SITUATIONAL AWARENESS AND RISK PERCEPTION OF OPERATIVES USING PORTABLE LADDERS IN THE CONSTRUCTION INDUSTRY

John H Lonsdale

School of the Built Environment, Heriot-Watt University, Edinburgh EH14 4AS, UK

Accidents involving falls from portable ladders occur at a rate of 40 per week in the construction industry. Ladders are so common that they are taken for granted and the awareness and perceived risks, particularly at low levels, are often underestimated, with operatives having an 'it won't happen to me' attitude towards their safety. This paper reports information on risk awareness gathered from questionnaires and structured interviews taken from a cross section (by age, experience and work type) of 500 construction operatives, attending construction related training courses. The majority of operatives are aware of the hazards when using ladders but not the extent of the risks. There was a greater perception of risk at high levels but an underestimation of the risk at low levels. The information will be used to develop a ladder use training toolkit to promote the safe use of portable ladders by operatives of construction organisations.

Keywords: falls from height, ladder, risk perception, safety, training toolkit.

INTRODUCTION

Falls from height

Falls from height are the most common cause of injuries and death to employees in the construction industry of Great Britain, (Health and Safety Commission HSC 2002). Over a five-year period between 1996 and 2000 they accounted for 49% of fatalities, 34% of major injuries, and 12% of over-3-day injuries (defined as injuries necessitating more than 3 days absence from work), mainly involving falls from roofs, ladders, and scaffolds. Falls have also been the most common kind of accident to the self-employed, accounting for 59% of fatalities 43% of major injuries and 20% of over-3-day injuries, over the same period (HSC 2001).

Myers (2003), the HSE chief inspector for construction, identified falls from height as the single biggest cause of death, disability and injury in the construction industry of Great Britain. Accounting for almost half of all deaths and nearly a third of major injuries in 2001/2. Across all industries in Great Britain, falls from height accounted for 68 deaths, 5708 major injuries, and 8986 over-3-day injuries in 2000.

Falls from height is also an international problem, and is the leading cause of deaths in construction worldwide (Berg 1999). An analysis carried out by Cattledge et al. (1996) on construction fatalities in the United States between 1980 and 1989 found that 49% of all occupational related fatalities were due to falls in the construction sector. McVittie et al (1997) compared occupational falls in the United States to those in Ontario, Canada between 1988 and 1992, and found that 40% of all fatalities in Ontario were due to falls to a different level. A study of construction related fatalities in South Korea (Byung Yong Jeong, 1998) between 1991 and 1994 showed that falls

Lonsdale, J H (2004) Situational awareness and risk perception of operatives using portable ladders in the construction industry. *In:* Khosrowshahi, F (Ed.), *20th Annual ARCOM Conference*, 1-3 September 2004, Heriot Watt University. Association of Researchers in Construction Management, Vol. 1, 515-23.

from heights accounted for 42% of all construction related fatalities. The picture from the European member states is not clear, as individual countries define and report workplace injuries in different ways, some including commuting accidents in their statistics. However evidence from Eurostat (1996) suggests that the injury rates from falls are similar to those of the rest of the world, at approximately 50%.

Portable Ladders

British Standard European Directive (BS EN 131 1993) defines a ladder as a device incorporating steps or rungs on which a person may step to ascend or descend, and defines a portable ladder as a ladder which can be transported and set up by hand, without mechanical aid. There are basically two types; those that are self-supporting, and those that require support. Self-supporting types, normally called stepladders are two-piece, and are available in heights up to 3 metres incorporating up to 14 treads. Those that require support are known as leaning rung ladders and include both one-piece ladders, available for heights up to 10 metres, and extending ladders, having two or three sections arranged to slide parallel to one another, which can be hand or rope operated, and are suitable for heights up to 16 metres.

Falling off a ladder is by far the most significant agent of falls from height, resulting in construction accidents (Cliff 2004). A report by Bomel (2003) for the HSE analysed data obtained from employers and the self employed, via the Reporting of Injuries and Dangerous Occurrences Regulations (RIDDOR), over a five-year period between 1996 and 2000. This highlighted that portable ladders are involved in the largest number of accidents, being associated with over 4600 injuries, resulting in an average of 8 fatalities and 530 major injuries per year, representing 11% and 47% respectively of falls from height.

