CRASH DATA RESEARCH CENTER
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CALSPAN ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE CRASH INVESTIGATION
SCI CASE NO.: CA10003

VEHICLE: 2006 HONDA CIVIC Si COUPE

LOCATION: NORTH CAROLINA

CRASH DATE: NOVEMBER 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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16. Abstract This on-site investigation focused on the deployment of the Certified Advanced 208-Compliant (CAC) frontal air bag system and the Honda Advanced Compatibility Engineering (ACE) frame structure of a 2006 Honda Civic Si coupe was involved in an offset frontal crash with a 1972 International Harvester Model 1210 pickup truck. The Honda was equipped with four-wheel anti-lock brakes, a CAC frontal air bag system, seat-mounted side impact air bags, and side impact Inflatable Curtain (IC) air bags. The CAC system included dual-stage frontal air bags for the driver and right front passenger, seat track positioning sensors, front seat retractor and buckle pretensioners, safety belt buckle switch sensors, and a front right occupant weight sensor. The front left corner area of the Honda was impacted by the front of the International resulting in deployment of the CAC driver's frontal air bag, the right and left IC air bags, and both side impact air bags. The 24-year old female driver of the Honda was transported to a regional trauma center for treatment of severe head injuries. She was hospitalized for 87 days. The 24-year-old male driver of the International was transported to a local hospital where he expired the same day.			
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BACKGROUND

This on-site investigation focused on the deployment of the Certified Advanced 208-Compliant (CAC) frontal air bag system and the Honda Advanced Compatibility Engineering (ACE) frame structure of a 2006 Honda Civic Si coupe **(Figure 1)** was involved in an offset frontal crash with a 1972 International Harvester Model 1210 pickup truck. The Honda was equipped with four-wheel anti-lock brakes, a CAC frontal air bag system, seat-mounted side impact air bags, and side impact Inflatable Curtain (IC) air bags. The CAC system included dual-stage frontal air bags for the driver and right front passenger, seat track positioning sensors, front seat retractor and buckle pretensioners, safety belt buckle switch sensors, and a front right occupant weight sensor. The front left corner area of the Honda was impacted by the front of the International resulting in deployment of the CAC driver's frontal air bag, the right and left IC air bags, and both side impact air bags. The 24-year old female driver of the Honda was transported to a regional trauma center for treatment of severe head injuries. She was hospitalized for 87 days. The 24-year-old male driver of the International was transported to a local hospital where he expired the same day.

Figure 1: Left front oblique view of the 2006 Honda Civic.

The Honda Civic was identified through a visit to a regional vehicle salvage facility on January 11, 2010. Based on the location and severity of the damage, this case was assigned by the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration (NHTSA) to the Calspan Special Crash Investigations team (SCI) for an on-site investigation on January 13, 2010. The on-site investigation was initiated on January 14, 2010 and involved the inspection and documentation of the Honda and the International, a surrogate interview with the mother of the Honda driver, and an inspection of the crash site.

SUMMARY

Vehicle Data

2006 Honda Civic

The 2006 Honda Civic Si Coupe was manufactured in January 2006 and was identified by the Vehicle Identification Number (VIN) 2HGFG21536H (production number deleted). Based on the interview with the driver's mother, the vehicle's odometer reading was approximately 48,270 km (30,000 mi) at the time of the crash. 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 power-assisted front and rear disc brakes with four-wheel antilock and electronic brakeforce distribution. The Honda was also equipped with an indirect Tire Pressure Monitoring System (TPMS). All windows were closed at the time of the crash. The side and rear glazing was equipped with an aftermarket tint. The Honda was equipped with three BF Goodrich G-Force Sport tires, size P215/45R17. The left front wheel and tire had separated from the vehicle and were not available for inspection. The tires were mounted on 43 cm (17 in) five-spoke OEM alloy wheels. The tire size matched the vehicle manufacturer recommendation. 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	Unknown	Unknown	Unknown
Left Rear	165 kPa (24 PSI)	4 mm (5/32 in)	None
Right Front	186 kPa (27 PSI)	2 mm (3/32 in)	None
Right Rear	193 kPa (28 PSI)	3 mm (4/32 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 height adjustable head restraints. The driver's head restraint had been removed prior to the inspection, but was not damaged and operated normally when repositioned in the top of the seat back. The front right head restraint was found in the full-down position at the time of the SCI inspection. The driver's seat track was damaged and the seat was jammed in the full-forward position. The seat had been deformed by passenger compartment intrusion and the front left seat back was at an angle 40 degrees aft of vertical. The front right seat track was 5 cm (2 in) forward of the full-rearward position, and the seat back angle measured 20 degrees aft of vertical. The second row was a split bench seat with 60/40 folding backs and adjustable head restraints. The three rear head restraints were adjusted 4 cm (1.6 in) above the seat backs at all three seating positions.

