Safety of stairs for limited access in dwellings: A mixed methods study

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Stairs are an important element of building design, enabling the efficient utilisation of space by allowing people to traverse between different floor levels. However, the Royal Society for the Prevention of Accidents (RoSPA) estimate that over 700 people die and over 43,000 people are hospitalised every year in England due to a fall on stairs in the home. The design standards for stairs not only have an influence on the risk to a person's safety, they also influence the stair's usability, which is of particular importance for older adults and those with impaired mobility. Poor stair design can lead to a loss of confidence and accessibility, which often results in a loss of independence.

To help achieve the objectives set out in the Building Safety Regulators strategic plan, robust and objective evidence is needed to inform their technical policy advice and to inform the development of stair design guidance within the Approved Documents. This study aims to evaluate existing evidence on the safety and usability of, fixed ladders and alternating tread stairs, which are among the special stair types included in the current Approved Document K, as well as of steep stairs. These stair types are permissible for loft conversions where there is insufficient space for standard stair designs. The study includes: (i) a review of relevant literature; (ii) the evaluation and analysis of various datasets; (iii) ergonomics assessments of different stair designs, and; (iv) the collection and analysis of insights provided by key stakeholders, by means of a survey and online workshop.

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Safety of stairs for limited access in dwellings: A mixed methods study

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HSE wish to acknowledge the Ministry of Housing, Communities and Local Government for the data provided from the English Housing Survey, and the Department of Trade and Industry for the data provided from the Home Accident Surveillance System and the Leisure Accident Surveillance System (HASS/LASS).

Research ethics statement

This study was reviewed and approved by the Health and Safety Executive's Research Ethics Panel which operates under delegated authority from the University of Sheffield Medical School Research Ethics Committee (Reference REP 25-06, Date 15/08/2025).

In line with General Data Protection Regulation (Article 35 of the UK GDPR) and the Information Commissioner's Office (ICO) recommendations (ICO's recommendations), HSE conducts a Data Protection Impact Assessment (DPIA) for the majority of its research projects, particularly where the proposed processing of personal data is likely to represent a high risk to the rights and freedoms of data subjects.

Key Messages

1. The Royal Society for the Prevention of Accidents (RoSPA) estimate that over 700 people die and over 43,000 people are hospitalised every year in England due to a fall on stairs in the home. The Building Safety Regulator (BSR) is responsible for overseeing the safety and performance of all buildings in England and is responsible for the development of Approved Documents which provide minimum guidance to meet the requirements of the Building Regulations. This study was undertaken to inform BSR policy and guidance on the design and use of stairs for limited access in dwellings, specifically steep stairs, fixed ladders and alternating tread stairs.
2. The study found that there is a lack of longitudinal or epidemiological studies linking stair design to actual falls and injuries, and that questions have been raised about the utility of biomechanical fall risk indicators derived from laboratory trials. Furthermore, it is not possible to positively identify stair types within existing incident data or to compare the frequency and severity of falls associated with different stair types.
3. Despite these gaps in the evidence base, there is broad consensus within the literature that large rise heights and short goings, along with the associated steep pitch can increase the risk of falls. Dimensional inconsistencies have also been associated with an increased risk of falls. Although the alternating tread design provides the opportunity for larger goings than steep stairs and fixed ladders, this design was not favoured by our stakeholders or the results of our ergonomics assessment. Indeed, alternating tread stairs are likely to have additional unique risk factors associated with user technique, eg. leading with the wrong foot.
4. Stakeholder feedback concurred with the existing guidance in the current Approved Document K, i.e. a steep stair, fixed ladder or alternating tread stair should only be used where there is insufficient space to accommodate a standard private stair. Some suggested fixed ladders and alternating tread stairs were inherently dangerous and ought to be avoided. However, we did not identify definitive evidence to link these designs with an increase in falls.
5. Our ergonomics assessment highlighted the importance of handrails, the need for clearly visible treads, and the need to consider usability. Stakeholder feedback also stressed the need to consider usability.
6. The current quality of incident data, limits the opportunity to learn from real world incidents, but our review identified that fall simulation models can be successfully used to investigate the biomechanics of stair falls and to identify stair characteristics that influence the potential for injuries, which may help to address some of the gaps in the existing evidence base. However, these simulations may be most useful for investigating stairs with landings and/or changes in direction, which are likely to influence fall trajectories and potential outcomes.

Executive Summary

Background

Stairs are an important element of building design, enabling the efficient utilisation of space by allowing people to traverse between different floor levels. However, the Royal Society for the Prevention of Accidents (RoSPA) estimate that over 700 people die and over 43,000 people are hospitalised every year in England due to a fall on stairs in the home. The design standards for stairs not only have an influence on the risk to a person's safety, they also influence the stair's usability, which is of particular importance for older adults and those with impaired mobility.

The Building Safety Regulator (BSR) is responsible for overseeing the safety and performance of all buildings in England and is responsible for the development of Approved Documents, which provide minimum guidance to meet the requirements of the Building Regulations. This report details a research study commissioned by BSR, which was undertaken by the Health and Safety Executive (HSE) Science Division to help inform guidance on the design of "steep stairs", "fixed ladders" and "alternating tread stairs", which are only permissible for loft conversions when there is insufficient space to accommodate the dimensional requirements to comply with those specified for a private stair.

Methods

This study gathered evidence by means of: (i) a literature review; (ii) incident data analysis; (iii) ergonomics assessment, and; (iv) stakeholder engagement.

Literature review: A rapid evidence review was undertaken to identify and review relevant peer-reviewed studies and technical reports.

Data Analysis: Prevention of Future Death Reports, Coroner Reports, Home and Leisure Accident Surveillance System and English Housing Survey data were analysed to extract existing data on stair types including steep stairs, fixed ladders and alternating tread stairs.

Ergonomics Assessment: A Three-Dimensional Computer-Aided Design (CAD) software was used to explore the ergonomics of different stair designs based on the dimensions specified in relevant Standards for steep stairs, fixed ladders and alternating tread stairs.

Stakeholder Engagement (Survey & Workshop): These activities used a survey questionnaire developed by Human Factors Specialists from HSE's Science Division in collaboration with the Building Safety Regulator end user. The questionnaire consisted of questions for exploring the prevalence, use and safety of steep stairs, fixed ladders and alternating tread stairs; respondent role and experience; and relevant guidance.

The work forms part of the wider overall technical review of the Approved Document K (ADK) which aims to determine whether the relevant provisions in the ADK are fit for purpose and effective in meeting the minimum requirements in Schedule 1 Part K1, K2, K3, K4, K5, K6 of the Building Regulations 2010.

Findings

Literature review: The literature review found that there were no recently published studies regarding the safety of steep stairs, fixed ladders or alternating tread stairs, but identified many translatable studies, which considered the influence of stair dimensions. These studies have linked large rise heights and short goings (characteristics common to steep stairs, fixed ladders and some alternating tread stairs) to an increased risk of falls. However, most of these studies have been undertaken on experimental stair rigs (often consisting of ≤7 steps) in laboratory conditions, and measure biomechanical fall risk indicators, such as foot contact lengths, as opposed to actual falls. Our review highlighted that concerns have been raised over the relevance of such studies, and that there is a lack of studies conducted in a real-world environments, which report falls as an outcome measure. Our review found that the most comprehensive study of alternating tread stairs remains to be a 1989 field study, which has already been used to inform previous revisions of Approved Document K.

Data Analysis: The limitations within the available datasets were found to be too significant to allow for the formulation of conclusive results or definitive statistical findings.

Ergonomic Assessment: The ergonomics assessment showed that large rise heights and steeper pitches tend to be more inhibitory/less accessible and that steep stairs, fixed ladders and alternating tread stairs are likely to present a barrier to more vulnerable users (e.g. large, heavy men), due to the increased lower limb biomechanical efforts/requirements. When using steeply pitched fixed ladders, people will need to grasp onto handrails to prevent falling backwards, due to the positioning of their centre of mass. While alternating tread stairs offer some physical advantages (e.g. larger goings), without appropriate design features the visual requirements are likely to increase risk of falls due to foot misplacement.

Stakeholder Engagement (Survey & Workshop): The prevalence of steep stairs, alternating tread stairs and fixed ladders is difficult to ascertain due to limited data. Several accessibility and usability issues were highlighted for steep stairs, alternating tread stairs and fixed ladders, particularly for elderly occupants, children and occupants with impaired mobility. Alternating tread stairs and fixed ladders were considered to be the most problematic. A majority of participants recommended that steep stairs, alternating tread stairs and fixed ladders should only be used as a last resort where it is not possible to install a standard private stair.

Conclusions

Steep stairs, fixed ladders and alternating tread stairs all tend to have design characteristics (i.e. steep pitches, short goings and large rise heights) that have been shown to increase the risk of falling and make them difficult to use by a sizeable portion of the population, particularly large-bodied individuals. However, these and other “Special Stairs” do provide some benefits, in terms of space efficiencies and based on the evidence that is currently available, it is difficult to gauge whether the benefits outweigh the potential risk.

Contents

1 Introduction

1.1 Background

The Building Safety Regulator (BSR) is responsible for overseeing the safety and performance of all buildings in England and is responsible for the development of Approved Documents which provide minimum guidance to meet the requirements of the Building Regulations. In their 2023-26 Strategic Plan (2023) BSR committed to "*commence a more fundamental review of the Approved Documents, as recommended by Dame Judith Hackitt".* The Phase 2 report of the Grenfell Public Inquiry recommended that statutory guidance is kept under continuous review.

Stairs are an important element of building design, enabling the efficient utilisation of space by allowing people to traverse between different floor levels. However, the Royal Society for the Prevention of Accidents (RoSPA) estimate that over 700 people die and over 43,000 people are hospitalised every year in England due to a fall on stairs in the home. The design standards for stairs not only have an influence on the risk to a person's safety, they also influence the stairs usability. The usability of stairs is of particular importance for older adults and those with impaired mobility. Poor stair design can lead to a loss of confidence and accessibility, which often results in a loss of independence.

This report details a research study commissioned by BSR, which was undertaken by the Health and Safety Executive (HSE) Science Division to help inform guidance on the design of "steep stairs", "alternating tread stairs" and "fixed ladders", with examples of each shown in Figure 1. According to the current Approved Document K (ADK) these types of stairs are only permissible for loft conversions when there is insufficient space to accommodate the dimensional requirements to comply with those specified for a private stair, and when the stair is for access to one habitable room, and if desired, an additional bathroom. Other permissible designs, i.e. spiral and helical stairs were beyond the scope of the study.

This work forms part of the wider overall technical review of the ADK which aims to determine whether the relevant provisions in the ADK are fit for purpose and effective in meeting the minimum requirements in Schedule 1 Part K1, K2, K3, K4, K5, K6 of the Building Regulations 2010.

Figure 1. Left to right: Steep stair, Alternating Tread Stair, Fixed ladder
(source: Getty Images, under HSE licence. Images are for illustration purposes only and do not necessarily represent compliance or good practice.)

1.2 Research aim

The purpose of this research was to investigate the current understanding of good stair design with consideration for the suitability of existing guidance for the design and use of straight stairs with steeper pitches, fixed ladders and stairs with alternating treads (collectively referred to as "Special Stairs" within this report), which can be used in certain situations in dwellings.

The aim of the research was to generate evidence to help answer the following questions:-

1. What is the prevalence of Special Stairs for limited access within existing dwellings?
2. If Special Stairs are not widely installed, what would be the impact if the guidance for these types of stairs is removed from statutory guidance?
3. Could certain proposed policy options be overly prohibitive in some situations with consideration to the reasons that stairs for limited access may be installed over a "private stair", as defined in ADK?
4. What does safe stair design look like and what are the safety implications of using the alternative stair designs for limited access?
5. What are the key risk factors in the range of stair types for limited access within a dwelling?
6. What risk reduction measures could be applied to Special Stairs (including open risers, nosings) and can a reduction in risk be quantified so that cost benefit analysis can be carried out?

7. Are the stair designs associated with the highest risk of falls also associated with the highest risk of injury?
8. Should the use of fixed ladders remain within the ADK, and if so, should the design parameters be defined?
9. Are falls more likely from an accident on a stair for limited access than a domestic private stair?
10. Could injuries be more serious on certain types of limited access stairs? E.g. does the steeper pitch of an alternate tread stair or ladder have more serious consequences than a straight stair?

To answer these questions, the study obtained evidence by means of: (i) a literature review; (ii) incident data analysis; (iii) ergonomics assessment, and; (iv) stakeholder engagement.

2 Methods

2.1 Literature Review

A rapid evidence review was undertaken to identify peer-reviewed studies and technical reports. A search strategy was developed in consultation with HSE's Information Management Team with the aim of identifying research regarding the safety and usability of steep stairs, fixed ladders and alternating tread stairs. A literature search was conducted across Web of Science (Core Collection/Medline) and Ergonomic Abstracts, as well as across Proquest platform, which contains several engineering, construction and Occupational Health databases for papers published between 2009 and 2025, using the following search terms:

Search A
Set 1
"Alternat* tread stair*" or "fixed ladder*" or "steep stair*" or "loft stair*" or "basement stair*" or "special stair*" or "limited access stair*"
AND
Set 2
"safety or fall* or injur* or usability or ergonomic* or accident*"

Search B
Set 3
"stair* design" or "risk reduction measure*"
AND
Set 4
"Limited access stair*" or "special stair*"

This resulted in 34 hits, which provided 28 different papers and 6 duplications. Twelve papers were rejected based on the following exclusion criteria: (i) they related to stair/ladder designs that would not be expected in a domestic setting within Great Britain; or (ii) they related to novelty features, such as glass or sound emitting treads.

The remaining sixteen papers were reviewed in full, along with a further fifteen academic papers and nineteen technical documents, which were identified through extended online searches and/or feedback from stakeholders obtained via the survey/workshop (refer to sections 2.5, 2.6, 3.5 & 3.6 of this report).

The results of the literature review are reported in Section 3.1 of this report.

2.2 Review of supplementary literature

In addition to the targeted searches described in Section 2.1, exploratory online searched were conducted to investigate the feasibility of using simulation software to study stair falls and the influence of stair design on fall risks and outcomes. Searches were undertaken using Google and Google Scholar, with further information being obtained directly from supplier websites.

A review of relevant UK Approved Documents was also undertaken as part of our review of supplementary literature, with the specific purpose of comparing how each addressed steep stairs, fixed ladders and alternating tread stairs.

The findings form our review of supplementary literature are reported in Section 3.2 of this report.

2.3 Data Review

To analyse existing data relating to steep stairs, fixed ladders and alternating tread stairs (collectively referred to as “Special Stairs”), we considered various datasets discussed in the literature, as well as some suggested to us by key stakeholders, which included safety/housing professionals and other researchers. The following specific datasets were used:

- Prevention of Future Death Reports: The prevention of Future Death (PFD) Reports exist due to the Coroners and Justice Act 2009, which provides coroners with the duty to make reports to a person, organisation, local authority or government department or agency where the coroner believes that action should be taken to prevent future deaths. These documents are collated by the Courts and Tribunals Judiciary and presented through the government website search tool. The PFD reports included in this analysis range from 30th July 2013 – 22nd September 2025 (the date of analysis).

- Coroner Reports: The coroner’s investigation is to establish who has died, and how, when, and where they died. To find this out, the coroner may decide to hold an inquest, which is a fact-finding inquiry in a court. The coroner’s findings may be critical of what happened, but the coroner cannot blame individuals or organisations or find them responsible for the death. That will be for the criminal or civil courts. A report is then generated to capture these findings. The local authorities which provided data for this work are:

    - Central Bedfordshire Council region

    - Sheffield City Council region

- Home and Leisure Accident Surveillance System: This dataset contains records for the Home and Leisure Accident Surveillance Systems (HASS and LASS) from 1978 (two years after the system was set up) up to 2002 (the year before collection of home accident data ceased). HASS/LASS collected personal and incident information for patients attending hospital following an accident in the home or within leisure facilities. Leisure facilities can cover a wide range of areas, such as sports centres through to care homes.

- English Housing Survey: This is a continuous national survey commissioned by the Ministry of Housing, Communities and Local Government (MHCLG). It collects information about people's housing circumstances and the condition and energy efficiency of housing in England.

Each dataset contains different levels of detail and features for which to analyse and were therefore treated independently of one another and analysed in slightly different ways. They were selected specifically for their potential to contain information relating to stairs within a building, and associated health and safety considerations/incidents.

A relatively similar approach to data filtration and extraction was used across all datasets. Specific differences between each datasets approach are made clear in Section 3.3.

Filtering of the data was done as a two-step keyword search process, for several of the datasets and so is hereby referred to as the 'two-step filter'. This key word search process finds exact text matches between the database text and the keyword terms defined, i.e. does this word exist in the database text? This search ignored capitalisation, and the keywords were defined to account for differences in tense and plurality.

First the documents were filtered using a 'stair' or 'step' keyword search . This gave a 'stairs dataset'. The stairs dataset then went through a further keyword search filter process to identify 'Special Stairs' related text in the databases. To enable comparative analysis, the Special Stairs keywords were broken down into four main groups and searched separately as follows:

- **Cottage**: 'cottage' (Property which often features a stair with a steep or narrow tread.)

- **Cellar**: 'cellar, basement'

- **Loft**: 'loft', 'attic', 'conversion', 'convert', excluding 'ladder' (The reason for excluding mentions of ladder even though loft ladder falls within the definition of a Special Stairs is because this was deemed to be a technical term for this stair design that would not be used by the creators of PFDs or any further dataset. If a ladder was referenced in the context of lofts this was overwhelmingly used to describe temporary, folding, or stowaway ladders, which are out of the scope of the Special Stairs definition.)

- **Other**: 'split stair', 'split step', 'steep', 'alternat' (a catch-all for other Special Stair key words)

The name of the root dataset (given in bold) was joined together with the output from the Special Stairs filter process to form the 'Special Stairs dataset'. The specific findings from the process are given in Section 3.3.

Note that there are limitations to this approach. Namely, the inclusion of a key word within a text does not necessarily presume that this is an example of its classification and potentially creates false positives. An example of this could be a loft mentioned tangentially, for example ‘The person was heading up or down their stairs to fetch the loft key’ does not describe an incident occurring on a loft stair but would be labelled as such as part of this method.

Additionally, as the datasets studied were created without the intention of collecting details about the stairs, the specific type of stair will often only be described as a ‘staircase’ or similar, leading to false negatives which are difficult to quantify.

2.4 Ergonomics Assessment

From an ergonomics perspective, negotiating a stair is influenced by a combination of physical and sensory capability, anthropometric fit and balance control. The ability to ascend or descend safely depends on whether the user can generate sufficient strength to support and propel body weight, maintain stability by keeping the centre of mass within the base of support (or otherwise compensate for the loss of balance), and adapt to the spatial constraints imposed by tread geometry and pitch. Variations in rise height, tread depth (going), and handhold availability can significantly alter joint loading, muscle demand, and postural positions, particularly for individuals with reduced strength or mobility.

The ergonomics assessment examined the suitability of Special Stair designs by applying predictive strength data and anthropometric models to assess user capability. It also considered balance implications and the interaction between body mechanics and stair geometry. The aim was to identify whether current guidance adequately reflects human performance limitations and to highlight potential safety concerns that may warrant further refinement of design standards.

To explore the ergonomics of the different stair designs Three-Dimensional Computer-Aided Design (CAD) models were constructed using the JACK human and Environmental simulation software Version 9 (Siemens, 2026). Using this software, scaled CAD models of stairs were constructed, based on the dimensions specified in relevant Standards.

Four stair types were constructed in the CAD system; a standard private stair to provide a baseline, as well as a steep stair, a stair with alternating treads and a fixed ladder, which was based on the design guidance for companionway steps provided in “*BS4211:2005+A1:2008 Specification for permanently fixed ladders*”. Each type of stair was given a standardised number of steps (n=12) and flat step treads of 600mm width, and handrail of 20mm radius (these was selected for convenience; it had no bearing on the tests performed. Each stair was tested with the same anthropometric models of a 5th percentile (small) female adult and a 95th percentile (large) male adult. Two stair types, the alternating tread stairs and the companionway steps, were built twice to explore the effect of variations (e.g. pitch angle) in the stair designs. The variations in the designs of the stairs are outlined in Table 1.

Table 1. Critical dimensions of the four stair designs tested.

Stair Type	Tread depth (going) (mm)	Tread height (rise) (mm)	Pitch (°)	Tread overlap (mm)	Handrail height (mm)	Overall height of stairs (ground to top step) (cm)	Horizontal (Footprint) length of stairs (mm)
ADK Private stairs	220	200	42	0	900	242	2688
Steep stairs	180	200	50	0	900	242	2031
Alternating tread stairs 1	220 (at widest)	170	48.6	6.9 at wide point 0.8 at narrow point	900	242	2134
Alternating tread stairs 2	300 (at widest)	220	63.4	7.2 at widest 0.5 at narrow point	900	242	1212
Fixed ladder (Companionway steps) 1	90	220	60	-35 (gap)	250	242	1397
Fixed ladder (Companionway steps) 2	90	220	75	23.5	100	242	648

For each stair type two human models with anthropometric statute and weight measures of a 5th percentile adult female and a 95th percentile adult male were placed on the stairs and configured in postures adopted when ascending the steps. The models (were representative of the smallest and largest users of stairs from the mid 90% range of the population). The extremities of 'tallest and shortest' stature human models (and lightest and heaviest in weight) were chosen to help identify any issues with people in the potential 'highest risk' groups of users due to physical extremities. In these static positions analyses can be performed to check the ability of people to successfully use the stairs based on their anthropometric body sizes, static strength capabilities and centre of gravity position. The 5^{th} and 95^{th} percentile CAD human models were taken from the ANSUR2 database which includes the large-scale survey data of a population of 19 – 64 year olds, predominantly from the USA military. The ANSUR2 database was checked against the UK database and found to be a suitable equivalent for use in this case (PeopleSize, 2020). However, this does not account for 3rd age population, i.e. people aged 65 years and older.

2.4.1 Static strength prediction (SSP)

Static strength prediction (SSP) evaluates the percentage of a population that has the strength to perform a task based on posture, exertion requirements and anthropometry.

SSP evaluation is based on the 3D SSPP software from the University of Michigan. This evaluates the percentage of a population capable of performing a task based on biomechanical models and extensive population strength databases. It uses static linked-segment modelling to estimate the force and torque demands of a task on individual joints and compares these demands to the measured strength capabilities of various industrial and civilian populations. The model assumes static or semi-static conditions, meaning it's primarily used for slow movements where acceleration and momentum effects are negligible.

The forces and postures of the knee joint are of key interest when ascending/descending stairs. Peak forces tend to occur during ascent of stairs; higher peak patellar tendon forces, peak flexor forces, posterior cruciate ligament (PCL) forces and contact forces have been measured compared to descending (Lu et al. 2006). When an individual lifts their body up a steep step, their knee is required to bend more than on normal stairs, thereby changing the way forces act on the leg. In this situation, the weight of the body pushes down through the foot, and because of the angle induced by flexion of the hip and knee to elevate the foot onto the next higher step, the ground reaction force creates a turning effect (torque) around the knee. To overcome this, the thigh muscles (quadriceps) have to pull hard to straighten the knee to lift the person up. The forces inside the knee can be several times a person’s body weight on steep stairs, and significantly higher than what occurs during level walking.

For people at the extremes of body size (very small or very large, or 5^{th} and 95^{th} percentile stature and weight) this can be even more demanding. Small people often have less muscle mass and strength to generate the required force and due to a shorter stature need to use greater angles of flexion in the hips, knee and ankle to elevate their foot up to the next step. Large people are likely to produce higher absolute forces because of their high overall body weight. These extra demands mean that static strength (the ability to hold and control their body under load) is critical for safe stair climbing, especially in environments with steep stair designs which may extend requirements to the limits of human capability. The static strength prediction of the lower limbs and especially at the knees are of greatest importance in steep stair climbing.

2.4.2 Centre of Gravity

The theoretical basis for considering the centre of gravity is derived from the location of the centre of mass (COM), which is located at approximately 55% of stature when stood upright, at the intersection of the frontal (vertical front-back divide), transverse (horizontal head-tail divide), and sagittal (vertical left-right divide) planes of motion (NASA, 1978). See Figure 2.

Closely related, is the centre of gravity (COG), i.e. the point on the floor directly below the COM; stability is maintained when the COG rests within the body's base of support (BOS). The maximum theoretical limit for the BOS is defined as the area outlined by the feet in contact with the supporting surface. However, the area of functional stability, where the body's COG can be controlled, is approximately 50 – 60% of the area of the BOS in healthy men when the feet are hip-width apart (Holbein and Redfern, 1997) while standing on a flat flooring surface. The forward functional stability limit is ~6 cm inwards from the edge of the big toes, whilst the backward functional stability limit is about ~5 cm inwards from the rear edge of the heel. This is illustrated in Figure 3.

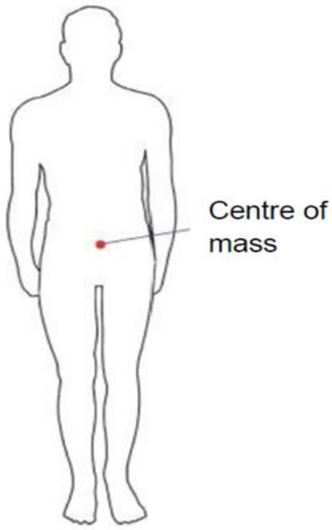

Figure 2. Illustration of the position of the centre of mass relative to stature in a standardised posture

An individual's base of support when standing on stairs will be different compared to when standing on flat ground and the area of functional stability is likely to be narrower on stairs due to the lack of available flat area on any one level. When climbing stairs, a person relies on a stable relationship between their COG and BOS to maintain balance while moving on the stairs. For safe movement on stairs, the COG should ideally remain within the BOS. When the COG moves outside the area of the functional BOS, the individual becomes less stable and more reliant on muscular effort or force application on the handrails to prevent loss of balance.

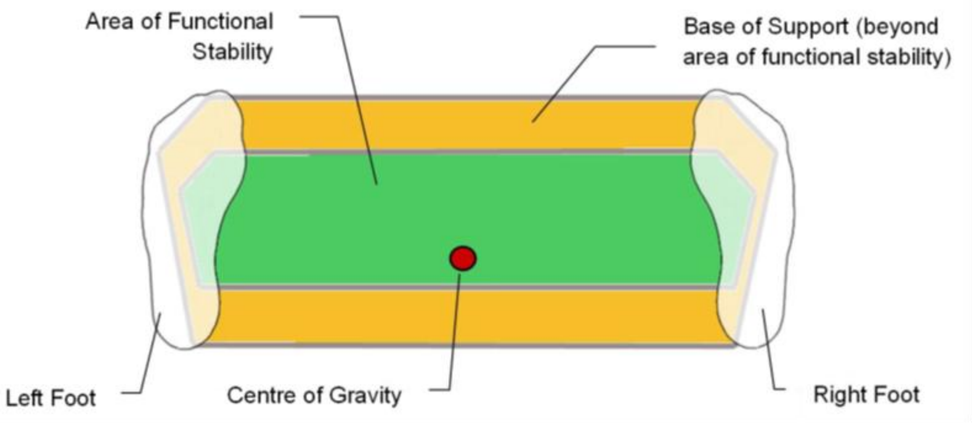

Figure 3. Diagram showing location of the body's centre of gravity within the base of support and the area of functional stability while adopting a neutral standing posture (not to scale) (adapted from Holbein and Redfern, 1997).

For each stair configuration built within the JACK CAD system the two human models of a 5th percentile female and 95th percentile male adult stature and weight were made to assume a posture resembling ascending the steps. JACK was then used to display the position of the COG and BOS for the models in the postures assumed. This clearly indicated when the model's COG was outside the BOS and 'imbalance' was occurring. When this was the case, the posture of the human models was manipulated, predominantly by increasing the flexion in the lower back to make them lean forwards, while holding onto the handrails. This moved the model's COG into within the BOS in most cases. There were some cases though that due to the restrictions afforded by the design of the stairs and handrails the models could not be manipulated fully into a state of balance. In these circumstances, the JACK measurement facility was used to measure the horizontal distance from the position of the COG to within the BOS. Generally the greater this distance was, the greater the level of imbalance associated with the assumed posture and thereby increased effort would be required to hold onto the handrails while employing a counter force to prevent toppling backwards.

2.4.3 Stair Visibility

Consideration was given to the visibility of stairs with alternating treads using the JACK human simulation software. For this, cones of visual ability from the eyes of the 95th percentile male mannequin were generated, when positioned at the top of the alternating tread stair, looking downwards on to the scene/stairs. This enabled a cursory understanding of potential factors effecting visibility. Various tread designs were considered to explore which might be more visible to a person about to descend the steps.

2.5 Survey

2.5.1 Survey development

A stakeholder survey was developed with the primary purpose of gathering top-level data to inform and guide the stakeholder workshop discussions. It is important to note that the survey was not designed to allow detailed statistical analysis. The survey was developed by Human Factors Specialists from HSE’s Science Division in collaboration with the end-users of the research.

The survey was developed using Microsoft Forms and consisted of questions exploring the prevalence, use and safety of steep stairs, fixed ladders and alternating tread stairs; respondent role and experience; and relevant guidance. The survey questions were designed to be appropriate and of relevance to building inspectors, along with members of an Approved Document K (ADK) working group identified by the BSR end-user of this research. Respondents were asked to confirm that they had read and understood the participant information sheet before being able to proceed with the completion of the survey. The full question set is provided in Appendix A.

2.5.2 Survey distribution

The survey was distributed electronically via an email, which included a survey link and QR code, as well as a participant information sheet. The survey was open for responses during an 8-week period between September and November 2025.

Table 2 outlines the stakeholder groups which received the survey, along with information on how these stakeholder groups were identified and the number of potential respondents estimated to have received the invitation to particate in the survey.

Table 2. Stakeholders included in survey distribution

Stakeholder group	Identification method	Number of potential respondents included in distribution
Approved Document K (ADK) working group members	Identified by end-user	12
Local Authority Building Control Departments in England	Identified by research team	~285
Stair manufacturers	Identified by end-user	2
Occupational therapists	Identified by stakeholder workshop participant	~10

The contact details for the ADK working group members and the stair manufacturers were provided by the BSR end-user of this research, with the permission of the individuals.

Local Authorities in England were identified using a list published online (HM Government, 2023). Building Control departments were identified using information available on the webpage of each Local Authority. The survey was distributed to Building Control departments which provide a contact email address on their website, and any departments which did not provide an email address or only provided other contact information, e.g. telephone or online form submission, were excluded. An undeliverable response email was received for a small number of the email addresses contacted.

Upon completion of the stakeholder workshop (see Section 2.6 'stakeholder workshop'), a workshop participant contacted the research team to request permission to distribute the survey to other occupational therapists. The participant estimated that the survey was shared with approximately ten occupational therapists and whilst attempts were made to share more widely within their profession, there is uncertainty on whether this was achieved. It is important to note that as this additional distribution was undertaken following the completion of the workshop, the responses were not included within the workshop development activities.

2.5.3 Survey analysis

Survey responses were monitored by the research team throughout the open period, and a top-level overview of results to date were used to inform the development of the stakeholder workshop.

Once the survey was closed to responses, basic descriptive and thematic analysis was conducted as appropriate. Details of the analytical method applied for each survey question are provided in Appendix B, with results presented in Section 3.5, as well as in Appendix C.

2.6 Stakeholder Workshop

2.6.1 Participant recruitment

Survey respondents were asked whether they consented to be contacted regarding workshop participation and, if consent was provided, the research team issued them with a Microsoft Teams invitation which included a participant information sheet and consent form to be completed ahead of participation.

2.6.2 Workshop development

The stakeholder workshop activities and discussion prompts were developed using survey responses received prior to the date of the stakeholder workshop and findings of a literature review undertaken as part of this research. An agenda was developed and issued to participants ahead of the workshop.

The activities and discussion prompts were created within interactive whiteboard software (Miro, 2026) to allow opportunity for participants to add comments during the discussions. The discussion prompts and Miro whiteboards templates used are provided in Appendix D.

The workshop activities included bow-tie analysis. Two bow-tie diagrams were developed by the researchers in advance of the workshop using the initial findings from the survey and literature review. The aim of the first bow-tie diagram was to identify the influencing factors, or ‘threats’, resulting in the outcome, or ‘top event’, of ‘installation of non-standard stairs’. Potential consequences were identified for if installation were to occur. The second bow-tie considered ‘person falls on or from stairs’ as the top event. For the second bow-tie-diagram, potential threats were identified, along with prevention barriers, mitigation barriers and consequences. The pre-prepared diagrams were shown to workshop participants who were asked to discuss the prepopulated information and then contribute any additional information they deemed relevant. Further information relating to bow-tie analysis methodology, along with the prepopulated and finalised bow-tie diagrams are presented in Appendix E.

The workshop was held virtually using Microsoft Teams, lasted for three hours, and was facilitated by two members of the research team. The recording and transcription functionality was utilised to accurately capture the discussions.

2.6.3 Workshop analysis

An analysis spreadsheet was created within Microsoft Excel which contained a designated sheet for each workshop activity and/or discussion topic to record the relevant data. Using the transcript and recording of the workshop, framework analysis was utilised to structure the data and report key findings.

The bow-tie diagrams were updated with the additional information identified by workshop participants and the diagrams updated, refer to Appendix E.

2.6.4 Supplementary Information

Upon completion of the workshop, some participants provided additional information to the research team via email, and an overview of this information has been reported in Appendix F, along with additional information obtained through general enquiries to some social housing organisations.

3 Findings

3.1 Literature Review

3.1.1 Stair falls

In England falls account for over 60 % of all accident-related hospital admissions and is the leading cause of accidental death. According to RoSPA's analysis of NHS England 2022/3 data, over 450,000 people were admitted to hospital as a result of a fall and falls resulted in 9,759 deaths, accounting for about 46 % of all accidental deaths (RoSPA, 2024). RoSPA found that 54 % of fatal falls in England occurred in the home, and that 9 % were specified as "a fall on or from stairs and steps". However, RoSPA also noted that 35 % of falls were unspecified and so the proportion of falls that occur on or from stairs and steps is likely to be much higher (RoSPA, 2024). According to The Scottish Government, (2024) about 50 % of all recorded falls within and around buildings are from stairways. An analysis of over 3500 coroners' reports for accidental deaths with external causes (E-codes) that possibly related to domestic buildings for the period 1993-1996, identified 1035 deaths related to building features and 80% of these were attributed to falls; 61 % of these falls occurred on stairs (Cayless, 2001). The estimated death rate due to falls on stairs in England is 12–14 deaths per million population per year, which is generally higher than the estimates for other countries, for example, the US estimated death rate is 5–7 deaths per million population and in Australia it is estimated to be 2 or 3 deaths per million population (Roys, 2025).

Older adults are most vulnerable to falls on stairs. In a 1-year longitudinal study, approximately one in five (17 out of 87) participants over 65 years suffered from a fall on stairs (Ackermans, 2019). An aging demographic may therefore partly explain why hospitalisations due to a fall have increased by 44 % over the last two decades (2002/3–2022/3) and deaths (per capita) due to falls have increased by 81 % (up 90 % in nominal terms) (RoSPA, 2024). However, older adults are not the only ones to suffer falls. An analysis US emergency department data found that although the highest stair fall injury rates occurred among younger children and older adults, the majority (67.2 %) of emergency department visits for stair-related injuries was by individuals 11–60 years old (Blazewick, 2018). Furthermore, despite lower mortality rates for falls than adults, children carry the largest fall injury burden with nearly 50 % of the total number of disability adjusted life years lost worldwide to falls occurring in children aged under 15 years (Ozanne-Smith, 2008).

The financial burden on society caused by falls is likely to increase from what is already substantial. The cost of falls to the NHS has previously been estimated to be between

£2.3bn[1] and £27bn[2] annually in England alone (Roys, 2008; NICE, 2013). In the US, where it's estimated that only 49 % of homes have stairs, a study established that, over a 23-year period, more than a million stair-related injuries are treated annually in emergency departments and the annual cost of non-fatal stair fall injuries was estimated to be as high as $92 billion (Blazewick, 2018; Koutamanis, 2024).

