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Final Report of the CII-HK

Research Project

Entitled

Construction Safety Involving Working at Height for Residential Building Repair and Maintenance

Compiled by:

Professor Albert P.C. Chan
Dr. Michael C.H. Yam
Ir. Albert W.K. Kwok
Dr. Edward C.Y. Yiu
Miss Esther Cheung
Professor Francis K.W. Wong
Dr. Daniel W.M. Chan
Professor Edwin H.W. Chan
Dr. Edmond W.M. Lam

Department of Building and Real Estate
The Hong Kong Polytechnic University

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Task Force Member	**Position**	**Company / Organisation / Department**
Mr. C.K. Lau (Task Force Chairman)	General Manager (Project Management Department)	Henderson Land Development Company Limited
	Executive Director	Henderson Investment Limited
Mr. Augustine Chow	General Manager (Maintenance)	The Hong Kong Housing Society
Mr. M.T. Kan	Secretary	The H.K. Construction Industry Employees General Union
Mr. Alkin Kwong	Director and General Manager	Hong Yip Service Company Limited
Mr. K.L. Pang	Chief Occupational Safety Officer	Labour Department, HKSAR
Mr. C.M. Tang	Senior Structural Engineer	Buildings Department, HKSAR
Mr. W.S. Tang	Executive Director	Occupational Safety and Health Council
Mr. Conrad Wong	Managing Director	Yau Lee Construction Company Limited
Dr. Nicolas Yeung	Convener and Director	Construction Industry Institute (Hong Kong) Limited

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Thanked Individual	**Position**	**Company / Organisation / Department**
The Hon. W.Y. Chan	Legislative Councilor	Legislative Council
Mr. P.M. Cheng	Senior Maintenance Surveyor	Hong Kong Housing Authority, HKSAR
Mr. K.C. Cheung	Senior Divisional Occupational Safety Officer	Labour Department, HKSAR
Mr. K.T Cheung	Secretary	HK Construction Industry Employees General Union
Mr. K. Cho	Deputy Director	HK Construction Industry Employees General Union
Mr. C.W. Choi	Chairman	HK Construction Industry Employees General Union
Mr. S.M. Chow	Structural Engineer	Buildings Department, HKSAR
Mr. P.W. Chung	Deputy Chief Occupational Safety Officer	Labour Department, HKSAR
Mr. C.H. Fan	Managing Director	Synergis Holdings Limited
Mr. W.W. Fock	Senior Maintenance Surveyor	Hong Kong Housing Authority, HKSAR
Mr. Teddy Ho	Vice President	HK General Building Contractors Association Ltd
Mr. W.W. Ho	Secretary General	HK General Building Contractors Association Ltd
Mr. Ellis C.M. Ip	Senior Deputy General Manager	Hang Yick Properties Management Limited
Dr. Y.C. Lee	Senior Building Services Engineer	Hong Kong Housing Authority, HKSAR
Mr. Alex K.K. Leung	Technical Manager (Technical Department)	Hang Yick Properties Management Limited
Ms. Karen Lo	Centre Manager	Hong Kong Workers' Health Centre
Mr. Kinson C.F. Lo	Senior Technical Officer	Hang Yick Properties Management Limited
Mr. S.K. Low	Chief Supervisor	Wui Loong Scaffolding Works Company Limited
Mr. S.L. Ma	Quantity Surveyor	Wui Loong Scaffolding Works Company Limited

Mr. Bill Man	Senior Assistant Technical Manager	Hong Yip Service Company Limited
Ms. W.Y. Ng	Building Surveyor	Buildings Department, HKSAR
Mr. W.F. Pei	Director	HK General Building Contractors Association Ltd
Mr. C.K. Siu	Senior Maintenance Surveyor	Hong Kong Housing Authority, HKSAR
Ms. Emily W.Y. Tam	Technical Officer	Hang Yick Properties Management Limited
Mr. K.K. Tang	Senior Structural Engineer	Buildings Department, HKSAR
Mr. C.Y. Tse	Chairman	Hong Kong Construction Sub-Contractors Association
Mr. Joseph Tsieh	Committee Member	Hong Kong Construction Sub-Contractors Association
Mr. Alex Wong	Senior Consultant	Hong Kong Construction Association
Mr. B. Wong	Assistant Director – Estate Management	Hong Kong Housing Authority, HKSAR
Mr. Jason Wong	Senior Maintenance Officer	Occupational Health and Safety Council
Mr. K.I. Wong	Senior Maintenance Officer	Well Born Real Estate Management Limited
Dr. Louisa Wong	Principal Consultant	Occupational Health and Safety Council
Ms. Winnie W.L. Wong	Manager (Administration /Personnel Department)	Hang Yick Properties Management Limited
Mr. Winson Yeung	Senior Consultant	Occupational Health and Safety Council
Mr. George Yu	Assistant Technology Officer	The Hong Kong Construction Association

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Executive Summary

A safe working environment is important to the success of construction projects. Due to improper workplace management and lack of safety awareness of project participants, accidents happen among which falls of person from height have aroused considerable attention in densely populated cities where high-rise buildings are needed to meet housing demand. This problem is further aggravated in cities, like Hong Kong in which buildings become dilapidated and the increasing demand for repair and maintenance works has prompted an urgent need for construction safety research particularly related to working at height.

In order to critically investigate and examine solutions to preventing fall accidents in building repair and maintenance works, the Construction Industry Institute, Hong Kong (CII-HK) invited proposals for an industry driven study in January 2005. A research contract was subsequently awarded to the Construction Safety Research Team led by Professor Albert Chan and Professor Francis Wong of the Department of Building and Real Estate at The Hong Kong Polytechnic University.

The research aims to improve construction safety involving working at height for residential building repair and maintenance in Hong Kong. It sets out to identify situations where such works are necessary and to investigate the causes of associated accidents and problems. The objectives of the project are achieved by triangulating the findings from interview surveys, focus group meetings, literature review, questionnaire surveys, analysis of accident statistics and the analysis of case studies.

The construction industry was identified as one of the most hazardous industries internationally. Of all the construction-related injuries, falls are the leading category of death. The comprehensive literature review conducted identified the most common fall locations, the major causes of fall accidents and some practical solutions to fall accidents

including the use of new technologies and techniques, effective safety management system and concerted efforts of construction personnel were presented.

The use of bamboo truss-out scaffold was identified as a problematic area and the root cause of many recent fall accidents in Hong Kong. The bamboo truss-out scaffold is a unique feature of Hong Kong hence there were no lessons that could be learnt from overseas. There are many problems related to the procedure of installing and using the bamboo truss-out scaffold causing it to be unsafe. The lack of standards and requirements has caused the control of them to be difficult. The design of the bamboo truss-out scaffold has proved to be unreliable, hence the design should either be refined or alternatives to the bamboo truss-out scaffold for performing external building repair and maintenance works at height needs to be found. Therefore there should be guidelines, standards and legal enforcement concerning the design, installation procedure and dismantle procedure of the bamboo truss-out scaffold, to ensure that it is safe to use.

Bearing in mind the problems with the bamboo truss-out scaffold, the Research Team designed an alternative temporary working platform to be used for residential building repair and maintenance works at the external wall. The design has already obtained a patent application number from the Patent Office in the People's Republic of China. Refinement of the design is being conducted. More work should be carried out to either refine the design of the bamboo truss-out scaffold to be more reliable or to replace it with an alternative that is readily available in the market.

The analysis of the accident statistics showed that Hong Kong has achieved an enviable safety record in recent years. Unfortunately the same cannot be said to accidents resulted from fall of person from height. From 2000-2004, fall from height was the most frequently occurred fatal accident in repair and maintenance works. The most common place of fall was bamboo scaffolds (including bamboo truss-out scaffolds). The age group 40-44 experienced the highest number of fall accidents and accidents in repair and

maintenance works. 'Contusion and bruise' and 'fracture' were the most common injuries observed amongst fall accidents and accidents in repair and maintenance works.

Twenty-two fatal fall from height case studies in building repair and maintenance works were analysed. It was found that accidents often occurred at the end of the month and the end of the day. The statistics showed that workers that belonged to the age group of 45-49 experienced fatal accidents most frequently. Labourers, scaffolders and electricians were found to be the most common occupations of the deceased workers. The most unsafe condition/action was a result of the equipment being unsafe. Of the twenty-two fatal fall accidents, four (18.2%) involved the use of bamboo truss-out scaffolds.

Ten structured interviews were conducted providing valuable information from different aspects. It was noticed that many of the views and suggestions discussed during the interviews shared similarities. Some of these similarities include: regular monitoring and inspection; enhance safety awareness of construction workers via training and education; mitigate the consequences of an injury; prevent fall by the use of personal protective equipment; avoid fall from height risk in the first place; and redesign or replace the bamboo truss-out scaffold supported by steel brackets.

The findings from the focus group meetings held with the workforce level include: employer to provide appropriate personal protective equipment and anchor point; limit the use of non-local workers because they do not possess the same level of safety awareness and training as compared to local workers; increase contract price so that workers do not need to rush jobs risking accidents; and incorporate part of the contract sum for safety measures.

The findings from the focus group meetings held with the supervisory level include: workers must use personal protective equipment; increase monitoring, supervision and inspection; increase education and training; and workers to follow work guidelines and codes of practice.

The industry based questionnaire showed that the top three most favoured strategies for preventing fall from height accidents were: (1) For future building designs the designers should consider including facilities to ensure repair and maintenance safety, and hence reducing fall from height accidents; (2) Workers who work externally at height should be provided with specified safety training; and (3) A registration licensing system for workers working with the bamboo truss-out scaffold should be set up to reduce fall from height accidents.

A number of valuable findings can be concluded from the analysis of the flat owner/tenant questionnaire, some of these include: most respondents undertook repair works in the replacement of air conditioners, and plumbing and drainage works; one-third of the respondents did not have clear understanding about their legal responsibilities in relation to building repair works. Therefore, the concerned parties such as the government and the mass media should disseminate the message to the occupants more clearly and comprehensively; more than half respondents were not sure about the purchase of insurance by the repair works contractors. Moreover, well over half of the respondents did not purchase insurance for the repair works. Again, the concerned parties should publicize the importance of purchasing insurance for maintenance works regardless of size in order to increase the awareness of the occupants about their legal responsibilities on proper implementation of the repair works.

It is believed that construction safety can only be improved with the concerted efforts of various stakeholders in the industry so that effective solutions can be developed to ensure a safe workplace in construction.

Brief Biography of The Hong Kong Polytechnic University Construction Safety Research Team

Professor Albert Chan, *MSc (Aston), PhD (S. Aust.), FCIOB, FAIB, FHKICM, FHKIE, MAIPM, MIEAust, AAIQS, MRICS, RPE(Bldg),* had 5 years hands-on experience in the field of construction project management before changing to an academic career in 1987. He is a Chartered Builder, Engineer, Project Manager, and Quantity Surveyor by profession. Prof. Chan has worked in a number of tertiary institutions both in Hong Kong and overseas, including City Polytechnic, the predecessor of the City University of Hong Kong, the University of South Australia, the Queensland University of Technology, and The Hong Kong Polytechnic University. He has been commissioned by a number of organisations to provide consultancy services in project management and construction economics. Prof. Chan holds an MSc in Construction Management and Economics at the University of Aston in Birmingham, and a PhD in Project Management at the University of South Australia. He is currently Associate Head of the Department, an Adjunct Professor of the Queensland University of Technology, Australia and the University of South Australia; and a Founding Director of the Construction Industry Institute, Hong Kong. His current research interests are in construction management, construction partnering, construction safety, and project management.

Professor Francis Wong, *BSc(Hons), MSc, PhD, FCIOB, FHKIE, FHKICM, RPE(Bldg), MRICS, MCIArb, MCMI, MIOSH,* obtained his BSc (Hons) in Building Degree from the then Brighton Polytechnic in the U.K. He worked for a building contractor in Hong Kong in 1980 and the Mass Transit Railway Corporation two years after. In 1984, he joined the Department. In 1988, he completed his Master's Degree at the University of London, majored in building economics and management. He completed his PhD Degree at the South Bank University in England in 2000 on 'Construction Safety in Hong Kong'. He is currently Head of the Department and the Director of the Research Centre for Construction and Real Estate Economics. In terms of community and professional services, he was the Senior Vice-Chairman of the Chartered Institute of Building (HK Branch) in year 1994/95. Chairman of the Safety Specialist Group of the Hong Kong Institution of Engineers (HKIE) in Year 1999/2000, and Vice-chairman of the Construction Safety and Health Committee of the Occupational Safety and Health Council in Hong Kong from 2001 to 2004.

Dr. Michael Yam, *BSc, MSc, PhD, MASCE, MIEAust, CPEng, MIPENZ, PEng, MHKIE,* obtained his BSc. in Civil Engineering with Distinction and MSc. at the University of Alberta, Canada and completed his PhD degree at the same University in 1994. He subsequently was appointed as a research engineer at the University before returning to Asia in 1995. Prior to joining the Department of Building and Real Estate in early 2002, Michael has spent several years with the University of Macau as Assistant Professor of Civil Engineering, as well as the Hong Kong Technical College as Lecturer. He has also obtained consultancy experience in the areas of the design and construction of both reinforced concrete buildings and structural steelworks in Hong Kong. Michael is a member of the Hong Kong Institution of Engineers, Institution of Professional Engineers New Zealand, Institution of Engineers, Australia and the American Society of Civil Engineers.

Dr. Daniel Chan, *BEng(Hons), PhD, MAPM, MHKICM, MASCE, ICIOB, AMAIB,* is currently an Assistant Professor in Construction Management and Engineering at the Department of Building and Real Estate, The Hong Kong Polytechnic University. He is a project manager and construction manager by profession. He obtained his BEng(Hons) degree in Civil and Structural Engineering and PhD degree in Construction Project Management, from the Department of Civil Engineering, The University of Hong Kong. Upon graduation, he started his engineering profession as an Assistant Structural Engineer by joining a local leading building design consulting engineering practice. He joined PolyU as a Postdoctoral Research Fellow at the Department of Building and Real Estate in Mid-April 2001. He has published several research papers on the broad theme of project management in refereed academic journals and international conference proceedings. His current research interests include construction procurement systems, project partnering and strategic alliancing, construction safety management, public private partnership and target cost contracting. Furthermore, Dr. Chan has been appointed as the Editor of the CII-HK Newsletter "*The Innovator*" and a Member of the CII-HK Editorial Board since July 2003. He has also served on the Committee of the Association for Project Management (Hong Kong Branch) responsible for membership recruitment and university education since November 2005.

Ir Albert Kwok, *MSc (Civil), CEng, MHKIE, RPE(Civil & Structural), MICE, MIStructE, CMIOSH, Registered Safety Officer*, had 12 years working experience in the field of construction work in civil and structural engineering, engaged in a number of housing, footbridges and highways projects before joining The Hong Kong Polytechnic University. He is a Senior Engineer in the Industrial Centre (IC) of the University responsible for planning and administration of IC training programmes for construction students of the University and the sister institutions. He is one of the key teaching staff in subjects of construction safety and safety management in safety programmes offered by IC. Ir Kwok holds a MSc in Civil Engineering at The Hong Kong Polytechnic University and is a Chartered Civil and Structural Engineer by profession, he served in the Safety Specialist Committee of the Hong Kong Institution of Engineers from 1998 to 2005 and has been the HKIE's representative in Board of Studies of CITA safety Courses for two years. His research interests and consultancy work are mainly in areas of construction safety and safety management.

Professor Edwin Chan, *Architect (Authorized Person), Building Engineer, Barrister-at-law and Arbitrator*, studied Architecture in England and then learnt Law at London University and Hong Kong University. He obtained his PhD degree from London University on construction dispute management. He is a Chartered Architect (Authorized Person) and is also a Barrister-at-Law called to the UK and Hong Kong Bars. Before joining the Hong Kong Polytechnic University, he had worked in industry for over 10 years with practical experience in project management and building control in the UK and Hong Kong. His is currently involved with teaching/research and consultancy on development control framework, construction law and dispute resolution.

Dr. Edward Yiu, *BSc(Hons), MPhil, PhD, MRICS, MHKIS, PFM,* is a qualified Building Surveyor by profession. He has worked in two tertiary institutions in Hong Kong, including the City University of Hong Kong and the Hong Kong Polytechnic University. Dr. Yiu holds a PhD in Real Estate Economics at the University of Hong Kong in Hong Kong. He is currently the technical committee chairman of the Asian Institute of Intelligent Buildings and a corporate member of the Hong Kong Institute of Facility Management. His current research interests are in building maintenance and management, and real estate economics and finance.

Dr. Edmond Lam, *BSc, PhD,* obtained his BSc(Hons) degree in Construction Economics and Management with commendation (First in Class). After graduation, Edmond worked in a construction cost consultancy firm in Hong Kong as Assistant Quantity Surveyor and later joined the University again where he obtained his PhD degree in Construction Procurement Management. He is currently a Post-doctoral Fellow in Construction Management at the Department of Building and Real Estate, The Hong Kong Polytechnic University. Dr. Lam has published several research papers on the theme of construction procurement management in refereed academic journals and international conference proceedings.

Miss Esther Cheung, *BEng(Hons), MPhil,* obtained her BEng(Hons) degree in Environmental Engineering at The University of Nottingham in England. After several years of working in research she further studied for an MPhil degree in Civil Engineering at The Hong Kong Polytechnic University. She is currently a Research Associate in the Department of Building and Real Estate at the Hong Kong Polytechnic University.

TABLE OF CONTENTS

Chapter 5 Analysis of Statistical Data

Chapter 6 Case Studies on Fatal Accidents

Chapter 7 Analysis of Interviews and Focus Group Meetings

List of Tables

List of Figures

Chapter 1

INTRODUCTION

Chapter 1 Introduction

1.1 Background

The ageing of buildings in Hong Kong has become an alarming concern for the government and the general public recently. In order to manage the residential buildings in good condition, there is an increasing demand on repair and proper maintenance of existing housing stocks. The Hong Kong's construction industry has shown significant improvement in safety performance recently. The number of industrial accidents in the construction industry has decreased from 11,925 in 2000 to 3,833 in 2004, which is an encouraging drop of almost 68%. However, fall of person from height has always represented a large proportion of the fatal accidents. In 2004, fall of person from height represented just over 47% of the total number of fatal accidents in the construction industry. There exists an urgent need for ways to improve construction safety at work, particularly in residential building repair and maintenance in the local context so that better safety performance can be pursued.

Falls from height in construction projects have long been a major problem and the prevention of accidents involving falls from height remains a high priority for the construction industry (Glasgow Caledonian University, 2005). Previous researchers have conducted surveys on causes of fall accidents, types of fall precautionary measures and practical solutions to fall accidents. For instance, Huang and Hinze (2003) pointed out that the inadequate or inappropriate use of fall protection equipment and inoperative safety equipment can contribute to more than 30% of the falls. Moreover, Construction Worker Research Group (1998) explained the effects of human factors, which are involved when the causes of accidents are attributed to the failure of an individual to act promptly to avoid it. More recently, Glasgow Caledonian University (2005) conducted a comprehensive study on fall prevention and arrest equipment available to the construction industry, including purlin trolley systems, safety decking, fall arrest mats, safety netting,

cable and track-based fall arrest systems, and the use of fall arrest equipment when erecting, altering and dismantling scaffold. Some practical solutions to reducing fall accidents at the workplace, such as the use of new technologies and techniques, an effective safety management system and the concerted efforts of construction personnel, have been suggested by previous researchers (Dalton, 2002; Howell *et al*., 2002; Huang and Hinze, 2003). However, most research focuses on general construction at large and the nature of repair and maintenance is less taken into consideration.

1.2 Recent advancements on construction safety involving working at height

Construction safety is not only the concern of researchers in the academic field; however, practitioners from the government and the industry have also put much effort in improving safety performance of working at height for residential building repair and maintenance works. The Labour Department of the HKSAR has stipulated various ordinances, regulations, guidelines and safety procedures for maintaining construction safety. Statutory provisions on the prevention of fall of person from height are set out mostly under the Factories & Industrial Undertakings (F&IU) Ordinance and its subsidiary regulations, as well as under the Occupational Safety and Health Ordinance. The Accident Analysis and Information Division of the Labour Department recently produced a report entitled 'Accidents in the Construction Industry of Hong Kong (2000-2004)' to identify the category, trend and causes of fall of persons on building repair and maintenance works. The Labour Department and the Occupational Safety and Health Council have also produced many safety work guidelines related to fall prevention, fall identification and fall minimization. These documents have adapted international best practices and combined them with the local context to derive suitable guidelines for Hong Kong. With a view to tackling malpractice in the use of ladders, the Hong Kong Architectural Services Department produced key notes on enhanced measure for safe use of ladders. Internationally, the Work at Height Regulations 2005 of U.K. have just been in force in April 2005 for proper implementation of working at height. Some property

management companies in Hong Kong have set out working at height guidelines, safety handbook and working at height instructions for workers to follow.

In Hong Kong, residential building repair and maintenance works rely heavily on the use of bamboo truss-out scaffold supported by steel brackets. However, the current practice of erecting a temporary platform by way of a bamboo truss-out scaffold supported by steel brackets is considered as highly unreliable and a number of fatal accidents have occurred. To provide local contractors with a suitable anchor point, a temporary transportable anchor device was devised and manufactured in the U.S. and the U.K. The Labour Department and the Occupational Safety and Health Council jointly launched such devices for use by maintenance contractors through a sponsorship scheme. In the private sector one of the largest property developers in Hong Kong produced a report to prevent accidents with bamboo truss-out scaffolds in 2005. Another leading scaffolding specialist has recently introduced a computerized climbing scaffold system to the local market.

1.3 Aim and objectives of the current study

The study aims at improving construction safety involving working at height for residential building repair and maintenance works. It sets out to identify situations where such works are necessary and to investigate the causes of any associated accidents and problems. The objectives of the study include:

(a) To conduct a full scale investigation to identify situations where working at height are necessary in residential building repair and maintenance and to establish data on the scale of their significance in quantitative terms;
(b) To investigate the causes of these accidents;
(c) To recommend practical, cost-effective and user-friendly technological solutions to tackle the problem;
(d) To recommend precautionary measures so as to prevent the occurrence of the problem;

(e) To propose a viable regulatory framework to address the legal, economic, and social aspects of the problem.

1.4 Research approach

To achieve the objectives set, the following research approach has been adopted:

(a) Literature on fall from height accidents in repair and maintenance works are extensively reviewed, including books, journals, magazines, newsletters, proceedings from conferences, workshops, seminars and other sources.
(b) Past and current practices of fall accidents are documented. The review exercise includes the development of an instrument to conduct the interviews, focus group meetings and questionnaires.
(c) Statistical data of accidents in Hong Kong are collected to identify the causes of accidents. The analysis from the statistics is used to verify the literature study conducted. The statistical data together with the literature review combine to form the foundations for the interview questions, questionnaire survey and discussion topics in the focus group meetings.
(d) Structured interviews and focus group meetings are held with government officials and practitioners in the industry to solicit views on safety practices and management, causes of fall related accidents at workplace, practical solutions to construction safety for working at height and roles of concerned parties in construction safety. The information collected from the interviews, questionnaire surveys and focus group meetings are fully documented individually.
(e) Questionnaire surveys are conducted to perform a large scale analysis of whether the ideas solicited in the literature review, interviews and focus group meetings are representative.
(f) Possible solutions are suggested to improve construction safety involving working at height.

1.5 Structure of the report

The report is composed of nine chapters. This chapter is a general introduction to the research. It consists of an introductory background of previous research and recent advancements in construction safety involving working at height. This chapter also outlines the aim and objectives of the research, the overall research approach and the structure of the report.

Chapter Two reviews the literature on principal locations and causes of fall accidents, types of fall precautionary measures, practical solutions to fall accidents, relevant codes of practice; and major current legislative controls for fall accidents in construction projects.

Chapter Three explains the methodology adopted for the research. The research framework will be introduced in this chapter.

Chapter Four reviews the current practice for doing external maintenance work in Hong Kong. Some of the collected local and international practices will be presented. In addition, an engineering solution which can be an alternative for the bamboo truss-out scaffold designed by members of the research team will also be outlined.

Chapter Five presents the statistical data collected from the Architectural Services Department and the Labour Department. The category, trend and causes of fall of persons on building repair and maintenance works will be figured out to identify the key issues. The two sources of data will then be compared and contrasted for similarities and differences.

Chapter Six illustrates 22 fatal industrial accidents associated with fall of persons from height in repair, maintenance, minor alteration and addition works between 2000 and 2004 from the statistics of the Labour Department. The common causations and features

of the mishaps will be identified, analogy on the rationale will be drawn and appropriate preventive measures for the industry will be recommended from a comparative analysis.

Chapter Seven presents the summary of structured interviews and focus group meetings with representatives from the governmental departments, private construction companies and workers organizations. Such details as safety practices and management, causes of fall related accidents at workplace, practical solutions to construction safety for working at height and roles of concerned parties in construction safety will be illustrated and analysed.

Chapter Eight delivers the results from industry based questionnaire and flat owner/tenant questionnaire. Details of the distribution of questionnaires will be given, analysis and major findings will be presented.

Chapter Nine gives a summary of the major findings derived from the research. It provides conclusions and recommendations for the research.

1.6 Summary

This chapter describes the scope of the research. The background of the research has been presented. The aim and objectives of the study are clearly stated to direct the study of this research. The structure of the report is also formulated.

Chapter 2

LITERATURE REVIEW

Chapter 2 Literature Review

2.1 Introduction

Literature related to fall from height accidents in repair and maintenance works will be extensively reviewed in this chapter. The literature search was conducted by referencing from books, journals, magazines, newsletters, proceedings from conferences, workshops, seminars and other sources. This chapter provides a review of literature on (1) principal locations and causes of fall accidents; (2) types of fall precautionary measures and (3) practical solutions to fall accidents; (4) relevant codes of practice; and (5) major current legislative controls for fall accidents in construction projects. The review exercise will include the development of an instrument to conduct the interviews, focus group meetings and questionnaires which are presented in Chapters 7 and 8 of this report.

2.2 Principal locations of fall accidents

Falls from height in construction projects are a major problem and the prevention of accidents involving falls from height remains a high priority for the construction industry (Glasgow Caledonian University, 2005). There are a number of locations where fall accidents are most likely to take place.

Fall is used to imply a loss of equilibrium and control, including subsequent recovery by the subject (Ertas *et al*., 1990). In general, fall injuries can be classified as occurring from an elevated work surface (e.g., ladders, scaffolds, roofs, buildings, stairs, vehicles, into an opening, etc.) or from the same level (Cattledge *et al*., 1996a). Moreover, nonfatal falls from elevation present a significant problem for individuals employed in the construction industry. Working at height is either carried out from the permanent structure or from some form of additional access equipment. This could either be permanently attached or dedicated to the structure, such as permanent gantries, suspended cradle, ladders or

walkways. In some cases, they may be temporarily installed for the work, such as scaffolds, mobile elevating work platform, suspended platforms or ladders (Malcolm, 2000). In some buildings, work at height is required to deal with natural deterioration.

Hinze and Russell (1995) identified the most common fall locations listed in order of occurrences as follows: (1) off roof, (2) collapse of scaffolding, (3) off scaffolding, (4) collapse of structure, (5) through floor opening, (6) off ladder, (7) off structure, (8) through roof opening, (9) off edge of open floor, (10) off beam support. They also attributed fall accidents to some external forces, such as the collapse of a support system, getting struck by an object, falling through an unknown or unprotected opening, and so on. The classifications are similar to those of Construction Worker Research Group (1998), and Huang and Hinze (2003), who associated falls with workers on roofs, scaffolds, ladders, edges of structures, beam supports and floors with openings. Moreover, Agnew and Suruda (1993) found that fall injuries mostly happened with use of the ladder as a work platform and, Cohen and Lin (1991) pointed out that falls from ladders are second only to stairway falls as the most frequent source of injury involving falls from elevation.

It is clear that falls from elevation can cause serious injuries and falls from ladders are quite common in the workplace. The next section examines the causes of fall accidents in construction works.

2.3 Causes of fall accidents

Previous researchers analysed the causes of fall injuries from three main perspectives, namely unsafe conditions, management inactions and human-related factors.

2.3.1 Unsafe conditions

Toole (2002) identified the root causes of construction accidents, namely unsafe site conditions, lack of proper training, deficient enforcement of safety, insufficient provision of safety equipment, unsafe methods or sequencing, workers not using provided safety equipment, poor attitude toward safety, and isolated and sudden deviation from prescribed behavior. Cohen and Lin (1991) provided a detailed account of the reasons of falls from ladders, which are due to unevenness or slipperiness of the surface at work. Other causes of ladder fall accidents included excessive angle of inclination, breathing of toxic fumes or vapors present in the work area and using ladders with rear rail removed. Abdelhamid and Everett (2000) also identified that failing to identify an unsafe condition that existed before an activity started or that developed after an activity started can be a reason for fall injuries.

2.3.2 Management inactions

In fact, workers may die or be injured if scaffold equipment and fall protection systems are defective or misused. The Centers for Disease Control (1992) pointed out that fatal falls occur as a result of defective scaffold equipment, improper installation or operation, improper training of workers, or a failure to use appropriate personal fall protection equipment. Janicak (1998) also believed that the lack of protection in place was the most frequently identified cause, followed by structure/equipment collapse, improper work surface and damaged fall protection measures. This was echoed by Cattledge *et al.* (1996a) who analyzed that falls may occur from elevated scaffolds, walkways, and work platforms because of insufficient or nonexistent guardrails or personal fall protection systems. Huang and Hinze (2003) pointed out that the inadequate or inappropriate use of fall protection equipment and inoperative safety equipment can contribute to more than 30% of the falls. Malcolm (2000) related the causes of fall accidents to improper safety management, which include poor training, inadequate supervision and management, lack

of maintenance of access equipment and structures, and the provision of unsuitable equipment or implementation of unsuitable working procedures.

2.3.3 Human-related factors

Some human-related factors contribute significantly to the causes of fall accidents. The Construction Worker Research Group (1998) explained the effects of human factors, which are involved when the causes of accidents are attributed to the failure of an individual to act promptly to avoid it. The accidents were not necessarily caused directly by the victims, but may result from the lack of action or the use of inappropriate action by any one person in the activities leading up to the accident. Cohen and Lin (1991) found out that the falls from ladders are due to the workers not wearing personal protective devices (e.g., fall arresters), and not properly securing the top section of an extension ladder which slid down while the injured employee was on it. Abdelhamid and Everett (2000) suggested the uniqueness of the construction industry dictate the need to tailor many of the contemporary accident causation models and human error theories. They pointed out that workers may still proceed with a work activity even after the existing unsafe condition was identified. The workers may also act unsafely regardless of initial conditions of the work environment.

In fact, the three main causes of fall accidents are inter-related (Malcolm, 2000). Abdelhamid and Everett (2000) believed that the unsafe conditions are due to four causes: (1) management actions/ inactions; (2) unsafe acts of worker or coworker; (3) non-human-related events; (4) an unsafe condition that is natural part of the initial construction site conditions. Moreover, a fall is rarely the result of only one of these reasons and the actual risk faced by those who work at height is therefore dependent on the inter-relationships among the reasons (Malcolm, 2000). The design of the workplace and the tasks to be performed also contribute to fall accidents (Cattledge *et al*., 1996a).

2.4 Types of fall precautionary measures

Working at height is dangerous, especially in residential building repair and maintenance works where the sites are congested with restricted space available. It is necessary to wear appropriate fall precautionary measures to save lives from accidents. Huang and Hinze (2003) classified the measures into active measures (those that prevent workers from falling, for example, guardrails) and passive measures (those that protect workers after falling, for example, safety nets).

2.4.1 Common types of fall preventive measures

Glasgow Caledonian University (2005) conducted a comprehensive study on fall prevention and arrest equipment available to the construction industry, and the common precautionary measures are described as follows.

(a) Purlin Trolley Systems (Figure 2.1): the systems are prefabricated trolleys that are attached to a safety deck, which is adjustable to various purlin spacings, and are positioned just below the purlin surface. The safety deck ensures fall prevention between the trolley and the open edge of the roofing sheets being fitted. If purlin trolley systems are considered for refurbishment works, attention must be paid to the load-bearing capabilities of the existing structure.

Figure 2.1 Purlin trolley systems (Glasgow Caledonian University, 2005)

(b) Safety Decking: all safety decking systems are lightweight working platforms positioned just below the working area and capable of supporting a person and their light tools; popularity is growing. Two common categories are: made up of plastic decking panels supported in position by props (PSD, Figure 2.2); and an extended aluminum trellis arrangement, which is positioned on the joists or trusses of the roof being constructed (EAT, Figure 2.3). On many occasions, PSD cannot be considered for refurbishment works, due to a lack of restraining walls on all four sides of the system, to provide lateral support.

Figure 2.2 PSD system (Glasgow Caledonian University, 2005)

Figure 2.3 EAT system (Glasgow Caledonian University, 2005)

(c) Fall Arrest Mats; there are two types in the UK: the air-mats (Figure 2.4), and the soft-filled mats (Figure 2.5). The mats are designed to decelerate or cushion the operatives' fall and hence minimize the worst effects of a fall from height. They were not originally designed for use during maintenance and refurbishment works but advances in system design of air-mats, i.e., the parapet bags, has provided potential for use under certain conditions in this industry.

Figure 2.4 Air-mats (Glasgow Caledonian University, 2005)

Figure 2.5 Soft-filled mats (Glasgow Caledonian University, 2005)

(d) Safety Netting (Figure 2.6): the netting used in UK construction industry is manufactured and using techniques adopted from the fishing industry. Types include safety netting with a border rope, attached on brackets for horizontal use, attached to supporting framework for vertical use, and with a border rope attached to a gallow type support. Situations exist during maintenance and refurbishment that favours the use of safety nets as a fall arrest system, e.g., below roof level during re-roofing works.

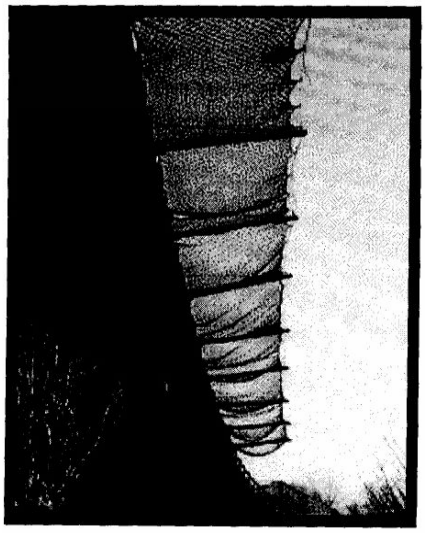


Figure 2.6 Safety netting (Combs et al., 1998)

(e) Cable and Track-Based fall arrest systems (Figures 2.7 and 2.8): the systems consist of a number of components that together provide continuous attachment and 'hands-free' working to the users. They can either restrain the user from accessing the area of risk or arrest them in the event of a fall. Cable and track systems are 'personal fall arrest systems' and, as such, are at the lower end of the fall protection hierarchy. Installation and dismantling of the system involves time and coordinated effort by trained personnel. They are mostly used when people are working at height near to, or at, an exposed edge or other fall hazard. They are installed primarily to assist in maintenance functions during the building's life.

Figure 2.7 Typical cable system (Glasgow Caledonian University, 2005)

Figure 2.8 Typical track safety system (Glasgow Caledonian University, 2005)

(f) NASC's SG4:00: The Use of Fall Arrest Equipment when Erecting, Altering and Dismantling Scaffold – SG4:00 (Figure 2.9) is a significant step forward for safety in the scaffolding industry published by the National Access and Scaffolding Confederation (NASC). In order that SG4:00 is properly implemented, there is a requirement to use fall arrest equipment. With continued support from key industry stakeholders, the system will become industry normal good practice and be accepted by all scaffolders as the safe way to work.

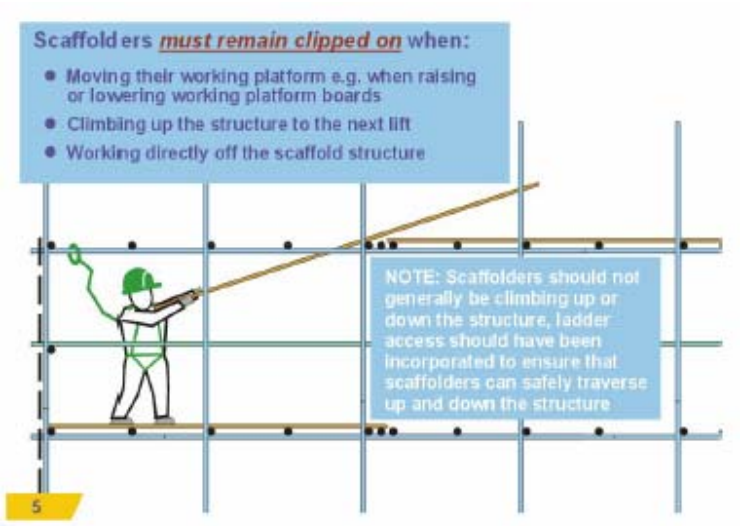


Figure 2.9 SG4:00 in pictorial format (Glasgow Caledonian University, 2005)

Glasgow Caledonian University (2005) introduced the principles of the 'hierarchy of risk control', which are important when selecting appropriate safety equipment for working at height. The order of preference for the above precautionary measures should be prevention, such as the use of guardrails, purlin trolleys and safety decking, followed by the mitigation of any consequences of an accident. Moreover, the risk of a fall must be designed out and the selection of fall protection equipment should be carefully considered prior to opting for a particular system.

Other researchers, such as Cattledge et al. (1996a) suggested that most fatal fall injuries can be prevented through the use of proper personal fall protective equipment, such as

lifelines, lanyards and employee training in fall prevention. The suitable safety measures such as working platform, guard-rails, toe-boards, safe access and egress should be provided to prevent fall accidents (Agnew and Suruda, 1993). Gillen et al. (1997) further suggested some simple hazard control measures in the common fall locations, e.g., perimeter protection for roofs and floor edges, correct ladder placement and anchorage, guarding of floor openings, comprehensive housekeeping activities, inspection and maintenance of ladders and aerial lifts, proper scaffold erection and modified work practices. In fact, Huang and Hinze (2003) pointed out that the current personal fall arrest systems (PFAS) can effectively protect workers after they fall from an elevation.

Prevention is always better than cure. Results showed that 33% of the fatalities in construction were caused by falls (Hinze *et al*., 1998). Apart from the various precautionary measures, some practical solutions were proposed by previous researchers to safeguard construction safety at work.

2.5 Practical solutions to fall accidents

Previous researchers suggested some practical solutions to reducing fall accidents at the workplace, which rely on the use of new technologies and techniques, an effective safety management system and the concerted efforts of construction personnel.

2.5.1 Use of new technologies and techniques

Various new technologies and techniques have been adopted by organizations within the scaffolding industry to attempt to prevent falls, such as the above-head fixing clamps, portable clamps incorporated into a lanyard, inertia reels/blocks, advanced guardrails and pole systems (based mainly on technique rather than equipment) (Glasgow Caledonian University, 2005). Moreover, training should be provided for scaffolders. Huang and Hinze (2003) evaluated some innovative fall protection measures for fall accidents occurring on low-rise roofs and concluded that prefabrication was the most promising

method, followed closely by the personal fall arrest system. In fact, safety is always overlooked until the start of the construction phrase (Gambatese and Hinze, 1999). Therefore, designers should be trained in health and safety issues or such experts should be recruited to work with the designer at the design stage (Dalton, 2002). For instance, clients, architects, and engineers planning renovation or designing new facilities should incorporate strategically located anchor points on structural members of buildings for future exterior maintenance and repair work so anchor drop lines for body belts or harness systems and tiebacks for suspension scaffold support devices can be used. Drop lines and tiebacks should be secured to separate anchor points on structural members (Centers for Disease Control, 1992). Moreover, Gambatese and Hinze (1999) believed that facility designers can positively influence construction site safety by integrating safety considerations into the design process.

2.5.2 Effective safety management system

Cattledge et al. (1996a) stressed the importance of management implementation and enforcement of fall protection and prevention measures at the jobsite. The Centers for Disease Control (1992) also recommended some measures to prevent serious injuries and fatal falls while working from suspension scaffolds, such as the inspection of all scaffolds, scaffold components and personal fall protection equipment before use. They believed that the scaffolds should be erected, moved, dismantled, or altered only under the supervision of a competent person. All components of personal fall protection equipment, including body belts or harnesses, lanyards, droplines, trolley lines, and points of anchorage should be inspected by a competent person before use. Any visibly damaged or worn equipment should be removed from service immediately. The scaffold manufacturers' guidance regarding the assembly, rigging, and use of scaffolds should also be strictly followed. In fact, employee training is crucial to ensuring that the fall protection program works (Janicak, 1998). Employees should be trained on the fall hazards in the work-place. Those situations that require fall protection and the proper system to use should also be addressed. Training should also include how to properly

install, use, test, and inspect the fall protection systems. This idea was echoed by Janicak (1998), who believed that prevention activities should include employee training, the enforcement of the use of fall protection systems, and inspection and testing of the fall protection system in use. Howell *et al*. (2002) asserted that worker training and motivation is the key to prevention, and Howell *et al*. (2002) described the essential elements of most safety programs, including training, responding to regulation, motivation, planning, investigation and incident analysis.

2.5.3 Concerted efforts of construction personnel

The roles of design and construction professionals in site safety should be clarified (Toole, 2002). It is problematic that detailed expectations about safety roles are not written in project contracts or governmental standards. The clients should be obliged to promote health and safety, e.g., a requirement to take an active part in the selection and approval of subcontractors (Dalton, 2002). They should encourage designers to specifically address construction worker safety in their designs (Gambatese and Hinze, 1999). They should take an initiative to enforce the proper use of fall protection systems and establish fall protection inspection and maintenance programs to ensure that when the systems are used, they perform adequately (Janicak, 1998). For instance, the scaffold workers should be protected by a Type I guardrail system or a combination of body belt or harness system with a Type II guardrail system (Centers for Disease Control, 1992, Figure 2.10). However, when single-point and two-point adjustable suspension scaffolds are used, workers should be protected by both a body belt or harness system and a Type I or Type II guardrail system. Also, when boatswain chairs, catenary scaffolds and float scaffolds are used, workers should be protected only by a body belt or harness system. Malcolm (2000) pointed out that the competence of the persons doing the work, both of the operatives and their managers/supervisors, is critical if accidents are to be avoided. Such workers should always be reminded to avoid fall hazards through warnings and administrative controls such as training and inspections (Huang and Hinze, 2003). Moreover, safeguarding construction safety requires management ownership and

commitment. Such parties should be aware that the commercial disadvantages and reputational hazards of poor safety performance may motivate improvements in management commitment.

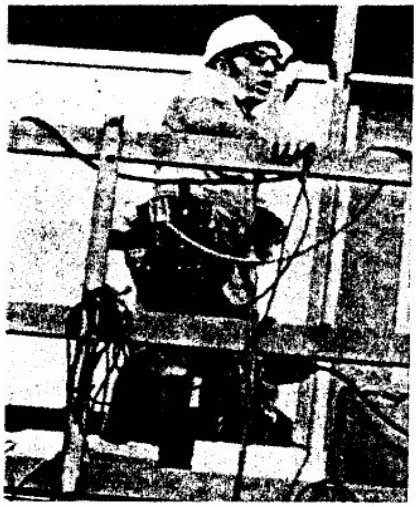


Figure 2.10 Preventive measures in suspension scaffolds
(Centers for Disease Control, 1992)

Work-related deaths can be prevented by improvements in the physical work environment and more attention to personal safety (Construction Worker Research Group, 1998). Malcolm (2000) advocates an approach to safety that is based on a hierarchy of protection. The hazards can be eliminated by the work being done at ground level where possible, which is agreed by Huang and Hinze (2003) who believed that the elimination of or substitution for the operation that can lead to falls can control fall hazards. If it is not possible, then other options would be required to guard the hazard, to protect the person, and to provide some form of mitigation measures. In fact, safety efforts should be focused on fall protection if dramatic improvements in safety performance are to be made (Hinze and Russell, 1995).

2.6 Review of regulatory framework in HKSAR government

The Labour Department of the HKSAR has stipulated various ordinances, regulations, guidelines and safety procedures for maintaining construction safety (Table 2.1). Statutory provisions on the prevention of fall of person from height are set out mostly under the Factories & Industrial Undertakings (F&IU) Ordinance and its subsidiary regulations, as well as under the Occupational Safety and Health Ordinance. The main objective of the legislation is to ensure that workplaces on construction sites are safe and to safeguard the workers from exposure to hazards during construction. The most notable requirements regarding falling from height are explicitly stated in Part VA of the Construction Sites (Safety) Regulations (CSSR) (CAP 59I 2003). In addition to these regulations, the third schedule of the Construction Sites (Safety) Regulations lists out all specific requirements and practices for performing works in construction sites.

Other statutory provisions on the use of safety equipment include the use of suspended working platform under regulation 15 of the Factories and Industrial Undertakings (Suspended Working Platforms) Regulation; the use of a receptacle of less than 900mm deep for carrying persons by a lifting appliance under regulation 18B(1) of the Factories and Industrial Undertakings (Lifting Appliances and Lifting Gear) Regulations..

The above regulations with regard to fall of person from height also impose responsibilities on both employers and employees. Indeed, Section 6A and 6B of the Factories & Industrial Undertakings Ordinance enforce general duties on proprietors and employees of industrial undertakings. Section 6A states that employers should provide all necessary equipment to ensure that the works are safe and without risk to health. These provisions are not only binding for principal contractors, subcontractors who are employers and who have management or control of construction activities within the site are also regarded as proprietors and are therefore bound by Section 6A. Section 6B specifies that every employee should take reasonable care for the safety and health of

himself and other persons; and to follow the duty and requirement given by the employers for securing health and safety.

Table 2.1 Current legislations affecting working at height

Current Legislations affecting Working at Height
Factories and Industrial Undertakings Ordinance, Chapter 59
Construction Sites (Safety) Regulations, Chapter 59I
Factories and Industrial Undertakings (Lifting Appliances and Lifting Gear) Regulations, Chapter 59J
Factories and Industrial Undertakings (Suspended Working Platforms) Regulation, Chapter 59AC
Factories and Industrial Undertakings (Safety Management) Regulation, Chapter 59AF
Occupational Safety and Health Ordinance, Chapter 509
Buildings Ordinance, Chapter 123

2.7 Types of control

There are 3 main types of control by the Government to arouse safety awareness to the construction industry, i.e., safety legislation, codes of practice and practice notes.

2.7.1 Safety legislation

The laws governing safety on construction sites fall under 4 categories:

a. the Common Law, which broadly assigns responsibility for the safety of people working on a site to those who exercise control over them;
b. the Factories and Industrial Undertakings Ordinance, Chapter 59 and its subsidiary regulations relevant to construction works;
c. the Occupational Safety and Health Ordinance, Chapter 509 which is to ensure the safety and health of persons when they are at work and to amend the Factories and

Industrial Undertaking Ordinance;

d. the Buildings Ordinance, Chapter 123, which addresses the planning, design and construction of buildings and associated works; and makes provision for the rendering safe of dangerous buildings and land..

The Factories and Industrial Undertakings Ordinance was enacted in 1955. It is the principal legislation governing health and safety at work in Hong Kong and is enforced by the Factory Inspectorate of the Labour Department. It empowers the Commissioner for Labour to make and amend the regulations and to approve codes of practice that are applicable to the construction industry.

Some of the major construction safety related subsidiary legislations under Factories and Industrial Undertakings Ordinance are listed below:

1. Construction Sites (Safety) Regulations;
2. Factories and Industrial Undertakings (Lifting Appliances and Lifting Gear) Regulations;
3. Factories and Industrial Undertakings (Safety Officers and Safety Supervisors) Regulations;
4. Factories and Industrial Undertakings (Suspended Working Platforms) Regulation;
5. Factories and Industrial Undertakings (Safety Management) Regulation.

A. Factory and Industrial Undertakings Ordinance

These clauses were introduced by the Factory and Industrial Undertakings (Amendment) 1989. Clause 6A states that the employers should take all reasonably practicable steps to ensure the health and safety of all persons employed at the workplace. Clause 6B states that the workers have the duty to exercise reasonable care at work and co-operate with the employers on safety measures. Clause 6C extends the scope of legislation to incidents which may occur off the construction site, but during which time the worker is still engaged in activities which are related to his task as a construction worker. The Regulation 6 of the Factories and Industrial Undertakings Ordinance was enacted in 1999.

It stipulates that all construction personnel including workers, management and professional site staff should receive the approved safety training course and to obtain a pass before they are being allowed to enter construction sites. This approved training course is the Construction Industry Mandatory Basic Safety Training Course (Green Card Course). It aims at educating site personnel about the importance of site safety and their rights and duties in site safety. This legislation is effective for implementation since September 2000. The Green Card will be valid for three years and a half-day refresher course is required to attend for revalidating the certificate.

B. Construction Sites (Safety) Regulations

The Construction Sites (Safety) Regulations was enacted in 1978. The key sections are highlighted below:

Part IA: Employment of Persons Under 18 Years on Construction Sites: It restricts the employment of persons under 18 years of age on construction sites.

Part II-IV: Use of Hoists: These clauses set out detailed responsibilities of the contractor in term of construction of the hoist and employment of hoist operators.

Part V: Carrying of Persons and Securing of Load on Hoists: It deals with hoists carrying persons and the need to ensure the hoist door is closed before the hoist moves.

Part VA: Scaffolds, Working Platform and Ladders: It deals with precautions when working at height. It should be read in conjunction with the Labour Department's Code of Practice on Scaffolding Safety which stipulates the requirement in the construction and maintenance of steel. Wooden and bamboo scaffolds and working platforms.

Part VIII: Before commencement, construction works including repair and maintenance ones need to notify the Labour Department. But the regulations state that if the work is less than six weeks of duration or involves below ten workers there is no need inform the Labour Department.

C. Factory and Industrial Undertakings (Safety Officers and Safety Supervisors) Regulations

Theses regulations were enacted in 1986 to encourage the formation of a self-regulatory framework in a safety management. In amendment in 1994, a contractor is required to hire a safety officer if he employs 100 or more employees in one or more of his construction sites, and a safety supervisor in any site with 20 or more employees. They assist contractors in promoting the safety and health of workers. Their main duties includes advising safety and health measure, inspecting and reporting potential hazards of the workplace, investigating accidents and dangerous occurrences.

D. Occupational Health and Safety Ordinance

These regulations were enacted in 1997. Regulation 9 states that the Commissioner for Labour may issue improvement notice on an employer if the employer is contravening this Ordinance, Regulation 10 states that the Commissioner may serve a suspension notice on an employer if an activity undertaken on the premises, or the condition or use of any plant or substance located on the premises, shall result in an imminent risk of death or serious bodily injury.

E. Buildings Ordinance

The Buildings Ordinance controls the buildings and the building works instead of the labours, the relevance of this Ordinance to the issue of labour safety shall be perceived as indirect or supplementary. For example, section 4 of the Buildings Ordinance stipulates the requirement of appointing an authorized person as the coordinator and a registered structural engineer for the structural elements of building works or street works. Section 8B requires the registration of building contractors where the applicant must satisfy the Building Authority on, inter alia, the adequacy of its management structure; the appropriate experience and qualifications of his personnel. Site safety record is one of the considerations in the approval of the contractor registration application.

Section 14 and 14A further require the submission of building plans and supervision plan for approval and consent for the commencement of the building works or street works. The technical memorandum of supervision plan, authorized by section 39A of Buildings Ordinance and came into operation on 22 December 1997 and has been replaced by an amended version on 31 December 2005, the new version requires a registered geotechnical engineer to be included in the arrangement and communication structure. The ordinance sets out, inter alia, the principles, requirement and operation of supervision plans. One of the objectives of this plan is to ensure site safety supervision. It addresses the control of hazards from building works or street works so as to mitigate the risk to (1) the workers on site; (2) all persons around the sites; and (3) adjoining buildings, structures and land (Section 4 of the Technical Memorandum). In section 14A of the ordinance the authorized person is required to lodge a supervision plan prior to consent of the application, no approval of the supervision plan is required. A clearly defined management and communication structure, comprising of authorized persons, registered structural engineers and technically competent persons, is required in the supervision plan.

However, some building maintenance works can be exempted from the application of approval and consent by virtue of section 41(3). It renders the above site safety supervision plan not applicable on these exempted works. In the second reading of the Buildings (Amendment) Bill 2003 (Buildings Department, 2003), the introduction of a control regime for minor works was mentioned. The existing control regime under the Buildings Ordinance applies to all private building works with few exemptions. Even minor building works have to comply fully with all the provisions for building works under the Buildings Ordinance.

F. Factories and Industrial Undertaking (Safety Management) Regulation

This regulation was enacted in 1999. It stipulates a contractor to develop, implement and maintain a safety and management system. This system contains 14 elements of which the following elements are being enforced:

1. A safety policy to state the contractor to safety and health at work
2. A structure to implement the commitment to safety and health at work.
3. Training to equip personnel with knowledge to work safely and without risk to health.
4. In-house safety rules to achieve safety management objectives.
5. A programme of inspection to identify hazardous conditions and to rectify any such conditions at regular intervals.
6. A programme to identify hazardous exposure or the risk of such exposure to the workers.
7. Investigation of accidents or incidents and arrangement to prevent recurrence.
8. Emergency procedures to develop, communicate and execute plans prescribing the effective management of emergency situations.
9. Evaluate, elect and control sub-contractors to ensure that sub-contractors are aware of their safety obligations.
10. Establishment of safety committees - contractors with 50-100 workers in a day working in a single or more construction sites must adopt the first 8 elements. For 100 or more workers, the contractors must adopt all the 10 elements and conduct safety audits of their safety management system.

G. Construction Sites (Safety) (Amendment) Regulations 2003

It was approved by the Legislative Council on November 26, 2003 and was published in the Gazette on November 28, 2003 to take immediate effect. The main provisions are:

1. To extend the duties imposed on the principal contractor under most provisions of the principal regulation to any contractor or sub-contractor who has direct control over any construction works in the site;
2. To prescribe in regulation 38A the specific measures required to ensure the safety of workplaces in construction sites;
3. To prescribe in regulation 44 the specific measures required to effectively guard a prime mover, transmission machinery and dangerous parts of other machinery used in construction sites.

Apart from the principal contractor, any contractor or sub-contractor who has direct control over any construction work in the construction site shall be liable for offences committed in carrying out the work. However, it does not mean that the responsibility of the principal contractor to ensure the safety and health at work on the site is diminished.

