

CRASH DATA RESEARCH CENTER

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**CALSPAN ON-SITE SIDE IMPACT INFLATABLE OCCUPANT
PROTECTION SYSTEM CRASH INVESTIGATION**

SCI CASE NO: CA09021

VEHICLE: 2007 HONDA CIVIC

LOCATION: NORTH CAROLINA

CRASH DATE: MARCH 2009

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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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TABLE OF CONTENTS

BACKGROUND	1
SUMMARY	1
CRASH SITE	1
VEHICLE DATA - 2007 HONDA CIVIC SEDAN.....	2
VEHICLE DATA - 1991 CHEVROLET ASTRO MINIVAN.....	2
CRASH SEQUENCE	3
PRE-CRASH.....	3
CRASH	3
POST-CRASH.....	3
VEHICLE DAMAGE.....	4
EXTERIOR - 2007 HONDA CIVIC	4
INTERIOR - 2007 HONDA CIVIC.....	4
MANUAL SAFETY BELT SYSTEMS - 2007 HONDA CIVIC	5
FRONTAL AIR BAG SYSTEM - 2007 HONDA CIVIC.....	5
SIDE IMPACT AIR BAG SYSTEM - 2007 HONDA CIVIC	6
AIR BAG CONTROL MODULE.....	6
OCCUPANT DEMOGRAPHICS/DATA.....	7
DRIVER INJURIES	7
DRIVER KINEMATICS	7

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BACKGROUND

This on-site investigation focused on the side impact inflatable occupant protection system and the Advanced Compatibility Engineering (ACE) frame structure in a 2007 Honda Civic sedan (Figure 1). The vehicle was equipped with four-wheel antilock brakes, a Certified Advanced 208-Compliant frontal air bag system (CAC), seat back-mounted side impact air bags, and inflatable curtain (IC) air bags. The manufacturer of the Honda has certified that the vehicle is compliant with the advanced air bag portion of Federal



Figure 1. 2007 Honda Civic case vehicle.

Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC system included dual-stage frontal air bags for the driver and right front passenger positions, seat track positioning sensors, retractor and buckle pretensioners, and a front right occupant presence sensor. The Honda was involved in a side impact crash with a 1991 Chevrolet Astro minivan. The Chevrolet sideswiped the left side of the Honda, pocketing at the left front door. The Honda subsequently deflected off the right side of the roadway, and struck a curb with the right side wheels. The driver's safety belt pretensioners actuated and the driver's frontal air bag, left seat back-mounted side impact air bag, and both IC air bags deployed in the Honda. The 55-year-old male driver of the Honda was not transported from the scene but sought treatment later at a hospital for soft tissue injuries.

The crash was identified through a visit to a regional vehicle salvage facility on March 30, 2009. An image of the Honda was forwarded to the Calspan Special Crash Investigations (SCI) team for review on the same day. The police crash report was obtained using information from the insurance company. Based on the deployment of the IC air bags and the left seat back mounted side impact air bags, this case was assigned for an on-site investigation on March 30, 2009. The on-site investigation was conducted on March 31 and April 1, 2009, and involved the inspection of the Honda, the crash site, and an interview with the driver of the Honda. The Chevrolet was sold prior to this case assignment and was not inspected for this investigation.

SUMMARY

Crash Site

This crash occurred during daylight hours on the south side of a five-lane roadway immediately west of a four-leg intersection. The weather conditions were overcast with rain at the time of the crash. This intersection was not controlled in the east/west directions of travel. The north/south travel directions were controlled by stop signs. The roadway was surfaced with asphalt and was wet at the time of the crash. The outboard traffic lanes in both directions measured 5 m (16.4 ft) in width. The inboard lanes and the

center left turn lane measured 3.5 m (11.5 ft) in width. In the westbound direction, the roadway curved to the left with a radius of curvature of 182 m (597 ft). In the pre-crash area for the Honda, the roadway had a negative grade of 3.2 percent, and in the pre-crash area for the Chevrolet, the roadway had a negative grade of 4.9 percent. The roadway was bordered by concrete barrier curbs that were 16 cm (6.3 in) in height. Extending outboard of the curb line was a 90 cm (35.4 in) wide grass area followed paralleled by a concrete sidewalk that was 1.8 m (5.9 ft) in width. The Crash Schematic is included as **Figure 8** of this report.

