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# AN INVESTIGATION OF FATAL ACCIDENTS IN DEMOLITION WORK OF BUILDINGS

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Buildings constructed in Japan during a period of high economic growth, 1954–1973, have deteriorated, and many need to be demolished. In the course of that demolition work, accidents have occurred, but the causes and circumstances of many of them are largely unknown. This study investigates accidents that occurred during building demolition work in Japan between 2010 and 2014, with the goal of preventing future accidents. The results show that fatal accidents while demolishing buildings accounted for 6.5% of all fatal accidents on construction sites. The greatest number of fatal accidents can be attributed to falls and collapsing walls. The causes of falls were found to be two-fold. First, in the process of demolishing a building, frequently, a hole is cut in the floor and scrap materials are thrown into it to dispose of them; however, workers have been known to fall into this hole and be injured fatally. It was also found that many workers do not use full harnesses. The cause of collapsing walls was identified as follows. When a wall is demolished, its lower part is often cut through to weaken it, at which point the wall can collapse, crushing workers. Analysis of the study results shows that greater attention must be paid to creating a system that promotes fall prevention and safe wall-cutting on demolition sites.

*Keywords*: Fall, Collapse, Japan, Occupational injuries.

## 1 INTRODUCTION

The buildings constructed in Japan during a period of high economic growth, 1954–1973, have deteriorated, and many need to be demolished. In addition, accidents have occurred during restoration work after the 2011 Great East Japan Earthquake. But, the causes and circumstances of many of them are largely unknown.

There is a difference in competence among demolition firms in Japan. Highly competent demolition firms can safely demolish high buildings. But, many accidents occur during work by incompetent demolition firms. Qualification programs exist to improve skills and safety (JCTC 2018 and JDCA 2018). These programs cover the duties of workers, the relevant laws, demolition methods, and the practical business of ensuring a safe work environment. Workers who complete the qualification programs become demolition site supervisors. In addition, the qualification examination exists to improve construction management ability (JDCA 2018). The examination tests knowledge of demolition methods and equipment, ability to create construction plans and quotations for demolition works, and ability to manage demolition works and teach workers. Workers who pass the qualification examination become technical managers of demolition works. But these programs and examinations do not address the present situation regarding accidents during demolition works.

There are papers on the destruction of concrete (Suzuki *et al.* 2018 and Yuasa 2018), a study on supporting machines on the floor (Aoki *et al.* 2018), and research on asbestos (Horie *et al.* 2017). However, there are no scholarly articles on the present situation of accidents during demolition work. There are safety prevention guidelines (PBA 2013), recommendations (JCOSHA 2012a, JCOSHA 2012b and JCOSHA 2016), and technical books (SGDM 2017) on demolition work, but they do not address the current situation of accidents during demolition work.

This study investigated fatal accidents that occurred during building demolition work in Japan over a five-year period, with the goal of preventing future accidents.

## 2 METHOD OF INVESTIGATION

The fatal accident data used were public data from the government of Japan (Ministry of HLW 2018) and included the types and causal agents of the accidents. From the fatal accident data, the study surveyed a sample of building demolition accidents that occurred during a five-year period, between 2010 and 2014.

## 3 RESULTS OF INVESTIGATION

### 3.1 Occurrences by Year

Figure 1 shows the fatal accidents occurring during building demolition work by year. The figure shows that the number of fatal accidents has decreased gradually since 2012. For comparison, Figure 2 shows fatal accidents at all construction sites by year. As that figure shows, the number of fatal accidents occurring annually at all construction sites remained consistent until increasing in 2014. The fatal accidents during building demolition work were about 6.5 % of all fatal accidents on construction sites during the period investigated.

