CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE CRASH INVESTIGATION

SCI CASE NO.: CA09024

VEHICLE: 2008 HONDA CIVIC COUPE

LOCATION: NORTH CAROLINA

CRASH DATE: SEPTEMBER 2008

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 occupant protection of the Certified Advanced 208-Compliant air bag system and the Honda Advanced Compatibility Engineering (ACE) frame structure of a 2008 Honda Civic coupe that was involved in a run-off-road crash with a tree line. The vehicle was equipped with four-wheel anti-lock brakes, a CAC frontal air bag system, front seat back-mounted side impact air bags, and roof side rail-mounted curtain air bags. The manufacturer of the Honda certified that the vehicle is compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC system includes dual-stage frontal air bags for the driver and right front passenger positions, seat track positioning sensors, safety belt pretensioners, and a front right occupant presence detection sensor. The right front corner area of the Honda impacted a tree resulting in deployment of the driver's frontal air bag, the right side impact air bag and the right curtain air bag. The 29-year-old female driver of the Civic was transported to a local hospital for treatment of police reported minor severity injuries.			
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BACKGROUND

This on-site investigation focused on the occupant protection of the Certified Advanced 208-Compliant air bag system and the Honda Advanced Compatibility Engineering (ACE) frame structure of a 2008 Honda Civic coupe **(Figure 1)** that was involved in a run-off-road crash with a tree line. The vehicle was equipped with four-wheel anti-lock brakes, a CAC frontal air bag system, front seat back-mounted side impact air bags, and roof side rail-mounted curtain air bags. The manufacturer of the Honda certified that the vehicle is compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC system includes dual-stage frontal air bags for the driver and right front passenger positions, seat track positioning sensors, safety belt pretensioners, and a front right occupant presence detection sensor. The right front corner area of the Honda impacted a tree resulting in deployment of the driver's frontal air bag, the right side impact air bag and the right curtain air bag. The 29-year-old female driver of the Civic was transported to a local hospital for treatment of police reported minor severity injuries.

Figure 1. 2008 Honda Civic case vehicle

The crash was identified through a visit to a regional salvage facility on April 20, 2009. An image of the Civic was forwarded to the Calspan Special Crash Investigations (SCI) team for review on the same day. Based on the location and severity of the damage to the ACE frame and the deployment of the driver's frontal air bags, the right side impact air bag and the right curtain air bag, this case was assigned for on-site investigation on April 21, 2009. The on-site investigation was conducted on April 23-24, 2009 and involved the inspection of the Honda, a detailed interview with the driver of the vehicle and documentation of the crash scene.

SUMMARY

Crash Site

This crash occurred during the evening hours of September 2008 on the west road side of a two-lane rural roadway. The environmental conditions were police reported as clear, dry and dark at the time of the crash. The roadway consisted of two lanes surfaced with asphalt. The traffic lanes measured 4.1 m (13.5 ft) in width. The roadway was bordered by narrow asphalt shoulders approximately 0.9 m (3 ft) in width. In the location prior to the Honda departing the roadway, the roadway had a flat grade and a shallow curve to the left with a radius of curvature of 1,292 m (4,239 ft). The west roadside was surfaced with grass and had a negative grade of 1.6 percent.

To the west of this grass shoulder, the surface transitioned to pine straw with small brush. A tree line was located 9.3 m (30.5 ft) west of the fog line. A 70 cm (27.6 in) diameter tree located within the tree line was the initial point of impact. A 35 cm (13.8 in) diameter tree located 13.5 m (44.3 ft) north of the initial impact was contacted by the Honda as it came to final rest. The posted speed limit was 89 km/h (55 mph).

Vehicle Data

The 2008 Honda Civic EX Coupe was manufactured in February 2008 and was identified by the Vehicle Identification Number (VIN) 2HGFG11888H (production number deleted). The vehicle was purchased new in the summer of 2008 by the driver and used primarily for transportation to and from work and recreational activities. The odometer reading at the time of the crash was 9,455 km (5,875 miles).

