



写真 40 Type-1 の実験前の状況



写真 41 Type-1 の実験後の状況
(墜落防止された)



写真 42 Type-2 の実験前の状況

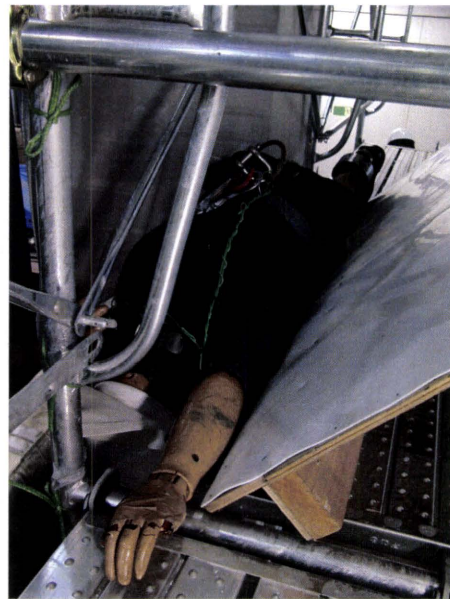


写真 43 Type-2 の実験後の状況
(墜落防止された)

5) わく組足場の妻面に使用するタイプの先行手すり機材の試作

試作した妻面に使用するタイプの先行手すり機材を写真 44(b)に示す。試作に当たっては、使用時に想定されるリスクを検討し、その低減策を考慮した。その結果を、以下に示す。

①妻面に二段手すりのような構造を持つ機材を取り付けると(写真 44(a)参照)、作業員が梯子のように登り墜落してしまう恐れがあることが危惧された。実際に、墜落した事例も報告されている。

そこで、このような墜落に対するリスクを低減するため、写真 44(b)に示すように、

2本の縦さんを持つ手すりわくとした。

②昨年度までに実施した手すり先行工法の評価結果より、機材が重いと、取り付け時に機材を下に落としてしまうことが危惧された。そこで、このような飛来落下に対するリスクを低減するため、鋼管より軽量なアルミニウム製の管により試作した。

D. 考察

1) メッシュシートと作業床のすき間を低減する方法

作業員が倒れ込んだ場合における、メッシュシートの水平移動量と、墜落の危険性を低減する効果の関係には不明な点が多い。しかし、本研究で検討したメッシュシートを床付き布わく付近で金具を使用して取り付ける場合は、作業性の面では若干劣るものの、墜落危険性を大幅に低減できる可能性があると考えられる。

また、メッシュシートを床付き布わく付近で2枚重ねた場合には、今回その墜落

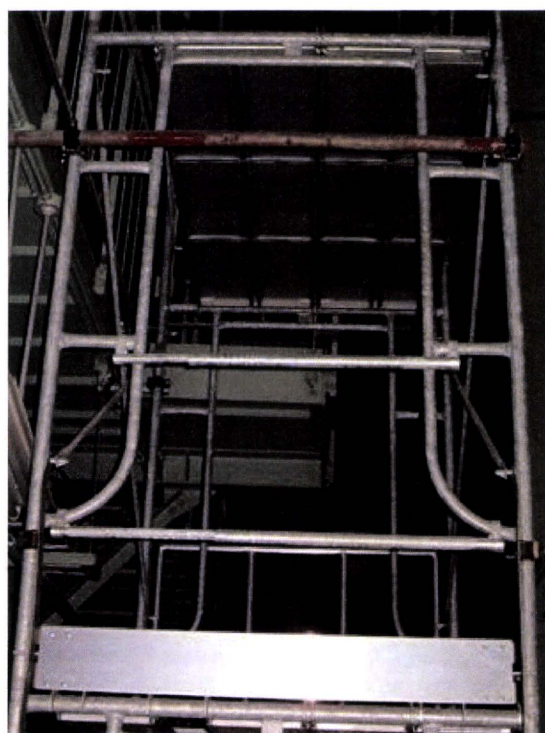
防止について大きな効果は確認できなかった。しかし、最初からメッシュシートの作業床部分を補強する、あるいは可能ならば製品化すれば、作業性がそれほど損なわれることはないと考えられる。このため、改良を加えていけば、簡易でより良い墜落防止効果を得られる方法になると考えられる。

2) メッシュシートと作業床のすき間を完全に塞ぐ新たな墜落防止機材の開発

本研究で開発した、メッシュシートと床付き布わくのすき間を完全に塞ぐ、「防護膜付メッシュシート」を利用する墜落防止方法は、改正規則による墜落措置と比べ、以下のような優位性があることが確認できた。

- ①墜落時の衝撃荷重に対し耐久性が高いこと。
- ②作業員が墜落時に受ける衝撃荷重を大幅に低減できること。
- ③メッシュシートを利用するため、手すりや交さ筋かいの上等、あらゆる場所からの墜落も防止できること。
- ④同様に、あらゆる場所からの飛来・落下も防止できること。

また、メッシュシートを使用する現場では、作業性の面で次の利点もある。



(a)梯子のような二段手すり



(b)2本の縦さんを持つ手すりわく

写真 44 試作した先行手すり機材

⑤ゴムを利用した専用取付金具等を使用することにより、ワンタッチで取付可能であり、かつ、新たな墜落や飛来・落下防止機材が不要であるため、大幅な作業性の向上が期待できること。

3) わく組足場の妻面に使用するタイプの先行手すり機材の試作

試作した妻面に使用するタイプの先行手すり機材について、一段下の床付き布わくから取り付けられるか確認を行った。その結果、容易に取り付けできることが確認できた。このため、先行手すり機材としての機能を有していることが明らかとなった。

また、JIS A 8961 (先行形手すり) に規定されている「安全帯取付設備性能試験」を実施した結果、軽量のアルミニウム製でありながら、安全帯を取り付けるための十分な強度を有していることが明らかとなった。

E. 結論

本研究では、諸外国の規制状況やすでに開発された工法の評価を通じ、安全性と普及しやすさの両方の向上を考慮して、墜落・転落防止のための新たな機材の開発を試みた。

このため、メッシュシートと作業床のすき間を低減する方法について検討し、メッシュシートを専用の金具で足場に取り付けることにより、簡易に墜落防止効果を高める可能性があることを見出した。

次に、さらなる安全性を目指し、メッシュシートと作業床のすき間を完全に塞ぐ新たな墜落防止機材として、「防護膜付メッシュシート」を考案し、諸外国の規制状況やすでに開発された工法の評価を参考に改良を重ねた。その結果、改正規則による墜落措置と比べ、安全面における優位性があることが確認できた。さらに、あらかじめメッシュシートを使用することが予定されている現場では、作業性の面でも利点があると考えられる。

以上の結果、本研究の目的である、安全でかつ普及しやすい墜落防止機材として、「防護膜付メッシュシート」を開発することができた。

今後は、本研究成果を学会等で公表することにより、成果の普及に努めていく予定

である。また、同時に試作した妻面に使用するタイプの先行手すり機材」については、本研究終了後においても継続的に安全性・作業性の向上を図り、成果の公表・普及に努めていく予定である。

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F. 健康危険情報

特に、健康に危険を及ぼすようなことはなかった。

G. 研究発表

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H. 知的財産権の出願・登録状況

特になし

II. 研究成果の刊行に関する一覧表

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III. 研究成果の刊行物・別刷

INTERNATIONAL SURVEY ON PREVENTION SYSTEM OF LABOR ACCIDENTS AT CONSTRUCTION SITE

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ABSTRACT

An international survey on systems to prevent labor accidents at construction sites in foreign countries was carried out for this study. Many fatal accidents have periodically happened in the construction industry. Various measures, such as applying new construction methods or, safety and health management systems, have applied with the goal of accident prevention. However, labor accidents in the construction industry in Japan still account for about 40% of the total across all industries. Hence, new effective measures for the prevention of labor accidents are required. Literature research and field investigations were carried out at construction sites in other advanced nations. This paper compiles a summary of the survey results.