2.7.2 Code of practice

A. Code of Practice for Bamboo Scaffolding Safety

The code of practice for Bamboo Scaffolding Safety is issued by the Commissioner for Labour under Section 7A of the Factories and Industries Undertakings Ordinance, Chapter 59. It provides practical guidance for the compliance of the requirements set out in Sections 6A & 6B of the Factories and Industrial Undertakings Ordinance and the requirements of the Construction Sites (Safety) Regulations regarding the safety in bamboo scaffolding.

B. Code of Practice for Safe Use and Operation of Suspended Working Platforms

Suspended working platform, which are commonly known as gondolas, are widely used in Hong Kong. The Code of Practice is issued by the Commissioner for Labour in accordance with Section 7A of the Factories and Industrial Undertakings Ordinance, Chapter 59. It provides practical guidance to the owner of a suspended working platform for compliance with the requirements under the provisions of the Factories and Industrial Undertakings (Suspended Working Platforms) Regulation.

C. Code of Practice for Metal Scaffolding Safety

The Code of Practice for Metal Scaffolding Safety is issued by the Commissioner for Labour under Section 7A of the Factories and Industrial Undertakings Ordinance, Chapter 59. It provides practical guidance for the compliance of the requirements set out in Sections 6A & 6B of the Factories and Industrial Undertakings Ordinance and the requirements of the Construction Sites (Safety) Regulations regarding the safety in metal scaffolding.

D. Code of Practice on Safety Management

The Code of Practice on Safety Management is a Code of Practice issued by the Commissioner for Labour under section 7A of the Factories and Industrial Undertakings Ordinance (Chapter 59). It aims to provide practical guidance for proprietors and contractors of relevant industrial undertakings to comply with the legal requirements.

E. Code of Practice for Site Supervision

The Code of Practice for Site Supervision is a Code of Practice issued by the Buildings Department under Buildings Ordinance. It aims to give guidelines to Authorised Persons, Registered Structural Engineers, Registered Geotechnical Engineers, Registered Contractors and other personnel in the building industry for the preparation of supervision plan. It guides such persons in carrying out their respective supervision duties and other site supervision matter.

2.7.3 Practice notes

The Buildings Department published Practice Notes for Authorized Persons and Registered Structural Engineers (PNAP) and Practical Notes for Registered Contractors (PNRC). The Practice Notes provide information to practitioners in construction industry.

A. Practice Note for Authorized Persons and Registered Structural Engineers

The following sections of Practice Notes are related with construction safety:

1. PNAP 184 Code of Practice for Scaffolding Safety

The practice note introduces Codes of Practice for Scaffolding Safety under section 7A of the Factories & Industrial Undertakings Ordinance, Cap 59, which provides practical guidelines to the construction and maintenance of bamboo or metal (tubular) scaffolds. The Code also recommends a safety management system to be developed to meet the provisions of section 6A of the FIUO on general duties.

2. PNAP 185 Suspended Working Platforms

The practice note introduces the Factories and Industrial Undertakings (Suspended Working Platforms) Regulation.

3. PNAP 186 Monitoring for Site Safety

The practice note introduces the Site Monitoring Section in the Legal & Management Division of the Buildings Department to enhance the safety of building works on construction and demolition sites.

B. Practice Note for Registered Contractors

The following sections in Practice Notes deal with construction safety:

1. PNRC 28 Code of Practice for Scaffolding Safety

The practice note introduces the Code of Practice for Scaffolding Safety under section 7A of the Factories & Industrial Undertakings Ordinance, Cap 59.

2. PNRC 31 Monitoring for Site Safety

The practice note introduces the Site Monitoring Section in the Legal & Management Division of the Buildings Department to enhance the safety of building works on construction and demolition sites.

2.8 U.K. legislation

A. Work at Height Regulations 2005

The Work at Height Regulations address aspects of work at height including the selection and use of work equipment, and the way the work is planned, organized and managed. The regulations are intended to minimize the risk of falls whilst working at height.

1. Application

Regulations 3 and 14 state that the Work at Height Regulations 2005 apply to all work at height where there is a risk of a fall liable to cause personal injury. They place duties on employers, the self-employed, and any person who controls the work of others.

2. Persons Involved

Regulations 5 & 6 state that everyone involved in the works is competent. This includes involvement in organization, planning, supervision, and the supply and maintenance of equipment.

3. Employer's Duty

Regulation 6 states that an employer must do all that is reasonably practicable to prevent anyone falling. He is to ensure all work at height is properly planned and organized; all work at height takes account of weather conditions that could endanger health and safety; those involved in work and height are trained and competent; the place where work at height is done is safe; equipment for work at heights is appropriately inspected and the risks from falling objects are properly controlled.

4. Provision of Equipment

Regulations 6, 7, 8 & 12 state an employer must provide equipment for preventing a fall occurring. If the precautions do not entirely eliminate the risk of a fall occurring, an employer must do all that is reasonably practicable to minimize the distance and effect of a fall.

5. Constant Inspections

Regulations 12 & 13 state that an employer must ensure that each individual place at which work is to be done at height is checked on every occasion before the place is used.

2.9 Summary

The construction industry has been identified as one of the most hazardous industries. Of all the construction-related injuries, falls are the leading cause of death. The first half of this chapter identified the common fall locations and the major causes of fall accidents. It also introduced different types of fall precautionary measures and the practical solutions to fall accidents.

The Hong Kong Government imposes legislations, codes of practice and practice notes to arouse safety awareness in construction safety. The second half of this chapter reviews all the statutory requirements in Hong Kong and legislation in U.K. concerning working at height and maintenance. In fact, there are related controls governing construction safety in general. Still, the small-scale and short duration nature of building repair and maintenance works should deserve more attention. Therefore, more effort should be put to rectify the situation, particularly in the area of building repair and maintenance involving working at height.

Chapter 3
RESEARCH METHODOLOGY

Chapter 3 Research Methodology

3.1 Introduction

Construction safety involving working at height for residential building repair and maintenance works arouses much concern and there exists a need for in depth investigation. Various research methods have been applied to achieve the objectives set for this study. Both qualitative and quantitative methods will be adopted for data analysis. Results from the analysis of data will be triangulated to verify the accuracy of the findings.

3.2 Overall research approach

The research will combine the use of questionnaire surveys, structured interviews, focus group meetings and case studies to collect information and data on construction safety against fall of person from height accidents in residential building repair and maintenance works. The collected data will contribute to the design of the technological solution and the conclusions and recommendations for the final report. The research framework is shown in Figure 3.1.

Literature on fall from height accidents in repair and maintenance works will be extensively reviewed, including books, journals, magazines, newsletters, proceedings from conferences, workshops, seminars and other sources. Past and current practices of fall accidents will be documented. The review exercise will also include the development of an instrument to conduct the interviews, focus group meetings and questionnaires.

Statistical data of accidents in Hong Kong will be collected to identify the causes of accidents. The analysis from the statistics will be used to verify the literature study conducted. The statistical data together with the literature review will combine to form

the foundations for the interview questions, questionnaire survey and discussion topics in the focus group meetings. The information collected from the interviews, questionnaire surveys and focus group meetings will be fully documented individually.

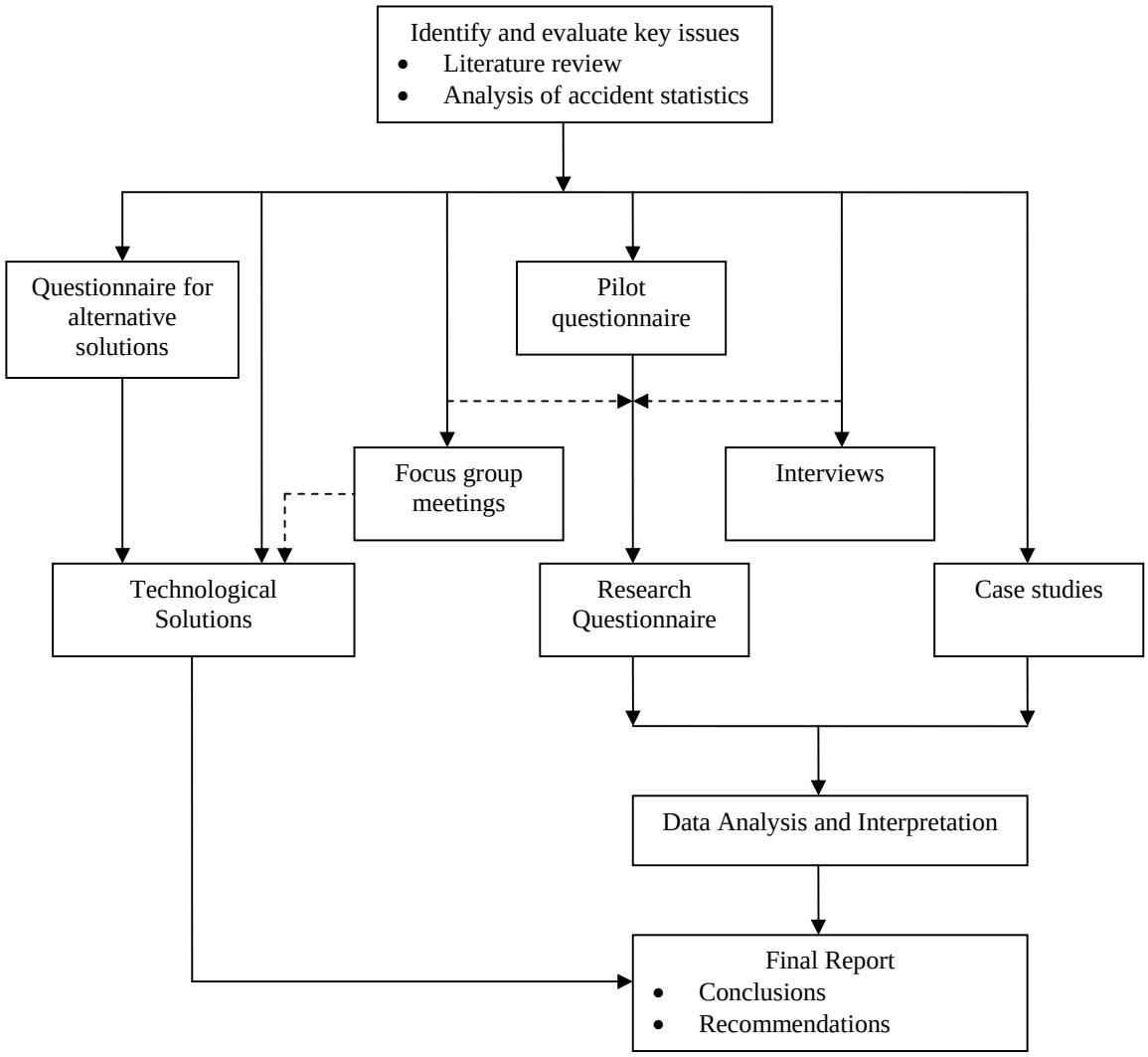


Figure 3.1 A flowchart of the overall research framework

3.3 Quantitative data analysis

3.3.1 Pilot questionnaire

The pilot questionnaire would be drafted to examine whether accidents in repair and maintenance works are effected by safety education and training, the effectiveness of safety messages, the safety attitude of repair and maintenance workers compared to workers of new works, the perception of legislation and responsibility for repair and maintenance works amongst different working levels and also to derive some practical solutions to prevent fall from height accidents in repair and maintenance works by the means of open ended questions. The pilot questionnaire will enable the fine-tuning of the research questionnaire.

3.3.2 Research questionnaire

The research questionnaire is an effective method to seek a large sample size for quantitative data analysis. It was refined by the comments gained from the pilot questionnaire survey and will only target experienced practitioners of repair and maintenance works in Hong Kong from the managerial, supervisory and front-line levels. Two sets of questionnaire survey were developed for the research: 1) Industry based questionnaire; and 2) Flat owner/tenant questionnaire. Following a comprehensive literature review and comments from industry participants, the skeleton of the first set of research questionnaire was formed which covers seven sections: I) Information of Respondent; II) Safety Education and Training; III) Occurrence of Accidents in Repair and Maintenance Works; IV) Safety Messages; V) Safety Attitude of Repair and Maintenance Workers; VI) Legislation and Responsibility; and VII) Practical Solutions to Reduce Fall of Person from Height. They are considered as essential elements for achieving the objectives set for the study. While most questions are set closed-ended on a five-point Likert scale for respondents to rate their level of agreement from ‘Strongly Agree’ to ‘Strongly Disagree’, an open-ended question was set requesting respondents for

their opinion on practical solutions to reduce fall of person from height. This questionnaire focuses on the relationships between accidents and the respondents' background, safety knowledge in repair and maintenance works and attitude towards safety. It also analyses whether improvements to the legal framework are required and which areas are still insufficient. Finally a list of solutions to prevent fall from height accident would be ranked and further solutions will be sought.

Buildings in Hong Kong are ageing and the number of repairs and maintenance works in residential units has been increasing over the last decade. In fact, the occupants in the residential units are mostly the initiators for maintenance work, who engage the maintenance contractors to carry out the required works. In order to investigate the roles of owners and tenants in residential building repairs and maintenance works, the second set of client questionnaire was developed in the survey and was divided into three parts: 1) Information of the respondent; 2) Information of the residential building; and 3) Conditions of maintenance and Legal responsibilities. This questionnaire collects information on the background of respondents and their knowledge about safety at height for repair and maintenance works. It will also indicate the frequency of repair works required and how knowledgeable owners/tenants are towards safety at height. In addition, their feedback on safety aids and promotion from the government will be sought for attention. The quantitative data collected will be analysed using the Statistical Package for Social Sciences (SPSS).

3.3.3 Questionnaire for alternative solutions

In Hong Kong, residential building repair and maintenance works very much rely on the bamboo truss-out scaffold supported by steel brackets. The increasing number of construction accidents related to the bamboo truss-out scaffold supported by steel brackets has meant that effective solutions need to be sought. To proceed with the search for alternatives, the third set of questionnaire was designed requesting for practices/systems in dealing with this type of work. The list of questions covers the faults

related to the bamboo truss-out scaffold supported by steel brackets and the possible solutions to it. The questionnaire was sent to overseas contacts of the research team members and task force members, and via e-mail to members of the group Co-operative Network for Building Researchers (cnbr). Such useful and valuable information was planned to house by an electronic archive in a more logical and systematic manner, both locally and internationally.

3.4 Qualitative data analysis

3.4.1 Case studies

To gain an in depth understanding of the causes of fall accidents in repair and maintenance works, this study will identify a selection of local case studies and analyse them for common failures, features and problems. With the kind help from the Labour Department, information on 22 fatal industrial accidents associated with fall of persons from height in repair, maintenance, minor alteration and addition works between 2000-2004 was obtained under an agreed undertaking and framework. The cases were analysed comparatively with a view to identify the common causations and features of the mishaps, drawing analogy on the rationale and recommending the appropriate preventive measures for the industry. It is hoped that solutions could be sought as a result of identifying the similarities. And hence prevent fall accidents in future repair and maintenance works, especially fatal ones. The findings from the case studies will enable us to verify and triangulate the findings from the other sources of data collection used in this study. The case studies will be analysed collectively to validate the findings. The approach adopted for the case studies will be mapped and the decision making process in the selection of particular approaches and processes will be documented.

3.4.2 Interviews

The target respondents of the interviews will be practitioners of managerial level and supervisory level in repair and maintenance works. The interview questions will be drafted based on the comprehensive literature review. The topics covered in the interview will include safety practices and management, causes of fall related accidents at workplace, practical solutions to construction safety for working at height and also the roles of concerned parties in construction safety. The interviews will be studied individually and collectively. The comments of the interviewees will be incorporated into the research questionnaire for further verification.

3.4.3 Focus group meetings

Focus group meetings will be conducted with practitioners of different working levels in repair and maintenance works. The participants will be at supervisory level and workforce level. The meetings with these two groups of people will be conducted separately in order to gain accurate outputs from the participants. Each meeting will include at least 20 participants, split into groups of 6-10 people. The participants will be asked to discuss issues relating to safety for repair and maintenance works at height. At the end of the discussion each group will present their findings to the other participants via the group leader. The meetings aim to seek reasons behind the causes of fall accidents in repair and maintenance works identified from the literature review, the analysis of statistical data and the case studies. In addition practical solutions may be identified by the practitioners, which will help towards the design of the technological solutions. The insights gained from the interviews and focus group meetings will generate key issues for the refinement of research questionnaire. In fact, both qualitative and quantitative research methods were applied to achieve the objectives set in Chapter 1 ‘Introduction’ (Table 3.1).

Table 3.1 Objectives and research methods of the study

Objectives/Methods	**Literature review**	**Accident statistics**	**Questionnaire**	**Case studies**	**Interviews**	**Focus groups**
To identify situations where working at height are necessary in residential building repair and maintenance; establish data on the scale of their significance in quantitative terms	✓	✓		✓		
To investigate the causes of these accidents	✓	✓		✓	✓	✓
To recommend practical, cost-effective and user-friendly technological solutions to tackle the problem	✓		✓	✓	✓	✓
To recommend precautionary measures so as to prevent the occurrence of the problem	✓		✓		✓	✓
To propose a viable regulatory framework to address the legal, economic, and social aspects of the problem	✓		✓	✓	✓	✓

3.5 Validation of results

Research data and analyses will be triangulated from the multiple sources to help improve the credibility of the findings. Results derived from both the quantitative and qualitative analyses will be cross-referenced to complement each other. The findings will be presented and discussed with experienced practitioners to generate relevant information and to supplement and/or confirm outcomes of these analyses.

3.6 Summary

The chapter provides a detailed account of the research methodology for the study. It presents the overall framework of the research. It also describes the quantitative and qualitative methods by means of questionnaire, case studies, interviews and focus group approach, and highlights the importance of triangulation from various research methods so as to achieve objectives of the study.

Chapter 4

ALTERNATIVE SOLUTIONS TO FALL ACCIDENTS

Chapter 4 Alternative Solutions to Fall Accidents

4.1 Introduction

In Hong Kong, residential building repair and maintenance works very much rely on the bamboo truss-out scaffold supported by steel brackets as shown in Figures 4.1 and 4.2. Due to height and the existing conditions of the high-rise buildings, external wall repair and maintenance works are extremely difficult. For example, it would be impractical to use scaffolding towers or equivalent devices which need to be erected from the ground, to reach a flat say on the 28th floor, for a small job such as changing an air conditioner. However, a lot of fall from height accidents are related to the use of the bamboo truss-out scaffold.

The current practice for doing external maintenance work in Hong Kong is to erect a temporary platform by way of a bamboo truss-out scaffold supported by steel brackets. However, the practice appears to be highly unreliable and a number of fatal accidents have occurred. Between 2000-2004, there were four fatal fall accidents in repair and maintenance works amongst 22 fatal cases that involved the use of bamboo truss-out scaffold (refer to Chapter 6 'Case Studies on Fatal Accidents'). Introduction of steel brackets simplified the procedure by saving time, skill and labour. The simplicity meant that young scaffolders with less experience were also able to construct bamboo truss-out scaffolds. These young scaffolders often lack safety awareness.

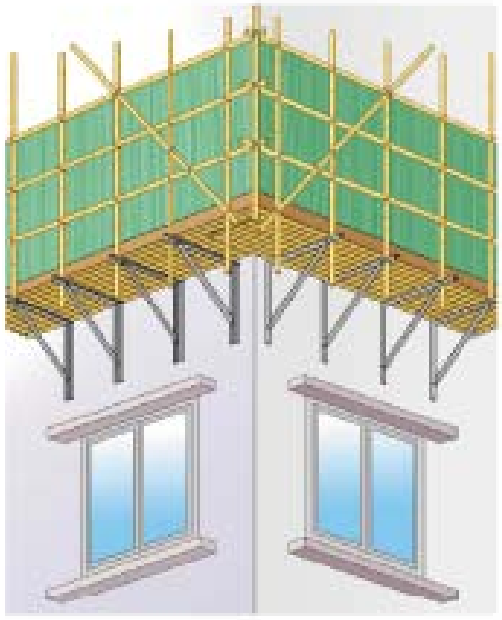
According to the guidelines published by the Labour Department (2002), the bamboo truss-out scaffold should be designed by a competent person or an engineer. The design should include the maximum safety load and the construction method proposed for the bamboo truss-out scaffold. The external wall should be properly examined to ensure that it is strong enough to hold the bamboo truss-out scaffold. The holes drilled for the anchor

bolts should not be too large and be able to just fit the anchor bolts. The anchor bolt should be drilled into the wall and not just the surface finishings of the wall. The steel supporting frames (i.e., steel brackets) should not be positioned too close to the wall edges. Each steel supporting frame should be installed with three anchor bolts unless otherwise approved by a competent person. The bamboo truss-out scaffold should be constructed by an experienced worker and supervised by a competent person. Workers must wear a safety belt which is attached to an individual lifeline or an anchor point that can resist a tensile force of 5 kN. The safety belt must not be attached to the window, window frame or any other object which would be unstable. The bamboo truss-out scaffold should have an appropriate working platform protected by covering. Before the bamboo truss-out scaffold is used, a competent person should inspect the scaffold and report the results using Form 5 issued by Labour Department. Form 5 is an approved from for reporting the results of fortnightly or other inspections of scaffolds under the Construction Sites (Safety) Regulations. The bamboo truss-out scaffold should be inspected regularly especially after bad weather conditions. If problems are detected the use of the bamboo truss-out scaffold should be ceased immediately. In addition the following should not be used or performed: the use of weak steel supporting frames, the use of material or glue to fill up oversized holes for the anchor bolts, the use of broken, split or weak bamboo, overloading the bamboo truss-out scaffold and remove parts of the bamboo truss-out scaffold to avoid obstruction during work.

As told in the first focus group meeting by the workers (refer to Chapter 7 'Interviews and Focus Group Meetings'), in reality the bamboo truss-out scaffold is often constructed by a worker who is probably the same person as the worker performing the repair or maintenance work. Firstly, they will fix the steel brackets to the external wall and this procedure is most likely done by leaning out from a window. The steel brackets are held in place by often only one or two anchor bolts, as the workers claimed that the third anchor bolt is too far and difficult to reach. Then a layer of bamboo will be placed on top of the steel brackets to form a temporary working platform. Surrounding the temporary working platform the workers will also construct a guard rail by use of bamboo.

Figure 4.1 Photo of a bamboo truss-out scaffold supported by steel brackets on a typical residential flat

Figure 4.2 Illustration of a bamboo truss-out scaffold (Labour Department, 2004)



As a result of the increasing number of accidents involving the bamboo truss-out scaffold, the research team felt that Hong Kong needs to rapidly search for alternative methods to the bamboo truss-out scaffold supported by steel brackets. An interview was conducted with a local scaffolding specialists company Wui Loong Scaffolding Works Company Limited (refer to Chapter 7 'Analysis of Interviews and Focus Group Meetings'). To proceed with the search for alternatives a questionnaire (Appendix 1) was designed requesting for practices/systems in dealing with this type of work. The questionnaires were sent to overseas contacts of the research team members and task force members, and via e-mail to members of the Co-operative Network for Building Researchers (CNBR). The questions covered in the questionnaire included the following:

1. What might be the potential problems in adopting bamboo truss-out scaffold supported by steel brackets?
2. Do you use similar system in your country? If so, do you experience similar problems?
3. If not, what system do you use in your country?
4. What other alternatives are available?

As a result of the questionnaire feedback and continuous literature search, a vast amount of information relating to the topic was collected. In order to document such useful and valuable information in a more logical and systematic manner, an electronic archive of literature of solutions preventing fall from height accidents, both locally and internationally, to serve the construction industry is proposed. This archive will be placed on the departmental website (www.bre.polyu.edu.hk) of the research team so that both practitioners and academics can easily get access to the 'working at height' information. At present, there is no such source of information which provides solutions on an international scale. The author of each piece of work was requested for their permission to include their work in the archive, many of the authors have already allowed their permission in writing.

In the following sections of this chapter some of the collected local and international practices will be presented. In addition, an engineering solution which is proposed to reduce the frequent use of the bamboo truss-out scaffold by members of the research team will also be presented.

4.2 Local practices

This section presents some of the measures and devices used for external repair and maintenance works. The information was collected as a result of a continuous search via literature and contacts of the research team members.

4.2.1 Local legislation and codes of practice

Local legislation and codes of practice have already been studied in detail in Chapter 2 Literature Review. Hence this section will only briefly touch on the available local legislation and codes of practice related to fall from height in repair and maintenance works.

The legislation listed in Table 4.1 is also applicable for general construction site activities. 59J and 59AC are more related to working at height. Table 4.2 shows a list of the local codes of practice. The codes of practice normally target a particular working agent, for example the bamboo scaffold. As discussed later in this chapter there are notes related to the correct use of the bamboo truss-out scaffold.

Table 4.1 List of local legislation

Hong Kong legislation
Factories and Industrial Undertakings Ordinance, Chapter 59
Construction Sites (Safety) Regulations, Chapter 59I
Factories and Industrial Undertakings (Lifting Appliances and Lifting Gear) Regulations, Chapter 59J
Factories and Industrial Undertakings (Suspended Working Platforms) Regulation, Chapter 59AC
Factories and Industrial Undertakings (Safety Management) Regulation, Chapter 59AF
Occupational Safety and Health Ordinance, Chapter 509
Buildings Ordinance, Chapter 123

Table 4.2 List of local codes of practice

Hong Kong codes of practice
Code of Practice for Bamboo Scaffolding Safety
Code of Practice for Safe Use and Operation of Suspended Working Platforms
Code of Practice for Metal Scaffolding Safety
Code of Practice on Safety Management
Code of Practice for Site Supervision

4.2.2 Local guidelines

4.2.2.1 Labour Department and Occupational Safety and Health Council guidelines

The Labour Department and the Occupational Safety and Health Council have produced many safety guidelines related to fall prevention, fall identification and fall minimization. These documents have adapted international best practices and combined them with the local problems to derive suitable guidelines for Hong Kong. The documents are readily available on their websites for public access. Table 4.3 and 4.4 list the documents related

to fall from height in repair and maintenance works produced by the Labour Department and the Occupational Health and Safety Organisation respectively.

Table 4.3 Labour Department guidelines relating to fall from height

Labour Department guidelines
Double Row Scaffolding with Platform Saves Lives
Falling a Few Feet can Cause Serious Injury, Use Suitable Working Platform
Guidance Notes on Classification and Use of Safety Belts and their Anchorage Systems
Guidance Notes on the Inspection, Thorough Examination and Testing of Suspended Working Platforms
Safety at Work - A Guide to Personal Protective Equipment
Safety Hints on Operation of Suspended Working Platform
Safety Hints on Renovation Work
Work Safety in Renovation and Maintenance Works
使用「狗臂架」懸空式棚架的安全措施
狗臂架式棚架安全須知
竹棚架工作安全守則
竹棚架工作安全簡介
吊船操作安全簡介
安全使用和操作吊船工作守則
工作安全 ─ 梯子及升降工作平台簡介
工作安全 個人防護裝備簡介
慎防從高處墮下
裝修工程 工作安全須知
雙棚再加工作台 穩陣安全防意外
失足幾尺 抱憾終身 須使用合適工作台

Table 4.4 Occupational Safety and Health Council work guidelines relating to fall from height

Occupational Safety and Health Council guidelines
維修及保養安全須知
Construction Site Safety Hints
個人防護用具須知
裝修從業員工作安全須知
裝修工程職業安全健康要點
建造業高空工作安全檢查表
建造業高空工作安全須知

4.2.2.2 Architectural Services Department notes

The Hong Kong Architectural Services Department identified a large number of accidents related to the use of ladders, and as a result produced the document 'Key notes on enhanced measure for safe use of ladders' (Appendix 2). The notes are split into two main sections. The first section gives a general overview outlining the correct way to use ladders safely. The second part of the notes describes the correct ways to inspect, maintain and store ladders to prevent accidents. Statistics presented in Chapter 5 'Analysis of Accident Statistics' has shown that ladders is one of the high risk agents involved with fall accidents in repair and maintenance works. Hence this document is believed to be an extremely effective educational tool for workers.

4.2.2.3 Synergis Holdings Limited guidelines and inspection report

Synergis Management Services Limited established in 1978, (formerly known as Hsin Chong Real Estate Management Limited) is a subsidiary of the Hsin Chong Group, and is one of the leading property management companies in Hong Kong and Asia. Synergis provided the research team with two documents relating to fall from height prevention.

The first (Appendix 3) is a set of guidelines for working at height. The guidelines outline the correct safety procedures for working at height, the main points relating to the safe use of mobile scaffolding towers and steel tubular scaffolding, the correct safety procedures for using mobile scaffolding towers and steel tubular scaffolding, the correct safety procedures for using ladders and personal protection equipment.

The second document (Appendix 4) is an inspection report used to monitor the contractors hired. The report is a template designed to record the information observed for each inspection. Fourteen criteria are assessed at each inspection and these include site management, office safety, first aid, electricity, chemical safety, working at height, machinery/plant, scaffolding, gondola, confined space work, gas welding work, road work, personal protection equipment and specific checking for cleaning operation. Four levels of tick boxes are used to assess each of these criteria, including good, satisfactory, poor and not applicable. The inspector is also asked to list any faults observed and provide recommendations on the form.

4.2.2.4 Henderson Land Development Company Limited guidelines

The principal business directions of Henderson Land Development Company Limited include investment holding, property development and investment, construction, finance and project and property management. Three in-house working at height safety documents were provided. These included working at height guidelines and working at height instructions (Appendices 5 and 6). The working at height guidelines, contain general safety guidelines for working at height targeting the supervisory level staff. The safety handbook is a comprehensive source of information providing safety prevention, measures and knowledge for all the possible dangers on construction sites.

4.2.2.5 Well Born Real Estate Management Limited guidelines

Well Born Real Estate Management Limited was one of the property management companies interviewed in this project. They provided a set of in-house working at height guidelines (Appendix 7) to the research team. The guidelines include the purpose of protecting working at height, the definitions of terms used such as 'competent person' and they also provided some general proper working guidelines for working at height.

4.2.2.6 Buildings Department guidelines

In May 2006, The Buildings Department published a set of new guidelines on the design, construction and use of bamboo scaffolds (Appendix 8). The 'Guidelines on the Design and Construction of Bamboo Scaffolds' set out recommended good practices on the design, erection, maintenance, inspection and dismantling of bamboo scaffolds.

The guidelines contain information on: technical standards of design; construction of typical types of bamboo scaffolds including bamboo truss-out scaffolds; and material specifications (Buildings Department, 2006b). The guidelines are aimed for the use of scaffolders, building contractors, estate management companies, flat owners and tenants, and business operators.

4.2.3 Local reports

4.2.3.1 Sun Hung Kai Properties report

Sun Hung Kai Properties is one of the largest property developers in Hong Kong. In 2005 they produced a report entitled 'Measures to prevent accidents with truss-out scaffolds' (Appendix 9). The report outlines the causes of accidents, immediate actions within Sun Hung Kai Properties to minimize risks and thoughts for improvement in the long-term which included some possible anchor devices. In the appendix of the report

mentioned is another report entitled 'A discussion paper on preventive measures to fatal accidents for construction workers of minor works and external works whilst working at height'. This report presents a briefing of recent accidents, causes of fatal accidents, preventive measures, conceptual revolutionary changes on the safety issue by all parties, the introduction of propriety products to enhance the safety of workers and suggested future studies.

4.2.3.2 The Hong Kong Polytechnic University research monographs

Some research team members of this project had previously been involved with a similar project entitled 'A study of the construction safety in Hong Kong – accidents related to fall of person from height'. The findings of this report were published as a research monograph in 2005 (Wong et al., 2005). The monograph presented a comprehensive literature review, findings from the analysis of accident statistics and also analysis of the feedback from the workshop.

4.2.3.3 Labour Department report

As mentioned previously in this report the Labour Department produced a special report entitled 'Accidents in the construction industry of Hong Kong (2000-2004)' (Appendix 10). The report was produced especially to aid the analysis of this research study. The detailed statistics provides information of accidents in the whole construction industry as well as for repair and maintenance works. The statistics are clearly broken down into different categories such as type of accident, month, type of work performed, body part injured, injury nature, age group and sex.

4.2.3.4 Occupational Safety and Health Council reports

The Occupational Safety and Health Council (OSHC) has always been actively involved in a number of research projects (some of these have been named in this section). Several

reports of these projects are accessible on its website (http://www.oshc.org.hk/). Available reports included 'A survey of safety culture in Hong Kong construction industry', 'A survey on usage of personal protective equipment in Hong Kong' and 'Safety attitudes, safety climate, and employee health among older and younger workers working at height in construction industry: a facet approach'. In addition, with particular relevance to this study the Council also provided the research team with a report entitled 'An engineering study for improving safety and reliability of bamboo scaffoldings'.

4.2.4 Local technology

Two local technologies which claim to reduce fall accidents in repair and maintenance works were found, these have been shown in Table 4.5.

Table 4.5 Local technology

Technology	Organisation/Company
Climbing scaffold	Wui Loong Scaffolding Works Company Limited
Temporary transportable anchor device	Introduced by the Occupational Health and Safety Council and the Labour Department from the U.S. and Europe

4.2.4.1 Wui Loong Scaffolding Works Company Limited climbing scaffold

Wui Loong Scaffolding Works Company Limited is a leading company in Hong Kong providing scaffolding services. A recent development of the company is the computerized climbing scaffold (Figure 4.3, Appendix 11). The invention is a safe means of carrying out external works. The need for scaffold construction and dismantle is prevented, eliminating many accidents caused when the scaffolding is not properly erected. The climbing scaffold can be moved upwards and downwards depending at

which level it is required. The company claims that this invention has been able to reduce their accident figures as a result of fall.

Figure 4.3 The computerized climbing scaffold (source was provided by Wui Loong Scaffolding Works Company Limited)

4.2.4.2 Temporary transportable anchor device

The temporary transportable anchor device (Fig. 4.4) is manufactured knowingly in the U.S. and Europe. A number of these devices have been introduced jointly by the Labour Department (LD) and the Occupational Safety and Health Council (OSHC) to provide local contractors with a temporary anchor point at work. The LD and the OSHC will subsidize contractors to purchase this device on the condition that from their company one employee will attend a one-day course on the temporary transportable anchor device, and two employees will attend a half-day course on bamboo truss-out scaffold safety (OSHC and LD, 2005). The name of the device has already indicated that it can be used as a temporary anchor point which is easily transportable. The device can be fixed to a door frame or a window frame, a fall arrest system can be connected to the device and if

load is applied to the device it will push against the frame to prevent the worker from falling (OSHC, 2006b).

Since the introduction of this scheme in November 2005, the Labour Department informs that there has been no fatal fall from height accidents involving the bamboo truss-out scaffold. Therefore, a connection between the scheme and the number of fall accidents may be possible. Although the device is ought to act as the last means of protection in a fall accident, the use of it is very much encouraged as it can provide a temporary anchor point which would otherwise be impossible for many old buildings without available anchorage for safety belt and lifeline.

Figure 4.4 A temporary transportable anchor device against a door frame – demonstration from an OSHC seminar

4.3 International practices

The information presented in this section was the responses received from the questionnaires sent out. In many cases, the respondents did not necessarily fill out the questionnaire but instead provided us with alternatives to the bamboo truss-out scaffold. A total of 71 practitioners/researchers from 13 different countries around the world were contacted and 11 of these responded to our search.

4.3.1 International legislation and codes of practice

The Work at Height Regulations 2005 of U.K. came into force in April 2005. Under these regulations the relevant parties are required to avoid work at height if at all possible; where working at height is unavoidable, sensible measures and the use of protection equipment to prevent falls is vital; and also to prepare appropriate measures to minimize the distance and impact of falls.

Due to the limitations in time for this project, a detailed international search of legislation and code of practice was not possible, but two Australian codes of practice which have been highlighted by one of our contact points include: COP 29 – Prevention of Falls in Housing Construction 2004 and COP 28 – Prevention of Falls in General Construction 2004. Both of these codes of practice are recently produced and hold a strong relationship to the current study. The documents also presented some alternative agents found for working at height, but their appropriateness for use in Hong Kong needs to be further studied. Figure 4.5 shows a top plate hung bracket system which is a typical bracket scaffold. Figure 4.6 shows a fabricated hung scaffold, which was purposely designed to be a temporary structure that can be anchored to a permanent structure to support a working platform.

Figure 4.5 Top plate hung bracket system (Worksafe Victoria, 2004a)

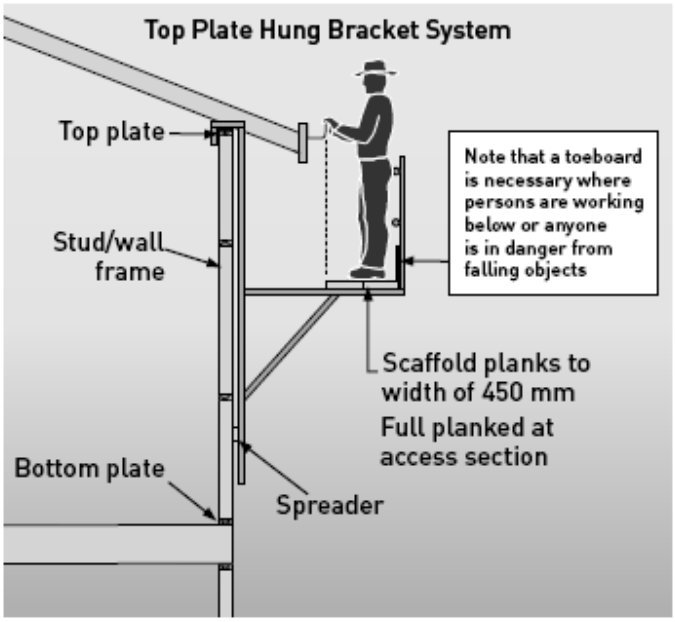
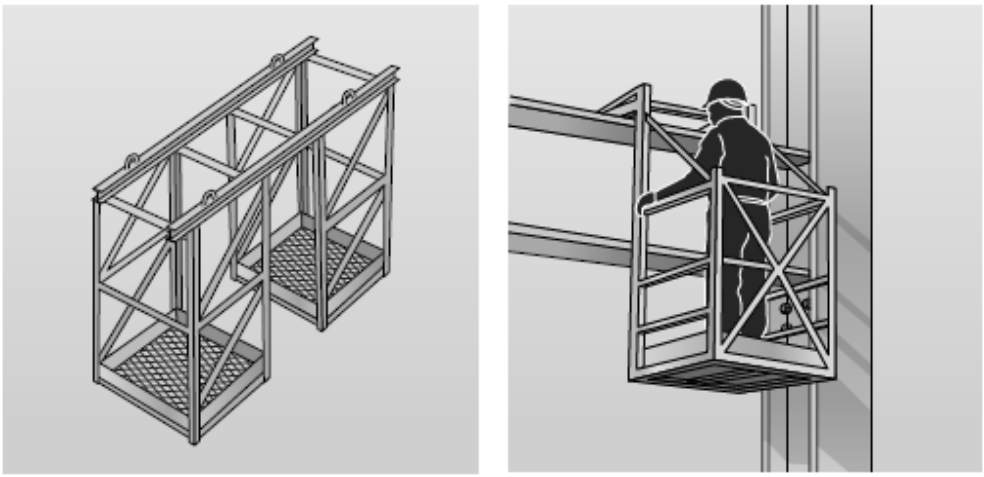


Figure 4.6 Fabricated hung scaffold (Worksafe Victoria, 2004b)



4.3.2 International reports

Selected international reports have been shown in Table 4.6. These reports are recommended to be high in value for the current study, and many of these were previously used in our 'Literature Review' as presented in Chapter 2.

Table 4.6 International reports

Health and Safety Executive (2003), Casual Factors in Construction Accidents. U.K.
Health and Safety Executive (2005), A technical guide to the selection and use of fall prevention and arrest equipment. U.K.
National Institute for Occupational Safety and Health (1998), Preventing Injuries and Deaths from Falls during Construction and Maintenance of Telecommunication Towers. U.S.
National Institute for Occupational Safety and Health (2000), Workers Deaths by Falls – A Summary of Surveillance Findings and Investigative Case Reports. U.S.
National Institute for Occupational Safety and Health (1992), Preventing Worker Injuries and Deaths Caused by Falls from Suspension Scaffolds, No. 92-108. U.S.
National Institute for Occupational Safety and Health (1989), Preventing Worker Deaths and Injuries from Falls through Skylights and Roof Openings, No. 90-100. U.S.

4.3.3 International technology

Two international technologies which claim to reduce fall accidents in repair and maintenance works were found, these have been shown in Table 4.7.

Table 4.7 International technology

Technology	Organisation/Company
Podium access system	Gammon Construction Company Limited purchased from Loft and Ladders Company Limited in U.K.
VIRCON 4D tools	University College London, Teesside University, The University of Wolverhampton and eleven construction companies in the U.K.

4.3.3.1 Podium access system

The podium access system (Figure 4.7) imported from the U.K. has been purchased by a local contractor to replace the A-frame ladder. The advantages of the podium access system over the A-frame ladder include that the wheels can be locked and therefore not allowing the system to slip, in addition the worker is protected by all round guardrails, hence the system is much safer to use then the A-frame ladder. A common problem with the A-frame ladder is that it can be easily misused, for example workers often move around whilst still on their ladders but using the podium access system misuse is difficult.

A telephone interview (Appendix 12) was conducted with one of their colleagues responsible for the system. The company intends to purchase a further 50-100 of these systems to gradually replace all the A-frame ladders used on their construction sites. The initiative originated from the company's investigations into the high number of accidents occurring below 2m. Although the systems are relatively costly in comparison to ladders,

the company anticipates that replacing all ladders will still be more cost effective than paying for accident compensation.

Figure 4.7 Podium access system (Lofts and Ladders, 2006)

4.3.3.2 VIRCON tools

VIRCON (The VIrtual CONstruction Site) was a collaborative project in U.K. between University College London, Teesside University, The University of Wolverhampton and eleven construction companies, funded by EPSRC (U.K. governmental funding). The research project was completed in August 2003 (Centre for Construction and Innovation and Research, 2006).

This project built on work by the collaborators and elsewhere which advanced the visualisation of task sequences beyond the Gantt chart, while adding a new dimension to construction planning, that of critical space analysis. The aim was to provide a tool that

would allow planners to trade off the temporal sequencing of tasks with their spatial distribution. The result was a more robust and rehearsed project schedule.

VIRCON was developed in response to the realisation that there is a looming skills gap in the construction industry amongst those with the expertise to plan major construction projects, and that there are a range of technical opportunities becoming available which may make it possible to bring computing to bear on what has until now been a task that is only tractable by experienced and expert personnel. Thus the research proposed here aims to develop a prototype strategic planning support application for evaluating, visualising and optimising construction schedules within a desk-top environment - The Virtual Construction Site (VCS).

The tool was recommended by one of our contact points, but the effect towards safety when working at height needs further study.

4.4 Engineering Solutions

The traditional practice for undertaking external maintenance works in Hong Kong is to erect a temporary working platform by way of a bamboo truss-out scaffold supported by steel brackets. However, the number of fatal accidents associated with the bamboo truss-out scaffold has shown that this practice is highly unreliable. Problems identified in this system include:

- There are no standards for the steel bracket.
- Often steel brackets are self made by the workers, hence the quality is unpredictable.
- The condition of external walls will vary depending on age of the building, the concrete strength and the thickness of wall finishes, therefore the steel brackets may not have a secure surface to anchor to.

- The steel brackets are designed to be fixed by three anchor bolts, but often only two anchor bolts are used as workers find the bottom (i.e., the third) anchor bolt too difficult to secure.
- Cheap anchor bolts of low quality are often used.
- Workers often work without wearing proper safety equipment such as safety belts and harnesses.
- The construction of the bamboo truss-out scaffold is complicated, often accidents occur during the installation and dismantling instead of whilst it is being used, this fact was shown observed during the analysis of the case studies provided by the Labour Department between 2000-2004 as presented in Chapter 6.

To address these problems associated with the bamboo truss-out scaffold, a temporary working platform was designed as an alternative. The design being developed can provide a rapid, demountable temporary working platform for inspection, repair and maintenance works on external wall of buildings. The design has already obtained a patent application number from the People's Republic of China.

The temporary working platform will be hung over the building wall and eliminate the use of anchor bolts. There will be a working platform constructed with demountable panels. The working platform will be supported by two supporting frame units and two triangular frame units, each pair of these units will hold the platform on either side. The supporting frames will hang over the building walls. And the triangular frames will slot into the supporting frames and hold the working platform. The frames will be adjustable to suit walls of different heights and thicknesses. The temporary working platform will also have railings and toe-boards to prevent the user from falling out. It is anticipated that light weight materials will be used for the temporary working platform.

The temporary working platform will address the previously mentioned problems by eliminating the need to install steel brackets. The special features of the concept lie in the

fact that it can be mounted from inside of the building and no anchor bolts are required to be installed on the external walls (hence reduce the risk of falling). The temporary working platform will be easily installed/dismantled by a trained worker in a short period of time making it handy to use. In addition, the temporary working platform will not require any consumable items (as compared to the conventional bamboo truss-out systems which require anchor bolts and bamboos).

The use of the temporary working platform will be limited to standard parapet wall (i.e. excluding bay window). The system utilises adjustable fixings which are capable to fit to most commonly used window frames and parapet walls (with variable thickness) in residential/commercial buildings in Hong Kong. The current concept can be applied to standard aluminum window frame, however other types of window frames may also be suitable for the system.

The temporary working platform presented is only an initial concept and further study is required to perfect the design and test for its ability to withstand load.

4.5 Summary

The bamboo truss-out scaffold is a unique feature of the Hong Kong building industry. As a result the problem is also very unique and the search for improvements and alternatives to the system has been difficult. This chapter has presented both local and international practices for works at height with truss-out scaffold. As a result of the ongoing research the research team members have introduced a prototype as an alternative for the bamboo truss-out scaffold. Although the prototype is in the early stages of design it is anticipated that it will help to reduce fall from height accidents caused by or related to the use of bamboo truss-out scaffolds.

Chapter 5
ANALYSIS OF STATISTICAL DATA

Chapter 5 Analysis of Statistical Data

5.1 Introduction

Literature can only provide us information to a certain extent. In order to identify the key issues in the local context, statistical data was collected from the Architectural Services Department (ArchSD) and the Labour Department. Statistical data from the ArchSD was collected first. The data were retrieved from the "Public Works Projects Construction Site Safety and Environmental Statistics (PCSES)" of the ArchSD. During 1995-2004, there were 4,775 construction accidents with 1,401 (29%) cases concerning building repair and maintenance works. More detailed data of construction accidents were available from 2001-2004. During these years, there were 300 construction accidents in building repair and maintenance works, with 57 (20%) cases related to "fall of persons from height". Moreover, there were 23 (40%) out of these 57 cases resulted in "serious" injuries.

Although the sample size of the statistics was representative and the detail was fruitful, the statistics collected from the ArchSD was limited to a proportion of public works only. Hence a meeting was held between the PolyU research team and the Labour Department to request for statistics of all the reported construction accidents in Hong Kong. It was mutually agreed that statistical information relating to fall from height accidents would be essential for the study. Hence, an official letter (Appendix 13) was written to the Labour Department requesting for the statistics. For the convenience of the research team's analysis, the Accident Analysis and Information Division of the Labour Department produced a report named 'Accidents in the Construction Industry of Hong Kong (2000-2004)' (Appendix 10).

The objectives of this chapter are to identify the category, trend and causes of fall of persons on building repair and maintenance works. This chapter will first identify the

key issues from the ArchSD statistical data and then from the Labour Department statistical data. Finally the two sources of data will be compared and contrasted for similarities and differences.

5.2 Identification of key issues from ArchSD statistical data

Each accident record kept by ArchSD is recorded on an injury report form, which also provides details on the brief account of the accident and the measures taken to avoid recurrence of similar accidents. In the research, all records related to fall of person from height from 1995 to 2004 were retrieved for analysis and the results are presented in the following sections.

From 1995 to 2004, 160 records related to fall of person from height in building repair and maintenance works were retrieved. The following key issues were identified for analysis:

1. Year distribution
2. Age distribution
3. Trades involved with accidents
4. Injury nature and body part injured
5. Agent involved
6. Personal factors
7. Unsafe action
8. Unsafe condition
9. Day of the week distribution
10. Season distribution

Since 2001, ArchSD introduced a more detailed injury report in the revised PCSES system. With more data available, the analysis can be done more thoroughly between 2001 and 2004. During this period, PCSES recorded 300 construction accidents in

building repair and maintenance works, with 57 (20%) cases related to "fall of persons from height". As a result more key issues were identified, including:

1. Location of fall
2. Height of fall
3. Type of work performed during accident
4. Length of experience in the construction industry

5.2.1 Year distribution

Table 5.1 and Figure 5.1 show the number of injuries related to fall of person from height recorded in PCSES from 1995 to 2004. During this period, accidents related to fall of person from height which led to fatality happened in three years, i.e. 1996, 1998, and 2002. However, the severity of injuries increases over these years. For instance, most of the accidents recorded in 1996 (89%) were minor but in 2003, 57% of the accidents resulted in serious injuries. In 2004, half of the accidents were of the minor and serious types of accidents. The drops in the total number of accidents in 2003 and 2004 are probably due to an increase in safety awareness on construction works.

Figure 5.1 Breakdown of severity of fall of persons from height (ArchSD, 1995-2004)

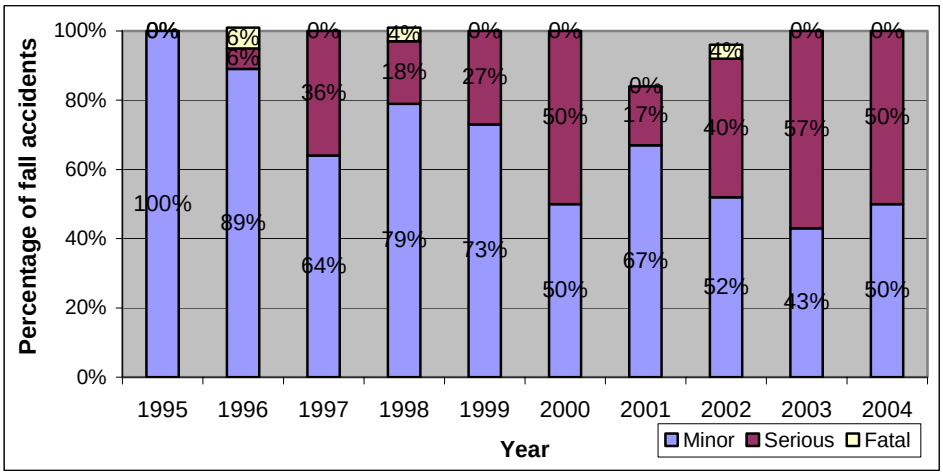


Table 5.1 Number of injuries related to fall of person from height during 1995 to 2004 (ArchSD, 1995-2004)

PCSES statistics		Year										Total	%
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004		
Total no. of accidents		143	253	152	177	209	157	90	107	69	44	1401	-
Severity of fall injuries	Minor	13	16	7	22	11	9	8	13	6	3	108	67
	Serious	0	1	4	5	4	9	2	10	8	3	46	29
	Fatal	0	1	0	1	0	0	0	1	0	0	3	2
	No Spec.	0	0	0	0	0	0	2	1	0	0	3	2
Total no. of fall accidents		13	18	11	28	15	18	12	25	14	6	160	100
% of fall injuries		9	7	7	16	7	11	13	23	20	14		

Although there is a clear falling trend in terms of total number of accidents from 1995 to 2004 (Figure 5.2a), there is also a contrasting rising trend in the percentage of fall injuries (Figure 5.2b). This implies that fall of person from height remains as an acute problem and represents a significant portion of accidents in building repair and maintenance. More resources should be channeled to alleviate this type of accident.

Figure 5.2a Total no. of accidents (ArchSD, 1995-2004)

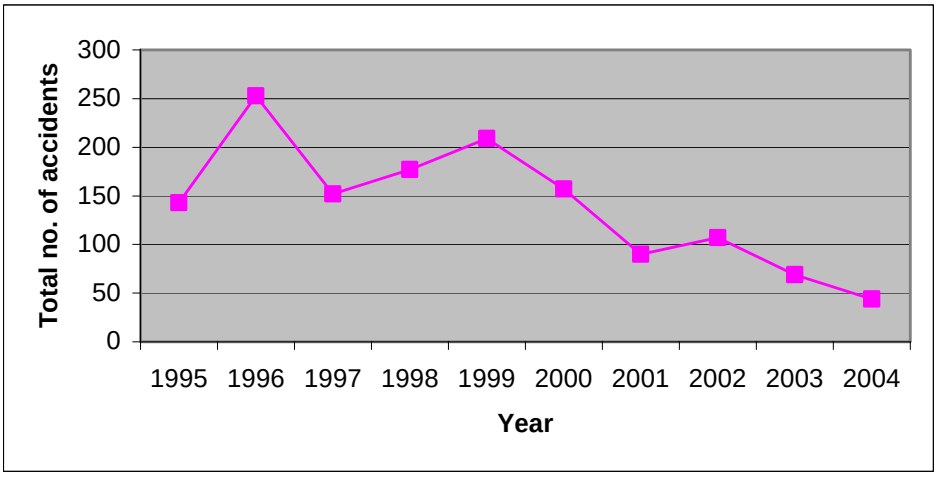
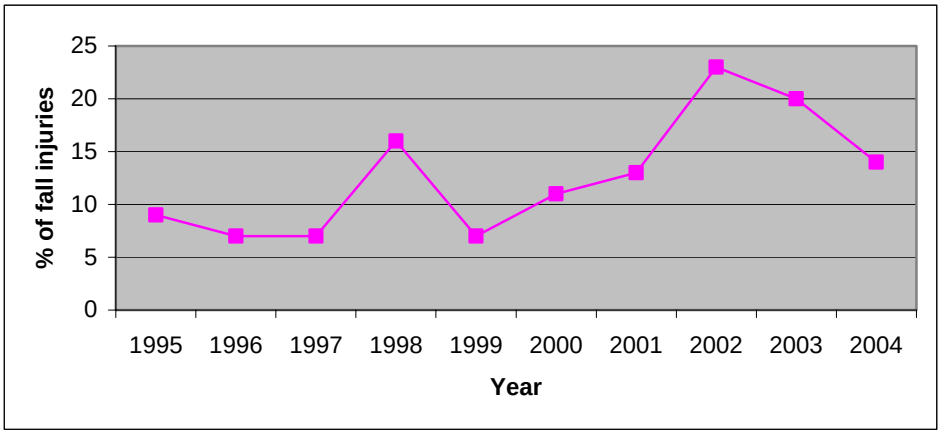


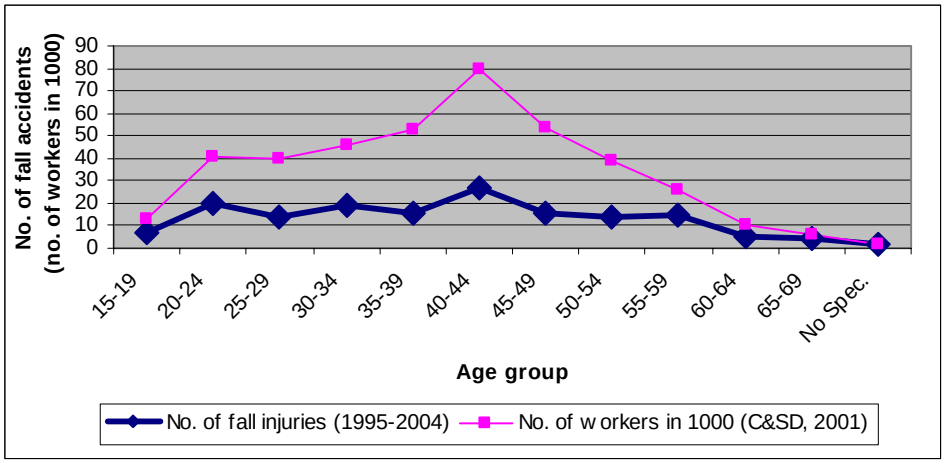
Figure 5.2b % of fall injuries (ArchSD, 1995-2004)



5.2.2 Age distribution

Figure 5.3 shows the distribution of the age group of the injured workers due to fall injury. Most accidents occur in the range of ages between 40 and 44. Incidentally, such age range was also the largest group of construction workers in the 2001 population census statistics (Census and Statistics Department, 2005) This finding coincides with Wong *et al*. (2005) who also discovered that the age group of 40-44 is most prone to fall injury. Moreover, another peak occurs at younger ages (20-24) probably due to inexperience at construction repair and maintenance works.

