CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE ROLLOVER CRASH INVESTIGATION

SCI CASE NO.: CA09015

VEHICLE: 2007 HONDA CIVIC SI COUPE

LOCATION: NORTH CAROLINA

CRASH DATE: FEBRUARY 2009

Contract No. DTNH22-07-C-00043

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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 are 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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BACKGROUND

This on-site investigation focused on a run-off-road rollover crash of a 2007 Honda Civic Si coupe **(Figure 1)**. The vehicle was equipped with four-wheel anti-lock brakes, Electronic Stability Control (ESC), a Certified Advanced 208-Compliant frontal air bag system, and Inflatable Curtain (IC) air bags. The manufacturer of the Honda has certified that the vehicle is compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC system consisted of dual-stage frontal air bags for the driver and front right passenger positions, seat track positioning sensors, buckle and retractor pretensioners, safety belt buckle switch sensors, and a front right occupant presence sensor. The vehicle departed the roadway to the right and rotated counterclockwise before rolling five-quarter turns and coming to rest on its right side. The inflatable curtains and the left side impact air bag deployed in this rollover crash. The 20-year old female driver was transported by ambulance to a local hospital where she was treated for soft tissue lacerations and released.

Figure 1: 2007 Honda Civic case vehicle

The crash was identified through a visit to a regional salvage facility on Thursday, March 12, 2009. Based on the rollover of the late model year vehicle and the deployment of the IC air bags, this case was assigned for on-site investigation on March 12, 2009. The on-site portion of this investigation was conducted on March 17-19, 2009. This investigation involved the inspection and documentation of the Honda and the crash site, and a surrogate interview with a family member of the driver of the Honda. The driver refused to be interviewed.

SUMMARY

Crash Site

This crash occurred during evening hours on a two-lane east-west roadway. The traffic lanes were 3.5 m (11.5 ft) in width and were surfaced with asphalt. Narrow asphalt shoulders bordered both sides of the roadway. The north shoulder was 0.3 m (1 ft) in width and the south shoulder was 0.6 m (1.9 ft) wide. Outboard of the north shoulder was a level grass shoulder that was 1.8 m (5.9 ft) in width. This shoulder transitioned to an embankment that was 2 m (6.5 ft) in width and dropped 1.8 m (5.9 ft) for a negative grade of -90 percent. At the bottom of this embankment was a grass area with a slight negative grade of -1.6 percent. This grass area was 6.4 m (21 ft) wide and was bordered on the north side by trees and an irrigation canal. The conditions at the time of the crash were police reported as clear, dry and dark. The area was not lighted. The driver of the Honda was westbound, negotiating a curve with a documented radius of curvature of 307 m (1007

ft). The roadway was banked in the curve with a superelevation of 3.2 percent from south to north. The Crash Schematic is included as **Figure 9** of this report.

Vehicle Data

2007 Honda Civic

The case vehicle was a 2007 Honda Civic Si Coupe. The Honda was manufactured in September 2006 and was identified by the Vehicle Identification Number (VIN): 2HGFG21557H (production number deleted). The front-wheel drive Honda was powered by a 2.0-liter inline 4-cylinder engine linked to a 6-speed manual transmission. The braking system consisted of front and rear disc brakes with four wheel anti-lock and electronic brake force distribution. The Honda was also equipped with Electronic Stability Control (ESC), traction control, and a direct Tire Pressure Monitoring System (TPMS). All windows were closed at the time of the crash. The vehicle was equipped with four matching Michelin Pilot Escalto tires with Tire Identification Numbers (TIN) of F3N0 KMRX 1606 and sized at P215/45R17. The vehicle manufacturer recommended tire size was P215/45R17. The tires were mounted on five-spoke OEM alloy wheels. The vehicle manufacturer recommended cold tire pressure was 221 kPa (32 PSI), front and rear. The specific tire data at the time of the SCI inspection was as follows:

Position	Measured Tire Pressure	Measured Tread Depth	Tire/Wheel damage
Left Front	186 kPa (27 PSI)	3 mm (4/32 in)	None
Left Rear	200 kPa (29 PSI)	2 mm (3/32 in)	None
Right Rear	200 kPa (29 PSI)	2 mm (3/32 in)	None
Right Front	Flat	2 mm (3/32 in)	De-beaded

The interior of the Honda was configured with cloth surfaced five-passenger seating. The front bucket seats were equipped with height adjustable head restraints and separated by a center console. Both front head restraints were adjusted to the full-down position at the time of the SCI inspection. The front left seat track was adjusted 7 cm (2.8 in) forward of the full-rear position, and the seat back angle was 23 degrees rear of vertical. The front right seat track was found in the full-rearward position, and the seat back angle was 22 degrees aft of vertical. The front left seat was height adjustable and was 2 cm (0.8 in) below the top adjustment position. The second row was equipped with a single spilt-bench seat with 60/40 folding backs and adjustable head restraints for all three seating positions. The three rear head restraints were in the full-down position.

