ITA COSUF
ITA Committee on Operational Safety of Underground Facilities

Newsletter 24, December 2016

Contents

1. Message from the Chairman

Dear friends of ITA COSUF,

This is the second and last newsletter of 2016. Consequently, it brings a short look back to the last year and a view on the activities of ITA COSUF in the coming year.

In section 2 you will read about our private ITA COSUF workshop in Helsinki, which was well organised by the colleagues of the Finnish Transport Agency and with the help of liaison Max Lakkonen. I would like to thank them once again for their efforts in making another successful event.

Like in previous years, the Steering Board has decided to launch the established ITA COSUF Award also in 2017. This had proven to be a big help to attract the interest of the new generation of professionals on safety and security of underground facilities. It is a clear demonstration of the aim of ITA COSUF to stimulate a widespread adoption of best practices in the field of safety and security underground. In section 4, you can read how candidates can apply.

Then I would like to point your attention to next ITA COSUF events in 2017. First of all, a half day ITA COSUF Workshop in Bergen, focussed on new security challenges for design and operation. The resilience of underground infrastructure against physical or cyber-attacks is a really catchy topic. For instance, enhancing the cyber security levels of tunnel control centres are a concern for all of us.

In November 2017, another ITA COSUF Workshop will be scheduled as part of the Congrès International Paris, “L’Espace Souterrain Notre Richesse”, organized by the French Tunnelling Committee (AFTES). We will organise a one day ITA-COSUF workshop most likely on operational safety of multiple layer systems. Please, save the dates (calendar week 46/2017) .

So close to the end of this year, all Steering Board members and I would like to take the opportunity to thank you for the support and the cooperation of ITA COSUF in the past twelve months and we wish you good health and a – professionally and personally – happy and prosperous New Year.

Yours

Roland Leucker – ITA COSUF Chairman

2. Workshop Operating Road and Rail tunnels in Helsinki 25-26 October 2016

On the 26th of October, an ITA-COSUF Internal Workshop in Helsinki took place. This workshop was organised by the Finnish Transport Agency (FTA). About 25 participants took part. The workshop started with the General Assembly 2016 and the hand-out of the ITA COSUF Award 2016 to Wilson Ulises Rojas Alva by ITA COSUF Chairman Roland Leucker for an outstanding contribution to the safety of underground facilities from (see section 3 of this Newsletter).


ITA Award Winner 2016 Wilson Ulises Rojas Alva

First of all, a short introduction of FTA was given by Laura Väisänen. Laura explained that the host of this workshop is responsible for the Finnish roads, railways and waterways and the development of the Finnish transport system. Not only road and railway safety but also maritime safety are important focus areas. FTA strives for a smooth, efficient and safe travel and transport. One of the strategic goals is reliable digital services leading to greater operational efficiency. Some impressive road and railway statistics were shown. There are amongst other 44 railway tunnels and 20 road tunnels in Finland.


Laura Väisänen

Marko Järvinen

Then Marko Järvinen of the Helsinki Rescue Department presented the western extension of the Helsinki Metro, comprising a length of 21 km (all underground), 13 underground stations and 1 underground depot. All the underground developments are key processes for the Helsinki Rescue Department. It means full time jobs for many fire officers and officers in the alarm centre. The safety strategy of Helsinki Rescue Department in underground facilities is to take part of the planning of the tunnels as early as possible; this is even enforced by the Finnish Rescue Law. During the construction time, building areas are visited and emergency exercises are organized. For instance, in the west metro extension project about 35 exercises took place. Just before opening a new tunnel, the Helsinki Rescue Department will ensure that smoke control can be handled and standard operational procedures can be finalized. Furthermore, fire inspections will take place on a continuous basis.

