Hot Issues in Fire Engineering

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An Update on Design Fires of Vehicular Tunnels

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Introduction

In vehicular tunnel fire safety design, very low design fires [1] were adopted as reported [2,3] years ago. This assumption has to be reviewed because the style of living, the traffic flow, passenger loading, the amount of combustibles carried by cars, cargo vans or light goods vehicles (LGV) and heavy goods vehicles (HGV), and the expectations of citizens have drastically changed. Therefore, all these changes pose great challenges to the fire safety provisions for vehicular tunnels. Further, fire technology has improved significantly in the past decades, making it easier to put out big fires. This is the right time to review the fire safety provisions for both existing tunnels and the forthcoming tunnel projects. Note that there are urban traffic link tunnels (UTLT) [4] in China. Some identified problems can also be solved by using the new experimental data on heat release rate upon burning different types of vehicles. In 2011, the design fire was increased to 100 MW for HGVs in NFPA 502 [5].

An updated review [6] on tunnel fire safety which was carried out by a fire research mentorship programme between Fire Services Department (FSD) and the Hong Kong Polytechnic University (PolyU) will be published very soon. The potential impact of having higher design fires on upgrading fire safety for existing tunnels and criteria for new tunnels will be discussed in the Continued Professional Development Programmes organized by PolyU. It is important to list the updates on the heat release rates of burning different vehicles and fuels in order to raise the public awareness of the fire safety of tunnels, particularly those with low design fires.

Updated Reviews on Heat Release Rate

With so many big vehicular fire accidents observed, researchers all over the world have reviewed [7,8] the heat release rates of burning different vehicles with varied amount of combustibles, and their findings [9-13] are shown in Table 1. Full-scale burning tests were carried out in order to study the heat release rate of burning cargo vans or LGVs in Taiwan [12], while similar tests were conducted in Europe to find out the heat release rates of burning HGVs.

Fig. 1 shows the heat release rate curves of burning a LGV in three tests conducted by Chuang et al. (2005-06) [12]. Fig. 2 shows the findings of Ingason and Lönnermark (2005) [13], a typical heat release rate curve of burning an HGV. It is clear that the heat release rate of burning any goods vehicles will give a much higher heat release rate than the old design value of 5 MW. Note that the design fire was as low as 2 MW for some bridge links [12].

Remedial Action

Traffic flow rate across vehicular tunnels and the combustibles carried by vehicles in this part of the world including Hong Kong has become much higher [2,3]. Both LGVs and HGVs carry large amounts of inflammable materials including plastic, wood and paper. Even smaller cars going to the airport might store combustibles goods up to 25 kg per passenger. If these vehicles catch fire, it will result in a heat release rate that is much higher than the low design value of 5 MW, which was used to determine the fire safety provision several decades ago [7] in the Far East as indicated clearly in the two figures and Table 1.

PolyU is working closely with FSD to solve this problem [6]. New specifications on fire service installations for railway systems are formulated [14]. All new tunnels must be designed in a way that they can cope with a design fire of higher heat release rate of at least 100 MW for HGV. Burning an LGV can give over 40 MW heat release rate. Upgrading the hardware fire safety provisions in old tunnels is impossible due to space limitation; the reconstruction works would also incur too high an economic cost. Operating longitudinal ventilation system might even increase the heat release rate while burning LGV or HGV [15]. A feasible approach is to implement a workable fire safety management scheme. For example, limiting the use of the tunnels by HGV in rush hours might be a solution. In some tunnels, such as the Shing Mun Tunnel in Hong Kong, HGVs and LGVs were driven at a high speed [16]. Speed check of HGVs and LGVs must be done more vigilantly to lower the occurrence of collisions.

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Table 1: A brief listing on updated results

Project	Vehicle burnt	Heat release rate	Sources
Eureka Project (Haack 1994)	Vehicle Van / Bus HGV	3 MW average 9 MW average 120 MW average	Reviewed by Kashef et al. (2012)
Benelux Project (Dutch Ministry of Transport 2002)	Van / Bus	5 MW average	
Runehamar Project (Ingason and Lönnermark 2003)	HGV	139 MW average	
LGV in Taiwan	Test 1: LGV 890 kg wood pallets Test 2: LGV 890 kg wood pallets Test 3: LGV 452 kg plastic barrels	23.38 MW peak 20.92 MW peak 47.47 MW peak	Chuang et al. (2005-06)