3.1.2 An overview of stair safety research

Despite the strong evidence that stair falls are a serious problem and that the design of stairs is likely to have a significant influence on the safety of stair users, some suggest that modern stair design is based on tradition rather than on robust science and ergonomics assessments (Cohen, 2009). Indeed, a review undertaken by the National Association of Home Builders (NAHB) Research Centre in 1992 for the US Department of Housing and Urban Development highlighted the limitations of the existing research. The authors were of the opinion that the utility of the findings from the majority of stair safety research was low because they were based largely on controlled laboratory studies or observational studies, using surrogate outcome measures, such as foot contact lengths, as opposed to actual falls occurring on stairs (NAHB Research Center, 1992). Wootton (2024) suggests that this continues to be a limitation, concluding that there are no longitudinal or epidemiological studies linking stair design with an actual reduction in falls or injuries. This author's review of 57 papers, included only one study that had been conducted in a real-world environment. Furthermore, Ram (2024) demonstrated that biomechanical risk factors may present differently between stairs in uncontrolled (real home) environments and stairs in controlled (laboratory) environments. Results showed statistically significant difference effects of stair environment on factors such as cadence, foot clearance and foot contact length ratio between houses (uncontrolled environment, representative of the 1920s, 1970s and 2010s) and laboratory stairs (controlled environment), when older adults (>65 years) traversed the stairs. During ascent, the older adults were observed to walk more slowly and to adopt a safer strategy in the laboratory than in the houses. In contrast, a riskier strategy was adopted during decent in the laboratory compared to in the home. The findings support the need for research that is focused on real environment situations rather than hypothetical or laboratory situations.

Steep stairs with a pitch of more than 42°, fixed ladders and alternating tread stairs were found to have received little research attention. Although some of the literature reviewed considered these stair designs, they were rarely the primary focus and tended to be given relatively little consideration. Figure 4 shows the proportion of papers identified by our targeted search that considered each of these stair types, though in many cases this consideration was not in depth.

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[1] Annual cost to the NHS in England of falls in older adults, National Institute for Health and Care Excellence (NICE), 2013

[2] The minimum annual cost of non-fatal fall accidents to the NHS in England. Roys & Wright, 2008

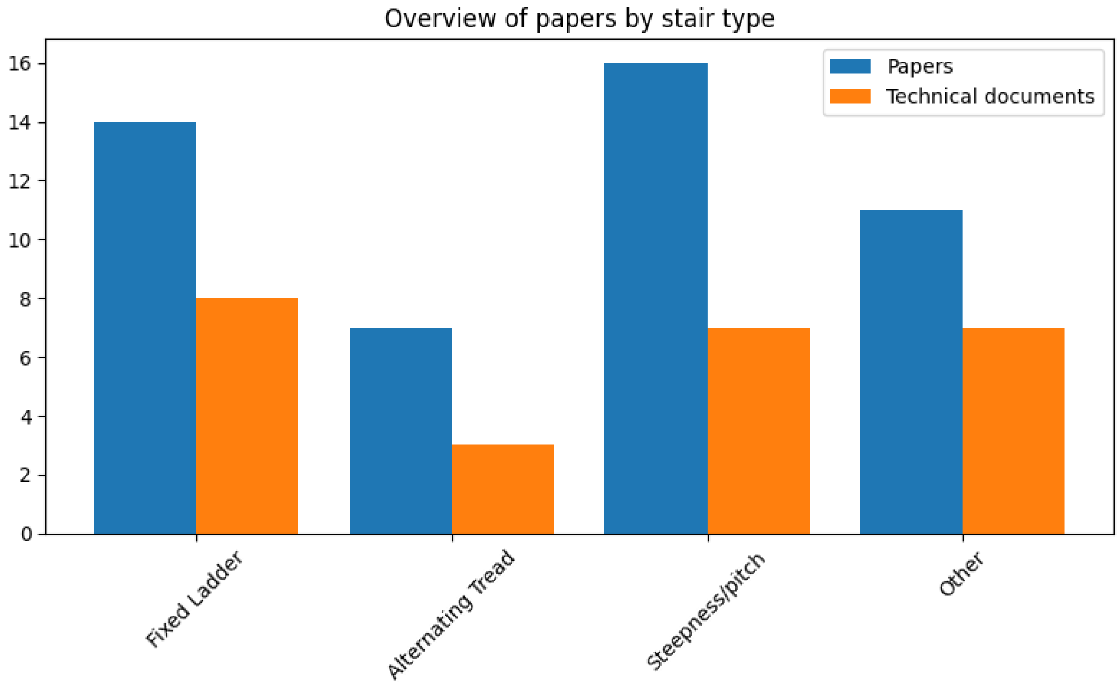


Figure 4. Breakdown of the documents included in our review by stair type considered. (Note: Other relates to papers that only considered conventional stair designs, but included findings relevant to Steep Stairs, and/or Fixed Ladders and/or Alternating Tread Stairs. Although papers made reference to steep stairs, they only considered stairs with pitches 42° and below, with 42° being considered the steep stair. Therefore, none of the papers considered what would be defined as a "Steep Stair" in the context of this study.

3.1.3 Steep stairs and fixed ladders

Although a significant proportion of the documents considered the pitch or steepness of the stair, none of them considered pitches beyond those permissible for a private stair (i.e. 42°) and so didn’t consider pitches that may be used for steep stairs and fixed ladders providing access to loft conversions. Stairs with pitches in excess of 42° are also commonly used in older properties, i.e. those built prior to the introduction of British Standards for stairs (BS585) in 1944. It has been suggested that before 1944 the pitch of a private stair was generally greater than 42° and that the majority of stairs built since 1944 will have pitches < 42° (Webber G, 1985). Some studies have attempted to identify stair characteristics associated with accidents by analysing coroners’ and/or inquest reports on the basis of the age of the property in which incidents occurred as a proxy variable (assuming houses built prior to 1944 would have a pitch > 42° and those built after 1944 would have a pitch ≤ 42°) to identify trends (for example Cayless, 2001; Webber G, 1985). These studies concluded that inquest reports lack the necessary information to link building features to injuries.

Ackermans (2019) conducted a behavioural laboratory-based study to assess the usability and safety of experimental stairs with a variety of pitch angles. The study compared stair negotiation behaviour of older individuals on a ‘‘shallow” staircase (150 mm step height (rise) 280 mm a tread depth (going) and pitch of 28.2°), and on a ‘‘steep” staircase

(200 mm rise 250 mm going and pitch of 38.7°). Refer to Figure 5 for stair dimensions and terminology. Results showed that older adults did not adapt their ascent and descent strategies between stairs of different designs and Ackermans noted that staircases with large rise heights create additional demands in terms of joint moment generation during stair ascent.

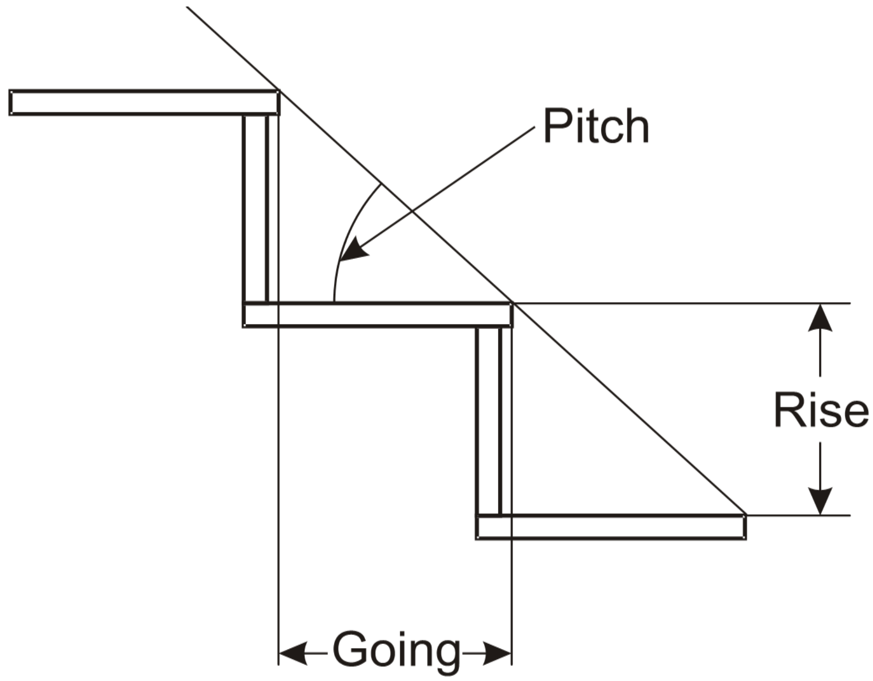


Figure 5. Schematic showing common stair dimensions and terminology

Biomechanical studies have made similar findings. Riener (2002) investigated the biomechanics and motor co-ordination of ten human subjects whilst they ascended and descended three five-step staircases of different pitches (24°, 30°, 42°). Results showed that inclination had a large influence in joint powers, related to the varying amount of potential energy that has to be produced (during ascent) or absorbed (during descent) by the muscles. Stacoff (2005) measured the ground reaction force generated by twenty healthy subjects whilst they ascended and descended an experimental stair at three inclinations (19.8°, 30.4° and 41.0°). Results showed that the steepest stair descent condition associated with the most demanding effort (the average vertical load increased up to 1.6 x body weight) and the least stable gait (largest variability and left-right asymmetry).

One study also considered how the pitch of the stair can influence physical exertion by monitored the heart rate, the Borg Rating of Perceived Exertion (RPE) and flexion angles of knee joints, hip joints and trunk angles of nine participants as they ascended and descended stairs with pitches of 24°, 30° and 36°, at walking speeds of 72, 96, and 132 steps per minute, whilst also carrying a load (Tseng, 2011). The study demonstrated that increased stair pitch and walking speed were associated with increased heart rate and RPE.

The results of these studies would therefore suggest that steeper stairs are more reliant on users having good muscle strength and fitness levels, and steep stairs are therefore likely to be problematic for users who are less able bodied and/or heavy. Steeper stairs are also more likely to result in user instability and, as inclination increases, the opportunity for users to arrest any falls is likely to diminish. Indeed, a review of stairway falls by Jacobs (2016), concluded that changes in stair architecture, such as increasing stair height, can increase the demand of stair negotiation for young adults through required knee and ankle displacements, moments, and powers, as well as increased muscle activation. According to this author, increasing stair height or decreasing tread length also decreases opportunity for centre of mass stability and time in double support (the point in the walking cycle at which both feet are simultaneously in contact with the ground) as well as increases ground reaction forces during descent.

3.1.4 Stair dimensions

Stair dimensions are considered an important safety factor and have been the focus of much research. Research has focussed on the depth of the usable tread (usually referred to as the “going”) and the height between treads (usually referred to as the rise), illustrated in Figure 5. These dimensions will influence the pitch of the stair, with steep stairs having a relatively short going and/or a large rise. The going must be of sufficient length to allow stair users space to securely place their feet and the rise must not be too large to ensure users can control their shifting weight as they move from one tread to the next (Loo-Morrey, 2003; Roys, 2003).

Stairs with shorter goings, such as those often used with steep stairs, fixed ladders and in some cases alternating treads, are likely to increase the risk of an “over-step”, where the foot lands beyond the tread of the stair, or an “under-step”, where the heel catches the riser (vertical part of a step) of the step above. Short goings are also likely to make it more difficult to regain balance should a fall situation occur, because there is limited space to securely place a foot to arrest the fall (Ackermans, 2019). A large rise combined with a short going (which is often characteristic of steep stairs fixed ladders and alternating tread stairs), will increase muscular force demand and is likely to further decrease foot clearances and the amount of foot placed on each step, leading to an increased risk of a fall (Francksen et al., 2020; Francksen, 2022; Loo-Morrey, 2003; Roys, 2003).

Research has shown that having consistent dimensions throughout the fight is also important. It has long been understood that inconsistent going dimensions can increase the risk of falls (Roys, 2003), but more recent research (Francksen et al., 2020, Francksen N, 2022) suggests that inconsistent rise heights may be even more problematic. Francksen reported that adults were able to adjust stepping over 10 mm inconsistencies in going, but not for 10 mm inconsistencies in rise. This could explain the findings of an ergonomics analysis of 80 stair falls, which identified a greater frequency of serious falls on stairs with inconsistent rise (60 %) than inconsistent goings (34 %) (Cohen, 2009).

3.1.5 Alternating Tread Stairs

Alternating tread stairs require a usage strategy that is very different from standard stairs and it is important to start ascending/descending the flight with the correct foot, which is determined by the shape of the first step. It is therefore not surprising that subjective feedback from novice users, tend to be favour more conventional stair designs (Fothergill

& Roys, 1998). However, alternative tread stairs do have some advantages, as they afford users a more generous going upon which to place their feet than would be possible with other stair designs within the same space.

Jorna (1989), assessed the ease of use, safety and comfort of a 68° alternating tread stair and a 68° conventional ship's ladder (both had a vertical ground-to-top distance of 2.75 m), using 80 undergraduate male students as test participants. Each test participant wore military uniform and ascended and descended both structures under load (i.e. carrying a 9 kg toolbox) and no-load conditions. Results showed that the alternating tread stair was associated with significantly fewer missteps, and it was perceived to be safer and more comfortable to use than the conventional ship's ladder. Fothergill & Roys (1998), concluded that straight alternating tread stairs were considered safer and were associated with fewer missteps than alternating tread stairs with landings and/or spirals.

The most comprehensive study of alternating tread stairs included in this review was undertaken in 1989 for the Building Research Establishment (BRE) and the findings of this study was used to inform subsequent revisions of Approved Document K (Webber & Feeney, 1996). This study obtained information on 151 alternating tread stair installations; 76 % had been installed in the last 19 months and 75 % had been installed for more than 10 months. Data was obtained during visits to 99 homes (including on-site stair assessments); 25 telephone interviews and a postal questionnaire survey. Table 3 provides a summary of some of the data reported for both the alternating tread stair installations and the main stairs within the properties included in the study.

Table 3. Comparison of alternating tread stair and main stair recorded by the BRE field study.

	Alternating tread stair	Main stair
Pitch	54–72° (88 % ≤ 63°)	36–49°
Rise	185–235 mm (96 % ≤220 mm)	160–220 mm
Going	145–270 mm (71 % ≤220 mm)	180–260 mm (45% ≥220 mm)
Tread surface	94 % polished wood/5 % carpet (Slippery treads reported by 72 % of those surveyed)	96 % carpet (Slippery treads reported by 12 % of those surveyed)
Usage	1–12 times per day	7–19 times per day

The study captured the experiences of a broad demographic. The majority of stair users (61 %) were aged 15–64, with 4 % of users being children under 5 and 13 % children between 5 and 9, with only 1 % being aged 65 or over. In 15 % of households there were a few cases of persons (i.e. children, the elderly, disabled) specifically not using the stair. The survey results showed that 70 % of people reported experiencing difficulties using the alternating tread stair (though this was mainly when carrying objects on the stair), compared with 6 % of people who reported experiencing difficulties on the main stair.

Furthermore, it was reported that 41 accidents had occurred on the 151 alternating stairs compared with 18 on the 85 main stairs (incident rate: 27% & 21%, respectively). Of the 24 people who had had accidents in the interview sample, 8 were children (6 boys & 2 girls) and 16 were adults (9 males & 7 females). The research team acknowledged that accident numbers couldn't be rigorously compared due to incomplete exposure data relating to the total number of uses (by all users) of each stair. However, although the reported accident rate was similar, the overall usage of the main stair is likely to be higher, so they concluded that there is a strong indication of a higher relative risk on the alternating tread stair, compared to the main stair.

The findings from the onsite stair assessment would suggest that the alternating tread stairs were relatively poorly built; faults identified included inconsistent dimensions/pitches, sloping treads, deflection upon loading. These faults, as well as the higher prevalence of slippery treads reported by the survey may, in part, account for the increase in risk. These deficiencies may have also had an influence on the number of difficulties experienced by users. However, as the reported difficulties were mainly associated with carrying, as opposed to step/tread characteristics, for example, slippery treads, most of the identified difficulties are likely to be attributable to the design itself.

The BRE study concluded that comparing the characteristics of alternating tread stairs involved in a fall occurred with those not involved in a fall revealed little evidence about relative risk, except for some indication of higher accident rate associated with pitches of 67 degrees or more and tread projections of 25 mm or more (Webber & Feeney, 1996). These findings have informed subsequent revisions of Approved Document K, which now specifies dimensional tolerances and a maximum pitch of 63.5°. Based on the data reported by Webber and Feeney from the onsite stair assessments, 30% of the 151 installations surveyed would not be compliant with current guidance and so the strong indication of a higher relative risk may not be applicable to modern day installations. Furthermore, Webber and Feeney identified that construction defects and suboptimal features, such as sloping and slippery treads, were more common on alternating tread stairs, which raises questions about whether any increased relative risk is due to bad design or bad implementation. The fact that this study was conducted in 1989, shortly after alternating tread stairs had been introduced into Building Regulations guidance, may have meant that construction techniques were still in their infancy. Changes to construction and installation practices may have been made since the time of the study.

3.2 Review of supplementary literature

3.2.1 Use of stair fall simulation models

Additional online literature searches were undertaken to assess the feasibility of using computer generated stair fall simulations to inform the design of stairs and to identify potential hazards. The search identified two studies that had used stair fall simulations to help identify the causes of falls and to assess the safety of stairs (Bertocci, 2001; Wach, 2014).

Bertocci (2001) and Wach (2014) independently concluded that computer simulation techniques are useful for investigating the biomechanics of stair falls and to identify stair characteristics that have an effect on the potential for injuries. The authors also concluded that biomechanical simulation can bring invaluable benefits in exposing the mechanism of a fall event. Our search also identified one paper that used finite element analysis to model bone geometry, properties and loads to predict injury outcomes associated with stair use (Deng, 2011). Deng used motion analysis and inverse dynamics methods, combined with musculoskeletal modelling, static optimization, and finite element (FE) femur model, to compare the difference of femoral neck strains between stair ascent vs. descent, and young vs. older populations. Similar methodology could be used to compare the potential influence of different stair designs on injury outcomes associated with long term use. However, absolute values of biomechanical measures, such as injury criteria generated by unvalidated models should not be considered definitive.

Simulation and 3D modelling programs such as MADYMO, LS-Dyna, PCCrash and Working Model 3D (references to further information provided in the bibliography) can be used to model different stair designs and represent a stair user by a multibody system (MBS). Indeed, HSE's Science, Engineering and Analysis Division has previous experience of using simulation software to recreate accident scenarios to study the relationships between accident-environment factors and biomechanical measures.

With regards to steep stairs, fixed ladders and alternating tread stairs, the benefit of utilising fall simulation techniques may be limited, as due to their steep pitch, fall trajectories are likely to be similar for each design. However, they may help us to identify the pitch beyond which the recovery of a fall becomes increasingly unlikely. Stair fall simulations are likely to be most useful for stair configurations that include a change in direction or a landing, and they may provide useful insight to address the limitations of the existing evidence, which is primarily based on laboratory studies of stair-fall biomechanical risk factors. Such studies have raised concerns about tapered treads increasing the risk of falls, without considering their potential to reduce injury outcomes.

3.2.2 Guidance for Steep stairs, fixed ladders and alternating tread stairs provided by UK Approved Documents

This review also considered the current guidance provided for steep stairs, fixed ladders and alternating tread stairs in Approved Document K (ADK), England (2013), as well as ADK, Wales (2010), Technical Handbook H, Northern Ireland (2012) & Domestic Technical Handbook, Scotland (2023).

ADK England (2013) and ADK Wales (2010) permit the use of “Special Stairs”, (which includes fixed ladders, alternating tread stairs) for loft conversions only when there is insufficient space to accommodate the dimensional requirements to comply with those specified for a private stair and when the stair is for access to one habitable room. For existing buildings where there are dimensional constraints, the English ADK (2013) also suggests the use of stairs with steeper pitches than would normally be permissible, i.e. steep stairs.

The English ADK doesn’t specify a maximum pitch for stairs used in such situations and invites the discretion of the relevant building control body. ADK, Wales (2010), Technical Handbook H, Northern Ireland (2012) & Domestic Technical Handbook, Scotland (2025) do not invite such discretion, but as these are all guidance documents, some discretion is implicit.

BS 5395-4:2011 “Code of practice for the design of stairs for limited access” recommends three types of stair that are suitable for use in limited access situations and suggests that wherever possible, a straight stair should be specified, followed by spiral stair and then an alternating tread stair. It provides a design specification for a straight steep stair, which in most aspects aligns closely with the ADK design guidance for a private stair, but the goings can be smaller (minimum going = 180 mm) and the pitch can be steeper (maximum pitch = 50.7°). None of the approved documents specify similar limits for a “steep stair”, and although they refer to other parts of BS 5395, they don’t reference part 4 “Code of practice for the design of stairs for limited access”. BS 5395-4 also specifies design criteria for an alternating tread stair, which is comparable with that specified in the current ADK.

The design requirements for fixed ladders are not well defined in any of the Approved Documents. For dwellings, ADK England and ADK Wales simply states that may be used to provide access to one habitable room and should have fixed handrails on either side. Whereas, Technical Handbook H, Northern Ireland (2012) & Domestic Technical Handbook, Scotland (2025) only permit the use of fixed ladders solely for the purpose of maintenance/plant room access. For industrial buildings/maintenance all documents refer readers to the now withdrawn BS5395-3:1985, Stairs - Part 3: “Stairs, ladders and walkways - Code of practice for the design of industrial type”, and BS 4211:2005+A1:2008, “Specification for permanently fixed ladders”, but otherwise provide little guidance. The inclusion of fixed ladders, in addition to allowing the installation of steep stairs, may suggest to readers that the requirements differ, and there is likely to be confusion about what is appropriate for a fixed ladder.

Comprehensive design guidance is provided for alternating tread stairs in ADK England (2013) and ADK Wales (2010), which is based on the evidence gathered during the previously referenced BRE field study findings (Webber & Feeney, 1996) and is analogous with BS 5395-4:2011 and the findings of this review. Technical Handbook H, Northern Ireland (2012) and Technical Handbook non-domestic, Scotland (2025) do not include alternating tread stairs.

3.3 Data Review

In this section, each of the datasets that were analysed will be discussed; the method of extracting Special Stairs related documents will be explained, and the findings will be presented. Some datasets did not yield sufficient results for a worthwhile analysis, and these will be addressed in turn.

An important consideration is that all datasets were not collected to record information on stair type, and there is no definition for steep stairs, fixed ladders and alternating tread stairs used when recording the data. This makes it difficult to definitively count the number of each type of stair and so it was necessary to consider them collectively as “Special Stairs”, as well as to make some assumptions. The unique limitations of each dataset will also be addressed in each section.

The conclusion of this section will give an evaluation on the quality and outputs of the analysis of the datasets included from a Special Stairs perspective.

3.3.1 Prevention of Future Death Reports

There are several limitations to this dataset. The first is that there was no defined way of recording information in a Prevention of Future Deaths (PFD) report. This meant that different documents recorded different information and with differing levels of detail. Also, the reports featured in this dataset tend to focus on how uniform services react to an incident, rather than the incident itself. Therefore, it goes into much more detail on the response and the person-person interactions.

To filter out relevant Special Stairs documents, two approaches were used. The first was through searching the key word ‘stair’ in the search tool and then manually reading the resulting 21 reports to determine if the stair incident in this case took place on a Special Stair.

The second approach used web scraping tools to download all PFD documents locally and use python (programming language) to extract free text contained within each of the documents. This resulted in a total of 12,521 documents for which to analyse. These documents were then filtered using the two-step filter described in Section 2.3.

Applying both these search methods, only a single PFD report emerged as a Special Stairs document. This reported a man falling down cellar steps due to the door at the top being left open.

3.3.2 Coroner Reports

Coroners’ reports are collected by the relevant local authorities in which the death took place. However, as Coroners are independent of the local authority, they are exempt from the Freedom of Information (FOI) Act and are only obliged to disclose information to interested parties, as defined in Coroners (Inquests) rule, 2013, part 3, section 13. Furthermore, as Coroners are independent judicial officers there are inconsistencies in the way data is recorded and many only began transitioning to electronic records following the Coroners and Justice Act 2009, which came into effect on July 25, 2013. We requested data from all Coroners' Offices in England, but most were only able to retrieve data using names and dates of death, as opposed to cause of death. This made the retrieval of relevant data too onerous for most local authority areas. However, reports were collected for two local authority areas: Central Bedfordshire Council and Sheffield City Council as their data collection methodology allowed easy access to cause of death information. Due to the Coroner in each local authority area having the freedom to collect data in their own way, the recording process was vastly different between these two authority areas, so each dataset will be treated separately.

Firstly, the Central Bedfordshire council area returned 219 PDF Reports ranging from 2015 - 2022. Therefore, the two-step filter approach as described in Section 2.3 was used to extract and filter these documents. This resulted in 31 reports within the stairs dataset, but no reports in the Special Stairs dataset.

Coroner reports from the Sheffield City Council area were stored within a data table, with 2460 individual rows – each representing a different coroner report. This dataset focused on deaths classified as 'misadventures' which took place between 1st January 2000 and 31st December 2022.

Whilst most columns were not helpful within the analysis one column 'details how death occurred' provided a free-text description of the events leading to the subject's death. The two-step filter is applied to this column resulting in 223 stairs records, and 8 Special Stair records.

The distribution of the Special Stairs reports between the sub-categories are shown in Figure 6. From the 'Other' category, all reports are extracted due to the 'steep' keyword.

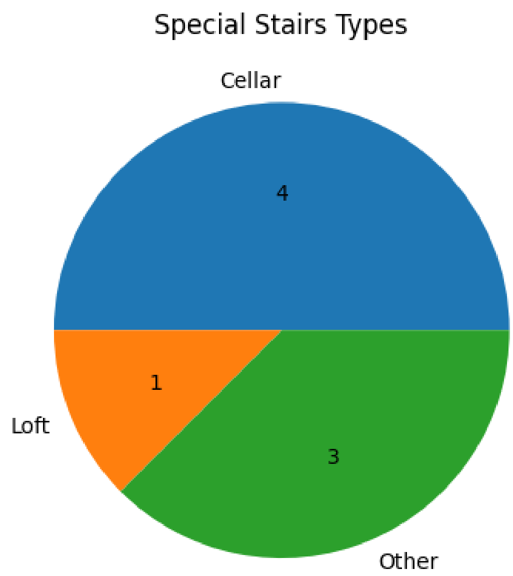


Figure 6: Distribution of Special Stair types amongst the Sheffield Council Coroner Reports.

It should be noted that within the analysis of coroner's reports, only having results from two local authority areas may result in bias within the results. Similarly, as mentioned, the recording practises between these local authority areas is inconsistent and therefore have varying levels of information for analysis. It cannot be said for sure that the Sheffield City Council area has more Special Stairs incidents than Central Bedfordshire Council area.

3.3.3 Home and Leisure Accident Surveillance System (HASS/LASS)

This dataset was compiled by the Department of Trade and Industry and runs from 1978 – 2002 as a relational database. Once the relevant columns were extracted there was a total of 4,968,678 individual records.

The two-step filter approach was slightly altered for this dataset, in that for the first step, instead of filtering for stairs on the free-text column ('Accident Text'), the data was filtered according to two categorical columns within the data:

- Article Group: If it was classified as 'stairs or steps', or
- Fall Type: if it was classified as 'Fall on/from stairs/steps'

resulting in 421,656 documents. The second step was applied as normal, but to the concatenation of all the categorical and free-text columns for each record, resulting in 3309 Special Stairs records.

After applying a keyword search, some records fell within two Special Stairs sub-categories as demonstrated in Figure 7. For this analysis it was decided to treat the sub-categories as single label, and therefore prioritisation was given to the loft and cellar categories (there was no intersection between these categories), followed by Other. Cottage was given the lowest priority as this is the category deemed to have the weakest association with a Special Stairs type. The new frequencies can be seen in Figure 8.

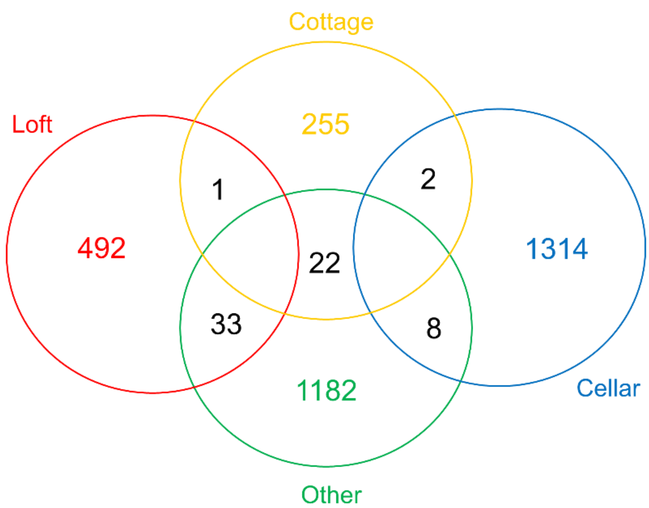


Figure 7. Intersection between the Special Stairs sub-categories within the HASS/LASS dataset.

Of all the HASS/LASS records, 8.5% were classified as involving stairs, 0.78% of which were classified as involving Special Stairs (meaning 0.067% of all HASS/LASS involved Special Stairs).

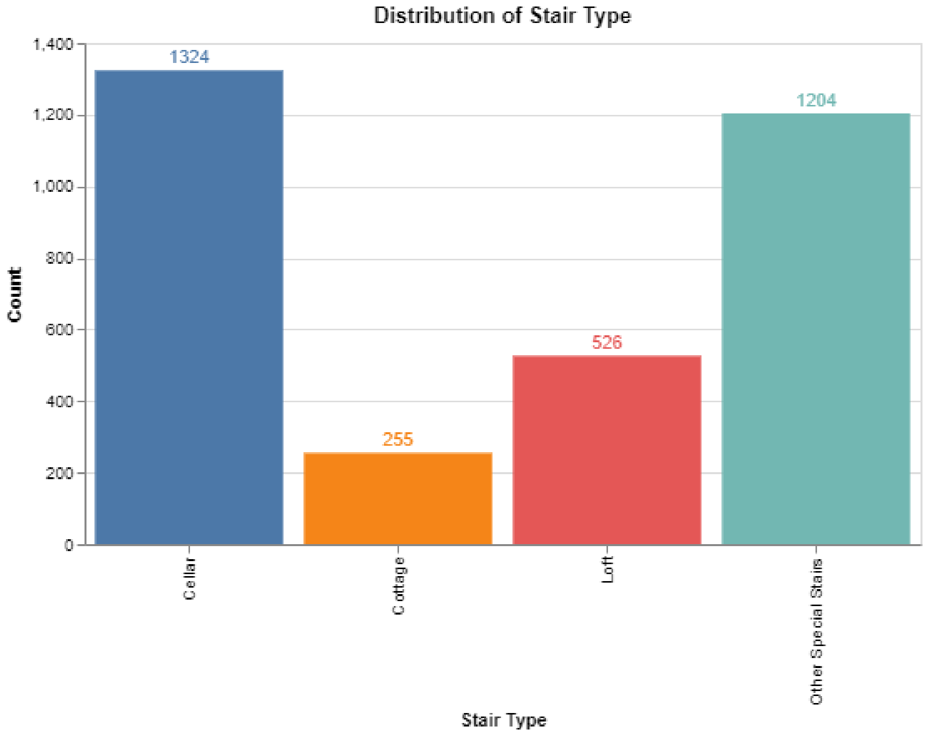


Figure 8. The frequency of each Special Stair sub-category within Special Stairs HASS/LASS dataset.

As shown in Figure 8, ‘Cellar’ and ‘Other’ are the sub-categories with the highest frequency, more than double the next highest ‘Loft’. Stricter filters on Loft may contribute to lower count than cellar. Similarly, not all loft conversions may be declared as such, and instead referred to as a traditional room.

Figures 9 and 10 give a breakdown of Special Stairs HASS/LASS by the sex of the individual who was injured. Incidents with a female victim are more common for every age category, except for 0-10, and for every stair type. For less than 1% of incidents, there are multiple sexes injured as part of the incident, or the sex is unknown.

53% of all HASS/LASS incidents involve males and 46% involve females, whereas 40% and 59% of Special Stairs incidents involve males and females, respectively. This means that the share of incidents involving females has jumped by 13% percentage points when controlling for only Special Stairs related incidents.

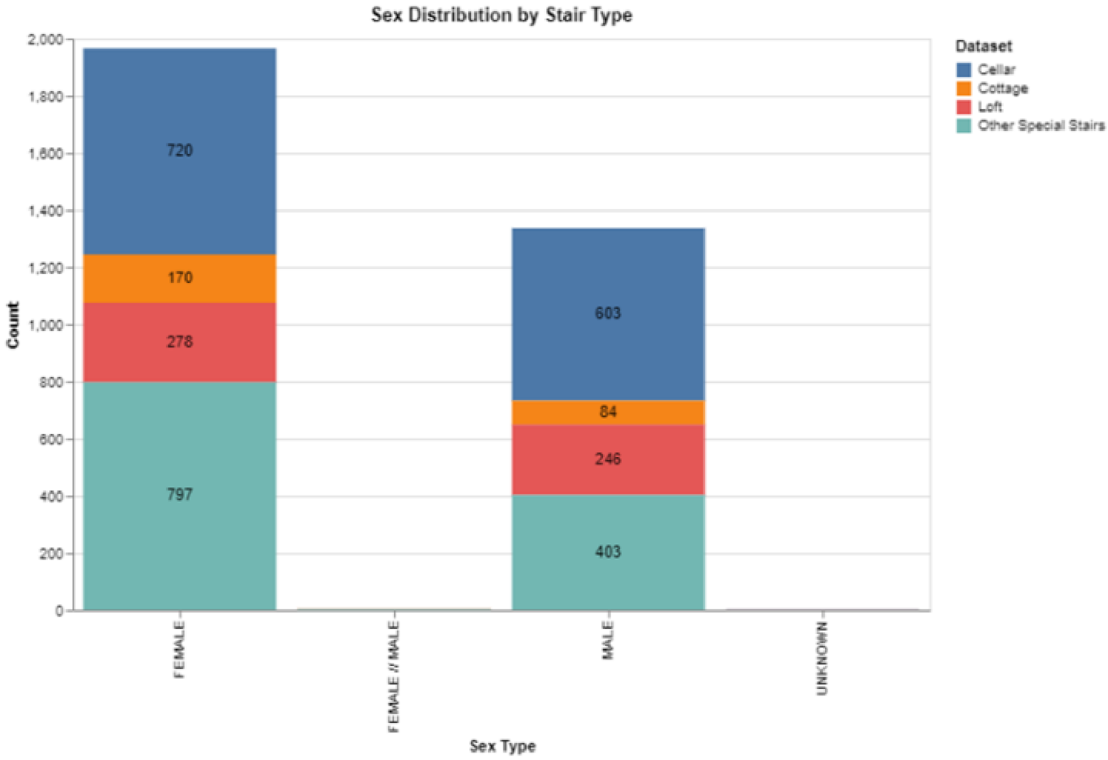


Figure 9. Breakdown of sex of the injured person for each sub-category within the Special Stairs HASS/LASS dataset.

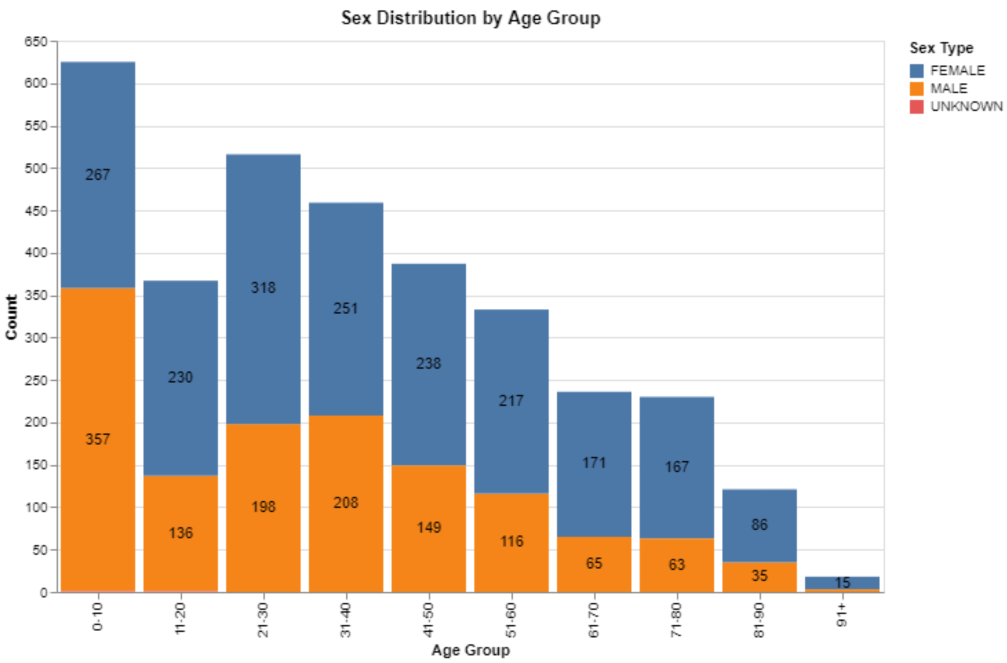


Figure 10. Breakdown of sex for each age band within the Special Stairs HASS/LASS dataset.

Figures 11, 12 and 13 shows a comparison in the breakdown by age across all HASS/LASS, across all stairs, and across those within subcategories. The distribution is consistent across the three datasets, except for Special Stairs age category 11-20, where it is comparatively lower than the 21-30 age category. This is not true for all data, and stairs datasets.

