

CRASH DATA RESEARCH CENTER
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**CALSPAN ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION
COSCO VOYAGER HIGH BACK BOOSTER SEAT**

SCI CASE NO: CA04-040

**VEHICLE: 1995 CHEVROLET BERETTA
LOCATION: NEW YORK
CRASH DATE: SEPTEMBER, 2004**

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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<p>16. Abstract</p> <p>This investigation focused on the crash dynamics and fatal injury sources of a three year old male seated in a Cosco Voyager high back belt positioning booster positioned in the front right of a 1995 Chevrolet Beretta. The child and booster seat were restrained in the vehicle by the vehicle's automatic door-mounted lap and shoulder restraint. The Chevrolet was involved in an offset frontal collision with a 2004 Dodge Ram 3500 pick-up truck. Reportedly, the 45 year old driver of the Chevrolet crossed the centerline directly into the path of the Dodge. A witness to the crash, traveling behind the Chevrolet, stopped to render aid. The witness reported that he unbuckled the seat belt restraining the child and removed him from the vehicle. The child was unresponsive at that time. The child was transported to a local hospital and was pronounced dead one hour post-crash. An autopsy was performed the day following the crash; the preliminary report from the medical examiner indicated the child died from neck trauma.</p> <p>This fatal crash was identified through the local news media by the Special Crash Investigations Team at Calspan. The Crash Investigation Division of the National Highway Traffic Safety Administration was notified of the crash on September 20, 2004 and an on-site investigation was assigned the next day. Cooperation with the investigating police department was established and the vehicles and child safety seat were available for inspection. The on-site portion of the investigation took place on September 27, 2004.</p>			
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**VEHICLE: 1995 CHEVROLET BERETTA
LOCATION: NEW YORK
CRASH DATE: SEPTEMBER, 2004**

BACKGROUND

This investigation focused on the crash dynamics and fatal injury mechanisms of a three year old male seated in a Cosco Voyager high back belt positioning booster positioned in the front right of a 1995 Chevrolet Beretta. The child and booster seat were restrained in the vehicle by the vehicle's automatic door-mounted lap and shoulder restraint. The Chevrolet (**Figure 1**) was involved in an offset frontal collision with a 2004 Dodge Ram 3500 pick-up truck. Reportedly, the 45 year old driver of the Chevrolet crossed the centerline directly into the path of the Dodge. A witness to the crash, traveling behind the Chevrolet, stopped to render aid. The witness reported that he unbuckled the seat belt restraining the child and removed him from the vehicle. The child was unresponsive at that time. The child was transported to a local hospital and was pronounced dead one hour post-crash. An autopsy was performed the day following the crash; a verbal report given by the medical examiner to the police investigator indicated the child died from neck trauma. Medical records were not available.



Figure 1: Left front view of the Beretta.

This fatal crash was identified through the local news media by the Special Crash Investigations Team at Calspan. The Crash Investigation Division of the National Highway Traffic Safety Administration was notified of the crash on September 20, 2004 and an on-site investigation was assigned the next day. Cooperation with the investigating police department was established and the vehicles and child safety seat were available for inspection. The on-site portion of the investigation took place on September 27, 2004.

SUMMARY

VEHICLE DATA

1995 Chevrolet Beretta

The 1995 Chevrolet Beretta was identified by the Vehicle Identification Number (VIN): 1GILW15M6SY (production sequence deleted). The front-wheel drive, two-door coupe was equipped with the Z26 trim package. The power train consisted of a 3.1 liter, V6 engine linked to a four-speed automatic transmission. The service brakes were a front disc/rear drum system with four-wheel ABS. The Supplemental Restraint System consisted of a driver (only) air bag. The safety belt system consisted of automatic door-mounted lap and shoulder belts in the front

positions, 3-point lap and shoulder belts in the rear outboard positions and a center rear lap belt. The odometer had registered 280,023 km (174,003 miles) at the time of the inspection. The Chevrolet was equipped with Futura 755 Radial AS tires, size P205/55R16 mounted on the OEM alloy wheels. The manufacturer’s recommended tire pressure was 207 kPa (30 PSI). The specific measured tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	76 kPa (11 PSI)	6 mm (7/32 in)	Yes	None
LR	34 kPa (5 PSI)	6 mm (8/32 in)	No	None
RF	200 kPa (29 PSI)	5 mm (6/32 in)	No	None
RR	231 kPa (34 PSI)	7 mm (9/32 in)	No	None

