

CRASH DATA RESEARCH CENTER

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**CALSPAN ON-SITE ADULT AIR BAG RELATED FATALITY CRASH
INVESTIGATION**

CASE NO: CA05-029

VEHICLE: 2003 HONDA CIVIC LX

LOCATION: VIRGINIA

CRASH DATE: MAY 2005

Contract No. DTNH22-01-C-17002

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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 – 2003 HONDA CIVIC LX.....	2
VEHICLE DATA - 1984 FORD E350-VAN BASED MOTOR HOME.....	2
CRASH SEQUENCE.....	3
PRE-CRASH.....	3
CRASH.....	3
POST-CRASH.....	3
VEHICLE DAMAGE.....	3
EXTERIOR – 2003 HONDA CIVIC.....	3
INTERIOR – 2003 HONDA CIVIC.....	4
FRONTAL AIR BAG SYSTEM.....	5
EVENT DATA RECORDER.....	7
MANUAL SAFETY BELT SYSTEMS.....	7
DRIVER DEMOGRAPHICS/DATA.....	8
DRIVER INJURIES.....	8
DRIVER KINEMATICS.....	9

**CALSPAN ON-SITE DRIVER AIR BAG RELATED FATALITY CRASH
INVESTIGATION
SCI CASE NO.: CA05-029
VEHICLE: 2003 HONDA CIVIC LX
LOCATION: VIRGINIA
CRASH DATE: MAY 2005**

BACKGROUND

This on-site investigation focused on the severity of the crash and the source of injury that contributed to the death of a 70-year old female driver of a 2003 Honda Civic. The Honda was equipped with dual stage frontal air bags and buckle pretensioners for the driver and front right positions. The driver of the Civic was apparently distracted and failed to detect a stopped 1984 Ford E-350 van-based motor home that was stopped ahead of the Civic's path of travel. The full frontal area of the Civic (**Figure 1**) impacted and partially underrode the rear of the motor



Figure 1. Frontal damage to the 2003 Honda Civic.

home. The crash forces deployed the frontal air bags in the Civic and actuated the driver's pretensioner. The driver of the Civic sustained multiple bilateral rib fractures with pneumothoraces and flail chest, fractures of T5 and T6 with a cord contusion, bilateral patella fractures, a chest contusion, and contusions of the extremities. The driver was transported to a regional Level 1 trauma center where she was admitted for a period of nine days prior to her death that was attributed to complications of her injuries.

The crash was reported to NHTSA through the Crash Injury Research and Engineering Network (CIREN) and assigned to the Calspan Special Crash Investigations team on May 10. Cooperation was established to inspect the Civic and the on-site aspect of this case was conducted on May 11, 2005. The investigation involved the inspection of the Honda Civic, documentation of the crash site, and acquisition of the medical data. The motor home was driven from the scene and was not available during this on-site investigation. Additionally, the air bag control module was removed from the vehicle and forwarded to NHTSA for download by Honda. The EDR output data is summarized in this narrative report.

SUMMARY

Crash Site

The crash occurred on a two-lane state route in a commercial area during evening hours. The roadway was wet at the time of the crash. The roadway consisted of two travel lanes that were 3.7 m (12.1') in width and delineated by a double yellow centerline. The road edges were marked with painted white edge lines and bordered by a



Figure 2. Overall westbound view of the crash site.

1.2 m (4') wide north shoulder and a 4.2 m (13.8') wide south shoulder. The south shoulder was paved while the north shoulder was constructed of crushed limestone. In the vicinity of the crash site, the roadway was intersected by two driveways that provided access to a park. The driveways intersected the south edge line and were separated by a 21.2 m (69.6') wide area of grass. The roadway was straight with a positive grade of two percent to the west. The asphalt road surface was recently repaved with a construction site bordering the north shoulder. The posted speed limit was 72 km/h (45 mph). There was no physical evidence at the crash site. **Figure 2** is an overall view of the crash site. The Crash Schematic is attached as **Figure 11** of this narrative report.

