ITA COSUF
ITA Committee on Operational Safety of Underground Facilities

Newsletter 18, September 2014

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1. Message from the new Chairman

Dear friends of ITA COSUF,

After the summer holidays it is time to put fresh energy in COSUF activities and I hope that you all enjoyed a nice break before getting back at work. Already three months have passed since the open ITA COSUF Workshop on "Balancing Operational Needs and Safety Research Developments" has been held on 5 June in Berlin. During this event Francesco Collela was announced as the winner of the ITA COSUF Award 2014. The event was lively and successful and if you have not had the chance to participate you can find a short summary below and all presentations are available from the website.

In combination with the workshop we also held our annual General Assembly. One topic was that the COSUF Steering Board has proposed Max Wietek (Hagerbach Test Gallery) as new vice-chairman and Eric Premat (CETU) as new member of the Steering Board. Both members have already shown their enthusiasm for COSUF and the General Assembly confirmed those proposals. Eric Premat will introduce his institute on the membership introduction page of this newsletter.

We have been working on more visibility in the professional world with the aim to be recognised as the experts for operational safety and security. Examples are the published guideline on An Engineering Methodology for Performance-Based Fire Safety Design of Underground Rail Systems and recommendations on our website and a new flyer that can be downloaded. Besides that we are still busy with strengthening the activity groups as the very basis of ITA COSUF. You can learn about the latest developments of the activity groups below.

The next ITA COSUF internal Workshop for all ITA COSUF members will be in Copenhagen on 29 October 2014. Our Danish members have prepared a very interesting programme including a site visit to the Copenhagen metro. I look forward to meeting all of you there so that we can together contribute to the future of ITA COSUF for continuous improvement of operational underground safety!

Looking forward to seeing you in October in Copenhagen,

Yours,

Roland Leucker - ITA COSUF Chairman

2. Report of the ITA COSUF Workshop in Berlin, 5 June 2014

On the 5th of June the COSUF General Assembly took place in Berlin followed by the 2014 open workshop. Theme of the Workshop was Balancing Operational Needs and Safety Research Developments. Speakers from the research community, industry and tunnel management organisations succeeded in highlighting the benefits and the downsides of research applications. The many opinions expressed by various stakeholders led to an interesting program with lively discussions.

At the end of the workshop, the annual prize, awarded for outstanding work in the field of work of COSUF was awarded for the fifth time. After Enrico Ronchi (28) last year, in 2014 Francesco Colella (33) received the price for his work on the modelling of tunnel ventilation systems with a multi-scale model. His paper is included in section 6 of this newsletter.

3. ITA COSUF Workshop and AG Meetings in Copenhagen, 28-29 October 2014

On 28 October (15:00 – 18:00) the Activity Group Meetings will take place at the premises of Metroselskabet I/S (Metrovej 5 2300 København S). On 29 October the private ITA COSUF Workshop (only for COSUF members) will start at the metro Control and Maintenance Centre (CMC). Tailor-made presentations will be given for our COSUF members on the safe operation and maintenance of both the old and the new metro lines in Copenhagen by experts and operational staff. Visits to CMC and to the new metro construction will be part of the program. Please register; more details are found on http://www.ita-aites.org/en/wg-committees/committees/ita-cosuf/news-annoucements

4. Report from the Activity Groups

AG1 Interaction with European and international initiatives

During the last meeting the output and activities of AG1 were brought in line with the general ITA COSUF mission statement. The main focus of AG1 will be on liaising with relevant initiatives on operational safety of underground facilities. The corresponding activities are the creation of a dynamic list with potential initiatives and proposals if and how to liaise (e.g. PIARC, ISTSS2014, ITA Tech, ITA CUS) and to promote COSUF as a major stakeholder at conferences and other networking platforms. Besides our communication plan will be followed, meaning that newsletters will be issued, the ITA COSUF Award will be opened annually, and the content of the website will be actual. AG1 will also contribute to COSUF review reports on research reports that demand comments of individual COSUF members.

AG2 Regulations and best practices

During the last months AG2 has been working on the various following topics. First of all, recommendations for layout of human machine interface of SCADA systems (Interface between operator and system – user system) have been established and a first draft of this guideline is to be finished in Q1 2014. Secondly, an engineering methodology for performance-based fire safety design of underground rail systems was launched (and also posted on http://cosuf.ita-aites.org) and a first version of the guideline was finished. The update of the previous survey of existing regulations and recognized recommendations for road tunnels was finished. Upcoming activities are road tunnel standards (updating the previous report made by AG2 on standards for existing road tunnels), SCADA, disabled persons in emergency scenarios, tunnels influences on the wider road network and cross passage design in rail tunnels.

