

# ACCIDENT AVOIDANCE IMPORTANCE FOR BUILDING DEMOLITION

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## ABSTRACT

Building demolition, as compared to building construction is always carried out as quickly and cheaply as possible. The nature of limited time and resources of the demolition project sometimes translate into poor work planning and safety precautions. In recent years, demolition work has become more complicated due to the high diversity of building types and there are various demolition techniques and strategies. It is important to have a clear understanding of the type of building to be demolished, the method to be used and risks involved to ensure proper work planning. Using historical data on demolition related accidents; this paper discusses the classification of injuries and causes of the accidents. To conclude, strategies for better understanding of demolition work and good practices of site safety are recommended.

**Keywords:** Building demolition, Safety, Workplace accidents, Injury

## INTRODUCTION

Safety is a major concern in the construction industry. Work related injuries and fatalities cause great loss to the industry. In Australia (ABS, 2006) and New Zealand (Statistics New Zealand, 2003), construction industry is recorded as the third highest rate of injuries among other main industry. Being one of the most high risk occupational areas in the world, workers in construction industry face a wide range of physical hazards. These include working at elevated areas, mobile machinery, electricity, various tools and power tools.

Accident avoidance is always an ultimate goal in safety related researches. Construction safety researches cover many topics; one of the main topics is safety management where researchers investigate management practices and policies that can improve safety performance. Other researches include safety hazard identification and integrating safety with construction schedule where all safety consideration can be included at the early stage of construction (Carter and Smith, 2006). There are also researches on accident causes and analysis, where here researchers investigate into the causes of accident to understand how it happened so that measures to avoid it can be taken (Hinze et al., 1998; Ale et al., 2008). Safety culture and awareness among construction organisation and personnel are also being studied, in this field of research, it is found that safety awareness, knowledge and safety training are key important elements to promote safety culture (Zou and Zhang, 2009; Mohamed, 2003).

Similar to construction, building demolition also possesses certain safety risk. Since the nature of demolition work is different from construction work, it is believe that demolition work imposed slightly different safety hazard. However there is no study focus on demolition safety. A better understanding of the safety risks in demolition work is therefore needed to avoid demolition related accidents in the future.

This paper aims to classify the causes of injury related to building demolition works. Firstly, the nature of demolition work is briefly described. Then, construction industry fatal injuries narratives are investigated, injuries related to demolition are extracted and the causes of injuries are classified. From here the trend of demolition related injury is identified and concluded that it is different compared to construction. Potential measures for accident avoidance are outlined at the end of this paper.

## BUILDING DEMOLITION METHODS

The demolition process is the opposite of construction. Construction involves putting up a structure while demolition involves pulling it down. The most common reasons for demolition job are the building age and the safety condition of the building. When a building is no longer fulfil its purpose, it will be demolished to make way for new building to be constructed. Demolition work use to be a simple job. It can be handled by a few men with unsophisticated equipment. Nowadays building structure has evolved becoming more complicated and so does the demolition work. There are many ways to demolish a building. The selection of demolition method must consider the building size, structural types and building location. The general rule is the safest and simplest method that can do the job is the one selected.

Generally, demolition work can be carried out either manually or mechanically. Manual demolition work involves the uses of intensive labour and normally it will take a longer time to accomplish. This type of demolition is also known as deconstruction, where building component will be dismantled systematically in the reverse order of construction process. The main advantages of this method are, it will produces building materials that are in good quality, easily to be sorted and readily to be reused or recycled. Mechanical demolition on the other hand involves the uses of heavy machineries such as excavators and bulldozers to pull or push down a building. Less labour is required for mechanical demolition and the job could be handled rather quickly. This method however produces mixed debris of building materials which normally to be sent to landfill area (Pun et al., 2006). Sometimes contractor used both of this method on a building demolition project. The combination of these two methods often called hybrid demolition technique. Using this method, the contractor will gain advantages from both methods describe above where the project could be carried out quickly, less labour intensive and can gain some income from salvaged material.

From here, it is seem that building demolition when compared to building construction is always carried out as quickly and cheaply as possible. The nature of limited time and resources of the demolition project sometimes translated into poor work planning and safety precautions.

## ACCIDENT FREQUENCY DURING DEMOLITION ACTIVITIES

Accidents do happened during building demolition process but accident records specifically on demolition project are not available. Demolition accident records are normally included in the construction injuries databases. Work related injury report or database from Australia and United Kingdoms is used as an example to support this study. Initial indication of demolition related injuries come from Australian Safety and Compensation Council's reports on "Work-Related Injury Hospitalisations, Australia 2002–03 and 2003–04" where it indicated that 66 cases of injuries happened at demolition site (Table 1). The percentage of injuries related to demolition work is relatively low (0.4%) as compared to injuries happened at construction site which is 2,611 cases or 17.6%.