Vehicle Data – 2003 Honda Civic LX

The case vehicle in this crash was a 2003 Honda Civic LX, 4-door sedan. The Civic was manufactured in March 2003 and was identified by Vehicle Identification Number (VIN) 2HGES16573H (production number deleted). The electronic odometer was not functioning at the time of the SCI inspection due to the expended vehicle battery. However, the odometer reading was marked on the windshield as 19,090 km (11,862 miles). The vehicle's Gross Vehicle Weight Rating (GVWR) was placarded at 1,560 kg (3,440 lb), distributed 821 kg (1,810 lb) front and 762 kg (1,680 lb) rear. The Honda was powered by a 1.7 liter, transverse mounted I-4 gasoline engine linked to a four-speed automatic transmission with a console mounted shifter. The service brakes were power-assisted front disc/rear drum without anti-lock. The Civic was equipped with OEM steel wheels with Dunlop SP20FE 185/70R14 all-season radials. The manufacturer recommended tire pressure was 210 kPa (30 PSI). The specific tire data at the time of the SCI inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Damage
Left Front	138 kPa (20 PSI)	6 mm (8/32")	None
Left Rear	207 kPa (30 PSI)	6 mm (8/32")	None
Right Front	207 kPa (30 PSI)	6 mm (8/32")	None
Right Rear	221 kPa (32 PSI)	6 mm (7/32")	None

The interior of the Honda Civic was equipped with cloth covered front bucket seats with adjustable head restraints and a bench seat with a split, forward folding seat back. The front head restraints were adjusted to the full down positions. The Civic was also equipped with power windows and door locks, air conditioning, and a center armrest mounted on the console. The safety systems included dual-stage frontal air bags and manual safety belts for the five designated seated positions. These systems are addressed later in this report.

1984 Ford E350-Van Based Motor Home

The struck vehicle in this crash was a motor home that was built on a 1984 Ford E-350 van based chassis. A witness to the crash reported that the vehicle was equipped with a large rear step-type bumper with a 9 kg (20 lb) propane cylinder mounted to the bumper. This cylinder was not ruptured in the crash. The vehicle was driven out-of-state prior to the SCI notification of this crash.

Crash Sequence

Pre-Crash

The driver of the motor home was stopped in a westerly direction and was waiting to turn left into a driveway to the park. The 70-year old female driver of the Honda Civic was traveling in a westerly direction and approached the back of the stopped motor home. She was either distracted or failed to detect the motor home as she continued westbound. The frontal damage to the Civic was skewed to the left indicating a probable right steering maneuver prior to impact. The driver also applied a braking input at or immediately prior to impact. There was no physical evidence at the crash site to support the level of braking. The brake pedal was deformed by driver loading and a shoe scuff mark was present on the rubber pad to support the braking input.

Crash

The full frontal area of the Honda Civic impacted the rear bumper of the motor home. The resultant directions of force were 12 o'clock for the Civic and 6 o'clock for the struck motor home. Initial contact involved the front bumper system of the Civic against the rear bumper of the motor home. As the Honda's bumper crushed to a maximum depth of 30 cm (11.6"), the front bumper underrode the motor home which allowed the grille and hood face to engage the rear of the struck vehicle. A protruding narrow object mounted to the rear of the motor home, possibly a trailer hitch, penetrated the air conditioning condenser and radiator of the Civic right of center. The upper radiator support crushed to a maximum depth of 29 cm (11.5"). The motor home was outside the scope of the WINSMASH program; therefore, a barrier equivalent velocity change of 30 km/h (18.6 mph) was computed for the Honda.

Post-Crash

The Civic came to rest near the point of impact, toward the right edge line of the roadway. The driver remained in the vehicle post-crash and was removed by rescue personnel. She was transported by ground ambulance to a regional Level 1 trauma center where she was admitted for treatment of her injuries. She developed complications due to the injuries and expired nine days following the crash. The occupants of the motor home were not injured. The Honda was towed from the scene of the crash and transferred to a regional insurance salvage yard where it was inspected for this investigation.

