

NEW CAPABILITIES IN ROAD TUNNEL OPERATION EDUCATION

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Key words: Simulator, Tunnel, Safety, Accident, Emergency.

Abstract. Faculty of Civil Engineering at University of Žilina, especially the staff of the Department of Construction Management, has recently dealt with a project focused on applied research on new technologies to improve the safety of road tunnel operation. One of the results is Tunnel Traffic & Operation Simulator (Simulator), a unique device for simulation traffic in two-tube road tunnel with possibility of interrupting the traffic flow by various emergency events. It is also possible to simulate the failures of different technological equipment. A new study subject “Tunnels” was created in the last re-accreditation of the second degree study program in 2015. Within the laboratory exercises, the students are taking practical lessons on Simulator in order to learn the principles of road tunnel safety operation. In our paper, the Simulator will be described in detail followed by the opportunities for student education and vocational training of real road tunnel operators in terms of accredited educational program “Management of Tunnel Operation” of lifelong continuing education.

1 INTRODUCTION

Simulator is a unique feature and new opportunity for education at the field of university and training of real road tunnel operators of Slovak tunnel administrator. Simulator was created as a result of a research project “Centre of Transport Research”.

On the basis of simulator existence a new study subject “Tunnels” was created in the last re-accreditation of the second degree study program called “Technology and building management”. This study program deals with the operation and maintenance of road tunnels, designing individual technological equipment. Within a laboratory exercises, the students as virtual road tunnel operators are taught how to control the tunnel during emergency events, standard and nonstandard situations, breakdowns and failures of tunnel equipment. Safety of

road users is paramount.

Another advantage with regard to the existence of the simulator was the possibility to set up a new accredited educational program of lifelong continuing education. This program was prepared in cooperation of National Motorway Company (NMC) that is administrator of all road tunnels in Slovakia.

Nowadays we have a road tunnel „construction boom“ in Slovakia. Eight road tunnels are operated under the NMC's administration. Four of them are two-tube tunnels with strictly uni-directional traffic and rest of them are single-tube tunnels operated bi-directionally:

- Branisko (4975 m, 2003), bi-directional, semi-transversal ventilation system, the longest tunnel in Slovakia;
- Horelica (605 m, 2004), bi-directional, frequent traffic jams due to the near city junction, 4% of longitudinal slope in tunnel;
- Sitina (1440 m, 2007), uni-directional, highway capital city tunnel with high traffic volume, tunnel closure causes a traffic collapse in Bratislava;
- Bôrik (999 m, 2009), uni-directional, located under the High Tatras at high altitude;
- Šibenik (588 m, 2013), uni-directional, the newest road tunnel opened last year;
- Poľana (898 m, 2017), bi-directional, low traffic volume;
- Svrčinovec (420 m, 2017), bi-directional, low traffic volume;
- Považský Chlmec (2249 m, 2017), uni-directional, the newest tunnel in Slovakia

Other 4 tunnels are in construction process, including the longest tunnel of Slovakia, tunnel Višňové (7500 m, 2020). For all real road tunnel operators is this educational program mandatory in its specific modules. In regard to European Directive 2004/54/EC of the European Parliament and of the Council of 29 April 2004 on minimum safety requirements for tunnels in the trans-European road network, the administrative authority of road tunnel shall ensure regular training of operational staff. The personnel involved in the operation as well as the emergency services shall receive appropriate initial and continuing training [1,2]. The person responsible for the training is a safety officer, main person involved in all modules of educational program.

2 SIMULATOR

Training of real Slovak road tunnel operators is generally performed within the competence of tunnel safety officer of Slovakia inter alia at the Simulator (Fig. 1 and Fig. 2) regularly every year from 2013. Simulator was created as the result of research project in 2013, so the technology equipment of virtual tunnel, visualization of Central control system (CCS) and way of operation/control is in accordance with Slovak legislation valid at that time. It allows simulate incidents which are rare in the real tunnel traffic with the aim of verification of correctness and philosophy of the tunnel operation. The correct choice of traffic-operation state and consistent the optimal managing of emergency event are a key element to achieve successful solution of any emergency event. Visualizations of the tunnel traffic and technology management are the same as on the real operator workplace of a two-tube tunnel. It is possible to control a virtual tunnel by two independent operators (for traffic and technology) and their work is changeable, so it means that single operator can control entire tunnel from his/her workstation. In contrast to real traffic, simulation of video surveillance shows a virtual traffic in the tunnel tubes and in front of them. The simulator will

be complemented next year by the results of applied research of “Models of formation and spread of fire to increase safety of road tunnels“, namely of 2D and 3D visualizations of the spread and stratification of smoke from the fire in road tunnel [3].