The occupant safety systems consisted of 3-point lap and shoulder belts for all five seating positions, front safety belt pretensioners (both buckle and retractor mounted), dual stage frontal air bags, front seat-mounted side impact air bags and IC air bags that provide protection to the four outboard positions. The Honda was not equipped with rollover sensing for the IC air bags.

Crash Sequence

Pre-Crash

Figure 2: Honda's pre-crash trajectory

The restrained 20-year-old female driver of the Honda was on her way home from work and was traveling west on the two-lane roadway, entering the left curve (**Figure 2**). The driver stated to family, emergency, and hospital personnel that a deer ran out in front of her vehicle. The driver steered to the right to avoid the animal. The vehicle departed the right road edge at a departure angle of 10 degrees of her initial heading. A rotating tire mark from the right side tires was present on the grass shoulder and the negatively sloped embankment. The driver attempted to steer left to regain the roadway; however, the slope of the embankment induced a counterclockwise (CCW) yaw as the Honda traveled off the north road side.

Crash

Figure 3: Embankment and rollover site

The Honda was traveling diagonal to the embankment and initiated a right side leading rollover event. Due to the slope of the embankment, the rollover initiation type was classified as a fall-over. The Honda rolled five-quarter turns to the right and rotated approximately 50 degrees counterclockwise, coming to rest on its right side at the bottom of the embankment 5.8 m (19 ft) north of the road edge. The distance from the initiation of the rollover to final rest was approximately 14 m (46 ft). **Figure 3** depicts the rollover site. The rollover site was surfaced with grass and marsh grass with weeds and thin brush. Grass was embedded between the body panels of the Honda at the time of the inspection. The Honda did not impact the trees at the north edge of the rollover site. This rollover was classified an uninterrupted event. The IC air bags and the left seat-mounted air bag deployed as a result of ground contact during the rollover. The right seat back side impact air bag did not deploy during the crash.

Post-Crash

Immediately following the crash, the driver retrieved her cellular telephone and called the 9-1-1 emergency response system to report the crash. She also called a family member who responded to the scene of the crash. Police and local Emergency Medical Service (EMS) personnel responded to the crash site. The driver remained in the vehicle as the first responders cut the windshield from the vehicle and assisted the driver from the Honda. She was transported by ground ambulance to a local hospital where she was treated for soft tissue injuries of the head, face and left arm and released.

Vehicle Damage

Exterior

The exterior of the Honda sustained moderate severity damage to the top, right, and left side planes as a result of the rollover crash. The scratches on the roof were oriented laterally, indicating that the vehicle had rolled onto the roof only one time. The direct contact damage to the roof of the vehicle extended 119 cm (46.9 in) laterally from side rail to side rail. The longitudinal direct contact damage extended from the leading edge of the hood rearward 282 cm (111 in) to a point aft of the sunroof opening. The maximum vertical crush to the roof was 11 cm (4.3 in), located on the windshield header 30 cm (11.8 in) inboard of the right A-pillar/side rail junction. The maximum lateral crush was 2 cm (0.8 in) located at the junction of the left A-pillar and the windshield header. **Figures 4 and 5** depict the rollover damage sustained by the Honda. The Collision Deformation Classification for this rollover event was 00-TYDO-3.

The doors remained closed during the crash and were operational post-crash. Both side door and the backlight glazing disintegrated during the rollover. The windshield was fractured and holed at the header area and was subsequently cut from the vehicle by the first responders. The sunroof was closed and remained intact during the crash.

Figure 4: Vertical displacement of the windshield header.

Figure 5: Overall view of the rollover damage.

Interior

The Honda sustained moderate severity interior damage that resulted from intrusion and driver contact. The roof and windshield header were displaced vertically, bowing more deeply towards the center of the vehicle than the outboard edges. The damaged windshield had been partially cut out of the vehicle and was unavailable for inspection.

