National Transportation Safety Board

Washington, D.C. 20594

Highway Accident Brief

Accident Number:	HWY14MH006
Accident Type:	Tire deflation and tread separation, cross-median crash
Location:	US Route 90 near milepost 160.2, near Centerville, St. Mary Parish, Louisiana
Date and Time:	Saturday, February 15, 2014, about 11:30 a.m.
Vehicles:	2004 Kia Sorento sport utility vehicle 2005 IC Bus (66-passenger school bus)
Fatalities:	4
Injuries:	2 serious, 30 minor

Crash Description

On Saturday, February 15, 2014, about 11:30 a.m. local time, a 2004 Kia Sorento sport utility vehicle (SUV), occupied by a 37-year-old driver and four passengers, was traveling westbound on US Route 90 (US-90) near Centerville, Louisiana. The SUV was traveling in the right lane at a witness-estimated speed of 70 mph (roadway speed limit) when the driver lost control of the vehicle due to a tread separation and rapid air loss in the left rear tire. The SUV veered into the left westbound lane, rotating in a counterclockwise direction, and departed the roadway into a 64-foot-wide depressed earthen median. It continued through the median, now rotating in a clockwise direction; entered the eastbound traffic lanes of US-90; and collided with a 2005 IC Bus (66-passenger school bus), which was traveling in the right lane.[1] The left front of the SUV contacted the right front of the school bus, resulting in the rapid clockwise rotation of the SUV and secondary impacts along the right side of the school bus. The driver of the SUV and three rear passengers were ejected. The fourth passenger remained in the vehicle.

The Kia came to a rest in an earthen area separating US-90 from a frontage road on the south side of the highway. The SUV engine and other components came to a rest on the frontage road, southeast of the initial impact area. The school bus continued in a southeasterly direction, departing the roadway to the right, where it crossed the earthen area, the frontage road, and a drainage ditch before coming to a rest in a sugar cane field (figure 1). The school bus was occupied by a 40-year-old driver and 34 members of the Lafayette High School baseball team (four adults and 30 students).

[1] IC Bus is a subsidiary of Navistar International Corporation. The series/model of the accident bus is CE300/PB10500.

