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ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION INVESTIGATION

CASE NUMBER - IN11009
LOCATION - OHIO
VEHICLE - 2009 HYUNDAI SONATA SE
CRASH DATE - February 2011

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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.

Technical Report Documentation Page

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16. <i>Abstract</i> The focus of this on-site investigation was the side impact air bag system of a 2009 Hyundai Sonata SE. The Hyundai was occupied by a restrained 50-year-old female driver and a restrained 31-year-old female front right passenger. The Hyundai was stopped at the stop sign of a 4-leg urban intersection heading west. A 2006 Ford Fusion was traveling south on a through roadway approaching the intersection. The driver of the Hyundai accelerated into the intersection where the front plane of the Ford impacted the right side plane of the Hyundai. The force direction on the Hyundai was within the 3 o'clock sector and the impact force triggered a deployment of the right side impact Inflatable Curtain (IC) air bag and the front right seat-mounted side impact air bag. The driver and front right passenger of the Hyundai were examined by emergency medical personnel at the crash scene and no injuries were reported. The driver and second row center passenger of the Ford were also not injured. Both vehicle's were towed from the crash scene due to damage.					
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The focus of this on-site investigation was the side impact air bag system of a 2009 Hyundai Sonata SE (**Figure 1**). This crash was brought to our attention by the National Highway Traffic Safety Administration (NHTSA) on March 4, 2011 through the sampling activities of the National Automotive Sampling System (NASS)-General Estimates System (GES). This investigation was assigned on March 9, 2011. The crash occurred in February, 2011, at 1132 hours, in Ohio and was investigated by the State Highway Patrol. This crash involved the Hyundai and a 2006 Ford Fusion. The Hyundai was inspected on March 11, 2011. The driver of the Hyundai was interviewed on March 14, 2011. The crash scene was inspected on March 17, 2011. An inspection of the Ford was not conducted since the vehicle could not be located.

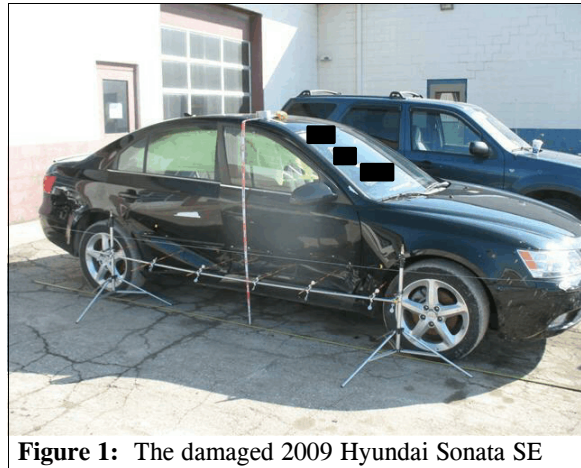


Figure 1: The damaged 2009 Hyundai Sonata SE

The Hyundai was a 4-door sedan equipped with front seat-mounted side impact air bags, side impact Inflatable Curtain (IC) air bags, and driver and front right passenger frontal air bags. The Hyundai was involved in a right side plane impact with the front plane of the Ford. The Hyundai's front right seat-mounted side impact air bag and right IC air bag deployed in this crash. The Hyundai was occupied by a restrained 50-year-old female driver and a restrained 31-year-old female front right passenger. They were not injured in this crash. The Ford was occupied by a restrained 21-year-old female driver and a 3-year-old male second row center passenger, who was seated in a Child Restraint System (CRS). They were not injured in this crash.

CRASH SUMMARY

Crash Site: The crash occurred within the 4-leg intersection of two, 2-lane, undivided, state highways during daylight hours and clear weather conditions. The roadway for the Hyundai was straight and traversed in an east-west direction. It had one lane in each direction and was bordered by concrete sidewalks. Each lane was 3.7 m (12.1 ft) in width and parking was allowed on each side of the roadway. The roadway pavement marking consisted of double yellow center lines, a solid white stop bar at the intersection and a designated pedestrian crosswalk. The roadway for the Ford was straight and traversed in a north-south direction. It had one lane in each direction and was bordered by concrete sidewalks. Each lane was 3.7 m (12.1 ft) in width and parking was allowed on each side of the roadway. The pavement markings consisted of double yellow center lines and a designated pedestrian crosswalk at the intersection. A brick building was located on the northeast corner of the intersection. The roadway surface for both roadways was dry, level bituminous. The speed limit for both vehicles was 56 km/h (35 mph). The Crash Diagram is on page 7 of this report.