The RIDDOR reported injuries in Great Britain become even more significant because there is evidence to show that they are severely under reported. Research carried out as part of a Labour Force Survey for the Office for National Statistics (Institute of Employment Research 2000) shows that the rate of falls from height is more than twice that indicated for employees and that the self-employed report less than 5% of non-fatal injuries. This problem is also evident in the USA where it was estimated from an analysis of labour statistics (Leigh 2004) that between 33% and 69% of all non-fatal injuries were missed, representing a substantial under capture mainly due to underreporting. The total number of falls from portable ladders is therefore unknown, but is probably closer to 2000 per year, representing a rate of approximately 40 per week in Great Britain.

Falls from portable ladders are divided broadly into two kinds, namely, low falls and high falls. A low fall is defined as a fall below two metres, whereas a high fall is a fall above two metres (Health and Safety Commission 2000). Whether the fall results in fatality, major or over 3 day injury, largely depends on the height of the fall (Bomel 2003). It can be anticipated that high falls will lead to a higher percentage of fatalities and major injuries than low falls (Cliff 2004), however, in an analysis of fall accidents Snyder (1977) showed that people who fell less than 6 metres landed on their heads 76% of the time, and people who fell more than 6 metres landed on their feet 63% of the time. Therefore in relatively short falls, the head is more likely to be injured than in higher falls, with a greater risk of a major injury.

Falls from ladders are almost equally divided between low and high falls, accounting for over 2500 and 2100 of falls respectively, during the period 1996 to 2000 (Bomel 2003). Despite the safety knowledge relating to ladders, the causes of falls tend to remain the same, and the current advice or regulations do not appear to be preventing

ladder accidents. Clift (2004) from his studies of available literature concluded that recommendations for the safe use of ladders were vague, and open to wide interpretation. He identified that user related factors are the largest cause of accidents, (see table 1).

Table 1: User related factors in the causation of ladder accidents

CAUSES ASSOCIATED WITH LADDER FALLS	FREQUENCY (ROUNDED PERCENTAGES)
Untied and un-secured ladder	33
No known cause	21
Over-reaching	13
Slipped/lost footing	8
Defective ladder	6
Knocked off	5
Overbalanced	5
Scaffold overturned	5
Dismantling	2
Age of victim	2

For straight ladders, slipping at the base is the most common event preceding a fall. Low angle of inclination is the most common contributory factor (Bjornstig and Johnson 1992), mainly due to reduced friction caused by the ladder not being erected at a suitable working angle, for example 75º, or a quarter of the height, 1 out 4 up ratio. For stepladders the most common event preceding a fall is the ladder tipping sideways or slipping at the base (Axelsson and Carter 1995).

Portable ladders are commonly used pieces of work equipment for gaining access to height and due to their simple design and ease of use they are often taken for granted and the safety implications are overlooked. Current legislation places emphasis on the requirement that a ladder should not be used unless it is reasonable to do so, having regard to the nature of the work, its duration and the risks to the user (Construction Health, Safety and Welfare Regulations 1996). Future legislation will place greater emphasis on the use of safer alternatives to ladders, and specific requirements will require the work to be risk assessed, organised, and planned, and take account of the distance and consequences of a fall. (HSC 2004). Whether the regulations will have any impact on the small and micro organisations is questionable, as safety knowledge at this level of the industry tends to be rather limited and the requirements of legislation are not generally known.

There is an abundance of safety information available on ladder safety, in the form of checklists, safety cards, and leaflets; however they often remain unread (Lawrence et al 1996). The operatives are either not getting the message, don't understand it, or are choosing to ignore it, and taking a chance. The fact is that a ladder is one of the simplest and most easy-to-use pieces of equipment in the industry, and statistics suggest that their abuse and misuse is a rule rather than an exception. There are still horror stories to be told of the cavalier attitude of some site operatives, with a comment such as "it will only take a minute" (Singleton 2004). Lawrence et al (1996) concluded that there was a definite need to raise awareness of the safety messages.

Risk Perception and Situational Awareness.