Keywords: Prevention System of Labor Accidents, Labor Law, International Survey

63 1. INTRODUCTION

It is highly desirable to decrease the rate of labor accidents for employee working in the construction industry all over the world. Administrative systems in advanced nations designed to prevent labor accidents at construction sites were investigated in this study. Labor accidents in the construction industry in Japan account for about 40% of the total across all industries. Many countermeasures to address this problem have been proposed and carried out. However, accidents keep occurring with depressing regularity. Hence, new effective measures for prevention of labor accidents are always keenly anticipated. The purpose of this study is to obtain fundamental data that can be used to establish new effective preventive measures to reduce the incidence of labor accidents. Our survey methods were literature research and field investigation. This paper compiles a summary of the survey results.

2. METHODS

Our international survey on prevention systems of labor accidents in the construction industry was designed to identify and incorporate the following factors.

- (1) Jurisdictions of administrative organizations related to labor safety

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- (2) Assignment of responsibility for labor safety
- (3) Methods of investigating labor accidents
- (4) Compensation to accident victims
- (5) Requirement to appoint safety supervisor or manager
- (6) Costs of labor safety
- (7) Administrative penalties or social sanctions pertaining to labor accidents

We investigated six countries in total, including the U.K., Germany, France, the U.S., Canada and Japan. Literature researches and field investigations were carried out in each country and defined our methods. We identified and investigated the relevant laws, regulations, and rules in each country. We also researched past literature relevant to labor safety in the construction industry, including websites of labor safety-related organizations. Field surveys methods included interviews with the safety inspectors employed by the various administrative bodies.

3. RESULTS

3.1. Jurisdictions of administrative organizations related to labor safety

Administrative organizations related to labor safety are usually attached government offices (JFCC 2009). In Germany, however, the social code confers authority and responsibility for labor safety inspections to non-government organizations (L'owisch 1995; GIAJ 2001; Otani 2001; Furuse et al. 1999; Kittner et al. 2005; Nishimura 1980; Götz 1994). Those organizations are cooperative unions of industrial injury insurance run by the professional community. The social code authorizes their constitutive power regarding labor regulations, and also grants them collection power in response to any infraction of their established regulations. Their staff have national accreditation of industrial associations which confers certain rights (Kittner et al., 2005). For example, these include, "permission to enter the construction site," "call a temporary halt to the contractor," and other similar rights (Kittner et al. 2005). Photo 1 shows an official inspection at a construction site in Berlin, where staff were conducting an inspection in conjunction with Berlin city employees.

Official inspections of construction sites are carried out in all countries of this study (JFCC, 2009). The inspector generally investigates legal compliance relevant to issues of labor safety. France is one country, that has a unique system (GIAJ, 2001). Inspectors in France have been authorized with not only "entry to the construction site," but also to "participate in the Safety and Health Committee" (GIAJ, 2001; Teyssié, 2008). Inspectors in France investigate labor safety management systems at each construction site by using similar methods to those previously described.

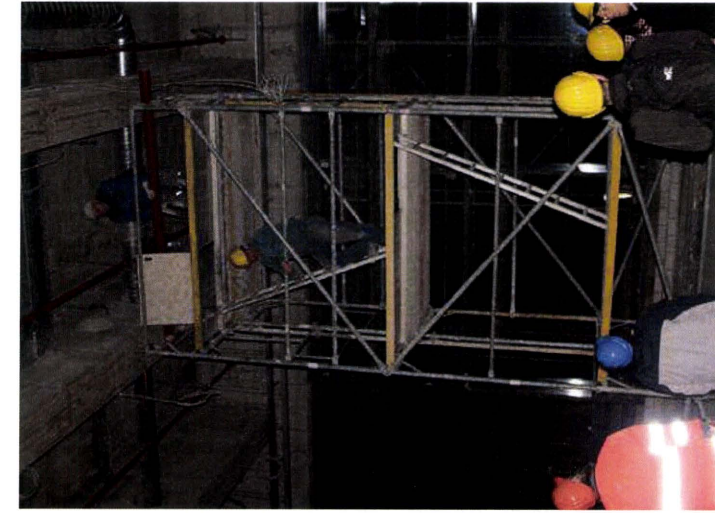


Photo.1: Official inspection at a construction site in Berlin.

3.2. Responsibility for labor safety

In each country, there are some differences in the degree of responsibility for the main contractor and sub contractors regarding labor safety. France, Japan and the U.K. impose large responsibility on the main contractor with a few relative differences. For example, in the U.K. the main contractor assumes responsibility as a general rule, whereas in France and Japan, the main contractor always takes responsibility, even if the accident occurred due to the negligence of a sub contractor. This relates to a belief in France that the main contractor must bear responsibility for the original selection of the sub contractor.

On the other hand, Germany, the U.S. and Canada assign equal responsibilities to the main and any sub contractors. In Germany, a company found to be negligent takes maximum responsibility for accident. In the U.S. and Canada, the degree of responsibility is decided by each individual contract.

3.3. Labor accident investigation methods in each country

In any country construction companies must report each labor accident as soon as it happens. Many countries impose a requirement to report accidents to a government office, but a few countries require reporting to non government organizations. For example, construction companies in Germany need to report accidents to the union bodies of industrial injury insurance which are NGOs (Furuse et al., 1999; JCOSHA, 2007). Also, companies in France need to report accidents to the public corporation of social insurance (Hobara, 1981; Shionoya, et al. 1999; Yamaguchi, 2002).

Investigations at the accident sites are performed in most countries. However, the detail and degree of the investigation varies by location. Serious accidents are investigated regardless of location; however, minor accident vary widely in the detail of investigation methods. For example, the regulatory authority of the U.K. investigates those accidents where the victim's business must be suspended for more than three days. In Germany, the type of accident investigation is decided at the discretion of the inspector in charge.

3.4. Victim compensation

There are occupational injury insurance systems in each country (Fujita et al. 2000; Nakakubo, 1995; Hayashi, 1979; Kuwabara, 1980; RCP, 2009). In all countries of this study, the contractor must have indemnity insurance. However, details of the insurance systems vary; some are public and some are private. Germany, France, Canada and Japan have adopted public insurance systems. Conversely, the U.K. and the U.S. have adopted private insurance systems. In Japan, the major contractor is responsible for taking out the insurance. Hence, sub contractors in Japan generally are not liable to pay an insurance premium. In many countries the insurance contractant is the company that the victim works for. In the U.S. the contractant is fixed by each contract independently. Hence, the contractant may be the employer, the main contractor, or the supervisor of construction work.

