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# The underlying causes of falls from vehicles associated with slip and trip hazards on steps and floors

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## RESEARCH REPORT 437

# The underlying causes of falls from vehicles associated with slip and trip hazards on steps and floors

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The objectives of the project were:

- To identify the degree and causes of slipperiness of cab and trailer steps, 5th wheel and trailer floor.
- To assess the best types of flooring used and available.
- To identify tripping hazards.
- To give an indication of drivers' 'normal practice' when accessing and egressing vehicles, including the frequency and purpose of accessing loads on the backs of trailers, and the provision and adequacy of on-board access equipment.
- To identify the types of footwear used by drivers and their suitability as anti-slip footwear.

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# EXECUTIVE SUMMARY

This study was carried out at the request of Deborah Walker (HSE Safety Unit) on behalf of the Workplace Transport Priority Programme.

### Aims and Objectives

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5. To identify the types of footwear used by drivers and their suitability as anti-slip footwear.

### Methodology

In order to achieve the aims and objectives, a number of different methodologies were utilised. Many types of vehicle were examined and measured. Vehicle types included Large Goods Vehicles (LGVs), vans and forklift trucks (FLTs). Slipperiness measurements were taken from a variety of surfaces, including load areas, 5$^{th}$ wheel areas, and cab steps. Measurements of cab step heights and depths were taken, and notes made of the materials used in all these surfaces. Face-to-face interviews were carried out with 87 drivers and managers were interviewed to explore their opinions about the causes of falls from vehicles. Three focus groups were used to confirm the interview findings and consider how falls from vehicles can be reduced.

### Main Findings

The cab steps are used hundreds of times per week, and most of the time the drivers negotiate them without difficulties. When they do have a fall, they tend to blame their inattention. However, consideration of the dimensions of cab steps points to design aspects that could reduce the need for concentration in order to negotiate the steps safely. There is very little consistency in step dimensions, both height and depth. The variation in height is most likely to catch out a person climbing or descending the steps. Drivers emphasised that handholds play a vital role in avoiding falls from the steps. Drivers complained that the cab door can get in the way of the steps if they have to descend in a limited space. The slip resistance of the cab steps relies on a physical interlock between the operators shoe cleats and the profiled surface of the step. How effectively this interlock works on a given vehicle depends on the driver’s footwear, which varies enormously. Increased levels of roughness of the cab step surface would improve the slip resistance in wet conditions regardless of drivers’ footwear. Some drivers (generally younger drivers) jump from the cab rather than using the steps, resulting in occasional slips or falls, but perhaps more significantly, a cumulative strain on the back and the knees that reduces mobility in future years. Some older drivers reported their inability to jump from the cab, demonstrating the long-term effects of repeatedly jumping from the vehicle.

Access to the 5$^{th}$ wheel area is generally quite poor. Usually there are few steps with considerable height rises, handholds are often difficult to access (they are commonly tucked behind aerodynamic fairings which don’t always fold back) and a patchwork of underfoot surfaces placed at different levels can catch out the unwary. Consistency in surface finishes is preferable, as transitions in slip resistance are recognised to lead to accidents. Trip hazards may be presented by changes in level as little as 10mm. The physical nature of the tasks undertaken in the 5$^{th}$ wheel area place further demands on the slip resistance of the surface, often with the posture of the operator compromised by the confined space. Drivers suggested that additional space to manoeuvre in the 5$^{th}$ wheel area would lead to a reduction in accidents. Drivers consistently argued that the biggest problem with the 5$^{th}$ wheel area is diesel contamination. The diesel tank of vehicles is commonly situated in the vicinity of the 5$^{th}$ wheel, and often the tank forms part of the access to the 5$^{th}$ wheel area with steps built into it. The access in this area commonly becomes contaminated with diesel which might result in drivers slipping, or at the least their footwear becoming contaminated. Many drivers felt they had experienced slip accidents caused by diesel on their footwear.

The materials used for the load areas of vehicles (in rigid, curtainsided and flatbed vehicles) generally provide low slip potential, even when water is present. The area of the load bed that does cause concern to the authors is the threshold, which is usually part of the steel structure of the vehicle, either smooth metal or paint finish, and as such presents a significant slip potential when wet. A pedestrian slip is more likely to occur where the person moves from an area with one level of slip resistance to one with a different level of slip resistance, such as from the main load bed to the threshold. On the whole, where load areas are well maintained, potential for trips are limited to the load itself, securing straps, or waste materials such as shrink-wrap and pallets left in the vehicle. On some occasions, trailers were observed with a raised lip along the edges, creating a trip hazard.

Provision of access to the load area varies from nothing to good, with most vehicles falling somewhere between the two extremes. Fold out ladders are commonplace, but generally are inadequate, with a very high first step, very narrow treads and an absence of handholds. For egress they are difficult to see from above resulting in the operator fumbling around to find the top step, or perhaps more commonly, jumping down without using the steps. Some vehicles did have substantial steps that folded or slid out from under the load bed. Steps that resemble stairs are easier to use than ladders in terms of secure footings and visibility from above for egress. If operators are to maintain three points of contact during access and egress, then there needs to be provision of suitable handholds. Where handholds are absent, use of the load as a handhold where possible is likely. For example, a number of accidents are known to have resulted from the banding on pallets breaking due to the drivers using them as handholds. As with the cab area, younger drivers tend to find access to and egress from the load area much easier, but repeatedly jumping from the load area can result in reduced mobility in the longer term. Many drivers have personal experience of falling from vehicles, and through this process they learn to take more care.

The materials used for tail lifts generally present a high slip potential in at least one direction, and therefore the design of these lifts could be improved. This is a high-risk area, where a slip could see the vehicle operator falling as much as 1.3m. Examples of tail lifts with edge protection have been observed, although on one such occasion the handrails were not being used as intended (with both guard rails in the upright position). Improvements to the slip resistance of the surfaces may be a more useable solution than the provision of guardrails, though if there are no rails there is always the possibility of stepping off the edge. When the vehicle operator has to unload using a tail lift, problems are encountered if the load is too large for the platform, such as when a pallet and pallet truck are used on the smaller lifts, which are primarily designed to carry roll cages. Thought needs to be given to the loads carried and the way they are packaged to avoid such problems.

In relation to Fork Lift Trucks (FLTs), falls appeared to be rare and the drivers interviewed did not consider falls to be a pressing safety issue. The company visited for the interviewing of FLT drivers did include messages in their training to avoid falls. These messages included: maintain three points of contact during access and egress; survey the surrounding ground before dismounting and clean up spills and obstacles promptly. The FLTs examined generally had handholds to facilitate access, and the use of antislip finishes was noted on a number of occasions.

In considering footwear, most drivers wear ‘safety boots’ which have a steel toecap to protect them from falling objects. Many drivers choose oil resistant soles, in the belief that this means slip resistant, but unfortunately it does not. Qualifying what is meant by slip resistant footwear is difficult, as it depends not just on the properties of the footwear, but also on the surface to be walked upon, and any contamination that is present between the two. Tests carried out by HSL (2005) do show that the slip resistance of footwear varies enormously, and that claims of slip resistance in footwear catalogues often gives little indication of likely performance. The choice of footwear is further complicated by the variety of materials on a vehicle. For example, a 7.5 tonne delivery truck might have a metal profiled cab step, requiring a good interlock with the shoe cleats, a smooth aluminium tail lift, requiring anti-slip soles that does not rely on interlock, and a wooden load bed which is not a significant slip risk. The shoes that work well on the cab steps may not work on the tail lift, and vice versa. Where footwear becomes contaminated, with for example, diesel or mud, drivers need to be able to clean it before they encounter surfaces which will be made more slippery with these contaminants.

Various contaminants are present in the haulage industry. Most commonly water from rainfall, and snow or ice in the winter months. Around the 5$^{th}$ wheel area oil and grease residues can present problems, and some drivers reported a lack of cleaning equipment to remove such contamination from their vehicles. Diesel spills, encountered at filling stations, depots and around the vehicle fuel tank can result in slippery surfaces. Where access to the 5$^{th}$ wheel area is needed, setting steps into the diesel tank is likely to invite slip incidents. The steps are generally too small, providing no more than a toehold, and diesel contamination further increases the likelihood of an accident.

Maintenance of vehicles needs to encompass aspects that affect the drivers’ safety as well as the safe operation of the vehicle itself. For example, anti-slip surfaces can change significantly with wear, and need to be replaced periodically. Facilities are also needed to wash away contaminants such as oil and diesel residues.

Weather conditions can make the drivers’ job more difficult and hazardous when loading and unloading. The effects of ice and snow on the slipperiness of surfaces are obvious, but wind also poses problems with unloading operations, significantly increasing exertions needed for some procedures. For example, curtains on large goods vehicles can act as a sail and drag the driver from a surface. Hot weather can lead to heat stress, resulting in faintness and the risk of falling. Winter working can also involve significant time spent working in the dark, as drivers often start work very early in the morning. Lighting of load areas on trucks tends to be poor, and uneven ground around the vehicle will present a more significant risk in the dark.

Drivers work with little or no supervision and little or no contact with management. “Health and Safety” is often not the priority in the haulage industry, with cost and time factors taking the precedence. This is reflected in the demands placed on the drivers with for example, instances of delivery times scheduled to windows of a few minutes. With the unpredictable nature of traffic conditions, schedules slip and drivers can feel pressure to cut corners and rush, both of which are likely to result in accidents. Where training is provided, it seems to give the right messages, but all too often training is not provided, and drivers are left to learn through personal experience or through colleagues. Frequently initial training is not reinforced with either refresher training or by a positive management attitude to individuals' health and safety. Some drivers interviewed felt that company attitudes towards operational pressures "undid" the good work of being trained, as many drivers felt that they were not allowed enough time to do their jobs safely, and they felt that their managers would prioritise jobs being done to time.

It is likely that there will be many differences between large national companies and small and medium sized companies, which are less likely to have dedicated personnel for health and safety matters. A representative from the Road Haulage Association felt that the big companies have good training and health and safety policies and procedures in place. He felt that the depots of large companies are well organised. The representative also felt that most issues would be likely to lie with the 'one man' businesses where less attention is paid to health and safety.

Working hours do not seem to have reduced significantly by the introduction of the European Working Time Directive (2003). Fatigue can be a significant factor in fall-related accidents. Schemes that reward fast working, such as task and finish or per-load payment encourage rushing, which again, contributes to falls. Drivers undertaking multi-drop deliveries frequently have to sort though the load during deliveries to find the correct goods for the drop. At least one company visited had tackled this problem with regular planned routes, allowing the warehouse staff to load each vehicle so that the goods are removed in order, significantly reducing the time spent by operators on the load area, at risk from falling.

Frequently drivers talk about health and safety being 'common sense'. This is endemic across many sectors, especially in relation to slips, trips and falls. However, this does not sit well with either the accidents rates in the industry or the findings of this report. There are many simple and cost effective interventions to reduce the risk of slip and trip accidents. When the full cost of an accident is calculated and balanced against the cost of a simple intervention, a compelling business case may be formed. For example, the food sector has embraced the task of reducing slip and trip accidents, and many businesses have drastically reduced their accident rates. Some interventions need to be introduced at the vehicle design stage, and will consequently take longer to have an effect on the industry as a whole. The most difficult changes to make will be towards attitudes and behaviours within the industry, and the industry's culture of focussing on time and financial cost.

### Recommendations

The report makes a large number of suggestions for improvements which are believed, will contribute to reducing falls from vehicles. Some recommendations target vehicle designers and manufacturers, or vehicle operators, for example, use of antislip surfaces, improved access and egress provision, improved maintenance and housekeeping of vehicles. Other recommendations are suggestions of actions the HSE could take to further raise awareness of falls from vehicles, such as producing industry specific guidance, working to address shortfalls in current British and European Standards and working with industry bodies to help to tackle the industry's inherent "rushing" culture.

# 1 INTRODUCTION

## 1.1 BACKGROUND

This study was carried out at the request of Deborah Walker (HSE Safety Unit) on behalf of the Workplace Transport Priority Programme.

**The problem**

Over the past five years, accidents reported to HSE and local authorities show that nearly 60 employees were killed and 5000 seriously injured in the haulage and distribution industries (HSE, 2003). A further 23 000 workers suffered injuries serious enough to keep them away from work for over three days (HSE, 2003). These figures exclude work-related ill health, for example, bad backs or stress. These figures represent a higher rate of accidents to employees in either the construction or agricultural industries, which are both regarded as hazardous industries (HSE, 2003).

Being struck by a moving vehicle and people falling from a vehicle are the two most common types of workplace transport accidents that cause major injuries (e.g., broken bones) to employees (HSC, 2003). Over the period 1998/99 to 2002/03, the percentage share of major injuries caused by people falling from a vehicle has increased (from 39% in 1998/99 to 47% in 2002/03) (HSC, 2003).

As discussed above, falls from vehicles represent around one third of workplace transport accidents and are spread across a wide range of industries. An analysis of HSE accident data for 'goods type vehicles' (Walker, 2004) would suggest that at least one third of these accidents are caused by an initial slip or trip. In Walker's analysis 448 accident reports were examined. At least 124 accidents involved a slip before the fall and 16 involved a trip before the fall. This suggests that at least 31% of falls from vehicles were preceded by a slip or trip (140 accidents). Walker also highlighted that 9% of incidents occurred when drivers were using steps.

The wider literature also indicates that falls from workplace vehicles are a pertinent issue. Lin and Cohen (1997) showed from a data analysis of employee injuries /illnesses that 'slips and falls', followed by 'struck by' and 'overexertion' (injuries resulting from excessive force used during the handling of objects greater than 20 pounds) were the most commonly reported accident types for the haulage industry in the USA. Vehicle ingress and egress was cited as one of the four most critical accident problems for the haulage industry. Slips and falls accounted for over 27% of all cases reported which resulted in lost workdays, second highest behind motor vehicle accidents. This study also revealed that there were three times as many egress accidents as ingress accidents. Approximately 35% of the injured employees slipped on vehicle parts, a further 20% was associated with walking, working and traffic surfaces, such as platforms, loading docks and sidewalks. Inclement weather conditions (rain, snow and ice) were also frequently mentioned.

Jones and Switzer-McIntyre (2003) carried out a study based on information from a workers compensation database in Canada. They showed that the most common site of falls from trucks was the back of the truck or trailer, the truck step and the cargo being transported (accounting for 83% of total falls).

In combination, these data sources suggest that slips and falls from and around workplace vehicles are a genuine problem. The remit for this piece of work was to consider a wide cross section of workplace vehicles and to investigate the underlying reasons for falls from them.

Particular emphasis was given to assessing slip and trip hazards as a cause of falls. The views of workplace vehicle drivers (Large Goods Vehicles (LGVs), vans and Fork Lift Trucks (FLTs)) were also sought.

**Preventing falls from vehicles**

There are a number of HSE publications which discuss the prevention of falls from vehicles, e.g., Avoiding falls from vehicles (HSE 2004a), Workplace transport safety (HSE 1995), Health and safety in road haulage (HSE 2003), Safe unloading of steel stock (HSE 2000) and Workplace transport safety in food and drink premises (HSE 1999). HSE (2004b) discusses a hierarchy of control in preventing falls from vehicles. This hierarchy is described below.

1. Avoid the need for people to go up high on a vehicle. For example, mechanical sheeting devices speed up unsheeting and negate the need for people to climb onto the load area.

2. If access to height is unavoidable, provide on-vehicle fall prevention systems such that the safeguards travel with the vehicle, for example, guard railed platforms and harness systems using on-vehicle anchor points.

3. If on-vehicle solutions are not feasible, provide off-vehicle safe access such as fixed or portable platforms/ gantries. Off-vehicle fall prevention/ restraint systems using harnesses fixed to anchor points in the roof space may also be used. There may be problems in guaranteeing such equipment at sites controlled by external duty holders.

It should be noted that harness systems rely on good training, instruction and supervision.

Smaller scale practical measures as described in HSE (2004b) should also be considered:

1. Keep vehicle beds tidy to prevent trips (and slips).

2. Provide non-slip footwear to drivers.

3. Provide adequate steps to the cab and load area.

4. Use three points of contact when climbing up or down from vehicles.

5. Provide supervision to ensure fall precautions are actually taken.

HSE literature also discusses the potential confusion as to who is responsible for preventing falls from vehicles. Where vehicles leave a duty holder's premises, disagreements may arise over which duty holder should provide fall protection measures. Manufacturers of cabs and trailers are highly influential in affecting the ease of access to vehicles. Provision of steps and handholds will facilitate vehicle access, however, weight restrictions are often cited as a reason for not including them in vehicle specifications. Encouraging vehicle manufacturers and bodybuilders to include these access systems as standard will help to improve vehicle access.

**Standards**

The design and manufacture of LGVs is governed primarily by Road Vehicle Construction and Use Legislation. There is a dearth of guidance or standards in relation to vehicle access systems specifically, however, there are three publications that should be considered. These are British Standards, BS5395-3:1985 (Stairs, ladders and walkways – Part 3: Code of practice for the design of industrial stairs, permanent ladders and walkways), BS4211:2005 (Permanently fixed ladders), and also BS EN ISO 2867-2001 (Earth-moving machinery – Access systems). These publications consider aspects such as step dimensions, handhold provision and anti-slip properties of surfaces. The Building Research Establishment (BRE) document (Roys & Wright, 2003), may also be of use in terms of the design and properties of step nosings.

In relation to the measurement of slip resistance, there are currently no relevant European standards. For the purposes of this study, slip resistance was measured in line with the Guidelines Recommended by the UK Slip Resistance Group (UKSRG) (2000) which incorporates BS7976-2 (Pendulum testers. Method of Operation). The UKSRG Guidelines are routinely used by HSE and HSL for investigation of pedestrian slip accidents. It should be noted that subsequent to the completion of data collection for this project, new UKSRG Guidelines were published in October 2005.

## 1.2 AIMS AND OBJECTIVES

The project aim was to establish the underlying reasons for slip, trip and fall accidents to professional drivers.

