Combination Child Safety Seat Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: 2006-81-042B
1989 Honda Civic
Washington
May 2006

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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 be 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

The focus of this remote investigation was on the performance of a child safety seat installed in the rear seat of a 1989 Honda Civic. This three vehicle crash occurred in Washington. The case vehicle is a 1989 Honda Civic four-door sedan driven by a 24-year-old male. There were three additional occupants in the vehicle. The first other vehicle was a 1988 Chevrolet Camaro driven by a male. The second other vehicle was a 1993 Toyota pickup that was legally parked and not in transport. The crash occurred within the confines of a four-leg intersection. The Chevrolet Camaro was traveling northbound. The 1993 Toyota pickup was parked. At the intersection, the Honda Civic driver stopped the vehicle and then proceeded through the intersection. The driver of the Chevrolet Camaro failed to stop, entered the intersection, and struck the right side of the Civic. The 9-month-old second row right side occupant of the Honda was ejected and fatally injured. The Camaro entered the northern leg of the intersection and struck the rear of the Toyota pickup. The driver of the case vehicle sustained a concussive head injury, a shoulder sprain, a cervical spine strain, a scalp contusion, and a lower extremity abrasion. He was transported to a local trauma center. The 2-year-old second row middle seat occupant sustained brain injuries. The 22-year-old female second row right occupant sustained brain injuries, multiple chest and pelvic fractures, and internal injuries. The 9-month-old child was transported to a local trauma center where she died shortly after arrival.

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Dynamic Science, Inc.
Crash Investigation
Case Number: 2006-81-042B

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BACKGROUND

Figure 1. Right side damage, Honda Civic

The focus of this remote investigation was on the performance of a chid safety seat installed in the rear seat of a 1989 Honda Civic. An Evenflo infant safety seat was present in the front right seat of the Civic, but was unoccupied at the time of the crash. This three vehicle crash occurred in Washington in May 2006 at 2134 hours. The case vehicle is a 1989 Honda Civic four-door sedan driven by a 24-year-old male. There were three additional occupants in the vehicle: a 2-year-old male who was seated in the second row middle seat position and was restrained in a child safety seat, a 22-year-old female who was seated in the second row right seat position, and a 9-month-old female who was seated in the lap of the second row right occupant. The first other vehicle was a 1988 Chevrolet Camaro driven by a male. The second other vehicle was a 1993 Toyota pickup that was legally parked and not in transport. The crash occurred within the confines of a four-leg intersection. The Chevrolet Camaro was traveling northbound. The 1993 Toyota pickup was unoccupied and legally parked in the northern leg of the intersection facing north. At the intersection, the Honda Civic driver stopped the vehicle and then proceeded through the intersection. The driver of the Chevrolet Camaro failed to stop, entered the intersection, and struck the right side of the Civic (see Figure 1). The Civic began a rapid clockwise rotation. During the rotation, the 9-month-old second row right side occupant was ejected and fatally injured. The Civic continued rotating before coming to rest off-road in the northeast quadrant facing northwest. The Chevrolet Camaro was redirected slightly to the right and continued traveling northbound. The Camaro entered the northern leg of the intersection and struck the rear of the Toyota pickup. The 24-year-old driver of the case vehicle sustained a concussive head injury, a shoulder sprain, a cervical spine strain, a scalp contusion, and a lower extremity abrasion. He was transported to a local trauma center. He was treated for his injuries and then released after being under observation for his head injury. The 2-year-old second row middle seat occupant sustained brain injuries. He was transported to a local trauma center. The 22-year-old female second row right occupant sustained brain injuries, multiple chest and pelvic fractures, and internal injuries. She was transported to a local trauma center. The 9-month-old child had come to rest under a bush in the northeast quadrant of the intersection. She was found unresponsive, with a faint pulse, and with difficulty breathing. She was transported to a local trauma center where she died shortly after arrival. The case vehicle was towed due to damage.

The crash was identified by the local National Automobile Sampling System (NASS) team via a Field Safety Notification. The team had reported that the second row middle occupant was in a child safety seat and sustained serious head injuries during a side impact. DSI was assigned the case on October 20, 2006.

SUMMARY

Crash Site

The crash occurred within the confines of a four-leg intersection. The intersection is controlled by stop signs in all directions. The roadways were wet at the time of the crash and the streetlights were on. The intersecting roadways were of asphalt construction. They were straight and level. The speed limit in all directions is 40 km/h (25 mph).