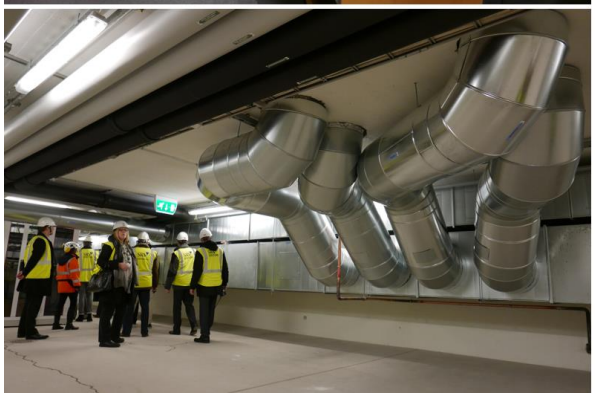
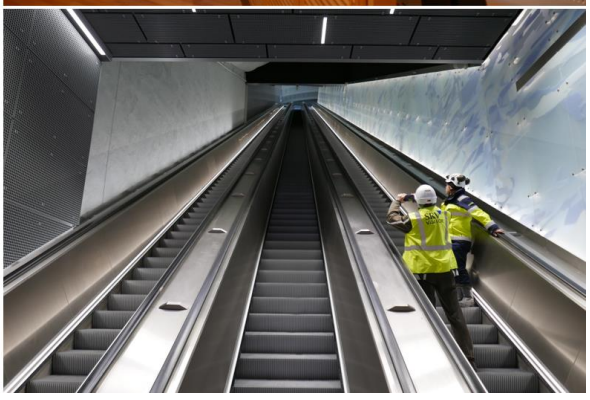
Marko Järvinen explained that in the rolling stock (M300-junat) in this new metro line there are smoke detectors installed as well as phones to the driver and even a high pressure water sprinkler, that can be launched by the driver: every wagon has 7 water heads, pressured by Nitrogen gas (200 bar under the train) and three water tanks of 80 liter each. It will take 10 minutes until all the water is finished. The smoke ventilation principle in

and between the stations were outlined. The most important safety targets are a proper self-evacuation possibility and a safe access route for firefighters taking into account that breathing apparatus only have a limited duration. Besides, the need for good communications and detailed information (like plans and drawings) is clear. After this interesting presentation, everybody realised that making tunnels is not just a task for the engineers; to plan and construct all tunnels as safe, reasonable and cost-effective as possible is a challenge for all stakeholders. Furthermore, the authorities involved in safety and security must prepare with quite a large training program and standard operational procedures in every project. In the western extension firefighters spent 16 050 working hours in one year!

Finally, an introduction to the visit to Train Security Control Centre and Road Traffic Management Centre were given by Arto Muukkonen and Mika Jaatinen, respectively. These traffic management centres are spread out in Finland with the purpose to monitor the traffic and weather (situation awareness), to provide information for road users, to control the traffic control by variable message signs. The tunnel management systems of nine road tunnels in Helsinki are operated from the Helsinki Metropolitan Area Traffic Management Centre. Incident Management takes places in close co-operation with other authorities and support from the centres is given for road maintenance.

Mika Jaatinen explained the potential and benefits of close co-operation between the authorities in the Helsinki Metropolitan Area. In each road incident, the road traffic management centre is able to save time for the travellers; time savings are estimated to be at least ten and perhaps hundred million euros a year. Each prevented traffic accident causing injuries will save circa 0.5 million euros and each prevented fatality over 2.5 million euros. Additional benefits include reduced emissions and material damages.



After a tasteful lunch a site visit to a new metro station took place. The participants were not only impressed by the safety features, but also by the fine architecture and the high quality of finishing the stations with natural stone.

At the end, all participants returned home with a happy feeling about the lively and successful program and provided technical site visits.