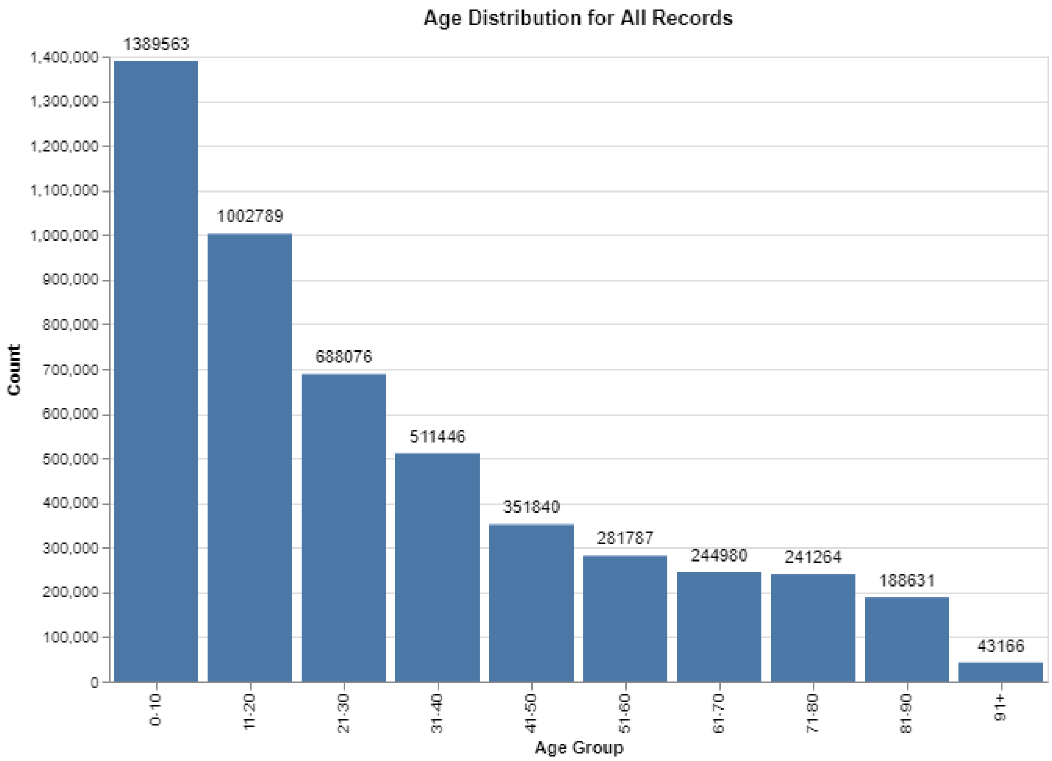


Figure 11. Age distribution for all HASS/LASS records

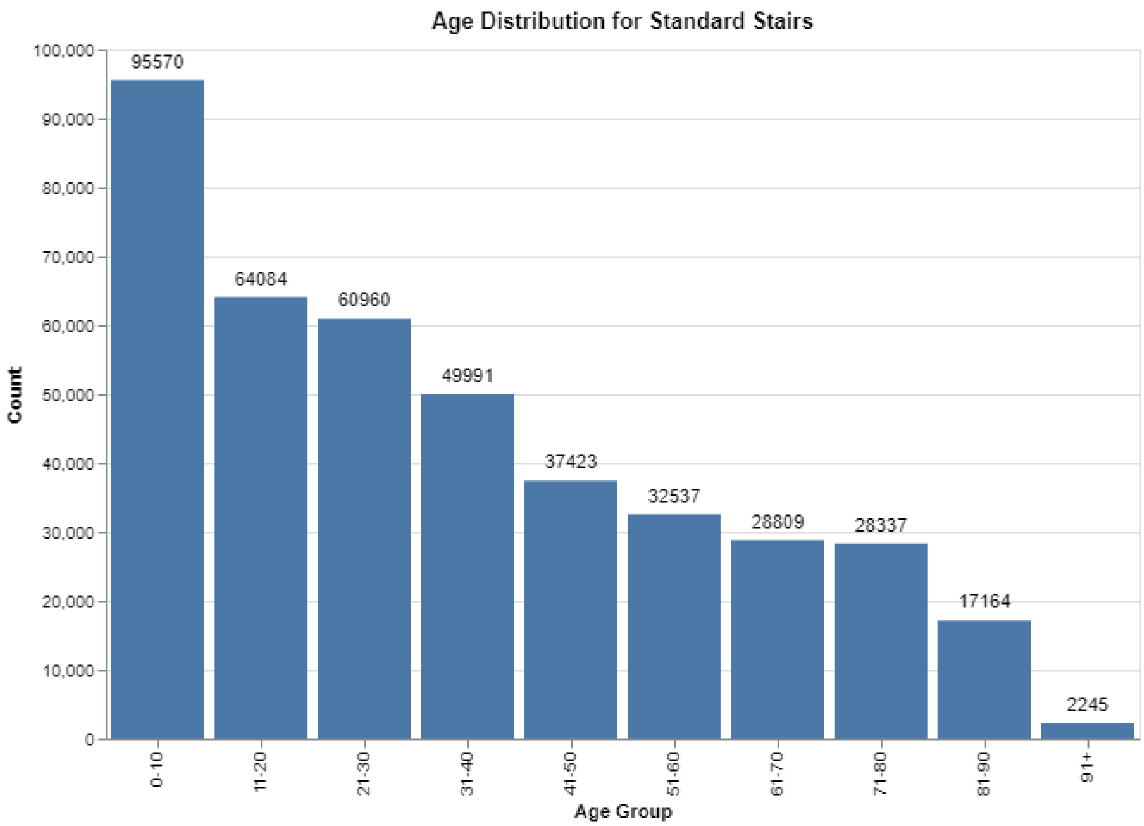


Figure 12. Age distribution for HASS/LASS stair records

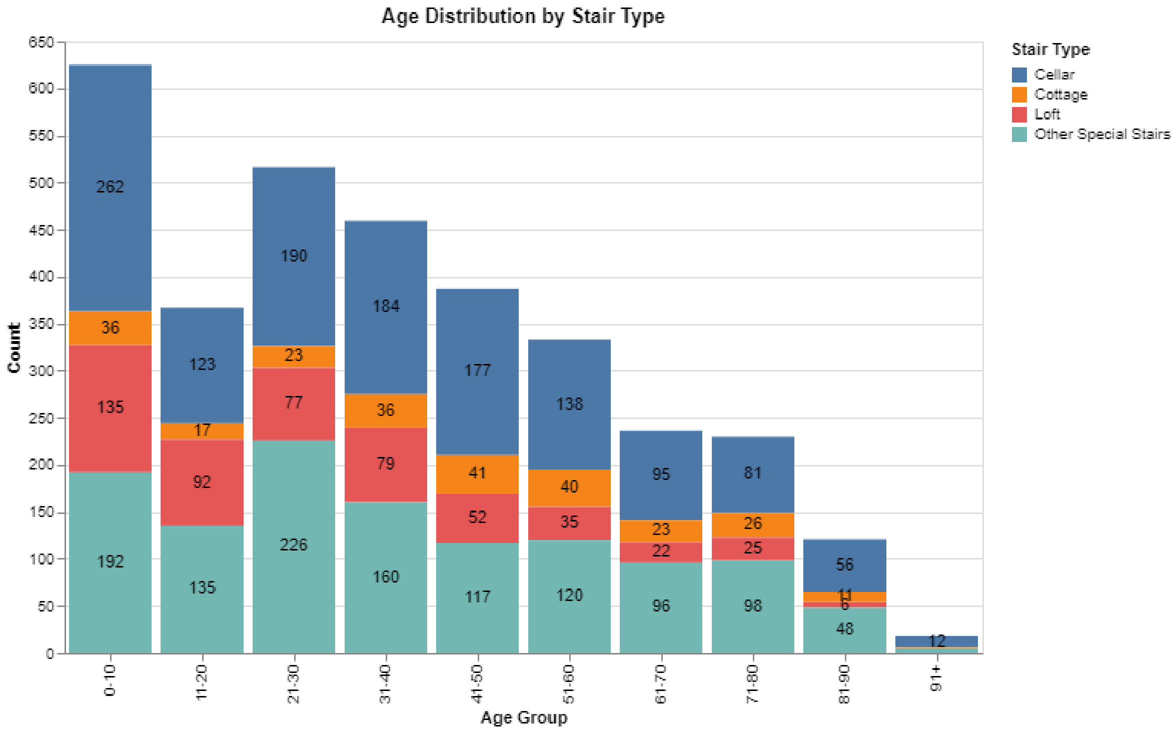


Figure 13. Age distribution for Special Stairs categories within HASS/LASS records

Alongside categorical information, the free-text information provided with each Special Stairs report was analysed and is presented in the word clouds in figures 14, 15, 16 and 17. A word cloud presents the most frequently appearing words within a corpus of free-text. Larger words in the word cloud appear more frequently, where effort has been taken to remove the amount of stop words (and, the, it, etc.). Note that ‘Pt’ appears frequently across all the Special Stairs sub-categories. This is the acronym for ‘patient’ used when collecting this data.

Figure 14 gives the word cloud for Loft related Special Stairs incidents. Notable trends within the free-text are wooden and carpeted describing the material of the stair, banister and conversion describing the features of the staircase. Body parts, such as head, back, ankle, and foot/feet appear commonly, which may be describing the body parts injured by the fall, or may have been used to describe the circumstances of the fall, for example, “foot slipped off tread”.

Incidents occurring on Cellar stairs can be seen in Figure 15. The dominant materials in cellar stairs are stone and concrete, alluding to much more rugged staircases that may have been installed during the buildings original construction. As with Loft stairs, heads appear to be the most referenced body part followed by back and ankle.

The cottage Incidents word cloud is given in Figure 16, where overwhelmingly the most frequent word to appear is holiday. Ankle also appears more frequently to head for this dataset, though it is still a commonly referred to body part alongside foot. Another predominant word in this corpus is old, suggesting the type of person who lives in these residences, or the property itself.

Finally, the Other Special Stairs frequent words appear in Figure 17. Due to the fact this is a ‘catch-all’ class, the distribution of words is much more spread out leading to few dominant words appearing in the word cloud. The only word which appears relatively frequently is steep, a key word for filtering out this category of documents.

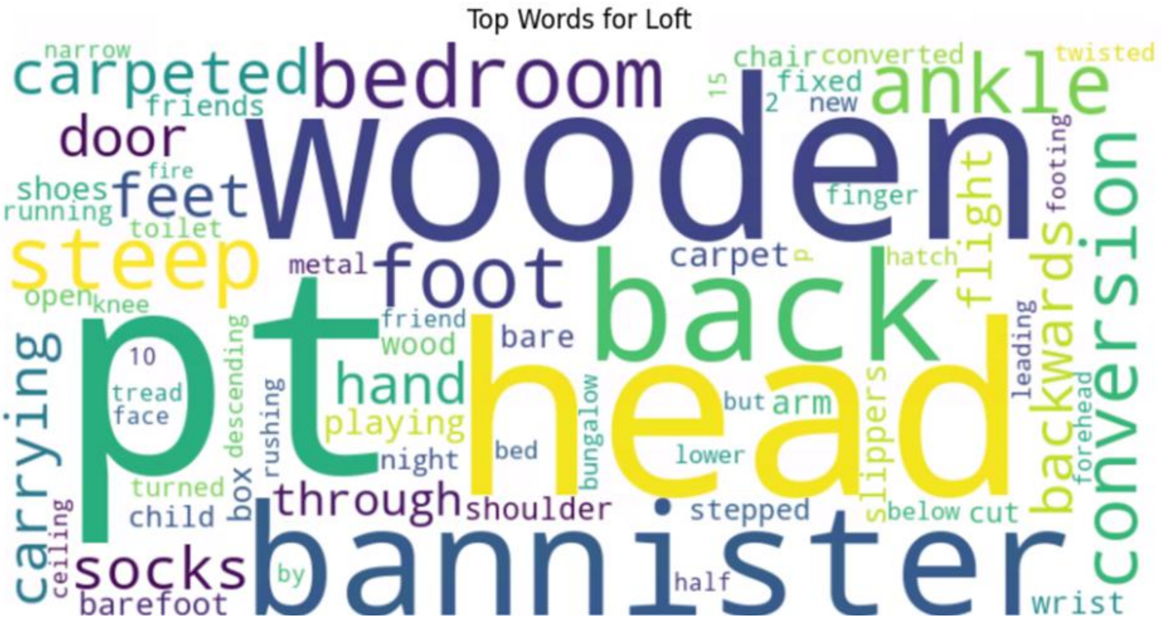


Figure 14. Word cloud for the free-text of Loft related Special Stairs HASS/LASS incidents

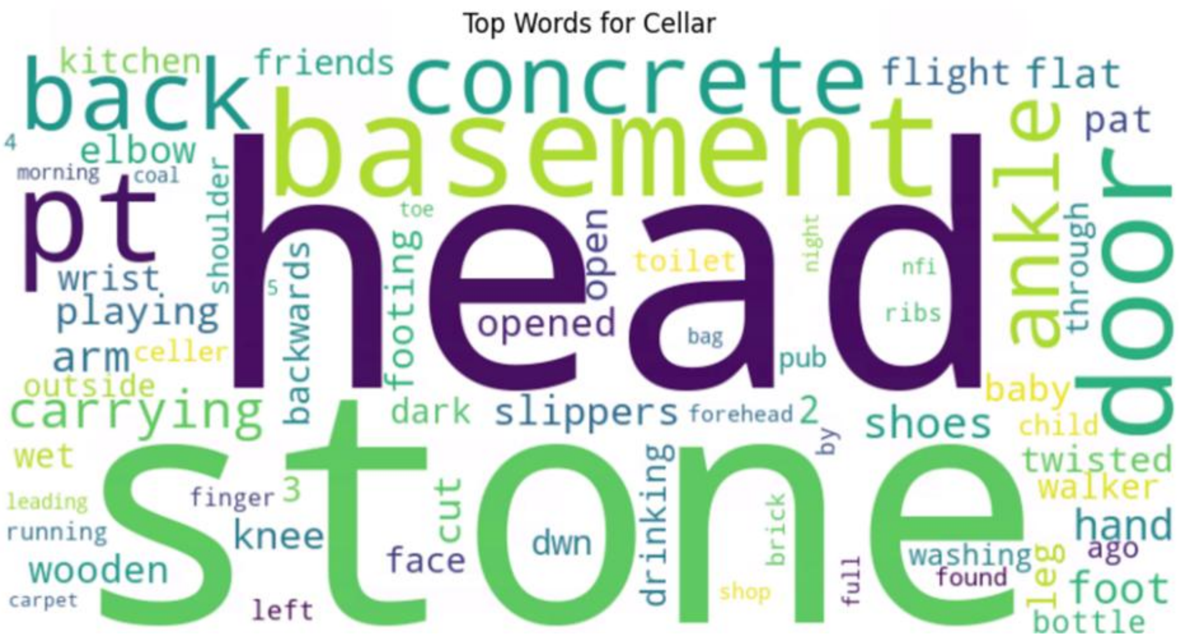


Figure 15. Word cloud for the free-text of Cellar related Special Stairs HASS/LASS incidents

Figure 16. Word cloud for the free-text of Cottage related Special Stairs HASS/LASS incidents

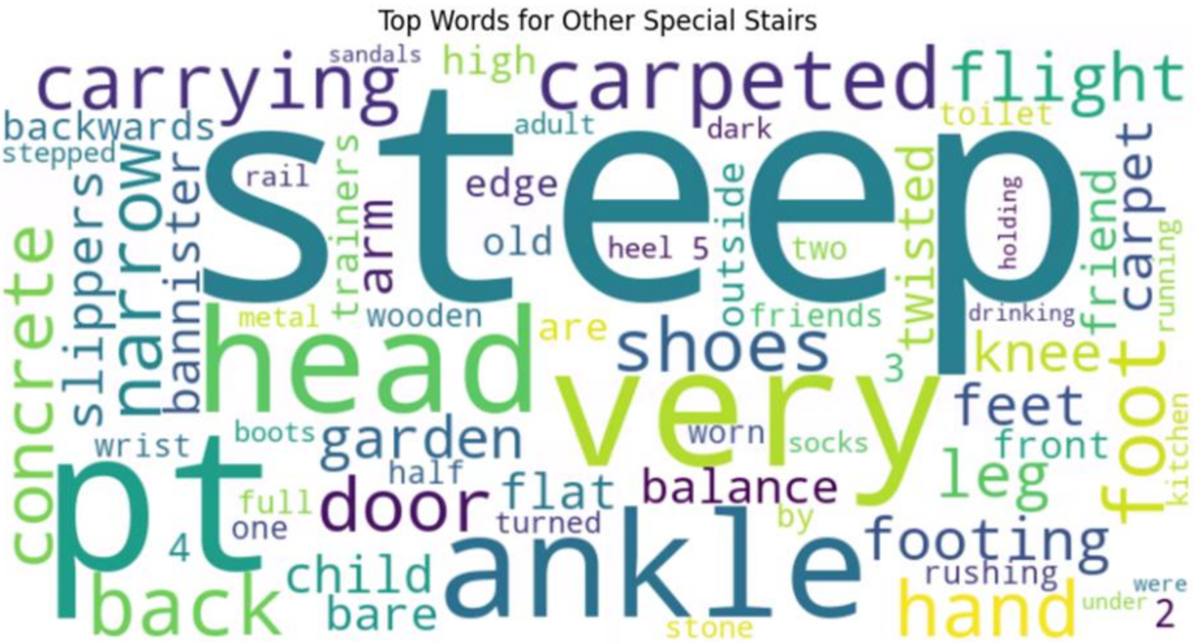


Figure 17. Word cloud for the free-text of 'Other' related Special Stairs HASS/LASS incidents

The depth of analysis of this data is limited by the small amount of free-text information available to apply filtering. There is also no information available on actual counts of lofts, cellars, and cottages within Great Britain, so it is difficult to compare the frequencies within the results to determine if either category is over or underrepresented.

3.3.4 English Housing Survey

The English housing survey (EHS) exists as a relational database, similar to HASS/LASS. EHS data exists from April 2000 – March 2024 and is made of almost entirely categorical data. Therefore, the approach to analysing the EHS does not use the two-step filtering method.

From April 2007 – March 2009 the following variable existed on the EHS:

‘Other types of work done to the house: Loft conversion’

Where the response can be yes, no, unknown, not applicable or missing. Properties which answered ‘yes’ to this question will hereby be referred to as Loft-Converted Properties (LCPs) and those which answered ‘no’ will be referred to as Regular Properties (RPs) for the sake of brevity.

There is also a health and safety element to the EHS. One of the questions determines if there is a higher-than-average risk of a fall on stairs in the property. If the subject answers yes, then they are followed up with a series of questions about this heightened risk, such as to find the likelihood of extreme, severe, or serious incident taking place on a staircase at the property, and the elements of the staircase which requires an action to improve. These elements are:

- A Handrail needs to be installed,
- A Balustrade needs to be installed,
- The current cover of the Handrail/balustrade is dangerous,
- Repair or replacement of the stair is required,
- The staircase needs a redesign,
- The stair surface is slippery,
- There is poor lighting and visibility on the staircase,
- There are obstacles to remove on the staircase.

When completing the EHS, not all sections are completed, meaning a substantial proportion of the data contains missing values.

When removing any surveys for which the loft conversion variable was not answered ‘yes’ or ‘no’, the resulting dataset contains 114 LCPs, and 23023 RPs. Not all the surveys answered the health and safety on stairs element of the survey, and therefore reducing to only surveys which answered both sections results in 32 LCPs, and 5177 RPs. This means of those who answered the survey question on loft conversions with a definitive answer AND completed the H&S section, 0.61% have a loft conversion.

64% of LCPs are considered higher risk (or are lived in by higher-risk population), whilst only 43% of RPs are high risk, though this is not statistically significant at 95% confidence. It is also worth noting that any health and safety risk questions refer to any staircase within the property, not necessarily the staircase leading to the loft conversion. Therefore, we cannot say for certain that if a heightened risk has been reported for a LCP, it relates to the loft staircase.

The rest of the analysis will focus on only those surveys which have filled out both the loft conversion question and marked the residence as having a higher-than-average health and safety risk.

Figure 18 gives the distribution of likelihood scores between LCPs and RPs. Whilst the likelihood is represented by continuous values, there are only 9 values for which the likelihood can take and have therefore been treated as categorical variables. Table 4 gives the mean likelihood scores for each of extreme, severe, and serious health and safety incidents taking place on a staircase. Due to the large imbalance in data, and reasonably close likelihood scores, we cannot reject the hypothesis that the likelihood is the same for LCPs and RPs for all levels of risk.

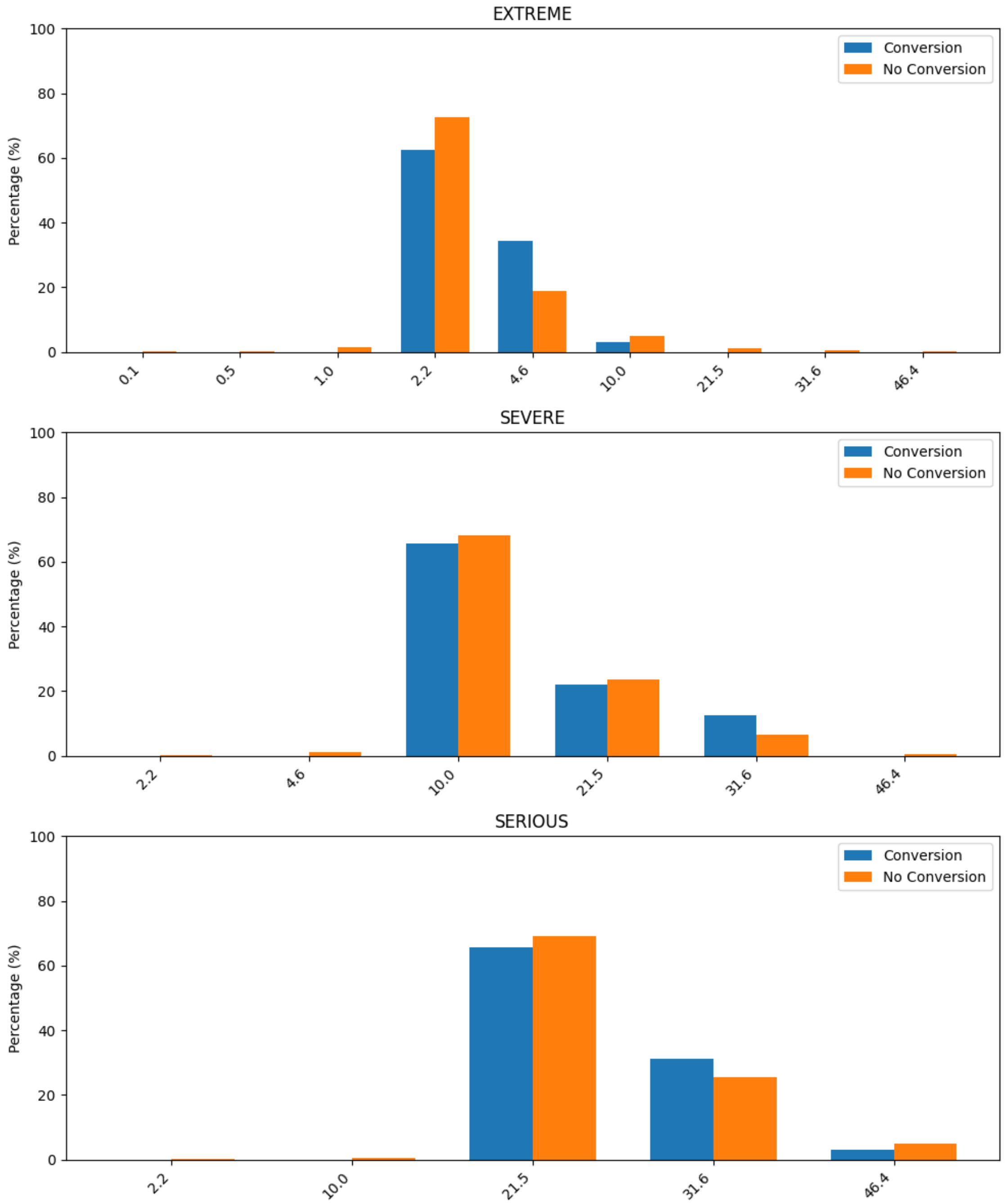


Figure 18. Difference in distributed proportion of likelihood of extreme, severe, and serious health and safety stair incidents for LCPs and RPs.

Table 4: Mean likelihood of extreme, severe, and serious health and safety incidents for LCPs and RPs

Loft Converted?	Count	Mean Likelihood		
		Extreme	Severe	Serious
Converted	32	3.27	15.22	25.43
Not Converted	5177	3.47	14.16	25.27

When focusing in on the elements to be actioned of the higher-than-average risk staircases between LCPs and RPs, Figure 19 shows that for both sets, the handrail is the most important element in which to action. LCPs are more likely to require actions to install balustrades, redesign staircases, improve lighting/visibility, and remove obstacles from a staircase within the property.

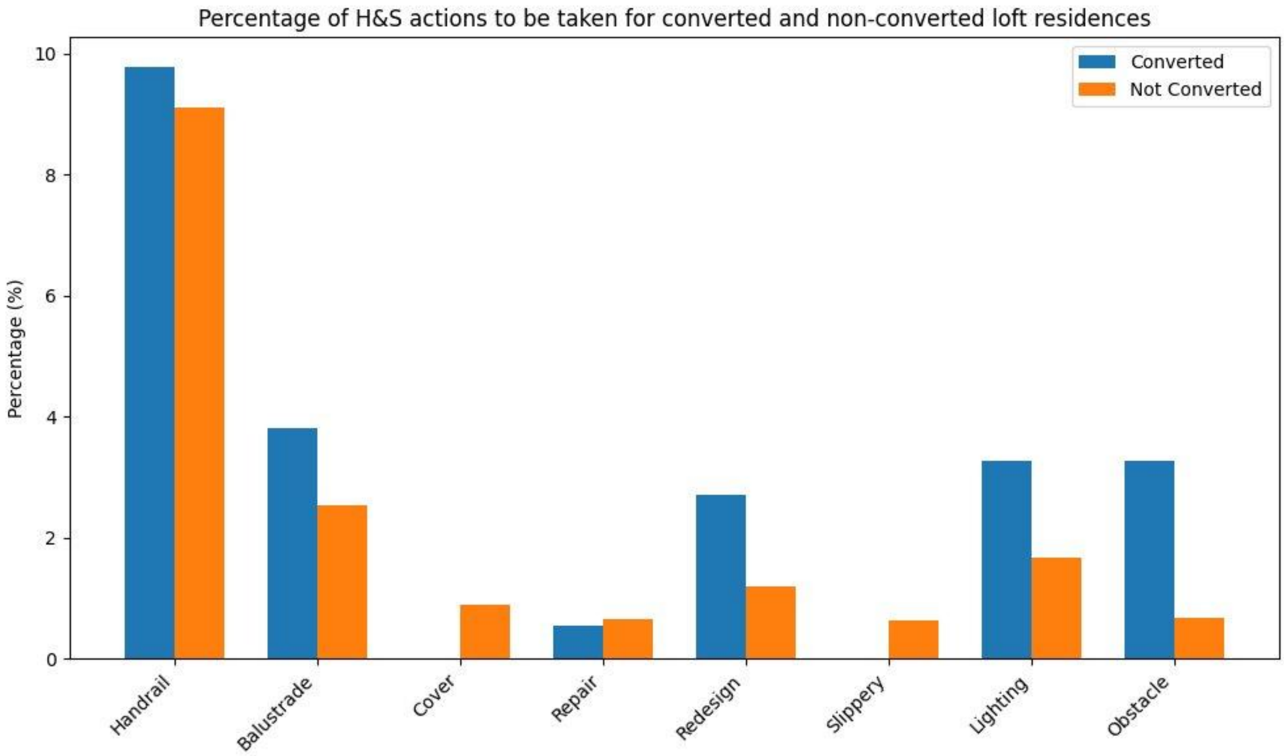


Figure 19. Health and Safety actions within the EHS relating to different aspects of stair safety for both converted and not-converted properties

The major limitations of this dataset, as discussed, is that only a small subsection of data contains information which could allude to Special Stairs, i.e. mention of a loft conversion at the property. Additionally, there is no way of asserting if higher health and safety risk at a property is because of the loft conversion staircase or another stair in the property.

3.4 Ergonomics Assessment

3.4.1 Static strength prediction (SSP)

Some variations were found in the percentage of the foreseeable population who are capable of ascending the different stair designs without potential difficulties. The general tendency is for steeper pitched stairs to present a greater problem, predominantly for larger people who are represented by the 95th percentile male mannequin.

Table 5 shows the predicted percentage of the population capable of applying the required forces to ascend the various designs of stairs according to static strength prediction models.

Table 5. Static strength predictions for different stair types and populations

Stair type	Mannequin Size (stature and weight)	Joint (percentage capable %)		
		Hips	Knees	Ankles
Standard Stairs	5th percentile	99	98	100
	95th percentile	99	96	100
Steep Stairs	5th percentile	100	95	100
	95th percentile	99	86	100
Alternating Stairs 48.6º pitch	5th percentile	100	99	100
	95th percentile	99	85	100
Alternating Stairs 60º pitch	5th percentile	100	99	100
	95th percentile	99	85	100
Fixed Ladder (Companionway Steps) 60º pitch	5th percentile	98	92	100
	95th percentile	99	89	100
Fixed Ladder (Companionway Steps) 75º pitch	5th percentile	97	99	100
	95th percentile	98	54	99

Across all stair designs, the knee is the limiting joint. The percentage of population capable of sustaining the forces required in the hip and ankle remain very high (97–100%) for both small (5th percentile) and large (95th percentile) body sizes, indicating that within the static strength prediction model the hip and ankle rarely constrain performance. By contrast, predicted knee capability decreases for taller, heavier people as pitch increases and as the design moves away from the pitch angle and riser dimensions specified for standard stairs. This means the torque required about the knee exceeds what a sizeable portion of the population can produce, especially among larger-bodied users.

For standard stairs, capability is essentially universal: 96–100% at the knee, hips, and ankles. This suggests that conventional stair geometry keeps the external moment arm at the knee short enough that both small and large users have adequate static strength capability to ascend them without foreseeable biomechanical barriers.

For steep stairs, knee capability drops to 95% (5th percentile) and 86% (95th percentile). In practical terms, nearly 1 in 7 large (taller, heavier) users may not have sufficient knee torque capabilities to meet the force demand to elevate themselves up the steep staircase. Some compensation is likely to occur with users pulling their body weight upwards with their hands on handrails, assuming their upper body strength and capabilities allow for this. The figures do suggest though that static strength capability becomes exclusionary for part of the population as the pitch increases, even before considering any potential dynamic effects (speed changes, fatigue, carrying loads, wet surfaces).

For alternating stairs (both 48.6° and 60°), the knee again dictates capability: with 99% of 5th percentile people capable of applying the requisite forces, but 85% for 95th. The alternating tread pattern raises required knee torque because the ground reaction force acts further behind the knee at higher flexion angles, and taller, heavier users experience higher absolute loads. In practice, this means alternating stairs are potentially not inclusive for larger (taller, heavier) users based on the strength requirements of the leading knee; roughly 1 in 6 may be constrained by knee strength.

For the fixed ladder (companionway steps) at a 60° pitch angle, knee capability is at 92% (5th percentile) and 89% (95th percentile). This could be considered borderline exclusionary for both body sizes if the design target for inclusive use is ≥90% accommodation. At a 75° pitch angle companionway step, the design becomes highly excluding for large users: knee capability for the 95th percentile drops to 54%, implying almost half of the larger sized heavier users lack the sufficient static knee strength to ascend the staircase. Interestingly, the 5th percentile knee capability is 99% at 75° pitch angle, while hip capability dips slightly (97%). A likely explanation is geometric: at very steep pitches the smaller body size reduces knee moment arms enough to keep knee torque within limits, whereas larger users face a combination of higher body mass and longer lever arms that drives knee torque beyond static capacity.

3.4.2 Centre of Gravity (COG)

On steep stairs, there is reduced access for the knee to elevate to the requisite height to plant the leading foot on the next highest step. This is accommodated by the climber pushing their hips backwards to make space for their femur and knee. In doing this, the body's centre of gravity (COG) can shift behind the base of support (BOS) during ascent, particularly when the climber lifts one foot to the next step. This creates a momentary imbalance where gravitational forces act to pull the body backward. To counter this, individuals employ several compensatory strategies:

- **Trunk Flexion to Lean Forwards** - By bending the trunk forward at the hips and lower back, the climber moves their COG forwards, bringing it closer to or within the BOS. This posture reduces the backward tipping moment but increases the demand on spinal and hip extensors, potentially leading to fatigue over repeated climbs. Assuming forwards leaning postures requires that the stairs in front of them are not a barrier for the torso and head and also requires easy access to the handrails without needing significant extension in the shoulders (i.e. moving the upper arms backwards to maintain grip on the handrails).

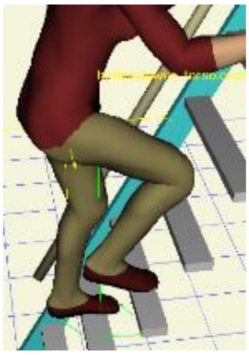
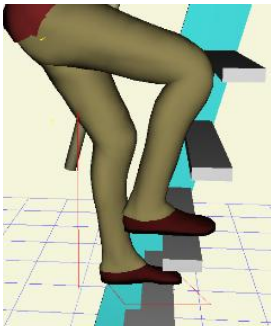
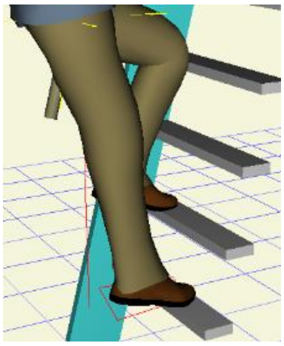
- **Use of Handrail for Stability and Propulsion** - Grasping the handrail provides an additional point of support, effectively enlarging the BOS and creating a stabilizing force. Users may also apply an upward or forward pull on the rail to assist knee extension and reduce the load on lower limb muscles while ascending. This reliance on handrails becomes critical as stair pitch increases.

- **Dynamic Knee Extension and Foot Placement** - When raising the foot to a higher tread, the knee must flex significantly, often requiring greater hip flexion and ankle dorsiflexion. This movement temporarily narrows the BOS to a single point of contact, amplifying instability. Once again, as a result, the reliance on handrails becomes more critical as stair pitch increases.

The relationship between the COG and BOS while moving on the stairs was explored with the 5th percentile female and 95th percentile male mannequins on each stair design. The tests considered the worst (highest risk) postures when ascending the stairs but with two feet planted on adjacent steps, which occurred when the leading foot was planted on the upper step and the trailing foot on the step below (i.e. just before leg extension to elevate the 'person' onto the next step).

JACK human simulation software (Siemens, 2026) displays the COG and BOS on the mannequin models as green when the COG is within the BOS, or as red when the COG is outside the BOS and the model is unbalanced. The results of these tests are provided in Table 6.

Table 6. Relative positions of the centre of gravity and base of support when ascending stairs for different stair types for both 5th and 95th percentile models.

Stair type	5th percentile female	95th percentile male	Comments
Steep Stairs			While ascending the steep stairs the COG stays within the BOS for both model sizes, indicating that this is achievable while remaining in balance without the requirement to hold onto handrails (for balance purposes)
Alternating Stairs 48.6º pitch and 60º pitch			While ascending the alternating tread stairs (with 48.6º pitch and 60º pitch) the COG stays within the BOS for both model sizes, indicating that this is achievable while remaining in balance without the requirement to hold onto handrails (for balance purposes)
Companionway Steps 60º pitch			While ascending the companionway steps with 60º pitch the COG stays within the BOS for both model sizes, indicating that this is achievable while remaining in balance. While the use of handholds may not be required for balance purposes, ascending these stairs without handholds is not advisable.
Companionway Steps 75º pitch			Handholds are required to accommodate a lack of balance on the companionway steps with a pitch angle of 75º. Manipulating the mannequin posture (e.g. bending at the torso) to achieve balance was not possible on these steps.