Figure 2. Eastern approach to impact area (Honda Civic)

Pre-Crash

The case vehicle is a 1989 Honda Civic four-door driven by a 24-year-old male. There were three additional occupants in the vehicle: a 2-year-old male who was seated in the second row middle seat position and was restrained in a child safety seat, an unrestrained 22-year-old female who was seated in the second row right seat position, and a 9-month-old female who was seated in the lap of the second row right occupant.

The Honda Civic was initially traveling eastbound and stopped at the stop sign (see Figure 2). The Chevrolet Camaro was traveling northbound (see Figure 3). The 1993 Toyota pickup was unoccupied and legally parked in the northern leg of the intersection facing north. At the intersection, the Honda Civic driver stopped the vehicle and then proceeded through the intersection.

Figure 3. Northern approach to area of impact (Chevrolet Camaro)

Crash

The driver of the Chevrolet Camaro failed to stop, entered the intersection, and struck the right side of the Civic with its front end (see Figure 4). The right side window and backlight of the Civic disintegrated during the impact. The Civic began a rapid clockwise rotation. There was a secondary impact between the front of the Honda and the right side of the Camaro as the Honda was spun around. During the rotation, the 9-month-old second row right side occupant was ejected and fatally injured. The Civic continued rotating before coming to rest off-road in the northeast quadrant facing northwest. The Chevrolet Camaro was redirected slightly to the right and continued traveling northbound. The Camaro entered the northern leg of the intersection and struck the rear of the Toyota pickup (see Figure 5).

Post-Crash

The 24-year-old driver of the case vehicle sustained a concussive head injury, a shoulder sprain, a cervical spine strain, a scalp contusion, and a lower extremity abrasion. He was able to exit the vehicle under his own power. He was transported to a local trauma center. He arrived with a Glasgow Coma Scale (GCS) score of 15. He was treated for his injuries and then released after being under observation for his head injury. He lost 60 working days.

Figure 4. Front, 1988 Chevrolet Camaro

The 2-year-old second row middle seat occupant sustained serious brain injuries. He was transported to a local trauma center and was hospitalized for 22 days.

The 22-year-old female second row right occupant sustained brain injuries, pelvic fractures; and injuries to the liver, spleen, kidney, colon and lungs. She was unable to exit the vehicle under her own power. The doors were jammed but she was not otherwise entrapped. She was transported to a local trauma center. She arrived with a GCS score of 15.

Figure 5. Rear damage, 1993 Toyota pickup

The 9-month-old child had come to rest under a bush in the northeast quadrant of the intersection. She was found unresponsive, with a faint pulse, and with difficulty breathing. She sustained a thoracic spinal cord laceration, rib fractures, skull fractures, subarachnoid hemorrhage, and multiple contusions and abrasions. She was transported to a local trauma center where she died shortly after arrival.

The case vehicle was towed due to damage.

VEHICLE DATA -1989 Honda Civic

The 1989 Honda Civic was identified by the Vehicle Identification Number (VIN): 1HGED355XKAxxxxxx. The Civic was a four-door sedan that was equipped with a 1.5 liter, four-cylinder engine, a manual transmission, and front wheel drive.

The 1989 Honda Civic was equipped with Copper Zeon ZPT P205/40R16 tires on the front, a Falken ZE502 P205/40R16 tire on the left rear, and a BF Goodrich Control P185/70R13 tire on the right rear. The specific tire data is as follows:

Tire	Tread	Measured Pressure	Recommended pressure
LF	6 mm (8/32 in)	228 kPa (33 psi)	345 kPa (50 psi)
LR	5.5 mm (7/32 in)	200 kPa (29 psi)	345 kPa (50 psi)
RF	6 mm (8/32 in)	228 kPa (33 psi)	345 kPa (50 psi)
RR	5 mm (6/32 in)	Flat	241 kPa (35 psi)

The seating in the Honda Civic was configured with front bucket seats and a rear bench seat with a folding back. The driver's seat was adjusted to the forward most track position and the seat back was upright. The front right passenger seat was unoccupied.

VEHICLE DAMAGE

Exterior Damage - 1989 Honda Civic

The 1989 Honda Civic sustained moderate right side damage as a result of the impact with the Chevrolet Camaro (see Figure 6). The direct damage began 51.0 cm (20.1 in) aft of the rear axle and extended 173.0 cm (68.1 in) forward along the right side plane. The front right, left rear and right rear doors were jammed shut. The windshield was cracked from impact forces. The right rear windows and the backlight were disintegrated. Six crush measurements were documented at the mid door level as follows: C1 = 1.0 cm (0.4 in), C2 = 33.0 cm (13.0 in), C3 = 37.0 cm (14.6 in), C4 = 33.0 cm (13.0 in), C5 = 16.0 cm (6.3 in), C6 = 0 cm (0 in).

