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16. Abstract This report documents the on-site investigation of a rear-facing child restraint system (CRS) used to secure a 10-month-old female in the second-row right position of a 2005 Honda Accord during a road departure crash into a guardrail end treatment. The infant sustained fatal blunt force head injuries during the multiple-event crash. In addition to the infant, the Honda was occupied by a 22-year-old belted female driver, a 21-year-old belted female in the front-row right position, a 4-month-old male in a rear-facing CRS in the second-row left position, and a belted 3-year-old female in the second-row center position. The crash occurred when the Honda driver lost control during rain and under wet road conditions. The vehicle rotated clockwise off the roadway and struck the guardrail end treatment with its back plane and then the guardrail face with its right plane. The right-side inflatable restraint systems deployed. The 10-month-old was transported by ambulance to a hospital, where she was pronounced deceased. The adult female in the front-row right position sustained police-reported (B-level) non-incapacitating injuries and was hospitalized. The driver and the two other children in the second row, with police-reported possible (C-level) injuries, were transported by ambulance to a hospital, where they were treated and released.			
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On-Site Child Restraint System Crash Investigation
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BACKGROUND

This report documents the on-site investigation of a rear-facing child restraint system (CRS) used to secure a 10-month-old female in the second-row right position of a 2005 Honda Accord (**Figure 1**) during a road departure crash into a guardrail end treatment. The infant sustained fatal blunt force head injuries during the multiple-event crash. In addition to the infant, the Honda was occupied by a 22-year-old belted female driver, a 21-year-old belted female in the front-row right position, a 4-month-old male secured in a rear-facing CRS in the second-row left position, and a belted 3-year-old female in the second-row center position. The crash occurred when the Honda driver lost control during rain and under wet road conditions. The vehicle rotated clockwise off the roadway and struck the guardrail end with its back plane and the guardrail face with its right plane. The right-side inflatable restraint systems in the Honda deployed. The 10-month-old was transported by the ambulance to a local hospital, where she was pronounced deceased. The adult female in the front-row right position sustained police-reported (B-level) non-incapacitating injuries and was hospitalized. The driver and the two other children in the second row, with police-reported possible (C-level) injuries, were transported to a hospital, where they were treated and released.

Figure 1. Right-rear oblique view of the 2005 Honda Accord.

The crash was identified by the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration through a review of online news reports and forwarded to the Special Crash Investigations (SCI) team in May 2016. The SCI team contacted the investigating police agency and achieved cooperation to conduct an investigation. The on-site portion of this investigation occurred in May 2016 and was conducted jointly with the police agency. The on-site activities consisted of the inspection of the Honda, measurements of its exterior and interior damage, an assessment of the manual and supplemental restraint systems, and the identification of occupant contact points. The CRSs, which remained with the vehicle, were examined for occupant loading and crash-related damage. Due to its age, the Honda was not equipped with an Event Data Recorder (EDR). The crash site was inspected and documented; however, the damaged guardrail had been replaced.

SUMMARY

Crash Site

This single-vehicle crash occurred on a limited-access, three-lane, interstate highway during the afternoon hours in May 2016. The police-reported environmental conditions at the time of the crash were daylight, rain, and wet road surfaces with standing/moving water. The environmental conditions in the area reported by the National Weather Service included rain and overcast skies with a temperature of 7.2 °C (45 °F), 81 percent relative humidity, and 11.1 km/h (6.9 mph) north-northeast winds. Rain had been reported for a 3-hour period prior to the crash.

Figure 2. North-facing lookback view along the limited-access roadway.

Figure 3. South trajectory view at the crash site and the replaced guardrail system.

The physical environment of the crash site was documented during the SCI inspection using a Nikon Nivo 5.M+ total station system. In the area of the crash, the asphalt-surfaced north/south interstate was straight and level with a posted speed limit of 113 km/h (70 mph). The respective travel directions were separated by a 4.9 m (16.0 ft) median. The three southbound lanes were separated by broken white lines. The width of the right and center lanes measured 3.8 m (12.5 ft), while the left lane measured 3.5 m (11.8 ft) wide. The right shoulder was 4.1 m (13.5 ft) wide and was separated from the travel lanes by a solid white line. A 41 cm (16.0 in) wide rumble strip was cut into the surface of the shoulder adjacent to the white line. The width of the left shoulder was 1.4 m (4.6 ft). It was separated from the left lane by a solid yellow line. The respective sides of the road were bordered by W-beam guardrail systems. The guardrail located along the right (west) side of the road was the point of impact. The guardrail had been replaced prior to the SCI inspection. Specific information regarding the installation can be found in the guardrail section of this report on Page 4. **Figure 2** depicts a north-facing lookback view from the Honda's approach, while **Figure 3** depicts the vehicle's southbound trajectory toward the guardrail and end terminal. A crash diagram is included at the end of this report.

Pre-Crash

The 2005 Honda Accord was traveling south, operated by the 22-year-old female driver and occupied by the 21-year-old female in the front-row right position and three children in the vehicle's second row. The two adults, seated in the front row, and the 3-year-old female, seated in the center position of the second row, were restrained by the vehicle's 3-point lap and shoulder seat belts. The 4-month-old male was secured in a Graco SnugRide rear-facing CRS

belted to the second-row left seat. The 10-month-old female was secured in an Evenflo Embrace rear-facing CRS belted to the second-row right seat.

The occupants were en route to their homes after an afternoon of shopping. They had traveled approximately 32 km (20 miles) on the limited-access highway, but had missed the intended exit. It was the driver's intention to take the next exit, which was located approximately 1.6 km (1 mile) south of the crash site, and turn around to travel north.

Figure 4. South-facing view of the end terminal along the approximate trajectory of the Honda.

