Tunnelling Update

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1 **Analysis of the behavior of DOT tunnel lining caused by rolling correction operation**
Shen S-L, Horpibulsuk S, Liao S-M, Peng F-E
Tunnelling and Underground Space Technology, 2009
Volume 24, Number 1, pages 84-90

One of the characteristics of the Double-O-Tube (DOT) shield machine is that it is easy to roll during construction. A rolling correction operation is necessary to correct this deviation laterally. One of the rolling correction operations is to grout in the opposite direction of rolled angle, resulting in a torque on the tunnel lining. Therefore, the surrounding environment and the internal force in the lining will be changed during the process of a rolling correction. In order to investigate the behaviour of the tunnel lining, the finite element method (FEM) is used to analyse the internal force in the lining caused by the rolling correction. The results indicated that rolling correction causes significant changes in the internal forces of the lining. An increase in rolling angle produces in the internal force with some points showing increase (the maximum can be five–six times) and with some points showing decrease. Therefore, it is reasonable to consider the redistribution of these internal forces in the lining design.

2 **Delayed failure at the Messochora tunnel, Greece**
Kontogianni V, Papantonopoulos C, Stiros S
Tunnelling and Underground Space Technology, 2008
Volume 23, Number 3, pages 232-240

Geodetic and extensometer data are used to shed light on the poorly known effect of delayed tunnel deformation. Four weeks after full section excavation and without any evidence of gradual strain accumulation, significant convergence of the tunnel walls and cracking of the lining occurred along a 36 metre long, weak rock zone in the Messochora tunnel in Greece. Deformation extended also to nearby, previously stabilised sections. This event is in variance with predictions of an exponential type pattern of decrease of strain accumulation based on theoretical and field evidence; it can only be explained if we accept that at the weak zone the tunnel was at a critical stability level, and that some small-scale interventions, which would otherwise have no effects, triggered a new phase of deformation transferred to nearby sections. Evidence from this tunnel indicates that, especially in weak rock zones, post-excavation stabilisation may only be transient, depending on the balance between stresses and the combined strength of the rocks/lining.

3 **Design fire curves for tunnels**
Ingason H
Fire Safety Journal, 2009
Volume 44, Number 2, pages 259-265

Various ways exist to represent a design fire curve for tunnels. These can include different fire growth rates or combinations of fire growth rates with constant levels of heat release rate (HRR) coupled to a decay period. This means that the curve has to be represented with different mathematical expressions for different time periods. A more convenient way is to describe the design fire curve with a single mathematical expression. This paper presents a new, single exponential, design fire curve with a constant maximum HRR. A presentation of available design curves is given as well.

4 **Developing air pollutant profiles using routine monitoring data in road tunnels: A note**
Mak KL, Hung, WT
Transportation Research Part D: Transport and Environment, 2008
Volume 13, Number 6, pages 404-411

A methodology is developed to convert gaseous pollutant concentrations collected at fixed monitoring points in tunnels to continuous concentration profiles. An instrumented car driven through a road tunnel is used to collect instantaneous vehicular exhaust concentration data. Regression analysis is used to compare the data obtained at fixed points in the tunnel in the same periods of time. It was found that the two sets of data were strongly correlated based on the relative slopes of the pollutant concentration profiles. There is also clustering by traffic volume.

5 **Engineering in a changing environment**
Australian Tunnelling Society
Australian Tunnelling Conference, 13th, 2008, Melbourne, Victoria, Australia

The proceedings of this conference cover a range of topics related to the challenges affecting underground engineering, such as environmental, technical, social and legal issues. The topics covered by the papers in these proceedings include: Australian tunnelling projects, the design and development of ground support, developments in tunnel lining, fire and life safety, geotechnical and hydrogeological developments, risk management, boring machine tunnelling and concrete segmental linings for tunnels and shafts.

6 **Experimental study of water mist fire suppression in tunnels under longitudinal ventilation**
Chen L, Zhu W, Cai X, Pan L, Liao G
Building and Environment, 2009
Volume 44, Number 3, pages 446-455

This paper studies water mist fire suppression under different longitudinal ventilation velocities in tunnels by small scale experiments. After a scaling study, two mist nozzles are used for suppressing crib fires under five ventilation speeds. The result demonstrates that fire suppression process can be divided into three stages including flame unitary restraining stage, surface flame extinguishing stage and inside flame suppression stage.

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7 **In-vehicle information systems to improve traffic safety in road tunnels**
Vashitz G, Shinar D, Blum Y
Transportation Research Part F: Traffic Psychology and Behaviour, 2008
Volume 11, Number 1, pages 61-74

To evaluate the effect of in-vehicle displays on driving safety in road tunnels, this paper addresses two questions with a driving simulation study: (1) can we still add information to in-vehicle displays without compromising safety? and (2) if information can still be added, how much information should added? The study concluded that safety related information displays can be added to improve safety even when some of their benefits are offset by increased distraction.