In many countries investigated in this study out-of-court settlements relating to labor accidents are not usual. In the U.K., for example, legal remedies are generally applied by the courts to solve issues relevant to labor accidents (Kuwabara, 1980; RCP, 2009; Komiya, 2001). Conversely, accident victims employed in Germany, France, the U.S. or Canada are banned from bringing damage suits relating to their labor accident (L'owisch, 1995; Furuse et al., 1999; Nishimura, 1980; Hobara, 1981; Shionoya et al., 1999; Nakakubo, 1995; Hayashi, 1979). Accident victims are therefore rarely able to sue their employer for damages citing criminal intent or gross negligence. However, victims in France can recover damages by way of out-of-court settlements (Hobara, 1981). In Japan, accident victims can sue for any damages that are not recoverable by industrial accident compensation. According to past statistics, there are many such judicial or extrajudicial settlement contracts in Japan.

3.5. Requirement to appoint safety supervisor or manager

Safety supervisors or safety managers must be appointed in every country of this study (JFCC, 2009; Teyssié 2008; JCOSHA, 2007; JCOSHA, 2005). In the U.K. Germany and Canada these specialists are appointed by the operating body. In France they are appointed by the client. The operating body in the U.K. has a duty to appoint a capable director and they usually appoint affiliates of the Institute of Occupational Safety and Health (IOSH). Safety supervisors in Germany take part in a special training program for 12 weeks and must pass a national examination.

3.6. Costs of labor safety in the construction industry

The cost for labor safety is added to the cost computation regardless of the work category such as public or private work (JCOSHA, 2007; Komiya, 2001). However, there are differences between Japan and other countries. For public works the cost is added to the overall project cost computation. Main contractors in Japan usually cover any deficits. For private works the cost is not usually added to the overall cost computations but is absorbed by the main contractors.

3.7. Administrative penalties and social sanctions pertaining to labor accidents

Administrative penalties for main contractors are applied in many countries. Penalties in the U.S. the U.K. France and Japan include the possibility of “interruption of business,” “shut-down of public bid,” and the like. But the government or the labor unions in Germany impose only temporary stop-work instructions as the penalty. Main contractors are only restricted from making public bids for contracts if evidence indicates that the company has fallen behind in their tax installments.

Conversely, social sanctions are not applied in many countries. However, some criminal prosecutions have been executed in every country of this study (Kittner, 2005; JCOSHA, 2005). In the U.K. a corporation may be charged with ; the offence of criminal homicide. In France the convicted company may be obliged to publish the judicial decision in the newspaper at their own expense (Teyssié, 2008) . In the U.S., one judicial decision ordered the defendant to pay ten million dollars in compensation. In Germany and France, the account of industrial injury insurance paid by the main contractor is increased following a claim, even if the labor accident was caused by the negligence of a sub contractor. In Canada the supervisor has a high possibility of being fined as well as the employer and the fines levied are usually heavy.

4. CONCLUSION

The conclusions of this study are shown as follows:

- 1) Administrative organizations related to labor safety are usually government departments. In Germany, the social code assigns authority and responsibility for to labor safety inspections to some non-government organizations.
- 2) Official inspections for the construction sites are carried out in all countries of this study. Inspectors in France are authorized to “enter the construction site,” and to “participate in safety

and health committees”.

- 3) France and the U.K. impose most responsibility on the main contractor. Conversely, Germany, the U.S. and Canada impose equal responsibility to the main and sub contractors.
- 4) In any country employers must report the occurrence of a labor accident when it happens.
- 5) In the U.K. they have generally used court remedies to solve issues relevant to labor accidents. Conversely, accident victims employed in Germany, France, U.S. or Canada are usually prohibited from bringing damage suits relevant to their labor accidents.
- 6) The cost of labor safety is generally added to the overall cost computation of a project regardless of the work category, such as public or private work. However, there are differences between Japan and other countries.
- 7) Administrative penalties for main contractors have been imposed in many countries. The penalties in the U.S. the U.K. and France include the possibility of “interruption of business,” “shut-down of public bid,” and the like. The government or the unions of Germany impose only temporary stop-work injunctions as a penalty.

- 8) Social sanctions are not been applied in many countries. In the U.K. a corporation may be charged with criminal homicide. In France, the convicted company may be obliged to publish the judicial decision in the newspaper at their own expense. In Canada, the construction supervisor has a high likelihood of fined as well as the employer, and the fines imposed are usually heavy.

5. ACKNOWLEDGMENTS

We would like to express our gratitude to the staff of the institutes shown in Appendix 1, and we are especially grateful to Mr. Bernd Horn, Department of Labor Protection, Health Care, and Safety Technology, City Government of Berlin, and to Markus Stiller, Cooperative Union of Construction Industry, Germany and to Patrick Moutel, Professional Organization of Accident Prevention on Public and Construction Works, France, and to David Snaith, Construction Safety Association of Ontario.

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APPENDIX I

We visited the following institutes, as well as their web pages, to conduct preliminary surveys and various interviews:

- (1) LAGeSi (Department of Labor Protection, Health Care, and Safety Technology, City Government of Berlin, Germany), <http://www.berlin.de/lageisi/>
- (2) BAU (Cooperative Union of Construction Industry, Germany), <http://www.bgbau.de/d/pages/index.html>
- (3) OPPBTP (Professional Organization of Accident Prevention in Public and Construction Works, France), <http://www.opbtp.fr/>
- (4) Ministry of Labor, Social Relations, Family, Solidarity, and Urbia, France, <http://www.travail-solidarite.gouv.fr/>
- (5) HSE (Health and Safety Executive, United Kingdom) <http://www.hse.gov.uk/>
- (6) HSL (Health and Safety Laboratory, United Kingdom) <http://www.hsl.gov.uk/>
- (7) OSHA (Occupational Safety and Health Administration, United States), <http://www.osha.gov/>
- (8) DCCI Danny's Construction Co., Inc, United States, <http://www.dannysconstruction.com/>

- (9) Japan International Center for Occupational Safety and Health, <http://www.jniosh.go.jp/icpro/jicosh-oid/index.html>
- (10) EU (European Union), <http://europa.eu/>
- (11) Statutory Accident Insurance Fund, Germany, <http://www.dguv.de/>
- (12) INRS (National Institute for Research of Safety, France), <http://www.inrs.fr>
- (13) BLS (Bureau of Labor Statistics, United States), <http://www.bls.gov/>
- (14) MOL (Ministry of Labor, Ontario), <http://www.labour.gov.on.ca/>
- (15) Construction Safety Association of Ontario, <http://www.csao.org/home.cfm>

STUDY ON FALL PROTECTION FROM SCAFFOLDS BY SCAFFOLD SHEETING DURING CONSTRUCTION

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ABSTRACT

The frequency of fall accidents is one of the most serious problems in construction industries, and the countermeasures, such as guidelines, etc., for falls from scaffolds have been tightened in Japan. These countermeasures particularly affect the decrease in the number of the fatal accidents by falls from scaffolds. However, the rate of such accidents from falls is still high in the construction industries. In order to examine further countermeasures to reduce falls, the Japanese Ministry of Health, Labor, and Welfare has established a committee at the authors' institute.