Place	Number of cases	%
Factory & plant	5,923	39.8%
Construction area	2,611	17.6%
Mine & quarry	1,240	8.3%
Shipyards	172	1.2%
Oil & gas extraction	74	0.5%
Demolition site	66	0.4%
Power station	52	0.3%
Others industrial & construction area	1,677	11.3%
Unspecified industrial & construction area	3,054	20.5%
Total	14,869	100.0%

Source: (ASCC, 2007)

**Table 1: Places of injury occurrence for industrial and construction area, Australia 2002-03 and 2003-04.**

Another available record of demolition injuries is from a survey conducted by British Market Research Bureau's (BMRB), "The Construction Workers Survey" participated by 5,813 construction workers between January 2005 and April 2006 indicate that 15 cases or 3.2% incidents happened at demolition site (Table 2). Similar to the data from ASCC' report, the number of injuries is relatively low as compared to other construction projects. However, BMRB survey also indicates that incident rate at demolition projects is relatively high (2.91 accidents per project). From this data, it is believed that demolition work imposed a higher safety risk to the worker as compared to normal construction work.

Project where accidents occurred	No of cases (%)	Ratio Acc/Proj
New building	104 (22.2%)	0.69
Refurbishment/repair	120 (25.7%)	0.95
Civil engineering	24 (5.1%)	0.73
Demolition	15 (3.2%)	2.91
Roads and paving	21 (4.5%)	1.50
Roofing	15 (3.2%)	1.07
Painting and decorating	12 (2.6 %)	0.65
Electrical work	21 (4.5%)	1.13
Cable/pipework	7 (1.5%)	0.75
Exterior cleaning - buildings	6 (1.3%)	6.50
Bridge building	6 (1.3%)	2.89
Building services	19 (4.1%)	0.68
Other	97 (20.8%)	2.97

Source: (HSE, 2008)

**Table 2: Project where accidents occurred, United Kingdom.**

### ACCIDENT CAUSES DURING DEMOLITION ACTIVITIES

When there is an injury happened, normally the reporting system will identify what type of accident and how does it occur (Abdelhamid and Everett, 2000). According to OSHA (1990), how the accident occurs is classified into five categories which are falls, struck-by, electric shock, caught in or between and others. Some researchers think that the accidents investigation normally stops at premature level since why the accidents occur are not addressed (Choudhry and Fang, 2008). However there are many accident causation theories had been developed such as domino theory in 1930 by Heinrich H. W. and multiple causation model by Petersen D. in 1971. There are also human error theories to explain accident causes.

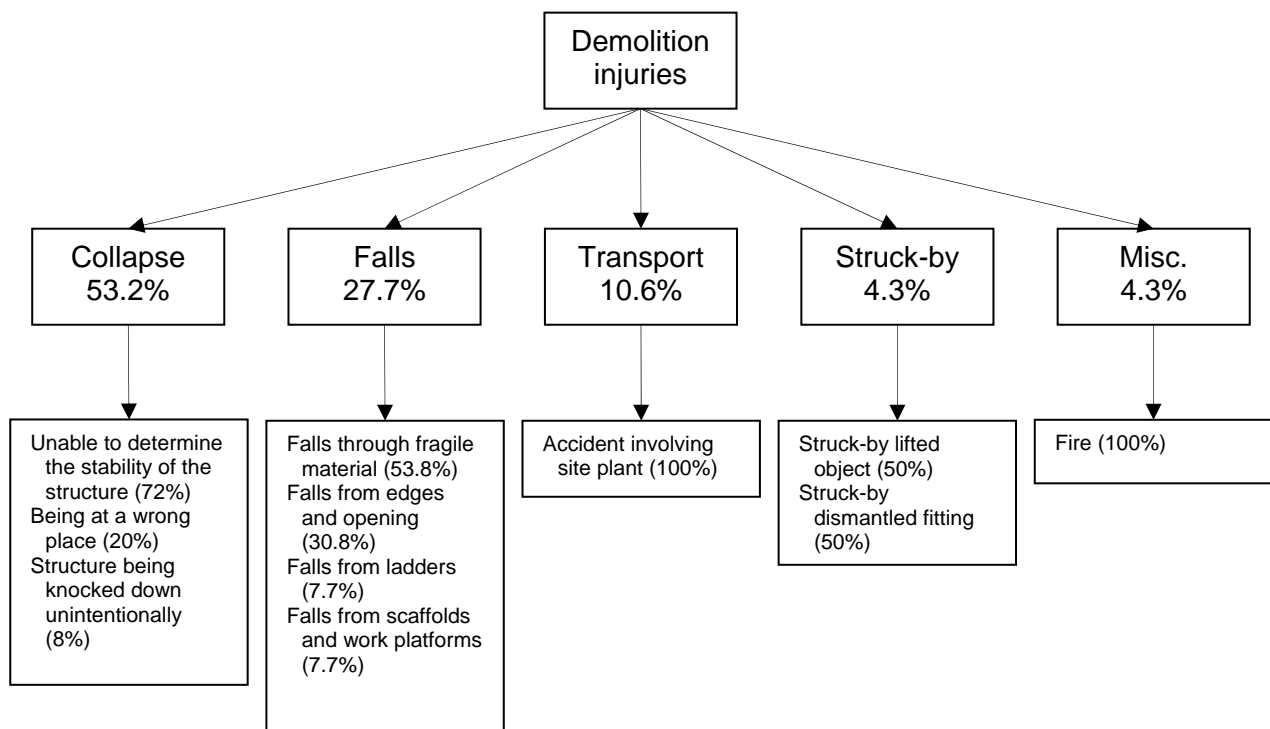
Causes	Demolition		Construction		Total	
	Number of cases (%)		Number of cases (%)		Number of cases (%)	
Falls	13	1.97%	312	47.34%	325	49.32%
Electricity	0	0.00%	57	8.65%	57	8.65%
Transport	5	0.76%	105	15.93%	110	16.69%
Collapse	25	3.79%	46	6.98%	71	10.77%
Struck-by	2	0.30%	52	7.89%	54	8.19%
Miscellaneous	2	0.30%	40	6.07%	42	6.37%
Total	47	7.13%	612	92.87%	659	100%