Vehicle Data - 2007 Honda Civic

The case vehicle was a 2007 Honda Civic EX four-door sedan. The Honda was identified by the Vehicle Identification Number (VIN) 1HGFA16837L (production number deleted). The driver’s door was jammed closed as a result of the damage and the placard that showed the date of manufacture was not visible. The front-wheel drive Honda was powered by a 1.8-liter inline four-cylinder engine linked to a 5-speed automatic transmission. The braking system consisted of power-assisted front and rear disc brakes with four-wheel anti-lock and electronic brake force distribution. The Honda was equipped with Bridgestone Turanza tires with Tire Identification Numbers (TIN) of 0BT2 PM2 0307, size P205/55R16. The tires were mounted on 5-spoke OEM alloy wheels. The vehicle manufacturer recommended cold tire pressure was 221 kPa (32 PSI) for the 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	Tire flat	3 mm (4/32 in)	7 cm (2.8 in) cut in sidewall, 10 x 3 cm (3.9 x 1.2 in) segment missing from rim.
Left Rear	200 kPa (29 PSI)	3 mm (4/32 in)	None
Right Front	200 kPa (29 PSI)	3 mm (3/32 in)	None
Right Rear	186 kPa (27 PSI)	2 mm (3/32 in)	None

The interior of the Honda was configured with cloth surfaced five-passenger seating. The front bucket seats were separated by a center console and equipped with adjustable head restraints. The front left head restraint was adjusted to 6 cm (2.4 in) above the full-down position. The front right head restraint was adjusted to 4 cm (1.6 in) above the full-down position. Both front seat tracks were adjusted to the full-rear position. The front left seat back was adjusted to 19 degrees aft of vertical with the front right seat back adjusted 21 degrees rearward of vertical. The second row was equipped with a split bench seat with 60/40 folding seat backs and adjustable head restraints that were in the full-down positions.

The interior occupant safety systems consisted of 3-point lap and shoulder belts for the five designated positions, front retractor and buckle-mounted pretensioners, a CAC frontal air bag system, front seat back-mounted side impact air bags, and the IC air bags.

Vehicle Data - 1991 Chevrolet Astro Minivan

The 1991 Chevrolet Astro was an extended wheelbase minivan. The vehicle was identified by the VIN 1GNDM19Z8MB (production sequence deleted). The rear-wheel drive

Chevrolet was powered by a 4.3-liter, V-6 engine linked to a 4-speed automatic transmission. The braking system consisted of power-assisted brakes with rear wheel antilock. The Chevrolet was equipped with a roof rack that held three aluminum ladders at the time of the crash, and the cargo area of the van was reported to be full of one and five gallon containers of paint by a neighbor who heard the crash and photographed the vehicles at final rest. This vehicle was sold prior to the case assignment and was not inspected.

Crash Sequence

Pre-Crash

The restrained 55-year-old male driver of the Honda was traveling north on lane two of the five-lane roadway, negotiating the left curve (**Figure 2**) at a police estimated speed of 48 km/h (30 mph). The driver of the Honda was en route to work and was holding a cup of coffee in his right hand. It was raining heavily at the time of this crash. The 26-year-old female driver of the Chevrolet was traveling south in lane two of the same roadway, negotiating a curve to the right and traveling downhill at a police estimated speed of 56 km/h (35 mph). As the driver of the Chevrolet was negotiating the curve, she lost directional control of the Chevrolet and



Figure 2: Honda's pre-crash trajectory.

traveled across the center turn lane into the northbound traffic lanes. There was no physical evidence at the scene to support avoidance actions by either driver.

Crash

The front left corner of the Chevrolet impacted the left front of the Honda 15 cm (5.9 in) aft of the front left bumper corner (Event 1). The Chevrolet sideswiped the left side of the Honda, pocketing at the left front door. The door pocketing ended immediately forward of the B-pillar; however, minor surface scratching continued onto the left quarter panel, ending forward of the left rear bumper corner. The direction of force was within the 12 o'clock sector for the Honda and the Chevrolet. The Chevrolet rotated clockwise (CW) and came to rest facing northwest straddling the center turn lane and outboard eastbound travel lane. The Honda was deflected in an easterly direction and began a slight counterclockwise (CCW) rotation. The right side tires and wheels of the Honda impacted the 16 cm (6.3 in) barrier curb (Events 2 and 3). The Honda traveled 15 m (49.2 ft) from the initial point of impact (Event 1) to final rest. The right tires mounted the curb as the vehicle came to rest straddling the curb and with the left side tires on the roadway. The driver's frontal air bag, seat back-mounted side impact air bag, and both IC air bags deployed during the multiple impact crash sequence. The sideswipe configuration was outside the scope of the WinSMASH reconstruction program.

