

On-Site Inflatable Curtain Air Bag/Headliner Defect Investigation

SCI Case No. DS13001

Office of Defects Investigation

Vehicle: 2012 Hyundai Elantra

Location: California

Crash Date: December 2012

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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 The Hyundai was involved in an intersection collision with a 1991 Toyota 4Runner. The Hyundai was initially traveling north in the right lane approaching the intersection. The Toyota was traveling west in the right most travel lane. As the driver of Hyundai approached the intersection, he maneuvered the vehicle to begin a turn to the right. He slowed the vehicle, looked to the left, and began his turn. As the Hyundai entered the intersection and began the right turn, the front plane of the Toyota impacted the left plane of the Hyundai. The Hyundai's Supplemental Restraint Systems (SRS) included side impact IC air bags for both rows and seat-mounted side air bags for the front seats. The left IC air bag and left seat-mounted side air bag deployed during the impact. The Hyundai continued traveling eastbound and impacted a curb with the right front tire. The driver of the Hyundai sustained minor injuries. The Hyundai was towed from scene due to damage and was declared a total loss by the insurance company.				
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BACKGROUND

This on-site investigation focused on an Inflatable Curtain (IC) air bag defect and the crash dynamics surrounding the crash of a 2012 Hyundai Elantra (**Figure 1**). The Hyundai was involved in an intersection collision with a 1991 Toyota 4Runner. This investigation was initiated by the Office of Defects Investigation (ODI) because a metal stiffener in the IC air bag module was exposed during the crash. Dynamic Science, Inc. (DSI) was forwarded information regarding the vehicle's current location on January 22, 2013 with instructions to obtain cooperation for an on-site investigation that would include the recovery of the IC air bag and the air bag module. DSI requested permission from the insurance company on January 22, 2013. Permission to inspect the vehicle was obtained and the vehicle inspection took place on January 29, 2013. The vehicle was not supported by the Bosch Crash Data Retrieval System. Permission to remove the IC air bag and air bag module was refused by the insurance company but before any follow-on action could be taken representatives from Hyundai removed the stiffener from the vehicle. The police responded to the crash but did not complete a crash report. An Incident report was generated by the dispatchers and was obtained on March 5, 2013. The scene was located and documented on the following day.



Figure 1. 2012 Hyundai Elantra

The Hyundai was initially traveling north in the right lane approaching the intersection. The Toyota was traveling west in the right most travel lane. As the 29-year-old driver of Hyundai approached the intersection, he maneuvered the vehicle to begin a turn to the right. He slowed the vehicle, looked to the left, and began his turn. As the Hyundai entered the intersection and began the right turn, the front plane of the Toyota impacted the left plane of the Hyundai. The Hyundai's Supplemental Restraint Systems (SRS) included side impact IC air bags for both rows and seat-mounted side air bags for the front seats. The left IC air bag and left seat-mounted side air bag deployed during the impact. The Hyundai continued traveling eastbound and impacted a curb with the right front tire. The driver of the Hyundai sustained minor injuries. He did not seek medical attention. The Hyundai was towed from scene due to damage and was declared a total loss by the insurance company. There are no reports that the male driver of the Toyota was injured.

CRASH SUMMARY

Crash Site

This two-vehicle crash occurred at the large 4-leg intersection of a north/south road and an east/west road in an urban commercial setting. The traffic flow through the intersection was controlled by overhead red/amber/green traffic signals. The north leg of the intersection consisted of three lanes: a southbound travel lane, a left turn lane, and northbound travel lane. The asphalt roadway was straight with a positive 9.5% grade 15 m (50 ft) south of the intersection and a positive 0.6% grade at the intersection. The Hyundai was in the northbound travel lane turning eastbound at the time of the crash (**Figure 2**). The west leg of the intersection consisted of eight lane, five eastbound and three westbound. The right-most eastbound lane was designated for right turning traffic and the left-most eastbound lane was designated for left turning traffic. The east and west lanes were divided by a raised center median. The roadway was curved to the left with a radius of 380 m (1248 ft) and a positive 1.7% grade 30 m (100 ft) from the intersection. The Toyota was in the second lane from the right at the time of the crash (**Figure 3**). The speed limit in the area of the intersection was 72 km/h (45 mph). The weather at the nearest reporting station was 13° C (55° F), humidity 86 percent, visibility 4.0 km (2.5 miles), and the winds were out of the southeast at 13.0 km/h (8.1 mph). A Crash Diagram is attached at the end of this technical report on page 9.



