RAIB

Rail Accident Investigation Branch

Rail Accident Report

Accidents involving a wheelchair rolling onto the track at Southend Central, 28 August 2013; and a pushchair rolling onto the track at Whyteleafe, 18 September 2013

Report 17/2014
August 2014

This investigation was carried out in accordance with:

- the Railway Safety Directive 2004/49/EC;
- the Railways and Transport Safety Act 2003; and
- the Railways (Accident Investigation and Reporting) Regulations 2005.

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Accidents involving a wheelchair rolling onto the track at Southend Central, 28 August 2013; and a pushchair rolling onto the track at Whyteleafe, 18 September 2013

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Summary

On Wednesday 28 August 2013 a wheelchair user and her carer were waiting at Southend Central station for the arrival of a train when the wheelchair started to roll towards the edge of the platform, and then fell onto the track. Although the passenger and her wheelchair were recovered to the platform before the train arrived, the passenger was seriously injured in the fall.

On Wednesday 18 September 2013, a mother and her two young children entered Whyteleafe station, near Caterham in Surrey. As the mother was purchasing a ticket from the ticket machine on the platform, the pushchair with baby strapped in started to roll away. The mother was unaware of this until it was too late to stop the pushchair rolling off the edge of the platform and onto the track. The baby suffered minor injuries in the fall.

The RAIB investigation into the accidents found that the platforms at both Southend Central and Whyteleafe stations sloped towards the railway. At the time of their construction there was no specific requirement for platforms to slope away from the railway.

The RAIB's investigation also found that the individuals in charge of the wheelchair and pushchair had not applied the brakes and had not noticed that the platform sloped towards the track. There was nothing to alert users of either station to the presence of the slope.

The railway industry had generally recorded previous incidents of a similar nature as due solely to errors by the individuals concerned. As a consequence, the industry had not recognised the part that sloping platforms had played in the incidents.

The RAIB has identified one learning point for the railway industry in relation to the importance of providing a means for station staff to contact signallers in case of emergency.

The RAIB has made four recommendations. One recommendation has been made to Network Rail and the train operators (who as 'Station Facility Operators' are responsible for the safety of passengers at most stations in Britain) in respect of improvements in their processes for managing the risk of wheelchairs or pushchairs rolling off platforms. Two recommendations have been made to Network Rail for work to be undertaken to improve industry's understanding of the role played by platform slopes in incidents and accidents and methods for managing the risk, and for improving intelligence on accidents and incidents where slopes on platforms may have been a causal factor. One recommendation has been made to the Association of Train Operating Companies on the provision of guidance on methods for managing the risk of wheelchairs or pushchairs rolling off platforms.

Introduction

Preface

1 The purpose of a Rail Accident Investigation Branch (RAIB) investigation is to improve railway safety by preventing future railway accidents or by mitigating their consequences. It is not the purpose of such an investigation to establish blame or liability.

2 Accordingly, it is inappropriate that RAIB reports should be used to assign fault or blame, or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

3 The RAIB's investigation (including its scope, methods, conclusions and recommendations) is independent of all other investigations, including those carried out by the safety authority, police or railway industry.

Key definitions

4 All dimensions in this report are given in metric units, except locations which are given in imperial units, in accordance with normal railway practice. Where appropriate the equivalent metric value is also given.

5 The report contains abbreviations and technical terms (shown in *italics* the first time they appear in the report). These are explained in appendices A and B.

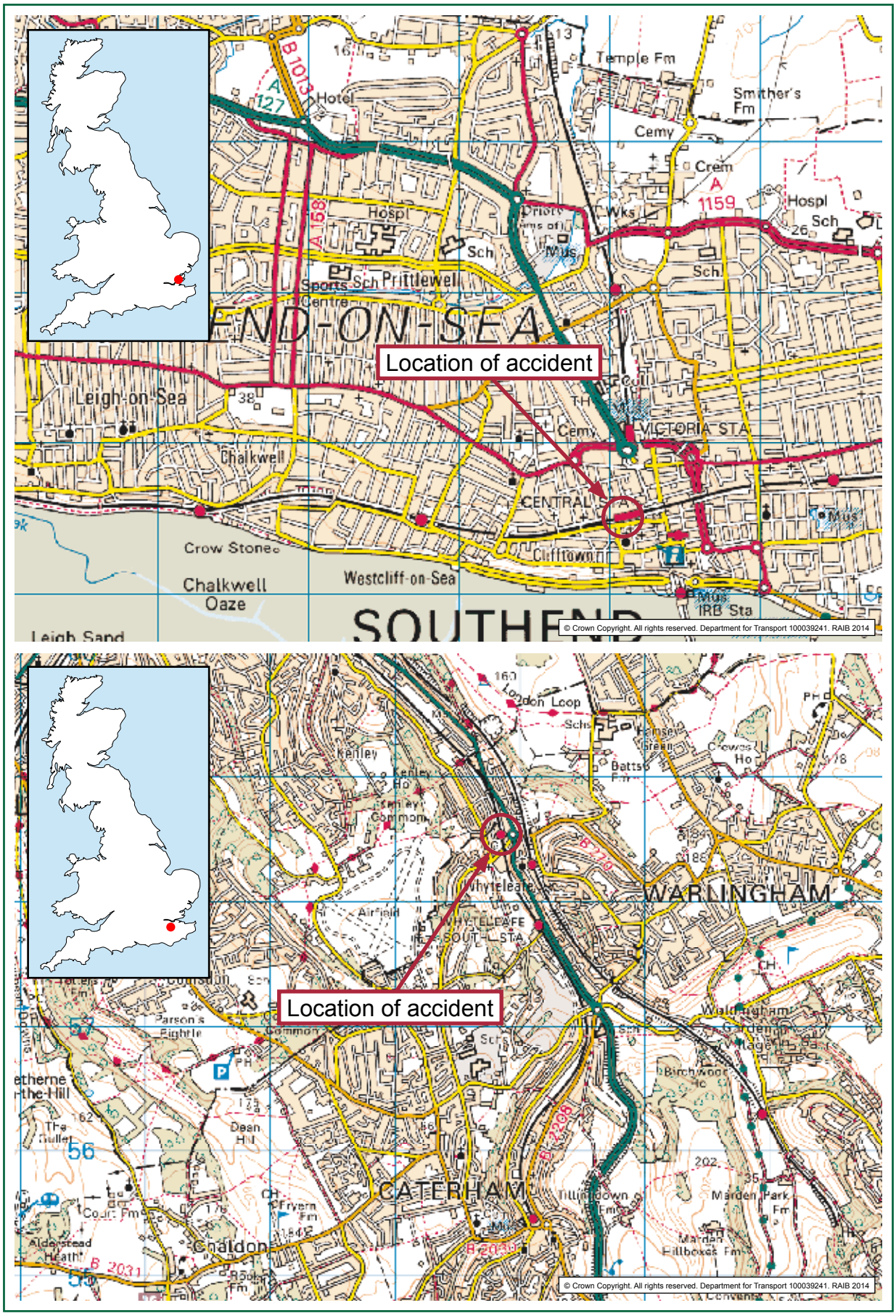


Figure 1: Extract from Ordnance Survey map showing locations of both accidents

The accidents

Summary of the accidents

6 In August and September 2013, two separate accidents were reported to the RAIB, one involving a passenger in a wheelchair and another involving a baby in a pushchair, both of which had 'rolled off' station platforms. The details of each accident are described in the following paragraphs.

Southend Central station: 28 August 2013

7 Shortly before 18:13 hrs, a wheelchair user and her carer were escorted onto platform 3 by a member of station staff. The carer, who was pushing the wheelchair, and the member of station staff awaited the imminent arrival of train 2B53, the 18:05 hrs Shoeburyness to London Fenchurch Street service, which was due to stop at Southend Central at 18:15 hrs. The carer did not apply the parking brake on the wheelchair, and before the arrival of the train the carer became distracted. Neither the carer nor the member of station staff noticed the wheelchair start to move slowly forward towards the platform edge (figure 2). The wheelchair and its occupant, who was strapped in, rolled forward approximately 2.6 metres before falling off the platform and onto the railway line. The wheelchair occupant sustained a fractured hip and shock.

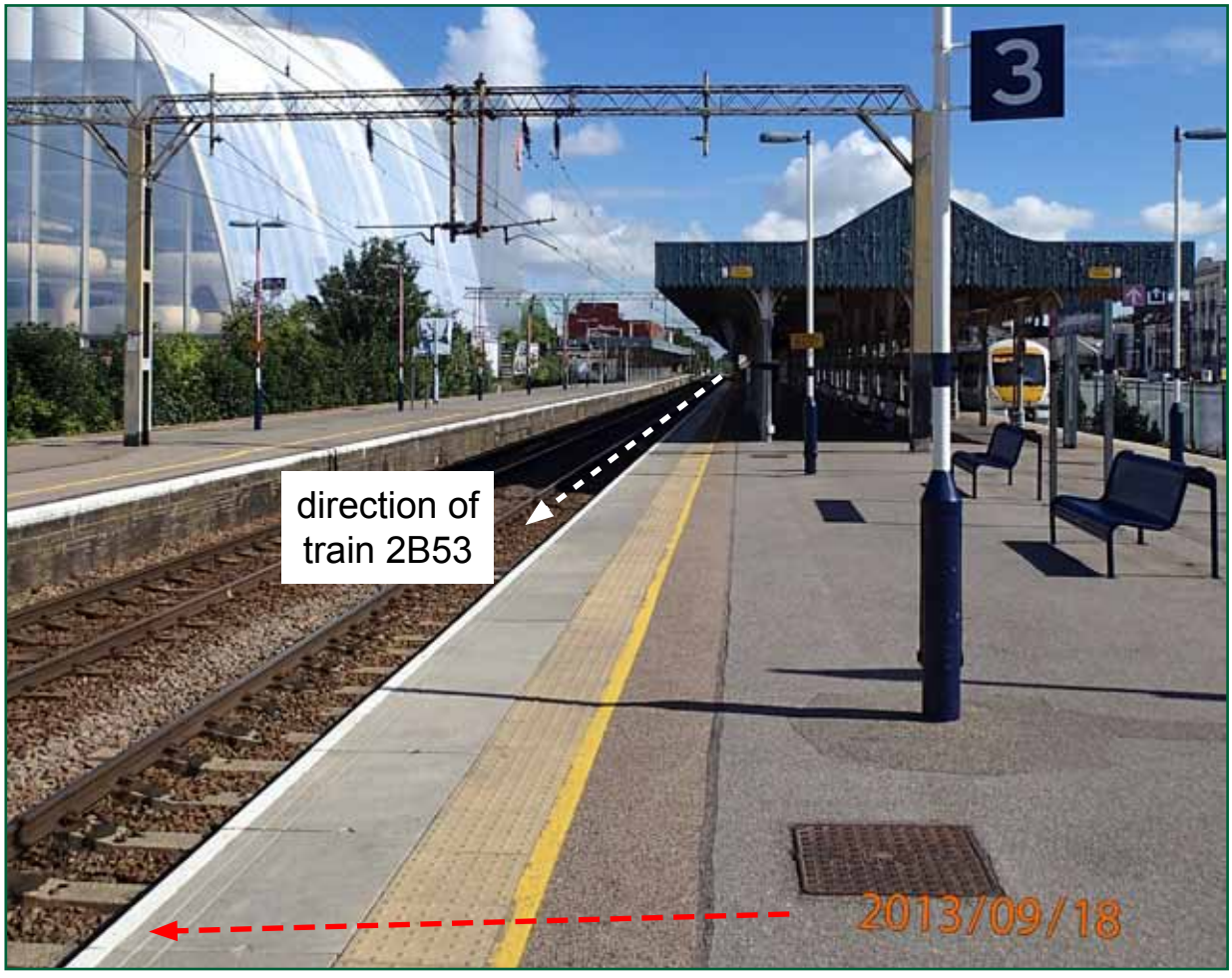


Figure 2: Southend Central station platform 3 showing position of the wheelchair when stationary, and its route (red dotted line)

Whyteleafe station: 18 September 2013

8 At 10:39 hrs, a mother and her two children (a baby strapped into a pushchair and a toddler walking beside her) walked onto platform 1, the London-bound side of Whyteleafe station, intending to travel on train 2G40, the 10:39 hrs Caterham to London Bridge service, which was on its way to Whyteleafe and due to arrive at 10:43 hrs. The mother stopped the pushchair while she operated the ticket machine on the platform, but did not apply the pushchair's parking brake. While her attention was focused on the purchase of her ticket, she was unaware that the pushchair had started to roll slowly along the platform and had then veered to the right and towards the platform edge (figure 3). The mother was alerted by the toddler to the pushchair's movement, and turned to see it rolling towards the track. She tried to reach it before it fell onto the track, but was unable to do so. The pushchair narrowly missed the electrified *conductor rail*. The baby suffered minor cuts and bruising.