2004 Dodge Ram 3500 Pick-Up Truck

The 2004 Dodge Ram, **Figure 2**, was identified by the Vehicle Identification Number (VIN): 3D7MA48C94G (production sequence deleted). The 3500 series (one ton) four-door Quad cab pick-up truck was configured with a 407.7 cm (160.5 in) wheelbase and dual rear wheels. The 4x2 truck had a Gross Vehicle Weight Rating (GVWR) of 4,990 kg (11,000 lb). The power train consisted of a 5.9 liter V8 engine linked to a four-speed automatic transmission. The service brakes were a four-wheel disc antilock system (ABS). The Supplemental Restraint System consisted of advanced multi-stage air bags for the driver and front right passenger. The manual restraint system consisted of three-point lap and shoulder belts in the five seat positions. The two front safety restraints were equipped with retractor pretensioners. The force of the crash caused the pretensioners to fire, and frontal air bags to deploy. The digital electronic odometer could not be read at the time of the inspection; the odometer reading was unknown. The truck was equipped with Goodyear Wrangler SR-A tires (size LT 235/80R17-E). The recommended tire pressures were 380 kPa (55 PSI) front/448 kPa (65 PSI) rear. The specific measured tire data was as follows:



Figure 2: Left front view of the Dodge.

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	0 kPa	11 mm (14/32 in)	Yes	Debeaded at impact
LR inside LR outside	Unknown Unknown	9 mm (11/32 in) 9 mm (11/32 in)	No	None
RF	393 kPa (57 PSI)	11 mm (14/32 in)	No	None
RR inside RR outside	Unknown Unknown	9 mm (11/32 in) 9 mm (11/32 in)	No	None

CRASH SITE

This two-vehicle crash occurred during the daylight hours of September, 2004. At the time of the crash, the weather was not a factor. The asphalt road surface was dry. The crash occurred on a two-lane north/south US state route immediately south of the village limits. The 7.5 m (12.0 ft) wide travel lanes were separated by painted markings indicating a “No Passing Zone” in the southbound direction. There was a 60 m (96 ft) long concrete bridge at the crash scene. The travel lanes were bordered by 2.4 m (8.0 ft) wide paved shoulders and a box-beam guardrail system. The impact occurred in the area of at the northbound termination of the bridge. The speed limit in the area of the impact was 48 km/h (30 mph) and transitioned to 72 km/h (45 mph) south of the crash site. **Figure 3** is a southbound trajectory view leading into the area of the impact.



Figure 3: Southbound trajectory view approaching the point of impact.

CRASH SEQUENCE

Pre-Crash

The 1995 Chevrolet Beretta was southbound driven by a 45 year old restrained male. The Chevrolet’s front right position was occupied by a 3 year old male seated in a Cosco Voyager high back belt positioning booster seat. The child was restrained by the vehicle’s automatic door-mounted lap and shoulder belt. The 2004 Dodge Ram 3500 pick-up truck was northbound driven by a 60 year old restrained male. The Dodge was occupied by four additional passengers: a 53 year old restrained female front right passenger, a 64 year old unrestrained male rear left passenger, a 64 year old unrestrained female rear right passenger and a 4 year old restrained female center rear passenger. The driver of a non-contact vehicle traveling in front of the Chevrolet reported that the Chevrolet crossed the centerline and entered the northbound lane directly in the path of the Dodge. That witness indicated the southbound traffic was traveling approximately 48 km/h (30 mph).

Crash

The front left area of the Chevrolet impacted the front left area of the Dodge in an offset head-on configuration. The direction of force in the impact was in the 12 o’clock sector for both vehicles. The force of the impact caused the driver (only) air bag in the Chevrolet and both

frontal air bags in the Dodge to deploy. The severity of the crash (delta V) calculated by the WINSMASH model was 65 km/h (40.6 mph) and 28 km/h (17.1 mph) for the Chevrolet and Dodge, respectively.