Figure 2. Northbound view of Hyundai's pre-crash travel path



Figure 3. Eastbound view of Toyota's pre-crash travel path

Pre-Crash

This crash occurred during the morning hours of December 2012. The Hyundai was initially traveling north in the right lane approaching the intersection. The Toyota was traveling west in the right travel lane. As the driver of Hyundai approached the intersection, he maneuvered the vehicle to begin a turn to the right (**Figure 4**). He slowed the vehicle, looked to the left, and began his turn. He did not recall the color of the traffic signal light.



Figure 4. Path of Hyundai as it turned right

Crash

As the Hyundai entered the intersection and begin the right turn, the front plane of the Toyota impacted the left plane of the Hyundai (Event 1). The direction of impact force to the Hyundai was in the 8 o'clock sector.

For the Hyundai, the Missing Vehicle algorithm of the WinSMASH program calculated a Total Delta-V of 10.0 km/h (6.2 mph). The longitudinal and lateral velocity changes were 3.0 km/h (1.8 mph) and 9.0 km/h (5.6 mph), respectively. The collision fit the model and the results appear reasonable. The force of the impact caused the actuation of the driver's safety belt retractor pretensioner and the deployment of the left inflatable curtain (IC) air bag and driver's seat-mounted side air bag. For the Toyota, the program calculated a Total Delta-V of 8.0 km/h (4.9 mph). The longitudinal and lateral components were -6.0 km/h (-3.7 mph) and -5.0 km/h (-3.1 mph), respectively. The results were considered borderline because the Toyota was not inspected.

The impact momentum displaced the Hyundai to the southeast and the Hyundai impacted the curb along the south side of the east/west road with its right front tire (Event 2). The Hyundai came to rest against the curb facing southeast. The Toyota came to rest facing east with a portion of the vehicle blocking the right lane of the north/south roadway.

Post-Crash

Both drivers were able to exit their respective vehicles under their own power. The driver's door for the Hyundai was jammed shut and he exited the vehicle through the right door. The driver of the Hyundai sustained minor contusions. There were no reported injuries to the driver of the Toyota. Police responded to the crash but did not file a crash report. The drivers exchanged insurance information and requested a tow from the scene. The Hyundai was towed from the scene and later declared a total loss by the insurance company. The status of the Toyota is not known.

2012 HYUNDAI ELANTRA***Description***

The 2012 Hyundai Elantra 4-door sedan was identified by the Vehicle Identification Number (VIN): KMHDH4AE8CUxxxxxx. Its date of manufacture was February 2012. The vehicle mileage was 18,841 km (11,707 miles). The driver purchased the vehicle used approximately one month prior to the crash. During that time the vehicle had not been involved in any crashes or had any service work done on its safety systems. According to a CARFAX report there were no previous crashes. The vehicle was equipped with 1.8-liter 4-cylinder engine, a 6-speed automatic transmission, front wheel drive, and 4-wheel disc brakes with electronic brake force distribution. The vehicle manufacturer recommended P205/55R16 tires for the front and rear with a cold tire pressure of 221 kPa (32 psi). The vehicle was equipped with Hankook Optimo tires of the recommended size. The specific tire information was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	Tire Flat	5 mm (6/32 in)	No	Holed (10.0 x 4.0 x 7.0 cm)

LR	200 kPa (29 psi)	6 mm (8/32 in)	No	None
RR	193 kPa (28 psi)	5 mm (6/32 in)	No	None
RF	Tire Flat	5 mm (6/32 in)	No	De-beaded

The seating in Hyundai was configured with front bucket seats and a split-bench folding rear seat.

Exterior Damage

The Hyundai sustained moderate left side damage as a result of the impact with the other vehicle (**Figure 5**). The direct damage began 16.0 cm (6.3 in) forward of the front axle and extended 128.0 cm (50.3 in) rearward. The Field L began 16.0 cm (6.3 in) forward of the front axle and extended 164.0 cm (64.5 in) rearward. Six crush measurements were documented at the mid-door level as follows: $C_1 = 0$ cm, $C_2 = 3.0$ cm (1.2 in), $C_3 = 7.0$ cm (2.8 in), $C_4 = 4.0$ cm (1.6 in), $C_5 = 13.0$ cm (5.1 in), $C_6 = 0$ cm. The maximum crush was located between C_4 and C_5 and measured 17.0 cm (6.7 in). The height of the maximum door crush was 47.0 cm (18.5 in) and the Door Sill Differential (DSD) was 6.0 cm (2.4 in). The Collision Deformation Classification (CDC) for the side impact with the other vehicle was 08LYAW3.