The objectives of the project were:

1. To identify the degree and causes of slipperiness of cab and trailer steps, 5th wheel and trailer floor.
2. To assess the best types of flooring used and available.
3. To identify tripping hazards.
4. To give an indication of drivers' 'normal practice' when accessing and egressing vehicles, including the frequency and purpose of accessing loads on the backs of trailers, and the provision and adequacy of on-board access equipment.
5. To identify the types of footwear used by drivers and their suitability as anti-slip footwear.

The types of vehicle included in this study were: Large Goods Vehicles (LGVs), Vans and Forklift Trucks (FLTs). Vehicles not included in the scope of this project were specialist vehicles such as tankers, tippers, refuse vehicles, skip vehicles, etc.

The intended outcome for this project is that the information may be used by the HSE, operators and manufacturers to reduce the number of falls from vehicles. Project conclusions may be incorporated into guidance and/ or standards and may be used to guide future research in the topic area. The information may also be used to encourage manufacturers to embrace 'Safety by Design'.

# 2 METHODOLOGY

A multi-faceted approach was taken in conducting this research, which was carried out in two main phases. The first phase involved the gathering of physical data from workplace vehicles (LGVs, vans and FLTs). The second phase involved the examination of attitudes from haulage industry stakeholders in relation to the underlying causes for falls from workplace vehicles.

Over the course of the project contacts were made with a number of organisations and industry bodies. Organisations that assisted in providing data included: distribution company, vehicle testing station, brewing companies, soft drinks company, steel manufacturer, vehicle hire companies, food companies, builders merchants, retail outlet, motorway service stations, dockside company, county council, facilities management company, haulage industry bodies and trade union body.

## 2.1 PHYSICAL DATA

Surface slipperiness measures, cab access systems and trip hazards were recorded from workplace vehicles using the following methodologies.

1. Slipperiness data from the load area, tail lifts and cab steps were taken where possible. Slipperiness was indicated by measures taken with the Pendulum, a device that measures the floor surface coefficient of friction (CoF). The higher the coefficient of friction (or pendulum slip resistance value (SRV)), the less slippery the surface. In general terms, SRV values above 36 indicate a low slip risk; SRV values below 25 indicate a high slip risk. The method is based on a swinging, dummy heel (using a standardised rubber soling sample) which is swept over an area of flooring in a controlled manner. The pendulum gives realistic CoF results with water or other contaminants, see Appendix E – "The Assessment of Pedestrian Slip Risk; The HSE Approach" for further explanation of the measurement of surface slipperiness.

2. Surface microroughness measures were also taken where possible. Microroughness gives an indication of surface slipperiness. Measurements of the Rz parameter were taken from surfaces. Rz is a measure of the total surface roughness of a surface, calculated as the mean of several peak-to-valley measurements of profiles in the surface. In general terms, the greater the microroughness value, measured in μm, the lower the potential for slip. The relationship between Rz and the Pendulum Slip Resistance Value (SRV) has been established by the Health and Safety Laboratory (and others) over a number of years by comparing Rz and SRV data collected from floor surfaces. As the relationship between Rz roughness and slip resistance is derived from the relationship between Rz roughness and SRV, greater importance is given to the SRV where both types of data are available. Where it is not possible to measure SRV, Rz roughness gives a good indication of slipperiness.

3. Step dimensions (heights and depths) to the vehicle cab and the 5$^{th}$ wheel area were measured along with the provision and placement of handholds. Access equipment to the load area was also recorded, taking note of the materials used, their state of repair and evidence of contamination.

4. Where tripping hazards were present, for example, on the load area details were recorded and photographs taken.

The slipperiness measurements presented in this report relate only to the surfaces under study at the time of testing. Materials may change significantly during their lifetime. Slip resistance is critically dependent on the level and type of contamination, wear, maintenance and effective cleaning.

In total, 64 Large Goods Vehicles (including 14 flatbeds), 18 Fork Lift Trucks and 6 vans were examined.

## 2.2 BEHAVIOURAL DATA

The second key aspect of the project was to establish stakeholders' attitudes towards falls from vehicles. Stakeholders included drivers, safety trainers, managers, trade union representatives and industry body representatives. Areas for exploration during interviews and focus groups were the underlying reasons for falls, and also recommendations for how falls might be reduced.

Two main methods of data collection were employed. These were semi-structured interviews and focus groups.

**Semi- structured interviews**

Interviews were carried out with 87 individuals, including drivers of LGVs (67), vans (8) and FLTs (12). Additionally, interviews were carried out with 7 driver or health and safety mangers.

The majority of interviews were conducted at motorway service stations when drivers were taking a rest break. Interviews were also carried out at various companies to capture specialist driving roles such as flatbed vehicles and FLTs. Drivers were first asked if they were willing to take part, with the aims for the project explained to them. Confidentiality of responses (both in respect to the individual and their company) was also assured. Interviews were conducted by two researchers, one to lead questioning, and the other to record responses. The interview schedule can be found in Appendix C.

The interviews were semi-structured, allowing both respondents and the interviewer to expand upon points of discussion as necessary. Topics discussed included: experience of falls; unloading activities; access provision; handling aid provision; slip/ trip hazards; effect of time pressures; effect of weather and suggestions for reducing falls.

Details of the driver's approximate age, vehicle type, years experience of driving, shift patterns and type of work (e.g., single or multi- drop load) were also recorded.

**Focus groups**

Focus groups were held to validate the findings emerging from the interviews, thus adding to the robustness of the study.

Three focus groups were conducted with LGV drivers. Two focus groups were held at the Transport and General Workers Union and the other was arranged through a beer distribution company. In total, 24 participants attended. A £20 cash incentive was provided for focus group attendees as the sessions were held outside normal working hours.

At the start of the session, the aims of the project were explained to participants. Reassurances were also given relating to confidentiality of responses. The focus groups lasted approximately one hour. Two researchers were involved in the focus group, one to lead the session and the second to record responses.

Photographs of vehicle access systems were used to prompt discussion. Other topics for discussion included experience of falls; access to the cab, $5^{th}$ wheel and load; loading/ unloading issues; design improvements and company attitudes towards health and safety (See Appendix D for focus group protocol).

# 3 RESULTS AND DISCUSSION: LGVS

The LGVs examined included vehicles ranging from 7.5 tonnes up to 44 tonnes. The types of LGVs examined included non-articulated and articulated vehicles, with rigid containment, curtain-sided containment or open flatbed trailers.

In total, 67 interviews and three focus groups (24 participants) were conducted with LGV drivers.

## 3.1 CABS

Physical measurements were taken from 48 cabs. The cabs examined were made by a wide variety of manufacturers and ranged in size and height from those with one step to those with four steps. Cabs of all types of LGVs were found to be similar, so all data relating to cabs (both physical and behavioural) has been combined.

### 3.1.1 Physical data

Physical data was collected from 48 cabs.

**Step height**

A chart of the step heights for all of the cabs can be found in Appendix A, Figure 11. The largest step height was always between the ground and the first step. The smallest ground to first step height measured was 340mm, the largest was 530mm. Only four of the cabs measured had consistent step heights (cabs 5, 20, 46, 47), whilst the majority had inconsistent step heights. The majority of step heights (46 out of 48) were less than 400mm, with most falling in the range 250-400mm.

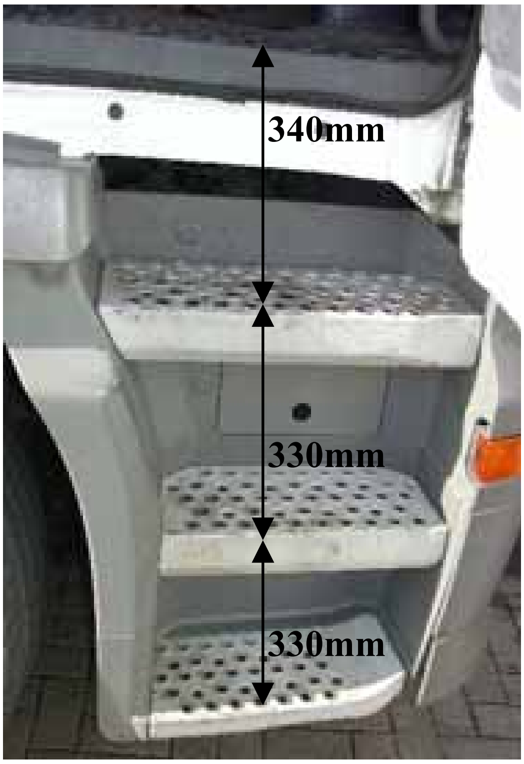

Figure 1 – Cab steps with consistent step heights.

In general terms Standards relating to access state that rise (step height) shall be constant wherever possible (BS EN ISO 14122-3:2001, Safety of machinery – Permanent means of access to machinery – Part 3: Stairways, stepladders and guard-rails). In relation to industrial stairs, BS5395-3:1985 (Stairs, ladders and walkways – Part 3: Code of practice for the design of industrial stairs, permanent ladders and walkways) states that consistency of rise (step height) and going (step depth) is of great importance for user confidence and safety. In terms of step risers (step height), maximum spacings of 400mm for steps and ladders and 250mm for stairways are recommended (BS EN ISO 2867:1999, Earth-moving machinery – Access systems).

BS EN ISO 2867:1999 states that the first step height should be no more than 700mm with 400mm being the basic measure. 38 of the 48 first step heights measured in this study were above this basic level of 400mm. Caws et al. (1999) described five biomechanical problems connected with too great a first step height:

- A bent knee posture does not allow a person to produce as much force as one in which the legs are straighter.
- The greater the height one steps down from, the harder it is to lower the body in a controlled slow manner. This may increase the likelihood of ankle and spinal injuries.
- The higher the step, the harder it will be to bring the body's centre of gravity within its base of support, which may result in strains.
- Depending on the placement of the handrails and the height of the step, three point contact may be almost impossible to maintain as the descending leg reaches for the ground.

- Having only point contact (rather than whole foot contact) with the step increases the risk of slipping.

It seems intuitive that cab steps should be made as consistently as possible and within recommended dimensions as specified in related British and International standards. This will be especially important in circumstances where drivers are exposed to different cabs on a regular basis and may not be accustomed to the differences in dimensions between vehicles. Caws et al (1999) commented on the differences in quarry vehicle designs. They described how drivers that changed vehicles infrequently might expect handholds and step positions to be the same as their usual vehicle; any design differences may thus increase the chance of an accident.

**Step depth**

A chart of the step depths for all of the cabs can be found in Appendix A, Figure 12. The smallest step depth measured was 130mm, the largest was 270mm. In general terms, the larger the step depth the better the likelihood that a user can gain a good footing on the surface. 14 of the 48 cab steps measured had step depths less than 200mm. Figure 2 below, demonstrates how altering the depth of a stair tread affects the contact area made with the sole of the shoe. In addition, the lower schematic shows how restrictions on the height of a toehold can reduce the contact area made between the shoe sole and the step surface. BS EN ISO 2867:1999 recommends that tread depths should have basic dimensions of 200mm for steps and ladders and 300mm for stairs.

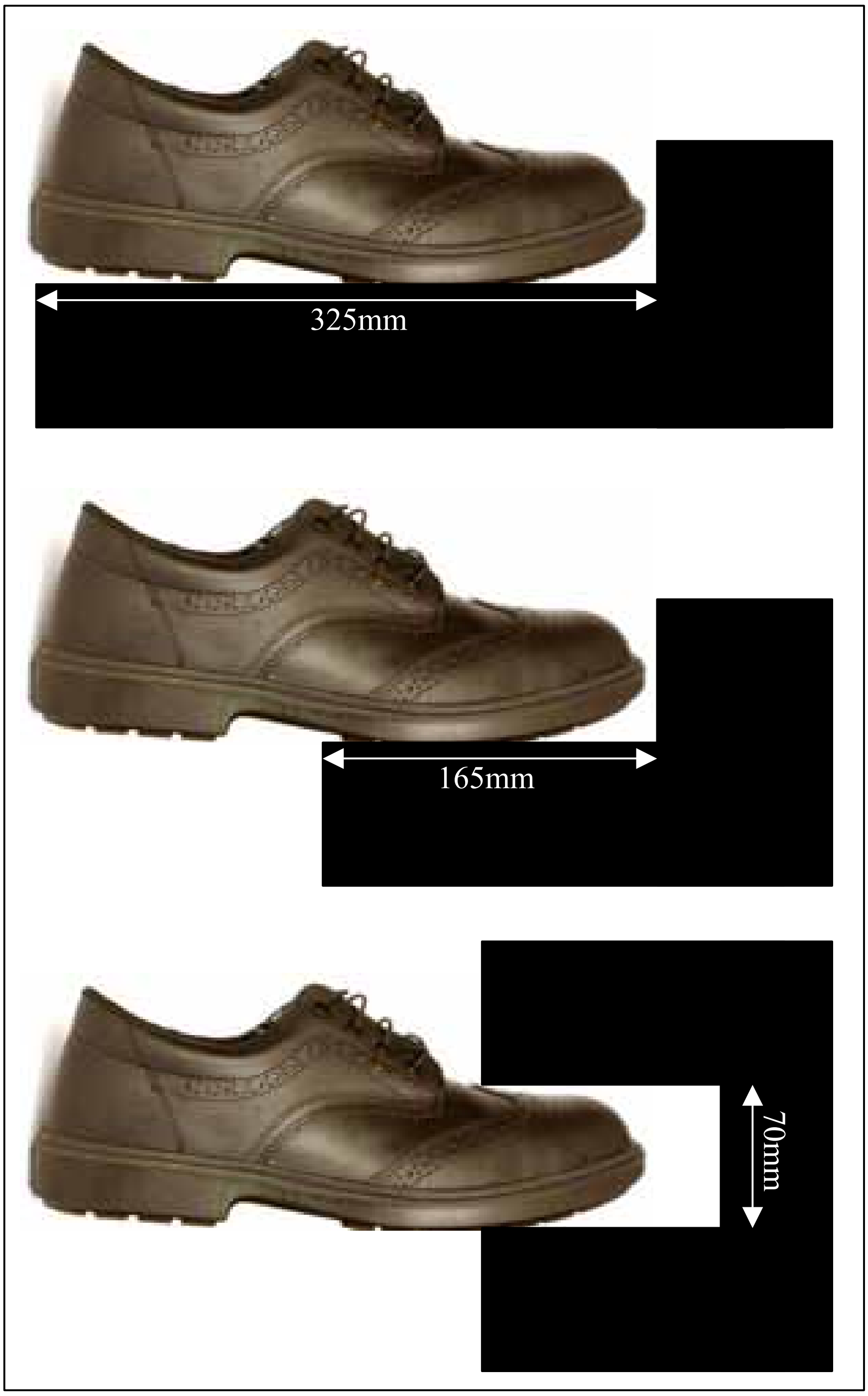


Figure 2 - Schematic of shoe contact area on steps

**Step materials and surface roughness**

The materials used in the manufacture of measured cab steps varied. On the whole, steps were made from metal with a profiled surface. Other materials used were plastic, plastic coated metal and rubber. A limited number of steps were seen with modified surfaces, such as abrasive tapes and high roughness fibreglass sheets.

Where possible, the surface microroughness of the cab steps were measured (n=11). The limited dimensions of some cab steps precluded the measurement of surface microroughness. Data relating to step microroughness can be found in Section 11.1, Appendix A. For metal steps with highly worn areas, surface roughness measures of below 10µm (Rz parameter) were commonly recorded. This indicates a very poor level of slip resistance in wet conditions, meaning that the potential for slipping is high. Metal steps with very low levels of wear were often lightly corroded, leading to roughness values of 20µm or more. Whilst this higher level of roughness would suggest adequate slip resistance in wet conditions, it should be considered that areas in this condition are not routinely contacted by the drivers' shoe. The area on the cab steps receiving the most wear tended to be on the outer edge of the step where the boot rotates over the edge of the step. As a result, this area tended to be the smoothest, and thus potentially the most slippery, just where the friction demand is greatest (Fig 3). Standards relating to steps used on machinery state that steps should offer satisfactory slip resistance to avoid any risk of slipping (BS EN ISO 14122-3:2001).

Figure 3 – High levels of wear is usually seen on the outer edges of cab steps.

For adequate slip resistance in clean water wet conditions, a minimum Rz surface microroughness of 20 µm is required. More viscous contaminants, such as dirty water, oil, grease, require more roughness to provide adequate slip resistance (see Appendix E). This higher level of roughness was only present where surfaces had been modified, such as with the addition of abrasive materials.

Cab steps are generally of a profiled design, which gives the possibility of a physical interlock with the cleats of the drivers' shoe. However, this is difficult to predict because the design of the cleats on shoe soles vary in layout, dimensions and depth. Figure 4 attempts to simplify the interaction of the shoe sole with a profiled surface in order to illustrate the issues. Figure 4, Interlock A shows a good interlock between the cleats of the shoe and the profiles surface. Figure 4, Interlock B shows that where interlock is poor, little is gained from the shapes of the surfaces and it is the surface microroughness which determines the slip resistance. Figure 4, Interlock C shows the same sole as Interlock A, but with the tread depth reduced by wear, to illustrate how the slip resistance experienced by the driver may change. When new shoes are used with a different cleating pattern, the extent of the interlock with the given surface will change.