3.4.3 Stair Visibility

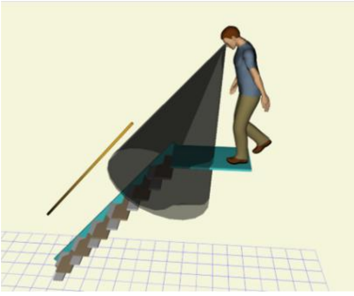
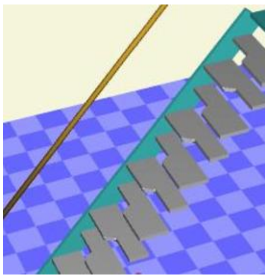
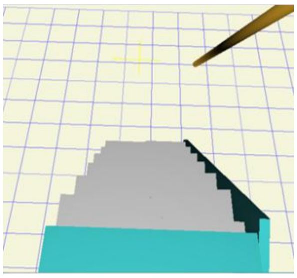
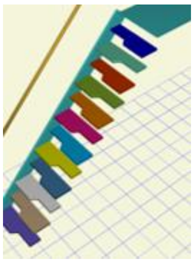
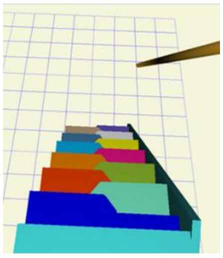
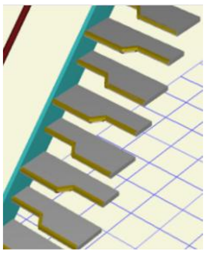
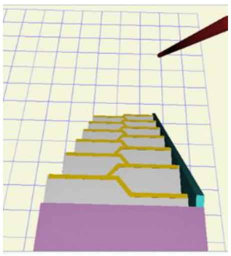
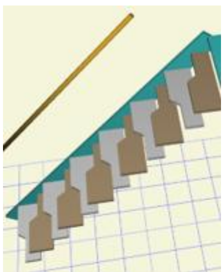
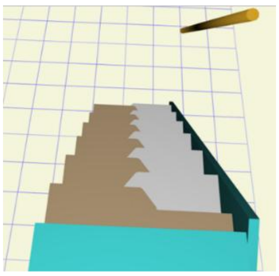
Visibility on stairs is dependent on numerous factors that are outside the scope of this study. There are certain factors that are pertinent to Special Stairs and especially non standard designs such as alternating tread stairs.

Beyond the provision of adequate lighting levels, alternating tread stairs present additional visual challenges due to their non uniform visual appearance (compared to standard steps) and tread edge (nosing) conspicuity. The example image of alternating tread stairs in Figure 20 demonstrates some of the potential visual barriers on stairs that do not necessarily conform to people's normal expectations.

Figure 20. Alternating tread stairs (source: Getty Images, under HSE licence. Images are for illustration purposes only and do not necessarily represent compliance or good practice.)

The asymmetric geometry of alternating tread stairs potentially makes it harder for users to visually judge which part of the tread to step on, especially when descending. Without tread markings or contrasting nosings there may be some ambiguity about the sequence of steps or depth of each step (i.e. the position of the nosing on each step) leading to missteps. As these stairs will potentially be a steeper pitch/angle, the consequence of mis-stepping may mean that users descending the stairs have less space/time to visually correct a mistake once their centre of mass begins shifting and find it harder to recover due to the relative low position of the handrails. Visual accessibility to all stairs is essentially important, but this is arguably more so with alternating steps as they do not conform to commonly and deeply held habitual strategies for negotiating standard steps. In a rudimentary way, this was explored with the models created in the JACK human simulation software by considering the visibility of different designs of steps. Comments are provided in Table 7.

Table 7. Alternative designs of alternating steps, viewed from above.

		Comments
		Showing the eye point view cones of the mannequin at the top of the alternating stairs indicating their viewing angle and field of view.
All goings the same colour		
		No markings on alternating stairs with no colour change between each step. While exaggerated due to the nature of the CAD image, this illustrates the issue of the potential reduced conspicuity of each step. Visual cues provided by the individual goings and inner string provide a false impression of the position of the goings.
All goings a different colour		
		Individual colour for each individual step. This provides a more accessible view of the steps allowing the user to discern each individual step clearly, reducing the probability of foot misplacement. While functional, it is unlikely to be considered an acceptable design in most private premises.
Colour contrast nosing's		
		Increasing the conspicuity of the tread edge (nosing) improves depth perception reducing the probability of foot misplacement, especially when descending.
Alternating coloured goings		
		Alternating the colour of each step provides some clarity, but tread edge on each side may be lost due to the lack of contrast between the following steps on the same side.

While this exploration of the conspicuity of alternating steps is rudimentary, it does indicate that consideration should be given to providing some specification for the visual appearance and affordance of visual cues on non-uniform steps such as alternating tread stairs.

3.5 Stakeholder Survey

The following sections provide an overview of the survey respondent demographics, along with findings in relation to the prevalence of steep stairs, alternating tread stairs, and fixed ladders. Survey findings regarding prevalence have been included within this section as they provide some evidence, though only limited, that supports and addresses the first aim of this research, 'What is the prevalence of Special Stairs for limited access within existing dwellings?'. The remainder of the survey findings were used to inform development of the Stakeholder Workshop and are reported in full in Appendix C.

It is important to note that the results provided are a summary of participant perceptions, opinions and experiences. Whilst the results reported are accurate, in that they are a true reflection of participant comments, factual accuracy of the content has not been assessed and cannot be guaranteed.

3.5.1 Respondent demographics

The stakeholder survey received a total of 18 responses and respondent roles were reported as being designer (n=3), supplier (n=1), inspector (n=13), occupational therapist (n=2), and access consultant (n=1). One respondent reported their role as being both designer and supplier, and one respondent reported their role as being both occupational therapist and access consultant. The survey also included installer and user as response options, however there was a nil response for both options. Figure 21 illustrates the proportion of respondents by role.

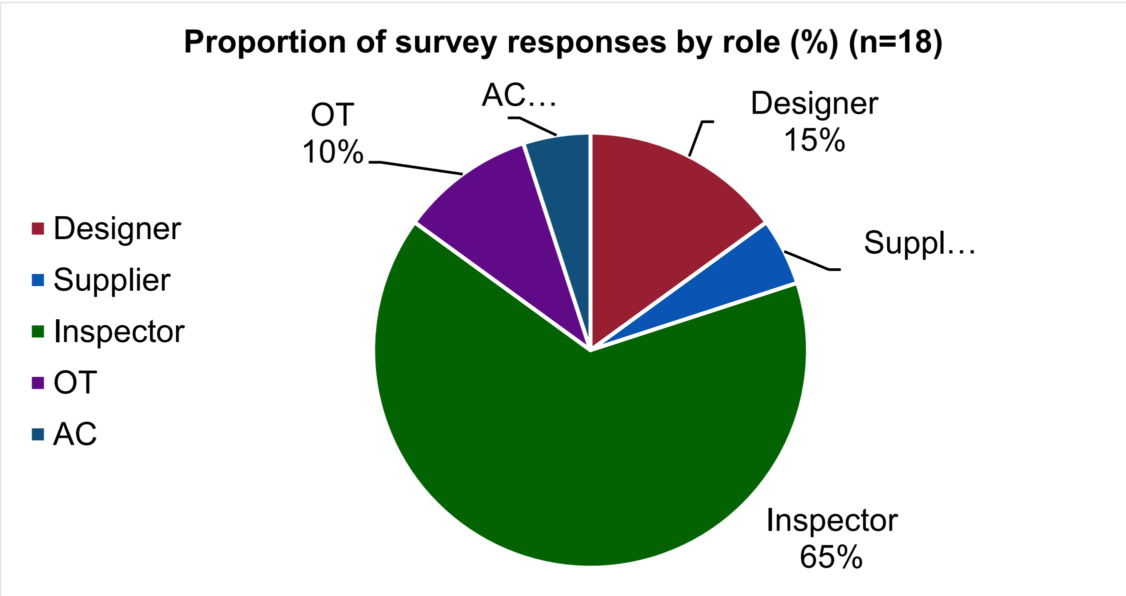


Figure 21. Proportion of survey responses by role (N.B. OT = occupational therapist, AC = access consultant)

Estimated total number of dwellings, irrespective of stair type, encountered by respondents within an inspector role (n=11) during a typical 24-month period ranged between 12.5 and 200,000. The average estimated proportion of dwelling-types encountered within a 24-month period by respondents in an inspector role were newbuild: 51.7%, renovation: 17.3%, extension: 16.2%, 4.2%: change of use, and 10.6% adaptation. These figures are illustrated in Figure 22.

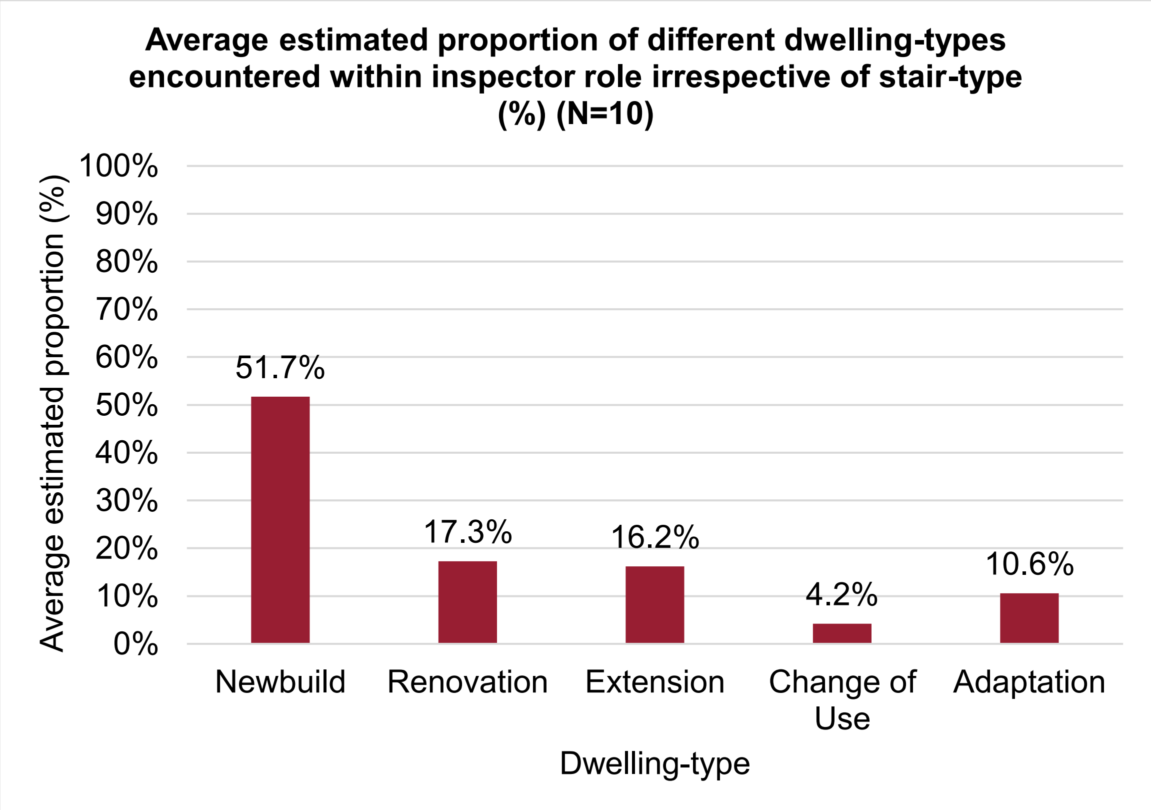


Figure 22. Average estimated proportion of different dwelling-types encountered by respondents within an inspector role irrespective of stair-type

3.5.2 Prevalence

Steep stairs

For respondents in an inspector role (n=10), over half reported encountering between one and ten dwellings within a typical 24-month period which had steep stairs, and this is illustrated in Figure 23. Further, responses (n=11) indicate that the most prevalent residential context for using steep stairs were loft conversions followed by the ‘other’ residential context category. Examples of ‘other’ residential contexts in relation to steep stair use identified by respondents included bedsits with sleeping platforms, Victorian properties and farmhouses, and heritage and conservation properties. Figure 24 illustrates the average percentage of steep stairs encountered by those in an inspector role by residential context.

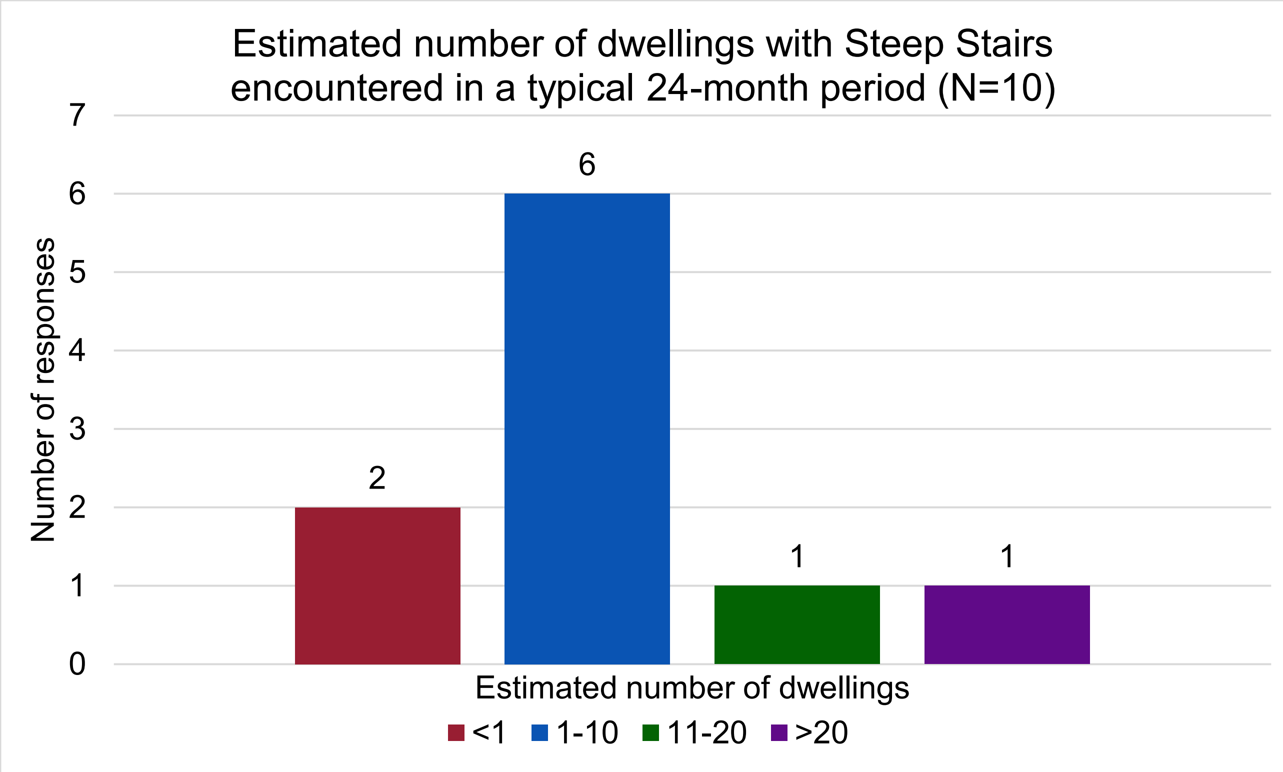


Figure 23. Estimated number of dwellings with steep stairs encountered in a typical 24-month period by respondents within an inspector role

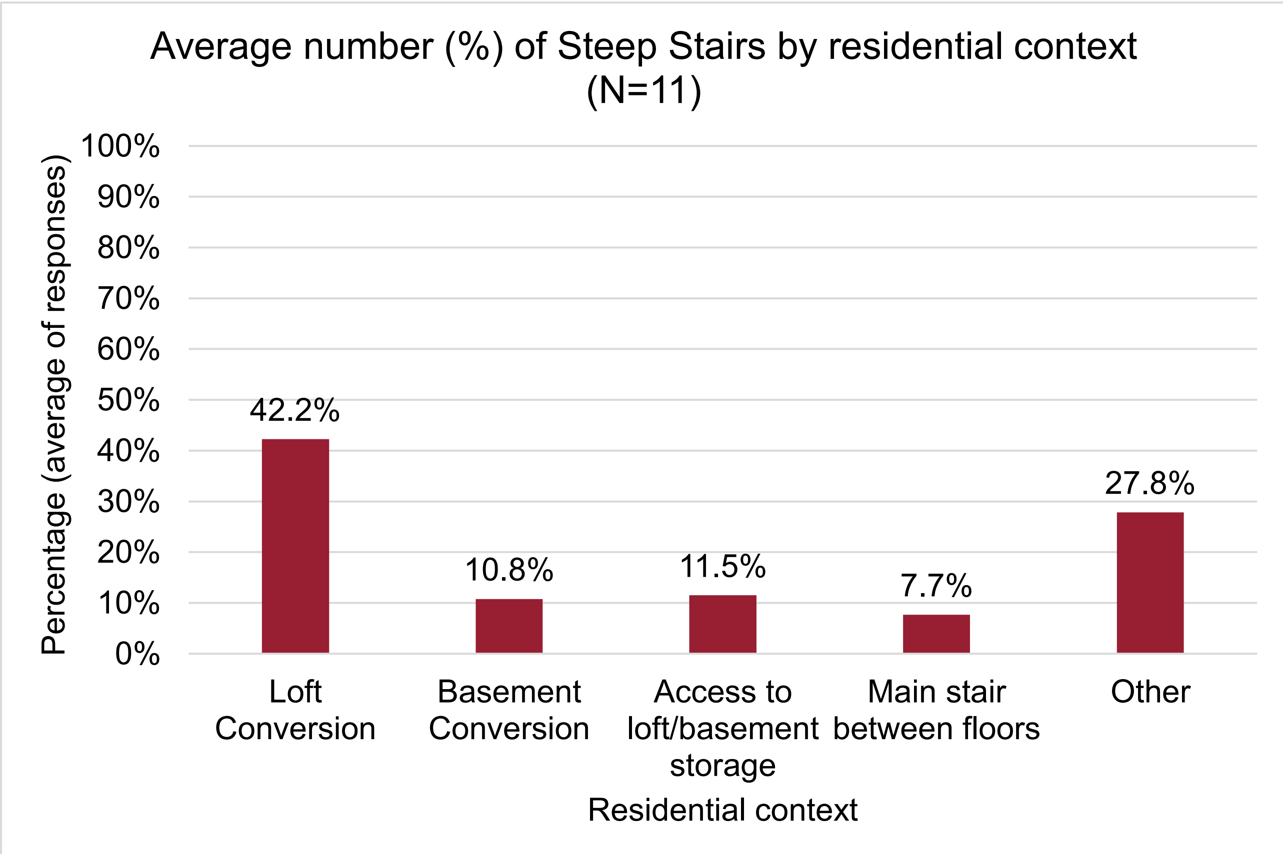


Figure 24. Average estimated number of dwellings with steep stairs by residential context by respondents in inspector role (%)

Alternating tread stairs

For respondents in an inspector role (n=11), a majority estimated the number of dwellings encountered within a typical 24-month period with alternating tread stairs to be between one and ten, and this is illustrated in Figure 25. Further, responses (n=11) indicate that the most prevalent residentials context for using alternating tread stairs were loft conversions followed by the ‘other’ residential context category. Only one example of ‘other’ residential contexts in relation to alternating tread stair use was identified which was in relation to farmhouse conversions where this was on the only viable option to install stairs leading to an upper mezzanine. Figure 26 illustrates the average percentage of steep stairs encountered by those in an inspector role by residential context.

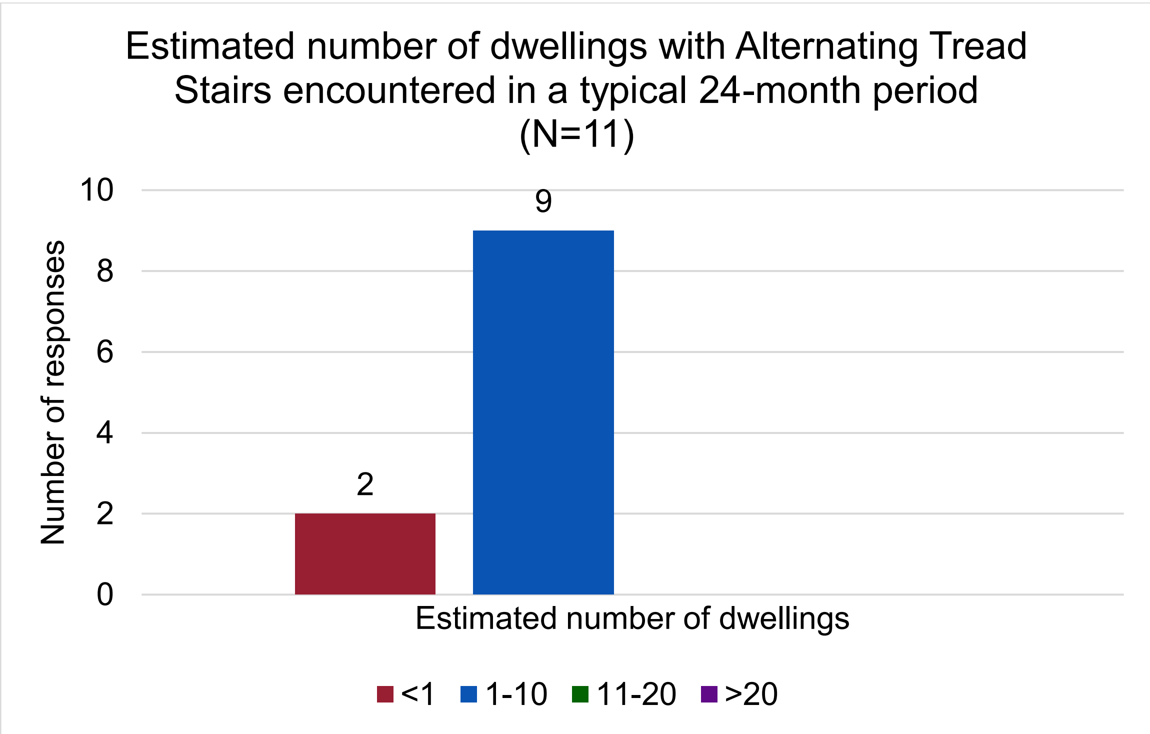


Figure 25. Estimated number of dwellings with alternating tread stairs encountered in a typical 24-month period by respondents within an inspector role

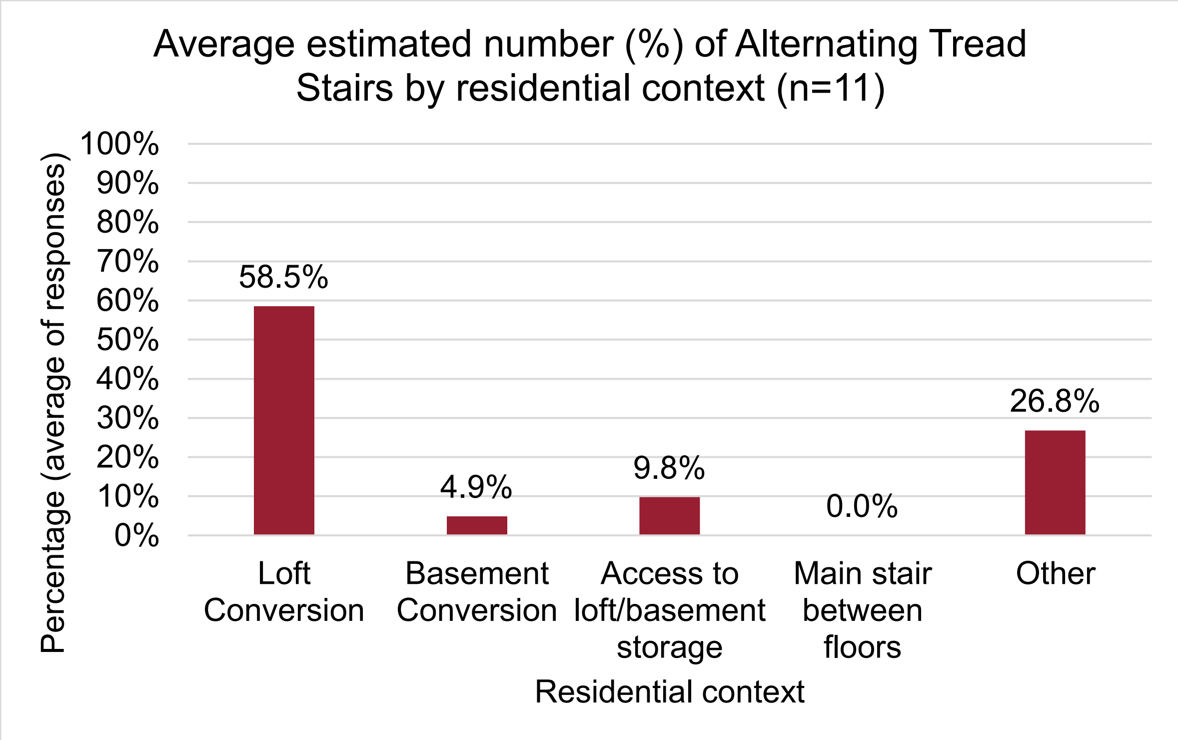


Figure 26. Average estimated number of dwellings with alternating tread stairs by residential context by respondents in inspector role (%)

Fixed ladders

For respondents in an inspector role (n=11), more than half estimated the number of dwellings encountered within a typical 24-month period with fixed ladders to be less than one, and this is illustrated in Figure 27. Further, responses (n=10) indicate that the most prevalent residentials context for using fixed ladders were access to loft or basement storage followed by the loft conversion residential context category. Figure 28 illustrates the average number of fixed ladders encountered by those in an inspector role by residential context.

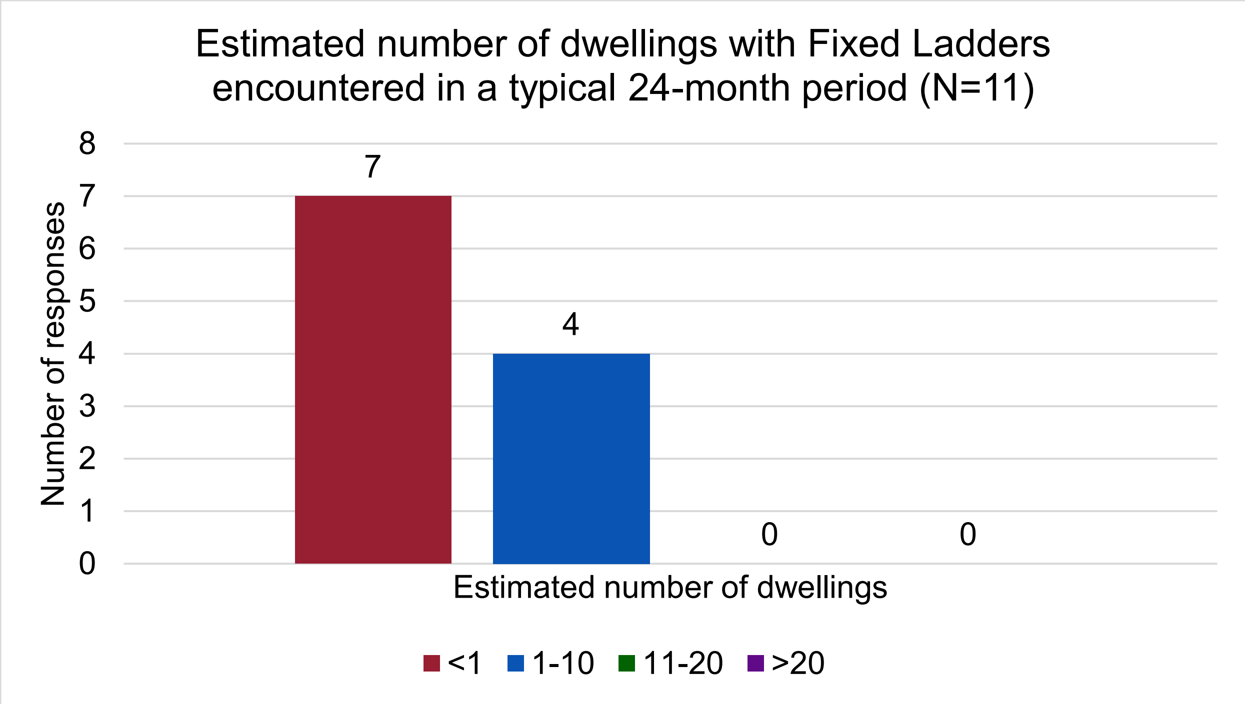


Figure 27. Estimated number of dwellings with fixed ladders stairs encountered in a typical 24-month period by respondents within an inspector role

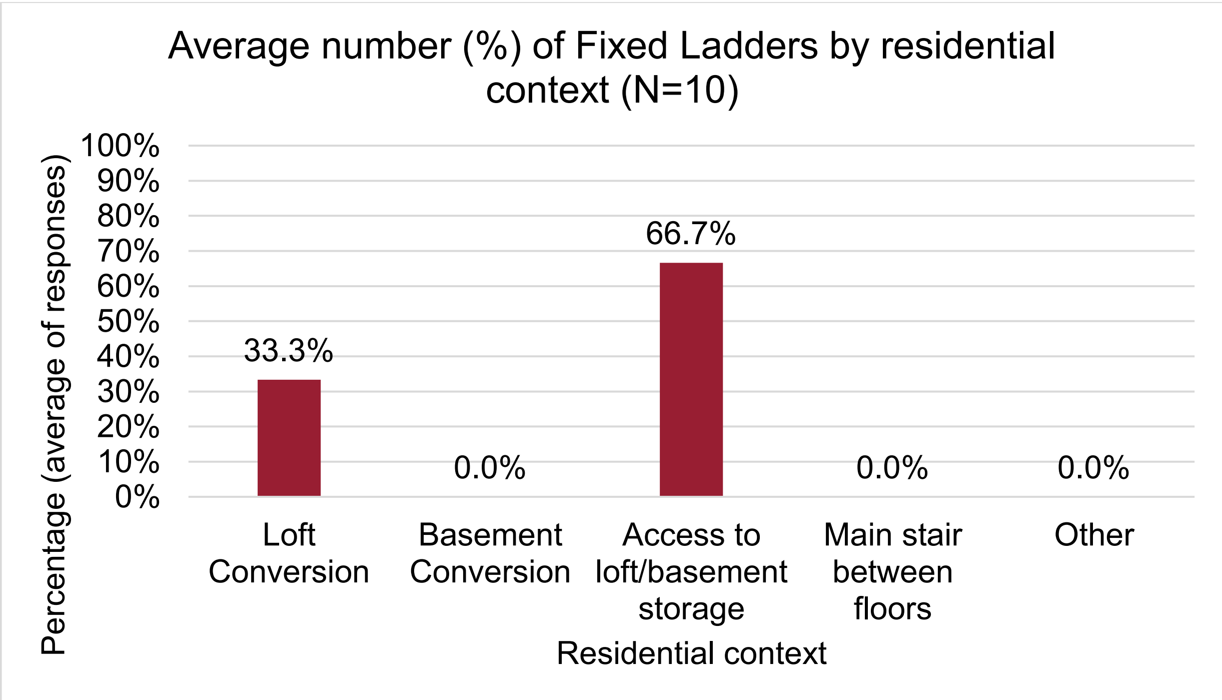


Figure 28. Average estimated number of dwellings with fixed ladders by residential context by respondents in inspector role (%)

3.6 Stakeholder Workshop

The workshop was attended by 7 participants whose roles included building control officers and managers, occupational therapists, stair manufacturers, and technical directors. Participant length of time in role and/or breadth of experience ranged from 21 years to 50 years. Participant experience included site inspections; design and delivery of new builds; involvement in guidance, standard development and revisions; building control management; manufacturing; committee members and chairs; and accessibility.

The following sections provide an overview of comments provided by participants during the workshop activities and discussions outlined in Appendices C & D of this report. It is important to note that the results provided are a summary of participant perceptions, opinions and experiences. This provides valuable insights to help understand the issues and challenges associated with different stair designs, but it should not be considered to be conclusive or representative, given the small sample size. Whilst the results reported are accurate, in that they are a true reflection of participant comments, factual accuracy of the content has not been assessed and cannot be guaranteed.

Further, whilst the focus of this research is on steep stairs, alternating tread stairs and fixed ladders, discussions also included wider considerations such as general application of Approved Documents and other guidance. The researchers have deemed it appropriate to also report these findings.

3.6.1 Installation of Steep Stairs, Alternating Tread Stairs and/or Fixed Ladders

Influencing factors and preventative controls

The following influencing factors and preventative controls relating to the installation of steep stairs, alternating tread stairs and fixed ladders were identified and discussed by participants within the workshop.

It should be noted that the influencing factors of space constraints, cost or profit-driven decisions, builder competency, and aesthetic priorities over safety were prompts included in a bow-tie diagram produced ahead of the workshop based on the survey responses and findings from the literature review. The prepopulated bow-tie diagram was reviewed by workshop participants. Whilst participants did not raise any concerns or objections to the content of the bow-ties, some influencing factors were not discussed in any further detail and are therefore excluded from the below summaries. Influencing factors identified by participants which were not included within the prepopulated bow-tie diagram included building control enforcement challenges, unauthorised/unregulated work and staircase design, and industry reluctance to report non-compliance, and property location and style.

Further, the prepopulated bow-tie diagrams included several suggested preventative controls which were generic across factors and focused on guidance documentation, design specification and reviews, Building Control approval, inspection, and accessibility criteria. Participants did not raise any concerns or objections to these prepopulated preventative control measures. The prepopulated and finalised bow-tie diagrams are presented in Appendix E.

Space Constraints

It was acknowledged that staircase designs such as winders and steep stairs require less space which may influence installation in properties with less space available. Consideration of landings was discussed, and it was highlighted that the guidance is not explicit regarding the measurements of landings between doors and from bedrooms to the top of staircases. It was raised that some designs had been seen where the limited space has resulted in doors being positioned where they are close to overlapping the top of a staircase. It was also highlighted that other factors, such as cupboards when they are opened, can obscure stairs in smaller spaces.

Regarding installation and the influence of space constraints, preventative controls identified included the need for architects, designers and builders dedicating time to advise on the type of staircase which can be fitted and discussing this with the stair supplier to select the most appropriate solution for the space available.

Cost or profit-driven decisions

It was acknowledged that staircase designs such as winders and steep stairs cost less than other staircase designs.

It was acknowledged that within health and safety, it is encouraged to reduce the risk to as low as reasonably practicable. However, it was raised that in some interventions, the cost can be perceived as quite excessive compared with the improvements in reduction to risk. It was suggested that the cost aspect should be minimised and accepted as reasonable if acknowledged that whilst a particular staircase might be more expensive, that it is a much safer option when compared to the cheaper alternative.

It was suggested that, depending on the type of staircase, installation of a safer alternative may not be particularly significant in the overall cost of the property build. However, participants then highlighted that the influence of cost is not only in relation to the staircase, but in the overall design of a property. An example provided was if there was a 250mm well opening, then a 38° staircase can result in a knock-on effect that is significant to the overall property design, potentially resulting in the loss of a bedroom or impacting on the size of the bathroom or kitchen. This can then feed back into the influence of space constraints on the type of staircase selected for installation.

The importance of accessibility and adaptability for all users was also highlighted as cost implications can result in the installation of staircases which are less accessible.

Regarding installation and the influence of cost, preventative controls identified included providing evidence to designers and builders of long-term cost savings and safety to support in selecting the most appropriate and safe staircase design. Building up the evidence base as to why steep stairs are not appropriate for the wider population and communicating this effectively to relevant stakeholders was also identified.

Builder competency

There were several comments made, and issues highlighted, by participants regarding the potential impact of builder competency levels on the installation of steep stairs, alternating tread stairs, or fixed ladders. It was acknowledged that the more competent and responsible builders will consult with Building Control as to whether a proposed staircase design is sufficient when a standard staircase cannot be fitted. However, it was raised that less competent builders may: install non-standard staircases without consulting with Building Control; may not be aware of the relevant design standards; have limited understanding and knowledge regarding the end product and how to visualise this; purchase standard staircases with incompatible floor-to-floor heights resulting in inappropriate installation; and provide incorrect measurements to Building Control due to basing these on the drawings as opposed to determining what the final measurements will be once the fitting has been completed.

Factors influencing builder competency were discussed and it was suggested that competency levels may have declined across the builder industry during the last thirty years due to the relative ease of individuals being able to purchase supplies from local hardware stores and then advertise as a builder without any previous experience or training. It was also suggested that within some parts of the industry, some builders may not have experienced any negative consequences for completing work that is not to the correct standard which can lead to a culture of completing work that ‘will do’ as they feel they can ‘get away with it’. Concerns were raised that this culture then has the potential to spread throughout the industry. Further, it was suggested that less competent builders may be chosen to undertake the work due to them charging less than what a more competent and experienced builder may charge.

It was also suggested there may be a lack of accountability from builders to take responsibility for the building work they are undertaking, with an overreliance on Completion Certificates provided by Building Control. Further, Local Authorities may not have the ability to use the same building contractors for different projects which then results in trying to ensure compliance of the builders for each new job.

Regarding installation and the influence of builder competency, participants identified preventative control measures already in progress including work being undertaken by the Industry Competence Committee towards stair installation becoming a compulsory element under site carpentry and bench joinery NVQs. Working groups within the Construction Leadership Council are also exploring how to ensure competence across various elements. Other preventative control measures suggested included: ensuring full planning applications; encouraging builders to work with reputable manufacturers who can provide guidance and advice regarding safe staircase design; and requests for builders to provide accurate floor-to-floor measurements to Building Control.