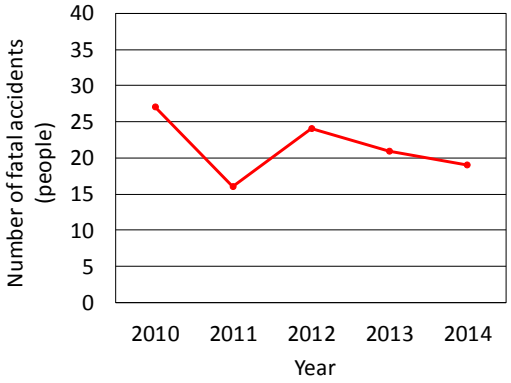



Figure 1. Fatal accidents during building demolition work by year.

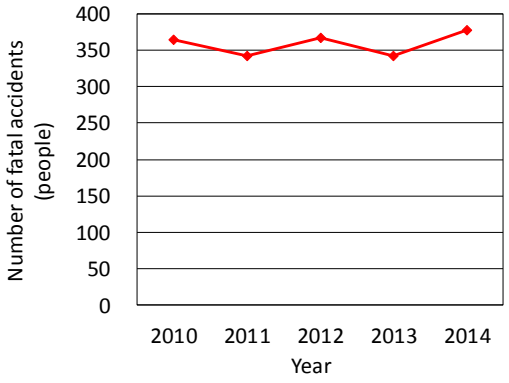



Figure 2. Fatal accidents at all construction sites by year.

### 3.2 Occurrences by Type

Figure 3 shows fatal accidents during building demolition work by type. The highest number, 56, were attributed to "Fall," which accounted for 52% of fatal accidents during demolition work, followed by "Collapse," which killed 20 workers and accounted for 19% of fatalities.

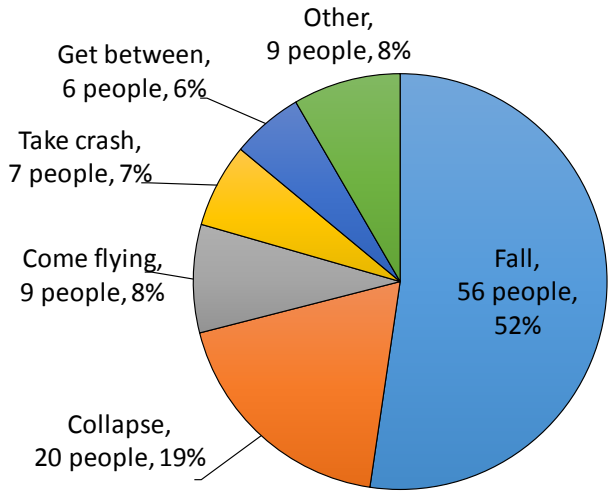



Figure 3. Fatal accidents during building demolition work by type.

### 3.3 Fatal Fall

Figure 4 breaks down fatal falls by the cause of the fall. Slate roof, wooden house, and steel-framed building each caused a significant number of fatal falls.