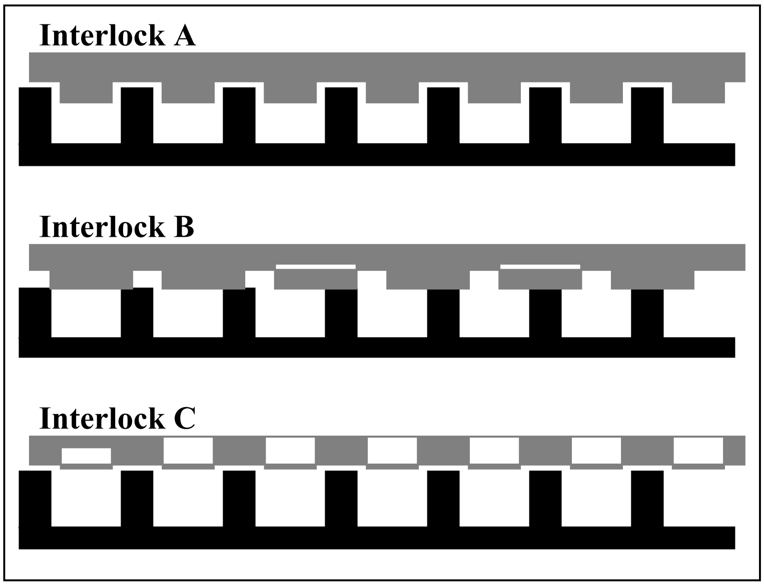


Figure 4 - Simplified schematic of interlock between the shoe sole and profiled step.

**Handholds and handrails**

The majority of cabs measured had handholds (See Section 11.2, Appendix A, for handhold height measurements). In most cases, handholds were situated both on the left and right-hand side of the cab steps. Their design varied in whether they were a continuous length just inside the cab door or a more discrete, shorter length. The height of handholds varied from 1180mm to 1760mm from the ground according to the size of the cab, which is usually determined by the load being transported, or the distance being transported. Larger tractor units tow heavier loads and cabs intended for long distance haulage tend to be taller. On the whole, vehicle cabs appeared to have satisfactory handhold and handrail provision.

Handholds and handrails provide a grip for the hands, thus forming part of the overall support system for accessing and egressing the cab. Handrails have the advantage that the hand can be slid along it without having to release grip completely. Handrails can also provide adequate hold for people of different body dimensions. It can be harder to correctly locate handholds for a wide variety of users i.e. for very short people. BS EN ISO 2867:1999 states that steps for earth moving machinery shall be co-ordinated with properly positioned handrails and handholds to accommodate the 5$^{th}$ percentile operator through the 95$^{th}$ percentile operator dimensions as defined in ISO 3411.

### 3.1.2 Behavioural data

Seven of the LGV drivers interviewed had experienced an accident that involved a fall from the cab. These incidents are summarised below:

- A driver missed the last step whilst getting out of his cab. He was driving a different cab to his usual one and thought that the different height of the steps was the reason for his fall ("because it was not what I was expecting").

- Three drivers slipped on the cab steps, either in wet conditions, or because they had diesel on their shoes, or both.

- A driver missed the bottom step when exiting the cab.

- A driver slipped when exiting the cab, there was also a pothole in the road and he lost his footing.

- The wind blew a cab door open, dragging a driver out of his cab. He hit himself on the cab steps as he fell. The driver described this as a “freak accident”.

Aspects of cab design were discussed both in one-on-one interviews and during the focus groups. On the whole, there was a consensus of opinion that cab design has improved over the last 20 to 30 years, from the point where drivers used to access their cabs by standing on the wheel and using the steering wheel to grab on to.

When asked whether drivers had any issues with the cab in terms of access or egress, responses included:

- The first step is sometimes spring mounted, which makes it prone to damage and it also increases the riser height to the second step.

- Large (overweight) cab drivers find it difficult to negotiate vertical access routes.

- Cabs are getting higher to improve road visibility, but this makes the climb into the cab more difficult.

- Step depths are not large enough.

- There are big differences between cab designs (in relation to steps) which can make it difficult to successfully negotiate alternate designs.

- Short drivers cannot always reach handholds from standing.

- Cab doors do not open wide enough, and the lack of space for access/egress is exacerbated by the cab doors becoming thicker to accommodate speakers for stereo systems, cupboard space etc.

- The parking of vehicles in close proximity to other vehicles or buildings constrains how wide the door can be opened, and this forces drivers to adopt awkward postures in accessing or egressing the cab.

There was a split of opinion as to whether cab design can be improved. Some drivers felt that the design is as good as it can get in terms of access. However there were some suggestions for improvement. These included moving the cab steps back towards the wheel arch so that drivers can ascend the steps square on to the cab, rather than on a diagonal, which induces twisting of the trunk. Another suggestion was to allow the cab doors to open wider to allow drivers to equally distribute their weight between the two handholds (currently, drivers tend to pull much harder on one handhold than the other because of space constraints).

Some drivers admitted to jumping out of their cabs, and usually they said that they did this to save time, “You might have problems if you try to get out (the cab) too quickly and are not concentrating”. Despite the propensity to jump, drivers are fully aware of the proper way to access and egress a cab, “There’s only one way to access a cab, and that is facing into the cab and maintaining three points of contact at all times”. One driver felt that 95% of drivers followed the three points of contact rule. This small number of drivers who jump out of cabs is in line with Walker (2004) who found that 10 accidents out of 448 had been caused by a driver stepping or jumping out of the cab.

Cab entry is included in the LGV driving test, though very few drivers reported that they had ever been trained in cab entry or egress. Drivers of a brewery fleet said that cab access is included in their training and refresher training.

## 3.2 5TH WHEEL

The 5th wheel is the device that couples the trailer to the tractor unit of a large goods vehicle. Drivers (and occasionally maintenance personnel) are required to climb onto the 5th wheel area, in order to link up the airlines and the electrical connections from the cab to the trailer unit (Fig 5). Drivers must do this every time they change trailer units. The frequency that drivers change trailer units varies greatly from a few times a day to less than once a week for long-distance drivers.

Figure 5 – 5th wheel area of an LGV

### 3.2.1 Physical data

There is a great deal of variation in the layout and the surfaces used in the 5th wheel area. Often there are steps / ladders to assist access to the 5th wheel area, and normally there will be a handhold to facilitate access.

Step height data for the $5^{th}$ wheel area is presented in Appendix A, Figure 13. In all cases, the first step height was the greatest. A first step height of 800mm was recorded in one case, which is above the maximum step height of 700mm recommended in BS EN ISO 2867:1999 for earth moving machinery. The lowest step height measured was 120mm. In some cases, there was considerable variation in step heights for the $5^{th}$ wheel region (e.g. see vehicle 9 in Figure 13). The step depths measured in the $5^{th}$ wheel area tended to be relatively narrow, with 100mm being a common measure.

Due to its position next to the diesel tank(s) on the vehicle, the surfaces in the $5^{th}$ wheel area tend to become contaminated with diesel. Drivers reported that it is easy to spill when refuelling and it was observed that on many vehicles the diesel tank and surrounding area was contaminated with diesel. Where steps are inset into the fuel tank, this makes it difficult, firstly to position the foot firmly in the constrained space of the foothold, and secondly to avoid slipping due to potential contamination by diesel.

The surfaces used in covering the $5^{th}$ wheel area (including battery unit) tend to be profiled metal or plastic surfaces. Often, a 'patchwork' of surface materials is used such that there is very little consistency. Profiled surfaces generally offer less slip resistance in wet or contaminated conditions than is perceived by designers. Where a physical interlock with cleats on the shoe occurs, slip resistance is good. In the worst-case scenario where there is no interlock of the shoe sole cleats with the profiled surface, it is the surface microroughness of the peaks of the profile that is critical. Where a mixture of surfaces are used, a particular shoe may interact well with one surface, and poorly with another, giving the operator an inconsistent level of grip. Often, slip accidents occur when there is a significant change in available friction, such as when walking from a good, slip resistant surface to a slippery surface e.g. when walking from a dry surface to a wet surface that has just been mopped. Consistency in surfaces used adjacent to one another eliminates this potential hazard.

Consideration should also be given to the manual handling tasks undertaken in this area. Attaching the air lines for the trailer braking system requires reasonable physical force from the driver, which will increase the friction demanded of the surfaces, increasing the likelihood of a slip.

Sometimes, the $5^{th}$ wheel region has areas that are not covered, for example between the chassis members. The reason for not completely covering the $5^{th}$ wheel area may be for ease of access for maintenance purposes. However, this leaves the driver to walk on a very uneven surface, made up of chassis rails, compressed air tanks, fuel tank etc. the surfaces of which are generally smooth, and therefore slippery in wet conditions. The uneven nature presents a trip hazard.

### 3.2.2 Behavioural data

Interviews with drivers revealed two fall incidents that had occurred from the $5^{th}$ wheel area, these incidents are summarised below:

- A driver slipped sideways from $5^{th}$ wheel and broke his ankle. There was wet weather at the time: his shoes were wet and the catwalk surface (surface covering the $5^{th}$ wheel) was wet.

- A driver fell off a greasy catwalk. He sprained his ankle, and took seven weeks off work.

A number of issues concerning the 5th wheel region were raised during interviews and focus groups and these are summarised below.

- Spilt diesel, grease and dirt on the 5th wheel are slip hazards.

- There is often a lack of space for coupling up airlines and electrics in the 5th wheel area. Coupling up is a physical activity and requires pushing and pulling. The limited space in the 5th wheel region constrains this activity. Some drivers cope by manoeuvring the trailer at an angle, near to the tractor unit, coupling up the lines, and then reversing to properly join the two units. This practice is dangerous because the braking system is not fully secured and there is a risk that the trailer may move, and is discouraged by the HSE (HSE, 2002).

- Given the constrained space at the 5th wheel region, large (overweight) drivers find it especially difficult to manoeuvre around this area.

- Wet weather can make the 5th wheel slippery.

- Catwalks can be flimsy and bend when walked on.

- Where footholds are positioned in the diesel tanks, often these are not large enough to accommodate a driver's shoe.

- Often there are no handholds to assist access to 5th wheel area.

- Where there are grab rails along the inside of the fairings, the fairings often do not pull back enough to give adequate access to the rails.

- The wires attached to the device that operates the tail lift can pose a trip hazard.

Suggestions were put forward to improve the functionality of the 5th wheel region. Some drivers had encountered trailers with a sliding contraption which enables better access to the airlines. The suggestion of non-return valves on airlines means that less force would be needed for coupling up and therefore less space for manoeuvring would be required. Drivers felt that it was dangerous to be in a confined space with the hazard of backward pressure present. The provision of non-slip surfaces were also suggested, as were adequate cleaning facilities for removing grease and diesel spills.

## 3.3 ENCLOSED LOAD AREA (RIGID AND CURTAINSIDED VEHICLES)

The load area is the space on the vehicle used for the carriage of goods. The load area is enclosed either by a rigid shell or by 'curtains'. The trailers tend to be built by vehicle body builders to the specification stipulated by the company and within the constraints of the Construction & Use Regulations. The vehicle cab, chassis and mechanical systems are type approved to ensure compliance with the regulations. However, body builders work on the vehicles after this stage, and it is understood that there is no inspection process for bodywork, until the first MOT test.

### 3.3.1 Physical data

**Surface materials**

The materials used for the surface of the vehicle beds varied. Many vehicle beds were made from layered plywood, finished with a resin coating. Often the resin surface has a light profile scored into it, or a profile rising from the surface. Surfaces used on operating goods vehicles should be capable of providing adequate friction to prevent loads moving and to protect operators from slipping accidents, particularly under contaminated conditions. The surfaces generally used in refrigerated load areas were more consistent with those you would expect to provide good pedestrian slip resistance.

Wooden planks, epoxy coatings and metal chequer plate or metal durbar are also common materials used for vehicle beds (see figures 14-21 in Appendix A).

**Pendulum and roughness measurements**

Where possible, Rz microroughness and pendulum slip resistance value (SRV) data were generated from the load area surfaces (See Section 11.3, Appendix A).

Without exception, the materials used present a low slip potential in clean dry conditions (Pendulum SRV > 36).

When wet contamination was introduced (such as that from rainfall), the slip resistance was reduced. On some surfaces, the slip potential remained low (Pendulum SRV > 36), but on others the slip potential was increased to a high level (Pendulum SRV < 25), and as such pedestrians would be expected to have difficulty walking on these surfaces (see Appendix B). Most materials were measured in various states of wear, and the slip resistance varies accordingly. Some of the surfaces have improved slip resistance with wear; whilst others have reduced slip resistance due to wear. Manual handling operations would increase the friction demand, thereby increasing the slip potential. Where the driver has to unload the vehicle whilst it is parked on a hill, the friction requirement is increased, with for example a 5° slope increasing the required SRV from 36 to 45.

The materials have been ranked below, from best to worst, in terms of typical slip resistance values with water contamination.

1. Resin & Aggregate
2. Square Profile Resin Plywood
3. Durbar Profile Resin Plywood
4. Hexagonal Profile Resin Plywood
5. Plywood
6. Painted Plywood
7. Wooden Planks
8. Wide Aluminium Strip

Surface microroughness measurements show that the slip potential is significantly increased around the edges of most load areas, where the surface material changes to the smooth steel structure of the vehicle (See Section 11.4, Appendix A). This smooth threshold is the critical area because the operator would fall from the vehicle if a slip occurred. The shape of the threshold is important: square edges are better than rounded edges because they increase the effective tread depth for pedestrians. This reduces the likely overhang of the foot/shoe, thus keeping the pedestrian's centre of gravity within their base of support.

The slip resistance of these areas is improved when the surface microroughness is higher, which often occurs due to scratching of the surfaces during loading and unloading operations or light surface corrosion. Aesthetics are obviously a consideration for manufacturers and operators, with some surfaces finished with high gloss paints, or polished metal. Unfortunately, these smooth surfaces significantly increase the slip potential.

The correlation between Rz surface microroughness and Pendulum Slip Resistance Values was not very good on the wooden surfaces studied in this project. The use of Rz measurements of surface microroughness can produce misleading results, especially with directional surfaces such as wood. For example, roughness measurements will be higher across the grain than along the grain. Thus, Rz results require careful interpretation when measuring directional materials. However, Rz does provide a useful indication of slip resistance in situations where test methods such as the pendulum cannot be utilised, such as on steps. HSE's Slip Assessment Tool (SAT) uses Rz data. Hence, it is recommended that expert advice is sought if using Rz measures on directional surfaces such as wood. For details of the SAT, see the HSE SAT website, www.hsesat.info.

Vehicles were observed with modified surfaces, designed to tackle the issue of pedestrian slips. Anti-slip paints and abrasive tapes have been used to give a high roughness finish to critical areas of vehicles, such as the threshold around the load area.

**Load area access**

Observation of vehicles revealed that occasionally, steps or ladders may be fitted to the rear of a goods vehicle to assist with access onto the load area. Sometimes, vehicle body builders may fit these, or the company operating the vehicle may add them. The robustness of these ladders or steps varies. In some cases, 'fold-out' steps are provided, which give substantial footings up to the vehicle load. In other cases, the ladders may be relatively flimsy, made from light aluminium material, and prone to becoming damaged. The condition of the steps or ladders varies. Some have been damaged over time, and others seem not to be used at all – perhaps perceived as a waste of time by the driver of the vehicle.

It was observed that handholds rarely accompany the steps or ladders fitted on to vehicles. If the steps or ladders are positioned to one side of the rear of the vehicle, the driver may be able to use the side of the vehicle as a handhold to assist entry.

Where designated steps or ladders are not present, drivers may use the rear bumper or impact barrier as a step up. The rear bumper is not designed with the intention of it being used as a step; however often there is evidence both of anti slip paints or materials being added to the step to reduce slip potential. These modifications and the presence of footprints suggest that rear bumpers are often used as a step.

### Side impact barriers

Side impact barriers are usually made from metal materials (steel or aluminium). Sometimes these materials are finished with paint. Freshly painted impact barriers provide a very smooth finish. Microroughness values as low as 1.4μm were recorded for a freshly painted side impact barrier. Depending on the degree of paint wear or metal wear, the upper level of surface roughness for the barriers was 29.7μm. Due to the narrow nature of the impact barriers, pendulum measures could not be obtained. The minimum surface microroughness required for slip resistance in wet conditions is 20μm, suggesting that very few of the side impact bars observed would provide satisfactory slip resistance, even when contaminated with clean water. The profiled surfaces tend to be very subtle, compared with cab steps for instance, so this is unlikely to improve the slip resistance through interlock with shoe cleats regardless of footwear.

Side impact barriers are not intended as a means of access to the vehicle bed, however observation suggested that they are used for this purpose. Their usage as a step can be seen from evidence of wear on the barriers themselves. Barriers are often fitted with anti-slip materials such as ribbed metallic finishes or the addition of anti-slip coatings. This addition of anti-slip materials suggests that manufacturers are aware of the use of impact barriers as a step up onto workplace vehicles.

### Tail lifts

Mechanical tail lifts are fitted to the rear of an LGV where the vehicle will load or unload away from the depot. Observation suggested that there are two main designs of tail lift, either those folding underneath the rear of the vehicle, or those that fold up against the doors. The platform of the tail lifts tend to be made from aluminium, and usually have a ribbed or profiled surface. Some of the platforms have ‘flaps’ which are used, primarily to ensure the load wheeled onto the platform does not roll off.

Pendulum data suggests that tail lifts offer adequate slip resistance in clean dry conditions, as would be expected.

In wet conditions, tail lifts tend to present a high slip potential. Both Rz surface microroughness (generally < 10μm) and pendulum slip resistance values (generally < 25) support this. The profile of the lifts tends to be directional, so that they provide greater slip resistance walking directly to and from the vehicle, but very little slip resistance when walking across from one side of the vehicle. This may be intentional, as the ideal route with goods may be directly across the platform, but commonly they are of insufficient size and the operator has to manoeuvre the load in all directions. For roadside deliveries, the load may be taken off the side of the lift onto the pavement, again necessitating the use of the surface in all directions. The tail lifts which did offer satisfactory slip resistance in wet conditions were those which were older and had suffered more wear and scratching, increasing the surface microroughness (See Section 11.5, Appendix A).

Certain tail lift designs introduce a potential trip hazard (see Fig 6). It may be foreseeable, that a driver unloading goods may walk backwards, and trip over this ‘lip’. Similar platforms without this lip are in use, suggesting it could easily be redesigned to eliminate this problem.

Figure 6 – Tail lift design that could result in a trip.

Two vehicles were seen which had handrails guarding the sides of the tail lift, to prevent drivers from falling. In one case, the handrails were hinged from the platform, and the driver only lifted one side into place, risking tripping over the other whilst working on one half of the platform.