Bomel (2003) developed a network to gain an insight into the underlying influences on falls from height and the work identified that one of the main factors that had a direct influence on falls was the situational awareness and risk perception of workers. They suggested that this was at least partly due to familiarity with the hazard and

complacency towards the risk e.g. ‘it won’t happen to me’. Inadequate risk perception was thought to contribute to accidents, in that people recognise the hazard but do not modify their behaviour accordingly, and have a greater perception of risk for work at high levels but an underestimation of risk at low levels. Clift (2004) identified that the perception of risk varies both with the individual, and with their level of expertise, and where a situation is familiar; the perception of risk is likely to be lessened. It has also been reported by Page (2000) that people are more willing to accept risks, and that some individuals actively seek out risk rather than avoid it, described by Zuckerman (1994) as ‘thrill seekers’.

Holmes et al (1999) identified that if the necessary safety measure is perceived to present too great a level of effort it will be ignored. The perception may be that the cost is the extra work effort required to implement the safety procedure. Johnson et al (1998) came to the same conclusion but further showed that workers would forgo personal safety if they felt speed and comfort were more important. Bomel (2003) concluded that awareness was the key factor, and although large companies take ownership and responsibility for safety, smaller companies and the self-employed do not put safety high on their agenda, if at all. Therefore, if the level of injuries associated with ladder falls is to be significantly reduced, and the industry is to meet its revitalising targets it is essential that personnel are made more aware of the risks, and the consequences of falling, especially at low levels.

It is clearly established that in the construction industry, accidents caused by falls continue to be a major problem. Also established is the fact that many of the falls occur whilst using portable ladders. This study focuses on ladder users as the main underlying cause of falls. It uses results from questionnaires and structured interviews, taken from a large sample of construction operatives, and outlines the initial development of a training toolkit, designed specifically to raise the situational awareness and risk perception of ladder users, and which will be reported in more detail in a future paper.

METHOD

The data used for the study was obtained from questionnaires and structured group interviews, taken from operatives attending construction related training programmes, (see table 2), at a college located within Northumberland, England. The participants represented a broad cross-section of the construction industry with regards to age, experience and work type, and included operatives from micro, small, medium and large enterprises, employing between 2-9, 10-49, 50-249 and 250 or more people respectively (European Commission 2003), as well as the self-employed. Their work in the industry was varied and included the building, civil engineering, services, and maintenance sectors.

Training programmes were chosen to facilitate a longitudinal study, by using some operatives who would be available to be revisited, allowing the validity of the training aid to be tested at various stages of its design. The initial questionnaire was designed, following discussion with the training providers, to be an integral part of the operatives’ training programme, and all those attending took part in the survey.

Table 2: Training programmes used with the research.

TRAINING PROGRAMME	DESCRIPTION
Safety Passport Client Contractor National Safety Group (CCNSG)	A two-day basic health and safety programme, designed for construction/engineering operatives and consisting of ten health and safety modules, including safe working practices. Updating is required every three years.
Construction Safety awareness	A one-day basic health and safety programme, consisting of six health and safety modules, including working at height. Updating 'as required' by individual organisations, but not exceeding 3 years.
National Vocational Qualification (NVQ) level 2 and 3, and Construction Skills Certificate Scheme (CSCS)	A three-year programme, incorporating one health and safety unit, which involves preparing the following construction operatives for the industry's touch screen health and safety test. Bricklayers, Painters and decorators, Plumbers, Electrical fitters, Gas appliance fitters, Carpenters and joiners, Dry liners, Plasterers, Wall and floor tillers, Ceiling fixers
Construction National Certificate (NC) level 3 and 4	A two-year programme, incorporating one health and safety unit, which involves preparing construction technicians for the industry's touch screen health and safety test.
Specialist Training programmes	One day programmes incorporating health and safety, designed for specific training in the following areas: Tower scaffolding Roof maintenance Wall tie replacement Building maintenance.

