Certified Advanced 208 Compliant Air Bag Investigation
Dynamic Science, Inc. (DSI), Case Number DS08027
2008 Smart Fortwo Passion
Washington
July 2008

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

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

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16. Abstract

This on-site investigation focused on the Certified Advanced 208-Compliant (CAC) air bag system in a 2008 Smart Fortwo Passion. This two-vehicle crash occurred in July 2008 at 1833 hours in an urban area of the state of Washington. The crash occurred within the confines of a four leg intersection. The intersection was controlled by traffic signals at each leg. The 2008 Smart Fortwo was being driven north in the outboard lane by a 49-year-old male. According to the driver of the Fortwo, the light at the intersection was in the green phase for northbound traffic. As he entered the intersection, he initiated a turn to the right to go east. The other vehicle was a 2008 Dodge Caravan that was being driven east in the middle lane by a 50-year-old female. As the Fortwo entered the intersection, the front of the Fortwo struck the right side of the Caravan. The Fortwo's driver air bag deployed and the seat belt pretensioner actuated during the impact. There was also a secondary, side slap impact between the two vehicles. The driver of the Smart Fortwo sustained a dislocated right thumb, left side rib contusions, and a neck strain. He was transported from the scene to a local hospital. A passenger in the Caravan was also transported from the scene.

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Dynamic Science, Inc.
Crash Investigation
Case Number: DS08027

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Background

This on-site investigation focused on the Certified Advanced 208-Compliant (CAC) air bag system in a 2008 Smart Fortwo Passion (**Figure 1**). The multi-stage air bags were certified by the manufacturer to be compliant with the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. This two-vehicle crash occurred in July 2008 at 1833 hours in an urban area of the state of Washington. The crash occurred within a four leg intersection. The Fortwo was being driven north in the outboard lane by a 49-year-old male. According to the driver of the Fortwo, the light at the intersection was in the green phase. As he entered the intersection, he initiated a turn to the right to go east. The other vehicle was a 2008 Dodge Grand Caravan that was being driven east in the middle lane by a 50-year-old female. As the Fortwo entered the intersection, the front of the Fortwo struck the right side of the Caravan. The Fortwo's driver air bag deployed and the seat belt pretensioner actuated during the impact. There was also a secondary, side slap impact between the two vehicles. The driver of the Smart Fortwo sustained a non-disabling injury and was transported from the scene to a local hospital. A passenger in the Caravan was also transported from the scene.

Figure 1. Subject vehicle, 2008 Smart Fortwo Passion

This CAC investigation was identified by a National Automotive Sampling System (NASS) team during a visit to a local tow yard. Photos and information about the 2008 Smart Fortwo were forwarded to the National Highway Traffic Safety Administration (NHTSA). On July 17, 2008 DSI was instructed to obtain permission to inspect the vehicle. The vehicle was originally located at an insurance salvage lot. At some point, the insurance company decided to repair the vehicle instead of declaring the vehicle a total loss, and the vehicle was moved to a repair facility. The owner of the vehicle obtained the services of an attorney to prevent this action. DSI obtained permission to inspect the vehicle from the owner's attorney. Field work was completed on August 22, 2008.

Figure 2. North approach for the 2008 Smart Fortwo

Summary

Crash Site

This two vehicle crash occurred within a four-leg intersection in July 2008. At the time of the crash, there were no adverse weather conditions and the roadway surface was dry. The northbound leg of the intersection was configured with two

northbound travel lanes, a left turn lane, and two southbound travel lanes. The outboard lane had a concrete surface while the remaining lanes were comprised of a mixture of concrete and asphalt. The roadway was heavily patched and had a negative 6% northbound grade. The eastbound leg of the intersection was configured with a right turn lane, two eastbound travel lanes, and a westbound travel lane. The asphalt roadway had a positive 1% eastbound grade. The speed limit for both roadways was 40 km/h (25 mph).

Figure 3. East approach for the 2008 Dodge Caravan

Pre-Crash

The Fortwo was traveling north in the outboard lane approaching the four-leg intersection. (**Figure 2**) The 49-year-old male driver stated that the traffic signal was in the green phase for northbound traffic as he was approaching the intersection. His statement was corroborated by several witnesses. As Fortwo reached the intersection, the driver initiated a right hand turn. The Caravan was traveling east in the first through lane and was approaching the intersection (**Figure 3**). In addition to the 50-year-old driver, there were as many as eight additional passengers in the Caravan. The Caravan entered the intersection against the red light.

Crash

The front of the Fortwo struck the right side aspect of the Caravan near the right front tire. The impact severity was moderate, and resulted in the deployment of the Fortwo's driver air bag and the actuation of the safety belt pretensioner. The missing vehicle algorithm of the WinSmash program computed a Total Delta V of 14 km/h (8.7 mph), based on the Fortwo's front crush profile. The longitudinal and lateral components were -11 km/h (-6.6 mph) and 9 km/h (5.6 mph), respectively. The Fortwo was displaced in a clockwise rotation and a secondary impact occurred between the left rear of the Fortwo and the right side of the Caravan. This was a minor impact with minimal damage to the Fortwo. Both vehicles came to rest facing east.