BS EN 1756-1:2001 (Tail lifts – Platform lifts for mounting on wheeled vehicles) sets out the requirements for the design of tail lifts. The standard states that the platform surface shall be resistant to slipping and that it shall be easy to remove hazardous substances, particularly ice, snow and fluid without damaging the surface. In addition the standard states that any platform on which an operator may walk or stand shall be free from any permanent impediment that might cause tripping with the following exceptions: 1) a safety barrier 2) a deployed stop device 3) when not exceeding 25mm: any lighting device, control for a stop device or any foot control. Any part of the platform on which an operator may not walk or stand shall be clearly marked.

### 3.3.2 Behavioural data

A number of drivers interviewed had experienced a fall on or from the load area. Some of these incidents are summarised below:

- Dismounting backwards off the side of the trailer using side impact barrier, driver could not see the ground and fell onto the curb landing on his back.
- On load area, the load moved knocking driver off. The driver broke his ankle and damaged his knee.
- On the trailer, driver fell through a rotten floorboard and broke his wrist.
- Slipped on load bed when it was raining.
- Stepped backwards into ‘air’ from a box trailer resulting in a bruised hip.
- Getting onto the back of a trailer, it was raining and the vehicle bed was wet, driver slipped off the vehicle bed and hurt his shoulder.

When asked about unloading operations, different drivers were involved to different extents. Some drivers were not involved in unloading at all and simply had to open their curtains, some drivers were involved occasionally and other drivers were always involved with unloading. The unloading itself ranged from 'handball' (physically lifting the goods off), to the use of handling aids (e.g., sack trucks, trolleys, roller cages) and also fork lifting goods off on pallets. Sometimes unloading may take place at designated loading bays, whilst on other occasions tail lifts to street level may be required.

Some of the issues concerning access to the load area were as follows:

- Trailer beds can get wet and icy in inclement weather, making the surface slippery.
- In wet weather, one driver said he would be particularly wary of stepping on steel surfaces used on the threshold of many trailers.
- When loads are packed tightly, it is difficult to move and have adequate space to work in.
- Where trailers do have slide-out ladders it is difficult to push them back in once on top of the load (in order to avoid damage to the ladders by forklift trucks).
- Some vehicles have side-skirts to cover up the side impact barriers and to create a better 'look'. In some of these skirtings, there are no footholds which restrict access to the load.
- Shrink-wrapping in the back of trailers can cause trips.
- If pallets are ordered wrongly for unloading, the driver will need to climb up onto the trailer to rectify the situation, he may use the pallets as a climbing frame, running the risk of upsetting the load.
- Some forklift truck drivers will lift LGV drivers up onto the load with their FLT. This presents an obvious risk of falling.
- Overweight drivers find it difficult to access the trailer if there are no dedicated steps for this purpose.
- There seems to be a lack of clarity concerning the new Work at Height Regulations (2005). Some depots will not allow drivers to access trailer load areas without a fall arrest harness, whilst at other locations there are no enforced restrictions.
- In refrigerated vans, condensation often forms on the trailer surface creating slippery conditions.
- Some drivers commented that the rungs of fold out ladders are very narrow and do not provide adequate support.
- Fold out steps are often broken or damaged by forklift trucks.
- Lighting can be poor and drivers may find themselves feeling for steps and hand holds in the dark.
- Cardboard from returns is often wet and it transfers moisture onto the load bed making it wet and slippery.
- Where additional access equipment is provided, often it is not used e.g., monkey ropes are permanently tied up and ladders become seized up through lack of use.

Suggestions for improving access to the load area were put forward during interviews and focus groups. Suggestions were as follows:

- Some companies, that drivers have visited, enforce the use of ladders etc to access the load.
- Anti-slip coatings e.g., resins, fibreglass, gritted paint and antislip tape should be used where possible (including tail lifts).
- Where ladders and handholds are provided, overweight and older drivers found them particularly useful.
- Lower the trailer bed e.g., by using air suspension.
- Provide better lighting.
- Place handholds at a convenient place in relation to steps.

- Some companies have checklists to be signed at the beginning of each day to say that, for example, steps are in good condition and can be used.
- Provide waste disposal facilities for waste cardboard etc.
- Encourage good housekeeping of load area.
- Rigid handholds are better than, for example, movable monkey ropes.

It was interesting to hear from a number of drivers that there is a certain degree of expectation that "Everyone falls off a trailer at some time". It seems that drivers might accept this as a hazard of the job.

In relation to tail lifts, the main issue seems to be when they get wet from inclement weather and become slippery. One driver commented that chequer plate, often used on tail lifts is "the worst surface you could have" with reference to slipperiness.

Some drivers reported to have anti-slip finishes on the tail lifts of their vehicles. These were said to be effective, if they are maintained adequately. Handrails were also present on a minority of vehicles to prevent falling from the lift sides. Some tail lifts were cited to be temperamental, breaking down on occasion. Some tail lift designs did not seem to be conducive to use, "I haven't used a tail lift in 8 years".

## 3.4 OPEN LOAD AREAS (FLATBED VEHICLES)

Flatbed vehicles are used primarily for transporting heavy and bulky loads. Flatbeds are often used when an overhead crane is required to lift the load from the vehicle, which prevents the use of closed load areas. Typical goods carried on flatbeds are steel and heavy building materials. The flatbed is usually in the form of a cab unit with a detachable trailer forming an articulated load.

The flatbed trailers seen in this study were made in a standard fashion. The trailer consisted of a steel chassis frame, usually with hardwood timber fastened to the frame to carry the load. The timber is usually in 'plank' form, which allows the replacement of specific areas when any damage occurs. It was suggested that many of the flatbed trailers in use are old curtainsided trailers cut down and refurbished to extend their life.

Two main types of flatbed trailer were seen: those without side barriers, and those with drop down sides. The latter type also had capacity for a crane to be housed on top of it, to allow independent unloading at building sites.

### 3.4.1 Physical Data

**Surface condition**

The condition of the trailer surfaces varied between vehicles and related to the state of repair of the trailer. The surface often becomes damaged with wear and tear from the load. Forklift trucks may also dent the side impact barriers and the wooden surface of the load. Some of the wooden planks were in a very poor state of repair with broken planks and protruding nails presenting foreseeable trip hazards (Fig 7).

Figure 7 – Damaged plank presenting a trip hazard.

Drivers commented that the load areas sometimes become covered in a film of algae or moss during wet weather conditions if the trailers are left outdoors. At the time of testing, there was no evidence of such growth, but this was probably due to the fair weather conditions at the time. It may be expected however, that if the surface were covered with either algae or moss, the slip potential would increase.

**Microroughness and pendulum measures**

The material normally used to construct the load area is wooden planks. Keruing, a hard wood is commonly used for this purpose. Where possible, Rz microroughness and pendulum slip resistance value (SRV) data were generated from the load area surfaces. Section 11.3 in Appendix A details the slip resistance values generated from the wooden surfaces.

The sample of flatbed trailers included vehicles with relatively new wooden planks and those with well-worn planks. The newer planks tended to have a higher slip resistance values in both the dry (64) and water-wet (29) condition as compared to older planks (60 dry, 24 wet).

Without exception, the materials used presented a low slip potential in clean dry conditions (SRV > 36). When wet contamination was introduced (such as that from rainfall), the slip resistance was reduced. On only one wood surface did the slip potential remain low (SRV > 36). On the others, the slip potential was increased to a high level (SRV < 25), and as such pedestrians would be expected to have difficulty walking on these surfaces. Manual handling operations would further increase the friction demand, and therefore increase the slip potential.

The correlation between Rz surface microroughness and Pendulum Slip Resistance Values is not very good on the wooden surfaces studied in this report, and therefore surface microroughness may offer limited value in terms of understanding the slip potential of these surfaces.

Surface microroughness measurements show that the slip potential is significantly increased around the edges of most load areas, where the surface material changes to the smooth steel structure of the vehicle. This smooth threshold is the critical area that would see the operator fall from the vehicle if a slip occurred. The slip resistance of these areas is improved when the surface microroughness is higher. This is often due to scratching of the surfaces that occurs during loading and unloading operations or light surface corrosion. Several trailers were observed with a raised lip around the threshold, posing a trip hazard.

**Access to the load**

*Flatbeds without side barriers*

It is necessary for drivers to access the load bed to prepare the surface for receiving the load and for sheeting and unsheeting operations, if this is conducted manually. Access provision to the load area for flatbed vehicles is limited. HSE guidance (2000) states that delivery plans should minimise the amount of time that an individual is on top of the vehicle. Access to the vehicle should normally be via steps, a loading gantry, or some other built in means. Otherwise it should be from the front of the vehicle and around the headboard, never via the sidebars.

From the vehicles examined, there were no alternative access routes to the load bed, other than the $5^{th}$ wheel access and the side impact barriers. However, after the data collection phase was complete, a flatbed with rear access ladders was observed by one of the researchers. The side impact barriers are not considered a safe means of access since they are often positioned slightly under the load bed, so that the driver has to negotiate his way over the lip of the load bed, which is a difficult manoeuvre. The rear 'bumper' may also be used as a step, but once again is not intended for a means of access. Both the side steps and rear bumper on flatbeds are positioned away from any handholds, further increasing the difficulty of accessing the load. With a load in place, it is likely that the operator would use the load itself or strapping as a handhold, which may not be strong enough to support the weight of a driver. It is worth noting that the height of the load above ground is quite substantial (generally 1 – 1.3m), and thus the consequences of a fall could be serious.

*Flatbeds with drop-down sides*

A number of builders merchants' vehicles were assessed with additional access systems to their load area. In a selection of vehicles, two single steps were fastened to the drop down side barriers, such that they could be used for accessing the load area (Fig 8). It should be noted that when this photo was presented to drivers at one of the focus groups, they thought that the steps looked flimsy and would not be particularly durable. Also, fold out ladders were provided at the rear of the vehicle, which could be stowed away when the vehicle is in motion.

Figure 8 - Fold out steps on drop-side flatbed trailer

The surface materials used on the load area were equivalent to those used on flatbed vehicles without any side barriers (wooden planks).

### 3.4.2 Behavioural Data

Thirteen flatbed drivers were interviewed, either at motorway service stations or at a steel distribution company.

When asked if the driver had ever experienced a fall from, or on their vehicle, eight drivers said that they had experienced a fall, and five said they had not. Summarised below are some of the incidents that occurred.

- Whilst sheeting in the rain, driver slipped on the vehicle bed and fell off.

- Whilst sheeting in snowy conditions, driver fell over the side of the vehicle. The vehicle bed was also greasy which resulted in the slip.

- Whilst unsheeting, the driver stepped backwards onto ‘air’ and fell.

- Driver tripped on the load, fell backwards and had seven weeks off work with back trouble.

- Driver tripped on the wire that bound the load.

- Driver fell through a vehicle bed up to his knee, this was due to a broken plank. He hurt his back and took five and a half months off work.

Flatbed drivers often need to climb onto the vehicle bed in order to sheet and unsheet the load. The unloading itself is usually carried out by machinery, given the heavy and bulky nature of the loads. One company’s suggested method for mounting a flatbed is to climb on to the vehicle at the 5$^{th}$ wheel and to then climb over the headboard, which they thought provided easier access than mounting using the side access bars. However, accessing the load at the 5$^{th}$ wheel area, which is close to the diesel tank means that the drivers’ footwear may become contaminated with diesel which results in slippery underfoot conditions. Drivers more commonly use the side impact bars as a means of access and they may use the load itself as a handhold. The use of the load as an anchor point means that the driver may upset the load and fall backwards.

Flatbed drivers on the whole did not receive formalised training in sheeting, vehicle access or unloading. Their experience was assimilated over time, with learning taking place through trial and error or by learning techniques, such as sheeting, from colleagues.

When asked about time pressures in their work, drivers responded differently. Some claimed that time pressures did not affect them at all, with the opinion that becoming stressed is pointless. Some drivers had a system of work by which they were paid per load transported, which encourages rushing. Frustrations were aired in relation to unloading points, where different premises take varying amounts of time to unload, which can result in queues forming for unloading.

A common problem was that of a lack of space for unloading, especially at customers’ premises. One driver said that he had refused to drop a load because the lack of space to carry out the unloading was unacceptable.

Flatbeds are particularly susceptible to inclement weather such as rain, ice and snow. Precipitation can cause the surface to become slippery, which can pose problems when the driver needs to walk across the vehicle bed. Unloading operations often occur outdoors so exposure to the elements is common. Also cited as being problematic was sheeting in windy conditions. One driver commented that, “In the wind a 40ft sheet will lift you into the air”. Obviously this could pose a problem for falls if the driver was to land awkwardly. Shelter from the elements is thus extremely important in protecting the vehicle and driver from precipitation and wind.

When asked about access to the cabs, most drivers reported to be satisfied with the cab design. Two drivers commented that cab design has improved greatly over the years, where previously drivers had to access their cab by climbing up the wheel. Steps and handholds have also improved this situation in recent years.

Suggested design improvements to facilitate access to the load area included: on-vehicle steps or ladders, or the provision of off-vehicle ladders, steps or gantries at loading or unloading points. One driver commented that, “gantries are brilliant, they help a lot”. One driver who suggested the addition of steps to the flatbeds commented that, “steps at the back and side of the trailer would be used by modern, unfit drivers”.

When drivers were asked what they perceived to be the main cause for falls a number of different responses were cited and included: inclement weather; oil contamination on the vehicle bed; difficulties in walking over a sheeted load (which disguises potential trip hazards) and uneven planks on the load area.

Suggestions to reduce the likelihood of falls included: provision of steps and platforms at loading/ unloading points; provision of covered loading bays to prevent exposure to precipitation and wind, and steps and ladders on the vehicles themselves. It was interesting to note that none of the drivers cited fall arrest harnesses as potential prevention measures, most probably because their use will delay their work.

When drivers were asked to summarise whether they felt falls were an issue, a common response was that they weren't much of an issue because they were, "down to common sense" and "care and attention".

The distribution manager and the health and safety manager of a steel distribution firm were also interviewed. In terms of interventions, they felt that alterations to the wider work environment rather than the vehicle itself would be more plausible. Alterations to the working environment might include the provision of gantries or hydraulic platforms to improve vehicle access.

The managers commented that problems with delivery might occur at the businesses that receive the steel. Often these premises have limited space and the likelihood of platforms being installed is limited due to space constraints and cost implications. Another frustration was that customers often request their load to be sheeted; the primary reason for this is to keep the load dry. Often however, drivers will arrive at their destination and will be instructed to leave the steel outdoors without any cover. This circumstance was corroborated by a number of flatbed drivers interviewed. This practice therefore suggests that the sheeting of the load is not always required in the first instance, and often it is the sheeting procedure that exposes the driver to the risk of falling.

The managers also discussed the difficulties with assembling drivers at one time and place to deliver safety briefings. These briefings often have to be conducted on a Saturday morning with a number of sessions held to accommodate all of the drivers.

### 3.4.3 Good Practice - Gantry to assist unloading

On one of the visits, information was gathered regarding premises that had carried out alterations to its unloading area, to assist flatbed drivers (Fig 9). The premises had installed a platform to enable drivers to walk up a set of stairs and carry out strapping down and unloading from the side of the vehicle on the platform. This not only improved access, but eliminated the possibility of a fall from height whilst undertaking these tasks. Drivers that had visited these premises were satisfied with the modification and hoped that its occurrence would become more widespread.

Figure 9 – Platform to assist the loading and unloading of steel.

### 3.4.4 Trip Hazards

No official guidance exists to define the dimensions of a trip hazard. A HSL study (2003) commissioned by HSE suggests that the toe clearance of healthy individuals during normal walking gait is of the order of 14.5mm. Differences in surface level greater than this may, therefore, pose a trip hazard. The likelihood of a trip resulting in a fall is relatively low (approximately 10%). Other factors such as lighting, encumbrance and intoxication can increase the likelihood of a fall. In the case of workplace transport, the proximity to the edge of the vehicle when a trip occurs is also likely to increase the chance of a fall. Differences in level of less than 14.5mm may pose a trip hazard when a driver is working on a vehicle, perhaps tending to walk sideways or backwards whilst undertaking certain loading or unloading tasks.

Trip hazards were found on a number of LGVs, though their occurrence was not particularly widespread. The most notable trip hazards were where the surface of the load area had been damaged by impact or due to warping of the surface materials (See Fig 7). Where vehicles were decked with wooden planks, these have a tendency to warp and splinter, posing potential trip hazards. This was particularly apparent on flatbed vehicles. Protruding nails and fastenings also posed a trip hazard.

In some cases, the metal edging at the perimeter of the load area stood proud of the surface material of the main load area. It might be foreseen that this would pose a problem if a driver were to step backwards, and catch their heel.

In some cases, the design of tail lifts was such that the edging might pose a trip hazard (see Fig 6)

Other potential trip hazards include debris left in the rear of vehicles such as polythene wrapping, broken pieces of pallet, cardboard and other waste.

Some companies had vehicles where the fastening clips for load ties could drop down into the vehicle body rather than stand proud and pose a trip hazard (see Fig 10).

Figure 10 - Retracting fixing eye to avoid trip hazard

# 4 RESULTS AND DISCUSSION: VANS

The criterion for the selection of vans was to only consider those vehicles in which a person can stand upright.

Two generic designs of van were studied, panel vans, where the vehicle manufacturer assembles the vehicle body, and box vans where the cab and chassis are made by the vehicle manufacturer and a load box is added by a body builder. It is common practice for the interior of panel vans to be adapted by the owner, specifying the interior to their own needs, either making alterations themselves, or using a vehicle body builder.

## 4.1 PHYSICAL DATA

In total, 6 vans were assessed. In assessing each van, the following parameters were considered: cab access (step and handhold provision), access to the side of the van (step and handhold provision) and access to the rear of the vehicle (step and handhold provision). Also examined were the slip resistant properties of the surfaces used on the van floor. Where vans are fitted with a tail lift, these have been considered in Section 3.3, as the tail lifts are of the same type as those used on larger vehicles.

