

Research on Fall Prevention and Protection from Heights in Japan

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Abstract: The high frequency of fall accidents is a serious problem in Japan. Thus, more stringent countermeasures for preventing falls from scaffolds were developed and incorporated into institutional guidelines. These countermeasures aim to decrease deaths caused by falls from scaffolds. Despite the improvements in such measures, however, the rate of accidental fall deaths remains high in Japan's construction industries. To improve the rigor of the countermeasures, a committee was established in our institute by the Japan Ministry of Health, Labour, and Welfare. This committee investigated the regulations applied in other countries and evaluated construction industry compliance with existing fall prevention guidelines. After considerable research and discussion, the Occupational Safety and Health Regulations and Guidelines were amended in 2009. The effects of the amended regulations have recently been investigated on the basis of accident reports. This paper describes the investigation and its results. The paper also discusses other research and workplace safety countermeasures for preventing falls and ensuring fall protection from heights.

Key words: Fall, Accident, Scaffolds, Construction, Advanced guardrail

Introduction

Fall accidents from heights are a serious problem in the construction industry in Japan, with approximately 40% of fatal accidents during construction attributed to workers' falls. To resolve this problem, Japan introduced countermeasures for reducing falls from scaffolds and strictly enforces these measures with various safety guidelines. These countermeasures have lessened the number of fatal accidents caused by falls from scaffolds. Nevertheless, the frequency of such accidents remains high in the construction industry, thus prompting officials to consider additional countermeasures a priority in the 11th Occupational Safety & Health Program. To examine further countermea-

asures for reducing falls, the Japan Ministry of Health, Labour, and Welfare (MHLW) established a committee in our institute, the National Institute of Occupational Safety and Health (JNIOSH). As a result of the committee's research and discussion, the Occupational Safety and Health Regulations of Japan were amended in 2009. The effects of the amended regulations have recently been investigated on the basis of the accident reports provided by the Labour Standard Office of Japan.

This paper describes research on the amended regulations and the results of the investigation into their effects. The paper also discusses other workplace safety research initiatives and countermeasures for fall prevention and protection from heights.

Background of Regulation Amendment

Figure 1 shows the number of accidental deaths in the Japanese construction industry in 2009. As previously

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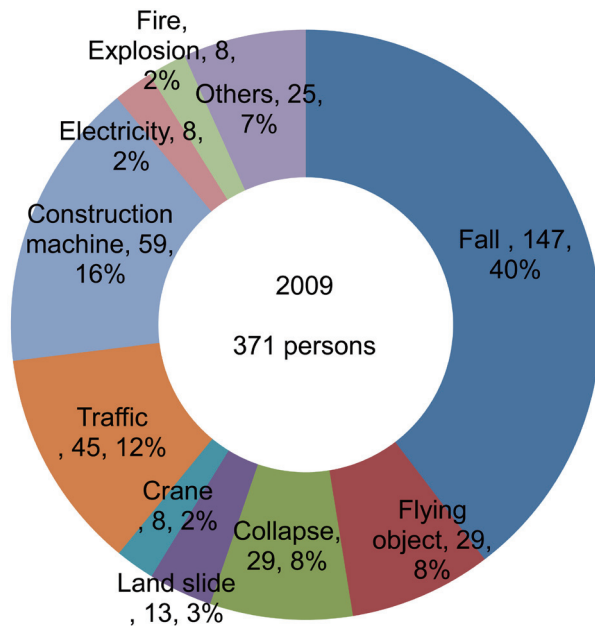


Fig. 1. Number of accidental deaths in the Japanese construction industry in 2009.

stated, approximately 40% of fatal accidents during construction were caused by workers' falls from heights and some were caused by falls from scaffolds.

To develop additional preventive measures for scaffold-related falls, the MHLW established a committee at the JNIOHS. This committee is mandated to investigate the safety regulations applied in the construction industry in other countries and to evaluate various Japanese construction methods in accordance with current safety guidelines. The committee's work experimentally confirms the effectiveness of using scaffold sheeting as a covering around scaffolds in preventing falls. This method is extensively used in Japan, as shown in Fig. 2.