AG3 Research and new findings

AG3 is working on the latest research projects and their results with regard to safety and security of underground infrastructure. Recently performed activities were the support of a master thesis regarding the prediction of concrete spalling under tunnel fires and the preparation of a “Marie Curie”-proposal within Horizon2020.

AG4 European Tunnel Safety Officers

AG4 aims to be the Platform for European Tunnel Safety Officers for exchange of experiences through its bi-annual forum and development of best practices. The 3rd Forum for European Tunnel Safety Officers took place on March 27 & 28 in Luxembourg. Based on the evaluation of the 3rd Forum it was concluded that the format of the Forum should remain as it is: a two day event with speakers and a workshop combined with a site visit. The 4th EU TSO Forum is planned in March 2016. Topics of interest are maintenance and refurbishing during operation, the role and responsibility of emergency services, degrading of tunnels and failures, minimal operation requirements and best practices on tunnel safety documentation.

6. Paper of ITA COSUF Award Winner 2014 Franceso Collela

Multiscale Modeling of Tunnel Ventilation Flows and fires

Francesco Colella, PhD, CFEI, Exponent Inc. USA, fcolella@exponent.com

Nowadays, tunnel ventilation design is widely performed by using numerical computational fluid dynamics (CFD) tools. For long tunnels, this type of approach has the drawback of the required computational time (up to several days per each simulated scenario). This limitation affects the validity of the analyses since only a limited number of scenarios can be explored leaving a wide range of possible conditions unexplored.

The high computational cost arises when CFD model has to include important tunnel characteristics or equipment in locations far away from the region of main interest. This is the case, for example, of tunnel portals, shafts, ventilation inlet/outlets, and ventilation stations or jet fan series located long distances away from the fire. In these cases, even if only a limited region of the tunnel has to be investigated using CFD (e.g. around the fire seat), a correct solution of the smoke movement requires including all the active ventilation devices, the conditions at the portals and the whole tunnel layout. For typical tunnels, the resulting computational domain could be several kilometres long and traditional CFD techniques do not handle it efficiently.

An efficient solution to the problem is multiscale modelling which couples one-dimensional (1D) and CFD modelling techniques resulting in a more rational use of the computational resources without affecting accuracy. The 1D model is used in the long regions of tunnel where the flow is fully developed (far field), and detailed CFD is used in the short regions where the flow features complex 3D patterns (e.g. in the vicinity of the fire). The solution of the multiscale problem is reached by means of iterative computing procedures which allow the 1D and CFD models to exchange information dynamically (See Figure 1). Comparison against full CFD shows that multiscale modeling provides high fidelity solutions, in significantly shorter computational time (up to 100 times shorter).

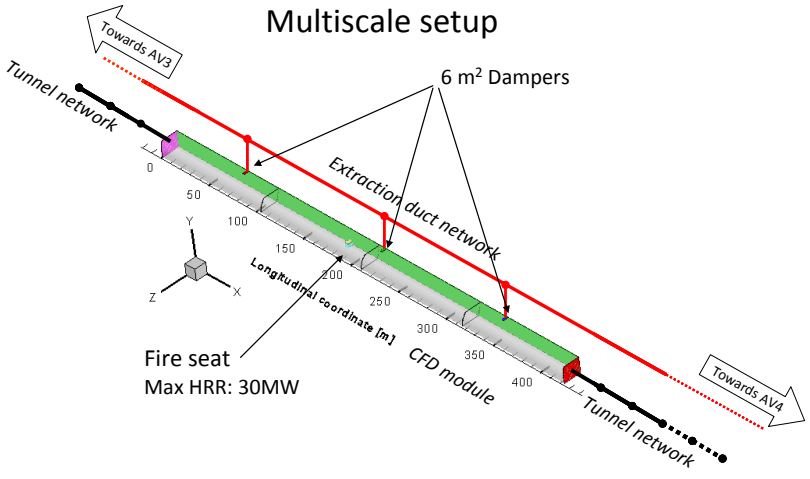


Figure 1. Example of multiscale model setup for the Frejus tunnel (Italy-France).