Figure 5.3 Distribution of age group of injured workers during 1995 to 2004 (ArchSD, 1995-2004)



5.2.3 Trades involved with accidents

Table 5.2 shows the different trades of fall injuries as recorded in PCSES (ArchSD, 1995-2004). The top three trades with accidents involving fall of person from height in building repair and maintenance works are painter and decorator (29%), labourer (21%) and metal worker (10%). These trades accounted for 60% of fall related accidents. Most maintenance works involve painting and decoration and there is also a need to work at height. This probably explains why painters and decorators are most susceptible to fall injuries. Metal worker is another identified trade which is more prone to fall injuries.

Table 5.2 Different trades of fall injuries during 1995 to 2004 (ArchSD, 1995-2004)

Trade of Injured Worker	Number	Percentage
Painter and decorator	46	29
Labourer	33	21
Metal worker	16	10
Plasterer	13	8
Demolition worker	12	8
Building services/E&M worker	8	5
Carpenter (formworker)	7	4
Bamboo scaffolder	5	3
Construction/Mechanical plant mechanic or fitter	4	3
Plumber	3	2
Others (Concretor, Joiner, etc.)	7	4
Not specified	6	4
Total	160	100

5.2.4 Injury nature and body part injured

PCSES provides information about the 1st injury and the part of body injured in each accident (Table 5.3). The results show that more than 78% injuries resulted in fracture, and contusion & bruise. Both upper and lower limbs are most susceptible to injury in accidents. These observations reinforce the general perceptions that when a person falls from height, he may use his limbs to maintain balance and the force from a difference in height may cause fracture, and contusion and bruise of the body parts concerned.

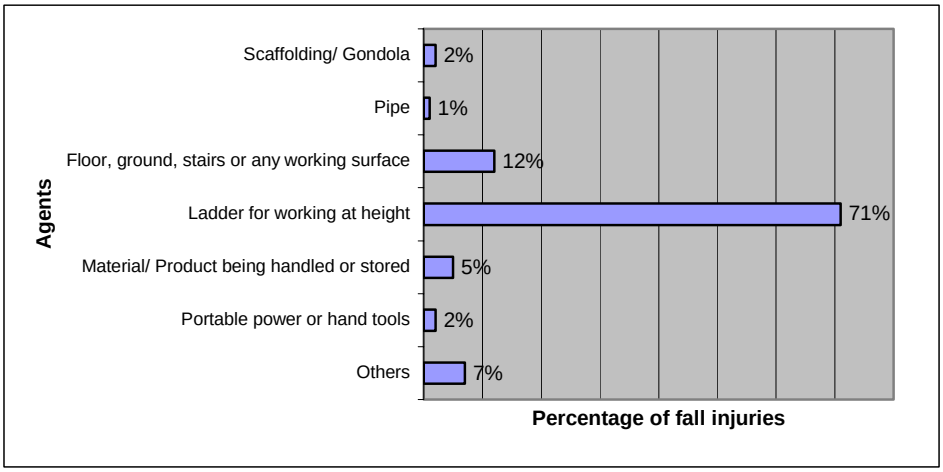
Table 5.3 Distribution of nature of injuries during 1995 to 2004 (ArchSD, 1995-2004)

Level	Nature of Injury	Number	Percentage	Part of Body Injured	Number	Percentage
1st Injury	Fracture	60	41	Upper limbs	51	34
	Contusion & bruise	53	36	Lower limbs	46	30
	Concussion & other internal injury	9	6	Neck & trunk	42	28
	Laceration & cut	9	6	Head	12	8

5.2.5 Agent involved

The agents involved in fall accidents are shown in Figure 5.4. "Ladder or working at height" constituted 71% of the accidents related to fall of person from height in building repair and maintenance works. The second most common agent involved was "Floor, ground, stairs or any working surface". When people need to work at height, the most common agent used to enable them to reach the required height is a ladder. Because of the notorious record of ladder-related fall accidents, the ArchSD has recently released a practising note on enhanced measures for safety use of ladders for their contractors (ArchSD, 2005).

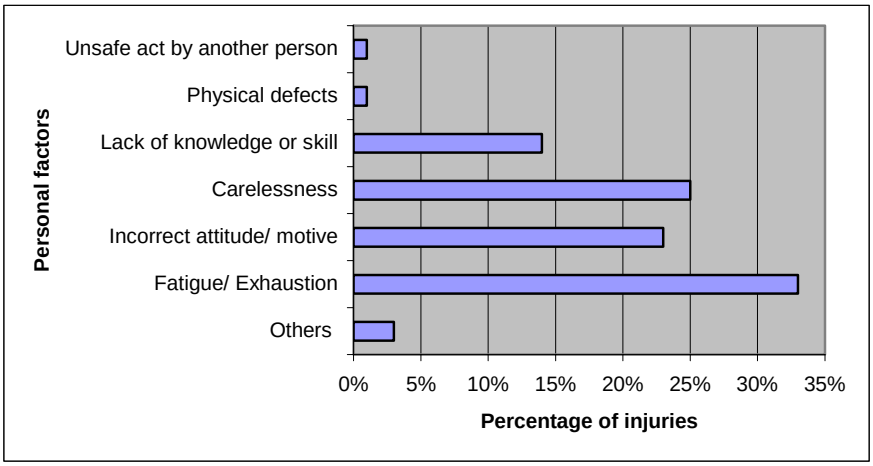
Figure 5.4 Distribution of agents involved during 1995 to 2004 (ArchSD, 1995-2004)



5.2.6 Personal factors

Figure 5.5 demonstrates the distribution of personal factors leading to fall accidents. "Fatigue/Exhaustion" was identified as the most influential person factor of fall accidents, which accounted for one-third (33%) of fall injuries. If workers become tired, they may not be physically fit to handle the construction work, which requires intense attention on safety issues. Otherwise, accidents may result because of a lack of energy to remain balance in carrying out the work at height. "Carelessness" and "Incorrect attitude/ motive" collectively accounted for nearly half of the fall injuries (25% and 23% respectively). These two factors are closely related to the mindset of the workers. Workers' attitudes towards construction safety have a significant impact on reducing accidents on site (Chan *et al.*, 2005).

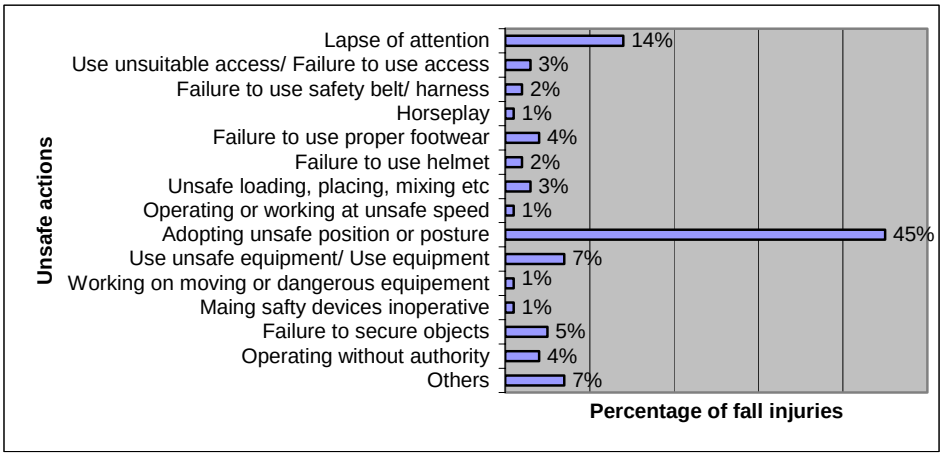
Figure 5.5 Distribution of Personal Factors during 1995 to 2004 (ArchSD, 1995-2004)



5.2.7 Unsafe action

Figure 5.6 shows the distribution of unsafe action of the injured workers. The most unsafe action related to fall injuries was "Adopting unsafe position or posture", which accounted for nearly half (45%) of the accidents. "Lapse of attention" was the second one, representing 14% of fall injuries. The third unsafe action was "Use unsafe equipment/use equipment unsafely" (7%). Such unsafe actions are related to the working environment and the provision of safety equipment. In fact, personal factors such as fatigue, carelessness and poor safety attitude may lead to unsafe action. For instance, if the workers are careless and they do not have correct attitude/motive, they may not adopt safe position or posture at work since they are not attentive at safety-related issues. When they are in rush, they may use equipment incorrectly and unsafely.

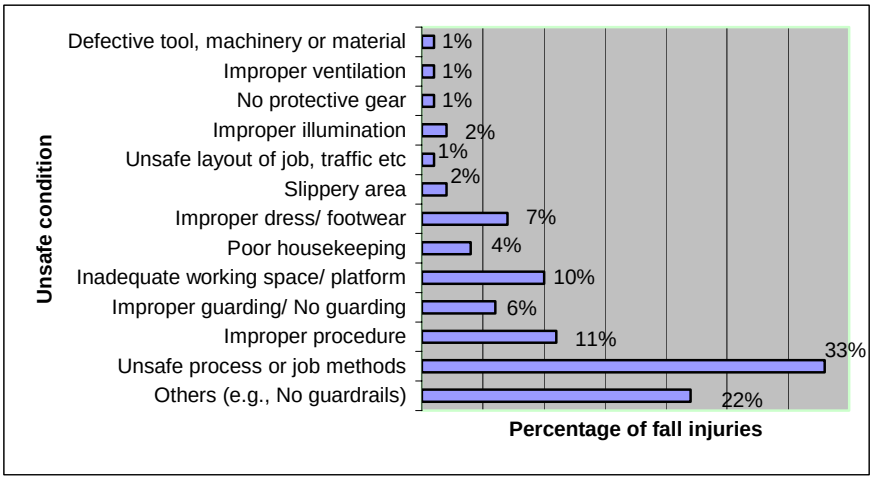
Figure 5.6 Distribution of unsafe actions during 1995 to 2004 (ArchSD, 1995-2004)



5.2.8 Unsafe condition

Figure 5.7 shows the distribution of unsafe condition in fall accidents. It was found that "Unsafe process or job methods" was the most unsafe condition in fall injuries, which accounted for one-third (33%) of the accidents. Ignoring the unclassified category, the next most unsafe condition was "Improper procedure" (11%) and the third one was "Inadequate working space/platform". Therefore, proper communication channels should be established between the front-line workers and the management level in order to develop the necessary procedures for construction process at work (Wong *et al*., 2004).

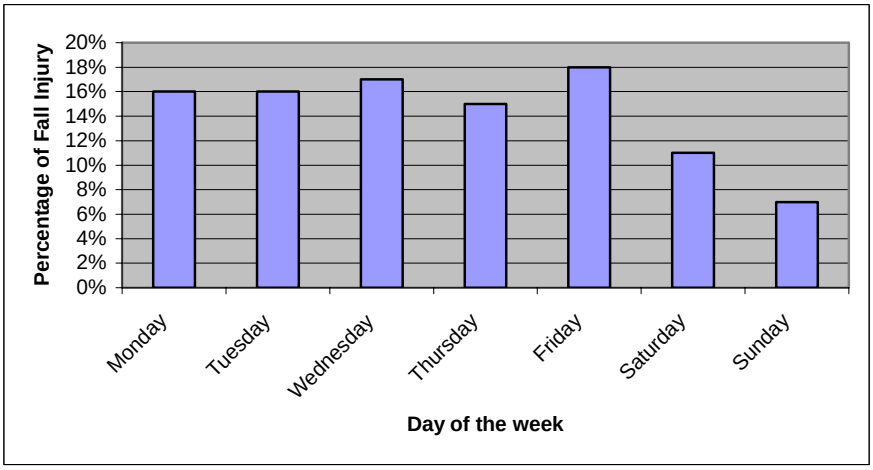
Figure 5.7 Distribution of Unsafe Condition during 1995 to 2004 (ArchSD, 1995-2004)



5.2.9 Day of the week distribution

Figure 5.8 shows distribution of fall injuries by day of the week. The distribution of fall injuries spreads quite evenly over a week, with relatively more accidents happened on Friday (18%). Fewer accidents occurred on Saturday and Sunday probably due to shorter working hours and fewer construction works.

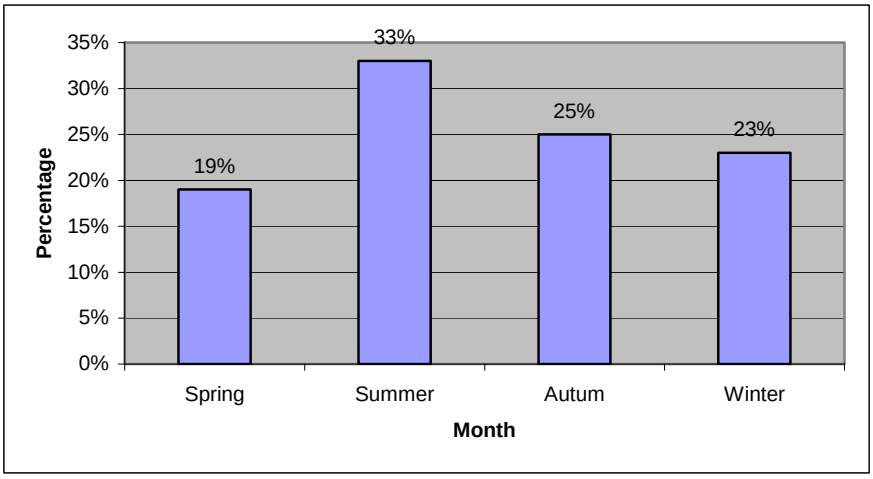
Fig. 5.8 Distribution of fall injuries by day of the week during 1995 to 2004 (ArchSD, 1995-2004)



5.2.10 Season distribution

Fall injuries were further categorized into four seasons, with March, April and May classified as months in Spring; June, July and August as Summer; September, October and November as Autumn; and December, January and February as Winter. Figure 5.9 shows the results. Summer was identified as the season with most accidents, probably because of the hot and humid weather. High temperature can easily lead to fatigue/exhaustion of workers. Moreover, too much rainfall may create more slippery working surfaces resulting in more fall accidents. The comparatively smaller number of accidents in winter may be due to better working environment with lower temperature and humidity level, possibly also due to the festival season and fewer working days in winter time.

Figure 5.9 Distribution of fall injuries by seasons during 1995 to 2004 (ArchSD, 1995-2004)



5.2.11 Location of fall

Table 5.4 shows the distribution of location of fall from 2001 to 2004. Fall from ladder was again found to be the most common location of fall injuries (30%), followed by fall from external work/scaffolding/gondola (14%). These two locations accounted for nearly

half of the accidents related to fall of person from height in building repair and maintenance works. The findings are in line with those of the agents involved in fall accidents (Figure 5.4), where ladder was identified as the most common agent involved in fall accidents. Therefore, ArchSD's introduction of a practising note on the proper use of ladder in building repair and maintenance works is timely and appropriate. Other locations of fall include working platform, surface channel and planter wall.

Table 5.4 Distribution of location of fall during 2001 to 2004 (ArchSD, 2001-2004)

Location of Fall	Number	Percentage
Fall from ladder	17	30
Fall from external work/scaffolding/gondola	8	14
Fall from roof/top of building	3	5
Fall from stair/passage	3	5
Fall from floor/floor opening	2	4
Fall from falsework and formwork	1	2
Others	16	28
Not known	7	12
Total	57	100

5.2.12 Height of fall

Figure 5.10 demonstrates the distribution of height of falls between 2001 and 2004. Most fall accidents were less than 2 metres high, which accounted for 80% of fall injuries. The relations between the height of falls and the fall location were shown as Figure 5.11. While all fall accidents from floor/ floor opening were below 1 metre, the findings further reiterate that all accidents related to the fall from ladder are less than 2 metres high. Fall injury does not necessarily result from larger height. One should not under-estimate the danger of working at relatively shorter height. The statistics shows that most of the falls

from ladder were less than 1m high (56%). One the other hand, some locations are prone to fall from a larger height. For instance, one-third (33%) of the falls from roof/ top of building happened at a height larger than 6 metres.

Figure 5.10 Distribution of height of falls during 2001 to 2004 (ArchSD, 2001-2004)

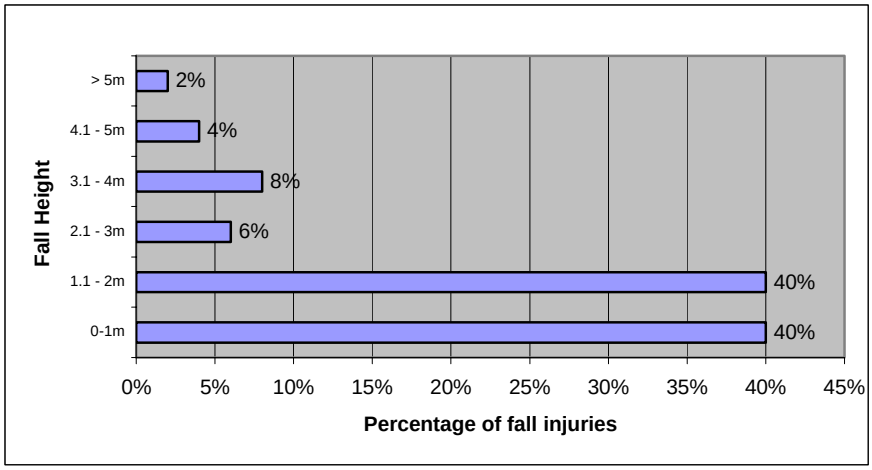
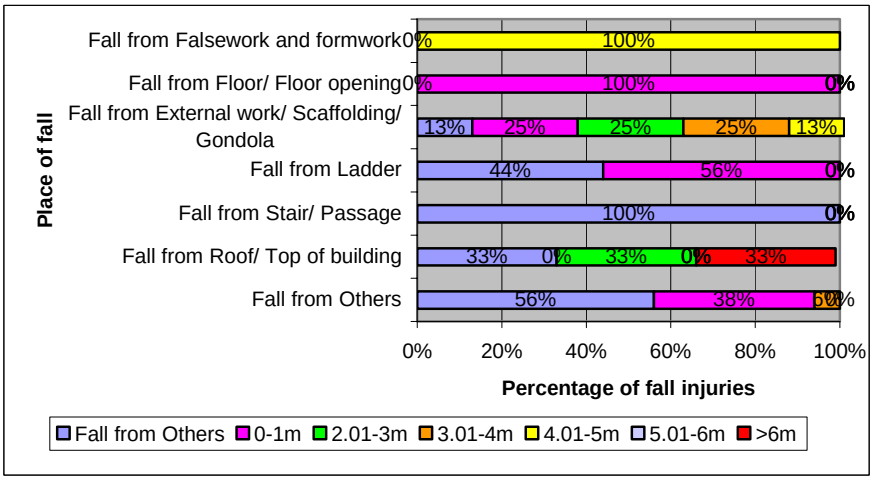


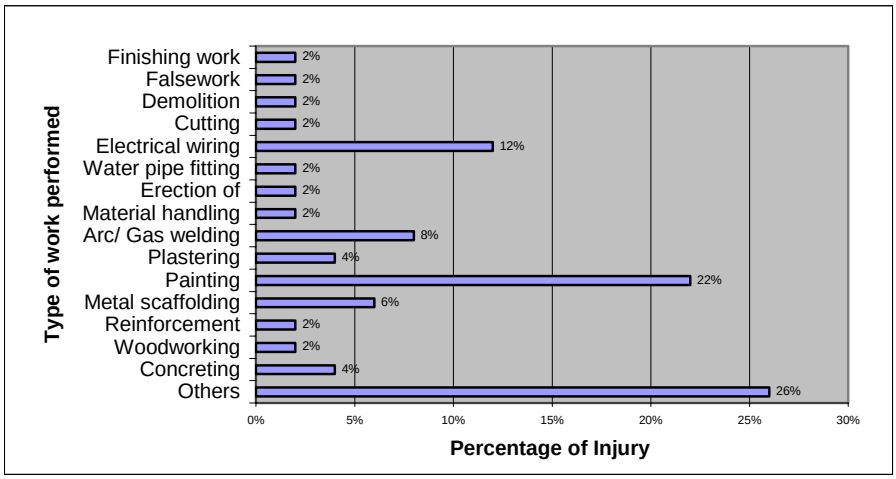
Fig. 5.11 Distribution of fall location and height of fall during 2001 to 2004 (ArchSD, 2001-2004)



5.2.13 Type of work performed during accident

Figure 5.12 shows the distribution of type of work performed at the time when fall injuries occurred. The result reinforces our previous finding as indicated in Table 5.2, which show that the painting trade accounted for a high number of injuries. Because of the job nature, painters are frequent users of ladders in maintenance work.

Figure 5.12 Distribution of type of work performed during 2001 to 2004 (ArchSD, 2001-2004)



5.2.14 Length of experience in construction

Figure 5.13 shows the distribution of workers by years of construction site experience. More than half of the workers (62%) of the injured workers have less than 10 years of construction site experience. Less experienced workers are more prone to fall injury. At project level, Figure 5.14 demonstrates the time at which the injured workers stayed at the incident sites. Half of the injured workers (50%) only stayed at the incident site for one month or less. This shows that most fall accidents occur when the workers were new to the site and were not familiar with the site conditions. A proper safety briefing to highlight the potential hazards in the working environment is absolutely essential to avoid site accidents.

Figure 5.13 Distribution of workers by wears of construction site experience from 2001 to 2004 (ArchSD, 2001-2004)

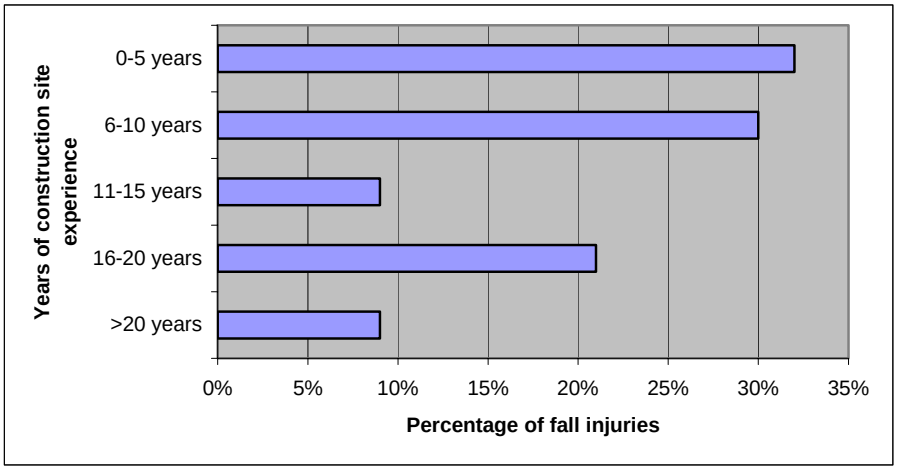
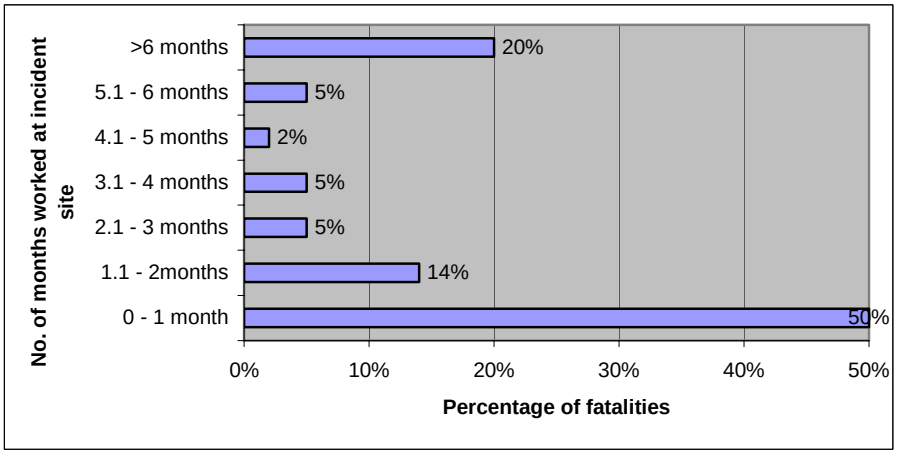


Figure 5.14 Distribution of worker by number of months worked at the incident site from 2001 to 2004 (ArchSD, 2001-2004)



5.3 Identification of key issues from Labour Department statistical data

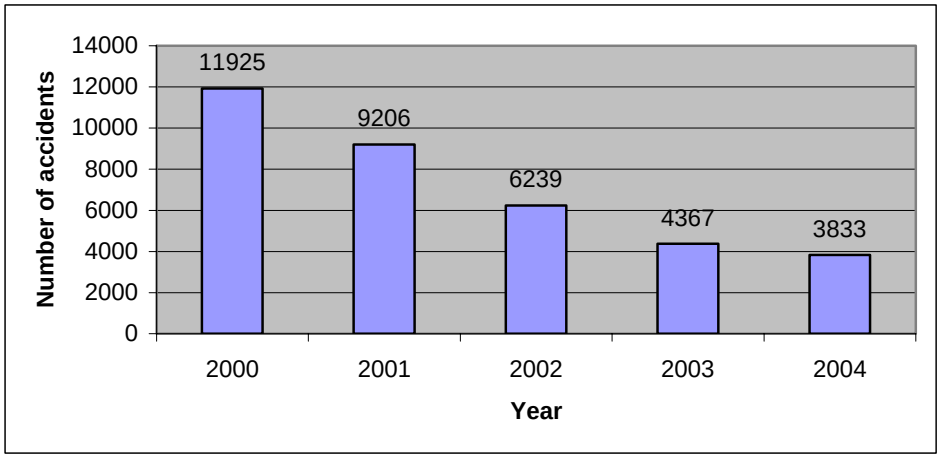
The statistical information provided by the Labour Department records all the construction accidents in Hong Kong between 2000 to 2004. Nine key issues were identified for analysis, these included:

1. Year distribution
2. Month distribution
3. Type of accident
4. Employers, self-employed and illegal workers
5. Type of work performed during accident
6. Body part injured
7. Injury nature
8. Age distribution
9. Sex distribution

5.3.1 Year distribution

The figures on accident rates in the construction industry have been decreasing rapidly since 2000. The accident rate per 1000 workers fell from 150 in 2000 to 60 in 2004. This encouraging improvement has proved that Hong Kong has an excellent performance in construction safety and is one of the leading countries in this field. Figure 5.15 shows the rapid drop of accidents during 2000 to 2004 from 11,925 to 3,833.

Figure 5.15 Industrial accidents in the construction industry during 2000-2004 (The Labour Department, 2005)



5.3.2 Month distribution

Figure 5.16 shows the average distribution of accidents over the months during 2000 to 2004. The distribution shows a trend that over the summer months accidents increase. Similarly for fatal accidents a similar behaviour can be observed as shown in Figure 5.17. The possible reason that both non-fatal and fatal accidents occur more likely over the summer months is probably due to several reasons. Summer weather in Hong Kong can reach high temperatures of 35-37°C at these conditions occupations that require work outdoors can be immensely uncomfortable. Hence it is likely that under these circumstances workers feel more frustrated and their bodies do not adapt to the heat well causing them to neglect safety precautions and to be more careless resulting in a higher frequency of accidents. In addition, it is likely that workers work for longer hours during the summer days as illumination lasts for a few more hours compared to the winter days. Construction projects very much rely on speed of work to gain profit hence contractors often insist on workers to work longer hours if possible. As a result, it is likely that workers may be injured more easily as they have been working for longer hours and feel more exhausted to be alert of possible accidents. Another possibility is that people tend to feel more relaxed in the summer months causing again awareness to decrease. The

analysis shows that precautions should be taken to make sure that safety awareness maintains. The increase of inspections and monitoring should be considered. In addition, it is vital that for all times of the year workers get sufficient rest and they are not strained to inappropriate long hours.

Figure 5.16 Accidents in repair and maintenance works during 2000-2004 analysed by month (The Labour Department, 2005)

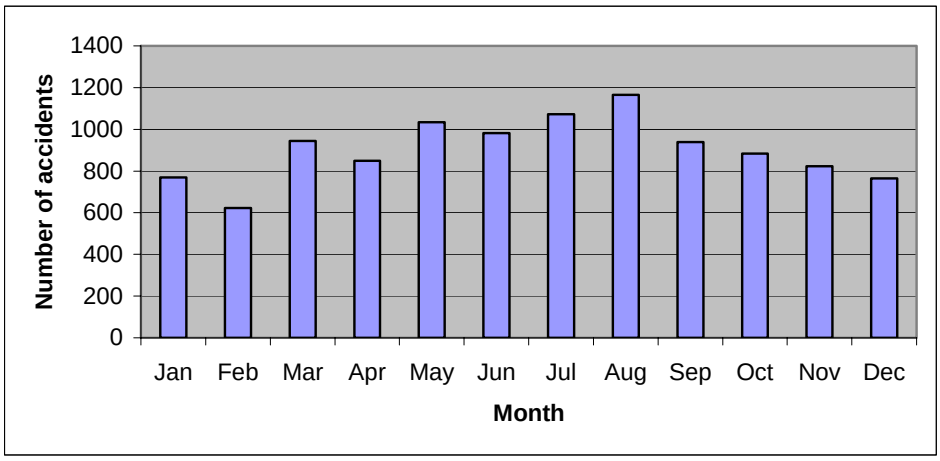
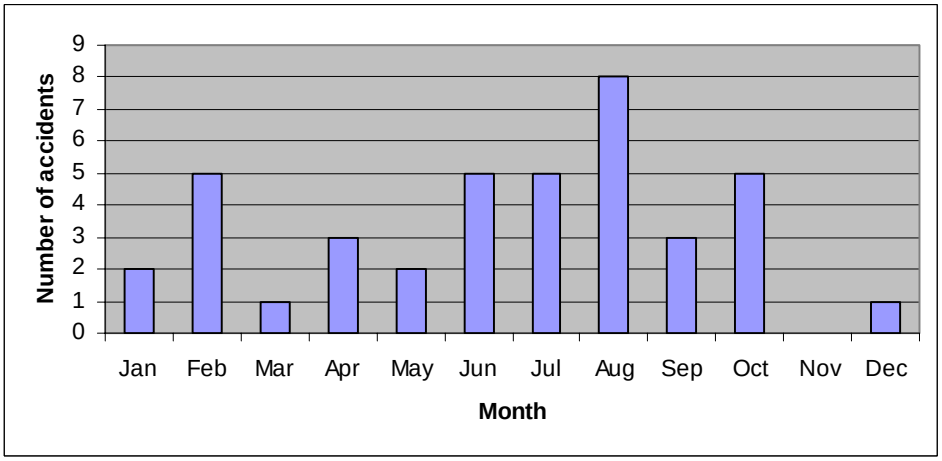


Figure 5.17 Fatal accidents in repair and maintenance works during 2000-2004 analysed by month (The Labour Department, 2005)



5.3.3 Type of accident

Figure 5.18 shows the top five types of accidents which occurred during 2000-2004. It was found that the focus of this research project 'fall of person from height' took fourth place in the most frequent types of accidents during 2000 to 2004 with 1,383 accidents. Instead 'striking against or struck by moving object' caused the most accidents with 2,403 during 2000 to 2004. Although the figures for 'fall of person from height' appear not to be lethal it can seen from Figure 5.19 that it topped first place in construction site killers. The findings are not a surprise. It is understandable that more serious injuries are caused as a result of fall such as head and skull injuries or multiple injuries. Although fall from height is not the most frequent accident on construction sites in Hong Kong it is definitely the most fatal.

Figure 5.18 The top five types of accidents in repair and maintenance works during 2000-2004 (The Labour Department, 2005)

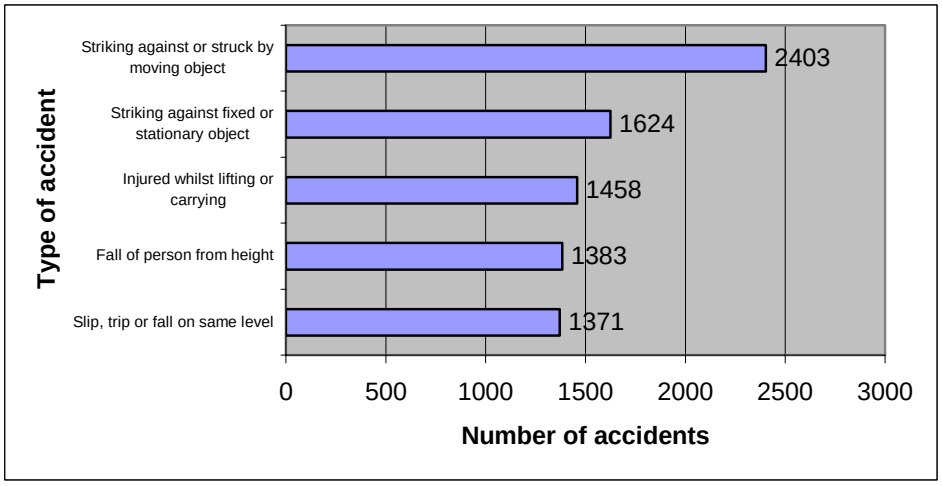


Figure 5.19 The top four types of fatal accidents in repair and maintenance works during 2000-2004 (The Labour Department, 2005)

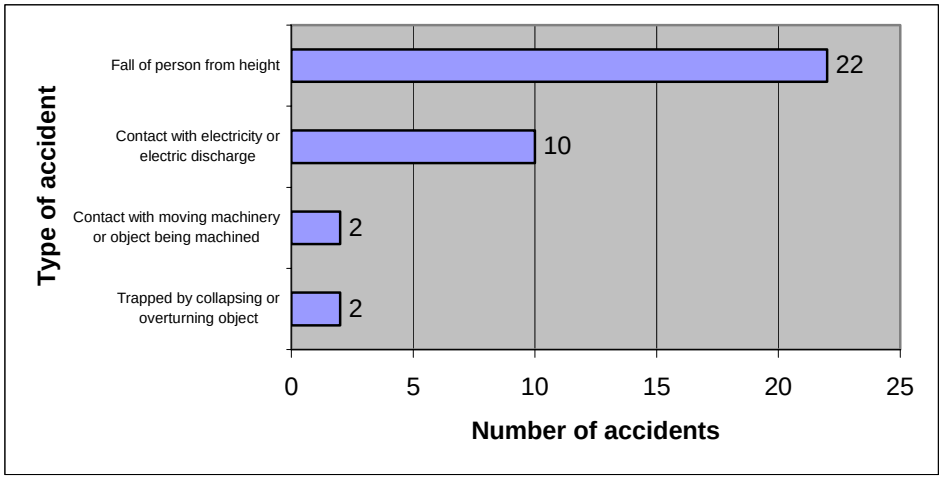


Figure 5.20 shows the distribution of fall accidents from 2000 to 2004. The statistics show that a slow drop in accidents from 1,024 in 2000 to 447 in 2004 has been experienced. Figure 5.21 further shows a comparison of the total number of accidents and fall accidents; the graph shows that the fall accidents are a minority compared to the total accidents. But Figure 5.22 shows a comparison of the total number of fatal accidents and fatal fall accidents. This graph shows that fatal fall accidents represent a large proportion of the total number of fatal accidents. Over the five years fatal fall accidents represent approximately half of the total fatal accidents. This finding is astonishing especially when the fall accidents appear to be so much less than the total number of accidents. The statistics call for the need for more work to be done in the area of safety for fall from height accidents.

Figure 5.20 Industrial accidents resulted from fall of person from height during 2000-2004 (The Labour Department, 2005)

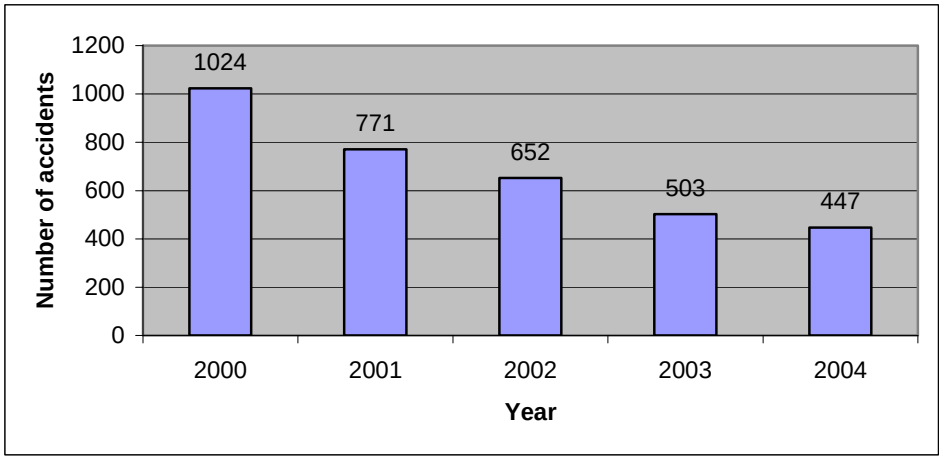


Figure 5.21 A comparison of the total number of industrial accidents and industrial accidents resulted from fall of person from height during 2000-2004 (The Labour Department, 2005)

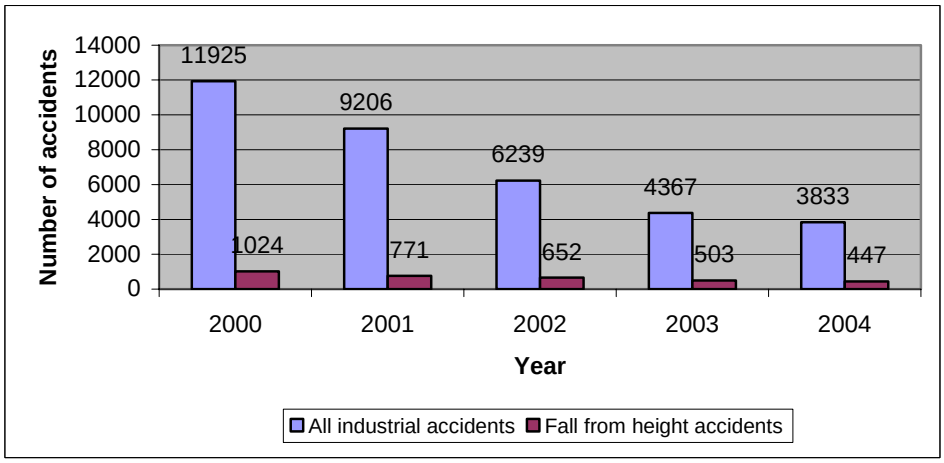


Figure 5.22 A comparison of the total number of fatal industrial accidents and fatal industrial accidents resulted from fall of person from height during 2000-2004 (The Labour Department, 2005)

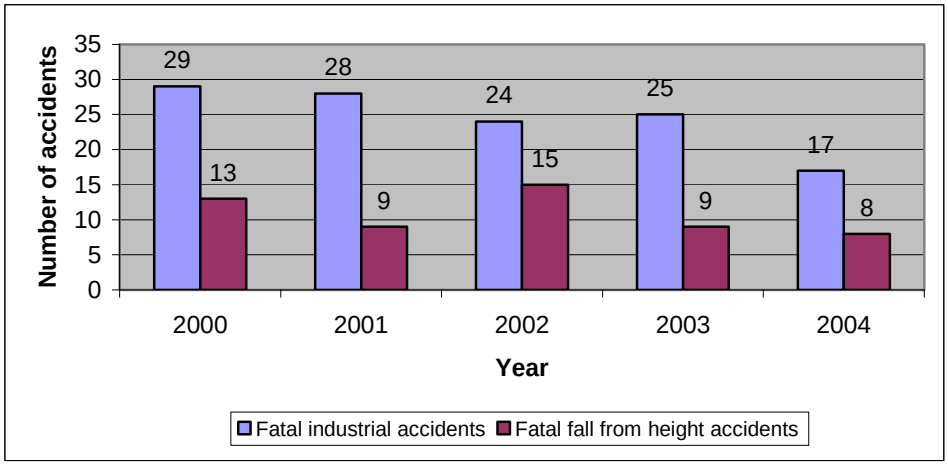


Figure 5.23 compares the total number of accidents, repair and maintenance accidents and repair and maintenance accidents which resulted from fall from height. The statistics show that the repair and maintenance accidents resulted from fall from height accidents are negligible compared to the total number of accidents and repair and maintenance accidents. Figure 5.24 on the other hand compare these three types of accidents again but for fatal accidents. Similar to previous findings it is shown that fatal repair and maintenance accidents resulted from fall from height represented a large proportion of the fatal accidents. Hence it is important for fall from height accidents to be reduced but especially the ones in repair and maintenance works.

Figure 5.23 A comparison of the total number of industrial accidents and repair and maintenance work accidents during 2000-2004 (The Labour Department, 2005)

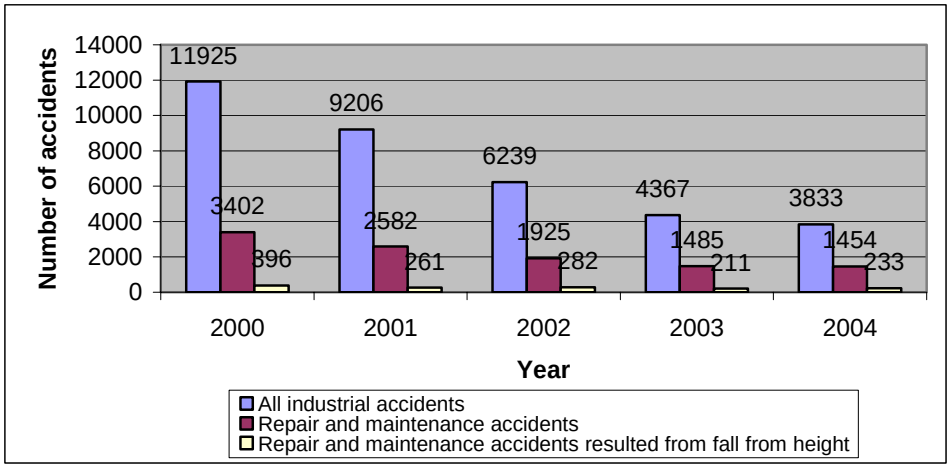
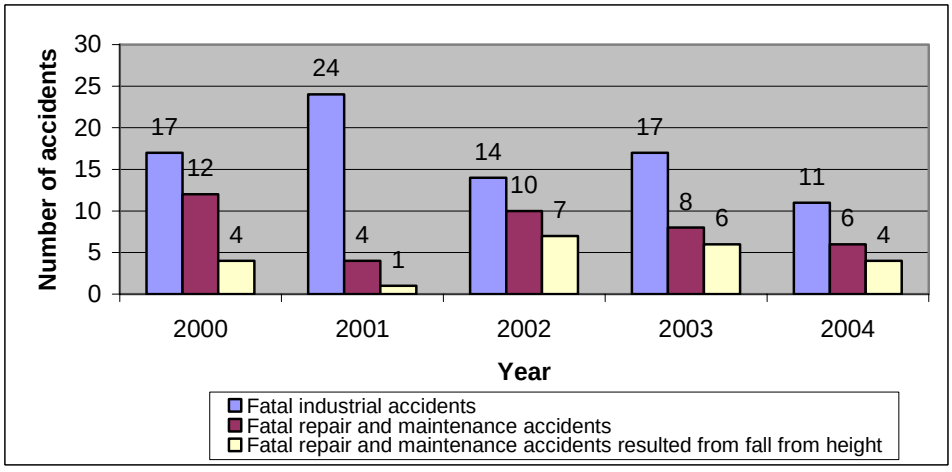


Figure 5.24 A comparison of the total number of fatal industrial accidents and fatal repair and maintenance work accidents during 2000-2004 (The Labour Department, 2005)

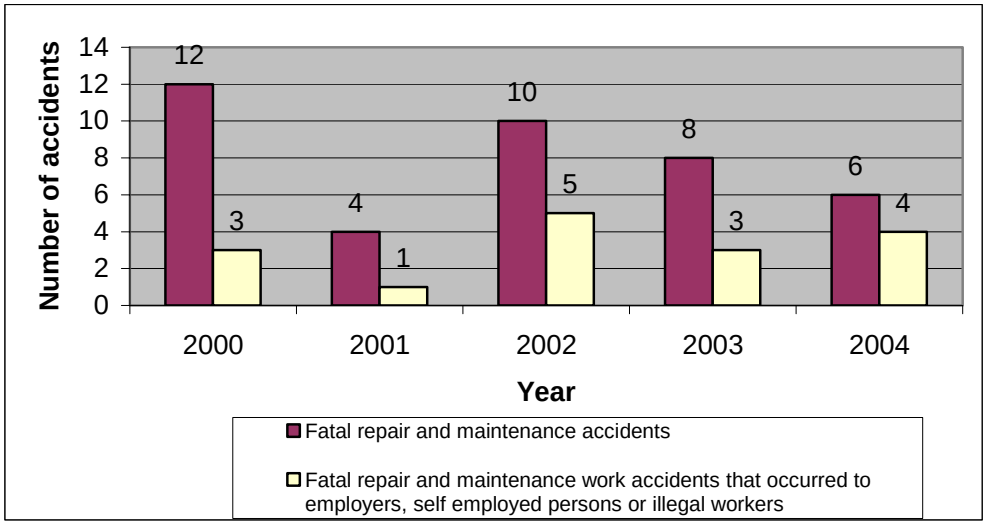


5.3.4 Employers, self-employed and illegal workers

Accidents involving employers, the self employed and illegal workers are sometimes difficult to include in published statistics. The reported cases are often fatal as the police have been involved for the incidents to be recorded. The non-fatal accidents involving these groups of people are unpredictable. Figure 5.25 shows the number of fatal

accidents which occurred whilst performing repair and maintenance works, and also the ones that occurred whilst performing repair and maintenance works to employers, self employed and illegal workers. The statistics show that these groups of people can represent up to two thirds of the total fatal accidents that occurred during repair and maintenance works. The findings show that these groups of people are very much prone to accidents and that more precautions should be carried out to prevent these accidents. It is likely that for employers and the self-employed they take more risks to complete projects faster and they reduce safety precautions to the minimum to increase profits. In addition their safety knowledge and safety equipment is often a lot less compared to contractors who employ people with safety expertise to supervise, monitor and design the works. For illegal workers it is likely that they possess little or no knowledge in construction safety as they probably did not even work in the same industry before arriving in Hong Kong. In addition safety standards vary for different countries, so the same level of safety may not be acceptable in Hong Kong. Workers that work illegally often live in unstable conditions and are therefore tight for money, resulting in them to be willing to work for low prices. At very low prices it is likely that safety measures cannot be included. More research needs to be carried out to investigate the reality behind these people and solutions need to be sought to eliminate their accidents. In general, a large proportion of accidents in repair and maintenance works occur to employers, the self-employed and illegal workers. These groups of people are a lot more difficult to monitor and control hence the accidents are harder to prevent. More work should be carried out to provide employers and the self-employed with sufficient support and safety knowledge. Construction sites should be monitored regularly to prevent illegal workers and employers of illegal workers. If caught the employer and the illegal worker should be penalized heavily.

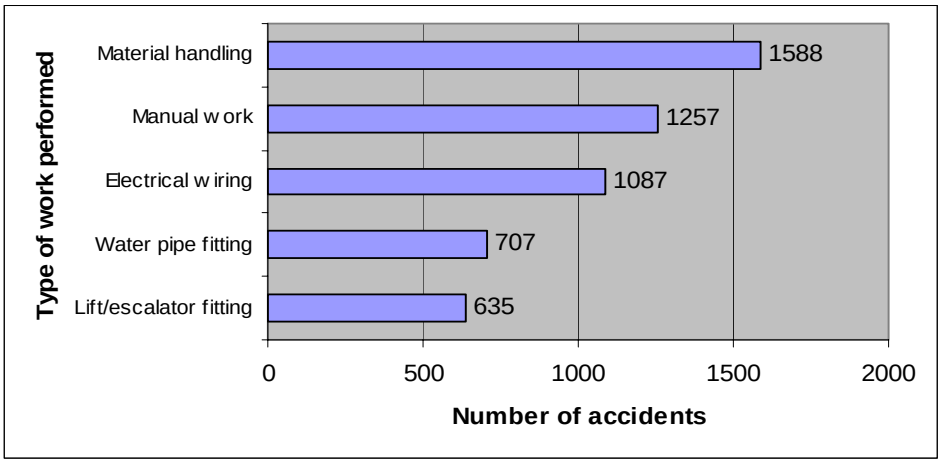
Figure 5.25 A comparison of all fatal repair and maintenance work accidents and fatal repair and maintenance work accidents that occurred to employers, self-employed persons or illegal workers during 2000-2004 (The Labour Department, 2005)



5.3.5 Type of work performed during accident

Figure 5.26 shows the top five types of work performed when accidents occur in repair and maintenance works. The statistics show that material handling topped first place with 1,588 accidents and was closely followed by manual work and electrical wiring. In addition water pipe fitting and lift/escalator fitting were also amongst the top five types of work performed. These findings are predictable as these chores are common on construction sites. The more common the chores are carried out the more chance there is of accidents. Figure 5.26 shows the number of accidents for repair and maintenance works only, when analysing the statistics for the whole construction industry during the same period it was realized that the top four types of work performed when accidents occur were the same.

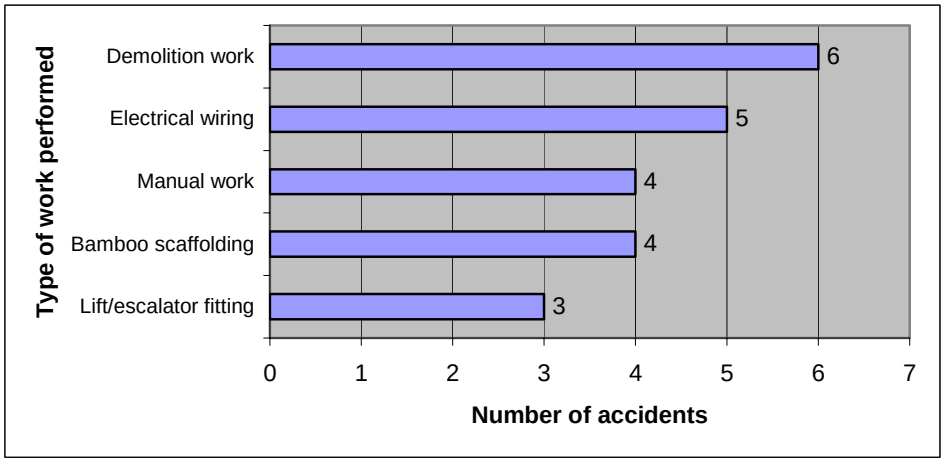
Figure 5.26 The top five types work performed when accidents occur in repair and maintenance works during 2000-2004 (The Labour Department, 2005)



On the other hand Figure 5.27 shows the top five types of work performed when fatal accidents occur in repair and maintenance works. The results are slightly different from the ones showing fatal and non-fatal accidents. Demolition work is the most lethal in repair and maintenance works, probably because much work involves heavy machinery and working at height. The working conditions of demolition work are a lot more unstable and unpredictable hence the likelihood of accidents is aggravated. In addition electrical wiring, manual work, bamboo scaffolding and lift/escalator fitting were also amongst the top five types of work causing fatal accidents in repair and maintenance works. It is interesting to find that all these types of work involve working at height. The statistics show that safe practice when working at height must be promoted. Extra attention should be given to works that are performed frequently. And also more safety plans and precautions should be carried out before demolition works start to compensate for the higher risks involved. In addition, the order of the top five types of work performed when fatal and non-fatal accidents occur in repair and maintenance works was very similar to that for fatal accidents only. In general, the statistics also showed that works that are carried out more often on building sites have a higher likelihood of accidents. Demolition work caused the most fatal accidents during 2000-2004 in repair and maintenance works. Hence more precautions and planning before demolition works

begin should be carried out to prepare for the unpredictable and unstable conditions involved.

Figure 5.27 The top five types work performed when fatal accidents occur in repair and maintenance works during 2000-2004 (The Labour Department, 2005)

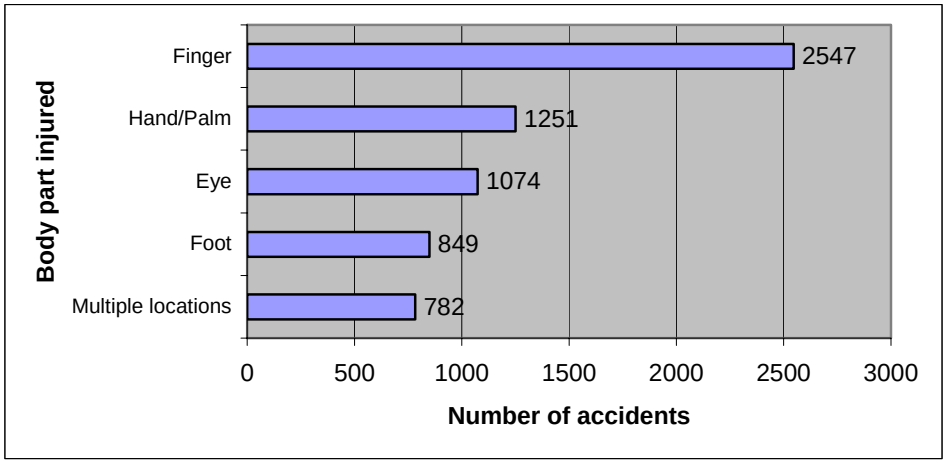


5.3.6 Body part injured

The top body part injured by far from accidents in repair and maintenance works was finger. Other body parts in the top five included hand/palm, eye, foot and multiple locations. Again similar to the discussion for type of work performed, it is obvious that the body part exposed and used the most is the part that will be injured more often, it is believed that this is also the case for the statistics presented in Figure 5.28. Statistics for the top five body parts injured from accidents in the whole construction industry were very similar in ranking. In addition for both accidents in the whole construction industry and repair and maintenance works, the body parts injured from fatal accidents were multiple locations followed by skull/scalp. Therefore more attention should be drawn to prevent fall from height which is the common cause of multiple injuries and head protection is also important to protect the skull/scalp. The findings are logical as fatal accidents are likely to be caused by injury to multiple locations or skull/scalp, and not to the finger! In general, body parts which are more frequently used and exposed are more

prone to accidents, such as the finger and the hand/palm. But fatal accidents result from injuries multiple locations or head/skull. Therefore focus should be played to prevent these injuries by improving fall from height safety and personal protection equipment.