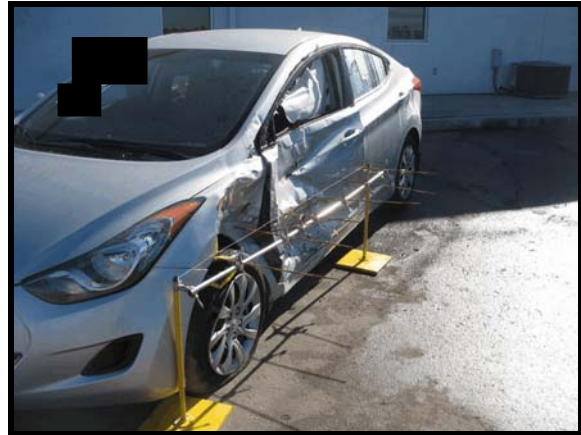


Figure 5. 2012 Hyundai Elantra, side damage

The Hyundai sustained minor damage to the right front tire that was caused by a curb impact (**Figure 6**). The rim was deformed 2.0 cm (0.8 in) and the tire was de-beaded. The CDC for this impact was 12FRWN3.



Figure 6. 2012 Hyundai Elantra, right front rim damage

Interior Damage

The Hyundai sustained minor interior damage that included air bag deployments, occupant contacts, and intrusion. The left IC and seat-mounted air bags deployed. There was lateral intrusion to the forward lower quadrant of the left door that measured 1.0 cm (0.4 in). The left armrest was displaced by occupant contact. The left door was jammed shut while the other doors remained closed and operational. The left side glass was disintegrated; the remaining glazing was intact.

Manual Restraint Systems

The Hyundai's front row seating was equipped with 3-point manual lap and shoulder safety belts with continuous loop webbing, sliding latch plates, height adjustable shoulder anchorages, and retractor/anchor pretensioners. The driver and front right passenger safety belts displayed signs of historical usage and both anchorage adjustments were in the full-up position. The driver's safety belt was locked in the spooled out position and exhibited a scuff mark that measured 9.0 cm (3.5 in) in length and was located 94.0 cm (37.0 in) from the stop button and an area of loading from the latch plate located 40.0 cm (15.7 in) from the stop button. The driver's safety belt retractor pretensioner actuated but the anchor pretensioner did not (**Figure 7**). The retractor pretensioner is designed to actuate during side impacts and the anchor pretensioner is designed to deploy during rollovers. Based on the vehicle inspection, the driver was wearing the available safety belt.



Figure 7. Left anchorage pretensioner

The second row seats were equipped with 3-point manual lap and shoulder safety belts.

Supplemental Restraint Systems

The Hyundai's Supplemental Restraint Systems (SRS) included an air bag control module, driver and front passenger frontal air bags, side impact IC air bags, and seat-mounted side air bags for the front seats.

The left IC air bag deployed through the headliner from the module mounted to the roof side rail (**Figure 8**). The air bag was rectangular in shape with an overall length of 166.0 cm (65.3 in) and an overall height of 37.0 cm (14.6 in). The air bag overlapped the lower window frame by 7.0 cm (2.8 in). The leading edge of the air bag was attached to the A-pillar by a 8.0 cm (3.1 in) tether. The air bag extended to the C-pillar, providing coverage for both seating rows. At a point 121.0 cm (47.6 in) forward of the C-pillar, the air bag height decreased until it measured 14.0 cm (5.5 in) at the A-pillar. Aft of the A-pillar, there was a triangular area of side glass not covered by the air bag. The area measured 25.0 cm (9.8 in) in length and 14.0 cm (5.5 in) in height. There was no contact evidence or damage to the air bag. The left seat-mounted side air bag deployed forward from the seat back. The air bag was semi-circular in shape with a height of 47.0 cm (18.5 in) and width of 20.0 cm (7.9 in) extending forward from the seat back. The air bag was configured with a 9.0 cm

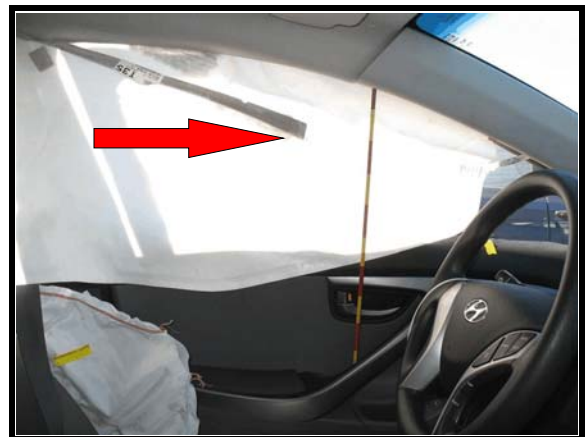


Figure 8. 2012 Hyundai Elantra, left IC air bag. Metal stiffener identified by red arrow.