The driver was operating the Honda in the center lane of the highway. The driver reported to the police investigator that she attempted to change lanes to the right and lost control. The police determined that the combination of speed, marginal tire tread, and wet road surfaces with standing water contributed to the loss of control. The SCI reconstruction of the crash determined that the Honda began to rotate clockwise as it traveled through the right lane and onto the right shoulder. The estimated departure angle was 20 degrees. As the vehicle approached the guardrail adjacent to the shoulder, the Honda had rotated approximately 200 degrees clockwise. The wet road conditions prevented the generation of tire marks that would have denoted the Honda's trajectory.

Crash

The back plane of the Honda struck the end terminal of the guardrail installation (Event 1). The vehicle's back plane deformation was consistent with the geometry of the end terminal. **Figure 4** is a view of the end terminal and guardrail along the approximate trajectory of the Honda. The impact displaced the end terminal to the south along the W-beam and fractured (wooden) post 1. The sudden deceleration of the initial impact accentuated the clockwise rotation of the Honda, and the vehicle's right plane struck the guardrail installation (Event 2). The force of this impact fractured wooden posts 2 to 7 and displaced the W-beam to the west. The Honda penetrated through the guardrail along its southwest trajectory and entered the roadside. The vehicle continued 31.3 m (102.7 ft) through a swale, evidenced by rolling tire impressions, and came to rest facing southwest near the tree line (**Figure 5**).

Figure 5. Looking to the southwest of the Honda at final rest. (Image provided by an internet news source.)

Post-Crash

Passersby stopped to render aid and notified the emergency response system of the crash. The

police, fire rescue, and emergency medical services (EMS) responded to the crash site. The driver and front occupant were assisted from the vehicle through the left-front door and transported by ambulance to separate hospitals. The driver was treated and released with minor soft tissue injuries. The front occupant was hospitalized for one day for treatment of a right-lower extremity fracture. The three child occupants in the second row of the Honda were removed from the vehicle through the left-rear door and transported to separate hospitals. The 4-month-old male in the second-row left was removed from the CRS and transported by ambulance to a hospital where he was treated for soft tissue injuries and released. The 3-year-old female in the second-row center was hospitalized for three days of treatment and observation after sustaining an orbital fracture, a concussion, and soft tissue injuries. It was reported to the police investigator that the CRS in the second-row right position was tipped up and rotated rearward at first observation. The 10-month-old occupant was removed from the CRS and transported by ambulance to a hospital, where she was pronounced deceased upon arrival. The vehicle was removed from the scene by flat bed and transported to the police impound, where it was located at the time of the joint police and SCI inspections.

FLEAT 350 END TREATMENT AND GUARDRAIL

The end treatment and guardrail was a Fleat 350 flared, 7-wooden-post installation manufactured by Road Systems, Inc.[1] As described on the manufacturer's website, the system had energy-absorbing capabilities during head-on impacts and was tested in accordance with the Test Level 3 (TL3) conditions of the National Cooperative Highway Research Project Report 350.[2] The Fleat 350 comprised an impact end terminal, two wooden posts installed in foundation tubes at post locations 1 and 2, a ground strut, a cable assembly, five 15 x 20 cm (6.0 x 8.0 in) posts, block-outs at post locations 3 to 7, three 3.8 m (12.5 ft) sections of W-beam, and associated hardware. The overall length of the installation was 11.4 m (37.5 ft). The end treatment then transitioned to standard 10 x 15 cm (4.0 x 6.0 in) I-beam posts with composite block-outs for the length of the run. **Figure 6** is an overall view of the repaired installation. The wooden posts were installed through the asphalt of the expanded shoulder. The height of the repaired guardrail measured 70 cm (27.5 in). The offset of the flared end treatment measured 84 cm (33.1 in). All seven wooden posts and the three W-beam sections had been replaced at the time of the SCI inspection.

Figure 6. Longitudinal view looking south along the repaired guardrail and depicting the flared offset at the crash site.

[1] Guardrail literature and installation manuals can be retrieved from www.roadsystems.com/fleat.html.
[2] National Cooperative Highway Research Program, retrieved from http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_350-a.pdf.

2005 HONDA ACCORD

Figure 7. Overhead right-side view of the Honda during the SCI inspection.

Description

The 2005 Honda Accord EX 4-door sedan (**Figure 7**), manufactured in July 2005, was identified by Vehicle Identification Number 1HGCM56755Axxxxxx. The powertrain consisted of a 2.4 liter, transverse-mounted, 4-cylinder, gasoline engine linked to a 5-speed automatic transmission with a console-mounted shifter. Standard equipment included 4-wheel power-assisted disc brakes with ABS and electronic brakeforce distribution, traction control, and power-assisted speed proportional rack-and-pinion steering. The gross vehicle weight rating for this vehicle was 1,870 kg (4,125 lb) with gross axle weight ratings of 1010 kg (2,225 lb) front and 900 kg (1,985 lb) rear. At the time of the crash, the Honda was configured with Mastercraft Touring LSR all-season radial tires mounted on 7-spoke aftermarket alloy wheels. The tires were of the vehicle manufacturer recommended P205/60R16 size. The vehicle's recommended tire pressures remain unknown. Specific tire data at the time of the SCI inspection included:

	Measured Pressure	Measured Tread Depth	Restriction	Damage
LF	221 kPa (32 PSI)	6 mm (7/32 in)	No	None
LR	214 kPa (31 PSI)	4 mm (5/32 in)	No	None
RR	221 kPa (32 PSI)	5 mm (6/32 in)	No	None
RF	228 kPa (33 PSI)	2 mm (3/32 in)	No	None, 10 cm (3.9 in) fracture of outer bead of wheel