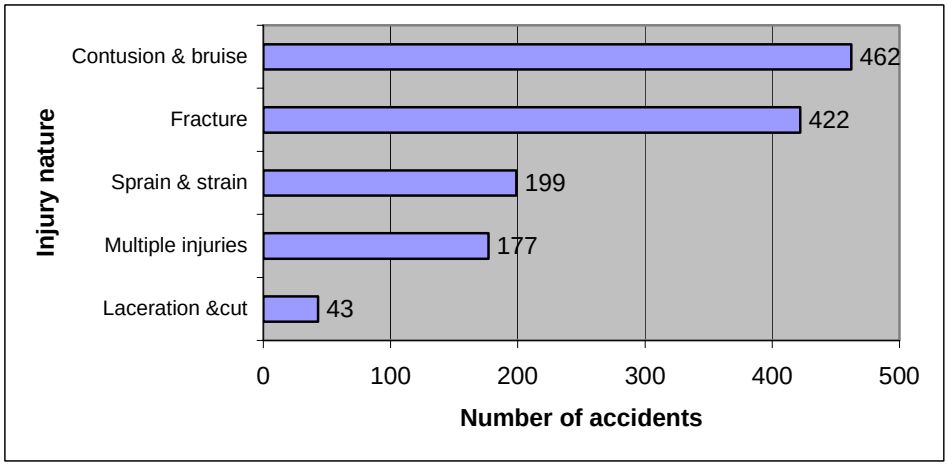
Figure 5.28 The top five body parts injured from accidents in repair and maintenance works during 2000-2004 (The Labour Department, 2005)



5.3.7 Injury nature

The top five injury natures of accidents in the whole construction industry and in repair and maintenance works during 2000 to 2004 are the same. As shown in Figure 5.29 contusion and bruise contributed the most accidents in repair and maintenance works, 462 accidents amongst the 1,383 which represents a third of the total accidents in repair and maintenance works. Closely followed by fracture with 422 accidents, which is also approximately a third of the total accidents in repair and maintenance works. Other injury natures in the top five included sprain and strain, multiple injuries, and laceration and cut. For accidents in the whole construction industry and repair and maintenance works multiple injuries followed by contusion and bruise were the injury natures that caused the most fatal accidents. This finding is very similar to the one found for body part injured. It was realised that multiple locations caused the most fatal accidents. Multiple injuries are often caused by fall from height accidents.

Figure 5.29 The top five injury natures of accidents in repair and maintenance works during 2000-2004 (The Labour Department, 2005)



5.3.8 Age distribution

Statistics show that most accidents in the construction industry from 2000 to 2004 occur to workers in the age group 40-44. This trend is the same for repair and maintenance works as shown in Figure 5.30. It is logical for accidents to occur to workers of this age group due to a number of assumptions. Many workers are within the age group 40-44. Assuming that a worker starts their career at 20 years old, at age 40-44 the worker would have had over 20 years experience and experience often leads to over confidence. It is therefore possible that workers in this age group are over confident and take risks for convenience and speed, as well as to impress younger and less experienced workers of their ability, and in a sense showing more superiority amongst colleagues. Fatal accidents in the construction industry also occurred to workers in the age group 40-44. But in repair and maintenance works most fatal accidents occurred to workers in the age group 30-34 as shown in Figure 5.31. It is likely that a large proportion of repair and maintenance workers are younger than workers of the general construction industry. As repair and maintenance jobs are often unstable and involve high risk, but workers especially the younger ones are attracted to these jobs as the pay is often better and quicker as the jobs are a lot shorter in duration. The findings show that more work needs

to be carried out to re-educate the experienced workers, ensuring that they remain alert and safe at all times, as well as receive up to date information on safety practices. In addition repair and maintenance works although are shorter in duration should also carry out strict safety procedures comparable to those of large construction works.

Figure 5.30 Accidents in repair and maintenance works during 2000-2004 analysed by age group (The Labour Department, 2005)

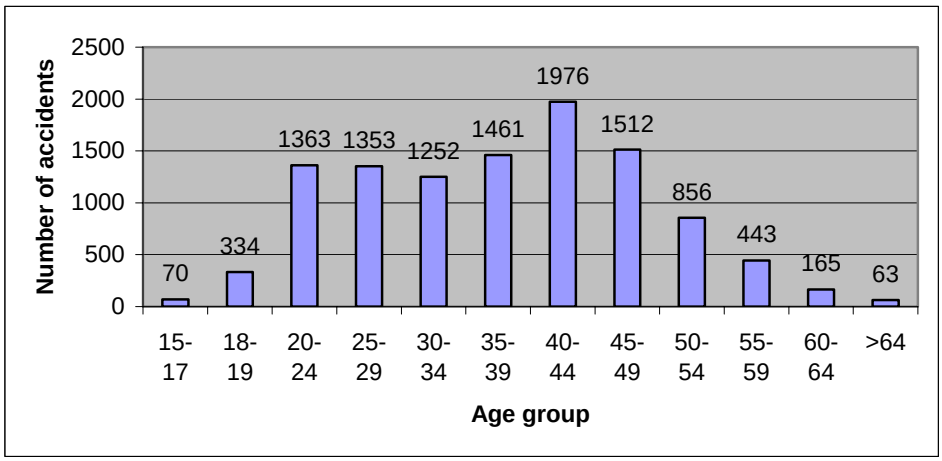
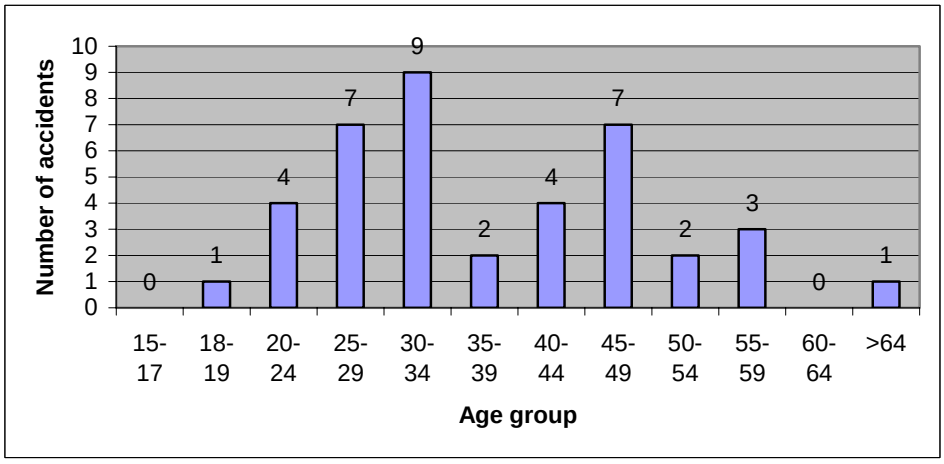


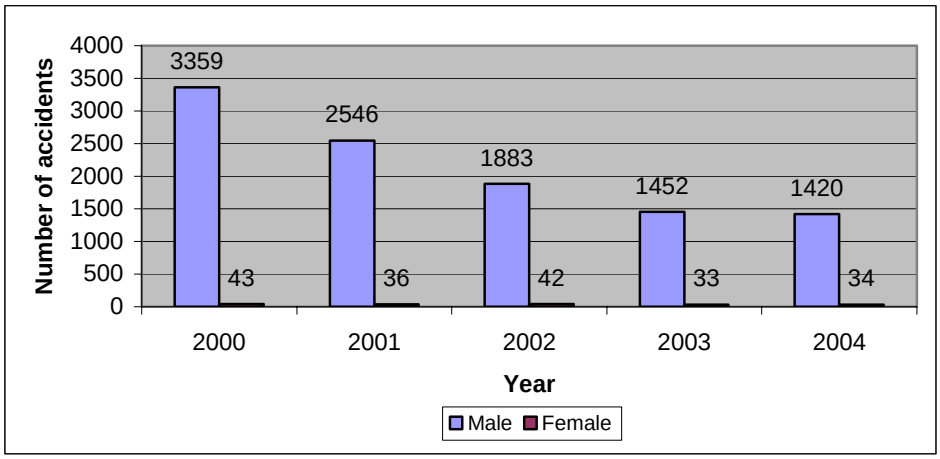
Figure 5.31 Fatal accidents in repair and maintenance works during 2000-2004 analysed by age group (The Labour Department, 2005)



5.3.9 Sex distribution

Figure 5.32 shows expectedly that the majority of accidents occurred to male workers instead of female workers. From 2000 to 2004, 10,660 male workers were injured compared to only 188 female workers which is less than 2% of the total accidents in repair and maintenance works. It is known that the construction industry is a male dominated industry hence the findings are not of surprise that the majority injured are male workers. All fatal accidents recorded for repair and maintenance works occurred to male workers only. The statistics show that safety messages should be targeted particularly at male workers as they represent the majority.

Figure 5.32 Accidents in repair and maintenance works during 2000-2004 analysed by sex (The Labour Department, 2005)



5.4 Comparison of the Labour Department and the ArchSD statistical data

A comparison of some of the common key features identified from the statistical data provided by the ArchSD and the Labour Department was performed. Comparison was difficult as there were only four common features which were available from each source. The data provided from the ArchSD showed data relating to fall injuries for a proportion of public works during 1995-2004. Whereas the data provided by the Labour Department provided data for all accidents in the construction industry during 2000-2004. The Labour Department data was further categorized into accidents that were involved in repair and maintenance works, which were also the statistics analysed in this chapter. The statistics in repair and maintenance works can be further categorized into 'all accidents' and 'fatal accidents'. Therefore a direct comparison of these categories for fall accidents only was impossible as this information was not provided by the Labour Department. Therefore Table 5.5 compares the statistics of fall accidents from ArchSD with the 'fatal' and 'fatal and non-fatal' accidents from the Labour Department.

Analysis of the common key features showed that for age distribution, the ArchSD statistics and the Labour Department (all accidents) statistics were identical. Compared to the Labour Department (fatal accidents) statistics the findings were very similar, but the age groups were slightly lower. In addition, two types of injury nature were identical, the body parts injured were completely different and only one type of work performed was identical between the two sources of data.

In general, it was difficult to compare the two sources of statistics as the group classification and sample size were quite different. But it is believed that the analysis of the statistics alone is extremely useful for highlighting the places of high risk for different groups of accidents. The Labour Department statistics represent the statistics for the whole construction industry in recent years, whereas the ArchSD statistics represent a proportion of public work accidents for a longer period of time.

Table 5.5 Comparison of the statistics from ArchSD and the Labour Department

Attributes	ArchSD statistical data (fall accidents) (A)	Labour Department statistical data (repair and maintenance accidents)		Comparison	
		All accidents (B)	Fatal accidents (C)	(A) vs (B)	(B) vs (C)
Age distribution	1. 40-44 2. 45-49 3. 35-39	1. 40-44 2. 45-49 3. 35-39	1. 30-34 3. 45-49 3. 25-29	Same	Similar
Injury nature	1. Fracture 2. Contusion and bruise 3. Contusion and other internal injury/ joint/ laceration and cut	1. Contusion and bruise 2. Fracture 3. Sprain and strain	1. Multiple injuries 2. Contusion and bruise 3. Concussion	Similar	Similar
Body part injured	1. Upper limbs 2. Lower limbs 3. Neck and trunk	1. Finger 2. Hand and palm 3. Eye	1. Multiple locations 2. Skull and scalp	Different	Different
Type of work performed	1. Painting 2. Electrical wiring 3. Arc and gas	1. Material handling 2. Manual work 3. Electrical wiring	1. Demolition work 2. Electrical wiring 3. Manual work	Similar	Similar

Note: The number indicates the order of significance of the attributes concerned, 1 being most important.

5.5 Summary

Statistics show that Hong Kong has achieved an enviable safety record in recent years. Unfortunately the same cannot be said to accidents resulted from fall of person from height. The statistics showed that fatal fall accidents represented approximately half of the total fall accidents. The findings cry for more work to be done in the area of fall from height safety and especially in the area of repair and maintenance works.

In general, the statistical information has been extremely useful in providing the picture of common failures, acts and circumstances resulting in accidents in repair and maintenance works. With this information the study scope can be narrowed to pin point the main causes in order to derive practical solutions to eliminate fall from height accidents in repair and maintenance works.

Chapter 6
CASE STUDIES ON FATAL ACCIDENTS

Chapter 6 Case Studies on Fatal Accidents

6.1 Introduction

The Hong Kong's construction industry has shown significant improvement in safety performance recently. The number of industrial accidents in the construction industry has decreased from 11,925 in 2000 to 3,833 in 2004, which is an encouraging drop of almost 68%. Fall of person from height has always represented a large proportion of the fatal accidents. In 2004, fall of person from height represented just over 47% of the total number of fatal accidents in the construction industry. The figures show that although the overall number of accidents has dropped immensely, the same cannot be said for fall from height accidents.

According to the statistics of the Labour Department, there were a total of 22 fatal industrial accidents associated with fall of persons from height in repair, maintenance, minor alteration and addition works between 2000-2004. To facilitate the study, the 22 cases were provided to the research team, under an agreed undertaking and framework, for comparative analysis with a view to identify the common causations and features of the mishaps, drawing analogy on the rationale and recommending the appropriate preventive measures for the industry.

6.2 Process of accident investigation

The fatal cases were investigated by Occupational Safety Officers of the Labour Department. The study reveals that investigation of fatal accidents remains to be a very complex and complicated process involving on-the-spot investigation and subsequent investigations, collection of evidence and information of the accident scene, examination of the equipment, evaluation of the probable causes and developing appropriate preventive measures. In-house legal advice had to be sought in most of the cases and in

many of the cases, technical advice and assistance were also required for completion of the investigation.

6.3 Comparison of case studies

The 22 cases under scrutiny involved all the fatal fall from height accidents in repair and maintenance works that occurred during 2000-2004. The cases selected during these five years can be compared to the accident statistics also provided by the Labour Department during 2000-2004. The 22 cases were confined to fatal accidents occurred to workers which were reported by the employers to the Labour Department. With a basic understanding of the investigation process the cases were thoroughly studied individually. The cases were further analysed by identifying 16 common factors believed to share a high degree of importance to the cause of these fatal accidents. Simple statistical analysis of the cases under these factors was carried out, and the findings are presented in the following section. It should be emphasised that the analyses presented hold limitations as they only represent a small sample size of 22 cases. It is not our intention to generalize the findings with these limited samples but rather we hope to identify some lessons learned through the scrutiny of these 22 cases. The factors studied included:

1. Date of accident – The date of the accident is important to observe for any changes that may occur in accident rates over different years, months and days. If a noticeable pattern or trend can be spotted there must be a reason for a certain period to be more prone to accidents and hence there could be a way to eliminate the trend.
2. Time of accident – The time of the accident is equally interesting to investigate. There are no similar studies in Hong Kong which looks at the time of when a fall from height accident occurs. It is worthy therefore to study.
3. Age of worker – Accident statistics have shown that workers of a certain age group are more prone to accidents, and workers of another age group are more prone to fatal accidents. It is therefore worth studying the age group of workers

that experience fatal fall from height accidents in repair and maintenance works. As a result to see whether there is any relationship between the statistics.

4. Trade of worker – This factor will look at which trades are more prone to fall accidents in repair and maintenance works. Whether a worker needs to work at height is very much related to their occupation.
5. Length of experience – Previous studies (Chan *et al.*, 2005) have shown that the safety attitude of workers is a determining factor contributing to accidents. Their length of experience in the industry can very much affect their attitude towards safety. Hence it is important to analyse whether experience is beneficial towards reducing accidents.
6. Height of fall – Wong *et al.*, 2005 presented statistics that showed that most fall accidents occurred below 2m of height and that most fatal fall accidents occurred below 10m. It is therefore of interest to see how the cases presented here are compared to previous statistics.
7. Place of fall – This factor studies whether there are any similarities amongst the accidents for place of fall.
8. Agent involved – Analysis in Chapter 4 has shown that certain agents are more likely to be involved in accidents. It is therefore of interest to see if the cases hold any similarities in agent involved.
9. Type of work performed – The type of work performed is an important factor affecting the likelihood of an accident. It is therefore important to identify these works and try to eliminate them if incorrect. If the works are correct but just high risk chores it is important to seek solutions via better safety management and work planning to reduce the accidents as a result of these works.
10. Unsafe condition/action – Unsafe conditions exposed and unsafe actions performed are often a result of human failure. Human failure is an area that can be prevented with proper precautions. It is therefore of great achievement to identify these failures and prevent them in future works. These failures will obviously be unique as the cases presented here are for repair and maintenance works only.

11. Safety education and training – The local government has invested heavily in safety education and training. It is obviously aimed that increasing safety knowledge and training will as a result decrease accidents. This section will look at the level of safety training the deceased people had received.
12. Use of safety equipment – The use of safety equipment could help prevent an accident from occurring. It is therefore important to investigate whether the contractor had provided the necessary safety equipment and taken adequate steps to ensure workers using the equipment and the worker had correctly used the equipment so provided in the 22 cases presented.
13. Individual flat owners/tenants – Recent awareness has been drawn to accidents as a result of repair and maintenance works for individual flat owners/tenants. Different from an estate management company, individual flat owners/tenants are less likely to possess the knowledge and resources to provide safety measures to workers and consequently it is often assumed that more accidents may be resulted.
14. Employment condition – Similarly the employment condition is also likely to affect the occurrence of an accident. Contractors are believed to possess more safety knowledge and resources for the provision of a safer environment when compared to sub-contractors.
15. Special features – This section investigates any special features which could have caused the accidents.

6.4 Identification of common failures

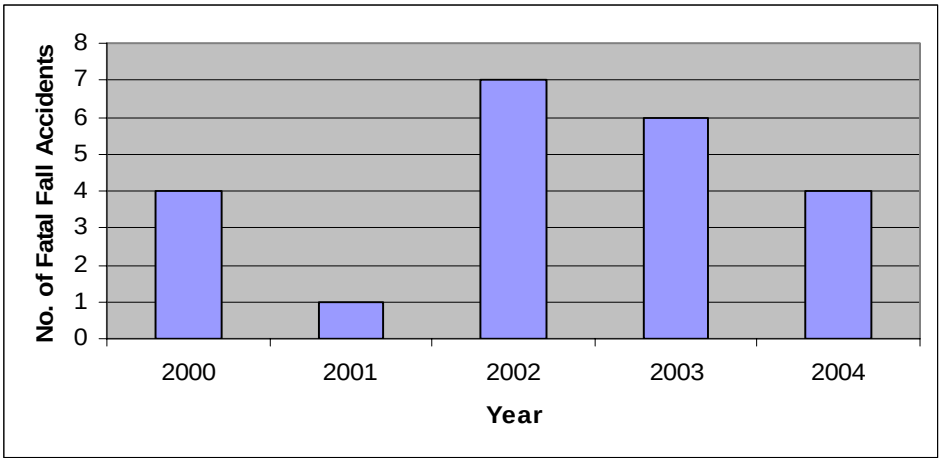
6.4.1 Date of accident

The date of the accident was the first factor studied. Previous analysis of accident data collected from the Labour Department and the Architectural Services Department (Chapter 5) has shown that at a certain time of the year and week there is a higher probability of accidents across the construction industry. The sources showed that accidents as well as fall accidents were more common in the summer months. Statistics

from the Architectural Services Department also showed that Friday was more prone to fall accidents. Hence it is possible that this pattern also holds true for fatal fall accidents. In addition to looking at the month and day of the week, the year and day of the month were also studied.

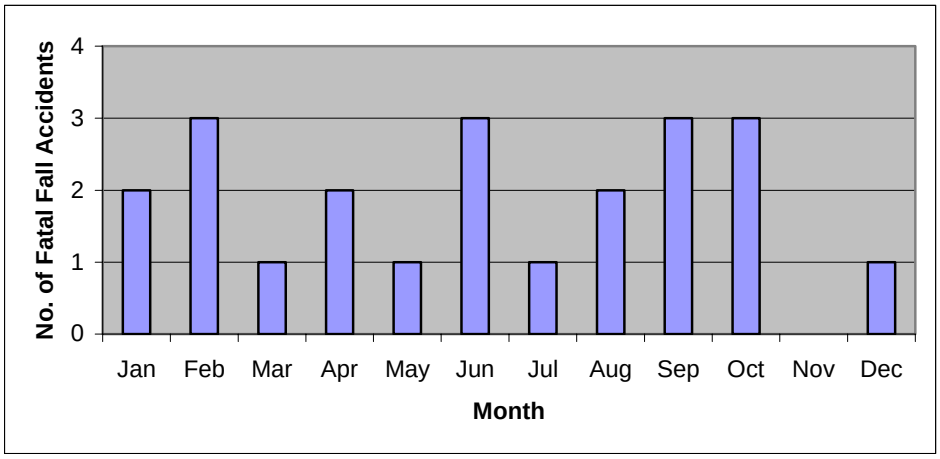
Figure 6.1 shows the number of fatal fall accidents from year 2000 to 2004. The statistics do not appear to show much trend. There was the same number of accidents (four cases) during year 2000 and 2004, but some fluctuations were experienced in between. These figures could not provide any immediate similarities amongst the accidents.

Figure 6.1 Number of fatal fall accidents from 2000-2004



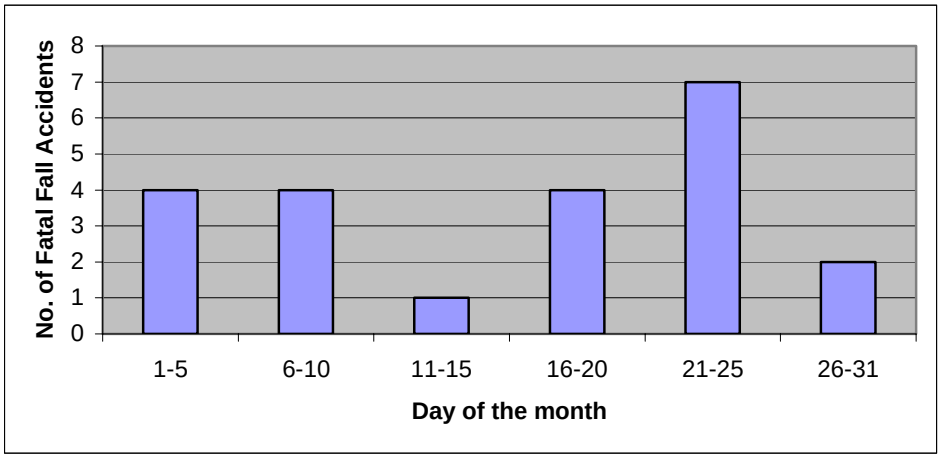
As mentioned previously other sources of accident statistics has shown that the summer months are more prone to accidents. Figure 6.2 shows that this trend is only partially true. June experienced three fatal fall accidents which are the highest in number, but the months February, September and October also experienced three accidents from year 2000-2004. The comparison does not necessarily contradict the previous statistics, but instead a larger sample size would be more reliable as the information discussed in this chapter is limited to only 22 cases.

Figure 6.2 Number of fatal fall accidents from 2000-2004 analysed by month



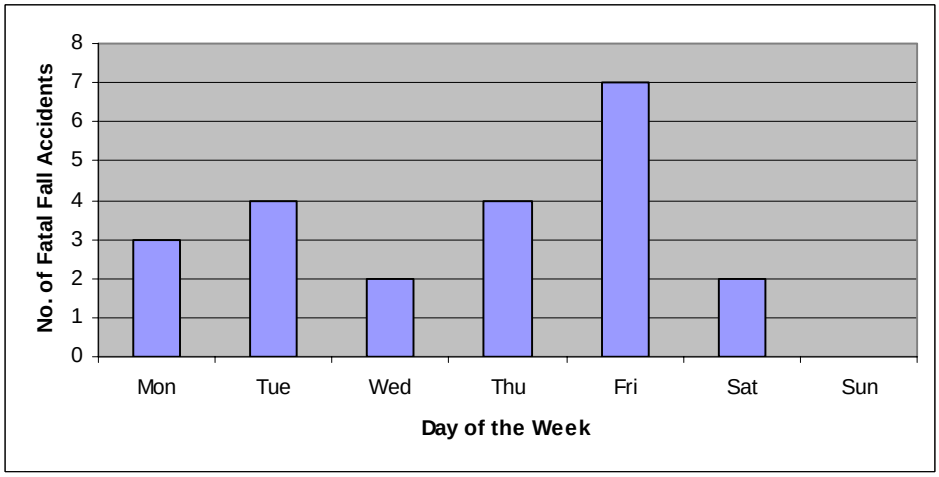
Previous local studies have not considered looking at the day of the month that accidents are more prone. Figure 6.3 shows that the days of the month have been split into 6 periods, and the aim is to compare which period experiences the highest number of accidents. The figure shows that the period from 21-25 days experienced the highest number of accidents by far with seven cases, followed by four cases experienced by 1-5, 6-10 and 16-20 days. Days 26-31 experienced much fewer accidents as for many months there is no day 31 and for February no day 29-31. As the days 29-31 occur less often than the days 1-28 in a year, the possibility of accidents occurring on them would consequently lower.

Figure 6.3 Number of fatal fall accidents from 2000-2004 analysed by day of the month



Statistics analysed in Chapter 5 showed that Friday experienced the highest number of fall accidents in a week. This pattern also holds true for the 22 fatal cases discussed in this chapter. Figure 6.4 shows that seven accidents amongst the 22, almost a third occurred on a Friday, next followed by four accidents which occurred on a Tuesday and Thursday.

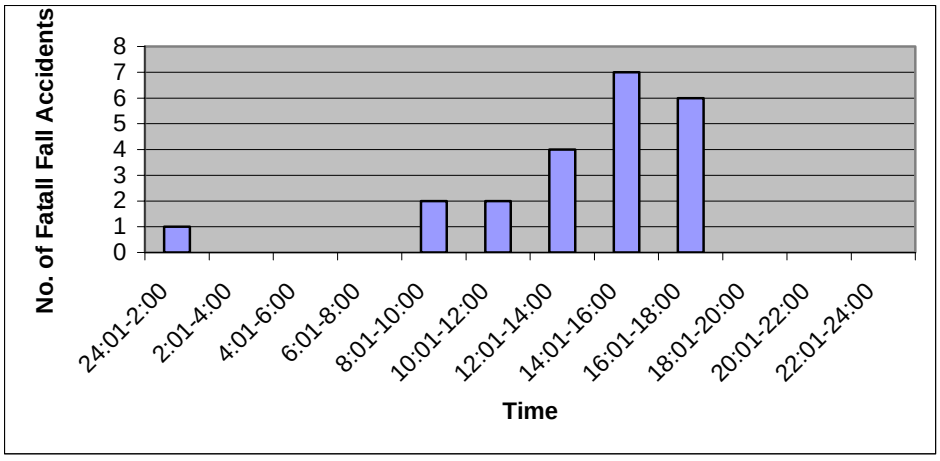
Figure 6.4 Number of fatal fall accidents from 2000-2004 analysed by day of the week



6.4.2 Time of accident

Similar to studying the date of the cases, the time of accident also indicates the hours of the day that are more prone to accidents. Figure 6.5 shows that most accidents occur in the afternoon. During 14:01-16:00 hours the number of accidents amongst the 22 cases was seven, followed by six experienced during the hours 16:01-18:00. It is also suggested that increasing safety inspection and monitoring by contractors in the afternoon would effectively reduce the accidents.

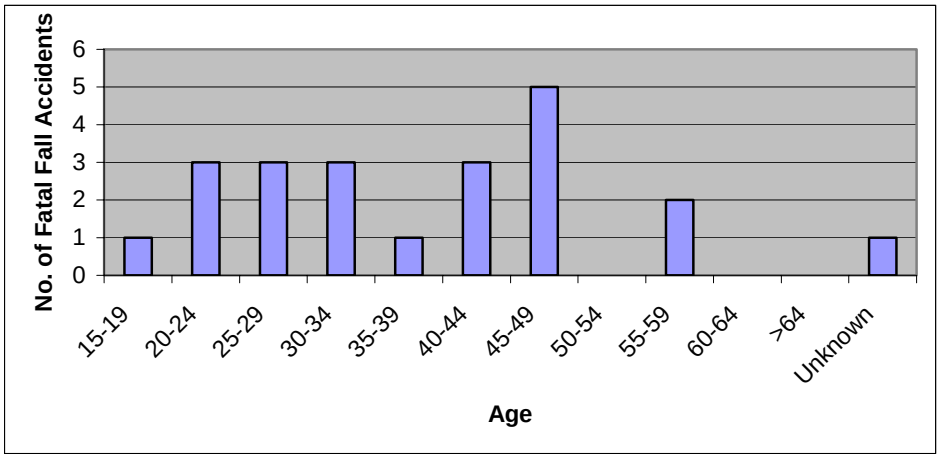
Figure 6.5 Number of fatal fall accidents from 2000-2004 analysed by time of accident



6.4.3 Age of worker

Statistics in Chapter 5 show that the highest number of fall accidents occur amongst workers aged between 40-44. However, in terms of fatal accident for repair and maintenance works the age group 45-49 topped the rank. This pattern is comparable to the ones presented in Figure 6.6. The figure shows that workers aged 45-49 experienced the highest number of fatal fall accidents, totaling five cases from year 2000-2004. Next was followed by three accidents experienced by workers in the age groups 20-24, 25-29 and 30-34.

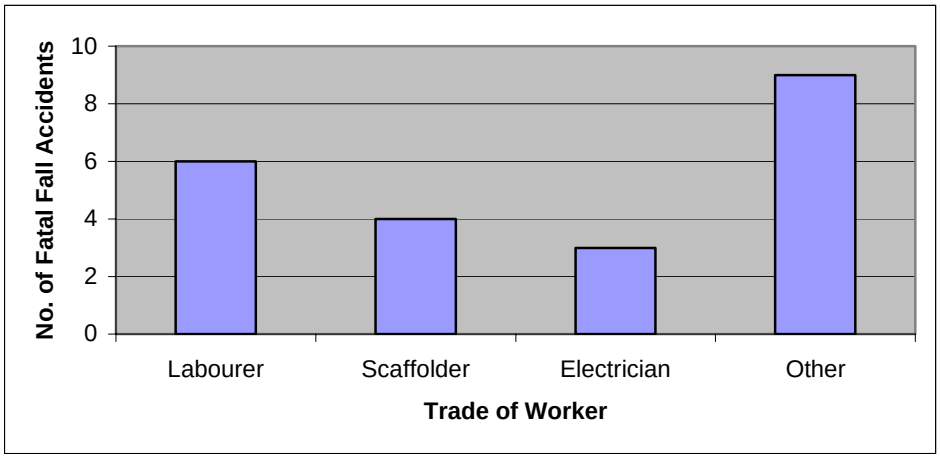
Figure 6.6 Number of fatal fall accidents from 2000-2004 analysed by age of worker



6.4.4 Trade of worker

Analysis of the cases by the trade of the workers was difficult. This again was due to the small sample size available. It was found that the trade of the workers varied immensely, hence where the trade of the worker was not repeated in the 22 cases the case was counted as 'other' as shown in Figure 6.7. Labourers, scaffolders and electricians were amongst the trades that experienced the highest number of fatal fall accidents, the frequency of accidents was six, four and three respectively for the trades. Therefore special attention should be given to these occupations.

Figure 6.7 Number of fatal fall accidents from 2000-2004 analysed by trade of worker



6.4.5 Length of experience

The length of experience that a worker has is believed to be a determining factor towards their accident rate. This factor has also been incorporated in the industry questionnaire for validation. Figure 6.8 shows that almost 60% of the accidents for these 22 cases occurred to workers with less than 10 years of experience in the industry. The experience of 18% were unknown, hence only just over 20% of accidents occurred to workers with over 10 years of experience. Accidents can happen at any length of experience. It is generally accepted that safety training and education is an effective means to prevent accidents. This finding shows that irrespective of the length of experience, training is important for all.

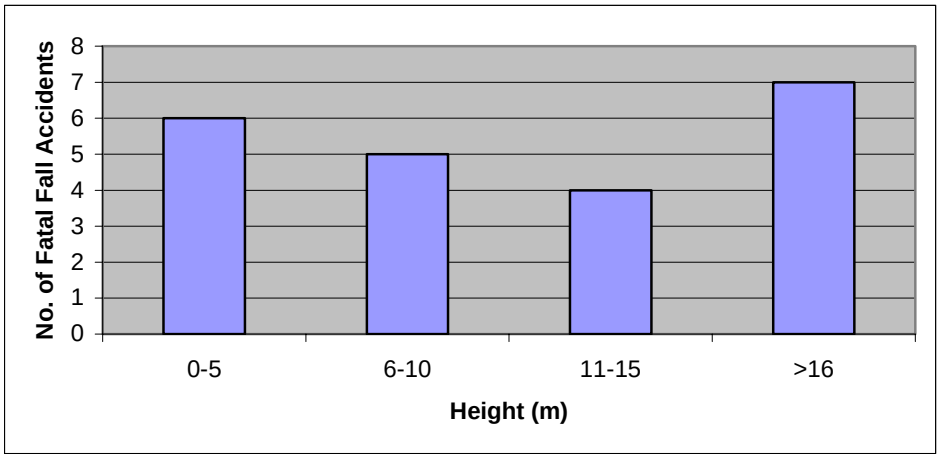
Figure 6.8 Number of fatal fall accidents from 2000-2004 analysed by the workers' length of experience in the construction industry

6.4.6 Height of fall

A previous study looking at accidents related to fall of person from height (Wong *et al*., 2005) showed that the majority of fall accidents occurred below 2m of height. Contradictory the statistics from the 22 cases showed that only two out of the 22 cases were below 2m of height, which is a mere 9%. The differences can be attributed to the fact that the statistics presented here are for fatal accidents arising from repair and maintenance works only whereas the previous statistics were for all fall related (i.e. both fatal and non-fatal) accidents. In addition the sample size of the previous study is much larger than the one studied here hence the statistics may not be as representative. Figure 6.9 shows that the majority of fatal accidents occurred below 15m of height, almost 70%. A trend was observed that more fatal accidents occurred at lower heights. The percentage of accidents that occurred at heights 0-5m, 6-10m and 11-15m was 27%, 22% and 18% respectively. The statistics show an obvious downward trend of accidents as height increases. For accidents in the category 'above 16m' these accidents actually occurred between 32 to 75m of height. Much literature present devices, technologies and job procedures for preventing falls from height, but often these are for tall buildings. It is natural to assume that tall buildings require these solutions as fall is more obvious. But

statistics show that fall could occur at any heights and their damages could be equally devastating. One should not relax their vigilance when working at lower heights.

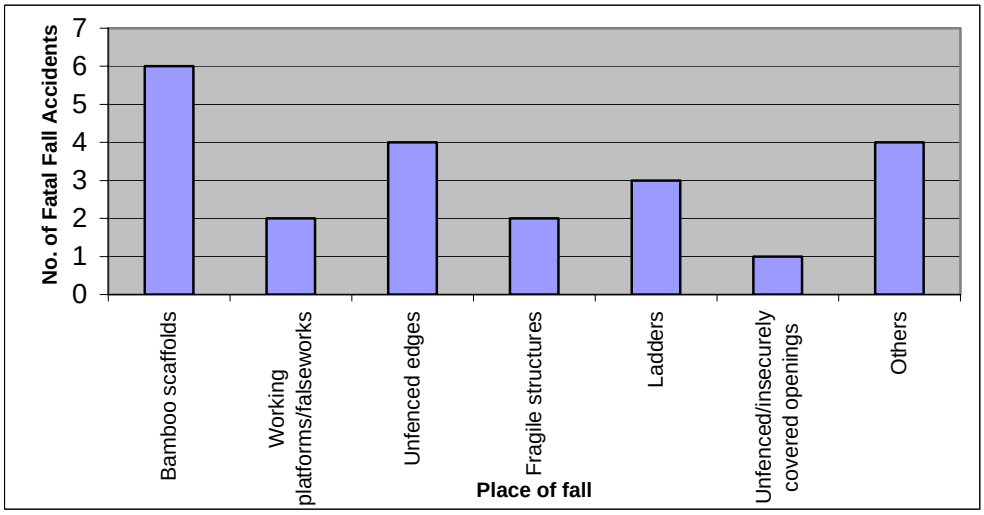
Figure 6.9 Number of fatal fall accidents from 2000-2004 analysed height of fall



6.4.7 Place of fall

The places of fall for the 22 cases were studied and as shown in Figure 6.10 the places were common to those recorded in previous literature. Bamboo scaffolds, including bamboo truss-out scaffold, showed the highest danger with over 27% of accidents resulting from the use of it. Unfenced edges were next on the list of places of fall, these represented 18%. In addition, other places of fall included ladders, working platforms/falseworks, fragile structures and unfenced/insecurely covered openings which are also commonly recorded places of fall.

Figure 6.10 Number of fatal fall accidents from 2000-2004 analysed by place of fall



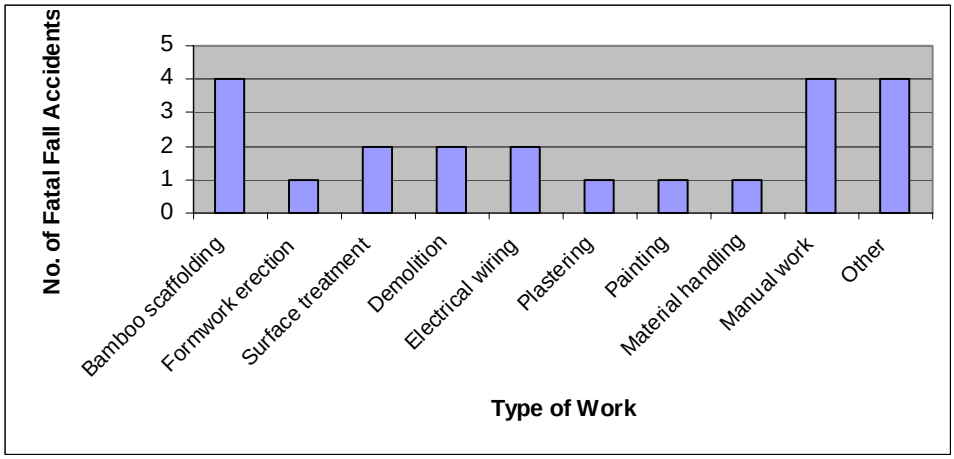
6.4.8 Agent involved

Amongst the 22 cases, bamboo scaffolds and ladders were the main agents involved. Six of the cases included bamboo scaffolds whereas three involved the ladder. This trend is similar to the accident statistics presented in Chapter 5.

6.4.9 Type of work performed

Figure 6.11 shows that bamboo scaffolding and manual work each represented almost 20% of the fatal accidents that occurred in repair and maintenance works from 2000 to 2004. Surface treatment, demolition and electrical wiring each represented almost 10% amongst the types of work performed during the accidents. Other accidents also occurred whilst the works formwork erection, plastering, painting and material handling were performed. The top place of fall, agent involved and type of work performed amongst the 22 cases has been bamboo scaffolding/scaffolds.

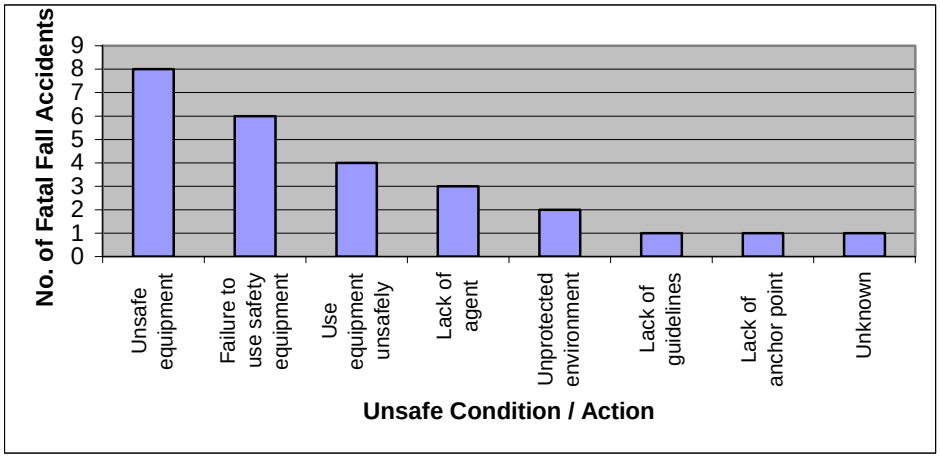
Figure 6.11 Number of fatal fall accidents from 2000-2004 analysed by type of work performed



6.4.10 Unsafe condition / action

Unsafe conditions and unsafe actions performed are often related to human errors. The case studies showed that often an accident occurs as a result of an unsafe condition or action. Figure 6.12 shows that in over 36% of the cases the occurrence of the fatal accident was a result of the equipment provided by the contractor being unsafe. Provision of safe equipment and proper maintenance are essential in accident prevention. Failure to use safety equipment resulted in 27% of the accidents. In third place was using the equipment unsafely which accounted for 18% of the accidents. Other unsafe conditions / actions included lack of agent, unprotected environment, lack of guidelines and lack of anchor point. The statistics show that the main causes of the accidents were all related to the equipment.

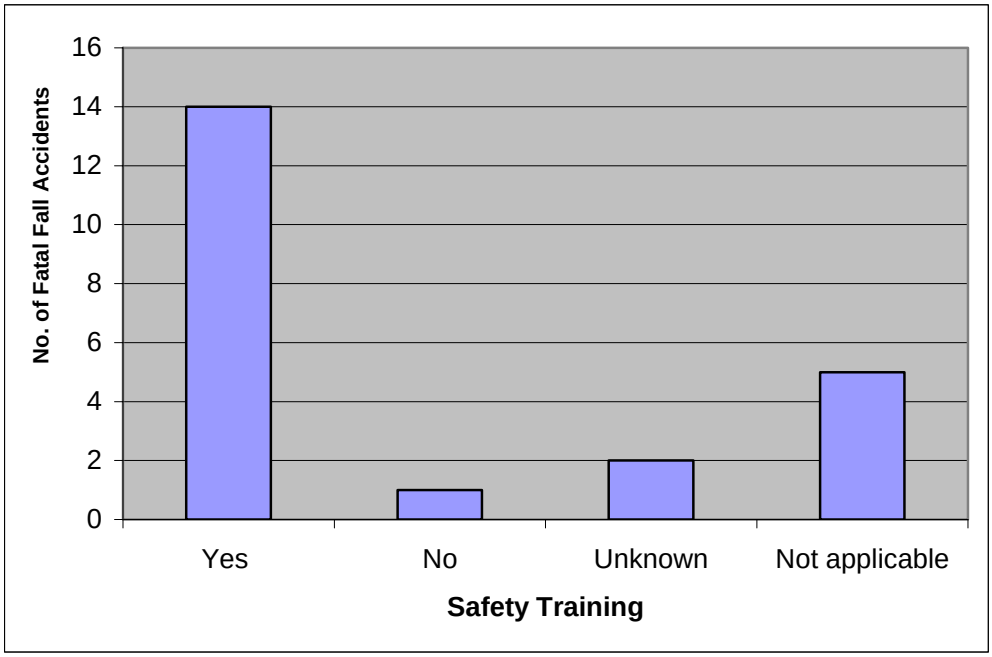
Figure 6.12 Number of fatal fall accidents from 2000-2004 analysed by unsafe condition / action



6.4.11 Safety education and training

Since 1st May 2001 employers should not employ a worker who has not been issued a 'Green Card' or whose 'Green Card' has expired under the Factories and Industrial Undertakings Ordinance. As such, workers need to attend the mandatory safety training and obtain a 'Green Card' before working on a construction site. Amongst the 22 cases studied in this chapter, five of these occurred before the effective date of this mandatory requirement. As shown in Figure 6.13 amongst the remaining 17 workers, it was only sure that fourteen of these victims possessed a 'Green Card'. For two of the victims it was unsure whether they had received any safety training. For one of the victims, investigations confirmed he did not receive any safety training at all. As discussed earlier, safety training and education is an effective means to prevent accidents. It is therefore important to ensure that all workers should fulfill this mandatory requirement before they are allowed to work in a construction site. Up to the end of 2004, the Labour Department has issued 58 summonses to employers for employing a worker who had not been issued a 'Green Card'.

Figure 6.13 Number of fatal fall accidents from 2000-2004 (only accidents after 1st May 2001 are included) analysed by safety training



6.4.12 Use of safety equipment

The use of personal protection equipment is particularly important when all other safety precautions and measures do not work as planned (Figure 6.14). The 22 cases were investigated and it was found that in most of the cases (36%), safety belt/harness was not provided by the employer. Nearly 22% of the deceased did not use the safety belt/harness provided. And only 32% of the deceased worn the safety belt/harness. Employers are under the legal duties to provide their employees with the necessary safety equipment and to take appropriate steps, such as exercising adequate supervision, in ensuring workers to make full and proper use of the safety equipment so provided.

Figure 6.14 Number of fatal fall accidents from 2000-2004 analysed by use of safety equipment

6.5 Recommendations to prevent recurrence of these fatal accidents

For each case recommendations were provided in the investigation report. Table 6.1 summarizes the recommendations made for each case and shows which recommendation occurs most frequently. The top five recommendations have been further tabulated in Table 6.2 to highlight their importance. The top recommendation was 'Provide and maintain a safe system of work' which occurred 11 times. In second place was 'Provide suitable working platform' which occurred 10 times. The recommendations 'Provide safety information/training/ instruction/supervision' and 'Provide suitable fall arresting system/anchorage' both occurred eight times. The last recommendation on the list was 'Maintain workplace safe' which occurred four times. Besides the top five recommendations, seven other recommendations were identified.

Table 6.1 Prevention recommended for each case study

	Prevention recommended												
Case No.	Provide and maintain a safe system of work	Provide suitable working platform	Provide safety information/ training/ instruction/ supervision	Provide suitable fall arresting system/ anchorage	Maintain workplace safe	Provide suitable covering and guardrail	Provide maintenance programme	Provide suitable design by CoP/ professional engineer	Provide and ensure use of ladder	Provide communication between designers and operatives	Implement agreed procedures/ follow instructions	Take adequate steps to prevent fall of persons	**Total**
1	✓				✓	✓							**3**
2		✓											**1**
3	✓		✓										**2**
4	✓	✓					✓						**3**
5													**0**
6				✓				✓					**2**
7		✓	✓	✓									**3**
8					✓	✓							**2**
9		✓	✓										**2**
10	✓		✓						✓				3
11	✓		✓	✓									**3**
12	✓							✓		✓			3
13	✓			✓				✓					**3**
14	✓	✓	✓	✓									**4**
15		✓		✓									**2**
16		✓			✓								**2**
17		✓											**1**
18	✓		✓								✓		3
19	✓				✓							✓	3
20		✓											**1**
21	✓	✓		✓									**3**
22			✓	✓		✓					✓		**4**
Total	**11**	**10**	8	8	**4**	3	**1**	**3**	**1**	**1**	2	**1**	

Table 6.2 Top five recommendations

Rank	Top Five Recommendations	Frequency
1	Provide and maintain a safe system of work	11
2	Provide suitable working platform	10
3 (tier)	Provide safety information/training/ instruction/ supervision	8
3 (tier)	Provide suitable fall arresting system/anchorage	8
5	Maintain workplace safe	4

6.6 Summary

This chapter summarises the result of the analysis from the 22 fatal accident cases occurred between 2000 to 2004, and highlights the areas of concern in relation to fall from height for future repair and maintenance works.

For analysis of accidents by the month and the day, both findings showed that accidents occurred towards the end of the period. For the analysis of the time of accident, it was found that accidents also occur towards the end of the day. It is important that to eliminate the increase of accidents during these times, extra monitoring and inspections should be carried out by the management to alert the workers.

The statistics showed that workers belonging to the age group of 45-49 experience the most fatal accidents. This may reflect that most of the workers engaged in RMAA works falls within the age group of 45-49 (This is an assumption that needs verification).

Labourers, scaffolders and electricians were found to be the most common occupations of the deceased workers. In these 22 cases all deceased workers, irrespective of occupation, fell to death from height. Adequate attention should be given on the system of work, necessary safety equipment and due supervision provided by employers to workers who need to work. It is, however, noted that of the three deceased electricians, two involved

use of wooden folding ladders. Safety training should be strengthened with special emphasis on some trade mal-practices.

Statistics showed that accidents could occur at any years of working experience in the industry. Therefore regular safety training courses should be provided to workers with any years of experience. The training course should emphasize the need for and the correct usage of safety equipment.

Workers often neglect safety precautions when working at low level as fall from height is less obvious. But statistics show that accidents often occur not far from the ground so safety precautions should not be neglected even for works at low level, the same degree of seriousness should be adapted for all works at height.

The most common place of fall derived from the cases reinforced the findings from previous literature. The most unsafe condition/action was a result of the equipment being unsafe. It is necessary to provide proper and safe equipment and proper maintenance to ensure that it is safe for use. In addition, workers must be properly trained to handle the equipment they will use to ensure for safety. Failure to use safety equipment or to use safety equipment incorrectly, were also common unsafe conditions/actions observed. The statistics show a need for increasing workers' safety training and education, to ensure that they are fully aware of correct safe procedures for work and how to protect themselves by using correct personal protection equipment.

Only a very low proportion of the deceased people had received any form of safety education or training. It is generally believed that the accidents were highly related to lack of safety knowledge. The statistics prove the importance for safety training and education. In addition it is believed that safety training and education courses for working at height in repair and maintenance works would be of benefit to the industry.

The statistics show that a number of the victims were not provided with any personal protection equipment and some did not wear the equipment properly. It should be noted that employers are legally liable to provide the necessary personal protection equipment to their employees and to provide adequate supervision to ensure that their employees put on this equipment properly. Monitoring and inspection should be increased to ensure that workers follow the rules.

To avoid recurrence of similar accidents, a number of recommendations were made following investigation of each accident. The following recommendations were identified as the top five strategies to avoid similar happenings:

- Provide and maintain a safe system of work
- Provide suitable working platform
- Provide safety information/training/ instruction/ supervision
- Provide suitable fall arresting system/anchorage
- Maintain workplace safe

Employers are legally liable to provide a safe working environment to their employees and to provide adequate supervision to ensure that their employees perform safely at the work place. Likewise, employees should work diligently to implement the safety instructions.

The recommended strategies can be best illustrated by Robens' Doctrine (1960):

> 'The primary responsibility to tackle safety and health at workplaces should rest with those, therefore both the employers and the employee, who create and work with risks. For accident prevention, it should be prudent on the onset for the employers to provide a safe system of work with necessary training, information, instruction and supervision to their employees. It is equally important that the employees should follow the

safety rules, make proper use of the personal protective equipment and exercise due vigilance at work.'

It is important to note that, of the twenty-two fatal industrial accidents, four (18.2%) were involving bamboo truss-out scaffolds. In protecting the safety of workers engaged in RMAA works, special attention should also be placed on erection, dismantling and use of bamboo truss-out scaffolds.

Chapter 7

ANALYSIS OF INTERVIEWS AND FOCUS GROUP MEETINGS

Chapter 7 Analysis of Interviews and Focus Group Meetings

A significant part of the study focused on interviews and focus group meetings with construction practitioners from various sectors and disciplines. The questions and topics for discussion were primarily derived from the literature review and the analysis of statistical data related to construction safety involving working at height. The analysis of data gleaned from the interviews and focus group meetings were triangulated with the analysis of the case studies and questionnaire surveys, to ensure that the interpretations of the findings would be genuine and reflective.

7.1 Introduction

Face-to-face interviews were conducted with ten interviewees, including from relevant government departments, non-government organizations, property management companies and legislative councillor (Table 7.1). The interviewees were selected based on the available contacts from the research team and the requirements of the study as it progressed.

Focus group meetings were launched four times throughout this study (Table 7.2). Two of these were held with supervisors and sub-contractors involved with maintenance works of the property management companies. The other two were conducted with front-line workers: the first with general construction workers and the second with workers involved in repair and maintenance works only.

Table 7.1 List of interviewees

Date	Department/Organisation /Company	Interviewee	Position
30 March 2005	Hong Yip Service Company Limited	Mr. Bill Man	Senior Assistant Technical Manager
6th April 2005	Buildings Department	Mr. C.M. Tang Mr. K.K. Tang Mr. S.M. Chow Ms. W.Y. Ng	Senior Structural Engineer Senior Structural Engineer Structural Engineer Building Surveyor
15th July 2005	Housing Authority	Mr. B. Wong Ir. Dr. Y.C. Lee Mr. Danny P.M. Cheng Mr. C.K. Siu Mr. W.W. Fock	Assistant Director (Estate Management) Senior Building Services Engineer Senior Maintenance Surveyor Senior Maintenance Surveyor Senior Maintenance Surveyor
20th July 2005	Hong Kong Housing Society	Mr. Augustine Chow	General Manager (Maintenance)
10th August 2005	Occupational Safety and Health Council	Mr. W. S. Tang Mr. Jason Wong	Executive Director Senior Consultant
18th August 2005	Hong Kong Workers' Health Centre	Mrs Karen Lo	Centre Manager

19th August 2005	Wui Loong Scaffolding Works Company Limited	Mr. S.K. Low Mr. S.L. Ma	Chief Supervisor Quantity Surveyor
5th September 2005		Mr. W.Y. Chan	Legislative Councillor
23rd September 2005	Hang Yick Properties Management Limited and Well Born Real Estate Management Limited	Mr. Ellis C.M. Ip Ms. Winnie W.L. Wong Mr. Alex K.K. Leung Ms. Emily W.Y. Tam Mr. Kinson C.F. Lo Mr. K.I. Wong	Senior Deputy General Manager, Hang Yick Manager (Administration/ Personnel Department), Hang Yick Technical Manager (Technical Department), Hang Yick Technical Officer, Hang Yick Senior Technical Officer, Hang Yick Senior Maintenance Officer, Well Born
8th November 2005	Synergis Holdings Limited	Mr. C. H. Fan	Managing Director

Table 7.2 List of focus group meetings

Date	Department/Organisation/Company	Address
27th July 2005	Construction Industry Employees General Union	4/F, On Yip Building, 395 Shanghai Street, Yau Ma Tei, Kowloon
21st October 2005	Hong Yip Service Company Limited	Room R508, 5/F, Block R, The Hong Kong Polytechnic University, Hung Hom
8th November 2005	Construction Industry Employees General Union Hong Kong Construction Sub-Contractors Association Hong Kong General Building Contractors Association Limited	Room W610, 6/F, Block W, The Hong Kong Polytechnic University, Hung Hom
28th November 2005	Synergis Management Services Limited	Room R507, 5/F, Block R, The Hong Kong Polytechnic University, Hung Hom

7.2 Interviews

The target respondents of the interviews were practitioners at either managerial or supervisory level engaged in building repair and maintenance works. A set of interview questions (Appendix 14) were compiled based on the comprehensive literature review described in Chapter 2. The questions covered areas which included: safety practices and management; causes of fall related accidents at workplace; practical solutions to construction safety for working at height; and roles of concerned parties in construction safety. The questions were used as a general template for interviewing. Depending on the organization/company/department interviewed, the questions were adjusted to suit the background of the interviewees. This section provides a concise summary of each interview conducted. The detailed minutes for each interview can be found in the Appendices.

