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Preventing Falls – Learning From Design-Related Issues in Care Homes

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Abstract

Falls are a major health and safety issue, disproportionately affecting older people. Hospital inpatients are a vulnerable group, with over 200,000 reports of inpatient falls in hospitals in England and Wales each year. In the UK, costs for hospital and social care subsequent to hip fracture are estimated at £2 billion. In care home environments there are many hazards that can give rise to a risk of falling. Some hazards are shared with hospital environments and some are more specific to care homes.

This paper explores fall hazards and risk factors at care homes for both residents and staff and considers how good design can reduce fall risk. It presents anonymised evidence on design-related issues based on physical assessments of fall risk conducted in 11 different care homes on behalf of Health and Safety Executive and Local Authority inspectors. At least seven of these assessments were requested following a fall, including two falls that resulted in fatalities.

Fall risk is explored in common areas, bathrooms and showers, kitchens, stairs, dining rooms and outdoor spaces. Topics considered include: selecting an appropriate floor for the environment, safe stair design and preventing trips. Measurement techniques used during the assessments include floor friction measurements using the pendulum test, measurements of stair dimensions made in accordance with the method described by Johnson, as well as an assessment of the suitability of handrails and measurements of Light Reflectance Values of important stair features.

The paper concludes by describing a range of design factors that can be considered in order to reduce fall risks.

Keywords: slip, trip, fall, slip resistance, stair, care home

Introduction

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Falls are a major health and safety issue, disproportionately affecting older people. Hospital inpatients are a vulnerable group, with over 200,000 reports of inpatient falls in hospitals in England and Wales each year (Healey & Scobie, 2007). In the UK, costs for hospital and social care subsequent to hip fracture are estimated at £2 billion (Torgerson et al 2001). In care home environments there are many hazards that can give rise to a risk of falling. Some hazards are shared with hospital environments and some are more specific to care homes.

The Health and Safety Executive (HSE) has a range of free guidance, information, case studies and an e-learning tool on preventing slips, trips and falls. This is published at http://www.hse.gov.uk/slips/publications.htm along with links to helpful information from other sources.

The author's team of falls prevention specialists currently undertakes 20 - 30 assessments of fall risk a year in a wide range of premises, including care homes, in support of HSE and Local Authority (LA) inspectors. These assessments are based on measurement of the physical environment. The team also undertakes many more assessments for commercial clients. Based on physical assessments at care homes, this paper explores the hazards and design-based risk factors.

Anonymised findings are given from physical assessments of fall risk carried out in 11 different care homes over a span of 10 years for HSE and LA inspectors. At least seven of the 11 assessments were requested following a fall, including two falls which resulted in fatalities. In nine of the care homes visited, the purpose of the visit was to conduct a physical assessment of the slip resistance of the floor. In one of these visits the issue of trip hazards was also raised during the assessment. In two of the care homes visited the purpose of the visit was to conduct a physical assessment of one or more stairs.

The paper concludes by describing a range of design factors that can be considered in order to reduce fall risks.

Background

Slip Test Methods and Standards

Floors are typically not slippery when clean and dry. In areas where floors are likely to get contaminated in normal use, such as kitchens, bathrooms or outdoors, a floor which is also slip resistant when contaminated will reduce the risk of falls. Many different types of flooring are available which offer excellent slip resistance when wet and even when contaminated with more viscous contaminants such as body fluids or oil.

There are many different test methods available worldwide which can assess the level of friction offered by a floor surface. Many of these tests are used by flooring manufacturers, architects and safety professionals to identify suitable flooring and justify specification decisions. The United

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Kingdom Slip Resistance Group (UKSRG) produces guidelines detailing a method for assessing the slip resistance of flooring materials relevant to pedestrian gait (UKSRG, 2011). HSE and the UKSRG advocate the use of the pendulum test as the primary method for assessing the slip resistance of flooring (HSE, 2012). This is for two reasons:

> "Firstly, unlike most other available instruments, it reproduces the same hydrodynamic uplift characteristics that occur when a person slips in liquid-contaminated conditions. Secondly, good correlation between the readings given by the instrument and the incidence of pedestrian slipping accidents has been observed since the 1940s." (UKSRG, 2011)

The pendulum is a portable test which allows validation of the slip resistance of flooring on site and monitoring of slip resistance over time. The correct operation of the pendulum is essential to obtaining reliable results:

"Research has confirmed the pendulum to be a reliable and accurate test, so HSE has adopted it as its standard test method for assessing floor slipperiness in both dry and contaminated conditions. However, to use it reliably, it needs to be operated and interpreted by a suitably trained and competent person." (HSE, 2012)

Caution is needed to ensure that any testing carried out is relevant to the proposed environment in which the floor will be used (for example, the German floor slip resistance standard DIN 51130 (DIN, 2014) is undertaken using industrial boots on a floor contaminated with motor oil: these conditions are not relevant to slipping in a care home setting). Pendulum testing can be conducted with any relevant contaminant. Most pendulum testing is conducted using a rubber slider known as Slider 96, which was developed to represent a footwear sole material of moderate slip resistance. However, in areas where barefoot pedestrians are likely, such as bathrooms and shower rooms, a second rubber slider known as Slider 55 also needs to be used. Slider 55 is softer than Slider 96 and is used to simulate barefoot pedestrians. Specifying shod slip resistance only, in areas where barefoot pedestrians are foreseeable, should be avoided.

Methodology

Slip Assessment

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Slipperiness assessments were undertaken in accordance with the UKSRG Guidelines (UKSRG, 2011) and BS 7976-2:2013 (BSI, 2013). The assessments considered in this paper span a 10 year period from 2004 to 2014 and the then current version of these documents was used.

Measurements of the floor surface Pendulum Test Value (PTV), which is closely related to the coefficient of dynamic friction, were made using a calibrated Stanley Pendulum instrument. Further tests were undertaken using a surface microroughness transducer set to the Rz parameter where appropriate.

The UKSRG has devised a classification system for slip potential, which is based on research undertaken by the UK Building Research Establishment (Pye and Harrison, 2003). The level of friction required by an individual in order to walk without slipping is related to the speed of movement and the step length. The level of friction required varies from person to person. Where the required friction is greater than that available from the interaction of the shoe sole, flooring material and any contamination, the person will experience a slip. Table 1 gives the UKSRG slip potential classifications and how they relate to PTV.

Table 1: Slip potential classifications for PTV

Pendulum Test Value	**Slip Potential**
0 – 24	High
25 – 35	Moderate
36 +	Low

The classifications shown in Table 1 apply to basic conditions, i.e., for low activity, normal walking on a level surface. Walking on sloped surfaces and activities such as rushing, turning, pushing or pulling, are likely to require a higher level of friction than normal walking.

Stair Assessment

Measurements of the dimensions of the stairs were made using a calibrated steel ruler, a calibrated inclinometer and tape measure, as appropriate. Measurements of the Light Reflectance Values (LRV) of a number of features were made using a calibrated Cromocon Instrument.

The angle and distance between the nosings is measured as shown in figure 1, in accordance with the nose-to-nose method of measuring stair dimensions described by Johnson (Johnson, 2006). The going and rise of each step is calculated from measurements, using equations 1 & 2. Figure 2 illustrates the terminology used to describe the stair.

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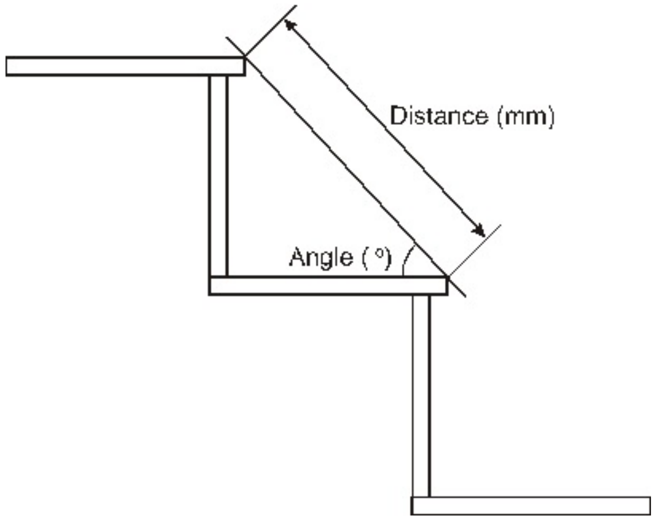