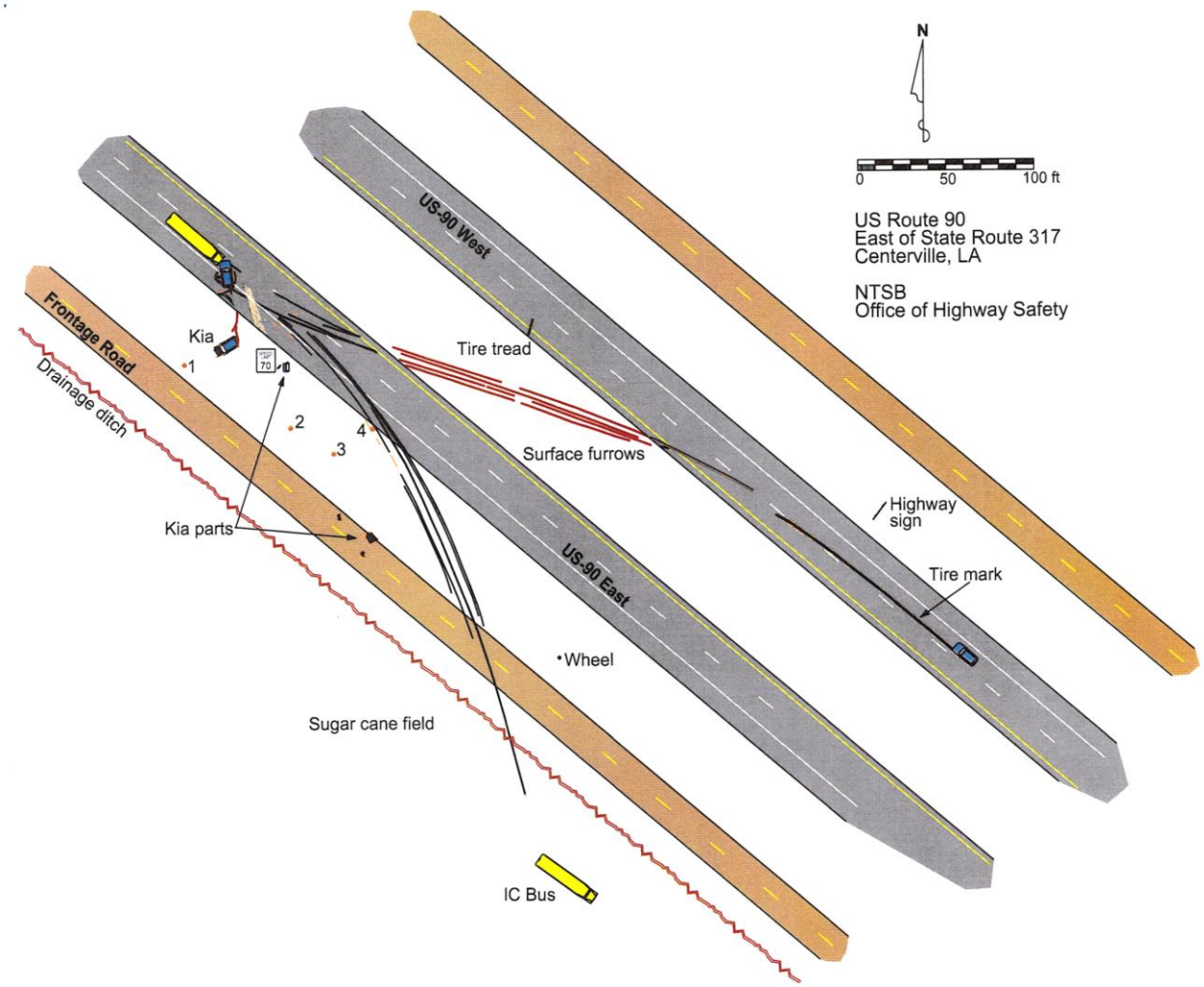

Figure 1. Scene drawing showing crash sequence, from Kia loss of control and tire tread separation to final rest positions of both vehicles. Locations of ejected Kia occupants are marked 1–4.

As a result of the crash, the Kia driver and the three rear seat passengers died. The fourth SUV passenger was seriously injured. Of the 35 school bus occupants, one student received serious injuries, 29 passengers and the bus driver sustained minor injuries, and four passengers were uninjured. The bus driver was wearing a seat belt, but the bus was not equipped with passenger seat belts. At the time of the crash, the weather was clear and the road conditions were dry.

Highway Information

The crash occurred on US-90 near milepost 160.2. The tire failure that initiated the collision occurred in the westbound lanes. The Kia and the school bus collided in the eastbound lanes. The roadway in the crash area is a straight four-lane divided highway with a posted 70-mph speed limit. US-90 consists of two 12-foot-wide lanes in each direction. The right-hand shoulders are 10 feet wide, and the median shoulders are 4 feet wide. All shoulders have rumble strips. A 64-foot-wide center earthen median with no median barriers separates the eastbound and westbound travel lanes. The crash area extended to a frontage road on the south side of US-90. A 49-foot-wide earthen area separates US-90 and the frontage road, as shown in figure 1. The frontage road consists of two lanes, each about 10 feet wide.

According to the Louisiana Department of Transportation and Development (LADOTD) and the American Association of State Highway and Transportation Officials (AASHTO) *Roadside Design Guide*, a median barrier was not warranted at the crash location.[2] The LADOTD forecast of average daily traffic for 2014 was 24,620 vehicles, and no cross-median crashes had been reported between mileposts 153 and 163 in a 5-year period preceding this crash.

Vehicle Information

The Kia SUV and the school bus were removed from the scene and transported to the Louisiana State Police Troop I headquarters in Lafayette, where NTSB investigators conducted detailed inspections.