7.2.1 Interview with Hong Kong Housing Society

The Hong Kong Housing Society (HKHS) was set up to provide affordable housing and related services for the people in Hong Kong. An interview was conducted with the General Manager of HKHS who is involved with maintenance work (Figure 7.1, Appendix 15). The HKHS set up a safety and health management system in June 2004. Most of the working procedures and guidance notes used in the HKHS are based on those of the Labour Department. The HKHS has now achieved recognition from the Occupational Safety and Health Council to issue 'green' cards. In-house staff has come up with technologies to prevent working at height. An example is a paper roll with a cleansing towel controlled by pulling strings. This invention can be used for cleaning the top of a footbridge replacing traditional scaffolding towers.

Our interviewee believes that there are three approaches to preventing fall from height in repair and maintenance works. These include: (1) to avoid risk for example using scaffold instead of ladder even if the job can possibly be done using ladder; (2) to prevent fall for example by provision of safety belt, guard rail and lifeline; and (3) to mitigate the injury consequence of fall by for example safety nets.

In addition, there is a need for enhancing safety awareness of construction workers through training, education and inspection.

Figure 7.1 Photo taken after interview with Mr. Augustine Chow the General Manager for maintenance of the Hong Kong Housing Society

7.2.2 Interview with Hong Kong Housing Authority

The Hong Kong Housing Authority (HKHA) was established as a statutory body in April 1973 under the Housing Ordinance. The HKHA determines and implements public housing programmes. Apart from planning and building public housing, it manages public rental housing estates, interim housing estates, transit centres, flatted factories and ancillary commercial and non-domestic facilities such as shopping centres, market stalls and car parks (Hong Kong Housing Authority, 2006). An interview was conducted with the Assistant Director of Estate Management, a Senior Building Services Engineer and three Senior Maintenance Surveyors of the HKHA (Figure 7.2, Appendix 16).

The main focus of the interview was based on the Maintenance Assessment Scoring System (MASS). MASS is an assessment tool used to measure the performance of term contractors. In addition, a MASS Working Group would monitor the operation of MASS itself. The safety components accounted for roughly 10-15% of the total MASS scores.

Figure 7.2 Photo taken after interview with Mr. B. Wong the Assistant Director in estate management of the Hong Kong Housing Authority

7.2.3 Interview with Buildings Department

The Buildings Department is a government department that facilitates and promotes the construction and maintenance of private buildings through the services provided under the ambit of the Buildings Ordinance and its related regulations (Buildings Department, 2006). An interview was conducted with a Senior Structural Engineer and another two colleagues of the Buildings Department.

The questions asked during the interview were especially designed focusing more on the legislative aspect of the topic (Appendix 17). A detailed record of the interview dialogue can be found in Appendix 18. The main topic discussed during the interview included the Minor Works Contract.

A minor works control proposal, as part of the Buildings (Amendment) Bill 2003, was tabled to the Legislative Council in the Year 2003-2004 but was eventually excluded from the Bill. A revised minor works control proposal was being prepared. Tentatively,

three categories of minor works namely, Category 1, Category 2 and Category 3 involving different levels of statutory control would be designated.

7.2.4 Interview with Occupational Safety and Health Council

Established under the Occupational Safety and Health Council Ordinance in 1988, the Council is a statutory body for promoting safety and health at work and sustaining the valuable workforce of Hong Kong (Occupational Safety and Health Council, 2006). An interview was conducted with the Executive Director and a Senior Consultant (Figure 7.3, Appendix 19).

In the interview the faults related to the truss-out scaffold supported by steel brackets were raised. Some of these included: non-uniformity of steel frames, no standard design for truss-out scaffold and easy purchase of steel frames at local shops. The OSHC have asked other researchers to conduct testing on the steel frame. The tests were conducted to compare the difference of walls made using different materials such as brick and concrete and compare the effect of the scaffold loading.

The following solutions were derived to prevent 'fall from height' accidents:

- Effective construction design management;
- Redesign of the truss-out scaffold supported by steel brackets;
- Research on safety equipment and bamboo scaffolding;
- Proper safety management;
- Good housekeeping;
- Safe working cycle;
- Regular monitoring and inspection;
- Consideration of anchor points such as the vertical pole.

Figure 7.3 Photo taken after interview with Mr. W.S. Tang the Executive Director and Mr. Jason Wong a Senior Consultant of the Occupational Safety and Health Council

7.2.5 Interview with Hong Yip Service Company Limited

Hong Yip Service Company Limited (Hong Yip) is one of the largest property management companies in Hong Kong with a market share of 10%. There are more than 300 sites managed by the company and 70% of the sites are residential (Hong Yip Service Company Limited, 2006). The company maintains statistical data on accidents from 1 November in the former year to 31 October in the following year. An interview was held with the Senior Assistant Technical Manager of the company on 30 March 2005 (Appendix 20) and accident data from the last four years were obtained. Table 7.3 shows the types of accidents from 2001 to 2004.

The most common type of accidents is 'twist', which remains the top injuries over the past 4 years. Other common types of accidents include fall on the same level, bruise and cut. The pattern and frequency of accidents is similar in this period. The percentage of fall from height is not high when compared with other types of accidents. However, it should be noted that the company has out-sourced most of the maintenance works to

other contractors and accidents suffered by the contractors' workers may not be reported in Hong Yip's record.

Table 7.3 Types of accidents from Hong Yip Service Company Limited (2001-2004)

Types	2001		2002		2003		2004	
	No.	%	No.	%	No.	%	No.	%
Fall from height	2	2	5	6	1	1	3	2
Twist	21	25	24	29	31	27	29	24
Fall on the same level	11	13	8	10	13	12	22	18
Cut	10	12	7	8	20	18	13	11
Heat	2	2	0	0	1	1	1	1
Bruise	7	8	11	13	25	22	21	17
Struck by	0	0	0	0	0	0	1	1
Burnt	0	0	0	0	0	0	2	2
Contusion	0	0	1	1	0	0	2	2
Slip	8	9	0	0	0	0	1	1
Injured while pulling	0	0	0	0	0	0	1	1
Trapped in	4	5	5	6	6	5	4	3
Others	31	36	31	37	29	26	45	37
Total	85	100	84	100	113	100	123	100

7.2.6 Interview with Hang Yick Properties Management Limited and Well Born Real Estate Management Limited

Hang Yick Properties Management Limited (Hang Yick) and Well Born Real Estate Management Limited (Well Born) are both wholly-owned subsidiaries of Henderson Land Development Company Limited.

An interview (Figure 7.4, Appendix 21) was conducted with the Senior Deputy General Manager of Hang Yick. It is understood that the interviewee also undertakes a role at Well Born hence the interviews with both companies were held jointly. In addition, a

Senior Maintenance Officer of Well Born, the Technical Manager of Hang Yick, the Administration/Personnel Manager of Hang Yick and three other colleagues from Hang Yick participated in the interview.

The interview focused on the safety practice of the companies, especially in the area of fall from height. It was found that both companies adopted their own guidelines. In addition, the companies actively worked with some local organizations such as the OSHC in order to build up more safety knowledge. Most of the materials they used to educate and train their in-house staff are provided by the OSHC.

Figure 7.4 Photo taken after interview with Hang Yick Properties Management Limited and Well Born Real Estate Management Limited

7.2.7 Interview with Synergis Management Services Limited

Established in 1978, Synergis Management Services Limited (Synergis, formerly known as Hsin Chong Real Estate Management Limited) is a subsidiary of the Hsin Chong Group, and currently a leading property and facility management service provider in

Hong Kong and Asia (Synergis Management Services Limited, 2006). An interview was held with the Managing Director of Synergis (Figure 7.5, Appendix 22).

A unique feature compared to other property management companies, is that Synergis has a Centre of Excellence which is in charge of refining and creating designs for products and processes. Initially the company found that employees would come up with worthy solutions but there was a need for refinement hence the establishment of the Centre of Excellence. The Centre is governed by a chairman who will assign the tasks to the relevant expert colleagues. The advantage of this Centre is that once the product or process is recognized by the Centre, the whole company will utilize the product or process. Whereas before the set up of the Centre, an invention may be kept in one department only with a very initial design. One example of these in-house products is a safety device called the 'Safety Railing Cart' (Figure 7.6), which is supported by rollers. This device prevents the worker from falling when working at height using a surrounding fence. Although the device is simple in concept, it is also handy and convenient to use.

Figure 7.5 Photo taken after interview with Mr. C.H Fan the Managing Director of Synergis Management Services Limited

Figure 7.6 Safety Railing Cart (Synergis Management Services Limited, 2005)

7.2.8 Interview with Legislative Councillor Mr. Chan Wai-Yip

Mr. Chan Wai-Yip had commented in a local newspaper concerning the design of the bamboo truss-out scaffold. The research team organized an interview with Mr. Chan (Figure 7.7). The interview questions (Appendix 23) mainly focused on the provisions for safety legislation and the recorded interview minutes can be found in Appendix 24.

Mr. Chan believes that there has been enough and effective statutory control for new construction works whereas insufficient if not no statutory control exercised on residential building repair and maintenance projects, particularly for working at height. In addition, before any new legislation can be imposed for working at height, the term “minor works” must first be defined.

Figure 7.7 Photo taken after interview with Legislative Councillor Mr. Chan Wai-Yip

7.2.9 Interview with Hong Kong Workers' Health Centre

An interview was conducted with the Centre Manager of the Hong Kong Workers' Health Centre (Figure 7.8, Appendix 25). In general, the Centre provides assistance to injured workers of all industries. The construction industry represents approximately one third of the cases the Centre deals with, because injury in the construction sector often causes them not to be able to get back to their original job, so often they require help searching for a new job. The services provided by the Centre can be categorized into three main areas:

- Prevention – Advertisement, education e.g. visits to construction sites, visits to restaurants where construction workers take their meal and are provided with safety information.
- Specialist help – Doctors and physiotherapists provide workers with free consultation service. Social workers are available to help workers with mental and social problems.
- Community integration – Workers are given help to seek employment.

7.2.10 Interview with Wui Loong Scaffolding Works Company Limited

The increasing number of construction accidents related to the bamboo truss-out scaffold supported by steel brackets has meant that effective solutions need to be sought. A question list (Appendix 26) was designed covering the faults related to the bamboo truss-out scaffold supported by steel brackets and the possible solutions to it. An interview was conducted with a chief supervisor of Wui Loong Scaffolding Works Company Limited (Wui Loong) who is also an experienced scaffolder and a quantity surveyor of the same company (Appendix 27).

The climbing scaffold is one of Wui Loong's recent developments, which is currently being utilized on many of their projects. The climbing scaffold can be mechanically raised to the working height required. When compared to the traditional bamboo scaffolding methods, the benefits of this technology include environmental friendliness, improved corporate safety image, reduced accidents, stable operation even under adverse weather conditions and fewer workers required.

In the past, the construction of bamboo truss-out scaffolds was immensely more difficult, complicated and time consuming. The technique used was to support the scaffold by bamboo wherever possible, forming a spider web layout. Screws were screwed into the wall at least 4-5 inches deep. Wire was thread through the loop at the end of these screws fixing the bamboo. And finally more bamboos would be erected around to form the whole scaffold. The traditional bamboo truss-out scaffold was a bit safer due to its high structural redundancy.

The following problems related to the bamboo truss-out scaffold supported by steel brackets were raised:

- Lack of standard design for the bamboo truss-out scaffold with steel brackets and anchor bolts;
- Age and conditions of building walls render their quality unpredictable;

- Uneven wall surface finishing;
- Poor quality anchor bolts easily available on market;
- Unsafe installation and dismantling procedures;
- Steel frames are often self made;
- Depth of anchor bolts screwed into wall is often insufficient;
- Few, if any, statutory guidelines for constructing/dismantling the bamboo truss-out scaffolds;
- Few, if any, structural calculations to support the stability of bamboo truss-out scaffold;
- Few, if any, inspection procedures.

7.2.11 Summary of interviews

The ten interviews conducted provided valuable information in a variation of different areas. It was noticed that many of the views and suggestions discussed during the interviews shared similarities. Tables 7.4 – 7.6 summarise the findings from the ten interviews and a recently produced report by So *et al*. (2005). The report titled 'A discussion paper on preventive measures to fatal fall accidents for construction workers of minor works and external works whilst working at height' covers many similar areas to the interview questions, hence it was also included in the summary tables for comparison purposes.

7.2.11.1 Causes of fall related accidents at workplace

Table 7.4 shows the findings of Questions 5 – 7 of the question list in the section 'Causes of fall related accidents at workplace'. Question 5 asks 'What are the situations where working at height is necessary in residential building repair and maintenance works?'. The findings show that the majority of interviewees believed that working at height is necessary when performing external building works at height. These specific tasks mainly include repairing roofs and walls etc.

In Question 6 the interviewees were asked 'What do you think are the root causes of accidents in residential building repair and maintenance works?'. The findings show that the weak safety attitude, low safety awareness or lack of safety knowledge was the most significant root cause of accidents in building repair and maintenance works suggested by four of the interviewees and So *et al.* (2005). Personal protective equipment used incorrectly, not used or not supplied was the second highest root cause of accidents in building repair and maintenance works suggested by three of the interviewees and So *et al.* (2005). Some of the other causes included improper use or lack of maintenance of equipment, the use of illegal workers and lack of standards and guidelines relating to the installation of the bamboo truss-out scaffold.

Question 7 asks the interviewees 'Can you suggest some measures to reduce fall related construction accidents for repair and maintenance works?'. The most frequent measure suggested was a construction workers registration or licensing system for minor works or constructing bamboo truss-out scaffolds, which was suggested by five interviewees as well as So *et al.* (2005). Although many of the interviewees suggested a licensing system, it is acknowledged that the establishment and operation will be time-consuming and may not be able to be introduced in the near future. It is therefore recommended that self-regulation should be encouraged to the workers for performing safety measures at the interim. Five of the interviewees believed that fall accidents could be reduced by continuous monitoring and frequent inspection. Whereas two of the interviewees and So *et al.* (2005) believed that safety provisions should be incorporated at the design stage of buildings.

Table 7.4 Comparison of responses in section 'Causes of fall related accidents at workplace' of the interview questions

Interviewing Organization	Question number		
	Q5	Q6	Q7
Hong Yip Service Company Limited	-	-	• Monitoring
Buildings Department	-	-	-
Hong Kong Housing Authority	-	-	• Adequate training for contractors • Control and monitoring • Prevent at design stage • Contractors must follow safety plan
Hong Kong Housing Society	• Roof water leakage • Exterior wall finishes peeling off	• Workers being unknowledgeable, frustrated, over-confident lack of safety awareness and possessing bad habits • Not use personal protective equipment • Agents not used properly e.g. ladders • Equipment not periodically checked	• Avoid risk, prevent fall and to mitigate consequence of fall • Appropriate supervision
Occupational Safety and Health Council	-	• Lack of anchorage • Illegal migrants and self employed contribute to a large proportion of the accidents	• Design for safety • Redesign the steel supporting frame • Monitoring and inspection • Using OSHC safety tool kits
Hong Kong Workers' Health Centre	• Exterior wall repair works involving the use of bamboo scaffold or gondola • Roof maintenance • Remove illegal fixtures/flower brackets	• Low safety awareness of workers	• Need statutory body to enforce legislation • Workers registration system for all repair and maintenance works
Wui Loong Scaffolding Works Company Limited	-	• No standards for anchor bolts and steel supporting frame • Wall conditions are often unknown • No use of personal protective equipment • Lack of safety guidelines concerning the truss-out scaffold • Lack of inspection	• Increase contract price, contractors will normally perform safety if profit is reasonable. • Government increases inspection and increases penalty for unsafe acts • Labour Department introduces licensing system for workers using the bamboo truss-out scaffold

Mr. W.Y. Chan	-	• Illegal workers • No licensing system	• Should develop a control mechanism or licensing system for undertaking minor works • Regular site inspections by competent persons • Licensing system for workers • Prohibit illegal workers
Hang Yick Properties Management Limited and Well Born Real Estate Management Limited	• Changing pipes on external walls. • Internally for cleaning air filter of air conditioning system and lighting replacement.	• Workers' negligence, carelessness, laziness and bad habits.	• Warning letters issued to contractors for unsafe acts • Use of appropriate personal protective equipment • Continuous training and education • Suggest certification or licensing of minor works workers.
Synergis Holdings Limited	-	• Workers' lack of safety awareness • Workers not using or using incorrectly safety equipment that is provided	-
So *et al*. (2005)	-	• Personal protective equipment not supplied or not used. • Lack of supervision • Wrong working procedures • Workers made to work long hours and tight project schedule • Contract price too low to include safety, often contract awarded to lowest bidder • Workers unsure about wall conditions • Destruction of bamboo for convenience • Workers' negligence • Lack of experience by young workers	• More publicity on safety issues and proper use of personal protective equipment • Special courses for truss-out scaffold • Registration system for truss-out scaffold workers • Punishment for workers not using personal protective equipment • Housing estates provide personal protective equipment and monitor that the equipment is used • Estate management companies check qualifications of workers • Design for safety

(Q5: What are the situations where working at height is necessary in residential building repair and maintenance works?
Q6: What do you think are the root causes of accidents in residential building repair and maintenance works?
Q7: Can you suggest some measures to reduce fall related construction accidents for repair and maintenance works?)

7.2.11.2 Practical solutions to construction safety for working at height

Table 7.5 shows the findings of Questions 8 – 10 of the question list in the section 'Practical solutions to construction safety for working at height'. Interviewees were asked in Question 8 'How can you increase the awareness of construction workers towards safety for working at height in maintenance works?'. Four interviewees suggested continuous safety education and training, whereas four interviewees suggested frequent monitoring and inspection. There were two interviewees' companies that had been involved in safety competitions and have found the benefits in increasing the awareness of construction workers towards safety.

In Question 9 interviewees were asked 'What do you think are the cost-effective and user-friendly technological solutions?' A number of different suggestions were made. Some of these are readily available including scaffolding towers, fall arrest systems, hydraulic platforms, lifting appliances etc. Whereas some of these were self inventions including the Safety Railing Cart of Synergis Holdings Limited and the patented Climbing Scaffold of Wui Loong Scaffolding Works Limited Company.

Question 10 asks 'Do you find legal controls effective in maintaining a safe workplace? Why/Why not?'. In general, the interviewees' responses were quite neutral on this topic. There were two interviewees who thought that the existing legislative controls in maintaining a safe workplace were quite sufficient, whereas one interviewee felt that the legislation in new construction works was sufficient but not in repair and maintenance works.

Table 7.5 Comparison of responses in section 'Practical solutions to construction safety for working at height' of the interview questions

Interviewing Organization	Question number		
	Q8	Q9	Q10
Hong Yip Service Company Limited	• Education • Award competitions • Internal audits of contractors • Monitoring	-	-
Buildings Department	-	-	-
Hong Kong Housing Authority	• Bonus incentive	• Fall arrest system	-
Hong Kong Housing Society	• Training • Inspection • External corporate competitions	• Own invention of paper roll with cleansing towel controlled by pulling strings to clean the top of footbridges • Scaffolding towers	• Thinks that legislation is sufficient. • Supportive of Minor Works legislation.
Occupational Safety and Health Council	• OSHC organizes a construction safety day annually for their staff	• Vertical pole for attaching safety belt.	-
Hong Kong Workers' Health Centre	• Registration/enforcement system	-	• Well developed
Wui Loong Scaffolding Works Company Limited	• Monitoring and inspection • Follow safety management plan provided by company	• The climbing scaffold	-
Mr. W.Y. Chan	-	-	• Insufficient or no statutory control exercised on residential building repair projects, particularly for working at height • Difficult to define minor works
Hang Yick Properties Management Limited and Well Born Real Estate Management Ltd	• Using OSHC training aids	• Hydraulic platform	-

Synergis Holdings Limited	• Government could further publicise and educate the public • Inspection • Employ more safety officers • Safety checklists • Regular meetings with contractors	• Safety Railing Cart (own invention)	-
So *et al*. (2005)	-	• Suspended system scaffold • Lifting appliance for installation of truss-out scaffold • Portable modular system that can be installed from inside the building	-

(Q8: How can you increase the awareness of construction workers towards safety for working at height in maintenance works?
Q9: What do you think are the cost-effective and user-friendly technological solutions?
Q10: Do you find legal controls effective in maintaining a safe workplace? Why/Why not?)

7.2.11.3 Roles of concerned parties in construction safety

Table 7.6 shows the findings of Question 11 of the question list in the section 'Roles of concerned parties in construction safety'. The interviewees were asked 'What roles should the following parties play in safeguarding working at height for repair and maintenance works?'. The parties included (a) Client; (b) User; (c) Government; (d) Contractor; and (e) General public. For the 'Client', the interviewees suggested that they should participate more at the design stage, employ more safety staff, provide the necessary safety training, equipment, information and management and also not to choose their contractors based on the lowest bidder as often the low contract prices are not sufficient to cover safety provisions.

For the 'User', the interviewees suggested that they should participate in the safety training provided, they should follow safety rules and instructions, demand for a safe working environment if not already provided, concentrate only on the job when working and ensure that the personal protective equipment provided is sufficient.

For the 'Government', the interviewees suggested that the Labour Department could increase monitoring, further publicise and educate the public on safety, establish an effective control mechanism for monitoring minor works and also motivate the industry by taking the lead. In actual fact, the Labour Department have developed a reporting mechanism with the Hong Kong Association of Property Management Companies since 2004, through which members of the association would notify the Labour Department of their schedules of property renovation and maintenance works using truss-out scaffolds for the department's prompt follow-up inspection. Up to present, the Labour Department's records show that they have received more than 200 referrals through the reporting mechanism. This type of reporting mechanism is believed to be effective but the control for minor works is often more difficult as many estates are not under the control of a management company.

For the 'Contractor', two of the interviewees believed that they should hold the most responsibility as they possess the largest authority on-site. In addition the contractor should ensure that safety measures are carried out, provide safe working environment, provide adequate equipment, conduct frequent monitoring, encourage workers to participate in safety training and assess workers' capability before assigning tasks. So *et al*. (2005) also suggested that the contractor must provide adequate instruction, supervision and training to workers.

Table 7.6 Comparison of responses in section 'Roles of concerned parties in construction safety' of the interview questions

Interviewing Organization	Question number				
	Q11a Client	Q11b User	Q11c Government	Q11d Contractor	Q11e General public
Hong Yip Service Company Limited	-	-	-	-	-
Buildings Department	-	-	-	-	-
Hong Kong Housing Authority	-	-	-	-	-
Hong Kong Housing Society	• Participate more at design stage • Employ safety staff • Provide necessary training	• Participate in training provided • Follow safety rules and instructions	• No suggestions	• Largest responsibility • Prepare programme of works • Ensure safety measures to be carried out	• No responsibility required
Occupational Safety and Health Council	-	-	-	• Largest responsibility as they possess the largest authority on-site.	-
Hong Kong Workers' Health Centre	• Provide workers with safety information, equipment and management	• Demand safe working environment if not provided	• Labour Department can increase monitoring • Further educate the public on safety matters	• Provide safe working environment, adequate equipment, correct procedures and frequent monitoring	• The public have little responsibility as the majority are not familiar with construction health and safety
Wui Loong Scaffolding Works Company Limited	-	-	-	-	-
Mr. W.Y. Chan	-	-	• Government should establish effective control mechanism for monitoring minor works	-	-

Hang Yick Properties Management Limited and Well Born Real Estate Management Limited	• Clients often choose contractors based on the contract price, often safety measures are eliminated to compensate for the price.	• Check that he has the necessary personal protective equipment • Be self motivated in participating with safety training • Concentrate only on the job when working	• Government to provide more education • Government should motivate the industry by taking the lead.	• Encourage workers to participate in safety training • Provide necessary personal protective equipment • Assess workers' capability before assigning tasks.	• Not to opt for the contractor with the lowest price.
Synergis Holdings Limited	-	-	-	-	-
So *et al*. (2005)				• Contractor must provide necessary instruction, supervision and training to workers	• Be aware of safety issues when having repair and maintenance works carried out for their home

(Q11: What roles should the following parties play in safeguarding working at height for repair and maintenance works? a. Client, b. User, c. Government, d. Contractor, and e. General public)

7.2.11.4 Regulatory control

Questions 6, 7 and 10 were phrased to solicit views on the adequacy of current legislative and regulatory control on construction safety in residential building repair and maintenance works. The views of the interviewees were rather divided. There was a general belief that although the legislation relating to new construction works is sufficient, the same does not hold in repair and maintenance works. In particular, residential repair and maintenance works are normally of smaller scale and of shorter duration, and there is also an influx of illegal migrants and self employed workers working in this sector, which makes the regulatory control difficult if not impossible to execute. There is an increasing need to establish a statutory body to enforce legislation specifically for this sector. Worker registration system should be extended to cover repair and maintenance works as well but obviously it is acknowledged that this would be difficult to carry out in the short-run and hence for the time being self regulation should be encouraged to help reduce fall accidents in repair and maintenance works. At the same time, the relevant departments of the HKSAR Government should increase the frequency of inspection and increase penalty for unsafe acts.

Bamboo truss-out scaffold is known to be one of the most severe safety hazards in residential building repair and maintenance works. It has been suggested that the relevant authority should introduce a licensing system for workers using the bamboo truss-out scaffold system. Along this line, a more rigorous control mechanism or licensing system, perhaps something similar to Contractor Registration System which has been established and implemented successfully for several years in the new work and major work sectors, should be established to monitor and regulate the personnel undertaking minor works such as residential building repair and maintenance. There are a number of perceived benefits in establishing a registration system for repair works and works involving truss-out scaffold. Clients of minor works are normally not professionals in safety. For them to recognize a capable worker a license would simplify the task. A registration system would mean that there is a central body governing the standard of the workers. The client

will also be confident to higher a licensed worker due to possible insurance complications. For the workers themselves a license could possibly mean more employment opportunities. They would also be part of a recognized body. And lastly a licensing system would mean that workers are forced to perform safety measures. But again, as mentioned previously although a mandatory registration system is ideal, the actual introduction would be time consuming and may not be implemented in the short-run. Most importantly the licensing system must be accepted by the industry as beneficial before it can be established. The support from the industry and the government is vital. Therefore, at the interim, a voluntary licencing system is recommended.

7.3 Focus group meetings

Focus group meetings are a convenient, effective and fast way to collect a vast amount of information from a reasonable number of participants compared to the traditional one to one interview technique. Focus groups have been found to provide highly effective, efficient way of investigating human factors aspects of health and safety problems (Haslam, 2003). Vaghn *et al.* (1996) believe that focus groups should possess two core elements: 1) a trained moderator who sets the stage with prepared questions or an interview guide; and 2) the goal of eliciting participants' feelings, attitudes and perceptions about a selected topic. In a focus group meeting, it is best that participants form groups of approximately six to ten people (Morgan, 1997). The reason is that below 6 it may be difficult to sustain a discussion and above 10 it may be difficult to control one. The groups are given an introduction: this part of the focus group meeting is vital to its success. The typical introduction will include a welcome, an overview of the topic, the guidelines for the discussion and the opening question (Krueger and King, 1998). The interaction between group members is known to be an effective way in obtaining adequate information. The following section presents the findings from four focus group meetings carried out during this study.

7.3.1 Focus group meeting with general construction workers

Thirteen general construction workers were invited by the Hong Kong Construction Industry Employees General Union (HKCIEGU) to participate in the first focus group meeting of this study. Figures 7.8 and 7.9 show photographs taken at the focus group meeting. The participants included five carpenters, one representative from the carpenter's union, two representatives from HKCIEGU, two decoraters, one painter, one labourer and one representative from the plasterer's union. The participants were randomly split into two groups of six and seven participants. Two research team members were assigned to sit in each group to trigger their discussions and responses. Each group was asked to nominate a group leader who would present the group's findings and suggestions at the end of the meeting.

The meeting started with a short presentation given by one of the research team members. Accident statistics provided by the Labour Department and the Architectural Services Department (refer to Chapter 5 Analysis of Statistical Data) were presented to the participants. The power point file used for the presentation can be found in Appendix 28. After being presented with the statistics the participants in their groups were asked to come up with some possible reasons behind the trend of the statistics. Each group was asked the same ten questions (Appendix 29) relating to the trend of the statistics. A detailed record of the questions and responses can be found in Appendix 30.

Some of the views expressed by the participants are listed below:

- The self-employed represent a large proportion of the accidents as 1) they often take up more jobs to maintain their profits due to the downturn market; 2) jobs are often undertaken quickly and carelessly; 3) working hours are also often long; and 4) the self-employed are more likely to take risks to increase profit margins.
- The age group of 30-34 is physically the fittest but ironically results in most of the fatal accidents because they are always over confident and more likely to take

risks. On the other hand workers between the ages of 40-44 years old have a heavier family burden, hence are more cautious about safety.

- A large proportion of fall accidents result in fatalities as these accidents are often serious.
- Repair and maintenance works often use ladders for the sake of convenience, to save time and in order not to obstruct passer-bys. This is very different from new works, where the job schedule is not often so demanding (e.g. for some retrofitting works, the only available time to fix the repair and maintenance works would be over the weekend, hence imposing huge time pressure onto the workers), the working area is more spacious and there are few people to obstruct.
- These days scaffolding often relies on the steel supporting frame (e.g. steel brackets). As there is no unique application technique and there are differences in application, it is easier for accidents to occur. Whereas scaffolders in the past considered strength and stability more as they had nothing to rely on but the bamboo components.
- Working at height is often required on the exterior wall of buildings to perform chores such as pipe changing, tile repairing, painting and repairing of air conditioner units.
- To prevent fall accidents in repair and maintenance works the legal liability of property owners should be widely promoted. In addition, the government should consider issuing trade licenses to workers working at height similar to electricians.

Figure 7.8 Group photo taken at the focus group meeting with general construction workers

Figure 7.9 Group discussion at the focus group meeting with general construction workers

7.3.2 Focus group meeting with repair and maintenance workers

Based on the experience drawn from the first focus group meeting with general construction workers, the second focus group meeting was planned. The second focus group meeting was held targeting at repair and maintenance workers only. Figure 7.10 and 7.11 portrays photos taken at the meeting.

This meeting was co-organised by the research team members, HKCIEGU, the Hong Kong Construction Sub-contractors Association (HKCSA) and the Hong Kong General Building Contractors Association Limited (HKGBCA). Seventy-one participants of various backgrounds and trades attended the meeting. The participants were further split into six groups with each group consisting of participants from various trades. Similar to the previous meeting each group was asked to nominate a group leader to present the group's findings and suggestions after discussion.

Again the meeting kicked off with a presentation given by one of the research team members. The presentation materials also included the accident statistics, six different cartoon strips (Appendix 31) and their case histories (Appendix 32), each representing a real life case of fall accident in repair and maintenance works. The powerpoint file used for presentation can be found in Appendix 33. After the presentation each group was given one of the cartoon strips presented and asked to discuss the following issues: 1) What caused the accident; 2) Who is responsible for the accident; 3) How the accident could have been avoided with safety procedures and equipment; and 4) How the accident could have been prevented with safety legislation and new technology (The questions can be found in Appendix 34).

Some of the key findings have been summarized in Table 7.4 (for a detailed record of the discussed items, please refer to Appendix 35). The findings derived from the meeting not only provided effective solutions to preventing fall, but also helped revise the cartoon strips to be more accurate and reflective.

Figure 7.10 Group discussion at the focus group meeting with repair and maintenance workers

Figure 7.11 A group leader presenting the group's findings and suggestions at the focus group meeting with repair and maintenance workers

Table 7.7 Summary of key findings from focus group meeting with repair and maintenance workers

Cartoon strip description	Key findings
Case 1: Fall from scaffold	• No safety belt; • Young, inexperienced scaffolders; • Large construction sites are inspected and monitored but small jobs are often neglected; • Increase penalty for not complying with safety rules, penalize the worker rather than the employer; • Difficult to find anchor points and to place anchor bolts.
Case 2: Slipped and fell from 3/F to G/F	• No fencing around the edges to protect worker; • No warning signs; • Use bonus system, if workers report unsafe conditions they obtain bonus; • Create licensing system; • Increase safety advertisements.
Case 3: Fall from scaffolding tower	• Scaffolding tower overloaded and materials not evenly placed; • The tower has no support points; • Works must be carried out by competent persons; • Works should be supervised; • Workers should undergo intensive safety training.
Case 4: Fall from roof	• Owner's corporation should share responsibility; • Add fencing at roof edges; • No safe working environment planned at design stage; • Some buildings do not have owner's corporation hence many repair and maintenance works not carried out; • Enhance safety education via media.
Case 5: Fall from bamboo truss-out scaffold	• No standard design for truss-out scaffold; • No personal protective equipment; • The bamboo truss-out scaffold should be approved by competent person before use; • Create licensing system for truss-out scaffold workers; • Promote the liability of the owner and the property management company.
Case 6: Fall from ladder	• Ladder too tall; use working platform instead; • No safety courses especially designed for the use of ladders; • Metallic ladders are unsuitable for grounds that are not level; • Should not work alone; • Increase the frequency of inspection and monitoring.

7.3.3 Focus group meeting with supervisors and contractors of Hong Yip Service Company Limited

A focus group meeting was held with nineteen supervisors and contractors of Hong Yip Service Company Limited. Amongst them thirteen were involved with repair and maintenance works. The focus group meeting began with a presentation (Figure 7.12, Appendix 36). The participants were split into 4 groups (Figure 7.13), and each group was asked to nominate a group leader to present their findings and feedback. Each group was asked three similar questions relating to company safety procedures, available measures and technology to reduce fall accidents, difficulties in implementing safety procedures, causes of fall accidents, responsibility and legislation. The questions for the meeting can be found in Appendix 37.

A detailed record of the notes taken in this focus group meeting can be found in Appendix 38. But in summary the participants raised two main important areas of concern. The first is the different standards of the green card safety training courses offered by various organizations. The standard to these training courses should be unique and consistent. Those offering organizations should be closely monitored by a central statutory body from the government to ensure the standard of the course. Secondly, accidents occur due to the low contract prices which do not include the cost of safety procedures and equipment. Hence in the discussion some of the participants felt that the government should take the lead in abolishing the traditional practice that the lowest bidder wins the job. Instead contractors should be considered for their work quality and previous safety track record. It is likely that if the government takes the leading role, contractors in the private sector will then follow.

Figure 7.12 A research team member presenting accident statistics to supervisors and contractors of Hong Yip Service Company Limited

Figure 7.13 Group discussion at the focus group meeting with supervisors and contractors of Hong Yip Service Company Limited

7.3.4 Focus group interview with supervisors and contractors of Synergis Holdings Limited

Fourteen participants joined the meeting. This focus group meeting was conducted in the same manner as the focus group meeting held with supervisors and contractors of Hong Yip Service Company Limited (Figure 7.14). The same powerpoint file was presented and the same discussion items were provided to the participants. Similarly the participants were split into four groups with each group nominating their own group leaders to present the findings and suggestions at the end of the discussion session (Figure 7.15).

Some of the participants perceived that many individual flat owners/tenants were unaware of their legal responsibilities hence more advertisement in this area should be carried out. In addition, the legislative control may be unclear, and most of the safe working procedures for working at height in repair and maintenance works are only guidelines rather than legal requirements. Similar to other focus group meetings the need for a proper licensing system for working at height was suggested. For a detailed record of the discussed items, please refer to Appendix 39.

Figure 7.14 Group discussion at the focus group meeting with supervisors and contractors of Synergis Holdings Limited

Figure 7.15 A group leader presenting the group's findings and suggestions at the focus group meeting with supervisors and contractors of Synergis Holdings Limited

7.3.5 Summary of focus group meetings

Four focus group meetings were conducted in this project. Two were conducted with participants from the workforce level, and the other two with participants from the supervisory level. The findings from the focus group meetings have been summarized in Table 7.8 under the headings 'Causes of fall accidents', 'Measures to reduce fall accidents' and 'Responsibility and legislation'.

7.3.5.1 Causes of fall accidents

The results were found to be very similar to the findings achieved via the interviews. The worker group believed that the influx of illegal immigrants and self-employed workers was one of the major causes for fall accidents. These groups of workers did not have adequate safety equipment, and lacked proper safety training and experience, and hence would be more prone to accidents. The worker group also mentioned that personal protective equipment was not always provided by their employers. They also believed that lack of supervision and inspection from their supervisors would be another major reason for accident. Many of the focus group participants felt that the 'lowest bidder gets the job' tradition and no provision for safety in the cost budget means that safety is often compromised to reduce costs. Therefore it was suggested that if the government could take the lead to rectify the situation, the private sector would be likely to follow.

7.3.5.2 Measures to reduce fall accidents

Again training and education for the workers, contractors and individual flat owners/tenants were believed to be important. In addition, it was also suggested to increase publicizing safety messages and alerting the flat owners/tenants of their liability. The workshop participants also expressed that some of the contract sum should be set aside for safety provision, so that adequate personal protective equipment and monitoring and inspection could be provided by their employers. Apart from imposing heavier

penalties for unsafe acts, the workshop participants also suggested a more extensive use of incentive or award schemes to reward good safety practices. The Housing Authority in Hong Kong has taken the lead by adopting a 'pay for safety scheme' for repair and maintenance works. However, in the private sector, only a number of the larger construction companies have started to adopt this scheme for new works. It is believed that some kind of incentive scheme is effective in motivating workers to carrying out safety measures. These incentives could involve awards which will recognize the good safety performance of workers or contractors and hence improve their status and credibility. Incentives could also be in the form of monetary bonuses. Incentives schemes are believed to be effective and are encouraged for the way forward.

The participants were asked to recommend technological solutions to prevent fall from height, but the solutions recommended were only measures that are readily available including working platforms, gondolas and aluminum and metal scaffolding.

7.3.5.3 Responsibility and legislation

In general, the participants felt that legislative controls were insufficient and unclear, but few of the respondents presented ideas on how legislation could be improved. Many believed that more detailed guidelines, increased safety training courses, increased inspection and monitoring, increased advertisements, increased incentive schemes to reward and recognize good safety practices should be provided by the government. Some suggested a mandatory licensing system for repair and maintenance workers. The bamboo truss-out was recognized as one of the main areas of concern; therefore the need for a licensing system for workers in this area was suggested. In addition, a licensing system for repair and maintenance workers is also recommended. As discussed earlier in this chapter a licensing scheme is idealistic in the long-run but the actual establishment and implementation will take time, effort and acceptance. Hence for the time being self-regulation is very much encouraged.

Table 7.8 Summary of focus group meetings

Participants in focus group meeting	Category		
	Causes	Measures	Legislation
General construction workers	• Self-employed usually inadequate in safety equipment due to lack of finance, usually skilled therefore over confident, rush jobs to increase profit • Illegal workers lack safety training and experience • No standards for constructing truss-out scaffold • Old scaffolding methods lost • Difficult to apply third anchor bolt on steel supporting frame • Lack of communication on site • Lack of supervision and inspection • Lowest bidder gets job, no budget allowing for safety • Lack of governmental controls • No use of personal protective equipment • Lack of education and training	• Increase safety education and training • Monitoring and inspection • Licensing system for maintenance workers • Allow part of contract sum for safety, increase contract price • Publicise legal liability of flat owners/tenants • Use personal protective equipment	• Increase regulations for repair and maintenance works
Repair and maintenance workers	• Personal protective equipment not used or not supplied by employer • Poor safety attitude and awareness of workers • Many temporary workers • Young workers lacking experience • Unknown wall conditions • Lack of warning signs • Lack of supervision • Cut safety cost to increase profits • Lack of owners' corporation	• Current system only penalizing contractor should also penalize worker • Employer must provide personal protective equipment • Increase safety messages at peak hours instead • Publicise responsibility of flat owners/tenants • Precise guidelines • Increase safety training and education • Award scheme • Licensing system for truss-out	• Legislation should be more precise

		scaffold workers • Design for safety • Ensure safe environment • Monitoring and inspection	
Supervisor and contractors of Hong Yip Service Company Limited	• Profit affects safety • Vague guidelines for working at height • Poor safety attitude of workers • Rushed work schedule • Cost of safety not included in contract price • Different standards of the one day green card course depending on the organizing organization, the quality should be controlled	• Provide safety equipment • Educate flat owners/tenants on their responsibility • Educate contractors • Monitoring and inspection • Contract sum allowing for safety • Increase safety knowledge of workers • Safety signage	• Flat owners/tenants should be aware of safety messages • Legislative controls can force flat owners/tenants to ensure safety • Workers should ensure themselves that they are competent • Government should provide more detailed guidelines, increase safety training courses, increase inspection and monitoring, increase advertisement and present awards and recognition to good contractors • Contractors should take the largest responsibility • Government takes a lead by abolishing lowest bidder get job tradition
Supervisor and contractors of Synergis Holdings Limited	• Rushed jobs • Old tools and agents • Low contract price, short project duration • Poor safety attitude of workers • Difficult to find anchor point • Unclear guidelines • No supervision on scaffold construction	• Publicise the liability of flat owners/tenants • Use of personal protective equipment • Increase training and education • Permanent employment contracts for workers	• Few legislation mainly guidelines • Workers should be motivated to participate in training • Workers should ensure that they use personal protective equipment • Flat owners/tenants employ only competent workers • New legislation that workers must have license for repair and maintenance works • Contractors must monitor workers

(Causes: Causes of fall accidents; Measures: Measures to reduce fall accidents; Technology: Technology to reduce fall accidents; and Legislation: Responsibility and legislation)

7.4 Summary

Valuable qualitative information was collected via a series of interviews and focus group meetings. The information collected only represents a small sample size; hence all of the findings were incorporated into the survey questionnaires for validation by more industry players. The findings presented in this chapter forms the basic skeleton for the subsequent questionnaire surveys.

Chapter 8

QUESTIONNAIRE SURVEYS

Chapter 8 Questionnaire Surveys – Results and Analysis

8.1 Introduction

Two questionnaire surveys were reported in this chapter: (1) Industry based questionnaire (Appendix 40); and (2) Flat owner/tenant questionnaire (Appendix 41). The questionnaires were distributed via contacts from the research task force members of this study, the interviewees of this study and the focus group meetings. The findings of the two questionnaires are presented in this chapter.

Questionnaire survey was one of the essential tools selected to achieve the aim of this study. A wide range of quantitative data was collected for statistical analysis. The general objectives of the questionnaire surveys are:

- To generate practical strategies to improve existing construction safety involving working at height for residential building repair and maintenance.
- To perform a large scale analysis of testing whether the ideas solicited in the interviews and focus group meetings are feasible and representative.
- To verify the accuracy of the literature review and the appropriateness of international practices if adopted in Hong Kong.

8.2 Background of industry based questionnaire

The industry based questionnaire was distributed to a number of relevant organisations and companies as shown in Table 8.1. A total of 1,820 printed copies of the questionnaire were sent to these organisations. But the exact number of questionnaires distributed was expected to be higher as in many cases the organisations photocopied additional copies or printed further copies from the electronic copy which was also provided by the research team. The questionnaires were collected from these organisations but in some cases the respondents returned their completed questionnaires

by fax or mail directly themselves. The total number of completed questionnaires collected from these organisations was 434 copies and the number of questionnaires returned directly to research team members by either fax or mail was 147 copies (it is unknown which organization the respondent got the questionnaire from if they returned by fax). Therefore the total number of questionnaires collected for the industry based questionnaire was 581 copies, which represented a response rate of approximately 32%.

Table 8.1 Distribution and collection of industry based questionnaire

Distributors of the industry based questionnaire	**No. of printed questionnaire copies delivered**	**No. of completed questionnaires collected**
Hong Yip Service Company Limited	300	Participants returned direct to research team.
Hong Kong Housing Society	300	249
Synergis Holdings Limited	300	77
Henderson Land Development Company Limited	300	98
Hong Kong Construction Industry Employees General Union	Printed himself	10
Yau Lee Construction Company Limited	300	Participants returned direct to research team.
Hong Kong Construction Association	320	Participants returned direct to research team.
Total delivered to and collected from distributors	1,820	434
Questionnaires received via mail and fax	-------	147
Total	**1,820**	**581**

The industry based questionnaire covers seven sections which are combined to address the objectives of the research. These sections are explained in detail as follows:

I. Personal Information of Respondent

- The background of the respondent relates to their safety attitude, training and experience.
- With the information collected in this section it would be possible to recommend strategies for improvement to suit respondents with different experiences and backgrounds.

II. Safety Education and Training

- This section seeks information about the respondent's safety education and training, which is believed to have an important relationship to their accident record covered in section III.
- The responses will also reflect the attitude of the respondent towards safety training and education. The safety attitude of the respondent is regarded as an important factor affecting the likelihood of accidents (section V).

III. Accidents Related to Repair and Maintenance

- The nature, frequency and seriousness of accidents are affected by all sections of the questionnaire. All of these factors hold a strong relationship with occupational accidents.
- This section intends to identify and detail the accidents experienced by the respondent and analyse the factor which holds the highest impact contributing to accidents.
- In addition this section also looks into safety attitude and knowledge of the respondent towards accidents.

IV. Safety Messages

- This section studies the effectiveness of safety messages which have recently been promoted in Hong Kong.
- The effect of safety messages may have a connection towards the respondent's participation in education and training (section II), their accident record (section III), their attitude towards safety (V) and their views towards legislation and responsibility (section VI).

V. Safety Attitude of Repair and Maintenance Workers

- The questions of this section were developed from an intensive literature review as well as ideas and views solicited from interviews and focus group meetings.
- The questions will be used to judge whether the information collected in interviews and focus group meetings are valid and representative.
- The responses to this section will be affected by the respondent's background, training and education as well as personal accident record.

VI. Legislation and Responsibility

- Legislation is one of the effective ways to ensure safety at work. However, there is an urgent need to review whether the existing practice is sufficient for building repair and maintenance works.
- The responses will give an indication of the need to increase legislative controls.
- The responses to this section will be mainly affected by the respondent's attitude towards safety.

VII. Practical Solutions to Reduce Fall of Person from Height

- This section covers practical solutions to the research topic.
- The ideas and views solicited from interviews and literature have been listed for the respondents to verify.

- The respondents will give each solution a scale of intensity and from the responses the best solution perceived by the respondents will be identified.
- International solutions collected from literature will also be ranked by the respondents.

8.3 Analysis of industry based questionnaire

The quantitative data collected were analysed using the Statistical Package for the Social Sciences (SPSS). The techniques that were used, in respect of quantitative data for the industry based questionnaire, include descriptive statistical analysis, cross tabulation and discriminant analysis. The analysis of this questionnaire presented is based on the feedback from the 581 respondents.

8.3.1 Analysis of section I – Personal information of respondent

Figure 8.1 shows the working level of the respondents. The levels were split into 'managerial', 'supervisory', 'workforce' and 'other'. The analysis shows that the three working levels named were quite evenly distributed, with each representing approximately one third of the respondents. The percentage of respondents that chose 'other' was 4.5%, and the number of respondents who did not answer this question was 1%.

Figure 8.1 Q2. Working levels of the respondents

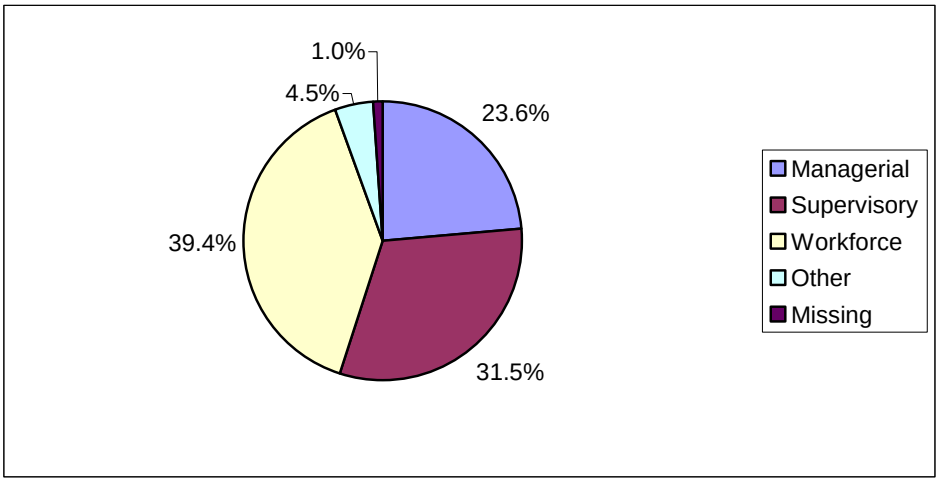
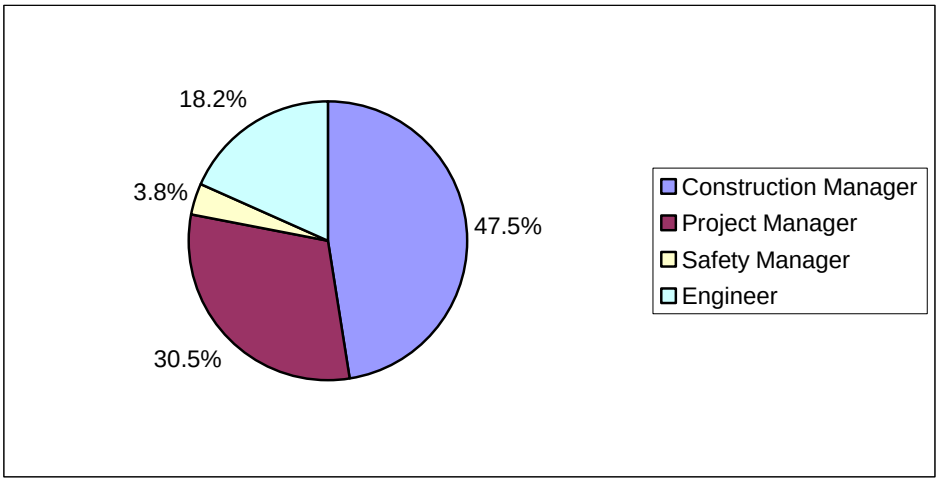


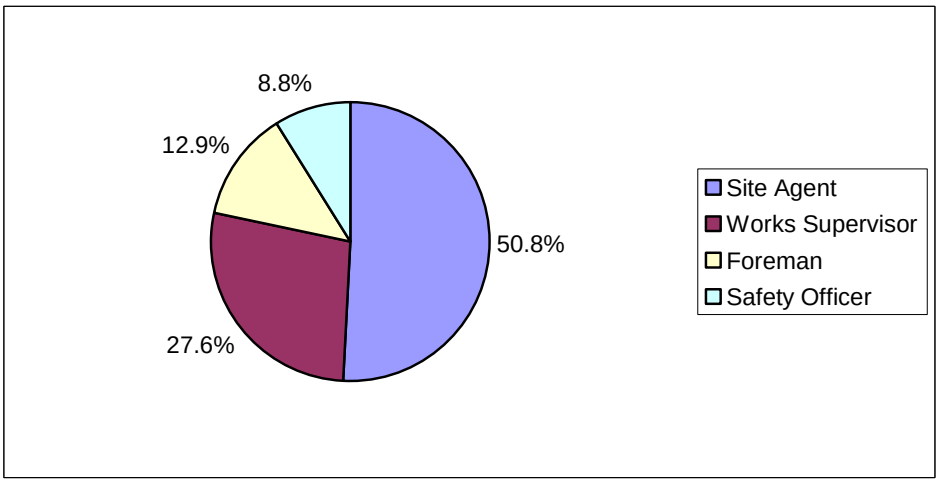
Figure 8.2 further investigates the managerial level of the respondents. The respondents of the managerial level were further asked to specify their working positions. The options given to the respondents included 'Construction Manager', 'Project Manager', 'Safety Manager' and 'Engineer'. The statistics indicates that almost half of the respondents at the managerial level were 'Construction Manager'. 'Project Manager' followed closely behind representing one third of the respondents at the managerial level. 'Engineer' and 'Safety Manager' represented 18% and 4% respectively of the respondents at the managerial level.

Figure 8.2 Q2b. Managerial working position



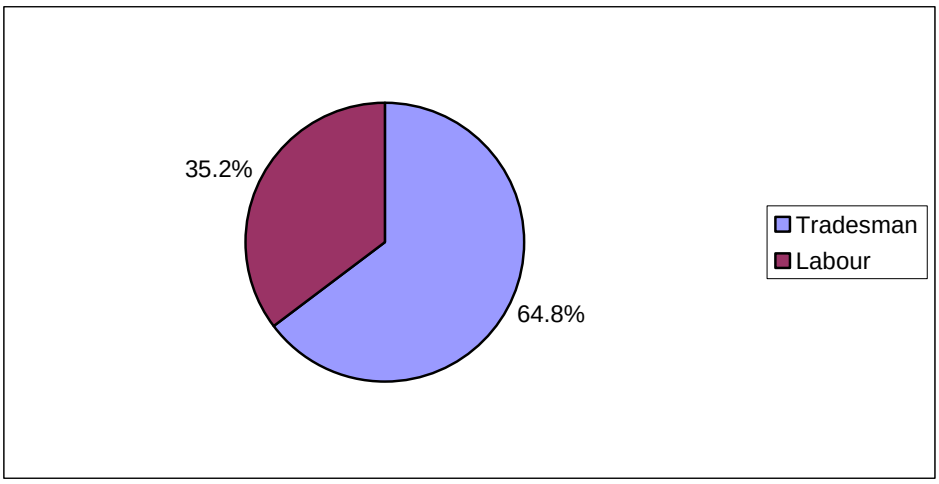
Similarly the respondents at the supervisory level were asked to specify their working positions amongst the choices 'Site Agent', 'Works Supervisor', 'Foreman' and 'Safety Officer'. Figure 8.3 reveals that half of the respondents at the supervisory level were 'Site Agent' and almost one third were 'Works Supervisor'. 'Foreman' and 'Safety Officer' represented 13% and 9% respectively of the respondents.