The main aim of the study was to establish the individual's level of awareness and risk perception on entry, and before any training had taken place. Prior to the administration of the questionnaire the participants were verbally briefed as to its purpose, use of results and confidentiality, the method of completion was also fully explained, together with the definition of the terms risk, hazard, and danger, which according to Young (1990) are often confused. Help was available throughout the survey, to provide further clarification and/or explanation, and those participants who had difficulty reading were read the questions at the end of the session, and their answers taken verbally. As a result, nearly 500 questionnaires were successfully completed during the study period, (see table 3), and very few papers were spoilt, representing a 98% success rate.

Table 3: Training programmes

TRAINING PROGRAMME	NUMBER (N = 490)
Safety Passport	103
Construction Safety awareness	96
National Vocational Qualification	175
Construction National Certificate	46
Specialist Training programmes	70

Immediately following the questionnaire, structured group interviews were carried out with all groups to allow the participants the opportunity to add any further comments

or raise any issues in relation to the subject matter. The responses were clarified and noted during the session, and details were taken regarding those respondents who agreed with the statements made.
The results from the questionnaires and interviews were used to guide the design of a prototype training toolkit to be used to improve the situational awareness and risk perception of construction operatives. The prototype will be tested both on operatives from the original samples and on new operatives who have no prior knowledge of the study. Feedback from the tests will be used to further modify the design, which will be reported later.

RESULTS

The results of the survey have produced basic user profiles, which reflect the operative's ability to recognise hazards and evaluate risks, and the responses are summarised below. Demographic information in relation to age group, employment status, employer type and size, occupation, and number of years experience in the industry has not been detailed, but do form part of the results.

Frequency of ladder use

It is well understood that familiarity with a hazard causes complacency towards the risk, and therefore frequent ladder users are more likely to put themselves at risk. To gauge this tendency the participants were asked how regularly they used a ladder or stepladder in the course of their normal work (see table 4). The results show that ladders are commonly used equipment within the industry, with nearly 70% of the respondents using ladders at least once per week, and 85% using ladders every month.

Ladder training / Instruction

Suitable training is a legal requirement for all ladder users and is essential to ensure competence in using the equipment safely. The participants were asked if they had received any formal training in ladder use, or advice on safe procedures whilst using ladders (see table 5). Considering the high usage of ladders, it is surprising that formal training was given to only 20% of the respondents. It was established during the interview sessions that the form of the training was mainly during toolbox talks on site. They were further asked if they had received any informal training, or received any written information regarding ladder use, e.g. checklists, guides, safe working at height leaflets, etc. The results are shown in tables 6 and 7 respectively. Again considering the high usage it is surprising that only 25% and 20% respectively responded positively. Furthermore, only 15% of those who had received training or information were in small/micro organisations. During the interview session it was reported that safety information was not generally read on site due to its 'boring' content.

Table 4: Frequency of ladder use.

FREQUENCY	SCORES (N = 492)
Every day	199
Every week	142
Every month	86
Less than once per month	42
Rarely	23

Table 5: Formal training in ladder use.

FORMAL TRAINING	SCORES (N = 476)
Yes	104
No	364
Don't know	8

Table 6: Informal training in ladder use.

INFORMAL TRAINING	SCORES (N = 486)
Yes	123
No	348
Don't know	15

Table7: Information on ladder use.

INFORMATION	SCORES (N = 476)
Yes	96
No	359
Don't know	21

Accident history

Individuals who have been involved in a fall from height are affected by the experience, and evidence shows that they are more aware of their work situation, and their risk perception is positively affected. Participants were asked if they had fallen from a ladder or stepladder during the course of their work or at home, the height of fall was not requested, as there might have been a tendency for exaggeration, (see table 7). Nearly half of the respondents had experienced a fall from height, which may influence their future perception of risk. This figure seems high considering 32% of the sample had worked in the industry for less than 5 years. It was further established during the interview sessions that the majority of falls were from low levels. As all the respondents were still actively working in the industry the level of harm was assumed not to be major, although no information was gathered regarding this.