Kia SUV

The Kia sustained significant contact damage to the left front axle area and the entire left (driver) side as a result of the initial and subsequent impacts with the school bus (figure 2).[3] The engine block and a portion of the transmission were broken away from their mounts, displaced from the vehicle, and located about 170 feet from the area of impact. The rear hatch was also detached from its mounts and found about 69 feet east of the area of impact.

[2] Considerations for the selection and placement of median barriers include, for example, crash history, median width, and traffic volume. Some states have median barrier guidelines that are more robust than those contained in the *Roadside Design Guide*. See AASHTO. 2011. *Roadside Design Guide*, 4th edition. Washington, DC.

[3] The right front door, the right rear doors, and the B-pillar of the Kia were cut away from the vehicle by emergency service personnel during extrication of the right front passenger.

Figure 2. At left, damage to front and driver side of Kia. At right, damage to roof and rear of Kia.

NTSB investigators were unable to complete a functional check of the Kia's steering, brake, and electrical systems because of the extensive damage to the vehicle. The National Highway Traffic Safety Administration (NHTSA) databases contained no safety-related recalls or defects for the SUV.[4]

School Bus

The school bus sustained contact damage primarily to the front end, with additional damage to its right side along the skirt panel below the bus frame (figure 3). The NHTSA databases contained no safety-related recalls or defects for the school bus that would have affected its involvement in this crash.

Figure 3. At left, damage to front of school bus. At right, damage to front and right side of school bus.

[4] See http://safercar.gov.

Kia Left Rear Tire and Wheel

The left rear tire tread separated from the tire carcass prior to the collision sequence.[5] The left rear rim and tire carcass were still attached to the Kia postcollision. The Louisiana State Police later removed these components from the vehicle and transferred them to the NTSB materials laboratory. NTSB investigators recovered the separated tread from the scene for further examination.

The subject tire was a Michelin Cross Terrain manufactured in late October 2003.[6] The tire tread was composed of five ribs with zigzag grooves between each rib. Tread depth measurements were taken in all four grooves, every 4 inches along what would have been the circumference of the tire (figure 4).

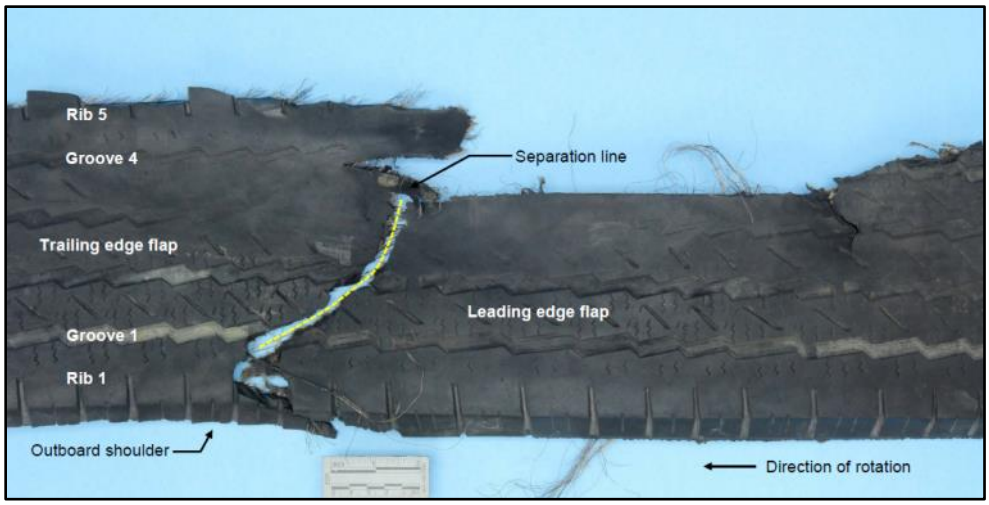

Figure 4. Surface side of separated tread, with two flaps in their approximate positions prior to separation.