**Table 3: Comparison of injury causes for demolition and construction works.**

For the purpose of this study, the data from Health and Safety Executive (HSE), UK "Summaries of Fatal Accidents for 1997/98 – 2004/05 is used as an example to identify injury causes related to demolition work. From the construction fatal accident narratives listed in the report, accidents related to demolition work are identified and sorted into 6 categories which are falls, electricity, transport, collapse, struck-by and miscellaneous. As shown in Table 3, the highest cause of fatality

related to building demolition is collapse of the building structure (3.79%) followed by falls (1.97%), transport (0.76%), Struck-by and miscellaneous both at 0.30% and there is no cases caused by electricity (0%). It seems that the trend of demolition related accident causes is different as compared to the trend of overall construction accident causes which goes by falls being the highest causes at 49.32%, followed by transport (16.69%), collapse (10.77%), electricity (8.65%), struck-by (8.19%), and miscellaneous (6.37%).

Further investigation on the main cause of injury which is collapse of building structure; indicate that 72% of the accidents happened because the workers are unable to determine the stability of the structure, 20% injury caused by workers being at a wrong place during demolition work and another 8% are caused by structure being knocked down unintentionally. Investigation on falls reveals that 53.8% of injuries are caused by falls through fragile material, 30.8% are by falls from edges and opening. Falls from ladders and falls from scaffolds or work platforms are both at 7.7%. All transport related injuries are caused by accidents involving site plant such as bulldozer, excavator and telescopic handler. Two Struck-by injuries are caused by lifted object and dismantled building component and miscellaneous injuries are caused by fire. These entire figures are summarized in Figure 1 below.