**Cab access**

Access to the cab of the van tended to consist of one (usually plastic) step, with a ribbed surface. The step is usually inset into the frame of the door with an average height of 420mm. In the vehicles examined, there were no handholds to assist entry into the cab, but given the relatively low level of the vehicle, a handhold is not essential. The driver may use the steering wheel as a handhold.

**Side access**

Most of the panel vans examined had side doors for accessing the load. The side of the van could be accessed with an inset step. The step tended to be made from ribbed plastic. The average height of the side step was 460mm. There were no handholds to assist with entry to the side of the vehicles, though the door surround may be used in practice.

**Rear access**

Access to the rear of the vehicle varied. Most of the vans examined did not have steps or handholds. However, a couple of vehicles had access steps and handholds at the rear, which were not fitted by the vehicle manufacturer but added later by the company. One of the vans had anti-slip coating applied to the step, which provided good anti-slip properties. Although access steps might appear to always be a good idea, more than one company mentioned that they had had problems with steps on vans: if fork-lift trucks are used to load the vans a step can prevent the fork lift truck from getting close enough to the load area to load safely. These companies said they had experienced damaged steps caused by fork lift trucks in the past, and now thought that having no step was an easier design for the driver to cope with. One company had removed the steps supplied with a new vehicle.

**Surface materials**

The materials used for the vehicle load area were relatively consistent. Common materials used were plywood and resin coated fibre boards (see Section 11.3, Appendix A).

Where possible, Rz microroughness and pendulum slip resistance value (SRV) data were generated from the load area surfaces. Without exception, the materials used presented a low slip potential in clean dry conditions (SRV > 36).

When wet contamination was introduced (such as water from rainfall), the slip resistance was reduced. On some surfaces, the slip potential remained low (SRV > 36), but on others the slip potential was increased to a high level (SRV < 25), and as such pedestrians would be expected to have difficulty walking on these surfaces. Most materials were measured in various states of wear, and the slip resistance varied accordingly. Some of the surfaces have improved slip resistance with wear; whilst others have reduced slip resistance due to wear. Manual handling operations would increase the friction demand, thereby increasing the slip potential. Where the driver has to unload the vehicle whilst parked on a hill, the friction requirement is increased, with for example a 5° slope increasing the required SRV from 36 to 45.

The threshold areas tend to be covered with the manufacturers' step material, which on the whole seemed to be designed to give good pedestrian slip resistance. This is also advantageous in terms of consistency throughout the vehicle.

**Trip hazards**

From the vehicles studied, very few trip hazards were noted, but trip hazards may arise after impact of loads on the load bed. Other potential trip hazards are the hooks on the load bed which are used to strap loads securely, but drivers were generally very aware of where in the vehicle bed these are located, and so do not find them to be a trip hazard.

## 4.2 BEHAVIOURAL DATA

Eight interviews were conducted with van drivers from a facilities management company, a city council and courier companies. A face-to-face interview was also conducted with the manager of a courier firm.

Four of the eight drivers interviewed had experienced a fall whilst carrying out driving work. Incidents included:

- A driver fell from the cab due to diesel on his shoes.
- A driver slipped in wet weather because of wet surfaces and wet shoes.
- When getting out of the cab, a driver stepped into a pothole and fell over.
- A driver stepped onto 'air' from a tail lift and fell over.

When asked about loading and unloading, all drivers replied that they were very often, or always involved. If the driver is transporting a heavy or awkward load, they may ask for assistance from the unloading premises. Sometimes there may be handling aids available such as sack barrows or trolleys.

In relation to training, very little was received with reference to falls. Most drivers had been trained in manual handling, and how to get goods out of their vehicles. A common response was that training specifically concerning falls would be 'common sense'.

Time pressures did seem to have a considerable effect on working practices. One driver talked of a friend who had to complete 120 drops per day, and the fact that if a person is unable to cope with this, "someone else will take his place". A van driver who carried out home deliveries for a supermarket commented, "with 30 drops a day, you'll be chasing time, but with 15, you can go steady". One driver described how with "increased stress [due to time pressures], you lose concentration [which might result in a fall]".

Wet and icy weather conditions did seem to influence the likelihood of falls, with 5 out of 8 drivers citing the weather as being problematic. The effect however, was linked to the environment beyond the van such as wet kerbs and icy pavements. One driver commented how they slipped on an icy path when carrying a delivery into a customer's home. Windy conditions may result in the van doors being blown open/ closed, which could injure the driver.

When asked about van design in the context of falls, a number of points were raised. One driver commented how he likes the low load level of modern vans compared to older models. It was suggested that all vans should have side doors so that unloading can be carried out onto the pavement rather than onto the road. Where tail lifts are fitted to vans, the use of colour (yellow and black suggested) to highlight the perimeter of the platform may be beneficial. The use of non-slip surfaces "thick abrasive cloth" is becoming more widespread on walking surfaces. In terms of improving van design, fixed steps at the rear were cited as being a good addition when accessing/ egressing the rear. At one stage a driver reported to carry a portable caravan step with them`, as the step up into the van was too high to negotiate in one movement.

There were mixed views as to whether falls are perceived to be an issue for van drivers. One driver said, "If you hadn't asked, I wouldn't have thought about it". Two drivers said that there is always room for improvement, especially in relation to van design e.g., inclusion of steps, anti-slip surfaces and colour contrasting paint. Another driver commented that as he has gained more experience in driving, he has come to realise that falls are usually the fault of the driver, in terms of not taking enough care or concentrating.

# 5 RESULTS AND DISCUSSION: FORKLIFT TRUCKS

There is a vast array of forklift truck types. The criteria for the selection of forklift trucks in this study was to consider only counter-balanced types used in warehouse environments, but which commonly travel outside for loading or unloading operations thereby becoming contaminated with rainwater during normal use.

## 5.1 PHYSICAL DATA

18 FLTs were examined. In assessing a forklift truck the following parameters were considered: cab access (step and handhold provision) and an assessment of the slip resistant properties of the underfoot surfaces in the compartment area (using the surface roughness meter).

**Cab access**

Most of the FLTs examined had profiled steps. The materials and finishes used included metal, rubber and paint. All of the first step heights measured were within the limits set out by BS EN 1726-1:1999 (Safety of industrial trucks), with the highest first step measured as 540mm. The standard states that for trucks with a compartment floor height greater than 550mm, a step or steps shall be provided. The first step shall not be more than 550mm from ground level and succeeding steps shall be evenly spaced at intervals not exceeding 550mm.

Where steps were cut into the sides of the bodywork, as is common practice, the dimensions of the cut out were small, relative to a typical safety boot with steel toecaps. This type of step is much harder to locate during descent, when the driver cannot see the foothold. One particular design of large FLT had chequer plate steps, with the diesel filler set into one step, inevitably leading to contamination of the step.

Most of the FLTs had handholds to assist cab access. Where handholds were not provided, often there was evidence of usage of the FLT frame as a handhold. Evidence to suggest this was wear of paintwork. BS EN 1726-1:1999 states that for trucks with a floor height above 300mm, handholds shall be provided which may form part of the truck structure.

**Surfaces**

The threshold of the FLT compartment floor often consisted of painted metal. Depending on the age of the vehicle, this threshold area often showed signs of considerable wear, where the driver's footwear rotates over the threshold during ingress and egress. Painted surfaces were often seen to be worn back to the steel frame.

Some of the companies visited added anti-slip materials onto their vehicles. Anti-slip materials included sticky-backed abrasive paper, or paints with incorporated grit.

BS EN 1726-1:1999 states that the compartment floor frequented by the operator, steps and walkways shall have a slip resistant surface, e.g., ribbed mats, abrasive coating or expanded metal.

**Surface microroughness**

The materials used in the manufacture of FLT steps varied. On the whole, steps were made from metal either painted and / or with a profiled surface. The only other material seen in use was rubber.

Where possible, the surface microroughness of the steps and compartment thresholds were measured. For metal steps with highly worn areas, surface roughness measures of below 10μm (Rz parameter) were commonly recorded. Metal steps with very low levels of wear were seen with roughness values of 20μm or more (Section 11.6, Appendix A). Whilst this higher level of roughness would suggest adequate slip resistance in wet conditions, it should be considered that areas in this condition are not routinely contacted by the drivers' shoe. The area on the steps receiving the most wear tended to be on the outer edge of the step where the boot rotates over the edge of the step. As a result, this area tended to be the smoothest with a rounded edge, and thus potentially the most slippery, just where the friction demand is greatest. The use of square edges (or nosings) on steps increases the effective tread depth of the step and thus reduces the amount of overhang of the foot. This reduces the likelihood of losing balance and falling (Roys & Wright, 2003).

For adequate slip resistance in wet conditions, a minimum Rz surface microroughness of 20 μm is required. More viscous contaminants, such as dirty water, oil and grease require more roughness to provide adequate slip resistance (see Appendix E).

FLT steps are generally a profiled design, which gives the possibility of a physical interlock with the cleats of the drivers' shoe. However, this is difficult to predict, and in the worst-case scenario, it is the surface microroughness which determines the slip resistance. This interaction is also likely to change with wear to the driver's shoes, or when new shoes are used with a different cleating pattern (see section 3.1.1 for further explanation).

**Trip hazards**

There did not appear to be many trip hazards on or around the FLTs examined. The main foreseeable trip risk would be debris or obstacles on the surrounding ground such as potholes or pallets.

## 5.2 BEHAVIOURAL DATA

Twelve interviews were conducted with FLT drivers from two depots of a multinational soft drinks company.

Of the twelve people interviewed, only one had experienced an injury whilst getting off a FLT. The individual had wedged his foot in the foothold whilst getting off the FLT and this resulted in a sprained ankle. This finding is in line with that found by Male (2003), who found that of 1204 industrial lift truck accidents analysed, only 4% involved a slip/ trip/ fall from a height of less than 2 metres. The most common cause of injury was being struck by a moving truck (49%).

When asked about training in relation to getting on or off FLTs, the main comments raised were that drivers should maintain three points of contact at all times and check the surrounding area for spills and obstacles before dismounting. These elements were included in the induction training for FLT drivers and also in the refresher training, which occurs at two-yearly intervals. Spills training also links into the reduction of falls, as surface contamination can initiate a slip. A commonly cited contaminant is oil, which may leak from the FLTs.

Concerning vehicle design, most drivers reported their vehicles to have anti-slip surfaces on parts of their vehicles, for example, the threshold of the compartment floor on the dismounting side. Anti-slip surfaces included paint with grit incorporated in it and sticky-backed abrasive paper. Rubber was also a common material for compartment floors. Some drivers commented that the anti-slip surfaces are not always maintained in good condition as a result of wear.

When asked about improvements to FLTs all responses concerned factors unrelated to falls such as visibility when accessing pallets, cab heights and seat comfort.

Although falls were perceived to occur rarely, when asked what the main causes for falls were, drivers cited oil spills, debris (e.g., wood from pallets) on the ground, water shed from lorries and also fatigue, "At 3am you tend to get accident prone".

The main suggestions for reducing falls were to maintain three points of contact and to clear away spills and obstacles. The company in question also had in place a spills procedure in which oil leaks were treated with absorbent powder and then swept up. The company also had a vehicle pre-check card which included a diagram of an FLT. One of the pre-checks was to ensure that the FLT cockpit is dry, clean and free from debris.

Most drivers felt that falls could take place, however their rarity meant that drivers were not unduly concerned by the hazard. If three points of contact are maintained and the driver is aware of slip and trip hazards, then falls should not be too problematic, "STFs are not an issue, but you need to be aware of them".

# 6 WIDER INFLUENCES AFFECTING DRIVER BEHAVIOUR

A number of wider influences upon driver behaviour were identified from the interviews and focus groups. These influences may affect a driver's behaviour directly or indirectly, and affect their likelihood to experience a fall. These influences can be broadly defined into three categories: individual, organisational and environmental, and these shall be discussed in turn.

## 6.1 INDIVIDUAL INFLUENCES

**Age**

In general, older drivers seemed less likely to jump from their vehicles or to rush. Quotes from older drivers included: "I don't jump anymore I climb", and "I'm too old to fall, I wouldn't get up". Younger drivers on the other hand seemed more likely to jump down from or onto their vehicles. One driver in his late twenties recognised that age affects how easy it is to access an LGV, "I'm young so I don't have any problems accessing the vehicles".

The propensity of older drivers to take fewer risks may reflect health issues or experience of falls earlier in their career, which makes them less likely to jump or rush unduly. These factors are discussed below.

**Health**

Driving an LGV involves a great deal of climbing up and down from cabs and load areas, especially for those drivers who carry out multi-drop work. The technique used in egressing the cab or load will affect the health of the knee joints and the structures in the back. Jumping out of a cab exerts a high torque at the knees and high compressive forces within the spine. Sustained static postures whilst driving also produces stiffness in the back. Jumping from a cab after prolonged periods of driving is therefore a risky habit. Drivers with 20-30 years in the industry reported to have back complaints and bad knees, and these individuals now have no choice but to climb from their vehicles, because jumping is too painful.

**Weight**

The subject of obesity in drivers was raised regularly in interviews and focus groups. Being overweight makes it difficult to access the cab, the load and the 5$^{th}$ wheel. One overweight driver said, "I find it difficult to get up onto the trailer if there are no steps", another driver commented that, "Steps at the back and side of the trailer are used by modern, unfit drivers". There was a suggestion that there may be a degree of self-selection for overweight drivers to take the driving jobs that require little physical exertion, "Drivers of containers and refrigerated vehicles tend to be overweight, they don't need to do any unloading". Flatbed drivers tended to be less heavy and in better physical condition, probably due to the relatively high activity levels required from tasks such as sheeting and the frequent accessing of the load area. One driver commented that some companies would not employ drivers heavier than 19 stones; this was due to weight restrictions on the driving seat.

**Experience of falls**

Where drivers had experienced a fall, their awareness of falls and appreciation of the risk of falls was heightened. These drivers will be aware of the costs of falls, both to the body and in financial terms. A significant proportion of drivers are self-employed or work for agencies, where time off work will involve a loss of earnings.

## 6.2 ORGANISATIONAL INFLUENCES

### Training

The amount of training drivers received from their companies ranged from none at all to comprehensive training, refreshed on a regular basis. For those drivers who received no training, they tended to pick up the skills of the job from trial and error and by learning from colleagues. A frequent comment was that training was not necessary, because it is “common sense”. Training from companies often involved techniques for accessing the cab, i.e., maintain three points of contact and descend backwards. For one beer delivery company, the driving test involved cab entry. Training in unloading, e.g., manual handling was also conducted by some companies. Very rarely was training received that mentioned slips, trips and falls specifically.

Focus groups involved a number of drivers that were health and safety trainers. There was a general consensus among trainers that driver safety is ultimately down to the individual. Trained drivers know what the correct techniques for vehicle access and egress are, but often they will not adhere to these safe practices. Reasons for not using safe practice may include lack of supervision, lack of management reinforcement of health and safety practices and time pressures, topics that are discussed below. Trainers from one company commented that there was seldom enough time to carry out refresher training for existing drivers because they are too busy conducting induction training for agency drivers.

One interviewee talked in depth in relation to how training should be conducted. He felt that training should be administered by people who have experienced the job and will be able to make the potential risks and dangers real by using anecdotes of personal experience and the experiences of colleagues. For example, a training item might be safe egress from the cab. The reason for maintaining three points of contact and descending backwards (instead of jumping) would be to avoid falling, which might result in broken bones, and to avoid cumulative stress on the knees and back, which can affect mobility.

### Job design

Despite the introduction of the Working Time Directive, some drivers still work very long hours. The Working Time Directive was introduced to limit the working week to 48 hours. A significant number of drivers interviewed however, were still working 12 hour days or 60-hour weeks. Fatigue is likely to decrease levels of care and attention during access and egress to the vehicle and during unloading operations.

Pay schemes are likely to influence how drivers behave. Job and finish systems and payment per load transported are likely to encourage rushing, either to get the work finished or maximise pay. Rushing may precipitate in a fall.

Bonus systems which relate to work completed within allotted time scales would also result in rushing, and conflict with incentives to work steadily and safely.

### Time pressures

Time pressures are inherent to the haulage industry. Some drivers are influenced by these time pressures acutely: “90% of time you’re under pressure, either booking time to customers or running out of time"; "We're against the clock all the time". Other drivers have adopted a more laid back outlook: "We're constantly trying to hit times that can't be done, but I don't let it get to me"; "It's not a problem to be late at all, I just phone and say I'm going to be late".

Different companies have different scheduling arrangements such that time slots may be am or pm, two-hour slots, one-hour slots, half-hour slots etc. One company was reported to have deliveries down to the minute, because the delivery process had been characterised in such detail (i.e., time spent driving, time spent unloading etc). Clearly such a discrete time slot is impossible to meet.

The effect of timed deliveries is to encourage drivers to rush. Some drivers are able to cope with this pressure, viewing the pressures placed upon them as unrealistic, whilst others will try to meet their targets by cutting corners. Cutting corners may involve jumping from cabs or not using access equipment such as sliding ladders, and may result in falls.

**Management**

The influence of management was explored in greater depth during the focus groups. There was a consensus that health and safety was not the main priority for management. Profitability and production targets were the main consideration. In most cases, procedures were in place for health and safety, however, these were believed to bear little resemblance to what happens in reality. For example, procedures might state that loading should take place under cover, however space constraints means that loading takes place in the open with drivers exposed to the elements and other workplace vehicles. Management would be aware of this unsafe situation but do not do anything to rectify it.

Drivers also spoke of 'fads' in health and safety such that there may be a two-week stint where all workers are told to wear hard hats in loading areas. However, this safety message is quickly forgotten and therefore not reinforced, so workers soon revert to the old ways of working.

**Supervision**

The job of driving goods vehicles is usually a solitary role with minimal supervision. Drivers work between various calling points where the responsibility for health and safety constantly changes. Supervisory responsibilities therefore change as well, but because drivers are transient within the environments they come into contact with, responsibility for driver supervision tends to get bypassed such that bad habits or unsafe working acts are not identified. As a consequence these bad habits go unchecked.