Figure 6. Honda Civic, right side damage

The Honda Civic also sustained minor damage to the front bumper as a result of contacting the Chevrolet Camaro during rotation (see Figure 7). The direct damage began at the front right bumper corner and extended 13.0 cm (5.1 in) laterally along the front bumper.

Figure 7. Honda Civic, front right bumper corner damage

CDC:	Impact 1: 03RZEW3 Impact 2: 12FRLE1	
Delta V (Impact 1):	Total	26 km/h (16.2 mph)
	Longitudinal	-45 km/h (-27.9 mph)
	Latitudinal	-26 km/h (-16.2 mph)
	Energy	49,952 joules (36,842 ft-lbs)

Interior Damage - 1989 Honda Civic

The 1989 Honda Civic sustained moderate interior damage as a result of passenger compartment intrusion (see Figure 8). The right side doors, B pillar, C pillar and roof side rail sustained lateral intrusion. As a result of the lateral intrusion, the second row right seat cushion and seat back were compressed laterally.

The specific passenger compartment intrusions were documented as follows:

Position	Intruded Components	Magnitude of intrusion	Direction
FR	B pillar	25.0 cm (9.8 in)	Lateral
FR	Door side panel	26.0 cm (10.2 in)	Lateral
FR	Roof side rail	8.0 cm (3.1 in)	Lateral
FM	Front seat back	10.0 cm (3.9 in)	Lateral
RR	Door side panel	20.0 cm (7.9 in)	Lateral
RR	Roof side rail	5.0 cm (1.9 in)	Lateral
RR	Floor pan	25.0 cm (9.8 in)	Lateral
RR	C pillar	>= 8.0 cm (3.1 in) < 15.0 cm (5.9 in)	Lateral

Figure 8. Intrusion at second row right door

Manual Restraint Systems - 1989 Honda Civic

The 1989 Honda Civic was configured with manual 3-point lap and shoulder belts for each outboard seating position. The second row middle seat was configured with a lap belt. Both front seat safety belts were equipped with anchorage adjusters that were in the full up position. The driver's safety belt was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). The front right safety belt was configured with a sliding latch plate and an unknown type retractor. The rear outboard safety belts were configured with sliding latch plates and ELR retractors. The middle lap belt was configured with a locking latch plate.

Child Safety Seat

Evenflo Tribute

An Evenflo Tribute convertible child safety seat (CSS) was positioned in the second row middle seat of the Honda (see Figures 9 and 10). Based on the right side loading damage from the second row right seat occupant, it appears more likely that it was in the forward facing mode. The model number was 3792096 P1 and the date of manufacture was July 18, 2003. The CSS was configured with a five-point harness and a harness retainer clip. The harness was threaded through the top slots. The manufacturer recommends child seat usage as follows:

Rear facing 2.3 - 14 kg (5-31 lbs)
Forward facing 9-18 kg (20-40 lbs)

The child's weight in this case was 14 kg (31 lbs), which was within the manufacturer's guidelines for either mode.

The child seat was anchored to the vehicle using the vehicle lap belt. It is not known if the lap belt was used or routed properly.

The child seat was damaged on the right side from occupant contact/loading.

Figure 9. Evenflo Tribute child safety seat

Figure 10. Child seat in vehicle at time of inspection (on its back and not anchored)

Evenflo Discovery

An Evenflo Discovery child safety seat was positioned in the front right passenger seat of the Honda (see Figure 11). It was not occupied at the time of the crash. The model number was 5501536A and the date of manufacture was January 6, 2005. July 18, 2003.

Figure 11. Evenflo child safety seat (unoccupied)

VEHICLE DATA -1988 Chevrolet Camaro

Description:	1988 Chevrolet Camaro two-door convertible	
VIN:	1G1FP31F3JLxxxxxx	
Engine:	5.0 liter, V8	
Reported Defects:	None noted	
Cargo:	None	
Damage Description:	Moderate front end damage.	
CDC:	Impact 1: 12FDEW2 Impact 2: 12RBWN1 Impact 3: 12FREW9	
Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

