Clear and present danger?

Underground rail travel is safer than ever, but the risk of fire still lurks in even the most modern infrastructures. Mosen's managing director **Dr Fathi Tarada** explains what must be done to keep on protecting passengers from harm in the tunnels.

Underground railway tunnels and stations are, without any doubt, generally safe. The vast majority of journeys made by passengers through the subterranean sections of mass transit networks in cities, as well as within long-distance mainline railway tunnels, are incident-free. However, the effects of any fires that do break out at of fires when they do break out in tunnels or at stations can be catastrophic.

The King's Cross fire in the London Underground in 1987 killed 31 and injured 100. More recently, the blaze at the funicular railway tunnel in Kaprun, Austria, 14 years ago, caused 155 fatalities, while the one at the Jungangno Station in Daegu, South Korea in 2003 claimed 192 lives.

Many lessons have been learned from these and other incidents: laws have been enacted, design standards updated and operational responses improved. However, engineers like me still face many challenges in designing underground railway systems with an adequately high standard of fire safety.

Provision of combustion-resistant rolling stock that is easily evacuated in an emergency is crucial. The recently published European standard, EN 45545, permits operators to specify engines and carriages of an appropriate fire-resistance category, including those destined for use in tunnels. The construction of the stock is a vital part of the effort to minimise the probability of a fire, to control the rate and extent of any combustion and to limit the impact of any incident on passengers and staff.

Dr Fathi Tarada
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Managing the blaze

Modern rolling stock is generally very resistant to fire. The three London tube trains bombed on 7 July 2005, for example, smouldered, but did not flash over. Smoke from those fires was therefore limited and the 39 fatalities were caused by the effects of the blasts, rather than from inhalation injuries.

Despite the improved fire-proofing of modern trains, many lines will have to operate with old rolling stock for many years to come, and this presents a significant risk. Tests undertaken by the SP research institute in Sweden on an old carriage indicated a peak heat release rate of 77MW, 13 minutes after ignition. Such a figure implies untenable conditions for passengers within a burning coach and would also threaten anyone within its immediate vicinity.

Even if the stock is specified as being highly fire-resistant, blazes may break out in 'imported' combustibles, such as on-board lorries that are being transported. The Channel Tunnel, for example, has suffered from four fires (in 1996, 2006, 2008 and 2012) from on-board vehicles during its 20-year service. In response, in 2011, Eurotunnel installed four firefighting stations to deliver a high-pressure water mist onto any burning trains. The open 'lattice' structure of the coaches carrying lorries enables the mist to be applied directly to any affected cargo. The use of fixed fire-suppression in a tunnel is, however, unique to the Channel Tunnel, due to special risks that apply to the structure. Other railway tunnels maybe only provided only with fire hydrants for use by the rescue services. Many older tunnels do not even have such facilities, and this represents a significant challenge to the fire brigade.

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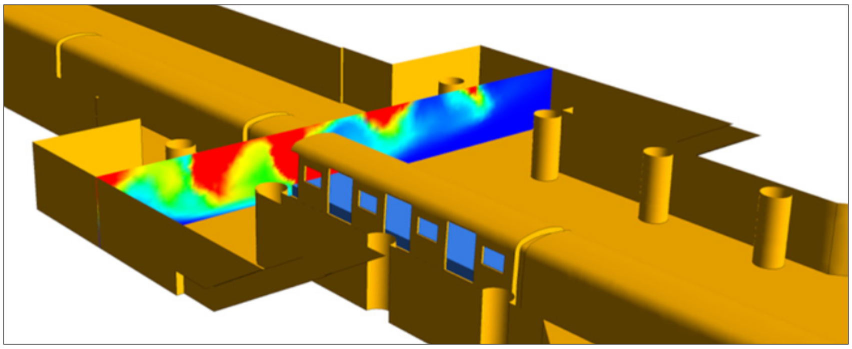
Ventilation is vital and must be provided to support the evacuation of passengers and the deployment of emergency services. Within running tunnels, airflow can be provided to blow smoke away from escaping passengers, allowing safe evacuation to an adjacent station or portal. However, removing people from tunnels can be slow and



Computational fluid dynamics can be used to visualise how smoke will spread in a station in the event of a train fire.

Full-scale fire-suppression test, simulating a fully loaded lorry.

hazardous, even if walkways are provided, so most railway operators plan to stop incident trains at a station, or outside tunnels, where evacuation can be effected more readily, and where quicker assistance can be provided.

If a burning train stops within an underground platform, the objective of any ventilation system should be to maintain safe and clear evacuation routes in order to enable rapid passenger escape. Many modern underground stations incorporate shafts at both ends of the platform to extract smoke. In my experience, however, the most effective arrangement for smoke control within stations involves a combination of mechanical smoke extraction with full-height platform screen doors.

The use of the latter is widespread in cities with warm climates (Dubai and Singapore, for example), where they are used to decouple the air-conditioned station environments from the warm tunnels. Even though parts of the glass screens may crack during a blaze, it is likely that a significant proportion of the screens will remain intact, protecting escaping passengers from the effects of smoke. The advantages screen doors provide in controlling fumes from train fires, as well as in reducing suicides, tend to be welcomed by rail operators.

Screen time

In more temperate climates, like those found in Europe, full-height platform screen doors are rarely installed. Partial-height units, such as those in London's Jubilee Line, are justified on the grounds of passenger safety (including suicide reduction), but these do not significantly assist in isolating platforms from smoke.

In designing station extraction systems, it is important to ensure that passenger escape routes, such as escalators and cross-passages, are kept clear of smoke. The design of such systems normally involves undertaking computational fluid dynamics (CFD) simulations that enable the visualisation of smoke movement in selected scenarios. Even though CFD is now a widely used engineering tool, its results are still only as good as the underlying assumptions made when specifying scenarios. Great care, therefore, is required in envisaging these hypothetical situations, as well as in designing robust ventilation responses that are able to deal with a wide range of foreseeable events.

Ensuring the safety of passengers in case of an underground incident is not only about the installation of appropriate systems, it is also about enabling an appropriate response from the railway operators and the emergency services.

In the UK, the Railways and Other Guided Transport Systems Regulations 2006 imposes a duty on operators to provide plans for action, alerts and information in case of crises. Such plans are meant to be developed and coordinated with other public bodies, including fire and rescue.

In 2012, the Department of Communities and Local Government of the UK in association with the chief fire and rescue adviser issued operational guidance on how to deal with railway incidents. However, such advice is generic and is meant to support the development of integrated risk-management plans with reference to the infrastructure in question. Such plans to ensure that the appropriate organisation, policy and procedures are in place for dealing with incidents.

The attractiveness of stations as potential targets for terrorism has also caused significant recent interest in the design of physical security measures, such as minimising the effects of explosions. In 2012 the UK's Department for Transport issued a guide for security in station design.

It deals with commissioning, planning, designing and managing new, or redeveloped stations. Physical measures, including hostile vehicle mitigation, CCTV, access control, lighting, perimeter fencing and detection are now implemented in major station constructions, such as London's Crossrail.

Although passenger transport is very safe, the challenge of maintaining that level of safety is onerous. Designers, operators, the emergency services and others need all the help they can get to meet that challenge. ■