

CRASH DATA RESEARCH CENTER

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**CALSPAN ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE
CRASH INVESTIGATION**

SCI CASE NO.: CA08008

VEHICLE: 2007 TOYOTA COROLLA

LOCATION: NEW JERSEY

CRASH DATE: DECEMBER 2007

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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TABLE OF CONTENTS

BACKGROUND.....	1
SUMMARY	1
CRASH SITE.....	1
VEHICLE DATA	2
CRASH SEQUENCE.....	2
PRE-CRASH	2
CRASH.....	3
POST-CRASH	3
VEHICLE DAMAGE	3
EXTERIOR.....	3
INTERIOR.....	4
CERTIFIED ADVANCED 208-COMPLIANT FRONTAL AIR BAG SYSTEM	5
EVENT DATA RECORDER.....	5
MANUAL SAFETY BELT SYSTEMS	5
DRIVER DEMOGRAPHICS/DATA.....	6
DRIVER INJURIES.....	6
DRIVER KINEMATICS	7
FIGURE 11 – CRASH SCHEMATIC	8

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BACKGROUND

This on-site investigation focused on the severity of the crash, the deployment of the frontal air bag system, and the injury severity for the 27-year old female driver of a 2007 Toyota Corolla. The Toyota was equipped with a Certified Advanced 208-Compliant frontal air bag system for the driver and front right passenger positions. The manufacturer of this vehicle has certified that the Corolla meets the requirements for advanced air bags under Federal Motor Vehicle Safety Standard No. 208. The Toyota was involved in a single vehicle road-side departure crash (**Figure 1**) with a utility pole that resulted in the deployment of the driver's air bag. The female driver was restrained by the manual safety belt system. She complained of soft-tissue chest injuries and was transported to a local hospital where she was treated for her injuries.



Figure 1. Frontal view of the damage to the 2007 Toyota Corolla.

The crash was identified by Crash Investigation Division of the National Highway Traffic Safety Administration through a review of Police Accident Reports (PARS) submitted by the National Automotive Sampling System (NASS). The PAR was forwarded to the Calspan Special Crash Investigations (SCI) team and assigned for on-site investigation. The investigation involved the detailed inspection and documentation of the Toyota Corolla and the crash scene. The driver consented to a partial interview; however, she failed to provide details regarding her injuries. Attempts at acquiring medical records were unsuccessful, as the treating medical facility could not locate any records on the driver.

SUMMARY

Crash Site

The crash occurred on a two-lane road during nighttime hours. The asphalt travel lanes were 3.8 m (12.5') in width and were separated by a painted yellow centerline that permitted passing in the eastbound direction. Paved shoulders were adjacent to the travel lanes and were 2.7 and 2.6 m (8.9 and 8.5') in width for the south and north shoulders respectively. Concrete barrier curbs bordered the shoulders. The posted speed limit



Figure 2. Overall view of the crash site.

was 72 km/h (45 mph). At the time of the crash, the pavement was dry. **Figure 2** is an overall view of the crash site.

The Toyota departed the south roadside and impacted a wooden utility pole. The pole was 50 cm (19.7”) in diameter and was located 0.6 m (2’) outboard of the south curbline. Two vertically positioned 5 cm (2”) diameter galvanized conduits were affixed to the pole to conceal ground wires and were 180 degrees opposed. The outboard conduit was struck by the vehicle. Damage to the pole consisted of superficial gouges. The Crash Schematic is attached as **Figure 11** of this report.

Vehicle Data

The involved vehicle in this crash was a 2007 Toyota Corolla LE, four-door sedan. The Corolla was manufactured on 02/07 and was identified by Vehicle Identification Number (VIN) 1NXBR32E57Z (production number deleted). The Toyota was powered by a 1.8 liter transverse mounted four-cylinder engine linked to a four-speed automatic transmission with a console mounted shift lever. The service brakes were power-assisted front disc with rear drum. It’s unknown if this vehicle was equipped with the optional anti-lock brakes, traction control, or stability control. The tires were Goodyear Integrity all-season radials, size P195/65R16 mounted on OEM steel wheels. The vehicle manufacturer recommended tire pressure was 210 kPa (30 PSI). The tire data at the time of the SCI inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Damage
Left Front	165 kPa (24 PSI)	5 mm (6/32”)	None
Right Front	193 kPa (28 PSI)	5 mm (6/32”)	None
Left Rear	179 kPa (26 PSI)	6 mm (8/32”)	None
Right Rear	200 kPa (29 PSI)	6 mm (7/32”)	None

The interior of the Corolla was configured with five-passenger seating with front bucket seats and a rear bench with split folding backs. All five positions were equipped with adjustable head restraints that were in the full down positions. The seat surfaces were cloth. The Corolla was equipped with power windows and door locks and a tilt steering column that was set to the full-up position. The steering wheel was configured with three spokes at the 3, 6 and 9 o’clock positions.