The force of the crash and the offset impact configuration caused the Chevrolet to initiate a counterclockwise rotation during separation and the northbound momentum of the Dodge reversed the travel direction of the Chevrolet. The Chevrolet came to rest facing northeastward straddling the centerline of the road 7.6 m (25.0 ft) north of the point of impact. The Dodge was deflected to its right by the force of the impact and came to rest facing northeast straddling the outboard fog line. A schematic of the crash is attached to the end of this report, **Figure 16**.

Post-Crash

A witness to the crash traveling behind the Chevrolet stopped to render aid. Reportedly, he removed the safety belt securing the 3 year old and removed the child from the vehicle due to the potential of a post-crash fire. The child was unresponsive at that time. This individual's statements to the police investigator were unclear as to how the safety belt was positioned on the child. The child was transported to a local hospital and pronounced deceased prior to admission. An autopsy to determine the nature and extent of the child's injuries was conducted the day following the crash. The results of that autopsy determined the child sustained fatal neck trauma (specifics unknown). The child did not have any external soft tissue injury. It is believed his fatal neck injury mechanism was related to a flexion injury over the shoulder portion of the safety belt. Medical records could not be obtained.

The driver of the Chevrolet was transported to a local hospital with unspecified non-life threatening injuries. The driver, rear left and rear right adult passengers of the Dodge were transported to a local hospital and released with complaints of soreness and minor contusions. The front right adult passenger suffered a fractured hip and was admitted to a local hospital. The 4 year old restrained rear center seated child was not injured.

1995 CHEVROLET BERETTA

Exterior Damage

Figures 4 and 5 are the front and left lateral views of the Chevrolet's frontal damage. The vehicle's frontal plane exhibited a combined width of direct and induced damage that extended across the entire 150 cm (59.0 in) undeformed end width. The direct contact damage measured 100 cm (39.5 in). The direct damage began 25 cm (10.0 in) right of center and extended to the left corner of the front bumper. The collision resulted in severe frontal damage that was documented along the front bumper reinforcement bar. The measured residual crush profile was as follows: C1 = 82 cm (32.3 in), C2 = 105 cm (41.3 in), C3 = 89 cm (35.0 in), C4 = 74 cm (29.1 in), C5 = 60 cm (23.6 in), C6 = 40 cm (15.7in). The maximum crush was located 25 cm (10 in) left of center at C2. The base of the left A-pillar deformed rearward 14 cm (5.5 in). The roof buckled 5 cm (2 in) vertically upward above the driver position. The left door was jammed shut by the compressive force of the impact and buckled. The right door remained closed during the impact and was operational post-crash. The windshield was fractured by the rearward deformation of the hood. The left wheelbase was reduced 29 cm (11.4 in). The right wheelbase

dimension was unchanged. The Collision Deformation Classification (CDC) of the vehicle was 12-FYEW-4. The total delta V calculated by the Damage Algorithm of the WINSMASH collision model was 65 km/h (40.6 mph). The longitudinal and lateral delta V components were -64 km/h (-40 mph) and -11 km/h (-7.0 mph), respectively.



Figure 4: Front view of the Beretta.



Figure 5: Left lateral view at the front plane.

2004 DODGE RAM 3500 PICK-UP TRUCK

Exterior Damage

Figure 6 is a front view of the moderate frontal damage sustained by the Dodge. The front plane sustained a combined 168 cm (66.0 in) width of direct and induced damage that extended across the vehicle's undeformed end width. The direct contact damage measured 86 cm (34.0 in). The direct damage began 3 cm (1.0 in) right of center and extended to the left front bumper corner. The residual damage measured along the front bumper was as follows: C1 = 38 cm (15.0 in), C2 = 16 cm (6.3 in), C3 = 35 cm (13.8 in), C4 = 14 cm (5.5 in), C5 = 0, C6 = 0. The maximum crush was located at C1, the left front bumper corner. As a result of the offset collision, the left corner deformed rearward and inboard about the left frame rail. The left corner of the bumper impacted and deboned the left front tire. The left front fender was crushed longitudinally and deformed. The left wheelbase was reduced 5 cm (2.0 in). The right wheelbase dimension was unchanged. All four doors were operational post-crash. There was no damage to the windshield or side window glazing. The Collision Deformation Classification (CDC) was 12-FYEW-2. The total delta V calculated by the Damage Algorithm of the WINSMASH collision model was 28 km/h (17.1 mph). The longitudinal and lateral delta V components were -28 km/h (-17.1 mph) and 0.0 km/h (0.0 mph), respectively.