The occupant safety systems consisted of 3-point lap and shoulder belts for all five designated seating positions, front safety belt dual pretensioners (buckle and retractor mounted), dual-stage

CAC frontal air bags, front seat-mounted side impact air bags and roof side rail-mounted side impact IC air bags that provide protection for the four outboard seat positions.

1972 International Harvester Pickup

The 1972 International Harvester Model 1210 pickup truck was identified by a 13-character VIN: B13205H (production sequence deleted). The rear-wheel drive International was powered by a 5.0-liter, V8 engine linked to a 3-speed manual transmission. The braking system consisted of front and rear drum brakes. The International was equipped with a General Ameritrac TR tire on the left front wheel, Michelin LTX M/S tires on the rear wheels, and a Samson Radial XT tire on the right front wheel. All tires were size LT235/85R16. The vehicle manufacturer recommended tire size and cold tire pressure was unknown. 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	11 mm (14/32 in)	De-beaded, wheel bent, sidewall cut, tread to bead
Left Rear	Tire flat	6 mm (7/32 in)	De-beaded, wheel bent, sidewall cut
Right Front	200 kPa (29 PSI)	10 mm (12/32 in)	None
Right Rear	283 kPa (41 PSI)	6 mm (7/32 in)	None

Crash Site

This crash occurred during evening hours on a two-lane north/south rural roadway. The environmental conditions were clear, dry and dark at the time of the crash. The roadway consisted of two asphalt surfaced travel lanes. The traffic lanes measured 2.8 m (9.2 ft) in width. The roadway was bordered by narrow asphalt shoulders that were 20 cm (7.9 in) in width. Outboard of the shoulders, the roadsides consisted of grass terrain with embankments that sloped away from the roadway. Adjacent to the west roadside, the grade was negative 1.6 percent for 1.9 m (6.2 ft), transitioning to a negative grade of 29 percent 1.9 m (6.2 ft) west of the road edge into a drainage ditch. In the pre-crash area for the Honda, the roadway had a level grade and included a right curve. The radius of curvature measured 179 m (587 ft). The pre-crash area for the International was also level. The curved section of roadway included a superelevation of 3 percent from east to west. Located near the Point of Impact (POI) was a two-lane roadway that intersected the east side of the main roadway at a 130 degree angle. This intersecting roadway was straight and level and the two travel lanes measured 3 m (9.8 ft) in width. The posted speed limit in the area of the crash was 89 km/h (55 mph). The Crash Schematic is included as **Figure 11** of this report.

Crash Sequence

Pre-Crash

The unrestrained 24-year-old female driver of the Honda was operating the vehicle southbound on the rural roadway at a police-estimated speed of 121 km/h (75 mph). She was en route to her residence and was approximately 4.8 km (3 miles) from her destination. Prior to the crash, she entered the right curve. **Figure 2** depicts the Honda's pre-crash trajectory. The unrestrained 24-year-old male driver of the International was operating the vehicle northbound in the left curve. As the vehicles neared the intersection, the Honda crossed the center line and entered the northbound travel lane. There was no physical evidence at the crash site indicating avoidance actions prior to impact. The front of the Honda approached the front left corner of the International.

Figure 2: Pre-crash southbound trajectory of the Honda.

Crash

The front left corner of the Honda impacted the front left corner of the International (Event 1). The direction of force was within the 12 o'clock sector for both vehicles. The force of the impact resulted in the deployment of the driver's frontal air bag, both side impact air bags, and both IC air bags. The damage algorithm of the WinSMASH program was used to calculate the severity of the crash. The total delta-V of the Honda was 53 km/h (32.9 mph). The Honda's longitudinal and lateral delta-V components were -52.2 km/h (-32.4 mph) and 9.2 km/h (5.7 mph), respectively. The total delta-V for the International was 36 km/h (22.4 mph) with longitudinal and lateral components of -35.5 km/h (-22.1 mph) and 6.3 km/h (3.9 mph). As the impact progressed, the Honda traveled slightly under the left side of the International, separating the pickup's front axle and displacing its toe pan rearward. The front of the Honda then engaged the left rear wheel of the International, fracturing the axle mounting bolts and suspension.

