A Study of the Construction Safety in Hong Kong - Accidents Related to Fall of Persons from Height

Prepared by
Francis Wong, Principal Investigator
Albert Chan, Co-Investigator
Michael Yam, Co-Investigator
Edmond Wong, Co-Investigator
Kenny Tse, Co-Investigator
Kendra Yip, Research Assistant
The Hong Kong Polytechnic University
Department of Building and Real Estate

Research Monograph

A Study of the Construction Safety in Hong Kong -
Accidents Related to Fall of Person from Height

Research Team Members

Prof. Francis K.W. Wong, Principal Investigator

Prof. Albert P.C. Chan, Co-Investigator

Dr. Michael C.H. Yam, Co-Investigator

Mr. Edmond Y.S. Wong, Co-Investigator

Mr. Kenny T.C. Tse, Co-Investigator

Miss Kendra K.C. Yip, Research Assistant

April 2005

All rights reserved. No part of this publication may be reproduced or transmitted, in any form or by any means, electrical or mechanical, including photocopying, recording or any information storage and retrieval system, without permission in writing from the research team.
ACKNOWLEDGEMENTS

This research is funded by the Institutional Research Grant (Project Account Code: G-T746), The Hong Kong Polytechnic University. The research team would like to thank the following members of the Safety and Environmental Advisory Unit (SEAU), the Architectural Services Department (ArchSD) of the Hong Kong Special Administrative Region Government, for their assistance in providing valuable data and the safety workshops:

- Mr. M. C. Ng (Chief Building Services Engineer)
- Mr. H. T. Chan (Senior Structural Engineer)
- Mr. T. S. Mak (Structural Engineer)
- Mr. H. M. Lin (Clerk of Works)

The comments of the study are the views of the research team only and do not represent the opinions of any of the above-mentioned institutions and individuals.
# TABLE OF CONTENTS

ACKNOWLEDGEMENTS ................................................................. II

TABLE OF CONTENTS ................................................................. III

LIST OF TABLES ........................................................................ VI

LIST OF FIGURES ....................................................................... VII

CHAPTER 1  INTRODUCTION ...................................................... 1

  1.1 BACKGROUND .......................................................................... 1

  1.2 OBJECTIVES OF THE RESEARCH ............................................... 3

  1.3 RESEARCH METHODOLOGY ..................................................... 3

  1.4 STRUCTURE OF THE MONOGRAPH ............................................ 3

CHAPTER 2  LITERATURE REVIEW .......................................... 5

  2.1 PRINCIPAL LOCATIONS AND CAUSES OF FALL ....................... 5

  2.2 FALL PROTECTION SYSTEMS .................................................. 6

  2.3 FAILURE OF FALL PROTECTION SYSTEMS ............................... 7

  2.4 FALL ACCIDENTS IN HONG KONG: COURT CASES ................... 8

  2.5 FALL PROTECTION SYSTEMS IN HONG KONG ....................... 11

  2.6 PROPER USAGE OF FALL PROTECTION SYSTEMS .................. 12

  2.7 SAFETY MANAGEMENT SYSTEMS ........................................... 13

  2.8 CURRENT LEGISLATION/REGULATION ................................. 13

  2.9 SUMMARY .............................................................................. 15
CHAPTER 3  ANALYSIS OF FALL RECORDS................................................................. 16

3.1  INTRODUCTION ............................................................................................................. 16

3.2  STATISTICAL DATA AND RESULTS (1994 TO 2003).................................................. 17
  3.2.1  NUMBER AND SEVERITY OF CONSTRUCTION FALL ACCIDENTS ............................. 17
  3.2.2  MAJOR TRADES SUFFERING FROM FALL INJURIES ..................................................... 18
  3.2.3  NATURE OF INJURIES AND PART OF BODY INJURED ...................................................... 19
  3.2.4  AGENT INVOLVED IN FALL INCIDENTS ........................................................................... 20
  3.2.5  TYPES OF WORK ................................................................................................................. 21
  3.2.6  PERSONAL FACTORS ............................................................................................................ 22
  3.2.7  UNSAFE ACTIONS ................................................................................................................. 23
  3.2.8  UNSAFE CONDITIONS .......................................................................................................... 24
  3.2.9  MONTH AND SEASON OF ACCIDENTS .................................................................................... 25
  3.2.10 DAY OF ACCIDENTS ........................................................................................................... 26

3.3  DATA COLLECTION AND RESULTS (2001 TO 2003).................................................. 27
  3.3.1  LOCATION OF FALL ......................................................................................................... 27
  3.3.2  HEIGHT OF FALL .............................................................................................................. 30
  3.3.3  WORKER’S AGE GROUP ......................................................................................... 33
  3.3.4  WORK EXPERIENCE ........................................................................................................ 34
  3.3.5  TRADES OF WORK .............................................................................................................. 35

3.4  CASE STUDY RELATED TO FALL OF PERSON FROM HEIGHT .................................. 36

3.5  SUMMARY .................................................................................................................. 37

CHAPTER 4  ANALYSIS OF WORKSHOP FEEDBACK......................................................... 39

4.1  INTRODUCTION .............................................................................................................. 39

4.2  SAFETY PERFORMANCE WHEN WORKING AT HEIGHT .................................................. 40

4.3  CAUSES OF ACCIDENTS .................................................................................................... 41

4.4  IN-HOUSE SAFETY PROCEDURES AND GUIDELINES .................................................. 41

4.5  THE TYPES OF WORKS AFFECT CONSTRUCTION SAFETY ....................................... 42

4.6  PROBLEMS IN IMPLEMENTING SAFETY PROCEDURES & GUIDELINES ...................... 43

4.7  POTENTIAL FALL HAZARDS .......................................................................................... 43

4.8  REASONS OF FALL INJURIES .......................................................................................... 44

4.9  FALL RELATED TO THE USE OF LADDERS ........................................................................ 45

4.10 DIFFERENCES BETWEEN ARCHSD AND PRIVATE PROJECTS ................................. 45

4.11 SUMMARY ..................................................................................................................... 46
CHAPTER 5  CONCLUSIONS & RECOMMENDATIONS............................... 47

5.1 CONCLUSIONS ............................................................................................... 47

5.2 RECOMMENDATIONS....................................................................................... 48

5.3 LIMITATIONS OF THE RESEARCH ............................................................... 49

5.4 AREAS FOR FURTHER RESEARCH............................................................... 50

REFERENCES ...................................................................................................... 51

APPENDICES ....................................................................................................... 57

APPENDIX I – CHAPTER 59AF FACTORIES AND INDUSTRIAL UNDERTAKINGS (SAFETY MANAGEMENT) ........................................................................................................ 57

APPENDIX II – CHAPTER 59I CONSTRUCTION SITES (SAFETY) REGULATIONS .......... 60

APPENDIX III – WORKSHOP’S QUESTIONNAIRE ............................................... 62
# List of Tables

Table 1: Statistics of Fall Accident from 1998 to 2002 .......................................................... 2  
Table 2: Selected Court Cases (1996-2002) of Fall of Person from Height ............... 10  
Table 3: Number of Injuries Related to Fall of Person from Height (1994-2003) 17  
Table 4: Worker-related Fall by Trade of Injured Worker ................................. 19  
Table 5: Distribution of Nature of Injuries (1994-2003) ..................................................... 20  
Table 6: Distribution of Agent Involved (1994 – 2003) .................................................... 21  
Table 7: Distribution of Personal Factor (1994-2003) ....................................................... 23  
Table 8: Distribution of Unsafe Condition (1994-2003) ..................................................... 25  
Table 9: Distribution of Location of Fall (2001-2003) ....................................................... 30  
Table 10: Distribution of Height of Construction Fall Accidents (2001-2003) .... 30  
Table 11: Factors of Safety Performance Improvement ................................................. 40  
Table 12: Major Causes of Accidents Related to Fall of Person from Height ........ 41  
Table 13: In-house Safety Standards and Procedures for Persons Working at Height .......................................................................................................................... 42  
Table 14: Different Types of Works Affecting Construction Safety Involving Fall of Persons from Height ........................................................................................................ 42  
Table 15: Problems in Implementing Safety Procedures & Guidelines .......... 43  
Table 16: Common Potential Hazards ............................................................................ 44  
Table 17: Reasons for Frequent Happening of Fall Accidents Involving Ladders from 2001 to 2003 ......................................................................................................................... 45  
Table 18: Factors for Safety Improvement Involving Ladders ........................................ 45  
Table 19: Major Differences in Safety Standards and Procedures between ArchSD Projects and Private Projects ................................................................. 46
LIST OF FIGURES

FIGURE 1: INDUSTRIAL ACCIDENT RATES IN MAJOR INDUSTRIES OF HONG KONG........... 1
FIGURE 2: TYPES OF FATALITY IN THE HONG KONG CONSTRUCTION INDUSTRY DURING 2002
........................................................................................................................................... 2
FIGURE 3: BREAKDOWN OF SEVERITY OF INJURY OF FALL OF PERSON FROM HEIGHT...... 18
FIGURE 4: FALL INJURIES BY CONTRACT TYPES, 1994-2003............................................. 22
FIGURE 5: DISTRIBUTION OF UNSAFE ACTIONS, 1994-2003............................................ 24
FIGURE 6: DISTRIBUTION OF FALL INJURY BY MONTH OF YEAR, 1994-2003.................... 25
FIGURE 7: DISTRIBUTION OF FALL INJURED BY SEASONS, 1994-2003........................... 26
FIGURE 8: DISTRIBUTION OF FALL INJURED BY DAY OF WEEK, 1994-2003.................... 27
FIGURE 9: DISTRIBUTION OF HEIGHT OF FALL BY SEVERITY, 2001-2003........................ 31
FIGURE 10: DISTRIBUTION OF FALL LOCATION AND HEIGHT OF FALL, 2001-2003......... 32
FIGURE 11: DISTRIBUTION OF LOCATION OF FALL AND SEVERITY, 2001-2003............. 32
FIGURE 12: DISTRIBUTION OF LOCATION OF FALL AND AGE, 2001-2003....................... 33
FIGURE 13: DISTRIBUTION OF AGE GROUP OF INJURED WORKERS CAUSED BY FALL OF
PERSONS, 2001-2003........................................................................................................ 34
FIGURE 14: DISTRIBUTION OF WORKERS BY YEARS OF TOTAL SITE EXPERIENCE, 2001-2003
........................................................................................................................................... 35
FIGURE 15: DISTRIBUTION OF WORKERS BY MONTHS OF PROJECT EXPERIENCE, 2001-2003
........................................................................................................................................... 35
FIGURE 16: DISTRIBUTION OF TRADES OF WORK PERFORMED, 2001-2003................... 36
CHAPTER 1 INTRODUCTION

1.1 BACKGROUND

The accident rate of the construction industry in Hong Kong has been declining in recent years (Figure 1). However, the fatality rate in construction is the highest amongst other industries. Taking 2002 as an example, there were 22,453 industrial accidents in Hong Kong, of which 6,239 accidents were construction related cases (OSHB, 2003). As shown in Table 1, there were 24 fatalities out of the 6,239 construction accidents in 2002. Of the 24 fatalities, 15 or 63% was due to fall of person from height as shown in Figure 2. In view of this phenomenon, it is worth to investigate the problems associated with fall of person from height in the construction industry in Hong Kong and to recommend measures for improvement.