Figure 6: Front view of the Dodge.

1995 CHEVROLET BERETTA

Interior Damage

Figures 7 and 8 are interior views of the Chevrolet. The Beretta sustained moderate severity intrusion in the front left position as a result of the exterior crash force. The measured front left intrusion is identified in the table below. The intrusion into the front right position was limited to the toe pan and measured 6 cm (2.4 in). Additional interior damage consisted of the deployment of the driver (only) air bag and the identified driver's interior contacts. There were no identified interior contacts associated to the front right child passenger.

Front Left Intrusion		
<i>Component</i>	<i>Magnitude</i>	<i>Direction</i>
Left A-pillar	14 cm (5.5 in)	Longitudinal
Left instrument panel	11 cm (4.3 in)	Longitudinal
Driver knee bolster	11 cm (4.5 in)	Longitudinal
Toe pan – left	15 cm (5.9 in)	Longitudinal
Roof side rail - left	5 cm (2.0 in)	Vertical



Figure 7: Front left interior view.



Figure 8: Front right interior view.

Inspection of the driver's knee bolster revealed two areas of contact related to driver's lower extremities. A 5 cm x 5 cm (2 in x 2 in) contact was located 10 cm (4 in) left of the steering column centerline related to a left lower extremity contact. A 2 cm x 5 cm (1 in x 2 in) contact was located 13 cm (5 in) right of the steering column centerline and was related to right lower extremity contact.

The leather wrapped two-spoke steering wheel was rotated approximately 160 degrees counterclockwise at inspection. The upper sector of the rim deformed forward and was in contact with the left aspect of the instrument panel. The rim deformation measured 10 cm (3.8 in) in the 12 o'clock sector. The rim deformation was the result of the driver's (inertial) loading through the deployed air bag as he rode down the force of the crash. There was a complete separation of the steering column's shear capsules. The steering column had dropped down and was resting on the top of the bolster panel. The shear separation resulted from the combination of the driver loading and the intrusion of the instrument panel.

The driver seat was jammed in position and could not be moved. Inspection of the seat track determined that the inboard roller attached to the aft aspect of the driver seat had disengaged from the seat track that was mounted to the floor pan at the center console. The roller was embedded in the carpet as a result of the weight of the driver sitting in the seat. Inspection of the seat track and roller indicated that the separation pre-existed the time of crash. Using the front right seat as a reference, the driver seat was located 3 cm (1.3 in) rearward of full forward. The total seat track travel measured 11 cm (4.5 in). The recline angle of the seat back measured 35 degrees. The horizontal distance from the seat back to the center of the steering wheel measured 58 cm (23 in).

The front right seat was located in a mid-track position that measured 5 cm (2.0 in) rear of full forward. The total seat track travel measured 11 cm (4.5 in). The seat back recline angle measured 30 degrees. The horizontal distance from the seat back to the vertical face of the instrument panel measured 70 cm (27.5 in). In a manner similar to the driver seat, the inboard seat track roller had also disengaged from the seat track at sometime prior to the crash. **Figure 9** is a view of the disengaged roller and seat track. In the figure, the seat was pushed forward and the aft aspect of the seat elevated to facilitate the photograph.



Figure9: View of the front right seat and disengaged seat track roller.

The roller was attached to the inboard aspect of the seat by a formed metal bracket. Inspection of the assembly revealed that the formed bracket and the axle shaft of the roller were deformed. The direction of the deformation indicated that the resultant deformation would have occurred from a compressive load placed in the front right seat. This type of loading was inconsistent with dynamics of the crash; therefore, this damage pre-dated the crash.