The International ramped up the left side of the Honda and was redirected into a counterclockwise (CCW) rotation. The International rotated approximately 65 degrees on the roadway and rolled over due to the vehicle-to-vehicle contact. The International rolled to the right two-quarter turns over an uninterrupted distance of 10.6 m (34.8 ft). The International came to rest in the northeast corner of the intersection on its roof, facing west.

The Honda was redirected approximately 20 degrees to the right by the initial impact with the International. A fluid spill began near the Point of Impact (POI) and followed a curving path and ended in an 80 x 150 cm (31.5 x 59.1 in) fluid spill at the Honda's final rest position. The right

front tire marked the roadway and evidenced the Honda's trajectory to final rest. This tire mark transitioned to a rut in the grass roadside as the vehicle traveled off the west roadside for a distance of 32.7 m (107.3 ft). The right rear wheel and the left rear wheel furrowed into the ground, these marks measured 23 m (75.5 ft) and 18 m (59.1 ft), respectively. The Honda then reentered the road as it approached final rest. The Honda came to final rest in the southbound travel lane facing east.

Post-Crash

Police, emergency medical and tow personnel responded to the crash site. The driver of the Honda was mechanically restrained in the vehicle by the intrusion of the instrument panel, the left door and the steering assembly. Emergency personnel removed the roof, windshield and left door from the Honda and freed the driver. The driver of the Honda was transported by air ambulance to a regional trauma center where she was admitted for treatment of critical head injuries, multiple fractures and associated soft tissue injuries. The first responders removed the left door from the International in order to extricate its driver due to serious injuries. The International driver was transported by ground ambulance to a local hospital where he expired the same day. Both vehicles were towed from the scene due to disabling damage. The Honda and the International were subsequently transferred from the local tow yards to a regional vehicle salvage facility where they were inspected.

2006 Honda Civic

Exterior Damage

The Honda sustained severe damage in this offset frontal crash to the front and left planes **(Figure 3)**. On the front plane, the direct contact damage began 33 cm (13 in) left of the vehicle centerline, and extended left 58 cm (22.8 in) to the front left bumper corner. The front bumper had been displaced to the left 10 cm (3.9 in) by the impact forces. The maximum crush was located at C1, the front left bumper corner and measured 71 cm (28 in). The combined direct and induced damage extended across the entire frontal end-width of the vehicle. A residual crush profile was documented along the bumper reinforcement bar and was as follows: C1 = 71 cm (28 in), C2 = 57 cm (22.4 in), C3 = 43 cm (16.9 in), C4 = 24 cm (9.4 in), C5 = 12 cm (4.7 in), C6 = 0 cm. The impact reduced the left wheelbase 33 cm (13 in); the right wheelbase elongated 7 cm (2.8 in) due to body deformation. The Collision Deformation Classification (CDC) assigned for this impact was 12FYEW4.

Figure 3: Frontal damage to the Honda.

The direct contact damage wrapped around the left front corner and extended along the left plane 278 cm (109.4 in) to the left rear axle area. **Figure 4** is an overhead oblique view of the damage to the Honda. The left front wheel separated from the suspension and was not available for inspection. The left door was damaged, intruded into the passenger compartment, and was jammed shut post-crash. Emergency personnel cut the left door and roof from the Honda in order to extricate the driver. The maximum lateral deformation from the prolonged engagement was an estimated 15 m (6 in). The windshield was completely fractured and had been removed from the Honda by rescue personnel. The left windows, backlight, sunroof right rear window were disintegrated due to impact forces. The front right window was not damaged.

Figure 4: Overhead front oblique view of the damage to the Honda.