Figure 3: Whyteleafe station platform 1 showing position of the stationary pushchair and its route (red dotted line)

Context

The stations

9 Southend Central station was opened in 1856. The station has four platforms, with the central pair (platforms 2 and 3) being through platforms used by trains running between London Fenchurch Street and Shoeburyness and the outer pair (platforms 1 and 4) being platforms with buffer stops for trains terminating at Southend Central. This means that platforms 2 and 3 are *island platforms* when adjoining platforms 1 and 4 respectively and conventional side platforms for the remainder of their length. The railway is electrified on the overhead 25 kV AC system and the signalling is controlled from Upminster signalling centre.

10 Whyteleafe station was opened in 1900. The station has two side platforms serving the lines between Caterham and London Bridge. The railway is electrified on the *third rail* 750 v DC system, and the signalling is controlled from Three Bridges signalling centre.

11 The platforms at Southend Central and Whyteleafe stations were originally designed with a 1 in 40 (2.5 %) slope, falling towards the railway (figure 4). This was to assist in the drainage of water from the platform onto the track. At the time of the accidents in 2013, each platform still had a slope falling towards the track.

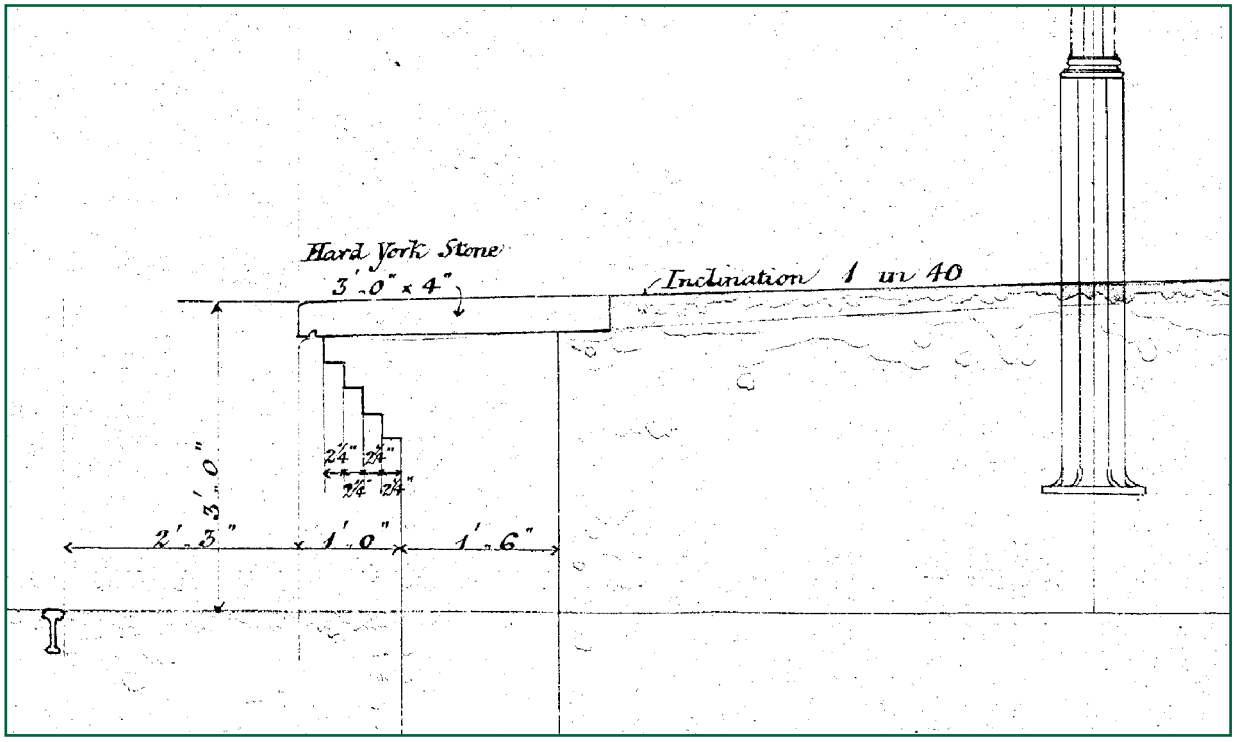


Figure 4: Southend Central station – cross-section drawing from 1899 showing 1 in 40 slope on the platform, falling towards the railway

Organisations involved

12 Network Rail owns and maintains railway infrastructure and stations on the national network. There are two principal types of station:

Managed Stations

The station buildings, platforms, and station furniture are owned and operated by Network Rail. Network Rail manages 17 major stations, including 10 London terminals

Leased or Franchised Stations

The freehold of the station, including its buildings, platforms and station furniture, is owned by Network Rail; but the station itself is managed by a *Train Operating Company*. The Train Operating Company holds the lease for the franchised station and is known as the *Station Facility Operator* (SFO). The vast majority of the 2,500 stations on the British main line rail network are leased by SFOs. The SFO is responsible for the station environment and for the safety of passengers using the station. The SFO is also responsible for the maintenance of station assets including signage, lighting, information systems, closed circuit television (CCTV) systems, help points and public address systems and the provision of customer services to passengers using the station.

13 The Train Operating Company c2c was the SFO for Southend Central station, and was also the employer of the train driver and station staff involved in the Southend Central accident. Southern was the SFO for Whyteleafe station and the employer of the booking office clerk. Network Rail, c2c and Southern freely co-operated with the investigation.

Staff involved

14 The member of platform staff present at the time of the accident at Southend Central station had been employed by c2c and its predecessors as a platform assistant since 1986. The RAIB found no evidence that the actions of this person contributed to the accident at Southend Central (paragraph 63). No member of staff witnessed the accident at Whyteleafe station.

External circumstances

15 The weather at the time of both accidents was dry and both occurred in daylight. There were no external circumstances relevant to either accident.

Sequence of events

Southend Central station

16 The lady in the wheelchair and her carer entered Southend Central station and the member of staff offered to escort them onto the train. The group moved along platform 3. The wheelchair was stopped mid-way along the island part of the platform (paragraph 9), facing the railway. The carer did not apply the wheelchair's *parking brake* and at some point he released his hold on the wheelchair. The carer and the member of station staff waited for the arrival of the London-bound service, but both were unaware that the wheelchair had started to roll forward towards the platform edge.

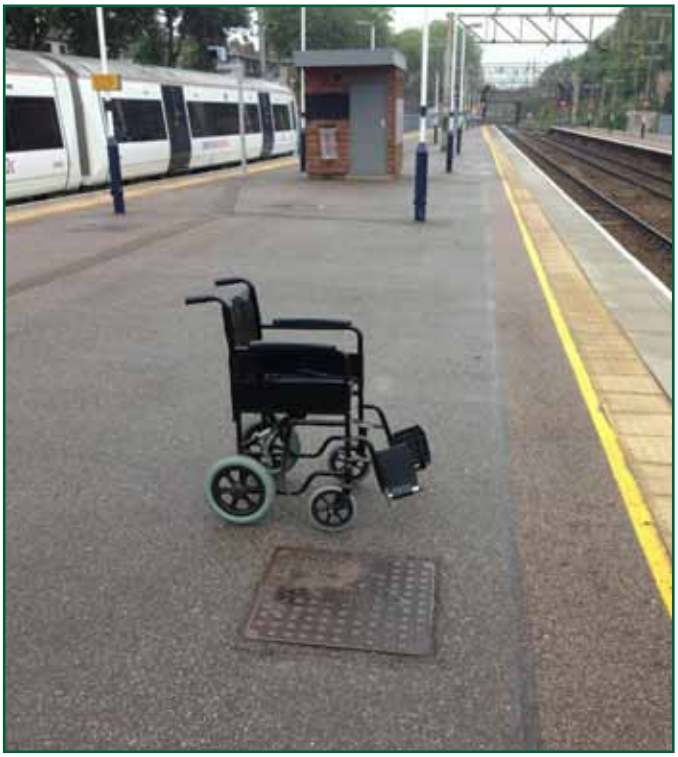


Figure 5: Photograph showing the position (reconstruction) of the stationary wheelchair on platform 3 at Southend Central station before it started to roll forward (image courtesy of c2c)

17 The wheelchair and its occupant rolled approximately 2.6 metres before falling off the platform onto the *up line* (figure 5). Members of public who were standing on the platform jumped down onto the railway, followed by the member of station staff (who was aware of the imminent arrival of train 2B53). The member of staff contacted the booking office clerk using his radio[1], advising him of the accident and requesting that the line be blocked.

18 The booking office clerk, on receiving the message, could not immediately contact the signaller. The telephone number for the signalling centre had been handwritten on an information poster in the booking office, but sunlight had faded the writing so that it was illegible. The booking clerk contacted the c2c service delivery centre co-located with the Upminster signalling centre and obtained the telephone number for the signaller. He called the signaller, but by then the train was entering the station.

19 Train drivers on the up line approaching Southend Central have a good view of the station. When the train driver was contacted by the signaller, he had reduced the speed of the train for the station stop and had already observed people on the track ahead. The train entered the platform travelling at low speed, and by that time everyone was clear of the line.

[1] c2c had provided staff with a mobile telephone to contact the signaller direct in the event of an emergency. However, the member of staff had left his mobile telephone in the concourse area. The delay in contacting the signaller did not affect the emergency response on this occasion, but might have done so under slightly different circumstances.

Whyteleafe station

20 The mother and her two children entered the platform at 10:39 hrs, intending to catch the 10:43 hrs train to London Bridge. She stopped the pushchair, and faced the platform ticket machine (with her back to the railway) to purchase a ticket. The pushchair was parked immediately to her right, parallel with the railway. The handbrake was not applied. As she purchased her ticket, she was unaware that the pushchair had started to roll along the platform.

21 The pushchair initially rolled slowly and parallel to the railway, but the incline towards the track caused it to turn right and run towards the edge of the platform (figures 6a and b). The older child, who was standing to her mother's left, saw the pushchair moving towards the railway and alerted her mother (figures 6c and d). The mother turned and ran, attempting to grab the pushchair, but she was unable to prevent it rolling off the platform and onto the track. The mother shouted for help before jumping down onto the railway track to retrieve her baby.

Figure 6: Closed Circuit Television (CCTV) images showing the accident at Whyteleafe station. The configuration of the CCTV system resulted in periodic gaps of a few seconds at a time when no recording was made[2].

22 The mother initially attempted to remove the baby from the pushchair. This was delayed by her having to untangle medical equipment for the baby on the pushchair. She became aware of the audible alarm for the nearby level crossing, which had started its closure sequence for the arrival of the train.

[2] The CCTV system at Whyteleafe was configured to maximise the recording of the entry/exit gates to the platform and this diminished the recording capability of other cameras, producing an interval of 6-8 seconds between successive images.

23 The baby and pushchair were recovered onto the platform by the mother, assisted by other passengers on the platform. Station CCTV evidence shows that the mother and other passengers were clear of the line at 10:40 hrs, two minutes before the arrival of the train. The driver of the train did not witness the accident and thus made no report to the signaller. The booking office clerk on duty at the station became aware of the noise on the platform and later contacted Southern's Duty Station Manager to inform her of the incident. A Network Rail Mobile Operations Manager subsequently attended the station to take photographs.

Events following the accidents

Southend Central station

24 British Transport Police (BTP) and Essex Ambulance Service attended the scene of the accident. The wheelchair occupant was taken to hospital for treatment to her injuries.