Automatic Restraint Systems

The safety belt system for the front positions of the 1995 Chevrolet Beretta consisted of automatic door-mounted lap and shoulder belts. The belt webbings spooled from dual Emergency Locking Retractors (ELR's) mounted within the respective front door cavity. The lap belt exited through a cut-out in the lower aspect of the door's interior panel. The shoulder belt webbing was routed vertically, exited the top aspect of the panel and through a fixed D-ring attached to the upper aspect of the door. The two webbings were connected together by a sewn-on latch plate. **Figure 10** is a view of the front right belt system.



Figure10: Front right manual three-point restraint.

Examination of the driver restraint revealed evidence of its use at the time of the crash. A 5 cm (2 in) transfer was identified on the shoulder belt webbing. The transfer was located 103 cm (40.5 in) above the latch plate. Examination of the D-ring revealed a full width friction abrasion associated to the aforementioned transfer. The latch plate exhibited historical usage marks consistent with the vehicle's age. All the evidence observed at the time of the inspection indicated the driver was restrained.

The first responder to the crash scene stated to the police that he unbuckled the safety belt from the child seated in the booster seat in the front right position. Examination of the front right manual restraint revealed crash related evidence indicative of use during the crash. An 8 cm (3 in) abraded region was identified on the lap belt webbing. The abrasion began 46 cm (18 in) above the latch plate and ended 53 cm (21 in) above the latch plate reference. This abraded area was related to a frictional interaction with the outboard aspect of the base of the booster seat. The face of the D-ring displayed a minor abrasion from contact with the shoulder belt. Examination of the latch plate revealed evidence of historical use. All the evidence gathered at the inspection determined the child was restrained by the manual safety belt. (Refer to the Child Safety Seat section of this report for greater detail regarding the routing of the belt.)

The rear bench seat of the Chevrolet was equipped with 3-point lap and shoulder belts in the outboard positions. These safety restraints utilized a continuous loop webbing, ELR retractors and locking latch plates. The rear center position was equipped with a lap (only) belt.

Air Bag System

The frontal air bag system in the 1995 Chevrolet Beretta consisted of a driver (only) air bag. The air bag module was designed into the center hub of the steering wheel rim and had deployed as a result of the crash. The symmetrical vinyl cover flaps were designed in an H-configuration. The width of the flaps measured 19 cm (7.5 in). The measured heights of the upper and lower flaps were 7 cm (2.6 in) and 5 cm (2.0 in), respectively. The deployed driver air bag measured 61 cm (24 in) in its deflated state. It was not tethered and was vented by two 1 cm (0.4 in) diameter ports located in the 3/9 o'clock sectors. There was no contact evidence identified on the face of the air bag.

CHILD SAFETY SEAT DATA

Cosco Voyager High-Back Belt Positioning Booster

The three year old male was seated in a Cosco Voyager high-back belt positioning booster and restrained within the front right position of the Chevrolet. **Figure 11** is a front view of the Cosco booster seat, Model No: 02-452-WAL. The seat was manufactured on February 22, 2003. The seat was labeled for use by child from 14 kg to 36 kg (30 lb to 80 lb) and up 132 cm (52 in), as long as the mid-point of the child's head was not above the seat back. There were two warning labels on the seat that stated "Do not use with lap belt only". The seat's instruction manual was not present. Three shoulder belt positioning clips were designed into the respective outboard edges of the seat back. The purpose of the clips was to position the shoulder belt for a better fit to the seated height of the child. These clips were not in use at the time of the crash.



Figure11: Front view of the Cosco Voyager.

Inspection of the booster seat identified evidence related to loading of the locked (after ELR actuation) safety belt system at the time of the crash. The fabric cover of the seat was abraded and torn in two locations on its upper left aspect. The tears measured 6 mm (0.25 in) in diameter and were located 53 cm (21 in) and 58 cm (23 in) above the seat base, respectively. Inspection of the plastic shell underneath the fabric at that location revealed a 6 mm (0.25 in) long abrasion of the shell. **Figure 12** is a close-up view of the abraded fabric and shell. A minor 4 cm (1.5 in) long fabric abrasion was observed on the right lower aspect of the seat. This abrasion was located 28 cm (11 in) above the seat base. The bight of the booster seat was designed to position the lap belt during use. Abrasions to the shell were observed on both sides of the shell from the seat's interaction with the locked lap belt during the crash. **Figure 13** is a view of the shell's abrasion on the left side of seat.