That committee's work experimentally confirmed the effectiveness of using scaffold sheeting as a covering around scaffolds to protect against falling construction materials (a method widely used in Japan). Based on those results, the scaffold sheeting was improved for fall protection, and the effect of the improved sheeting could be confirmed experimentally.

Keywords: Fall accident, Scaffold, Scaffold sheeting, Construction safety.

1. INTRODUCTION

Falling accidents are a serious problem in the construction industry in Japan, as approximately 40% of fatal accidents during construction are caused by workers' falls. Therefore, Japan has introduced countermeasures to reduce falls from scaffolds and strictly enforces these measures with various safety guidelines. These countermeasures have led to a reduction in the rate of fatal accidents caused by falling from scaffolds.

Because the rate of fatal accidents from falls is still high, however, in the construction industry, possible countermeasures became the main issue of the 11th Labor Accidents Prevention Plan in Japan. In order to examine further countermeasures to reduce such falls, the Japanese Ministry of Health, Labor, and Welfare (MHLW) established a committee at the authors' institute to conduct an investigation of the regulations that exist in overseas countries and to evaluate various construction methods according to present safety guidelines.

From the results and the discussion, it was found that workers sometimes fell from the space between the hand rail and the work platform. To prevent the fall of the workers from this space, the

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space has to be narrowed. The scaffold sheeting, which covers around the scaffolds and is widely used in Japan, as shown in Photo 1, had some effect for this purpose according to the experiment by the committee. However, the workers still occasionally fell from the space between the work platform and the scaffold sheeting. One reason for this is because the space was spread by the workers weight, as shown in Photo 2, and the workers fell from the spread space (Ohdo et al. 2009). Therefore, in this study, the scaffold sheeting, which was plastic, was improved for fall protection from the spread space, and the effect of the improved plastic sheeting was examined experimentally.

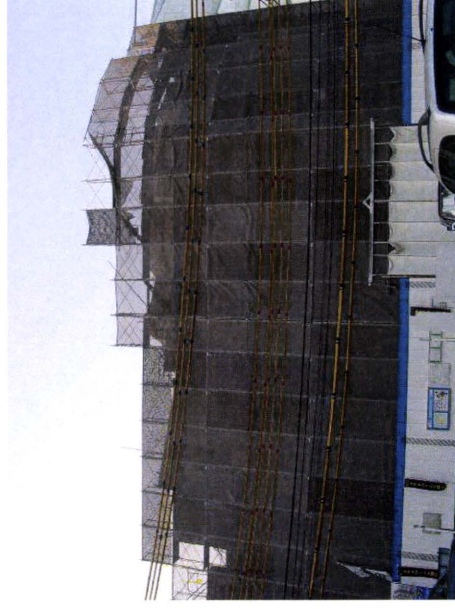


Photo 1: Scaffolds covered with sheeting.



Photo 2: The spread space by the workers weight.

2. WORK EFFICIENCY BY GUARDRAIL-FIRST ERECTION METHOD

In Japan, the guardrail-first erection method is occasionally used for fall protection of the scaffolds as shown in Photo 3, and MHLW is aiming to spread the method by their safety guidelines. However, the method is not wide spread because of poor work efficiency.



Photo 3: Prefabricated scaffolds constructed by guardrail-first erection method.

Figure 1 shows the results of a questionnaire survey on the work efficiency of the method shown in Photo 3. 18 workers answered the questionnaires. More than 80% of the workers felt that the method took more time, was complex, and had heavy pieces for the erection of the scaffolds.

Figure 2 and Figure 3 show the results of the survey on the safety and use of the method, respectively. Approximately 90% of the workers felt that the scaffolding work improved safety, but more than 60% of the workers answered that they did not want to use the method because of its poor work efficiency.

Therefore, in this study, the safe and easy installation method for fall protection for the scaffolds was developed by improving the scaffold sheeting.

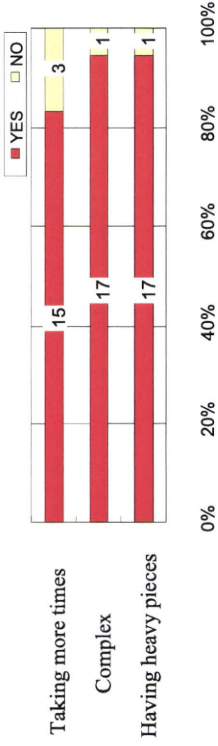


Figure 1: Results of a questionnaire survey on the work efficiency of the guardrail-first erection method.

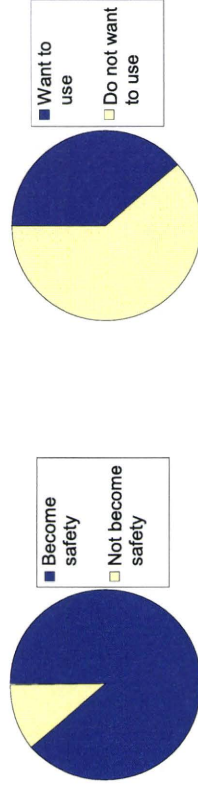


Figure 2: Results of the survey on the Safety of the guardrail-first erection method.

Figure 3: Results of the survey on the use of the guardrail-first erection method.

3. IMPROVEMENT OF PLASTIC SHEETING

In this study, the plastic sheeting was improved for fall protection from the spread space, as shown in Figure 4. The improved sheeting has additional attached sheets, as shown in Photo 4, and the attached sheets were sewn with the plastic sheeting near the work platform.

The effect of the improved plastic sheeting was examined experimentally by using a sand bag or human dummy.

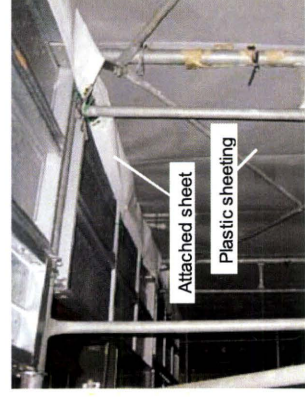
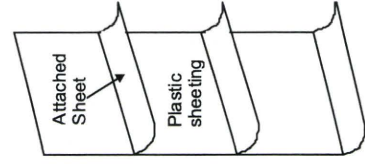


Figure 4: Improved sheeting.

Photo 4: Attached sheet sewn with plastic sheeting.

3.1. Experimental method

Table 1 shows experimental conditions for examining the effect of fall protection provided by the improved sheeting. The attached sheets were fixed to the work platform by three kinds of materials.