![Figure 1: Industrial Accident Rates in Major Industries of Hong Kong](image)

Sources: Occupational Safety and Health Statistics Bulletin, Issue No.2 (July 2003), Labour Department
Table 1: Statistics of Fall Accident from 1998 to 2002

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Number of Persons Falling from Height</th>
<th>No. of Fatality</th>
<th>Total Number of Construction Accidents</th>
<th>No. of Fatality</th>
<th>Fatal fall as a percentage of all construction deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>1,647</td>
<td>31</td>
<td>19,588</td>
<td>56</td>
<td>55%</td>
</tr>
<tr>
<td>1999</td>
<td>1,124</td>
<td>24</td>
<td>14,078</td>
<td>47</td>
<td>51%</td>
</tr>
<tr>
<td>2000</td>
<td>1,021</td>
<td>13</td>
<td>11,925</td>
<td>29</td>
<td>45%</td>
</tr>
<tr>
<td>2001</td>
<td>771</td>
<td>9</td>
<td>9,206</td>
<td>28</td>
<td>32%</td>
</tr>
<tr>
<td>2002</td>
<td>652</td>
<td>15</td>
<td>6,239</td>
<td>24</td>
<td>63%</td>
</tr>
<tr>
<td></td>
<td>mean=49%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sources: Hong Kong Monthly Digest of Statistic, July 1999
Occupational Safety and Health Statistic Bulletin, Issue No.3, July 2003
Occupational Safety and Health Council

Figure 2: Types of Fatality in the Hong Kong Construction Industry during 2002

Sources: Hong Kong Monthly Digest of Statistic (1998-2003), Census and Statistics Department of HKSAR
1.2 Objectives of the Research

This research aims to improve construction safety performance related to fall of person from height. The three specific objectives are:

i. To identify the characteristics of fall of person accidents in Hong Kong.

ii. To examine the use and the effectiveness of personal fall arrest systems.

iii. To draw recommendations on safety of work at height.

1.3 Research Methodology

This research began with a review of the available literature related to construction safety and fall of person on construction sites. Based on Architectural Services Department’s accident data in the Public Works Programme Construction Accident Statistics System (PCAS) of the Environment, Transport and Works Bureau (ETWB), the second stage investigated the characteristics of fall of person accidents. The use and the effectiveness of personal fall arrest systems were examined with reference to detail accident reports. Following the statistical analysis, a safety workshop was then jointly organized by the research team and ArchSD. The aim of this workshop was to collect the advice and views about the statistical results from safety-related practitioners. To facilitate a systematic data collection, a set of questionnaires were developed and used in the workshop.

1.4 Structure of the Monograph

This monograph is divided into six chapters. Chapter 1 outlines the background information regarding construction related accidents in Hong Kong and illustrates the research framework of this report. Chapter 2 reviews the literature, court cases and the relevant regulations in Hong Kong. Data collected from the Public Works Programme Construction Accident Statistics System (PCAS) and the Safety Workshops are presented
in Chapter 3 and Chapter 4 respectively. Chapter 5 draws the conclusions and provides recommendations on reducing the number of construction injuries relating to fall of person from height.
CHAPTER 2 LITERATURE REVIEW

2.1 PRINCIPAL LOCATIONS AND CAUSES OF FALL

Fatalities can be caused by fall of person from various workplaces, such as scaffold, ladder, raised staging, working platform, roof and opening (Janicak, 1998; Hinze et al., 1998; Huang and Hinze, 2003). According to McCann (2003), the Occupational Safety and Health Administration (OSHA) published a report on falls from scaffolds in late 70s (OSHA, 1979). The report shows that from 1974 to 1978, suspended scaffolds were involved in 27 deaths (25 incidents) out of a total of 87 scaffold fall deaths (82 incidents); 17 of these incidents involved equipment failure. Another study by Johnson et al. (1998) indicates that falling from roof accounted for 12% of all residential construction accidents in Hawaii. Cattledge et al. (1996) revealed that 21.4% of non-fatal work-related falls were from scaffolds in the 90s. They also examined all fatal occupational falls in the USA for the period from 1980 to 1989, which indicated that 18.6% of the falls were from scaffolds. The fatal work-related falls from scaffolding in 1994 accounted for approximately 20.6% of all fall-related deaths in the construction industry in the U.S (Janicak 1998). Workers fall from scaffolds were mainly due to the loss of their balance, the scaffold being wet and slippery, and the workers’ unawareness to the edge of the scaffoldings (Kines 2003). In Hong Kong, interior work surfaces have become the leading accident locations in recent years (Rowlinson 2001).

Fall of person is mainly resulted from slipping, tripping, environmental causes and/or the collapse of working platform (Chen et al., 1995), together with a lack of fall protection equipment at the time of incident (Janicak, 1998 and Johnson et al., 1998). Hazard is being defined as source or situation with a potential for harm in terms of death, ill health or injury, or a combination of these (BSI, 2004). In order to minimize the probability of fall
of person from height at workplaces, the use of suitable fall protection equipment should be enforced. To determine the root causes of the safety problems, Abdelhamid and Everett (2000) suggested a safety model called “Accident Root Causes Tracing Model (ARCTM)”. The ARCTM model indicates that the accidents occur due to three root causes, they are: 1) failing to identify an unsafe condition that existed before an activity; 2) deciding to proceed with a work activity after the worker identifies an existing unsafe condition; and 3) deciding to act unsafe regardless of initial conditions of the work environment.

2.2 **FALL PROTECTION SYSTEMS**

Since fall of person from height is a serious safety problem on construction sites, many studies on the prevention methods have been conducted (e.g. Huang and Hinze, 2003). In the USA, a standard (OSHA 3146, 1998) entitled “fall protection”, has been drafted to provide guidelines for contractors to develop a safe working environment for employees who are exposed to fall hazards (OSHA, 1998). The standard specifies activities which require proper fall protection measures and provide to employers with guidelines on the selection of appropriate fall protection measures according to the type of work performed.

Fall protection equipment is an important measure to protect workers against fall from height. Fall protection generally can be provided through the use of guardrail systems, safety net systems, personal fall arrest systems, positioning device systems, and warning line systems, etc. In a section of the OSHA regulations (1926.502(d)) (McCann 2003), the requirements of employers to provide fall protection for workers on scaffolds and ladders and for workers engaged in steel erection of buildings are stated. Warren and Ralph III, B, (1991) reviewed the practices in the USA for both fall protection and debris protection in
high rise construction. They compared the performance between active and passive protection; and flexible and rigid passive protection structures. Singh (2000) investigated fall accidents occurring on low-rise roofs and evaluated some innovative fall protection measures. Duncan and Bennett (1991) concluded that both active measures such as guardrails, and passive measures such as safety nets, are useful in reducing fall injuries. Vargas et al (1996a, 1999b) developed an expert system that analyzed the causes of fall of person by using fault-tree methods. It was concluded that guardrails, safety nets, and Personal Fall Arresting System (PFAS) can all be inadequate, under different circumstances. Weisgerber and Wright (1999) provided the outline of a comprehensive program to prevent fall at the design phase. Hinze and Gambatese (1996) similarly developed a software program that would help designers address safety in the design phase.

2.3 Failure of Fall Protection Systems

On the other hand, it is hard to guarantee all these protective provisions are safe. According to Baszczynski (2003), energy absorbers and guided type fall arresters are very popular for fall protection. But dynamic elongation of this equipment and the force acting on anchor point during fall arresting will be influenced by different weather conditions. These phenomena decide directly about the fall arresting process and can influence safety of people working at height. Hsiao et al. (2003) evaluated the fit and sizing efficacy of a harness system. Based on the results obtained from 72 male and 26 female construction workers, it was found that redesigning each harness component and an integration of overall harness components are needed. The fit test of the fall-protection harness showed that 40% of the subjects did not meet the performance criteria in either standing or suspended condition. In the paper of Chen et al. (1995), they developed a computerized system entitled “SAFECON” (SAFE CONstruction) to analyze fall accidents and fall
protection in construction. With the use of eleven real cases from OSHA Fatal Facts, the result showed that SAFECON matched the OSHA investigation results with an accuracy of 82%.

2.4 FALL ACCIDENTS IN HONG KONG: COURT CASES

A number of accidents related to fall of person from height have been handled by the court of Hong Kong. There were a total of 656 court cases related to falls on construction sites during the period from 1905 to 2003. These court cases provide useful evidence for analyzing the key factors leading to fall of person from height in the local construction industry. Table 2 tabulates the details of 12 available court cases related to fall of person from height from 1996 to 2002. It indicates that nearly 84% of the employers (10 cases) did not provide adequate safety measures such as safe access or anchorage point for worker to attach a safety belt. Besides, two cases of non-fatal fall injuries were associated with the negligence of the worker during work. All the accidental fall incidents reported in Table 2 involved violation of the Construction Sites (Safety) Regulation made under the Factories and Industrial Undertaking Ordinances (Chapter 59). These regulations include providing safety workplaces, fencing of dangerous platform, trained workmen to operate hoist, maintenance of safe access or egress and take adequate steps to make prevention of fall, etc. Safe workplaces should be places for suitable footholds, and whenever necessary, provided with adequate fall protection equipment. Several key variables of fall could be identified in Table 2. Items in this table include sex, post of the worker, the location and causes of accidents, the results of accidents, the responsibility and the reasons of fall. Falls could be categorized into fall from ladder, hoistway, lift shaft, demolition works, suspended working platform, fall from an opening and fall by falling objects. Fall from height
represents the largest category with over 12 cases across the 7-year period. It was also found that all of the victims were men. This might be due to the fact that male workers are still dominating the construction industry by tradition.