Figure 3 shows the typical pipe scaffolds and prefabricated scaffolds used in Japan before 2009. On pipe scaffolds, workers sometimes fall from the space between a guardrail and a work platform, whereas on prefabricated scaffolds, falls occur from the space between braces and a work platform. Scaffold sheeting, which envelops a scaffold, can prevent workers from falling, as shown in Fig. 3, but the level of its effectiveness remains unclear. To address this problem, the effectiveness of scaffold sheeting was experimentally examined using a human dummy that weighs 700 N, which is the average weight of Japanese males.

Table 1 describes the experiments, for which the cases are the same as those considered in earlier studies¹⁾. A dummy was arranged in positions or postures that simu-



Fig. 2. Scaffolds covered with scaffold sheeting.

lated walking (Cases 1 and 4), tripping at the edge of a platform (Cases 2, 5, and 10), and sitting while at work (Cases 3, 6, and 11). An experiment was also carried out using a slide to confirm the strength of scaffold sheeting (Cases 7–9). For Case 8, deteriorated sheeting was used because scaffold sheeting is typically re-used in construction sites. In all the experiments, the dummy did not fall from the scaffold despite the postures and the deterioration of the sheeting, thus leading us to conclude that scaffold sheeting is an effective fall prevention measure²⁾.

Regulation amendment

Nonetheless, occasional falls from the space between work platforms and scaffold sheeting continued to occur. Such incidents are attributed to space expansion stemming from the pressure exerted by workers' bodies (Fig. 4). When workers reach down to the sides of scaffolds to conduct work, they push the sheeting to make room for movement, thereby widening the space between the platform and the sheeting. Given this consideration, the committee regarded scaffold sheeting as an imperfect means of preventing falls from scaffolds. With reference to the regulations in other countries, the committee discussed and recommended the installation of mid-rails, lower bars, and other similar structures to prevent falls from the space between a guardrail and the work platform erected on scaffolds.

In consideration of the committee's recommendations, the Occupational Safety and Health Regulations were amended in 2009 (Fig. 5). This study investigates the effects of the amended regulations on the basis of the accident reports provided by the Labour Standard Office of Japan.

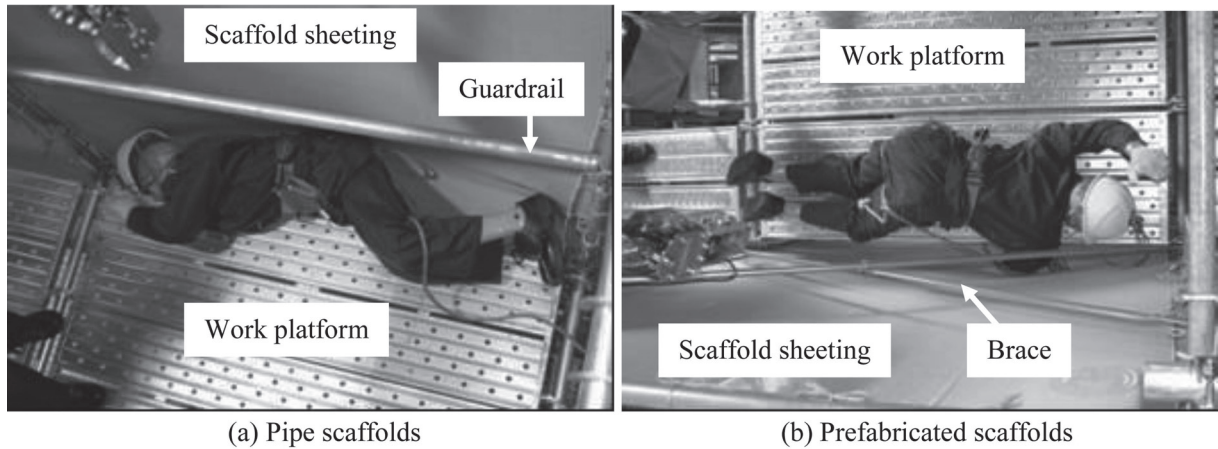













Fig. 3. Typical pipe and prefabricated scaffolds used in Japan before 2009.