Vehicle Damage

Exterior – 2003 Honda Civic

The frontal area of the Honda Civic impacted and partially underrode the rear bumper of the struck motor home. The front bumper fascia was separated from the vehicle and abraded by the road surface; therefore the direct contact damage was documented across the level of the hood face and fenders (**Figure 3**). The damage was full width to the vehicle and measured 144 cm (56.5"). The bumper beam was crushed rearward and displaced upward due to the vertical component of the underride. The upper radiator support also displayed measurable crush which was documented for this investigation. The crush profiles at these levels were as follows (**Figure 4**): Bumper Beam – C1 = 30 cm (11.6"), C2 = 29 cm (11.5"), C3 = 26 cm (10.3"), C4 = 19 cm (7.3"), C5 = 10 cm

(3.8”), C6 = 0 cm; Upper Radiator Support – C1 = 14 cm (5.6”), C2 = 22 cm (8.6”), C3 = 29 cm (11.5”) , C4 = 27 cm (10.6”), C5 = 12 cm (4.75”), C6 = 2 cm (0.9”). The bumper beam crush profile was used for the WINSMASH reconstruction of the vehicle’s delta V. The Collision Deformation Classification (CDC) for this event was 12-FDEW-2.



Figure 3. Frontal damage to the 2003 Honda Civic.



Figure 4. Overhead view of the crush depth at both levels.

A protruding component of the motor home, probably a trailer hitch, penetrated the air conditioning condenser and the radiator of the Civic. These components were not structural; therefore the crush at this level was excluded from the crush profiles.

The Civic’s hood was displaced rearward which resulted in the rear edge of the hood contacting and fracturing the windshield. The hood edge did not penetrate the laminated glazing. All four doors remained closed during the crash and were operation post-crash. The side and backlight glazing remained intact.

Interior – 2003 Honda Civic

The interior of the Honda Civic sustained minor severity damage as a result of air bag deployment and driver loading of frontal components. The frontal air bags deployed during the crash. There was no reduction of the occupant space due to intrusion.

The female driver was restrained by the manual safety belt system. Her loading force against the safety belt resulted in a D-ring transfer to the belt webbing and a subtle transfer to the driver’s side of the shoulder belt webbing. An additional frictional transfer was noted to the lap belt webbing from loading against the latch plate. This is described in further detail in the *Manual Safety Belt* section of this report.

Due to the driver’s presumed forward seat track position, the driver loaded through the deployed driver’s air bag deforming the steering wheel and mounting flange. The gap between the wheel hub and the steering column was closed at the top surface and opened to 1 cm (0.5”) at the bottom (**Figure 5**). The upper steering wheel rim was deformed forward 1 cm (0.4”) at the 12 o’clock sector.

The driver’s left knee contacted the left upper corner area of the bolster panel adjacent to the steering column. This contact scuffed the rigid bolster panel and the mid left

instrument panel 44-48 cm (17.5-19”) left of the vehicle centerline and 29-34 cm (11.5-13.5”) below the upper instrument panel. Her right knee impacted and fractured the steering column cover. The fracture was located 20-33 cm (8-13”) left of center and 28-34 cm (11-13.5”) below the top instrument panel. **Figure 6** depicts both knee contact points.



Figure 5. Steering wheel/column gap reduction.



Figure 6. Driver's knee contacts points.

The driver applied a braking force pre-crash. This was evident by a shoe scuff mark on the brake pedal and deflection of the pedal pad from loading during the crash event.

Frontal Air Bag System

The Honda was equipped with dual-stage frontal air bags for the driver and front right passenger positions. In addition, the Honda was equipped with buckle pretensioners for the front occupant positions. As a result of this front-to-rear crash, the air bags deployed (**Figure 7**) and the driver's pretensioner actuated. The front right seat was unoccupied; therefore the belt system was not engaged to close the buckle switch required to fire the pretensioner.



Figure 7. Deployed Stage Two frontal air bags.

The air bag system was controlled by a passenger mounted sensing and diagnostic module. This module was located on the forward aspect of the center tunnel forward of the transmission shifter. This module also had Event Data Recording (EDR) capabilities. Two external crash sensors were mounted to the outboard forward aspects of the front frame rails. The left sensor mounting bracket was deformed by the crash and the unit was rotated left and rearward as a result of frontal crush. The right sensor was not involved in the crush pattern.

The driver's air bag deployed from an H-configuration module cover that was located within the four spokes of the steering wheel rim. The spokes were positioned at the 3/9

and the 5/7 o'clock sectors. The flaps were 16 cm (6.4") in width at the horizontal tear seam with the face of the upper flap measured 5 cm (2.1") in height while the lower flap measured 7 cm (2.75") vertically. There was no driver contact evidence or damage to the cover flaps.