These court cases provide an indication on the causes of fall from height in the Hong Kong construction industry. Although the cases only provide limited information about the circumstances of the accident falls, these findings are useful in formulating hypotheses for further research on fall of person from height in the construction industry of Hong Kong. Since fall of person has been a major cause of fatalities over the past five years, more efforts must be channelled to fall protection and enhancing safety awareness amongst people in the construction industry.
<table>
<thead>
<tr>
<th>No.</th>
<th>Year /Sex</th>
<th>Post</th>
<th>Fall Location</th>
<th>Situation</th>
<th>Responsible</th>
<th>Causes</th>
<th>Adequate safety measures?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1996/M</td>
<td>Scaffold holder</td>
<td>Ladder</td>
<td>Injured</td>
<td>Employer</td>
<td>Lost balance. No sufficient safe access and egress were properly maintained. Besides, no scaffolds, ladders or other means of support, ladders or other means of support were properly maintained.</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>1997/M</td>
<td>Scaffold holder</td>
<td>Shingle</td>
<td>Injured</td>
<td>Worker</td>
<td>Snapped of the shingle. This was due to negligence of the worker. According to his duty, it was not necessary for him to climb on the asbestos to check the surface area and thus caused the injured.</td>
<td>Unknown</td>
</tr>
<tr>
<td>3</td>
<td>1997/M</td>
<td>Driller</td>
<td>Moving platform</td>
<td>Injured</td>
<td>Employer</td>
<td>Struck by a beam when he was performing demolition work. No safety workplace provided by the employer. This lead to no practical place for the worker to attach a safety belt on the guardrail.</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>1997/M</td>
<td>Odd job worker</td>
<td>Floor opening</td>
<td>Injured</td>
<td>Employer</td>
<td>Insufficient safety protection provided by the employer. No guardrail, fence, surrounding the opening and no sign board warned people the potential danger. The covering had not been properly and clearly marked to show its purpose nor was it securely fixed in its position.</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>1998/M</td>
<td>Formwork worker</td>
<td>Planks</td>
<td>Injured</td>
<td>Employer</td>
<td>One of the planks had suddenly broken. The contractor failed to provide suitable and adequate safe access to the area near the formwork for the worker to carry out his work. The contractor did not take adequate step to prevent the worker falling from height.</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>1998/M</td>
<td>Concrete worker</td>
<td>From a pipe</td>
<td>Injured</td>
<td>Employer</td>
<td>Lost his grip on the section of pipe that he was holding. The contractor did not provide any working platform or scaffolding for which the sufferer could operate and attach the safety harness.</td>
<td>No</td>
</tr>
<tr>
<td>7</td>
<td>1999/M</td>
<td>Worker</td>
<td>Hoist-way</td>
<td>Death</td>
<td>Employer</td>
<td>Misjudgement by worker. Contractor failed to ensure that it was not used unless the hoist-way enclosure and the gates extended to a height of 2 metres unless a lower height was sufficient to prevent a person from falling down the hoist-way and there was no risk of any person coming into contact with any moving part of the hoist.</td>
<td>No</td>
</tr>
<tr>
<td>8</td>
<td>1999/M</td>
<td>Worker</td>
<td>Residential building</td>
<td>Injured</td>
<td>Worker</td>
<td>Lost balance when performed formwork materials. It was necessary for the sufferer to -re-anchor the belt’s attachment at least at every level of his ascent.</td>
<td>Unknown</td>
</tr>
<tr>
<td>9</td>
<td>2001/M</td>
<td>Formwork worker</td>
<td>From a parapet into basement</td>
<td>Injured</td>
<td>Employer</td>
<td>Did not know the full circumstances of his fall. There was nothing provided by the contractor to prevent the worker fell from the parapet into the basement.</td>
<td>No</td>
</tr>
<tr>
<td>10</td>
<td>2001/M</td>
<td>Worker</td>
<td>From an iron beam</td>
<td>Injured</td>
<td>Employer</td>
<td>One of the metal brackets used to support the beam had suddenly broken. There was no safety net under the iron beam, although the sufferer was wearing a safety belt, no point for him to anchor the belts. Moreover, no working platform or scaffold erected for him to do his work.</td>
<td>No</td>
</tr>
<tr>
<td>11</td>
<td>2002/M</td>
<td>Steel bending worker</td>
<td>Opening of a working platform</td>
<td>Death</td>
<td>Employer</td>
<td>Negligence by the worker. Unsafe workplace provided by the contractor and failed to take adequate steps to prevent a person on the site from falling from height of 2m or more.</td>
<td>No</td>
</tr>
<tr>
<td>12</td>
<td>2002/M</td>
<td>Painter</td>
<td>Opening of a working platform</td>
<td>Injured</td>
<td>Employer</td>
<td>Negligence by the worker. Unsafe workplace provided by the contractor and failed to take adequate steps to prevent a person on the site from falling from height of 2m or more.</td>
<td>No</td>
</tr>
</tbody>
</table>

2.5 **Fall Protection Systems in Hong Kong**

To protect workers from the impact of fall, effective fall protection equipment, e.g. Personal Fall Arresting System (PFAS) should be introduced. According to the guidance notes prepared by the Occupational Safety and Health Branch (OSHB) of the Labour Department of Hong Kong, a personal fall arresting system is defined as a system combined with a safety belt and an appropriate anchorage system. It should also be noted that using safety belt and its anchorage system is only the last resort of fall protection if it is impracticable to provide properly fenced working platform in a workplace. Five types of safety harness are commonly used in Hong Kong, which are full/general body harness, general purpose safety belt, chest harness, pole safety belt and safety rescue harness. General safety harnesses are harnesses incorporating thigh straps and shoulder straps used in conjunction with safety lanyards for attachment to anchorage points. Since safety harness should be used together with a proper anchorage system, specifications of choosing an anchorage should not be neglected. Anchorages are categorized into three types including fixed anchor, independent lifeline and a fall arresting system. Fixed anchorage is used for direct attachment of the lanyard of the safety belt to prevent fall from height, such as built-in eye bolt, a rigid beam or column of a building.

Contractors in Hong Kong normally arrange to have a safe load capacity of at least 5 kN for the use of anchors. Vertical independent lifeline is a very common safety precaution to prevent a person wearing safety belt from falling from height. It works with a lanyard and a positioning device such as a rope chuck, rope grab or rope adjuster, the same with fixed anchorage, the upper end of it should attach securely to a structural anchorage point. Fall arrester works with lifelines, guide rails or energy absorbers to protect the user from body injury during a fall and it is better used in connection with safety harnesses.
2.6 PROPER USAGE OF FALL PROTECTION SYSTEMS

Prior to the selection of safety belt and its anchorage system, it is important to ensure the availability of anchorage points for the system. For example, concrete beam, column, and structural steel beam are suggested to be used for anchoring lifelines as these points are strong enough than temporary structures, such as scaffolding. Lifeline should only be used by one person at any particular time. In addition, the types of safety belts should meet the specifications of international safety standards, such as the British Standard (BS or BSEN); American National Standard (ANSI); Japanese Industrial Standard (JIS) or Safety Belt Standard of Japan’s Ministry of Labour and the People’s Republic of China National Standard (GB) or equivalence. Although the requirements of this fall protection equipment have been stated clearly, it was found that only 29 per cent and 60 per cent of safety belts and harness have been labeled with international standards respectively (OSHC, 2000). This is an important issue to be addressed as people might rely on them as the principal means of preventing fall from height.

For the selection of anchorage system, Labour Department (1998) recommends the consideration of the type of anchorage that is best fit to the workplace. For example, full body harness and fixed anchorage are used for window cleaning work (where an eye bolt as the fixed anchorage); rope chuck and vertical independent lifeline may be used for external window panel installation work and bamboo scaffolding; guide rope, rope grab and rope adjuster are used for electrical tower assembling work and guided type fall arrester on a rigid anchorage line is used for power generation plant. During the process of selection, particular attention should be paid to the choice and limitation of connectors, fittings, the self-locking devices, shock absorbers, lifelines and supports of the anchorage to be used. It is also strongly
recommended that a safety harness incorporating buttock straps should be used when adopting safety belt.

2.7 SAFETY MANAGEMENT SYSTEMS

Apart from these fall protection equipment, appropriate safety management system should be introduced on site to minimize the risk of workers working at height. In the study of Whitaker et al. (2002), they indicated that a safety management system entitled Decision Support Systems (DSS) offered a method of providing a content and structure to reduce the hazards due to worker falling from scaffolds. DSS are designed to manage and quantify data and present it in a form that supports the decision-making process of the user.

In Hong Kong, safety management system is stipulated by the Factories and Industrial Undertakings (Safety Management) Regulations. It contains a maximum of 14 safety elements which employers have to follow based on the following criteria. If a contractor has 100 or more workers in a day working in a single construction site or the value of the construction works exceeds $100 million, it is required to adopt at least 10 elements of the safety management system. If a contractor has 50 or more but less than 100 workers in a day working in a single construction site, it is required to adopt 2 elements of the safety management system. For a contractor with 50 workers or less is exempted for the time being (Appendix I).

2.8 CURRENT LEGISLATION/ REGULATION

The Labour Department of the HKSAR has stipulated various ordinances; regulations; guidelines and safety procedures for working at height. 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 regulation 38 of the Construction Sites (Safety) Regulations (CSSR) (CAP 59I 1997). In addition to these regulations, the third schedule of the CSSR lists out all specific requirements and practices for performing works in construction sites (Appendix II).

Other statutory provisions on the use of safety equipment include the use of suspended working platforms under regulation 15 of the Factories and Industrial Undertakings (Suspended Working Platforms) Regulations; 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; and the safety of hoistways, platforms and cages under regulation 31 of the CSSR.