Whyteleafe station

25 Surrey Ambulance Service attended the accident and treated the mother for shock. Neither mother nor child was hospitalised.

The investigation

Sources of evidence

26 The following sources of evidence were used:

- witness evidence;
- data from the trains' on-train data recorders;
- station CCTV recordings;
- site photographs and measurements;
- historical records relating to platform work and alterations;
- Railway Group Standards relating to platform design;
- Network Rail company standards and guidance relating to new and altered platform design;
- RSSB[3] guidance documents relating to platform design;
- liaison with other National Investigation Bodies (NIB) worldwide in respect of similar accidents occurring in other countries;
- discussions with a representative from Passenger Focus / London Travelwatch regarding passengers' perspectives on sloping platforms; and
- information provided by the Department for Transport including policy and guidance documents relating to station accessibility.

Acknowledgements

27 The RAIB would like to thank and acknowledge the assistance of:

- First Great Western, First ScotRail, London Midland, First Capital Connect, South West Trains and the Association of Train Operating Companies (ATOC) for providing additional information on sloping platforms elsewhere on the national rail network and on their responses to previous roll-off incidents and accidents;
- Mumsnet.com and the 'Which' magazine technical department for assisting the RAIB's understanding of the awareness of sloping platforms among the general public and technical developments in pushchair design; and
- Imperial College London and University College London (UCL) who used their Pedestrian Accessibility Movement Environment Laboratory (PAMELA) facilities to undertake some specific research on slope angles and the propensity of wheelchairs to move on them, which is described in appendix F.

[3] A not-for-profit company owned and funded by major stakeholders in the railway industry, and which provides support and facilitation for a wide range of cross-industry activities. The company is registered as 'Rail Safety and Standards Board', but trades as 'RSSB'.

Key facts and analysis

Identification of the immediate cause[4]

28 **The wheelchair and pushchair involved in the accidents at Southend Central and Whyteleafe respectively were able to roll because the brakes were not applied and there were slopes present on both platforms.**

29 The people in charge of the wheelchair at Southend Central and the pushchair at Whyteleafe had not applied the brakes on their vehicles (the possible reasons for this are discussed in paragraphs 49 to 56). Initial testing undertaken by University College London (see appendix F) has shown that a vehicle such as a wheelchair or pushchair without its brakes applied can start to move on its own on a gradient of 1 in 28 (3.5%). Those tests were limited in scope and could not replicate all of the possible factors that might determine whether a vehicle without brakes would move or not, such as the ground surface conditions, orientation of the leading wheels and the weight of the occupant. The tests did not include gradients shallower than 1 in 28 (3.5%), so it is possible that this does not represent the shallowest gradient on which vehicles without brakes applied could roll.

30 The platform gradient in the area where the accident at Southend Central occurred varied from 1 in 40 (2.5%) at its shallowest to 1 in 8 (12.5%) at its steepest. At Whyteleafe, the initial movement of the pushchair involved was along the platform (and parallel to the railway). The gradient along the platform in the vicinity of the ticket machine (where the pushchair had initially been stopped) was 1 in 12 (8.5%), and the gradient towards the railway ranged from 1 in 20 (5%) to 1 in 14 (7%).

Identification of causal factors[5]

31 The accidents occurred due to a combination of the following causal factors:

- the platforms at the two stations sloped towards the railway (paragraphs 33 to 47);
- the individuals responsible for the wheelchair at Southend Central and pushchair at Whyteleafe had not applied the brakes and were not aware of the slope (paragraphs 49 to 59); and
- no risk mitigation measures had been implemented at locations where there were slopes on platforms towards the railway (paragraphs 60 to 67).

[4] The condition, event or behaviour that directly resulted in the occurrence.

[5] Any condition, event or behaviour that was necessary for the occurrence. Avoiding or eliminating any one of these factors would have prevented it happening.

Factors influencing the design and continuing existence of platform slopes

32 The platforms at the two stations sloped towards the railway. This was because:

- the slope was provided for drainage purposes when the platforms were built, (paragraphs 33 and 34);
- there was no subsequent requirement for platforms to be modified to provide a slope away from the railway (paragraphs 35 to 42); and
- no action was taken at Southend Central or Whyteleafe to eliminate the slope during works undertaken at each station (paragraphs 43 to 48).

Each of these factors is now considered in turn.

Slope design at the time of construction

33 **At the time of the construction of the platforms at Southend Central (1856, extended 1899) and Whyteleafe (1900) stations there was no specific requirement for platforms to slope away from the railway.**

34 The platforms on both stations were constructed with a 1 in 40 (2.5%) slope, falling towards the railway. This was probably intended to provide natural drainage from the platform towards the track, preventing the pooling of water on the platform and avoiding the need for any other form of drainage to be provided. Although prams and wheelchairs were in use at the time the stations were constructed, the hazard that slopes presented to them may not have been considered as the railways were not designed at that time with the accessibility requirements of the very young or disabled in mind. Early references to wheeled vehicles on station platforms mainly related to barrows, which were the responsibility of railway staff. Rules for their use appear in official documents from an early date. However, roll-off incidents did occasionally occur. An investigation by the Railway Inspectorate into a derailment at Wellingborough station in 1898[6] identified the immediate cause of the accident as the platform sloping towards the railway. A luggage trolley rolled forward onto the railway, where it was struck by a passenger train, which derailed with serious consequences. Other such 'luggage trolley and barrow' type roll-off incidents across the rail network were identified in the investigation report. The Wellingborough accident report recommended that platforms should be level, or slope away from the track. However the government requirements for new railway construction were not modified accordingly, and the recommendation seems to have been forgotten.

[6] www.railwaysarchive.co.uk/documents/BoT_Wellingborough1898.pdf.

Subsequent requirements relating to slopes on platforms

35 **There was no subsequent requirement for platforms to be modified to provide a slope away from the railway.**

Regulatory Guidance

36 In 1996, HM Railway Inspectorate (HMRI) published 'Rail Safety Principles and Guidance, Section 2b, Guidance on Stations'. Paragraph 24 (l) stated: '*All platforms should slope away from the adjacent track … island platforms should slope towards the centre and away from both adjacent tracks*'. This was the first time that the railway's safety regulator had specifically identified a need for the slope on a platform to fall away from the track. However, as is normal for many changes to standards having far-reaching effects on railway infrastructure, HMRI made no requirement for immediate changes to be made to bring existing infrastructure into compliance.

Railway Group Standards[7]

37 Reference to slopes on platforms was first included in Railway Group Standards in October 1993. Standard GC/TT0196, 'Station Platform Design Requirements' specified that the surfacing of the platform be constructed to provide a fall away from the rear edge of the platform *coper* (ie away from the track) at a gradient of between 1 in 20 (5%) and 1 in 80 (1.25%), with an optimum slope of 1 in 40 (2.5%)[8]. However, because Railway Group Standards also did not apply retrospectively, there was no requirement to alter existing infrastructure to make it compliant.

38 Although there was no requirement for any measures to be taken purely to bring gradients on platforms into compliance with Railway Group Standards or guidance from the regulator, there was an expectation that alterations to stations should contribute to improving safety overall, and significant alterations to platform infrastructure (major works) would trigger consideration of how compliance could be achieved. Railway Group Standard GI/RT 7016, 'Interface between Station Platforms, Tracks and Trains' and its associated Guidance Note, GI/GN 7616 'Station platform geometry', record this expectation and define an alteration as:

> *'The substantial lengthening or rebuilding of all or part of an existing platform and/or an associated structure, or renewal of station equipment or platform furniture, which provides a reasonable opportunity to bring the items concerned into conformity with the requirements of this document'.*

[7] Railway Group Standards mandate the technical or operating standards required of a particular system, process or procedure to ensure that it interfaces correctly with other systems, process and procedures. Network Rail produces its own company standards that detail how the requirements of the Railway Group Standards are to be achieved on its system.

[8] GC/TT0196 has been superseded and the current standard that addresses slopes on platforms is GI/RT7016, 'Interface between Station Platforms, Tracks and Trains'. The current version is Issue 5, introduced in June 2014. This now specifies a slope away from the track within the range 1 in 80 (1.25%) to 1 in 40 (2.5%) with a nominal value of 1 in 50 (2%) and brings the standard into line with current guidance from the Department for Transport. It does not apply retrospectively.

Network Rail company standards and practice

39 Network Rail does not have a company standard which defines clearly when a reasonable opportunity exists for existing platforms to be brought into compliance with Railway Group Standard GI/RT 7016. However, Network Rail's company standard NR/L3/CIV/162 'Platform extensions', which sets out a generic process for managing platform extension works and gives specific guidelines for certain types of work such as the provision and installation of tactile surfaces[9], commits Network Rail to looking for reasonable opportunities to make safety improvements. It indicates that a reasonable opportunity exists when an existing platform is rebuilt or resurfaced and more than 75% of the usable platform length is refurbished or altered. However, it also states that when an existing platform is extended, without any work undertaken on the existing platform, this shall not be considered a reasonable opportunity to install tactile paving.

40 Although the criteria described in paragraph 39 were only strictly applicable to the provision of tactile surfaces, witness evidence indicates that Network Rail's Route Asset Managers and project management engineers were using the principles described to determine whether proposals to undertake other types of work (ie not related to tactile surfacing) presented a reasonable opportunity to bring the whole platform into compliance with other aspects of Railway Group Standard GI/RT 7016. This meant that while platform extensions were designed to be compliant with the standard, no reasonable opportunity was necessarily seen to bring the existing adjoining platform into compliance.

Minor works undertaken by SFOs

41 The installation of station furniture and platform ticket machines is routinely undertaken by SFOs in consultation with Network Rail.

42 Evidence obtained from several SFOs indicated that when minor works (such as the installation of ticket machines) take place, the platform slope is not considered when the detail of the works is being developed. The work could involve the surface of the platform being disrupted and altered. As this is not considered in the risk assessment process applied by SFOs to the works, there is no recognition of the possibility that the works might create, or worsen, a slope towards the railway or that opportunities to mitigate an existing slope locally might be missed.

Platform works at Southend Central and Whyteleafe stations

43 **No action was taken at Southend Central or Whyteleafe stations to eliminate the slope as part of improvement works undertaken at each station. In the case of Whyteleafe it is possible that the slope on the platform was worsened by work carried out during 2010 and 2011.**

[9] Reference is made to the RSPG guidance '*still being valid as a reference document in the absence of other national safety legislation such as Building Regulations*'.

Works at Southend Central

44 Work was undertaken on platform 3 at Southend Central between 2005 and 2007, including installation of coping stones and tactile surfaces over the whole length of the platform and the refurbishment of the island part of the platform where it adjoins platform 4 (paragraph 9). Part of the refurbished platform sloped away from the track and towards a new central drain (marked in yellow at figure 7c). However, the works on the portion of the island platform where no central drain was installed (marked in red at figure 7c) resulted in the existing slope towards the track becoming steeper. The gradient falling towards the railway at the location where the accident occurred (figures 7a and b) increased from the 'as-designed' 1 in 40 (2.5%) to 1 in 28 (3.5%) with some sections being 1 in 8 (12.5%) (figure 8). The RAIB has been unable to establish why this happened.

45 The RAIB considers that the extent of the work undertaken on the platform at Southend Central (installation of coping stones and tactile surfaces throughout and the installation of central drainage) could have constituted a reasonable opportunity to bring the whole length of the platform into compliance with Railway Group Standard GI/RT7016, which would then have entailed removal of the falling slope towards the track.

