

Fire in Oshimizu tunnel

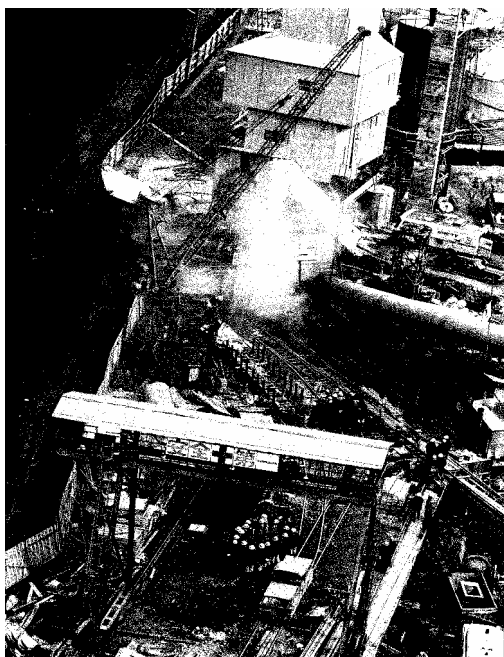
[20th March 1979, Minakami Town, Tone District, Gunma Prefecture]

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On 20th March 1979, in Minakami Town, Tone District, Gunma Prefecture, a fire broke out from the Hotozawa construction field (5350m-long) in Oshimizu tunnel (22.3km-long as a whole) when Maeda Corp doing demolition of the steel jumbo drill stand. As a result, 14 out of 54 workers and 2 workers, who went into the tunnel with the self-contained compressed air breathing apparatus to figure out the condition, were surrounded by the smoke and died of the carbon monoxide intoxication.



Map of Oshimizu tunnel

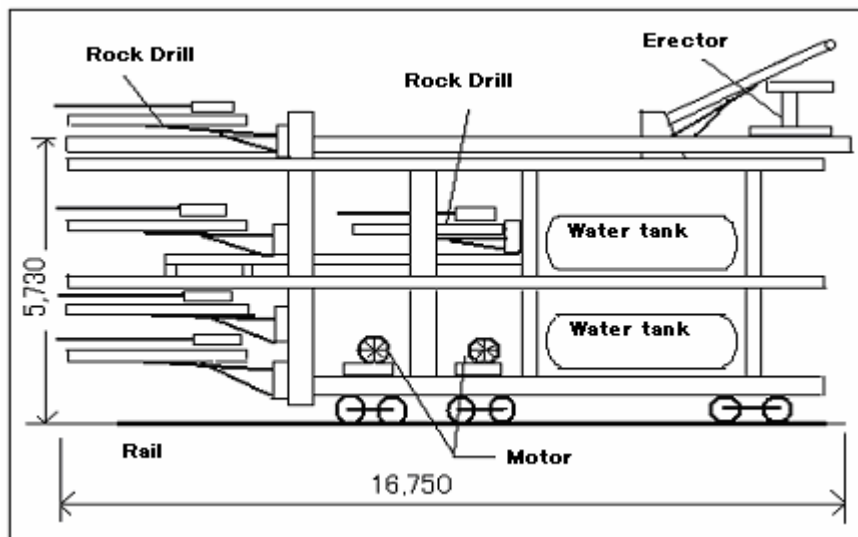


Smoke from the entrance of Hotozawa mine (photograph: Kyodo News Service)

1. Event

Oshimizu tunnel was divided into 6 construction sections, Hotonozawa construction section, in which fire broke out, was the second section from Omiya. An inclined shaft (518m) was established for the boundary between the first section and this section, and, in this section, 5350m-long tunnel was supposed to be constructed to the Niigata prefectural boundary.

On that day, 11 persons, consisted of 1 staff and 10 workers, were in charge of the demolition of the jumbo drill stand (two stage of decks, upper stage and middle stage), and they started working from around 20 o'clock. At around 21:30, they were doing fusion cuttings of the volt of boom mount on the upper deck of the jumbo drill by the oxyacetylene gas fusion cutting machine, then sparks of fusion cutting, etc. fell onto the middle deck and set fire to the oily wood chips which were piled up and adhered to the deck. After the flame was found, they tried to extinguish fire by the three fire extinguisher equipped with on the jumbo drill. However they all failed to emit the powder in the fire extinguisher, besides the wind from Niigata because of the penetration of tunnel helped the fire to broaden. Finally they gave up fire extinguishing, and escape and report to another workplace were conducted.