Figure 8.3 Q2c. Supervisory working position



Respondents at the workforce level were also requested to state their working positions between two levels 'Tradesman' and 'Labour'. The statistics in Figure 8.4 reflects that 'Tradesman' represented two thirds of the respondents at the workforce level, whereas 'Labour' only contributed one third.

Figure 8.4 Q2d. Workforce working position

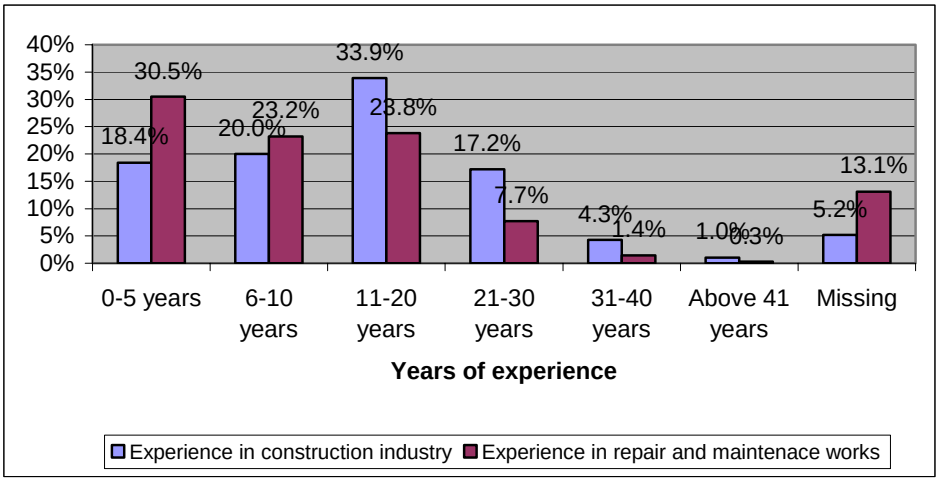


The respondents were asked of their years of experience in the construction industry as shown in Figure 8.5. Six options were provided for selection including '0-5 years', '6-10 years', '11-20 years', '21-30 years', '31-40 years' and 'above 41 years'. The first four categories represented 90% of the respondents, meaning that most of the respondents possessed experience below 40 years. Over 30% of the respondents had '11-20 years' of experience. The categories '0-5 years', '6-10 years' and '21-30 years' were chosen by 20% of the respondents each. The categories '31-40 years' and 'above 41 years' were chosen the least, with each representing approximately 5% of the respondents only. It is worth noting that over 80% of the respondents had more than 5 years working experience in the construction industry. It is fair to assume that their perceptions on the safety practices as solicited in the questionnaire should be practical and representative.

The respondents were further asked about the years of experience they possessed in repair and maintenance works. The findings (Figure 8.5) show that the respondents possessed

lesser experience in repair and maintenance works when compared to their experience in the construction industry. One third of the respondents possessed only '0-5 years' of repair and maintenance works experience. Respondents with '6-10 years' and '11-20 years' of experience each represented over 23%. Seven percent of the respondents possessed '21-30 years' of experience, 1% possessed '31-40 years' experience and there were no workers that possessed above '41 years of experience' in repair and maintenance works. Respondents that did not answer this question represented 13%. This distribution reinforces the common belief that traditionally if given choice, workers would like to work on new work projects rather than repair and maintenance works. Since the working conditions and environment of the two sectors are quite different, those who are new to the repair and maintenance works need special briefing and induction in safety aspects when they start working in this sector.

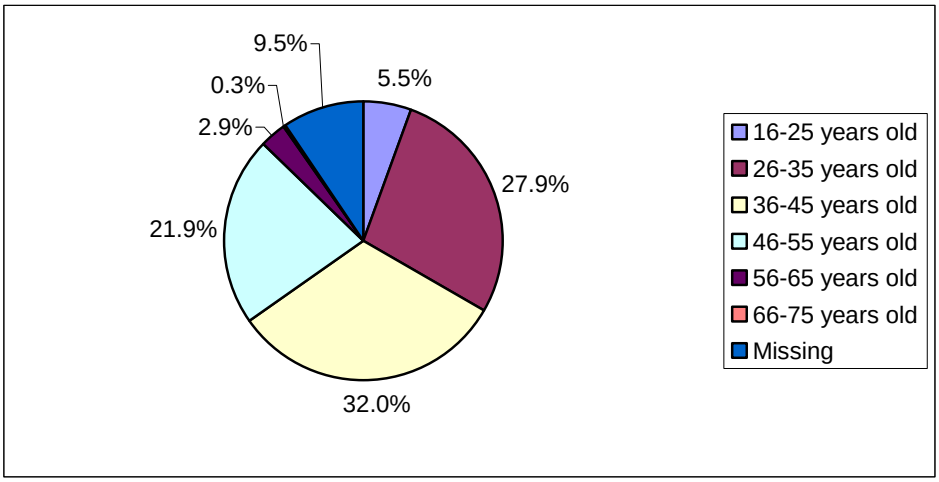
Figure 8.5 Q3. Years of experience in the construction industry and in repair and maintenance works



As shown in Figure 8.6, more than 80% of the respondents fell between the ages of 26-55 years old. Over 30% of the respondents fell into the category of '36-45 years old', this was closely followed by the category '26-35 years old' (just under 30%), and then the '46-55 years old' category (over 20%). Only 3% of the respondents belonged to the age

group '56-65 years old'. And hardly did any respondents belong to the age group '66-75 years old'.

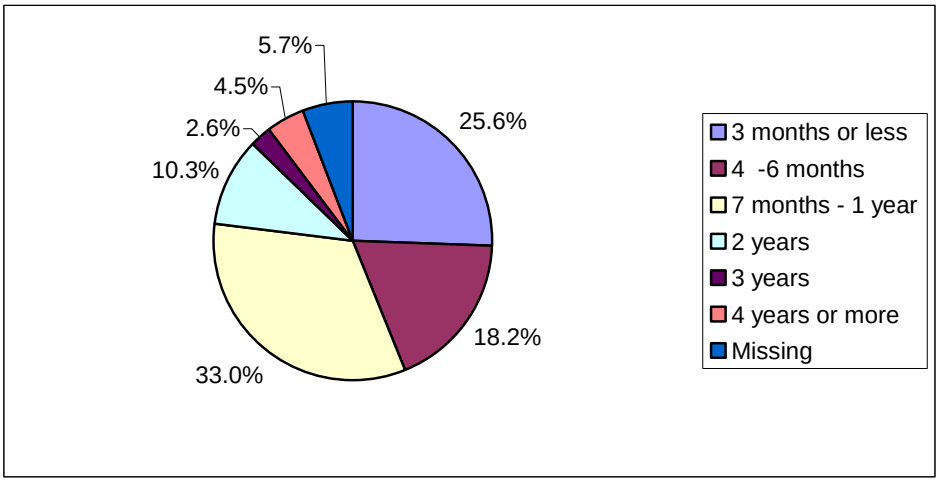
Figure 8.6 Q5. Which of the following age groups do you belong to?



8.3.2 Analysis of section II - Safety education and training

The respondents were asked how long ago did they attend a safety training course and their answers were shown in Figure 8.7. The results were positive and it was found that about 77% of the respondents had attended a safety training course in the past twelve months. Over 30% of the respondents had participated in some type of safety training course in the past '7 months – 1 year'. A quarter had attended one in the past '3 months or less'. Just below 18% fell in the '4-6 months' category. The proportion of respondents that did not participate in any safety training for over a year was relatively low representing only 17%.

Figure 8.7 Q6. How long ago was the last time you attended a safety training course?



The respondents were asked to name the type of safety training that they felt was most suitable for their job and their answers were shown in Figure 8.8. They were given four choices to choose from including 'Lecture', 'Seminar', 'Training Workshop' and 'Other'. 'Training Workshop' was by far the most popular type chosen representing over 50% of the respondents. Since many safety practices and procedures require hands-on experience and demonstration, a more interactive workshop environment appears to be a more appropriate format in delivering safety training. 'Seminar' and 'Lecture' each represented approximately 15% of the respondents. Only 3% of the respondents chose 'Other' as the most relevant for them. Whereas many of the respondents appeared to be unsure of what type of training would be suitable as 16% of the respondents did not answer this question.

Figure 8.8 Q7. Which type of safety training do you feel is best meeting your job requirements?

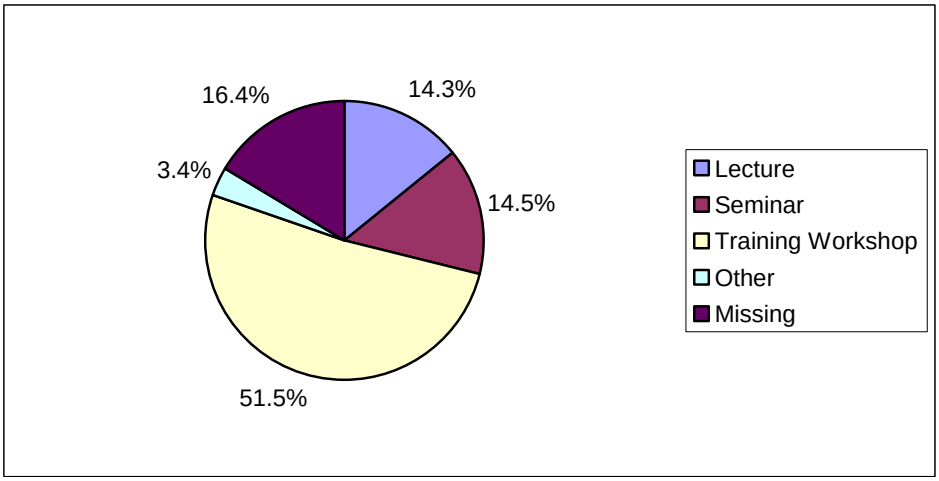
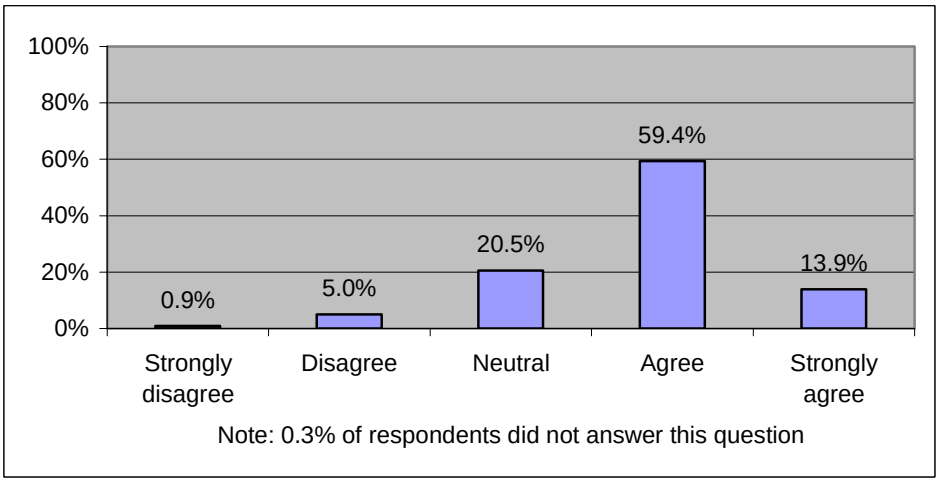


Figure 8.9 shows the intensity of how willing the respondents were to attend safety training. Five levels of intensity measures ranging from 'strongly disagree' to 'strongly agree' were provided. The majority (60%) of respondents agreed that they participated in safety training willingly. Fourteen percent 'strongly agree', 20% felt 'neutral' and only a minor 6% either 'disagree' or 'strongly disagree' that they were willing to participate in safety training.

Figure 8.9 Q8. You are willing to participate in safety training.



Respondents were asked to rate the effectiveness of safety and health training courses, by judging whether safety knowledge gained from training courses are forgotten by workers. Figure 8.10 shows that the responses fell in the categories 'disagree', 'neutral' and 'agree' with each representing approximately one third of the responses. This tends to suggest that the training courses were not as effective as one could envisage.

Figure 8.10 Q9. Most workers forget what they have learned from safety and health training courses.

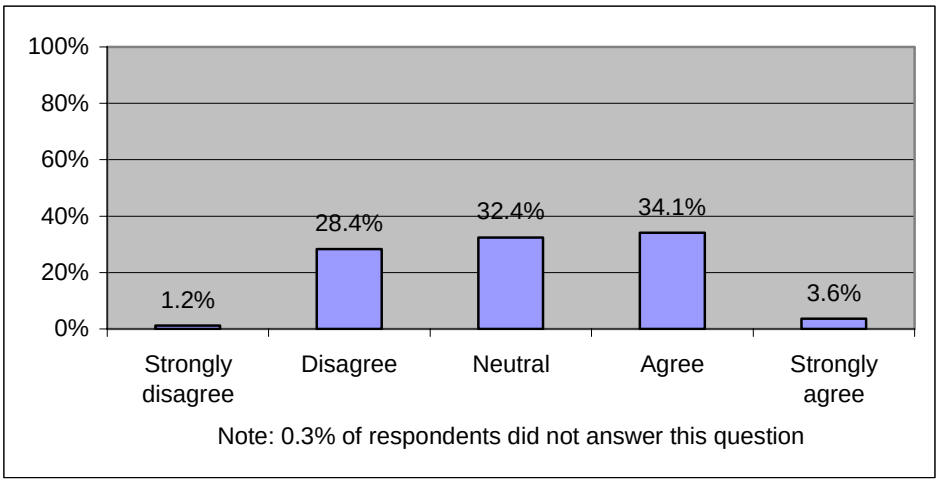


Figure 8.11 shows that respondents 'agreed' more than 'disagreed' that the one day green card training course is sufficient for the repair and maintenance works that they carry out. Just 22% of the respondents 'strongly disagreed/disagreed' with this statement and. Thirty percent of the respondents felt 'neutral'. In general, the respondents were contented with the duration and adequacy of the one day green card training course for repair and maintenance works.

Figure 8.11 Q10. The one day green card safety training course is sufficient for the repair and maintenance works which I undertake.

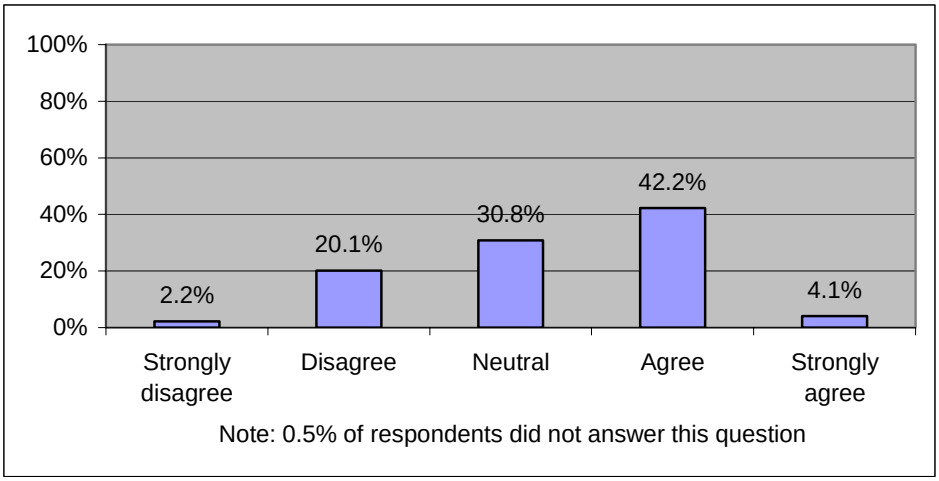
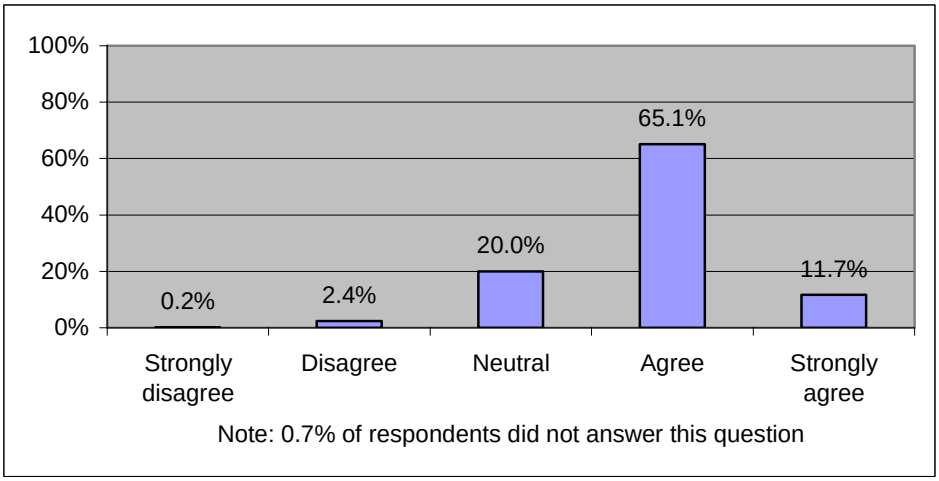


Figure 8.12 shows that almost 80% of the respondents 'strongly agreed/agreed' that the green card safety training course ought to educate workers on how to use personal protective equipment correctly. The large proportion shows that the need for teaching on personal protective equipment is necessary and warranted. This information should provide good references to safety training providers in designing the content and scope of their training courses. Twenty percent of the respondents felt 'neutral' about this topic. And only 3% of the respondents felt negatively.

Figure 8.12 Q11. The green card safety training course ought to educate workers on how to use personal protective equipment correctly.



The respondents were asked whether they thought that the green card safety training course ought to educate workers on how to locate a suitable anchor point for safety belt (Figure 8.13). Similar to the previous question, the majority (80%) of respondents felt that there was a need. Twenty percent of the respondents felt 'neutral' about this topic. And only 2% of the respondents showed a negative response. Again the statistics confirms the need for training construction workers how to locate a suitable anchor point in the green card course.

Figure 8.13 Q12. The green card safety training course ought to educate workers on how to locate a suitable anchor point for safety belt.

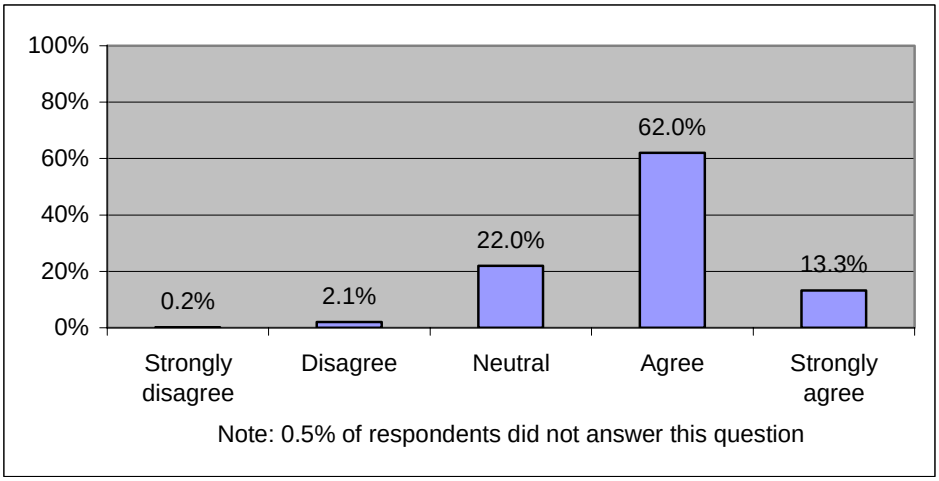


Figure 8.14 shows that 60% of the respondents felt that it is necessary to have specific training courses relating to the bamboo truss-out scaffold. Thirty percent of respondents felt 'neutral' on this issue. And a mere 7% did not feel that this would be necessary. This finding reinforces the need to educate workers on how to install a bamboo truss-out scaffold supported by steel brackets.

Figure 8.14 Q13. There should be specified safety training courses available to educate workers on how to install the bamboo truss-out scaffold supported by steel brackets.

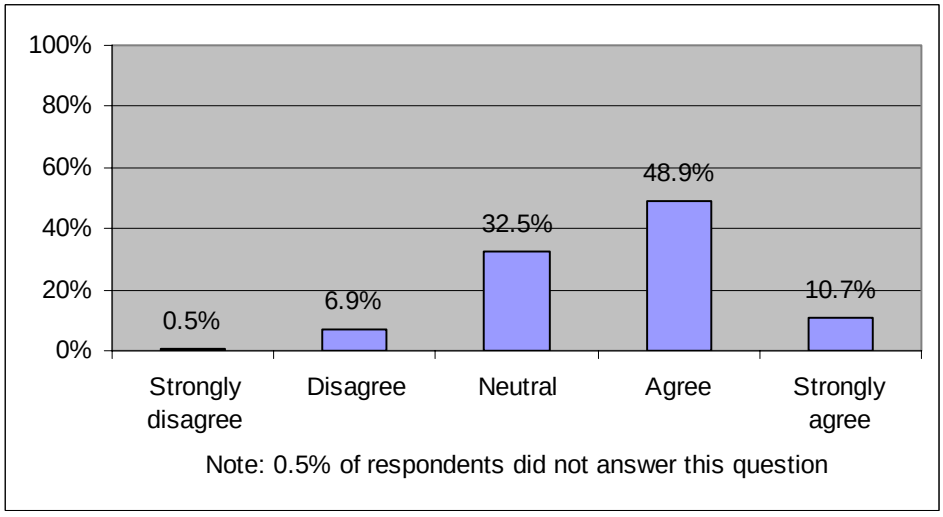
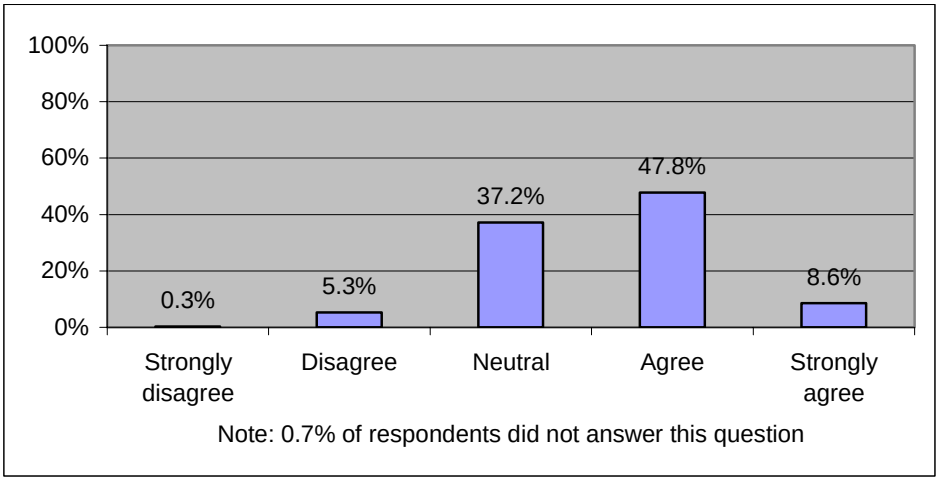


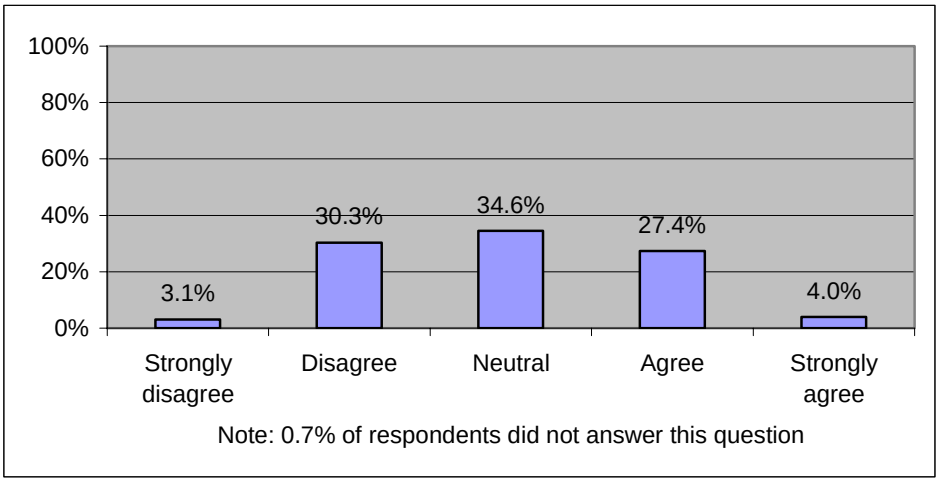
Figure 8.15 shows that 60% of the respondents felt that there is a need to improve the current design of the personal protective equipment. Almost 40% felt 'neutral' and a mere 6% felt negatively on this issue. Those who are engaged in the design of the personal protective equipment should take note of the respondents' preference.

Figure 8.15 Q14. The current design of personal protective equipment should be improved.



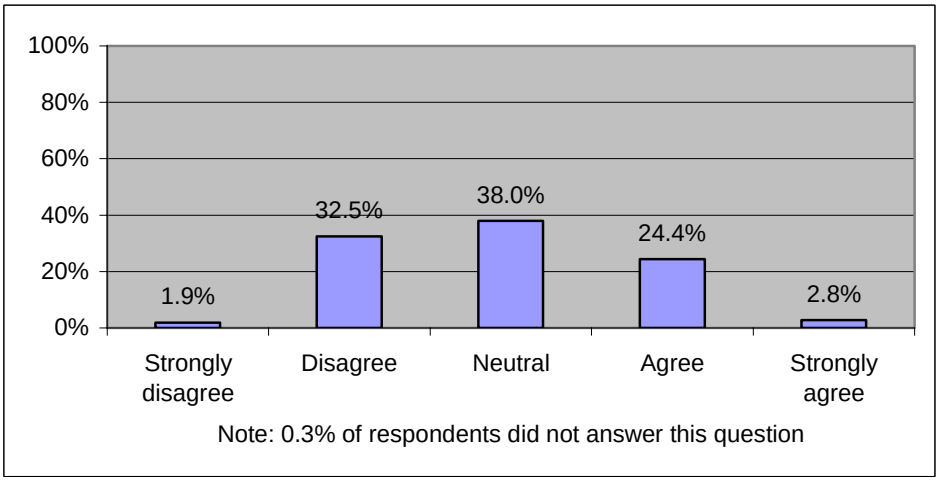
Respondents were asked whether the safety belt disturbed their work progress (Figure 8.16). The responses amongst 'disagree', 'neutral' and 'agree' were quite evenly distributed, with each representing approximately one third of the responses. Again, this reinforces the previous finding that there should be room for improvement in terms of the design of personal protective equipment. It may depend on how the construction workers wear their safety belts and their actual functions.

Figure 8.16 Q15. Wearing a safety belt would disturb my work progress.



Respondents were asked if the independent life line is difficult to use. Again Figure 8.17 shows that the responses were quite 'neutral' on this topic.

Figure 8.17 Q16. The independent life line is difficult to use.



Respondents were asked whether they felt safety training courses for repair and maintenance works should be increased (Figure 8.18). A large proportion (60%) of the respondents agreed. Thirty percent felt 'neutral' and only 7% felt negatively. This

finding is enlightening and reinforces the need in organizing more training courses for repair and maintenance works to improve current safety performance.

Figure 8.18 Q17. The number of safety training courses for repair and maintenance works should be increased.

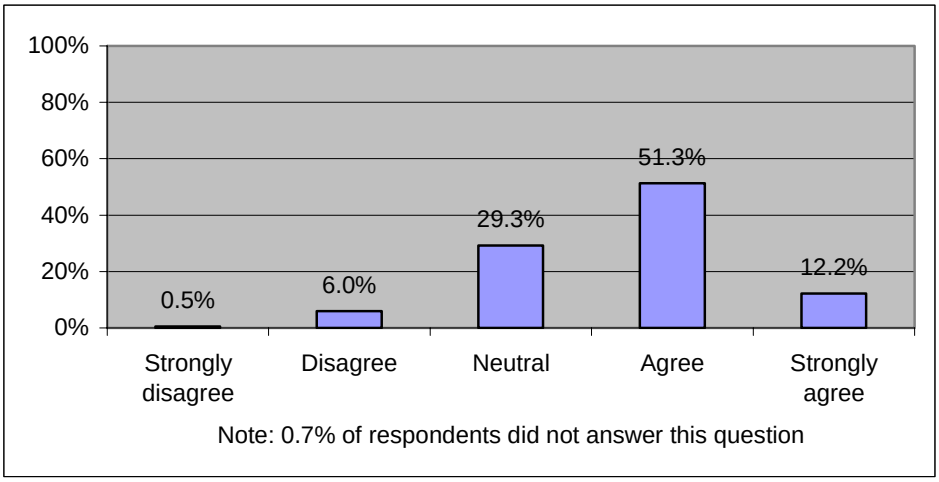
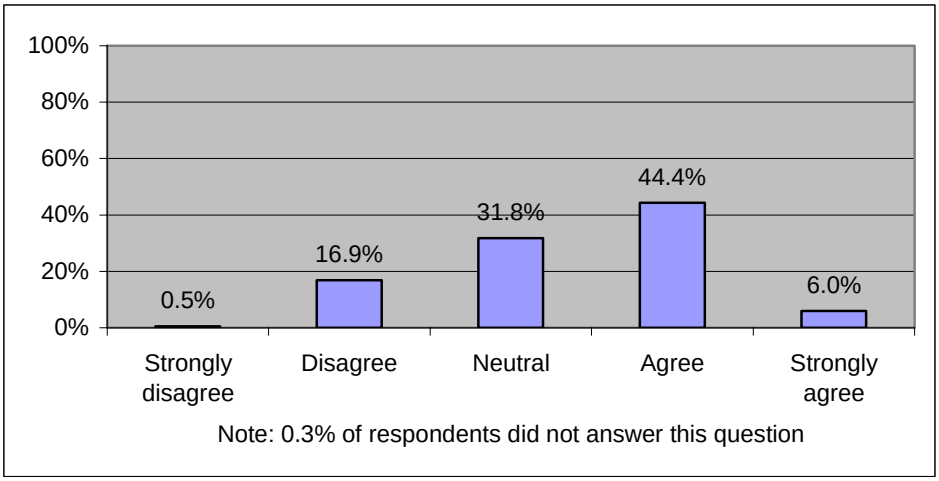


Figure 8.19 shows whether the respondents felt that it is difficult to locate a suitable anchor point for safety belt for most buildings. Over 50% of the respondents 'strongly agreed/agreed' with this statement, 30% felt 'neutral' and below 20% felt not difficult. This response generally reflects a lack of design consideration in providing a suitable anchor point for safety belt. Perhaps the concept of 'design for safety' should be more actively pursued. Clearly if more safety considerations are given at the design stage, a lot of potential safety hazards can be prevented at the construction and maintenance stages. Prevention is always better than cure.

Figure 8.19 Q18. For most buildings it is difficult to locate a suitable anchor point for safety belt.



Respondents were asked whether most flat owners/tenants would allow workers to install an anchor point for safety belt from within their premises (Figure 8.20). Almost half the respondents confirmed that flat owners/tenants would not allow this. Approximately 40% felt 'neutral' and 20% felt that flat owners/tenants would allow this. No doubt providing an anchor from within a premise may create inconvenience to the occupants. Again if a proper anchor point is provided at the design stage, it will eliminate the need to install an anchor point from within the premises.

It is believed that to alleviate the severity of the high accident rate in repair and maintenance works, permanent repair and maintenance safety measures considered and provided at the design stage, instead of the temporary personal protective equipment that is currently used, should be incorporated into buildings. Not only will these safety devises provide more reliable measures, they can also be incorporated into the main design features to preserve the aesthetic value of the building.

Safety measures for repair and maintenance works can generally be divided into four types: elimination of risk at the source, minimization of risk by modifying the system,

active protective measures and passive protection measures, based on the hierarchies of risk control in the UK and NSW (Great Britain, 1995 and WorkCover, 2001).

The safety measures which aim to eliminate risk at the source during repair and maintenance works can be achieved by special designs e.g. windows that can be safely cleaned on both sides from within the building (BS8213-1, 2004). Minimization of risk can be achieved by two approaches: one is to minimize the requirements of repair and maintenance works (Pavitt and Gibb, 2003), and the other is to minimize the risk faced by repair and maintenance works workers during work (Gambatese, et al., 1997, WorkCover, 2001, Behm, 2005). For instance facade materials used can be stainless steel or pre-cast tiles and hence reduce the requirements of repair and maintenance works (WorkCover, 2001). Elevated exterior structures next to roof edges should be avoided to minimize the risk suffered by repair and maintenance works workers when they are working on facades.

Active protective measures are provisions to avoid the occurrence of accidents, e.g. provision of permanent walkways. Passive safety measures are provisions that save lives when accidents happen, e.g. provision of safety harnesses with locating anchor points and safety lines strategically so that workers are not exposed to risks throughout the whole working process.

The questionnaire responses show that there is a need to promote ‘design for safety’ and the options discussed in this section can be used for consideration.

Figure 8.20 Q19. Most flat owners/tenants will not allow workers to install an anchor point for safety belt from within their premises.

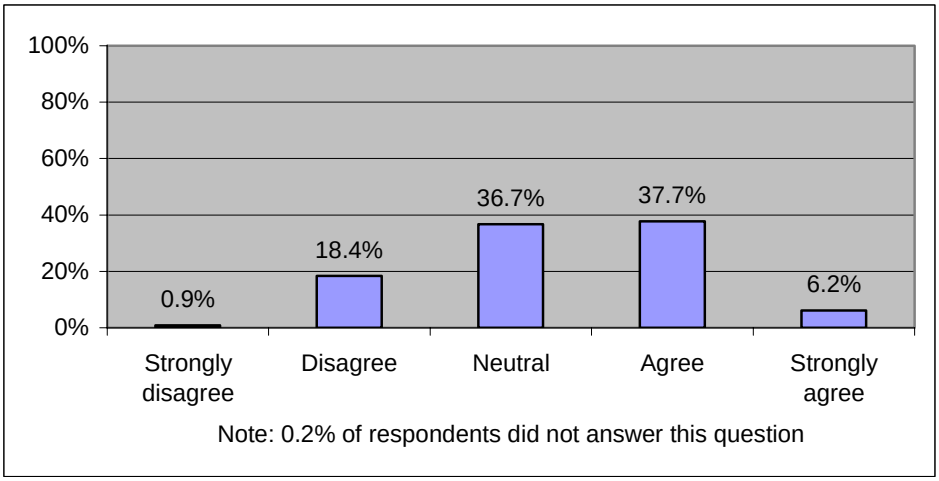
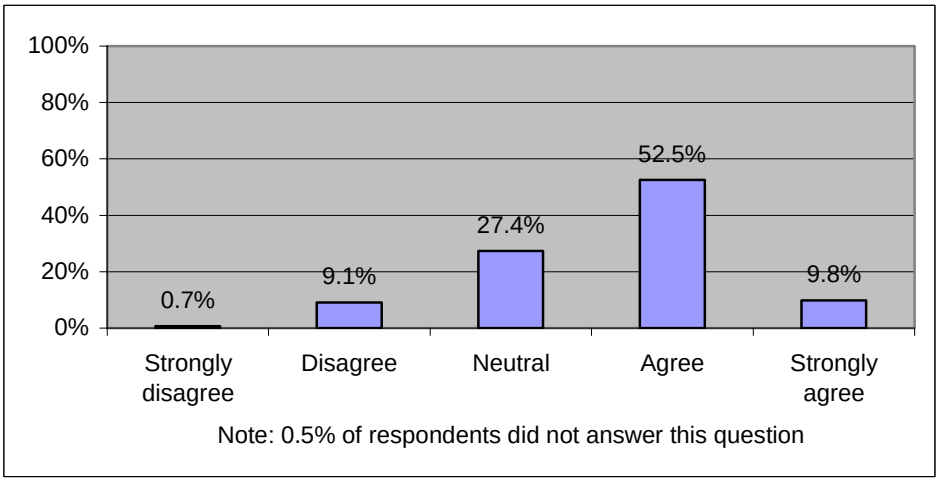


Figure 8.21 shows that over 60% of the respondents agreed that most buildings are not designed with an anchor point for safety belt with less than 10% who perceived the otherwise. This perception is consistent with the previous findings and reinforces the need for more safety considerations at the design stage.

Figure 8.21 Q20. Most buildings are not designed with an anchor point for safety belt.



Respondents were asked whether they knew how to locate a suitable anchor point for the safety belt. Figure 8.22 shows that 40% of the respondents know how to locate an anchor point. Thirty-five percent of the respondents felt 'neutral' and just over 20% admitted that they do not know how to locate an anchor point. This echoes the need to educate workers the proper procedures of using and wearing personal safety devices in the safety training course.

Figure 8.22 Q21. I do not know how to locate a suitable anchor point for safety belt.

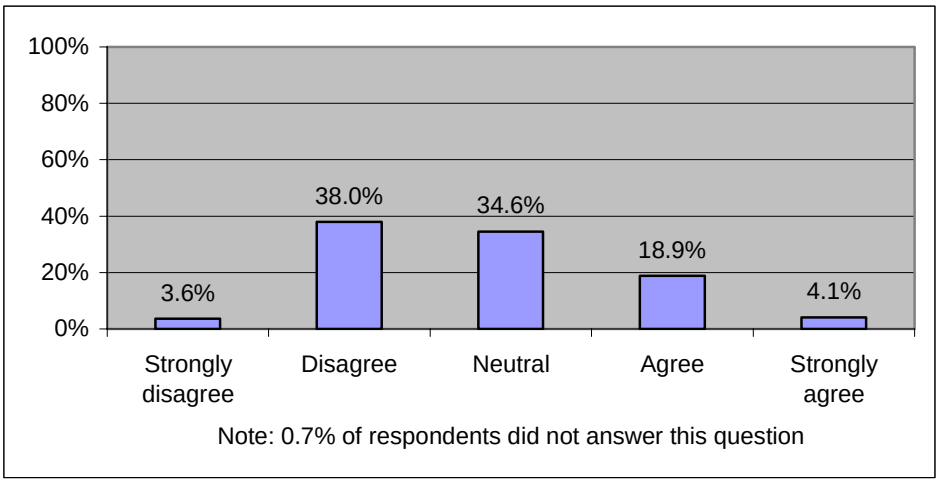
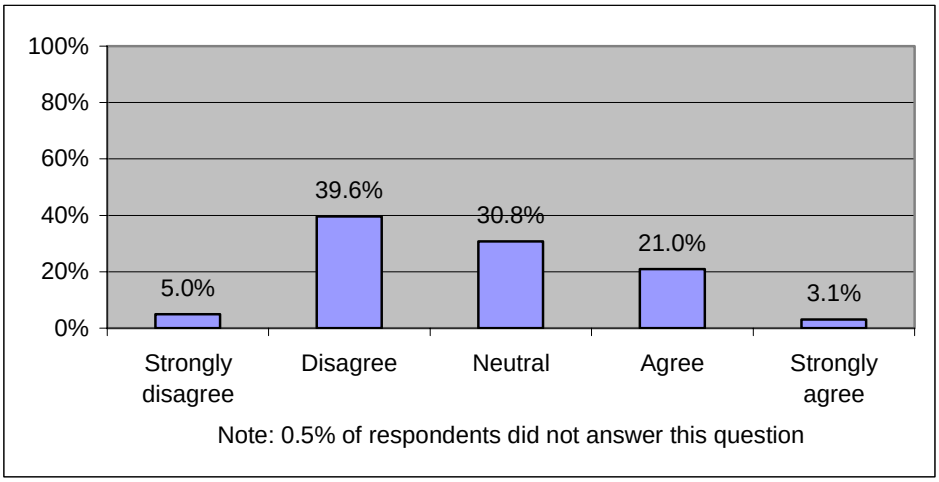


Figure 8.23 shows that almost a quarter of the respondents believed that using personal protective equipment would disturb their work progress. Thirty percent of the respondents felt 'neutral'. And over 40% did not believe that personal protective equipment would be of disturbance to them. Still there is a significant portion of workers (some 25%) who need to be convinced the importance of personal protective equipment. However, at the same time, there are rooms for improvement for the current personal protective devices so that they are convenient to use and will not be considered as disturbing work progress.

Figure 8.23 Q22. Using personal protective equipment would disturb my work progress.



The respondents were asked whether they knew how to use personal protective equipment correctly and the results were shown in Figure 8.24. Sixty percent of the respondents believed that they do know how to use personal protective equipment. Whereas only 15% admitted that they did not know how to use personal protective equipment. A quarter of the respondents felt 'neutral' on this topic. The result is affirmative but more efforts should be placed to enhance the competency of the remaining 15% in using the personal protective equipment correctly through attending safety training courses.

Figure 8.24 Q23. I do not know how to use personal protective equipment correctly.

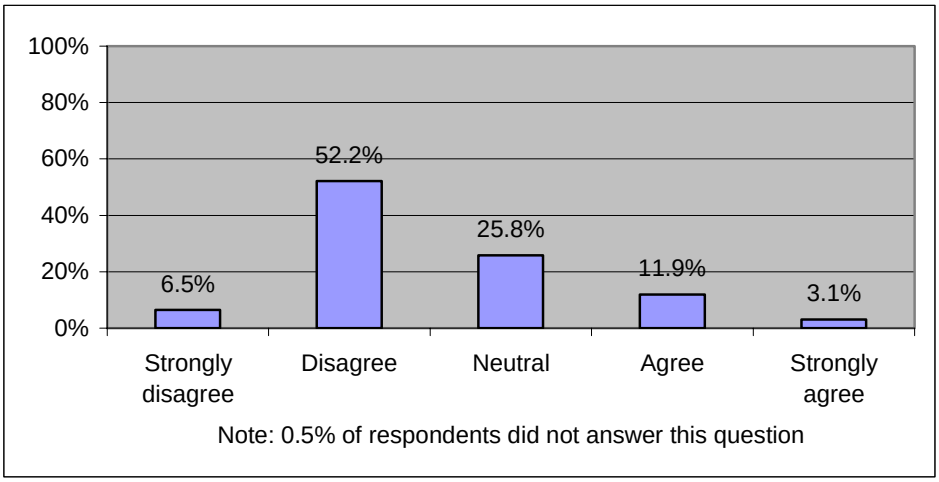
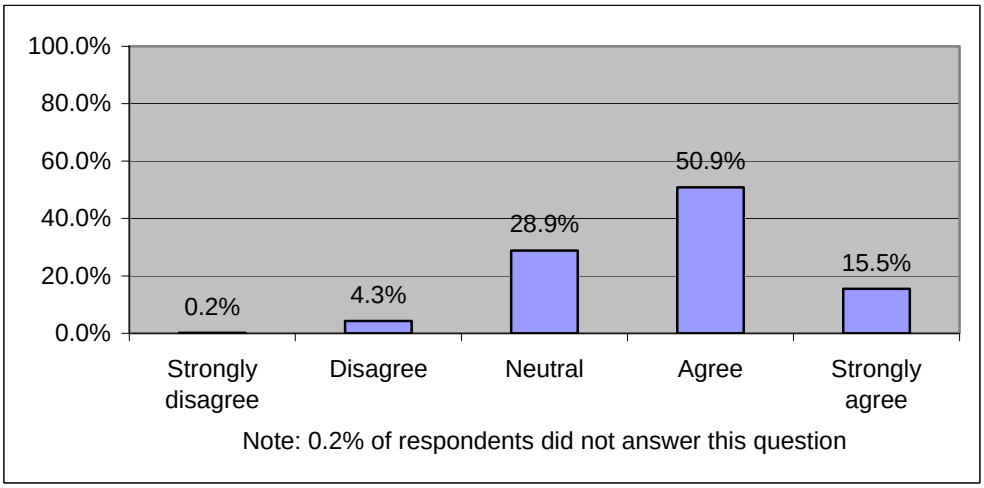


Figure 8.25 shows that 70% of the respondents felt that there should be specified training courses for workers who undertake external works at height. Thirty percent of the respondents felt 'neutral' on this topic. And only 5% of the respondents felt that it was unnecessary. The statistics illustrate an obvious need for training courses relating to external works at height. The patterns of responses were found to be similar to the perceptions obtained from Q13 on installing the bamboo truss-out scaffold.

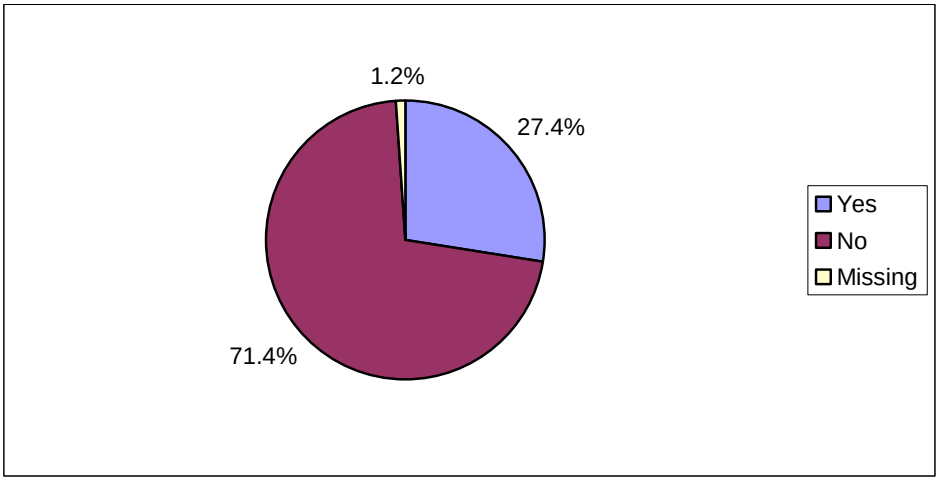
Figure 8.25 Q24. There should be specified safety training courses available for workers who undertake external works at height.



8.3.3 Analysis of section III – Accidents related to repair and maintenance

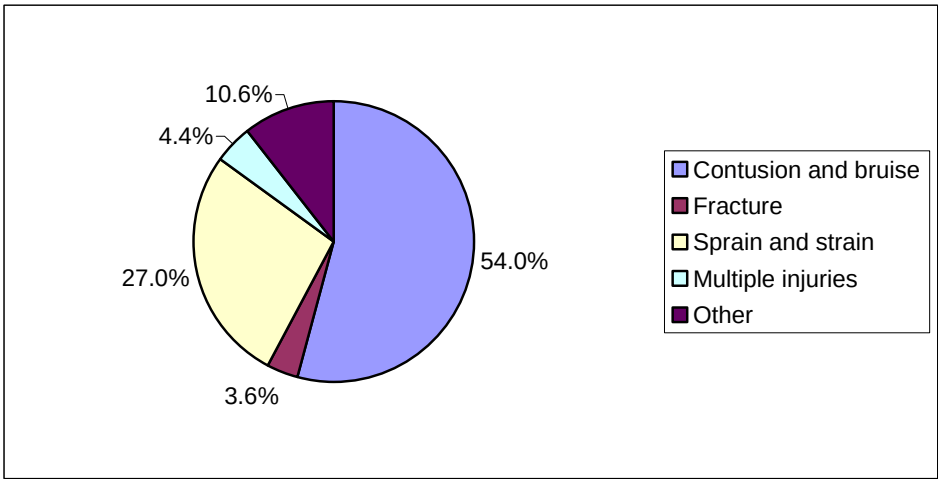
The respondents were asked if they had ever been injured due to work. As shown in Figure 8.26, over a quarter of the respondents have previously been injured due to work and three quarters had not been injured.

Figure 8.26 Q25. Have you ever been injured due to work?



Respondents that had been injured during work were further asked the type of injury that was caused. As shown in Figure 8.27, the respondents were given five choices to choose from: 'Contusion and Bruise', 'Fracture', 'Sprain and Strain', 'Multiple Injuries' and 'Other'. 'Contusion and Bruise' was the most likely injury experience with over half of the respondents. 'Sprain and Strain' was the next most common injury experienced by almost one third of the respondents. 'Fracture' and 'Multiple Injuries' represented only 4% each of the respondents. And approximately 10% of the respondents did not answer this question.

Figure 8.27 Q26. If you have been injured due to work, what type of injury was it?



The previously injured respondents were asked whether they needed hospitalization due to their injury. The results in Figure 8.28 indicate that the majority (96%) of the respondents did not require hospitalization.

Figure 8.28 Q27. If you have been injured due to work, did you need hospitalization?

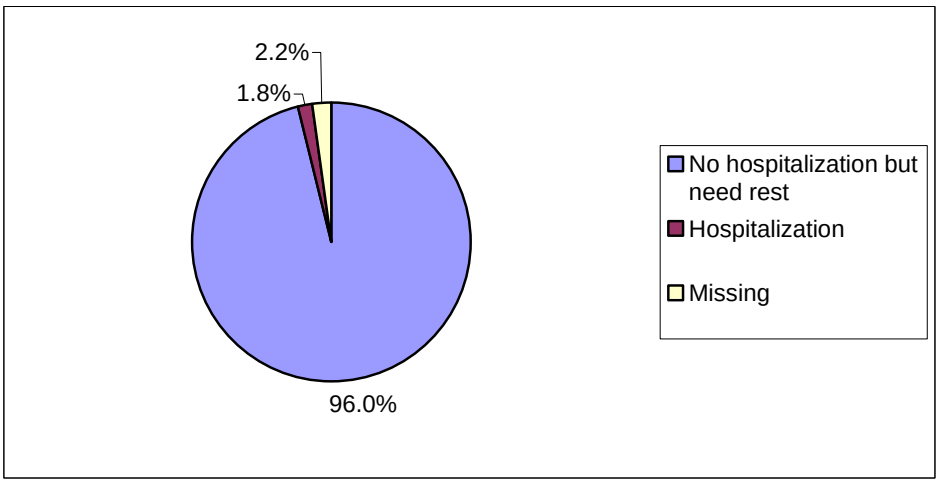
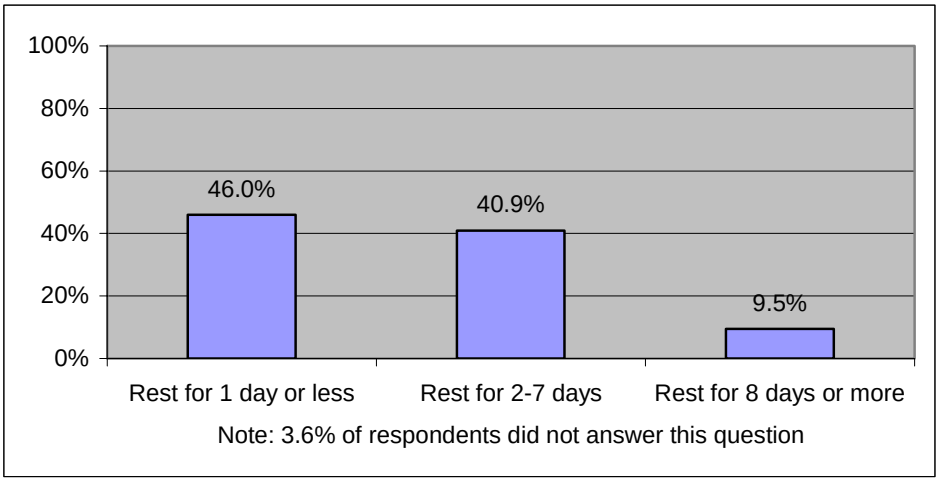


Figure 8.29 shows the number of days of rest required for the respondents who were injured but not hospitalized. The respondents were asked to choose from three choices: 'Rest for 1 day or less', 'Rest for 2-7 days' and 'Rest for 8 days or more'. The majority

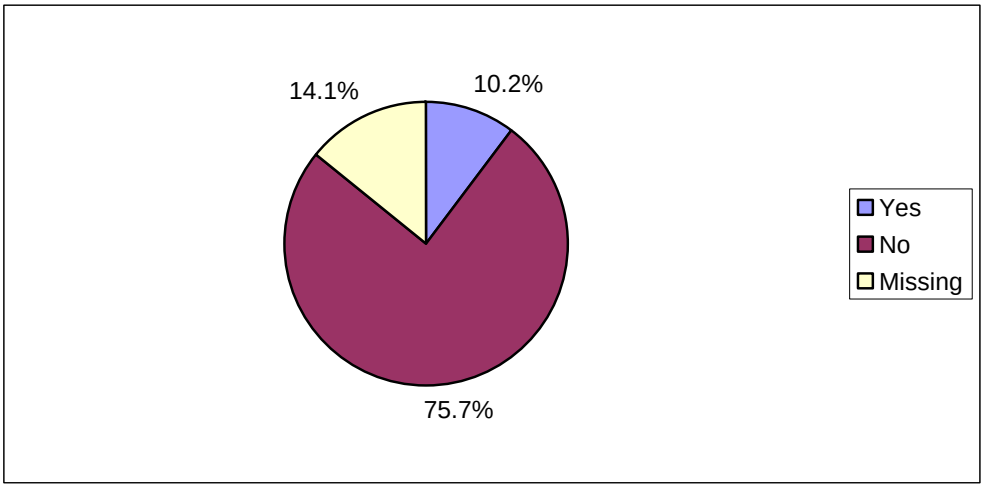
of respondents chose the first two categories. And only 10% of the respondents chose 'Rest for 8 days or more'.

Figure 8.29 Q27a. If you did not require hospitalization, how many days rest did you have?



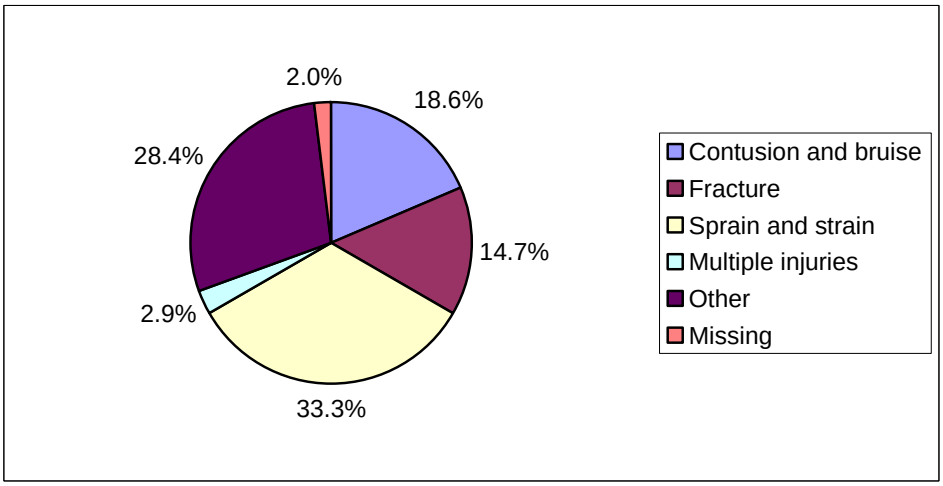
Questions 25 to 27a analyse the experience and nature of work injuries of the respondents. The research sample shows that over 27% of the respondents had suffered work injuries in the past. Obviously more should be done to reduce this injury figure. The respondents were further asked if they had been injured due to working at height. As shown in Figure 8.30 the respondents that had been injured due to working at height compared to the respondents who had been injured by their work was less than half (10%). Three quarters of the respondents had never been injured as a result of working at height and 14% of the respondents chose not to answer this question.