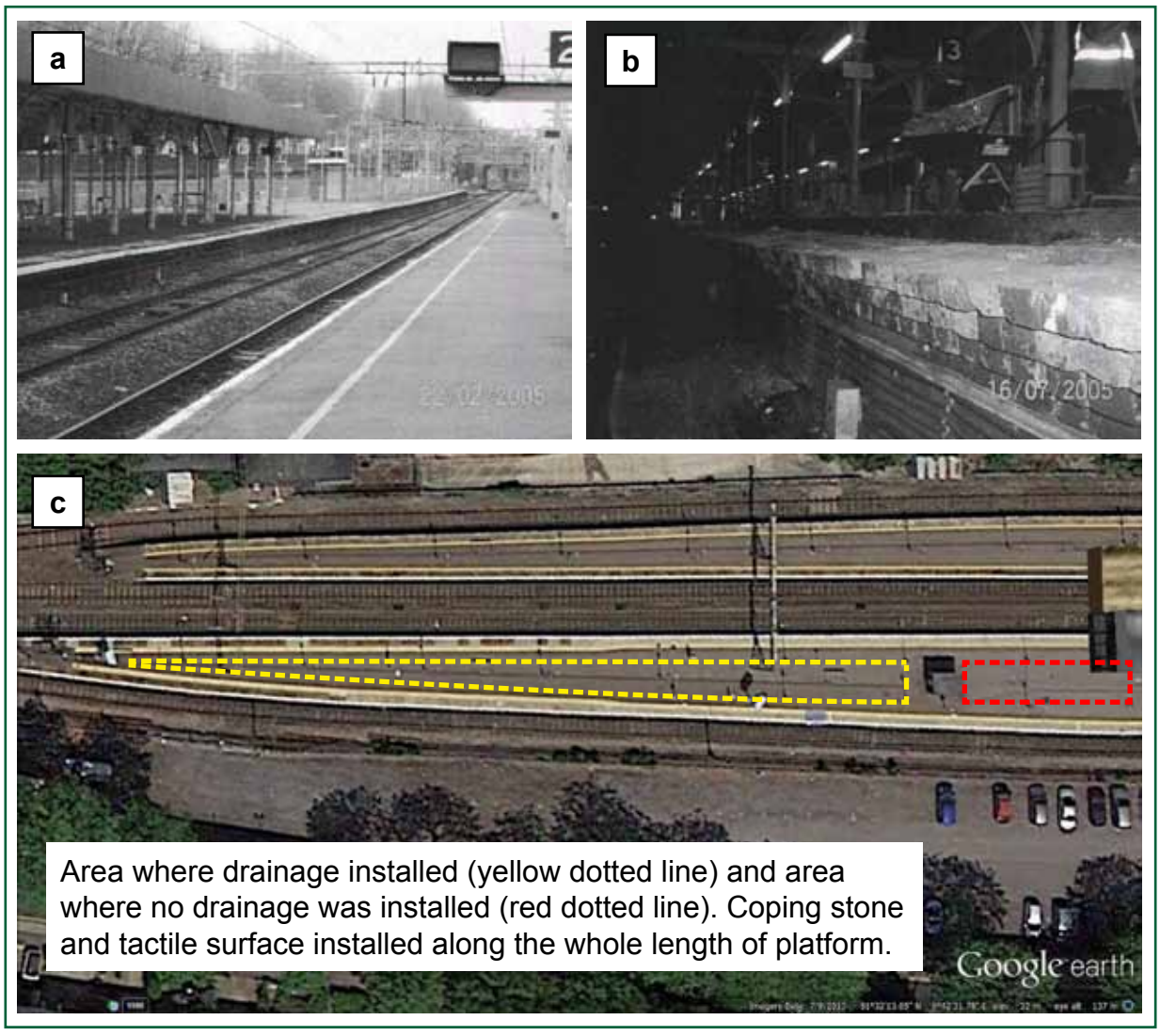


Figure 7: Refurbishment work undertaken on platform 3 (a and b) at Southend Central station and Google Earth image

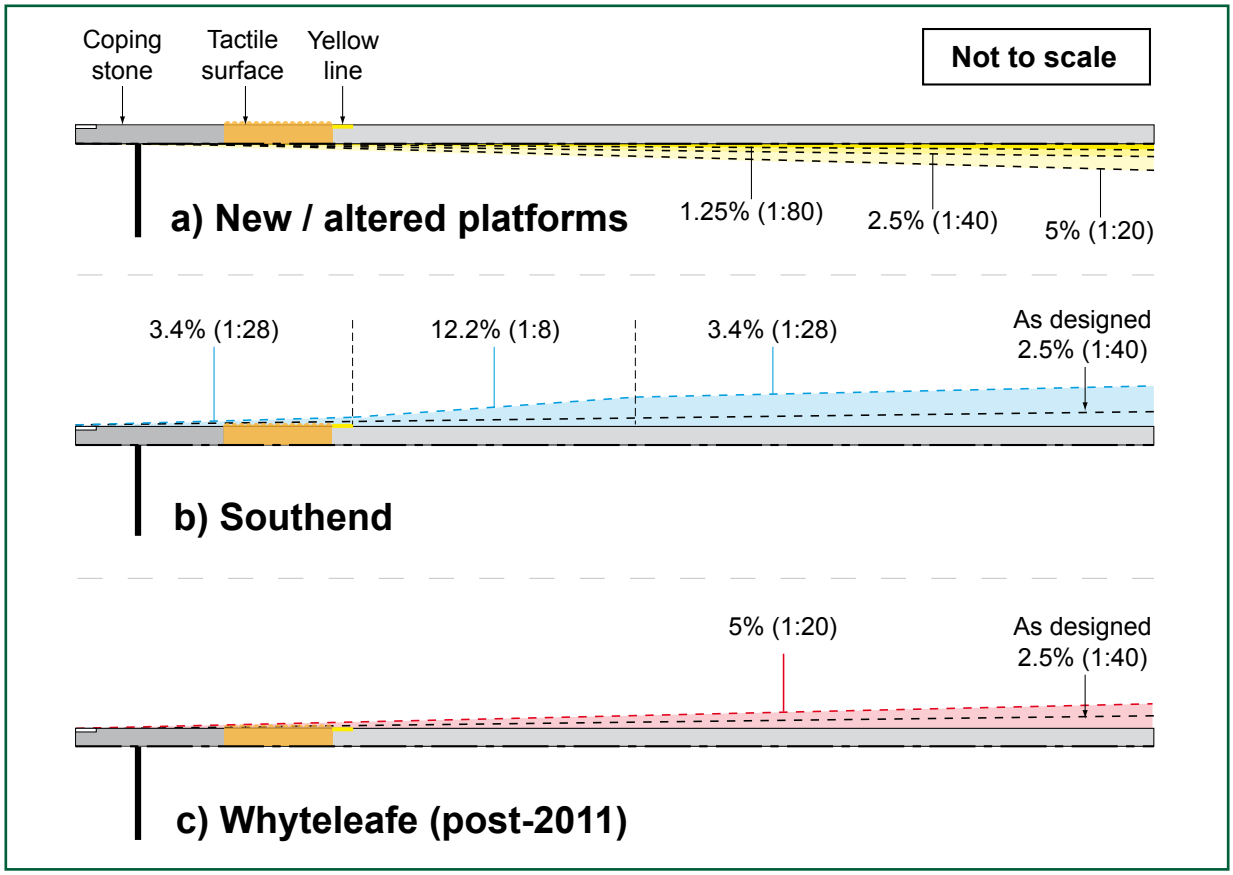


Figure 8: Diagrams showing standard gradient against gradients at Southend Central and Whyteleafe stations

Whyteleafe station

46 During 2010 and 2011 refurbishment work to the platform surface and coping stones was undertaken at Whyteleafe station. The health and safety file for this project noted the current standards which should be applied when undertaking work to the platform edge design. A decision was recorded on the file not to install drainage on the platform and that the '*cross falls* were to remain' (this meant that the platform would continue to slope towards the track). The decision appears to be consistent with Network Rail's guidance existing at the time on what constituted a reasonable opportunity to bring the platform into compliance with Railway Group Standards.

47 The RAIB considers it possible that the work at Whyteleafe resulted in the gradient towards the railway increasing from the originally designed 1 in 40 (2.5%) to around 1 in 20 (5%) at the location where the accident occurred. In other areas the platform sloped at 1 in 14 (7%) towards the railway (figure 8). The RAIB has been unable to identify any other works on the platform that could have caused the change in gradient.

Liaison between Network Rail and the SFOs following works at Southend Central and Whyteleafe

48 Network Rail's company standard NR/L2CIV/003 'Engineering Assurances of Building and Civil Engineering Works' states that when any proposed work affects a station leased by a train operating company as SFO, Network Rail shall request the train operating company's comments on the works. Network Rail's health and safety files relating to the work at both Southend Central and Whyteleafe show Network Rail had complied with this requirement and the SFO had formally accepted the completed work by signing a 'hand back certificate'. In neither case did Network Rail or the SFO identify the risk associated with the increase in gradient towards the railway.

The actions of the persons in charge of the wheelchair and pushchair

49 **In both accidents, the person in charge did not apply the brakes when they arrived on the platform, and they did not initially realise that the wheelchair/ pushchair had started to roll away.**

50 Post-accident tests showed that the brakes on the wheelchair involved in the Southend Central accident, and the pushchair involved in the Whyteleafe accident, were effective when applied. A reconstruction at the site of the accident at Southend Central undertaken by c2c and British Transport Police confirmed that the wheelchair involved (in loaded and unloaded condition) moved forward without any force being applied by the occupant or a person at the rear of the wheelchair (there was no equivalent test undertaken at Whyteleafe).

51 The people in charge of the wheelchair at Southend Central and the pushchair at Whyteleafe both stated that they had not applied the brake because they were not aware of the slope and that they had not initially realised that the roll away was occurring. This was probably due to a combination of one or more of the following factors:

- the fact that the slope was not apparent did nothing to challenge the expectation of the individuals concerned that the platform would be level (paragraphs 52 to 56);
- they may have been distracted (paragraphs 57 to 59); and
- there was nothing (for example, signs or announcements) to alert them to the presence of a slope (paragraphs 60 to 64).

The slope was difficult to see

52 **The fact that the platform slope was not apparent did nothing to challenge the expectation of the individuals concerned that the platform would be level.**

53 The station environment provided no visual cues to the individuals concerned that a slope existed. The RAIB's visual inspection of Southend Central station confirmed that the slope was not immediately obvious. The slope at Whyteleafe was more visible, but the RAIB considers that it would probably not have been apparent unless someone was actively looking for it (figures 9 and 10). The absence of a conspicuous slope did nothing to challenge the expectation of the people involved that station platforms would be level; it did not occur to them that significant slopes would be present. There was no signage to indicate otherwise (discussed later at paragraphs 60 to 64).

54 A person's perception of slope is prompted either by optical input (eyes) and/or the *proprioceptive* input channels within the human body (nerves and skeletal frame) recognising a geographical slope or slant. It is not known which input channel is more sensitive, or what the trigger point is for each one. In research 'slant' is defined as 'optical' or 'geographical'.

Optical slant

55 An individual's interpretation of slant is affected by their perception of the orientation of the surface they are standing on relative to the objects and structures within their line of sight. An individual's perception of optical slant will vary as their line of sight changes. The nature of the intersections between the structures in their line of sight affects how easy it is to identify slant; it is easier to see slant where there is a rapid change in angle or intersection (figures 11 and 12). Other than the ticket machine at Whyteleafe and a station lighting column at Southend Central, there were no structures intersecting the platform surface in the immediate vicinity of the places where the accidents happened. The lack of intersection with the platform surface would have made the optical identification of the slope more difficult.

Figure 9: Southend Central station

Figure 10: Whyteleafe station

Figure 11: Ashtead station

Figure 12: Andover station

Geographical slant

56 Conscious proprioception of balance varies from person to person. It is possible that an individual's awareness of geographical slant may be heightened when pushing a wheelchair or pushchair, as the direction of the slant may be transferred through the wheels and frame of the transport to the person pushing it. However, there are other factors that might affect an individual's predisposition to notice relatively minor slants, including their own levels of stress and anxiety and other distractions such as noise. It is not possible to know whether these factors affected the perception of the two individuals involved in the accidents, but if they did, they might help to explain why neither identified the slope on the platforms at Southend Central and Whyteleafe.

Distraction

57 **The individuals in charge of the wheelchair at Southend Central and the pushchair at Whyteleafe were, for different reasons, distracted.**

58 The carer involved in the Southend Central accident believed that he had control of the wheelchair. He could not explain why it had started to roll forward, but stated that he had become distracted, and this was the reason why he had not applied the handbrake on the wheelchair and had released his hold on it.