The driver's air bag membrane was tethered by two 7 cm (2.6") wide straps sewn to the face of the bag at the 12 and 6 o'clock sectors. The maximum air bag excursion at the tether locations was 29 cm (11.5"). The bag was vented by two 4 cm (1.5") diameter ports located within the 11 and 1 o'clock sectors at the top panel of the bag, 19 cm (7.5") forward of the peripheral seam.

There were several areas on the driver's air bag that contained probable tissue and or body fluid transfers (**Figure 8**). It should be noted that this SCI investigator was the second or third person to examine this air bag. Due to the multiple handling of the air bag, these subtle transfers dislodged from the membrane. Markings on the bag by another investigator identified the locations of these transfers.



Figure 8. Circled areas of suspected transfers on the driver's air bag.

The first area of suspected transfer was located 13 cm (5") above the horizontal centerline and 1 cm (0.5") right of center, extending 3 cm (1") left of center. The second area, which also contained dirt from post-crash handling, was located 8-11 cm (3.25-4.25") above the centerline and 5-8 cm (2-3") left of the vertical centerline. Both transfers were located on the upper left quadrant of the air bag. There was no damage or tears of the bag from the deployment sequence.

The front right passenger air bag was a top mount design in the upper right instrument panel. The module was concealed by two H-configuration flaps that were 22 cm (8.75") in width at the horizontal tear seam. The respective vertical dimensions of the flaps were 6 cm (2.5") and 4 cm (1.75"). The front right air bag membrane was not tethered, but vented by two 6 cm (2.5") ports located on the side panels at the 3 and 9 o'clock sectors. The bag measured 56 cm (22") vertically by 34 cm (13.5") horizontally. This air bag was not contacted by the driver or involved in this crash; therefore, there was no damage to the air bag.

This Civic was not equipped with the optional side impact air bags.

Event Data Recorder

The Event Data Recorder (EDR) was harvested from the vehicle by the SCI investigator and forwarded to NHTSA for download. The output data was provided to the SCI team. The Summary Information identified the 2003 Honda as equipped with a dual stage air bag system, buckle pretensioners for the driver and passenger positions, mechanical front crash sensors, and side impact (thorax) air bags with B-pillar mounted sensors. The VIN identifies the Civic as equipped with frontal air bags only. The SCI inspection of the Civic did not identify the seat mounted side air bag option. There were no modules within the seat backs and no tags identifying this option.

The EDR output data identified three parameters associated with this deployment event. The deployment command was recorded at 16 ms after Algorithm Enable. The system recorded the driver's seat belt as buckled and as a result of the crash, a dual stage deployment was provided for driver and front right air bags. The EDR output did not report a delta V for the frontal impact event.

Manual Safety Belt Systems

The 2003 Honda Civic was equipped with manual 3-point lap and shoulder belts in the five designated seated positions. All belt systems utilized continuous loop webbings and sliding latch plates. The driver's retractor was an Emergency Locking Retractor (ELR) with the webbing sensitive feature. The remaining four belt retractors utilized switchable ELR/Automatic Locking Retractors (ALR). The front buckles were equipped with pretensioners. The driver was belted at the time of the crash, therefore the pretensioner actuated for this position. The front right (unoccupied) pretensioner did not fire.

The driver loaded the manual safety belt system in response to the frontal crash forces. Her loading was exhibited by a frictional latch plate transfer on the webbing that was located 104 cm (41") above the floor anchor point. The transfer was 5 cm (1.8") in width. A 4 cm (1.75") diagonally orientated frictional abrasion was noted to the shoulder belt webbing from loading against the D-ring (**Figure 9**). This transfer began 177 cm (69.5") above the referenced anchor point. A third transfer was located on the inside surface of the webbing (side against driver). This transfer appeared to be a subtle fabric transfer from the driver's clothing and located in the vicinity of her left shoulder area. The transfer was located 179-185 cm (70.5-72.75") above the anchor point.



Figure 9. Driver's D-ring transfer.

