver initiated a lateral and slightly forward trajectory towards the 10 o'clock direction of force. The driver's safety belt pretensioner actuated and the side air bag and left side curtain deployed. The case vehicle began to rotate counterclockwise as it traveled toward the southeast corner of the intersection. As the vehicle reached the end of the asphalt and the beginning of the grass and dirt shoulder, it began to rollover to the right, resulting in the deployment of the right side curtain air bag. At the scene, the driver sustained strains to her neck and both shoulders due to impact forces. She was transported by ambulance to an area hospital for treatment.

Front Right Occupant Kinematics

The 16-year-old front right male passenger was seated forward facing in the leather covered bucket seat and was restrained by the 3-point manual lap and shoulder belt. The shoulder belt anchorage was in the full up position. The seat was adjusted between the middle and rearmost track position. The seat back was reclined at a 70 degree angle and the seat bottom had a 15 degree angle. During the initial left side impact, this passenger initiated a lateral and slightly forward trajectory towards the 10 o'clock direction of force. The passenger's safety belt pretensioner actuated. The case vehicle began to rotate counterclockwise as it traveled toward the southeast corner of the intersection. As the vehicle reached the end of the asphalt and the beginning of the grass and dirt shoulder, it began to rollover to the right, resulting in the deployment of this passengers seat back mounted side air bag and the right side curtain. It appears that during the crash this passenger's lower left leg struck and scuffed the glove compartment door. At the scene, this passenger complained of neck and abdominal injuries and was transported by ambulance to an area hospital for treatment.

Figure 19. Glove compartment door, front right occupant contact points

Attachment 1. Scene Diagram