

**17th International  
Symposium on  
Aerodynamics, Ventilation  
& Fire in Tunnels 2017**

Lyon, France  
13 – 15 September 2017

ISBN: 978-1-5108-5166-5

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

Copyright© (2017) by BHR Group  
All rights reserved.

Printed by Curran Associates, Inc. (2017)

For permission requests, please contact BHR Group  
at the address below.

BHR Group  
The Fluid Engineering Centre  
Cranfield, Bedfordshire MK43 0AJ  
United Kingdom

Phone: +44 1234 750422  
Fax: +44 1234 750074

[info@bhrgroup.com](mailto:info@bhrgroup.com)

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2633  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

17th International Symposium on  
**AERODYNAMICS, VENTILATION & FIRE IN TUNNELS**  
Lyon, France: 13–15 September 2017

## CONTENTS

FOREWORD	1
<b>AERODYNAMICS AND ACOUSTICS</b>	
Pressures and velocities inside trains – Influence of inter-car connections <i>A E Vardy, University of Dundee and Dundee Tunnel Research, UK; M Sima, MSiCo AB, Sweden</i>	5
Boundary layer development along high-speed trains in tunnels as possible cause for contact disturbances of pantographs <i>S Uster, M Flueckiger, A Busslinger, P Reinke, S Nyfeler, T Wicht, HBI Haerter Ltd; M Raeber, AlpTransit Gotthard AG, Switzerland</i>	25
Influence of shaft:tunnel geometry on steep pressure waves <i>H Wang, Southwest Jiaotong University, China; A E Vardy, University of Dundee and Dundee Tunnel Research, UK</i>	41
Assessment of the pressure load of cavities in a single-track tunnel by model-scale experiments and CFD simulation <i>H Kühnelt, M Rudolph, Austrian Institute of Technology GmbH (AIT), Austria; D Heine, K Ehrenfried, Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany; F Saliger, Austrian Federal Railways (ÖBB), Austria</i>	55
New approach to assess aural pressure comfort in high-speed trains running on German high-speed lines with single-track tunnels <i>P Claus, P Deeg, T Tielkes, DB Systemtechnik GmbH, Germany</i>	71
Acoustic modelling of micro-pressure waves emitted from high-speed railway tunnels with vented tunnel hoods <i>T Miyachi, T Fukuda, Railway Technical Research Institute, Japan; M Hieke, C Gerbig, T Tielkes, DB Systemtechnik GmbH, Germany</i>	79
Integration of tunnel ventilation and train control systems <i>M Duckham, K Brown, C F Fleming, SNC-Lavalin, Canada</i>	93
<b>AIR QUALITY</b>	
Holistic approach to improve air quality and provide smoke management for Chicago Union Station and tunnels using hybrid longitudinal and semi-transverse ventilation <i>J Ko, I Maeviski, Jacobs Engineering; J Grella, HNTB Corporation, USA</i>	105

Biofiltration of road tunnel discharge – An experimental study <i>B Vidal, J F Burkhart, CETU (Tunnels Study Centre); J F Petit, P Barbe, C Neaud, CEREMA (Centre for Research and Expertise on Risks, the Environment, Mobility and Planning); T Jacquet, B Goussebayle, PHYTORESTORE; D Muller, CNRS, Université Claude Bernard; T Chardiny, F Faugier, ENGIE AXIMA, France</i>	119
Temporary tunnel ventilation for construction and fitting out of large metro projects <i>J Bristow, S Dar, D Eckford, Mott MacDonald; T Kelly, Costain, UK</i>	133
Ventilation control of unidirectional urban tunnels with on- and off- ramps <i>S Abe, T Matsumoto, I Nakahori, Sohatsu Systems Laboratory Inc., Japan; A E Vardy, University of Dundee, UK</i>	149
Diesel locomotive considerations for long passenger rail tunnels <i>A Louie, S Li, S Marsico, WSP, USA</i>	167
Developing dynamic boundary conditions for modelling moving diesel locomotives in long passenger rail tunnels <i>S Marsico, S Li, A Louie, WSP, USA</i>	181

