National Transportation Safety Board
Washington, D.C. 20594

Railroad Accident Brief

Accident No.:	DCA-05-FR-007
Location:	Glencoe, Kentucky
Date:	January 5, 2005
Time:	3:04 a.m. eastern standard time[1]
Railroad:	CSX Transportation
Property Damage:	$185,000
Injuries:	2
Fatalities:	None
Type of Accident:	Derailment (tunnel collapse)

The Accident

On January 5, 2005, about 3:04 a.m., southbound CSX Transportation (CSX) freight train Q231-01 derailed its lead locomotive and six of its cars at CSX's Eagle Tunnel No. 3 near Glencoe, Kentucky. The train was operating about 7 mph on a single main track when it struck debris from the collapse of a section of the tunnel. The engineer had placed the train into emergency braking about 6 seconds before the impact. The engineer and the conductor sustained minor injuries during the derailment. The property damage was about $185,000.

CSX train Q231-01 had originated in Detroit, Michigan, and was bound for Louisville, Kentucky. The train was routed through Cincinnati, Ohio, and consisted of 2 locomotives and 41 freight cars. The train crew consisted of an engineer and a conductor. They stated that, while en route, they had encountered two air leaks in the train's brake line. After stopping to repair the second air leak, the engineer had gradually increased the train's speed to 17 mph. The speed for operating on the track through the tunnel was restricted to 25 mph. The crew stated that as the train had traversed the last curve before the tunnel's entrance, they could see the tunnel and a "fog-like" appearance inside the north end of the tunnel. Because of the misty rain conditions, they did not see any blockage until the train traveled closer to the tunnel. About 6 seconds before impact, according to the train's event recorder data, the emergency braking was initiated from the locomotive cab, and the train's speed had decreased to 7 mph at impact. The crew said that the train had derailed after colliding with debris. The collapse left a hole in the top of

[1] All times in this brief are eastern standard time.

the tunnel that was approximately 27 feet long and 15 feet wide. The hole was about 48 feet from the tunnel's north entrance. (See figure 1.) The tunnel was at milepost T 73.6.

The lead locomotive remained upright with only its lead truck derailed, while the third through the eighth cars, which were loaded with automobiles, derailed in an upright accordion manner. The train's remaining 35 cars were undamaged.

Investigators examined the track structure outside the tunnel, inspected the train's locomotives and cars for mechanical deficiencies, reviewed the event recorder data, and interviewed the train crew about its operation of the train. No factors that contributed to the accident other than debris from the tunnel's collapse were identified.

Figure 1. Excavation of Eagle Tunnel No. 3. (Track misalignment caused by derailment.)

Eagle Tunnel No. 3

Construction and Maintenance

Eagle Tunnel No. 3 was built in the 1870s when the railroad line was constructed. The tunnel was brick lined; it had an inverted U-shape construction with masonry portals and was about 636 feet long. The tunnel had a single track with drainage ditches parallel

to the track. The history of the tunnel was reviewed through a series of engineering drawings, maintenance documentation, consultants' reports, and interviews of tunnel inspectors. In 1990, CSX had considered eliminating the tunnel by removing the hill. Instead, between 1995 and 1996, CSX replaced portions of the tunnel's crown[2] in the south section of the tunnel with steel rings. As part of the tunnel improvement, the track was lowered about 2 1/2 feet to improve the clearance for freight cars. Consequently, the drainage ditches also had to be lowered, which exposed the shale and limestone that supported the tunnel walls to erosion.

On the west side of the tunnel, the foundation rock was moving and causing cracks in the wall. Further, CSX consultants had reported problems regarding the tunnel floor, drainage ditch blockage, and water flow issues relating to erosion.

West Wall Collapse

The area had experienced significant rain and snow that caused nearby streams to flood before the tunnel collapsed. The water formed a pond above the tunnel and filled the ditches in the tunnel. Behind the tunnel walls was a layer of packing stones that provided channels from which the water could drain from the sides of the tunnel. In 2004, the concrete supporting walls at the north end of the tunnel were extended. This modification may have diverted water beneath sections of the foundation. Because CSX recognized that it had a maintenance issue with the tunnel, a reinforcement project for the west wall was scheduled for July 2005; however, before the project was started, the tunnel collapsed.

During the construction of the concrete supporting walls in 2004, according to a former inspector, the foundation was found to be eroded, and on the west wall, the foundation was moving and causing cracks in the wall.

Measurements made before and after the collapse indicate that erosion had undermined some foundation stones by 18 inches or more. This undermining allowed the sand from the brick and mortar foundation to erode into the drainage ditch, which could have easily transported the sand downstream. As the foundation eroded, the brick wall settled and cracked. According to CSX, its tunnel inspectors thought the west wall foundation was 36 inches wide. Based on this assumption, CSX thought that the 18 inches of undermining was not yet critical. However, CSX had failed to discover that the footer was actually only 18 inches wide. An examination of the remnants of the tunnel wall by investigators after the accident indicated that water had flowed beneath the foundation and undermined its footing. Because of the undermining, the west wall had settled, separated, and rotated inward.

[2] A *crown* is the portion of the tunnel arch that is above the springline, which is where the vertical and the curved portions of the tunnel meet.

Tunnel Failure Modes

A brick tunnel arch is designed to function while in compression. If a tunnel settles or moves, the resulting tension imposed on the brick segments can crack the mortar and eventually separate the bricks.

The American Railway Engineering Association's *Manual for Railway Engineering*, Part 121, "Inspection of Concrete and Masonry Structures," states the following:

> Arch failures may result from one or more of the following conditions: (1) Settlement or shift in the foundations, (2) Spalling, scour or undermining, (3) Loss of mortar in brick or stone joints, [and] (4) Improper or blocked drainage.

The accident tunnel had several of the conditions noted above before its collapse: (1) the tunnel was settling and shifting as noted by CSX personnel, (2) the foundation was being undermined by erosion, and (3) the tunnel had a recurring drainage problem. Further, during the postaccident investigation, discolored mortar was found between the bricks, indicating that the mortar was likely deteriorating.

Tunnel Inspections

CSX's policy is to inspect tunnels annually or more frequently if needed. Before the accident, the two most recent tunnel inspections had been on February 6, 2003, and March 30, 2004. The tunnel inspector stated that in addition to those inspections, he had looked at the tunnel five or six times in 2004, the last time near Thanksgiving, to monitor the drainage ditches and water flow. Inspection records indicate that the accident tunnel's foundation was in poor condition and required monitoring during each annual inspection.

Postaccident Actions

After the accident, CSX eliminated the entire tunnel by excavating the land above it. (See figure 2.) Before the accident, CSX had retained tunnel inspection and maintenance records for 1 year. CSX reported that it has changed its records retention policy, effective January 2007, to include "ACTIVE plus six years" of records related to the testing and inspection, design, construction, and maintenance of bridges, tunnels, culverts, piers, and related structures. CSX also has created an electronic database of inspection records of its active tunnels.

Figure 2. The track after removal of hill and Eagle Tunnel No. 3.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the January 5, 2005, train derailment near Glencoe, Kentucky, was the collapse of Eagle Tunnel No. 3 due to CSX Transportation's failure to repair the previously identified deteriorating section of the tunnel.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

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