- a: Fiber rope
- b: Steel wire with a diameter of 1.0 mm
- c: Steel wire with a diameter of 2.3 mm

Table 1: Experimental conditions

Case	Fixed by	Fall Height	Fallen object
1	Fiber rope	640 mm	Sand bag
2	Wire(1.0mm)	640 mm	Sand bag
3	Wire(2.3mm)	640 mm	Sand bag
4	Wire(2.3mm)	640 mm	Human dummy
5	Wire(2.3mm)	1000 mm	Human dummy
6	Non	640 mm	Human dummy

The experiments were performed by using a sand bag and a human dummy. The sand bag or human dummy were dropped from the height of 640 mm above the work platform into the spread space by using a slide. Only in case 5, the human dummy was dropped from the height of 1000 mm in order to confirm the further safety, as shown in Photo 5.

The weight of the sand bag and human dummy was 735 N for each. The space between the plastic sheeting and the work platform was set to be 160 mm, which was the maximum space of the prefabricated scaffolds, as shown in Figure 5.

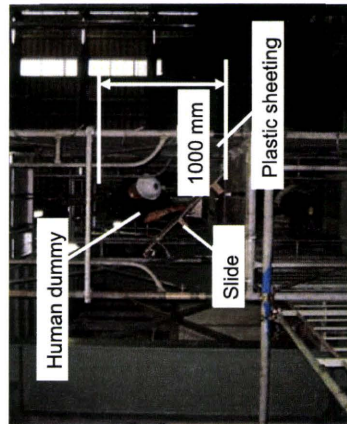


Photo 5: Fall from height of 1000 mm.

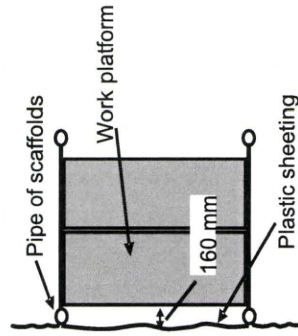


Figure 5: The space of 160 mm.

3.2. Results of experiment

Table 2 shows the results of the experiment. For cases 1-2, the sand bag fell below the work platform. Therefore, the fiber ropes and the steel wire with 1.0 mm diameter were severed by the mass of the sand bag. However, the sand bag did not fall below the work platform for case 3, as shown in Photo 6.

From the results of cases 1 and 2, the fiber ropes and the steel wire with 1.0 mm diameter would not be used as the materials for fixing the attached sheets to the work platform. Therefore, a steel wire with 2.3 mm diameter was used as the material for fixing the attached sheets, in cases 4 and 5. Additionally, the human dummy was used for the fallen object in those tests.

Table 2: Results of experiment

Case	Fixed by	Fall Height	Results(Fell / Not fall)
1	Fiber rope	640 mm	Fell, sand bag
2	Wire(1.0mm)	640 mm	Fell, sand bag
3	Wire(2.3mm)	640 mm	Not fall, sand bag
4	Wire(2.3mm)	640 mm	Not fall, human dummy
5	Wire(2.3mm)	1000 mm	Not fall, human dummy
6	Non	640 mm	Fell, human dummy

For case 5, the human dummy did not fall below the work platform, even though the fall height was 1000 mm, as shown in Photo 7. However, for case 6, in which the attached sheets were not fixed to the plastic sheeting to mimic the normal construction condition, the human dummy fell below the work platform, as shown in Photo 8. Therefore, it can be concluded that the improved sheeting was effective for fall protection from the scaffolds when the attached sheets were fixed by steel wire with at least a 2.3 mm diameter.



Photo 6: Result of case 3.

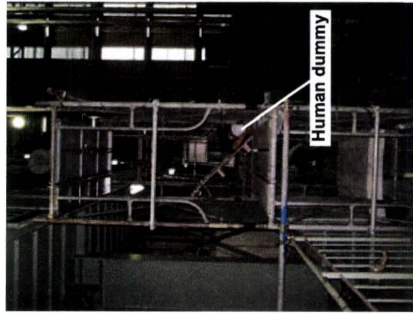


Photo 7: Result of case 5.

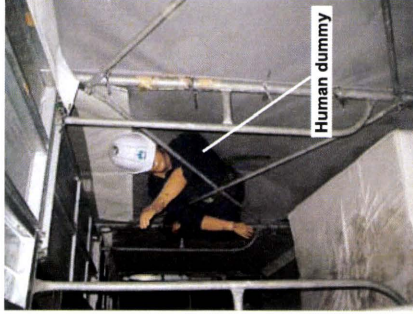


Photo 8: Result of case 6.

3.3. Improvement of work efficiency of the improved sheeting

Case 7 in Table 3 was performed to improve the work efficiency, and the fixing material was changed from steel wires to twisted pair fiber ropes. Then, the weight of the human dummy was increased from 735 N to 833 N for confirming further safety. In this case, the human dummy also did not fall below the work platform, and the work efficiency could be slightly improved. Consequently, the sheeting has been designed to be improved continuously.

Table 3: Results of experiment for improvement of work efficiency

Case	Fixed by	Fall Height	Results(Fell / Not fall)
7	Twisted pair fiber rope	1000 mm	Not fall, human dummy

4. CONCLUDING REMARKS

In this study, the scaffold sheeting was improved for fall protection from scaffolds, and the effect of the improved sheeting was examined experimentally. The results are summarized as follows.

- (1) The plastic sheeting was improved for fall protection from the spread space by sewing additional attached sheets.
- (2) From the results of the experiments, it was found that the improved sheeting was effective for fall protection from the scaffolds when the attached sheets were fixed by steel wires with a diameter of 2.3 mm.

(3) The work efficiency could be slightly improved when the fixing material was changed from steel wires to twisted pair fiber ropes. Consequently, the sheeting has been designed to be improved continuously.

5. ACKNOWLEDGMENTS

This study was supported by Health and Labour Sciences Research Grants (Research on Occupational Safety and Health) in 2010 from the Ministry of Health, Labour and Welfare of Japan.

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STUDY ON FALL PROTECTION FROM SCAFFOLDS BY IMPROVED SCAFFOLD SHEETING

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The frequency of fall accidents is one of the most serious problems in construction industries, and the countermeasures for the fall from the scaffolds had been tightened as the guidelines, etc., in Japan. These countermeasures take the particular effect as the decrease of the death accidents by fall from the scaffolds. However, the rate of fatal accidents from falls is still high in the construction industries. In order to examine further countermeasures to reduce such falls, the Japanese Ministry of Health, Labour and Welfare had established a committee in the authors' institute. That committee's work experimentally confirmed the effectiveness of using the scaffold sheeting as a covering around scaffolds to protect against falls of construction materials (a method widely used in Japan). Based on those results, the scaffold sheeting was improved for fall protection, and the effect of the improved sheeting could be confirmed experimentally.

Introduction

Fall accidents are a serious problem in the construction industry in Japan, and approximately 40% of fatal accidents during construction are caused by workers' falls. Therefore, Japan has introduced countermeasures to reduce falls from scaffolds, and strictly enforced these with various safety guidelines. These countermeasures have led to a reduction in the rate of fatal accidents caused by falling from scaffolds.