Table 7: Fall from height, accident

FALL ACCIDENT	SCORES (N = 493)	PERCENTAGE (ROUNDED)
Never	260	53
Once	173	34
Between 2 and 4 times	43	9
Between 5 and 10 times	9	2
Over 10 times	1	1
No response	7	1

Hazard Perception

A hazard is defined as 'anything having the potential to cause harm'. The participants were asked to place in rank order agents they considered to be associated with the highest and lowest number of falls from height hazards. The agents represented those taken from an HSE report for the number of high and low fall accidents over a five year period between 1996/7 and 2000/1(Bomel 2003). They have been ranked in numerical order, from the agent responsible for the highest number of falls to the lowest number of falls. The scale used to generate the scores is shown below, and the results, representing the percentage of respondents who correctly identified the ranking order are shown in table 8. Photographic images were provided to clarify the agent type, and maximise understanding.

The majority of the operatives are aware of the hazards of ladders in relation to other types of agent, with 82% ranking correctly. However there was uncertainty with the hazards related to other agents, and the results were spread across a wide range. Operatives who have been in the industry for 10 years or more scored over 90% on the hazard recognition.

Participants were also asked to place in rank order the kind of hazard associated with the most deaths. The agents represented those taken from the HSC National Statistics, for the number of fatal injuries to workers by kind of accident (HSC 2002). They have

been ranked in numerical order, from the agent responsible for the highest number of fatalities, to the lowest number of fatalities. The scores represent the percentage of respondents who correctly identified the ranking order, see table 9. Once again, falls from height were correctly identified by 73% of the sample. Operatives from the small/micro organisations who had less than five years experience scored less well, only identifying 38% correctly, and their results were spread across the agent types. (Questionnaire instructions 1: Place in ranking order from 1 to 5, where 1 = involved in the highest number and 5 = involved in lowest number.)

Table 8: Fall from height by agent.

AGENT	RANK	SCORE %
	1	82
Ladder / step ladder	2	27
	3	42
	4	18
	5	22
Scaffold		
Trestle scaffold		
Stairs		
Tower scaffold		

Table 9: Fatalities by agent.

AGENT	RANK	SCORE %
Fall from a height	1	73
Struck by a falling object	2	18
Trapped by something collapsing	3	12
Struck by a moving vehicle	4	21
	5	8
Contact with electricity		

Risk perception

Risk is defined as 'the likelihood of a hazard being realised', perhaps more commonly known as the probability of having an accident. To test the participants' ability to rate the level of risk, they were given a series of photographic images, showing a random series of ladder use situations, and asked to score them in relation to the extent of the risk. The scale used to generate the scores is shown below, and the results are shown in table 10, together with a brief description of the risk situation, including height of fall.

(Questionnaire instructions 2: Rate the level of risk to the ladder user by circling a number between 1 and 10 after each task, where 1 = low risk and 10 = high risk.)

Table 10: Risk perception scores for ladder use situations (N = 500)

Ladder type	Height in m	Ladder use situation	Mean score
Straight ladder	4	Pointing brickwork using both hands	5.5
Step ladder	2	Standing on top step using both hands	3.1
Pole ladder	8	Leaning out using one hand	6.8
Extension ladder	6	Using power drill, using both hands	6.3
Step ladder	1.5	One foot on adjacent surface, using angle grinder	2.8
Extension ladder	6	Standing too near to top, no handhold	6.4
Extension ladder	4	Using correctly for access	4.2
Pole ladder	8	Operative carrying window frame	6.7
Step ladder	2.5	Facing wrong way to fix ceiling tiles	2.1
Step ladder	2	Using correctly	1.8
Extension ladder	6	Two people on ladder carrying pipe	4.6
Straight ladder	4	One foot not on ladder whilst using power drill	3.6
Step ladder	3	Using for scaffold access	2.3
Step ladder	2	Two people using same steps to fix joists	2.5
Pole ladder	4	Facing wrong way to descend	3.4
Extension ladder	8	Too shallow an angle, 1 in 6	4.2
Extension ladder	4	Stepping over handrail for access	5.2
Step ladder	1.5	Knees above top step, fixing ceiling tiles	1.4
Pole ladder	10	Using correctly	5.4

Pole ladder	10	Leaning out to clean gutter	7.2
Step ladder	1	Using power drill, facing wrong way	2.6