The interior of the Honda was configured for seating of up to five occupants, with front-row bucket seats and a three-passenger rear bench seat with folding center armrest. All seating surfaces were cloth. The front-row seats and the left- and right-seat positions in the second row were equipped with adjustable head restraints. The driver's head restraint was adjusted 3 cm (1.0 in) above the seat back, the front-row right was adjusted 5 cm (2.0 in) above the seat back, and both second-row head restraints were adjusted 3 cm (1.2 in) above the seat back. Manual restraint was provided by 3-point lap and shoulder seat belts for the five seat positions. Supplemental restraint consisted of Certified Advanced 208-Compliant (CAC) front air bags for the driver and front-row right positions, and front-seat-mounted side-impact and roof-side rail-mounted inflatable curtain (IC) air bags. The Honda was equipped with lower anchors and tethers for children (LATCH) for the second-row left and right positions.

Exterior Damage

The back plane of the Honda (**Figure 8**) struck the end terminal of the guardrail system, resulting in a direction of force in the 5 o'clock sector. The direct contact damage began 8 cm (3.0 in) right of the vehicle's centerline and extended 51 cm (20.0 in) to the left. The impact deformed

the entire back plane and compressed the trunk space into a V-pattern. The combined length of the direct and induced damage spanned the vehicle's entire 147 cm (58.0 in) end width. The lateral component of the impact force displaced the back-right frame rail 17 cm (6.5 in) laterally to the left. The maximum crush measured 39 cm (15.3 in) and was located at the centerline of the bumper beam. The deformation was documented at the level of the bumper beam with a Field L 90 cm (35.0 in). Residual crush measurements were as follows: C1 = 4 cm (1.6 in), C2 = 19 cm (7.5 in), C3 = 37 cm (14.7 in), C4 = 39 cm (15.3 in), C5 = 12 cm (4.7 in), and C6 = 0. The Collision Deformation Classification (CDC) assigned to this damage pattern was 05BYEW3.

An analysis of the impact was performed using the barrier algorithm of the WinSMASH program to determine the severity of the crash in terms of velocity change (delta V). The results of this borderline calculation underestimated the crash severity due to the yielding properties of the guardrail. The total delta V was 22 km/h (14 mph), with a longitudinal component of 20 km/h (12 mph) and a lateral component of -7 km/h (-4 mph).

As the Honda continued to rotate CW, the right plane engaged the deformed guardrail, fractured the wooden posts, and penetrated through the installation. This Event 2 impact involved the entire length of the right plane (**Figures 9** and **10**). A residual crush profile was measured along the plane beginning on the fender, 37 cm (14.6 in) forward of the right-front axle, and extending rearward 378 cm (148.8 in) to a point 64 cm (25.2 in) aft of the right-rear axle on the deformed quarter panel. The documented residual crush profile was C1 = 21 cm (8.3 in), C2 = 10 cm (3.9 in), C3 = 4 cm (1.6 in), C4 = 6 cm (2.4 in), C5 = 6 cm (2.4 in), and C6 = 0. The crush profile under-represented the overall damage severity due to the wooden post construction of the guardrail and its yielding properties.

Figure 8. Overhead view of the Honda's back plane deformation.

Figure 9. Right view depicting the deformation of the rear half of the Honda.

Figure 10. Right view depicting the deformation of the forward half of the Honda.

Impact damage from contact with the W-beam during the vehicle's penetration through the guardrail system was noted on the right plane from the radiator support plane rearward to the rear corner. Isolated impact damage from contact with wooden posts was noted at multiple locations along the right plane. At the right-front axle, a narrow fracturing of the right-front wheel rim with the fracture of the lower control arm of the right-front suspension was observed. Focused deformation was located on the fender at the A-pillar and at the mid-aspect of the front door. The outer sheet metal of the right-front door had separated, which revealed a fractured door beam with consistent deformation of the right sill 150 cm (59.0 in) forward of the rear axle. The right-rear door intruded laterally during the engagement and was holed 20 x 38 cm (8.0 x 15.0 in). The magnitude of the dynamic intrusion was great enough to cause the door to impact and fracture the left side of the CRS that was secured at second-row right seat position. The door's outer sheet metal was snagged and pulled up and forward. The latches for both right doors remained engaged. The CDC assigned to this damage pattern was 03RDEW3. Analysis of this event was outside the scope of the WinSMASH program due to the yielding nature of guardrail and the rotational dynamics of the vehicle during the impact.

Figure 11. Overhead view through the right-rear window of the Honda depicting the second-row intrusion and the contact to the Evenflo CRS.

Event Data Recorder

The 2005 Honda Accord was equipped with an air bag control module (ACM) that controlled the diagnostic, sensing, and command functions of the vehicle's air bag systems. Due to the vehicle's date of manufacture, it was not equipped with an Event Data Recorder supported by the Bosch Crash Data Retrieval (CDR) tool. Crash data could not be imaged for this investigation.

Interior Damage

The interior of the Honda was damaged by exterior crash forces and reduced in size by intrusion of right-side components. The interior damage consisted of fracturing and separation of the right-side door panels, B-pillar trim, compression of the right mid-instrument panel, and deployment of the right-side impact air bag and right IC air bag. Discernable occupant contact evidence was minimal.

Figure 12. Lateral view of the front row depicting the intrusion of the right-front door.

