TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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REDESIGNED AIR BAG SPECIAL STUDY (RABSS)
SCI TECHNICAL SUMMARY REPORT

NASS RABSS CASE NO. 1998-45-804J

RABSS VEHICLE - 1998 HONDA CIVIC LX

LOCATION - STATE OF TENNESSEE

CRASH DATE - NOVEMBER, 1998

Contract No. DTNH22-94-D-07058

Prepared for:

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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 investigation focused on a single vehicle crash involving a 1998 Honda Civic LX 4-door sedan. The Honda Civic was equipped with redesigned frontal air bags that deployed as a result of a frontal collision with a large diameter tree. The Honda was westbound on a 2 lane rural roadway and negotiating a left curve when (for unknown reasons) the vehicle departed the right (north) pavement edge and subsequently re-entered the roadway in a counterclockwise yaw. The vehicle departed the left (south) pavement edge where the front right area impacted a large diameter tree resulting in severe damage. The vehicle came to rest off the south pavement edge facing northeast. The 40 year old female driver was improperly restrained by the available 3-point manual lap and shoulder belt system (lap belt worn over the abdomen/shoulder belt worn under the arm), seated in an upright posture with the seat track adjusted to the middle position. At impact, she initiated a forward/lateral trajectory in response to the 1 o'clock impact force and loaded the manual restraint which resulted in fractures of the left 6th and 7th ribs, a lacerated ileum, mesentery and colon. Her lower extremities loaded the knee bolster and steering column resulting in fractures of the left tibia and fibula. The driver continued the kinematic response pattern into the center and right instrument panel resulting in a cerebral contusion and subarachnoid hemorrhage. The driver was transported to a local hospital for treatment and admitted for 11 days.			
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CRASH DATE - NOVEMBER, 1998

BACKGROUND

This investigation focused on a single vehicle crash involving a 1998 Honda Civic LX 4-door sedan. The Honda Civic was equipped with redesigned frontal air bags that deployed as a result of a frontal collision with a large diameter tree. The Honda was westbound on a 2 lane rural roadway and negotiating a left curve when (for unknown reasons) the vehicle departed the right (north) pavement edge and subsequently re-entered the roadway in a counterclockwise yaw. The vehicle departed the left (south) pavement edge where the front right area impacted a large diameter tree resulting in severe damage. The vehicle came to rest off the south pavement edge facing northeast. The 40 year old female driver was improperly restrained by the available 3-point manual lap and shoulder belt system (lap belt worn over the abdomen/shoulder belt worn under the arm), seated in an upright posture with the seat track adjusted to the middle position. At impact, she initiated a forward/lateral trajectory in response to the 1 o'clock impact force and loaded the manual restraint which resulted in fractures of the left 6^{th} and 7^{th} ribs, a lacerated ileum, mesentery and colon. Her lower extremities loaded the knee bolster and steering column resulting in fractures of the left tibia and fibula. The driver continued the kinematic response pattern into the center and right instrument panel resulting in a cerebral contusion and subarachnoid hemorrhage. The driver was transported to a local hospital for treatment and admitted for 11 days.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as case number 98-45-804J for the Redesigned Air Bag Special Study. The Field Operations Branch of the National Highway Traffic Safety Administration (NHTSA) assigned the Special Crash Investigation (SCI) team at Veridian/Calspan the task of case review and final report preparation.

SUMMARY

Crash Site

This single vehicle crash occurred during the early morning hours of November, 1998. At the time of the crash, it was dark (no street lights) with no adverse conditions as the roads were dry. The crash occurred off the south pavement edge of an east/west 2 lane rural (asphalt) roadway which curved to the left for westbound traffic **(see Figure 9 - page 7)**. The speed limit at the crash scene was 48 km/h (30 mph).

Pre-Crash

The 40 year old female driver of the 1998 Honda Civic LX was operating the vehicle westbound and negotiating a left curve when (for unknown reasons) the vehicle departed the right (north) pavement edge. The vehicle continued in a tracking mode for an estimated 65.0 meters (213.3 ft). Upon recognition of the impending harmful event, the driver steered left and braked [30.0 meters (98.4 ft) of pre-impact yaw marks

documented at the crash site] and re-entered the roadway in a 30 degree sideslip angle. At this point, the vehicle departed the left (south) pavement edge and traveled approximately 6.0 meters (19.7 ft) prior to impact.

Crash

As the Honda Civic departed the left (south) pavement edge of the 2 lane rural roadway, the front right area struck a large diameter tree resulting in severe damage **(Figure 1)**. The impact induced deceleration was sufficient to deploy the Honda's redesigned frontal air bag system. The damage and trajectory algorithm of the WinSMASH program computed an impact speed of 26.9 km/h (16.7 mph) with a (barrier equivalent) velocity change of 40.9 km/h (25.4 mph). The specific longitudinal component was -31.4 km/h (-19.5 mph). The Collision Deformation Classification (CDC) for this impact to the Honda was 01-FREE-5. The vehicle rotated counterclockwise approximately 180 degrees before coming to rest in close proximity to the point of impact facing northeast.