The responses to the risk ratings were widely spread, with some scoring situations as high risk, whilst others scoring the same situation as a low risk. The scoring of the majority of the respondents was also inconsistent, with similar situations being scored completely differently. Some respondents scored all of the situations towards the high end of the scale, whilst others scored them towards the low end.
Generally it was thought that those having an accident history or long experience in the industry would have a more consistent score, however there was no evidence of this. Although the risk rating represents the true threat to the individual, the extent of the risks was not correctly identified. Generally there was greater appreciation of the risk at high levels, but an underestimation of the risks at low levels. This reinforces the understanding that operatives are poor at estimating the level of risk, especially at low levels.
Discussion during the interview sessions highlighted these points producing comments like 'it's not far to fall, therefore the risk must be low', suggesting that because the injury would be minor it would somehow be more acceptable. Asked whether there were any of the situations in which they would not be prepared to work, their responses were 'we take more care at high levels, because it's a long way to fall, and we might get badly hurt'. The point was also made that they use the equipment that is available in order to get the job done, and that the risks are an acceptable part of the job. It is clear that if they were made more aware of the risk situation then they could take more responsibility for their own risk management.

DISCUSSION

The results show that despite current legislation, awareness campaigns, and available literature in the form of checklists etc. the essential message regarding ladder use is not effectively reaching the majority of operatives on site. They are not aware of the risks when using portable ladders, especially at low levels. A system is needed that highlights the main issues in a clear and concise manner, and is interesting, informative and effective.

Development of a ladder use training toolkit.
A toolkit is being developed and produced on a digital versatile disk (DVD), capable of being modified by the training provider, and designed to deliver information to a varied audience in order to meet their different needs. One of the main features of the DVD will be the use of digital images, animation, and video clips, showing (in some cases graphic) real ladder use situations in the construction industry. The focus will be on how badly a person will get hurt, or even die, rather than (or to a lesser extent) the likelihood of getting hurt, from a ladder fall. The DVD will be produced so that the user can access different types of information, depending upon their needs.

The toolkit will include:

- A main menu on a home page to allow access to different sections by clicking on illustrated buttons. Once in the desired sections a browsing facility will allow page navigation and printing facilities.
- An interactive self-learning programme that guides the user through a series of scenarios, bringing the safety issues 'to life', and requiring them to make risk perception decisions, as they progress. Saving and returning to specific sections will be integral part of the programme.

- A series of ‘power point’ presentation slide shows, showing safe working practices and procedures. Designed to be used either for self-learning or as part of a formal training session.
- A portable ladder hazard perception test. This will allow the user to test their risk perception either prior to, or following other sections of the toolkit.
- A reference section including: definitions, fact sheets, safety checklists, ladder types, relevant legislation, and principles of ladder use.
- A library, containing general ladder images, suitable to be used to customise presentations, to suit training requirements.

The resource will be flexible, aimed not only at existing operatives within the industry but also young people and new workers who need risk skills before entry into the workplace. It is also aimed at young professionals such as engineers, architects, and managers who will determine the amount of risk others face. The resource will be available to all, irrespective of their age, experience, or employment status, and designed so that people can receive training, any time, any where, and at their own pace, as well as at formal safety sessions. The toolkit will not be designed to replace the essential hands on, practical aspects of training, which will need to be addressed separately, but will aim to inform and guide people, to improve their situational awareness and risk perception with the use of portable ladders.

The proposed Work at Height Regulations (HSC 2004) place a new emphasis on alternatives to the use of ladders, for example, scaffold towers. It is interesting to note that the regulations do not proscribe ladders as work platforms, even though research indicates that most ladder fall accidents occur when they are being used for this purpose. The new regulations will include a number of prescriptive provisions, directly addressing the hazards and risks associated with working from ladders, for example, ladders are to be used in such a way that a secure handhold and secure support are always available to the user. The regulations will place ladders at the bottom of the control hierarchy, thereby ensuring that more suitable alternatives are considered first. However ladders will continue to be used within the construction industry because in many cases there is no practical alternative. This will probably mean greater thought having to be put into the risk assessment process, and selection of ladders as the preferred piece of equipment, for height work, in the first place. It will be necessary for employers to continue to ensure that they have safe systems of work in place for the use of ladders and stepladders, and to be adequate, there has to be suitable training in the use of the equipment.