59 The mother involved in the accident at Whyteleafe station said that she had expected the platform to be level. She considered that a station platform was a different environment from a pavement next to a busy road, where she would normally hold on to her pushchair at all times. She had not applied the hand brake on the pushchair while she was buying a ticket from the platform ticket machine because the pushchair was in close proximity, facing along the platform (parallel to the platform edge) and she considered it to be safely away from the railway. Although she had been distracted while she used the ticket machine, she had not considered that there was any danger.

Management of risk at stations

60 **There was nothing to indicate to passengers at Southend Central or Whyteleafe stations that the platforms sloped towards the track.**

61 Station staff employed by Network Rail (managed stations) and SFOs (leased stations) inspect their stations regularly. Network Rail's company standard NR/SP/CIV/087 'Management of Existing Buildings and Station Structures' (2004) defines the requirements for the management of existing buildings and station structures on, over or under Network Rail's infrastructure to ensure safety is not compromised as a result of the condition, use or location of the building or structure. The evaluation section within the document outlines the various areas and hazards to be considered. This includes the station platform and the aerodynamic effects of trains passing through the station. However it does not recognise the risk from a platform slope falling towards the railway and therefore no mitigation measures are considered.

62 Every four to six to weeks staff employed by the SFO are required to visit and inspect stations under their management. The RAIB consulted with several SFOs and identified that the visual inspection process and checklists focus on the condition of the structures on the station and the condition of the platform surface. The SFOs' processes did not include the inspection of surfaces in respect of slopes.

63 The RAIB's discussions with other SFOs identified that the circumstances found at Southend Central and Whyteleafe were not unique to those two stations. Network Rail and the SFOs had not recognised the risk from a runaway wheelchair or pushchair on station platforms, and do not currently know the point at which a slope towards the railway becomes a hazard. No training and guidance was given to station staff to enable them to provide advice about the specific hazard of 'roll aways', and to emphasise the importance of applying the brake on pushchairs or wheelchairs in areas close to such features as ticket machines and shops/kiosks where passengers may have to release their hold on the chair.

64 Signs are used as a measure for controlling ongoing risk, and the type and location of a sign can help to prompt passengers to take appropriate action such as applying the brake. Although there were no signs to make the travelling public aware of the hazard of sloping platforms at Southend Central and Whyteleafe stations, it cannot be known for certain whether a sign, pictogram or surface transfer on the platform would have been seen or, in the case of pictograms, understood by the individuals involved in the two accidents. It is also not known whether such a sign would have resulted in either of them taking appropriate action.

Identification of underlying factor[10]

Accident and incident reporting

65 **Incidents and accidents in which wheelchairs or pushchairs had rolled off platforms had been reported in accordance with Railway Group Standards, but the events were not usually subject to detailed investigation and often solely attributed to user error, or wrongly classified. This resulted in a lack of awareness in the industry about the extent of the risk.**

66 Events involving roll-off type accidents have been reported to SFOs and Network Rail for many years. Since 2001, details of such incidents have been recorded on the industry's Safety Management Information System (SMIS). The RAIB identified a number of roll-off incidents that took place between 2001 and 2013 (appendix E and paragraph 71), and noted that only one of these incidents had resulted in the SFO identifying the infrastructure as a possible causal factor. In this case the SFO installed a sign warning passengers about the sloping platform (figure 13). Having identified the hazard at one location, the SFO did not take any action to identify if the hazard existed elsewhere.

[10] Any factors associated with the overall management systems, organisational arrangements or the regulatory structure.

Figure 13: Signage installed at Barrhead station (image courtesy of First ScotRail)

67 The RAIB also identified that some roll-off events had been classified as unlawful trespass or, in one case where a train had stopped before striking a pushchair on the track, as a 'train stopped short' incident. The contribution from the platform slope falling towards the railway had not been recognised and the immediate causes of the incidents were routinely classified as 'lack of supervision', or 'passenger behaviour' (these would have been factors in the incidents, but are unlikely to have been the only factors relevant to all incidents). Had consideration been given to the reasons why the incident had occurred, beyond the perceived error by the individual in charge of the pushchair or wheelchair, the platform slope, and any nearby higher risk areas (eg shops/kiosks and platform ticket machines where passengers may have to release their hold on a wheelchair or pushchair and are possibly distracted by the task in hand) might have been identified. The absence of a detailed investigation into the incidents resulted in the industry being unaware of any problem with slopes on platforms.

Observations[11]

Response to the emergency at Southend Central station

68 The Station Assistant at Southend Central station did not contact the signaller immediately, as he did not have his mobile telephone with him. In any case, the number for the signalling centre had not been programmed into the phone. The member of staff instinctively jumped down onto the track to assist other passengers helping the injured lady. If he had had his phone with him, and the signaller's contact number had been programmed into it, he would have been able to contact the signaller immediately to stop all trains, thus ensuring that it was safe to go onto the track and providing protection for those already there.

[11] An element discovered as part of the investigation that did not have a direct or indirect effect on the outcome of the accident but does deserve scrutiny.

Design of pushchairs and wheelchairs

69 In the course of this investigation the RAIB has observed that neither the wheelchair nor the pushchair involved in the two accidents had brakes that applied automatically when the carer released their hold on the handle (such an arrangement is often found on airport luggage trolleys, for example). Although such a feature would mitigate the risk of rolling away, it would be difficult to implement for most wheelchairs given the need for the user to move the wheelchair independently of a helper. Although this is not a consideration for pushchairs, it appears that there are relatively few models available with brakes that operate in this way. There is no requirement in the relevant British Standard, BS EN 1888:2012, 'Child Care Articles. Wheeled Child Conveyances. Safety Requirements and Test Methods', for pushchairs to be equipped with a brake that applies automatically when a carer releases their hold on the handle.

Other causes of wheelchairs or pushchairs rolling onto the track

70 This investigation has focused on two accidents involving a wheelchair and a pushchair rolling onto the track because the brakes were not applied and there were slopes on the platform towards the track. However, there are potential causes other than platform slopes which might result in wheelchairs or pushchairs rolling away, such as gusts of wind and being knocked into by people or luggage. Turbulence and the aerodynamic effects of passing or arriving/departing trains can also cause wheelchairs or pushchairs to move if brakes are not applied. On 23 July 2014, a pushchair that had been left in a cross passage linking the two platforms at Goodge Street underground station in London was sucked onto the track by the aerodynamic effect of a train departing from one of the platforms. Fortunately, it fell onto the track behind the departing train. It is important that carers understand the importance of applying brakes to wheelchairs or pushchairs whenever they are stationary on or near platforms.

Previous occurrences of a similar character

71 The investigation found that there have been three wheelchair and twelve pushchair incidents associated with roll-off type events recorded on Britain's main line railway network since 2001. The RAIB also identified three publicised pushchair incidents that occurred in Australia, and one in the United States of America where the infrastructure (sloping platform) was identified as a causal factor. Descriptions of the events are included in appendix E.

Summary of conclusions

Immediate cause

72 The wheelchair and pushchair involved in the accidents at Southend Central and Whyteleafe respectively were able to roll because the brakes were not applied and there were slopes present on both platforms (**paragraph 28**).

Causal factors

73 The accidents occurred due to a combination of the following causal factors:

a. The platforms at Southend Central and Whyteleafe sloped towards the railway due to the following factors:

- Many platforms had been designed with a slope towards the railway in order to provide natural drainage of surface water onto the track, and at the time of their construction there was no specific requirement for them to slope away from the railway (**paragraph 33, no recommendation**).
- There was no subsequent requirement for the platforms to be modified to provide a slope away from the railway (**paragraph 35, Recommendation 1**).
- No action was taken at Southend Central or Whyteleafe stations to eliminate the slope as part of the improvement works undertaken at each station. In the case of Whyteleafe it is possible that the slope on the platform was worsened by work carried out during 2010 and 2011 (**paragraph 43, Recommendation 1**).

b. In both accidents, the person in charge did not apply the brakes when they arrived on the platform, and they did not initially realise that the wheelchair/pushchair had started to roll away (**paragraph 49, Recommendations 2 and 3**).

c. The individuals responsible for the wheelchair at Southend Central and pushchair at Whyteleafe were not aware of the slope. This may have been due to one or more of the following factors:

- The fact that the platform slope was not apparent did nothing to challenge their expectation that the platform would be level (**paragraph 52, Recommendations 2 and 3**).
- They were, for different reasons, distracted (**paragraph 57, Recommendations 2 and 3**).
- There was nothing to indicate to passengers at either station that the platforms sloped towards the track (**paragraph 60, Recommendations 2 and 4**).

Underlying factor

74 Incidents and accidents in which wheelchairs or pushchairs had rolled off platforms had been reported in accordance with Railway Group Standards, but the events were not usually subject to detailed investigation and often solely attributed to user error, or wrongly classified, resulting in a lack of awareness in the industry about the extent of the risk (**paragraphs 65 to 67, Recommendation 4**).

Additional observations

75 Although not directly linked to the causes of the accidents on 28 August 2013 and 18 September 2013, the RAIB observes that:

a. If the member of staff involved in the accident at Southend Central had had his mobile phone with him with the number for the signaller programmed in, he would have been able to contact the signaller immediately to stop all trains before going onto the track (**paragraph 68, see also paragraphs 76 and 83**).

b. Neither the wheelchair nor the pushchair involved in the two accidents had brakes that applied automatically when the carer released their hold on the handle. Although such a feature is probably impracticable for most wheelchairs, there are very few pushchairs available with brakes that operate in this way (**paragraph 69, see also paragraph 82**).

c. There are causes other than platform slopes which might result in a wheelchair or a pushchair rolling away if its brakes have not been applied (**paragraph 70, Recommendations 1 and 3**).

Actions reported as already taken or in progress relevant to this report

c2c

76 c2c has reported that it has:

a. issued a 'Notification of Serious Incident' poster to all c2c stations to brief station staff on the circumstances of the accident and highlight the actions to be taken in the event of staff either having to stop a train in an emergency or make contact with the signaller before going onto the track to deal with an emergency;

b. reviewed the c2c safety procedures for wheelchairs within stations and recommended posters/ platform transfers asking for wheelchairs and pushchairs to be positioned parallel to the platform with suitable guidance for customers and staff on the platform;

c. reviewed its station notices on how to stop a train in an emergency to ensure contact telephone numbers are more prominent and legible, with additional notices placed elsewhere on the station to enable staff to have quick access;

d. trained and demonstrated to all relevant staff the 'Stopping trains in an Emergency' procedure;

e. put in place an annual assessment for all station staff on their knowledge and understanding of how to stop trains and how to get lines blocked in an emergency;

f. briefed managers responsible for checking Health and Safety notice boards to include the checking of key telephone numbers for readability;

g. revised procedures and re-briefed staff to remind the persons responsible for wheelchairs and pushchairs to apply the handbrake and position the equipment parallel to the railway;

h. checked all 'gate line' mobile telephones to ensure the relevant signaller's workstation contact number is programmed into the telephone and briefed and assessed staff to ensure they understand their use;

i. examined all c2c station platforms to identify slopes towards the platform edge (the visual survey identified that 50% of c2c stations had one or more platforms with a slope towards the railway); and

j. introduced platform stencils on platforms that have a slope towards the railway.