Figure 12: Close-up view of the fabric and shell abrasions caused by the locked shoulder belt.



Figure 13: Close-up view of the left side shell abrasion caused by the locked lap belt.

The crash-related safety belt evidence on the booster seat was used to reconstruct the probable usage position of the safety belt at the time of the crash. As evidenced by the abrasions, the designed belt positioning tabs were not in use. **Figure 14** is a view of the reconstructed position of the seat and safety belt taken at the time of the SCI inspection. In this position, the shoulder webbing crosses the centerline of the booster seat 42 cm (16.5 in) above the base, **Figure 15**.



Figure 14: View of the reconstructed position of the safety belt.



Figure 15: Reference view of the safety belt position.

OCCUPANT DEMOGRAPHICS

1995 Chevrolet Beretta

	<i>Driver</i>	<i>Front Right Passenger</i>
Age/Sex:	45 year old/Male	3 year old/Male
Height:	Not Reported	Not Reported
Weight:	Not Reported	Not Reported
Seat Position:	Forward track	Mid Track
Restraint Use:	Automatic door-mounted lap and shoulder	Automatic door-mounted lap and shoulder in a high-back belt positioning booster seat
Usage Source:	SCI inspection, PAR	SCI inspection, First responder, PAR
Medical Treatment:	Transported to a local hospital, treatment unknown	Fatally injured

DRIVER INJURY

The injuries sustained by the driver were not known at the time of this narrative report.

DRIVER KINEMATICS

1995 Chevrolet Beretta

The 45 year old driver was seated in a forward track position and was restrained by the automatic door-mounted lap and shoulder belt system. For unknown reasons, the driver allowed the

vehicle to cross the centerline directly into the path of the Dodge. At impact the safety belt's ELR retractors locked and the driver air bag deployed.

The driver responded to the 12 o'clock direction of the impact force by exhibiting a forward trajectory. The driver contacted and loaded the restraint as evidenced by the webbing transfer and D-ring abrasion. The driver's chest loaded the deployed air bag. Coincident with his forward kinematic pattern, the left structures of the interior were deforming rearward and intruding into his occupant space. The combination of the intrusion and the driver loading the steering column through the inflated air bag separated the steering column from the shear capsules. The driver's continued loading deformed the upper sector of the rotated steering wheel resulting in the identified rim deformation. The driver then rebounded back into his seat where he came to rest

FRONT RIGHT PASSENGER INJURY

1995 Chevrolet Beretta

<i>Injury</i>	<i>Injury Severity (AIS 98 Update)</i>	<i>Injury Mechanism</i>
Fatal cervical spine trauma, Specifics unknown	Unknown (615099.7,6)	Inertial flexion of the head/neck relative to the chest restrained by the safety belt

Note: the above injury data was based on police reported information. There were no external soft tissues injuries observed on the child. The Medical Examiner's Report was not available.

FRONT RIGHT PASSENGER KINEMATICS

1995 Chevrolet Beretta

The 3 year old child passenger was seated in a high-back belt positioning booster seat that was positioned in the front right of the Chevrolet. The child was restrained by the automatic door-mounted lap and shoulder belt, as described above.

At impact, the ELR retractors of the safety belt system locked. The child (and booster seat) responded to the 12 o'clock direction of the impact by exhibiting a forward trajectory. The child contacted and loaded the locked belt system with this chest and pelvis. The identified webbing abrasion, D-ring abrasion, and the load marks on the booster seat evidenced the belt loading. As the child loaded the safety belt system, his torso rode down the force of the impact, decelerated, and became restrained. The inertia of the unrestrained head caused the neck to continue forward into flexion. The head/neck flexed forward and exceeded the limits of the child's anatomical structures. This kinematic motion resulted in a fatal cervical spine injury. The child then rebounded back into his seat where he came to rest.