Figure 12. Front right, Chevrolet Camaro

OCCUPANT DEMOGRAPHICS - 1989 Honda Civic

	Driver	Occupant 2
Age/Sex:	24/Male	2/Male
Seated Position:	Front left	Second row middle
Seat Type:	Bucket seat. Seat adjusted to forward most track position. Seat back was upright.	Bench with folding back
Height:	173 cm (68 in)	Unknown
Weight:	91 kg (201lbs)	14 kg (31lbs)
Occupation:	Unknown	NA
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	NA
Driving Experience:	Unknown	NA
Body Posture:	Normal, upright	Seated in child safety seat
Hand Position:	Unknown	Unknown
Foot Position:	Right front on accelerator, left on floorboard	Unknown
Restraint Usage:	Lap and shoulder belt available, used.	Lap belt used with child safety seat
Air bag:	None	None

OCCUPANT DEMOGRAPHICS - 1989 Honda Civic

	Occupant 3	Occupant 4
Age/Sex:	22/Female	9 month/Female
Seated Position:	Second row right	Second row right (on lap of second row right occupant)
Seat Type:	Bench with folding back	Bench with folding back
Height:	168 cm (66 in)	74 cm (29 in)
Weight:	50 kg (110 lbs)	11 kg (24 lbs)
Occupation:	Unknown	NA
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	NA	NA
Driving Experience:	NA	NA
Body Posture:	Normal, upright	Seated on lap of Occupant 3
Hand Position:	Holding 9 month old child	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, not used	None
Air bag:	NA	NA

OCCUPANT DEMOGRAPHICS - 1988 Chevrolet Camaro

Age/Sex:	29/Male
Seated Position:	Front left
Seat Type:	Bucket with folding back
Height:	183 cm (72 in)
Weight:	76 kg (167 lbs)
Occupation:	Unknown
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	Blood ethanol level = 0.20 g/100 ml
Driving Experience:	Unknown
Body Posture:	Normal, upright
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt used

OCCUPANT INJURIES -1989 Honda Civic

Driver: Injuries obtained from emergency room records.

Injury	OIC Code	Injury Mechanism	Confidence Level
Concussive head injury, awake upon admission with unconsciousness known to be less than one hour	160414.2,0	Head restraint system	Probable
Shoulder sprain, left	751020.1,2	Steering wheel rim	Probable
Cervical strain	640278.1,6	Head restraint system	Probable
Scalp contusion, right	190402.1,1	Head restraint system	Probable
Right lower leg abrasion	890202.1,1	Center instrument panel and below	Certain

Second row middle occupant: Injuries obtained from Post-ER Medical Records

Injury	OIC Code	Injury Mechanism	Confidence Level
Large subdural hemorrhage/hematoma, left	140656.5,2	Interior, child safety seat	Probable
Brain stem compression	140202.5,8	Interior, child safety seat	Probable
Cerebrum infarction, left	140676.3,2	Interior, child safety seat	Probable

Second row right occupant: Injuries obtained from Post-ER Medical Records

Injury	OIC Code	Injury Mechanism	Confidence Level
Brain stem contusion	140204.5,8	Right side window frame	Certain
Cerebrum contusion, small, left	140606.3,2	Right side window frame	Certain

Pelvic fracture, anterior, comminuted	852604.3,5	Right side hardware or armrest	Certain
Pelvic fracture, closed, posterior	852602.2,6	Child safety seat	Certain
Pelvic fracture, closed, right	852602.2,1	Right side hardware or armrest[1]	Certain
Liver contusion (minor)	541812.2,1	Right side hardware or armrest	Certain
Liver laceration, moderate, OIS Grade III	541824.3,1	Right side hardware or armrest	Certain
Spleen laceration, moderate, OIS Grade III	544224.3,2	Child safety seat	Certain
Kidney laceration, minor, OIS Grade II	541622.2,2	Child safety seat	Certain
Bilateral lung contusion	441410.4,3	Right side interior surface	Certain
Rib cage, fracture 2-3 ribs, with hemo- / pneumothorax, right side. Ribs 4, 5 and 6.	450222.3,1	Right side interior surface	Certain
Colon laceration, OIS I or II	540822.2,8	Right side interior surface	Certain
Concussive head injury, awake upon admission with unconsciousness known to be less than one hour	160414.2,0	Right side window frame	Certain
Left elbow abrasion	790202.1,2	Child safety seat	Certain
Left thigh contusion	890402.1,2	Child safety seat	Certain

Second row right occupant (on lap of occupant 3): Injuries obtained from Autopsy Report