**Maintenance of vehicles**

The maintenance of vehicles is important in relation to falls. Anti-slip surfaces require regular attention to ensure they maintain their anti-slip properties. Vehicle cleaning facilities for removing contaminants such as diesel and dirt is also important in avoiding falls. The provision of such services needs the support of the organisation that the driver works in. Periodic vehicle checks might be an effective way to make sure that vehicles are kept in good condition. One driver commented that some trailers date from the 50s and 60s, so checking the robustness of, for example, the load area and the steps is crucial because damp or rust may have weakened the structures.

## Load planning

Load planning is extremely influential in how difficult or easy a driver's job can be. If pallets are placed onto a vehicle in the wrong order, this can delay drivers considerably, and expose them to risk if they have to climb on top of the load to rearrange it. It is important that the Planners are familiar with the drivers' role, and if the driver has a regular plan of work, to understand how best the load can be organised. One company visited had reorganised their load planning such that pallets were organised by the customer order rather than by the product itself. Previously drivers had to pick products from the pallets to make up the order whilst on the move, now the pallets are ready to be distributed as the customer requested. This system reduces the amount of time that the driver spends on the back of the truck and also reduces manual handling.

## Employee involvement

Where changes are made to the specification of working vehicles, it is vital to involve the people who will use them. Drivers know what the potential hazards are and their opinions need to be included at the design stage, working alongside vehicle designers and manufacturers. Trialling of vehicles is also important, before large sums of money are invested. Two companies visited over the course of this project had involved their drivers in the modification of their company fleets. These cases are summarised below.

One company had built a new prototype vehicle specifically for beer delivery, though many of the ideas could be used on similar vehicles. The prototype was constructed using input from draymen as to the desirable features for the vehicle. The following is a list of safety features for the dray:

- Use of coloured paint to indicate access points on to and off the vehicle.
  Yellow paint was used to indicate the position of ladders on the side of the vehicle. Red paint was used to mark the perimeter of the vehicle to warn individuals of the potential drop.
- Orange hand holds to assist entry on to the load bed.
  These handles were attached to the inner strapping of the load area. Trials of the handles revealed that initially they had been placed too high. Once they had been lowered, entry onto the vehicle was greatly facilitated for workers.
- Use of anti-slip paint on the rear of the vehicle.
  Microroughness and pendulum data revealed that this particular paint provided good anti-slip properties (pendulum numbers of 58 in the dry and 52 in the wet).
- Suspension system to lower the trailer bed at both axle points.
  The operation of this system was from the rear wheels to drop the rear suspension and from the cab to lower the front suspension. By fully lowering the suspension, the manual unloading is made easier and the height of a potential fall is reduced.
- Handholds positioned on the rear of the vehicle to assist entry.
  An initial trial of these handholds informed the company that their diameter was too narrow. It is intended that the diameter will be increased.
- Retractable 'goal post' shaped clips were used along the side of the vehicle.
  The clips are designed to provide an attachment for the load. The design, such that they can retract into the body of the vehicle means that they do not pose a trip risk to individuals working on top.
- The $5^{th}$ wheel area was decked such that there were minimal changes in level and in materials, thus providing a relatively consistent surface to stand on. A handrail was also provided to assist access onto the $5^{th}$ wheel.

A second company (soft drinks) had also made alterations to their vehicles after consultation with their drivers. The features for reducing falls were as follows:

- Colour coding of vehicle load area to indicate where wheel arch is, and thus where the driver can access or egress the load area.
- Anti-slip coating applied to load area and tail lift.
- Barriers attached to the side of the tail lift to prevent drivers from falling.
- Handling aids carried on the backs of vehicles – powered lift trucks and sack trucks.
- Handholds to assist entry onto the side of the vehicle.

## 6.3 ENVIRONMENTAL INFLUENCES

**Weather**

Inclement weather was often cited as being influential especially in terms of the likelihood to slip. Rain, snow and ice all increase the risk of slipping and falling. Loading and unloading under cover are important to prevent drivers from being exposed to the elements and also to keep the vehicle surfaces as dry as possible.

Wind poses problems when closing vehicle curtains or during sheeting of loads and can feasibly pull drivers from the load. Wind also adds to the physical exertion of the work.

Some drivers also talked about hot weather as being problematic. One driver said that, "if you are overweight, you're wearing heavy boots and the weather is hot, you will feel faint as you're unloading". Faintness may result in a fall.

**Lighting**

Poor lighting makes it difficult to identify slip and trip hazards. Drivers tend to start work early in the morning, so in winter time drivers are likely to start work in darkness. Provision of adequate lighting both at the premises drivers visit and also on their vehicles is important for drivers to work safely.

**Unfamiliar premises**

Drivers often find themselves unloading at unfamiliar premises. Inappropriate unloading facilities cause problems, and drivers may find themselves needing to improvise. Where possible, companies should endeavour to make sure that the unloading premises are fit for purpose and that the driver has the appropriate vehicle and tools (e.g., handling aids) to be able to carry out his job safely. Drivers should have the right to refuse to deliver if he feels that the unloading operation places him in danger.

**Traffic**

Busy roads have a significant impact on drivers with delays causing drivers to feel under increased time pressure. Traffic may also encourage drivers to start work earlier so that they beat the traffic, potentially leading to increased fatigue and increased likelihood of working in the dark. In town centres in particular, illegal parking at unloading points may cause drivers to double-park, exposing them to moving vehicles and abuse from the public. Parking at undesignated positions will also make the unloading operation more difficult.

**Perception of job by public**

Some of the drivers interviewed gave the impression that their role in society was viewed unfavourably. One driver said, “No one wants drivers. We get hassle for clogging up roads. No one wants to unload us, and we’re constantly being asked where we are. We’re at the bottom of the barrel getting it from everyone.” This individual had spent some time working in America where he felt that the occupation was looked upon more favourably and it was believed to be a respected job role.

# 7 FOOTWEAR

One of the objectives for this piece of work was to investigate the footwear types worn by drivers. Footwear is an important consideration for drivers. It needs to be comfortable, but also cope with a range of environments and contaminants. Drivers were questioned about their footwear choices as part of the interview. Data was received from 51 drivers. Drivers were questioned about whether their footwear was provided by their company, how much choice they got in selecting it, whether they thought their footwear was slip resistant, and if so, if they thought it provided a good level of slip resistance.

The footwear worn varied vastly, and there did not appear to be a common brand or style. Footwear tended to be of a 'safety' type with steel toecaps. Most drivers interviewed were supplied with footwear from their employer and given a range of footwear to choose from. Where boots were not supplied, drivers bought their own and were then refunded (in whole or in part) by their employer. In some cases, drivers had to pay for their own footwear.

Most drivers thought that their footwear was slip resistant with many claiming that slip resistance was an important factor to them when choosing new footwear. Many quoted "slip resistance is the first thing you think of" or similar. However, a common misconception was that where footwear was specified as being 'oil resistant', drivers believed this to mean 'slip resistant', which is not the case. Oil resistance relates to the susceptibility of the sole material to becoming harder, softer or weaker due to oil impregnation – nothing to do with slip resistance (BS EN ISO 20344:2004).

Some drivers changed their footwear depending on the task being undertaken. For example, drivers wore safety footwear when picking up or unloading, but then changed into more comfortable footwear for driving. This was more common for long distance drivers who spend far more time driving than 'picking up' or 'dropping off'.

Many drivers worked in conditions where their footwear regularly gets caked in mud, for example, on construction sites, farms or other outdoor sites. These drivers generally were aware that this would increase their chances of slipping, but they generally accepted this risk as part of their jobs.

Many drivers reported slipping or falling after getting diesel, oil or grease on the soles of their footwear. Drivers can be frequently exposed to diesel, oil, and grease, from fuelling their vehicles, working around the 5$^{th}$ wheel area or from the workplaces that they visit. It seems that in some cases, these hazards could be reduced but that it would be impossible to prevent drivers from coming into contact with these substances.

As an intervention to reduce slip accidents, slip resistant footwear is available to offer significantly increased levels of friction in wet conditions. However, the behaviour of this footwear is not known where large profiles are used (such as cab steps), as the physical interaction is difficult to predict. Where a vehicle has a variety of surfaces that are slippery when wet, one type of footwear may not work on every surface, further complicating selection.

# 8 GENERAL DISCUSSION AND CONCLUSIONS

In this section, conclusions from both the vehicle assessments and the interviews and focus groups will be drawn together.

The majority of this section refers both to LGVs and vans as many issues for LGV drivers are equivocal to those encountered by van drivers. A separate paragraph is dedicated to FLTs.

The cab steps are used hundreds of times a week, and most of the time the drivers negotiate them without difficulties. When they do have a fall, they tend to blame their inattention. However, consideration of the dimensions of cab steps points to design aspects that could reduce the need for concentration in order to negotiate the steps safely. There is very little consistency in step dimensions, both height and depth. The variation in height is most likely to catch out a person climbing or descending the steps. Handholds also play a vital role in avoiding falls from the steps. Drivers complained that the door is in the way of the steps if they have to descend in a limited space. The slip resistance of the cab steps relies on a physical interlock between the operators shoe cleats and the profiled surface of the step. How effectively this interlock works on a given vehicle depends entirely on the operator's footwear, which varies enormously. Increased levels of surface microroughness would improve the slip resistance in wet conditions regardless of the individuals' footwear and this should be considered. Many younger drivers jump from the cab rather than using the steps, resulting in occasional falls, but perhaps more significantly, a cumulative strain on the back and the knees that reduces mobility in future years. Some older drivers reported their inability to jump from the cab, demonstrating the long-term effects of repeatedly jumping from the vehicle.

Access to the 5$^{th}$ wheel area is generally quite poor. Usually there are few steps with considerable rises, handholds tucked behind aerodynamic fairings and a patchwork of surfaces and levels to catch out the unwary. Consistency in surface finishes is preferable, as transitions in slip resistance might lead to accidents. Trip hazards may be presented as changes in level as little as 10mm. The physical nature of the tasks undertaken in this area place further demands on the slip resistance of the surface, often with the posture of the operator compromised by the confined space.

The materials used for the load areas of vehicles generally provide good pedestrian slip resistance, even when water is present. The area of the load bed that does cause concern to the authors is the threshold, which is usually part of the steel structure of the vehicle, either smooth metal or paint finish, and as such presents a significant slip potential when wet. A pedestrian slip is more likely to occur where the person moves from an area with good slip resistance to one with little slip resistance, such as from the main load bed to the threshold. On the whole, where load areas are well maintained, potential for trips are limited to the load itself, securing straps, or waste materials such as shrink-wrap and pallets left in the vehicle. On some occasions, trailers were observed with a raised lip along the edges, creating a trip hazard.

Provision of access to the load area varies from none existent to perfectly adequate, with many vehicles falling somewhere between. Fold out ladders are commonplace, but generally are inadequate, with a very high first step, very narrow treads and an absence of handholds. For egress they are difficult to see from above resulting in the operator fumbling around to find the top step, or perhaps more commonly, jumping down without using the steps. Some vehicles did have substantial steps that folded or slid out from under the load bed. Steps that resemble stairs are easier to use than ladders in terms of secure footings and visibility from above for egress. If operators are to maintain three points of contact during access and egress, then there needs to be provision of suitable handholds. Where handholds are absent, use of the load as a handhold is likely. For example, a number of accidents are known to have resulted from the banding on pallets breaking due to the drivers using them as handholds. As with the cab area, younger drivers tend to find access to and egress from the load area much easier, but repeatedly jumping from the load area can result in reduced mobility in the longer term. Many drivers have personal experience of falling from the vehicle, and through this process they learn to take more care. An interview with a representative from the Road Transport Association indicated that 'bad behaviour' (i.e., jumping) is more likely to be responsible for fall accidents than design aspects.

The materials used for tail lifts generally provide little slip resistance in at least one direction, and therefore the design of these lifts could be improved. This is a high-risk area, where a slip could see the vehicle operator falling as much as 1.3m. Examples of tail lifts with edge protection have been observed, although on one such occasion the handrails were not being used as intended. Improvements to the slip resistance of the surfaces may be a more useable solution than the provision of handrails, though that does leave the possibility of simply stepping off the edge. When the vehicle operator has to unload using a tail lift, problems are encountered if the load is too large for the platform, such as when a pallet and pallet truck are used on the smaller lifts, primarily designed to carry roll cages. Thought needs to be given to the loads carried and the way they are packaged to avoid such problems.

In relation to FLTs, falls from them appeared to be very rare and the drivers interviewed did not consider falls to be a pressing safety issue. The company visited for the interviewing of FLT drivers did include messages in their training to avoid falls. These messages included: maintain three points of contact during access and egress; survey the surrounding ground before dismounting and clean up spills and obstacles promptly. The FLTs examined generally had handholds to facilitate access, and the use of antislip finishes was noted on a number of occasions.

In considering footwear, most drivers wear 'safety boots' which have a steel toecap to protect them from falling objects. Many are issued with oil resistant soles, in the belief that this means slip resistant, but unfortunately it does not. Qualifying what is meant by slip resistant footwear is difficult, as it depends not just on the properties of the footwear, but also on the surface to be walked upon, and any contamination that is present between the two. Tests carried out by HSL do show that the slip resistance of footwear varies enormously, and that claims of slip resistance in footwear catalogues gives very little indication of likely performance. The footwear situation is further complicated by the variety of materials on a vehicle. For example, a 7.5 tonne delivery truck might have a metal profiled cab step, requiring a good interlock with the shoe cleats, a smooth aluminium tail lift, requiring anti-slip soles that does not rely on interlock, and a wooden load bed which is not a significant slip risk. The shoes that work well on the cab steps may not work on the tail lift, and vice versa. Where footwear becomes contaminated, with for example, diesel or mud, drivers need to be able to clean it before they encounter surfaces which will be made more slippery with these contaminants.

Various contaminants are present in the haulage industry. Most commonly water from rainfall, and snow or ice in the winter months. Around the 5$^{th}$ wheel area oil and grease residues can present problems, and drivers reported a lack of cleaning equipment to remove such contamination. Diesel spills also result is slippery surfaces, at filling stations, depots and around the vehicle fuel tank. Where access to the 5$^{th}$ wheel area is needed, setting steps into the diesel tank is likely to invite slip incidents. The steps are generally very small, providing no more than a toehold, and there is a good chance of diesel contamination creating a slippery surface.

Maintenance of vehicles needs to encompass aspects that affect the drivers' safety as well as the safe operation of the vehicle itself. For example, anti-slip surfaces can change significantly with wear, and need to be replaced periodically. Facilities are also needed to wash away contaminants such as oil and diesel residues.

Weather conditions can make the drivers' job more difficult and hazardous when loading and unloading. The effects of ice and snow on the slipperiness of surfaces are obvious, but wind also poses problems with unloading operations, significantly increasing exertions needed for some procedures. For example, curtains on large goods vehicles can act as a sail and drag the driver from a surface. Hot weather can lead to heat stress, resulting in faintness and the risk of falling. Winter working can also involve significant time spent working in the dark, as drivers tend to start work very early. Lighting of load areas on trucks tends to be poor, and uneven ground around the vehicle will present a more significant risk in the dark. The use of fluorescent markings to delineate trailer edges and steps will be of use in low levels of light.

Drivers work with little or no supervision and little or no contact with management. Health and Safety does not seem to feature highly in the haulage industry, with cost and time factors taking the precedence. This is reflected in the demands placed on the drivers with for example, instances of delivery times scheduled to windows of a few minutes. With the unpredictable nature of traffic conditions, schedules slip and drivers can feel pressure to cut corners and rush, both of which are likely to result in accidents. Where training is provided, it seems to give the right messages, but all too often training is not provided, and drivers are left to learn through personal experience or through colleagues. Training is rarely reinforced with either refresher training or by a positive management attitude to individuals' health and safety. There are also likely to be differences between large national companies and small and medium companies, which are unlikely to have dedicated personnel for health and safety matters. A representative from the Road Haulage Association felt that the big companies have good training and health and safety policies and procedures in place. He felt that the depots of large companies are well organised. The representative also felt that most issues would be likely to lie with the 'one man' businesses where less attention is paid to health and safety.

Working hours do not seem to have reduced significantly by the introduction of the working time directive. Fatigue can be a significant factor in fall-related accidents. Schemes that reward fast working, such as task and finish or per-load payment encourage rushing, which again, contributes to falls. Drivers undertaking multi-drop deliveries frequently have to sort though the load during deliveries to find the correct goods for the drop. At least one brewery has tackled this with regular planned routes, allowing the warehouse staff to load each vehicle so that goods are removed in order, significantly reducing the time spent by operators on the load area, at risk of falling.

Frequently drivers talk about health and safety being 'common sense'. This is endemic across many sectors, especially in relation to slips, trips and falls. However, this does not sit well with either the accidents rates in the industry or the findings of this report. There are many simple and cost effective interventions to reduce the risk or slip and trip accidents. When the full cost of an accident is calculated and balanced against the cost of a simple intervention, a compelling business case may be formed. For example, the food sector has embraced the task of reducing slip and trip accidents, and many businesses have drastically reduced their accident rates. Some interventions need to be introduced at the vehicle design stage, and will consequently take longer to have an effect on the industry as a whole. The most difficult changes to make will be to the attitude and behaviour within the industry, and the industry's obsession with time and cost will be a significant barrier.

# 9 RECOMMENDATIONS

A series of recommendations are presented below which are believed will contribute to reducing falls from vehicles. These recommendations are presented in three sections, those targeting vehicle designers and manufacturers, recommendations targeting vehicle operators and those aimed at HSE.

**Vehicle Designers / Manufacturers**

Use anti-slip coatings on pedestrian surfaces where possible. Focus on surfaces with high microroughness, not profiled surfaces.

Consider the use of shot blasting or other surface finishing techniques to increase the surface roughness of metallic steps.