Post-Crash

The police were notified of the crash by a nearby resident. Both drivers and all passengers of the Chevrolet exited their vehicles without assistance. The driver of the Honda sustained minor severity injuries, but was not transported from the scene. He sought treatment at a local hospital at a later time. No injuries were reported in the Chevrolet. The Honda was

towed due to disabling damage to a police tow yard where it remained until it was transferred to a regional salvage facility where it was inspected for this investigation. The Chevrolet was towed to the owner’s residence. The Chevrolet was sold by the owner, but the owner refused to provide buyer information on the vehicle.

Vehicle Damage

Exterior - 2007 Honda Civic

The exterior of the Honda sustained moderate severity damage to the left plane and right wheels as a result of this multiple impact crash. The left plane sustained sideswipe-type impact damage from contact with the front plane of the Chevrolet (Event 1). The direct damage began 55 cm (21.7 in) aft of the left rear axle position and extended forward 370 cm (145.7 in). The maximum crush measured 10 cm (3.9 in) in depth and was located at C4, 167 cm (65.7 in) forward of the left rear axle. The height of the maximum crush was 40 cm (15.7 in) above ground level. The height of the sill under the maximum crush location was 25 cm (9.8 in) and the resulting Door Sill Differential (DSD) was 10 cm (3.9 in). The direct contact damage extended 12 cm (4.7 in) above the belt line onto the A-pillar. The crush profile for the resultant damage of the initial impact was as follows: C1 = 0 cm, C2 = 0 cm, C3 = 2 cm (0.8 in), C4 = 10 cm (3.9 in), C5 = 4 cm (1.6 in), C6 = 0 cm. The Collision Deformation Classification (CDC) assigned for this impact was 12-LDAS-2. **Figure 3** depicts the left side damage sustained by the Honda.



Figure 3: Front left view of the left side damage to the Honda.

The right side sustained two impacts to the front and rear tires and wheels as the right side of the Honda impacted and traveled over the 16 cm (6.3 in) curb as it came to final rest. Both wheels were angled outward slightly from the bottom to the top aspects. The CDC assigned for the right front wheel impact (Event 2) was 03-RFWN-1. The CDC assigned for the right rear wheel (Event 3) was 03-RBWN-1. Both tires were free of damage and were still holding air pressure at the time of the SCI inspection.

Interior - 2007 Honda Civic

The Honda sustained minor severity interior damage that was attributed to passenger compartment intrusion and deployment of the driver’s frontal and side air bags. The left front door and the A- and B-pillars intruded laterally.

The intrusion to the Honda is listed on the following table:

Position	Component	Direction	Magnitude
Row 1 Left	A-pillar	Lateral	3 cm (1.2 in)
Row 1 Left	Door, Forward Upper Quadrant (FUQ)	Lateral	6 cm (2.4 in)
Row 1 Left	B-pillar	Lateral	4 cm (1.6 in)
Row 1 Left	Left instrument panel	Lateral	3 cm (1.2 in)
Row 1 Left	Left instrument panel	Longitudinal	4 cm (1.6 in)

Manual Safety Belt Systems - 2007 Honda Civic

The Honda was equipped with manual 3-point lap and shoulder belts for the five designated seating positions. All belt systems utilized continuous loop webbing with sliding latch plates. The driver's belt retracted onto an Emergency Locking Retractor (ELR) and was equipped with both retractor and buckle-mounted pretensioners. The D-ring was height adjustable and set to the full-up position. The driver was using the safety belt at the time of the crash, which was supported by loading evidence. This evidence consisted of a frictional abrasion on the webbing from the latch plate. The abrasion was located 64 cm (25.2 in) above the floor anchor, and body fluid was located on the webbing 31 cm (12.2 in) above the floor anchor. Additionally, the actuated retractor pretensioner locked the safety belt in the used position. The total length of the locked webbing measured 153 cm (60.2 in). The buckle pretensioner had 4 cm (1.6 in) of distance remaining in the piston.

The front right and all second row safety belt systems utilized a switchable ELR/Automatic Locking Retractor (ALR). In addition, the front right belt system contained both a retractor and buckle mounted pretensioner. These positions were unoccupied at the time of the crash.