The intrusion was associated with the lateral engagement of the guardrail system as the vehicle rotated counterclockwise. The right-rear door panel intruded laterally and fractured the polymer shell (left aspect) of the Evenflo rear-facing CRS (**Figure 11**). This residual intrusion measured 10

cm (4.0 in). The residual lateral right-front door intrusion measured 20 cm (8.0 in) at the door's rear lower quadrant (**Figure 12**). Right B-pillar intrusion measured 8 cm (3.0 in). The front-row right seat was displaced laterally fracturing the center console. Compression of the door panel displaced the right lower A-pillar laterally 8 cm (3.0 in) into the right aspect of the instrument panel. Due to compression of the instrument panel, the mid-aspect of the instrument panel intruded longitudinally 10 cm (4.0 in). The kick panel forward of the lower right A-pillar intruded 8 cm (3.0 in) laterally into the floor space of the front-row right occupant position.

Manual Restraint Systems

The Honda was equipped with manual 3-point lap and shoulder seat belts for the five designated seating positions. All seat belt systems consisted of continuous loop webbings and sliding latch plates. The driver's seat belt retracted onto an emergency locking retractor (ELR) while the remaining four systems retracted onto switchable ELR/automatic locking retractors (ALRs). The retractors of the front-seat belts were equipped with pretensioners. The driver stated to the police during her interview that all the vehicle's seat belts were in use at the time of the crash.

The driver's seat belt was stowed in the retractor at the initial inspection. The retractor was operational, and the pretensioner was not actuated. The latch plate revealed indicators of historic use. The adjustable D-ring was in the full-down position. Examination of the driver's seat belt webbing was unremarkable. Evidence of occupant loading to the belt system would not be expected in a back plane or far-side crash event. Based upon her statement, the driver was belted at the time of the crash.

The front-row right seat belt was locked in an extended/worn position at inspection. Minor waffling of the webbing was observed at the latch plate location. The actuation status of the front-row right pretensioner was unknown. The lower B-pillar was displaced and damaged which may have also locked the retractor. The front-row right occupant was belted at the time of the crash based on the observations of the inspection.

The second-row left seat belt was used to secure the rear-facing Graco CRS. There was no identified loading evidence on the webbing or latch plate. The use of the ALR mode to secure the CRS was unknown.

The second-row center seat belt extended from the right-center aspect of the seat position and buckled to the left of the occupant's position. Based on injury data, the 3-year-old was possibly wearing the shoulder belt webbing under the arm and across the chest. There was no identified loading evidence of the belt system.

The second-row right seat belt system was used to secure the Evenflo rear-facing CRS. The lap belt webbing was positioned through the belt path. The status of the ELR/ALR could not be determined. There were subtle frictional abrasions on the webbing attributed to the webbing becoming captured between the shell of the displaced CRS and the intruding door panel during the crash.

Supplemental Restraint Systems

The Honda was equipped with six air bags to provide supplemental crash protection in frontal and side impact crashes. The frontal air bag system consisted of Certified Advanced 208-Complaint (CAC) air bags for the driver and front right occupant positions. In addition, the CAC system included seat track positioning sensors, seat belt buckle switch sensors, and a front-right occupant classification sensor with automatic suppression. The driver's frontal air bag was contained in the center hub of the 4-spoke steering wheel rim and did not deploy in this back- and right-plane crash. The passenger's frontal air bag was top mounted in the right instrument panel and not commanded to deploy.

Figure 13. Lateral view across the second row depicting the deployed IC and its relationship to the Evenflo CRS.

Supplemental side-impact crash protection was provided by seat-mounted and roof-side rail-mounted IC air bags. The IC air bags provided crash protection and occupant ejection mitigation for both front- and second-row occupants. The right-plane engagement with the guardrail rail system deployed the front-right seat-mounted and right IC air bags. The seat-mounted air bag deployed through the forward seam of the seat back to provide abdominal and thoracic protection. The oval-shaped air bag measured 38 cm (15.0 in) vertically and 25 cm (9.8 in) horizontally (**Figure 12** above). It was tethered internally and vented directly into the occupant compartment. There was no loading evidence or damage to the seat-mounted air bag.

Figure 14. Overhead view of the Graco CRS.

The right IC air bag deployed from the roof-side rail/headliner juncture (**Figure 13**). The overall length of the air bag measured 173 cm (68.1 in) which extended from the right A-pillar to the right C-pillar. Vertically, the IC air bag extended downward 41 cm (16.1 in) to the level of the beltline. There was a triangular void at the right A-pillar, as the IC air bag was not configured with a sail panel. There was no damage or occupant contact to the deployed IC air bag, which was located in the plane of the exterior deformation.

CHILD RESTRAINT SYSTEMS

Graco SnugRide Click Connect

The CRS installed in the second-row left position was a Graco SnugRide Click Connect 35 rear-facing infant seat (**Figure 14**). The CRS, manufactured on March 20, 2013, was identified by Model No. 1839421. Molded of a polymer shell and lined with a Styrofoam filler, the CRS was covered with a two-tone, gray-and-black fabric cover. The CRS was part of the Click Connect

system that used the CRS as the shell of a stroller system. The CRS was also designed with a detachable base. At the time of the crash, the CRS was installed without the base. Placarding listed the CRS as suitable for children in a weight range of 1.8-15.9 kg (4-35 lb) and less than or equal to 81 cm (32 in) in height. The weight of 4-month old male occupant was in the manufacturer's recommended limits. The occupant's height was not known. A folding carry handle was integrated into the shell of the CRS. A forward-folding sunshield was attached to the shell. At the time of the crash, the carry handle was in the mid-position, and the sunshield was partially extended. It should be noted that the CRS had been removed from the vehicle at the scene of the crash. The CRS was reinstalled in the vehicle by the investigating officer at the time of the joint police/SCI inspection. The CRS was designed with two methods to secure the shell to the vehicle, using either the LATCH system or the vehicle's 3-point lap and shoulder seat belt system. The LATCH system was incorporated into the detachable base unit. Since the base unit was not used in this installation, LATCH was not an option. The CRS was secured to the Honda via the vehicle seat belt system. The lap belt portion of the seat belt system was routed through the belt path across the shell (**Figure 15**).