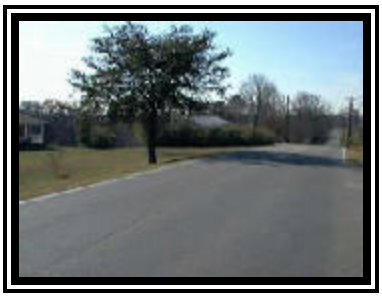

Figure 1. Westbound approach for the 1998 Honda Civic LX.

Post-Crash

Treatment was rendered at the scene by fire department personnel and emergency medical technicians (EMT's). The driver was removed from the vehicle with perceived serious injuries. The driver was transported to a local hospital for treatment and admitted for 11 days. The vehicle was towed from the scene.

RABSS VEHICLE

The 1998 Honda Civic LX was identified by the Vehicle Identification Number (VIN): 1HGEJ6678WL (production sequence deleted). The vehicle was a 4-door sedan equipped with front wheel drive and a 1.6 liter, 4 cylinder engine. Air bag warning labels were affixed to each front sun visor. The police report listed the driver as the owner of the vehicle. The vehicle's odometer reading was 5,510 km (3,424 miles) at the time of the crash. The seating was configured with front bucket seats and a folding (back) rear bench. The NASS researcher reported no cutoff switch for the redesigned passenger air bag. The interviewee reported no previous crashes or maintenance on the Honda's air bag system (original equipment). No cell phone was present or in-use at the time of the collision.

VEHICLE DAMAGE

Exterior Damage

The Honda Civic sustained severe frontal damage as a result of the impact with the tree **(Figure 2)**. The direct contact damage began at the front right bumper corner and extended 36.0 cm (14.2 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 55.0 cm (21.7 in). Six crush measurements were documented at the level of the reinforcement bar (bumper fascia

Figure 2. Frontal damage to the 1998 Honda Civic LX.

separation): C1 = 9.0 cm (3.5 in), C2 = 17.0 cm (6.7 in), C3 = 31.0 cm (12.2 in), C4 = 44.0 cm (17.3 in), C5 = 53.0 cm (20.9 in), C6 = 70.0 cm (27.6 in). The hood was displaced up and rearward from engagement against the tree. The right fender was displaced rearward to the A-pillar which restricted/deflated the right front wheel/tire and shattered the side glazing **(Figure 3)**. Induced buckling was noted to the roof area between the A-pillar and B-pillar. The windshield was fractured from exterior forces and the (interior) front right air bag module cover flap. Extrication damage was documented to the right A-pillar (cut) and right front door (removed).

Figure 3. Right side view.

Interior Damage

Interior damage to the Honda Civic identified through the NASS vehicle inspection was moderate and was attributed to occupant contact **(Figure 4)**. The front left restraint energy management loop deployed at the lower anchorage point (belt cut by EMS during the driver's extrication from the vehicle). In addition, loading marks were documented to the D-ring at the upper anchorage point. Blood spattering was noted to the (left) upper and lower quadrants of the driver air bag and left section of the passenger air bag. The left knee bolster was deformed (rigid plastic type). The steering column cover panel was fractured (tilt column set to center position) with 1.0 cm (0.4 in) of deformation to the lower section of the steering wheel rim **(Figure 4)**. The brake pedal was deformed forward into the (intruded) toepan. The center instrument panel was fractured and displaced to the right with smudge marks noted to the mid section. An indentation was documented on the right mid-instrument panel with make-up transfers to the surrounding area **(Figure 5)**. The floor mounted transmission lever was displaced to the right. The windshield was fractured from the front right air bag module cover flap. Longitudinal intrusions into the front right passenger space included 18.0 cm (7.1 in) of toepan intrusion and 26.0 cm (10.2 in) of instrument panel intrusion. A 7.0 cm (2.8 in) longitudinal toepan intrusion was also documented to the driver space.

Figure 4. Bolster/column damage.

Figure 5. Instrument panel damage.