The front-wheel drive Civic was powered by a 1.8-liter inline four-cylinder engine linked to a five-speed automatic transmission. The braking system consisted of power-assisted front ventilated and rear standard disc brakes with four-wheel antilock and electronic brakeforce distribution. The Civic was also equipped with an indirect Tire Pressure Monitoring System (TPMS). All windows were closed at the time of the crash. The Honda was equipped with four Bridgestone Turanza EL400 P205/55R16 tires mounted on 16-inch 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	193 kPa (28 PSI)	6 mm (8/32 in)	None
Left Rear	193 kPa (28 PSI)	6 mm (8/32 in)	None
Right Front	Tire Flat	6 mm (8/32 in)	Tire cut across tread
Right Rear	179 kPa (26 PSI)	6 mm (8/32 in)	None

The interior of the Civic 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. Both front head restraints were found in the full-down position at the time of the SCI inspection. The driver seat track was found to be adjusted 10 cm (3.9 in) forward of the full-rear position, and the seat back angle measured 30 degrees aft of vertical. The front right seat track was found in the full-rearward position, and the seat back angle measured 35 degrees aft of vertical. The second row was a single bench seat with split 60/40 folding backs and adjustable head restraints in the full-down position at all three seating positions.

The interior occupant safety systems consisted of three-point lap and shoulder belts for all five seating positions, front safety belt dual pretensioners (both buckle and retractor mounted), dual-stage frontal air bags, front seat back-mounted side impact air bags and roof side rail-mounted curtain air bags that provide protection for the four outboard seat positions.

Crash Sequence

Pre-crash

The restrained 29-year old female driver of the Honda was traveling north on the rural roadway, at a police estimated speed of 89 km/h (55 mph), negotiating a shallow left curve (**Figure 2**). As the curve transitioned back to a straight roadway, the driver continued her steering input to the left. Consequently, the vehicle initiated a northwest trajectory, crossed the center line and departed the left side of the road. The Civic continued its northwest trajectory across the grass shoulder onto the pine straw roadside and began to approach the pine trees.

Figure 2: Honda's pre-crash trajectory.

Crash

The forward right side plane of the Civic impacted the 70 cm (27.6 in) diameter pine tree (Event 1). The direction of force for the initial impact was within the two o'clock sector. The force of the impact actuated the driver's safety belt pretensioners and deployed the driver's fontal air bag, the right side impact air bag and right curtain air bag. The barrier equivalent algorithm of the WINSMASH program was used to calculate a delta-V of 47.7 km/h (29.6 mph). The longitudinal and lateral components of the delta-V were -30.9 km/h (-19.2 mph) and -36.8 km/h (-22.9 mph), respectively.

The angular impact force to the forward right side induced a counterclockwise rotation to the Honda. The vehicle rotated approximately 180 degrees within the off-road area and impacted the 35 cm (13.8 in) diameter tree with the right rear corner of the vehicle (Event 2). The direction of force for the minor secondary impact was within the five-o'clock sector. This impact resulted in minor damage. The vehicle came to rest in close proximity to the second tree facing south. **Figure 3** is an overall view of both trees involved. A schematic of the crash is included at the end of this report as **Figure 11**.

Figure 3: Initial and subsequent impact pine trees.

Post-Crash

Police, emergency medical, and tow personnel responded to the crash site. The driver was removed from the vehicle while unconscious by the first responders and transported by ground ambulance. She was admitted for treatment and observation due to an abdominal wall contusion and air collection in the anterior mediastinum. She was subsequently released one day post-crash.

Exterior Damage

The exterior of the Honda sustained moderate severity damage to the right side plane as a result of this multiple impact crash. The Honda impacted the 70 cm (27.6 in) diameter tree (Event 1) with the forward aspect of the right plane (**Figure 4**). The direct contact damage began on the forward aspect of the right fender, 305 cm (120 in) forward of the right rear axle. The direct contact damage extended 86 cm (33.9 in) rearward forming a pocketed region of deformation at the right A-pillar area. The right front suspension and wheel deformed rearward into the lower A-pillar. The right wheelbase was reduced 51 cm (20 in). The force of the impact caused an outward buckling of the front right door. This induced damage began at the right B-pillar. The combined length of the induced and direct damage measured 230 cm (90.6 in). A crush profile was documented along the right plane at the mid-door elevation and was as follows: C1 = 0 cm, C2 = 0 cm, C3 = 0 cm, C4 = 28 cm (11 in), C5 = 47 cm (18.5 in), C6 = 3 cm (1.2 in). The induced damage at crush locations C1, C2 and C3 was displaced outboard, resulting in negative crush measurements at those locations. Negative crush measurements are taken to be zero. The maximum crush measured 51 cm (20.1 in) and was located 251 cm (98.8 in) forward of the right rear axle. The Collision Deformation Classification for this event was 02-RYEW4.