Crash Sequence

Pre-Crash

The 27-year old female driver of the 2007 Toyota Corolla was traveling in a southerly direction on the two-lane road approaching a three-leg T intersection. North/southbound traffic flow through the intersection was not controlled. The driver’s intended path was to travel straight through the intersection and initiate a left turn approximately 1 km (0.5 mile) beyond the impending crash site. As she traversed the



Figure 3. Pre-crash trajectory of the Toyota Corolla.

intersection, the driver relinquished control of the vehicle. It appeared that the driver fell asleep due to alcohol intoxication. The Toyota crossed the centerline of the road and the opposing travel lane in a tracking orientation. The vehicle traversed the east shoulder and the front overhang cleared the barrier curb. There was no supportive physical evidence to indicate avoidance actions by the driver. **Figure 3** is the pre-crash trajectory of the Toyota.

Crash

The front left area of the Toyota impacted the large diameter utility pole (**Figure 4**) that was located 0.6 m (2') outboard of the referenced curb line. The direction of force was 12 o'clock. The front left corner of the bumper crushed to a depth of 67 cm (26.5"). The Trajectory Algorithm of the WinSMASH program was utilized to compute an impact speed of 49 km/h (30.4 mph) with a total delta V of 49 km/h (30.4 mph). The longitudinal and lateral components were 49 km/h (30.4 mph) and 0 km/h respectively. It should be noted that the computed delta V appeared to be high based on SCI experience.



Figure 4. Struck utility pole.

The impact deployed the front left air bag and actuated the driver's retractor pretensioner. As the Toyota crushed to maximum engagement, the off-set left impact resulted in an estimated 20 degrees of counterclockwise rotation. The vehicle came to rest fully engaged against the struck pole. The large diameter pole did not fracture or yield to the crash forces.

Post-Crash

The driver unbuckled her safety belt and opened the left front door and exited the vehicle post-crash. She waited at the scene for emergency personnel to arrive. The investigating officer detected an order of alcohol on her breath. She was treated at the scene for soft tissue injuries and transported by ground ambulance to a local hospital where she received additional treatment and a blood test to determine her level of impairment. She was subsequently charged with driving under the influence of alcohol and failure to maintain her lane.

Vehicle Damage

Exterior

The 2007 Toyota Corolla sustained moderate damage to the front left area as a result of the impact with the utility pole. The direct contact damage began 25 cm (10") left of the vehicle's centerline and extended 46 cm (18") to the left bumper corner. The maximum crush was 67 cm (26.5") located at the left corner of the bumper beam. The vertically oriented crush profile involved the bumper and the upper radiator support. The crush depth was greater at the bumper level and was documented as follows: C1 = 67 cm (26.5"), C2 = 62 cm (24.5"), C3 = 46 cm (18"), C4 = 30 cm (12"), C5 = 14 cm (5.5"), C6 = 0 cm.



Figure 5. Frontal view of the damage to the Toyota Corolla.



Figure 6. Lateral view of the depth of frontal crush.

The bumper fascia was removed during the tow process of the vehicle. The damage involved the fascia, bumper beam, hood, left headlight assembly, radiator, air conditioner condenser, upper radiator support, the inner structure and shock tower, the left front fender, and the left front suspension. The left front axle position was displaced rearward 16 cm (6.4") that resulted in a restriction of the tire. The Collision Deformation Classification (CDC) for the pole impact was 12-FLEW-3.

All four doors remained closed during the crash and were operational post-crash. The windshield was cracked at the lower left corner from the engagement of the tire into the vehicle structure. All side glass was closed and remained intact during the crash. The Toyota was not equipped with a sunroof.

Interior

The interior of the Toyota Corolla sustained minor severity damage as a result of intrusion and driver contact. The intrusion was limited to 13 cm (5") of rearward displacement of the left toe pan.

The driver was restrained by the manual safety belt system. She loaded the belt webbing that resulted in frictional abrasions to the lap belt from engagement against the seat back recline lever, frictional D-ring abrasions, and latch plate abrasions. The driver's left knee contacted the left lower instrument panel and displaced a storage compartment door from its mounting. The component measured 15 cm (6") in width and 11 cm (4.5") in height. Her knee probably contacted and fractured the forward aspect of the left door panel below the door release lever. The fracture site was located 33-56 cm (13-22") forward of the aft edge of the armrest and 17-24 cm (6.5-9.5") below the beltline. The driver's face contacted the deployed air bag that resulted in a subtle make-up transfer at the lower right quadrant of the bag.