However, the rate of fatal accidents from falls is still high in the construction industry, and possible countermeasures became the main issue of the 11th Labour Accidents Prevention Plan in Japan. In order to examine further countermeasures to reduce such falls, the Japanese Ministry of Health, Labour and Welfare had established a committee in the authors' institute to conduct an investigation of the regulations that exist in overseas countries and to evaluate various construction methods according to present safety guidelines.

From the results and the discussion, it was found that the workers sometimes fell from the space between the hand rail and the work platform. To prevent the fall of the workers from the space, the space have to be made narrow. The scaffold sheeting, which covered around the scaffolds and widely used in Japan, as shown in Photo 1, had a few effects for this purpose according to the experiment by the committee. However, the workers still occasionally fell from the space between the work platform and the scaffold sheeting. One reason is because the space was spread by the workers weight, and the workers fell from the spread space. Therefore, in this study, the scaffold sheeting, of which material was plastic, was improved for fall protection from the spread space, and the effect of the improved plastic sheeting was examined experimentally.

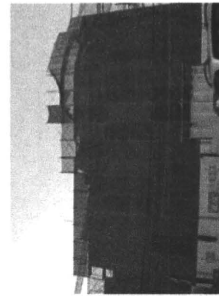


Photo 1. Scaffolds covered with sheeting



Photo 2. Typical prefabricated scaffolds

Improvement of plastic sheeting

Photo 2 shows the typical prefabricated scaffolds used in Japan. It was considered that the plastic sheeting, which envelop the scaffolds, are able to protect the workers from falling, but their effectiveness was not clear. Therefore, their effectiveness was examined experimentally using a human dummy. The human dummy weighed 700 N, the average body size of Japanese males. Table 1 shows the experimental cases.

Table 1. Experimental cases

Case	Posture	Type of scaffold	Photos	Case Posture	Type of scaffold	Photos
1	Standing	Prefabricated		Sitting and fall to 1 m using slide	Prefabricated	
2	Crawl on hands and knees	Prefabricated		Sitting and fall to 1 m using slide	Used sheeting	
3	Sitting and fall from back	Prefabricated		Sitting and fall to 1 m using slide	Pipe	
4	Standing	Pipe		Crawl on hands and knees, and fall to 0.2 m using slide	Prefabricated	
5	Crawl on hands and knees	Pipe		Sitting and fall from front	Prefabricated	
6	Sitting and fall from back	Pipe				

These cases were the same as those considered in earlier studies (Japan Construction Occupational Safety and Health Association, 2003). An experiment with a used plastic sheeting (Case 8) was carried out to determine the strength of deteriorated sheeting.

In all experimental cases, the human dummy did not fall from the scaffolds, and it was found that the plastic sheeting were effective for fall protection, given a perfectly installed sheeting. However, in some cases, the dummy almost fell from the scaffolds. Then, the space between the plastic sheeting and the work platform was spread widely, and the dummy almost fell from the space.

Thus, in this study, the plastic sheeting was improved for fall protection from the spread space, as shown in Figure 1. The improved sheeting has additional attached sheets, as shown in Photo3, and the attached sheets were sewed with the plastic sheeting near the work platform.

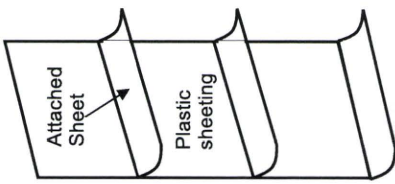


Figure 1. Improved sheeting Photo 3. Attached sheet sewed with plastic sheeting

Experimental method

Table 2 shows experimental conditions for examining the effect of fall protection by the improved sheeting. The attached sheets were fixed to the work platform by four kinds of materials.

- 1: Fiber rope
- 2: Steel wire with a diameter of 1.0 mm
- 3: Steel wire with a diameter of 2.3 mm
- 4: Twisted pair fiber rope

The experiments were performed by using a sand bag and a human dummy. The sand bag or human dummy were fallen from the height of 640 mm above the work platform into the spread space by using a slide. In only cases 5 and 7, the human dummy was fallen from the height of 1000 mm for confirming the further safety, as shown in Photo 4.

The weight of the sand bag or human dummy was 735 N, but in only case 7 the weight was 835N. The space between the plastic sheeting and the work platform was set to be 160 mm, as shown in Figure 2.

Table 2. Experimental conditions

Case	Fixed by	Fall Height	Fallen object
1	Fiber rope	640 mm	Sand bag
2	Wire(1.0mm)	640 mm	Sand bag
3	Wire(2.3mm)	640 mm	Sand bag
4	Wire(2.3mm)	640 mm	Human dummy
5	Wire(2.3mm)	1000 mm	Human dummy
6	Non	640 mm	Human dummy
7	Twisted pair fiber rope	1000 mm	Human dummy

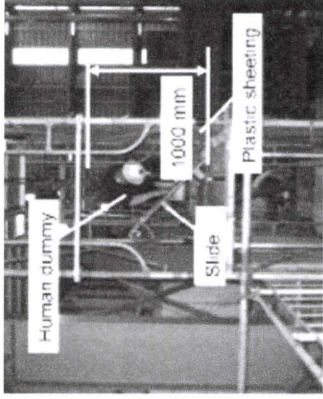
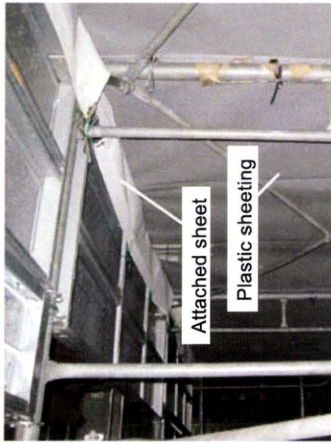


Photo 4. Fall from height of 1000 mm

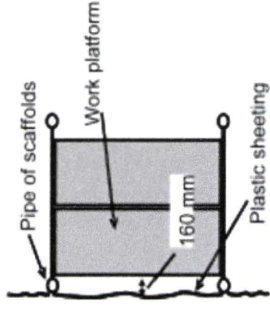


Figure 2. The space of 160 mm

Results of experiment

Table 3 shows the results of experiment. For cases 1-2, the sand bag fell below the work platform. Therefore, the fiber ropes and the steel wire with 1.0 mm diameter were cut by mass of the sand bag. However, the sand bag did not fall below the work platform for case 3, as shown in Photo 5.

Table 3. Results of experiment

Case	Fixed by	Fall Height	Results(Fell / Not fall)
1	Fiber rope	640 mm	Fell, sand bag
2	Wire(1.0mm)	640 mm	Fell, sand bag
3	Wire(2.3mm)	640 mm	Not fall, sand bag
4	Wire(2.3mm)	640 mm	Not fall, human dummy
5	Wire(2.3mm)	1000 mm	Not fall, human dummy
6	Non	640 mm	Fell, human dummy
7	Twisted pair fiber rope	1000 mm	Not fall, human dummy

From the results of cases 1 and 2, the fiber ropes and the steel wire with 1.0 mm diameter would not be used as the materials for fixing the attached sheets to the work platform. Therefore, the steel wire with 2.3 mm diameter was used as the material for fixing the attached sheets, in cases 4 and 5. Continually, the human dummy was used for the fallen object.