Interior Damage

The Honda sustained moderate severity damage that was attributed to passenger compartment intrusion, occupant contact and air bag deployment. **Figure 5** is a left lateral view of the interior damage. **Figures 6 and 7** are interior views of the intrusion into the driver's space and the driver's contacts. The driver loaded the steering wheel rim through the frontal air bag resulting in abrasions to the steering wheel rim at the 6 to the 11 o'clock position. The steering wheel was rotated approximately 70 degrees clockwise (CW) at the time of the SCI inspection. The shear capsules of the steering column were inspected and found to have compressed 4 cm (1.6 in) forward due to occupant loading. The lower section of the steering shaft separated due to the intrusion at the location where it passes through the cowl. The left instrument panel, left of the steering assembly, was scuffed by probable contact with the driver's chest. This scuff mark was 11 cm (4.3 in) in width and 22 cm (8.7 cm) in height. There were two contacts attributed to the driver's knees on the left lower instrument panel. The left contact consisted of scuff marks and fractured plastic that measured 8 cm (3.1 in) by 13 cm (5.1 in) and was located 4 cm (1.6 in) left of the steering column. The right contact consisted of scuff marks, measured 11 cm (4.3 in) wide by 10 cm (3.9 in) in height and began under the steering column and extended right. There was a scuff mark on the right side of the front of the driver's seat back. This scuff mark was 12 cm (4.7 in)

Figure 5: Left lateral interior view of the driver's position.

in width and 49 cm (19.3 in) in height and was located on the right side bolster of the driver's seat 5 cm (2 cm) below the top edge of the seat. There was a blood transfer on the inboard aspect of the right seat back that measured 16 x 25 cm (6.3 x 9.8 in) and was located 14 cm (5.5 in) below the top edge of the seat. There was also a localized fracture with body fluid on the windshield which had been removed by rescue personnel. This contact was located at the left aspect of the windshield adjacent to the left A-pillar, at the mid-point of its height. The left front door intruded laterally and compressed the left side of the front left seat back into the second row.

Figure 6: View of the Honda's instrument panel intrusion.

Figure 7: View of the driver's lower extremity contact to the Honda's intruded lower instrument panel.

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

Position	Component	Direction	Magnitude
Row 1 Left	Instrument panel	Longitudinal	41 cm (16.1 in)
Row 1 Left	A-pillar (lower)	Longitudinal	44 cm (17.3 in)
Row 1 Left	Toe pan	Longitudinal	32 cm (12.6 in)
Row 1 Left	Steering assembly	Longitudinal	19 cm (7.5 in)
Row 1 Left	Door, rear upper quadrant	Lateral	13 cm (5.1 in)
Row 1 Center	Instrument panel	Longitudinal	23 cm (9.1 in)
Row 1 Right	Instrument panel	Longitudinal	9 cm (3.5 in)
Row 2 Left	Front seat back	Longitudinal	20 cm (7.9 in)

Manual Restraint Systems

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 and sliding latch plates. None of the upper D-rings were height adjustable. The front safety belts utilized both buckle and retractor mounted pretensioners. The driver's belt retracted onto an Emergency Locking Retractor (ELR). The retractor was locked due to deformation of the B-pillar; the belt webbing

would not extend or retract. The belt webbing was cut 71 cm (28 in) above the lower anchor when the roof was removed. The driver's belt was not used at the time of the crash. There was no evidence of occupant loading to the webbing or latch plate.

The front right and second row belt systems utilized a switchable ELR/Automatic Locking Retractors (ALR). The retractor and buckle pretensioners did not actuate in this crash. The right belt was cut 99 cm (39 in) above the lower floor anchor. The balance of the webbing had spooled back into the retractor.

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 weight sensor, safety belt buckle and retractor pretensioners, and safety belt buckle switch sensors. The manufacturer of this vehicle certified that the Honda Civic was compliant with the advanced air bag portion of the Federal Motor Vehicle Safety Standard (FMVSS) Number 208.

The driver's air bag (**Figure 8**) was concealed within the center hub of a 3-spoke steering wheel by a tri-flap design. The upper flap measured 14 cm (5.5 in) in width at the horizontal tear seam and was 8 cm (3.1 in) in height. The lower flaps were triangular in shape with dimensions that were symmetrical; the upper aspects measuring 7 cm (2.8 in) in width at the horizontal tear seam, the sides measuring 9 cm (3.5 in) in height at the vertical tear seam and the lower aspects measuring 3 cm (1.2 in) horizontally. The driver's air bag measured 60 cm (23.6 in) in diameter in its deflated state. The air bag was vented by two vent ports at the 11 and 1 o'clock positions on the rear aspect of the air bag. The driver's air bag was tethered by two tethers at the 12 and 6 o'clock positions within a 16 cm (6.3 in) circular tether seam sewn to the face of the bag. The lower half of the face of the air bag was covered with blood, and there was a scuff mark that was 11 cm (4.3 in) in height and 8 cm (3.1 in) in width located on the face of the air bag, 4 cm (1.6 in) left of the circular tether seam.