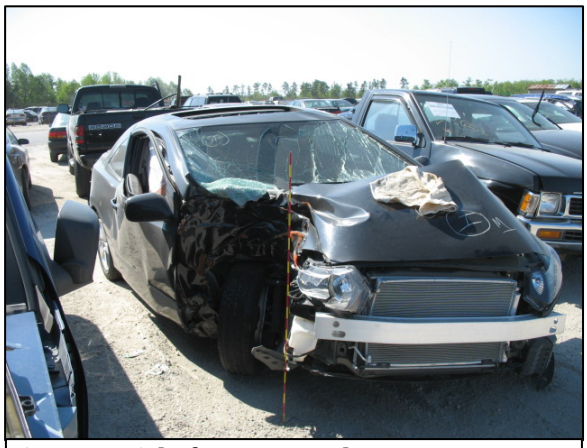

Figure 4: Right front corner damage.

Figure 5 and 6 are close-up views of the deformation to the right fender area. The ACE frame structure was within the area of the deformation.

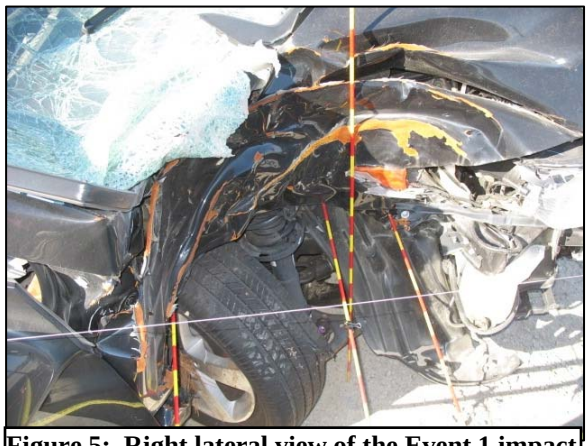

Figure 5: Right lateral view of the Event 1 impact damage.

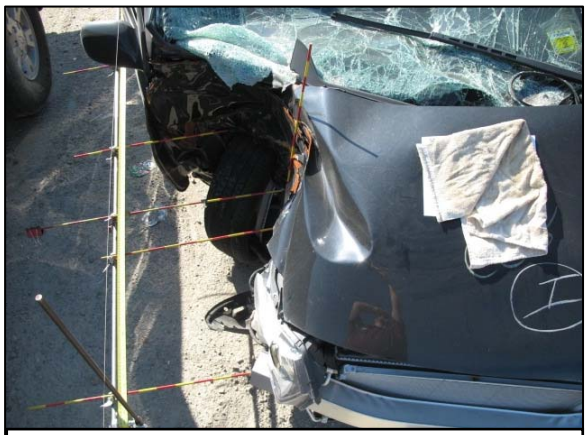

Figure 6: Longitudinal view of the Event 1 impact damage.

The impact with the 35 cm (13.8 in) diameter tree (Event 2) resulted in damage to the right rear corner of the Honda (**Figure 7**). The direct damage began 63 cm (24.8 in) rear of the right rear axle and extended rearward 10 cm (3.9 in). The induced damage began 17 cm (6.7 in) rear of the right rear axle and extended rearward 58 cm (22.8 in). The maximum crush was located at the right rear bumper corner and measured 14 cm (5.5 in). The CDC for this impact was 05-RBEE2.

Figure 7: Right rear corner damage.

Interior Damage

The Honda Civic sustained moderate severity interior damage that was attributed to passenger compartment intrusion, air bag deployment, occupant contact points, and occupant loading. The intrusion to the passenger compartment is listed in the following table:

Position	Component	Direction	Magnitude
Row 1 Left	Windshield	Longitudinal	7 cm (2.8 in)
Row 1 Center	Windshield	Longitudinal	13 cm (5.1 in)
Row 1 Right	Windshield	Longitudinal	14 cm (5.5 in)
Row 1 Left	Left instrument panel	Longitudinal	2 cm (0.8 in)
Row 1 Center	Center instrument panel	Longitudinal	7 cm (2.8 in)
Row 1 Right	Right instrument panel	Longitudinal	9 cm (3.5 in)
Row 1 Right	Toe pan	Longitudinal	46 cm (18.1 in)
Row 1 Right	A-pillar	Lateral	18 cm (7.1 in)
Row 1 Right	Side panel forward of A-pillar	Lateral	18 cm (7.1 in)

The driver contacted the knee bolster evidenced by a 9 cm (3.5 in) wide scuff to the bolster panel. The scuff was located 4-14 cm (1.6-5.5 in) above the bottom of the bolster and 17-26 cm (6.7-10.2 in) inboard of the left side of the instrument panel.