**Figure 1: Summary of demolition related injury causes.**

### IMPORTANCE TO AVOID ACCIDENT DURING DEMOLITION WORKS

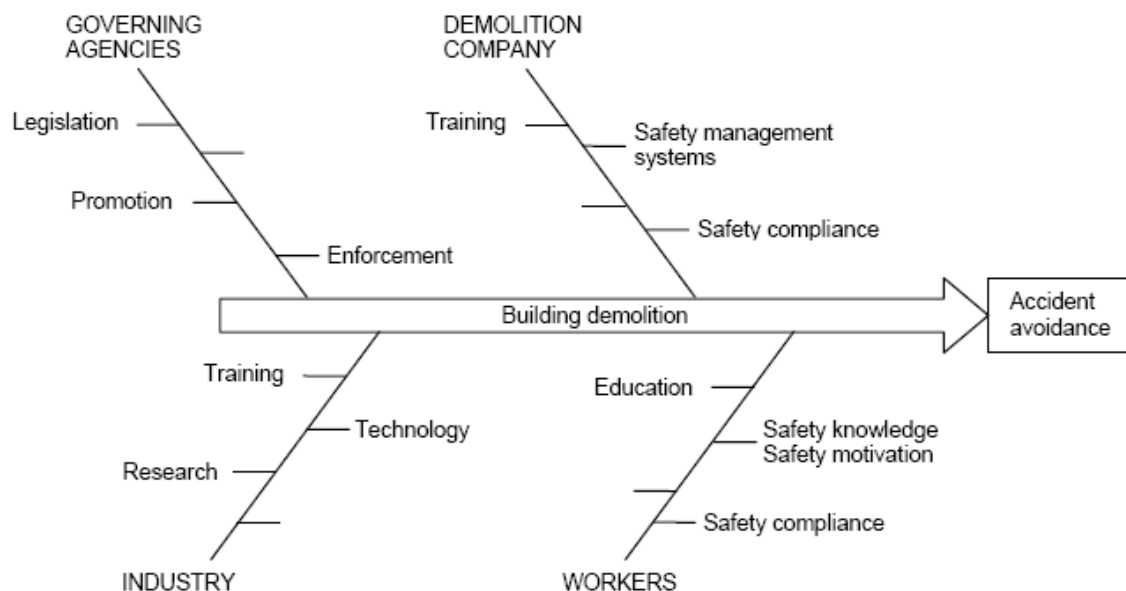
The number of accident in construction industry and also during building demolition can be considered as high. However, accidents can be avoided with the implementation of suitable safety measures. Accident avoidance in demolition project must begin with an understanding on the possible causation of the accidents. Basically accident happened due to two main factors which are unsafe conditions and unsafe practices. Unsafe conditions are referring to work environment at construction site and unsafe practices are related to workers attitudes and behaviours towards safety, knowledge, awareness and compliance on safety procedures. Most authorities recommend that accident can be reduced by better supervision, work planning and organisation. Petersen D. suggest that to avoid accidents at construction site, inspection procedures must be improved, conduct proper training to all workers, make better assignment of responsibility and proper planning prior to job execution (Choudhry and Fang, 2008).

In relation to normal practice at demolition project, the implementation of a strategic pre-demolition quality system that includes all safety requirements that will follow through from the planning to the execution of the demolition project will ensure that all parties involved adhere to the quality standards of the demolition process. As with all projects, successful planning concludes with successful projects, therefore implementing and the use of early quality strategies maintains early control with minimal cost and possible safety consequences.

The demolition quality system may be divided into 7 sections that includes there own sub headings. Clarity of all areas of the demolition project will enable prevention of demolition accident and underpin safety. The 7 sections are scope of demolition, planning and statutory requirement, hazardous material audits, hazardous material removal, methodology of demolition, isolation of works, and qualification of contractors.

Within each section there are compulsory safety requirements through the relevant Act, Regulations and codes. Furthermore to safety, organizational safety plans are required to coincide within the sections.

From the study we can see that the main cause of demolition accident is worker being struck-by collapsing building structures. It is seems that many demolition workers are not well converse of the structural nature of what is being taken down. Therefore a supervisor for demolition work must be someone that knowledgeable and highly experienced not just only in demolition but also in building construction. Before carry out the demolition work, the supervisor should examine building plan of the properties and if the plan is not available, he should make his own survey so that the building structural type can be identified and the demolition work can be properly planned. From this observation, a suitable demolition method can be selected and once the overall work plan has been lay-out it should be explained and discussed with all workers and other site operatives. During this briefing, not only the sequence of operations should be explained but it should also include the safety risk involve and safety measures to be taken. In carrying out the work that has been planned, it is best that supervision and guidance to worker are done continuously.



**Figure 2: Potential measures towards accident avoidance in building demolition.**

On a larger scale, potential measures towards accident avoidance in building demolition can comes from different level of organisations such as governing agencies, industry, demolition companies and lastly the workers or the individuals that involve with demolition work himself. Figure 2 suggest potential measures from different level of organisations. Governing agencies produce regulations, and by-laws related to safety. Later it will promote and enforcing it. The industry player can focus on research, introduce new technology and also conduct a promotion or

education program towards safety. Demolition companies can embrace safety management systems which include safety policy and objectives, safety standards, planning and organization of work and also conduct safety training for all workers. All these measures are related to one another to achieve the ultimate goal of accident avoidance.

## CONCLUSION

Demolition work is different from construction work; it is the direct opposite of construction work. There are various demolition methods available. Two of the most common methods are deconstruction and mechanical demolition. Even though demolition method selected is always the simplest and the safest method, there are accidents happened during demolition work being recorded. The number of reported demolition related accidents is relative low as compared to construction's accident but the accident rate is actually higher. While the result of this study is based on a very limited data; nevertheless it has shown that there are differences between injury trend in demolition work and construction work. Collapse of building structure is a main cause of injury in demolition work while falls is a main cause of injury in construction work. Further investigation on the collapse of the building structure indicates that accidents happened because of the inability to determine the stability of the structure by the workers. Safety pre-caution consideration during demolition work must be different from normal construction work with greater attention on how to bring down building structure safely and to avoid unintentional collapse. Collective measures from governing agencies, industry, demolition companies and workers are very importance to avoid accident from happening. However, further study on these measures and more research on demolition related injury should be conducted in the future to give better understanding on the risk involve and how to manage it.

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