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PROJECT:

Consultancy Services for Detailed Feasibility Study and Framing up of Phase-wise proposal (DPR) for construction of two tunnels at Z-Morh and at Zojila for all weather connectivity from Srinagar to Leh in Jammu & Kashmir State

ZOJILA TUNNEL

TITLE:

Phase II: Detailed Project Report - Preliminary Tunnel Design

Volume II: Tunnel Design Report

Addendum 3: Description of Self-Rescue System

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1 GENERAL

The main principles and facilities of the tunnel self-rescue system are described within this report. Incident scenarios including possible evacuation route and control of ventilation system are additionally laid down.

The safety system is designed in such way that every tunnel user is possible to escape from the tunnel by its own if this is required due to an incident.

Several tunnel facilities are designed for the so-called self-rescue system to provide adequate environment during evacuation period as listed, but not limited to the following:

- Separate egress tunnel parallel to the main tunnel
- Drivable and pedestrian-use cross passages
- Emergency telephone
- Ventilation system
- Electro-mechanical installations

First the incident is detected and if required communicated to the tunnel passengers, then if required the passengers are able to evacuate in time to the outside. The three main aspects, incident detection, communication and evacuation are described detailed below. Additionally the principle of the ventilation operation and the evacuation route is given in Section 5.

2 INCIDENT/FIRE DETECTION

The main and egress tunnel is equipped with CCTV cameras (see Fig. 1). Main specifications for the CCTV cameras are given in DPR Vol. X: Technical Specification Fixed Operating System. The CCTV cameras are connected to the control centre, located at the western tunnel portal. The control centre is manned with two men at any time.

Fig. 1 CCTV camera system

The incident detection function is able to detect anything out of standard situation, i.e. vehicles on hard shoulder, stopped vehicles or objects in lane and transverse or inverse moving objects (ghost drivers, persons, leaves, debris etc.) occurring in or

near the tunnel, on the specified road segment and on the associated hard shoulder areas, and automatically alert the operators of such incidents.

An automatic fire detection system is designed in the tunnel. A linear fire detection cabling is mounted on the ceiling of the tunnel. The maximum measuring point distance in the tunnel longitudinal direction shall not exceed 10m. The sensors shall be summarized in reporting sections. Controller units and amplifiers shall be installed in the tunnel niches.

The system is to be installed in the main tunnel and the egress tunnel.

The linear heat detection systems shall be connected the SCADA system through its own control system. Specific views on the SCADA system shall be developed to assume a complete monitoring and remote controls.

Additionally every incident can be communicated by passengers using the emergency telephone unit located every approx. 250 m inside the tunnel, at every lay-by and at the tunnel portals. An example of an emergency call unit and column is given in Fig. 2.

Fig. 2 Emergency call unit located inside the tunnel and at lay-bys and emergency call column located at tunnel portals

3 COMMUNICATION

The communication from the control building to the tunnel is essential, so passengers inside and outside the tunnel can be warned in time and evacuation process can start immediately if required due to an incident in the tunnel. Variable message signs (VMS) can be used to warn (see Fig. 3) or speakers to directly communicate with tunnel users.

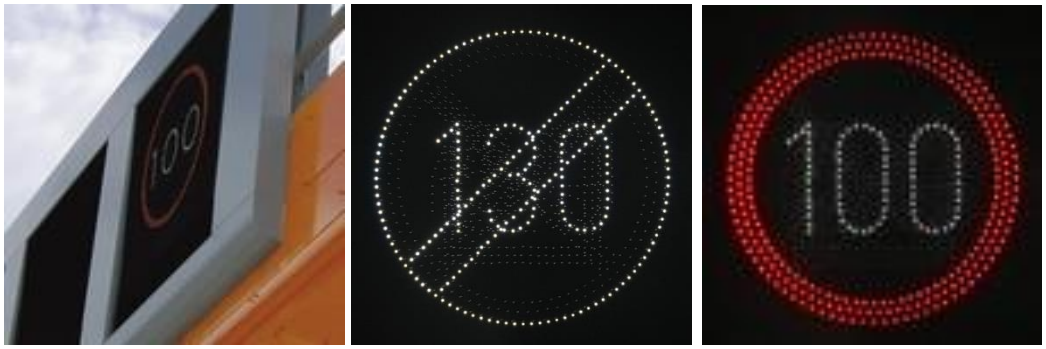

Fig. 3 Variable message signs (VMS)

Additionally the above presented emergency call units and columns can be used to communicate with tunnel users (see Fig. 2).