The above regulations with regard to fall of person from height also impose responsibilities on both employers and employees. Indeed, sections 6A and 6B of the F&IU Ordinance enforce general duties on proprietors and employees of an industrial undertaking. Section 6A states that employers should provide all necessary equipment to ensure that the works are safe and without risks 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/herself and other persons; and to follow the duty and requirement given by the employers for securing health and safety (CAP 59, 1997).
2.9 SUMMARY

Fall of person continues to be the major cause of fatalities in the construction industry in Hong Kong as well as in other countries. Statistics of OSHB from 1998 to 2002 show that fall of person from height accounted for 49% of the total fatalities on construction sites. This chapter reviewed the locations and causes of fall, fall protect systems, selected local court cases, safety management systems and current legislation. It provides the platform for data collection and analysis in the following chapters.
CHAPTER 3 ANALYSIS OF FALL RECORDS

3.1 INTRODUCTION

The objectives of this paper are to identify the category, trend, and causes of fall of person on construction sites. To fulfil the objectives, this research explored the statistical data in building works from the Public Works Programme Construction Accident Statistics System (PCAS) available from the Architectural Services Department (ArchSD) of the Hong Kong SAR Government. PCAS holds the following information about each incident:

- Personal information of the injured worker
- Description of accident,
- Particulars of employers,
- Trade of the injured worker,
- Place of accident,
- Nature of injury and part of body injured,
- Type of accident,
- Agent involved,
- Type of work performed,
- Unsafe action,
- Unsafe condition,
- Personal factor,
- Machinery involved, and
- Construction machinery.

The recorded information also provides data such as brief account on the time of accident, and the feedbacks of measures taken or actions to avoid recurrence of similar accidents. In this research, all the records related to fall of person from height from 1994 to 2003 were
retrieved for the analysis. This chapter also included the data collected from the questionnaire with registered safety officers and safety managers, based on questionnaire survey.

3.2 Statistical Data and Results (1994 to 2003)

As extracted from PCAS, there were 562 fall related incidents from 1994 to 2003. This section studies the characteristics of these incidents.

3.2.1 Number and Severity of Construction Fall Accidents

Table 3 shows the number of construction fall injuries reported to ArchSD and input into PCAS. There are three levels of severities of injury. They are minor injury, major injury and fatal. Minor injuries were defined as those which resulted in no hospitalization or hospitalization for less than 24 hours. Serious injuries were those resulting in hospitalization for more than 24 hours.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total no. of all types of accident</td>
<td>218</td>
<td>387</td>
<td>565</td>
<td>513</td>
<td>670</td>
<td>726</td>
<td>546</td>
<td>421</td>
<td>370</td>
<td>317</td>
<td>4733</td>
</tr>
<tr>
<td>Minor</td>
<td>20</td>
<td>35</td>
<td>57</td>
<td>45</td>
<td>60</td>
<td>62</td>
<td>39</td>
<td>30</td>
<td>36</td>
<td>20</td>
<td>404</td>
</tr>
<tr>
<td>Serious</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>12</td>
<td>15</td>
<td>13</td>
<td>25</td>
<td>15</td>
<td>25</td>
<td>23</td>
<td>141</td>
</tr>
<tr>
<td>Fatal</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>No Spec.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>40</td>
<td>65</td>
<td>58</td>
<td>77</td>
<td>77</td>
<td>64</td>
<td>48</td>
<td>66</td>
<td>44</td>
<td>562</td>
</tr>
</tbody>
</table>

The data from Table 3 are also plotted as illustrated in Figure 3. As shown in the figure, although the total number of fall injuries was decreasing, there was an increasing trend in the average number of serious injuries. In particular, the total number of serious injuries in 2002 and 2003 was at 48, almost 50% more as compared to 1998 and 1999. Figure 3 also shows
that workers mainly suffered from minor injuries and 25% of all fall injuries were serious injuries.

![Figure 3: Breakdown of Severity of Injury of Fall of Person from Height](image)

**3.2.2 MAJOR TRADES SUFFERING FROM FALL INJURIES**

Table 4 indicates that the three most common trades leading to fall injuries are labour, carpenter (formworker), painter/decorator. These trades accounted for a total of 55% of all fall related injuries.
Table 4: Worker-related Fall by Trade of Injured Worker

<table>
<thead>
<tr>
<th>Trade of Injured Worker</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>132</td>
<td>27</td>
</tr>
<tr>
<td>Carpenter (formworker)</td>
<td>79</td>
<td>16</td>
</tr>
<tr>
<td>Painter and decorator</td>
<td>60</td>
<td>12</td>
</tr>
<tr>
<td>Plasterer</td>
<td>42</td>
<td>8</td>
</tr>
<tr>
<td>Demolition worker</td>
<td>35</td>
<td>7</td>
</tr>
<tr>
<td>Painter and decorator</td>
<td>60</td>
<td>12</td>
</tr>
<tr>
<td>Plumber</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>Construction/ Mechanical plant mechanic or fitter</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td>Building services/ E&amp;M worker</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>Bar bender and fixer</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>Bamboo scaffolder</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Concretor</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Others (Joiner, Plant &amp; equipment operator, etc.)</td>
<td>46</td>
<td>9</td>
</tr>
<tr>
<td>Subtotal</td>
<td>497</td>
<td>100</td>
</tr>
<tr>
<td>Not known</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>562</td>
<td></td>
</tr>
</tbody>
</table>

The findings are not surprising given the job nature and working environment of these trades. In particular, “labour” accounted for 27% of the total fall accidents. This may be due to the fact that labours in general are either lack of or not familiar with the specific construction safety knowledge required at different working locations. Besides, because of their job nature, they have to handle various types of minor works at different locations on site and hence, they are more prone to different work hazards relating to fall of person from height. On the other hand, scaffold workers, who constantly work at height on incomplete structures, did not prone to more accidents.

3.2.3 Nature of Injuries and Part of Body Injured

The nature of injuries and body part injured were examined. Table 5 shows the nature of major injuries. It is clear that contusion & bruise were by far the most common nature of injuries, and neck & trunk were the most common part of body injured. These observations are in line with the nature of fall that when a person falls from height, it is usually associated with a loss of balance and hence the neck and trunk of the body parts are more prone to injury.
Table 5: Distribution of Nature of Injuries (1994-2003)

<table>
<thead>
<tr>
<th>Level</th>
<th>Nature of Injuries</th>
<th>Count</th>
<th>Percent</th>
<th>Part of Body Injured</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Injury</td>
<td>Contusion &amp; Bruise</td>
<td>201</td>
<td>40%</td>
<td>Neck &amp; Trunk</td>
<td>167</td>
<td>33%</td>
</tr>
<tr>
<td></td>
<td>Fracture</td>
<td>186</td>
<td>37%</td>
<td>Lowerlimbs</td>
<td>149</td>
<td>29%</td>
</tr>
<tr>
<td></td>
<td>Concussion &amp; Other Internal Injury</td>
<td>33</td>
<td>7%</td>
<td>Upperlimbs</td>
<td>137</td>
<td>27%</td>
</tr>
<tr>
<td></td>
<td>Laceration &amp; Cut</td>
<td>34</td>
<td>7%</td>
<td>Head</td>
<td>55</td>
<td>11%</td>
</tr>
<tr>
<td>2nd Injury</td>
<td>Fracture</td>
<td>12</td>
<td>27%</td>
<td>Upperlimbs</td>
<td>26</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td>Contusion &amp; Bruise</td>
<td>9</td>
<td>20%</td>
<td>Lowerlimbs</td>
<td>21</td>
<td>28%</td>
</tr>
<tr>
<td></td>
<td>Laceration and Cut</td>
<td>6</td>
<td>14%</td>
<td>Head</td>
<td>16</td>
<td>22%</td>
</tr>
</tbody>
</table>

3.2.4 Agent Involved in Fall Incidents

The agents involved in the fall incidents are shown in Table 6. The “ladder for working at height” constituted 50% of all injuries. The second most common agent of injuries was “floor, ground, stairs or any working surface”. It constituted 24% of all cases. “Material/ product being handled or stored” accounted for 7% of all cases. These observations correlate with the results in Table 4 that labour and painter/decorator are the two main trades of works that have the significant number of fall injury, since these trades inevitably involve the use of ladders in various types of working locations on sites. Although carpenter (formworker) is another trade having a large number of fall injuries, it is noticed that carpenters (formworkers) seldom use ladders on sites. It is suggested that appropriate personal protection equipment including safety harness with adequate anchorage should be arranged for carpenters (formworkers) when they are working near the edge of elevated position.
Table 6: Distribution of Agent Involved (1994 – 2003)

<table>
<thead>
<tr>
<th>Agent Involved</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ladder for working at height</td>
<td>200</td>
<td>50</td>
</tr>
<tr>
<td>Floor, ground, stairs or any working surface</td>
<td>94</td>
<td>24</td>
</tr>
<tr>
<td>Material/ Product being handled or stored</td>
<td>27</td>
<td>7</td>
</tr>
<tr>
<td>Scaffolding/ Gondola</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Construction formwork, shuttering &amp; falsework</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Excavation/ Underground work</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Portable power or hand tools</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Vehicle or associated equipment or machinery</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Other machinery</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Movable container or package of any kind</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Pipe</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Equipment for lifting/ conveying</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Sewage, manhole or other confined space</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Electricity supply, wiring apparatus or equipment</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Gas, vapour, dust or fume</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Nail, splinter or chipping</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Slope</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Steel bar/ rod</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Others</td>
<td>38</td>
<td>10</td>
</tr>
<tr>
<td>Sub-total</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>Not known</td>
<td>162</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>562</strong></td>
<td></td>
</tr>
</tbody>
</table>

3.2.5 TYPES OF WORK

Figure 4 shows the contract types in terms of new works, maintenance works, foundation works, renovation works and miscellaneous. It seems that fall injuries occurred more frequently in new works (93 %). This result may be reflecting the condition and amount of new works performed by ArchSD. More detail discussion regarding this issue will be presented in Chapter 4.
Figure 4: Fall Injuries by Contract Types, 1994-2003

3.2.6 PERSONAL FACTORS

Personal factors were also examined. As shown in Table 7, the factor “Fatigue/Exhaustion” was the most common personal factors leading to fall injuries and it accounts for 34% of the fall accidents. This factor will directly affect the workers’ physical ability and hence may cause them to lose their balance when working at height. “Incorrect attitude/motive” was the second common factor causing falls. “Carelessness” accounted for 17% of all fall injuries. The sum of these two factors accounted for 45% of the total number of fall injuries. It is believed that these two factors are to some extent relate to the safety climate of the organisation. Hence, to improve the safety of working at height, a better safety climate should be cultivated in order to “correct” the safety attitude of the workers.
Table 7: Distribution of Personal Factor (1994-2003)