Design cab steps to have even step heights and depths. Encourage manufacturers to be consistent with one another. Consistency in design will reduce the potential for mis-steps by users. Square step edges should reduce their slip potential (Roys & Wright, 2003).

Use colour contrast (preferably non-slip) to delineate load, step and lifting platform edges. Adoption of a uniform colour coding would be preferable. The use of fluorescent markings will be of use in low light levels. When considering anti-slip products, microroughness is the critical parameter, the surface needs to perform well when wet as the edges of the vehicle will inevitably become wet with rainwater.

Provide steps or ladders on vehicles. Steps are preferable to ladders as they give a more stable footing.

Provide handrails or handholds on both sides of the cab. Users of short stature should be able to reach them from the ground and use throughout the climb or descent.

Consider the use of guardrails on the edge of tail lifts. Ideally these should be designed such that they have to be in place for the tail lift to work, otherwise they may not be used.

Tail lifts should be designed such that they are large enough for manoeuvring goods upon. Clearly mark the tail lift with the type of load it is designed for, in addition to current weight labelling.

Design new vehicles with suspension lowering capability. This should increase the ease of access.

Position 5$^{th}$ wheel step access away from the fuel inlet. Diesel contamination of surfaces is a common cause of slips.

Design the 5$^{th}$ wheel area such that it is made of consistent materials, and installed on the level. For anti-slip surfaces, microroughness is the critical parameter, the surface needs to be anti-slip when wet as it will inevitably be exposed to rain water. Because it is likely that this area will also be contaminated with diesel, surfaces with higher levels of roughness should be used (see Appendix E). An alternative would be to move the diesel tank, to remove the potential for diesel contamination.

Provide handholds/ handrails to assist access to the 5th wheel. Users should be able to reach the handholds/ handrails from the ground and use throughout the climb.

As far as possible, maximise the space at the 5th wheel for facilitating access to airlines etc.

Redesign the airline coupling mechanism or layout at the 5th wheel either to avoid the need for drivers to work in confined spaces, or to reduce the effort required.

**Vehicle Operators**

Provide steps / gantries / platforms at loading or unloading points. Provision of off-vehicle access will help drivers where on-vehicle access is absent.

Where loading or unloading operations routinely take place, consider using fall arrest systems for personnel required to access vehicle loads. It should be noted that the use of harnesses for fall arrest systems requires adequate training and supervision.

Organise load planning such that the load is labelled clearly and is in the correct order for unloading from the vehicle.

Only load materials that are compatible with the unloading equipment should be used. For example, pallets might be too large for tail lifts and require significant manoeuvring, whilst roll cages are smaller and easier to move onto a tail lift.

Provide handling aids appropriate to the load. For example, sack trucks for small items and electric pallet lifters for larger items.

Implement regular vehicle checks for the integrity of the load and steps etc. Some falls occur when the driver falls through the load bed itself or where steps have failed. Regular structural tests should avoid this.

Provide vehicle-washing facilities to remove contaminants. Contaminants such as diesel or mud will increase the likelihood of slip incidents.

Provide convenient disposal facilities for waste packaging, broken pallets etc.

Consider whether sheeting is necessary. Often customers request sheeting to keep the load dry, however upon delivery, items are often stored outdoors without cover. Avoidance of sheeting will reduce falls.

Consider the use of automated sheeting devices to avoid manual sheeting.

Where possible try to ensure that drivers keep the same cab unit. Where drivers use different cabs, the change in design might lead them to misstep.

Ensure adequate lighting in vehicle depots and on the vehicles. Poor lighting will disguise slip and trip hazards.

Ensure that yards are even and free from potholes and obstacles.

Provide drivers with systems to document and report issues to management. Where possible feed these issues into the design of future vehicle prototypes.

Where new vehicles are specified involve workers in the design process.

Raise awareness of the costs of falls to employees (physical, financial etc). Use industry specific information so that it is relevant and tangible to drivers. If training is delivered, use trainers that have worked in the industry to give them credibility.

Provide driver training to avoid falls. Include cab access advice: 1) maintain three points of contact 2) take one step at a time 3) descend from the cab backwards 4) survey the ground for slip / trip hazards before exiting the cab. Also cover aspects such as vehicle cleaning. Provide refresher training at regular intervals.

Adopt systems of work that do not encourage rushing. Job and finish and payment per load will encourage drivers to rush.

**HSE**

Consider a targeted communications campaign for raising awareness of STFs in the haulage industry. Industry specific information is more likely to resonate with industry stakeholders.

Recommend the inclusion of access requirements in the Construction and Use Regulations. Currently there does not seem to be any reference to vehicle access.

Recommend the inclusion of a slips requirement for vehicle surfaces in the Construction and Use Regulations. At the least, this should state that surfaces should be 'antislip'.

Provide or update an industry-specific guidance sheet in relation to preventing slips, trips and falls from workplace vehicles.

Engage Industry bodies, Standards boards, vehicle Designers and Manufacturers in taking the subject of preventing falls forward in partnership.

Conduct accident investigations to establish relative causation for falls from vehicles.

Produce some industry specific case study material to demonstrate the seriousness of falls, for example, damage to knees, backs and broken bones.

Produce some industry specific case study material to demonstrate cost effective solutions.

Hold awareness events to feed back the findings from the current study.

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# 11 APPENDIX A: MEASUREMENTS AND TEST DATA

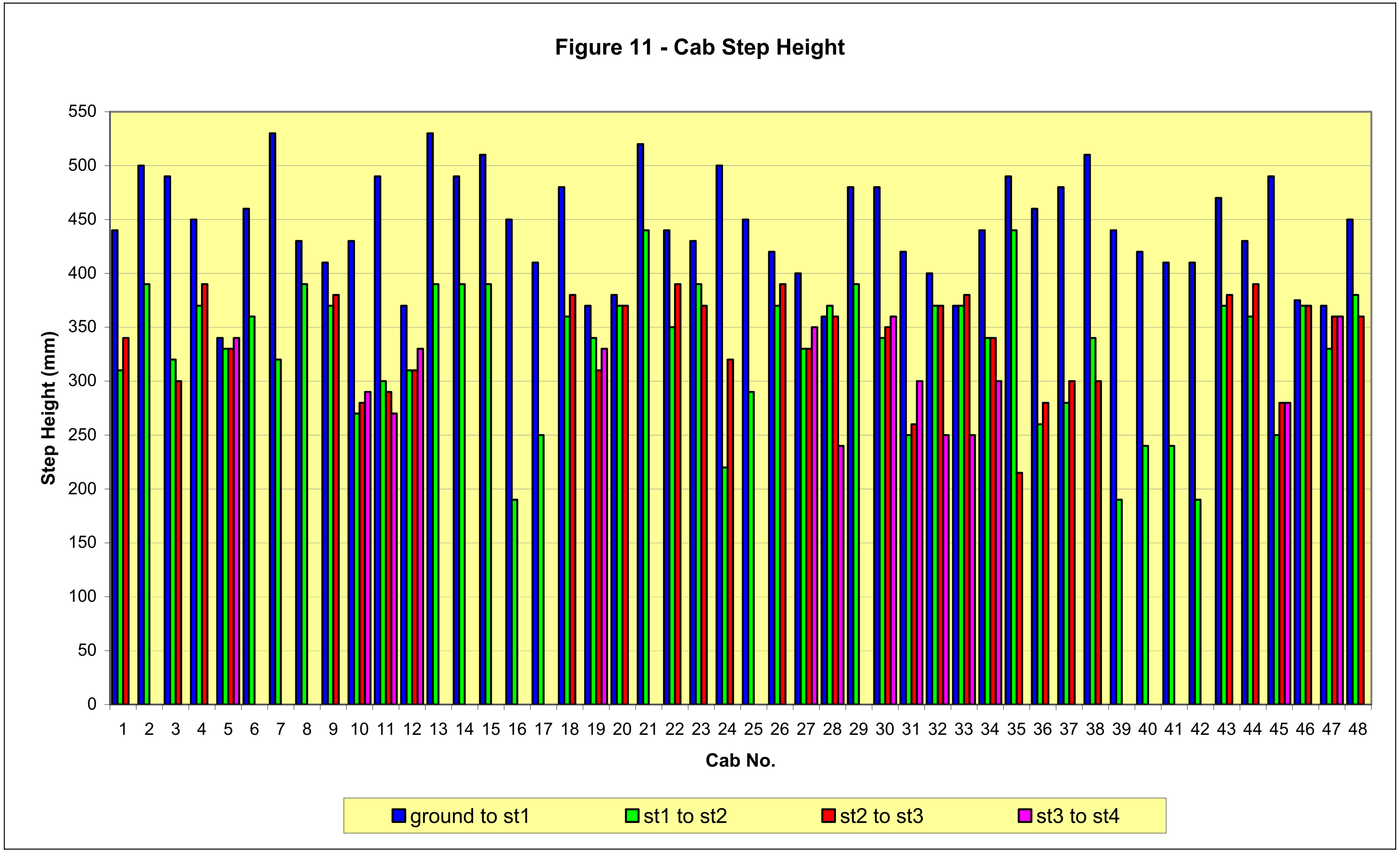

Figure 11 - Cab Step Height
Step Height (mm)
0
50
100
150
200
250
300
350
400
450
500
550
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48
Cab No.
ground to st1
st1 to st2
st2 to st3
st3 to st4

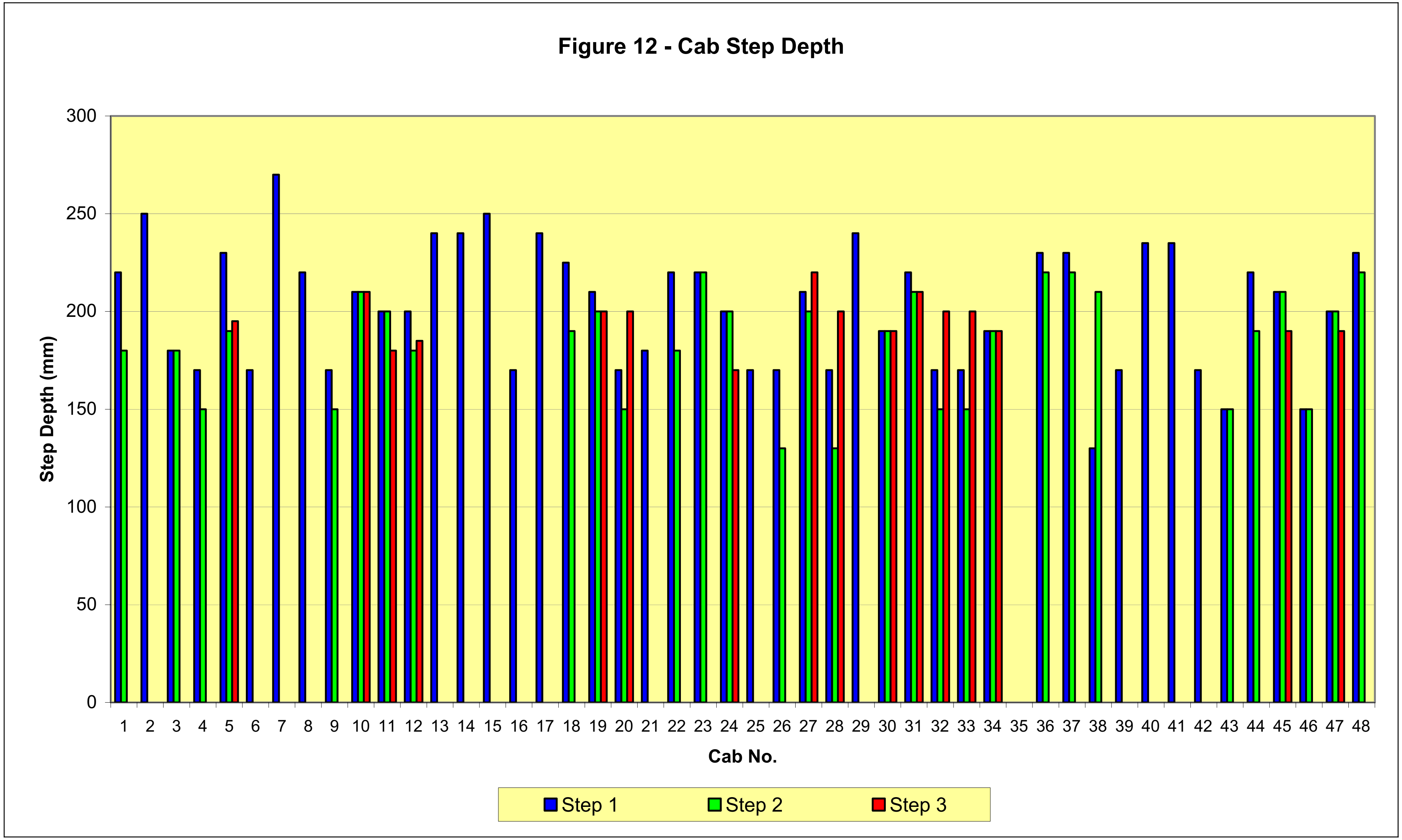
Figure 12 - Cab Step Depth
Step Depth (mm)
300
250
200
150
100
50
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48
Cab No.
Step 1
Step 2
Step 3

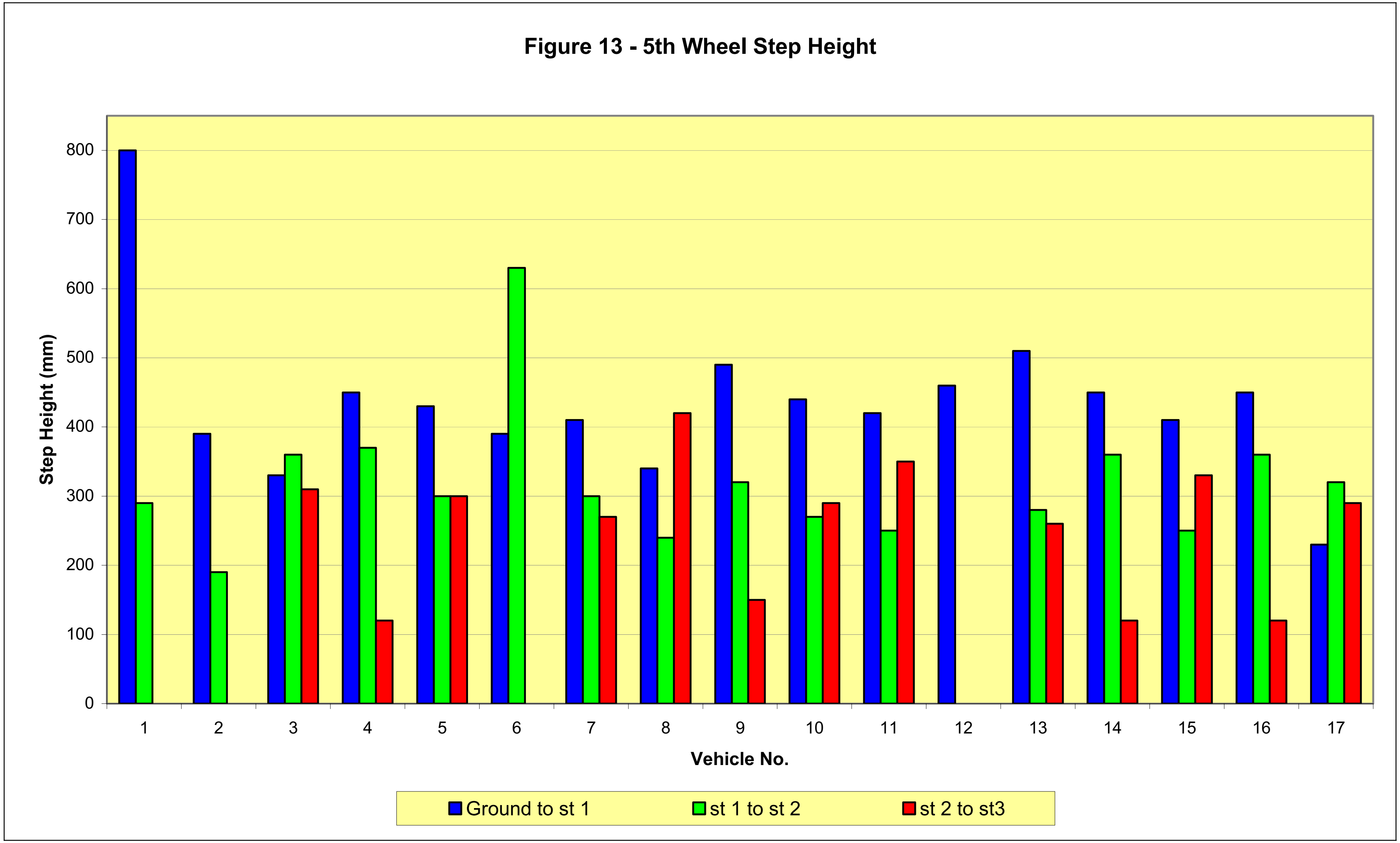
Figure 13 - 5th Wheel Step Height
Step Height (mm)
0
100
200
300
400
500
600
700
800
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Vehicle No.
Ground to st 1
st 1 to st 2
st 2 to st3

## 11.1 CAB STEP SURFACE MICROROUGHNESS

| Step Material | Rz (μm) |
| --- | --- |
| Ribbed Plastic | 12.8 |
| | 11.8 |
| Rubber | 5.5 |
| Aluminium Profile | 24.1 |
| | 20.7 |
| | 7.0 |
| | 6.0 |
| Plastic Coated Steel | 13.4 |
| | 7.5 |
| | 6.4 |
| Steel Profile | 4.9 |

## 11.2 LGV HANDHOLD HEIGHTS

| Height Left (mm) | Height Right (mm) |
|---|---|
| | 1740 |
| | 1320 |
| 1370 | |
| 1650 | 1650 |
| 1180 | 1600 |
| 1560 | 1560 |
| 1490 | 1490 |
| 1760 | 1570 |
| | 1680 |
| 1590 | 1500 |
| 1750 | 1600 |
| 1550 | 1650 |
| 1180 | 1140 |
| 1690 | 1690 |
| 1420 | 1480 |
| 1570 | 1700 |
| 1570 | 1680 |
| 1760 | 1760 |
| 1480 | 1440 |
| 1420 | 1680 |
| 1270 | 1270 |
| 1380 | 1350 |