The rear view mirror was detached from its mounting point and suspended by the electrical wire for the map lights. An apparent skin oil transfer was present on the mirror glass 5-11 cm (2-4.5") inboard of the left edge. The mirror glass and the plastic housing were not damaged.

Certified Advanced 208-Compliant Frontal Air Bag System

The 2007 Toyota Corolla was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system for the driver and front right passenger positions. This system consisted of dual-stage air bags, seat track position sensors, safety belt buckle switches, a front right passenger weight sensor, and front retractor pretensioners. The manufacturer of this vehicle has certified that the 2007 Corolla meets the requirements for advanced air bags under Federal Motor Vehicle Safety Standard No. 208. The CAC system utilized an air bag control module that provided crash sensing, diagnostic testing at each key cycle, and Event Data Recording (EDR).

The driver air bag was concealed in the center hub of the three-spoke steering wheel by asymmetrical cover flaps. The upper flap was 15 cm (5.75") in width at the horizontal tear seam and 6 cm (2.5") in height. The lower flap was 14 cm (5.5") in width at the bottom hinge point and split vertically at the midpoint. The air bag membrane was 51 cm (20") in diameter in its deflated state and was tethered internally by two straps. The air bag was vented by two ports located at the 10 and 2 o'clock positions. The maximum excursion of the bag (deflated) was 27 cm (10.5").



Figure 5. Deployed driver's air bag with make-up transfer.

The driver's face contacted the lower right quadrant of the air bag. A subtle make-up transfer was located 11-19 cm (4.5-7.5") right of center and 0-5 cm (0-2") below the horizontal centerline.

The Corolla was not equipped with the optional seat back mounted side impact air bags or curtain air bags.

Event Data Recorder

The Toyota was equipped with an air bag control module that had Event Data Recording (EDR) capabilities. Permission to remove the EDR from the vehicle for download by Toyota was not received.

Manual Safety Belt Systems

The safety belt systems consisted of continuous loop webbing and sliding latch plates for all five positions. The front systems were equipped with adjustable D-rings that were adjusted to the full-up positions. The driver's retractor utilized an Emergency Locking Retractor (ELR) with a load limiter. The front right and rear seat retractors were switchable from the ELR to the Automatic Locking Retractor (ALR) mode. Both front retractors were equipped with pretensioners. The CAC system detected the unoccupied front right seat and suppressed the deployment of the front right air bag and the pretensioner.

The driver was belted during the crash. She loaded the manual safety belt system that produced loading evidence at the lower lap belt area, the latch plate, the D-ring and the associated shoulder belt webbing.



Figure 8. Lap belt transfer from recline lever.



Figure 9. D-ring abrasion and belt evidence.

The lap belt webbing engaged the recline lever for the driver’s seat back resulting in a pronounced frictional abrasion/plastic transfer to the inside surface of the webbing and an abrasion to the lever (**Figure 8**). The belt abrasion/transfer was located 27-28 cm (10.5-11”) above the lower anchor point. The latch plate was abraded full width; however, there were no matching transfers on the belt webbing.

The D-ring was abraded and a 15 cm (6”) long frictional abrasion/transfer was present on the belt webbing (**Figure 9**) from driver loading, actuation of the retractor pretensioner, and spool-out due to the load limiter retractor. There was no damage to the hardware components of the belt system.

Driver Demographics/Data

Age/Sex: 27-year old/Female
 Height: 163 cm (64”)
 Weight: 64 kg (140 lb)
 Seat Track Position: Forward third position
 Eyewear: None
 Manual Safety Belt Use: 3-point lap and shoulder belt system
 Usage Source: Vehicle inspection
 Driver Egress from Vehicle: Unassisted
 Mode of Transport
 From Scene: Ground ambulance
 Type of Medical Treatment: Unknown

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Soft tissue injuries of the chest	Minor (490099.1,9)	Shoulder belt loading

Probable facial laceration or epitaxis (NFS)	Minor (290099.1,9)	Rear view mirror
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* *The above injuries were police reported.*

Driver Kinematics

The 27-year old female driver of the Toyota Corolla was seated in a forward track position with the seat back reclined 20 degrees and the head restraint adjusted to the full-down position (**Figure 10**). The seat track was adjusted 8 cm (3”) aft of full-forward and 15 cm (6”) forward of the full rear position. She was restrained by the manual safety belt system. Belt usage was supported by the actuated status of the retractor pretensioner and the loading evidence on the system’s components.



Figure 10. Right lateral view of the driver’s seated position.