Figure 15. Lateral view of the Graco CRS installed into the second-row left position of the Honda.

Figure 16. Front view depicting the fractured Styrofoam filler of the Graco CRS.

Figure 17. Overhead view of the Evenflo CRS.

The infant was restrained in the CRS by the integrated 5-point harness system. The shoulder belts were routed through the second lowest of the four available slots, and the center crotch strap with buckle was routed through the most rearward of the two adjustment slots. Based on these positions, it appeared that the harness was adjusted for the 4-month-old infant. The harness was configured with a chest clip that was engaged on both shoulder straps. There was no damage or loading evidence to the harness straps or its hardware. Damage to the CRS was limited to a vertical fracture of the Styrofoam at the left aspect of the upper portion of the unit (**Figure 16**). The fracture line was in the areas of the infant's head and left torso. The location of the fracture line indicated that the most likely source of the fracture was from contact with the second-row center occupant during the rebound phase of her kinematics.

Evenflo Embrace

The CRS installed in the second-row right position of the Honda was an Evenflo Embrace 35 rear-facing only infant seat (**Figure 17**). The CRS, manufactured on December 22, 2014, was identified by Model No. 31541576, with an expiration date of December 21, 2020. The CRS construction consisted of a molded polymer shell, a rigid Styrofoam liner, and a fabric cover. The CRS was designed for use with or without its detachable base. An adjustable carrying handle was mounted to the midpoint of the lateral aspects of the CRS. The CRS manufacturer recommended that the handle must be positioned in the full-down position at the child's feet or in one of the two most forward positions at the top of the CRS shell when the vehicle is in motion. Manufacturer specifications listed occupant size at 1.8 to 15.8 kg (4 to 35 lb) in weight and 43-76 cm (17-30 in) in height. The 10-month-old female occupant was in the recommended weight and height limits of the CRS.

The CRS was configured with an integral 5-point harness system that was adjustable in the shell. There were three vertical adjustment slots for the shoulder straps and two for the crotch strap buckle. At the time of the crash, the harness straps were adjusted to the upper of the three slots and the crotch strap was adjusted to the rearward position. The child occupant was restrained by the integral harness; however, there was no loading evidence of the harness straps or adjoining hardware. Body fluid was present on the right shoulder harness strap in the area of the shoulder and on both straps at the location of the latch plates.

Figure 18. Lateral view of the Evenflo CRS installed into the second-row right position of the Honda.

The CRS was reinstalled in the vehicle by the investigating officer at the time of the joint police/SCI inspection (**Figure 18** and **19)**. The lap belt was routed across the top of the shell through the rear-facing belt path. There was minor loading at the belt path due to frictional interaction between the seat belt webbing and the polymer shell of the CRS. This evidence was most prevalent at the left aspect of the belt path in the area exposed to the right-rear door.

Figure 19. Overhead view through the backlight depicting the relationship of the Evenflo CRS to the right-rear door of the Honda.

The force of the right-plane/guardrail impact caused the right-rear door to intrude. The intruded door struck the left side of the Evenflo CRS. The CRS shell was fractured adjacent at the pivot point (**Figure 20**) with a complete fracture/separation of the carrying handle 10 cm (3.9 in) above the pivot. The left aspect of the

shell was abraded with associated stress marks in the polymer. After removal of the padded fabric covering, it was observed that the Styrofoam filler was fractured vertically on both sides of the CRS in the areas of the child's head and shoulders (**Figure 21**). The left-side fracture was attributed to the loading of the intruding right-rear door while the right-side fracture line was attributed to the loading by the second-row center occupant.

It was reported to the police investigator that the first responders to the crash found the Evenflo CRS tipped up and rotated rearward in the second-row right position. **Figure 22** and **23** are images depicting the reconstructed post-crash position of the Evenflo CRS. It was theorized that the combination of the kinematic response to the back-plane impact and the right-plane impact force and intrusion caused the displacement of the CRS.

Figure 20. Close-up, left-side view of the CRS and the fractured shell attributed to the intruding right-rear door of the Honda.

Figure 21. Front view depicting the fractured Styrofoam filler of the Evenflo CRS.

Figure 22. Left lateral view of the reconstructed post-crash position of the Evenflo CRS in the second row of the Honda.

Figure 23. Right lateral view of the reconstructed post-crash position of the Evenflo CRS in the second row of the Honda.

2005 HONDA ACCORD OCCUPANTS

Driver Demographics

Age/sex:	22 years/female
Height:	163 cm (64 in)
Weight:	82 kg (180 lb)
Eyewear:	Unknown
Seat type:	Bucket seat with adjustable head restraint
Seat track position:	Mid-track
Manual restraint usage:	3-point lap and shoulder seat belt
Usage source:	SCI inspection
Air bags:	Front, seat-mounted side and IC air bags available; None deployed
Alcohol/drug data:	No alcohol involvement
Egress from vehicle:	Exited under own power
Transport from scene:	Ambulance to a local hospital
Medical treatment:	Treated and released

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Right lateral thigh hematoma	810402.1	Parking brake lever	Certain

Source: emergency room records.

Driver Kinematics

The belted Honda driver was seated in an upright driving posture with the seat adjusted to a mid-track position, the seatback slightly reclined, and the head restraint adjusted up 3 cm (1.1 in). She reported to the police that she lost control of the vehicle during a lane change on the wet roadway and that the Honda began to rotate clockwise. As it approached the end treatment of the guardrail, it had rotated approximately 200 degrees.