Aesthetic priorities over safety

It was highlighted that certain media influences, such as television programmes featuring building renovations and property design, could promote or influence the installation of staircase designs which may be considered unsafe or unsuitable. It was suggested that this could be prevented through communications with the relevant TV channel or TV programme stakeholders to request that they ensure that the designs shown comply with Building Regulations.

Building Control Enforcement Challenges

During the discussion, concerns were raised regarding enforcement challenges experienced by Building Control. It was highlighted that Building Control do not have the same resources or standing as HSE, for example, when attending sites for inspection and visits can often result in disagreements and debates with the builder. It was felt that this differs to outcome of a HSE site inspection, where it was presumed work is stopped whilst the investigation is carried out. It was also raised that Building Control can also experience conflicts with homeowners.

Issues were also identified regarding resourcing, with Building Control described as a 'declining industry'. It was suggested that this in part may be due to attempting to overcome issues within industry for a long period of time but the challenges not being resolved. Regarding prosecution, it was highlighted that there is a lack of industrial support in terms of being able to successfully prosecute.

It was acknowledged that Building Control does have the ability to serve Compliance Notices and, in rare instances, serve Stop Notices. In relation to staircases, it was suggested that it could likely be demonstrated when there is a risk of serious harm which would justify an escalation from informal to more formal action being taken. However, it was raised that often a Notice is served and is not then followed up as, based on experience, it is presumed that the work will need to be altered in the future when the property is placed on the market as any outstanding Notices will limit the ability for the property to be sold until the appropriate alterations are made.

It was also highlighted that the Building Safety Regulator (BSR) has an expectation that Building Control should be taking a more active role in enforcement. Participants raised that whilst there is guidance provided from the BSR, this states that inspectors should undertake risk assessments using available legislation and guidance and other than this guidance, Building Control feel 'on their own' with the responsibility.

Lastly, it was suggested that the competition from private sector property development dilutes the enforcement aspect resulting in wider interpretations of requirements to meet compliance.

Preventative controls suggested by participants were that there should be a legal obligation to make an application; and availability of a simplified version of a Building Notice to be able to submit basic information.

Unauthorised/unregulated work and staircase design

It was highlighted that for Building Control to issue a Notice or injunction for unauthorised or unregulated work, they would need to look at the whole project in terms of compliance and be aware of the context which would only be established by an investigation. The inspection would cover a range of things including fire safety, structure, staircases etc. It was further highlighted that, once notified, it would not only be Building Control with an interest as it would also impact on Mortgage Lenders and property insurance.

Participants discussed situations where contractors may attempt to build their own staircase, however this was identified as an outlier situation as it was agreed most contractors wish to avoid the aggravation of doing this and instead would choose to purchase a staircase and then arrange for installation.

Participants also discussed the possibility of staircase manufacturers being asked to build bespoke staircases which are not compliant, and that this situation may arise when replacing an already existing staircase due to space constraints.

Preventative controls suggested by participants included encouraging manufacturers to highlight when a staircase will not be compliant and advising customers on the most appropriate and compliant option, as well as providing guidance on installation once the staircase has been ordered.

Industry reluctance to report non-compliance

Participants highlighted that they have experienced reluctance from manufacturers to pursue or report non-compliance. It was raised that there are some products being provided for building construction, which are not just limited to staircases, which are not compliant. Participants recalled conversations with manufacturers where they acknowledged being aware of something not being done correctly but when asked if they have reported it, the response was that they did not want to be involved. It was suggested that manufacturers are reluctant to become involved as this may result in challenges for their own business when they are already in a position of having to compete with other businesses who are willing to undercut or take business away from those providing compliant staircases.

It was suggested that the development and implementation of a system to allow for confidential reporting of Building Control issues, similar to the system used for reporting assumed fire and structural risks, may improve the reporting of suspected non-compliance by those in industry.

Potential consequences of installation

Identified potential consequences following installation of Steep Stairs, Alternating Tread Stairs or Fixed Ladders included falling on or from stairs, poor usability for certain demographics, comprised household emergency evacuation, and impact on future property change of use plans.

Mitigating controls relating to these consequences were incorporated and discussed as part of the second workshop bow-tie analysis (reported in Section 3.6.2).

3.6.2 Person fall on or from Steep Stairs, Alternating Tread Stairs and/or Fixed Ladder

Influencing factors and preventative controls

Influencing factors and preventative controls relating to a person fall on or from Steep Stairs, Alternating Tread Stairs and/or Fixed Ladders were identified and discussed by participants within the workshop. The influencing factors of insufficient tread depth, absence or poor positioning of handrails, inadequate headroom, slippery step surfaces, poorly contrasting stair surfaces, and human behaviour on stairs were prompts included in the bow-tie diagram designed ahead of the workshop. The prepopulated bow-tie diagram also included excessive stair steepness, inconsistent rise heights, stair width restricted, inadequate lighting, poor visibility due to glare, shadow or poor contrast, inappropriate clothing or footwear, and poor housekeeping practices but, whilst participants did not raise any concerns or objections to these being included, they were not discussed in any further detail and are therefore excluded from the below summaries. Additional to the prepopulated factors, participants also identified emergency evacuation as an influencing factor. Other factors were identified by participants but were not discussed in further detail and therefore are excluded from the below summaries: no ongoing control from Building Control once work is signed off, doors and cupboards opening and obscuring stairs, and stairs not useable by certain demographics.

The prepopulated bow-tie diagrams included several suggested preventative controls which were primarily generic across factors focussing on guidance and regulations, design standards and reviews, and inspections, and suggested mitigating controls for the identified potential consequences. Participants did not raise any concerns or objections to the prepopulated preventative or mitigating control measures.

Insufficient tread depth

Participants discussed the minimum going of 220mm and there was a question around what this minimum standard is based upon, commenting that it is a historic number which does not account for modern changes in physical characteristics such as height and associated increases in shoe size. As a preventative control, it was suggested that depth should be increased for greater stability and firmer foot placement.

Absence or poor positioning of handrails

Participants highlighted that property occupiers may go on to remove handrails within the property once work has been signed off and completed.

Tapered steps were discussed, and it was highlighted that in these designs, the handrail is around the newel post which results in two or three steps at the top and bottom of the staircase with no handrail available.

Preventative controls suggested included installation of handrails on the outside of tapered treads, installation of mop stick handrails (i.e. a handrail profile that facilitates a secure grip), and for the importance of handrails remaining in place to be emphasised.

Inadequate headroom

Regarding headroom, participants highlighted that the final floor height in loft conversions can be variable.

As a preventative control, it was suggested that accurate staircase design dimensions should be provided to Building Control ensuring that the correct floor to floor height measurements are provided.

Slippery step surfaces

Participants explained that when staircases are supplied for installation, they are provided with a slip resistant peel clean film over the stair treads for the safety of the tradespeople during the development of the property. However, once the development has been completed, there is no control over whether the occupier removes these or what they choose to install over the top; it was acknowledged that it is predominantly carpet installed.

No preventative controls were identified for this factor due to the lack of control over occupant stair covering decisions once the work is completed.

Poorly contrasting stair surfaces

Participants raised that it can be difficult to know where one tread finishes and another one begins on staircases where the treads and nosings blend in.

No specific preventative control measures were identified for this factor.

Human behaviour on stairs

Participants discussed the influence of human behaviour on stairs, and it was raised that a lot of building design relies on responsible behaviour of the occupants. Regarding user-guidance, it was highlighted that it would be difficult to know whether an occupier would read guidance provided to them or would just declare that they have read and understood the information.

Regarding preventative controls in relation to user behaviour, an ongoing RoSPA campaign was acknowledged, which campaigns for safer stairs and educates users of the risks associated with staircase e.g. carrying objects, using mobile phones, and cluttering stair surfaces. Other preventative controls suggested by participants included using television adverts to illustrate the consequences of unsafe behaviour on staircases, property logbook or user guide on how to safely use the property when there is a change in occupants, and risk-based assessments and consumer/user information being provided as a regulatory requirement.

Emergency evacuation

Participants raised that if occupiers need to exit the property in a hurry, then alternating tread staircases are particularly problematic as putting the wrong foot onto the wrong starting tread, which may be more likely if the person is panicking, can then result in a fall.

Whilst no preventative controls were identified to ensure that feet are placed on the correct tread, participants did highlight the importance of handrails in that they are fundamental on alternating tread staircases to reduce a full fall if a person does misstep.

Potential consequences of fall and mitigating controls

The potential consequences of falling on or from staircases identified and discussed were injury or fatality, legal action, and loss of independence. Regarding potential legal action, participants discussed who would be considered responsible if an injury or fatality occurred on a staircase and it was suggested that information should be able to be provided from the start to end of the process including how the staircase was manufactured, delivered, built and installed. It was highlighted that if a non-compliant staircase was designed by an architect, for example, then the liability would be with the architect, and that if a staircase is compliant then it leaves no room for criticism of the designer or regulator.

Mitigating controls suggested by the participants included the installation of a “dog-legged” staircase (a staircase with flights running in opposite directions, connected by a 90° or 180° landing) or tapered treads to arrest the fall, rather than falling from the top to the bottom of the staircase. However, from an accessibility perspective, it was raised that dog-legged staircases or staircases with a change in direction can create issues for future installation of stair lifts.

3.6.3 Alternatives to Steep Stairs, Alternating Tread Stairs and/or Fixed Ladders

Participants discussed staircase designs which are alternatives to steep stairs, alternating tread Stairs and fixed Ladders and comments made regarding specific alternative designs are provided below. However, a more general comment was made that fixed ladders and alternating tread stairs are considered as inherently unsafe. A further comment was made that alternatives may not be considered as a project may not be able to go ahead or may impact on number of rooms or size of room if required to fit a standard staircase or staircase which takes up more space than Steep Stairs, Alternating Tread Stairs or Fixed Ladders.

Utility Staircase

Participants indicated that utility staircases are safer than limited access stairs, as they are more generous in size and allow for more people and activities. From an accessibility perspective, it was highlighted that Approved Document M recommends utility staircases if being used for access to ensure that ageing occupants can continue using stairs safely and access all rooms within the property.

Participants identified that utility staircase design has a larger footprint which can be a barrier for installation. It was also raised that even in new-build homes, designers will still choose a private staircase as opposed to a utility staircase as space is considered premium, even in a higher-end and more luxurious home with more space available. It was also highlighted that the consequence of changing from a private to utility staircase design could radically impact on overall design which may then be considered undesirable.

Private Staircase

Whilst it was acknowledged that utility staircases are considered the safest option, private staircase installation using existing guidance would be a good compromise as they are still considered safer than steep stairs, alternating tread stairs or fixed ladders but have a smaller footprint and size compared to utility staircases.

However, there were several barriers identified in relation to the installation of private staircases including designer sensibilities, cost, preferences, and preparedness to undertake alterations which would allow for installation.

Helical Staircase

Participants considered helical staircases to be safer than spiral staircases as they are likely to have a better tread, and less issues regarding the taper in the spiral column.

Spiral Staircase

Several issues were identified regarding spiral stairs including having a large footprint and being inconvenient for moving furniture up and down the stairs. It was also raised that if the going were increased to enlarge the tread, this would then limit the number of risers which could then reduce headroom clearance at the top of the staircase.

3.6.4 Accessibility considerations

There were several comments made during the workshop regarding accessibility considerations of stair design. Comments included:

- Accessibility and adaptability is important to consider.
- Approved Document M, section 4(2) 'Accessible and Adaptable Dwellings', is an optional standard for all new housing.
- Landings and winders need to be considered as there is a risk of wheelchair users tipping off the top of stairs.
- Consider the Lifetime Homes Design Guide in relation to staircases as, if limited access stairs are installed, ageing occupants may lose access to rooms in the home if they are no longer able to use the stairs.

3.6.5 Considerations of available Guidance in relation to the installation of Steep Stairs, Alternating Tread Stairs and/or Fixed Ladders

Guidance documents identified

A total of 33 documents, literature or communications were identified, referenced or discussed by workshop participants as either being directly relevant to staircase installation or as being important for more general considerations. A full list of references captured throughout the entirety of the workshop is provided within the bibliography, Section 6 of this report.

Participant discussions highlighted that guidance and standards commonly referred to in relation to steep staircases, alternating tread staircases and fixed ladders within England include:

- Approved Document K (ADK)
- BS 4211
- BS 5395-1; 2; 4
- BS 585-1; 2

- BS 6180
- BS EN 15644
- BS EN 1991-1-1
- CEN TS 15680
- EN 14122
- Housing Health and Safety Rating System Operating Guidance
- PD 6688-1-1

Challenges identified and suggestions on how to overcome these

Within the workshop, participants identified several challenges in relation to how guidance and standards are currently identified, accessed and used. Table 15 outlines the challenges and issues identified, and suggestions provided by participants on how these challenges or issues could be mitigated or rectified.

Table 15. Challenges with current guidance and suggestions for improvement

Challenges and issues identified	Examples and comments provided by participants	Participant suggestions to overcome challenges
Excessive number of documents	• It is not feasible to learn the content of all available standards. There are only 3 or 4 British standards which building safety regulators need to refer to. • Described as 'going down a rabbit hole' and 'bouncing from one standard to another' when trying to find a specific piece of information. • The various guidance and standards documents are not co-ordinated with one another. • Staircase load defined within Eurocode but then need to use other standards to determine timber sections necessary to support that load. • Work previously undertaken to simplify the multi-part document BS8000 but this process can be intangible and time consuming.	• Simplicity and clarity are needed. • Remove the standards that are not needed. • Redraft the standards within BSI followed by industry guidance to allow consumers and contractors to understand what the regulations require of them.

Challenges and issues identified	Examples and comments provided by participants	Participant suggestions to overcome challenges
Contradicting guidance across documents	• Within ADK, sections have been based on guidance provided in BS-585 but some of this guidance is contradictory to BS-5395. • Guidance provided within BS-585-1 and BS-585-2 is not fully compliant. • BS-5395-1 has been amended yet BS-5395-2 and BS-5395-4 have not been amended in the same style. • There are different loading requirements specified in BS-585 and BS-1991-1-1.	• Amend BS-585-1 to reflect BS-505-1 which is a prescriptive standard.
Consistency of document reviews and updates	• Standards which informed ADK may have now been superseded or discontinued. • In relation to helical and spiral staircases, ADK advises users to refer to BS-5395-2. However, this standard is being revised which will impact the guidance given in ADK.	• Update guidance to reflect revisions to standards to ensure consistency. • Provide the date and version number of referenced standards in the guidance.
Accessibility	• Need to pay to access documents. • Difficulty accessing documents can impact training and competency. If builders are not being supplied with the right tools, then they are not going to be able to do the right job. • Without the resource or ability to access a specific document, finding information is difficult and	• Make information accessible to ensure competent builders. • British Woodworking Federation (BWF) have developed industry design guide for private stairs, public access stairs and

Challenges and issues identified	Examples and comments provided by participants	Participant suggestions to overcome challenges
	can result in relying on subjective opinion instead of guidance. • Documents are becoming more specialised, diverse and academic which in turn is making them less accessible to some users.	installation guide which collates important and relevant information from across the various standards.

Approved Document K (ADK)

Strengths

It was suggested that, when compared to some of the other Approved Documents, ADK is considered one of the better documents as it provides clear guidance for the user, making it easier for decision-making. However, some limitations were highlighted, which are summarised in Table 16.

Table 16. Approved Document K limitations

Theme	Issues identified	Improvement suggestions
Guidance regarding fixed ladders	• Unclear guidance given in relation to fixed ladders and existing dwellings (specifically page 13). • The phrase ‘putting in a fixed ladder’ is a vague term. • Handrail information implies a need for companionway ladders but not made clear what guidance then needs to be referred to in relation to this. • Directs to BS-4211,	• Need a clear definition of ‘fixed ladder’.

Theme	Issues identified	Improvement suggestions
	which provides design guidance for various types of fixed ladder, including companionway ladders, which leaves uncertainty regarding the most appropriate design.	
Guidance regarding handrails	• Not clear on the type of handrail required e.g. mopstick or elliptical etc. • Not clear on dimension required for handrails e.g. to allow power grip. • Different demographics may require different types of handrails.	• Type of handrail needs to be appropriate to the circumstances.
Enforcement	• Guidance cannot be enforced in certain situations e.g. change of use. • In terms of specific enforcement of the Building Regulations, Part K not being a relevant requirement creates limitations.	• Address where requirements can actually be applied in relation to building work.
Lack of assurance that Approved Documents ensure compliance	• Concerns that following statutory guidance doesn't necessarily mean that the functional requirements of the Building Regulations have been met. This is	• To have it restated that by following the guidance, the functional requirements are being met.

Theme	Issues identified	Improvement suggestions
	following a circular letter which was issued in relation to Approved Document B.	
Accuracy of content and references	• Information not provided for flight length, landings and other aspects for private stairs. • Content developed based on BS585 and BS5395-1 which are not referenced. • Content based on BS585 contradicts the guidance provided in more recent BS5395-1.	• Consistency in reviewing and updating documents. • Include a commentary clarifying the standard which takes priority.

3.6.6 Supplementary Information

Following completion of the workshop, additional information was received from a workshop participant to highlight further considerations for stair design, specifically from an occupational therapist perspective. This information is included in Appendix F.

4 Conclusions

4.1 Summary of findings

4.1.1 Literature review conclusions

It is clear from the literature that falls on stairs are a major concern and that the design of stairs can have a big influence on helping to keep people safe and independent in their own home. One study found that out of 1035 deaths related to building features in coroners' reports in a year, 80% were attributed to falls and 61% to falls on stairs (Cayless, 2001).

Much research has been done to help understand how stair design can influence the risk of falls, with small goings, large risers and steep pitches (features common to most types of limited access/special stairs) being associated with an increased risk. However, some have questioned the relevance of much of this research, as it is usually undertaken in laboratory conditions, using experimental stair rigs (which tend to consist of ≤ 7 treads) and human subjects who lack the familiarity that a householder would have with their own stair. Furthermore, the measured outcome tends to be fall risk predictors, such as foot contact lengths, as opposed to actual falls.

Very few studies have specifically considered steep stairs, fixed ladders and alternating tread stairs in detail, and the findings of the most comprehensive study, which focussed on alternating tread stairs (Webber & Feeney, 1996), had already been used to inform previous revisions of ADK. Our review of ADK's content relating to steep stairs, fixed ladders and alternating tread stairs found that the guidance provided on alternating tread stairs is comparable with the best available evidence, which was generated back in 1989 (Webber & Feeney, 1996). The current ADK provides very little guidance on fixed ladders and doesn't define a maximum pitch, or dimensional tolerances for steep stairs. Although the current ADK refers readers to parts 2 and 3 of BS 5395, it doesn't make reference to part 4, "Code of practice for the design of stairs for limited access", which provides design guidance for a straight stair with a steeper pitch, up to 50.7°.

Our review identified two peer reviewed studies that used simulation software to study stair falls and both concluded that computer simulation techniques are useful for investigating the biomechanics of stair falls and determining the effect of stair characteristics on the potential for serious injuries. Fall simulation models, ergonomics assessments (similar to those undertaken in this study), and research undertaken in real-world environments (i.e. people's homes) would help to address the limitations of the existing evidence base.

4.1.2 Data analysis conclusions

It is difficult to make any meaningful conclusions from the data analysis due to the lack of data specific to Special Stairs. Indeed, the available data would present similar difficulties for all stair types, as well as for other types of safety incidents within dwellings that would be of interest to BSR. Our analyses would suggest that there is a need to improve data collection regarding safety incidents that occur within dwellings to provide BSR with the robust evidence base upon which to develop their guidance and policies. Furthermore, the quality of existing data limits opportunities for the much-needed study of real-world incidents.

EHS has the potential for a very rich dataset had it had consistent loft conversion data for all its years, but the amount of loft conversion data that could be analysed was too small to make any meaningful conclusions. HASS/LASS is the most lucrative dataset in terms of data points, but still presented limited information below the requirement needed for good analysis. Our analysis of HASS/LASS data found discrepancies in the gender distribution between incidents reported on Special Stairs, compared to those reported on other stairs, which could indicate that for Special Stairs the risk/exposure is greater for female users. Our analysis also found that there are age distribution discrepancies; the 11-20 years age category is comparatively underrepresented in incident data relating to Special Stairs, which would suggest that the risk/exposure is relatively lower for this age group. However, these findings are based on assumptions, which introduce much uncertainty. Currently, coroners' reports are difficult to filter and analyse due to the different recording practises in each local authority area.

To allow robust comparisons between the fall rates on different stair designs it is important to establish the type of stair upon which falls occurred, the relative prevalence of that type of stair within housing stock, and ideally the relative frequency of use. To perform this data harmonisation, consistent definitions for the various stair types would improve the ability to compare across the datasets. The relative frequency of use is likely to be particularly important in consideration of Special Stairs, which are likely to be used less frequently than other stairs within the same building. Unfortunately, our study could not find this information.

4.1.3 Ergonomics Summary Conclusions

The key findings from our ergonomics assessment are detailed below:

- Steep stairs, fixed ladders and alternating tread stairs will present a potential barrier to some users (e.g. taller, heavy men), due to the increased lower limb biomechanical efforts/requirements, but these will tend to be in a minority.
- In general, stairs with large rise heights and steep pitches tend to be more inhibitory/less accessible due to the increased physical biomechanical demands of ascending these stairs and reduced space afforded to the user.
- When using steeply pitched companionway steps/fixed ladders people are more likely to need to grasp onto handrails to prevent falling backwards, due to the positioning of their COM. End users (e.g., homeowners) should therefore be discouraged to install fixed ladders where frequent load carriage between floors is foreseeable. Carrying boxes, laundry baskets, tools, or groceries, etc. will increase knee and hip torques and greatly reduces stability margins due to a change in COM

(with the additional load) and compromise in ability to use hand rails for stability and support.

- While alternating tread stairs offer some physical advantages (e.g. the opportunity for more generous goings), without appropriate design features the visual and cognitive requirements (i.e. the need to be able to see and judge where to place your foot) are likely to increase risk of falls due to foot misplacement. Consideration should be given to the conspicuity of the different stair treads, especially when descending to minimise risk.

4.1.4 Stakeholder conclusions

The key findings from our stakeholder survey and workshop are summarised below, with the resulting bow-tie diagrams included in Appendix E.

Stakeholder survey and workshop key findings:-

- Prevalence of steep stairs, alternating tread stairs and fixed ladders is difficult to ascertain due to limited data. Results suggest that loft conversions and access to loft or basement storage are most common residential contexts in which a steep stairs, alternating tread stairs or fixed ladder is used.
- Loft conversions and access to loft or basement storage are most common residential contexts for installation of steep stairs, alternating tread stairs or fixed ladders.
- Alternating tread stairs and fixed ladders were considered the least preferable design and numerous safety concerns were identified. Steep stairs were considered more favourable, but “private” and “utility” stairs were considered the most preferable stair designs.
- A majority of participants recommended that steep stairs, alternating tread stairs and fixed ladders should only be used as a last resort where no other option is available.
- Several accessibility and usability issues were highlighted for steep stairs, alternating tread stairs and fixed ladders particularly for elderly occupants, children and occupants with mobility issues.
- Handrails, tread depths, anti-trip and anti-slip nosings and treads, and nosing colour contrasts were all commonly identified as potential measures to reduce the fall risk.
- It is important to consider the impact of user behaviour and attitudes in relation to stair use and safety as it was highlighted that building design relies on responsible behaviour of occupants. For example, occupants may choose to remove a handrail for aesthetic purposes; ascend or descend a staircase without using handrails; or use whilst distracted, e.g. by using mobile devices.

- Builder competency levels were highlighted as an important influencing factor in relation to design and installation.
- Enforcement challenges are experienced by Building Control, which can impact compliance and safety.
- There is a reluctance in industry to report non-compliance.

4.1.5 Overall conclusions

Stair falls are a major problem, accounting for many injuries and accidental deaths. Furthermore, our changing demographic (increasing stature and weight in the population, as well as a higher proportion of people being older and potentially more vulnerable) is likely to increase the need for safe and inclusive stair designs, which help keep people safe and facilitate independent living for as long as is possible. Indeed, stair design has the potential to not only have a significant influence on peoples' independence and safety, but also on wider societies ability to care for those who are more vulnerable. However, housing shortages and increasing construction costs also need to be considered when producing stair design guidance, as this can influence the number and size of rooms within a given building.

This study has set out to consider the potential risks associated with steep stairs, fixed ladders and alternating tread stairs and has highlighted a number of safety and usability concerns. However, the study was unable to identify robust evidence to link these designs to an increase in falls. This does however raise concerns about the way stair fall data is currently being recorded, which makes it difficult to gain any meaningful insight into the causes of the many stair falls that occur every year. Indeed, this study has shown that the evidence base that BSR will need to inform their policy on stairs, as well as other building features, is currently lacking.

This study has also highlighted concerns over the validity of much of the laboratory-based research upon which current stair design guidance is based. Without improvements to real-world data collection (e.g., consistent and detailed incident records, and/or long-term research studies involving private homes) the robust evidence needed to optimise stair design guidance may continue to be elusive. However, the use of stair fall simulations and ergonomics assessment may help to address some of the limitations of the existing evidence.

In conclusion, steep stairs, fixed ladders and alternating tread stairs all have design characteristics (i.e. steep pitches, small goings and large risers) that are widely considered to increase the risk of a fall and can make them difficult to use by a sizeable portion of the population, especially those who are larger-bodied. However, these and other "Special Stairs" do provide some benefits, in terms of space efficiencies and based on the evidence that is currently available, it is difficult to gauge whether the benefits outweigh the potential risk.

This study does raise questions about other "Special Stair" designs that were beyond the scope of our study. In particular, tapered treads can provide space efficiencies but are discouraged in some design guidance because of concerns that they reduce foot contact length, which is often used a fall risk indicator. However, the concerns we've highlighted regarding evidence generated through laboratory-based observations, would suggest this may not be a reliable predictor of falls, and unlike steep straight stairs, fixed ladders and alternating tread stairs, tapered treads have the potential to reduce the severity of a fall, because the change in directing that they introduce may curtail any falls. Further study and the consideration of accessibility requirements (e.g. stair lift installation requirements) would be needed to help understand the risks and benefits of the various stair designs.

In terms of the research questions stated in the aim of this study (refer to Section 1.2), there remains much uncertainty, but we address each one in turn below:

1. What is the prevalence of Special Stairs for limited access within existing dwellings? This study was unable to identify or generate any robust evidence by which to deduce the prevalence of steep stairs, fixed ladders or alternative tread stairs.

2. If Special Stairs are not widely installed, what would be the impact if the guidance for these types of stairs is removed from statutory guidance? Stakeholder's suggested that some building conversions would not be viable without the use of Special Stair designs, though the low response rate to our survey only provided limited data.

3. Could certain proposed policy options be overly prohibitive in some situations with consideration to the reasons that stairs for limited access may be installed over a "private stair", as defined in ADK? Stakeholder feedback concurred with the existing guidance in the current Approved Document K, i.e., a steep stair, fixed ladder or alternating tread stair should only be used where there is insufficient space to accommodate a standard private stair. However, some suggested fixed ladders and alternating tread stairs were inherently dangerous and should be avoided. Our data analysis and literature review did not identify definitive evidence to link these designs with an increase in falls.

4. What does safe stair design look like and what are the safety implications of using the alternative stair designs for limited access? Although there is a lack of longitudinal or epidemiological studies linking stair design with an actual reduction in falls or injuries, there is broad consensus within the literature that stair dimensions have an influence on the risk of falls. Safe stair designs should provide generous goings to help facilitate secure foot placement and rise heights that allow users to control their movement from one going to the next. Indeed, some researchers have suggested that that going sizes within existing guidance should be increased to reflect changes to our population (e.g., increasing foot size trends) and goings of >300mm have been proposed (Roys, 2025). Our stakeholder engagement and ergonomics assessment highlighted the need for inclusive designs, which consider accessibility requirements, with steep pitches being found to be exclusionary for a significant proportion of the population (see Table 5) and some design features make it difficult/expensive to make adaptations, for example the installation of a stair lift.

5. What are the key risk factors in the range of stair types for limited access within a dwelling? Small goings and large rise heights that are common to all limited access stairs, due to the need for them to be accommodated within a small space, is likely to increase the risk of falls. Although the alternating tread design does provide the opportunity for larger goings, this design was not favoured by our stakeholders or the results of our ergonomics assessment. Indeed, alternating tread stairs are likely to have additional unique risk factors associated with user technique.

6. What risk reduction measures could be applied to Special Stairs (including open rises, nosings) and can a reduction in risk be quantified so that cost benefit analysis can be carried out? Our ergonomics assessment highlighted the importance of handrails and the need for clearly visible treads. Furthermore, the ergonomics assessment as well as stakeholder feedback stressed the need to consider accessibility requirements. The literature highlighted the importance for consistent rise and going dimensions and the most comprehensive study of alternating tread stairs identified the need to improve tread slip resistance, as well as the general build quality of alternating tread stairs. The literature shows that the annual cost of stair falls in England is likely to run into the £billions, so there is huge scope for cost benefits, but their calculation is likely to be complex and is reliant on data that our review would suggest is inaccessible.

7. Are the stair designs associated with the highest risk of falls also associated with the highest risk of injury? All three stair designs included within the scope of this study (i.e. steep stairs, fixed ladders and alternating tread stairs) are likely to result in similar fall trajectories and the ability to arrest a fall is likely to be influenced by design specific features, such as the rise, going and pitch, as well as extrinsic features such as handrails, etc. In terms of the design specific features, the literature suggests that not only do large rise heights and small goings increase the risk of a fall occurring, they also make the recovery of balance more difficult. The literature shows that fall simulation models can be successfully used to investigate the biomechanics of stair falls and to identify stair characteristics that have an effect on the potential for injuries. However, these may be most useful for the study of stairs with landings, or changes in direction and can't be relied upon for accurate injury outcomes.

8. Should the use of fixed ladders remain within the ADK, and if so, should the design parameters be defined? The design parameters for fixed ladders within the current ADK are poorly defined and it is unclear what type of fixed ladder is permitted. The inclusion of fixed ladders gives the impression that they do not have the same requirements as a steep stair, whereas in fact the only difference may be their tread dimensions and pitch. As building control discretion is permitted for the tread dimensions and maximum pitch of steep stair, the inclusion of fixed ladders, in addition to steep stairs may just lead to confusion. Consideration should therefore be given to whether the design parameters for fixed ladders need to be better defined and whether fixed ladders should be included in the ADK Special Stairs Category.

9. Are falls more likely from an accident on a stair for limited access than a domestic private stair? The literature would suggest that falls are more likely from an accident on a stair for limited access than a domestic private stair. However, there is a lack of longitudinal or epidemiological studies linking stair design with an actual reduction in falls or injuries and we were unable to positively identify different stair types within incident data.

10. Could injuries be more serious on certain types of limited access stairs? E.g. does the steeper pitch of an alternate tread stair or ladder have more serious consequences than a straight stair? As already stated in the response to research question 9, we were unable to positively identify stair types within the incident data and in the absence of longitudinal or epidemiological studies linking stair design to actual falls and injuries, it was not possible to compare the frequency and severity of falls and associated injuries for different stair types.

4.2 Research limitations

Our literature review was designed to be semi-systematic with the aim of identifying relevant material from across a broad range of studies, which focussed on various stair designs, not just those within the scope of this project. Some of the findings reported were therefore not specifically generated on fixed ladders, steep stairs and alternating tread stairs, but are likely to be transferable.

As previously mentioned, the datasets analysed in this study were put together without the intention of collecting “Special Stairs” information and thus have no definitions of “Special Stairs” considered during their collection. Some assumptions were therefore necessary, which are likely to influence the accuracy of our findings. Special Stairs data may not have been picked up by any of the filtering key words used, leading to under counting. For example, a loft conversion may not be referred to as such, as it is just another room in the house. Over counting may have occurred where a key word has been used in a different context or tangentially to describing the staircase. Overcounting may have also occurred for the EHS dataset, where loft converted staircases were not the subject of the higher-than-average health and safety risk within a property.

Our exploration of ergonomics on Special Stairs has been expedient, and further work should focus on descent of Special Stairs, use of these types of stair by a 3rd age population (>65 years old), and accessibility (physical and visibility) requirements on non-standard stair types.

Our survey was primarily designed to support the development of the workshop, the design, functionality, and data obtained were not sufficient or appropriate for conducting statistical analysis beyond the basic figures reported within this report. Furthermore, the response rate was low and users/members of the public were not included. Insights from Special Stair users may have provided important information such as incident prevalence, user behaviour, risk perception and other data not provided within the current study.

4.3 Technical recommendations for future research

The study of real-world stair incidents would help to address some of the limitations identified by this study. However, the existing data sets limit research opportunities and do not provide the necessary information, i.e. the type of stair on which falls occurred, the relative prevalence of that type of stair within housing stock, and the relative frequency of use, to deduce relative risk associated with different stair designs. Our first recommendation would therefore be to investigate ways to improve data collection and recording of safety incidents involving stairs, as well as other building features that are of interest to BSR. This could be achieved by seeking an arrangement with Coronors' Offices, and/or by including specific questions in the EHS, or, as campaigned for by RoSPA, a reinstated HASS/LASS.

In the absence of better data recording, long-term studies involving private dwellings would help to address the limitations of the existing evidence base. The use of stair fall simulations and additional ergonomics assessment may also provide useful insights.

Any future survey plans should consider survey design, use of data, key stakeholders, distribution methods and engagement. A comprehensive stakeholder mapping exercise in relation to Approved Documents would help to inform future stakeholder engagement activities. Involving stair users/members of the public would allow the exploration of their perceptions, behaviours and experiences regarding stair safety.

Based on feedback from stakeholders involved in this study, there is also scope to undertake research to inform the implementation and enforcement of Building Regulations. Suggestions included further research to explore builder competency and Building Control challenges, as well as usability testing and research with Approved Document end-users to highlight challenges and improvement opportunities.

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7 Appendix A – Stakeholder survey questions

*FT = free-text response

*MC = multiple choice response

*R = ranking response

Steep Stairs

'Steep Stair' refers to a stair with a pitch of more than 42° which Approved Document K recommends as the maximum for a private stair.