The intrusions to the Honda are listed in the following table:

Position	Component	Direction	Magnitude
Row 1 Left	Windshield header	Vertical	6 cm (2.4 in)
Row 1 Left	Roof	Vertical	7 cm (2.8 in)
Row 1 Center	Roof	Vertical	12 cm (4.7 in)
Row 1 Center	Windshield header	Vertical	8 cm (3.25 in)
Row 1 Right	Windshield header	Vertical	11 cm (4.3 in)
Row 1 Right	Roof	Vertical	8 cm (3.1 in)
Row 2 Left	Roof	Vertical	3 cm (1.2 in)
Row 2 Center	Roof	Vertical	5 cm (2 in)
Row 2 Right	Roof	Vertical	6 cm (2.4 in)

The interior of the Honda sustained damage attributed to occupant contact. There was a scuff and hair on the inboard side of the front right seat back **(Figure 6)**, located 9-16 cm (3.5-6.3 in) below the top of the seat back. This contact was attributed to the right side of the driver's head. There was a body fluid transfer on the interior aspect of the left side curtain air bag, located 10-17 cm (3.9-6.7 in) up from the bottom of the curtain and 15-30 cm (5.9-11.8 in) rear of the front edge of the curtain air bag **(Figure 7)**. There was a scuff and hair at the front right corner of the map light/overhead console that was also attributed to the driver's head. Her right hip/flank area engaged the center console during the rollover, displacing the console 2 cm (0.8 in) to the right.

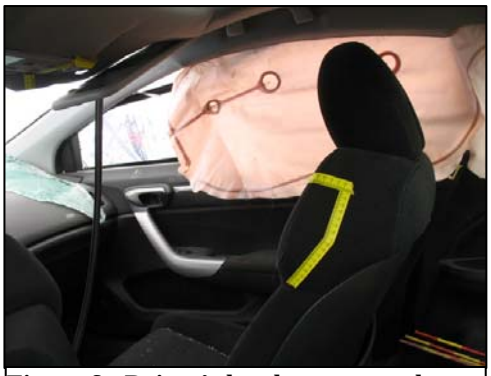

Figure 6: Driver's head contact to the front right seat back.

Figure 7: Body fluid transfer on the forward aspect of the left curtain air bag.

Manual Safety Belt Systems

The manual restraint systems in the Honda consisted of 3-point lap and shoulder belts at all five seating positions. The driver's restraint utilized continuous loop webbing, an Emergency Locking Retractor (ELR), a sliding latch plate and a fixed height D-ring. This restraint was equipped with both retractor and buckle pretensioners. These pretensioners did not actuate during the crash. There was no visible loading evidence to the belt system. Based on the location of the driver head contacts and the lack of other contact points within the vehicle, it was determined that the driver was restrained at the time of the crash.

The front right and rear seat restraints utilized continuous loop webbing, switchable ELR/Automatic Locking Retractors (ALR), sliding latch plates and a fixed height D-rings. In addition, the front right restraint system utilized a retractor and buckle pretensioner.

Frontal Air Bag System

The Honda was equipped with a CAC frontal air bag system that consisted of dual stage driver and front right passenger air bags, seat track positioning sensors, a front right occupant presence sensor, retractor and buckle pretensioners, and safety belt buckle switch sensors. The manufacturer of this vehicle has certified that this Honda is compliant to the advanced air bag portion of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208.

The driver's air bag was concealed within the center hub of the 3-spoke steering wheel and did not deploy in this rollover crash. The front right air bag was mounted within the top aspect of the right instrument panel. The right front seat was not occupied and the air bag did not deploy in this crash.

Side Impact Air Bag Systems

The Honda was equipped with front seat-mounted side impact air bags and IC air bags mounted in the roof side rails that provided coverage to the four outboard seat positions. The left front seat back air bag and both IC air bags deployed in this crash from contact with the ground during the rollover. The right front seat back air bag did not deploy.

The deployed IC air bags measured 137 cm (53.9 in) in length and 41 cm (16.1 in) in height at the front seat positions, including a 4 cm (1.6 in) non-inflating strip at the bottom of the air bag. In the rear seating position, the IC air bags measured 36 cm (14.2 in) in height. At the rear aspect of the IC air bag, the inflatable section measured 33 cm (13 in) in width and 34 cm (13.4 in) in height. Forward of this inflatable section was a non-inflated panel measuring 30 cm (11.8 in) in height and width, with an inflatable chamber connecting the front and rear inflatable sections of the curtain measuring 30 cm (11.8 in) in width and 6 cm (2.4 in) in height. Both IC air bags were tethered to the A-pillar by a 28 cm (11 in) strap. Vertically, the IC air bags extended below the belt line at each outboard position, providing full glass coverage. There was a triangular opening between the A-pillar and the leading edge if the IC air bags that measured 44 cm (17.3 in) in length, and 24 cm (9.4 in) and 11 cm (4.3 in) in height at the rear and front, respectively.