Pre-Crash: The Hyundai was stopped at the stop sign heading west (**Figure 2**). The driver intended to cross the intersection and continue westbound. The Ford was traveling south (**Figure**

3) and the driver intended to continue southbound. The driver of the Hyundai stated during the SCI interview that as she accelerated into the intersection, she observed the Ford approaching and increased the acceleration in an attempt to avoid the crash.

Crash: The right side plane of the Hyundai was impacted by the front plane of the Ford. The force direction on the Hyundai was within the 3 o'clock sector and the impact force triggered a deployment of the front right seat-mounted side impact air bag and right IC air bag. The calculated total Delta V for the Hyundai was 24 km/h (14.9 mph). The longitudinal and lateral velocity changes were -4 km/h (-2.5) and -24 km/h (-14.9 mph), respectively. The calculated total Delta V for the Ford was 27 km/h (16.8 mph). The longitudinal and lateral velocity changes were -27 km/h (-16.8 mph) and 5 km/h (3.1), respectively. Following the impact, the vehicles remained engaged as they came to final rest within the intersection. The Hyundai was heading slightly northwest and the Ford was heading south.

Post-Crash: Both drivers drove their vehicles to the side of the roadway. The police were notified of the crash at 1132 hours and arrived on scene at 1203 hours. Emergency medical services also responded. The driver and front right passenger were examined at the crash scene and no injuries were reported. They were not transported to a medical facility. The driver and passenger of the Ford were also not injured. Both vehicles were towed from the crash scene due to damage.

2009 HYUNDAI SONATA SE

The Hyundai was a front-wheel drive, 5-passenger, 4-door, sedan (VIN: 5NPEU46F69H-----) equipped with a 3.3-liter, V-6 engine, a 5-speed automatic transmission, 4-wheel, anti-lock brakes with electronic brake force distribution and braking assist, traction control, and electronic stability control. The driver and front right passenger frontal air bags were certified by the manufacturer to be compliant to the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) NO. 208. The windshield glazing was AS-1 laminated while the remainder of the glazing was AS-2 tempered. Prior to the crash, all of the glazing was either closed or fixed. The odometer reading at the SCI inspection was 56,206 kilometers (34,925 miles). The specified wheelbase was 273 cm (107.4 in).



Figure 2: View west; the Hyundai was stopped at the intersection; the Ford was southbound approaching from the right



Figure 3: Southbound approach of the Ford to the intersection, the Hyundai was westbound approaching from the left

The vehicle manufacturer’s recommended tire size was P215/55R17. The vehicle was equipped with tires of the recommended size. The recommended cold tire pressure for the front and rear tires was 221 kPa (32 psi). The tire data for the Hyundai are presented in the table below.

<i>Position</i>	<i>Measured Pressure</i>	<i>Measured Tread Depth</i>	<i>Restricted</i>	<i>Damage</i>
LF	276 kPa (40 psi)	3 mm (4/32 in)	No	None
LR	290 kPa (42 psi)	4 mm (5/32 in)	No	None
RR	276 kPa (40 psi)	4 mm (5/32 in)	No	None
RF	276 kPa (40 psi)	3 mm (4/32 in)	No	None

The front row was equipped with cloth/leather-covered bucket seats and adjustable head restraints. The second row was equipped with a cloth/leather-covered bench seat with folding backs and adjustable head restraints. The driver’s seat track was found adjusted to the rear position. The driver did not know the position the seat track at the time of the crash. The front right passenger’s seat track was adjusted to between the middle and rear positions. The second row seats had fixed tracks.