Figure 8: View of the Honda's frontal driver air bag.

Side Impact Air Bag System

The Honda was equipped with front seat-mounted side impact air bags and roof side rail-mounted IC air bags. The side impact air bags and the IC air bags on both sides deployed during this crash.

The side impact air bag deployed from a 35 cm (13.8 in) long seam in the upper outboard aspect of the front seat back. The air bag measured 60 cm (23.6 in) in height and 35 cm (13.8 in) in width. The side air bag had one vent port at the bag's forward aspect on the outboard side. The left side impact air bag **(Figure 9)** contained blood evidence located on the inboard side 9 cm (3.5 in) forward of the seat back and extending forward 16 cm (6.3 in). The outboard aspect contained a black plastic deployment transfer located 10-23 cm (3.9-9.1 in) above the lower edge of the air bag and 5-19 cm (2-7.5 in) aft of the front edge. The right side impact air bag was free from occupant contacts. There was a black plastic deployment transfer on the outboard side located 22-29 cm (8.7-11.4 in) aft of the front edge and 15-36 cm (5.9-14.2 in) below the top edge of the air bag.

Figure 9: Left side impact air bag.

The left and right IC air bags deployed from their respective roof side rails. The IC air bags measured 135 cm (53.1 in) in length and 40 cm (15.7 in) in height at the front seating position inclusive of a 4 cm (1.6 in) non-inflating strip at the bottom of the air bags. In the rear seating position, the IC's measured 36 cm (14.2 in) in height. At the rear of the IC, the inflatable section of the air bag measured 33 cm (13 in) in length. Forward of this inflatable section was a non-inflated panel measuring 30 cm (11.8 in) in height and length. The inflated forward section of the IC measured 71 cm (28 in). There was an inflatable tube connecting the front and rear inflatable sections of the IC measuring 30 cm (11.8 in) in length and 6 cm (2.4 in) in height. The IC's were tethered to the A-pillars by a 26 cm (10.2 in) tether strap. Both IC air bags were inspected for damage and occupant contact. None was found; however, both IC's were covered with dust and dirt, consistent with the vehicle's exposure in the environment at the salvage facility. The removal of the roof hampered the complete inspection of the IC air bags.

Occupant Demographics/Data - 2006 Honda Civic

Driver Demographics

Age/Sex:	24-year-old/Female
Height:	168 cm (66 in)
Weight:	60 kg (132 lb)
Eyewear:	None
Seat Track Position:	Unknown
Manual Safety Belt Use:	None
Usage Source:	SCI vehicle inspection
Egress from Vehicle:	Removed from vehicle while unconscious, GCS=3T
Mode of Transport from Scene:	Air ambulance
Type of Medical Treatment:	Admitted to regional trauma center for an 87 day hospitalization

Driver injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Diffuse Axonal Injury, unknown location	Critical (140628.5,9)	Intruding A-pillar
Bilateral intracerebral hemorrhage (in the left frontal lobe and the right parietal, small)	Critical (140646.5,3)	Intruding A-pillar
Bilateral subdural hematoma (over frontal lobes)	Critical (140654.5,3)	Intruding A-pillar
Basilar skull fracture (fronto-ethmoidal complex depressed fracture involving the cribiform plate)	Serious (150206.4,8)	Intruding A-pillar
Bilateral pulmonary contusions	Severe (441410.4,3)	Steering column
Subarachnoid hemorrhage (mild, diffuse)	Serious (140684.3,9)	Intruding A-pillar
Le Fort III facial fractures (extensive crush injury to the mid-face, fracture of all walls of the bilateral maxillary sinuses, medial and lateral walls and floors of both orbits, both anterior maxillary nasal spines, right zygomatic arch, nasal septum, alveolar ridge of the maxilla, the right globe is displaced inferiorly and laterally)	Serious (250808.3,4)	Intruding A-pillar
Right distal radius fracture (with extension through the articular surface, comminuted and displaced)	Serious (752804.3,1)	Steering wheel rim
Left distal radius fracture (comminuted)	Serious (752804.3,2)	Intruding door panel
Left distal ulnar metaphyses fracture (with volar and radial displacement)	Serious (753204.3,2)	Intruding door panel
Left acetabular fracture (displaced), with posterior and superior dislocation of the femoral head)	Serious (852604.3,2)	Left lower instrument panel
Sternal fracture (at the level of the manubrium)	Moderate (450804.2,4)	Steering column
Grade 1 spleen laceration NFS	Moderate (544222.2,2)	Intruding door panel arm rest, rear lower quadrant