The tunnel can be closed if required with traffic lights and variable message signs located on both tunnel portals.

4 EVACUATION

The evacuation route from the main tunnel to the outside can be divided into two sections, one section in the main tunnel and one section in a different structure separated from the main tunnel. The main principle of the self-rescue system is to minimize the length of the rescue route in the first section and increase in the latter. The egress tunnel serves as independent structure from the main tunnel, where harmful environment to persons and/or structures are prevented at all time during an incident in the main tunnel.

The egress tunnel is designed parallel to the main tunnel with a distance of approx. 25 m. The main tunnel and the egress tunnel are connected with cross passages every 250 m. Due to this the length of the evacuation route in the main tunnel is max. 250 m. With a predicted evacuation speed of 1 m/s the evacuation time from the main tunnel to the egress tunnel is approx. 4 minutes, hence every tunnel user should be able to access the egress tunnel within this time.

Safe evacuation environment is provided under all circumstances in the main tunnel within this critical time of minimum 4 minutes. The axial exhaust and fresh air fans and the jet fans provide fresh air, fume extraction, visibility etc. in this time. Details of

the ventilation design, including the control of the ventilation during a fire incident are given in DPR Volume VIII: Ventilation Design.

An evacuation guidance system of evacuation route and escape direction lamps (see Fig. 4), show passengers the nearest position of an emergency exit from the main to the egress tunnel and the shortest escape direction.

Fig. 4 Evacuation route and escape direction lamps

5 PRINCIPLE OF VENTILATION OPERATION AND EVACUATION ROUTE DURING FIRE INCIDENT

5.1 Fire near the tunnel portals

If there is a fire near the tunnel portals (up to 100 m from the tunnel portal) the hot smoke is blowing out across the portal by means of the jet fans. Fig. 5 and Fig. 6 illustrate the principal of operation if the fire is near the east or west portal. Passengers between the closer portal and the fire can directly evacuate to the outside from the main tunnel. Passengers behind the fire can evacuate to the closest emergency exit to the parallel egress tunnel and from there to the outside.