Post-Crash

The driver of the Fortwo sustained a dislocated right thumb, left side rib contusions, and a neck strain. He was transported from the scene to a local hospital where he was treated and released. A passenger in the Caravan was also transported from the scene. Both vehicles were towed from the scene. Though there was some left wheel damage, the Fortwo was driveable after the crash.

Vehicle Data - 2008 Smart Fortwo Passion

The 2008 Smart Fortwo Passion was identified by the Vehicle Identification Number (VIN): WMEEK31XX8Kxxxxxx. The vehicle's date of manufacture was April 2008. The vehicle was equipped with an electronic odometer which read 661 km (411 miles) at the time of the vehicle inspection. The Fortwo was a 3-door hatchback convertible that was equipped with a 1-liter, 3-

cylinder engine, automatic transmission, rear wheel drive, anti-lock brakes, and electronic stability and traction control. The Fortwo was 270 cm (106 in) in length and 156 cm (61 in) in width. The vehicle was configured with Continental Contiprocontact P155/60R15 tires. The tire manufacturer's recommended maximum pressure was 303 kPa (44 psi). The vehicle manufacturer's recommended cold pressure was 200 kPa (29 psi) for the front and 248 kPa (36 psi) for the rear. The specific tire information was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	234 kPa (34 psi)	8 mm (10/32 in)	No	None
LR	207 kPa (30 psi)	7 mm (9/32 in)	No	None
RR	207 kPa (30 psi)	8 mm (10/32 in)	No	None
RF	193 kPa (28 psi)	8 mm (10/32 in)	No	None

The seating in the Fortwo was configured with front bucket seats with integral head restraints. Both seats were adjusted to the full rear-track positions at the time of inspection. By design, the front right seat is positioned slightly rearward of the driver seat to optimize shoulder room. With the seats in the full rearward position, the front right seat was located 9 cm (3.5 in) aft of the driver's seat.

Vehicle Damage

Exterior Damage

The Smart Fortwo sustained moderate front end damage as a result of the initial impact with the Dodge Caravan (**Figure 4**). The direct damage began at the front left bumper corner and extended 121 cm (47.6 in) laterally to the right. The damage on the right side of the bumper fascia was minor and consisted of tire tread marks. The fascia was fractured at its left aspect. Six crush measurements were documented at the bumper level as follows: C1 = 8 cm (3.1 in), C2 = 3 cm (1.2 in), C3 = 0 cm, C4 = 0 cm, C5 = 0 cm, C6 = 0 cm. The plastic fascia had restituted to some degree and the crush along the bumper face under-reported the crush. Two crush measurements were taken using the visible outboard portions of the bumper backing bar as follows: C1 = 12 cm (4.7 in) and C2 = 7 cm (2.8 in).

Figure 4. Frontal damage, 2008 Smart Fortwo

The backing bar was shifted 6 cm (2.4 in) to the right (**Figure 5**). The upper mounting bracket was shifted 3 cm (1.2 in) to the right. The Collision Deformation Classification (CDC) for the impact with the Caravan was 11FDEW2.

There was 68 cm (26.8 in) of direct contact that extended from the left bumper corner down the left side of the vehicle. The left wheelbase was shortened by 4 cm (1.6 in). The left tire was cambered slightly inboard at the top. The tire was not restricted.

The Smart Fortwo also sustained minor left side damage as a result of a sideslap type impact with the right side of the Caravan (**Figure 6**). The direct damage began 17 cm (6.7 in) forward of the left rear axle and extended 44 cm (17.3 in) rearward along the left side plane. The CDC for this impact was 09LBEW1.

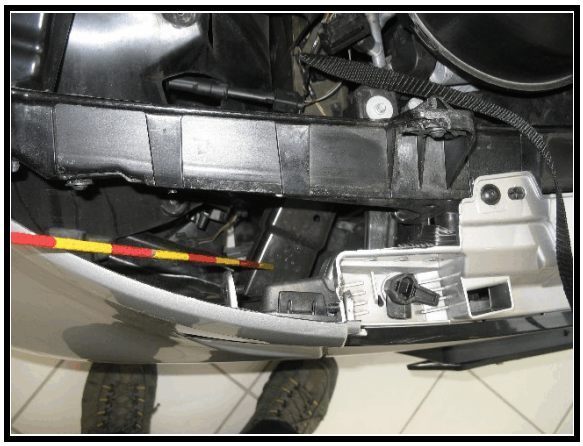

Figure 5. Top view of right mounting bracket and backing bar

Figure 6. Left side damage

Interior Damage

The windshield was cracked from impact forces. The doors and the hatchback remained closed and operational. There was no were passenger compartment intrusions or occupant contacts.