Southern Railway

77 Southern Railway has reported that it has:

a. started to survey and risk assess stations to identify platforms sloping towards the track, focusing in particular on the location of platform furniture (seats, ticket machines, help points, vending machines);

b. introduced a poster to warn passengers of the risk of pushchairs rolling away (figure 14);

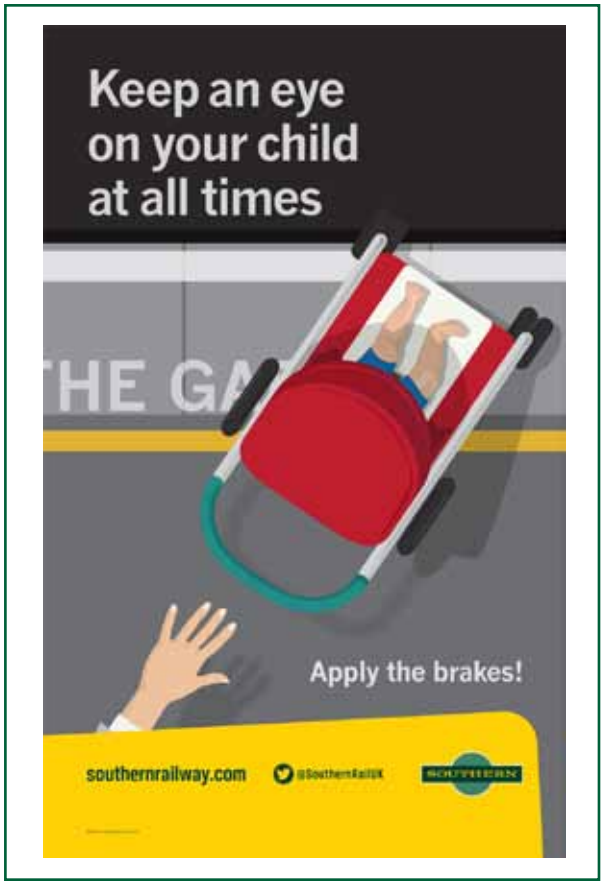


Figure 14: Southern platform poster introduced on platforms with slopes towards the railway

c. amended the Southern website page 'Your Safety' (http://www.southernrailway.com/your-journey/plan-your-journey/your-safety/) to include advice that children should be strapped into pushchairs and the brakes applied;

d. amended the Southern 'Accessibility Guide' to include reference to using the brakes on wheelchairs and pushchairs when on stations; and

e. amended guidance documents for accident investigation so that managers consider the risk posed by platform slopes when carrying out their investigations.

Network Rail

78 Network Rail has reported that it has:

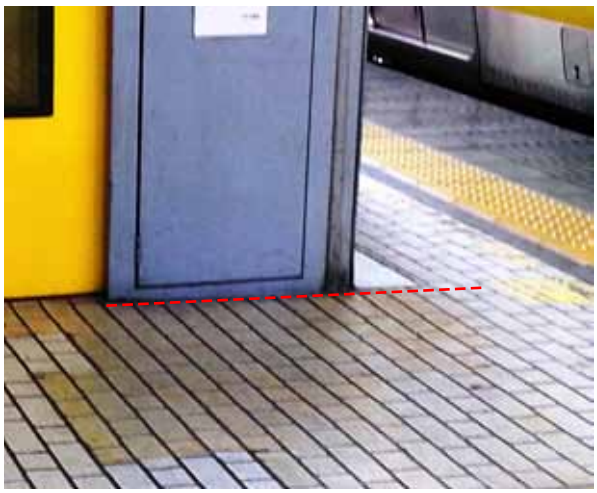
a. incorporated the slope risk to wheelchairs/pushchairs into the joint safety working group (Network Rail and RSSB) remit to review the risk associated with the platform/train interface;

b. reviewed its approach to platform slope issues and proposes to take the following actions:

- identify platforms sloping towards the track across the network, record any 'visible or known' cases of platforms sloping towards the track in Network Rail's Operational Property Asset Systems, and, with the SFOs, develop a risk matrix to help identify high-risk platforms; and
- where platforms sloping towards tracks are identified, prioritise these locations according to risk and take remedial actions (such as signage or other markings, public announcements and relocation of station furniture) as necessary;

c. implemented a process for ensuring that platform slopes falling towards the track are always considered for risk mitigation when works are undertaken on the platform; and

d. committed to undertaking a review of international best practice in the management of hazards at stations such as slopes towards the track and gaps between trains and platforms (figures 15 and 16).



'The platform is tilted. Please take care'

Figure 15: Platform transfers installed at Shinagawa Station, Tokyo, Japan (images courtesy of Professor N.Tyler. University College London)

Figure 16: Transfer used on the London Underground

Office of Rail Regulation (ORR)

79 Following discussion with the RAIB, in December 2013 the Office of Rail Regulation wrote to all train operators seeking information on:

- the SFOs' awareness of the hazard of platforms sloping towards the track;
- whether the hazard was included in the SFOs' risk assessment process; and
- if the hazard had been identified, whether controls or measures had been considered or implemented.

80 The results showed that a number of train operators had not identified or considered the risk and had therefore not incorporated the associated hazards into their visual inspections or considered any mitigation measures. Some train operators reported that they had now visually inspected their stations and identified previously unknown slopes, and some have put up posters on platforms where a slope towards the railway had been identified or have introduced announcements to remind passengers with pushchairs to apply the brakes when on the platform.

Rail Safety and Standards Board (RSSB)

81 The RSSB has informed the RAIB of its intention to include consideration of platform cross fall in the development of its national strategy for managing risk at the platform/train interface.

Rail Accident Investigation Branch

82 The RAIB will write to the UK's representative on the European body responsible for drafting technical standards on pushchair design to draw their attention to this report and the circumstances of the accidents at Whyteleafe and Goodge Street (paragraph 70), with particular regard to the issue of automatic braking arrangements on pushchairs (paragraph 75b).

Learning point

83 The RAIB has identified the following learning point[12] for the railway industry.

1 All Station Facility Operators are reminded of the importance of providing a means for their staff to call the signaller in case of emergency. Measures for consideration include the provision of mobile phones with a quick dial facility, or alternatively, posting a current and legible list of emergency numbers at prominent positions throughout the station.

[12] 'Learning points' are intended to disseminate safety learning that is not covered by a recommendation. They are included in a report when the RAIB wishes to reinforce the importance of compliance with existing safety arrangements (where the RAIB has not identified management issues that justify a recommendation) and the consequences of failing to do so. They also record good practice and actions already taken by industry bodies that may have a wider application.

Recommendations

84 The following recommendations are made[13]:

1 *The intention of this recommendation is to reduce the risk of pushchairs and wheelchairs rolling off platforms.*

Network Rail and Station Facility Operators should implement processes for managing the risk of wheelchairs and pushchairs rolling onto the track. These should include:

- the inclusion of platform slopes as a factor to be considered when assessing the risk to passengers on platforms;
- guidance to risk assessors on factors likely to exacerbate any risk of roll away (such as the presence of ticket machines, help points and shops/kiosks where people are more likely to release their hold on pushchairs and wheelchairs);
- consideration of measures to manage the risk (taking account of the work arising from the implementation of recommendation 3 in the short-term and recommendation 2 in the longer term);
- specific consideration of the impact on platform slopes of any works that are to take place at the station and methods of ensuring that those works will, as a minimum, not worsen the slope (and reduce or eliminate it if reasonably practicable to do so); and
- the sharing of information concerning any residual risk at the conclusion of works (paragraphs 73a and 75c).

continued

[13] Those identified in the recommendations, have a general and ongoing obligation to comply with health and safety legislation and need to take these recommendations into account in ensuring the safety of their employees and others.

Additionally, for the purposes of regulation 12(1) of the Railways (Accident Investigation and Reporting) Regulations 2005, the recommendations are addressed to the Office of Rail Regulation to enable it to carry out its duties under regulation 12(2) to:

(a) ensure that recommendations are duly considered and where appropriate acted upon; and

(b) report back to the RAIB details of any implementation measures, or the reasons why no implementation measures are being taken.

Copies of both the regulations and the accompanying guidance notes (paragraphs 200 to 203) can be found on the RAIB's website www.raib.gov.uk.

2 *The intention of this recommendation is for the rail industry to understand the point at which a slope becomes sufficiently steep for it to be more likely than not that an occupied wheelchair or pushchair without a brake applied would roll away. The work should consider the most appropriate methods of influencing the behaviour of passengers to minimise the risk.*

Network Rail in consultation with the Association of Train Operating Companies, RSSB and the Department for Transport, should (as part of the national strategy for managing the platform train interface risk) arrange for work to be undertaken to determine when a slope towards the railway could become a significant hazard, and ways of mitigating the risk. The scope of the exercise should consider:

- all slopes on platforms including those that have been installed intentionally (for example to accommodate changes in level along the platform length);
- at what point a slope towards the railway makes it more likely than not that a wheelchair or pushchair without brakes applied could roll away, taking account of modern designs of such equipment; and
- other factors such as how individuals perceive a slope hazard, the most appropriate way to highlight the hazard, appropriate methods to influence public behaviour, and other ways of mitigating the risk.

Once the work is complete the industry should publish appropriate guidance, including consideration of standardisation in the contents of signage, announcements, etc (paragraphs 73b and 73c).

continued

3 *The intention of this recommendation is for the Association of Train Operating Companies to consider the most appropriate ways of influencing the behaviour of passengers travelling with a wheelchair or pushchair, pending the outcome from recommendation 2.*

As an interim measure, pending the outcome of the research identified in recommendation 2, the Association of Train Operating Companies should, in consultation with passenger groups including those representing the interest of disabled passengers, review the findings of this report and seek to understand the ways in which the risk of wheelchairs and pushchairs rolling onto the track can be more effectively managed by operators. This review should include consideration of:

- locations where passengers may need to remove both their hands from a pushchair or wheelchair because of the nature of another task to be performed (eg at a ticket machine or shop/kiosk);
- reference to any existing good practice in this area; and
- measures that could most effectively influence the behaviour of passengers using wheelchairs and pushchairs on station platforms.

The output of the review should be consolidated into suitable guidance for train operators (paragraphs 73b, 73c and 75c).

4 *The intention of this recommendation is for the rail industry to capture, share and use information relating to roll-off events with a particular emphasis on identifying where platform slopes were a causal factor so that it has a better understanding of the causes of roll-off events and the associated risk.*

Network Rail, in consultation with Station Facility Operators and RSSB, should implement a process to improve the investigation and recording of roll-off incidents and the way in which data is shared. Particular attention should be paid to the following areas:

- improvements in capturing and recording incidents involving roll-off type events, including the identification of the key factors that caused the roll-off such as the presence of a slope towards the railway on the platform;
- a review of previous roll-off incidents and accidents (covering at least the last five years) to identify those that may have been solely attributed to ‘user error’ or ‘trespass’, including establishing whether there may have been other causal factors such as a slope at the location concerned; and
- a review of how intelligence on roll-off incidents should be shared within and between SFOs and Network Rail as an input to decisions on the nature and content of improvement works at stations (recommendation 1 also refers) (paragraphs 73b and 74).

Appendices

Appendix A - Glossary of abbreviations and acronyms

CCTV	Closed Circuit Television system
DfT	Department for Transport
HMRI	Her Majesty's Railway Inspectorate
ORR	Office of Rail Regulation
RSPG	Rail Safety Principles and Guidance
RSSB	Rail Safety and Standards Board
SFO	Station Facility Operator

Appendix B - Glossary of terms

Conductor rail	An additional rail, mounted alongside the track and raised slightly above rail level, that carries electricity at 750V DC for powering trains.
Coper or Coping stone	That part of the platform surface adjacent to the track, when formed of a separate concrete or masonry slab. Also known as the 'platform coping' or 'coping stone'.
Cross fall	The slant, slope or gradient of a surface allowing surface water to run in the direction of the fall.
Island platform	A platform with two faces, each adjacent to an operational track (each face is separately numbered).
Proprioceptive	An individual's perception or sense of position of one's own body relative to an environment or movement.
Station Facility Operator	The Train Operating Company holding the lease for a franchised station.
Third rail electrification	A general term used to cover the type of electrification that involved the supply of direct current (DC) to trains by means of a conductor rail laid along one side of the track (the 'third rail').
Train Operating Company	Holder of a specific franchise to operate passenger services.
Up line	In a direction towards London.