REDESIGNED AIR BAG SYSTEM

The 1998 Honda Civic LX was equipped with redesigned frontal air bags for the driver and front right passenger positions. The air bags deployed as a result of the crash. The driver air bag was housed in the center of the steering wheel with a horizontally oriented flap tear seam (H-configuration). The flaps were rectangular in shape as the upper flap measured 14.0 cm (5.5 in) in width and 7.0 cm (2.8 in) in height while the lower flap measured 14.0 cm (5.5 in) in width and 5.0 cm (2.0 in) in height. There was no contact evidence identified on the exterior surface of the module cover flaps, but blood spattering was noted at the (left) upper and lower quadrants of the air bag attributed to the driver's facial injury. The NASS researcher measured the diameter of the driver air bag at 48.0 cm (18.9 in) in its deflated state **(Figure 6)**. The bag was tethered by two internal straps and vented by two ports located at the 11 o'clock and 1 o'clock sectors on the rear aspect of the air bag.

Figure 6. 1998 Honda Civic LX redesigned driver air bag.

Figure 7. 1998 Honda Civic LX redesigned passenger air bag.

The front right passenger air bag deployed from a top mount module in the right instrument panel with a horizontally oriented flap tear seam (H-configuration). The cover flaps were rectangular/symmetrical in shape and measured 23.0 cm (9.1 in) in width and 5.0 cm (2.0 in) in height. Damage was noted to the lower windshield from the passenger air bag module cover flap. Although no contact evidence was identified on the exterior surface of the module cover flaps, blood spattering was documented to the left portion of the passenger air bag attributed to the driver's facial injury. The NASS researcher measured the passenger air bag at 55.0 cm (21.7 in) in width and 70.0 cm (27.6 in) in height in its deflated state **(Figure 7)**. No internal tether straps were present. The air bag was vented by two ports located at the 10 o'clock and 2 o'clock sectors on the side aspect of the air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	40 year old female
Height:	165 cm (65 in)
Weight:	54 kg (118 lb)
Seat Track Position:	Middle position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, surrogate interview, medical reports
Eyeware:	Prescription glasses
Type of Medical Treatment:	Transported to a local hospital and admitted (11 days)

Driver Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
Laceration ileum (massive)	Severe (541426.4,8)	Lap restraint
Subarachnoid hemorrhage cerebrum	Serious (140684.3,1)	Right instrument panel
Contusion cerebrum (small-5mm)	Serious (140606.3,1)	Right instrument panel
Fracture left 6th and 7th ribs	Serious (450250.3,2)	Shoulder restraint
Fracture left tibia (shaft)	Serious (853422.3,2)	Steering column
Fracture left tibia (medial malleolus)	Moderate (853412.2,2)	Toepan (indirect contact injury)
Fracture left fibula	Moderate (851606.2,2)	Steering column
Closed head injury (lethargic on admission - GCS 9-14)	Moderate (160602.2,0)	Right instrument panel
Laceration colon	Moderate (540822.2,8)	Lap restraint
Contusion colon	Moderate (540810.2,8)	Lap restraint
Laceration mesentery	Moderate (542020.2,8)	Lap restraint
Fracture right calcaneus (heel)	Moderate (851400.2,1)	Toepan
Contusion right eyelid	Minor (297402.1,1)	Center instrument panel
Contusion left eyelid	Minor (297402.1,2)	Center instrument panel
Contusion face (whole)	Minor (290402.1,0)	Center instrument panel
Contusion abdomen	Minor (590402.1,9)	Lap restraint
Dislocation subtalar joint	Minor (851203.1,1)	Brake pedal (indirect contact injury)
Contusion bilateral lower extremities (distal to the knee)	Minor (890402.1,3)	Knee bolster
Laceration chin	Minor (290602.1,8)	Center instrument panel

Driver Kinematics

The 40 year old female driver of the Honda Civic was improperly restrained by the available 3-point manual lap and shoulder belt system with the lap belt positioned over the abdomen and the shoulder belt positioned under the arm (anchorage adjustment placed to the full down position). She was seated in an upright posture with the seat back slightly reclined and the seat track adjusted to the middle position.

At impact, she initiated a forward/lateral trajectory in response to the 1 o'clock impact force and loaded the manual belt which resulted in fractures of the left 6th and 7th ribs, contusions to the abdomen, a lacerated ileum, mesentery and colon. Belt *usage* was confirmed by the deployment of the energy management loop at the lower anchorage point and webbing cut during the driver's extrication from the vehicle **(Figure 8)**. Belt *placement* was evidenced by the nature of injuries sustained relative to the extent of the occupant kinematic response pattern into the right instrument panel. Given the direction of force and counterclockwise (post-impact) rotation of the vehicle, contact to the driver redesigned air bag was unlikely. Her lower extremities loaded the knee bolster/steering column resulting in fractures of the left tibia/fibula and bilateral contusions (distal to the knee), evidenced by the fractured knee bolster and steering column panel. She sustained an additional fracture of the tibia (medial malleolus) from contact to the (intruded) toepan. Loading to the brake pedal resulted in a fractured right heel and dislocated ankle as evidenced by the deformed brake pedal in conjunction with pre-impact brake marks documented at the crash site.