Frontal Air Bag System - 2007 Honda Civic

The Honda was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system. The driver's air bag was concealed within the center hub of a 3-spoke steering wheel by a tri-flap design. The upper flap was 13 cm (5.1 in) in width at the horizontal tear seam and 7 cm (2.8 in) in height. The two lower flaps were symmetrical with the upper aspects measuring 7 cm (2.8 in) in width at the horizontal tear seam. The outboard sides measured 7 cm (2.8 in) in height and the lower aspects measured 3 cm (1.2 in) horizontally. The air bag (**Figure 4**) measured 60 cm (23.6 in) in diameter in its deflated state. The air bag was vented by two vent ports located at the 11 and 1 o'clock positions. The air bag was tethered by two tethers located at the 12 and 6 o'clock positions on a 16 cm (6.3 in) circular seam sewn to the center of the face of the air bag. There were no occupant contact points on the air bag; however, multiple drops of spilled coffee were noted on the right half of the bag.



Figure 4: Deployed driver's frontal air bag.

The front right air bag was mounted within the top aspect of the right instrument panel. The front right seat was not occupied during the crash; therefore, the CAC system suppressed the deployment of the air bag.

Side Impact Air Bag System - 2007 Honda Civic

The Honda was equipped with front seat back-mounted side impact air bags and roof side rail-mounted IC air bags. The left side impact air bag (**Figure 5**) and both IC air bags deployed during this crash.

The left seat back-mounted side impact air bag deployed from the upper outboard aspect of the seat back. The air bag measured 52 cm (20.5 in) in height and 32 cm (12.6 in) in width. The air bag had one vent port on the outboard aspect at the four o'clock position. There was no contact evidence or damage on the air bag.



Figure 5: Deployed left side impact air bag.

The IC air bags deployed from the roof side rails. The air bags measured 182 cm (71.7 in) in length. At the front seating positions, the IC measured 38 cm (15 in) in height and 35 cm (13.8 in) at the rear positions. The IC air bag provided coverage from the C-pillar to 22 cm (8.7 in) rear of the A-pillar. A triangular shaped void was present aft of the A-pillars. The vertical measurement of the void behind the A-pillars was 15 cm (5.9 in). Vertically, the IC air bags extended below the beltline at each outboard position. The left IC air bag was free of occupant contact points and contained multiple black deployment transfers that extended diagonally downward from right to left on the inboard aspects throughout the length of the air bag. The left roof side rail was torn at two locations. A 10 cm (3.9 in) vertical tear was located at the B-pillar, and a 5 cm (2 in) tear was present at the rear attachment point of the front left passenger grab handle. The right IC air bag was free of occupant contact points. A 14 cm (5.5 in) vertical tear was noted at the B-pillar. The IC air bags are depicted in **Figures 6 and 7**.



Figure 6: Left side IC air bag.



Figure 7: Right side IC air bag.

Air Bag Control Module

The 2007 Honda Civic was equipped with an Air bag Control Module (ACM) that reportedly had event data recording capabilities. Prior to the SCI investigator obtaining permission from the insurance company to remove the ACM from the Honda, the vehicle was sold at auction.

Occupant Demographics/Data

Driver Age/Sex: 55-year-old/Male
Height: 183 cm (72 in)
Weight: 91 kg (200 lb)
Eyewear: Eyeglasses
Seat Track Position: Full-rear
Manual Safety Belt Use: Lap and shoulder belt
Usage Source: Vehicle inspection
Egress from vehicle: Exited the vehicle unassisted through right front door
Mode of Transport From Scene: None
Type of Medical Treatment: Treated later in the emergency department and released

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Superficial lacerations to both hands	Minor (790602.1,3)	Unknown
Cervical strain	Minor (640278.1,6)	Impact forces
Lumbar strain	Minor (640678.1,6)	Safety belt
Right hip contusion	Minor (890402.1,1)	Safety belt
Vertically oriented left facial abrasion, 5 cm (2 in) in width	Minor (290202.1,2)	Left IC air bag

Source - Medical Records and driver interview

Driver Kinematics

The 55-year-old male driver was seated in a full-rear track position and was restrained by the manual 3-point lap and shoulder belt system. Prior to the crash, the driver was in an upright position with a cup of coffee in his right hand. The driver stated in the interview that he did not have enough time to react when he detected the Chevrolet and the imminent collision. As a result of the impact, the driver's pretensioners actuated and the driver's frontal air bag, seat back-mounted side impact air bag, and both IC air bags deployed. The driver initiated a forward and left trajectory within the front left seating position in response to the 12 o'clock impact force. During this forward and left trajectory, the driver loaded the safety belt system with his torso and hips. The loading of the belt system resulted in the right hip contusion and the lumbar strain. The driver's head flexed over the locked safety belt as his torso loaded the belt system. The flexion of his head resulted in the cervical strain. As his head flexed over the belt system, his face contacted the deployed left IC air bag resulting in the left facial abrasion. A source for the superficial lacerations to his hands could not be determined. The interior of the vehicle was free of glass from the disintegrated side glazing; therefore, this was not considered as a source for this injury.