EXTERIOR DAMAGE

The Hyundai sustained right side plane damage during the impact with the Ford. The right side doors and fender were directly damaged. The direct damage began 31 cm (12.2 in) rear of the right front axle and extended 180 cm (70.9 in) rearward along the right side plane. The crush measurements were taken at the lower-door level and the maximum residual crush was 31 cm (12.2 in) occurring at C₄ (**Figure 4**). The height of the maximum door crush was 43 cm (16.9 in). The door sill differential was 18 cm (7.1 in). The height of the sill was 36 cm (14.2 in). The table below presents the right side crush profile.

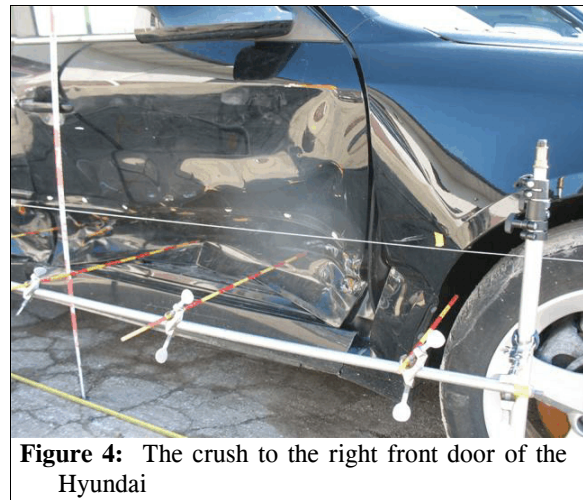


Figure 4: The crush to the right front door of the Hyundai

Units	Event	Direct Damage		Field L	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	180	31	207	1	13	23	31	24	0	14	6
in		70.9	12.2	81.5	0.4	5.1	9.1	12.2	9.4	0.0	5.5	2.4

The Collision Deformation Classification (CDC) was 03RYEW3 (80 degrees). The Missing Vehicle algorithm of the WinSMASH program calculated the total Delta V as 24 km/h (14.9 mph). The longitudinal and lateral velocity changes were -4 km/h (-2.5 in) and -24 km/h (-14.9 mph), respectively. Based on the damage, the results appeared reasonable.

INTERIOR DAMAGE

The inspection of the interior revealed no discernable evidence of occupant contact. There was no damage or displacement of the steering assembly.

The right front and right rear doors were jammed shut. The left front and left rear doors remained closed and operational. There was no window glazing damage.

The vehicle sustained seven intrusions of the passenger compartment. The most severe intrusion were the right B-pillar and forward upper quadrant of the right front door, which intruded laterally 12 cm (7.5 in) and 8 cm (5 cm), respectively into the front right passenger’s space. The front right seat cushion was deformed from the intrusion of the right front door.

MANUAL RESTRAINT SYSTEMS

The front row was equipped with driver and front right passenger lap-and-shoulder safety belts. The driver’s safety belt was equipped with continuous loop belt webbing, a sliding latch plate, an Emergency Locking Retractor (ELR), and an adjustable upper anchor that was in the full-down position. The front right passenger’s safety belt was equipped the same as the driver, but had a switchable ELR/Automatic Locking Retractor (ALR). The adjustable upper anchor was in the full-down position. The front seat positions were equipped with retractor-mounted pretensioners. There was no evidence of pretensioner actuation. The second row was equipped with lap-and-shoulder safety belts. Lower Anchors and Tethers for Children (LATCH) were present at the outboard seat positions. The second row safety belts were equipped with continuous loop belt webbing, sliding latch plates, switchable ELR/ALRs, and non-adjustable upper anchors.

Inspection of the driver’s safety belt assembly revealed no evidence of loading. There were historical usage scratches on the latch plate. The driver stated during the SCI interview that she was restrained at the time of the crash.

The front right passenger's belt webbing appeared to be slightly stretched. There was no evidence of loading on the D-ring or latch plate belt guide. The driver stated that the front right passenger was restrained at the time of the crash.

SUPPLEMENTAL RESTRAINT SYSTEMS

The Hyundai was equipped with a Certified Advanced 208-Compliant (CAC) driver and front right passenger frontal air bags. These air bags did not deploy in this crash.