The average tread depths for grooves 1 through 4 were 4/32, 2/32, 2/32, and 3/32 inch, respectively.[7] The tire had minimum tread depth values of zero at some locations (bald spots), where wear had exceeded the depth of the grooves.[8]

The state of Louisiana requires vehicle inspections every 2 years. The inspection requires that tires have at least 2/32 inch of tread measured in any two adjacent tread grooves and that

[5] The portion of the tire designed to contact the road surface (tire tread) separated from the rubber-bonded cord structure of the tire (tire carcass).

[6] Michelin Cross Terrain P245/70R16 106H; tire identification number: DOT 0CBU JDWX 4403.

[7] The original tread depth for the subject tire, according to manufacturer literature, was 11/32 inch.

[8] The minimum tread depth values measured for the left front, right front, and right rear tires were 11/32, 11/32, and 4/32 inch, respectively.

there are no knots, bulges, sidewall cracks, or tread exposure. According to the Louisiana Office of Motor Vehicles, the Kia passed inspection on April 11, 2013.

The tread separated from the tire carcass near a bald spot located toward the inboard edge of the tire. The separation started as a delamination between the inner and outer steel belts on the inboard side of the tire. It evolved into a thumbnail-shaped pocket that extended along the shoulder of the tire. The difference in wear between the delaminated region and the remainder of the tread indicates that the pocket was likely present for several hundreds to thousands of miles. Additional delamination formed along the outboard shoulder and progressed toward the inboard shoulder. The tread separated from the tire when the delaminations merged. The tire carcass subsequently split in the radial direction (from the outboard shoulder to the inboard shoulder), and the tire lost pressure (figure 5).

Figure 5. View of tire carcass, without separated tread, near split.

Three foreign objects had penetrated the tread and the outer steel ply. Figure 6 shows one object found approximately 46 inches clockwise from the tip of the leading edge flap.[9] The steel wires in the outer ply were deformed where the objects had penetrated the tread.

[9] The leading edge flap is the side of the tread that forms a triangular wedge of tread pointing toward the direction of rotation, as shown in figure 4.

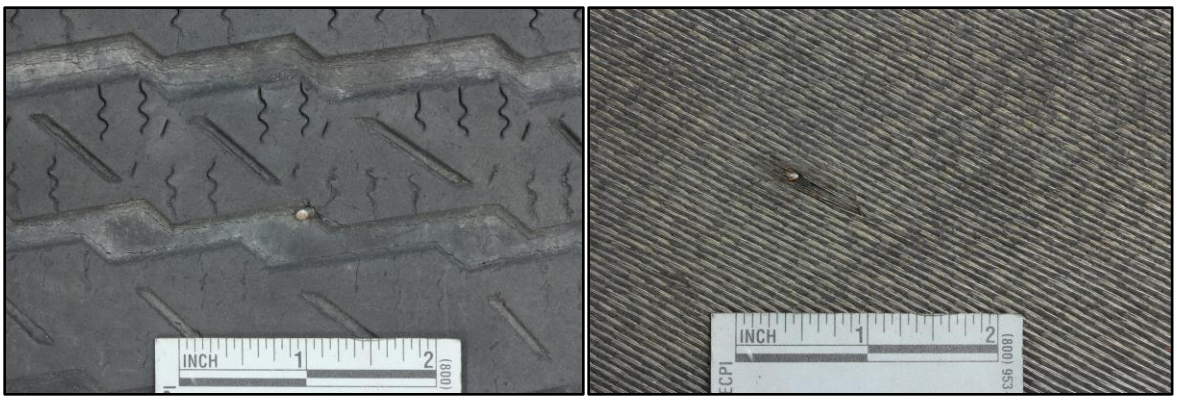

Figure 6. Tread and separation side images of foreign object that penetrated tread approximately 46 inches from separation.

Other physical damage to the subject tire included U-shaped compression set marks on the outboard sidewall and cracking along the sidewall, buttress, and shoulder area (figure 7, left).[10] The wheel weight clip, used to balance the tire, left multiple impression marks near the bead on the inboard side of the tire (figure 7, right), indicating that the tire had likely been operated in an underinflated condition at some point during its lifetime. No precollision damage was found on any of the rims.