Table 1. Experimental cases

Case	Posture	Type of scaffolds	Photos	Case	Posture	Type of scaffolds	Photos
1	Standing	Prefabricated		6	Sitting and fall from back	Pipe	
2	Crawl on hands and kness	Prefabricated		7	Sitting and fall to 1 m using slide	Prefabricated	
3	Sitting and fall from back	Prefabricated		8	Sitting and fall to 1 m using slide	Prefabricated Deteriorated sheeting	
4	Standing	Pipe		9	Sitting and fall to 1 m using slide	Pipe	
5	Crawl on hands and kness	Pipe		10	Crawl on hands and kness, and fall to 0.2 m using slide	Prefabricated	
				11	Sitting and fall from front	Prefabricated	

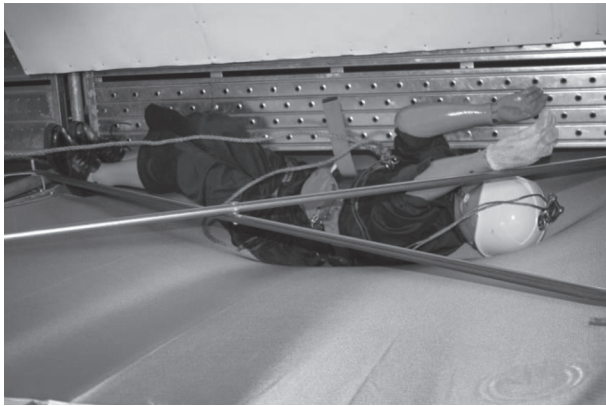


Fig. 4. This dummy almost fell from the space between the scaffold sheeting and the work platform.

Effects of Amended Regulations

Frequency of injury accidents

Labor accidents, in which workers are killed or are compelled to rest for more than three days because of injury, are documented by the Labour Standard Office. We examined the reports on injury accidents resulting from falls from scaffolds³⁾. Table 2 shows the changes in the number of injury accidents from 2007 to 2011. From 2008 to 2009, the number of scaffold-related fall accidents drastically decreased from 1,227 to 828. This finding confirms the effectiveness of the amended regulations in decreasing accident frequency.

Factors contributing to falls from scaffolds

To determine other factors that contribute to falls from scaffolds, the injury accident reports were further analyzed. Figure 6 shows the classification of factors that caused fall accidents in 2011. Approximately 90% of the accidents (involving 378 persons) occurred in work environments characterized by illegal conditions. Most of these fall accidents could have been prevented through compliance with the amended regulations. Additionally, 42.2% of the accidents (involving 38+140=178 persons) occurred because of unsafe acts. In addition to compliance with the amended regulations, therefore, risk assessment and safety education are needed.

Figure 7 shows an example of a risk assessment concept for preventing falls from scaffolds. This concept was adapted from that applied in the manufacturing industry in Japan. Taking into account construction site situations and work durations, such risk assessment should be performed to ensure the development and implementation of appropriate countermeasures for fall prevention and protection.

Scaffold Construction Guidelines

Preceding guardrail installation method

In Japan, the preceding guardrail installation method is occasionally used to prevent falls from scaffolds. The MHLW 2003 safety guidelines aimed to increase the adoption of this method, but these guidelines were amended in 2009 for the purpose of fostering enhanced safety in work environments. Figure 8 illustrates the installation method for a preceding guardrail. In this method, upper guardrails are always set from lower platforms using advanced guardrails, and workers are constantly protected from falls by the advanced guardrails at the top of a previously erected scaffold. The MHLW investigated the use rate of this method on 3,657 construction sites. Figure 9 shows the results. Approximately 34% of construction sites use this method³⁾, indicating moderate adoption.

Preceding scaffold construction method

In Japan, the preceding scaffold construction method is typically used in house construction projects (Fig. 10). The MHLW 1996 safety guidelines aimed to encourage the use of this method, but these guidelines were amended in 2006, also to ensure improved safety in work environments.

Figure 11 shows a house constructed by the aforementioned method, in which scaffolds are assembled before the frame of the house is erected and are used in all construction stages to prevent falls by guardrails. This method is extensively adopted in housing construction sites; as a result, fatal fall accidents in such areas decreased by more than 75% between 1996 and 2005⁴⁾.

Other Research on Fall Prevention and Protection from Heights

The 12th Occupational Safety & Health Program⁵⁾ addresses recent occupational accidents and social changes in Japan. The program is a five-year plan that was initiated in April 2013 and ends in fiscal year 2017. The research discussed in the succeeding section is performed in cooperation with the MHLW and the JNIOOSH and carried out in accordance with the Program.