<table>
<thead>
<tr>
<th>Personal Factor</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatigue/ Exhaustion</td>
<td>193</td>
<td>34%</td>
</tr>
<tr>
<td>Incorrect attitude/ motive</td>
<td>159</td>
<td>28%</td>
</tr>
<tr>
<td>Carelessness</td>
<td>97</td>
<td>17%</td>
</tr>
<tr>
<td>Lack of knowledge or skill</td>
<td>87</td>
<td>15%</td>
</tr>
<tr>
<td>Physical defects</td>
<td>9</td>
<td>2%</td>
</tr>
<tr>
<td>Others</td>
<td>14</td>
<td>2%</td>
</tr>
<tr>
<td>Unsafe act by another person</td>
<td>4</td>
<td>1%</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td><strong>563</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Not known</strong></td>
<td><strong>14</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>2 items or above</strong></td>
<td><strong>(15)</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>562</strong></td>
<td>-</td>
</tr>
</tbody>
</table>

3.2.7 Unsafe Actions

Figure 5 depicts the distribution of unsafe actions. It is found that the most common factor associated with fall injuries was “Adopting unsafe position or posture” (45%). “Lapse of attention” and “Use unsafe equipment/ Use equipment unsafely” were both determined the second most common unsafe actions (11%). The adoption of unsafe position or posture by the workers is directly related to the types of work, the safety attitude of the workers and the availability of suitable tools etc. To improve the situation, the workers should be reminded repeatedly during toolbox talk, safety meetings and other safety promotion activities that unsafe actions such as the adoption of unsafe position or posture is the leading cause of fall accidents. Also, management should discuss with supervisors and foremen to improve the working condition in order to reduce the unsafe action.
3.2.8 **Unsafe Conditions**

Table 8 tabulates the distribution of unsafe condition. It was found that unsafe process or job methods (29%) were the main cause of the incidents, followed by “Improper procedure (17%). These two factors constituted to 46% of the total fall injuries. Hence, to improve the situation it is believed that proper communication channels should be established between frontline workers and the engineering team in order to develop proper, practical and feasible construction process and methods for the construction works.
Table 8: Distribution of Unsafe Condition (1994-2003)

<table>
<thead>
<tr>
<th>Unsafe Condition</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsafe process or job methods</td>
<td>99</td>
<td>29</td>
</tr>
<tr>
<td>Improper procedure</td>
<td>59</td>
<td>17</td>
</tr>
<tr>
<td>Improper guarding/ No guarding</td>
<td>31</td>
<td>9</td>
</tr>
<tr>
<td>Inadequate working space/ platform</td>
<td>29</td>
<td>8</td>
</tr>
<tr>
<td>Poor housekeeping</td>
<td>17</td>
<td>5</td>
</tr>
<tr>
<td>Improper dress/ footwear</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>Slippery area</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>Unsafe layout of job, traffic etc</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Improper illumination</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Others (e.g. Smoking/Burning)</td>
<td>67</td>
<td>19</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>*347</td>
<td>-</td>
</tr>
<tr>
<td><strong>Not known</strong></td>
<td>*229</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>562</td>
<td>-</td>
</tr>
</tbody>
</table>

*Since Unsafe Condition could be addressed more than 1 item, the sum of these number exceeds 562.

3.2.9 **MONTH AND SEASON OF ACCIDENTS**

With regard to the month and season of accidents, Figure 6 shows that August was the month with a comparatively higher number of fall incidents, while February was the month with least occurrence over the past ten years. According to the Hong Kong Observatory (HKO 2004), August is on average the hottest month and has the highest amount of rainfall in a year, whereas February is on average the second coldest and the second driest month.

![Figure 6: Distribution of Fall Injury by Month of Year, 1994-2003](image-url)
Analysis also shows that winter (December to February) with relatively fewer fall injuries occurred; while summer (June to August) was the season with higher rate of fall injuries, as shown in Figure 7. As discussed above, since August is the hottest month and has the highest amount of rainfall of the year, it is believed that more fall accidents are prone to happen in the summer due to the higher temperature and possible dehydration of the workers both of which will reduce the physical ability of the workers. Besides, too much rainfall will likely create a slippery working surface and hence will lead to more fall accidents. It is also speculated that the comparatively smaller number of fall injuries occurred in the winter was due to the better working environment (lower temperature and level of humidity) and more statutory holidays (i.e. fewer working days).

![Figure 7: Distribution of Fall Injured by Seasons, 1994-2003](image)

### 3.2.10 Day of Accidents

For the distribution of injuries by day of the week, the occurrence of fall accidents did not show a clear pattern of occurrence. However, as shown in Figure 8, Monday shows slightly higher fall accidents rate than the other days of the week. Sunday is usually not a working day and hence, relatively fewer number of fall accidents occurred.
3.3 DATA COLLECTION AND RESULTS (2001 TO 2003)

Since more detailed information can be recorded in the revised PCAS system from 2001, it is worthwhile to examine extra information based on the data of the last three years’ accidents (2001 – 2003). During this period, there were 1,108 construction injuries resulted in 158 fall injuries.

3.3.1 LOCATION OF FALL

As shown in Table 9, most of the fall injuries were resulted from the use of ladders (22%) Fall from external work/ scaffolding/ gondola (15%) and fall from floor/ floor opening (12%) were also the common locations. These three locations accounted for half of all fall of person from height on construction sites. Although the percentage of fall injury (22%) related to the use of ladder is smaller in this period when comparing to that of the period from 1994 to 2003 (50%), it is still the leading agent/location where fall accidents occurred. This also implies that further improvement is required in the use of ladder for construction works.
Construction Safety Workshop I

Construction Safety Workshop II
Table 9: Distribution of Location of Fall (2001-2003)

<table>
<thead>
<tr>
<th>Location of fall</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall from Ladder</td>
<td>29</td>
<td>22</td>
</tr>
<tr>
<td>Fall from External work/ Scaffolding/ Gondola</td>
<td>19</td>
<td>15</td>
</tr>
<tr>
<td>Fall from Floor/ Floor opening</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>Fall from Falsework and formwork</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Fall from Roof/Top of building</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Fall from Stair/ Passage</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Fall from Liftshaft/Internal work surface</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Fall from Excavation/ Underground/ Basement</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Fall from Pre-casting/ Prestressing yard</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Fall from Tunnel/ Sewer/ Drain/ Nullah</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fall from Steel bending yard</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Others</td>
<td>31</td>
<td>24</td>
</tr>
<tr>
<td>Sub-total</td>
<td>130</td>
<td>-</td>
</tr>
<tr>
<td>Not known</td>
<td>28</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>158</td>
<td>-</td>
</tr>
</tbody>
</table>

3.3.2 Height of Fall

Information on the height of fall was recorded in 158 cases out of the 562 cases (28%). Table 10 indicates that there were 67% of fall happening within 0 – 2 meters height and the average height of injuries was 2.0 meters.

Table 10: Distribution of height of construction fall accidents (2001-2003)

<table>
<thead>
<tr>
<th>Height of Fall</th>
<th>2001</th>
<th>2001</th>
<th>2003</th>
<th>Total</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1 m</td>
<td>8</td>
<td>25</td>
<td>14</td>
<td>47</td>
<td>37</td>
</tr>
<tr>
<td>1 - 2 m</td>
<td>10</td>
<td>29</td>
<td>20</td>
<td>59</td>
<td>46</td>
</tr>
<tr>
<td>2 - 3 m</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>3 - 4 m</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>4 - 5 m</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>5 - 6 m</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>&gt; 6 m</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Sub-total</td>
<td>22</td>
<td>62</td>
<td>43</td>
<td>127</td>
<td>-</td>
</tr>
<tr>
<td>Not known</td>
<td>26</td>
<td>4</td>
<td>1</td>
<td>31</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>66</td>
<td>44</td>
<td>158</td>
<td>-</td>
</tr>
</tbody>
</table>

The relationship between the degree of severity and the height of fall is shown in Figure 9. It is noticed that the average height resulted in minor and serious injuries was 1.3 m and 2.1 m respectively. There was a fatal case occurred at a height of less than 2m.
Figure 10 reiterates that ladders were a common agent associated with most of the injury cases between 1.0 and 2.0 meters. This might be due to the fact that most injured workers are labourers and painters who are frequent users of ladders. However, it is also speculated that there might be other reasons for most of the fall accidents which occur at a height between 1m to 2 m. This may be due to the fact that fall accidents from above 2 m would have more serious legal implications on contractors; hence, there may be a possibility for contractors not to report the exact height of fall.
Figure 10: Distribution of Fall Location and Height of Fall, 2001-2003

Figure 11 shows the relationship between degree of injury severity and fall locations. Among the different fall locations, fall from ladder is being identified as the most common location of incidents. The figure also shows that fatal cases mainly happened in lift shaft /internal work surface since the height of fall involved in these situations is usually high.

Figure 11: Distribution of Location of Fall and Severity, 2001-2003
3.3.3 *Worker’s Age Group*

Figure 12 associates the correlation between location of fall and the age of injured workers. Since most of the injured workers fall in the age group of 40-49 (Figure 13), it is not surprising to find that the workers in this age group contributed a major proportion of fall accident in most of the locations. In fact, statistics from the population census (Census and Statistics Department 2001, 1996) conducted in 1996 and 2001 showed that the age group that had the highest number of construction workers were 35-39 and 40-44, respectively. Workers in the age group of 20-24 were found to have a higher accident rate when they work with ‘Ladder’ and ‘External work/ Scaffolding / Gondola’.