Figure 8.30 Q28. Have you ever been injured due to working at height?



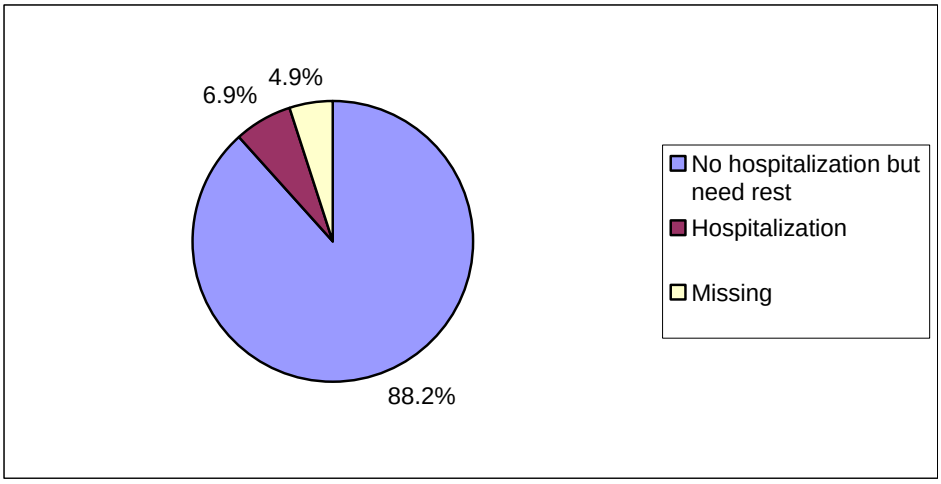
For the respondents who have been injured as a result of working at height they were asked to state the injury amongst five choices (Figure 8.31). As a result of fall from height one third of the respondents experienced 'Sprain and Strain', and another one third chose to opt for 'Other'. 'Contusion and Bruise' represented almost 20% of the responses and 'Fracture' represented 15%. Hardly any of the respondents (3%) chose 'Multiple Injuries'.

Figure 8.31 Q29. If you have been injured due to working at height, what type of injury was it?



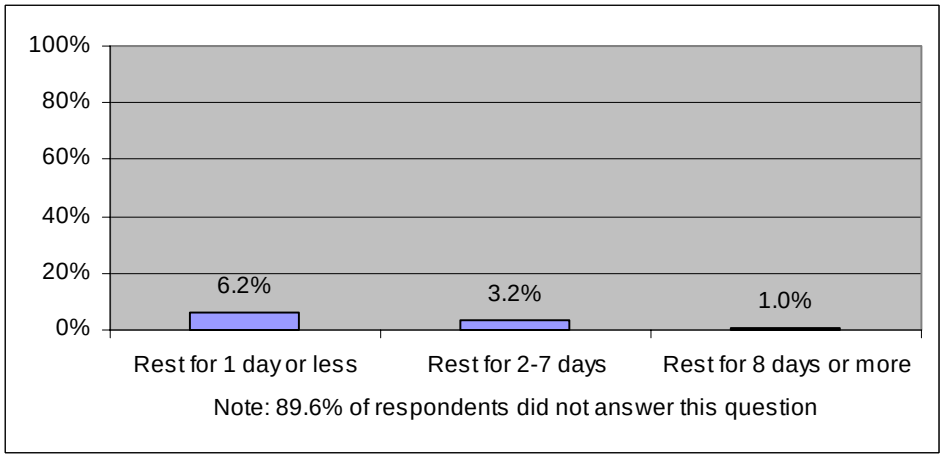
Similar to the results for Question 27, Figure 8.32 shows that the majority of the respondents (88%) did not require hospitalization.

Figure 8.32 Q30. If you have been injured due to working at height, did you need hospitalization?



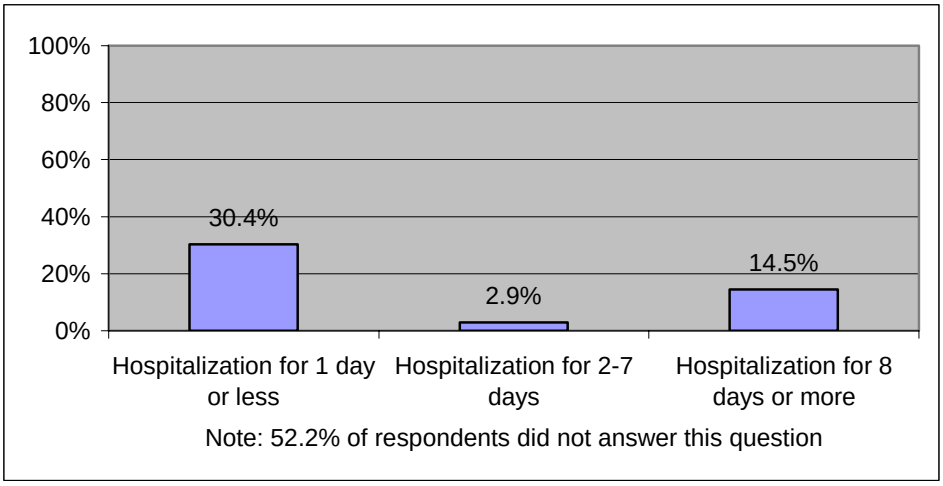
The respondents who did not require hospitalization as a result of fall from height injury were asked to state the number of days rest required amongst three choices. Almost 90% of the respondents did not answer this question (Figure 8.33).

Figure 8.33 Q30a. If you did not require hospitalization, how many days rest did you have?



For the respondents who were injured due to fall from height and required hospitalization, Figure 8.34 shows the days of hospitalisation that they required. The results similar to Question 30a are difficult to analyse as over half the respondents did not answer this question. Almost one third of the respondents required 'Hospitalisation for 1 day or less'.

Figure 8.34 Q30b. If you were hospitalized, for how may days?



Questions 3-6 in Sections I and II of this questionnaire were cross tabulated with Questions 25 and 28 of Section III. Cross tabulation was used to test whether there was a relationship between the experience and training of the respondents and their accident record in general construction works and working at height works. The significance level of the relationships were analysed by the Pearson Chi-Square Test. If the p-value (i.e. significance level) was below 0.05 then the results were defined as significant implying that correlation exists between the two variables under study. Tables 8.2a and 8.2b show the results of this analysis.

Table 8.2a Cross tabs between injuries due to work and the respective measures

	Q3		*Q4*		*Q5*		*Q6*	
	Value	***Sig.***	***Value***	***Sig.***	***Value***	***Sig.***	***Value***	***Sig.***
Q25	48.061	0.000	23.713	0.000	27.434	0.000	6.731	0.241
N	691		635		661		693	

Table 8.2b Cross tabs between injuries due to working at height and the respective measures

	Q3		*Q4*		*Q5*		*Q6*	
	Value	***Sig.***	***Value***	***Sig.***	***Value***	***Sig.***	***Value***	***Sig.***
Q28	23.497	0.000	8.858	0.115	13.638	0.018	7.182	0.207
N	527		502		523		532	

Notes: *Q3. Years of experience in the construction industry*

Q4. Years of experience in repair and maintenance works

Q5. Which of the following age groups do you belong to?

Q6. How long ago was the last time you attended a safety training course?

Q25. Have you ever been injured due to work?

Q28. Have you ever been injured due to working at height?

The results showed that the respondents' years of experience in the construction industry affected whether they had been injured due to work and due to working at height, therefore with increasing experience in the construction industry the likelihood of accidents would decrease. Thus, the experience level of the workers is essential in mitigating injuries and accidents at workplace.

On the contrary, the accident statistics presented in Chapter 5 (p.92), showed that workers in the age group 40-44 experienced the highest number of accidents in repair and maintenance works. Workers of this age group are assumed to possess a reasonable level of experience in the construction industry, probably 15-20 years. Based on this assumption, the findings from the statistics show that experience level does not necessarily result in fewer accidents. But it is important to bear in mind that workers of this age group experience more accidents probably because there are more workers of this

age group working in the industry. Also, workers that have experienced fatal or severe injuries would not have completed the questionnaire.

The respondents' years of experience in repair and maintenance works affected whether they had been injured due to their work but did not affect whether they had been injured due to working at height. Therefore with increasing experience in repair and maintenance works the likelihood of injury due to their work would decrease but not necessarily for injury during working at height.

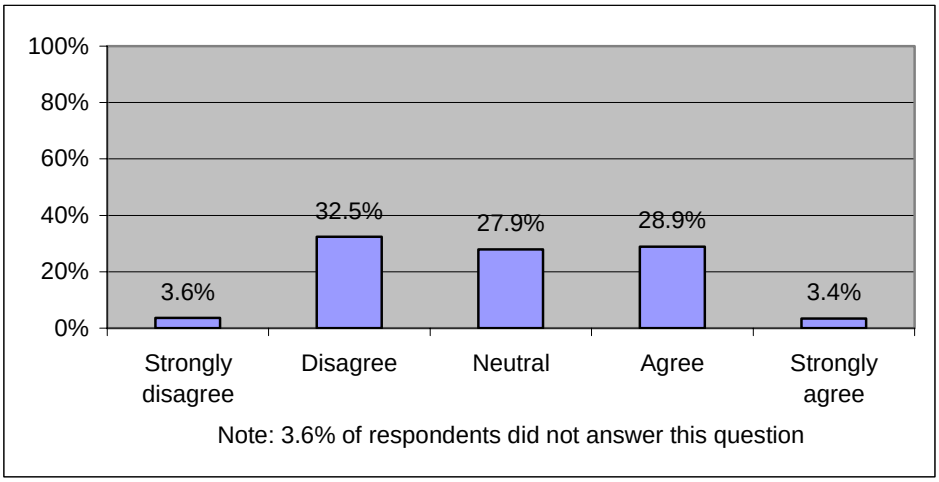
The results also showed that there is a correlation between the age group and the likelihood of having injuries whether due to work or due to working at height. With increasing age the likelihood of being injured due to their work and working at height would decrease. But as mentioned previously the statistics presented in Chapter 5 show some differences to the findings of the questionnaire. Again it is believed that workers that have been severely injured or died would not have answered this questionnaire. Although the questionnaire holds limitations, the questionnaire findings are representative for workers that have experienced minor injuries.

In addition, the last time the respondents participated in safety training courses showed no relationship towards the likelihood of accidents in both their work and during working at height. It seems that the most determining factor is whether they had undertaken safety training before but irrespective of how long ago they attended the course.

The detailed cross tabulation tables of Questions 3-6 with Questions 25 and 28 can be found in Appendix 42.

Respondents were asked whether accident investigations are mainly used to identify who is to blame. Figure 8.35 shows that the feelings were generally quite balanced.

Figure 8.35 Q31. Accident investigations are mainly used to identify who is to blame.



Question 32 asked the respondents whether they thought productivity is usually seen as more important than safety and health. Figure 8.36 shows that over 40% of the respondents 'strongly disagree/disagree' with this statement. Approximately a quarter of the respondents felt that productivity is important and the remainder felt 'Neutral' on this topic.

Figure 8.36 Q32. Productivity is usually seen as more important than safety and health.

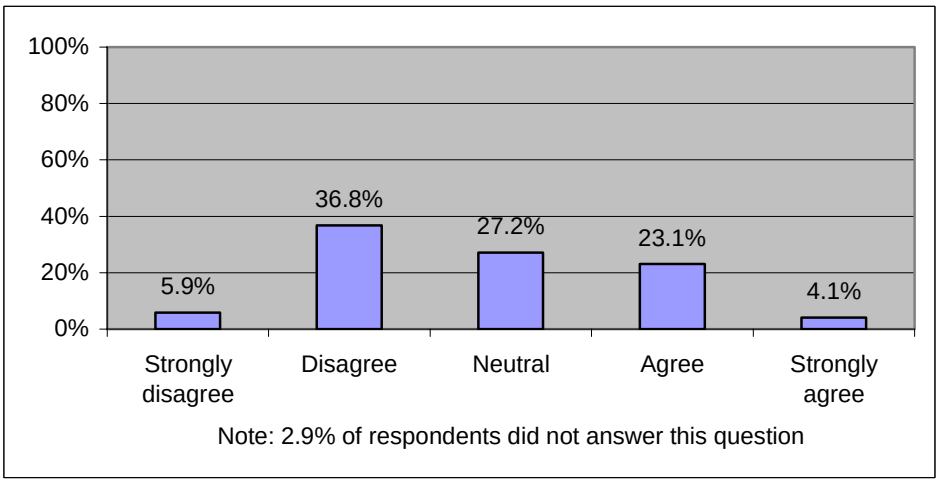


Figure 8.37 shows that over 60% of the respondents 'strongly agree/agree' that those accidents in repair and maintenance works are always reported. Only approximately 5% of the respondents felt that accidents were not always reported. About one third felt 'Neutral' on this topic.

Figure 8.37 Q33. Accidents in repair and maintenance works are always reported.

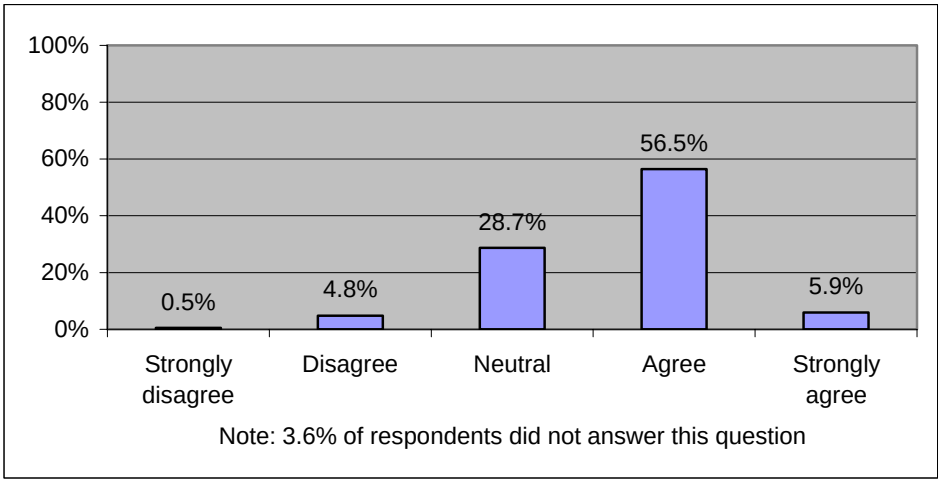


Figure 8.38 shows that the respondents felt quite 'Neutral' towards the statement 'Near misses in repair and maintenance works are always reported'. There were hardly any strong feelings on this topic. Almost 40% of the respondents felt 'Neutral' and respondents who 'agreed/disagreed' represented a quarter each of the responses.

Figure 8.38 Q34. Near misses in repair and maintenance works are always reported.

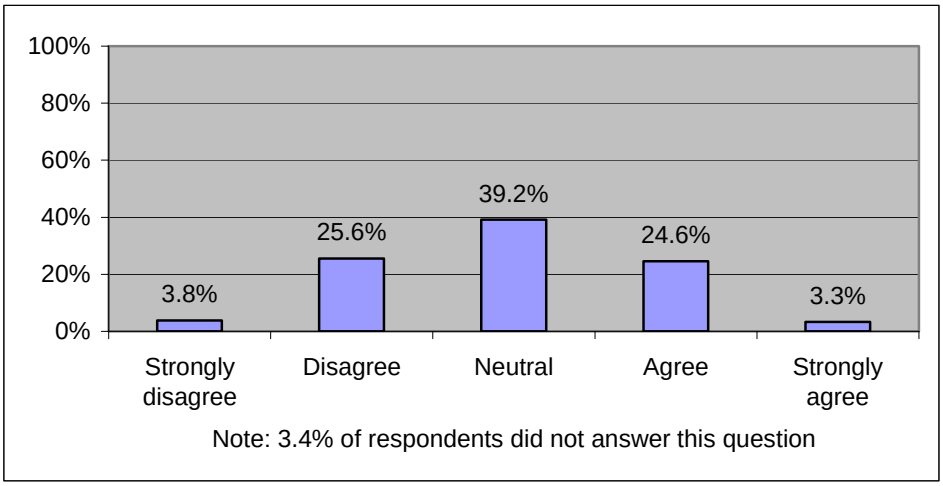
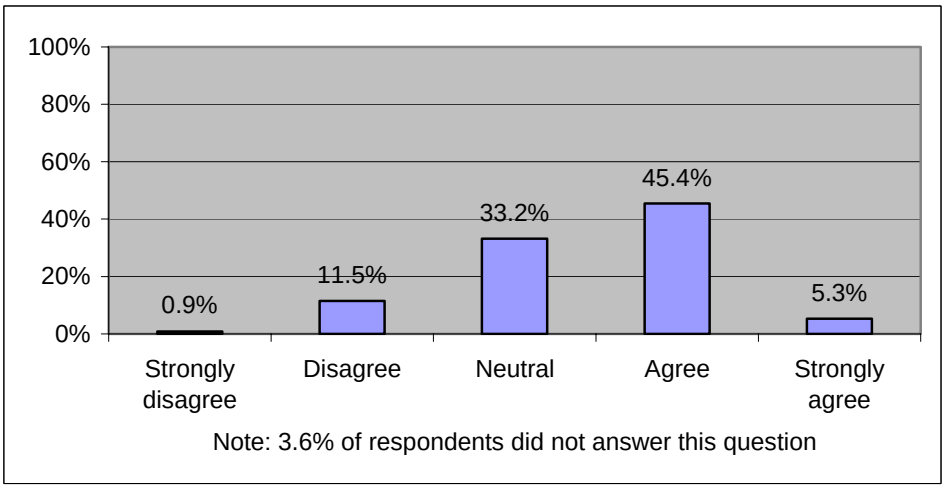


Figure 8.39 shows that over half of the respondents believed that they would be fully aware of how to deal with their compensation if they were injured due to work. One third of the respondents felt 'Neutral' and only about 10% of the respondents did not know how to claim for their compensation.

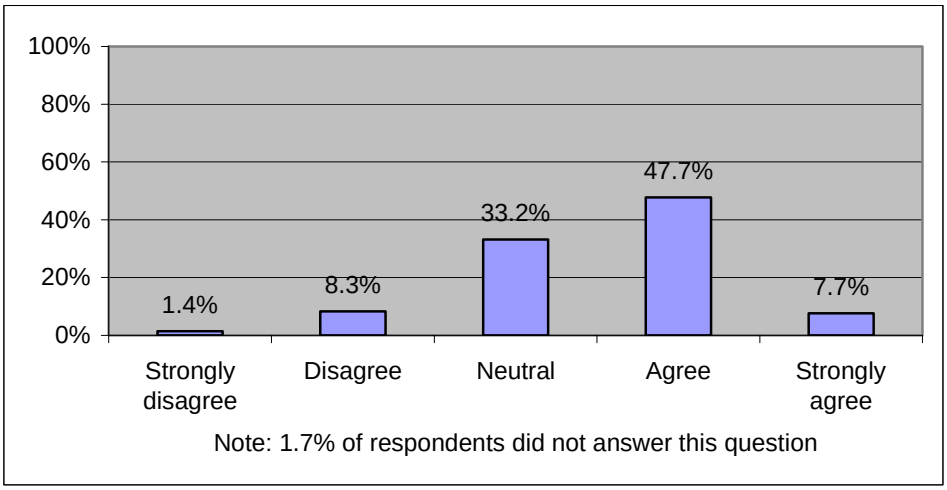
Figure 8.39 Q35. I am fully aware of how to deal with my compensation if my injury is due to work.



8.3.4 Analysis of section IV - Safety messages

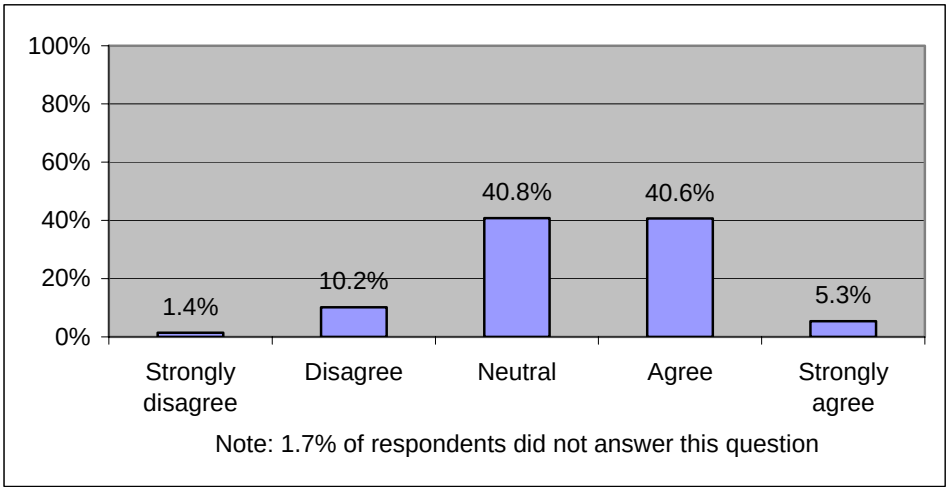
Respondents were asked whether construction safety was advertised frequently on television and radio (Figure 8.40). Over half of the respondents had noticed these broadcasts frequently. One third of the respondents felt 'Neutral' about this statement and less than 10% had not noticed these broadcasts often. Thus more safety messages should be advertised to remind workers of the importance of construction safety.

Figure 8.40 Q36. Construction safety messages are advertised frequently via media such as television and radio.



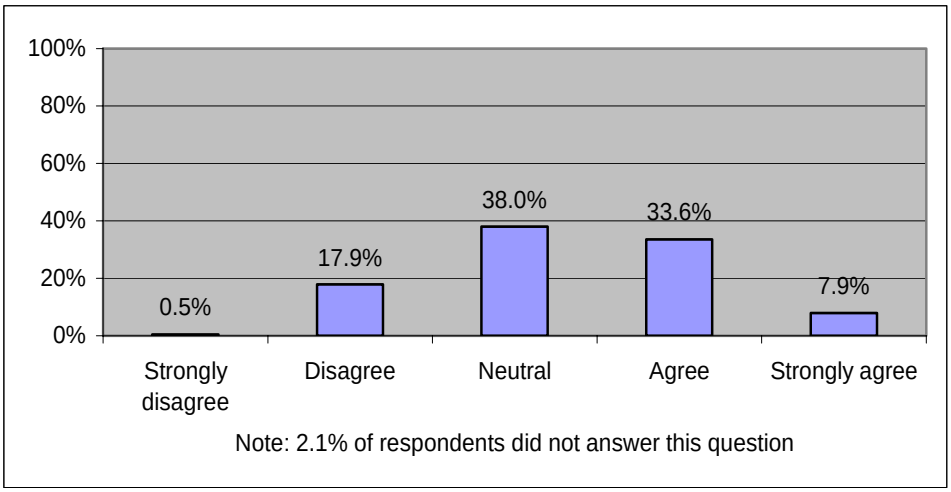
Respondents were asked whether construction safety messages advertised via media are extremely effective in reminding workers of construction safety (Figure 8.41). Approximately half of the respondents found messages effective, Forty percent of the respondents felt 'Neutral' and a tenth of the respondents felt that messages were not effective.

Figure 8.41 Q37. Construction safety messages advertised via media are extremely effective in reminding workers of construction safety.



Respondents were asked whether they agreed that there are not enough safety and health guidelines relating to working at height for repair and maintenance works (Figure 8.42). Forty percent of the respondents felt 'Neutral', 40% 'strongly agreed/agreed' and approximately 20% 'strongly disagreed/disagreed'. Hence relevant government departments and related private organizations should provide more guidelines for working at height for repair and maintenance works.

Figure 8.42 Q38. There are not enough safety and health guidelines relating to working at height for repair and maintenance works.



8.3.5 Analysis of section V - Safety attitude of repair and maintenance workers

The safety attitude of construction workers for building repair and maintenance works may be affected by the occurrence of accidents at work. In order to investigate the difference of safety attitude between workers with accident records and those without accident experience, discriminant analysis has been employed for data analysis.

Discriminant analysis (DA) is used to compare the results among groups of respondents (Lam *et al*., 2004). It is an appropriate statistical technique for testing the hypothesis that the group means of a set of independent variables for two or more groups are equal (Hair *et al*., 1998). The null hypothesis is rejected when the significance level of DA falls at or below 0.05, meaning that there is significant difference in the groups with respect to certain independent variables (Lam *et al*., 2004). This analysis is most effective when group membership is categorical. Moreover, the key assumptions for deriving the discriminant function are that the data to be analyzed have normal characteristics and equal variances (Hair *et al*., 1998). The ratio of sample size to the number of predictor variables should at least be 5 observations per independent variable. In the current study,

the ratio is nearly 42 observations per independent variable (541 valid samples to 13 independent variables), and the results can become more stable.

Discriminant analysis is used in the current study to identify the significant differences of safety attitude between workers with accident records and those without accident experience. In the design of industry-wide questionnaire, the respondents were requested to indicate their history of accident by the following question:

Q25. Have you ever been injured due to work (Yes/No)?

And the data represent the categorical dependent variable for DA. The independent variables were extracted from Chan *et al*. (2005) who conducted a survey on the effect of safety climate on construction safety. In that survey, 13 significant grouped safety climate factors were derived by statistical means from 71 safety climate factor statements in the Health and Safety Executive's Safety Climate Survey Tool. Those 13 grouped safety climate statements were incorporated in the industry-wide questionnaire and constitute the independent variables for the research (Table 8.3).

Table 8.3 Safety climate statements adopted in the research

Question No.	**Statement**
Q39	*My immediate boss would be very helpful if I asked for advice on safety and health matters.*
Q40	*Management would expect me to break safety and health procedures/instructions/rules to get the job done.*
Q41	*The company really cares about the safety and health of the people who work here.*
Q42	*Some safety and health procedures/instructions/rules do not reflect how the job is now done.*
Q43	*Supervisors here are not very effective in ensuring safety and health.*
Q44	*The training I had covered all the safety and health risks associated with the work for which I am responsible.*
Q45	*There is nothing I can do to further improve safety and health here.*
Q46	*People who work here sometimes take risks at work which I would not take myself.*
Q47	*Suggestions to improve safety and health are seldom acted upon.*
Q48	*Management sometimes turn a blind eye to safety and health procedures/instructions/rules being broken.*
Q49	*I am worried about my job security.*
Q50	*My job is boring and repetitive.*
Q51	*Accidents which happen here are always reported.*

Discriminant analysis was executed by the statistical program (SPSS) based on the stepwise approach and the results are shown as Table 8.4 and Appendix 43.

Table 8.4 Statements with significant difference

	Q45		*Q46*		*Q49*		*Q51*	
	Yes	***No***	***Yes***	***No***	***Yes***	***No***	***Yes***	***No***
Mean	2.81	2.95	3.65	3.37	3.38	3.11	3.71	3.48
Standard deviation	0.83	0.834	0.764	0.858	0.946	0.908	0.561	0.745

Sample size for 'Yes' = 147; Sample size for 'No' = 394; Sig. = .000;

H_0 = No significant difference in groups

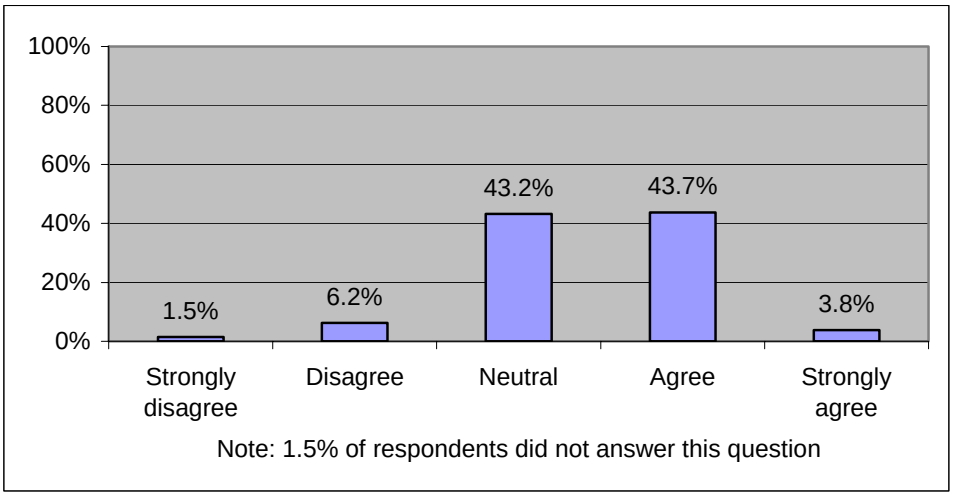
Of the thirteen safety climate statements, it was observed that there is significant difference in the response of workers with accident records and those without accident experience with respect to four statements (Questions *45*, *46*, *49* & *51*). Workers with accident experience less agree that Q45 'There is nothing I can do to further improve safety and health here'. When compared to those without accident records, workers with accident experience agree that Q46 'People who work here sometimes take risks at work which I would not take myself', Q49 'I am worried about my job security' and Q51 'Accidents which happen here are always reported' to a larger extent. This implies that workers with accident experience are more alert to construction safety than those without. Only by getting hurt in construction work can their awareness towards safety be increased. In fact, such phenomenon is in line with common perception that workers with accident experience are more conscious about their daily work to protect themselves from taking risks again at work, from being unemployed because of serious accidents and through reporting mechanism. However, it is desirable that both groups of workers, with or without accident experience, should be attentive to construction safety at work by means of education and training where experience sharing can be initiated by those with accident experience on the negative consequences of construction accidents. In addition, it is recommended that safety training should therefore include more case studies and

actual photos or illustrations of the accidents so as to reinforce or to improve the workers' safety attitude.

8.3.6 Analysis of section VI - Legislation and responsibility

Figure 8.43 shows that half of the respondents felt that the current legal framework is able to reduce fall from height accidents. Some 43% of the respondents felt 'Neutral' on this topic and the mere remainder did not feel that these controls could help. The respondents by and large believed that the prevailing statutory controls are sufficient to minimise fall from height accidents.

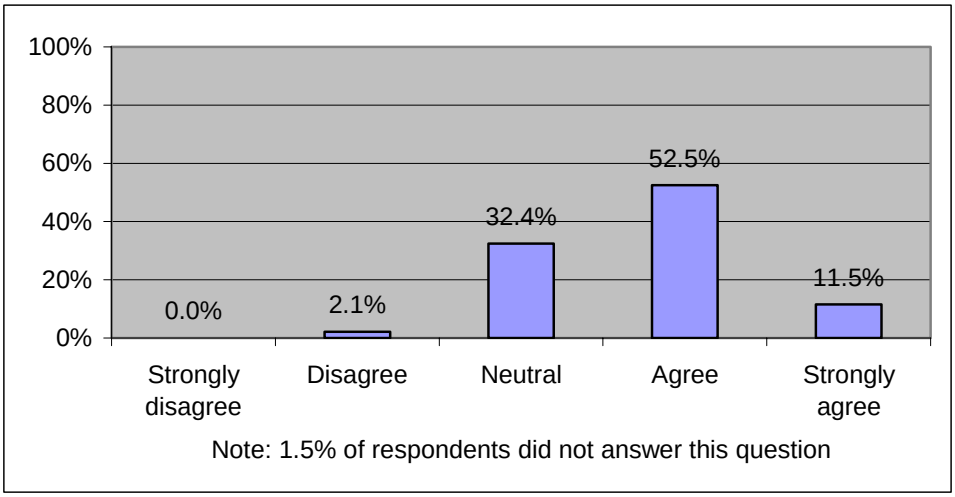
Figure 8.43 Q52. The current statutory controls are able to reduce fall from height accidents.



The respondents were asked whether they thought the government ought to enhance legislations relating to construction safety involving working at height for residential repair and maintenance (Figure 8.44). A large proportion (over 60%) of respondents agreed with this statement. One third of the respondents felt 'Neutral' and only 2% thought that the government should not enhance these legislations. Therefore there is a

clear message that the respondents would like to see enhanced legislations relating to construction safety involving working at height for residential repair and maintenance.

Figure 8.44 Q53. The government ought to enhance legislations relating to construction safety involving working at height for residential repair and maintenance.

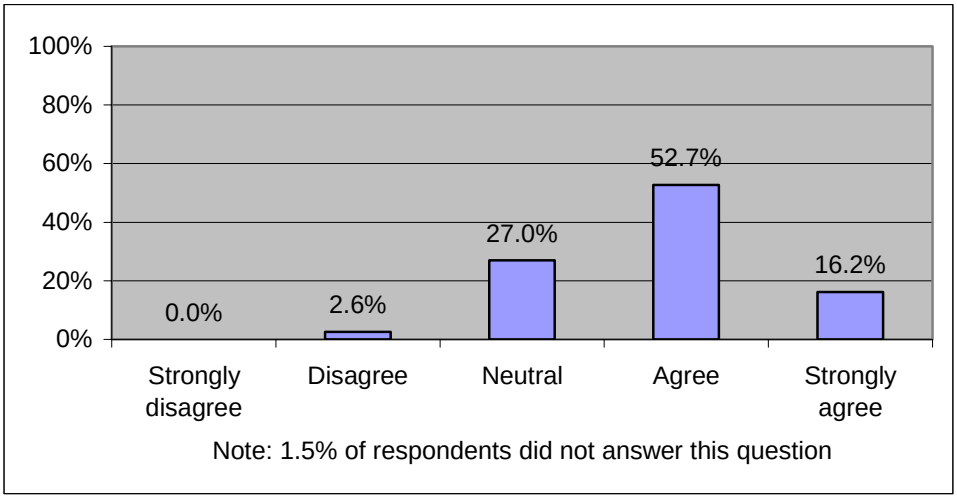


Respondents were asked whether they thought the government ought to issue work licenses to those workers involved in the installation of bamboo truss-out scaffolds, in order to reduce the occurrence of accidents (Figure 8.45). A high proportion (70%) of the respondents agreed with this statement whereas almost 30% felt 'Neutral'. A mere 3% did not agree that there should be work licenses for these workers. Therefore, it is recommended that a mandatory licensing system should be established for those workers engaged in the installation of bamboo truss-out scaffolds. A similar recommendation is derived from the structured interviews and focus group discussions reported in the previous chapter (Refer to Sections 7.2.11.4 & 7.3.5.3 of Chapter 7).

Throughout the data collection of this project various respondents from various sources expressed that a licensing system for repair and maintenance workers and workers involved with truss-out scaffolds is preferred. As discussed previously the system could be beneficial to all parties but as the establishment and implementation will take time and

cost it should be a goal for the long-run. In the interim, self-regulation is again highly recommended.

Figure 8.45 Q54. The government ought to issue work licenses to those workers involved in the installation of bamboo truss-out scaffolds, in order to reduce the occurrence of accidents.



8.3.7 Analysis of section VII - Practical solutions to reduce fall of person from height

This section analysed which practical measures would be effective in preventing fall from height accidents. Eleven solutions were provided and respondents were asked to rate the appropriateness of the measure. The eleven measures were ranked in order of importance according to all levels, managerial level, supervisory level and workforce level (Table 8.5). The rankings were analysed to see if there were any disparities in the rankings amongst different working levels.

The results showed that overall speaking, Question 59 'For future building designs the designers should consider including facilities to ensure repair and maintenance safety, and hence reducing fall from height accidents', was ranked the most important in reducing fall accidents in repair and maintenance works. The rankings of the three

working levels were very similar. All three working levels felt that designing for safety was important, with particular emphasis at the workforce level. Through the interviews and focus group meetings conducted in this study (refer to Chapter 7) the workforce participants expressed that they would perform safety if it was possible. For example it is difficult to find an anchor point for securing their safety belts and often flat owners/tenants would not allow an anchor point to be installed in their premises or even near their premises hence workers have to go without, therefore they favour very much for designing for safety so that these necessary measures can be included for their protection at work. The incorporation of safety measures for repair and maintenance works should be encouraged. The government should initiate incentive measures and provide practical guidelines. However, regulations which mandate buildings to incorporate permanent structures for safety of repair and maintenance works are believed to be difficult to enforce.

Question 64 'Workers who work externally at height should be provided with specified safety training', was ranked second. Again all working levels perceived that specified safety training would be important but the workforce level ranked this slightly lower compared to the other two working levels. This is probably because although the workforce level feels that specified training is important it would also be added duty to them, hence they ranked its importance slightly lower. For the managerial level and the supervisory level specified safety training for working at height would benefit them by reducing accidents and also their participation would not be required. Hence they ranked it as the most important strategy. In general, the interviewees and participants of the interviews and focus group meetings conducted in this study (refer to Chapter 7), showed that all working levels supported specified safety training for working at height.

Question 63 'A registration licensing system for workers working with the bamboo truss-out scaffold should be set up to reduce fall from height accidents', was ranked third. Again the rankings between the different working levels were very similar. The supervisory level was slightly more favourable of this strategy compared to the other two

levels. This finding probably shows the complications the supervisory level have when trying to choose competent bamboo truss-out scaffold workers. The licensing system would enable them to differentiate competent workers by ones who possess a valid license.

In fourth place was Question 65 'Practitioners ought to highlight and advertise to the public the dangers involved with working at height'. The results showed that the workforce ranked this strategy much lower compared to the other two working levels. In Chapter 7 the workforce focus group participants often emphasized their own responsibility and the responsibility of the contractors in ensuring safety. But rarely did they mention the responsibilities of flat owners/tenants; therefore it is assumed that workers do not consider flat owners/tenants as onerously responsible for fall accidents.

In fifth place was Q58 'The government should carry out more inspections of workplace in order to reduce fall from height accidents'. The results show that the workforce level was highly supportive of this strategy, whereas the managerial level and the supervisory level were not. The difference in their opinions was also quite large. Presently, it is the employer or the contractor that is penalized for unsafe acts on construction sites and not the workers themselves. Therefore it is understandable why the managerial and supervisory levels are not supportive of the government increasing their inspections.

Q60 'Future R&M contracts should require the contractor to put aside part of the contract sum for covering any expenses on necessary safety facilities and procedures' was ranked sixth place overall. The supervisory and workforce level gave this strategy a reasonable ranking whereas the managerial level ranked this strategy quite low. Obviously to include safety by increasing the contract price is unfavourable to the managerial level as they will need to spend more for the job and hence they may not be the lowest bidder in wining the contract. But for the supervisory and workforce level they are supportive as they would benefit a lot as a result of pay-for-safety.

In seventh place is Q57 'Practitioners should reconsider the current design of the truss-out scaffold supported by steel brackets'. All three working levels ranked this strategy similarly. The managerial level gave a slightly lower ranking as obviously it would be the managerial level that would most likely have to pay for or participate in the redesign of the bamboo truss-out scaffold.

In eighth place was Q56 'Practitioners should reconsider whether the current personal protective equipment for workers working at height is suitable and sufficient'. The rankings given by the managerial and supervisory level were similar, whereas the ranking given by the workforce level was slightly lower. This view was previously explained in the focus group meetings with the workforce (Chapter 7). The workforce believes that the present personal protective equipment is sufficient, instead the areas of focus should be how to ensure that workers will use the equipment, how to ensure that workers know how to use the equipment correctly and how to ensure that the employers will provide the necessary equipment.

In ninth place is Q61 'Some effective safety procedures and equipment should be introduced in Hong Kong from overseas'. The opinion towards this strategy varied amongst the different working levels. The managerial level felt that this strategy was the least important as it is likely that the managerial level will have to pay for any new safety procedures or equipment introduced. However, the workforce level was the most supportive as the introduction of new procedures and equipment would give them an extra alternative for protection. A good example is the 'Temporary Transportable Anchor Device'. Since its introduction in Hong Kong, the device has been proved to be welcomed by workers and effective in providing an anchor point. Anchor points are often unavailable especially for ageing buildings where the most repair and maintenance works are required. Although detailed research has not been carried out to analyze the effect of the introduction of this device to the decreased amount of recent fall accidents, it is believed a causal relationship exists. Therefore, the use of this device to overcome the current problem of lack of anchor points is encouraged.

In tenth place was Q62 'The government should prosecute and heavily penalise workers performing unsafe acts when working at height'. Unsuprisingly the workforce level was not too excited by this idea. The supervisory level also ranked this strategy the same as the workforce level. Whereas the managerial level was a lot more supportive towards this strategy as they might not need to be fined to the same extent for the workers' unsafe acts like they have to under the present system.

Q55 'Poor safety awareness of the workers is the main reason for fall from height accidents' was ranked the least preferred strategy amongst the eleven. The whole group gave this strategy a low ranking, in particular the supervisory and workforce levels. Therefore all three levels disagreed that workers in Hong Kong have poor safety awareness resulting in fall accidents.

Overall speaking, the results showed that the supervisory level and the managerial level respondents ranked the strategies in a similar way. Some additional measures suggested by the questionnaire respondents can be found in Appendix 44.

Table 8.5 Ranking of strategies preventing fall from height accidents

Strategies	Overall (All Levels)	Managerial Level	Supervisory Level	Workforce Level
Q55. Poor safety awareness of the workers is the main reason for fall from height accidents.	11	9	11	11
Q56. Practitioners should reconsider whether the current personal protective equipment for workers working at height is suitable and sufficient.	8	6	7	9
Q57. Practitioners should reconsider the current design of the truss-out scaffold supported by steel brackets.	7	8	6	7
Q58. The government should carry out more inspections of workplace in order to reduce fall from height accidents.	5	7	8	2
Q59. For future building designs the designers should consider including facilities to ensure repair and maintenance safety, and hence reducing fall from height accidents.	1	2	2	1
Q60. Future R&M contracts should require the contractor to put aside part of the contract sum for covering any expenses on necessary safety facilities and procedures.	6	10	4	5
Q61. Some effective safety procedures and equipment should be introduced in Hong Kong from overseas.	9	11	9	6
Q62. The government should prosecute and heavily penalise workers performing unsafe acts when working at height.	10	5	10	10
Q63. A registration licensing system for workers working with the truss-out scaffold should be set up to reduce fall from height accidents.	3	4	3	4
Q64. Workers who work externally at height should be provided with specified safety training.	2	1	1	3
Q65. Practitioners ought to highlight and advertise to the public the dangers involved with working at height.	4	3	5	8
Sample size	560	128	178	223

Note: The coloured portion represents the most important strategies preventing fall from height accidents.

8.4 Background of flat owner/tenant questionnaire

Buildings in Hong Kong are ageing and the number of repair and maintenance works in residential units has been increasing over the last decade. In fact, the occupants in the residential units are mostly the initiators for maintenance work, who engage the maintenance contractors to carry out the required works. As a result, such occupants play an important role of construction safety in maintenance works.

In order to investigate the roles of owners and tenants in residential building repair and maintenance works, a set of client questionnaire has been developed in the survey and was divided into three parts: (1) Information of the respondent; (2) Information of the residential building; (3) Conditions of maintenance and Legal responsibilities. The client questionnaire was distributed to different price rankings of residential units in Kowloon, Hong Kong Island and the New Territories recommended by major construction organizations and unions in Hong Kong, including Henderson Land Development Co., Ltd., Hong Kong Construction Industry Employees General Union, Hong Kong Housing Society, Hong Yip Service Company Ltd. and Synergies Management Services Ltd. As a result, 314 valid questionnaires were collected for subsequent data analyses.

8.5 Analysis of flat owner/tenant questionnaire

The quantitative data collected was analysed using the Statistical Package for Social Sciences (SPSS). The techniques that were used, in respect of quantitative data for the flat owner/tenant questionnaire, include descriptive analysis and cross tabulation. The analysis of this questionnaire presented is based on 314 respondents.

8.5.1 Information of the respondent

Of the 314 responses received, half are male (50%) and two-third (66%) are married. Moreover, well over half of the respondents (70%) fall in the range of 25 and 55 years

old (Figure 8.46). Half of them (50%) work as Managers and Professionals, Clerks and Technicians, and Sales and Businessmen (Figure 8.47).

Figure 8.46 Age of respondents

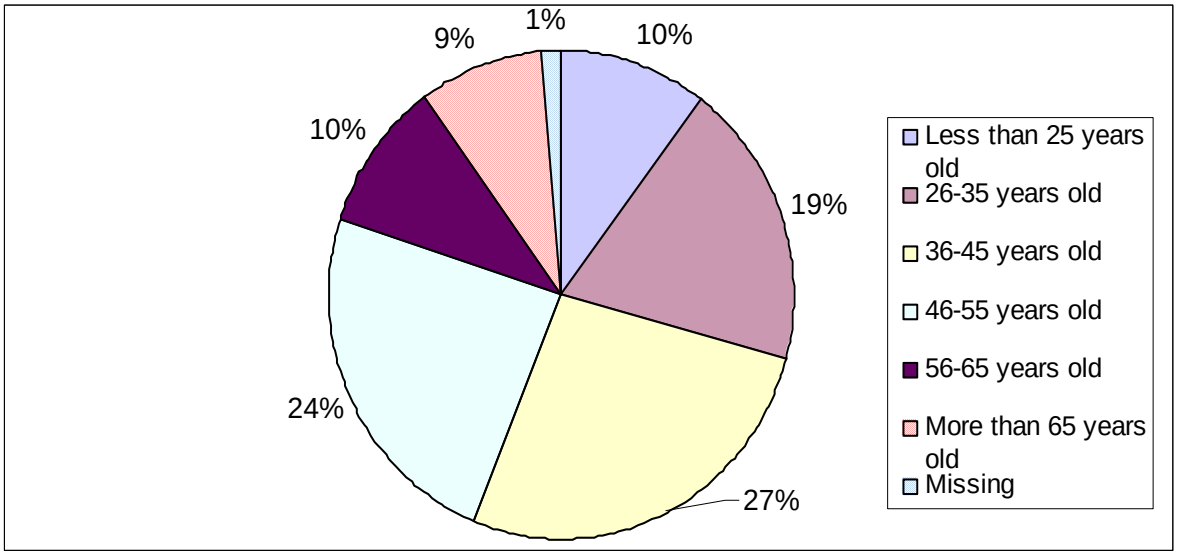
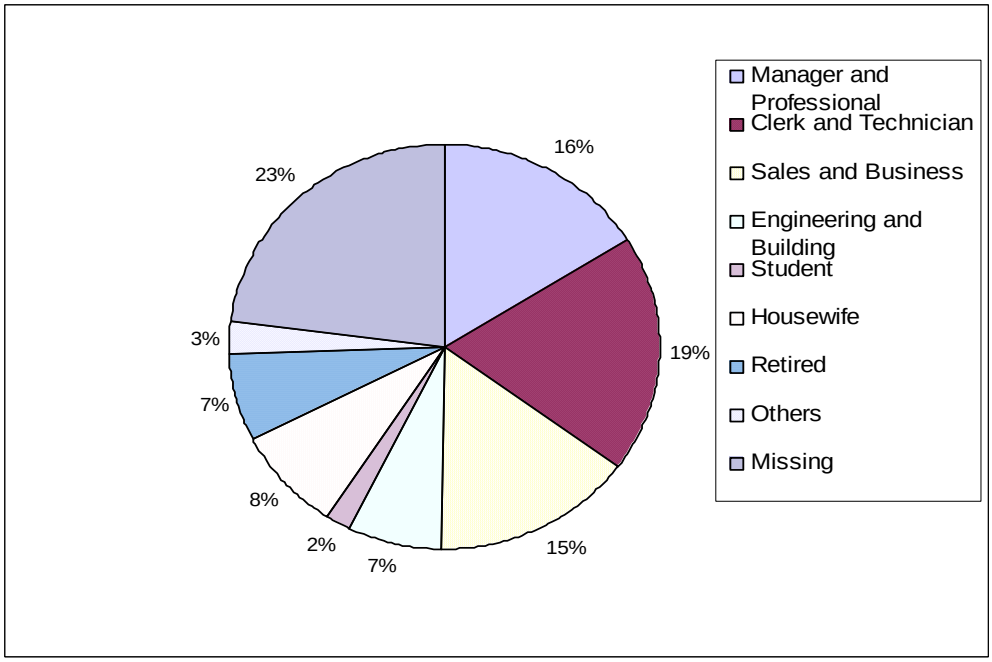
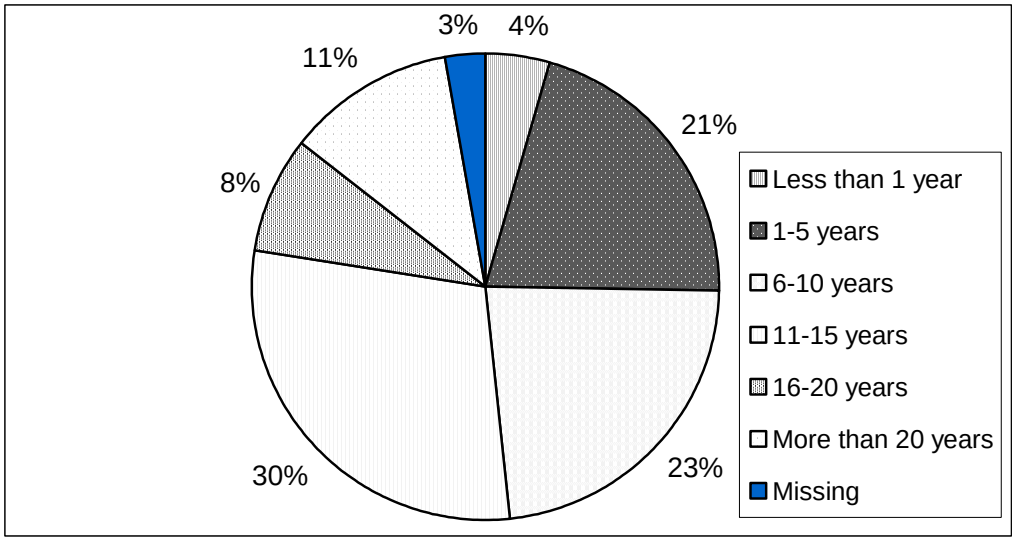


Figure 8.47 Occupation of respondents



While one-third (33%) of the respondents live in Kowloon, nearly half (42%) live in the New Territories and almost one-fourth (24%) of the respondents live on Hong Kong Island. Seventy-two percent of the respondents have been living in their premises for 6 years or more, indicating that they are quite familiar with the surrounding neighbourhood (Figure 8.48).

Figure 8.48 Years of residence of respondents



Nearly half of the respondents (46%) had college, university or above level of education, showing that the respondents are quite highly-educated (Figure 8.49). Over half of the respondents (55%) live with two to three people together and have a total family monthly income ranging from HK$10,000 to 40,000 (57%) (Figure 8.50).

Figure 8.49 Education level of respondents

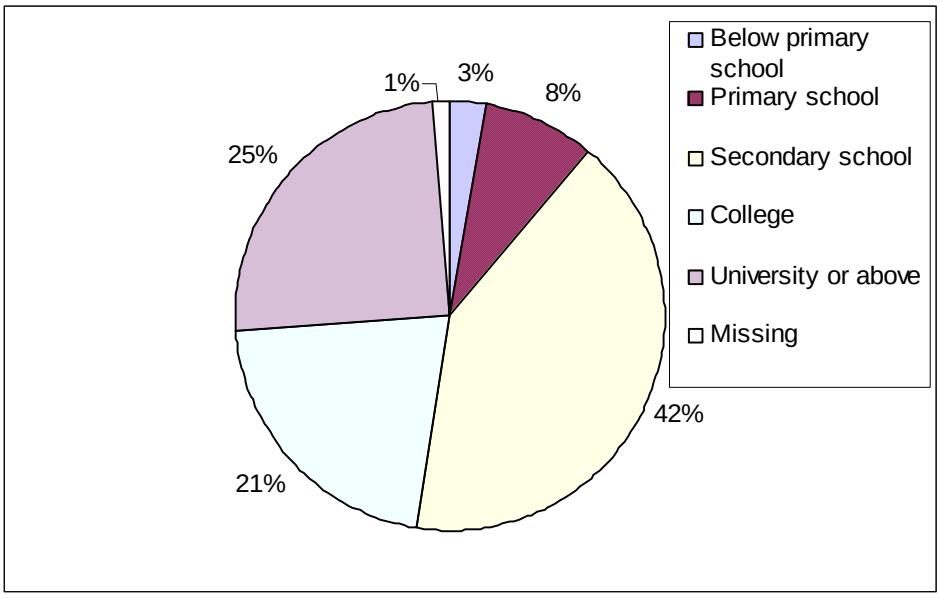
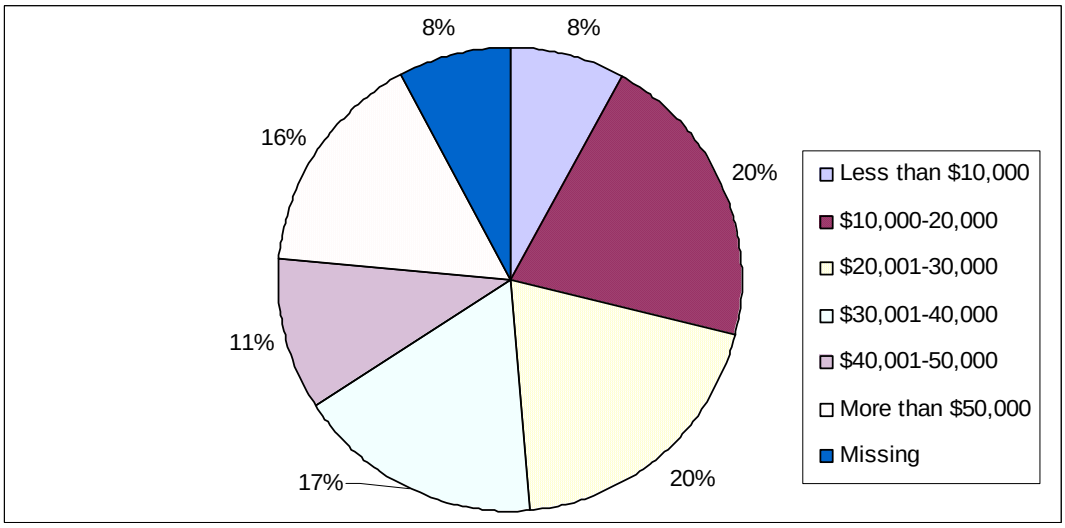


Figure 8.50 Total family monthly income of respondents



8.5.2 Information of the residential building

Of the responses received, half of them (50%) are public and more than half of the occupants (71%) are owners. While one-third of the respondents (33%) live below 10 floors, more than half (55%) live between 11 and 30 floors (Figure 8.51). Moreover,

nearly half of the respondents (49%) maintain their buildings by service of project management company (Figure 8.52).

