



MAŠINSKI FAKULTET UNIVERZITETA CRNE GORE U SARADNJI SA AKADEMIJOM
INŽINJERSKIH NAUKA CRNE GORE ORGANIZUJE

OKRUGLI STO
BEZBJEDNOST UČESNIKA U SAOBRAĆAJU U SLUČAJU
POŽARA U DRUMSKIM TUNELIMA

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ROUND TABLE DISCUSSION
THE SAFETY OF TUNNEL USERS IN CASE OF TRAFFIC
TUNNEL FIRES

PROGRAM

Mašinski fakultet Univerziteta Crne Gore
Faculty of Mechanical Engineering University of Montenegro
Podgorica, 17.10.2023

Organizacioni odbor
(Organizing Committee)

Dr Radoje Vujadinović, dekan Mašinskog fakulteta Univerziteta Crne Gore

Dr Radoje Vujadinović, dean of the Faculty of Mechanical Engineering, University of Montenegro

Dr Miloš Knežević, predsjednik Akademije inženjerskih nauka Crne Gore

Dr Miloš Knežević, the president of the Montenegrin Academy of Engineering Science

Akademik Petar Vukoslavčević

Academician Petar Vukoslavčević

Dr Boško Matović, rukovodilac studijskog programa Drumski saobraćaj, Mašinski fakultet

Dr Boško Matović, the head of the study program of Road Traffic, Faculty of Mechanical Engineering

*Okrugli sto se održava u svečanoj Sali Tehničkih fakulteta Univerziteta Crne Gore
(II sprat)*

Meeting venue: Ceremonial hall of the Technical faculties of the University of Montenegro (second floor).

Utorak, 17 Oktobar, 2023, 9:00 časova
Tuesday, October 17, 2023, 9:00 am

9:00 – 9:10

*Otvaranje Okruglog stola
(Opening of the Round table)*

Akademik Petar Vukoslavčević, prof. u penziji Mašinskog fakulteta Univ. Crne Gore

9:10 – 9:30

*Uvodne riječi:
(Introductory address)*

Prof. dr. Radoje Vujadinović, dekan Mašinskog fakulteta Univerziteta Crne Gore

Prof. dr. Miloš Knežević, predsjednik Akademije inženjerskih nauka Crne Gore

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9:30 – 11:00

*Predavanja po pozivu:
(Invited lectures:)*

Dr. Peter Sturm, Institute for Thermodynamics and Sustainable Propulsion Systems, Graz
University of Technology

**Uticaj električnih vozila na baterije na funkcionisanje i bezbjednost tunela
(Impact of battery electric vehicles on tunnel operation and safety)**

Dr. Miodrag Drakulić, Direktor Centra za tehničke sustave i požarno inženjerstvo, Zagreb
**Meteorološki aspekti dimenzioniranja sustava mehaničke ventilacije cestovnih
tunela**

**(Meteorological aspects of dimensioning mechanical ventilation systems of
road tunnels)**

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11:00 – 12:00

*Diskusija
(Discussion)*

Peter Sturm

Ao.Univ.-Prof. Dipl.-Ing. Dr. techn
Institute for Thermodynamics and
Sustainable Propulsion Systems
Graz University of Technology,
Austria.



He holds a PhD in mechanical engineering. Until Sept. 2023 he was head of the section "traffic and environment", deputy head of the Institute for Thermodynamics and Sustainable Propulsion Systems and Dean of Studies at the faculty of Mechanical Engineering and Economic Science, Graz University of Technology. He is currently senior-consultant at FVTmbH, Austria.

Over the last 30 years Peter Sturm and his team have been involved in the design and commissioning of more than 250 road and rail tunnels, in intensive fire and hot smoke tests for longitudinal and transverse ventilated tunnels as well as in underground mass transport stations. In addition, he is quite often involved in peer-reviewing and/or supervising ventilation and fire life safety systems for all types of subsurface road, rail and mass transport systems.

The research activity is closely linked to aerodynamic and thermodynamic issues in the field of tunnel ventilation and full scale tests on fire dynamics and fire behaviour in underground traffic systems. In recent years, these full-scale tests have included fires in very long railway tunnels and fire development of electric vehicles in road tunnels.