Figure 1: Measurements used to calculate rise and going

Equation 1: Calculation of going

$$\text{Going} = \cos(\text{angle}) \times \text{distance}$$

Equation 2: Calculation of rise

$$\text{Rise} = \sin(\text{angle}) \times \text{distance}$$

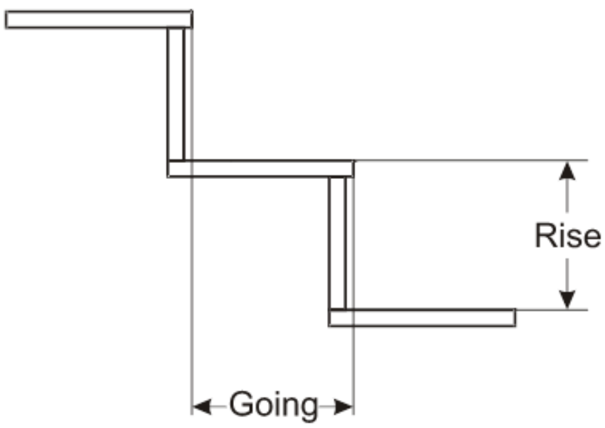

Figure 2: Schematic showing common stair terminology

Approved Document K of the Building Regulations (The Building Regulations, 2013), BS 5395-1:2010 (BSI, 2010 (1)), Building Research Establishment (BRE) Information Paper IP 15/03 (BRE, 2003) and BS 8300:2009 (BSI, 2010 (2)) were used as references when interpreting the information gathered during the visits. It should be noted the Building Regulations do not apply retrospectively. They do not give optimal values, however they do provide a suitable minimum

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starting point for good stair design that can be adapted if necessary depending the stair user and type of use.

Findings and Discussion

Slip Resistance of Flooring

Pendulum testing of installed flooring was conducted in a range of areas in nine care homes. All the floors tested presented a low slip potential in the as-found dry condition. Table 2 shows the results of the testing in the as-found wet condition. Where a range of wet slip resistance was found on a single floor surface, the worst case slip resistance is presented. Table 2 identifies where worst case results were taken. Each care home is described anonymously using a numerical identifier. Each floor tested at each care home is presented separately in Table 2. Where relevant, shod and barefoot results on each floor are also presented separately.

Table 2: Results of pendulum testing on site

Care Home	Location	Floor Type	Shod/Barefoot Test	Wet Slip Potential

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1	Kitchen	Safety Vinyl	Shod	Low
2	Laundry Room	Ceramic Tile	Shod	High
3	Living Room	Carpet	Shod	Low
4	Kitchen	Quarry Tile	Shod	High
5	Bathroom	Limestone Tile	Shod	High
5	Bathroom	Limestone Tile	Barefoot	High
6	Servery	Smooth Vinyl	Shod	High
6	Pot Wash	Smooth Vinyl	Shod	High
7	Outdoor Walkway	Grooved Timber Decking	Shod	High (worst case)
8	Assisted Shower Room	Riven Ceramic Tile	Shod	High
8	Assisted Shower Room	Riven Ceramic Tile	Barefoot	High
8	Bathroom	Safety Vinyl	Shod	Low
9	Bedroom	Smooth Vinyl	Shod	High

In 73% of the locations assessed (eight out of 11 locations), the floors tested presented a high slip potential when wet. The two safety vinyls and the carpeted floor tested presented a low slip potential when wet showing what can be achieved through good floor specification.