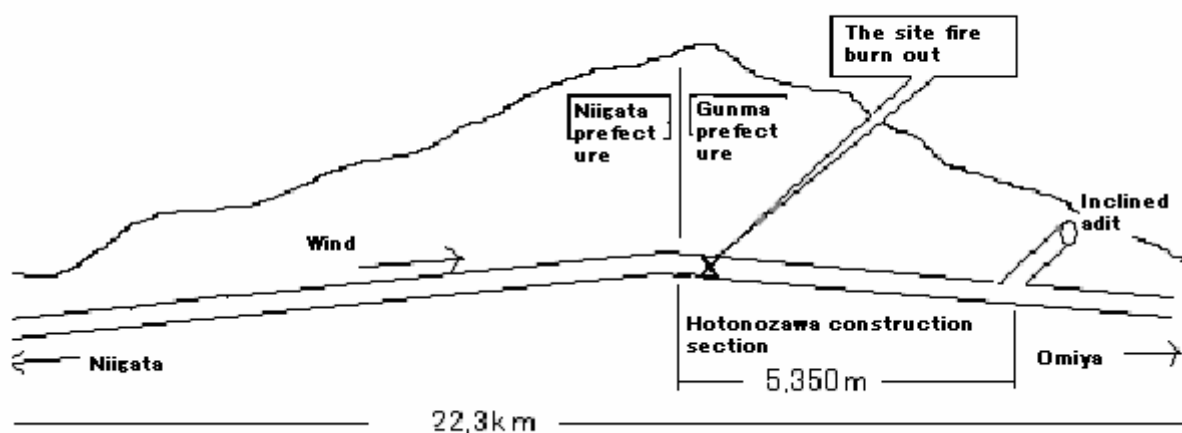


21 boom-jumbo drill stand (Source: Author made)

8 out of 11 workers in the group of demolition of jumbo drill stand succeeded to escape, since they ran to Niigata. But 3 workers who moved toward Omiya failed to escape and died winding by the smoke; this direction was windward. Also, although 3 out of 14 workers, who were doing lining concrete installation work (this work is; assembling the tunnel-shape mould, and pouring the concrete there) in the field which

was 254m-windward from the fire, succeeded in the escape to Omiya, 11 workers failed to escape and died winding by smoke. All the other workers who worked on the way managed to escape.

In the meantime, the two staff who received the report in the office went into mine to grasp the situation from the inclined shaft, with the self-contained compressed air breathing apparatus (Baitasu). But they also died winding by smoke, on the way to the office.



Cross-section figure of Oshimizu tunnel (Source: Author made)

2. Course

Ceremony for the penetration of the whole lines of Oshimizu tunnel was done on January 25th 1979, after that, aiming to complete construction in September, the lining concrete and etc. were preceded. The jumbo drill stand became unnecessary and demolition work started from the day before the accident day (19th March), since the full cross section off spread excavation finished about 20 days after the ceremony.

Night duty work on 20th of Marches in the accident day was carried out by 2 staff and 52 workers. The demolition work had been carried out by 1 staff and 10 workers at the place where it was about 70m close to Omiya from the Niigata-side boundary of the construction section. The lining concrete installation, where the largest number of workers suffered from the fire, was conducted by 1 staff and 13 workers at the place about 254m close to Omiya from the demolition workplace. In addition, there were such operations done in the tunnel as the secondary lining concrete installation work (16 workers), the mould assembly of the center sewage (6 workers), the preparatory

work of “Ryoban” concrete installation (4 workers), and the waste water treatment work (3 workers).

The fire broke out around 21:30, and the first report was sent to the office around 21:40 from the staff in charge of the lining concrete work group. The report said that fire had broken out and they did fire extinguishing. There was no report after the first report.

3. Cause

(1) Combustibles were scattered around the fire service space.

On the deck of the jumbo drill stand, wood chips etc. generated when cutting off the wood for the tunnel support piled up and adhered. In addition, they were easy to be burned because they sponged the oil leaking from hydraulic hose which was detached at the time when the disassembly operation.