Appendix C - Key standards current at the time

Railway Group Standard GI/RT7014	Infrastructure Requirements at Stations (2004)
Railway Group Standard GC/ RT5161	Railway Group Standard: Station platform design standards (1995)
Railway Group Standard GI/RT7016	Interface between Station Platforms, Track and Trains (2004 to 2014)
Network Rail Company standard NR/L3/CIV/162	Platform extensions
Network Rail Handbook	Operational Property Design And Construction
Network Rail Company standard NR/L2/CIV/003	Engineering Assurance of Building and Civil Engineering Works (2012) (formerly) RT/CE/P/003 (2001)
Network Rail Company standard NR/SP/CIV/087	Management of Existing Buildings and Station Structures (formerly) RT/CE/S/087 (2004)

Appendix D - Documents referenced in the text

The table below shows the evolution of references made within railway documents relating to slopes on platforms

Railway Group Standard GC/TT0196 'Station Platform Design Requirements' (1993)	**Platform Longitudinal slopes and cross falls** **Section 5.6.1** Where a platform coper forms the platform edge the surfacing shall be constructed to provide a fall away from the rear edge of the platform coper to the following limits: Minimum 1:80, Maximum 1:20. The optimum fall shall be 1:40. Platform copers shall be level from the platform edge to the rear of the coper. Where no coper to the platform edge is provided, the cross fall shall commence at the platform edge.
Railway Group Standard GC/RT5161 'Station platform design standards (1995)	Network Rail's Safety Management System is based on compliance with Railway Group Standards, which are produced, managed and maintained by the Rail Safety and Standards Board on behalf of "Railway Group Members" (Network Rail, TOCs (SFOs) operating on the national rail network). **Section 6.3.1** Surfaces of platforms and ramps shall be firm, even and non-slip and shall not provide tripping hazards. Surfaces shall be able to be cleaned of dirt and debris. **Section 6.3.2** Adequate provision for the removal of storm water and spillage shall be provided for platform surfaces, platform buildings and canopies to avoid surface discharge or ponding. **Section 6.3.3** Surfacing shall be constructed to provide a fall away from the rear edge of the platform coper or platform edge as applicable. **Section 6.4.3** At stations where there is risk of turbulence from passing freight and certain passenger trains, consideration shall be given to the provision of warning signs and marked safe areas for the use of passengers with wheel chairs, push-chairs and self-help trolleys.
Rail Safety Principles and Guidance (RSPG) (1996) part 2, section B, Guidance on stations	The RSPG documents were produced to support the 'Railways and Other Transport Systems (Approval of Works, Plant and Equipment) Regulations' 1994 (known as ROTS) covering the formal approval by HMRI of the railway infrastructure. The RSPG documents are considered to be obsolete, although they have not yet been formally withdrawn. **Paragraph 24 (l)** All platforms should slope away from the adjacent track, have an anti-slip surface and be terminated with ramps at a gradient not steeper than 1 in 8. Platform ramps should be not less than 2000 mm wide. Island platforms should slope towards the centre and away from both adjacent tracks.

Railway Group Standard GI/RT7014 'Infrastructure Requirements at Stations' (2004)	**Section C2.3: Platform and coper surfaces** For new platforms and alterations to platforms, unless otherwise justified, the surfacing shall be constructed to provide a fall away from the rear edge of the platform coper or platform edge if there is no separate platform coper. If provided, copers for new or altered platforms shall be nominally level from the platform edge to the rear of the coper.
Railway Group Standard GI/RT7016 'Interface between Station Platforms, Track and Trains' (2004 to 2014) **Version 4 issued in 2010.**	**Platform cross fall** **Section 11.1.3.1** For new platforms and alterations* to platforms, the surfacing shall be constructed to provide a fall away from the rear edge of the platform coper or platform edge if there is no separate platform coper. **Section 11.1.3.2** The fall should be at a nominal gradient of 1 in 40 or within the limits of 1 in 80 and 1 in 20. **Section 11.1.3.3** If provided, copers for new or altered platforms shall be nominally level from the platform edge to the rear of the coper.
Department for transport (DfT) 'Accessible Train Station Design for Disabled People'. Codes of Practice	**Section 2: Platform design** Cross-falls required for drainage purposes should slope away from the platform edge and be in the range of 1:80 to 1:40 on exposed platforms. A much shallower gradient can be used on sheltered or indoor platforms.

Appendix E - Previous roll-off incidents

The investigation found the following wheelchair and pushchair incidents, associated with roll-off type events on Britain's main line railways. Four other pushchair incidents were identified worldwide.

Hounslow 2001	Pushchair rolled onto the platform from the booking hall area. A barrier and hand rail was installed to prevent any further occurrence. No further details available.
Worcester Shrub Hill 2004	Whilst a passenger was standing at a coffee kiosk, her buggy rolled towards the edge of the platform and fell on the track. The immediate cause was that the carer had been preoccupied at the kiosk and the brake on the buggy was not applied. The Station Manager inspected the platform area and found that the platform sloped towards the track.
Bromley South 2005	A baby in a pram fell onto the track. The baby sustained head injuries. The mother reported that it was her fault as she had forgotten to put the brake on the pram.
Newhaven 2008	A passenger in a wheelchair rolled off the platform onto the track. No other detail available
Chislehurst 2009	A passenger in a wheelchair rolled forward off the platform onto the tracks landing face down. Her parent and carer went down onto the tracks to lift her back onto the platform assisted by a member of station staff. The girl sustained bruising on both legs, and a cut head.
Barrhead 2009	A passenger with a pram bent down to pick up an object from the platform without applying the brake on a pram. She was unaware that the pram had rolled off platform. The pram fell on the track at the rear of a stationary train. The baby (10 months old) sustained bruising to its forehead and a burst lip. The initial investigation identified the immediate cause as lack of care and attention. The area was inspected and no hazards were identified although a slope towards the railway was present. First ScotRail arranged for the gradient to be measured and for signs (figure 13) about the slope to be provided.
Birkenhead Central 2009	A guard reported that as he was entering Birkenhead Station he saw a baby and pram fall from the platform onto the track. The baby's father immediately jumped onto the track and retrieved the baby and pram. The father stated the brakes were on and he did not know how the incident occurred. Merseyrail station staff checked the platform and found nothing out of order with the platform surface.

Edinburgh Waverley 2010	Station staff reported that a pushchair containing a 7-month old baby had rolled off a platform onto the track. The father of the baby jumped onto the tracks to retrieve the pushchair and baby. At the time the line was closed and no trains were running. The baby received bruising to the head and as a precaution was taken to hospital. The cause of the incident was found to be that the father thought he had applied the pushchair's brakes, but he had not.
Andover 2010	A member of the public reported to station staff that a pushchair with a small child had rolled across the platform and on to the track. The pushchair and child were helped from the track by a fellow passenger. The child was strapped in and appeared shocked but uninjured.
Scarborough 2011	A disabled person in a wheelchair travelling on a steam train had detrained with his two carers and went to the front of the train to view the engine. During this time, the wheelchair rolled forward on the platform and fell onto the track on top of the occupant. The male went to hospital with minor injuries.
Orrell Park 2012	A male carrying a baby requested station staff call for an ambulance as his pram and child had just rolled off the platform onto the track. The child received injuries to its face.
Coulsdon South 2012	The driver of a train reported a pram was on the line. The mother had taken the baby out of the pram as she entered the platform and the pram had subsequently rolled forward across the platform falling onto the railway.
Cardiff Central 2013	Station staff were advised that a pushchair and baby had rolled forward on the platform and onto the track. No train was involved. There were no reported injuries but mother and child had suffered from shock.
Angmering 2013	The signaller was advised by the driver of a train that on approaching the up platform at Angmering he saw a buggy roll off the platform and onto the track. The driver stopped before reaching the buggy (there was no baby in it).
Sevenoaks 2013	Station staff at Sevenoaks station reported that a member of the public had forgotten to apply brakes on a child's pushchair, which had subsequently rolled onto the line. The member of the public then climbed down onto the line and recovered the child and pushchair. The child was reportedly uninjured.

Other worldwide incidents	
Ashburton station, Melbourne, Australia (Connex, Melbourne (now Metro trains) 2009	A near miss occurred after a pram holding a 6-month old baby rolled onto the tracks and into the path of an oncoming train as it entered the platform at Ashburton railway station.  The baby's mother had been distracted while she was standing on the platform, and was looking away as the pram rolled off the platform. The baby suffered minor cuts and bruises. It was reported that a previous identical accident had prompted the train operator to review the design of platforms in the Melbourne area, but the standards only require new platforms to slope away from the railway track.
Tooronga station. Melbourne 2010	A pram rolled off the platform and into the path of an approaching train at Tooronga station. No further details were supplied.
Fairfield station. Melbourne 2012	A mother standing next to her baby's pram on the platform became distracted. As she looked elsewhere the pram slowly rolled away on the platform and fell onto the railway track. As the pram fell, the mother noticed and ran across the platform and jumped onto the tracks. The pram and baby were recovered. Station officials confirmed that the baby was rescued uninjured before the next train arrived. It was reported that the incident was one of three identical incidents involving prams rolling off platforms in the Melbourne area in 2011.
56th Street station Philadelphia. USA 2013	A mother became distracted and unaware of her pushchair and child rolling forward onto the track. The mother and other passengers jumped down to rescue the child.  The train operator stated that the mother had become distracted and had not applied the brake. The platform is slanted slightly for drainage purposes causing the pushchair to roll forward. The child was taken to Philadelphia hospital with head injuries.

Appendix F - Pedestrian Accessibility Movement Environment Laboratory (PAMELA)

Report CH14A: Initial investigation into factors affecting rolling of wheelchairs from stationary on train platforms

The PAMELA platform was set-up with a 2.4m x 2.4m area on a slope. Two slope gradients were investigated: 2° (1:28 or 3.5%) and 5° (1:11 or 9%).The initial position of the wheelchair was adjusted so that its orientation relative to the edge of the slope was in one of three positions (figure F1):

1. Wheelchair at 0° with casters at 90°.
2. Wheelchair at 45° with casters at 90°.
3. Wheelchair at 90° with casters at 90°.

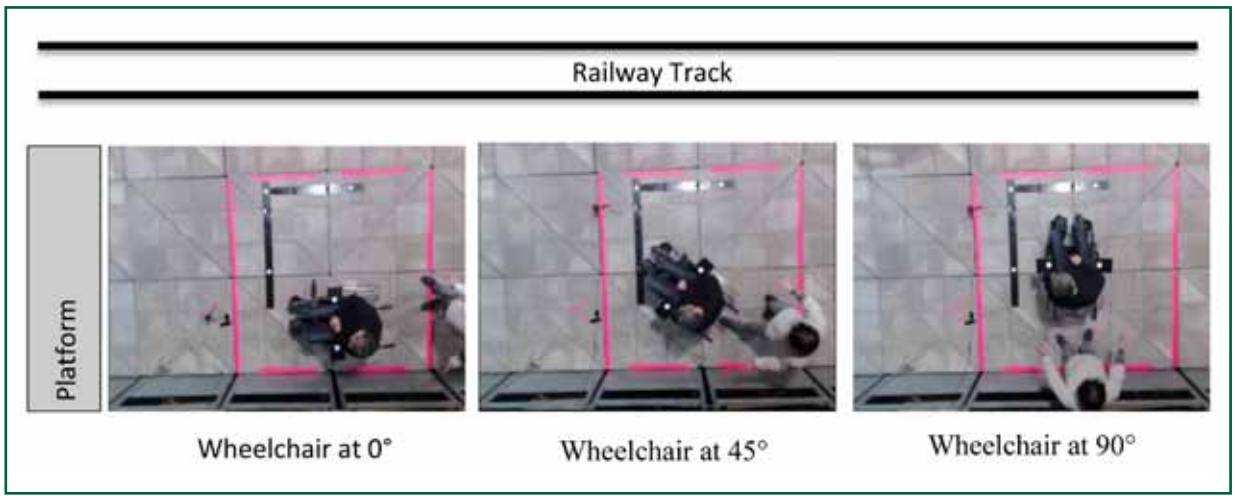


Figure F1: Wheelchair positions relative to the slope which runs downhill towards the top of the picture. The term '0°' refers to chair and/or wheels being side-on to the slope, while the term '90°' refers to the chair and/or its wheels facing down the slope.)

The wheelchair used had a weight of 14.5kg and an occupant weight of 85.05kg, giving a total weight of 99.55kg. Two reflective markers were placed on the arms of the wheelchair, which were then tracked using video cameras.