Figure 7. At left, cracking on inboard sidewall. At right, impressions left by balance weight clip.

[10] Cracking can be associated with overdeflection, foreign materials, ozone deterioration, loss of rubber elasticity over time, and temperature.

Occupant Protection

The 37-year-old driver of the Kia and her front seat passenger (a 17-year-old male) were wearing their seat belts at the time of the crash, based on the physical inspection of their lap and shoulder restraints.[11] The driver and front seat passenger frontal airbags deployed. All the seatbacks were broken and displaced rearward as a result of the extreme rotational and rearward forces exerted on the occupants (figure 8).[12] Although the driver was wearing her lap and shoulder restraints, she slipped under the seat belt when the seatback collapsed and was ejected from the vehicle. A 14-year-old male, a 6-year-old female, and a 17-year-old male were seated in the rear. An inspection of all three lap and shoulder restraints in the rear seat showed no evidence of usage at the time of the crash. According to the surviving right front passenger, at the time of the crash, the 6-year-old passenger was not using the booster seat found in the debris inside the vehicle. All three passengers in the rear seat were ejected from the vehicle and fatally injured.

Figure 8. Interior view of Kia showing collapsed seatbacks.

[11] At the time of inspection, the driver's seat belt was buckled and the seat belt webbing showed cloth color transfer, scuffing, and cupping. The front seat passenger seat belt showed heat abrasion to the webbing.

[12] If seatback failure occurs, use of the restraint system may not prevent the occupant from being ejected from the vehicle. See TES Limited. 1989. *Accidents Involving Seatback Failures*, report no. C1322/2, prepared for Transport Canada. Bedford, UK.

The state of Louisiana has a primary seat belt law requiring all occupants, including rear seat occupants, to use a seat belt when a vehicle is in motion.[13] In addition, the state's child occupant protection law requires that a child who is at least 6 years old or weighs more than 60 pounds use a seat belt or an appropriate booster seat.[14]

Driver Information

Kia Driver

At the time of the crash, the driver of the Kia was traveling from her home in Patterson, Louisiana, to the "Krewe of Head Start Recruitment Parade" in Franklin. She held a class E driver's license.[15] According to relatives, her vision, hearing, and general health were good. NTSB investigators examined cell phone provider records and determined that she was not using her cell phone at the time of the crash. Postcrash toxicological testing did not indicate the presence of alcohol or drugs.[16]

According to the surviving passenger in the Kia, after the tire failure, the vehicle drifted to the left and the driver responded by braking and steering. According to a truck driver traveling behind the SUV, when the tire "popped," the vehicle moved to the right, then overcorrected to the left, and crossed the median.

Field tests have found that drag forces are generated when a rear tire experiences tread separation. These forces pull the vehicle toward the side of the affected tire.[17] Noise and vibration were present in each field test before the vehicle began pulling to the side of the affected tire, providing an auditory cue to the driver. In most cases, experienced test drivers were able to keep the vehicle in the travel path with small steering corrections.[18] In other cases, the drag forces were significant and resulted in large vehicle deviations.[19] Other tests have reported that a higher vehicle speed and a longer duration of the tread separation are associated with

[13] Louisiana Rev Stat §32.295.1 (www.legis.la.gov).

[14] Louisiana Rev Stat §32.295 (www.legis.la.gov).

[15] A class E license is a personal vehicle license and permits the operation of any single motor vehicle under 10,000 pounds gross vehicle weight rating.

[16] Blood was tested for ethanol, acetone, isopropanol, and methanol. Blood was screened for amphetamines, antidepressants, barbiturates, benzodiazepines, cannabinoids, cocaine/metabolites, lidocaine, methadone, nonopiate narcotic analgesic, opiates, phencyclidine, phenothiazines, propoxyphene, acetaminophen, salicylates, oxycodone, fentanyl, and oxymorphone.