(2) There was no monitoring person in the middle deck in which fusion cutting spark, etc. fell.

Although the watchdog was appointed, there was nobody on the middle deck when fire broke out; as a result, it was too late to notice the fire.

(3) The powder in the fire extinguisher did not jet, therefore they failed to extinguish fire at first.

3 pressurizing powder fire extinguishers were arranged in the jumbo drill stand, however, it was reported that all of them did not work well. One reason why they did not work was that, since the fire extinguisher at that day could stop using halfway, the pressure was coming out as time past. Secondly, it is possible that the fire extinguisher might be solidified by the moisture in the tunnel, etc. Therefore fire extinguisher nowadays will not stop injection even if the lever is released.

(4) Considerable wind blew inside the tunnel after the penetration.

Due to the penetration of the tunnel whole line, considerable wind blew inside the tunnel. This seemed to promote the fire spread. Even there is some information that the speed of wind inside the tunnel was near 5m/second. The cause of the wind was air pressure difference between pit mouths, and the wind blew from Niigata to Gunma on that day. Besides, it is recorded that the direction of the wind depends on season and weather.

(5) The tunnel extension was very long.

Because of the length of the tunnel (5350m), it was impossible to refuge to the safe place.

(6) Emergency report to another workplace was delayed.

Though the call facility was located in each workplace, there was no record which showed the communication by the call facility to another workplace was done. There is information that a worker of the demolition of the jumbo drill stand ran to the lining concrete work place to inform them of the emergency. It is impossible to communicate by the call facility if there is nobody on the other edge of the line.

(7) Were there sufficient instruction from the predecessor between the daytime and nighttime worker?

In the daytime work on the fire break-out day, combustibles often burnt by the fusion cutting spark which came from the fusion cutting work of the mounting volt by the oxyacetylene gas cutter. But it was easy to put out the fire; fire extinguisher was not necessary, and just hitting by hemp sacks, etc., they can easily put out the fire. It was uncertain whether such information was succeeded as a precaution or not.

4. Immediate Action

The countermeasure headquarters was established just after the accident occurred, and rescue system was organized by the local fire station and the special rescue crew of the Maeda Corp (it was formed of the people who received rescue training and wore the oxygen breathing apparatus). However smoke from pit mouth was so intense that they must wait in front of the pit mouth. Special rescue crew went into the tunnel after the smoke went away. Finally all workers were carried out of the tunnel within four days, however all were dead.

5. Countermeasure

- (1) Combustibles should be removed around the fire. If impossible, they should be covered by the incombustible material.
- (2) The watchdog must be stationed in the fire work.
 - Fire can be easily extinguished in most of the case, if it is found when it is small.
 - The watchdog must not do the any work except for the monitoring.
- (3) Effective extinguishment facility should be prepared in the fire place.
 - Using the hemp cloth to put out the fire is the last means to adopt for fire extinguishing.
 - Accumulator fire extinguisher which is strong to the moisture in the tunnel construction should be arranged.
 - **The fireplug which utilized water supply pipe** should be used at the same time with fire extinguishers in the tunnel construction.
 - Maintenance and inspection of extinguishment facility should be done the

appropriate time.

- (4) The tunnel after the penetration must equip with the partition in order to control wind velocity in the tunnel.

The wind direction and velocity change after the penetration by the difference between weather conditions of the pit mouths, and the working environment in the tunnel considerably changes. The north wind makes the tunnel cold, dry, and the strong wind is very dangerous for fire.

- By equipping with the partition, the wind velocity should be controlled.

- (5) The tunnel extension was very long.

- The refuge tool for the individual in the emergency should be arranged **at the number of the workers.**

- The refuge tool for the exchange should be deployed **in proportion to the length of the tunnel.**

- "Kagoi" **facility** which can stand up the fire should be deployed in the tunnel in case of the worst situation. "Kagoi" facility is the place where workers can escape to in case of the failure of refuge, the air in "Kagoi" facility is sent by air supply tube and is cool down by a water supply pipe.

- (6) **Call facility, alarm facility** should be deployed.

- **Alarm facility** and **call facility** for simultaneously informing of danger to the workers of each workplace in the tunnel should be arranged.