## **EQUIPMENT**

Design and verification of air supply nozzle for low discharge airflow velocity used in a specified condition <i>T Hakozaki, C Inanobe, J Ishitoya, Metropolitan Expressway Company Limited; H Yanagi, ECHOPLAN Company Limited, Japan</i>	199
The effects of solid barriers on the behaviour of smoke in fire events within ventilated tunnels <i>F Chaabat, P Salizzoni, M Creyssels, University of Lyon, CNRS UMR 5509 Ecole Centrale de Lyon, INSA Lyon, Université Claude Bernard; A Mos, Centre d'Etudes des Tunnels, France</i>	213
Jet Fan Exhaust Stations – design, as-built verifications and life cycle cost analysis <i>M Finnson, WSP, Sweden</i>	229

## **FIRE AND SMOKE DESIGN**

Effect of intercarriage doors on tunnel annulus velocity during tunnel ventilation operations <i>P Sabapathy, C Biotto, E Bennett, Aurecon Group, Australia</i>	247
Can the fixed fire-fighting system protect tunnel final lining in case of a major fire event? <i>I Maevski, N Chen, Y Li, R Klein, Jacobs Engineering, USA</i>	263
Impact of platform edge doors on ventilation requirements of underground transit systems <i>A Golpaygan, N Eslaminasab, J Zhang, S Fiedler, J Habimana, Hatch, Canada</i>	275

Mathematical modeling of fires in double-track metro tunnel 287  
*A A Abashkin, A V Karpov, D V Ushakov, All-Russian Research Institute for Fire Protection (VNIIPO), Russia*

Flow reversal in case of fire in the proximity of the tunnel portal 299  
*R Gertl, J Mütterlein, D Stix, ILF Consulting Engineers Austria GmbH, Austria*

## FUNDAMENTALS, MODELLING

Automated coupling of standard one-dimensional and three-dimensional flow solvers for simulation of metro ventilation systems 317  
*Y Scott Shi, C Fleming, C Sejekan, E Wong, M Samimi, M Duckham, SNC-Lavalin Inc., Canada*

Full scale fire experiments for smoke propagation investigations in long rail tunnels 325  
*P Sturm, T Nöst, Graz University of Technology; J Rodler, D Fruhwirt, P Föbßleitner, FVTmbH Graz; T Thaller, J Kari, ÖBB Infrastruktur AG, Austria*

Critical velocity in inclined tunnels 339  
*L Jiang, M Creyssels, P Salizzoni, R Perkins, University of Lyon, CNRS UMR 5509 École Centrale de Lyon, INSA Lyon, Université Claude Bernard; A Mos, Centre d'Etudes des Tunnel, France*

Effect of meteorological conditions on smoke distributions in a railway tunnel 351  
*M Hieke, DB Systemtechnik GmbH, Germany*

Pressure drop caused by a fire in a tunnel 363  
*P Carlotti, Laboratoire central de la Préfecture de Police; P Salizzoni, University of Lyon, CNRS UMR 5509 École Centrale de Lyon, INSA Lyon, Université Claude Bernard, France*

Critical velocity – from pool fire to train fire 373  
*Q Zhang, GEODATA Engineering SpA, Italy*

SES software validation studies – is SES keeping up with the times? 389  
*S Fiedler, N Eslaminasab, A Golpaygan, J Habimana, Hatch Corporation, Canada*

Implementation of boundary conditions in a CFD model of a semi-transverse ventilation system 397  
*J Prince, J Alexander, M Tabarra, Arup, UK*

An experimental study of the interaction of a tunnel flow with an atmospheric boundary layer 411  
*T Kubwimana, University of Lyon, CNRS UMR 5509 École Centrale de Lyon, INSA Lyon, Université Claude Bernard and Centre of Expertise on Tunnels (CETU); P Salizzoni, P Méjean, M Marro, University of Lyon, CNRS UMR 5509 École Centrale de Lyon, INSA Lyon, Université Claude Bernard, France*

Thermophysical justification of new ventilation patterns for double-track subway tunnels in cold climate 427  
*S G Gendler, St. Petersburg Mining University; Eu A Savenkov, Open joint – stock company "LenMetroGiproTrans", Russia*