The Honda subsequently departed the right roadside and impacted a curb with the right side tires. These impacts were minor in severity and did not significantly displace the driver.

Following the crash, the driver exited the vehicle unassisted through the right front door, as the left front door was jammed shut as a result of damage. The driver was transported by a personal vehicle to his residence and was later transported by private vehicle to a local hospital where he was treated in the emergency department and released.

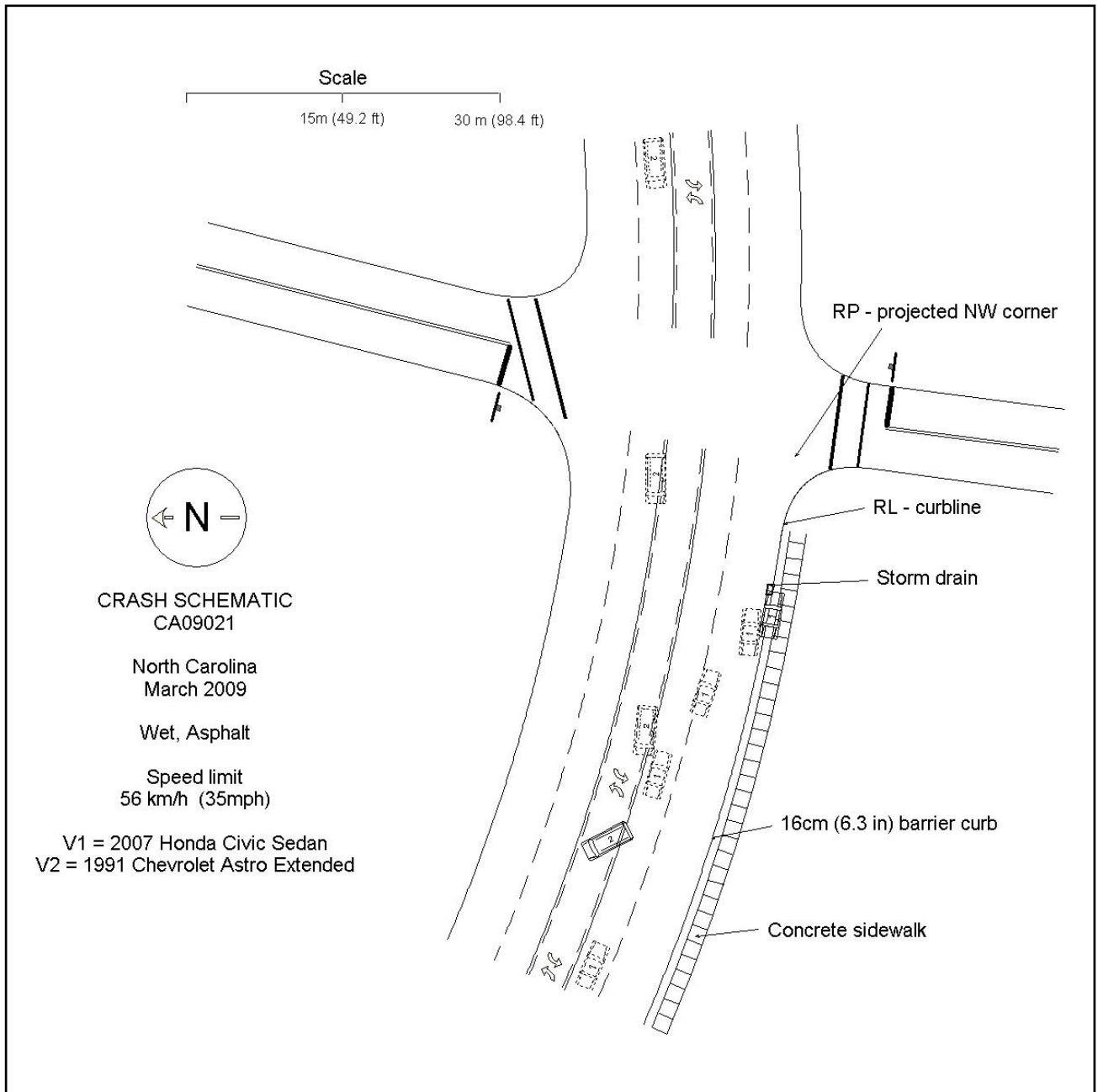


Figure 8: Crash Schematic