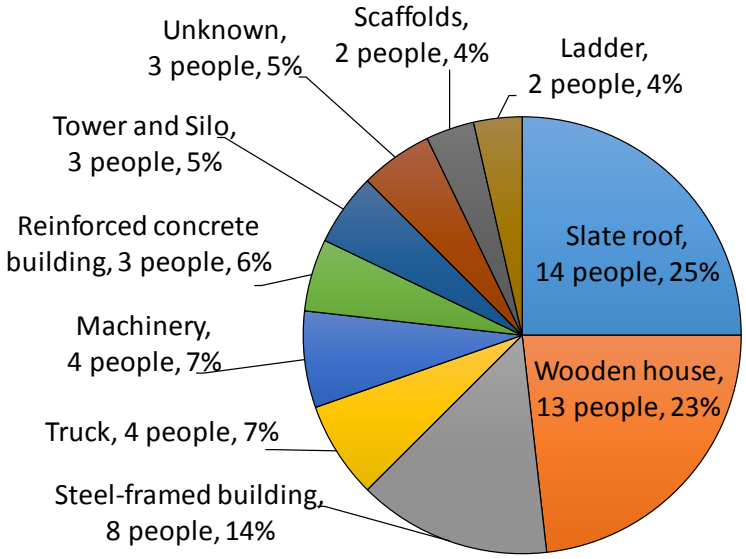
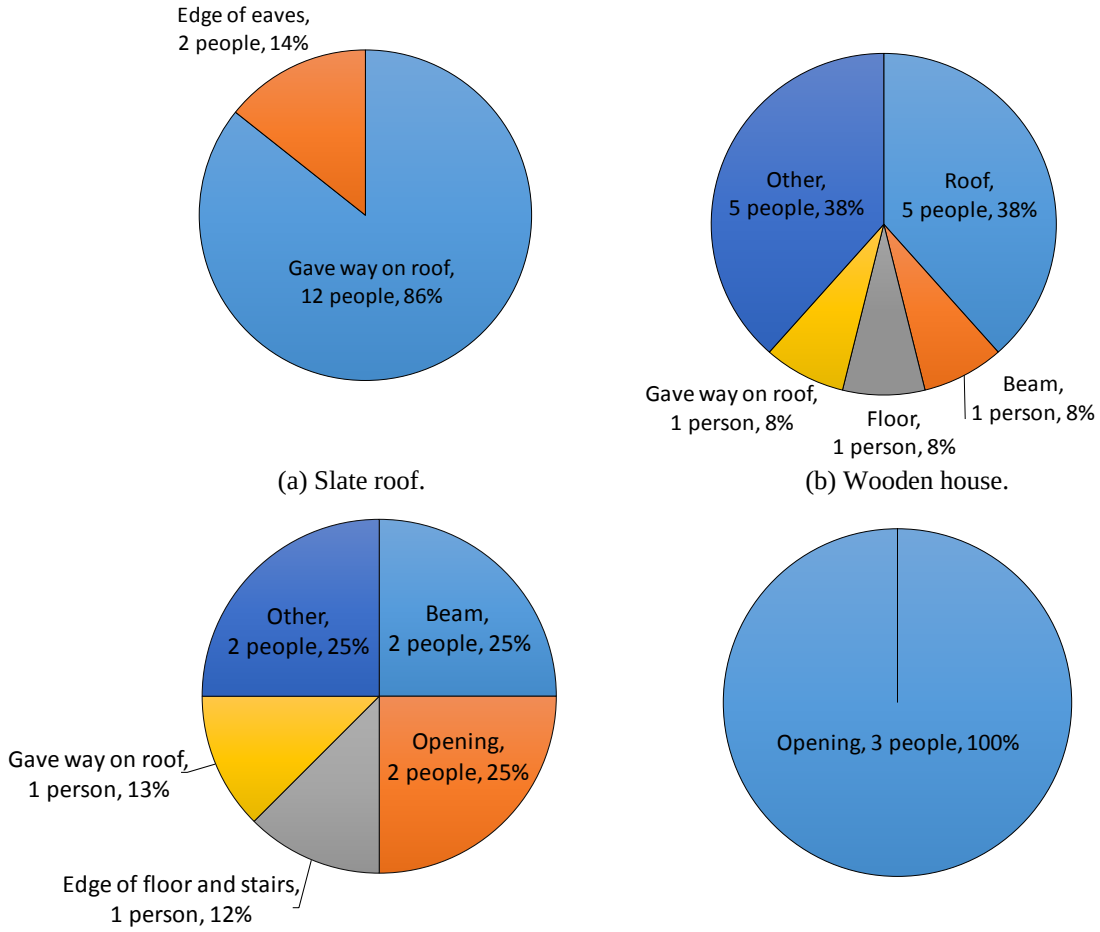



Figure 4. Fatal falls during building demolition work by causal agents.