Stair Falls

Assessments of stair fall risk were undertaken at two care homes. Several common issues were highlighted that give rise to an increased risk of falls on stairs, namely: the size of the rises and goings, the consistency of the rises and goings throughout the flight, the nosing design and the design of the handrail. These common issues are covered in current regulations and standards as follows:

Steeper stairs increase the risk of falls, particularly in descent. The size of the going is critical, with smaller goings increasing the risk of a large overstep, a significant risk factor for falls (BRE, 2003).

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Risk increases significantly on stairs with goings less than 300 mm. Inconsistencies between adjacent rises and goings increase the risk of a fall, particularly on goings under 300 mm. Differences of as little as 5 mm between adjacent goings can have a significant impact on the risk of falls, especially on smaller goings (BRE, 2013). The building regulations state:

> 'The standard of provision needed to give an acceptable level of safety for access and use depends on the circumstances. The standard of provision may need to be higher in a public building than in a dwelling, because people may not be familiar with the building and there may be more users'. (The Building Regulations, 2013)

Because of this, the Building Regulations allow steeper stairs to be installed in domestic premises than public buildings. Some care homes are converted buildings which include repurposed domestic stairs. The design of the handrails and nosings on these stairs will need to be suitable, as described below, to control fall risk.

The edge of each step (the nosing) needs to be clearly highlighted to allow pedestrians to accurately judge where the very edge of each step is and place their feet accurately (BSI, 2010 (1)). The colour of the nosing highlight should contrast with the main body of the step as well as the adjacent floor or landing. BS 8300 recommends a difference of at least 20 LRV between adjacent design elements in order to provide suitable contrast, with 30 being better for visually impaired pedestrians (BSI, 2010 (2)).

BS 5395 recommends that stairs should have a handrail on each side wherever possible. Handrails should be pitched between 900 mm and 1000 mm above the pitch line of the stairs (i.e. above the nosing). Handrails should have a graspable profile, ideally circular or elliptical with a perimeter between 100 mm and 160 mm and have clearance from the wall and the stair balustrade of at least 50 mm. If the stair is wider than 2000 mm a central handrail should be installed. The handrail should contrast with its surroundings as discussed above (BSI, 2010 (1)).

Trip Hazards

For trips, the most significant design risk is the height and visibility of the hazard. In one of the care homes assessed for slip resistance, a trip hazard was also identified: a metal strip approximately 20 mm in height between two adjacent areas of flooring.

The likelihood of tripping over an obstacle depends on the minimum clearance between the pedestrian's foot and the ground during the swing phase of gait, often called toe clearance. A review of trips literature by the Health and Safety Laboratory (HSL) (Loo-Morrey, 2003) showed that for young healthy adults in different studies, toe clearance varied between 8.7 mm and 21.9 mm. This suggests a change in level of around 10 mm can present a trip hazard, with bigger hazards being more likely to interrupt pedestrian gait. It should be noted that toe clearance decreases with age, so care home residents will be more likely to trip over smaller changes in level.

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Where it is not reasonably practicable to eliminate trip hazards, one possible risk control measure is to visually highlight the trip hazard to maximise the chance of a pedestrian spotting the hazard and negotiating it safely. The trip hazard should contrast with surrounding design elements as described above.

Conclusions: Reducing Fall Risk through Better Design

Good design can play an important role in reducing the risk of falls in care homes. The following issues can be considered when trying to prevent falls by good design:

- Use flooring specified with an appropriate test, such as the pendulum test. Obtain data appropriate to any contamination likely in the area it will be fitted in and the likely use and users.
- Take reasonably practicable steps to firstly eliminate trip hazards or, secondly, control the risks, for instance by visually highlighting the hazard in a way that will be clear to the user.
- For stair design consider whether: the size of the goings is sufficiently large for users; rises and goings are consistent; the nosing is clearly highlighted; and handrails are installed at an appropriate height, contrast clearly with their surroundings and can be grasped easily along their entire length.

DISCLAIMER

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