Train Fire in Hokuriku Tunnel

November 6, 1972 in the Hokuriku Tunnel

Masayuki Nakao (Institute of Engineering Innovation, School of Engineering, The University of Tokyo)

The late night train "Kitaguni" bound for Aomori from Osaka caught fire while the train was in the 13,870m long Hokuriku Tunnel. Criticism was raised at inadequate fireproofing and fire regulations that instructed operators to stop the train in a tunnel in case of fire. The accident killed 30 people including 1 crew and injured 714.

1. Event

The late night train "Kitaguni" bound for Aomori from Osaka caught fire while the train was in the 13,870m long Hokuriku Tunnel located in Fukui prefecture. The accident killed 30 people including 1 crew and injured 714. The cause of death was carbon monoxide poisoning, not death by fire. Photo 1 is a press photo of the accident.

Photo 1. Burnt-out Dining Car and Rescued Passenger [1]

2. Course

A dining car in the late night outbound train "Kitaguni" caught fire while the train was in the Hokuriku tunnel. The dining car was the 11th of the 15-car train. At around 1:10 am, passengers reported fire to a

train conductor. The train conductor immediately arranged an emergency stop, and at 1:13 am, the train stopped at 5.3km from the Tsuruga Exit (Figure 1).

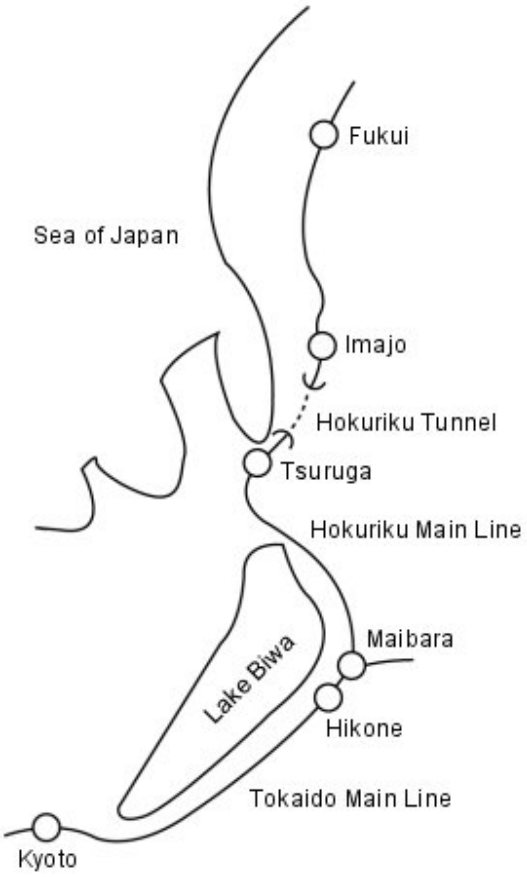

Figure 1. Hokuriku Tunnel

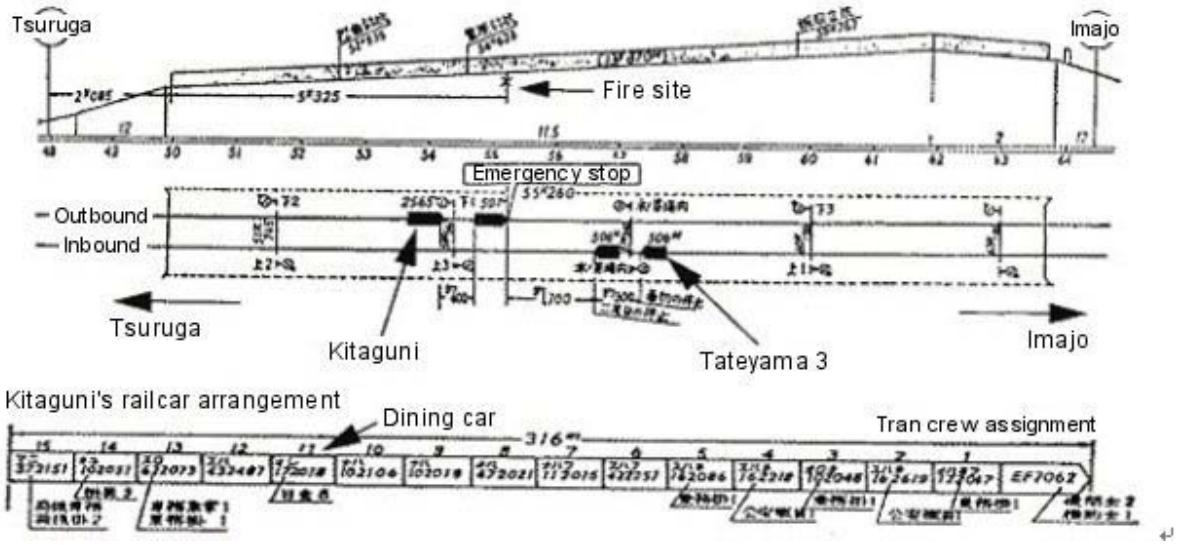

Figure 2. Schematic Illustration of Fire Site (Hokuriku Tunnel) [1]