Promote measures to prevent falling to a lower level from various locations

Falling from scaffolding accounts for about 15% of falling accidents, while falling from ladders and roofs accounts for about 40%. In addition to the measures to prevent falling from scaffolding, equipment and ways to

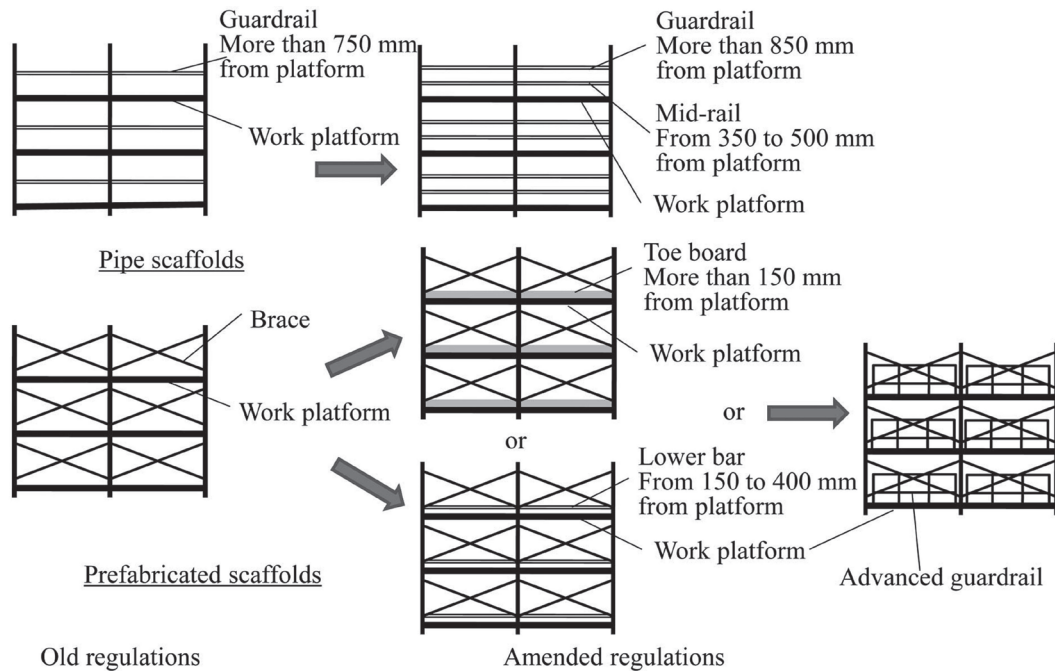


Fig. 5. Fall prevention as outlined in the amended regulations.

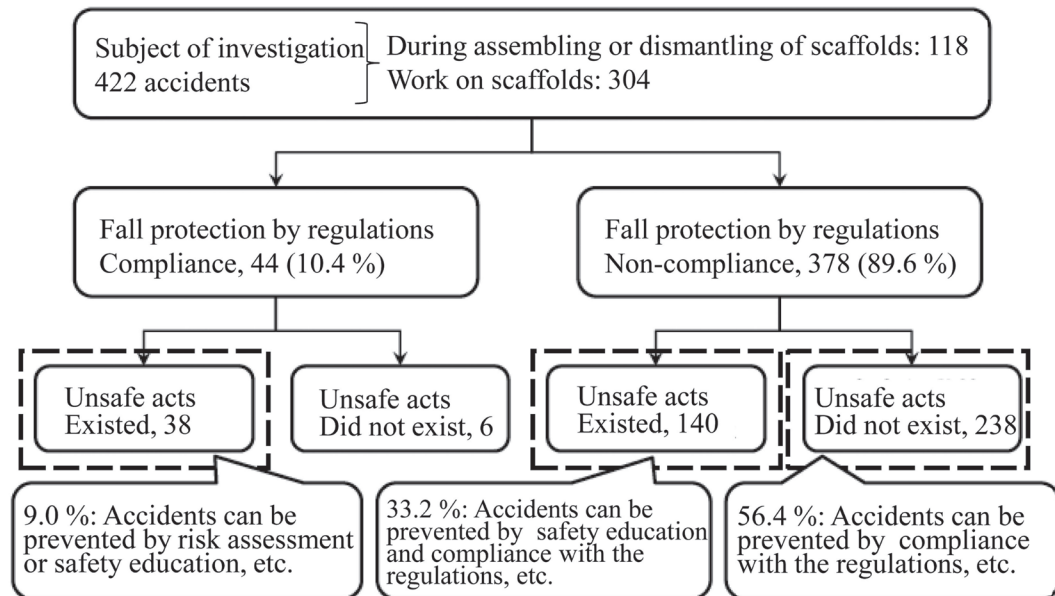


Fig. 6. Factors that contribute to fall accidents from scaffolds.