The back plane of the Honda struck the guardrail end treatment. The driver responded to the 5 o'clock direction of force by moving rearward and slightly to her right. She loaded the seat back with her back and her head probably engaged the head restraint. As the Honda continued its CW rotation, the right plane struck the W-beam and multiple posts of the guardrail. The driver responded to the lateral forces with a rightward trajectory. Her right thigh contacted the parking brake lever located in the center console. This contact resulted in a hematoma of the lateral right thigh. Her right abdomen contacted the armrest of the center console, resulting in a complaint of pain. During the crash sequence, she also loaded the seat belt system that held the driver in position, thus mitigating displacement from her seated position.

Following the crash event, the driver exited the Honda unassisted. She attempted to attend to the needs of the remaining occupants while she awaited the arrival of the first responders. The driver was evaluated at the scene and transported by ambulance to the emergency room of a local hospital, where she was treated for the right thigh injury and released.

Front-Row Right Occupant Demographics

Age/sex:	21 years/female
Height:	160 cm (63 in)
Weight:	79 kg (174 lb)
Eyewear:	Unknown
Seat type:	Bucket seat with adjustable head restraint
Seat track position:	Mid-to-rear track
Manual restraint usage:	3-point lap and shoulder seat belt
Usage source:	SCI inspection
Air bags:	Front, seat-mounted side-impact and IC air bags available; Seat-mounted side and IC air bags deployed
Alcohol/drug data:	None
Egress from vehicle:	Removed from vehicle by rescue personnel
Transport from scene:	Ambulance to a local hospital
Medical treatment:	Admitted and discharged one day later

Front-Row Right Occupant Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Minimally displaced fracture of the right fibula at the junction of the proximal and middle thirds of the shaft; Butterfly fragment with approximately 2 mm displacement	854471.2	Intruding right-front door panel, FLQ*	Certain
2	Anterior right thigh contusion	810402.1	Intruding right-front door panel, RLQ*	Certain
3	Anterior left thigh contusion	810402.1	Intruding right-front door panel, RLQ*	Certain
4	Anterior right shin contusion	810402.1	Intruding right-front door panel, FLQ*	Certain
5	Anterior left shin contusion	810402.1	Intruding right-front door panel, FLQ*	Certain
6	10 cm posterior right thigh abrasion	810202.1	Seat cushion	Certain
7	10 cm abrasion in right gluteal cleft	810202.1	Seat cushion	Certain
8	Lateral lower left thigh abrasion	810202.1	Center console	Probable

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
9	Posterior right calf abrasion	810202.1	Intruding right-front door panel, FLQ*	Certain

Source: hospital records.
**FLQ: forward, lower quadrant; RLQ: rear lower quadrant.*

Front-Row Right Occupant Kinematics

The belted front-row right occupant was seated in an upright posture with the seat track adjusted to a mid-to-rear position, the seatback slightly reclined, and the head restraint adjusted 5 cm (2 in) above the seat back. At impact, the back plane of the Honda struck the guardrail end treatment. The front-row right occupant responded to the 5 o'clock direction of force by moving rearward and laterally right, loading the seatback with her back and the head restraint with her head. As the vehicle continued to rotate CW, its right plane struck the guardrail, resulting in the deployment of the front-row right seat-mounted and right IC air bags. The continued engagement with the deformed guardrail system resulted in lateral intrusion of the right-front door into the occupant's space. The occupant responded to her right, loading the intruding door structure and the deployed air bags. Her contact to the intruding door resulted in a fracture of the right fibula and multiple soft tissue injuries to her lower extremities. The posterior abrasions at the junction of her right thigh and buttock were attributed to the loading of the seat cushion/seat back area. As the occupant rebounded, her left lateral thigh contacted the center console and was abraded during the vehicle's travel to final rest.

The front-row right occupant was assisted from the vehicle by rescue personnel and transported by ambulance to a trauma center. She was admitted for treatment of her injuries and released the following day.

Second-Row Left Occupant Demographics

Age/sex:	4 months/male
Height:	Unknown
Weight:	8.9 kg (19.6 lb)
Eyewear:	None
Seat type:	Rear-facing CRS secured by seat belt on bench seat
Seat track position:	Not adjustable
Manual restraint usage:	5-point harness system of a CRS
Usage source:	SCI inspection
Air bags:	IC air bag available; not deployed
Alcohol/drug data:	None
Egress from vehicle:	Removed from vehicle by driver
Transport from scene:	Ambulance to a local hospital
Medical treatment:	Treated and released

Second-Row Left Occupant Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Small contusion to left lower chin	210402.1	CRS shell	Probable
2	Small abrasion to chin	210202.1	CRS shell	Probable

Source: emergency room records.

Second-Row Left Occupant Kinematics

The infant second-row left occupant was positioned in a rear-facing CRS and restrained by the integral 5-point harness system. Based on the observed position of the harness system at the time of the SCI inspection, the harness appeared to have been adjusted to a position to adequately secure the infant's body at the time of the crash. The CRS was secured to the Honda by the vehicle's manual seat belt system. The seat belt webbing was routed through the rear-facing belt path.

At impact, the rear-facing infant moved rearward and to his left in response to the 5 o'clock direction of force impact. He loaded the harness system of the CRS which restrained him in the confines of the CRS shell. The CRS probably rotated rearward by pivoting about the belt path across the top of the carrier. During the vehicle's rotation and subsequent right-plane impact, it is likely that the infant sustained a contusion and abrasion of the chin from the contact to the shell of the CRS. The left aspect of the Styrofoam reinforcement of the rear-facing CRS was fractured vertically from probable contact by the second-row center occupant during rebound from her rearward and right trajectory.