3. Work of ITA COSUF Award 2016 Winner Wilson Ulises Rojas Alva

Longitudinal Ventilation Control in Tunnel using the Helium-Technique in a small-scale rig – The Influence of vehicular blockages and the tunnel slope

W. Ulises Rojas Alva, Grunde Jomaas, Anne S. Dederichs

Department of Civil Engineering, Technical University of Denmark, Denmark

It is well known that using the critical ventilation velocity to prevent smoke from spreading upstream (backlayering) will lead to an increase in the severity of a tunnel fire [1,2]. Therefore, a certain backlayering distance should be allowed in order to achieve an optimal situation where fire intensity will decrease and the smoke stratification downstream from the fire source will decrease or diminish. This longitudinal velocity can be identified as a confinement velocity, which is treated as a dimensionless parameter (ratio of longitudinal velocity to its corresponding critical velocity). The critical velocity has been studied in detail [1,3–6]. Nonetheless, the same is not the case of other important aspects in tunnel fire dynamics, such as the influence of vehicular blockage and the tunnel slope on the critical velocity, backlayering distance and longitudinal velocity (confinement velocity). There are still some studies on these topics [4,7–9], but these aspects still remain poorly understood.

In order to increase the knowledge regarding the tunnel fire dynamics several small-scale experiments were conducted, and the results were compared with large-scale data and data from other relevant studies. The ex-

periments were conducted in a small-scale, 4.7 m long rig (scale 1/30 of a tunnel with a section of 6 m by 9 m in full-scale), based on the helium-air technique developed by Mégret & Vaquelin [10–12]. The method consists in reproducing several phenomena from a full-scale fire to a densimetric small-scale fire by applying two sets of scaling principles based on dynamic similarities, namely Froude modelling and a thermal/densimetric analogy. It is worth to mention that the densimetric modelling does not take the heat losses into account; however, both the critical velocity and backlayering distance estimates lie within a conservative side inasmuch as it represents the worst case scenario in terms of buoyancy strength [13].

Several relevant and innovative scenarios were taken into account during the experimental work: a wide range of heat release rates (from 0.4 to 31 MW in full-scale); several tunnel sections, ranging from 27 to 94.5 m2 in full-scale; the presence of vehicular blockages in the tunnel model with different arrays (one or two buses, a train carriage, several car models), as a consequence, the relative size of the vehicular blockage occupied 10.3 to 41% of the tunnel model section; the position of the fire source with regards to the vehicular obstacle; and three slopes, uphill and downhill (0, 3 and 6%). The following list provides the key findings:

- Excellent agreement was found when the obtained results were compared against full-scale experimental data and reference correlation for the critical velocity, the dimensionless backlayering distance as a function of the confinement velocity, the vehicular blockage ratio, and the slope of the tunnel, see Figure 1. Hence, the small-tunnel model and the method were successfully validated.
- The presence of the vehicular obstacles can affect the tunnel fire dynamics, see Figure 2. It was found that the critical velocity is reduced proportionally to the vehicular blockage ratio (Ratio of the cross-sectional area of the vehicular blockage to the cross-sectional area of the tunnel), only if, the fire plume is directly affected by the longitudinal air stream. On the contrary, the critical velocity is further increased (up to 30%) when the buoyant plume is partly blocked from the longitudinal air stream. This might be owing to the relative size of the vehicular obstacle and the relative position of the fire source, the fire plume or buoyant jet might be partly blocked when it is reached by the longitudinal air stream. Thus, the critical velocity is higher than in the same case without vehicular blockage. Another possible explanation is the “flow recirculation” around the obstacles. The backlayering distance and the confinement velocity (ratio of longitudinal velocity to its corresponding critical velocity), in dimensionless form, are also affected by the vehicular obstacle.
- There are two different regimes, the lower and the upper dimensionless heat release rate (Q*), for the longitudinal velocity, confinement velocity, and the backlayering distance. In the upper Q* regime, it was found that the reference correlation for the confinement velocity underestimates the large-scale data.
- The tunnel slope influences the critical velocity and the backlayering distance. For the latter, it seems that the uphill tunnels affect the backlayering distance to a higher degree.

