Fatal tram accident at Croydon – human factors investigation

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ABSTRACT

At about 06:07 hrs on Wednesday 9 November 2016, seven people lost their lives and 62 were injured when a tram overturned on a sharp left-hand curve in Croydon, south London. The tram was travelling at a speed of approximately 73 km/h as it entered the curve, which had a maximum permitted speed of 20 km/h. The Rail Accident Investigation Branch (RAIB) investigation focused on how the speed of trams is controlled, as well as issues linked to the design, operation and management of trams. This paper describes the findings associated with the driving of the tram, in particular why the driver did not apply sufficient braking for the curve. The RAIB concluded that the most likely cause was a temporary loss of awareness of the driving task during a period of low workload, which possibly caused a microsleep. It is also possible that when regaining awareness, the driver became confused about his location and direction of travel. Fifteen recommendations were made addressing these factors as well as wider aspects of safety and risk management.

KEYWORDS

Accident investigation, Croydon tram accident, tram operation

The accident

The accident occurred on the approach to Sandilands Junction in Croydon, where the tramway runs off-street (i.e., separated from the public highway). For just over 1 km prior to the curve on which the tram overturned, there is a broadly straight section of track with a speed limit of 80 km/h. The second half of this section is covered by three closely spaced tunnels, which end about 94 metres before trams reach the start of the curve. There is a 20 km/h speed restriction sign located close to the start of this curve, which is required because the curve has a radius of 30 metres.

The tram involved in the accident passed the gap between the second and third tunnels, about 340 metres from the 20 km/h sign, travelling at about 79 km/h. Although the driver normally began to brake at this point to comply with the curve speed restriction, he did not do so on this occasion.

About four seconds after this brake application, the tram exited the tunnels into darkness and heavy rain, travelling at about 78 km/h. One second later, the driver applied the service brake, around 57 metres from the 20 km/h sign. The tram had slowed to approximately 73 km/h as it entered the curve and then travelled around part of the curve before overturning, sliding a short distance on its side and then stopping close to the junction. The tram's emergency brake was not used.

Investigation & analysis

The RAIB found that the accident occurred because the driver did not apply sufficient braking before entering the curve. Although some doubt remains as to the reasons why, the RAIB concluded that the most likely cause was a temporary loss of awareness of the driving task during a period of low workload, which possibly caused a microsleep.

On reaching the tram's maximum speed of 80 km/h on the straight section and through the tunnels, the driver needed to do very little to control the tram's speed for about 49 seconds. This is the longest section on the whole tramway on which there is minimal need for any active control by the driver. An analysis of driver workload undertaken by the RAIB determined that this section presented one of the lowest levels of workload on the tram network. The investigation report (RAIB, 2017) noted that such situations can result in mental underload, a state in which attention to the task can be diminished (Young et al., 2015). The RAIB concluded that it was most likely that underload led to the driver losing awareness of the driving task on the day of the accident.

The investigation also considered whether the driver may have been fatigued. Underload can affect performance on its own, or it can trigger a microsleep – even in the absence of fatigue (Buckley et al., 2016) – or it can interact with fatigue to exacerbate the effects on performance (cf. Matthews & Desmond, 2002). The RAIB concluded that the shift pattern followed by the driver should not have caused an increased risk of fatigue on the morning of the accident, above the general fatigue risk factor of very early starts. However, it is possible that his sleep pattern could have led to a sleep debt, a situation which can increase the propensity to microsleep (Buckley et al., 2016).

It is also possible that, when regaining awareness, the driver became confused about his location and direction of travel. In reconstructing his situation awareness, the driver would have been partly dependent on external information cues in the environment. These were not strong or distinct enough to prompt the driver that he was heading towards the curve at Sandilands Junction.

The tunnels did not contain distinctive features which would alert drivers during darkness to their normal braking point. A single 20 km/h speed restriction sign was located at the start of the curve and neither this sign nor the curve itself were visible from the braking point during darkness. There was no sign to indicate to drivers where they should begin to apply the brake for the Sandilands curve; they were expected to know this from their knowledge of the route. When compared with standards applicable to road signs, the 20 km/h sign was less conspicuous than an equivalent road speed limit sign. Moreover, good practice in road design would have resulted in additional advance warning signs for the curve, and chevron signs to mark out the curve itself.

Impact & implications

The RAIB report made 15 recommendations. These included the need for technology to intervene if trams approach hazardous features too fast, or when drivers lose awareness of the driving task, as well as improvements to lineside signs taking account of the requirements for other road users. Other recommendations focused on the need for better understanding of the risk associated with tramways, fatigue management, regulatory activities and some aspects of safety culture.

References

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