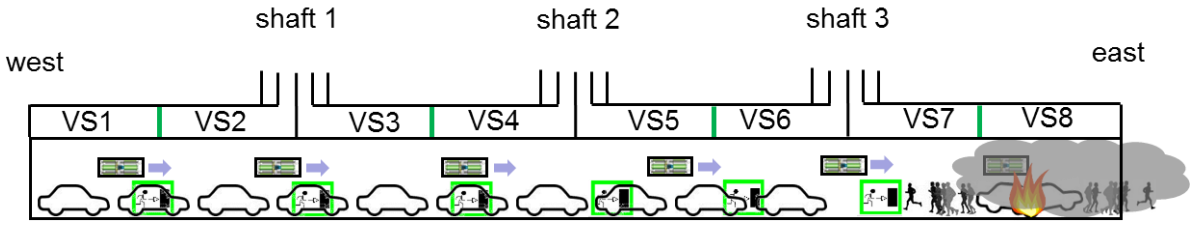

Fig. 5 Ventilation scheme in case of a fire near the east portal

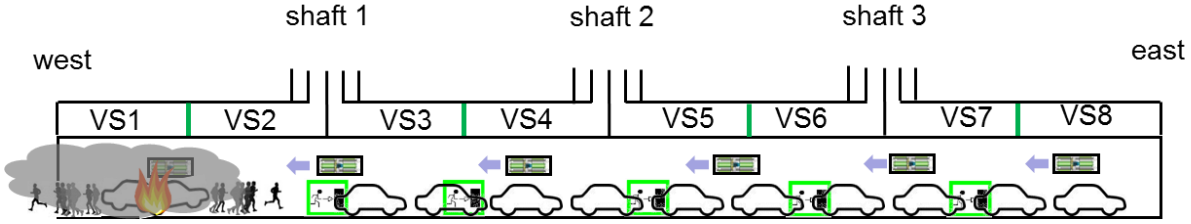

Fig. 6 Ventilation scheme in case of a fire near the west portal

5.2 Fire beyond the region of the tunnel portals

If there is a fire within the ventilation section 1 to 2 and beyond the region of the west portal (up to 100 m from the tunnel portal) detected the hot smoke will be extracted at the damper near the location of the fire. The remaining extraction dampers are closed to avoid undesired leakages. The butterfly flap which separates the ventilations section 1 and 2 is open so that the smoke can be extracted by both exhaust axial fans. These exhaust air fans are operated at their maximal power in order to get the maximum available extract output. The jet fans are operated so that it is possible to avoid an expansion of the hot smoke gases in the tunnel on the one hand and on the other hand to ensure an equal afflux of the fresh air upwind of the fire location to the extraction point Fig. 7 illustrates the principal of operation for a fire within the ventilation section 1 and 2.

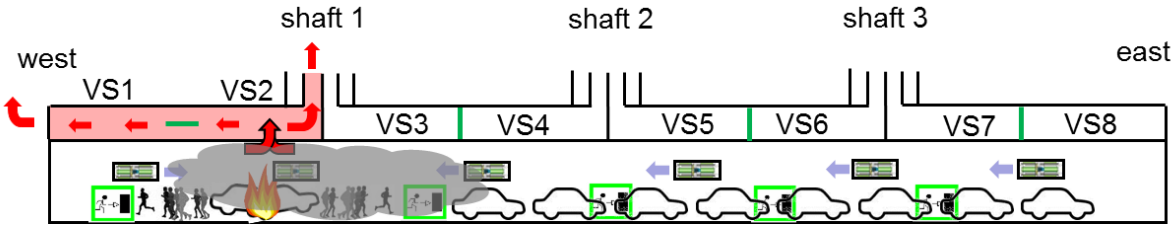

Fig. 7 Ventilation scheme in case of a fire within the ventilation section 1 and 2

The principal of operation for a fire within the other ventilation sections is similar as mentioned before. In this case the smoke is extracted by means of the appropriate exhaust axial fans of the ventilation section e.g. 5 and 6 as given in Fig. 8. Also the butterfly flap which separates the ventilation section 5 and 6 during the normal operation is open. The principal of operation for a fire within the ventilation section 5 and 6 is shown in Fig. 8.

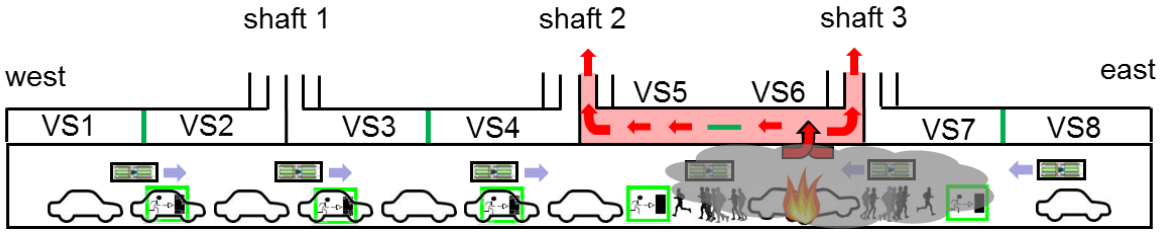

Fig. 8 Ventilation scheme in case of a fire within the ventilation section 3 and 4

In both cases (see Fig. 7 and Fig. 8) the passengers evacuate from the fire to the next cross passage to the egress tunnel.