1. Within a typical 24-month period how many dwellings do you estimate that you encounter in your role that has, or intends to have, Steep Stairs? *FT
2. Please provide the approximate number of Steep Stairs that you have encountered within the following residential contexts: *FT
    a. Loft conversion
    b. Basement conversion
    c. Access to loft-basement storage
    d. Main stair between floors, providing access to multiple rooms (i.e. not just one bedroom and ensuite)
    e. Other (please specify and provide an estimated number for each situation in which you have encountered a Steep Stair in a typical 24-month period)
3. In your opinion, what is the most common motivation for installing a Steep Stair in a dwelling? Please rank the below options with 1. being most common and 4 being least common. *R
    a. Space constraints
    b. Cost
    c. Aesthetic
    d. Considered the best choice on the basis of own knowledge, advice from others, and/or published guidance
4. Have you encountered any other motivators for installing Steep Stairs that were not included in the previous question? *FT

5. What proportion of the Steep Stairs that you encounter in dwellings do you consider to be the most practicable option for the situation in which they are installed? *MC
   a. 100%
   b. 75%
   c. 50%
   d. 25%
   e. 10%
   f. <10%
6. What alternative stair designs do you consider to be preferable in situations where you tend to encounter Steep Stairs? Please rank the below options from 1) most preferable to 8) least preferable. *R
   a. Fixed ladder
   b. Alternating tread stair
   c. Helical stair
   d. Spiral stair
   e. ADK private stair
   f. ADK utility stair
   g. None (steep stair is the preferable option)
7. In your experience, in a typical 24-month period how many loft/basement conversions would not be feasible without the use of a Steep Stair? *FT
8. From your experience, please provide an estimate of the proportion of Steep Stairs in dwellings that correspond with the following options: *FT
   a. No handrails (%)
   b. Handrails on both sides (%)
   c. A handrail on one side (%)
9. In your experience, how consistent is the design of Steep Stairs in dwellings? Please select one of the following options which best describes the majority of Steep Stairs that you encounter: *MC
   a. One consistent design

   b. Small number of designs

   c. Extensive range of designs

10. If you have encountered different types of design, please can you describe them in the box below and provide an indication of each designs popularity, by estimating what percent each would be of the total number of Steep Stairs that you've seen? *FT

11. From your experience, please provide an estimate of the proportion of Steep Stairs in dwellings that correspond with the following options: *FT

    (Please note: 'built' refers to the manufacturing process of the stair and its components and 'installed' refers to the installation process within the dwelling.)

    a. Well-built and well-installed (%)

    b. Well-built but poorly-installed (%)

    c. Well-installed but poorly-built (%)

    d. Poorly-built and poorly-installed (%)

12. In your opinion, what are the main pros and cons of installing Steep Stairs in dwellings? *FT

    a. Pros

    b. Cons

13. Do you have, or know of, any safety concerns regarding Steep Stairs? If so, please provide details: *FT

14. In your opinion, do you think Steep Stairs might present risks to particular demographics (e.g. age, impaired mobility etc.)? *FT

15. Are you aware of any common issues that might affect the usability of Steep Stairs? If so, please provide details. *FT

16. Can you suggest any ways to make Steep Stairs safer and/or more usable? If so, please provide details. *FT

Alternating tread stairs

17. Within a typical 24-month period how many dwellings do you estimate that you encounter in your role that has, or intends to have, an alternating tread stair? *FT

18. Please provide the approximate number of alternating tread stairs that you have encountered within the following residential contexts: *FT

    a. Loft conversion

b. Basement conversion

c. Access to loft-basement storage

d. Main stair between floors, providing access to multiple rooms (i.e. not just one bedroom and ensuite)

e. Other (please specify and provide an estimated number for each situation in which you have encountered an alternating tread stair in a typical 24-month period)

19. In your opinion, what is the most common motivation for installing an alternating tread stair in a dwelling? Please rank the below options with 1. being most common and 4 being least common. *R

a. Space constraints

b. Cost

c. Aesthetic

d. Considered the best choice on the basis of own knowledge, advice from others, and/or published guidance

20. Have you encountered any other motivators for installing alternating tread stairs that were not included in the previous question? *FT

21. What proportion of the alternating tread stairs that you encounter in dwellings do you consider to be the most practicable option for the situation in which they are installed? *MC

a. 100%

b. 75%

c. 50%

d. 25%

e. 10%

f. <10%

22. What alternative stair designs do you consider to be preferable in situations where you tend to encounter alternating tread stairs? Please rank the below options from 1) most preferable to 8) least preferable. *R

a. Fixed ladder

b. Steep straight stair

c. Helical stair

d. Spiral stair

e. ADK private stair

f. ADK utility stair

g. None (alternating tread stair is the preferable option)

23. In your experience, in a typical 24-month period how many loft/basement conversions would not be feasible without the use of an alternating tread stair? *FT

24. From your experience, please provide an estimate of the proportion of alternating tread stairs in dwellings that correspond with the following options: *FT

a. No handrails (%)

b. Handrails on both sides (%)

c. A handrail on one side (%)

25. In your experience, how consistent is the design of alternating tread stairs in dwellings? Please select one of the following options which best describes the majority of alternating tread stairs that you encounter: *MC

a. One consistent design

b. Small number of designs

c. Extensive range of designs

26. If you have encountered different types of design, please can you describe them in the box below and provide an indication of each designs popularity, by estimating what percent each would be of the total number of alternating tread stairs that you've seen? *FT

27. From your experience, please provide an estimate of the proportion of alternating tread stairs in dwellings that correspond with the following options: *FT

(Please note: 'built' refers to the manufacturing process of the stair and its components and 'installed' refers to the installation process within the dwelling.)

a. Well-built and well-installed (%)

b. Well-built but poorly-installed (%)

c. Well-installed but poorly-built (%)

d. Poorly-built and poorly-installed (%)

28. In your opinion, what are the main pros and cons of installing alternating tread stairs in dwellings? *FT

    a. Pros

    b. Cons

29. Do you have, or know of, any safety concerns regarding alternating tread stairs? If so, please provide details: *FT

30. In your opinion, do you think alternating tread stairs might present risks to particular demographics (e.g. age, impaired mobility etc.)? *FT

31. Are you aware of any common issues that might affect the usability of alternating tread stairs? If so, please provide details. *FT

32. Can you suggest any ways to make alternating tread stairs safer and/or more usable? If so, please provide details. *FT

Fixed ladders

33. Within a typical 24-month period how many dwellings do you estimate that you encounter in your role that has, or intends to have, fixed ladders? *FT

34. Please provide the approximate number of fixed ladders that you have encountered within the following residential contexts: *FT

    a. Loft conversion

    b. Basement conversion

    c. Access to loft-basement storage

    d. Main stair between floors, providing access to multiple rooms (i.e. not just one bedroom and ensuite)

    e. Other (please specify and provide an estimated number for each situation in which you have encountered a fixed ladder in a typical 24-month period)

35. In your opinion, what is the most common motivation for installing a fixed ladder in a dwelling? Please rank the below options with 1. being most common and 4 being least common. *R

    a) Space constraints

    b) Cost

    c) Aesthetic

    d) Considered the best choice on the basis of own knowledge, advice from others, and/or published guidance

36. Have you encountered any other motivators for installing fixed ladders that were not included in the previous question? *FT

37. What proportion of the fixed ladders that you encounter in dwellings do you consider to be the most practicable option for the situation in which they are installed? *MC

    a) 100%

    b) 75%

    c) 50%

    d) 25%

    e) 10%

    f) <10%

38. What alternative stair designs do you consider to be preferable in situations where you tend to encounter fixed ladders? Please rank the below options from 1) most preferable to 8) least preferable. *R

    a. Alternating tread stair

    b. Steep straight stair

    c. Helical stair

    d. Spiral stair

    e. ADK private stair

    f. ADK utility stair

    g. None (fixed ladder is the preferable option)

39. In your experience, in a typical 24-month period how many loft/basement conversions would not be feasible without the use of a fixed ladder? *FT

40. From your experience, please provide an estimate of the proportion of fixed ladders in dwellings that correspond with the following options: *FT

    a) No handrails (%)

    b) Handrails on both sides (%)

    c) A handrail on one side (%)

41. In your experience, how consistent is the design of fixed ladders in dwellings? Please select one of the following options which best describes the majority of fixed ladders that you encounter: *MC

    a) One consistent design

    b) Small number of designs

    c) Extensive range of designs

42. If you have encountered different types of design, please can you describe them in the box below and provide an indication of each designs popularity, by estimating what percent each would be of the total number of fixed ladders that you've seen? *FT

43. From your experience, please provide an estimate of the proportion of fixed ladders in dwellings that correspond with the following options: *FT

    (Please note: 'built' refers to the manufacturing process of the stair and its components and 'installed' refers to the installation process within the dwelling.)

    a) Well-built and well-installed (%)

    b) Well-built but poorly-installed (%)

    c) Well-installed but poorly-built (%)

    d) Poorly-built and poorly-installed (%)

44. In your opinion, what are the main pros and cons of installing fixed ladders in dwellings? *FT

    a) Pros

    b) Cons

45. Do you have, or know of, any safety concerns regarding fixed ladders? If so, please provide details: *FT

46. In your opinion, do you think fixed ladders might present risks to particular demographics (e.g. age, impaired mobility etc.)? *FT

47. Are you aware of any common issues that might affect the usability of fixed ladders? If so, please provide details. *FT

48. Can you suggest any ways to make fixed ladders safer and/or more usable? If so, please provide details. *FT

Current guidance and practice

49. What guidance do you currently refer to when designing/installing/assessing Fixed Ladders, Alternating Tread Stairs and Steep stairs? *FT

50. Do you think additional guidance is required, or that the existing guidance requires improvement? Please provide details. *FT

51. In your opinion, under what circumstances (if any) would it be inappropriate to allow the use of Fixed Ladders, Steep Stairs and Alternating Tread Stairs for residential loft and basement conversions? *FT

52. If you have any ideas or advice about the safety and/or usability of fixed ladders, Alternating Tread Stairs or Steep Stairs that has not been captured by the previous questions, please can you share it in the box below? *FT

About you and your role

53. Which option below best describes your role in respect to the responses that you have provided to this questionnaire? *MC

    a. Designer

    b. Supplier

    c. Installer

    d. Inspector

    e. User

    f. Occupational therapist

    g. Access consultant

54. To provide context to your responses to this questionnaire, please estimate the total number of dwellings (irrespective of stair type) that you dealt with during the same 24-month period for which you have based your answers? *MC

55. Irrespective of stair type, please estimate the proportion of dwellings that you encounter within your role: *FT

    a. New build (%)

    b. Renovation (%)

    c. Extension (%)

    d. Change of use (%)

    e. Adaptation (%)

56. Are there any other dwelling types which you have dealt with that were not included in the previous question? *FT

8 Appendix B – Analytical method used for survey data analysis

Survey questions	Analytical method and reported output
1, 17, 33	• Four categories were created to group responses (<1, 1-10, 11-20 >20) and findings have been reported as number of responses for each category and illustrated using bar charts.
54	• Findings have been presented as a range indicating the minimum number of dwellings reported and the maximum number of dwellings reported.
2, 8,11, 18, 24, 27, 34, 40, 43, 55	• Nil responses and responses which did not meet the question criteria (e.g. no number provided) were removed. • Responses which did not equate to a total of 100% across the response categories were removed so as not to assume the intention of the responses. • The average followed by total percentage was then calculated for the data within each response category using Microsoft Excel.
3, 6, 19, 22, 35, 38, 53	• Microsoft Forms output reported.
4, 10, 12, 13, 14, 15, 16, 20, 26, 28, 29, 30, 31, 32, 36, 42, 44, 45, 46, 47, 48, 49, 50, 51, 52, 56	• Qualitative summary of responses reported.

5, 9, 21, 25, 37, 41	• Microsoft Forms output reported and illustrated using pie charts.
7, 23, 39	• Three categories were created to group responses (<1, 1-10, >20) and findings have been reported as number of responses for each category and illustrated using bar charts.

N.B data were filtered to responses from respondents in an 'inspector' role with other respondent responses omitted from the analysis of questions 1, 17, 33, 54 and 55.

9 Appendix C – Stakeholder Survey Findings

The following sections provide an overview of the stakeholder survey findings additional to the findings presented within Section 3.5 of this report. It is important to note that the results provided are a summary of participant perceptions, opinions and experiences. Whilst the results reported are accurate, in that they are a true reflection of participant comments, factual accuracy of the content has not been assessed and cannot be guaranteed.

9.1.1 Installation motivators

Regarding the installation of **steep stairs**, respondents indicated that space constraints were the most common motivator followed by cost; being considered the best choice based on own knowledge, advice from others and/or published guidance; and aesthetic being considered the least common motivator. Other motivators identified for the installation of steep stairs included planning requirements for listed buildings, matching existing stair design when undertaking loft conversions, ignorance of guidance and Building Regulations, profit, convenience, and manufacturer brochures.

Regarding the installation of **alternating tread stairs**, respondents indicated that space constraints were the most common motivator followed by being considered the best choice based on own knowledge, advice from others and/or published guidance; cost; and aesthetic being considered the least common motivator. Other motivators identified for the installation of alternating tread stairs included lack of building competency in understanding Building Regulations, builders using the Building Notice route to design staircases, and profit.

Regarding the installation of **fixed ladders**, respondents indicated that space constraints were the most common motivator followed by being considered the best choice based on own knowledge, advice from others and/or published guidance; cost; and aesthetic being considered the least common motivator. Other motivators identified for the installation of fixed ladders included builders not being aware of regulations and using the Building Notice route to navigate around compliance issues.

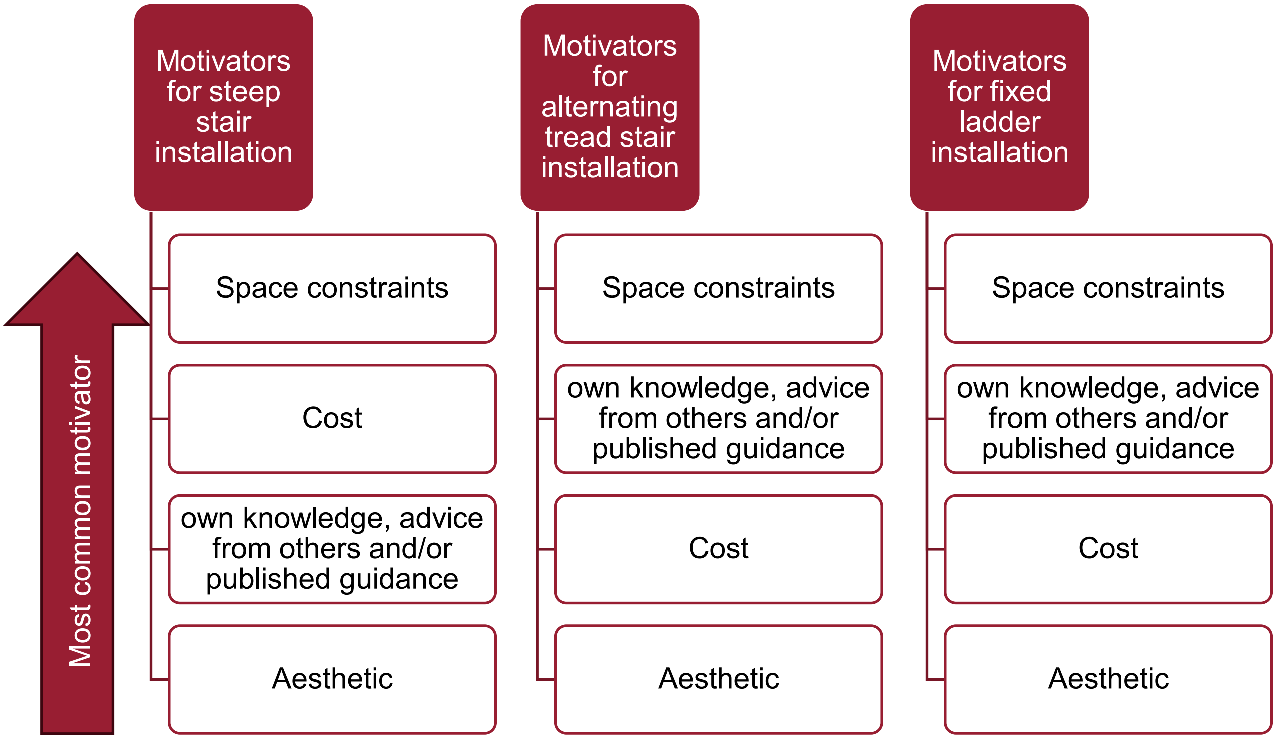

Figure C1. Motivators for installation of steep stairs, alternating tread stairs and fixed ladders as ranked by survey respondents

9.1.2 Practicability

In relation to **steep stairs**, over half of the survey respondents (n=8) indicated that less than 10% encountered were the most practicable option for the situation in which they were installed. Figure C2 illustrates responses relating to practicability of steep stairs.

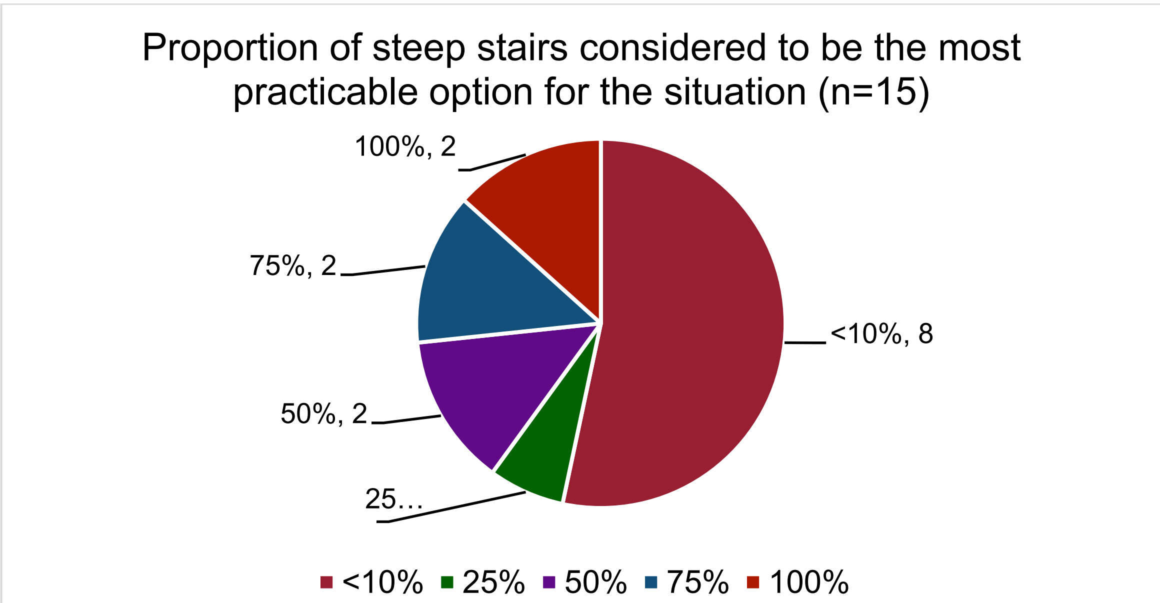

Figure C2. Proportion of steep stairs indicated to be most practicable option for the situation

In relation to **alternating tread stairs**, two-thirds of respondents (n=10) indicated that less than 10% encountered were the most practicable option for the situation in which they were installed. Figure C3 illustrates responses relating to practicability of alternating tread stairs.

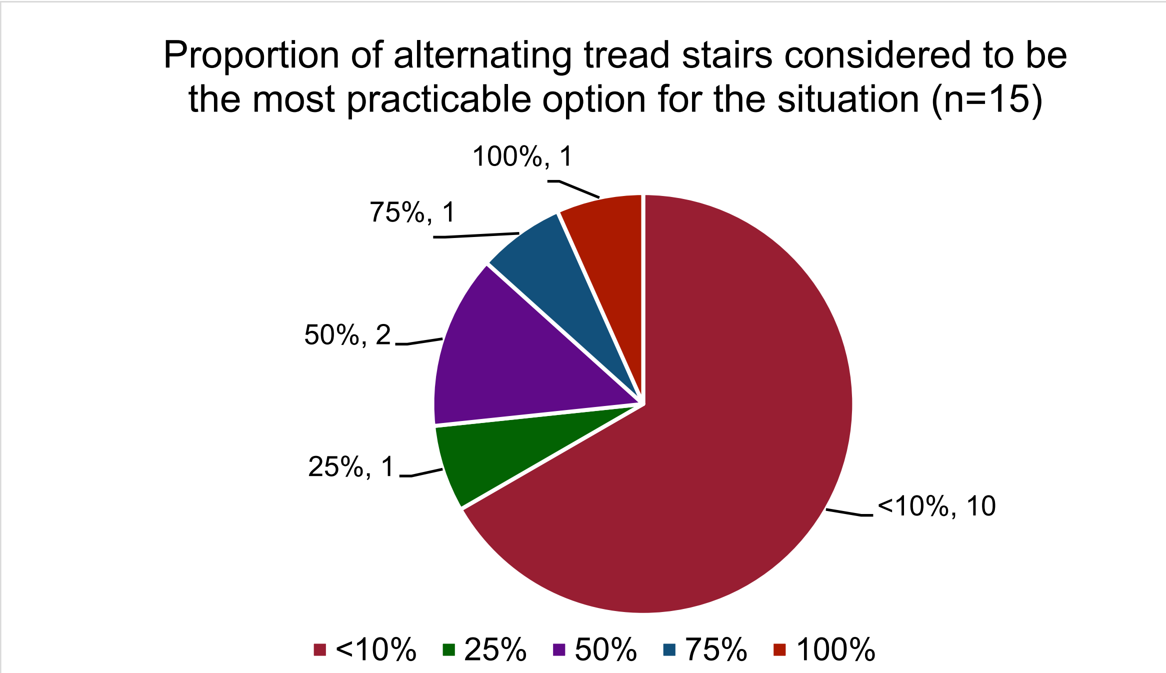

Figure C3. Proportion of alternating tread stairs indicated to be most practicable option for the situation

In relation to **fixed ladders**, over two-thirds of respondents (n=7) indicated that less than 10% encountered were the most practicable option for the situation in which they were installed. Figure C4 illustrates responses relating to practicability of fixed ladders.

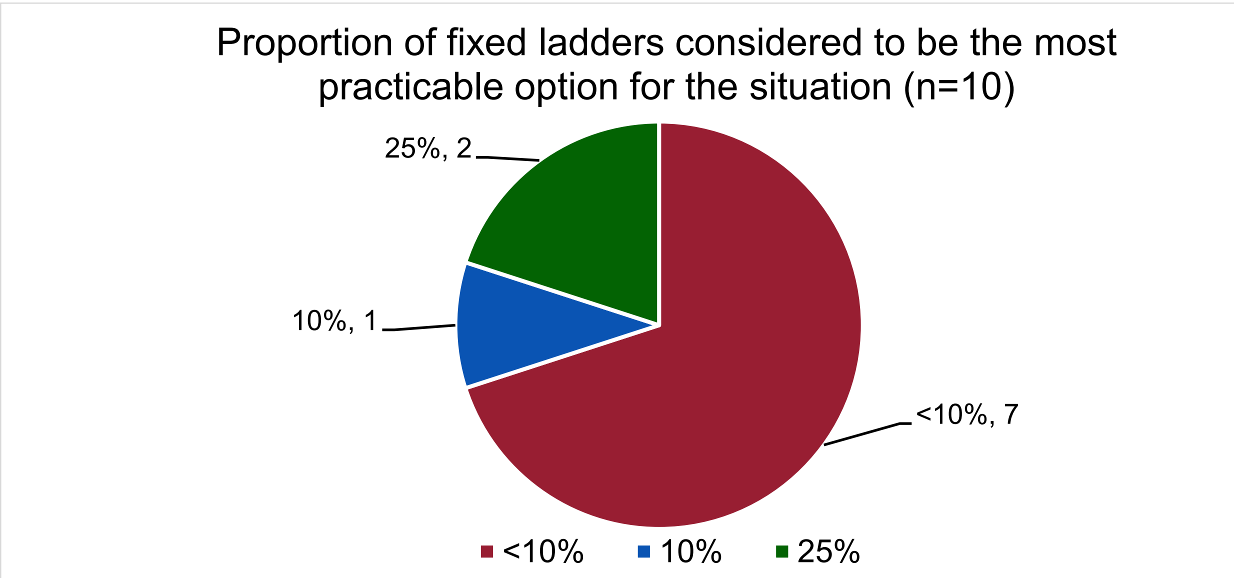

Figure C4. Proportion of fixed ladders indicated to be most practicable option for the situation

9.1.3 Design consistency

In relation to **steep stairs**, over half of responses (60%) indicated having encountered an extensive range of designs, with only 6.7% of responses indicating encountering one consistent design. Figure C5 illustrates responses relating to design consistency of steep stairs.

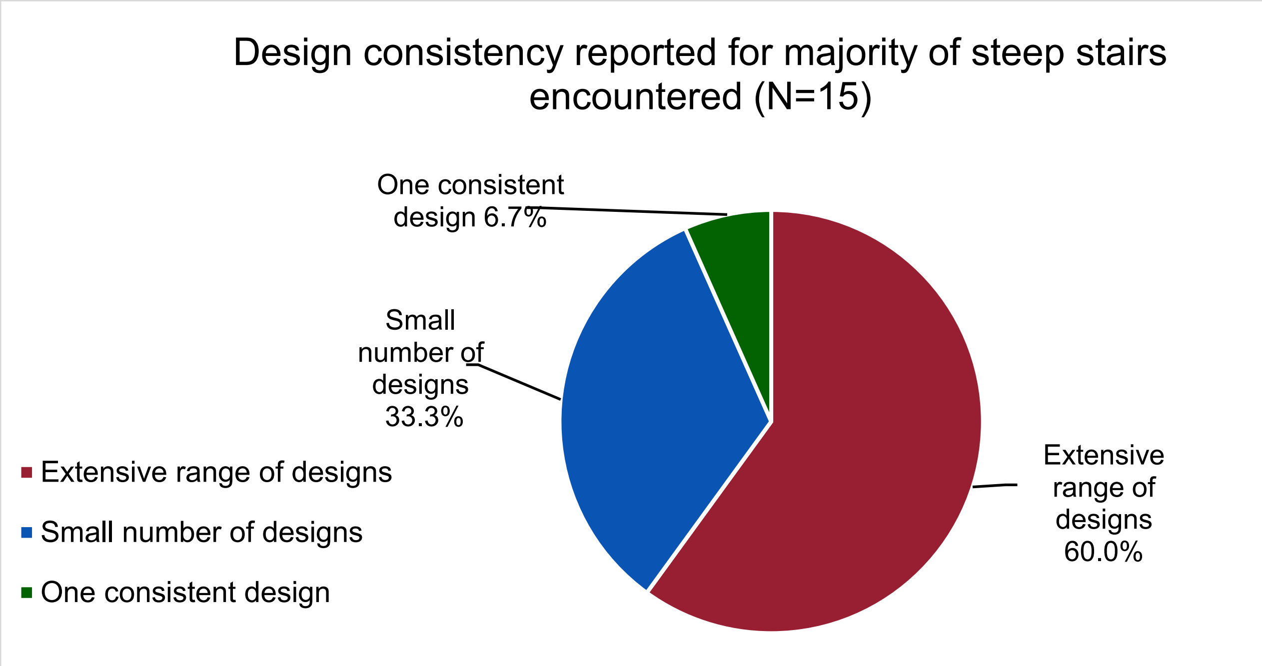

Figure C5. Consistency of steep stair design encountered by respondents

In relation to **alternating tread stairs**, responses were equal across all three response categories. Figure C6 illustrates responses relating to design consistency of alternating tread stairs

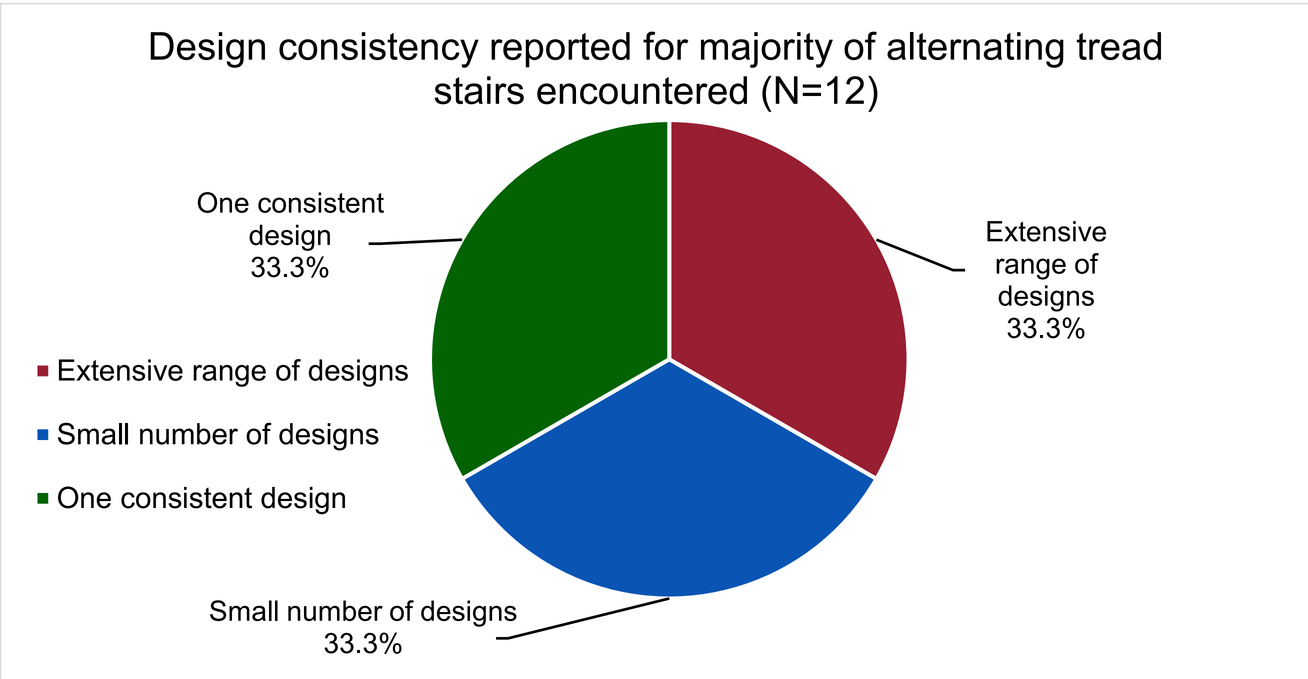

Figure C6. Consistency of alternating tread stair design encountered by respondents

In relation to **fixed ladders**, there were a greater proportion of responses (44.4%) indicating an extensive range of designs, with the lowest proportion of responses (22.2%) indicating a small number of designs. Figure C7 illustrates responses relating to design consistency of fixed ladders.

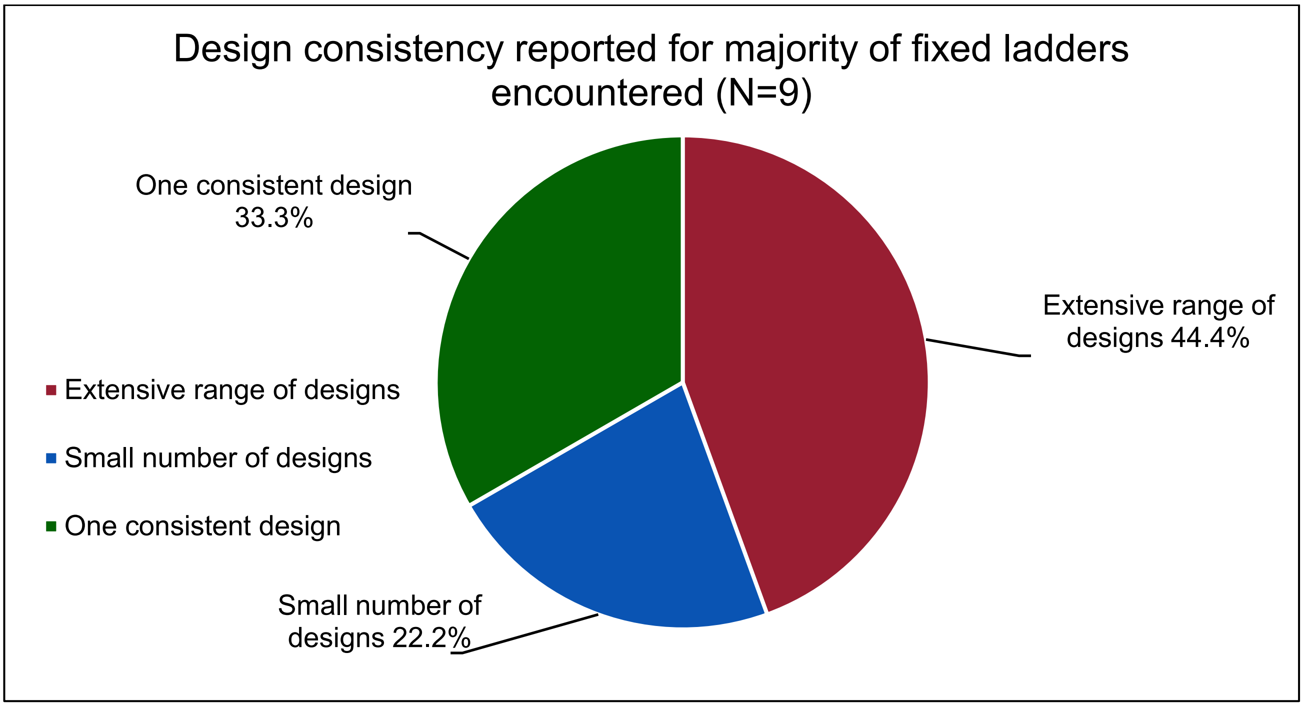

Figure C7. Consistency of fixed ladder design encountered by respondents

Respondents were then asked to describe any different design types encountered and provide an indication of the popularity of each design for steep stairs, alternating tread stairs and fixed ladders and responses are outlined in Table C1.

Table C1. Different staircase designs and popularity identified by survey respondents for steep stairs, alternating tread stairs, and fixed ladders

Steep stairs	Alternating tread stairs	Fixed ladders
• Pitches exceeding 45°. • Alternating tread (75%); spiral (25%). • Majority have at least one set of winders, one handrail, short tread, large riser and low ceiling. • Lateral with winders (50%). • Space-saver alternative tread (very popular); fixed ladder (less popular). • Steep stairs with winders (most common). • Steep stairs and ladders for maintenance use; avoid steep stairs for resident use. • Different widths.	• Solid riser (50%); open riser (50%). • Polished wood with handrail on one side. • Solid box riser. • Various way of alternating the treads. • Multiple designs illustrated on Pinterest and Instagram due to being popular in other countries.	• Steepness. • Tread sizes. • Handrails. • Companionway ladders common in maintenance access. • Normally used for poorly designed loft conversions.

9.1.4 Quality of build and installation

In relation to **steep stairs**, respondents estimated that over half could be considered well-built and well-installed. Respondents estimated less than 10% of steep stairs encountered to be either well-installed but poorly-built or poorly-built and poorly-installed. However, respondents estimated that almost one-fifth of steep stairs encountered could be considered well-built but poorly-installed. Figure C8 illustrates responses regarding the quality of build and installation of steep stairs.

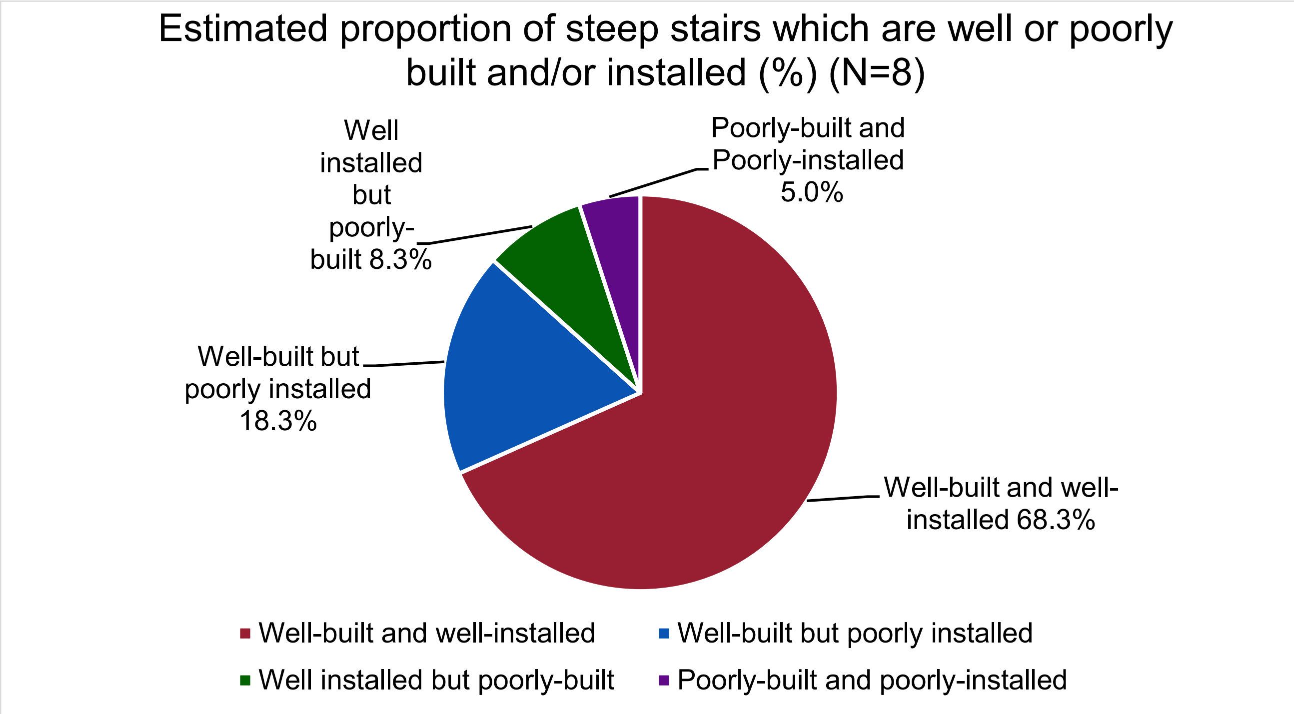

Figure C8. Quality of build and installation of steep stairs

In relation to **alternating tread stairs**, respondents estimated the highest proportion of these to be well-built and well-installed. However, it was estimated that almost one-quarter of alternating tread stairs encountered could be considered well-installed but poorly-built, and one-fifth being both poorly-built and poorly-installed. Figure C9 illustrates responses regarding the quality of build and installation of alternating tread stairs.