Two of the train crew tried fire extinguishers to stop the fire, but the force of the fire did not abate. The crew then decided to disconnect the burning car and evacuated the train. At around 1:24 am, railcars were separated between 11th and 12th by 60m (Figure 2).

At 1:29 am, the crew requested help to the exit stations of the tunnel, the Imajo Station and the Tsuruga Station. They attempted to disconnect the 9th and the 10th cars when a power failure on the outbound line brought the train to a stop in darkness at 1:52 am.

The long tunnel made the evacuation of 760 passengers difficult. The inbound train "Tateyama 3", which was made a stop due to the tunnel fire at that time, picked up some of the passengers and carried them to Tateyama Station. Many tried to evacuate by foot, and some were returned to the railcars because of the heavy smoke in the tunnel.

Rescue trains were driven in from the Tsuruga Station at 2:43 am and at 6:43 am, but the heavy smoke prevented the rescue crew from approaching the burning train. They picked up the passengers in the tunnel and returned to the station. It was 14:00 when the rescue effort made all live passengers and crew escape the tunnel.

The fire claimed lives of 29 passengers and 1 crew, all died of smoke inhalation. 714 were injured. The cause of death was carbon monoxide poisoning, not death by fire.

3. Cause

(1) The direct cause of the fire is in dispute. Different accounts report it to be a cigarette butt or a coal-cooking stove.

(2) The flammable material of the railcar contributed to the quick spread of the fire.

(3) The operations manual instructed an emergency stop in a tunnel, regardless of the tunnel length.

(4) The tunnel was not prepared for the possibility of fires.

At the time of the accident, the Hokuriku Tunnel was not equipped with fire safety measures. It had inadequate ventilation, relying on natural ventilation brought by passing trains. Radio transmission did not work inside the tunnel, and the railway phones installed every 300m were the only lines of communication available. The tunnel did not have a powered vehicle that can run in case of power failure. In spite of repeated warnings from the local fire department, the Japanese National Railways (current Japan Railways) had made no improvement but simply responded that they will review the fire safety measures.

4. Immediate Action

JNR aborted all dining cars of the OSHI-17 model that spread the fire in this accident. This resulted in termination of dining services in all express trains.

5. Countermeasure

(1) JNR employed fire retardancy for its new models. New railcar models equip incombustible material, flame-retardant structures, fire extinguishers and emergency lights.

(2) The rain operations manual were modified by requiring the train to move out of the tunnel rather than stop immediately after a fire breaks out in a tunnel.

(3) JNR announced strengthened fire regulations and safety measures for long tunnels. The improvement included assignment of powered rescue vehicles, installation of smoke control equipment and evacuation corridors. In response to this tunnel fire, the Seikan Tunnel also has parallel evacuation corridors. For roadway tunnels, the Nihonzaka Tunnel fire led many improvements in the fire safety measures.

6. Summary

The accident claimed many deaths and injuries because of the emergency stop of a railcar in flame, which made fire fighting and evacuation difficult. The train operators made this emergency stop simply following the obsolete operations manual that required the train to stop in a tunnel in case of fire. This fire regulation was created when tunnels were much shorter. If the operators assessed the situation quickly and let the train travel out of the tunnel, there would have been less injuries and deaths. If the operators had acted against the safety regulations may be held criminally accountable for any damages, but the accident scale must have been minimum.

If a tunnel fire occurs on a steep gradient, the tunnel acts like a chimney sucking cold air in on one side with the intense heat and smoke leaving on the other. As a result, the force of the fire as well as the damage to the accident multiplies. This chimney effect was seen in the 2003 subway fire happened in Daegu, South Korea.

7. Knowledge

(1) Operators cannot blindly follow safety plans given in the manual in emergency situations. They must take an appropriate action for the given situation. It may be difficult for operators to remain calm, but a proper training will raise the safety consciousness of operators so that they can always give reasoned judgment even under unexpected circumstances.