Manual Safety Belt Systems

The manual restraint systems in the Honda Civic consisted of three-point lap and shoulder belts in 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 utilized both retractor and buckle pretensioners, both of which actuated during the crash. The front left belt was locked in the used position by the actuation of the retractor pretensioner. The webbing was gathered in the latch plate. The latch plate was located 78 cm (30.7 in) above the floor anchor. Two contacts were noted on the belt webbing. A frictional abrasion located 172-176 cm (67.7-69.3 in) above the floor anchor and stretching located 120-148 cm (47.2-58.3 in) above the floor anchor. The driver was restrained at the time of the crash based on the observations of the SCI inspection.

The front right and the second row safety belt systems utilized continuous loop webbing, a switchable ELR/Automatic Locking Retractor (ALR), a sliding latch plate and a fixed height D-

ring. The front right restraint system contained a retractor and a buckle mounted pretensioner which did not actuate in this crash.

Frontal Air Bag System

The Honda Civic 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 detection sensor, safety belt pretensioners, and safety belt buckle switches. 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 was concealed within the center hub of a three-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 lower flaps dimensions were mirrored symmetrically, the upper aspects measuring 7 cm (2.8 in) in width at the horizontal tear seam, the outboard sides measuring 7 cm (2.8 in) in height vertically and the lower aspects measuring 3 cm (1.2 in) horizontally. The air bag (**Figure 8**) measured 60 cm (23.6 in) in diameter in its deflated state. The air bag was vented by two ports located at the eleven and one o'clock positions. The air bag was tethered by two straps located at the twelve and six 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 contacts to the driver's frontal air bag, but the upper left quadrant contained multiple droplets of an unidentified gritty substance. This substance was distributed in a semi-circular arc around the upper left quadrant, beginning 20 cm (7.9 in) and ending 30 cm (11.8 in) from the center of the air bag.

Figure 8: 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, as designed.

Side Impact Air Bag System

The Honda was equipped with front seat back-mounted side impact air bags and roof side rail-mounted curtain air bags. The right side impact air bag and the right curtain air bag deployed during this crash. The right side impact air bag (**Figure 9**) deployed from a 35 cm (13.8 in) long seam in the upper outboard aspect of the front right 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 three o'clock position. There was no contact evidence on the side air bag.

Figure 9: Deployed right side impact air bag.

The right side curtain air bag deployed from the right roof side rail (**Figure 10**). The air bag measured 137 cm (53.9 in) in length and 41 cm (16.1 in) in height at the front seating position, including a 4 cm (1.6 in) non-inflating strip at the bottom of the fabric. In the rear seating position, the air bag measured 36 cm (14.2 in) in height. At the rear of the curtain, the inflatable section of the air bag 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. There was an inflatable tube 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. The curtain was tethered to the A-pillar by a 28 cm (11 in) webbing strap. Vertically, the curtain air bag extended below the belt line at each outboard position approximately 5 cm (2 in). The curtain air bags provided head protection from the roof side rail to the belt line from the B-pillar forward 74 cm (29.1 in) and from the C-pillar forward 33 cm (13 in). There was an unprotected opening at A-pillar measuring 44 cm (17.3 in) in width and 24 cm (9.4 in) in height. The right curtain air bag was free from occupant contact points and damage.

Figure 10: Deployed right curtain air bag.

Occupant Demographics/Data

Driver Age/Sex:	29-year-old / female
Height:	165 cm (65 in)
Weight:	75 kg (165 lb)
Eyewear:	None
Seat Track Position:	Mid-track, 10 cm (3.9 in) fwd. of full-rear
Manual Safety Belt Use:	Lap and shoulder belt
Usage Source:	SCI vehicle inspection
Egress from Vehicle:	Removed from vehicle while unconscious
Mode of Transport from Scene:	Ground ambulance
Type of Medical Treatment:	Hospitalized 1 day

Driver injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Lower abdominal wall contusion	Minor (590402.1,8)	Safety belt
Lower lip abrasion	Minor (290202.1,8)	Deployed driver air bag
Posttraumatic air collection in the anterior mediastinum	Not codeable under AIS rules	Crash force

Driver Kinematics

The 29-year-old female driver was seated in a mid-track position and was restrained by the manual three-point lap and shoulder belt. At impact, the driver's pretensioners actuated and the driver frontal air bag, the right side impact air bag and the right curtain air bag deployed. The driver initiated a forward and right trajectory in response to the 2 o'clock direction of the impact force. During her forward trajectory, the driver's left knee contacted the lower left instrument panel evidenced by a scuff to the bolster panel. The driver loaded the locked safety belt system resulting in the abdominal wall contusion. As the driver rode down the force of the crash, her face contacted the deployed driver air bag evidenced by an abrasion to her lower lip.