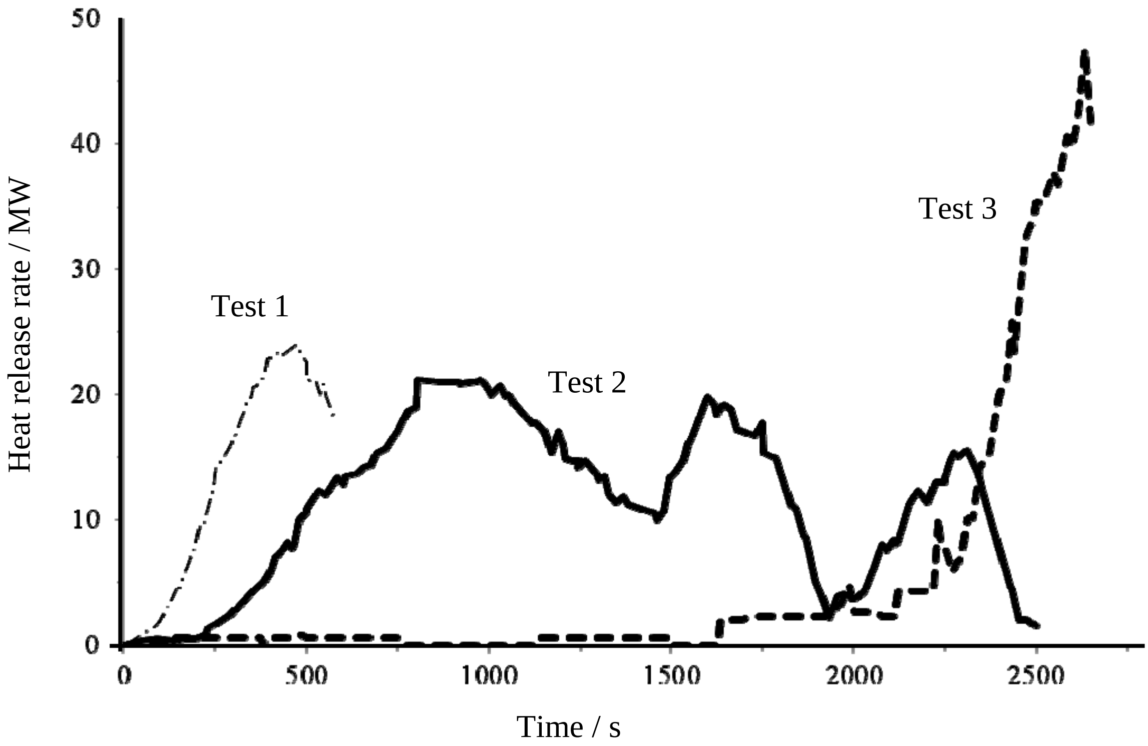

Fig. 1: LGV curves reported by Chuang et al. (2005-06)

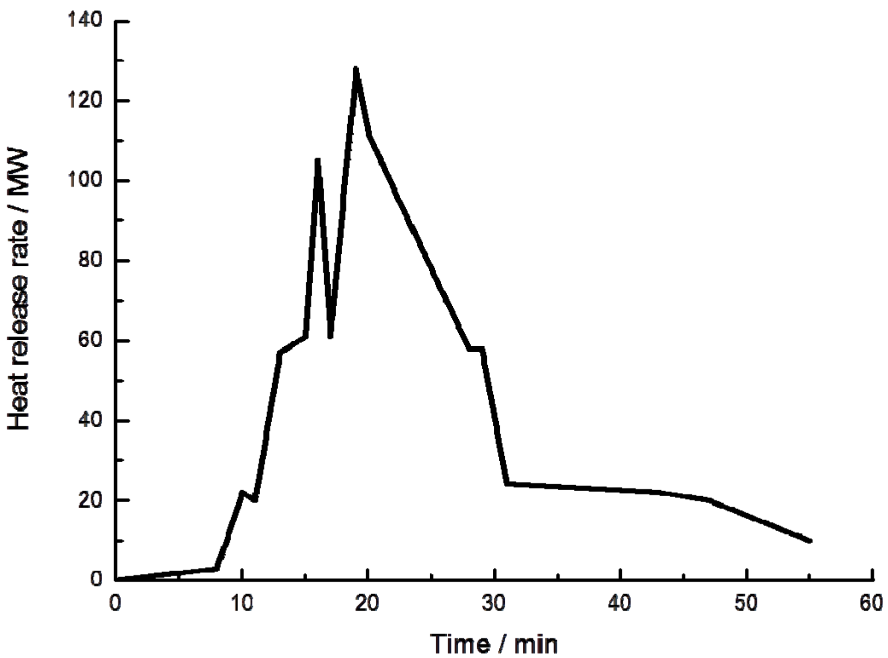

Fig. 2: An HGV curve reported by Ingason and Lönnermark (2005)