Figure 5 breaks down the three biggest causes of fatal falls, identified in Figure 4, by the major causal agents for each. Figure 5(a) shows that "Roof tile gave way" is the major cause of falls from slate roof. Figure 5(b) shows that "Falling from roof" is the major type of fatal fall associated with wooden houses. Figure 5(c) shows that "Beam" are the most frequent site of fatal falls from steel-framed building. Figure 5(d) shows that "Opening" are the most frequent site of fatal falls in reinforced concrete building. The workers fall through these openings, into which

they throw pieces of broken concrete to dispose of them. Workers must also set up guardrails around excavations to prevent falls.

The rates of these fatal falls are increased by the fact that workers are not using full harnesses during demolition work (JCOSHA 2018). Given this, these accidents cannot be prevented just by knowing the causal agents of the falls. Fall prevention must include making sure that every worker wears a full harness every time that it is warranted. However, the set of main rope is difficult during demolition work because the strength of an unstable structure is unclear. There is no fall prevention method during demolition work. Fall prevention methods must be examined during demolition.




(a) Slate roof. (b) Wooden house.

(c) Steel-framed building. (d) Reinforced concrete building.

Figure 5. Fatal falls during building demolition work by part of the structure involved.

### 3.4 Collapse

Figure 6 breaks down fatalities from collapsing walls, the second most frequent cause of demolition site fatalities, by causal agent.

In Japan, when workers demolish concrete and wooden walls, they knock them down (JCOSHA 2012a, JCOSHA 2012b). Before doing this, they cut through the lower part of each

wall to weaken it. If the cut is too deep, the wall may collapse during cutting and crush the worker. If a concrete wall is reinforced with steel, the worker cannot tell how much of the steel has been cut through, which may increase the chances that the wall collapse and crush the worker. Guidelines (PBA 2013), recommendations (JCOSHA 2012a, JCOSHA 2012b and JCOSHA 2016), and technical books (SGDM 2017) do not discuss the extent to which a wall should be cut. Because there is no uniform standard regarding how deeply to cut into walls, a worker knocking down a wall does not know how to minimize the danger of the wall collapsing. Another cause of crushing fatalities is workers entering areas of unsteady walls during the demolition process. Research is needed into how deeply to cut into walls. Such research would enable the proposal of uniform technical standards regarding wall demolition that would improve safety.

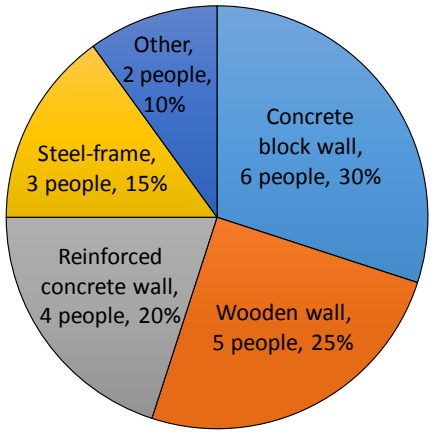



Figure 6. Fatalities due to collapsing walls by wall type.

## 4 CONCLUSIONS

This study investigated fatal accidents that occurred during building demolition work in Japan between 2010 and 2014. The results showed that fatal accidents while demolishing buildings accounted for 6.5% of all fatal accidents on construction sites during that period. The greatest number of fatal accidents can be attributed to workers falling and walls collapsing.

In the process of demolishing a building, frequently, a hole is cut in the floor into which workers throw scrap materials to dispose of them. A significant number of fatal injuries is caused by workers falling into this hole. Another significant cause of fatal falls is that workers fail to wear full harnesses. Furthermore, when a wall is demolished, its lower part is often cut into to weaken it, but if the cut is too deep, the wall may collapse, crushing the worker.

Given these major causes of fatalities on demolition sites, greater consideration must be given to promoting harness use to prevent fatal falls, and safe wall-cutting to prevent collapses that crush workers. Finally, we must evaluate the fall-prevention methods, and safety-management methods used during wall demolition.

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