[17] C. P. Dickerson, M. W. Arndt, and S. M. Arndt. 1999. "Vehicle Handling With Tire Tread Separation," paper no. 1999-01-0120. *SAE World Congress and Exhibition*. Warrendale, Pennsylvania: SAE International.

[18] R. F. Fay, R. D. Robinette, J. Smith, T. Flood, and G. Bolden. 1999. "Drag and Steering Effects From Tire Tread Belt Separation and Loss," paper no. 1999-01-0447. *SAE World Congress and Exhibition*. Warrendale, Pennsylvania: SAE International.

[19] D. F. Tandy, K. T. Tandy, N. J. Durisek, K. J. Granat, R. J. Pascarella, L. Carr, and R. Liebbe. 2007. "An Analysis of Yaw Inducing Drag Forces Imparted During Tire Tread Belt Detachments," paper no. 2007-01-0836. *SAE World Congress and Exhibition*. Warrendale, Pennsylvania: SAE International.

greater lateral deviation from the travel path.[20] Tests have also found that drag forces ended once the tread fully separated from the tire—whereas, for a partial tread separation, drag forces continued until the vehicle came to rest. If the affected tire lost air, drag forces also continued until the vehicle came to rest.[21]

Although an experienced test driver in a simulated environment—who is aware of an impending failure—may be able to control a vehicle following a tread separation, it can be difficult for a typical driver to have the same control in some real-world traffic environments. A rear tread separation at high speed reduces the lateral forces generated by the rear tires, which can result in excessive rotation and lateral motion for a given steer input. These changes in vehicle response and maneuverability characteristics can make it difficult for a driver to safely steer following a rear tread separation. In addition, drag forces could lead a driver to respond in a manner that further destabilizes the vehicle, resulting in a loss of control.[22]

The Louisiana Office of Motor Vehicles provides guidelines for new and current class D and E drivers on how to respond to a tire blowout, including staying calm, firmly holding the steering wheel and maintaining the vehicle in the same lane (noting that there may be a strong pull from the right or the left), slowing the vehicle, gently applying the brakes, and pulling off the road to a safe area.[23]

School Bus Driver

NTSB investigators interviewed the school bus driver, a 40-year-old female with a class B commercial driver's license.[24] She was transporting the Lafayette High School baseball team to a game at Berwick High School. The driver reported that the cruise control on the school bus was activated and set to 55 mph. She described her general health as great and stated that she was not experiencing any health issues on the day of the crash. NTSB investigators examined cell phone provider records and determined that she was not using her phone at the time of the crash. The results of a breath alcohol test administered to the driver approximately 3 hours after the crash were negative.

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[20] S. M. Arndt and M. W. Arndt. 2001. "The Influence of a Rear Tire Tread Separation on a Vehicle's Stability and Control," paper no. 258. *Proceedings, 17th International Technical Conference on the Enhanced Safety of Vehicles (ESV), Amsterdam, The Netherlands*. Washington, DC: NHTSA.

[21] G. Beauchamp, D. Koch, and D. E. Thornton. 2013. "A Comparison of 25 High Speed Tire Disablements Involving Full and Partial Tread Separations," paper no. 2013-01-0776. *SAE World Congress and Exhibition*. Warrendale, Pennsylvania: SAE International.

[22] Loss of control can occur for a variety of reasons. For the purpose of this report, "loss of control" refers to a change in vehicle response characteristics beyond which a driver can adapt and steer along the intended path.

[23] See web01.dps.louisiana.gov/DPSForms.nsf, accessed June 12, 2015.

[24] A class B license is a commercial driver's license that permits the operation of heavy straight vehicles. A straight vehicle is a vehicle that does not bend or have a moveable joint in its frame between the driver seat and the cargo or passenger compartment. The driver had the school bus and passenger endorsements.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the Centerville, Louisiana, crash was the Kia SUV driver's loss of control due to the tread separation and rapid air loss of the left rear tire, which altered vehicle handling characteristics. Contributing to the crash was the deteriorated condition of the tire due to inadequate maintenance.

Adopted: July 9, 2015