![Figure 12: Distribution of Location of Fall and Age, 2001-2003](image-url)
3.3.4 WORK EXPERIENCE

As indicated in Figure 14, over 60% of injured workers have less than a total of 10 years construction site experience. At project level, Figure 15 shows that work experience has a direct relationship to fall incidents. In particular, nearly half (43%) of the injured workers only had less than or equal to 1 month experience in the construction site where fall accidents occurred. This shows that most of the fall accidents occurred when the workers were new to the site and hence they did not have the appropriate information and experience regarding potential fall hazards that might exist in that particular construction site. Therefore, in order to improve the safety of the workers related to fall hazards, the management should ensure that appropriate briefing and training are provided to the new workers through frequent safety meetings and other channels at least in the first few days of their arrivals to the site.
Figure 14: Distribution of Workers by Years of Total Site Experience, 2001-2003

Figure 15: Distribution of Workers by Months of Project Experience, 2001-2003

3.3.5 Trades of Work

Figure 16 shows that some decoration works like plastering and painting accounted for high number of injuries. This may be due to the fact that plasterers and painters are frequent users of ladders and hence the number of fall injuries was relatively higher than that of the other trades.
3.4 CASE STUDY RELATED TO FALL OF PERSON FROM HEIGHT

The second objective of this chapter is to investigate the use and the effectiveness of personal safety equipment. It is based on the examination of three investigation reports substantiated by safety officers.

In the first case, the victim was erecting formwork on the roof of a hall. The main reason causing this fall injury was due to the slippery platform (floor edge and scaffold) after a heavy rainfall. The victim fell from the roof top of the school hall and his neck and back were injured. It was stated that the injured worker used the safety harness at the time of occurrence, but there was no evidence as to whether the injured worker had properly tied the safety harness or not.

In the second case, the injured worker was installing the decking on a roof. He forgot to anchor the independent lifeline to a suitable anchorage point. He fell to a level which was about 4 to 5 meters below the roof. As a result, his thigh and foot were injured. The main causes of the accident were that the victim had not attached his lanyard to the anchorage point.
and at the same time, his view was adversely affected by the reflection of sun light from the movable working platform.

In the third case, the injured person and a co-worker were carrying out dismantling work at the roof level of a fiberglass workshop. They had worn safety helmet and safety harness. Owing to the fumes cutting process for the dismantling work, the injured person was assigned to spray water on the fiberglass. The injured person released his own safety harness and was leaving for a lunch. At this moment, he was accidentally tripped and fell to the ground level which was 3.7 meters below the roof.

All these three cases discussed above involved the use of personal safety equipment. However, the equipment did not play a direct role in the incidents since worker had not attached it to their lifeline. In terms of the severity of injuries for these 3 cases, 2 out of 3 cases were serious injuries. Therefore, in order to improve the construction safety related to person working at height, appropriate use of personal safety equipment is required. Based on the above discussion, it can be seen that the location of anchorage point for the lanyard must be suitably placed and be easily accessed by the workers. In addition, workers working at height should have their safety harness properly tied to a secured anchor line at all times even though the workers are beginning to depart from but still on their elevated workplace.

3.5 SUMMARY

Having analysed the 562 fall incidents from year 1994 to 2003 and the 158 injuries from 2001 to 2003, it is revealed that fall injuries involving the use of ladders were frequently happened on construction sites. During the past ten years, over half of the injured workers were suffered from minor injury. However, the analysis of injury data from recent years indicated that a
greater proportion of injured workers had resulted in serious injury. Most of the injured workers were labour. This may be due to the fact that labours may be temporary workers and in general are either lack of or not familiar with the specific construction safety knowledge at different working locations. Besides, because of their job nature, they have to handle various types of minor works at different locations on site and hence, they are more prone to different work hazards relating to fall of person from height.

The study found that the natures of major injuries were contusion & bruise, and fracture and neck & trunk were the most common part of body injured. According to the accident data, most fall accidents involving ladders usually occurred below 2 meters. Plastering and painting were the most common type of work performed, and these types of work always involved the use of ladders. Therefore, there is a close correlation between the use of ladders and fall of person from height. Fatigue or exhaustion of workers was one of the main factors causing fall injuries. The cases indicate that physical ability of a worker may influence their safety performance. External factors like month and season may also affect the frequency of fall incidents. The analysis revealed that there were more fall injuries occurred in July and August in summer and this may be due to the poorer working conditions such as high temperature (which may lead to fatigue and exhaustion) and slippery work surface. Also, it is more likely to have fall incidents on Monday than the other days of the week. Working experience may also affect fall injuries. More than 49% of injured workers with less than 10 years construction site experience and over 50% were new to the incident sites. Besides, according to the fall data from 2001 – 2003, most of the fall accidents occurred when the workers were new to the site (less than one month) and hence they did not have the appropriate information and experience regarding potential fall hazards that might exist in that particular construction site. These factors were significant to the occurrence of fall injury.
CHAPTER 4 ANALYSIS OF WORKSHOP FEEDBACK

4.1 Introduction

Following the analysis of the data from PCAS and the safety reports, the research team and ArchSD had jointly organized a safety workshop with an aim to collect views and recommendations from construction safety practitioners. There were 32 safety managers/officers, representing 25 main contractors in Hong Kong, attending the workshop.

The workshop was started with a presentation of the initial findings based on the data from PCAS by the research team members. The second part was a discussion and feedback collection session. To facilitate a systematic session, four sets (A, B, C and D) of questionnaire had been developed beforehand (Appendix III). Each questionnaire contains three questions related to safety performance of workers working at height, major causes of fall of person from height, the effects of types of works and the differences between private and government construction projects.

The attendees were evenly divided into four groups and were given a set of questionnaire. A representative in each group was responsible for collecting the views of the group members. He/she was then invited to present and share the findings to members of other groups and the research team. The research team finally received 23 completed questionnaires for further analysis.
4.2 **Safety Performance When Working at Height**

Question A1 & B1 aimed to identify the methods for safety improvement of persons working at height. As indicated in Table 11, most of the respondents replied that “Reinforce safety training”; “Equipment for working at height” and “Award & penalty scheme” are the three main factors for improving the performance of construction safety related to working at height. In addition, other factors such as “Monitoring & supervision” and “Clear working procedure & guidance” were also significant for improving the safety performance of workers working at height.

**Table 11: Factors of Safety Performance Improvement**

<table>
<thead>
<tr>
<th>Factors</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforce safety training</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Equipment for working at height</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Award &amp; Penalty scheme</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>Monitoring &amp; supervision</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Clear working procedure &amp; guidance</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Safety Promotion &amp; Education</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Workers Registration system</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Use of safety equipment</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Management emphasis on supervision</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Design for safety</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Improvement of site tidiness</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Others</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>79</strong></td>
<td>100%</td>
</tr>
</tbody>
</table>

Broadly speaking, it can be seen that the safety practitioners generally agreed that proper safety training and site safety system (which includes safety equipment and safety management for working at height) are essential in improving construction safety for person working at height.
4.3 **Causes of Accidents**

For Question A2, the 34 comments are categorised into several major causes of accidents related to fall of person from height. As shown in Table 12, the major factors include “Improper equipment & working”, “Wrong safety attitude” and “Inadequate housekeeping”. Again, the two broad categories; namely, safety training and site safety system mentioned above constituted the major causes of fall accidents for person working at height as shown in Table 12.

**Table 12: Major Causes of Accidents Related to Fall of Person from Height**

<table>
<thead>
<tr>
<th>Causes</th>
<th>Count</th>
<th>Percent</th>
<th>Related Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improper equipment &amp; working platform</td>
<td>7</td>
<td>21</td>
<td>Site safety system</td>
</tr>
<tr>
<td>Wrong safety attitude</td>
<td>6</td>
<td>18</td>
<td>Safety training</td>
</tr>
<tr>
<td>Inadequate housekeeping</td>
<td>5</td>
<td>15</td>
<td>Site safety system</td>
</tr>
<tr>
<td>Lack of monitoring &amp; supervision</td>
<td>4</td>
<td>12</td>
<td>Site safety system</td>
</tr>
<tr>
<td>Lack of proper procedure &amp; guideline</td>
<td>4</td>
<td>12</td>
<td>Site safety system</td>
</tr>
<tr>
<td>Time constraints</td>
<td>3</td>
<td>9</td>
<td>-</td>
</tr>
<tr>
<td>Others</td>
<td>5</td>
<td>15</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>34</strong></td>
<td><strong>102%</strong></td>
<td>-</td>
</tr>
</tbody>
</table>

This figure does not equal to 100% due to round-up.

4.4 **In-house Safety Procedures and Guidelines**

The purpose of Question A3 & B2 was to find out any special in-house safety standards and procedures for people working at height. Table 13 reveals that guideline for the use of scaffold and gondola are the most common in-house safety standards for persons working at height. Not a great diversity of other guidelines followed by scaffold, such as guideline for the use of working platform, and guideline for working procedure and inspection, etc.
Table 13: In-house Safety Standards and Procedures for Persons Working at Height

<table>
<thead>
<tr>
<th>Safety Standards and Procedures</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guideline for the use of scaffold &amp; gondola</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>Guideline for the use of working platform</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Guideline for working procedure &amp; inspection</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Safety equipment guideline</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Guideline for the use of ladder</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Guideline for safety training</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Working at height guideline</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Others</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>52</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

4.5 The Types of Works Affect Construction Safety

Question B3 was intended to determine how the types of works such as new works, maintenance works and foundation works would affect the construction safety involving fall of persons from height. There were 27 responses but only 17 of them addressed the question properly. As can be seen in Table 14, most of the respondents address the issues related to maintenance works. These include site restrictions, safety supervision and monitoring. From supervision’s point of view, it is not easy to control effectively in maintenance works as their working spots are scattered.

Table 14: Different Types of Works Affecting Construction Safety Involving Fall of Persons from Height

<table>
<thead>
<tr>
<th>Different Types of Works</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance Works</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More site restrictions and obstructions, e.g. limited space, headroom, existing structure</td>
<td>6</td>
<td>35</td>
</tr>
<tr>
<td>Scattered areas of works, leading to difficulties in supervision and monitoring</td>
<td>5</td>
<td>29</td>
</tr>
<tr>
<td>Frequent use of ladders</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Relatively short project duration</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>New Works</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of more advanced technologies, e.g. large panel formwork, leading to higher risk at height</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Closer monitoring and supervision of site safety</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>17</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
4.6 PROBLEMS IN IMPLEMENTING SAFETY PROCEDURES & GUIDELINES

Question C1 investigates the problems in implementing safety procedures and guidelines. The safety supervision staff pointed out that poor safety attitude and behaviour was the biggest obstacle in implementing safety procedures for workers who work at height, as shown in Table 15. The other obstacles include lack of resources and lack of design for safety, improper design management of working platform and improper management by sub-contractor.