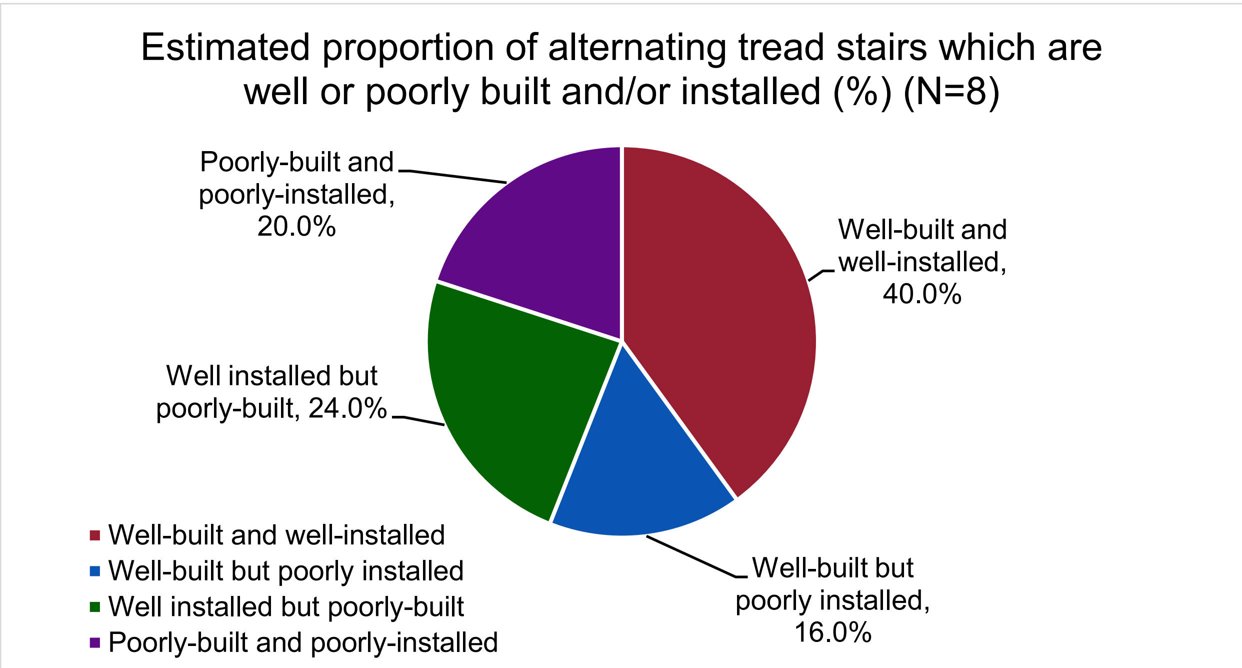

Figure C9 Quality of build and installation of alternating tread stairs

In relation to **fixed ladders**, respondents estimated a very high proportion of these to be well-built and well-installed, with all other three response categories being estimated at only 3.3%. Figure C10 illustrates responses regarding the quality of build and installation of fixed ladders.

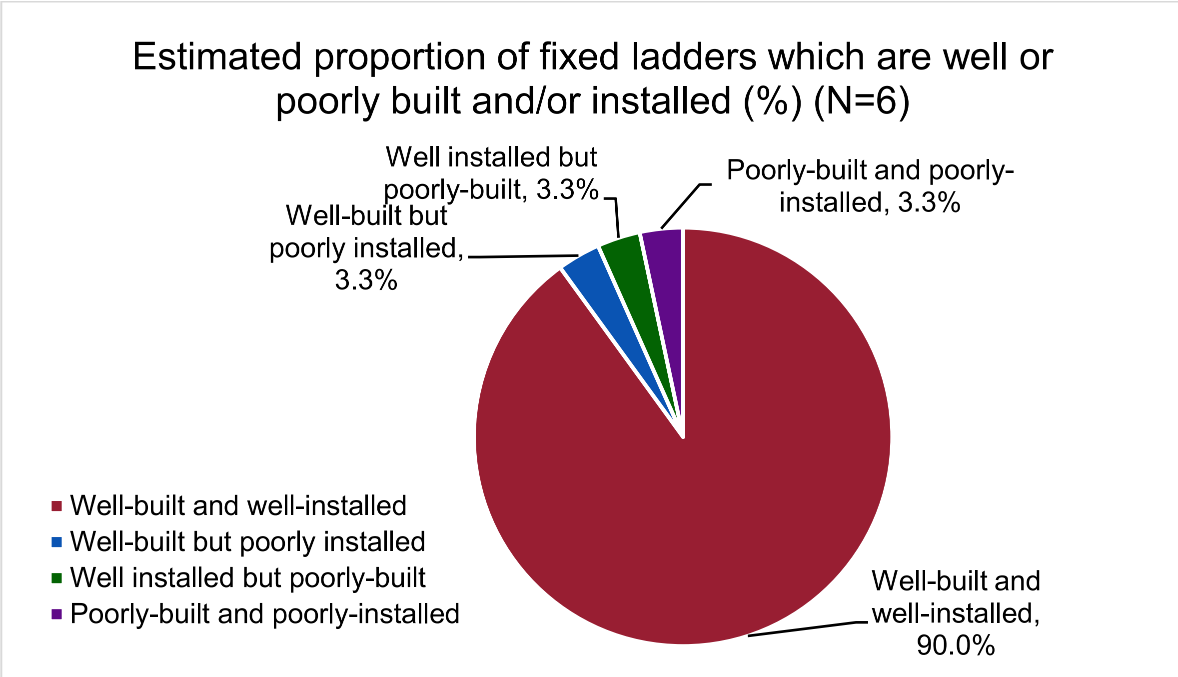

Figure C10. Quality of build and installation of fixed ladders

9.1.5 Handrail presence

In relation to **steep stairs**, respondents estimated just over half to have a handrail on one side and over a third to have handrails on both sides, and no handrails being estimated as the least likely occurrence. Figure C11 illustrates the estimated handrail presence for steep stairs.

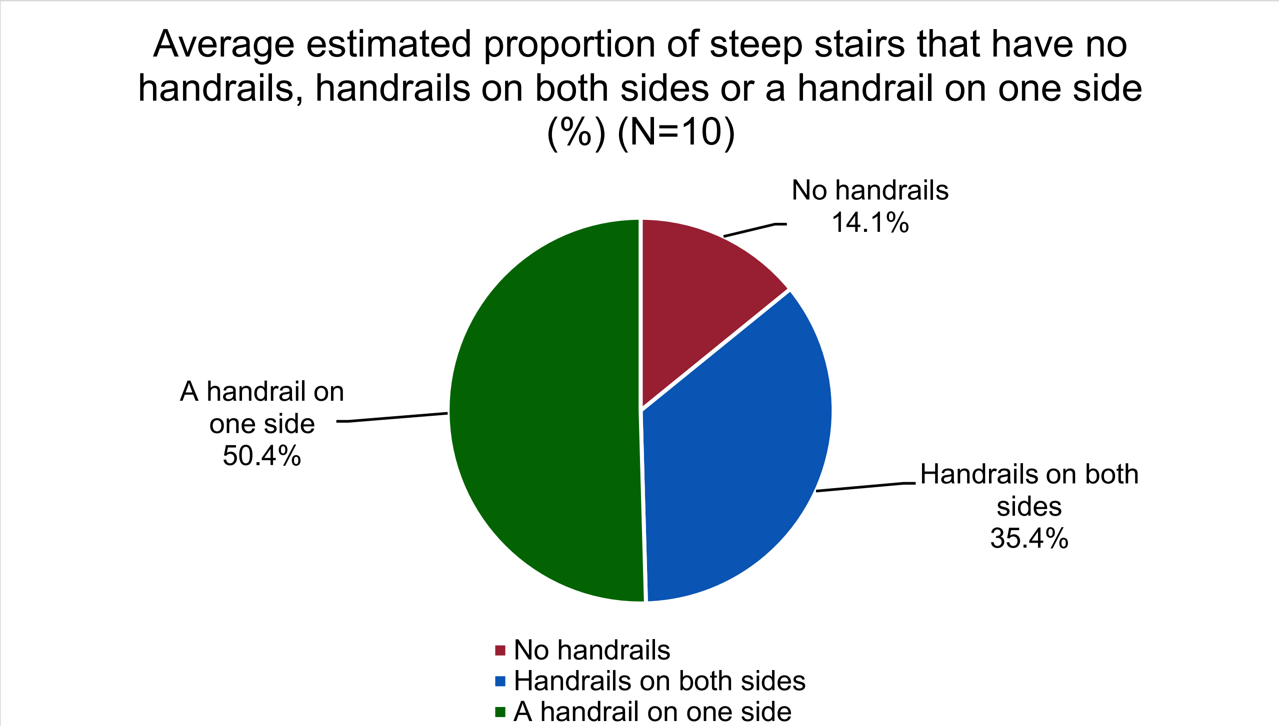

Figure C11. Estimated handrail presence for steep stairs

In relation to **alternating tread stairs**, respondents estimated almost three-quarters to have handrails on both sides, one-quarter to have a handrail on one side, and only a small proportion to have no handrails. Figure C12 illustrates the estimated handrail presence for alternating tread stairs.

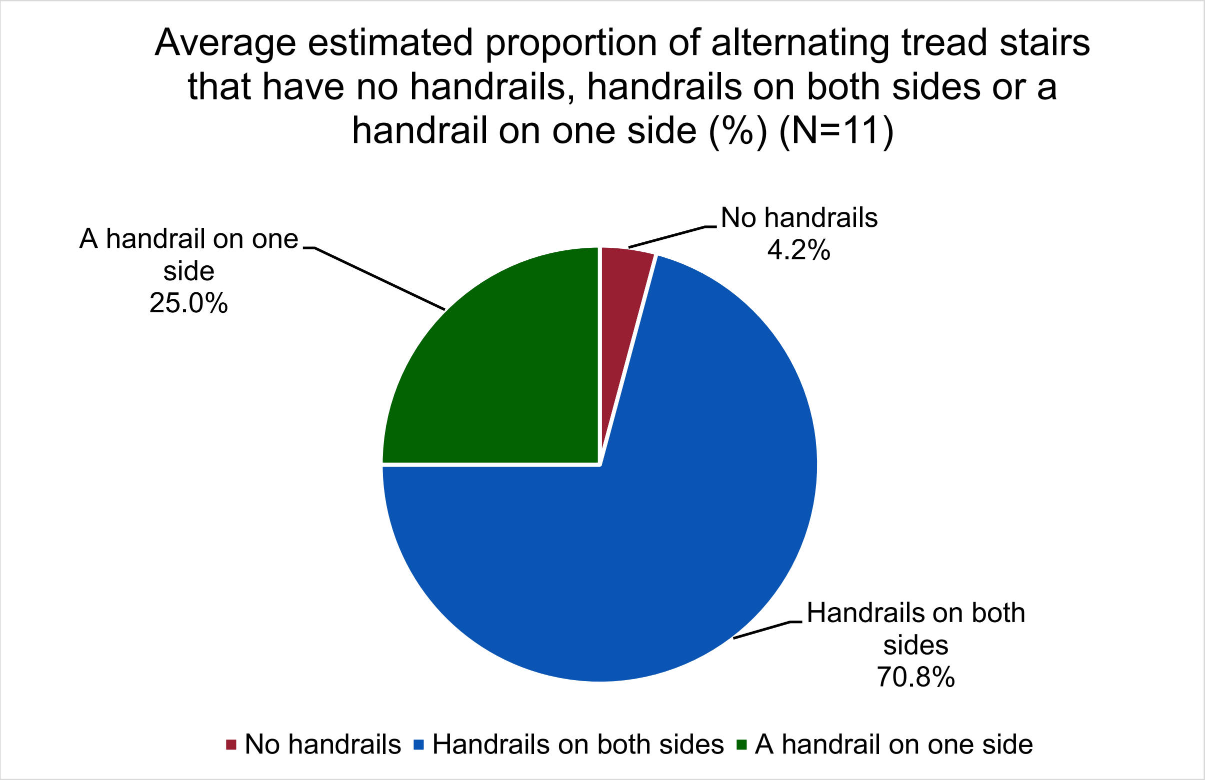

Figure C12. Estimated handrail presence for alternating tread stairs

In relation to fixed ladders, respondents estimated that three-quarters have handrails on both sides, and the other quarter have no handrails. Figure C13 illustrates the estimated handrail presence for fixed ladders.

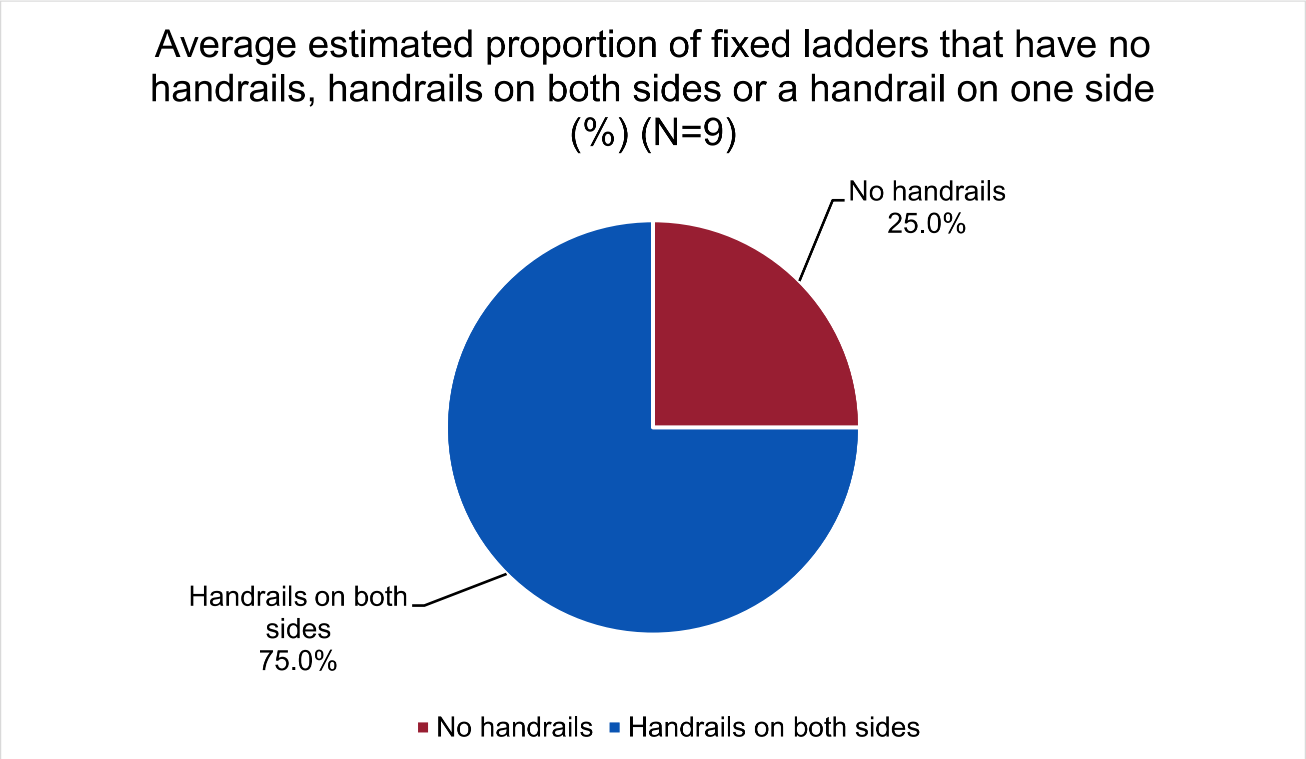

Figure C13. Estimated handrail presence for fixed ladders

9.1.6 Impact on loft and basement conversions

The number of loft or basement conversions which would not be possible without the use of a **steep stair** within a typical 24-month period were estimated to be below one by three respondents, between one and ten for three respondents, and over twenty for one respondent, and these results are illustrated in Figure C14.

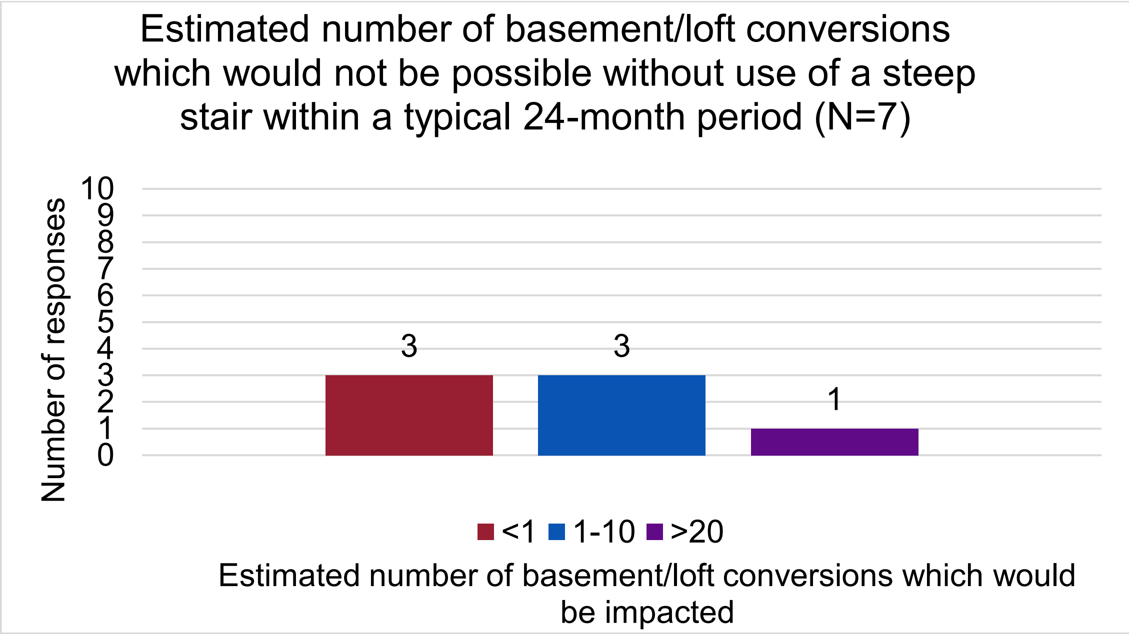

Figure C14. Estimated number of basement/loft conversions which would not be possible without the use of a steep stair

The number of basement or loft conversions which would not be possible within a typical 24-month period without the use of an **alternating tread stair** were estimated to be less than one by five respondents and between one and ten for five respondents, and these results are illustrated in Figure C15.

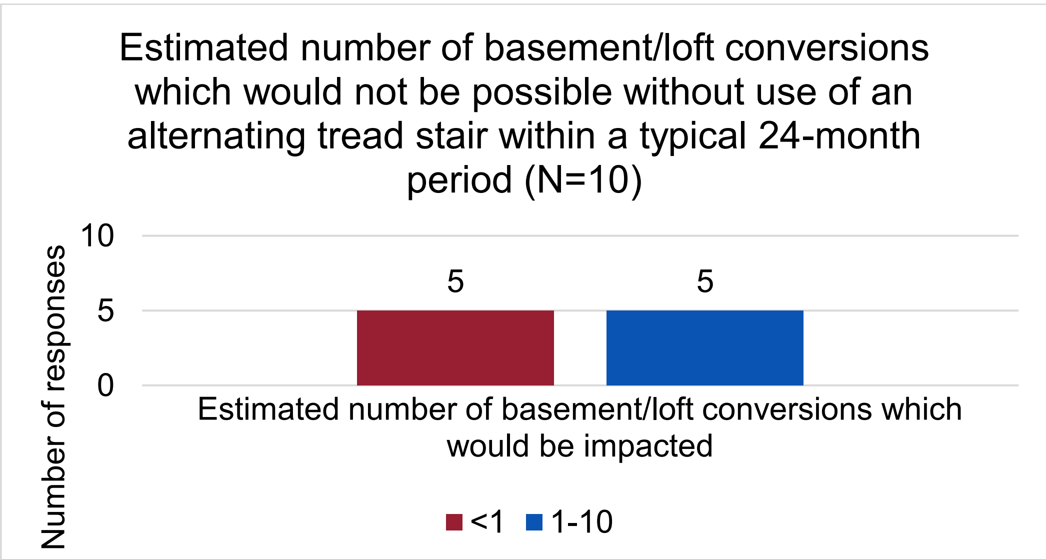

Figure C15. Estimated number of basement/loft conversions which would not be possible without the use of an alternating tread stair

The number of basement or loft conversions which would not be possible without the use of a **fixed ladder** within a typical 24-month period were estimated to be less than one by five respondents and between one and ten for three respondents, and these results are illustrated in Figure C16.

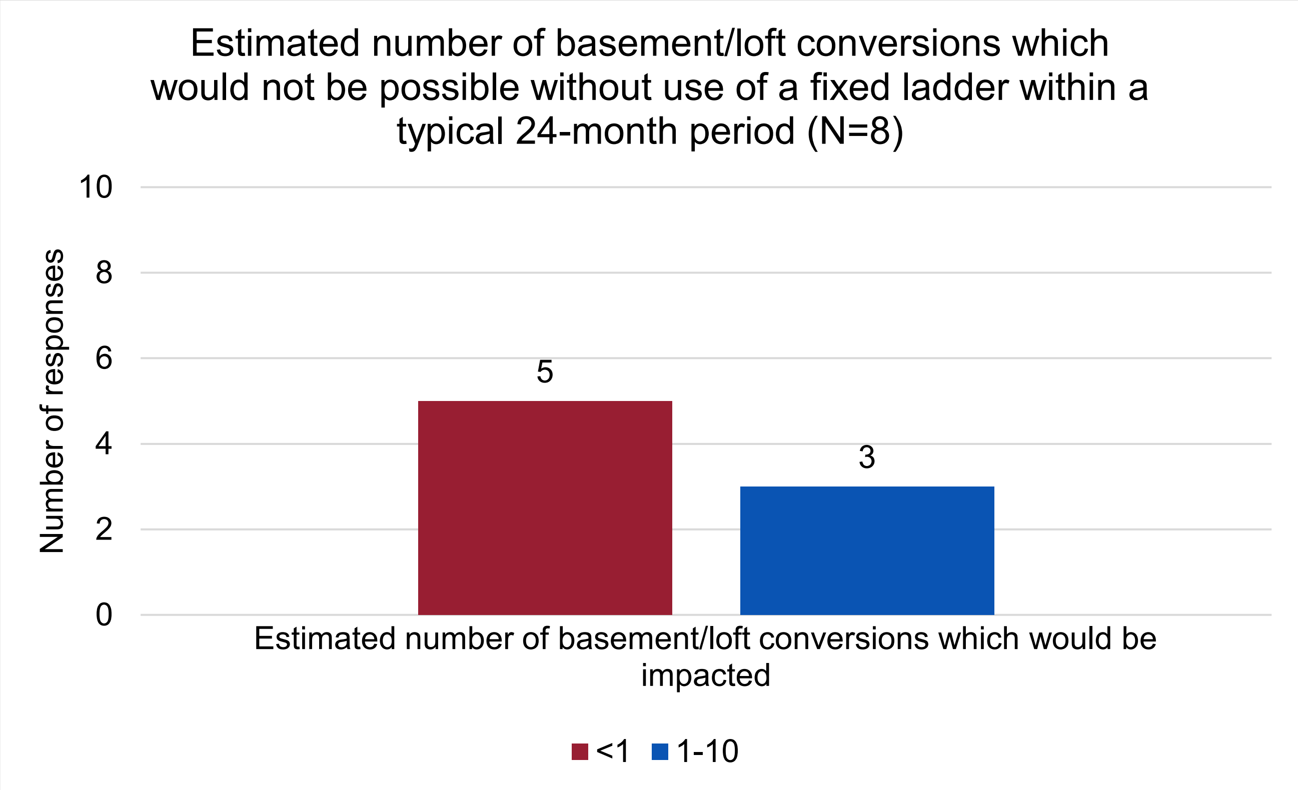

Figure C16. Estimated number of basement/loft conversions which would not be possible without the use of a fixed ladder

9.1.7 Appropriateness of use

Respondents commented on what, in their view, is an appropriate or inappropriate use of steep stairs, alternating tread stairs or fixed ladders in relation to residential loft and basement conversions.

Inappropriate uses identified were newbuilds and conversions, using for storage access or space only, where there is more than one room to be accessed, mass housing, and for access to basements. Some comments suggested that they are inappropriate in most situations, and that fixed ladders and alternating tread stairs are inherently unsafe and should not be used.

However, some respondents identified that there may be some potentially appropriate uses including the use of steep stairs when it is unlikely that the property will be occupied by those aged over 60 or children, small self-builds, and for certain conversions and extensions.

9.1.8 Staircase design preferences

Respondents were asked to indicate what alternative staircase design, if any, would be preferable in situations where steep stairs, alternating tread stairs, or fixed ladders have been encountered.

Respondents indicated that ADK private stairs would be the most preferable option, followed by ADK utility stairs. Respondents also indicated that the two least preferable staircase designs were fixed ladders and alternating tread stairs. Of the responses in relation to alternative designs that are preferable to steep stairs and fixed ladders, spiral stairs were indicated to be more preferable. However, from the responses relating to alternative designs to alternating tread stairs, steep stairs were indicated to be preferable designs compared to both spiral stairs and helical stairs. Respondent ranking of staircase design preferences is illustrated in Figure C17, with the staircase design at the top of the diagram being the most preferable and the staircase design at the bottom of the diagram being the least preferable.

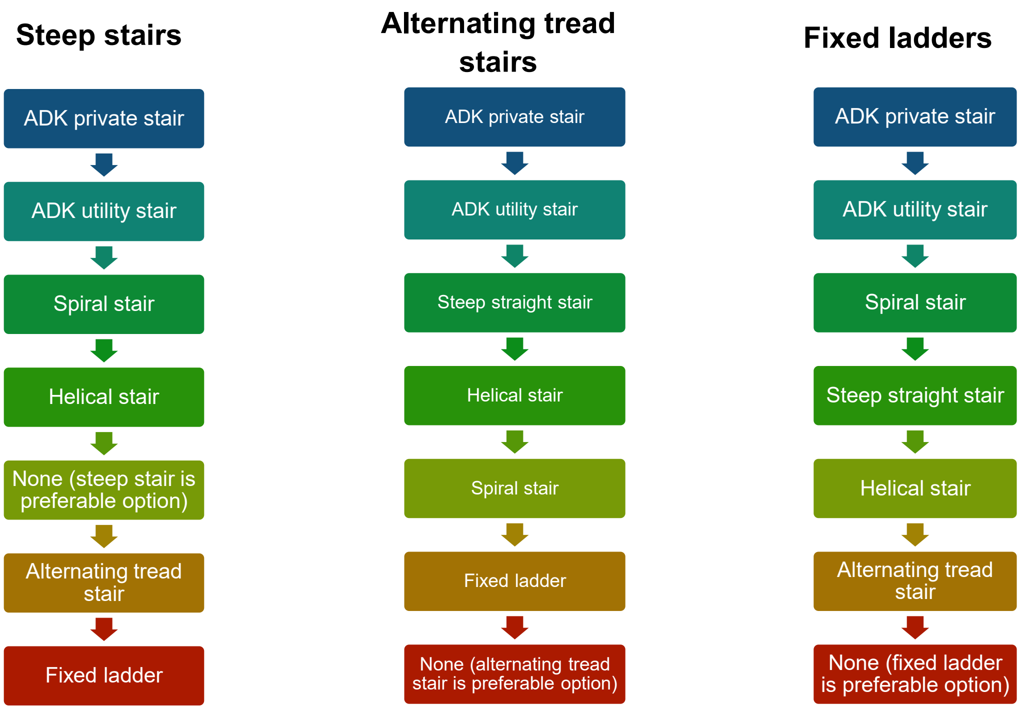

Figure C17. Preferable staircase designs to steep stairs, alternating tread stairs, and fixed ladders as ranked by survey respondents

9.1.9 Advantages and disadvantages

Steep stairs

Respondents were asked to identify advantages and disadvantages of steep stairs, and these are outlined in Table C2.

Table C2. Advantages and disadvantages of steep stairs identified by survey respondents

Advantages of steep stairs	Disadvantages of steep stairs
• Space efficiency. • Use in Listed Buildings. • Avoids structural alterations to existing buildings. • Allows loft conversions. • Can be safe if installed with dual handrails. • Preferable to alternating tread stairs and fixed ladders. • Essential for maintenance access. • Useful for storage access. • Easier installation in tight spaces. • Reduced installation cost when compared to an ADK private stair.	• Dangerous. • Familiarity can decrease care taken when ascending or descending. • Increased risk of falling for all users, particularly elderly occupants, children, and those with poor mobility. • Increased risk of impacts e.g. hitting head on low ceilings. • Can be poorly designed with safety defects. • Inappropriate landing sizes and doors opening close to staircase. • More difficult for users to navigate. • Difficult for second person to assist user on a steep stair. • Restricted ability to use when carrying items. • Challenges for moving furniture between floors. • Difficult to adapt with rails or stairlifts. • Limited appeal to people buying or renting homes.

Respondents were also asked to identify any safety concerns, risks impacting different demographic groups, and common issues impacting useability in relation to steep stairs. Responses are outlined in Table C3.

Table C3. Safety concerns, demographic risks, and issues impacting usability relating to steep stairs identified by respondents

Safety concerns	Risks impacting different demographic groups	Common issues impacting usability
• Missed step in ascent due to height of riser, limited foot placement, and catching foot on nosing above. • Increased risk of falling. • Missteps are common. • Gauging steps. • User overbalancing. • Trip hazards. • Difficult to become accustomed to using. • Falling from steep stair more likely to result in more serious injury as user less likely to be able to prevent fall. • Descending forwards is complicated and can be dangerous. • Adaptation difficulties. • High scores under the Housing Health and Safety Rating System used to assess risk from falls.	• Risk to all users but higher risk to older users. • Younger users which may be distracted by phone use. • Impaired or declining mobility will impact access and egress. • Children. • Users with strength or balance difficulties. • Users with hand (gripping) or leg (movement) disabilities. • May be risks but still preferable to fixed ladders and alternating tread stairs. • Pregnant users. • Users carrying items.	• Insufficient tread-depth. • Unsuitable handrails. • Poor choice of tread coverings. • Lighting. • Levels of cold within property. • Single occupation. • Difficulty raising of legs and stepping down on treads. • Difficulty for users with reduced mobility or sight. • Open treads. • Slip resistance.

		• Ageing population. • Increased riser heights and reduced tread-depth compromising footing and stability.

Respondents provided the following suggestions and comments in relation to improving the safety and usability of steep stairs:

- Handrails on both sides which are easy to grip.
- Strengthened walls to accommodate handrails.
- Anti-trip nosing profiles.
- Anti-slip material on stair nosings.
- Avoid bare timber.
- Recess risers or angle risers at the bottom to allow greater foot bearing.
- Good lighting with easily accessible switches at top and bottom of staircase.
- Contrasting step nosing colours.
- Good energy efficiency in property (as referred to within the Housing Health and Safety Rating System Operating Guidance).
- Clear level landings beyond and between the top and bottom of the staircase and doorways.
- Straight stairs with no winders.
- Stair width to accommodate stairlift tracks.
- Stair lift or through floor lift.
- Only use as a last resort.
- Require building industry to submit full design plans before commencing work so that compliance can be ensured.

Alternating tread stairs

Respondents were asked to identify advantages and disadvantages of alternating tread stairs, and these are outlined in Table C4.

Table C4. Advantages and disadvantages of alternating tread stairs identified by survey respondents

Advantages	Disadvantages
• Space efficiency. • Easier installation in tight spaces or where significant structural alterations would otherwise be needed. • Reduced installation cost in comparison to ADK private stair.	• Dangerous. • Increased risk of falling, particularly for the elderly, children, and users with mobility issues. • Unsuitable for inclusive housing standards. • Non-compliant with Building Regulation requirements. • Difficult to use. • Can be dangerous for users who tend to lead with the wrong foot. • Difficult to navigate. • Awkward to use. • Require concentration when descending. • Users can be unfamiliar with alternating tread pattern, making them unsafe particularly when first being used. • Difficult to move furniture between floors. • Limited appeal to people buying or renting homes.

Respondents were also asked to identify any safety concerns, risks impacting different demographic groups, and common issues impacting useability in relation to alternating tread stairs. Responses are outlined in Table C5.

Table C5. Safety concerns, demographic risks, and issues impacting usability relating to alternating tread stairs identified by respondents

Safety concerns	Risks impacting different demographic groups	Common issues impacting usability
• Must lead with correct foot to avoid fall. • Feel awful to use and need to be used in a specific way. • Mis-steps are common. • Dangerous when descending. • Would be classed as a 'category one hazard' under Housing Health and Safety Rating System. • Risks to elderly users, children or users with mobility or sight issues.	• Risks to elderly users and children. • Difficult for users which may experience impaired mobility. • Risk to all groups. • Pregnant users. • Users carrying items.	• Foot co-ordination. • Very dangerous without handrails. • Differ from standard stairs commonly used which can confuse users. • Unfamiliar designs. • Mobility. • Steep pitch, reduced tread depth and unfamiliar foot placement compromising footing and stability.

Respondents provided the following suggestions and comments in relation to improving the safety and usability of alternating tread stairs:

- Do not use.
- Replace with a standard stair where possible.
- Replace with another suitable alternative.
- Use steep stairs with two handrails as an alternative.
- Handrails on both sides.
- Colour tread nosings.
- Slip resistant tread surfaces.

Fixed ladders

Respondents were asked to identify advantages and disadvantages of fixed ladders, and these are outlined in Table C6.

Table C6. Advantages and disadvantages of fixed ladders identified by survey respondents

Advantages	Disadvantages
• Space efficiency. • Safer than alternating tread stairs if there are two handrails. • Easier installation in tight spaces or where significant structural alterations would otherwise be needed. • Reduced installation cost compared to ADK private stair.	• Dangerous. • Difficult for some user groups to manage. • Increased risk of falling. • Difficult to many users such as the elderly or children who are not familiar with the stair design. • Unsuitable for inclusive housing standards. • Generally non-compliant with Building Regulation requirements. • Steep angle and lack of wide treads makes descent particularly dangerous. • Restricts ability for users to safely carry items. • Difficulty moving furniture between floors. • Limited appeal to people buying or renting homes.

Respondents were also asked to identify any safety concerns, risks impacting different demographic groups, and common issues impacting useability in relation to fixed ladders. Responses are outlined in Table C7.

Table C7. Safety concerns, demographic risks, and issues impacting usability relating to fixed ladders identified by respondents

Safety concerns	Risks impacting different demographic groups	Common issues impacting usability
• Open rise can be disorientating. • Entrapment. • Increased risk of falling. • Unfamiliar to use. • Steep angle and lack of tread depth. • Fixed handrails do not provide continuous handrails which reduces support.	• Handrails must be used which relies on users having a good hand grip. • Difficult to step up. • Difficult to stop and rest when using. • Elderly users, children and those with mobility issues may have difficulty using. • Pregnant users. • Users carrying items.	• Steepness. • User strength. • User mobility issues. • Lack of robust handrails.

Respondents provided the following suggestions and comments in relation to improving the safety and usability of fixed ladders:

- Do not use.
- Improve handrail design.
- Tread coverings.
- More robust handrails on both sides.

General comments

Respondents also provided the following comments regarding the safety and use of steep stairs, alternating tread stairs and fixed ladders:

- Avoid where possible.
- Remove Building Notice route.
- Stairs should be safe to use for all intended users including in extreme situation e.g. means of escape in case of fire.
- Should only be used for loft conversions.

9.1.10 Guidance documents

The following documents were identified by respondents in relation to guidance which they currently refer to when designing, installing, or assessing steep stairs, alternating tread stairs or fixed ladders:

- Approved Document K (ADK) England
- Approved Document K (ADK) Wales
- BS 4211 EN 14122
- BS 5395-1
- BS 5395-2
- BS 5395-4
- BS 585-1
- BS 585-2
- BS 6180
- BS EN 15644
- BS EN 1991-1-1
- CEN TS 15680
- Housing Health and Safety Rating System Operating Guidance
- HSE guidance and webpages
- NI Technical Handbook H
- PD 6688-1-1
- Scottish Technical Handbook

Respondents were asked whether, in their opinion, additional guidance is required or whether existing guidance requires any improvement and the following comments were received:

- Guidance should encourage the use of a private stair.
- Revise ADK to remove alternating tread stairs.
- Poor situation as ADK can lead to hazards which then require the use of the Housing Act 2004 to commence enforcement action to remove hazards.

- Make stair design applicable to user group e.g. domestic, commercial, theatre, stadium, specific users etc.

- Provide clearer guidance on acceptable ‘relaxations’ to main staircase requirements where flexibility may be required.

- Update BS 4211 to reference latest EN 14122 guidance plus specific UK guidance.

10 Appendix D – Stakeholder workshop activities and discussion prompts

Discussion prompts and activities

The activities and discussion prompts used within the stakeholder workshop were:

1. Familiarisation exercise: designed to familiarise participants with the online whiteboard software whilst exploring views on word clouds generated from falls incident data related to stairs associated with the word 'loft', 'cellar' and 'cottage'.

2. Two activities involved the use of bow-tie-diagrams, which had been prepopulated by the research team, to explore the contributing factors and preventative controls relating to two situations:

    a. installation of steep stairs, alternating tread stairs, and/or fixed ladders.

    b. and a person fall on or from steep stairs, alternating tread stairs, and/or fixed ladders.

    The prepopulated draft bow-tie-diagrams (which were based on the initial results of the literature review and survey) and the finalised bow-tie-diagrams (which incorporate stakeholder feedback obtained during the workshop) are provided in Appendix E.

3. Alternative staircase design preferences activity: designed to seek participant views on staircase designs other than steep stairs, alternating tread stairs and fixed ladders, and their preference of these. Discussion prompts used were:

    a. Preferred alternative (e.g. ADK private stair ADK utility stair, spiral stairs, helical stairs).

    b. Why is this a preferred alternative?

    c. What are the barriers to using this preferred alternative?

    d. Suggestions on how to overcome these barriers.