Immediately following the crash, the driver exited the vehicle and opened the left-rear door and removed the second-row left occupant from the CRS. The infant was transported by ambulance to the emergency room of a local hospital, where he was treated for his injuries and released.

Second-Row Center Occupant Demographics

Age/sex:	3 years/female
Height:	Unknown
Weight:	17.0 kg (37.5 lb)
Eyewear:	Unknown
Seat type:	Bench
Seat track position:	Not adjustable
Manual restraint usage:	3-point lap and shoulder belt
Usage source:	SCI inspection
Air bags:	None available
Alcohol/drug data:	None
Egress from vehicle:	Unknown
Transport from scene:	Ambulance to a local hospital
Medical treatment:	Admitted and discharged three days later

Second-Row Center Occupant Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Non-displaced right lateral orbital wall fracture	251235.2	Second-row right CRS shell	Certain
2	Concussion with loss of consciousness; altered mental status but no intracranial bleed	161003.2	Second-row right CRS shell	Certain
3	4 cm right scalp laceration, superior and posterior to right ear	110602.1	Flying glass (disintegrated backlight glazing)	Probable
4	Superficial abrasion to right side of scalp	110202.1	Second-row right CRS shell	Probable
5	Abrasion to inner surface of right-upper arm	710202.1	Shoulder belt webbing	Probable

Source: hospital records.

Second-Row Center Occupant Kinematics

The second-row center occupant was positioned between two rear-facing CRSs and was seated in a forward-facing attitude. She was reported by the police as restrained by the vehicle's 3-point lap and shoulder seat belt system. The seat belt geometry would have positioned the shoulder belt webbing over her right with the latch plate buckled at the left hip location. The occupant's motion and the location and nature of her injuries indicated that the shoulder belt was probably routed under her right arm. There was no identified loading evidence on the seat belt system.

At impact with the guardrail end treatment, the second-row center occupant was displaced rearward and to her right in response to the 5 o'clock direction of force. Her rearward movement displaced her upward along the seatback. This motion exposed the right and posterior aspects of her head to the disintegrated fragments of the backlight glazing. The glazing fragments contacted and lacerated her scalp above and behind the right ear. During this motion she loaded the seat belt webbing, which abraded the inner aspect of her upper right arm.

The occupant's compression into the seat back, combined with the vehicle's right-side engagement with the deformed guardrail system, provided the child an accelerated forward and rightward rebound in the second row. Her forward movement, combined with the rearward displacement of the second-row CRS, allowed her right forehead area to impact the right side of the second-row right rear-facing CRS. This interaction fractured the right aspect of Styrofoam filler in the right CRS and resulted in the child's right orbital fracture, concussion with loss of consciousness, and right scalp abrasion.

The continued CW rotation of the vehicle caused the second-row center occupant to translate to her left, where she contacted the left wing of the rear-facing CRS in the second-row left position. This contact with her upper body fractured the Styrofoam of this CRS.

The second-row center occupant was removed from the vehicle by EMS personnel and transported by ambulance to the emergency room of a local hospital. She was hospitalized three days for continued treatment and for monitoring of her concussion symptoms.

Second-Row Right Occupant Demographics

Age/sex:	10 months/female
Height:	71 cm (28 in)
Weight:	7.8 kg (17.2 lb)
Eyewear:	Unknown
Seat type:	Rear-facing CRS secured by seat belt on bench seat
Seat track position:	Not adjustable
Manual restraint usage:	5-point harness system of a CRS
Usage source:	SCI inspection
Air bags:	IC air bag available; not deployed
Alcohol/drug data:	None
Egress from vehicle:	Removed from by EMS
Transport from scene:	Ambulance to a local hospital
Medical treatment:	None, pronounced deceased

Second-Row Right Occupant Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Brain is extensively lacerated and hemorrhagic, mostly at the parietal and temporal regions, bilaterally	140688.3	Tandem: Primary – CRS shell; Secondary – intruding right-rear door panel	Possible Certain
2	Extensive diffuse epidural cranial hemorrhage	140630.3	Tandem: Primary – CRS shell; Secondary – Intruding right-rear door panel	Possible Certain
3	Extensive diffuse subdural cranial hemorrhage	140650.3	Tandem: Primary – CRS shell; Secondary – Intruding right-rear door panel	Possible Certain
4	Extensive diffuse subarachnoid cranial hemorrhage	140693.2	Tandem: Primary – CRS shell; Secondary – Intruding right-rear door panel	Possible Certain

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
5	Skull is extensively fractured (dozens of fragments) mostly at left parietal and right temporal areas with right depressed fracture	150404.3	Tandem: Primary – CRS shell; Secondary – Intruding right-rear door panel	Possible Certain
6	Skull is separated with diastatic fracture at the sagittal and coronal sutures	150402.2	Tandem: Primary – CRS shell; Secondary – Intruding right-rear door panel	Possible Certain
7	Left parietal laceration with hemorrhage	110600.1	CRS shell *C.F. – intrusion	Certain
8	Left parietal contusion; scalp contusions at and above left ear with palpable depression of the skull	110402.1	CRS shell *C.F. – intrusion	Certain
9	Contusion of scalp at right side of forehead and temporal region overlying depressed fractures	110402.1	CRS shell	Certain
10	Abrasions at hairline extending from right ear to almost the midline	110202.1	Flying glass (disintegrated backlight glazing)	Probable
11	Abrasions on face on right side above and below cheekbone	210202.1	Flying glass (disintegrated backlight glazing)	Probable
12	Patterned contusion at point of left shoulder forming an “E” with 1-in legs and 1-in side	710402.1	CRS harness strap	Certain
13	Diffuse contusion at upper aspect of left forearm just below elbow	710402.1	Unknown	N/A