<table>
<thead>
<tr>
<th>Problems</th>
<th>Count</th>
<th>Percent</th>
<th>Related Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor safety attitude &amp; behaviour</td>
<td>4</td>
<td>31</td>
<td>Safety training</td>
</tr>
<tr>
<td>Lack of resources</td>
<td>3</td>
<td>23</td>
<td>Site safety system</td>
</tr>
<tr>
<td>Lack of design for safety</td>
<td>3</td>
<td>23</td>
<td>-</td>
</tr>
<tr>
<td>Improper design management of working platform</td>
<td>2</td>
<td>15</td>
<td>Site safety system</td>
</tr>
<tr>
<td>Improper management by sub-contractor</td>
<td>1</td>
<td>8</td>
<td>Site safety system</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>100%</strong></td>
<td>-</td>
</tr>
</tbody>
</table>

These problems can be again associated with safety training and site safety system as shown in Table 15 except for the problem “Lack of design for safety”. Safety practitioners in general agreed that construction safety for person working at height should also be dealt with at the design stage. That is, during the design stage of construction works, engineers/builders should consider construction safety and minimize the potential fall hazards through appropriate design.

4.7 POTENTIAL FALL HAZARDS

Although the feedback size of Question C2 was relatively small, it indicated the potential hazards that may cause a person to fall from height on construction site. Thirty-eight percentage of feedback reflected that improper use and erecting of scaffold was the main potential hazard for falling from height, as shown in Table 16.
4.8 Reasons of Fall Injuries

The purpose of Question D1 was to find out the reasons for fall accidents involving ladders from 2001 to 2003. From Table 17, it was found that the main reasons for fall injuries involving ladders from year 2001 to 2003 were due to “Poor maintenance condition of ladder” and “Improper use of ladder” respectively. This result identified by the safety officers was supplementary to the PCAS fall injuries statistics. Data in PCAS from 2001 to 2003 revealed that the major fall location was fall from ladders. Hence, it can be seen that the proper use of ladder is the key to reduce the number of fall accidents. Although safety practitioners have known the fact that ladder is the main agent involved in fall accidents, little has been done to rectify the situation. Hence, it is proposed to adopt a permit-to-use system for ladders such that they are always in working condition. Besides, proper training for the use of ladders should also be a mandatory item for those who need to work with ladders.
Table 17: Reasons for Frequent Happening of Fall Accidents involving ladders from 2001 to 2003

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Count</th>
<th>Percent</th>
<th>Related Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor maintenance condition of ladder</td>
<td>12</td>
<td>24</td>
<td>Site safety system</td>
</tr>
<tr>
<td>Improper use of ladder</td>
<td>10</td>
<td>20</td>
<td>Site safety system</td>
</tr>
<tr>
<td>Poor housekeeping</td>
<td>6</td>
<td>12</td>
<td>Site safety system</td>
</tr>
<tr>
<td>Lack of training</td>
<td>4</td>
<td>8</td>
<td>Safety training</td>
</tr>
<tr>
<td>Physical conditions of worker</td>
<td>4</td>
<td>8</td>
<td>Site safety system</td>
</tr>
<tr>
<td>Improper position</td>
<td>4</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>Lack of monitoring &amp; supervision</td>
<td>3</td>
<td>6</td>
<td>Site safety system</td>
</tr>
<tr>
<td>Time constraints</td>
<td>1</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Others</td>
<td>7</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>51</strong></td>
<td><strong>102%</strong></td>
<td></td>
</tr>
</tbody>
</table>

4.9 FALL RELATED TO THE USE OF LADDERS

Question C3 & D2 concerns the issue of improving the safety performance for persons working at height involving ladders. Most of the feedback indicated that a registration permit system can improve the safety performance when using ladders (Table 18). However, monitoring and better control for use of ladders are also the key factors which could minimize fall injuries from ladders.

Table 18: Factors for Safety Improvement Involving Ladders

<table>
<thead>
<tr>
<th>Factors</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration permit system</td>
<td>15</td>
<td>38</td>
</tr>
<tr>
<td>Monitoring</td>
<td>10</td>
<td>26</td>
</tr>
<tr>
<td>Better control</td>
<td>9</td>
<td>23</td>
</tr>
<tr>
<td>Training</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>39</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

4.10 DIFFERENCES BETWEEN ARCHSD AND PRIVATE PROJECTS

For Question D3, the major differences in terms of safety standards and procedures between ArchSD projects and private development projects are the level of close monitoring and supervision for ArchSD projects (Table 19). This might be due to the fact that government as
a client can provide more safety resources and are more concerned about safety issue.

Table 19: Major Differences in Safety Standards and Procedures between ArchSD Projects and Private Projects

<table>
<thead>
<tr>
<th>Major Differences</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close monitoring &amp; supervision for ArchSD project</td>
<td>12</td>
<td>32</td>
</tr>
<tr>
<td>Higher standard for ArchSD project</td>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td>Incentive &amp; safety promotion program</td>
<td>8</td>
<td>22</td>
</tr>
<tr>
<td>Penalty for poor safety performance</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>Others</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>37</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

4.11 Summary

The results obtained from the safety workshop suggested three key areas for reducing the number of accidents related to fall of person from height. These include reinforcing safety training, implementing proper site safety system (which includes safety equipment and safety management for working at height such as enforcing a penalty and award scheme) and the consideration of construction safety for person working at height in the design stage of the construction works.

It is also found that large number of fall injuries involving ladders in recent years were due to poor maintenance condition and improper use of ladders. Hence it is proposed to use a permit-to-use system for ladders such that they are always in working condition. The main problem of implementing safety guidelines and standards in construction sites was poor safety attitude of workers which is directly related to the safety climate of the organisation. Hence, it is believed that construction safety related to fall accidents can be improved by improving the safety climate of the organisation through reinforcing safety training.
CHAPTER 5 CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

This study provides a detailed analysis of fall injuries occurred in Architectural Services Department’s projects from 1994 to 2003. The result of the investigation was mainly based on an analysis of the accident data from the ArchSD’s Public Works Programme Construction Accident Statistic System (PCAS) and a safety workshop. The key findings are as follows:

(a) Although the total number of fall injuries was decreasing, there was an increasing trend in the average number of serious injuries.
(b) Fall injuries were frequently associated with the use of ladders;
(c) Most of the injured workers were unskilled labours working on a temporary basis;
(d) Most injured workers fell from workplace of lower than 2 meters;
(e) Plastering and painting were the most common type of work performed;
(f) Fatigue or exhaustion of workers was one of the main factors causing fall injuries;
(g) The unsafe conditions related to fall injuries were unsafe process or job methods and improper procedure;
(h) Fall injuries occurred more in summer and on Monday;
(i) Work experience (especially for those who have less than one month’s experience at a particular site) has a direct relationship to fall incidents;
(j) Improper equipment, inadequate housekeeping, lack of resources and lack of design for safety are contributing factors to fall injuries;
(k) Safety training is considered one of the most important factor in improving construction safety related to falls; and
(l) Poor safety attitude and behavior is the biggest obstacle in implementing safety procedures.
The findings from the case studies indicated that accidents related to fall of person from height may have happened not because of ineffectiveness of the personal fall arrest systems. Rather, it may have happened due to inappropriate use of the personal fall arrest systems by the workers (e.g. without proper anchorage of the safety harness while personal protection at height is still required).

5.2 Recommendations

Based on the limited fall accident statistics discussed in previous chapters and the analysis of the results from the safety workshop, the following recommendations are proposed:

(a) A better safety climate should be cultivated in order to “correct” the safety attitude of the workers such that safety performance of working at height can be improved. This can be accomplished by providing enhanced safety training for workers with updated information and communications of safety information related to fall injuries through proper channels such as frequent toolbox talks and site safety meetings.

(b) Refreshing safety talks should be conducted on regularly basis and preferably before commencement of works on Monday morning.

(c) Frontline management should pay special attention to the physical condition of workers working at height during summer time. More frequent rest for the workers may be necessary during this period of the year.

(d) Safety officers/supervisors should provide close supervision for trades which require the frequent use of ladders such as plastering and painting.

(e) A permit-to-use system for ladders should be introduced such that the ladders are always in working condition.

(f) Workers should be provided with adequate and appropriate safety equipment such as safety harness with fall arrestor and an independent lifeline.
(g) Clear and updated working procedures and guidelines should be provided.

(h) Proper communication channels should be established between frontline workers and the engineering team in order to develop proper, practical and feasible construction process and methods for the construction works.

(i) New employees for construction works (and especially for their first month on the site) are required to attend mandatory training for construction safety related to working at height. The training should include the proper use of ladders,

(j) Contractors should be encouraged to prepare a more comprehensive report in case there is an accident on site. The report should at least cover the scenario, the possible cause(s) and the recommendation(s). Wherever appropriate, lesson learnt should also be prepared to enhance safety training and promotion on site in order to prevent recurrence of similar accidents related to fall of person from height.

(k) A penalty and award scheme should be enforced for construction safety.

5.3 **Limitations of the Research**

The limitations of this research are:

(a) Accident data for this study are mainly collected from ArchSD of the Hong Kong SAR Government, which represented accident records limited to public sector projects from 1994-2003. Also, the data are mainly associated with new works rather than maintenance works. Therefore, more data from the private sector including the fall accidents for maintenance works are required in order to have a complete view of the construction fall problem.
(b) Due to limited resources available for this research, only 3 case studies were examined for the use and the effectiveness of personnel fall arrest systems. More case studies should be examined in future so that more conclusive findings can be obtained.

5.4 **Areas for Further Research**

Areas which are worthwhile for further research including:

(a) Fall of person from height related to repair and maintenance works;

(b) A comparison of fall of person from height between public sector projects and private sector projects; and

(c) An in-depth study concerning the appropriate use of personal fall arrest systems by workers.
REFERENCES


Manage., 129(2), 152-158.

34(4), 731-736.

Hong Kong Construction Industry Based on Total Quality Management Principals.”

absorbers and guided type fall arresters on a flexible anchorage line during fall arresting.


CAP 59 (1997). “Chapter 59 Factories and Industrial Undertakings”. Available at:

CAP 59AF (2002). “Chapter 59AF Factories and Industrial Undertakings (Safety and

CAP 59I (1997). “Chapter 59I Construction Sites (Safety) Regulations”. Available at:

Nonfatal occupational fall injuries in the West Virginia construction industry. Accident,
Analysis and Prevention, 28(5), 655-663.