## 11.3 Slipperiness measurements on load area surfaces

Slipperiness Measurements: Surface Microroughness (Rz); Slip Resistance Values (SRV);

| Surface Description | Rz (µm) | Pendulum Four-S Rubber | | | | Figure |
|---|---|---|---|---|---|---|
| | | Dry | | Water Wet | | |
| | | Direction | SRV | Direction | SRV | |
| Square Profile Resin Plywood | 39.1 | 1 | 59 | 1 | 44 | 14 |
| | 38.6 | 1 | 59 | 1 | 47 | |
| | 37.3 | 1, 3 | 63, 65 | 1, 3 | 56, 55 | |
| | 32.6 | 1, 3 | 61, 59 | 1, 3 | 36, 31 | |
| | 30.0 | 1, 2 | 70, 68 | 1, 2 | 60, 56 | |
| | 10.0 | 1 | 49 | 1 | 25 | |
| Durbar Profile Resin Plywood | 42.5 | 1, 2, 3 | 61, 65, 63 | 1, 2, 3 | 40, 39, 38 | 15 |
| | 39.4 | 1 | 59 | 1 | 32 | |
| | 27.7 | 1 | 59 | 1 | 30 | |
| | 25.2 | 1, 2, 3 | 62, 62, 60 | 1, 2, 3 | 36, 35, 33 | |
| | 21.8 | 1 | 57 | 1 | 30 | |
| | 19.2 | 1 | 58 | 1 | 32 | |
| Hexagonal Profile Resin Plywood | 20.2 | 1, 2, 3 | 58, 58, 61 | 1, 2, 3 | 34, 43, 35 | 16 |
| | 14.2 | 1 | 60 | 1 | 32 | |
| Wooden Planks | 58.1 | 1 | 59 | 1 | 23 | 17 |
| | 54.0 | 1 | 60 | 1 | 24 | |
| | 54.0 | 1 | 61 | 1 | 24 | |
| | 46.6 | 1, 2, 3 | 64, 65, 64 | 1, 2, 3 | 41, 44, 42 | |
| | 38.6 | 1 | 60 | 1 | 22* | |
| Plywood | 48.1 | 2 | 63 | 2 | 26 | 18 |
| | 43.5 | 1 | 61 | 1 | 40 | |
| | 43.1 | 1, 2 | 61, 63 | 1, 2 | 41, 40 | |
| | 29.7 | 1, 2, 3 | 63, 69, 70 | 1, 2, 3 | 28, 31, 32 | |
| Painted Plywood | 25.0 | 1, 2 | 61, 60 | 1, 2 | 40, 40 | 19 |
| Wide Aluminium Strip | 6.1 | 1 | 50 | 1 | 21 | 20 |
| Resin & Aggregate | 31.7 | 1 | 71 | 1 | 57 | 21 |
| | 31.2 | 1 | 69 | 1 | 58 | |

* Warped boards, poor slider contact

Figure 14 - Square Profile Resin Plywood Surface

Figure 15 - Durbar Profile Resin Plywood Surface

Figure 16 - Hexagonal Profile Resin Plywood Surface

Figure 17 - Wooden Planks Surface

Figure 18 - Plywood Surface

Figure 19 - Painted Plywood Surface

Figure 20 - Wide Aluminium Strip Surface

Figure 21 - Resin & Aggregate Surface

## 11.4 SLIPPERINESS MEASUREMENTS ON LOAD AREA THRESHOLD SURFACES

Slipperiness Measurements: Surface Microroughness (Rz); Slip Resistance Values (SRV);

| Surface Description | Rz (μm) | Pendulum Four-S Rubber | | | |
|---|---|---|---|---|---|
| | | Dry | | Water Wet | |
| | | Direction | SRV | Direction | SRV |
| Painted Steel | 35.1 | | | | |
| | 13.0 | 1 | 59 | 1 | 31 |
| | 11.6 | | | | |
| | 11.2 | | | | |
| | 10.9 | | | | |
| | 8.9 | | | | |
| | 6.1 | | | | |
| Hammerite Painted Steel | 8.0 | | | | |
| Steel | 28.4 | 1 | 58 | 1 | 43 |
| | 23.5 | 1 | 64 | 1 | 53 |
| | 13.9 | 1 | 52 | 1 | 35 |
| | 12.2 | | | | |
| | 12.2 | | | | |
| | 10.1 | 1 | 47 | 1 | 26 |
| | 9.5 | | | | |
| Galvanised Steel | 10.0 | 1 | 57 | 1 | 27 |
| | 5.1 | | | | |
| Anti-Slip Tape | 53.0 | | | | |
| | >100 | 1 | 74 | 1 | 69 |
| Anti-Slip Paint on Durbar | >100 | 1 | 58 | 1 | 52 |
| Plastic Circular Profile | 52.2 | | | | |
| | 25.0 | | | | |

## 11.5 SLIPPERINESS MEASUREMENTS ON TAIL LIFT SURFACES

| Surface Description | Rz (μm) | Pendulum Four-S Rubber | | | |
|---|---|---|---|---|---|
| | | Dry | | Water Wet | |
| | | Direction | SRV | Direction | SRV |
| Ribbed Aluminium | 8.8 | | | 1 | 32 |
| | 3.5 | | | 1 | 21 |
| | 13.7 | 1 | 59 | 1 | 40 |
| | 9.8 | 1 | 60 | 1 | 30 |
| | 7.9 | | | 1 | 25 |
| | 8.2 | 1 | 57 | 1 | 21 |
| | 11.3 | 1 | 51 | 1 | 22 |

## 11.6 FLT STEP MICROROUGHNESS

| Step Material | Rz (μm) |
|---|---|
| Metal Profile | 31.0 |
| | 27.7 |
| | 19.4 |
| | 7.6 |
| | 7.6 |
| | 6.4 |
| | 3.6 |
| Metal Durbar | 26.5 |
| | 15.8 |
| | 5.1 |
| Painted Steel | 21.0 |
| | 9.7 |
| | 8.1 |
| | 5.0 |
| Plastic Profile | 11.8 |

# 12 APPENDIX B: SLIPPERINESS ASSESSMENT TEST METHODS

Data relating to floor surface slipperiness was generated in accordance with HSL standard procedures, in line with the Guidelines Recommended by the UK Slip Resistance Group (UKSRG), 2000. The UKSRG is an influential body, chaired by HSL, with past and present members including floor and shoe manufacturers, forensic scientists/engineers, UK test-houses and members of relevant BSI, CEN and ISO Standards Committees. HSL and HSE are co-founder members of the Group and were co-authors of the UKSRG Guidelines, as referenced in HSE Information Sheet SLIPS1 (Appendix E).

Three complimentary slip resistance test methods were employed as outlined in the UKSRG Guidelines, [a] a Taylor Hobson Surtronic Duo Rz microroughness transducer (*The Surtronic*, see Fig 22 and section 12.1), [b] a Stanley TRL Pendulum Coefficient of Dynamic Friction (CoF) Test (*The Pendulum*, see Fig 24 and section 12.2) and, [c] a Mitutoyo Surftest SJ201P Rz microroughness transducer (*The Mitutoyo*, see Fig. 25 and section 12.3). All test methods are used routinely by HSL during on-site slipperiness assessments and during contract research for HSE.

## 12.1 SURFACE MICROROUGHNESS – SURTRONIC DUO RZ

The Surtronic Duo surface microroughness transducer (Fig.22) is a hand-held, electronic stylus-based instrument originally designed to assess the microroughness of metallic components in the engineering industry. The Surtronic uses a 5µm radius, 90˚ diamond-tipped stylus (Fig. 23), which is traversed across a 5mm section of the material under study. During measurement, the vertical movement of the stylus is monitored, and a mean of five separate *maximum peak to valley height* measurements is calculated and presented as a single figure, termed “Rz”.

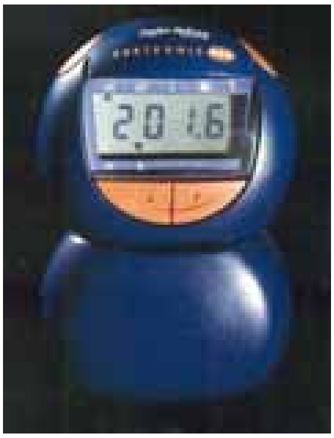

Figure 22 - The Surtronic Duo Rz surface microroughness transducer

Figure 23 - Stylus detail

The correct operation of the Surtronic was checked before the generation of test data using a specialist metallic foil of known roughness characteristics (Taylor Hobson). The check-foil was calibrated against a traceable UKAS standard specimen (Taylor Hobson) and was confirmed to be within its calibration period. All testing was carried out using a standardised three directional methodology to account for surface directional inhomogeneity.

Interpretation of the roughness data generated was carried out in line with HSE Guidance document Slips1 (HSE, 2004).

## 12.2 DYNAMIC COEFFICIENT OF FRICTION – THE TRL PENDULUM

The TRL Pendulum (Fig. 24) is currently the preferred method of slipperiness assessment of HSL/HSE and the UK Slip Resistance Group. The apparatus consists of a spring-loaded rubber test slider, which is set to traverse a 126mm section of the flooring under study. The slider (a carefully specified and prepared sample of simulated footwear soling material) is mounted at the end of a weighted pendulum arm, which is released from a raised, horizontal position to the right of the test area. The energy lost by the slider / arm assembly during the floor traverse limits the height of the upward pendulum swing to the left of the test area; the extent of this energy loss is represented on a simple Slip Resistance Value (SRV) scale. As a general rule, SRV values (also known as British Pendulum Numbers (BPN)) may be converted to Coefficient of Friction (CoF) by simple division by 100.

In 2002, a sub-committee of British Standards Committee B/556 (The Pedestrian Slip Resistance Coordinating Committee) produced three British Standards (BS 7976, Parts 1-3, 2000), which formally describe the specification, operation and calibration of the pendulum respectively. All testing was carried out in line with the methodologies outlined in BS 7976-2 where appropriate.

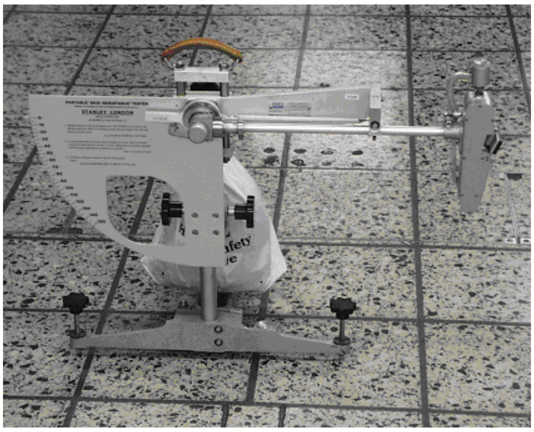

Figure 24 - The TRL Pendulum dynamic coefficient of friction test

A *Four-S* (standard simulated shoe sole) test slider was used during the investigation; this material was developed by the UKSRG to represent footwear-soling materials of moderate slip performance. Sliders were conditioned using the methodology jointly developed by the UK Slip Resistance Group and HSE/HSL (UKSRG, 2000). Sliders were prepared / conditioned fully before testing and between sets of tests in order to both ensure a consistent finish to the slider face, and to prevent cross-contamination between test areas. The pendulum was calibrated by the British Standards Institute prior to use, and was visually inspected *in situ* before use according to BS 7976-3 Informative Annex B.

Pendulum SRV (or BPN) data were generated in the as-found condition before and after the application of potable water by hand spray, and before and after cleaning where appropriate. Interpretation of the SRV data generated was based on the UKSRG Guidelines, 2000.

## 12.3 SURFACE MICROROUGHNESS – MITUTOYO SURFTEST SJ201P RZ

The Mitutoyo Surftest SJ201P surface microroughness transducer (Fig.25) is a hand-held, electronic stylus-based instrument originally designed to assess the microroughness of metallic components in the engineering industry. The Mitutoyo uses a 5μm radius, 90˚ diamond-tipped stylus, which is traversed across a 5mm section of the material under study. During measurement, the vertical movement of the stylus is monitored, and a mean of five separate *maximum peak to valley height* measurements is calculated and presented as a single figure, termed “Rz”. On surfaces where a single 5mm measurement is not possible, 5 separate 0.8mm measurements can be made and the mean of those used to give the Rz value. This technique was used on some profiled surfaces in this study.

Figure 25 - The Mitutoyo Surftest SJ201P Rz surface microroughness transducer

The correct operation of the Mitutoyo was checked before the generation of test data using a specialist metallic foil of known roughness characteristics (Mitutoyo). The check-foil was calibrated against a traceable UKAS standard specimen (Taylor Hobson) and was confirmed to be within its calibration period. Testing was carried out using a standardised three directional methodology to account for surface directional inhomogeneity where possible, though some profiled surfaces can only be measured along the length of the profile.

Interpretation of the roughness data generated was carried out in line with HSE Guidance document Slips1 (HSE, 2004b).

# 13 APPENDIX C: INTERVIEW SCHEDULE

Have you ever experienced a STF incident whilst: accessing/ egressing the cab/ 5$^{th}$ wheel/ load area of your vehicle?
[If yes] Could you describe what happened?
**Probe** Tasks, weather, time, and any time off?

Do you know of any colleagues that have experienced a STF incident whilst: accessing/ egressing the cab/ 5$^{th}$ wheel/ load area of your vehicle?
[If yes] Could you describe what happened?
**Probe** Tasks, weather, time, and any time off?

Are you involved in the unloading of your vehicle? **Probe:** always, sometimes, to help out etc. Is assistance available?

Are the unloading facilities suitable to the vehicle? **Probe** for examples

Do you have any handling aids, e.g., sack trucks, pallet lifters? (**Probe** Do you use them, and under what conditions?)

Have you received any training in loading /unloading?
**Probe:** Did your training meet all of your needs?

Do you have the authority **not** to deliver loads in unsuitable conditions? How often have you exercised this authority?

Have any modifications been made to your vehicle to reduce slips & trips?
**Probe:** Non-slip surfaces, additional hand holds etc?

Can you think of any vehicle modifications that might reduce the likelihood of STFs?

Are you provided with any training about good practice when accessing / unloading vehicles?
**If yes Probe:** What exactly did this training involve? Who provided the training (in-house/ external/ credited)? Did it meet your needs / could the training be improved in any way?

To what extent do time pressures to finish the job affect the way you work?

To what extent do weather conditions affect the way you work?

What do you think about the design of the tail lift? (the grip and size?)

Is the vehicle platform and cab generally clean and clear of debris?

Does your company supply your footwear, or do you buy your own? Do you think your footwear has adequate slip resistant properties?

What do you think are the main causes of STFs on and around your vehicle?

To summarise, would you say that STFs are an issue for lorry drivers or not? Can you explain your answer?

**Background**

Age of Driver <25 26-35 36-45 46-55 56-65 >65

Experience of Driver <1, 1-5, 6-15, 16-25, 26-35, >36

Type of vehicle

Employed/self employed

Bonus

Do you drive mainly during the day?

How long on average do you spend driving Hrs?
(from leaving your base to return)

Do you have a choice as to when to take a break?
**Probe**: How long for, when etc.?

Do you do multi drops or one drop?

How many drops/collections do you make in a day 1, 2–4, 5-9, >9

Do you use the same vehicle on most days?

# 14 APPENDIX D: FOCUS GROUP SCHEDULE

**Introduction**

We are currently working on some research for the HSE which is investigating non-driving accidents to drivers. In particular we are looking at accidents on or around the vehicle such as slips, trips or falls on or from the vehicle. We are interested in all areas of vehicles – cab access, 5$^{th}$ wheel access, load access and tail-lifts.

So far, we have interviewed around 80 drivers and have found out about their views about accident causation, vehicle design and improving safety. What we would like to do today is gather your views about the causes of accidents from or on vehicles, and discuss what you think could be improved. We'd like solutions which could reduce the potential for accidents. These solutions could relate to vehicle design, job design, training, the packaging of loads, all kinds of things. We're interested to find out the things which you think are most important.

**Confidentiality**

We will write up the results of this discussion and include it in our report which will be published and available to the public. However, we want to make it clear that we will not write anything which will identify an individual. The results of this focus group will be combined with the results of other focus groups, and general conclusions will be made e.g. "drivers felt that improvements in access to the load bed should be prioritised" "one driver thought that XX was really important, whereas most drivers thought that XX was more important". We will never publish your names or company details. In turn, we ask you to respect each other's confidentiality and not discuss further what we discuss today. We therefore ask you to talk openly and honestly and not to hold back with your comments and opinions.

Firstly can we go round the table and do some introductions? Please can you tell us your names, how long you've worked as a driver, what kind vehicle you drive now (flatbed, curtainsiders, long-distance, multi-drop), if you have experience of other vehicle types and whether you are typically involved in the unloading of vehicles.

**Discussion Topics**

1. Personal experience of accidents – have you ever had an accident caused by a slip, trip or fall from or around your vehicle?
2. Cab access/ egress (steps, handholds)
3. 5th wheel access/ egress (steps, handholds)
4. Load – headboard
   Sidebars
   Back – ladders (attached or freestanding)
   Tail-lift
   Bumpers/ bull-bars
5. Unloading – loading/ unloading facilities
6. Vehicle design improvements/ site improvements
7. Company attitudes to Health and safety training; reminders/ discipline/ STFs ever mentioned?
8. Related factors (physical fitness/ age/ obesity/ time pressures/ weather conditions)

**Thank you**

Thanks for being open and honest. Your cheques should be in the post and the end of the week

Other topics
Surfaces – examples of surfaces
Shoes – discussion of slip resistance

# 15 APPENDIX E: THE ASSESSMENT OF PEDESTRIAN SLIP RISK: THE HSE APPROACH

Can be found at:

http://www.hse.gov.uk/slips/information.htm

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