- **The emergency electric power source** should be prepared in order to use call facility, and alarm facility even in blackout.

- Fireproof electric wire is desirable for the electric wire used for call facility and alarm device.

- (7) The communication between daytime and nighttime should be surely conducted.

In the daytime work on that day, the wood chips in which the oil pressure oil soaked was ignited many times and put out by hitting by the hemp bag. If such information was informed, the monitoring would be surely carried out in the night work, and fire might not be generated.

6. Knowledge

- **Combustibles around the fire work should have been removed beforehand.** If impossible, they have to be covered with the noncombustible.

- By **stationing the watchdog** around fire workplace, the early detection of the fire should be done.

- The fire extinguisher placed in the tunnel has to be **accumulator fire extinguisher**

which is strong to the moisture.

- Other than fire extinguisher, **extinguishment facility which utilizes the fireplug** should be used. Besides, the maintenance and inspection should also be executed.
- In penetrated tunnel, it is necessary to control the wind velocity by **building a partition** in case of the wind velocity is rapid.
- In the construction of the long tunnel, the **individual refuge tool** (respiratory protective equipment, anti-smoke glasses, illuminator, etc.) must be deployed more than the number of the workers. The refuge tool for exchange on the way of refuge should also be deployed more than the number of the workers in the appropriate place.
- **Call equipment and alarm facility** for informing the worker who works in the tunnel in case of emergency have to be deployed.
- Information must be surely transferred between **daytime workers and nighttime workers**.
- **To prepare for the emergency, the education and training how to respond the accidents** have to be carried out beforehand.

7. Background

The penetration ceremony of Oshimizu tunnel was held on January 25th, 1979, about 20 days after that, the full cross section off spread excavation also completed. Then there was only about 300m-length lining concrete construction left. The tunnel fire happened when everybody was liable to be careless.

8. Sequel

It was not possible to do the on-the-spot investigation until 3 months after Oshimizu tunnel fire occurred. This might be evidence that proved how strong the tunnel fire was. And, it was also the fact that legal restrictions for preventing tunnel fire were lacked in Industrial Safety and Health Law. This tunnel fire encouraged to add the text about fire and explosion in tunnel construction on Industrial Safety and Health Law. The facts below seemed to be proven by this tunnel fire.

- It was thought that that it was natural that the smoke flowed to the workers who worked in leeward workplace, because they were informed of that there was a demolition work of the jumbo drill stand on that day. Therefore the workers of the lee side did not escape, and the work was kept as it had been. This proved how important the communication system of the emergency was.
- The workers who succeeded in the escape rode on the train. And those who

missed the train and those whose train derailed failed to escape. Human's walking speed is limited, therefore it is necessary to consider the refuge means such as utilizing trains, etc. in case of the fire in the long tunnel construction.

- The wind inside the tunnel blew strongly, and the testimony that the force of the fire suddenly strengthened was reported. It is necessary to control the force of the wind by equipping partition in penetrated tunnel at the proper place.
- In case of the tunnel fire, the heated air expands and it flows to the closest pit mouth of lee side, and the fresh air is supplied from the windward. Therefore the flow of the smoke is gradually intensified. This is the chimney effect. It is possible to observe the similar effect in subway fire in Tegu City, Korea, and the cable car fire for the mountain climbing in Austria. **It is an iron rule to escape to the windward in spite of the existence of the escape mask, when the fire breaks out in the tunnel.**

9. On the Side

In May, 1976, the catastrophe which observed 9 persons death by the methane gas exploding in the agricultural waterway tunnel construction in Yamagata Prefecture. But, after 2 years, the completely same disaster that observed 9 persons died by methane gas exploding in the different construction section of the same agricultural waterway tunnel construction in June, 1978, again. In the Joetsu Shinkansen construction, the fire that fortunately 20 persons could escape from Nakayama tunnel broke out in May, 1976. And also there was a fire that 37 persons blocked in Yuzawa tunnel occurred in July, 1977. It is safe to say that the human reflection continues only about 1 year, inferring from that similar disaster occurred in Oshimizu tunnel construction of the same Joetsu Shinkansen construction. It is necessary to prevent this kind of accident happen again **to freshen up by reexamining the disaster case at the proper time and to regularize the countermeasure.**