8 **Lessons learned from catastrophic fires in tunnels**
Carvel R
Proceedings of the Institution of Civil Engineers: Civil Engineering, 2008
Volume 161, Issue Special 2 – November, pages 49-53

Following the spate of tunnel fires which occurred in Europe at the turn of the century, the safety of European tunnels was assessed and found to be generally poor. Tunnel safety can only be improved if the lessons of past incidents are learned properly. This paper looks at some of the lessons learned from the Kaprun funicular tunnel fire of 2000; the King's Cross underground station fire of 1987; the Baku subway fire of 1995 and the Channel Tunnel fire of 1996. Some recent advances in technology, specifically state-of-the-art ventilation and water suppression systems, are also discussed. The 2007 fire in the Burnley tunnel in Melbourne, Australia is highlighted as an example of an incident where technology prevented the initial fire growing into a catastrophe.

9 **Mechanics of tunnelling machine screw conveyors: a theoretical model**
Merritt AS, Mari RJ
Geotechnique: 2008
Volume 58, Number 2, pages 79-94

A new theoretical model describing the total pressure gradient and torque in a tunnelling machine screw conveyor is proposed. The theory develops new equations relating the pressure gradient and torque to the screw geometry, the shear stresses acting in the screw conveyor, and the material flow. The equations are expressed in dimensionless form, allowing application to screw conveyors of different scales. The theory is validated against measurements from laboratory model screw conveyor tests with clay soils with varying properties and operating conditions. The theory successfully describes key features of the observed mechanics of the model conveyor operation, and accurately predicts the test measurements. The proposed theory provides insight into the fundamental mechanics of screw conveyor operations, and can be used in the design of tunnelling machine screw conveyors. The theory can also be applied to other forms of screw conveyors and extruders operating with plastic materials.

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10 **Mechanized tunnelling in urban areas: design methodology and construction control**
Guglielmetti E, Grasso P, Mahtab F, Xu S (editors)
Leiden, The Netherlands: Taylor & Francis, 2008

Internationally, the mechanised excavation of tunnels has intensified in the last two decades, as the number of tunnels being constructed for subways and railway underpasses increases. Hazards associated with the construction of tunnels in metropolitan areas include: poor ground conditions, water tables higher than the level of tunnels, and subsidence leading to damage to the existing structures on the surface. This book covers the application of technologies for achieving the stability of the tunnel and for minimising surface settlement and also discusses the issues of: accurate characterisation of the ground; rigorous assessment and management of risk from design to maintenance; the correct choice of a tunnel boring machine and a plan for the advancement of the tunnel; specific excavation procedures and real time monitoring of excavation parameters.

11 **Model predictive and fuzzy control of a road tunnel ventilation system**
Bogdan S, Birgmajer B, Kovacic Z
Transportation Research Part C: Emerging Technologies, 2008
Volume 16, Number 5, pages 574-592

In this paper the authors describe a control method for longitudinal ventilation of road tunnels. The proposed method consists of two main elements: (a) prediction of a number of jet-fans and (b) fuzzy control of pollutant levels. The method is tested by simulation and obtained results are compared with a method currently used in the ventilation system of the Ucka tunnel in Croatia.

12 **Performance of induction lamps and HPS lamps in road tunnel lighting**
Wencheng C, Zheng H, Liping G, Yandan L, Dahua C
Tunnelling and Underground Space Technology, 2008
Volume 23, Number 2, pages 139-144

The characteristics and performance of two tunnel lighting systems are investigated in this paper. Tunnel number 1 was installed with induction electrodeless fluorescent lamps and tunnel number 2 installed with high pressure sodium (HPS) lamps. It was found that the tunnel lighting system with induction lamps shows advantages in high brightness perception to drivers, good colour rendering, higher uniformity, better safety perception to drivers and low energy cost over the tunnel lighting system with HPS lamps.

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13 **Road-tunnel fires: Risk perception and management strategies among users**
Gandit M, Kouabenan DR, Caroly S
Safety Science, 2009
Volume 47, Number 1, pages 105-114

This paper describes a study where one hundred and fifty one road users (firemen, truck drivers, regular drivers, and driving-school students) filled out a questionnaire measuring their perceptions of risks and control in road tunnels, their awareness of safety and rescue devices, their level of anxiety, and their behavioural intentions in the event of a fire in a road tunnel. The results indicated a relationship between fire-risk perception, awareness of rescue and safety devices, and road-tunnel experience; a tendency toward comparative optimism (CO); an effect of perceived control on optimism; and a relationship between CO and awareness of safety devices. A significant interaction was found between tunnel users' anxiety level and their perceived control over the situation. The evacuation behaviours and coping strategies reported by the participants were far from reflecting the expected behaviours. Recommendations for a long-term prevention policy bearing jointly on beliefs, behaviours, improved information and warning systems are suggested.

14 **Theoretical and experimental study of external water pressure on tunnel lining in controlled drainage under high water level**
Wang X, Tan Z, Wang M, Zhang M, Ming H
Tunnelling and Underground Space Technology, 2008
Volume 23, Number 5, pages 552-560

To reduce environmental effects due to free tunnel drainage, a controlled drainage scheme is proposed in this paper for tunnels under high water level, for which there is no code provision for tunnel design. A suitable structure form is suggested and the distribution of water pressure on tunnel lining is studied by theoretical analysis, indoor test and field measurement. The study indicates that the grouting zone cannot reduce water pressure on lining with complete waterproofing. Only when the drainage measure is taken can the grouting zone be effective in reducing water pressure on the lining. It is also shown that while there is an optimum size for the grouting zone, an increase of the size of grouting zone may not unlimitedly reduce the water pressure on the lining.

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