Table 2. Changes in the number of injury accidents from 2007–2011 (persons)

	2007	2008	2009	2010	2011
All accidents	143,529	132,609	108,081	110,441	113,097
Falls	24,383	22,529	18,721	18,315	19,145
Falls from scaffolds	1,552	1,227	828	718	871

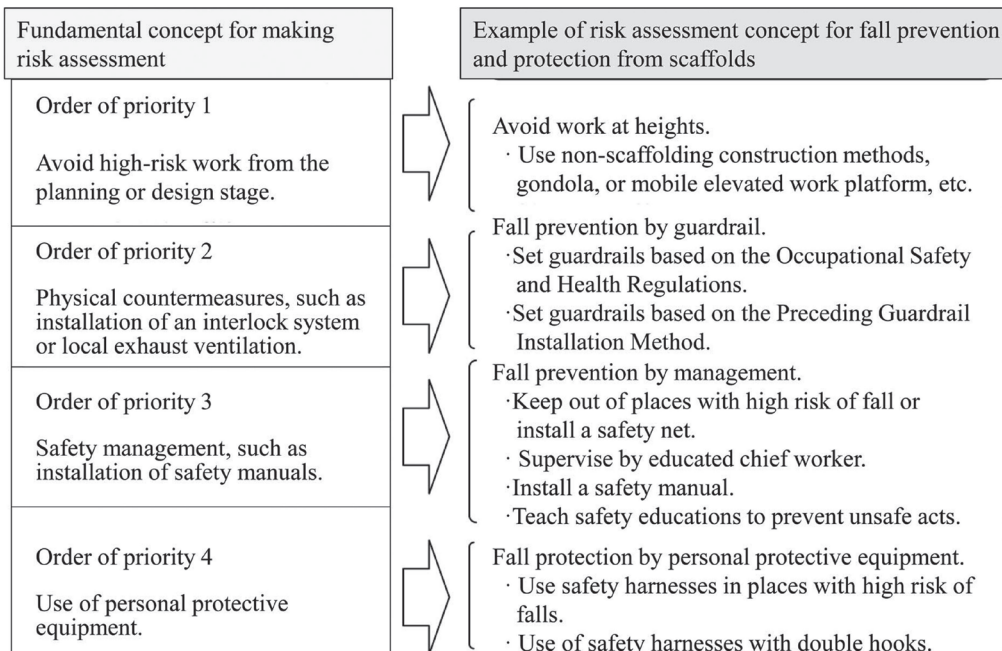


Fig. 7. An example of risk assessment concept for fall prevention and protection from scaffolds.

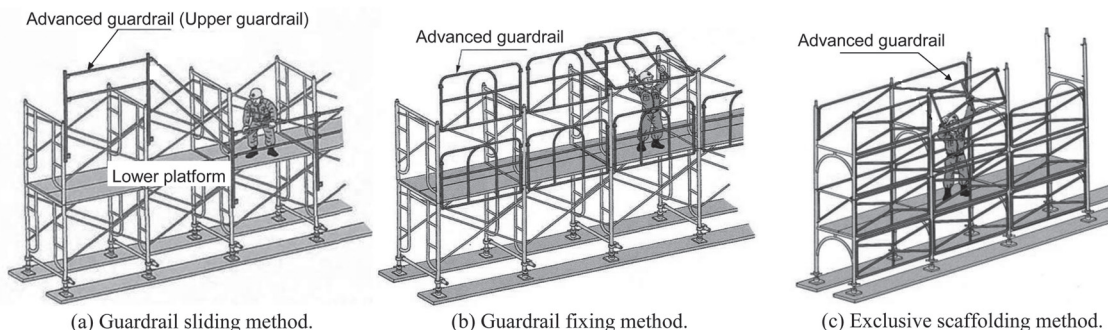


Fig. 8. Preceding guardrail installation method.