Driver Demographics/Data

Age/Sex: 70-year old female
 Height: 150 cm (59’’)
 Weight: 66 kg (145 lb)
 Seat Track Position: Presumed forward track based on demographics
 Manual Safety Belt Usage: 3-point lap and shoulder belt system
 Usage Source: Vehicle inspection
 Egress from Vehicle: Removed by rescue personnel
 Mode of Transport from Scene: Transported by ambulance to a Level 1 trauma
 Type of Medical Treatment: Admitted for treatment and expired nine days post-crash due to complications of her injuries

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Multiple bilateral rib fractures with pneumothoraces, pulmonary contusion, and flail chest	Critical (450266.5,3)	Expanding driver’s air bag
Thoracic cord contusion with fracture and dislocation at T5	Serious (640408.3,7)	Indirect injury from the rib fractures and the expanding air bag
Pedicle fracture of the thoracic spine at T6	Serious (650426.3,7)	Indirect injury from the rib fractures and the expanding air bag
Facet fracture of the thoracic spine at T6	Serious (650422.3,7)	Indirect injury from the rib fractures and the expanding air bag
Thoracic vertebral body fracture at T6 with minimal compression	Moderate (650432.2,7)	Indirect injury from the rib fractures and the expanding air bag
Interspinous ligament laceration	Minor (650484.1,7)	Indirect injury from the rib fractures and the expanding air bag
Right patella fracture	Moderate (852400.2,1)	Steering column cover
Left patella fracture	Moderate (852400.2,2)	Knee bolster
Right knee laceration	Minor (890602.1,1)	Steering column cover
Right forearm contusion	Minor (790402.1,2)	Driver’s air bag (possible)
Left chest contusion	Minor (490402.1,2)	Shoulder belt webbing
Right hip contusion	Minor (890402.1,1)	Lap belt webbing/hardware
Left anterior thigh contusion	Minor (890402.1,1)	Steering wheel rim

Source – Trauma center, official records

Driver Kinematics

The 70-year old female driver of the Honda Civic was seated in a presumed forward track position based on her demographics. Family members noted that due to her short stature, the driver sat on a pillow in close proximity to the steering wheel rim and the air bag module. She was restrained by the manual 3-point lap and shoulder belt system with the belt positioned over her left shoulder. Belt usage was confirmed by loading evidence at the hard points of the system and a fabric transfer on the webbing in the area of the right shoulder. Prior to impact, the driver braked in an attempt to avoid the crash. **Figure 10** is a lateral view of the driver's position and her forward trajectory. It should be noted that the seat track was moved to the full rear position prior to the SCI investigation. In this figure, the seat track was arbitrarily positioned 8 cm (3") forward of the full rear position.



Figure 10. Lateral view of the driver's position and trajectory.

At impact, the frontal air bag system deployed and the driver's buckle pretensioner actuated. The EDR data reported a dual stage deployment was commanded at 16 ms after Algorithm Enable. The expanding air bag engaged the driver's chest which compressed the chest resulting in multiple bilateral rib fractures with pneumothoraces and flail chest. The air bag induced compression of the rib cage lacerated the interspinous ligament of the thoracic spine, fractured the pedicle and facet at T6, fractured the vertebral body at T6, fractured and dislocated T5 with cord contusion. The driver sustained a right forearm contusion that possibly resulted from the initial expansion of the driver's air bag.

The driver responded to the frontal crash forces by initiating a forward trajectory and loading the manual safety belt system that produced a contusion over the left chest and the right hip. Due to her forward pre-crash position and her forward trajectory, the driver's torso and head loaded the air bag. Her loading force was transmitted through the bag and into the steering assembly resulting in 1 cm (0.4") of bending to the upper steering wheel rim and the steering wheel flange, thus closing the top gap between the steering wheel hub and the column.

Her left knee contacted and scuffed the left aspect of the knee bolster resulting in a fracture of the patella. The driver's right knee impacted and fractured the plastic steering wheel cover, compressing the cover into the steering column. This contact resulted in a laceration over the knee and a fracture of the right patella. The driver's left thigh contacted the bottom edge of the steering wheel rim producing a soft tissue contusion. Her right foot loaded the brake pedal which deformed the pedal and produced a shoe loading scuff to the rubber pedal pad.

The driver rebounded into the left front seat back where she came to rest. The forward positioned seat back minimized her rebound trajectory and distributed her rebound force over a large body area, thus reducing the possibility of further injury.