5.3 Egress Tunnel Ventilation

The egress tunnel must be held free from smoke and other dangerous gasses during a fire incident in the main tunnel. A shear wall with an emergency door is considered for each cross passage in order to maintain the egress tunnel free from

smoke. The air pressure in the parallel egress tunnel has to be higher than the pressure in the main tunnel, so when the emergency exit doors are opened during evacuation phase no harmful gasses will enter the egress tunnel.

On both egress tunnel portals an axial fan with an opening flap provides the high pressure and the fresh air. Additionally a lock is designed at both egress tunnel portals to reduce the pressure losses between the egress tunnel and the outside (see Fig. 9).

A detailed description is given in DPR Volume VIII: Preliminary Ventilation Design Report.

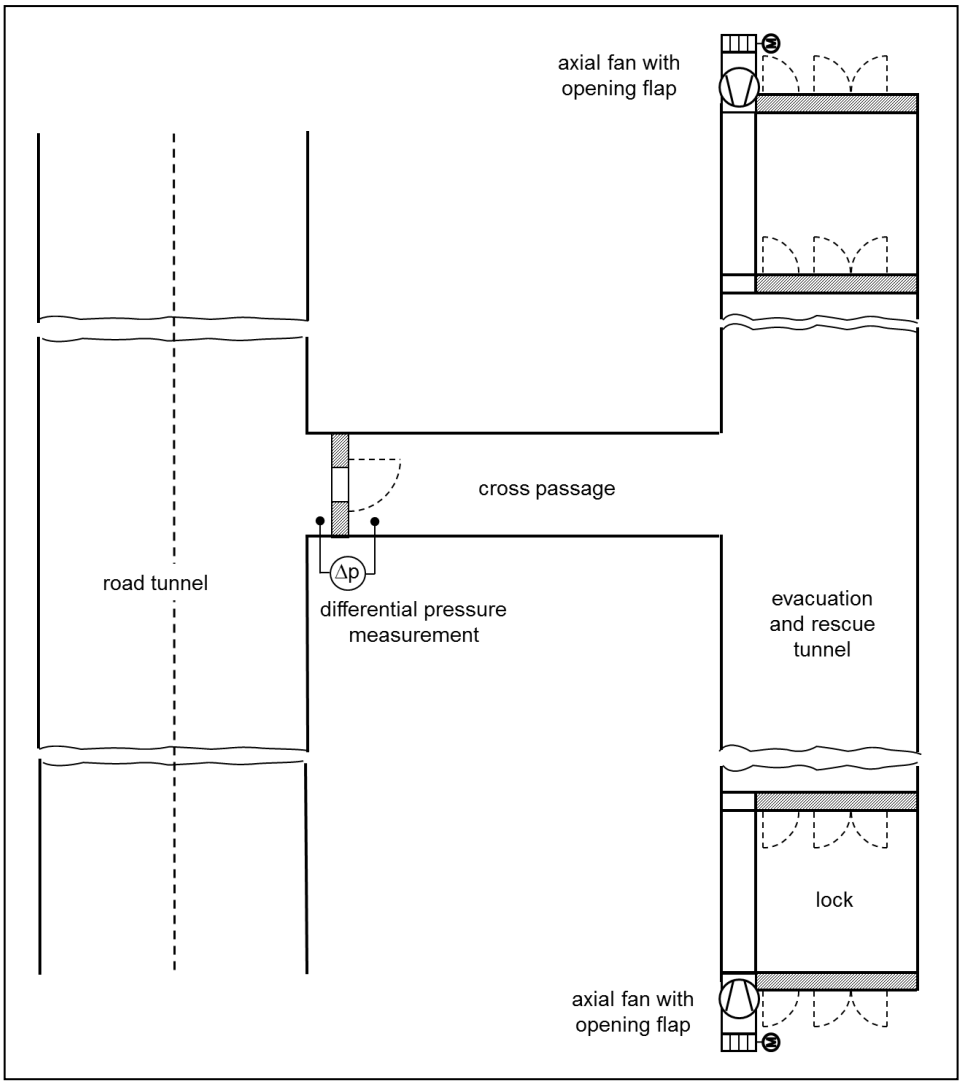

Fig. 9 Scheme of the cross passage and the evacuation and rescue tunnel