CONCLUSION

This study has shown that, despite current legislation, training in ladder use is being neglected, and operatives are being killed and injured as a result of falls. Training schemes like NVQ, safety passport and CSCS, do not place sufficient emphasis on falls, and there is a need to ensure that people are fully aware of the risks involved. A toolkit is being designed for this specific purpose that will be capable of being modified to facilitate a wide training audience, with the main aim of raising awareness and improving risk perception of everyone who use ladders. A future paper will describe its use and success.

REFERENCES

Axelsson, PO, and Carter N (1995) Measures to prevent portable ladder accidents in the construction industry. Ergonomics, 38(2), 250-259

Berg, U, (1999) Safety campaign 'fall risk in construction work' Implementation of safety and health on Construction sites. Proceedings of the 2nd International Conference of CIB working Commission. 853-866

Bjornstig, U and Johnson, J (1992) Ladder injuries: mechanisms, injuries and consequences, Journal of Safety Research, 23, 9-18

Bomel Limited (2001) Improving health and safety in construction. Phase 1 data collection, review and restructuring. HSE Contract Research Report 387/2001

Bomel, (2003) Falls from height, Prevention and risk control effectiveness, Research Report 116, Health and Safety Executive, London:

Byung Yong Jeong, (1998) Occupational deaths and injuries in the construction industry, Applied Economics, 29, 5

Cattledge, GH, Hendricks, S, Stanevich, R, (1996) Fatal occupational falls in the US construction industry 1980–1989, accident analysis and prevention.

Cliff, L, (2004) Evaluating the performance and effectiveness of ladder stability devices, HSE Research Report 205

Construction (Health, Safety and Welfare) Regulations (1996) Her Majesty's Stationery Office

Department of Trade and Industry (1993) The ladder user's handbook. Her Majesty's Stationery Office

European Commission (2003) Commission recommendation concerning the definition of micro, small, and medium-sized enterprises, document number C(2003) 1422

Eurostat (1996) accidents at work in the EU in 1996, statistics in FOCUS, theme 3 – 4/2000

Health and Safety Commission (2002) Statistics highlights 2001/02. National statistics, Health and Safety Commission, London

Health and Safety Commission (2001) Health and Safety Statistics 2000/01. National statistics, Health and Safety Commission, London

Health and Safety Commission (2002) Statistics of workplace fatalities and injuries - Construction 2001/02. Health and Safety Commission, London

Health and Safety Commission (2004) Proposal for Work at Height Regulations, consultative document. Health and Safety Commission

Holmes N, Lingard H, Yesilyurt, Z and De Munk, F (1999) An exploratory study of meanings of risk control for long term and acute effect occupational health and safety risks in small business construction firms. Safety Research, 30(4), 251-261

Institute of Employment Research (2000) Levels and trends in workplace injury: reported injuries and the Labour Force Survey.

Johnson, HM, Amarjit, S and Young RHF (1998) Fall protection analysis for workers on residential roofs. Construction engineering and management 124(5): 418-428

Lawrence, N, Hopkinson, NL, Norris, BJ and Wilson, JR (1996) Consumer safety research: assessment of the safety of stepladders. Consumer Safety Unit, DTI.

Leigh, JP et al (2004) An estimate of the US Governments undercount of non-fatal occupational injuries. Journal of Occupational and Environmental Medicine.

McVitte, D, Banakin, H and Brocklebank W, (1997) The effects of firm size on injury frequency in construction. Safety Science, 27(1), 19-23

Myers, L (2003) National construction blitz on falls from height, Health and Safety Executive press release E083:03 2003

Singleton, P, (2004) Use of ladders, Site Recorder Feb 2004, 4

Snyder, RG (1977) Occupational Falls. Ann Arbor Highways Research Safety Institute. University of Michigan URN96/913.

Young, SL, Brelsford JW and Wogalter, MS (1990) Judgements of Hazard, Risk, and Danger: Do they differ. Proceedings of the Human Factors Society 34th annual meeting 503-507

Zuckerman, M (1994) Behavioural Expression and Biosocial Bases of Sensation Seeking. University of Cambridge, USA