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Grade 1 liver laceration NFS (within the medial segmental lobe)	Moderate (541822.2,1)	Steering wheel rim
Right clavicle shaft fracture (displaced)	Moderate (752200.2,1)	Steering wheel rim
Left metacarpal fractures (base of the 1st and 2nd, metacarpal necks of the 3rd and 4th, and the metacarpal shaft of the 5th)	Moderate (752000.2,2)	Intruding door panel, forward upper quadrant
Right medial malleolar fracture (non displaced)	Moderate (853412.2,1)	Intruding toe pan
Right eyelid abrasion	Minor (297202.1,1)	Intruding A-pillar
Right eyelid laceration	Minor (297602.1,1)	Intruding A-pillar
Facial contusion	Minor (290402.1,9)	Intruding A-pillar
Complex facial lacerations (including bilateral cheeks, right forehead, nose, lip and chin)	Minor (290600.1,0)	Intruding A-pillar
Right anterior neck laceration (superficial)	Minor (390602.1,1)	Unknown
Center chest contusion (over sternal area)	Minor (490402.1,4)	Steering column
Left arm contusion	Minor (790402.1,2)	Intruding door panel, forward upper quadrant
Left buttock and hip bruise (large)	Minor (8904021.1,2)	Intruding door panel arm rest, rear lower quadrant
Right ankle abrasion	Minor (890202.1,1)	Foot controls

Driver Kinematics

The 24-year-old female driver was seated in an unknown track position. She was not restrained by the available manual 3-point lap and shoulder belt system. There was no evidence at the scene of any pre-crash avoidance maneuver attempted by the driver of the Honda.

The frontal offset impact deployed the driver's frontal air bag, the side impact air bags and the IC air bags. In response to the frontal impact force, the driver initiated a forward and left trajectory within the front left seating position. The unrestrained driver loaded through the deployed air bag and then engaged the steering wheel rim/column through the air bag. Steering column shear

capsule separation, scuff marks on the face of the air bag and abrasions on the steering wheel rim evidenced the loading. The driver's loading of the steering column resulted in the sternal fracture, bilateral pulmonary contusions, and the chest contusion. The right arm likely was flexed (at the elbow) and captured between the chest and steering wheel rim. During her forward kinematic pattern and loading, the right arm and clavicle was fractured by the steering wheel rim. Her loading of the rim also resulted in a liver laceration.

The driver continued on her forward trajectory towards the front left corner of the Honda. Coincident to this, the left A-pillar, instrument panel and door panel intruded into the driver's space. The driver's lower extremities contacted and loaded the lower instrument panel. This loading resulted in the (indirect) fracture of the left acetabular. The driver's head/face impacted the intruding A-pillar. This impact resulted in the multiple fractures of the face and skull, the multiple brain injuries and soft tissue injuries to the face. The intruding door panel impacted the driver's left flank resulting in the laceration of the spleen, the hip/left buttock contusions and fractures of the left arm and hand.

The driver then initiated a rebound trajectory within the front left seating position. She impacted the front left seat back as it was deforming from passenger compartment intrusion, depositing the scuff mark on the right bolster of the seat. Her lower body was restrained by the intrusion of the steering assembly and her upper body continued its rearward and right trajectory, coming to rest against the inboard side of the right seat back and evidenced by the blood transfer to the seat cushion.

The driver was unconscious when emergency medical personnel arrived at the scene. She was extricated from the vehicle and transported by air ambulance to a regional trauma center and was hospitalized for 87 days.

1972 International Harvester Pickup Truck

Exterior Damage

The frontal area of the International sustained moderate severity damage as a result of the impact with the Honda **(Figure 10)**, and the top plane sustained minor severity damage in the rollover that occurred subsequent to the initial impact. The direct contact damage began 26 cm (10.2 in) left of the vehicle centerline and extended left 54 cm (21.3 in). The maximum crush was located at C1, the front left bumper corner and measured 57 cm (22.4 in). The combined direct and induced damage (Field L)

Figure 10: Left front oblique view of the damaged International pickup.

extended from the front left bumper corner to the front right bumper corner. A residual crush profile was documented along the full width of the damaged front bumper and was as follows: C1 = 57 cm (22.4 in), C2 = 22 cm (8.7 in), C3 = 13 cm (5.1 in), C4 = 6 cm (2.4 in), C5 = 3 cm (1.2 in), C6 = 0 cm. The CDC assigned for this impact was 12FLEW3. The Honda's engagement continued down the left side to the wheelhouse of the left rear axle. The solid front axle of the International separated from the truck. The front and left planes of the Honda engaged and displaced the left cowl, A-pillar, toe pan, B-pillar and left rear axle.