## **GUIDELINES, RISK ANALYSIS**

- Risk and reward in delivery of rail tunnel ventilation systems 443  
*M Gilbey, WSP; I Sweetland, YySS Ltd, UK; G English, Seattle Fire Department, USA*
- Risk assessment of fire emergency ventilation strategies during traffic congestion in unidirectional tunnels with longitudinal ventilation 457  
*B Kohl, O Senekowitsch, ILF Consulting Engineers, Austria; I Nakahori, T Sakaguchi, Sohatsu Systems Laboratory, Japan; A E Vardy, University of Dundee, UK*
- Transient aerodynamic analysis to support safe evacuation strategy for rail tunnels separated by a single wall 473  
*G Weingertner, H Cheong, J Alexander, M Tabarra, Arup UK*
- Benefits from longitudinal ventilation at fires in bidirectional road tunnels without emergency exits 487  
*R Brandt, HBI Haerter, Switzerland*
- Compartmentation for train passenger fire safety 499  
*K J Harris, R Moreno, WSP, USA*
- Risk-informed specification of passenger train design fires for tunnel ventilation system design 513  
*I Bowman, Mott MacDonald, Canada; D Tooley, Mott MacDonald, UK; P Sabapathy, Aurecon Group, Australia*

## **PROJECT PRESENTATION**

- Using a real time simulator in a large and complex road tunnel for time and cost savings 529  
*L Elertson, Swedish Transport Administration, Sweden*
- The Marmaray project – an intercontinental tunnel 543  
*I Sweetland, AVR / YySS Ltd; M Gilbey, AVR / WSP Ltd, UK; A Faik Ascı, DLH/YGM, Turkey*
- Ventilation and safety concept of the emergency stop station and the cross passages of the 33 km long Koralm rail tunnel 559  
*M Bacher, P Sturm, Graz University of Technology; D Fruhwirt, J Rodler, FVTmbH; H Steiner, J Sampl, ÖBB Infrastruktur AG, Austria*
- Ventilation of a geological disposal facility – Nuclear ventilation 575  
*D Abi-Zadeh, Arup; R Hardy, RWM, UK*

## **RESPONSE TO INCIDENT, TESTING OF SYSTEMS**

- Tunnel ventilation and emergency responders 593  
*G English, Underground Command and Safety, LLC, USA*
- Re-validation of airflow and tunnel air velocities in working tunnels in Delhi Metro Rail Corporation, India 607  
*A K Garg, L Kumar, S Arora, Delhi Metro Rail Corporation Limited, India*

Report on the collapse accident of the ceiling boards for transverse ventilation at the Sasago Tunnel 621  
*A Mizuno, Kogakuin University, Japan*

The development of an emergency tunnel ventilation strategy for the WMATA system 631  
*N de los Rios, Mott MacDonald; T O'Dwyer, S Russo, AECOM; P Petersen, WMATA, USA*

## RETROFITTING OF TUNNELS

Replacement of a jet fan tunnel ventilation system in an operational road tunnel 647  
*S Johnson, E Draper, D Ajewole, Mott MacDonald Ltd, UK*

Innovative upgrade of a transverse ventilation system to manage a 100 MW design fire 663  
*M Bilson, P Kumar, S Marsico, WSP, USA*

Validation of 3D turbulent CFD modelling of retrofitting works ventilation with experimental measurements for a rail tunnel 677  
*N A Tonello, Y Eude, Renuda, UK; E Béraud, SNCF RÉSEAU, France*

## THERMAL COMFORT IN UNDERGROUND FACILITIES

The impact of groundwater flow on tunnel heat transfer 695  
*J A Thompson, C J Graham, WSP, UK*

Air quality and long term thermal prediction in complex underground systems: application to the Grand Paris Express metro 711  
*L Agnese, Setec TPI; G Baudienville, Setec ITS; L Fournier, Egis Tunnel; B Soler, Société du Grand Paris, France*

Global assessment to confirm the need of tunnel cooling in modern automatic metro under very hot climate and way of optimization: application on the Doha metro 725  
*P Gosset, M Gourdache, S Vassoudevane, SYSTRA, France; E Musluoglu, QATAR RAIL, Qatar*

Application of Model-based Predictive Ventilation Control (MPVC) to misty haze prevention in tunnels 741  
*T Azuma, A Ichikawa, M Akaishi, East Nippon Expressway Company Limited, Japan; S Azuma, Y Sasagawa, Nippon Expressway Research Institute Company Limited; M Yuhara, AMEC Consultants Co. Ltd, Japan*

## AUTHOR INDEX