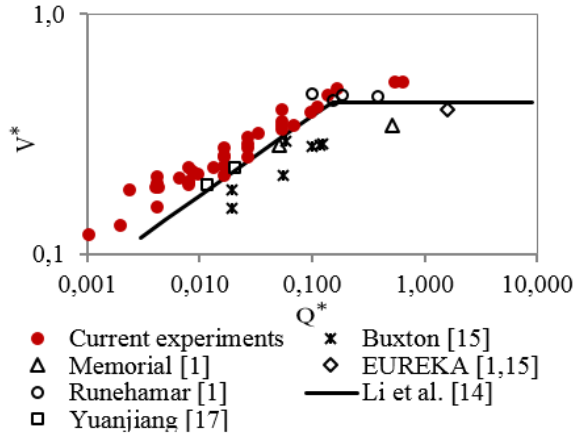


Figure 1 – The dimensionless critical velocity as a function of the dimensionless heat release rate. Overall results compared against full-scale data from a reference correlation [1,14–17].

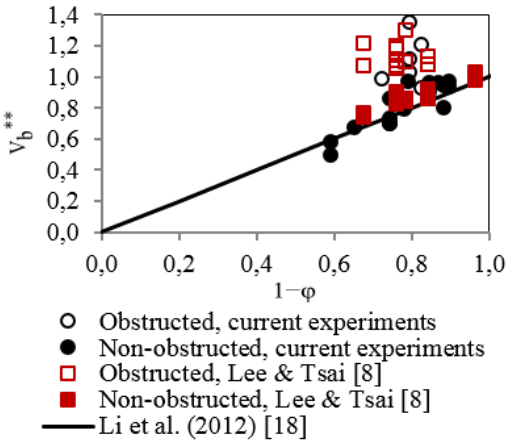


Figure 2 – Dimensionless critical velocity as a function of 1–φ. Data from experimental results and from Lee and Tsai [8,18].

There is clearly a knowledge gap concerning the influence of vehicular blockage on the tunnel fire Dynamics. Additionally, the confinement velocity and the longitudinal velocity for both Q* regimes are both not well understood, neither in horizontal tunnels nor in sloped tunnels. More experimental work should be carried out in small-scale thermal models in order to advance the knowledge in tunnel fire dynamics.

For further information, please consult the following publications:

- Rojas Alva, W. U., Jomaas, G., & Dederichs, A. S. (2015). Scaled experiments using the helium technique to study the vehicular blockage effect on longitudinal ventilation control in tunnels. In 16th International Symposium on the Aerodynamics, Ventilation & Fire in Tunnels (pp. 49–66). Seattle: BHR Group.
- Rojas Alva, W. U., Jomaas, G., & Dederichs, A. S. (2016). A Helium-Technique Experimental Study of Longitudinal Ventilation Control in Sloped, Small-Scale Tunnels. In H. Ingason & A. Lönnermark (Eds.), Seventh International Symposium on Tunnel Safety and Security, (pp. 689–690). Montreal, Canada: SP Technical Research Institute of Sweden.
- Rojas Alva, U., Jomaas, G., & Dederichs, A.S. (2016). The Influence of Vehicular Obstacles on Longitudinal Ventilation Control in Tunnel Fires. Fire Safety Journal. (Accepted with minor revisions).

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[13] F. Colella, G. Rein, R. Borchiellini, J.L. Torero, A Novel Multiscale Methodology for Simulating Tunnel Ventilation Flows During Fires, Fire Technol. 47 (2011) 221–253. doi:10.1007/s10694-010-0144-2.

[14] Y.Z. Li, B. Lei, H. Ingason, Study of critical velocity and backlayering length in longitudinally ventilated tunnel fires, Fire Saf. J. 45 (2010) 361–370. doi:10.1016/j.firesaf.2010.07.003.

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4. ITA COSUF Award 2017

Young researchers and tunnelling professionals are being called on to enter their research or practice in the field of underground safety for the ITA-COSUF 2017 safety award. The award is granted annually for outstanding theoretical research work, or practical application, in the field of operational safety or security of underground facilities. Candidates must be under-35 but do not need to be ITA-COSUF members.

"The ITA COSUF Award has succeeded in attracting the interest of young talented professionals on safety and security of underground facilities" said Dr Roland Leucker, Chairman of ITA-COSUF. The winner will receive an invitation to attend an award ceremony to be held during the ITA-COSUF workshop next year (2017), plus travelling and accommodation expenditures and a €1,000 cash prize. He or she will have the opportunity to present their work during a plenary session of the workshop.