The multiscale methodology has been applied to the analysis of the Dartford Tunnels located under the River Thames about 15 miles east of London (UK). The model has been subjected to a comprehensive validation process against a large set of experimental data, and it has been used to provide the tunnel operator with a comprehensive assessment of the fire risk in the Dartford Tunnels. More recently, the multiscale model has been applied to simulate the transverse ventilation system response in the Frejus tunnel (12780m) between France and Italy.

Multiscale models have been applied to simulate fires and tunnel ventilation flows, including jet fans, vertical shafts and portals, and then it has been extended to deal with transient flow interactions. Dozens of different fire and ventilation scenarios have been investigated involving different settings of the ventilation system, detection times and fires ranging between 10MW and 100MW. The multiscale model has been shown to perform excellently in all scenarios providing accurate predictions of flow and temperature as well as the timing to remove the upstream back layering.

Multiscale models allow for both steady-state and time-dependent scenario simulations. Time-dependent simulations (see Figure 2) allow determining the dynamic response of the ventilation system, the evolution of hazardous zones in the tunnel domain or the correct timing for the activation of fixed fire fighting systems. Multiscale modelling allows for full coupling of the fire and the whole tunnel domain including the ventilation devices. The much lower computational cost is of great engineering value, especially to conduct parametric and sensitivity studies in long tunnels, design ventilation systems, assess system redundancy and the performance under different hazards conditions.

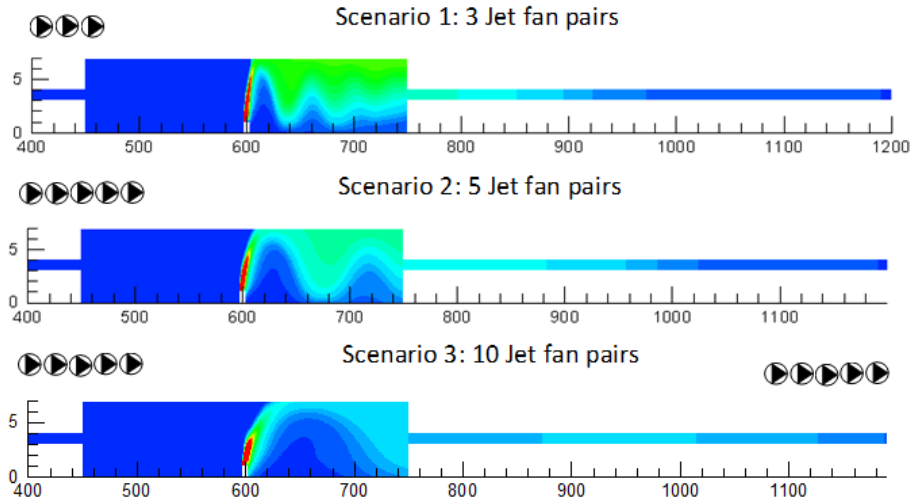


Figure 2. Example of time-dependent multiscale model results for a 30MW fire subject to different ventilation conditions.

For more information:

F. Colella, G. Rein, R. Borchiellini, V. Verda, Multiscale Modelling of the Transient Flows from Fire and Ventilation in Long Tunnels, Computers & Fluids (2011), 51(1):16-29, doi:10.1016/j.compfluid.2011.06.021

F Colella, G Rein, R Borchiellini, JL Torero, A Novel Multiscale Methodology for Simulating Tunnel Ventilation Flows during Fires, Fire Technology 47 (1), pp. 221-253, 2011. doi:10.1007/s10694- 010-0144-2. (Winner of 2010 Lloyd's Science of Risk Prize in Technology).

F Colella, G Rein, P Reska, R Carvel, JL Torero, Analysis of the Ventilation Systems in the Dartford Tunnels Using a Multiscale Modelling Approach, Tunnelling and Underground Space Technology 25, pp. 423–432, 2010. doi:10.1016/j.tust.2010.02.007.

F Colella, G Rein, R Borchiellini, R Carvel, JL Torero, V Verda, Calculation and Design of Tunnel Ventilation Systems using a Two-scale Modelling Approach, Building and Environment 44, pp 2357-2367, 2009. doi:10.1016/j.buildenv.2009.03.020.

F. Colella (2010). Multiscale analysis of tunnel ventilation flows and fires. PhD Thesis, Politecnico di Torino, Dipartimento di Energetica.