The driver was removed from the Honda Civic by emergency medical personnel and transported by ambulance to a regional Level 1 trauma center where she was admitted for treatment of her injuries. She expired nine days post-crash to complications of the chest injuries.

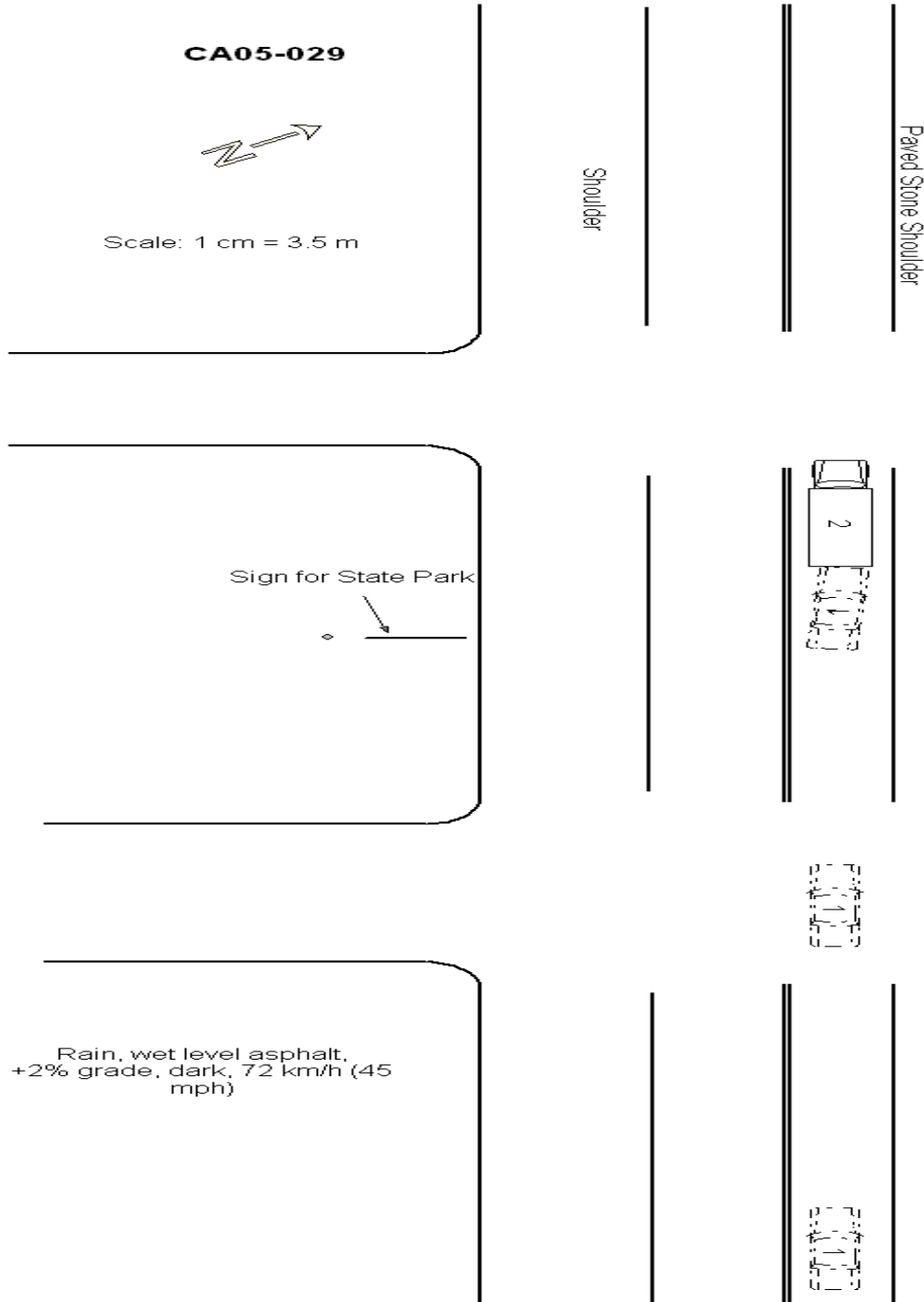


Figure 11. Crash Schematic