Memberships in several national and international organisations like: Climate & Air Quality Commission of the Austrian Academy of Science, the Austrian Research Association for Road Rail and Traffic (FSV) committee for the design guidelines for tunnel ventilation and safety issues, PIARC (world road association) technical committees for safety, ventilation and operation of road tunnels; Working group leader WG4 – new energy carriers, NFPA 502 (USA)

Impact of battery electric vehicles on tunnel operation and safety

Alternative (new) propulsion technologies, including battery-electric vehicles, are becoming more prevalent. As a result of these changes, the nature of tunnel safety risk (including from fire) is expected to change with time, and detailed consideration of the risk of significant incidents involving such vehicles is required. This should include the evaluation of incident consequences with particular attention paid to fire characteristics and toxic emissions and their impact on tunnel users and on emergency intervention strategies. In terms of risk analysis, new scenarios, frequency assessments, and consequence assessments need to be defined to account for the different impacts of BEV vehicles on road users compared to conventional fuelled vehicles.

The current standard of the energy storage device (battery) of a BEV is based on Li-Ion technology, the combustion behaviour of which is known to differ from that of conventional fuels. It is likely to result in more difficult firefighting conditions. Investigations to date focussed on fire tests of individual battery cells or packs and have been backed up by a few full-scale experiments with BEV. Recent tests on passenger cars were also performed under real world tunnel conditions. The knowledge gained from all these investigations on current state of the art Li-Ion battery technology will be presented.

Miodrag Drakulić

Assist. Prof., PhD.Mech.Eng.
Faculty of civil engineering,
University of Zagreb.
Director of the Center for technical
systems and fire engineering, Zagreb.



He has many years of professional experience in applied research in the field of ventilation systems of road and rail tunnels. The area of expertise is in the field of fire safety and tunnel ventilation, specially engaged in project of long tunnels like Prenj (over 10 km long). With his team from *Brodarski* institute in Zagreb he developed special ventilation algorithms for automatic control of smoke propagation in case of road tunnel fires, which are applied in all long tunnels in Croatia. He participated in the preparation of the program for determining the meteorological parameters relevant to the dimensioning of the ventilation system of the Sveti Rok (Croatia) and Prenj (Bosnia and Herzegovina) tunnels.

He organizes and provides training and educational courses for the maintenance staff and design engineers in the area of fire safety and ventilation in road and rail tunnels as well as participates in tests and commissioning of ventilation systems of road tunnels, including conducting fire tests according to Austrian guidelines for tunnels.

He was involved in a number of international projects, such as EUREKA "Fire Tunnel" (E! 2823) and NATO Programme SiP (Science for Peace) in the area of security technologies in long road tunnels. Also, representative of Croatia and expert at the World Road Organization (PIARC) in the period 2004 to 2011, focusing on fire and smoke control in road tunnels. He is the current president of the Croatian Association for Fire Protection Since 2007, he has been a lecturer at the postgraduate specialist study Fire Engineering and graduate study Materials at the Faculty of Civil Engineering, University of Zagreb.

Meteorological aspects of dimensioning mechanical ventilation systems of road tunnels

Dimensioning the mechanical ventilation system of road tunnels requires knowledge of numerous input parameters, including geometric, geomechanical and construction characteristics of the tunnel, traffic intensity and composition of vehicles, requirements regarding permitted concentrations of harmful gases and other pollutants inside the tunnel and in pre-portal zones, designed fire load and other potential exploitation risks, and finally the meteorological parameters of the area where the tunnel is located. Very often the mentioned meteorological aspects are neglected or misinterpreted.

In this lecture, meteorological aspects that significantly influence the dimensioning of the ventilation system will be presented, namely the effect of the wind and the geodetic pressure difference at the tunnel portals. The exact determination of the mentioned meteorological parameters requires long-term meteorological measurements and observations at the future location of the tunnel, which according to current practice in the wider region is not usually carried out. Another approach to solving this problem is the use of existing recognized meteorological numerical models, in combination with the available measured data of the nearest official meteorological stations, which can be used to determine the numerical values and associated statistical characteristics of the required meteorological parameters, which will be shown on the example of some tunnels from the region (the built St. Rok tunnel in Croatia and the planned Prenj tunnel in Bosnia and Herzegovina). A special review will be given to the behaviour of the ventilation system in fire conditions and the combined action of the mentioned meteorological parameters.