The vehicle was also equipped with roof side rail-mounted IC air bag and front seat-mounted side impact air bags. Based on the 2009 edition of the Holmatro Rescuer's Guide to Vehicle Safety Systems, the side impact sensors were located within the lower B-pillars. The inflators for the IC air bags were located within the C-pillars. The right IC air bag and front right seat-mounted side impact air bag deployed in this crash.

The deployed right IC air bag (**Figure 5**) extended from the A-pillar to the C-pillar. There were no external vent ports. The IC was 170 cm (55.1 in) in width and 32 cm (12.6 in) in height, and was attached to the A-pillar by an 8 cm (3.1 in) nylon tether. The IC did not extend below the beltline. Inspection of the deployed IC revealed no discernable evidence of occupant contact and no damage.

The deployed front right seat-mounted side impact air bag (**Figure 6**) was 22 cm (8.7 in) in width and 37 cm (14.6 in) in height. There were no external vent ports. There was no discernable evidence of occupant contacts and no damage to the air bag. The deploying air bag created scuff marks on the left B-pillar.



Figure 5: The Hyundai's deployed right IC air bag and seat-mounted side impact air bag



Figure 6: The Hyundai's deployed front right seat-mounted side impact air bag

2009 HYUNDAI SONATA SE OCCUPANTS

DRIVER DEMOGRAPHICS

Age/Sex:	50 years, female
Height:	163 cm (64 in)
Weight:	113 kg (250 lbs)
Eyewear:	None
Seat Type:	Bucket

Seat Track Position:	Unknown position
Restraint Usage:	Lap-and-shoulder
Usage Source:	Driver interview
Air Bags	Frontal, seat-mounted side impact, and IC, not deployed
Egress from Vehicle:	Through driver's door without assistance
Transport from Scene:	None
Alcohol/Drug Data:	Police reported none and not tested
Medical Treatment:	Examined by EMS at crash scene, not injured

DRIVER KINEMATICS

The impact with the Ford displaced the driver to the right within her safety belt. She remained in her seat position throughout the crash.

FRONT RIGHT PASSENGER DEMOGRAPHICS

Age/Sex:	31 years, female
Height:	173 (68 in)
Weight:	73 kg (160 lb)
Eyewear:	None
Seat Type:	Bucket seat
Seat Track Position:	Between middle and rear positions
Restraint Usage:	Lap-and-shoulder belt
Usage Source:	Driver interview
Air Bags	Frontal, Non-deployed; seat mounted and IC, Deployed
Egress from Vehicle:	Through left rear door without assistance
Transport from Scene:	None
Medical Treatment:	Examined by EMS at crash scene, not injured

FRONT RIGHT PASSENGER KINEMATICS

The impact with the Ford displaced the front right passenger to the right, opposite the 3 o'clock direction of force. While there was no discernable evidence of occupant contact, the right side of her torso probably loaded the seat-mounted side impact air bag and her head probably loaded the right IC air bag.

2006 FORD FUSION

The 2006 Ford Fusion was a front wheel drive, 5-passenger, 4-door sedan (VIN 3FAFP07Z56R-----) equipped with a 2.3 liter, 4-cylinder engine, a 5-speed manual transmission, and 4-wheel anti-lock brakes. The front row was equipped with lap-and-shoulder safety belts, dual stage driver and front right passenger frontal air bags, and safety belt pretensioners. The second row was equipped with lap-and-shoulder safety belts and Lower Anchors and Tethers for Children (LATCH). The manufacturer has certified that this vehicle is compliant to the Advanced Air Bag portion of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208.

EXTERIOR DAMAGE

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The Ford's front plane was damaged during the impact with the right side plane of the Hyundai. The Ford was not inspected since it could not be located.

The Missing Vehicle algorithm of the WinSMASH program calculated the Ford's total Delta V as 27 km/h (16.8 mph). The longitudinal and lateral velocity changes were -27 km/h (-16.8 mph) and 5 km/h (3.1 mph). The results should be considered borderline since they are based only on the crush to the Hyundai.

OCCUPANT DATA

Based on the police crash report, the driver of the Ford (21-year-old female) was restrained by the lap-and-shoulder safety belt. She sustained no injuries. The second row center passenger (3-year-old male) was restrained in a CRS. He sustained no injuries.