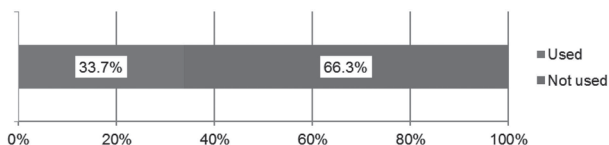


Fig. 9. Use rate of the preceding guardrail installation method in 2011.

prevent falling from ladders and roofs should be developed and disseminated.

Figure 12 shows a JNIOOSH test conducted on falls from a roof. This test was performed to confirm the effects of fall protection via rope access on a roof for short-term works, such as minor roof repair works and installation of TV antennas.



Fig. 10. Scaffolds erected by the preceding scaffold construction method.



Fig. 11. A house constructed by the preceding scaffold construction method.

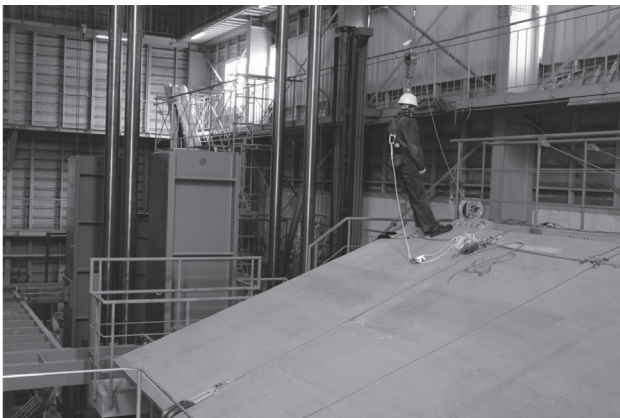


Fig. 12. Fall test from the roof at the JNIOOSH.

Promote the use of harness-type safety belts

The widely used safety belt wrapped around one's waist has a significant impact on the wearer in case falling occurs. With due consideration given to work efficiency, promote the use of safety belts with less impact in case of falling, such as the harness-type safety belts subject to mandatory use under certain conditions.

Enhance safety and health education for truck drivers

In cases where truck drivers are responsible for loading cargo as a result of sharing roles with cargo owners, etc., safety and health education for truck drivers should focus on measures to prevent falling to a lower level during cargo-handling operations, and on occupational accidents during transportation.

These measures should also be enhanced. Measures should also be taken to support the preparation of work

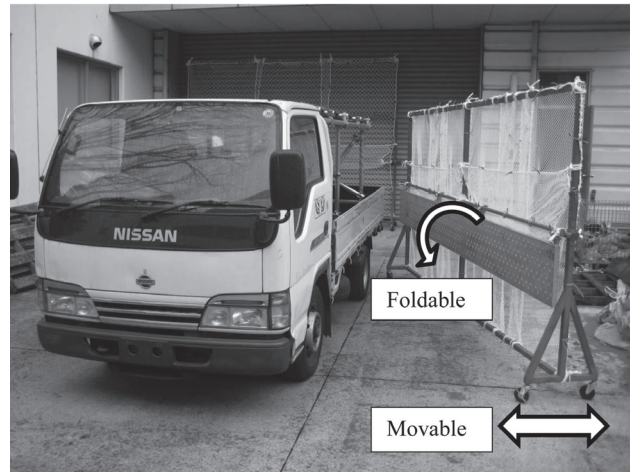


Fig. 13. Work stage developed by the JNIOOSH for preventing falls during cargo-handling operations.

procedures for cargo-handling operations.

Figure 13 shows a work stage developed by the JNIOOSH to prevent falls during cargo-handling operations. The work stage is designed to facilitate the use of narrow work spaces. For this purpose, the work stage was converted into a movable and foldable structure.

Concluding Remarks

The results of this study are summarized as follows.

1. The Occupational Safety and Health Regulations were amended in 2009 to prevent scaffold-related fall accidents.
2. The effects of the amended regulations were investigated on the basis of injury accident reports.
3. Most fall accidents from scaffolds can be prevented through compliance with the amended regulations.

4. Of the total accidents in 2011, 42.2% occurred as a result of unsafe acts, indicating the importance of safety awareness programs, such as risk assessment and safety education.

5. Other research and countermeasures for preventing falls and ensuring fall protection from heights were initiated in 2013 in accordance with the 12th Occupational Safety & Health Program.

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