Source: medical examiner’s report (invasive autopsy).
**C.F.: contributing factor.*

Second-Row Right Occupant Kinematics

The second-row right child occupant was seated in a rear-facing CRS restrained by the integral 5-point harness system. Based on the observed adjustments of the harness system, it appeared

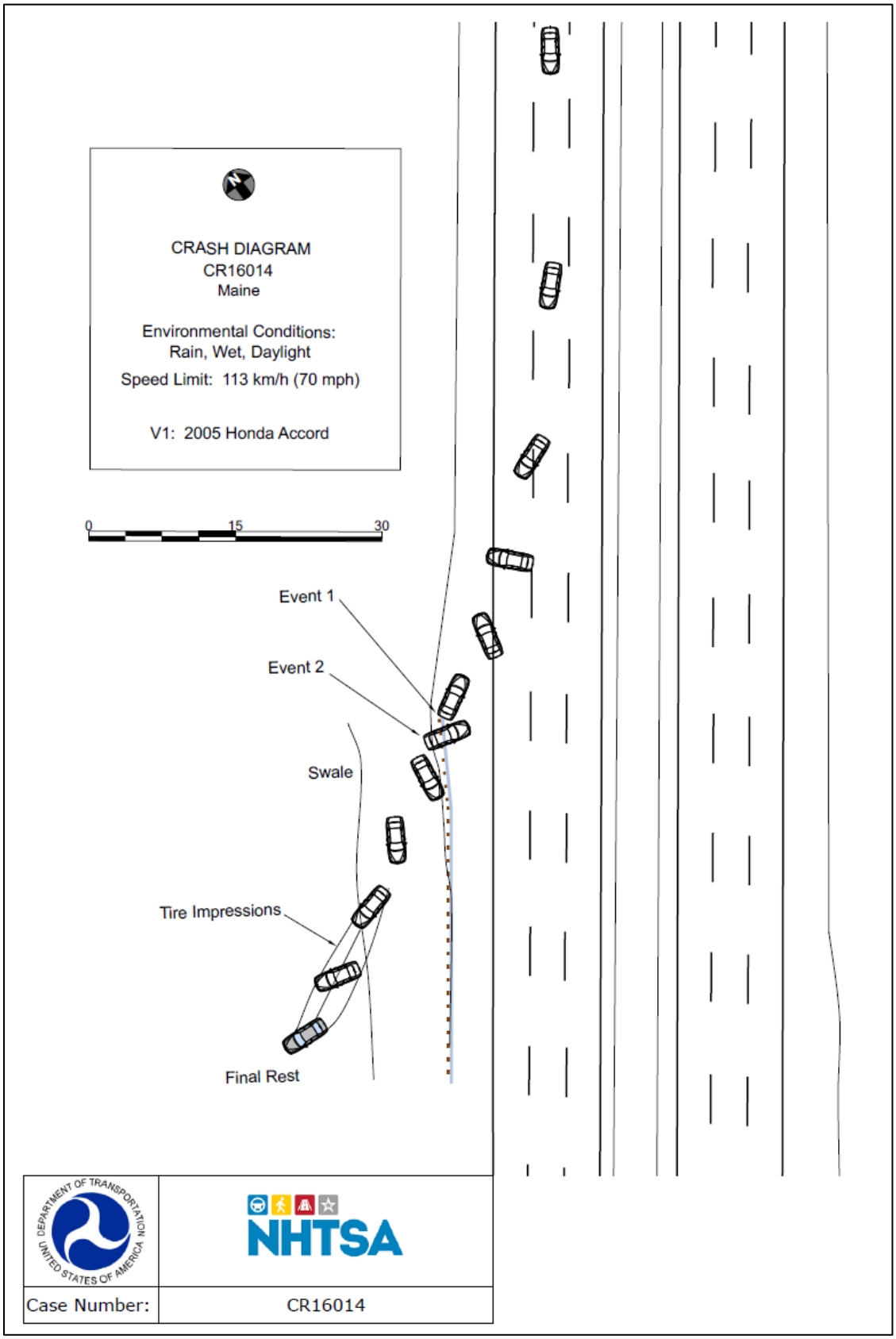
that the child occupant was adequately restrained in the CRS. The CRS was secured to the Honda by the vehicle's manual seat belt system routed through the rear-facing belt path.

At impact with the guardrail end treatment, the child and the CRS moved rearward and to the right with respect to the vehicle and in response to the direction of force. The child loaded the harness system of the CRS and sustained the patterned contusion over the left shoulder identified during the autopsy.

The first responders reported to the police that the CRS was tipped up and rearward upon observation. The CRS rotated rearward, pivoting about the belt path located across the top of the carrier. As the Honda continued to rotate CW, the right plane engaged the deformed guardrail. The CRS and the child responded to the lateral force with a rightward displacement. The force of the impact also caused the right-rear door to intrude into the second-row right occupant space. The door panel struck and compressed the CRS laterally, fracturing the left aspect of the rear-facing CRS. The child's head located adjacent to the side of the CRS shell, in close proximity to the force of the interaction, sustained the multiple skull fractures and fatal brain lacerations. The child's face was abraded by disintegrated glazing. It was not possible to determine if the second-row center occupant's interaction with the right side of the CRS played a role exacerbating this child's injuries. However, it was concluded that, to a reasonable degree of certainty, the fatal injuries could be attributed to the force of the intruding right-rear door.

Following the crash, EMS personnel removed the child from the vehicle while she was secured in the CRS. The child was subsequently removed from the CRS, placed in an ambulance and transported to a local hospital. The child was pronounced deceased on arrival at the hospital. Her body was transferred to the medical examiner's office for autopsy.

CRASH DIAGRAM



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