(3.5 in) vent port toward the top. A 3.0 x 5.0 cm (1.2 x 1.9 in) black scuff was documented to the top inner aspect of the air bag.

IC Air Bag Malfunction Observations/Discussion

During the left IC air bag deployment, a metal support bracket/stiffener that was attached to the headliner partially detached from the front and was displaced downward into the passenger compartment (**Figure 9**). The support bracket was glued/taped to the liner and measured 93.0 cm (36.6 in) in total length. The exposed section began 4.0 cm (1.6 in) forward of the B-pillar and extended 42.0 cm (16.5 in) forward from that point (**Figure 10**). The end of the bracket was 4.0 cm (1.6 in) wide, V-shaped, and 1.5 cm (0.6 in) deep (**Figure 11**). The end was located 9.0 cm (3.5 in) below the liner and 15.0 cm (5.9 in) above the window frame. The aft end of the bracket remained affixed to the roof liner (**Figure 12**). A recall involving the support bracket was reported on April 1, 2013 (NHTSA Campaign Number: 13V11500).



Figure 9. 2012 Hyundai Elantra, left IC air bag metal stiffener



Figure 10. Stiffener position just forward of B-pillar



Figure 11. Forward end of metal stiffener



Figure 12. Aft aspect of metal stiffener (looking forward)

2012 HYUNDAI ELANTRA DRIVER***Driver Demographics***

Age/Sex: 29 years/Male
 Height: 185 cm (73 in)
 Weight: 118 kg (260 lbs)
 Eyewear: None
 Seat type: Bucket
 Seat track position: Rear most
 Manual restraint usage: Lap and shoulder safety belt used
 Usage source: Vehicle inspection and interview
 Air bags: Driver frontal did not deploy. Seat-mounted side air bag and left IC air bag did deploy.
 Alcohol/Drug Data: None
 Egress from vehicle: Exited under own power
 Transport from scene: Private vehicle
 Type of medical treatment: None

Driver Injuries

Inj. No.	Injury	AIS 2005/08	Injury Source	Confidence Level
1	Contusion, left side of head	110402.1,2	IC air bag	Probable
2	Contusion, left chest	410402.1,2	Seat belt webbing	Probable
3	Contusion, left abdomen	510402.1,2	Seat belt webbing	Probable

Source: Interviewee

Driver Kinematics

The 29-year-old male driver was seated in an upright posture in a full-rearward track position with the seat back slightly reclined. The driver was restrained by the manual 3-point lap and shoulder belt. Restraint usage was determined by scuff and load marks and the post-crash spooled out position of the safety belt. The safety belt was in the spooled out position due to actuation of the retractor pretensioner. Both of the driver's hands were on the steering wheel and the right foot was on the accelerator.

At impact with the Toyota, the safety belt pretensioner actuated and the left seat-mount side air bag and left IC air bag deployed. The driver initiated a left lateral and rearward trajectory in response to the 8 o'clock direction of force. The driver's head was displaced laterally and contacted the IC air bag, causing a minor contusion. The driver reported sustaining "seat belt bruises" to his left chest and abdomen during impact. The driver did not come into contact with the metal stiffener.

The driver rebounded and came to rest within the driver seat. As the vehicle continued forward and

impact a curb with its right front tire the driver was displaced slightly forward. The driver was able to exit the vehicle through the right door. He did not seek any medical attention.

1991 TOYOTA 4RUNNER

Description

The 1991 Toyota 4Runner was a sport utility vehicle (VIN: JT3RN27V7M0xxxxxx) equipped with a 2.4-liter 4-cylinder engine and rear-wheel drive. The vehicle was towed from the scene.

Exterior Damage

According to the police crash report, the Toyota sustained frontal damage and was towed from the scene.

Driver Data

The driver of the Toyota was an unknown age male. Efforts to contact the driver were unsuccessful and no other data is available.

CRASH DIAGRAM