F. Colella, G. Rein, R. Borchiellini, V. Verda, One dimensional and multi-scale modelling of tunnel ventilation and fires, Chapter in: The Handbook of Tunnel Fire Safety II edition, Thomas Telford, Ltd.

7. Future ITA COSUF events

ITA COSUF workshops and Activity Group meetings

28 – 29 October 2014	**ITA COSUF Workshop and AG meetings, Copenhagen (Denmark)** This two-day event will include a technical visit to the Copenhagen Metro Blanka Tunnel on 29 October. AG meetings will be held in the afternoon of 28 October.
22 – 29 May 2015	**World Tunnel Congress 2015, Dubrovnik (Croatia)** ITA-COSUF will organize a whole day open workshop. AG meetings will take place on the afternoon of 25 May.
30 November 2015	**ITA-COSUF workshop on Crowd Management, Dortmund (Germany)** ITA-COSUF will organize a whole day in the frame of STUVA Conference 2015.

Other events organised or endorsed by ITA COSUF

1 – 2 December 2015	**STUVA Conference 2015 Dortmund, Germany.** IFAB: Workshop on Tunnel and Metro Stations, China.

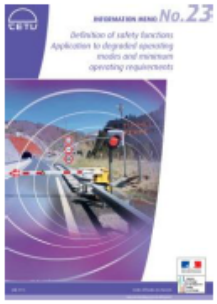
For all enquiries to ITA COSUF membership please contact Ben van den Horn ben.vandenhorn@arcadis.nl

8. ITA COSUF member introduction: Centre d'études des tunnels (Cetu)

The Centre d'études des tunnels (CETU) is the French national technical body of the Ministry in charge of transports and responsible for all technical aspects of tunnels. It is involved in all stages of tunnel work from design to asset management on matters relating to equipment or civil engineering. CETU has been involved in road tunnels since its creation in 1970 and has progressively widened the scope of its activities to include railway and canal tunnels as well as complex underground infrastructures.

A resource centre for knowledge and expertise on tunnels

- Contribution to the **development of knowledge** on underground infrastructures (state-of-the-art, research projects, collecting best practices)
- Participation in the **diffusion** of this knowledge (dissemination of technical and scientific information, educational and training activities)
- Elaboration of **guidelines, recommendations** and **standards** both at a national and international level
- **Engineering studies** and **expertise, technical advice** on projects and on operational issues for tunnel owners (including coordination of the activity of the French speaking road tunnel operators workgroup)



- **Representation of the French State** within national and international bodies (including safety committees of the Channel, Mont-Blanc, Frejus and Tende bi-national tunnels)

With **85 employees** and **7 departments**, CETU's multidisciplinary teams focus on **6 main research areas**: tunnel fires and ventilation systems; environmental issues and sustainable development; integration of human and organizational factors in tunnel design and safe operation; asset management and road tunnel operation policies; technical and economic risks related to tunnel construction; analysis and management of risks during operation.

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A wide variety of international activities

- **Several major European research actions**: the FIT thematic network (Fires in Tunnels), UPTUN project (improvement of fire safety in existing tunnels) and VIRTUAL FIRES project (fire simulation and visualization methods) …
- **Development of national and international tunnel regulations**: key contribution to the elaboration of the European Directive 2004/54/EC on minimum safety requirements for tunnels on the trans-European road network and representation of France on the monitoring committee for the directive's implementation.
- **PIARC Technical Committee 3.3 "Road tunnel operations"**: chairmanship from 1996 to 2007, currently French-speaking secretariat, chairmanship of the WG1 "Sustainable road tunnel operations", co-chairmanship of WG3 "Interaction with users, and active contribution to WG2 "Feedback from experience", WG4 "Fire safety" and WG5 "Complex underground road networks".
- **International working group "Work Stream on Tunnel Safety"** created by European road directorates aiming at benchmarking and sharing experiences in road tunnel safety
- **Strong connections with ITA since its creation** in 1974, as a member of different working groups and currently vice-chairman of ITA-CET (Committee on Education and Training). CETU has been involved in ITA-COSUF since 2005: everybody remembers Didier Lacroix now retired who chaired ITA-COSUF between 2011 and 2013. Today CETU is still an active member of AG 1, AG2 and AG 4 as well as a member of ITA-COSUF Steering Board.