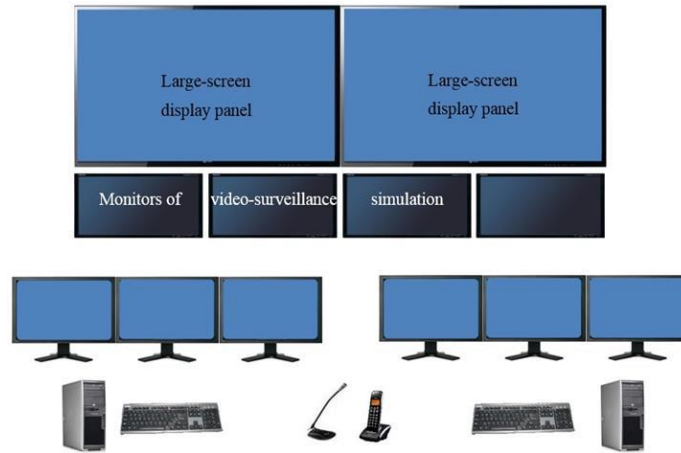


Figure 1: Scheme of Simulator



Figure 2: Real photo of Simulator

2.1 Simulation of emergency events

There are a lot of possibilities to simulate various emergency events from position of coordinator, e.g. (Fig. 3):

- slowly moving vehicle forming tailback of cars in tunnel tube,
- breakdown of vehicle (stopped vehicle) and possibility to make an accident,
- animal in tunnel and possibility of collision,
- pedestrian in tunnel and possibility of collision,

- stopped heavy good vehicle (HGV) with dangerous goods (DG) and possibility of leakage or fire,
- lost cargo and possibility of collision or fire,
- leakage of chemical substance,
- demonstration of people in tunnel,
- threat of terrorist attack,
- vehicle in bad direction,
- oversized vehicle stopped in front of the tunnel portal,
- stopped bus and a lot of people moving in the tunnel,
- accident of two cars and possibility of fire.



Figure 3: Simulation of emergency events (examples)

2.2 Simulation of warnings and alarms

There are also a lot of possibilities to simulate different standard and non-standard situations, technology equipment faults, all in combination with emergency events mentioned in the previous chapter:

- changes of physical values (opacity/visibility, level of carbon monoxide, luminosity, temperature, speed of airflow) due to actual conditions,
- changes of traffic flow (sporadic, normal, tailbacks, stop and go),
- faults and breakdowns of tunnel technologic equipment (cameras, various detectors, traffic signs, power supply, local connections, etc.),
- changes of operational parameters (day, night, fog, smog),
- emergency calls (from SOS cabin, with tunnel specialists, integrated emergency rescue system, rescuers, fireman and many other responsible persons).

3 ACCREDITED EDUCATIONAL PROGRAM

The regular education (training) of operators is ensured by University of Žilina through an accredited educational program called “Management of tunnel operation”. It consists of five training modules:

- Basics of operations management (BOM), within the range of 100 h,
- Management of technology (MT), 30 h,
- Operation of technological devices (OTD), 30 h,
- Tunnel management (TM), 10 h,
- Operation and management processes (OMP), 10 h.

After successful passing the course participant obtains a certificate of professional competence, which provides evidence to meet the qualification prerequisites for the profession. First two modules are very important and are described in the next subchapters.

3.1 Basics of operations management

This training module is basic (access) course designated for all staff of NMC within the work with tunnels, e.g. operators, tunnel technicians, tunnel specialists and management staff (head of the tunnel, director of center of highway’s and tunnel’s maintenance). This basic module is continued by other modules. The range of module of combined form (distance and attendance form) is 70 h of teaching (53 h of lectures and 17 h of practical exercises), 10 h of self-study and 20 h technical excursion. The goal of course is to acquire knowledge and skills required to manage the operation of the tunnel in all operating states and possible emergency situations. The graduate should know the basic principles of tunnel operation, construction technology of tunnel tubes, technological devices used to control tunnel. Should acquire skills from measurements in the laboratory, have necessary knowledge and understanding of the central control system (CCS) and technological equipment: lighting, ventilation, fire protection, tunnel inspections and maintenance, status evaluation of tunnel, technological devices and sensors of technical parameters needed for rational management of the tunnel. Complete the foundations of rhetoric, communication skills and psychology. Because of three new tunnels put in the operation last year, this module was performed in autumn 2017 (Fig. 4).



Figure 4: Lectures of basic educational module for 61 participants (09/2017)

12 CONCLUSIONS

In this paper some activities of Faculty of Civil Engineering at University of Žilina, mainly of Centre of Transport Research and Department of Construction Management are illustrated. One of the primary objectives of each tunnel is to advance the high level of traffic and users safety. Changes of the traffic-operation states and other equipment are reflecting at the simulated traffic, as well as simulations of various emergency events in traffic initiate changes in tunnel detecting and measuring devices. Training of tunnel operators by simulator and possibility to try different situations and to verify the correctness of their solutions repeatedly is never-enough-to-be-regretted.

ACKNOWLEDGEMENTS

„This work was supported by the Slovak Research and Development Agency under the contract No. APVV-15-0340“.

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