The application, in English, should be received by 30 May 2017 at the ITA Secretariat in Lausanne, Switzerland. Additional information will become available on the ITA-COSUF website.

The award winner will be selected by the ITA-COSUF steering board, who will be looking for evidence of research or practice that is specifically aimed at safety or security of underground facilities, preferably reflecting an interdisciplinary approach. Among other criteria, candidates should:

- describe new aspects in the area of safety in operation and/or security in underground facilities;
- have completed the study or practice no more than two years before the application date;
- give clear and concise descriptions of the objectives, scientific basis, work steps, results achieved and their relation to the current state of the art;
- present work that offers a unique contribution to the field of underground safety.

5. Future ITA COSUF events

ITA COSUF workshops and Activity Group meetings

13 June 2017	**World Tunnel Congress 2017, Bergen, Norway** *with a half day ITA COSUF Workshop New Security Challenges for Design and Operation.* This half day event will be held on Tuesday 13 June 2017.
13-15 November 2017	**Congrès International Paris, "L'Espace Souterrain Notre Richesse", Paris, AFTES.** *Including a one day ITA-COSUF workshop on Operational Safety of Multiple Layer Systems.*

Other events organised or endorsed by ITA COSUF

6-8 December 2017	**STUVA-Conference 2017 in Stuttgart.**

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

6. ITA COSUF member introduction: London Bridge

LONDON BRIDGE ASSOCIATES LTD

For the last 16 years London Bridge Associates, have been providing a wide range of value enhancing consultancy services to major projects. Our services encompass all stages of project delivery with a focus on enhancing value, efficiency, and safety by ensuring optimum constructability. This year, LBA won the NCE 100 best SME of the year.

Road Tunnel Operating Experience

LBA staff have a wide range of relevant experience for tunnel operations, both from an operation and construction and maintenance background. LBA has worked with PIARC for a number of years contributing skill and experience to a number of working groups, we are able to provide a range of services supporting operations including:

- Expert advice on calculation of evacuation response
- Emergency Planning
- Emergency Exercises
- Post incident debriefing
- Fire Safety Design Advice
- Risk Analysis and Auditing
- Peer review
- Emergency Response Training
- Tunnel Traffic Management

Project Example - Hindhead

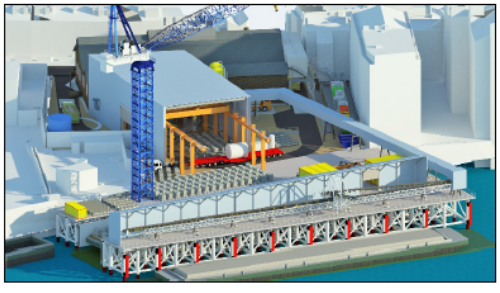
We carry out the role of Tunnel Safety Officer for Hindhead A3 Tunnel, overseeing the management of systems, procedures and strategy of the safe operation of the tunnel. Providing the interface between the highways services operator and the emergency services and reporting progress of the emergency management system to Highways England.

Our history with the ITA

LBA have strong links with the British Tunnelling Society which is also affiliated with the ITA. Les Fielding has represented us at the ITA COSOF workshop and we have benefited from sharing knowledge and experience

LBA

Collectively they cover many fields including, tunnelling and the construction of underground structures, roads, railways, civil engineering, building, supervision of mechanical and electrical services, geotechnical engineering, instrumentation, monitoring and engineering surveying. We have extensive experience and a range of technical and managerial skills that are of potential benefit to clients throughout the construction industry.



Leading technological innovation in tunnelling

Outside of operations planning LBA are a leader in the world of the Tunnel Construction, providing expert advice across the project cycle. Our Virtual Contrition Planning team use 4D technology to provide high quality models for site planning inputting into project planning submissions, feasibility studies and tendering. Virtual prototyping of sites helps prove feasibility and gives an opportunity to improve safety in the underground environment before works even start on site.

Get in touch via email at welcome@lba.london or call +44 (0) 20 8399 8614 – www.lba.london