The damage to the top plane of the International resulting from the rollover began at the leading edge of the hood and extended rearward to the backlight header. No roof crush measurements were taken from the pickup truck due to the extent of the offset frontal impact damage.

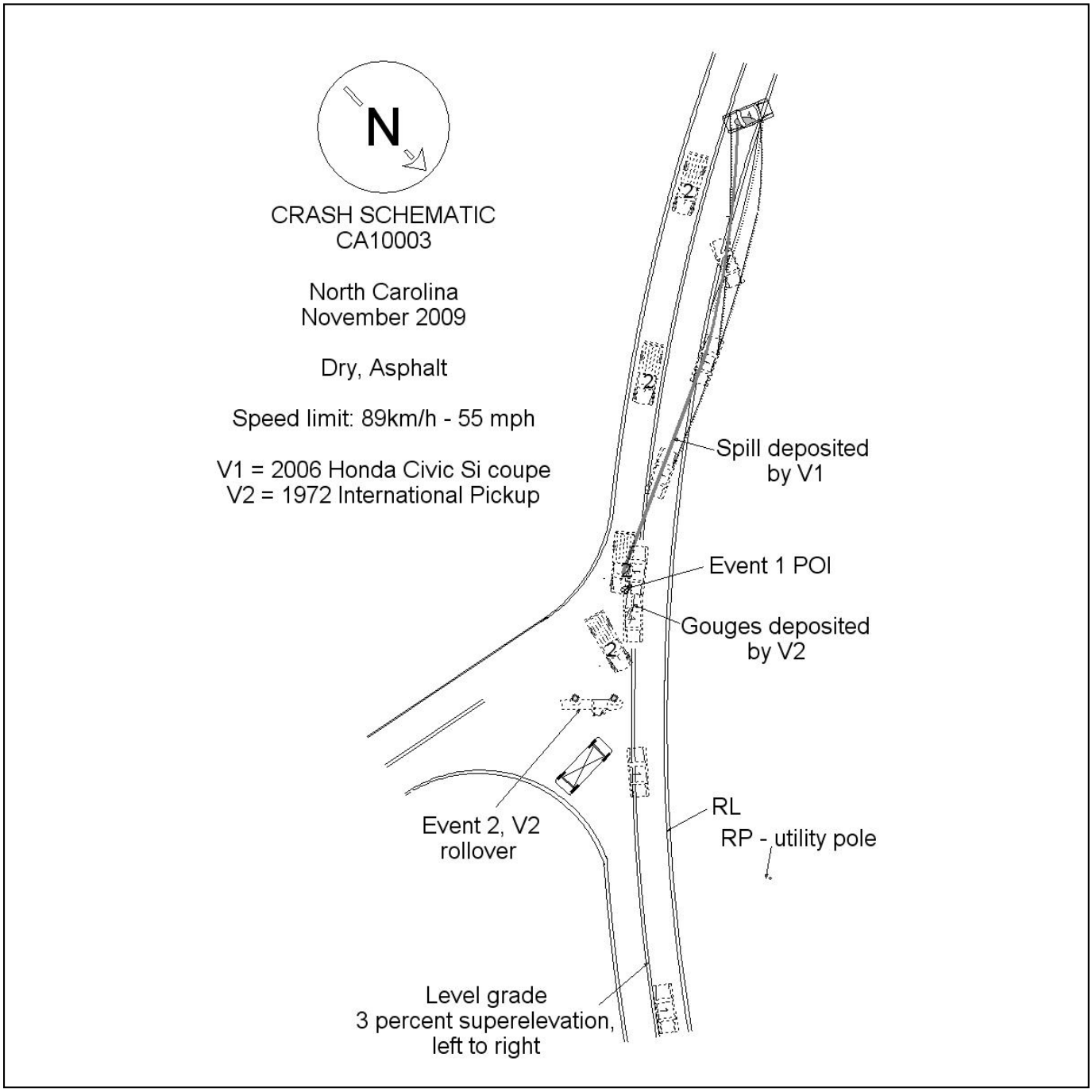

Figure 11: Crash Schematic