Figure 8.51 The floor level on which respondents are living

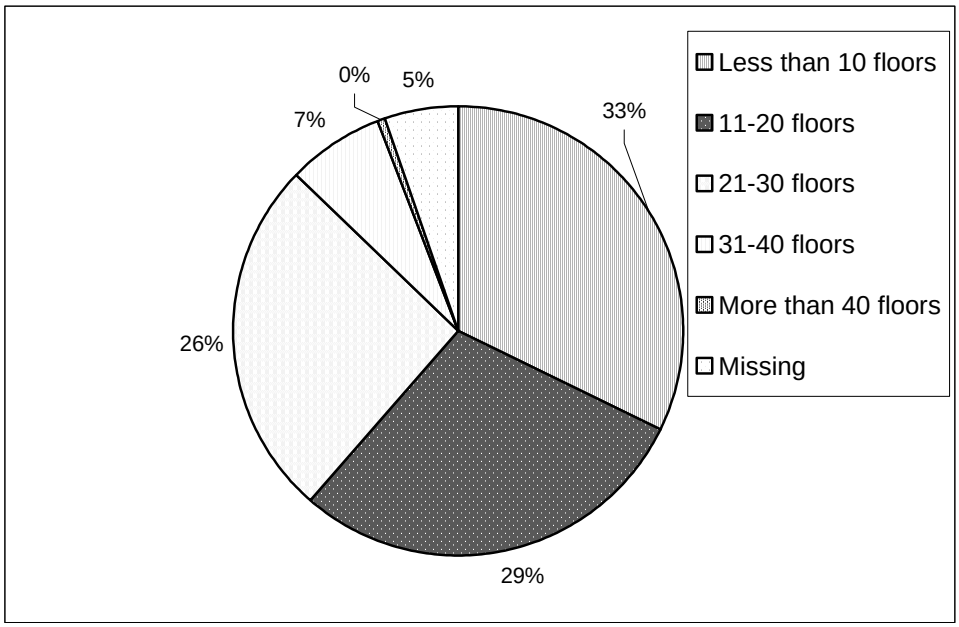
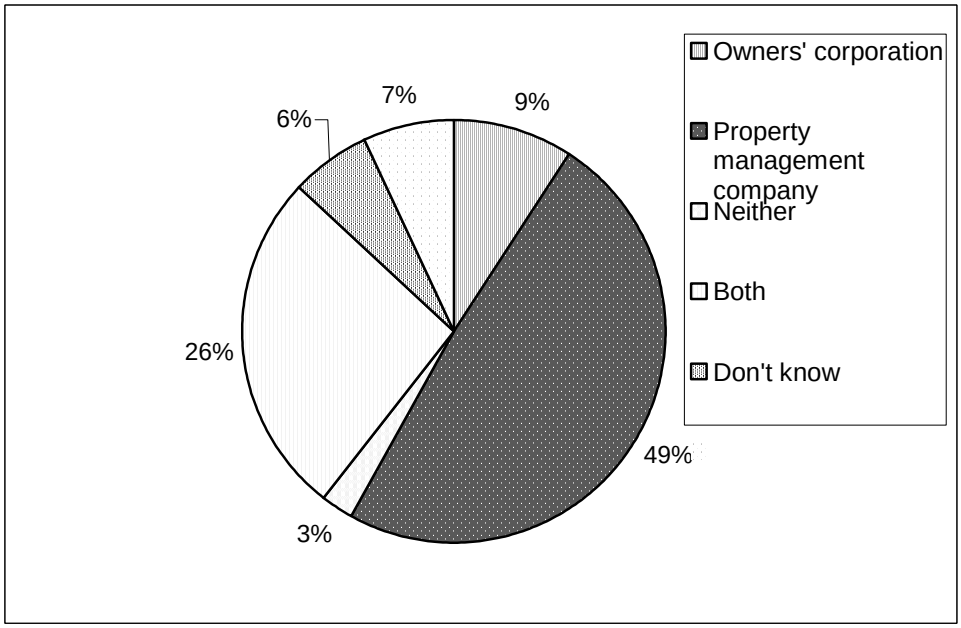
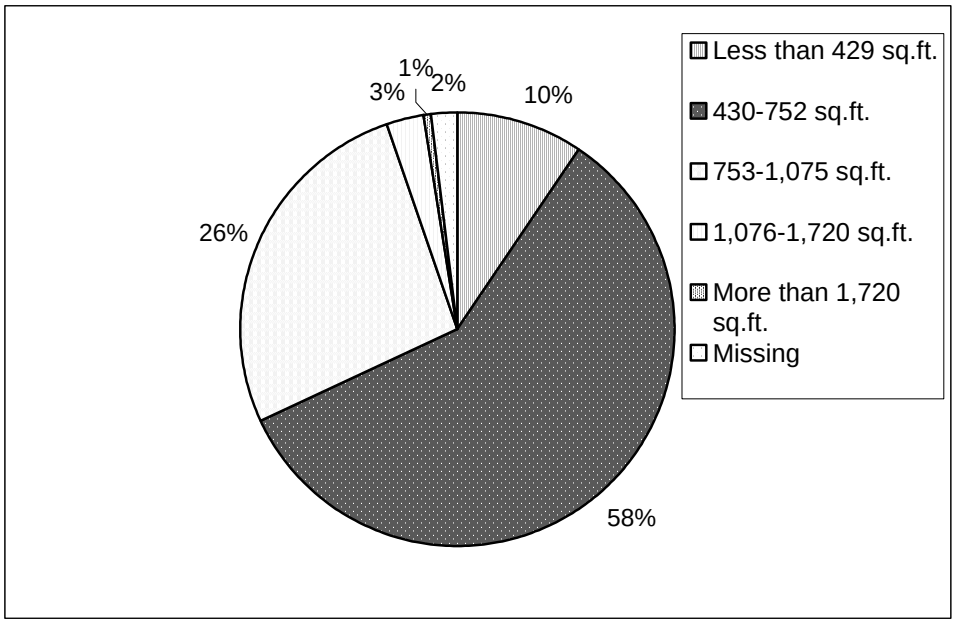


Figure 8.52 Mode of property management



Concerning the features of the buildings in the survey, well over half of them (72%) have floors between 21 and 40, and the flats of most respondents (84%) are of medium-size (Figure 8.53).

Figure 8.53 Construction floor area of respondents' residential flats (in square feet)



To determine whether there is any association between the type of building and the mode of property management, the technique of cross-tabulations was undertaken and the results are shown as Table 8.6 and Appendix 45.

Table 8.6 Cross tabs between type of building and mode of property management

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	53.964	4	.000
N of Valid Cases	284		

The result of cross-tabulations is significant at .000 significance level. Therefore, there is association between the type of building and the mode of property management. In fact, most private residential buildings have owners' corporation. In case of large private

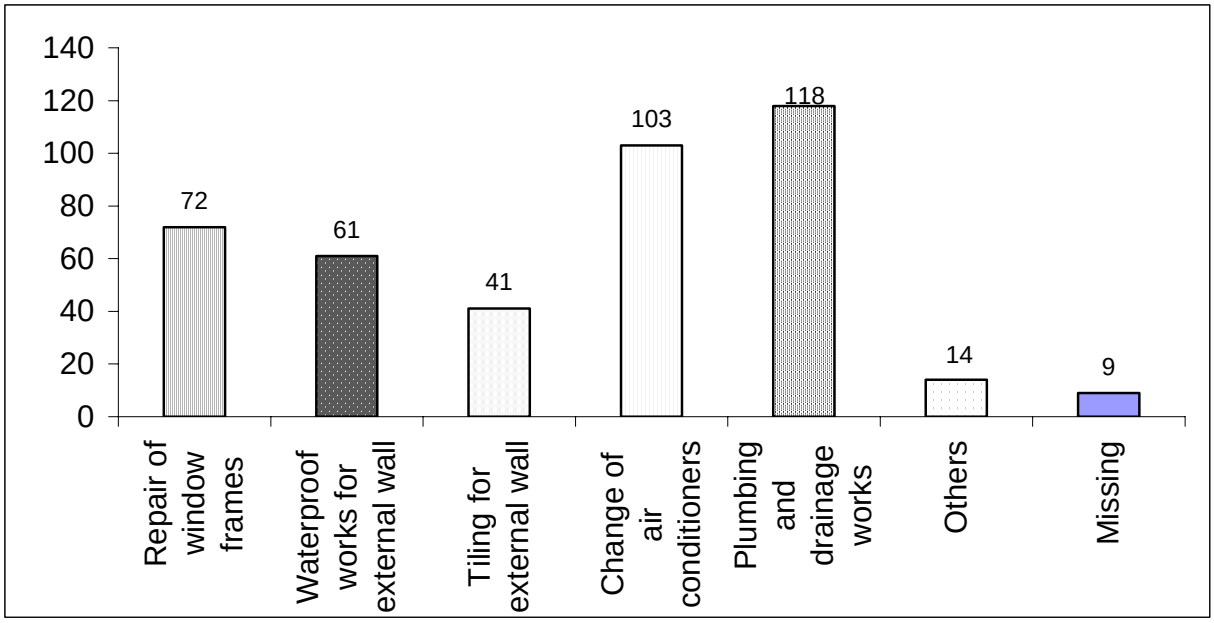
residential estates, maintenance will be served by property management companies. Recently, the maintenance of some public residential housing estates has been outsourced to property management companies for better quality standard.

8.5.3 Conditions of maintenance and legal responsibilities

As time goes by, buildings become ageing and occupants have to take care of their buildings in order to ensure the functionality of the flat area. When compared with the small-scale maintenance contractors, the performance of the large-scale maintenance contractors is considered as more satisfactory in terms of construction safety probably because of more resources invested in safety management and higher commitment of the company towards safety. Still, some private owners engage the small-scale contractors in the maintenance works. Such small-scale maintenance companies sometimes employ unregistered or illegal front-line workers to carry out the maintenance works. In fact, owners should employ the qualified workers for their maintenance works. They will be held liable for the consequences in case accidents occur.

In view of understanding the awareness of occupants on their important role of construction safety in maintenance works, the third section was constructed in order to investigate the general knowledge of occupants on maintaining residential buildings. The respondents were firstly asked if they had undertaken any repair works in their flats over the past five years and the types of repair works (Figure 8.54).

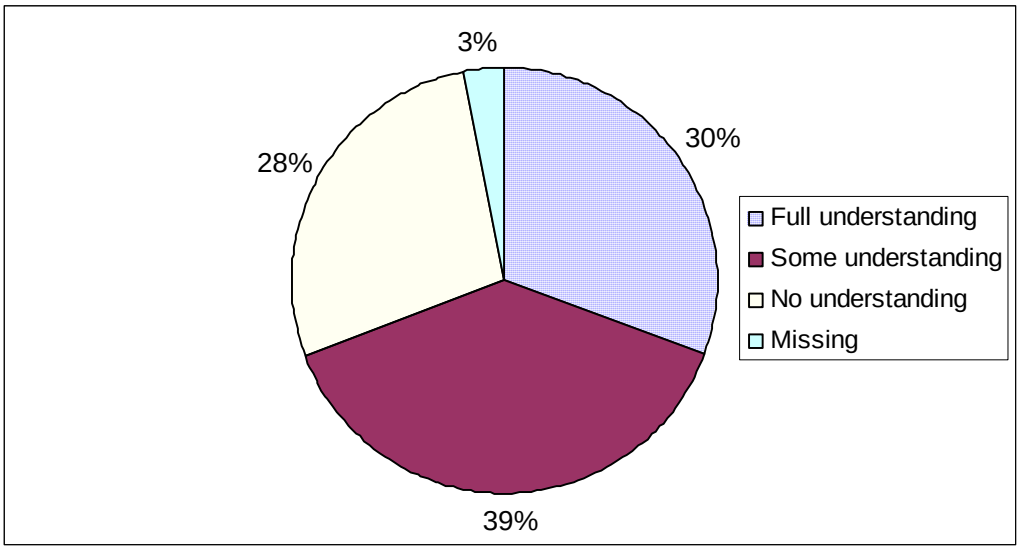
Figure 8.54 Types of repair works undertaken in the flat over the past five years



Most respondents undertook repair works in the change of air conditioners, and plumbing and drainage works. In order to provide a recent phenomenon of maintenance practice in Hong Kong, only those respondents with experience of undertaking repair works in their flats over the past five years will be further invited to answer the rest of the questions. When undertaking the repair works, almost all respondents (93%) replied that no accidents had occurred. Since there was no reply saying that accidents did occur in undertaking the repair works, the analyses on the level of injury and the need for the respondent to take responsibility for this accident cannot be done.

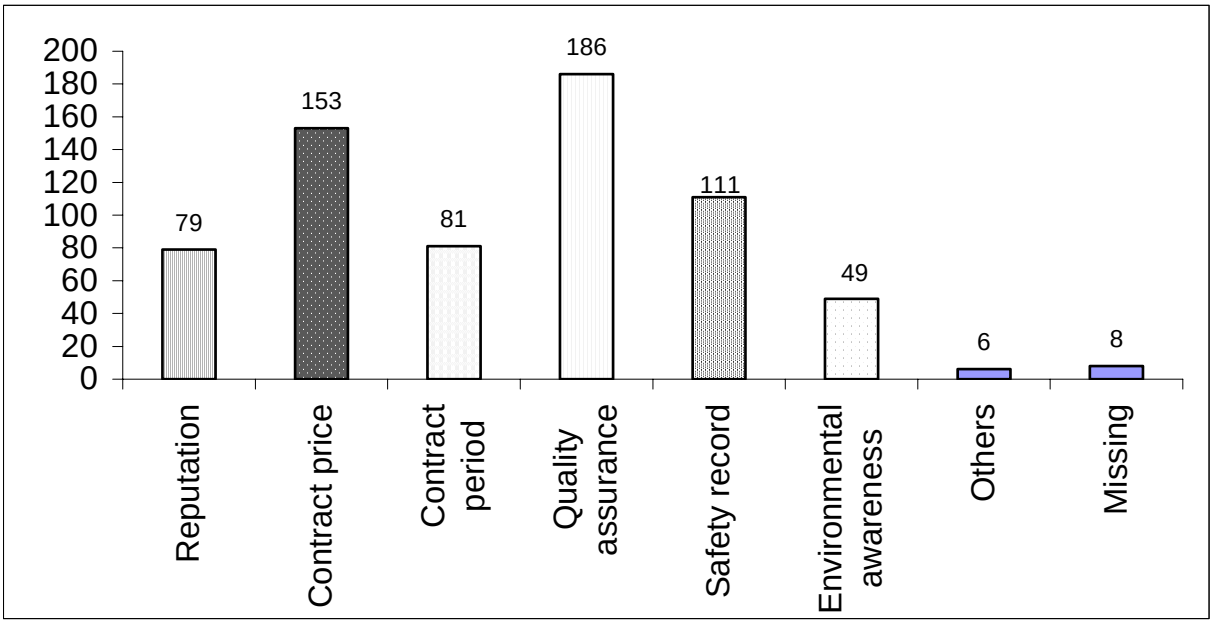
When the respondents were asked about their clarity about the legal responsibilities that a flat owner / tenant must take in relation to building repair works, the results are three-fold; only one-third (30%) of the respondents had full understanding while nearly one-third (28%) respondents did not have such understanding at all (Figure 8.55). Therefore, the concerned parties such as the government and the mass media should disseminate the messages to the occupants more clearly and comprehensively.

Figure 8.55 Clarity about the legal responsibilities that a flat owner / tenant must take in relation to building repair works



Similar to select a suitable contractor for a construction project, the next question requests the respondents to make their choice over a series of factors for selecting maintenance contractors (Figure 8.56)

Figure 8.56 Factors under consideration when selecting a repair works contractor



It is not surprising to note that most respondents selected the repairs contractors based on their quality assurance and contract price. It is clear that if there are quality problems in the maintenance works, the owners will be suffered in terms of time and cost. It is encouraging to see that more respondents preferred the factor of quality to price and price is no longer the top influential factor. Still, the factor of price has been another major factor that respondents selected for repairs contractors. Moreover, the factor of safety record of repairs contractors has been the third important factor for respondents to consider, which implies that the respondents were aware of the importance of construction safety in carrying out the maintenance works. Therefore, they expected their maintenance contractors to have proper safety record in previous working experience in order to reduce the likelihood of accidents.

In order to further examine the insurance issue in maintenance works, respondents were asked whether they were sure that the repair works contractor had purchased insurance for the job. Sadly to say, more than half (61%) respondents were not sure about the purchase of insurance by the repair works contractors (Figure 8.57). Moreover, well over

half (74%) of the respondents did not purchase insurance for the repair works (Figure 8.58). Some of them believe that the repair works are of small size while others thought that the purchase of insurance should be the responsibility of the contractor, the project management or the government. As a result, over half of the respondents (53%) did not request the repair works contractor to purchase insurance for the job (Figure 8.59). Again, the concerned parties should publicize the importance of purchasing insurance for maintenance works regardless of size in order to increase the awareness of the occupants on proper implementation of the repair works.

Figure 8.57 Knowledge of respondents on the purchase of insurance by repair works contractors

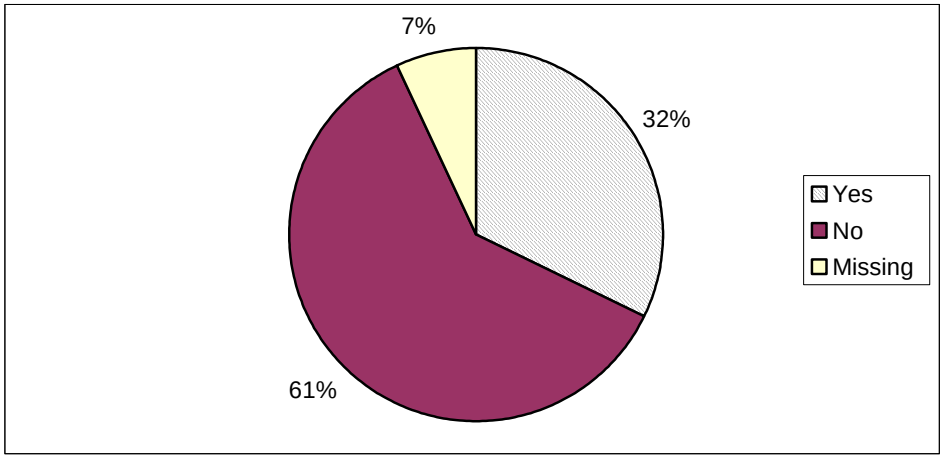


Figure 8.58 Respondents' purchase of insurance for the repair works

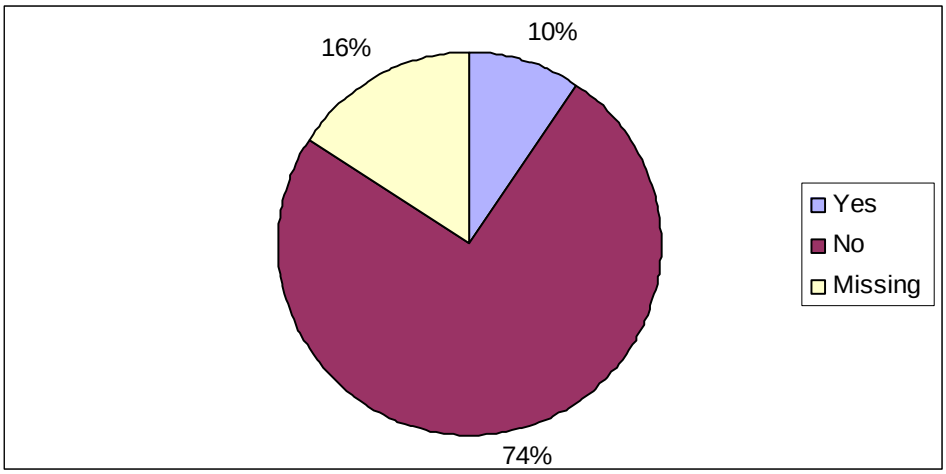
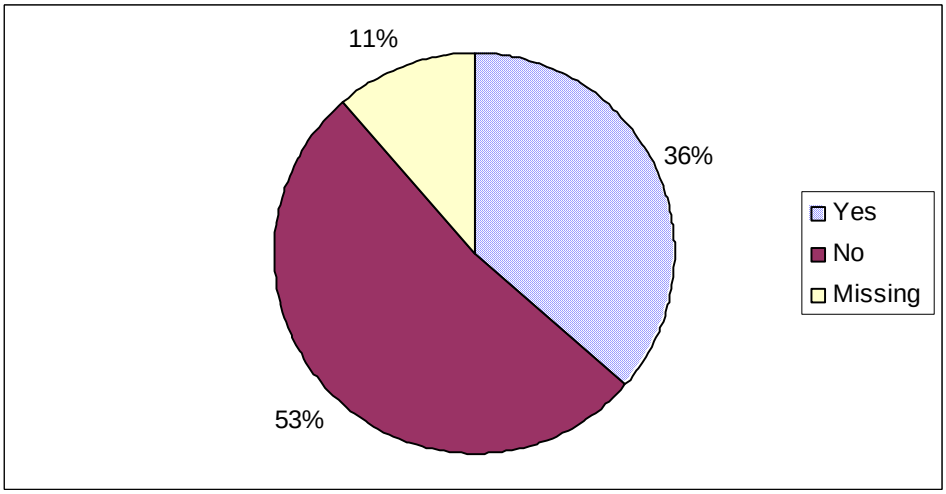


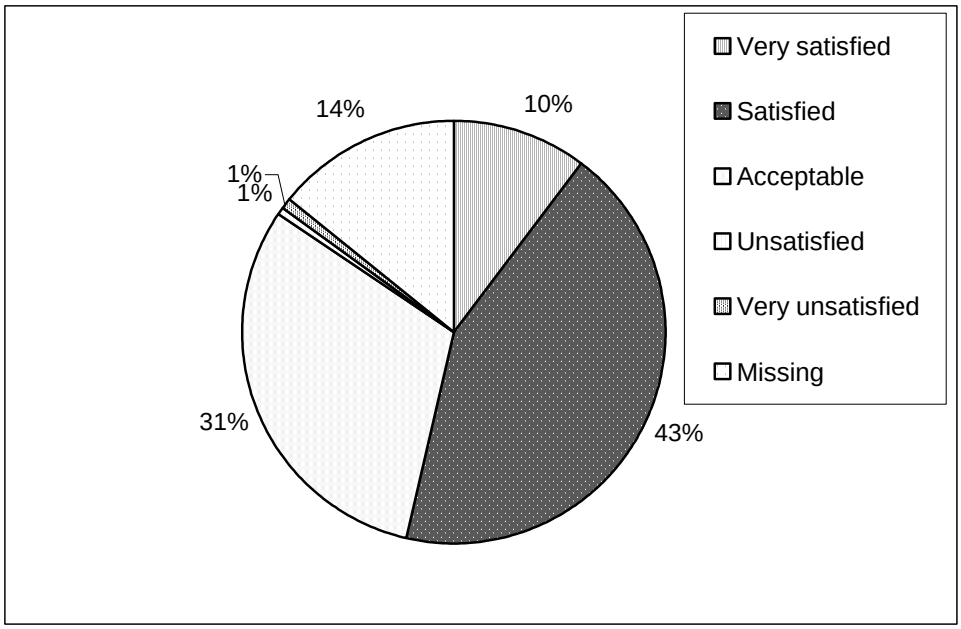
Figure 8.59 Respondents' request on purchasing insurance by repairs work contractors



With the increasing number of ageing buildings in Hong Kong, the property management service has flourished to provide management service for occupants on maintaining their flat area. The respondents were requested to advise whether the property management company provided any information about residential repair works. More than half respondents (57%) advised that they had received information about residential repair works from property management companies, such as notice on windows and water pipes, and cleaning schedules. Among the respondents with information about residential repair

works, more than half (53%) were satisfied or very satisfied with the information provided by the property management company (Figure 8.60).

Figure 8.60 Satisfaction level towards the information about residential repair works



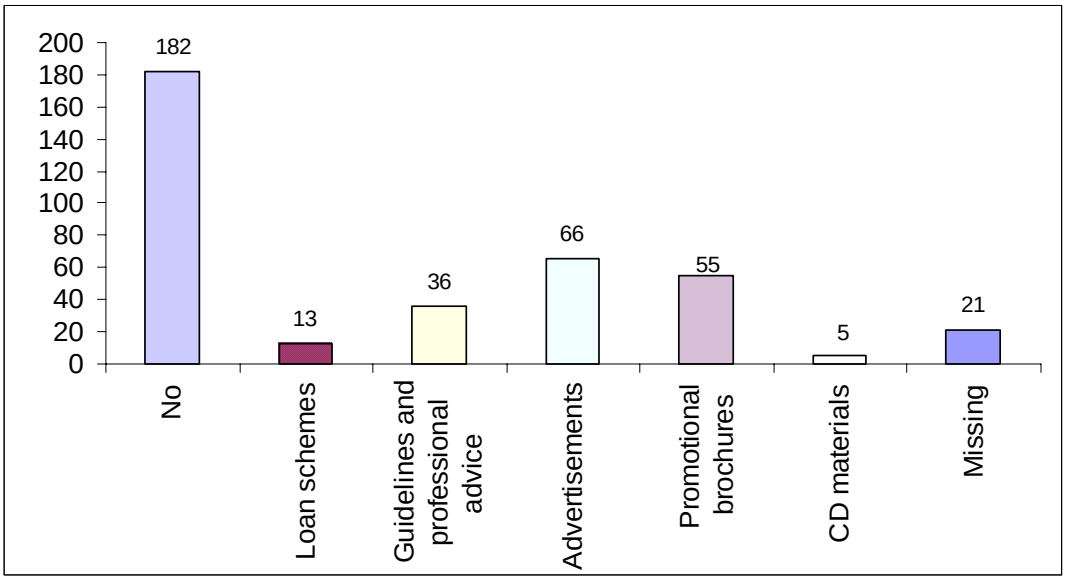
To determine whether there is any association between the type of building and the provision of information about residential repair works by property management companies, the technique of cross-tabulations was undertaken and the results are shown as Table 8.7 and Appendix 46.

Table 8.7 Cross tabs between type of building and provision of information about residential repair works

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	33.010	2	.000
N of Valid Cases	193		

The result of cross-tabulations is significant at .000 significance level. Therefore, there is association between the type of building and the provision of information about residential repair works by property management companies. In fact, the government has offered a range of service and information about residential repair works to both owners and tenants. Hence, the respondents were asked to indicate what kind of assistance they received from the government (Figure 8.61).

Figure 8.61 Frequencies of aids received by flat owners / tenants to carry out their repair works from the government



Of the respondents having received assistance from the government, advertisements and promotional brochures were the most frequently used aids. It is common for the occupants to get information from the mass media, their residential estates and local district offices. Some respondents also obtained guidelines and professional advice for their residential repair works from the government in carrying out maintenance works properly. Figure 8.62 shows the level of satisfaction of the respondents towards the aids provided by the government and over half of them (60%) were satisfied with the provision. However, the view of respondents on the government's promotion on construction safety of building repair and maintenance was rather negative with more

than half respondents (74%) felt it was only acceptable or insufficient (Figure 8.63). Therefore, the government should place more resources on promoting construction safety of building repair and maintenance through seminars, mass media or collaboration with the research community.

Figure 8.62 Satisfaction level of respondents towards the aids for residential repair works

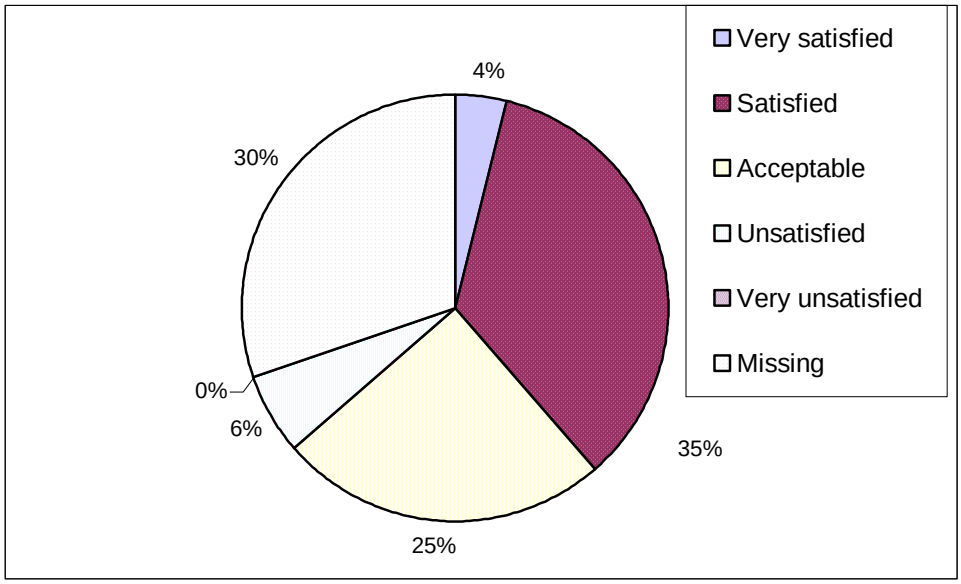
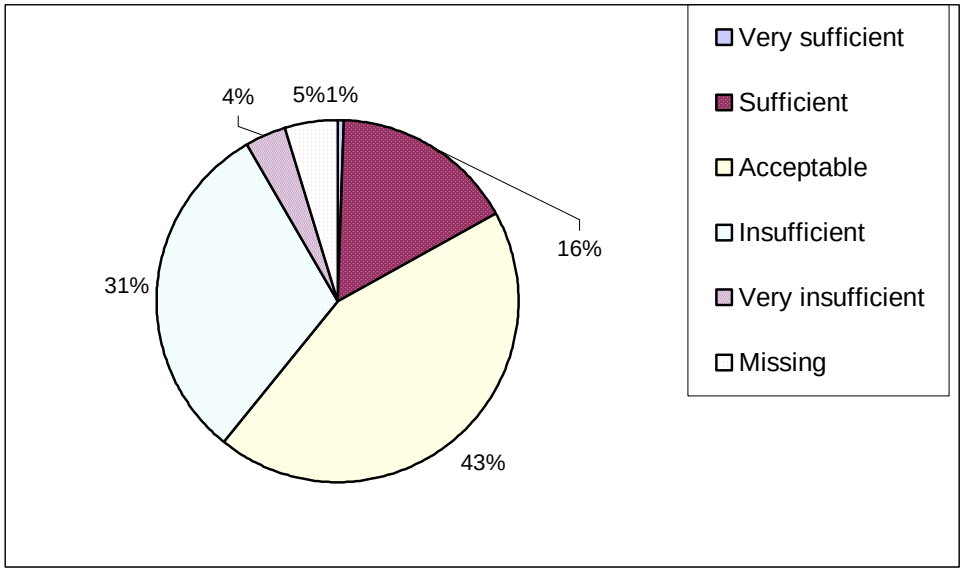


Figure 8.63 Sufficiency of the government's promotion on construction safety of building repair and maintenance



8.6 Summary

The questionnaire surveys were useful in providing quantitative data for statistical analysis to validate the findings collected from other sources, such as literature review, focus group meetings and interview surveys. The findings from the questionnaire survey are more representative due to the larger sample size.

A number of valuable findings can be concluded from the analysis of the industry based questionnaire and the flat owner/tenant questionnaire and these are shown in Tables 8.8 and 8.9 respectively.

Table 8.8 Summary of the main findings from the industry based questionnaire

Section of questionnaire	Main findings
II. Safety Education and Training	• Most respondents felt that training workshop best met their job requirement and were willing to participate in safety training. • Most respondents agreed that the green card safety training course ought to educate workers on how to use personal protective equipment correctly and how to locate a suitable anchor point for safety belt. • Most respondents felt that it is necessary to have specific training courses relating to the truss-out scaffold, for workers who undertake external works at height and for repair and maintenance works. • Most respondents felt that there is a need to improve the current design of the personal protective equipment and that they do know how to use personal protective equipment. • Most respondents agreed that most buildings are not designed with an anchor point for safety belt.
III. Accidents Related to Repair and Maintenance	• Increased experience in the construction industry decreases the likelihood of accidents, whereas increased experience in repair and maintenance works does not decrease the likelihood of injury during working at height. • Increased age decreases the likelihood of being injured during work but not necessarily during working at height. • The last time the respondents participated in safety training courses showed no relationship towards the likelihood of accidents in both their work and during working at height. • Most respondents agreed that accidents in repair and maintenance works are always reported. • Workers with accident experience are more careful about their daily operation to protect themselves from taking risks at work. • It is desirable that both groups of workers, with or without accident experience, should be attentive to construction safety at work by means of education and training.
IV. Safety Messages	• Half of the respondents had noticed safety messages advertised and 40% believed that they were effective. • 40% of respondents believed that there were not enough safety guidelines relating to working at height.
V. Safety Attitude of Repair & Maintenance Workers	• Of the thirteen safety climate statements, it was observed that there is significant difference in the response of workers with accident records and those without accident experience with respect to four statements Questions 45, 46, 49 & 51 (Note: Q45 ‘There is nothing I can do to further improve safety and health here’; Q46 ‘People who work here sometimes take risks at work which I would not take myself’; Q49 ‘I am worried about my job security’; and Q51 ‘Accidents which happen here are always reported’)
VI. Legislation & Responsibility	• Most respondents agreed that the government ought to enhance legislations relating to construction safety involving working at height and ought to issue work licenses to those workers involved in the installation of truss-out scaffolds.
VII. Practical Solutions to Reduce Fall of Person from Height	• The top three most favored strategies for preventing fall from height accidents were 1) For future building designs the designers should consider including facilities to ensure repair and maintenance safety, and hence reducing fall from height accidents; 2) Workers who work externally at height should be provided with specified safety training; and 3) A registration licensing system for workers working with the truss-out scaffold should be set up to reduce fall from height accidents.

Table 8.9 Summary of the main findings from the flat owner/tenant questionnaire

Section of questionnaire	Main findings
III. Conditions of main and legal responsibilities	• Most respondents undertook repair works in the change of air conditioners, and plumbing and drainage works. • When undertaking the repair works, no accidents had occurred. • One-third of the respondents did not have understanding about their clarity about the legal responsibilities that a flat owner / tenant must take in relation to building repair works. Therefore, the concerned parties such as the government and the mass media should disseminate the message to the occupants more clearly and comprehensively. • Most respondents selected the repairs contractors based on their quality assurance and contract price. • More than half respondents were not sure about the purchase of insurance by the repair works contractors. Moreover, well over half of the respondents did not purchase insurance for the repair works. Again, the concerned parties should publicize the importance of purchasing insurance for maintenance works regardless of size in order to increase the awareness of the occupants on proper implementation of the repair works. • More than half respondents advised that they had received information about residential repair works from property management companies. • Of the respondents having received assistance from the government, advertisements and promotional brochures were the most frequently used aids. • The view of respondents on the government's promotion on construction safety of building repair and maintenance was rather negative. Therefore, the government should place more resources on promoting construction safety of building repair and maintenance through seminars, mass media or collaboration with the research community.

Chapter 9

CONCLUSION AND RECOMMENDATIONS

Chapter 9 Conclusion and Recommendations

9.1 Introduction

A distinctive characteristic of Hong Kong is the large number of high-rise buildings. Many of these buildings in the old districts are crying out for maintenance works due to dilapidation. The number of fall accidents that have resulted from residential building repair and maintenance works has drawn particular attention to the general public. The overall accident rate in Hong Kong has decreased significantly over the past few years, but unfortunately the number of fall accidents particularly in building repair and maintenance has remained high. Therefore, this timely study has combined the use of quantitative and qualitative research methods to seek solutions in reducing fall from height accidents in residential building repair and maintenance works.

9.2 Review of project objectives

The aim of this project was to improve construction safety involving working at height for residential building repair, retrofitting and maintenance works. It set out to identify situations where such works are necessary and investigated the causes of associated accidents and problems. The objectives of the study were:

- To conduct a full scale investigation to identify situations where working at height are necessary in residential building repair and maintenance and to establish data on the scale of their significance in quantitative terms;
- To investigate the causes of these accidents;
- To recommend practical, cost-effective and user-friendly technological solutions to tackle the problem;
- To recommend precautionary measures so as to prevent the occurrence of the problem;

- To propose a viable regulatory framework to address the legal, economic, and social aspects of the problem.

9.3 Major Findings

Statistical data showed that the figures on accident rates in the Hong Kong construction industry have been decreasing drastically since 2000. The accident rate per 1000 workers fell from 150 in 2000 to 60 in 2004. This encouraging improvement has demonstrated that Hong Kong has an excellent performance in construction safety (refer to p.80).

But unfortunately the figures of fall of person from height accidents have remained high. During 2000-2004, fall of person from height was the top killer in repair and maintenance works (refer to p.83). In addition, fall of person from height represented almost half of the total number of fatal accidents in repair and maintenance works during these five years (refer to p.83-84).

The statistical data supports the need for the current study. The objectives were achieved using a combination of qualitative and quantitative research techniques. The following section explains in detail how and what each of the five objectives was achieved.

9.3.1 Achievement of objective 1

Objective 1 - To conduct a full scale investigation to identify situations where working at height is necessary in residential building repair and maintenance and to establish data on the scale of their significance in quantitative terms

Objective 1 was achieved via a combination of the literature review, the analysis of the accident statistics and the twenty-two fatal case studies provided by the Labour Department.

The literature review identified the construction industry as one of the most hazardous industries internationally. Falls from height in construction projects are a major source of accidents and the prevention of accidents involving falls from height remains a high priority for the construction industry (Glasgow Caledonian University, 2005 - refer to p.7).

The statistical data and the case studies showed when and where fall from height accidents occurred in building repair and maintenance works. The findings also identified situations where working at height is necessary in residential building repair and maintenance. It is likely that fall from height accidents occurring in situations where working at height is more common.

The analysis of the Architectural Services Department statistical data reflected that the works 'Painting' and 'Electrical wiring' were the most frequent works undertaken when fall accidents occurred (these statistics hold limitations as they were limited to a proportion of public works and they were mainly a result of the use of ladders, hence the case studies would be more representative in identify situations where fall took place - refer to p.78). These findings were confirmed by the participants of the focus group meeting with construction workers. The participants explained that working at height is often required on the exterior wall of buildings to perform chores such as pipe changing; tile repairing; painting and repairing of air conditioner units (refer to p.150).

The most common place of fall identified by the analysis of the twenty-two case studies provided by the Labour Department was the bamboo scaffold (refer to p.110-111). The category bamboo scaffold also includes the bamboo truss-out scaffold which represented four of the twenty-two case studies analysed. The bamboo truss-out scaffold has recently received much media attention due to the increasing number of fatal accidents as a result of fall. Often it is during the installation or dismantling of the bamboo truss-out scaffold that the accidents occurred. This shows that the structural stability of the

bamboo truss-out scaffold does not appear to be the main cause, but instead it is the procedure of assembly that warrants attention.

9.3.2 Achievement of objective 2

Objective 2 - To investigate the causes of these accidents

Objective 2 was achieved via a combination of the literature review, the analysis of the accident statistics, the twenty-two fatal case studies, the interviews and the focus group meetings.

The literature review identified that the major causes of fall accidents were unsafe conditions, management inactions and human related factors (refer to p.8).

Statistics of the Architectural Services Department showed that 'Fatigue/Exhaustion' was identified as the most influential personal factor of fall accidents, which accounted for one-third of fall injuries (refer to p.71-72). On the other hand, the most unsafe action related to fall injuries was ' Adopting unsafe position or posture' which accounted for nearly half of the accidents (refer to p.72-73). Finally 'Unsafe process or job methods' was the most unsafe condition in fall injuries, which accounted for one-third of the accidents (refer to p.73-74).

Statistics of the Labour Department showed that fatal accidents involving employers, self employed or illegal workers represented up to two-thirds of the total fatal accidents that occurred in repair and maintenance works (refer to p.87-89). The findings reveal that these groups of people are very much prone to accidents and that more precautions should be carried out to prevent these accidents. It is likely that employers and the self-employed take more risks to complete projects faster and they sacrifice safety precautions in order to increase profits. In addition, their safety knowledge and safety equipment is often less sufficient when compared to contractors who employ people with safety

expertise to supervise, monitor and design the works. For illegal workers it is likely that they possess little or no knowledge in construction safety as they probably have not worked in the same industry before arriving in Hong Kong. In addition, safety standards vary from countries to countries, so the same level of safety may not be acceptable in Hong Kong. Workers that work illegally often live in unstable conditions and lack money, resulting in being willing to work for low wages. At very low wages it is likely that safety measures cannot be included.

The analysis of the twenty-two case studies provided by the Labour Department indicated that the top three unsafe conditions/actions were all related to the equipment (refer to p.112-113). Eight of the cases were a result of the equipment provided by the contractor being unsafe. Provision of safe equipment and proper maintenance are essential in accident prevention. Failure to use safety equipment resulted in six of the fatal accidents. And using the equipment unsafely accounted for four of the fatal accidents.

The interviewees of this study were asked 'What do you think are the root causes of accidents in residential building repair and maintenance works?' The findings show that poor safety attitude, low safety awareness or lack of safety knowledge was the root cause of accidents in building repair and maintenance works (refer to p.136-137). Personal protective equipment used incorrectly, not used or not supplied was the second highest root cause of accidents in building repair and maintenance works. Some of the other causes included improper use or lack of maintenance of equipment, the employment of illegal workers and lack of standards and guidelines relating to the installation of the bamboo truss-out scaffold.

In the focus group meetings, one of the main causes of accidents identified was the tradition of 'the lowest bidder gets the job'. Many of the focus group participants felt that this tradition often means that safety is often compromised to reduce costs. The impractical low contract prices are often insufficient to provide for safety (refer to p.159).

9.3.3 Achievement of objective 3

Objective 3 - To recommend practical, cost-effective and user-friendly technological solutions to tackle the problem

Objective 3 was achieved via a combination of the literature review, the analysis of the questionnaires, the twenty-two fatal case studies, the interviews and the focus group meetings.

Readily available technologies identified via the literature review included the above-fixing clamps, portable clamps incorporated into a lanyard, inertia reels/blocks, advanced guardrails and pole systems (Glasgow Caledonian University, 2005 - refer to p.17).

The respondents of the questionnaire were asked to recommend solutions to fall from height accidents in repair and maintenance works. The technological solutions recommended include the working platform, lifting appliances, scaffolding towers etc. (refer to Appendix 44).

As mentioned previously the bamboo truss-out scaffold was regarded as one of the major causes of fall accidents in repair and maintenance works (refer to p.110). The problems related to construction procedure and lack of standards have suggested that the design of the bamboo truss-out scaffold should be redesigned to be safe or even replaced. To address the problems associated with the truss-out scaffold, a temporary working platform was designed as an alternative (refer to p.60-62). The design being developed by the Research Team can provide a rapid and demountable temporary working platform for inspection, repair and maintenance works on external wall of buildings. In addition, the design has already secured a patent application number from the Patent Office of the People's Republic of China.

The interviewees were asked in the interview 'What do you think are the cost-effective and user-friendly technological solutions?' A number of different suggestions were proposed; some of these are readily available including scaffolding towers, fall arrest systems, hydraulic platforms, lifting appliances etc. Whereas some of these are self inventions including the Safety Railing Cart of Synergis Holdings Limited and the patented Climbing Scaffold of Wui Loong Scaffolding Works Limited Company (refer to p.132-133 and 135 respectively).

The participants of the focus group meetings were also asked to recommend technological solutions to prevent fall from height. The solutions recommended were measures that are readily available including working platforms, gondolas and aluminum and metal scaffolding (refer to p.160).

9.3.4 Achievement of objective 4

Objective 4 - To recommend precautionary measures so as to prevent the occurrence of the problem

Objective 4 was achieved via a combination of the literature review, the analysis of the questionnaires, the interviews and the focus group meetings.

The literature review identified that practical solutions to fall accidents include the use of new technologies and techniques, effective safety management system and concerted efforts of construction personnel (refer to p.17).

The findings from the industry based questionnaire indicated that the top three most favoured strategies for preventing fall from height accidents were: (1) For future building designs the designers should consider including facilities to ensure repair and maintenance safety, and hence reducing fall from height accidents; (2) Workers who work externally at height should be provided with specified safety training; and (3) A

registration licensing system for workers working with the truss-out scaffold should be set up to reduce fall from height accidents (refer to p.213).

The interviewees were asked in the interviews 'Can you suggest some measures to reduce fall related construction accidents for repair and maintenance works?' The most frequent measure suggested was a registration or licensing system for minor works or constructing bamboo truss-out scaffolds, which was suggested by five interviewees. Five of the interviewees believed that fall accidents could be reduced by continuous monitoring and frequent inspection. Whereas two of the interviewees believed that safety should be incorporated at the design stage of buildings (refer to p.137).

The findings from the focus group meetings found that training and education for workers, contractors and individual flat owners/tenants was believed to be important. Safety messages advertising the liability of flat owners/tenants were also often suggested. In addition incentive schemes should be introduced to encourage workers to utilize safety measures (refer to 159-160).

9.3.5 Achievement of objective 5

Objective 5 - To propose a viable regulatory framework to address the legal, economic, and social aspects of the problem

Objective 5 was achieved via a combination of the literature review, the analysis of the questionnaires, the twenty-two fatal case studies, the interviews and the focus group meetings.

The literature review shows that in fact there are related controls governing construction safety in general. However, the unique nature of building repair and maintenance works such as small-scale and short duration should deserve more attention. Therefore, more

effort should be put to rectify the situation, particularly in the area of building repair and maintenance involving working at height (refer to p.32).

The industry based questionnaire asked the respondents to rank how important is Q58 'Should the government carry out more inspections of workplace in order to reduce fall from height accidents'. The results show that the workforce level was highly supportive of this strategy, whereas the managerial level and the supervisory level were not. The difference in their opinions was also quite large. Currently, it is the employer or the contractor who is penalized for unsafe acts on construction sites and not the workers themselves. The managerial and supervisory level respondents may consider this as an additional burden from their perspective (refer to p.210).

The respondents of the industry based questionnaire were also asked Q62 'Should the government prosecute and heavily penalise workers performing unsafe acts when working at height'. Unsurprisingly the workforce level was not too excited with this idea. The supervisory level also ranked this strategy the same as the workforce level. Whereas the managerial level was a lot more supportive towards this strategy as they might not need to be fined to the same extent for the workers' unsafe acts like they have to under the present system (refer to p.212).

In the flat owner/tenant questionnaire survey, one-third of the respondents (flat owner / tenant) were not clear of their legal responsibilities in relation to building repair works (refer to p.221-222).

More than half of the respondents from the flat owner/tenant questionnaire survey were not sure about the purchase of insurance by the repair works contractors. Moreover, well over half of the respondents did not purchase insurance for the repair works (refer to p.223-224).

The view of flat owner/tenant questionnaire survey respondents on the government's promotion on construction safety of building repair and maintenance was rather negative (refer to p.225-226).

As a result of the analysis of the case studies, increasing monitoring and inspection was believed to be highly important to uplift safety awareness of workers (refer to p.119).

In the structured interview survey, the interviewees generally believed that the existing statutory controls are sufficient. Whereas in the interview conducted with the Legislative Councilor The Honourable Chan Wai-Yip, his opinions towards the current statutory controls for repair and maintenance works were quite different. He believes that there has been enough and effective statutory controls for new construction works whereas insufficient if not no statutory control exercised on residential building repair and maintenance projects, particularly for working at height. In addition, before any new legislation can be imposed for working at height, the term “minor works” must first be defined (refer to p.133).

The respondents of the focus group meetings also shared similar views. In general, the participants felt that legislative controls were insufficient and unclear, but few of the respondents presented ideas on how legislation can be improved. Some suggested developing a mandatory licensing system for repair and maintenance workers (refer to p.160).

9.4 Recommendations for improvement

This section presents some key recommendations as a result of the findings from this project.

9.4.1 General recommendations

1. Increase safety education and training for workers performing external repair and maintenance works at height via workshops.
2. To refine the design of the truss-out scaffold to make it more reliable or to replace it with an alternative that is readily available in the market or by a new invention.
3. Continuous training for workers to improve their safety attitude and hence reducing the occurrence of unsafe acts or procedures.

9.4.2 Recommendations to prevent the causes of fall accidents

1. Impose a maximum number of work hours which workers must not exceed, so as to eliminate accidents as a result of fatigue and exhaustion. In addition, monitor and inspect that employers oblige to the requirement.
2. Enforce the legal requirement of eliminating illegal workers by more inspection and monitoring. And also be strict at giving warnings and penalties to the employers if they employ illegal workers.
3. Non-local workers must prove their safety knowledge as comparable to local workers by a competency test organized by a recognized body before being allowed to work.
4. Formalize ‘pay for safety’ system to make allowance for safety precautions so that the contractors and self-employed do not need to rush jobs in order to increase profit margins.
5. The ‘Pay for safety’ system should be extended to cover repair and maintenance works on top of new works.

6. Personal protective equipment must be provided by the employer to the worker.
7. The employer must be responsible for replacing old or faulty equipment and conduct regular maintenance for their equipment.
8. Workers should ensure that they have adequate safety equipment for the job and know how to use them.
9. There should be more defined guidelines relating to the construction procedure of the bamboo truss-out scaffold.
10. The Buildings Department bamboo scaffold guidelines should be widely publicized and enforced.
11. Rectify 'the lowest bidder gets the job' practice, as often safety precautions will be compromised if the bid is too low.

9.4.3 Technological recommendations

1. To further investigate the technologies available overseas and to see if they can be utilized in Hong Kong.
2. To improve and develop local technologies for safety.
3. To adopt the Temporary Transportable Anchor Device as a means of providing temporary anchor point for attaching personal protective equipment since for most maintenance and repair projects, it is difficult if not impossible to locate an anchor point.

9.4.4 Measures recommended

1. To extend and strengthen the implementation of safety management systems in residential repair and maintenance sector.
2. Design for safety – safety is not the sole responsibility for the contractor. It involves collaboration and contribution of all stakeholders. It can be best achieved if safety provisions are considered and built in at the design stage. By doing so the cost of safety would be cheaper in the long-run, and at the same time

the aesthetic aspect value of the building could be preserved and furthermore workers would be more willing to utilise safety measures if these are tailor-made for their use.

3. Increase the publicity of safety messages via the media to educate flat owners/tenants on their legal liabilities.
4. Provide more safety training workshops and education for workers, supervisors, and managerial staff.

9.4.5 Recommendations for regulatory framework

1. As identified from the case studies analysis 'providing and maintaining a safe system of work' is important in preventing fall from height accidents.
2. The prevailing statutory controls on construction safety, such as: the reporting mechanism between the Labour Department and the Hong Kong Association of Property Management Companies; and a sponsorship scheme for small and medium sized contractors to improve safety on truss-out scaffold launched by the Labour Department and the Occupational Safety and Health Council, are generally considered and accepted as adequate. However, the unique nature of building repair and maintenance works such as small-scale and short duration prompts additional attention in this sector.
3. Bamboo truss-out scaffold is known to be one of the most severe safety hazards in residential building repair and maintenance works, relevant authority should consider introducing a mandatory licensing system for workers using the bamboo truss-out scaffold system in the long-run. However, it is acknowledged that the implementation of this system will be costly and take time to establish and hence it may not be a achievable goal in the near future. Perhaps, at the interim, a voluntary registration scheme for the workers concerned should be introduced to encourage self regulation.
4. Recently there has been much work conducted to improve safety training especially from the Labour Department and the Construction Industry Training

Authority. These include enhancing existing courses to include fall prevention and also new specific courses to handle truss-out scaffolds. These courses are appropriate and useful however most of these courses are on voluntary basis. The findings from this study indicated that the industry still feels that there are rooms for improvement. Therefore formal and structured safety training for workers working at height externally should be considered to be made mandatory prior to allowing workers to work in these areas.

5. A mandatory licensing system should be introduced for workers performing minor works. Similar to the recommendation for a mandatory licensing system for workers using the bamboo truss-out scaffold system, a mandatory licensing system for minor works would be advantageous to the industry. But due to cost, time and acceptance matters, the mandatory system may only be possible to be introduced in the long-run. At the interim, self regulation for the workers is encouraged.
6. More safety messages and publicity should be communicated to flat owners and tenants to alert them of their safety duties and liabilities in commissioning residential building repair and maintenance works.
7. The importance of purchasing insurance for maintenance works regardless of size should be publicized to increase the awareness of the occupants on proper implementation of the repair works.
8. The government should place more resources on promoting construction safety in residential repair and maintenance by providing more detailed guidelines, organising more safety training courses, increasing inspection and monitoring, increasing incentive schemes such as ‘pay for safety’ to reward and recognize good safety practices, increasing advertisements through the mass media and collaboration with the research community.

9.5 Benefits of the research

This research has conducted a comprehensive review of the problems causing fall accidents in building repair and maintenance works. In addition, economical, social, legal, and technological solutions for preventing the recurrence of similar accidents in residential building repair and maintenance have been presented.

There have been no previous studies looking into the situation of fall from height for repair and maintenance works for residential buildings in Hong Kong, hence this study is original, timely and demanding. It is hoped that the findings and recommendations derived from this study can raise the awareness of the situation and motivate construction practitioners to carry out the necessary measures to eliminate fall accidents in building repair and maintenance works by using the recommended measures.

9.6 Limitations of the study

The current study involved a number of limitations:

1. The limited project duration was insufficient to conduct a comprehensive and thorough data collection. It is possible that given sufficient time more data could have been collected and more practical solutions may be derived.
2. The flat owner/tenant questionnaire was limited to a small sample size of 314 questionnaires. Although the number was sufficient for the statistical analysis conducted, a larger sample size would be more representative.
3. The flat owner/tenant questionnaire was distributed to those estates managed by large property management companies. The results may have been more representative if individual blocks in old districts were also included.
4. The search for international practices questionnaire only received eleven responses. It is anticipated that there may be more effective solutions adopted in other parts of the world which could be equally applied in Hong Kong.

9.7 Recommendations for future research

Areas which are worthwhile for further research include:

1. Refining the design of the bamboo truss-out scaffold that will ensure safety, and/or
2. Designing an alternative that will eliminate the use of bamboo truss-out scaffold.
3. Reviewing the potential use of information technology (such as the Virtual Construction Site - refer to p.59-60) towards construction safety for working at height)
4. Investigate the feasibility of including safety measures in the design stage.

9.8 Summary

Fall accidents can be prevented by adequate supervision, training, monitoring, advertisements, management, precautions and attention. This project has presented techniques, solutions and advice to construction practitioners for reference. In addition, an initial design of a prototype has been presented and in the process of obtaining patent from the PRC. It is anticipated that with further refinement, this product may be able to replace the traditional truss-out scaffold and help to reduce fall accidents in Hong Kong.

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