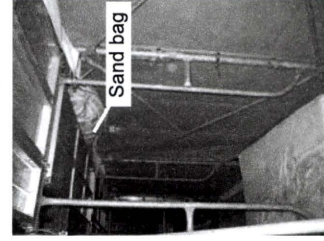


Photo 5. Result of case 3



Photo 6. Result of case 5

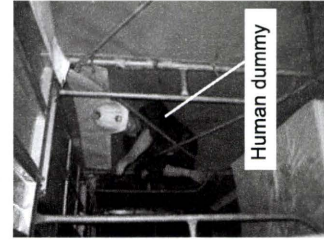


Photo 7. Result of case 6

For case 5, the human dummy did not fall below the work platform, even if the fall height was 1000 mm, as shown in Photo 6. However, for case 6 which the attached sheets were not fixed to the plastic sheeting as same as the normal construction condition, the human dummy fell below the work platform, as shown in Photo 7. Therefore, it can be concluded that the improved sheeting was effective for fall protection from the scaffolds when the attached sheets were fixed by the steel wire with at least 2.3 mm diameter.

Case 7 was performed for improving the work efficiency, and the fixing material was changed from steel wires to twisted pair fiber ropes. Then, the weight of the human dummy was increased from 735 N to 833 N for confirming the further safety. In this case, the human dummy also did not fall below the work platform, and the work efficiency could be slightly improved. Consequently, the sheeting has been planned to be improved continuously.

Conclusion

In this study, the scaffold sheeting was improved for fall protection from the scaffolds, and the effect of the improved sheeting was examined experimentally. From the results of the experiments, it can be concluded that the improved sheeting was effective for fall protection from the scaffolds.

Acknowledgment

This study was supported by Health and Labour Sciences Research Grants (Research on Occupational Safety and Health) in 2009 from the Ministry of Health, Labour and Welfare of Japan.

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メッシュシートを利用した足場からの墜落防止方法の耐久性の検討

(独) 労働安全衛生総合研究所 正会員 ○大幡勝利, 正会員 日野泰道, 高梨成次
正会員 高橋弘樹, 正会員 豊澤康男

1. はじめに

建設業における労働災害による死亡者数は、墜落災害によるものが最も多く、平成19年は207人、平成20年は172人が死亡している。このような状況の中、平成21年6月施行の改正労働安全衛生規則により足場等からの墜落防止措置が強化されており、わく組足場の場合には交さ筋かいの下に下さ筋かいまたは幅木を取り付けることが、それ以外の足場については二股手すりを設置することが義務付けられた。

これを海外にも目を向け、欧州三カ国(英国、ドイツ、フランス)および北米二カ国(米国、カナダ)の状況について調査すると、各国とも二股手すり(国によっては幅木)の設置が義務付けられており、ほぼすべての現場で実施されていた¹⁾²⁾(写真1参照)。また、米国ではわく組足場の主流であり、交さ筋かいの下に下さ筋かい(交さ筋かいの交点の位置によつては上さ筋かい)の設置が義務付けられており、ほぼすべての現場で実施されていた(写真2参照)。以上より、今回の改正規則により欧米と同程度の墜落防止措置が義務付けられたことになるが、それまでわが国ではメッシュシートが墜落防止に何らかの役割を果たしてきたと考えられる。

メッシュシートの墜落防止性能については、これまでに何度か実験的に検討されており、例えば文献3)では完全に墜落を防止することはできないが、ある程度の墜落防護機能が認められたとされている。このため、メッシュシートを改良し、今回の改正規則と同程度以上の墜落防止性能を発揮できるようにすれば、新たな墜落防止措置を行うことなく安全性の高い経済的な足場を設置することが可能となる。

そこで、本研究では、これまでの研究で検討したメッシュシートを利用した足場からの墜落防止方法⁴⁾について、さらなる安全性に関する検討を行うことを目的として、人体ダミーを用いた落下実験によりその耐久性を調べた。

2. 実験方法

これまでの研究⁴⁾では、図1に示すようにメッシュシートを改良したものを製作し、作業者の落下空間を完全に塞ぐ方法について検討を行った。その際の実験条件と結果を表1に示すが、鉄筋等を結束する番線により図1に示す付属のシート(メッシュシートと同じ材質のもの)と作業床を結束すれば、落体として使用した質量75kgの人体ダミーの落下を防止することが可能となることがわかった。しかし、1回実験が終了するたびにメッシュシートを張り替えたため、付属のシートの耐久性が確認できなかったこと、番線での結束では作業性が劣ること等の問題が残されていた。そこで、本研究では、付属のシートの耐久性を確認するため、作業床に取り付けた付属のシートを交換せずに複数回の落下実験を行った。実験の状況、写真3に示す。その際、人体ダミーの質量を75kgから85kgに増加させ、さらに人体ダミーの落下高さを1000mmに固定して、耐久性に加えさらなる安全性についても検討することとした。また、写真4に示すように付属のシートと作業床の結束を、通常のメッシュシートの結束に使用す

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る繊維ロープを2本に燃ったものを行い、作業性の向上を図った。

3. 実験結果と考察

表2に、本研究における実験条件と結果を示す。その結果、同一の付属のシートに対する実験により、6回目までは写真5に示すように人体ダミーの落下を防止することができた。また、2本に燃った繊維ロープについては、目立った損傷は見られなかった。これより、本研究の方法により高い墜落防止性能とある程度の耐久性があることが確認できた。しかし、7回目の実験では写真6に示すように、メッシュシートと付属のシートの接続部が破損して人体ダミーが落下した。今後は、この接続部の補強について検討し、安定した墜落防止性能を発揮できるように改良していく予定である。

4. まとめ

本研究では、これまでの研究で検討したメッシュシートを用いた墜落防止方法を改良し、さらなる安全性に関する検討を行うことを目的として、人体ダミーを用いた落下実験によりその耐久性を調べた。その結果、本研究の方法により、高い墜落防止性能とある程度の耐久性があることが確認できた。

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図1 改良したメッシュシート

表1 これまでの研究による実験条件と結果

実験名	シートを結束した材料	落下高さ	落下の有無
実験①	繊維ロープ1本	640mm	落下した
実験②	番線(φ1mm)	640mm	落下した
実験③	番線(φ2.3mm)	640mm	落下せず
実験④	番線(φ2.3mm)	640mm	落下せず
実験⑤	なし	1000mm	落下せず
実験⑥	なし	640mm	落下した

表2 本研究による実験条件と結果

実験名	シートを結束した材料	落下高さ	落下の有無
実験①	繊維ロープ2本	1000mm	落下せず
実験②	繊維ロープ2本	1000mm	落下せず
実験③	繊維ロープ2本	1000mm	落下せず
実験④	繊維ロープ2本	1000mm	落下せず
実験⑤	繊維ロープ2本	1000mm	落下せず
実験⑥	繊維ロープ2本	1000mm	落下せず
実験⑦	繊維ロープ2本	1000mm	落下した