A body fluid transfer was present on the inboard side of the left IC air bag. This transfer was located 10-17 cm (3.9-6.7 in) up from the lower edge of the air bag and 15-30 cm (5.9-11.8 in) rearward of the front edge of the bag. There was a horizontally oriented plastic-type deployment transfer from the roof side rail trim located 0-18 cm (0- 7.1 in) from the top of the air bag and 23-37 cm (9.1-14.6 in) from the front edge of the IC, on the inboard side. A scuff mark was present on the outboard aspect of the IC air bag from the disintegrated glazing. This scuff mark was located 6-22 cm (2.4-8.7 in) from the top of the IC and 13-46 cm (5.1-18.1 in) rearward of the leading edge.

The right IC air bag had a line of body fluid that began 7 cm (2.8 in) from the bottom of the air bag and extended to the top of the IC. The transfer was located 62 cm (24.4 in) from the front edge of the air bag on the inboard side. There was also a scuff mark on the outboard side from disintegrated glazing with no holing of the air bag. This scuff was located 8-22 cm (3.1-8.7 in) from the top of the IC and 18-41 cm (7.1 -16.1 in) from the front of curtain.

Figure 8. Deployed left side impact air bag.

The front left side impact air bag deployed from a panel in the upper outboard aspect of the seat back that measured 37 cm (14.6 in) in height, along the front outboard edge of the seat back. The air bag was 28 cm (11 in) in width and 48 cm (18.9 in) in height and contained one tether and one vent port on the outboard side at the 8 o'clock position. There was a black plastic transfer on the outboard side of the air bag that resulted from expansion against the cover flap. This transfer was located 13-30 cm (5.1-11.8 in) from the top of the membrane, and 0-12 cm (0-4.7 in) from the back of the air bag, on the outboard side. Body fluid was present on the outboard side of the air bag, distributed full

width and height of the air bag. There was no damage or contact evidence on the inboard side of the air bag. The front right seat back air bag did not deploy. **Figure 8** is a view of the deployed left side impact air bag.

Occupant Demographics/Data

Driver

Age/Sex:	20-year-old/Female
Height:	170 cm (67 in)
Weight:	113 kg (250 lb)
Eyewear:	None
Seat Track Position:	7 cm (2.8 in) forward of full rear
Manual Safety Belt Use:	3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Egress from Vehicle:	Assisted from vehicle by first responders
Mode of Transport from Scene:	Ambulance
Type of Medical Treatment:	Treated and released in the emergency room

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Closed head injury without loss of consciousness	Minor (160402.1,0)	Overhead console/map light
Small laceration of the left elbow	Minor (790602.1,2)	Flying Glass
Small lacerations of the forehead	Minor (290602.1,7)	Overhead console/map light
Scalp abrasion, specific location not specified	Minor (190202.1,9)	Seat back (possible)
Facial abrasion, specific location not specified	Minor (290202.1,9)	Seat back (possible)

Source – Emergency Room Records

Driver Kinematics

The 20-year-old female driver was seated in a rear track position and was restrained by the manual 3-point lap and shoulder belt system. As the vehicle rolled over, the IC air bags and the left seat-mounted side impact air bag deployed as a result of ground contact.

During the rollover, the driver initiated a lateral trajectory to the right. Her right hip contacted and displaced the center console 2 cm (0.8") to the right. No injury resulted from this contact. The console arrested the lateral motion of her lower body as her upper torso slid laterally out from under the shoulder belt webbing. The right side of the driver's head impacted the inboard aspect of the front right seat back. Hair evidenced the contact location to the seatback.

As the Honda rolled onto its roof, the driver's head impacted the map light of the overhead console. This component intruded as the roof and windshield header crushed downward. The driver sustained small lacerations of the forehead and a closed head injury without a loss of consciousness. This contact that was evidenced by a scuff mark with hair. She

sustained a laceration of the left elbow from flying glass and abrasions to unspecified areas of the scalp and face from unknown sources.

The Honda came to rest on its right side at the bottom of the embankment. The driver remained belted and suspended in her seat leaning toward the front right seat. She retrieved her cellular telephone and called the 9-1-1 emergency response system.