Census and Statistics Department (2001), 2001 Population Census, The Hong Kong SAR
Government.


OSHA (Office of Statistical Studies and Analysis) (1979) Occupational fatalities related to scaffolds as found in reports of OSHA fatality/catastrophe investigations. Washington, DC: Occupational Safety and Health Administration.


Portillo Garc’ and is-Pintos J. (2000). “Personal protective equipment against falls from height.” Instituto Nacional de Seguridad e Higiene en el Trabajo, c/Torrelaguna 73, 28027 Madrid, Spain, 14 pp.


55
APPENDICES

Appendix I – Chapter 59AF Factories and Industrial Undertakings (Safety Management)

Schedule 3 Proprietors and contractors who are required to have safety management systems

Part 1

1. A contractor in relation to construction work having an aggregate of 100 or more workers in a day working in a single construction site.
2. A contractor in relation to construction work with a contract value of $100 million or more.
3. A proprietor of a shipyard business having an aggregate of 100 or more workers in a day working in a single shipyard.
4. A proprietor of a factory having an aggregate of 100 or more workers in a day working in a single factory.
5. A proprietor of a designated undertaking having an aggregate of 100 or more workers in a day working in a single workplace.

Part 2

1. A contractor in relation to construction work having an aggregate of 50 or more but less than 100 workers in a day working in a single construction site.
2. A proprietor of a shipyard business having an aggregate of 50 or more but less than 100 workers in a day working in a single shipyard.
3. A proprietor of a factory having an aggregate of 50 or more but less than 100 workers in a day working in a single factory.
4. A proprietor of a designated undertaking having an aggregate of 50 or more but less than 100 workers in a day working in a single workplace.

Part 3

1. A contractor in relation to construction work having an aggregate of 100 or more workers in a day working in 2 or more construction sites.
2. A proprietor of a shipyard business having an aggregate of 100 or more workers in a day working in 2 or more shipyards.
3. A proprietor of a factory having an aggregate of 100 or more workers in a day working in 2 or more factories.
4. A proprietor of a designated undertaking involving any one or more of the activities specified in paragraph (a) of the definition of "designated undertaking" in section 2(1) of this Regulation, having an aggregate of 100 or more workers in a day working in 2 or more workplaces.
5. A proprietor of a designated undertaking involving any one or more of the activities specified in paragraph (b) of the definition of "designated undertaking" in section 2(1) of this Regulation, having an aggregate of 100 or more workers in a day working in 2 or more workplaces.
workplaces.
6. A proprietor of a designated undertaking involving any one or more of the activities specified in paragraph (c) of the definition of "designated undertaking" in section 2(1) of this Regulation, having an aggregate of 100 or more workers in a day working in 2 or more workplaces.

Part 4

1. A contractor in relation to construction work having an aggregate of 50 or more but less than 100 workers in a day working in 2 or more construction sites.
2. A proprietor of a shipyard business having an aggregate of 50 or more but less than 100 workers in a day working in 2 or more shipyards.
3. A proprietor of a factory having an aggregate of 50 or more but less than 100 workers in a day working in 2 or more factories.
4. A proprietor of a designated undertaking involving any one or more of the activities specified in paragraph (a) of the definition of "designated undertaking" in section 2(1) of this Regulation, having an aggregate of 50 or more but less than 100 workers in a day working in 2 or more workplaces.
5. A proprietor of a designated undertaking involving any one or more of the activities specified in paragraph (b) of the definition of "designated undertaking" in section 2(1) of this Regulation, having an aggregate of 50 or more but less than 100 workers in a day working in 2 or more workplaces.
6. A proprietor of a designated undertaking involving any one or more of the activities specified in paragraph (c) of the definition of "designated undertaking" in section 2(1) of this Regulation, having an aggregate of 50 or more but less than 100 workers in a day working in 2 or more workplaces.

Schedule 4 Elements of safety management system

Part 1

1. A safety policy which states the commitment of the proprietor or contractor to safety and health at work.
2. A structure to assure implementation of 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 provide instruction for achieving safety management objectives.
5. A programme of inspection to identify hazardous conditions and for the rectification of any such conditions at regular intervals or as appropriate.
6. A programme to identify hazardous exposure or the risk of such exposure to the workers and to provide suitable personal protective equipment as a last resort where engineering control methods are not feasible.
7. Investigation of accidents or incidents to find out the cause of any accident or incident and to develop prompt arrangements to prevent recurrence.
8. Emergency preparedness to develop, communicate and execute plans prescribing the effective management of emergency situations.

Part 2

1. Evaluation, selection and control of sub-contractors to ensure that sub-contractors are fully
aware of their safety obligations and are in fact meeting them.
2. Safety committees.

Part 3

1. Evaluation of job related hazards or potential hazards and development of safety procedures.
2. Promotion, development and maintenance of safety and health awareness in a workplace.
3. A programme for accident control and elimination of hazards before exposing workers to any adverse work environment.
4. A programme to protect workers from occupational health hazards.

(Extracted from CAP 59AF 2002)
Appendix II – Chapter 59I Construction Sites (Safety) Regulations

Schedule 3 Requirement with which certain safety equipment must comply

1. Width of working platforms, gangways and runs

(1) Subject to subsections (2) and (3), the width of any working platform, gangway or run shall be not less than 400 millimetres.
(2) Subject to subsection (3), the width of any gangway or run used for the movement of materials shall be not less than 650 millimetres.
(3) Where it is impracticable by reason of limitations of space to provide a working platform, gangway or run of the width required by subsection (1) or (2), then, in lieu of complying with that subsection, the working platform, gangway or run shall be as wide as is reasonably practicable.

2. Working platforms, etc. to be closely boarded, etc.

(1) Subject to subsection (2), every working platform, gangway and run shall be closely boarded or planked.
(2) Subsection (1) shall not apply to a working platform, gangway or run-
   (a) consisting of open metal work having interstices none of which exceeds 4000 square millimetres in area; or
   (b) the boards or planks of which are so secured as to prevent their moving and so placed that the space between adjacent boards or planks does not exceed 25 millimetres,
if there is no risk of persons below the platform, gangway or run being struck by materials or articles falling through the platform, gangway or run.

3. Boards and planks in working platforms, gangways and runs

Every board or plank forming part of a working platform, gangway or run shall-
   (a) be of sound construction, adequate strength and free from patent defect;
   (b) be of a thickness capable of affording adequate security having regard to the distance between the supports and be not less than 200 millimetres in width and not less than 25 millimetres in thickness or not less than 150 millimetres in width when the board or plank exceeds 50 millimetres in thickness;
   (c) not protrude beyond its end support to a distance exceeding 150 millimetres unless it is sufficiently secured to prevent tipping;
   (d) rest securely and evenly on its supports; and
   (e) rest on at least 3 supports unless, taking into account the distance between the supports and the thickness of the board or plank the conditions are such as to prevent undue or unequal sagging.

4. Coverings for opening

Every covering provided for an opening shall be-
(a) so constructed as to prevent the fall of persons, materials and articles; and
(b) clearly and boldly marked as to show its purpose or be securely fixed in position.

5. Height of toe-boards, etc.

The height of a toe-board or other similar barrier shall be not less than 200 millimetres.

6. Height of guard-rails

Subject to section 7, the height of a guard-rail above any place of work on a working platform, gangway, run or stairway shall be-

(a) in the case of a top guard-rail, not less than 900 millimetres and not more than 1150 millimetres;
(b) in the case of an intermediate guard-rail, not less than 450 millimetres and not more than 600 millimetres.

7. Exception to section 6

Section 6 shall not apply to a working platform on a bamboo scaffold if the platform is protected by not less than 2 horizontal bamboo members of the scaffold spaced at intervals between 750 millimetres to 900 millimetres.

8. Temporary removal, etc. of guard-rails, etc.

(1) Guard-rails, toe-boards and barriers may be removed or remain unerected for the time and to the extent necessary for the access of persons or the movement of materials or other purposes of the work concerned, but shall be replaced or erected as soon as practicable after the expiration of that time.
(2) Toe-boards shall not be required for stairs.

(Extracted from CAP 59I 1997)
Appendix III – Workshop’s Questionnaire

A1. How could we improve the performance of construction safety related to persons working at height?
如何提升工人在高空工作时的安全表现？

A2. What are the major causes of accidents related to fall of persons from height?
那些是构成高空下堕意外的主要因素？

A3. Are there any special in-house safety standards and procedures for persons working at height? If yes, what are they?
贵公司有没有一些已订立的安全指引或程序给予高空工作的员工？如有，请说明之。

B1. How could we improve the performance of construction safety related to persons working at height?
如何提升工人在高空工作时的安全表现？

B2. Are there any special in-house safety standards and procedures for persons working at height? If yes, what are they?
贵公司有没有一些已订立的安全指引或程序给予高空工作的员工？如有，请说明之。

B3. How would the types of works (e.g. new works, maintenance works and foundation works) affect the construction safety involving fall of persons from height?
工程的种类会对工人高空下堕的工业意外有何影响？（例如新建项目，保养工程和地基工程等。）

C1. What are the major problems/obstacles in implementing the safety procedures for persons working at height?
在执行高空工作的安全程序时，有那些主要的問題或困難？

C2. What are the common potential hazards that may cause a person falling from height in a construction site?
在工地内有那些普遍的潜在危险会导致工人从高处堕下？

C3. How can we improve the safety performance for persons working at height involving ladders?
怎樣可以改善工人於使用梯子時的工業安全？

D1. Can you provide any reasons for the frequent happening of fall accidents involving ladders based on 2001-2003 statistics (Please refer to appendix 1)?
就2001至2003年的意外数字（附件一），你能否提供那些導致工人由梯子下堕的原因？

D2. How can we improve the safety performance for persons working at height involving ladders?
怎樣可以改善工人於使用梯子時的工業安全？
D3. What are the major differences in terms of safety standards and procedures between ArchSD projects and private development projects?
就安全規則和安全程序而言，建築署的項目和私人發展的項目有何不同？
List of other safety research monographs published by Members of the Construction Safety Research Group of the Research Centre for Construction and Real Estate Economics (RCCREE):