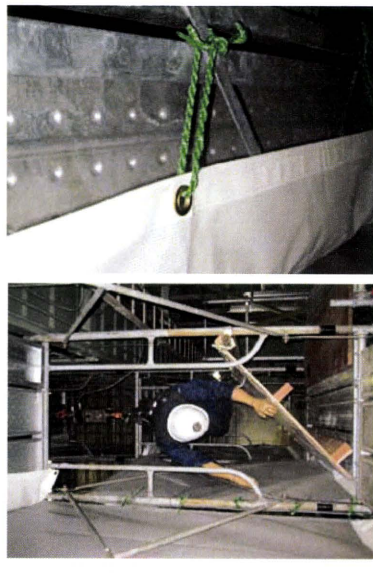


写真3 実験前の状況

写真4 2本に燃った繊維ロープ

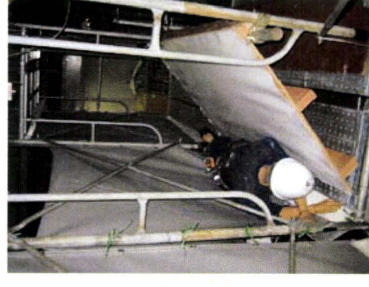


写真5 実験後の状況(落下せず)

写真6 実験後の状況(落下)

ドイツ建設業における労働安全管理体制の現場調査

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1. はじめに
昨年度に報告した文献等に基づく国内調査結果を踏まえ、足場に関する規格の調査を実施した。更にこれら調査で明らかとした法令・規則等が、現地においてどのように運用・機能しているかを明らかにするため、現地調査を実施した。本報は、それら調査結果の概要をまとめたものである。なお現地調査は、2つの都市(ベルリン市およびフランクフルト市)を対象として、これを実施した。

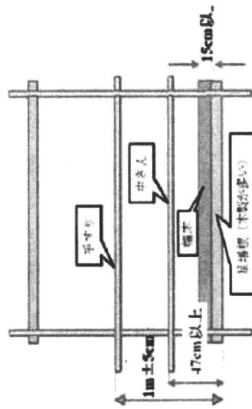


図1 ドイツにおける足場の設置規定

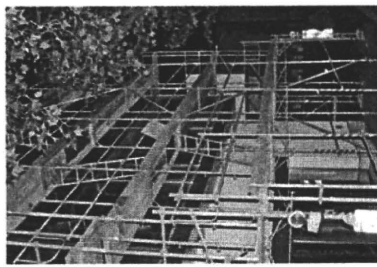


写真1. ドイツにおける足場の設置状況



写真2. 足場板の状況

2. ドイツにおける足場規格の概要
ドイツの足場規格は、欧州における共通規格となりつつあるEN規格がベースとなり、国内規定として作成されたものになっている。建設労働者の墜落防止対策としては、「2段手すり」を基本とし、上さんにについては高さ1m±0.05m、「中さ」については床高0.47m以上とするものであった。また「幅木」については、高さ0.15m以上に設置し、労働者の墜落防止用ではなく、物体の落下防止用として用いられる、というものであった(図1参照)。

なお、枠組み足場で用いられる「交差筋かい」は、日本においては手すりとみなされているが、同規定では、このような規定は存在していないようであった。

3. ドイツにおける足場の設置状況

フランクフルトならびにベルリンの市街地における足場の基本構造は、ほぼすべてにおいて2段手すりに幅木を設けた構造となっていた(写真1参照)。このほか日本と比較で特徴的な事は、①交差筋かいを用いた足場が見られなかった事、②足場用階段が足場板に組み込まれている事、③足場材料として用いられる単管式足場の単管直径が大きい事、④足場板には木製のものが多く用いられていたこと(写真2)が挙げられる。また足場用シートは、果敢に適合するようベントラントされていたのが印象的であった。

4. ドイツにおける安全衛生管理体制
現地調査では、ベルリン市役所の職員、あるいは建設業労災保険組合(BG-BAU)の職員らとともに建設現場を訪

と一致する内容であった。ただし具体的な手すりの高さは1.1mで、中さんは地面と手すりの中央(すなわち0.55m)であったとの事であったため、手すりの高さに関しては、事前調査より若干高い値を現在は採用しているようであった。なお、視察した建設現場では、同規定を満たさないものも見受けられたが、作業予定にない箇所については、違反とは見なさないとの事であった。

このほかの足場の規定としては、労働者の墜落を防止するために、足場と建物との間隔を一定間隔未満(具体的に0.3m未満)とする規定が存在するようであり、足場の際にその間隔(30cm未満)を定規で測るなどして、厳しくチェックしていた。足場は市役所の職員のほか、BG-BAUの職員に法的権限が認められており、何時でも入場することができ、抜き打ち点検を実施しているとの事であった。また足場の実施時期は特に決まらず、市役所・BG-BAUの職員それぞれが裁量で決定するようであるが、市役所とは情報共有して合同で行なう場合が多いとの事である。そして点検の結果、違反が見えた場合は、是正措置を促すほか、罰金も課すことが可能との事であった。命令に対する改善期限についても職員の裁量に任されているようであった。現場責任者に命令を出したのち、2時間後に再び現場へ点検に向かう場合もあれば、1週間後に確認する場合もあるとの事である。そして是正措置命令などに従わない場合は、当該違反箇所を封鎖する措置をとり、安全を確保するための措置がなされるまで、現場で監視する場合もあるとの事であった。なお、封鎖を行なうのは当該違反箇所のみであり、現場全体を封鎖する措置は死亡災害が発生しても原則として行なわれない模様である。この点においては、日本と事情がずいぶん異なっている。加えてドイツでは、最近5年間で100以上の法律を廃止したとの事である。これは法律さえ守れば責任を逃れられるような制度から脱却して、安全衛生マネジメントを各現場で行なわせるのが主な理由であるとの事であった。このほかドイツの安全衛生管理体制の特長としては、市役所とBG-BAUの連携が良いこと、加えて徹底した現場に対する安全指導が目についた。職員は違反を見つけたら労働者に対して直接その場でしかりつけるだけでなく(写真3参照)、当該現場責任者に連絡して是正指導を行なっていた。また前回の検査で指摘した事項の改善状況のチェック

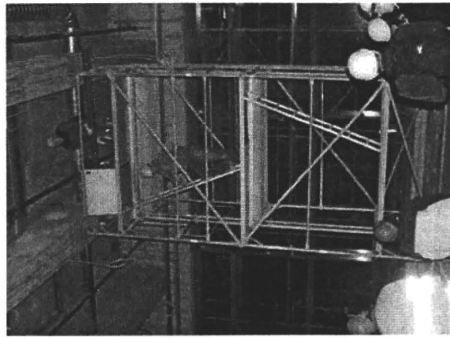


写真3. 足場の際に行われた指導の様相

も行なっていた。

5. まとめ

ドイツの足場規格は、欧州における共通の基準となりつつあり、またそのルールがきちんとして遵守されていること様子が現地調査から伺えた。また安全衛生管理体制に関しては、政府機関と労災保険組合の職員によって建設現場の職労等が頻りに行われていた。情報共有のみならず合同点検も比較的行われていた。情報共有のみならず合同点検も比較的行われていた。

謝辞

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