As the driver remained in the vehicle, the left seat back mounted side impact air bag deflated and extended over the left side of the driver's body. Her movement within the vehicle post-crash resulted in the body fluid transfers on the outboard aspect of the air bag. Body fluid from her lacerations also dripped onto the right side IC air bag.

Fire department personnel arrived on-scene and cut the laminated windshield along both pillars and at the header location and lower aspect of the glazing to remove the driver from the Honda. She released her safety belt system and was assisted from the vehicle through the windshield opening. The driver was subsequently transported to a local hospital where she was treated for her injuries and released.

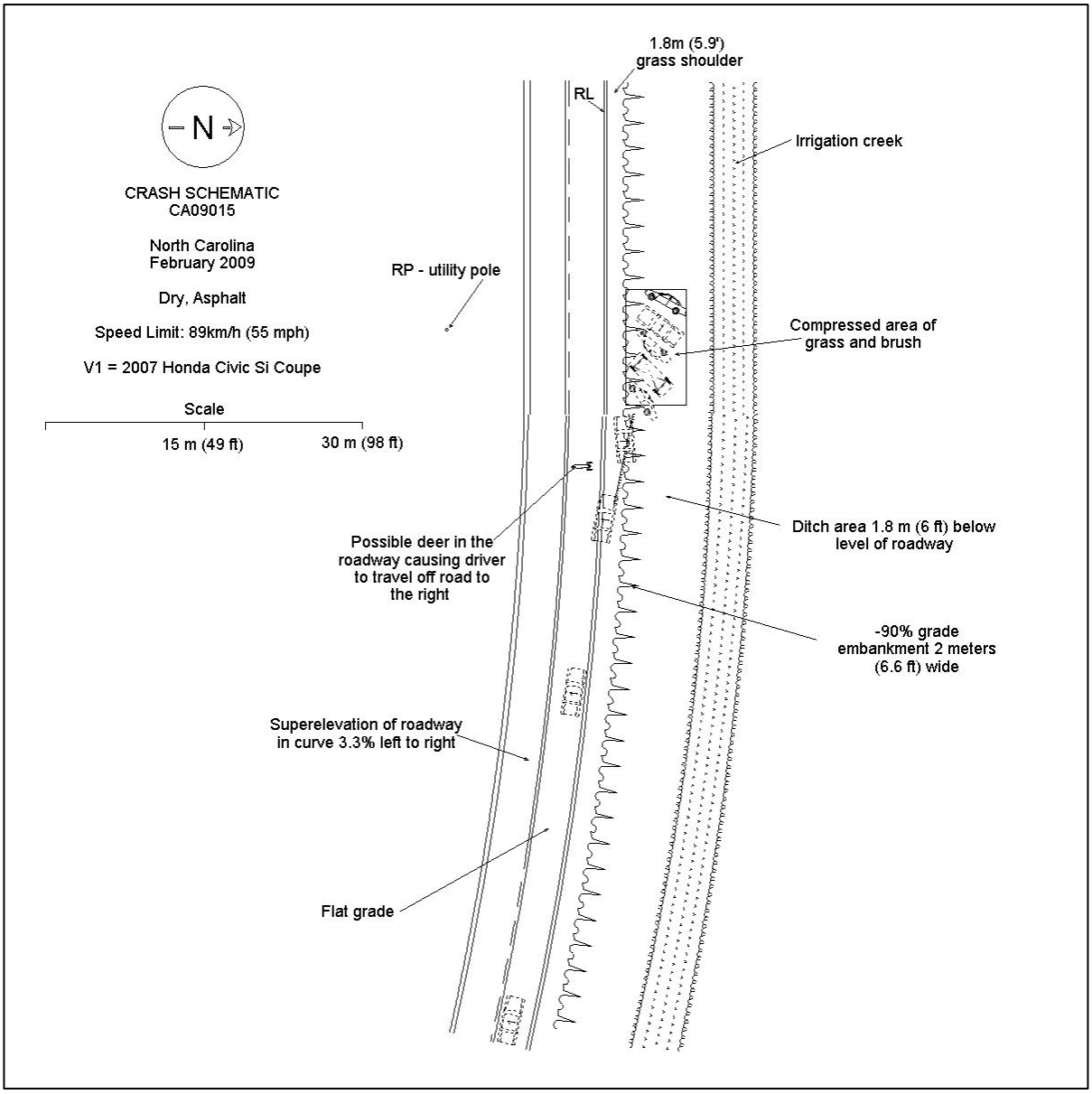

Figure 9. Crash Schematic