The first responder unbuckled the safety belt that restrained the child and removed him from the vehicle. He was unresponsive at that time. He was transported to a local hospital, where he was pronounced deceased one hour post-crash.

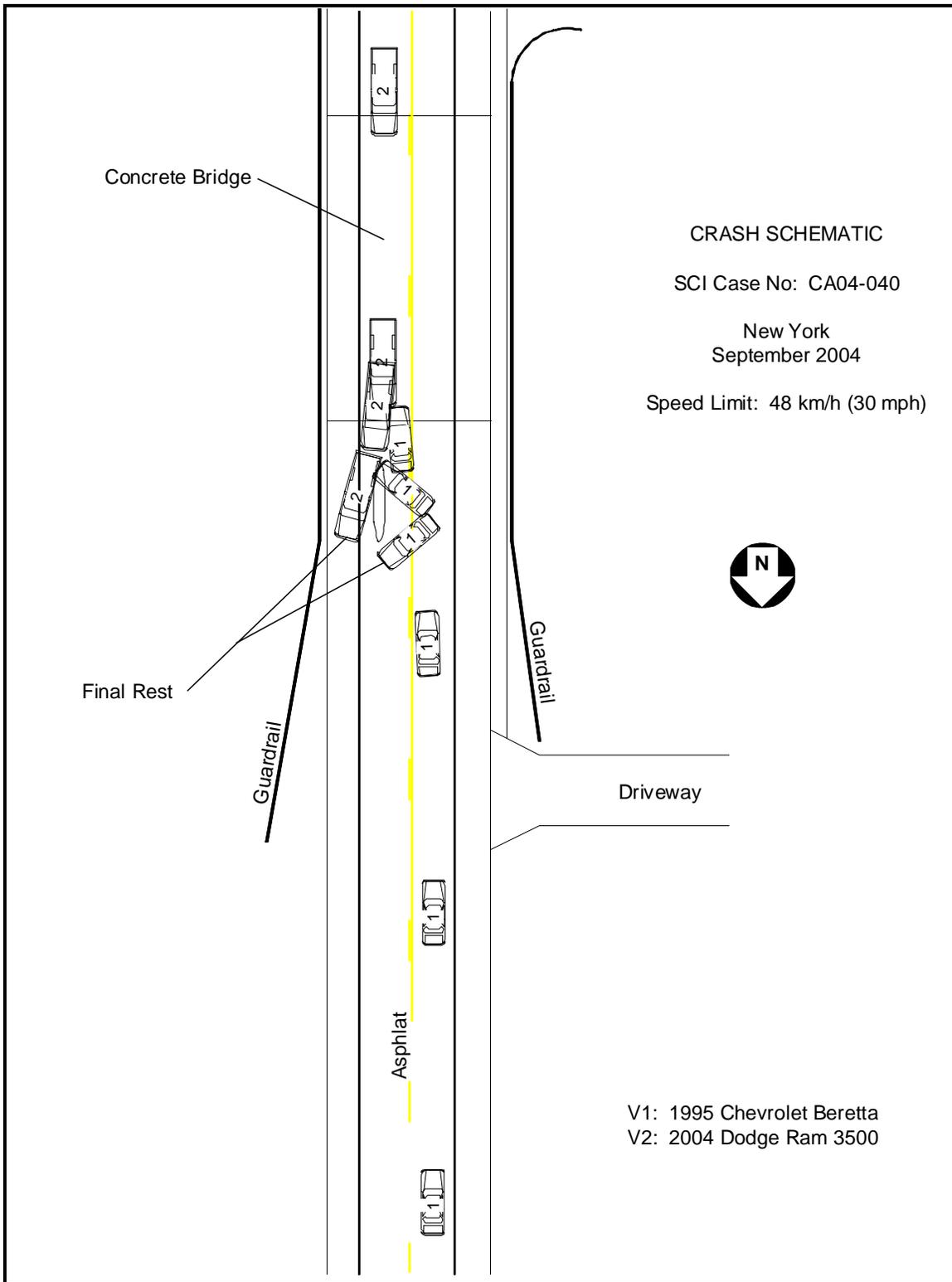


Figure 16: Crash schematic.