Figure 8. Energy management loop deployment at lower anchorage point (belt cut by EMS).

At this point, the placement of the shoulder belt under the arm allowed the driver's upper torso to flex forward and to the right (lap belt riding low on the pelvic region - holding the driver into place) as she continued the kinematic response pattern into the center and right instrument panel. Contact to the center instrument panel resulted in a laceration to the chin and contusions to the face and both eyelids, evidenced by the smudge marks and deformation documented to this component. Contact to the right instrument panel resulted in a cerebral contusion and subarachnoid hemorrhage as evidenced by the indentation and surrounding make-up transfers. She probably contacted the redesigned passenger air bag as evidenced by the blood spattering noted to the left section of the air bag. The driver was transported to a local hospital for treatment and admitted for 11 days. The medical report stated her blood alcohol content was .20.

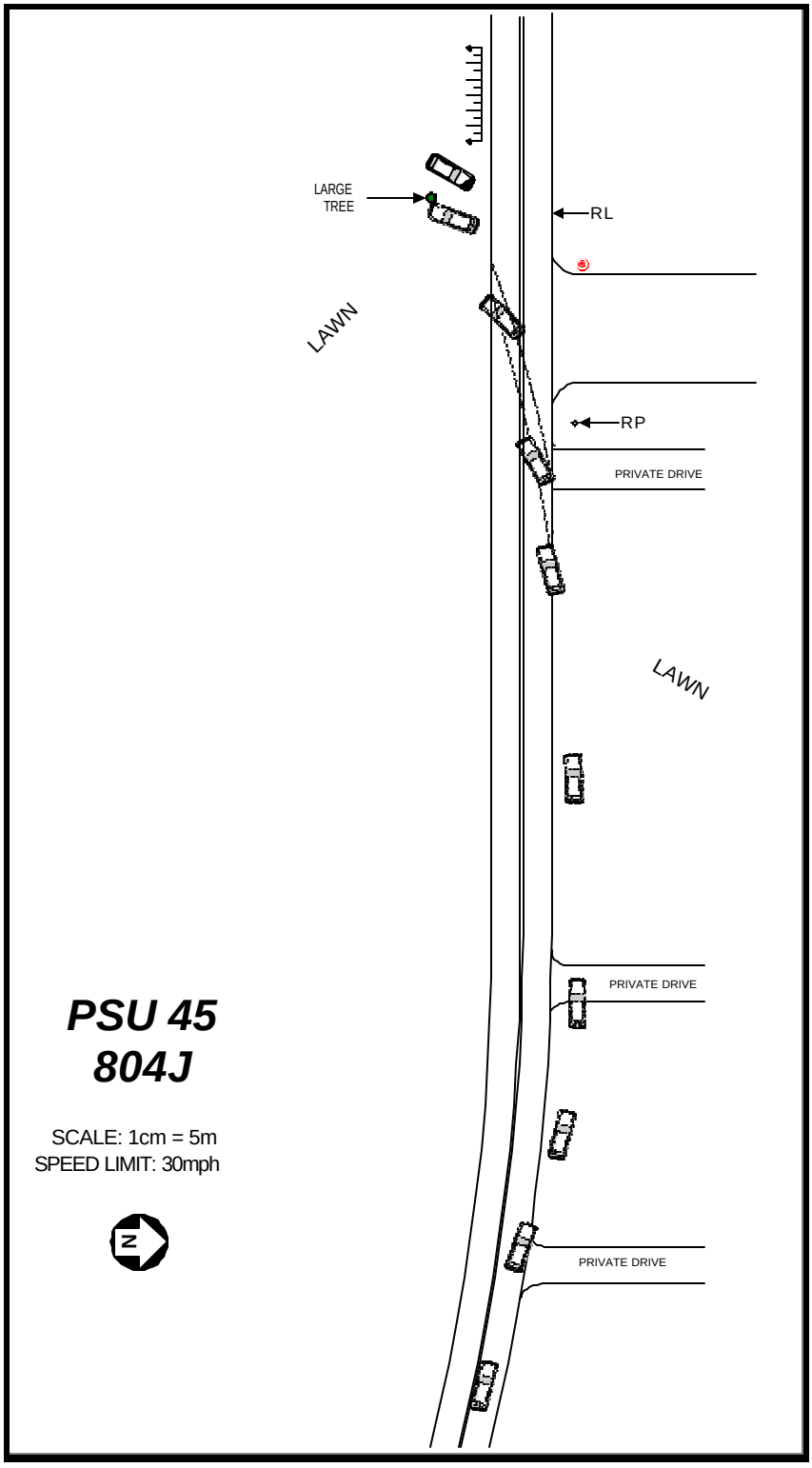

Figure 9. NASS Scene Diagram