At impact, the driver’s pretensioner actuated and the frontal air bag deployed as the driver initiated a forward trajectory in response to the 12 o’clock direction of force. She loaded the safety belt system that produced loading evidence on the webbing from engagement against the recline lever, frictional abrasions on the latch plate and D-ring, and an abrasion/transfer on the webbing from the D-ring. Her loading force against the belt webbing resulted in the unspecified chest injury.

The driver’s left knee contacted the storage compartment door located in the lower left instrument panel. This contact displaced the door from its mounting. Her left knee probably contacted and fractured the adjacent left door panel as the vehicle rotated CCW as it crushed to maximum engagement.

The driver’s face contacted the deployed driver’s air bag, evidenced by a subtle make-up transfer to the lower right quadrant of the air bag membrane. There was no damage or deflection of the steering wheel rim or column.

The rear view mirror separated from the header mounting point. A skin oil transfer was noted to the left aspect of the mirror glass. A large amount of body fluid was present in the center console and cup holders that probably resulted from a lesion associated from mirror contact to the driver’s face.

The driver rebounded into her seating position and bled onto the center console. She unbuckled her safety belt and opened the driver’s door and exited the vehicle unassisted. She was treated at the scene by paramedics and transported by ambulance to a local hospital where she received additional treatment for her injuries. The treating medical facility could not locate records for the driver.

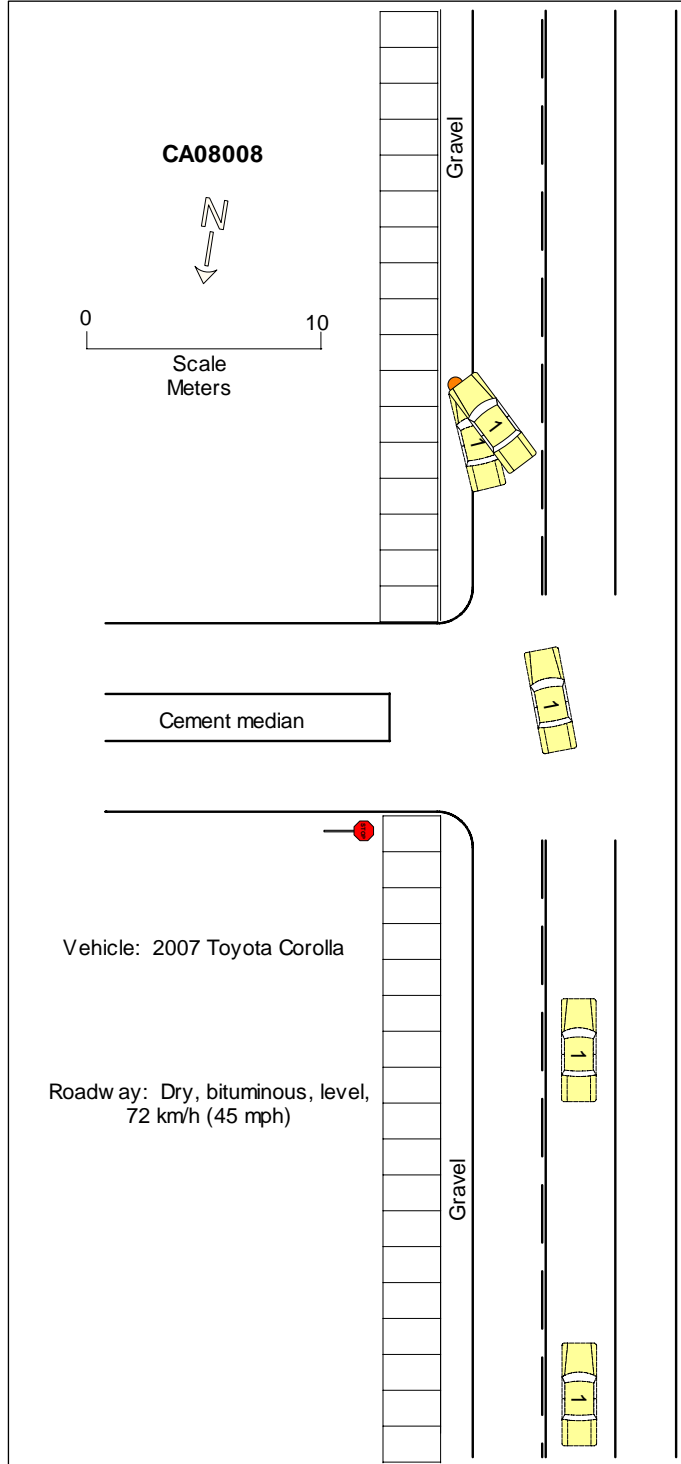


Figure 11 – Crash Schematic