(2) An operations manual should provide safety plans for various types of accidents and their recommended recovery procedure based on the analysis of various experimental tests.

(3) It is not safe to simply apply existing safety measures to new service systems. Safety measures and equipment need to always be updated, as they should have been in this accident for longer tunnels.

(4) Fire safety measures are usually taken in wake of an accident.

8. Background

During the period of postwar social and economic reconstruction, national and local organizations

cooperated to develop a fundamental plan for the use, development and conservation of the land, and formulated the Comprehensive National Land Development Act in 1950. The Hokuriku Tunnel was a tunnel for a double track railway completed on November 14, 1957 when the Hokuriku Main Line was electrified. The 13.87km-length tunnel was the 6th longest tunnel in the world, the second in Japan at that time. While the tunnel enhanced transportation capacity, it eliminated the old unelectrified single-track railway that had series of steep slopes. More tunnels were constructed after formulation of the Comprehensive National Development Plan in 1962 in an attempt to moderate the rural depopulation and reduce the income gap between central cities and outlying regions.

9. On the Side

Due to the difference in atmospheric pressure, many tunnels have air draft from one exit to the other. A fire in such tunnels induces a chimney effect, multiplying the force of the fire. The long road tunnels in the Alps are equipped with air forced ventilation systems that feed and exhaust air forcefully from the exits to reduce air draft. A malfunction in the ventilation system or an operational error will fail to stop the quick spread of fire, as was seen in the 1999 fire in the Mont Blanc Tunnel. In this 1999 fire, while the French company operating the tunnel maximized the air exhaust power immediately after a transport truck caught fire in the tunnel, the Italian company maximized the air feed power for 20 minutes. As the result, 30 vehicles were burned in the accident (Figure 3).

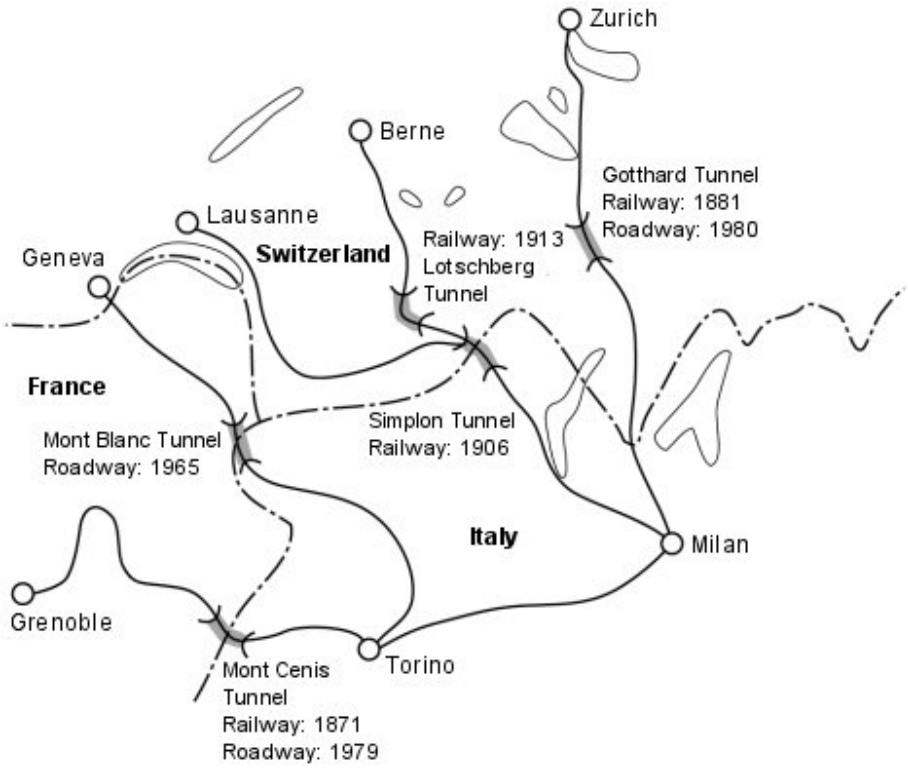

Figure 3. 10 km or Longer Tunnels in the Alps (Road/Rail and the Opened Year)

References

[1] Yotaro Hat amura (Edit or), Jissai-no Sekkei (Practical Design) Re search Foundat ion (1996) *Zoku-Zoku Jissai-no Sekkei (Practical Design III)*, The Nikkan Kogyo Shimbun, LTD.