Manual Restraints

The 2008 Smart Fortwo was configured with 3-point manual lap and shoulder belts for the two seating positions. Both safety belts were equipped with retractor pretensioners. The driver's safety belt was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). At the time of the vehicle inspection, the driver's retractor was restricted in the used position as a result of pretensioner actuation. The belt webbing exhibited a 19 cm (7.5 in) area of loading (**Figure 7**). The distance from the belt anchor to the beginning of the loading measured 154 cm (60.6 in). The passenger safety belt was configured with a sliding latch plate and a switchable ELR/Automatic Locking Retractor (ALR). The passenger side pretensioner did not actuated and the retractor was functional.

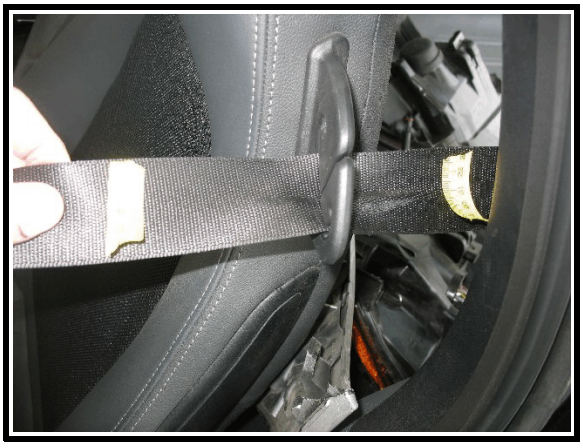

Figure 7. Loading to driver's seat belt webbing

Supplemental Restraint Systems

Figure 8. Deployed driver's air bag

The 2008 Smart Fortwo was equipped with advanced occupant protection systems including multi-stage driver and front right passenger air bags. The driver's frontal air bag deployed as a result of the longitudinal deceleration of the Fortwo during the first impact with the Caravan (**Figure 8**). The front right passenger's air bag did not deploy. The Fortwo was also equipped with seat- mounted side air bags that did not deploy. The driver's air bag deployed from the center of the steering wheel hub through asymmetrical I-configuration module cover flaps. The left flap measured 8 cm (3.1 in) along the top and 8 cm (3.1 in) vertically to a 4 cm (1.6 in) offset. The right flap measured 3 cm (1.2 in) along the top and 8 cm (3.1 in) vertically to a 4 cm (1.6 in) offset. The air bag measured 52 cm (20.5 in) in diameter in its deflated state. The air bag was tethered by a single internal strap. There was circular stitching on the face of the air bag that measured 16 cm (6.3 in). A single 3 cm (1.2 in) circular vent port was located at the 12 o'clock aspect on the back panel. There was a printed pattern along the bottom of the face of the air bag. There were no indications of air bag damage or occupant contacts on the air bag.

Vehicle Data - 2008 Dodge Caravan

The 2008 Dodge Caravan was identified by the VIN: 1D8HN54P98Bxxxxxx. The Dodge was fleet rental vehicle that was equipped with a 3.8-liter, 6-cylinder engine, automatic transmission, and rear-wheel drive. The vehicle sustained right side damage from the impact with the Fortwo and was towed from the scene. One passenger from the Dodge was possibly injured and was transported from the scene to a local hospital.

OCCUPANT DEMOGRAPHICS

	Driver
Age/Sex:	49/Male
Seated Position:	Front row left
Seat Type:	Bucket
Seat Track:	Rear-most track
Height:	183 cm (72 in)
Weight:	85 kg (187 lbs)
Alcohol/Drug Involvement:	None
Body Posture:	Normal, upright

	Driver
Hand Position:	Both hands on steering wheel, 10 and 2 o'clock positions
Foot Position:	Right foot on brake, left on floor.
Restraint Usage:	Lap and shoulder belt used.
Air bag:	Steering wheel mounted frontal air bag deployed.

Occupant Kinematics

Driver Kinematics

The 49-year-old driver was seated in a forward facing posture and was restrained by the 3-point manual lap and shoulder belt. The seat was positioned in the rear-track position. The driver was initiating a right turn. At impact, the frontal air bag deployed and the driver's safety belt pretensioner actuated. The driver initiated a forward and slightly lateral trajectory to the left. His right thumb was dislocated by the deploying air bag and he loaded the safety belt webbing. As the vehicle rotated clockwise, the driver engaged the rear upper door panel, causing the left side rib contusions. He also sustained a neck strain which was attributed to impact forces. He remained in place during the minor sideslap impact. He was able to exit the vehicle under his own power and was transported from the scene to a local hospital where he was treated and released.

OCCUPANT INJURIES

Driver: Injuries obtained from interviewee.

Injury	AIS Code	Injury Mechanism	Confidence Level
Dislocated right thumb	750402.1,1	Air bag	Probable
Rib contusions, left side	450202.1,2	Left rear upper door panel	Certain
Neck strain	640278.1,6	Impact forces	Certain

Attachment 1. Scene Diagram