The wheelchair was manoeuvred into position and the casters aligned with the wheelchair held in position by its occupant. The occupant then released his hold and sat still, with the wheelchair able to roll freely. The time taken for movement to commence and the trajectory of the wheelchair were measured. The test was repeated so that three runs per condition were tested. This resulted in 18 trials (three runs for each of the three wheel configurations at the two different slope configurations).

Initial results

Only 1 out of the 18 runs resulted in the wheelchair not moving. This occurred on one of the runs using the 1:28 (3.5%) slope with the wheelchair at 0° and casters at 90° (it did roll in the same configuration on the other two identical runs). All other trials resulted in the wheelchair moving without external interference ie under the influence of gravity only.

A detailed description of a single run from what is theoretically the 'best case' scenario in terms of safety of the wheelchair user with wheelchair at 0° and casters at 90° is analysed in detail for this initial investigation. The trajectory of the wheelchair for the 1:28 (3.5%) slope is shown in figure F2 and the trajectory for the 1:11 (9%) slope is shown in figure F3.

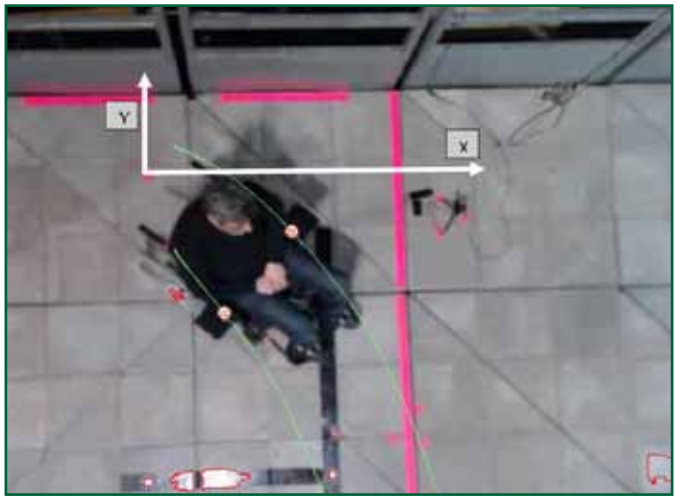


Figure F2: Tracked wheelchair (green lines) as it rolls down a 2° (1 in 28) slope

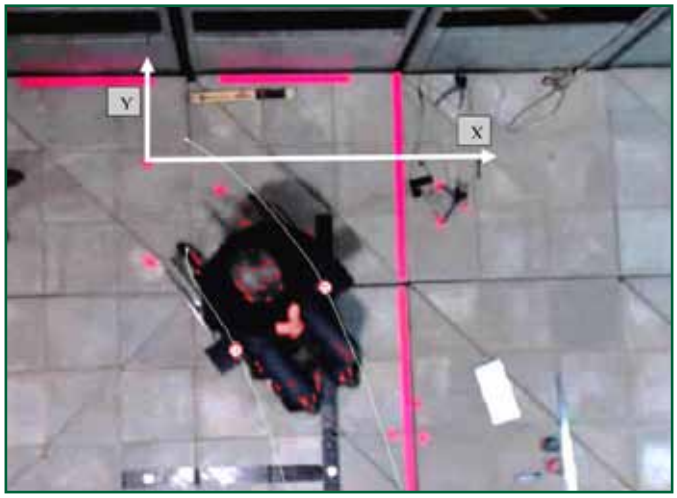


Figure F3: Tracked wheelchair (green lines) as it rolls down a 5° (1 in 11) slope

The trajectories for both slopes are also shown in figure F4, with the left wheels shown in green and right wheels in blue. The 1:11 (9%) slope (circles) resulted in a much tighter turning circle of the wheelchair compared with the 1:28 (3.5%) slope (solid lines).

Figure F4 details the trajectories of the left and right wheels of the wheelchair as indicated by the tracked markers. Y position is in the direction of the (imaginary) railway tracks. X position is travel along the length of the platform.

Figure F5 shows the distance travelled by the wheelchair against time. On a 1:11 (9%) slope the wheelchair begins to move within a second and has travelled 1m (shown as a black dashed line) in approximately 2.5 seconds. On the 1:28 (3.5%) slope the wheelchair takes longer to begin to move and takes approximately 12 seconds to move 1m, having moved very slowly for the first 7 seconds.

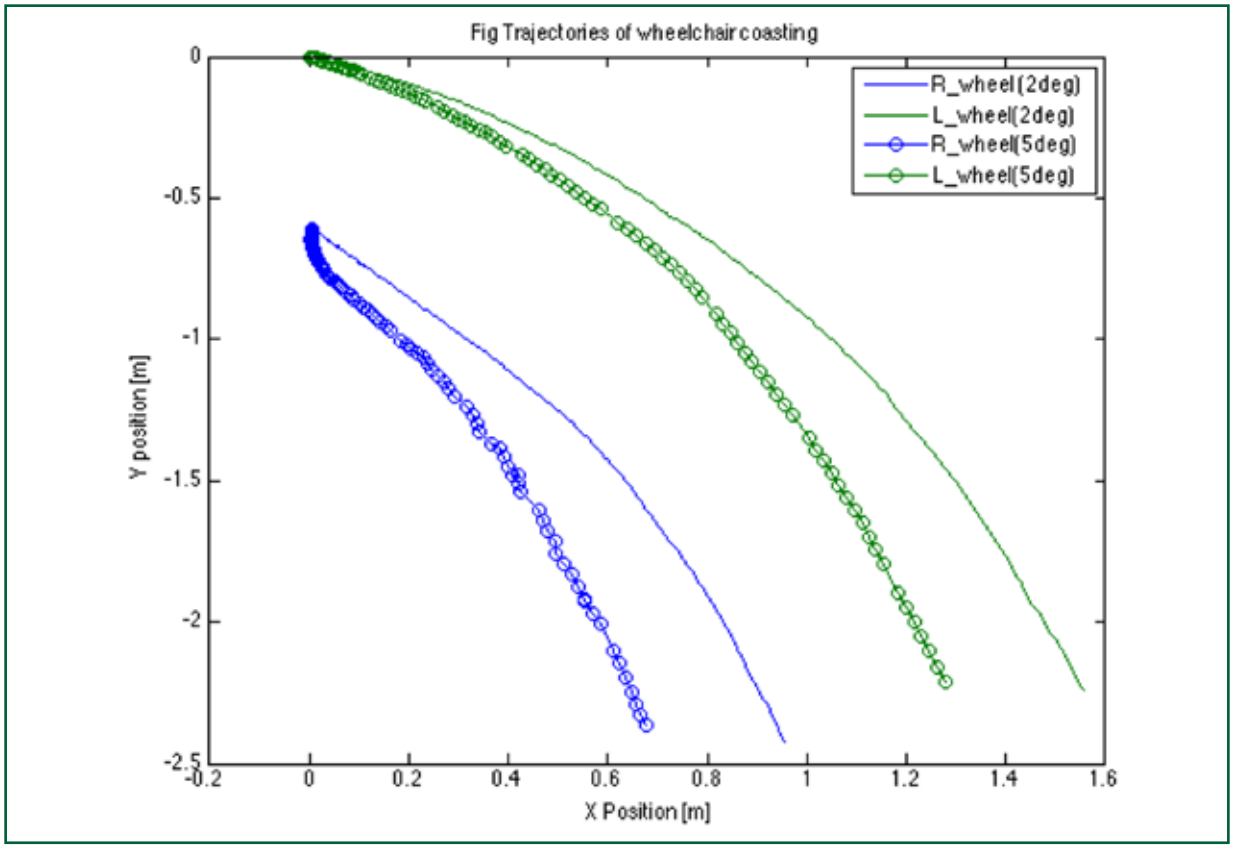


Figure F4: Trajectories of the left and right wheels of the wheelchair as indicated by the tracked markers

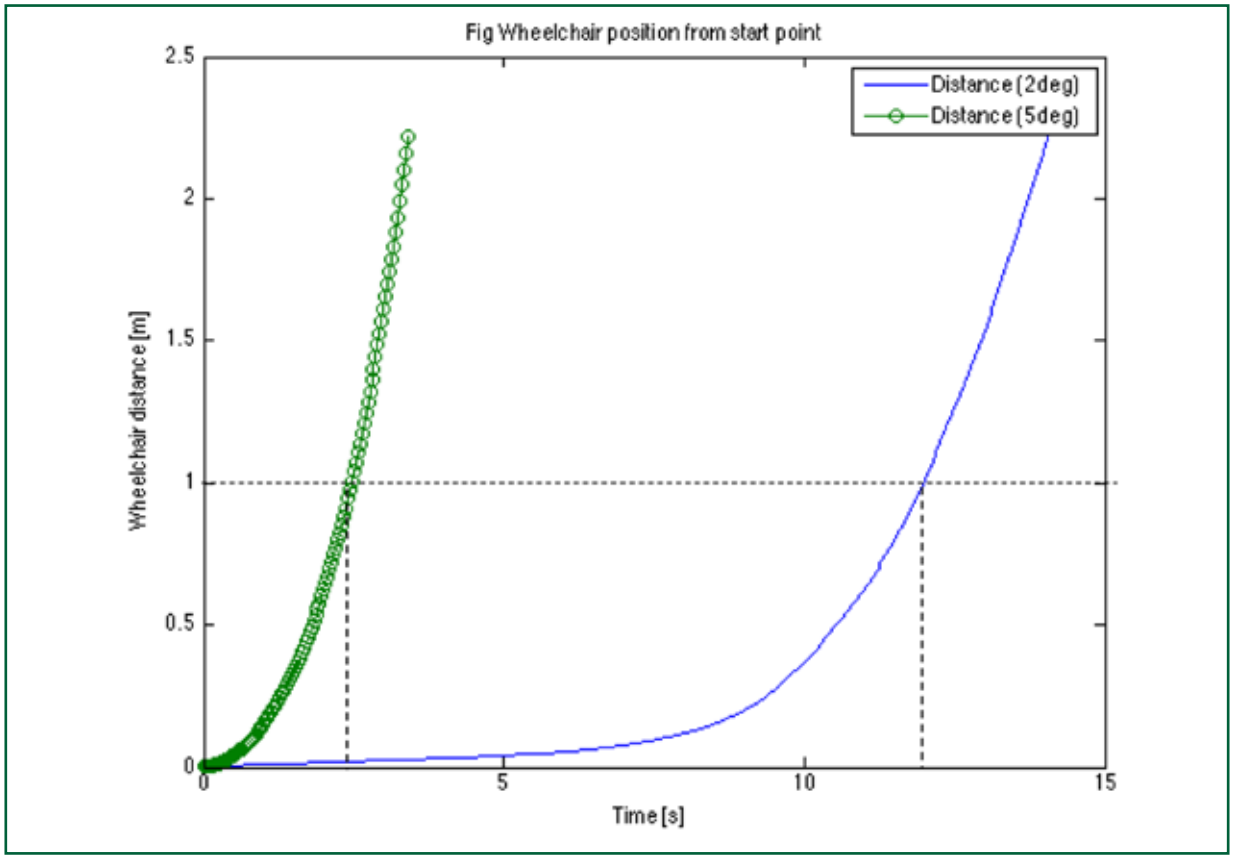


Figure F5: Time series plot of wheelchair movement as indicated by the tracked markers. Y position is in the direction of the (imaginary) railway tracks. X position is travel along the length of the platform.

The results of the initial investigation show there is a clear risk that an un-braked wheelchair will turn and roll down a slope when the slope is 1:28 (3.5%) or steeper. The way in which the wheelchair moves on the 1:11 (9%) and 1:28 (3.5%) slopes present different risks. On the shallower slope the wheelchair's movement is gradual and relatively slow at the start. This may not initially trigger a reaction from a carer or occupant. It may therefore be perceived as safe to leave, when given a few seconds it will not be. On the steeper slope the risk is more apparent as the movement of the wheelchair happens more quickly. However, this presents a different risk as people may simply not have the strength to stop the motion. This initial investigation identified the need for further investigation to understand:

- the energy gained by the wheelchair as it travels forward;
- the factors which affect this (including wheelchair design, centre of mass location, movement of the occupant); and
- the force necessary to prevent motion or to stop it once it has started to roll forward.

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