The Honda rotated counterclockwise from the initial impact and impacted the second tree with the right rear corner resulting in a 5 o'clock direction of force. The driver responded with a rebound trajectory, back into the driver seat where she came to rest. The driver was transported by ground ambulance to a local hospital where she was admitted for treatment of her injuries and for observation. She was released one day post-crash.

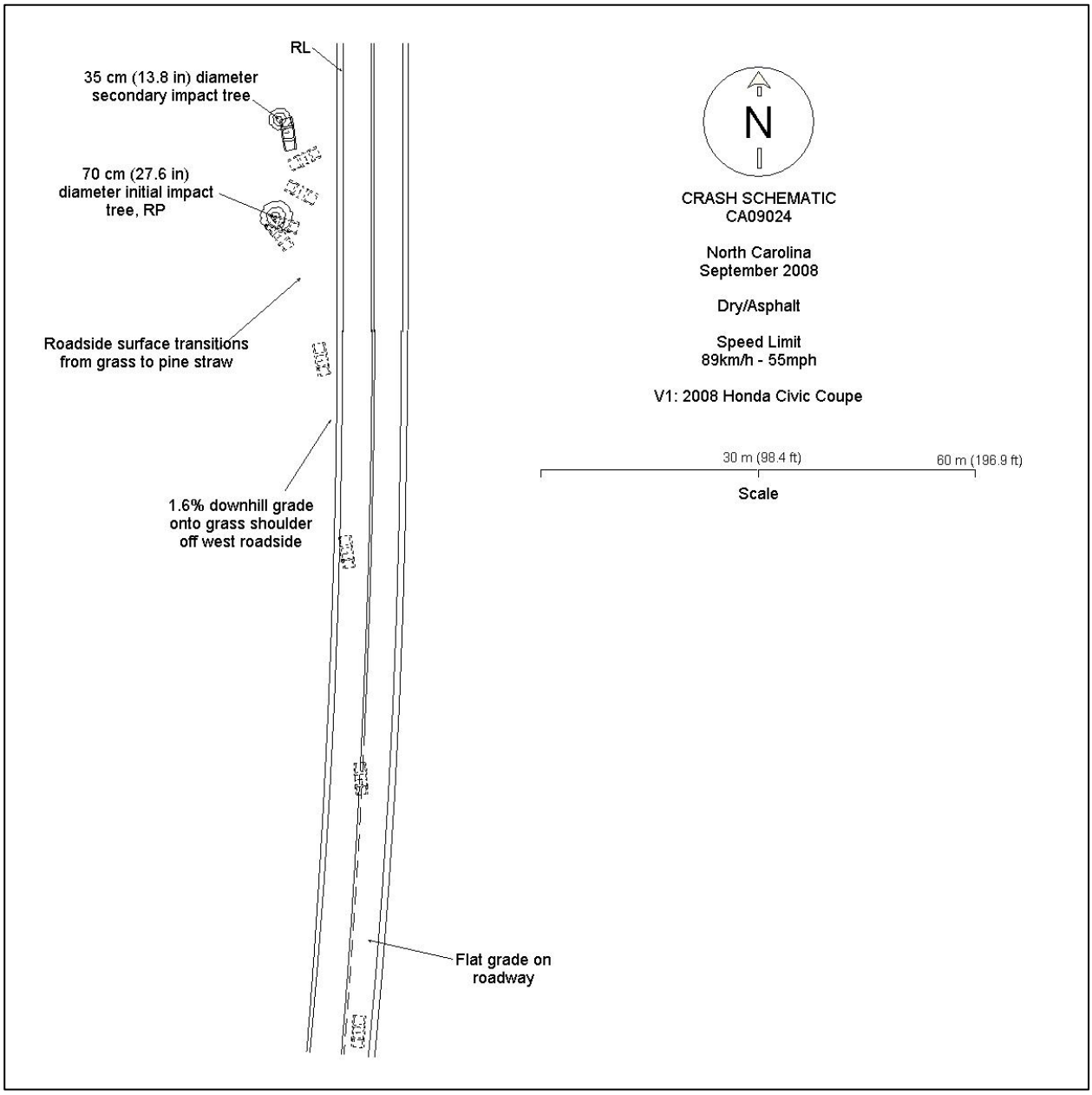

Figure 11: Scene Schematic