Injury	OIC Code	Injury Mechanism	Confidence Level
Thoracic spinal cord laceration, complete cord syndrome with fracture and dislocation, T5	640468.5,7	Door side panel[1]	Probable
Rib cage, fracture 2-3 ribs, with hemo- / pneumothorax, right side, ribs 6, 7 and 8.	450222.3,1	Door side panel[1]	Probable
Closed skull fracture, left	150402.2,2	Ground	Certain

[1]SCI/Reviewer changes

Closed skull fracture, anterior	150402.2,5	Ground	Certain
Subarachnoid hemorrhage, left	140684.3,2	Ground	Certain
Subarachnoid hemorrhage, right	140684.3,1	Ground	Certain
Cerebral hematoma/hemorrhage subdural, small, bilateral	140654.5,3	Ground	Certain
Cerebral contusion, multiple, on same side	140614.3,1	Ground	Certain
Scalp contusion, anterior	190402.1,5	Ground	Certain
Scalp contusion, left	190402.1,2	Ground	Certain
Facial abrasion, chin	290202.1,8	Ground	Certain
Right arm abrasion	790202.1,1	Flying glass	Probable

OCCUPANT KINEMATICS - 1989 Honda Civic

Driver Kinematics

The 24-year-old male driver was seated in an upright posture and was restrained by the 3-point lap and shoulder belt. The seat belt anchorage was in the full up position. The bucket seat was adjusted to forward most track position and the seat back was upright. At impact, the driver initiated a lateral trajectory to the right. His head engaged the head restraint system–causing a concussive head injury and a scalp contusion. He loaded the safety belt and probably flexed to the right while being held in place by the lap portion of the safety belt. The lateral motion likely caused the cervical strain. The case vehicle began a clockwise rotation after the initial impact. During rotation, the driver likely shifted to the right but was restrained by the lap and shoulder belt. There was a secondary impact with the Camaro but this was a minor impact and would have had little effect on the driver. The driver was able to exit the vehicle under his own power. He was transported to a local trauma center. He was treated for his injuries and then released after being under observation for his head injury.

Second Row Middle Occupant Kinematics

The 2-year-old male child was restrained in a forward facing child safety seat by the five-point harness. The CSS was installed in the second row middle seat position of the Honda Civic with the lap belt. It is not known if the child seat was properly anchored to the vehicle. At impact, the child and the CSS initiated a lateral trajectory to the right. Intrusion to the right door resulted in the movement of the second row right seat occupant in the direction of the child seat. There was loading evidence found on the right side of the CSS (see Figure 13). As the CSS became fixed in place while in contact with the right seat occupant, the child's head engaged the interior of the CSS shell causing a subdural hematoma, a brain stem compression, and a cerebral infarction. The case vehicle began a clockwise rotation after the initial impact. During rotation, this occupant likely shifted to the right but was restrained by the child seat. There was a secondary impact with the Camaro but this was a minor impact would have had little effect on this occupant. The 2-year-old was transported to a local trauma center and was hospitalized for 22 days for his injuries.

Figure 13. Right side loading damage

Second Row Right Occupant (Adult) Kinematics

Figure 14. Ejection path, right rear window

The 22-year-old female second row right occupant was seated in an upright posture. She was not using the available lap and shoulder belt. At impact, this occupant initiated a lateral trajectory to the right. She engaged the right side intruding door and door hardware with her entire right side causing the liver contusion/laceration, right side rib fractures, pelvic fractures and the lung contusions. Her head struck some portion of the window frame causing a brain stem contusion and a cerebral contusion. The intruding door pushed/compressed her against the center seat mounted CSS causing the spleen laceration, kidney laceration, and additional pelvic fractures. The case vehicle began a clockwise rotation after the initial impact. During rotation, this occupant likely shifted to the right but was captured by the intruded door on one side and the child seat on the other. There was a secondary impact with the Camaro but this was a minor impact and would have had little effect on this occupant. The 22-year-old female was unable to exit the vehicle under her own power. The doors were jammed but she was not otherwise entrapped. She was transported to a local trauma center.

Second Row Right Occupant (Infant) Kinematics

The 9-month-old female second row right occupant was seated, forward facing, on the lap of the adult occupant of this seat position. There were no restraints in use. At impact, this occupant initiated a lateral trajectory to the right. She engaged the right side intruding door with the right side of her body. This likely caused the thoracic spinal injury and the right side rib fractures. As the collision continued, she pitched laterally and was fully ejected through the right rear window during rotation. She landed on the roadway causing multiple skull fractures and brain injuries. She was transported to a local trauma center where she died shortly after arrival.

Attachment 1. Scene Diagram