4. Guidance exploration activity: designed to understand what guidance is currently available and used in relation to steep stairs, alternating tread stairs and fixed ladders, and provide opportunity for feedback on Approved Document K. Discussion prompts used were:

    a. Guidance used and referred to in relation to stair installation.

b. Thoughts on multiple guidance documents e.g. do they complement or contradict each other?

c. Suggestions on how challenges regarding multiple guidance documents could be managed.

d. Thinking specifically about ADK: what works well?

e. Thinking specifically about ADK: are there any issues?

f. Thinking specifically about ADK: improvement suggestions.

5. Any other considerations.

Miro whiteboard templates

Figure D1. Stakeholder workshop familiarisation exercise

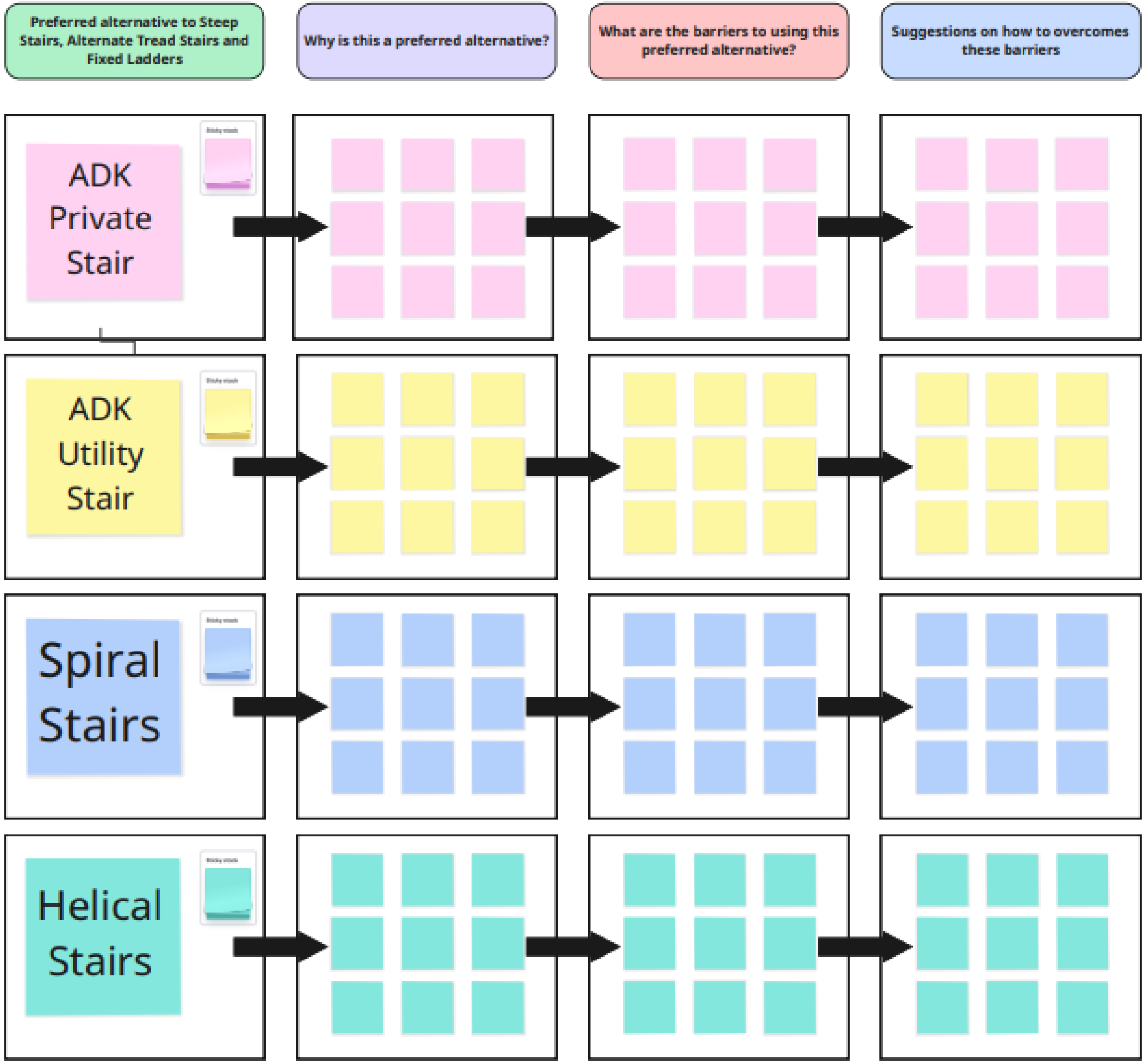

Figure D2. Stakeholder workshop activity exploring staircase design preferences

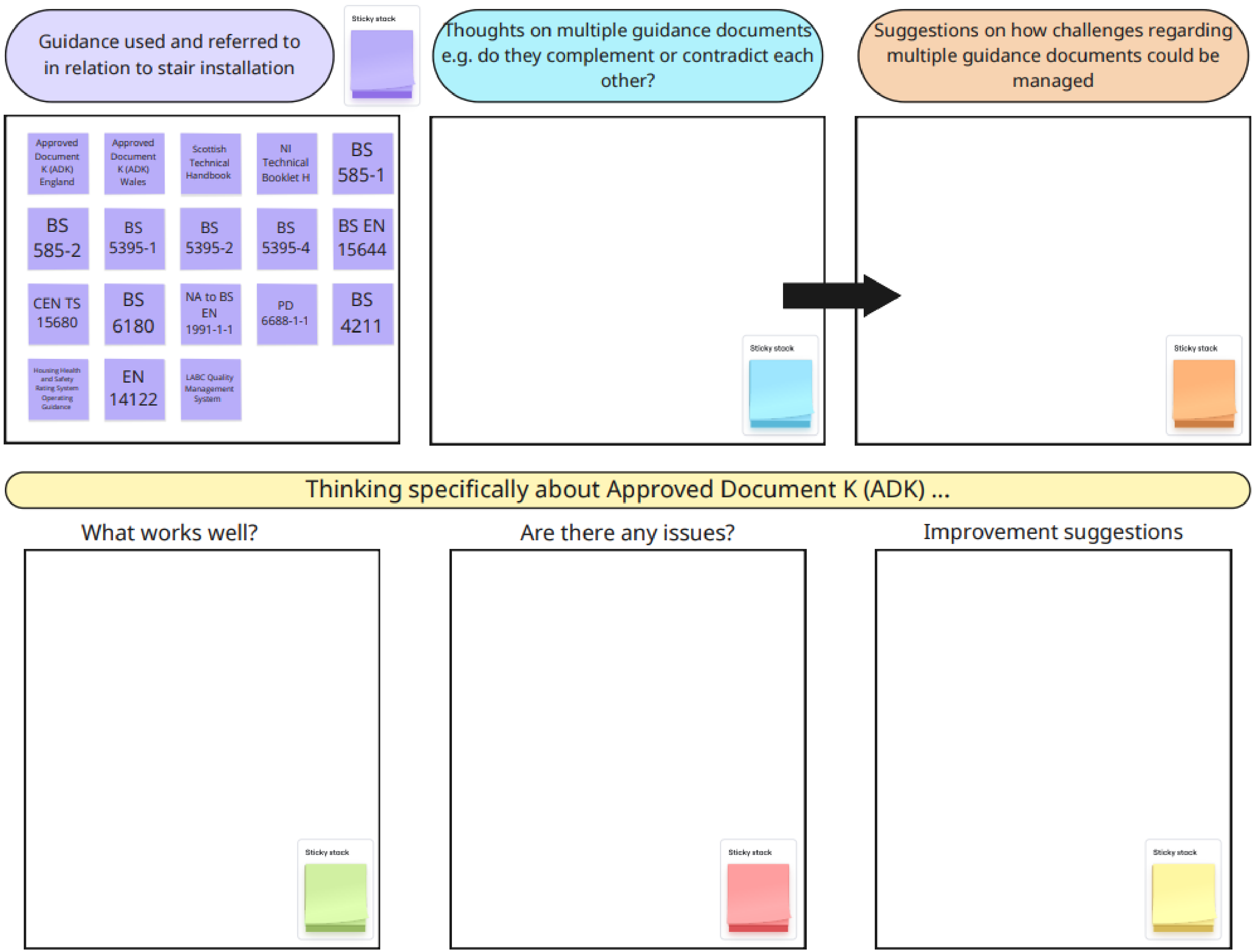

Figure D3. Stakeholder workshop activity exploring participant views on guidance

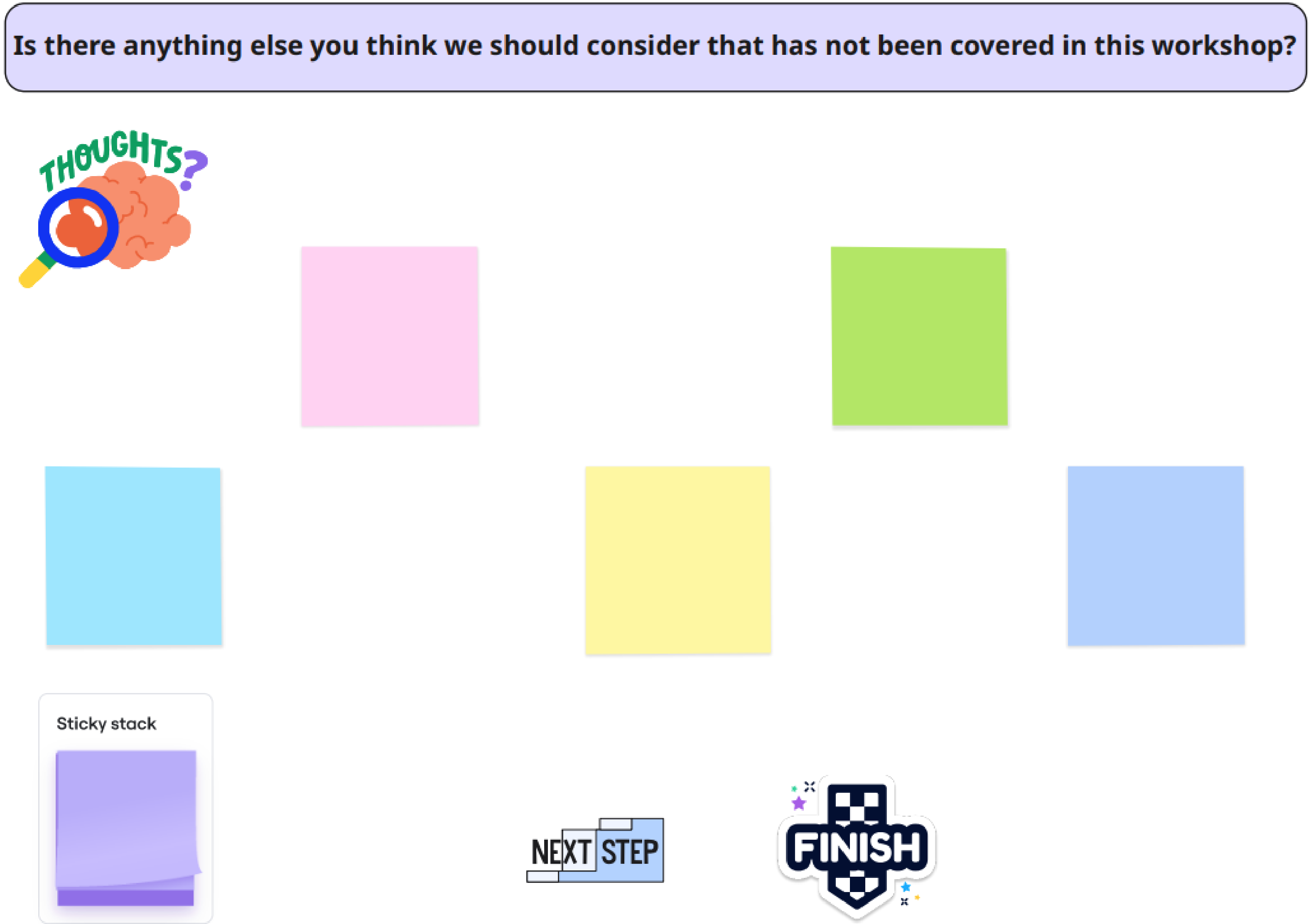

Figure D4. Stakeholder workshop prompt for other considerations

11 Appendix E – Stakeholder workshop bow-tie diagrams

A Bow-tie is a graphical risk analysis technique, allowing for a structured approach to identifying what causes may result in an unwanted event and how this, in turn, could ultimately lead to adverse impacts. This basic structure defines the scenario of concern, which then forces the identification of measures to prevent the loss of control and also measures to mitigate the extent of and recover from any resultant harm.

In this way the methodology maps out how risks are being managed, so that the risk can be understood, weaknesses identified, improvements made, and more informed decisions made for the future. A bow-tie structure is shown in Figure E1, with terms and definitions provided in Table E1.

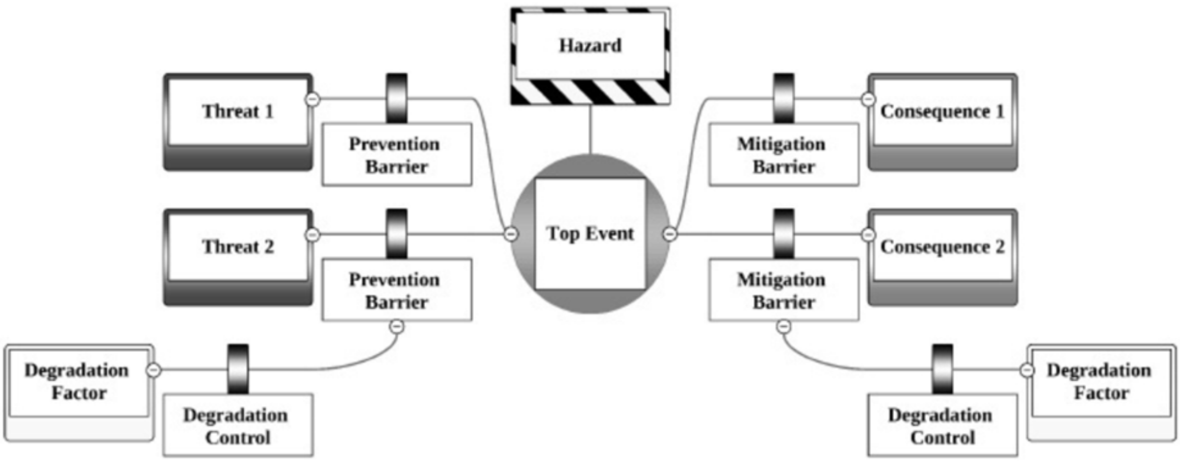

Figure E1. Bow-tie diagram structure[3]

The prepopulated bow-tie diagrams created based on the preliminary results of our literature review as well as the initial survey responses and then discussed in our Stakeholder workshop are presented in figures E2 and E3, with the finalised bow-ties, which incorporate any stakeholder feedback presented in figures E4 and E5.

[3] AIChE Center for Chemical Process Safety (CCPS), *Bow Ties in Risk Management Concept Book*, Wiley-AIChE, 2013. https://www.aiche.org/ccps/resources/publications/books/bow-ties-risk-management-concept-book-process-safety

Table E1. Bow-tie analysis terms and definitions

Term	Definition
Hazard	Something that has the potential to cause harm to something of concern.
Top Event	The ‘release’ of the hazard. The initial consequence that occurs when control of the hazard is lost. Also known as the ‘zero consequence event’.
Threat	Causes of loss of control of the hazard, which can lead to the top event.
Consequence	An event or chain of events that result from the release of a hazard i.e. what happens when the top event progresses.
Prevention Barrier	Prevention controls are protective measures put in place to prevent threats from releasing a hazard. Prevention controls can be engineered/hardware such as a physical barrier or piece of equipment, limits on operations or actions carried out by people usually in accordance with procedures. However barriers are implemented, they should be effective, independent and auditable.
Mitigation Barrier	Mitigation measures are the technical, operational and organisational measures that limit the chain of consequences arising from a top event. However, barriers are implemented, they should be effective, independent and auditable.
Degradation/Escalation Factor	Specific conditions that can result in the failure or impairment (reduction in effectiveness) of a prevention or mitigation barrier. These in turn may be prevented or mitigated by degradation factor controls.
Degradation/Escalation Controls	Degradation Controls contribute to maintaining barrier effectiveness by preventing degradation of a barrier. Degradation controls are themselves barriers against the realisation of a Degradation Factor, however, they may not always meet the criteria of a barrier (effective, independent, auditable).

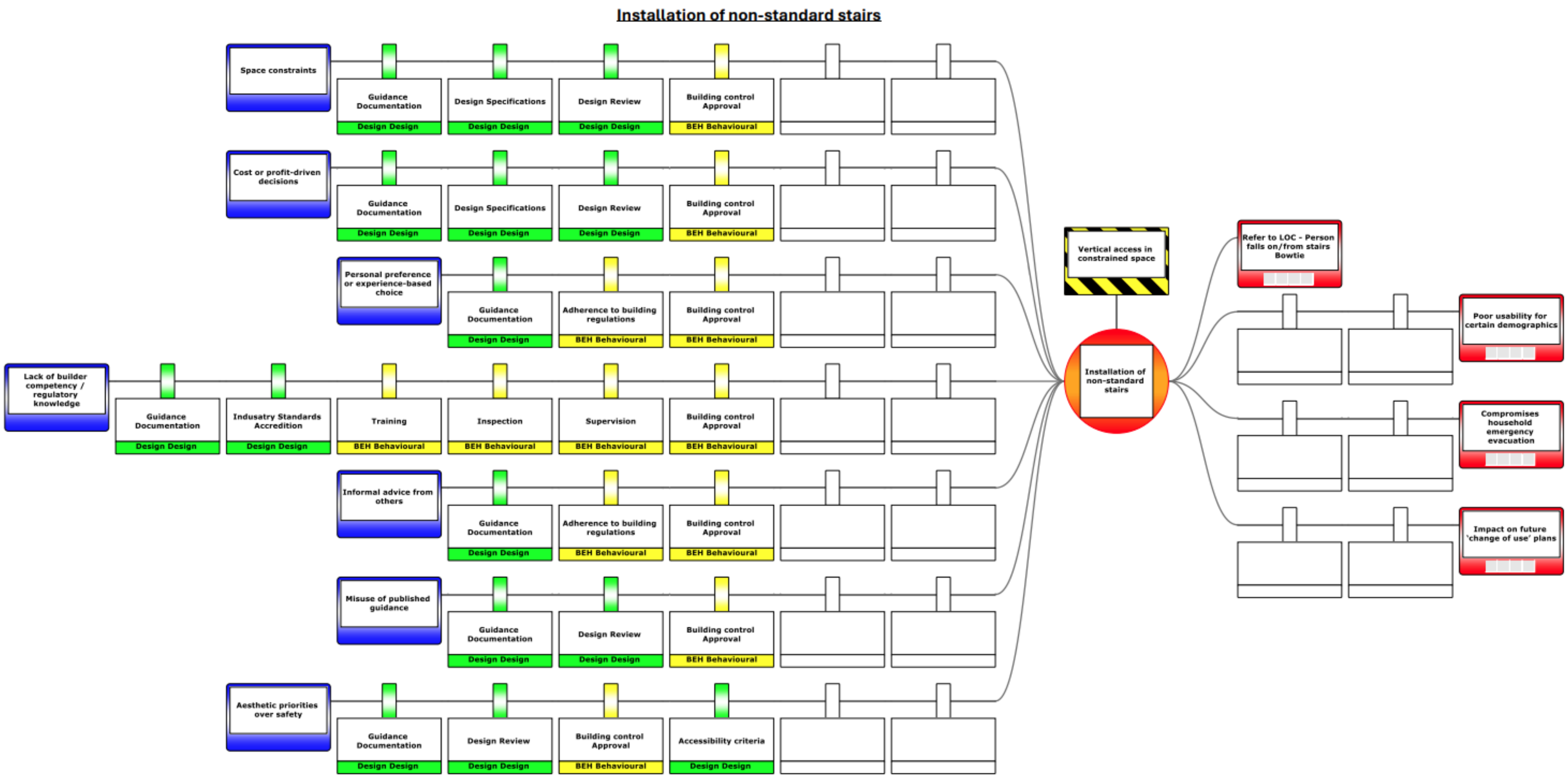

Figure E2. prepopulated bow-tie diagram for the installation of steep stairs, alternating tread stairs, and/or fixed ladders

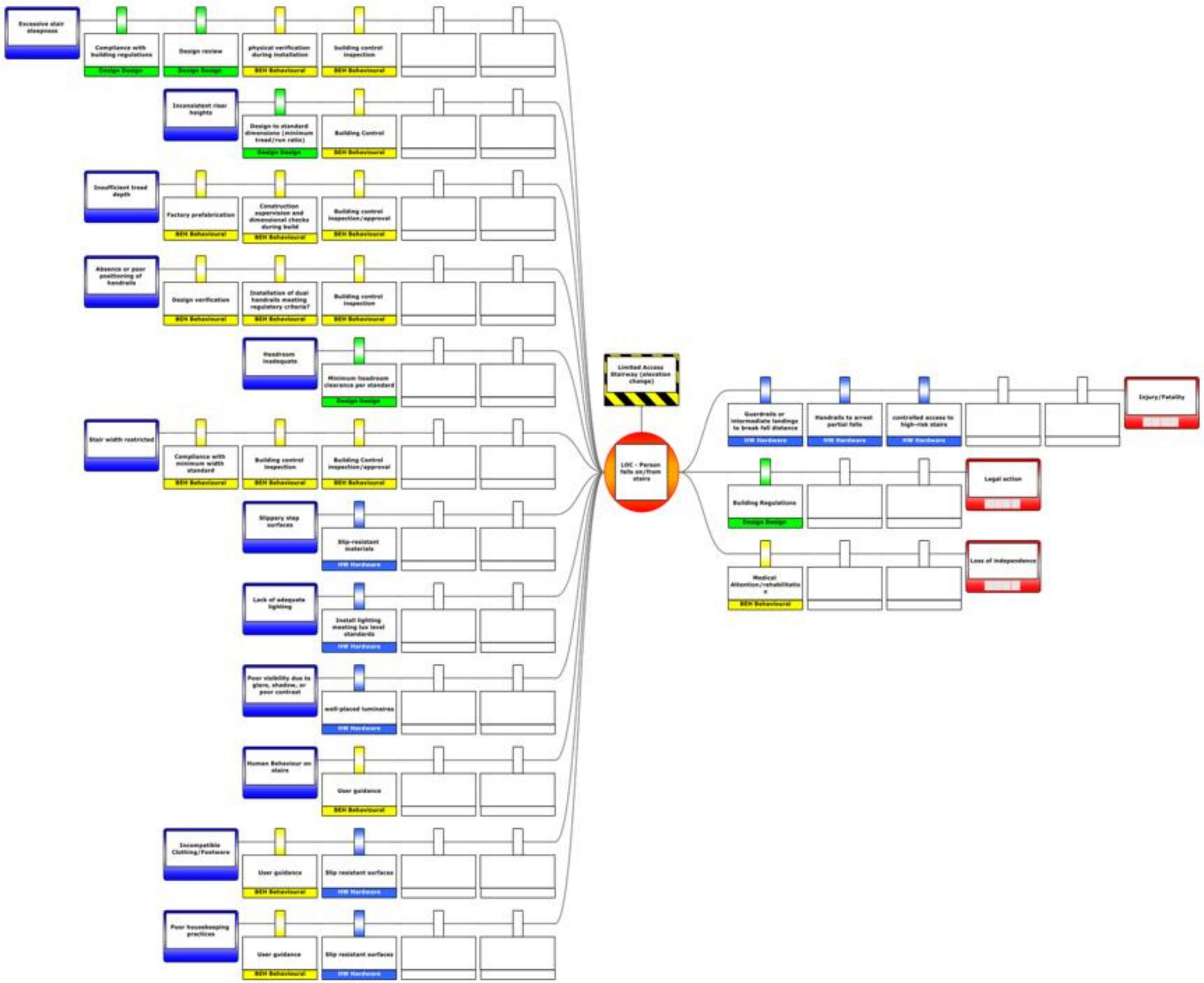

Figure E3. Prepopulated bow-tie diagram for a person fall on or from steep stairs, alternating tread stairs, and/or fixed ladders

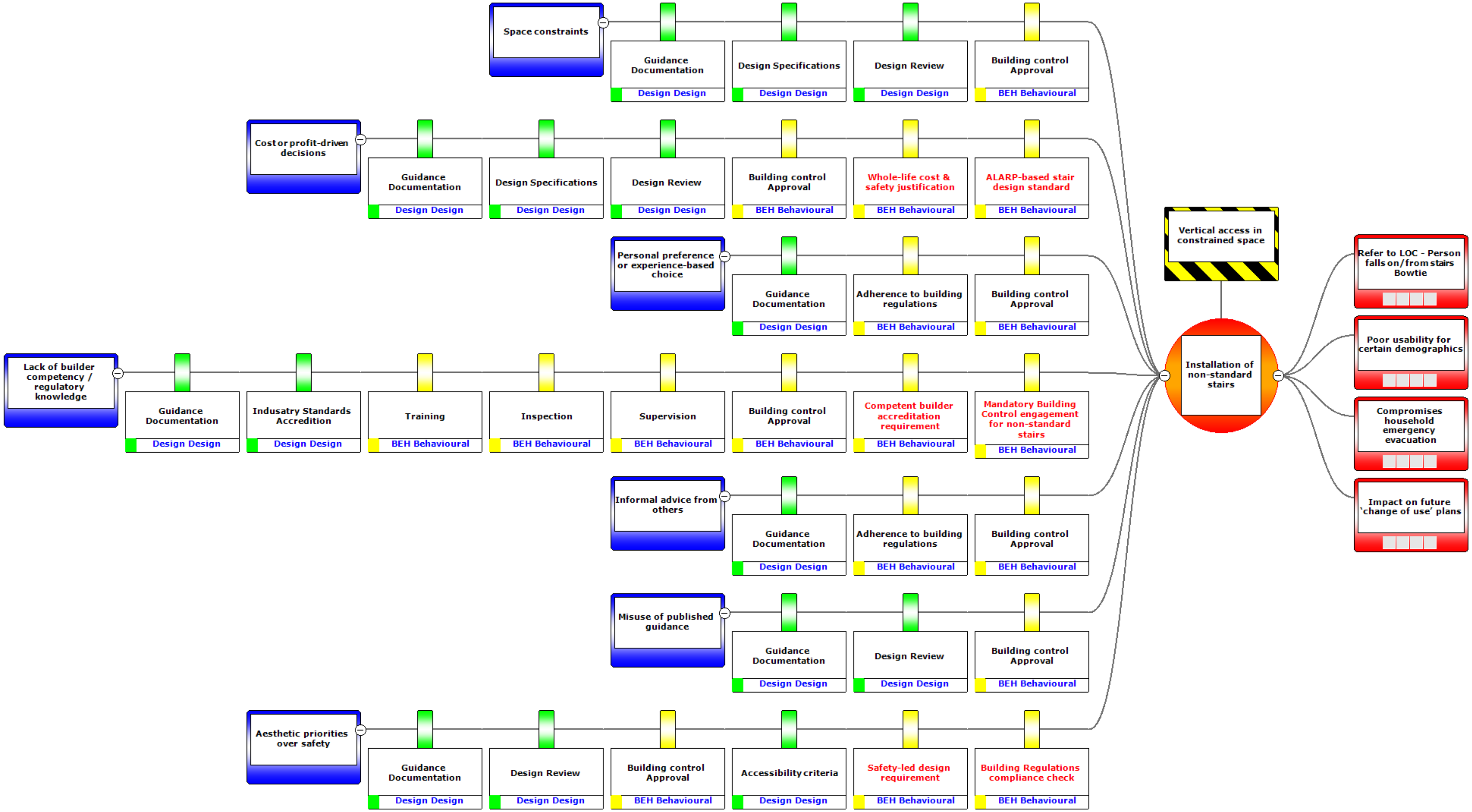

Figure E4. Updated post-workshop bow-tie diagram for the installation of steep stairs, alternating tread stairs, and/or fixed ladders

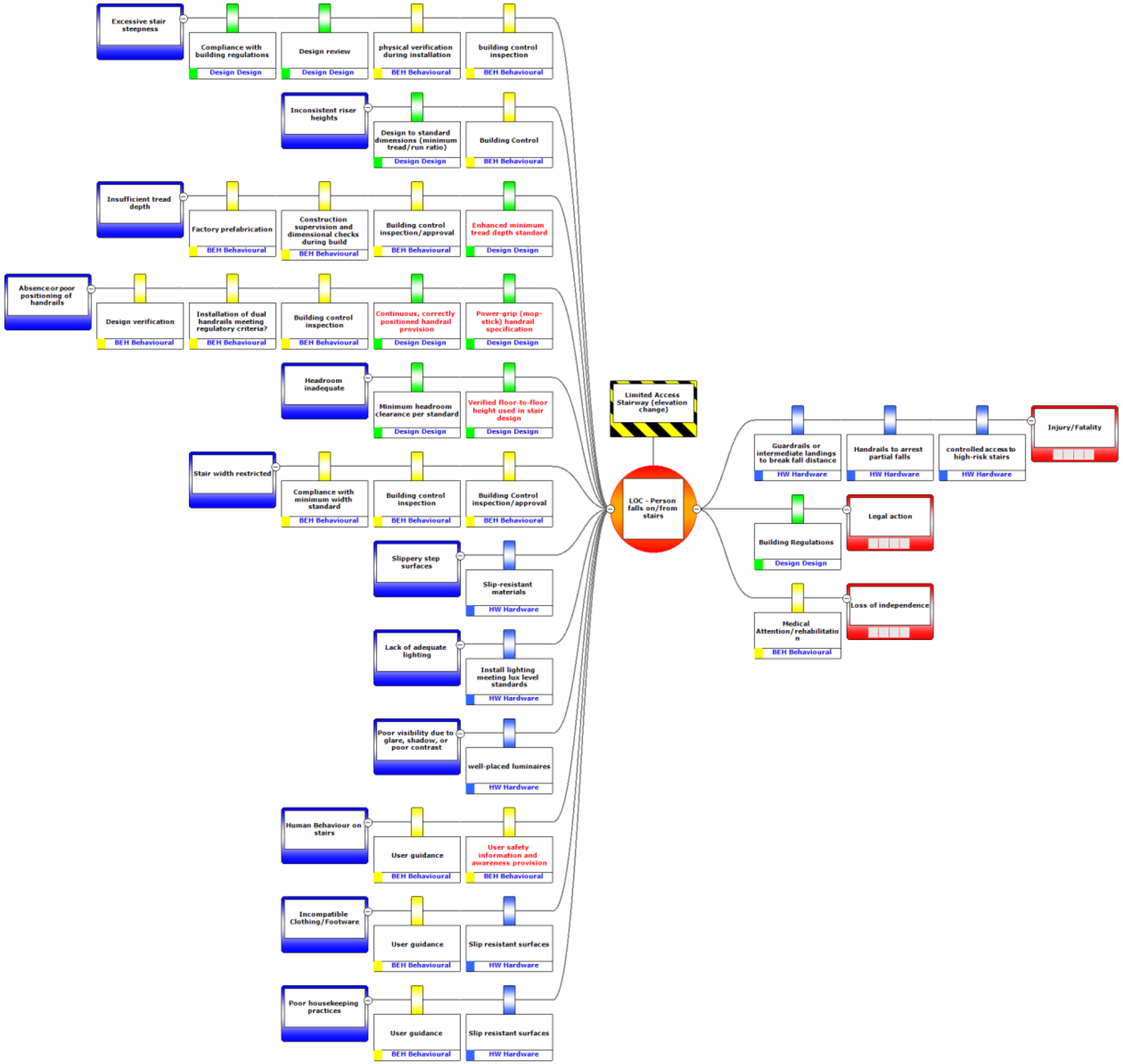

Figure E5. Updated post-workshop bow-tie diagram for a person fall on or from steep stairs, alternating tread stairs, and/or fixed ladders

12 Appendix F – Additional Stakeholder feedback

12.1 Insights from an Occupational Therapist's perspective

Following completion of the workshop, additional information was received from a workshop participant to highlight further considerations for stair design, specifically from an occupational therapist perspective. Additional considerations, and suggested improvements and solutions provided are summarised below.

Additional considerations and comments

- Falls prevention is a large area within occupational therapy, and research has been undertaken by the Royal College of Occupational Therapy.
- The greatest risks observed in stairs include steepness, unevenness, poor or loose flooring, no flooring over a slippery surface, high risers, shallow goings, no handrails, use of fingertip handrails, winders, and no landings.
- Where there are no, or limited, landings to the top and bottom of stairs, this reduces the ability to adapt and also increases the risk of a fall e.g. when leaving a bedroom to use a bathroom at night.
- A range of demographic groups are impacted including children, elderly with mobility impairments, cognitive impairments e.g. sensory and visual, people with poor proprioception or balance, and neurodivergent individuals.
- Research has been undertaken for Approved Document M with consideration to different demographics. This found that it is not just young or elderly individuals at risk but also people who have long term health conditions that affect breathing, stamina (heart), proprioception/co-ordination and balance, and potentially including people who are neurodivergent, autistic, and have a visual impairment.

Suggested improvements and solutions

- Replacing fingertip bannisters and providing "mop stick" handrails (i.e. with a profile that allows fingers to wrap around the handrail and obtain a secure grip) on both sides. This should extend beyond the top and bottom of the stairs and provide visual contrast against the background.
- Ensure that the wall provides the appropriate reinforcement, with guarding/banister rails that are robust and do not have gaps which are too wide.

- Ensure stairs are deep and wide enough to enable a person to negotiate stairs one at a time and place both feet on any step at one time.
- Use of contrasting colours to make stair elements (e.g. treads and handrails) easier to see.
- Providing enhanced but diffused lighting to stairs to enable clear vision of edges.
- Shorter flights of stairs which accommodate a straight stairlift.
- Straight flight with clear landings at top and bottom.
- Straight flight with goings (treads) of consistent depth (e.g. no winders) to provide safer use particularly for those less agile.
- Straight stairs without winders.
- Where winders are incorporated onto a stair, consideration should be given to ensure that an adequate going depth remains on the winders if a stair lift is installed.
- An Age Friendly home should have sufficient internal space to permit a person to move independently around their home. The provision of doors and circulation routes with adequate width, level access throughout and turning spaces are important to enable ease of movement. Sufficient internal and external storage space for mobility aids and other devices should be provided.
- Accidents can be caused by steep stairs. A shallower stair is easier to use and may enable a person to remain active in their home for longer. Ensure that the wall at a stair is constructed to allow for provision of a second handrail to the stairs, if needed in future. Stairs should not have winders / tapered treads. Height adjustable worktops, shelfing and storage units should be considered to enable ease of access for those with reduced mobility.

12.2 Insights from the Social Housing Sector

In addition to the defined research methodologies reported in the main body of this report, some general enquiries were made to stakeholders in the social housing sector, which provided some useful insights. These are summarised below:-

The Regulator of Social Housing has stated that it does not collect data on Special Stairs. The Business Intelligence Team at the Regulator is of the opinion that landlords won't collect the data either, unless it is identified as a hazard in the property. The Regulator asked how this would fit with the Housing Health and Safety Rating System, which is a tool that is designed to help local authorities identify and protect against risk and hazards to health and safety from any deficiencies identified in dwellings (Housing health and safety rating system (HHSRS): guidance for landlords and property-related professionals - GOV.UK).

Two large social housing providers told us that they would never authorise the installation of a Special Stair. One told us that it was not aware of any Special Staircases in its 12,000+ property portfolio, which includes new builds, leaseholds, high rise residential, and houses. It stated that it would not give permission for loft conversions, and if a tenant applied for permission to replace a standard staircase with Special Stairs then that request would be refused. The rationale that is any changes that increase property maintenance costs or reduce the ability to let the property in the future would generally be refused. New builds would not have any form of Special Stairs because they would make properties less accessible and therefore more difficult to sell/let.

Another social housing provider told us that there were no stair related questions in its Stock Condition Survey for domestic properties. They also told us that if the contractor that was completing a stock condition survey identified an issue with stairs that was deemed to be a Category 1 or 2 hazard under the Housing Health and Safety Rating System, then it would be reported to the social housing provider. However, there is no record of anything being reported for stairs. The Decent Homes Standard (info here - Decent Homes Standard: review - GOV.UK) includes criteria for “reasonably modern facilities and services” that makes reference to steep staircases within communal areas (see page 16 and 17 of the guidance - A decent home: definition and guidance - GOV.UK). This means that social housing landlords that have carried out stock condition surveys of communal areas may hold the information. The social housing provider didn’t have comprehensive stock condition information for the properties it manages and does not hold the information. They were of the opinion that the only time it would find properties with Special Stairs are in instances where customers had carried out unauthorised alterations to a property.