The Nature of Fall Accidents in Construction Projects: A Case of Indonesia

Yusuf Latief\textsuperscript{1}, Akhmad Suraji\textsuperscript{2}, Yulianto S. Nugroho\textsuperscript{3}, Rosmariani Arifuddin\textsuperscript{4}

\textsuperscript{1}Professor of Department of Civil Engineering, University of Indonesia
\textsuperscript{2}Lecturer, Department of Civil Engineering, Andalas University
\textsuperscript{3}Professor of Department of Mechanical Engineering, University of Indonesia
\textsuperscript{4}PhD Student, Department of Civil Engineering, University of Indonesia

Abstract--- Fall accidents in construction projects, particularly building works, are the most frequent accidents. Those accidents may result in death and serious injuries of workers involved and other consequences such as lost work days and the industry bad image. Robust accident prevention is required through improving continuously health and safety in construction. Therefore, understanding triggering events and their factors leading to fall accidents are of important input. The objective of this paper is to report findings of triggering events based on 100 fall accident cases. The fall accident cases were retrieved from accident reports provided by PT Jamsostek, the stated owned worker insurance company. In this paper, current profile of accident records of Indonesia is presented. This paper also presents the nature of fall accidents. The event area and their potential active failures leading to fall of accidents are described. It is expected the knowledge shared in this paper assist all people involved in construction projects to plan an accident prevention strategy properly.

Index Term--- construction projects, fall accident, triggering events, Indonesia

I. INTRODUCTIONS

Accidents in construction projects in many countries are of important issue to handle. The phenomena makes the construction industry has a bad image of risky place of accidents (Sawacha et al., 1999; Shi, 2009). The nature of construction project itself has potential hazards of accidents since its uniqueness, open space, exposure to weather, involving many unskilled labours, tight schedule of short targeted project duration, workers turn over and working at height, confined space and psychologically and physically vulnerable working environment (Chi, Chang et al., 2004; Lipscomb et al., 2006; Imriyas et al., 2007)

Fall accidents are the most frequent accident in construction projects. In USA, between 1992 to 2006 fall accidents contribute 32\% of fatality (Dong et al., 2009) and 37\% of death in the construction industry (Kaskutas et al., 2009). In New Zealand, fall from different height is also the most contributory accident in the industry (Bentley et al., 2006). The rate of fall accident accounts for 51\% of injuries in the China construction industry (Yung, 2009). A research conducted in Hong Kong found that fall accidents represent more than 47\% of total fatality in 2004 (Chan et al., 2008). Chi and Wu (1997) reported that more than 30\% of fatalities in Taiwan are caused by fall accidents. It has been concluded that fall is the most dangerous accident in many countries (Lipscomb et al., 2003, Horwitz dan McCall, 2004, Gavious et al, 2009). The fall accident has a costly impact to the industry. Annual cost associated with fall accidents in USA are around USD 6 billion in 2000 (Courtney et al, 2001). In Holland, total medical cost of handling accidents is almost USD 11 Billion in 2004 while 44\% of the total cost incurred for financing fall accidents (Meerding et al, 2005). Preventing fall accidents, therefore, is the priority programme in the construction industry development (Jeong, 1998, Gauchard et al., 2001, Kemmlert dan Lundholm, 2001, Kines, 2002, Ergor et al., 2003, Chi et al, 2004, Winn et al, 2004, Bentley et al, 2006, Lehtola et al., 2008).

Robust accident prevention is required through improving continuously health and safety in construction. Therefore, understanding triggering events and their factors leading to fall accidents are of important input. The objective of this paper is to report findings of triggering events based on 100 fall accident cases. The fall accident cases were retrieved from accident reports provided by PT Jamsostek, the stated owned worker insurance company. In this paper, current profile of accident records of Indonesia is presented. This paper also presents the nature of fall accidents. The event area and their potential immediate causation leading to fall of accidents are described. It is expected the knowledge shared in this paper assist all people involved in construction projects to plan an accident prevention strategy properly.
II. THE NATURE OF FALL ACCIDENTS

The term “accident” can be defined as something that is unplanned, uncontrolled, and in some way undesirables; it disrupts the formal functions of a person or persons and causes injury or near miss. During an accident a person’s body comes into contact with or is exposed to some object. Other person, or substance, which is injurious; or the movement of a person causes injury or creates the probability of injury (Anton, 1989). Accident in construction resulting in physical injuries and fatalities can be broadly categorised into the following eight basic groups (Hinze, 2005; Haslam et al 2005) in Kamardeen (2009). They are (i) falling from height, (ii) Struct by falling object/ moving vehicles, (iii) excavation-related accidents, (iv) operations of machinery/ tools related accidents, (v) electrocutions, (vi) fire/ explosion, (vii) failure of temporary structure, and (viii) others.

A fall is defined as an event in which a person coming to rest unintentionally on the ground or other lower level, not by the result of a major intrinsic event such as (stroke) or overwhelming hazard (Tinetti, 1988, dalam penelitian Ware, 2009). Fall accidents are significant public health risk and a leading cause of nonfatal and fatal injuries among construction workers worldwide. A more comprehensive understanding of causal factors leading to fall incidents is essential to prevent falls in the construction industry (Hu, et al 2009). There are many factors to research and variety of proposed methodology as well as locations will improve understanding of the nature of fall accidents including preventive actions to be developed for avoiding, reducing and eliminating potential hazards to fall accidents (Hu, et al, 2009).

In addition, Abdelhamid and Everett (2000) identified four factors of accident causation in construction namely, (i) working conditions, (ii) management failure, (iii) unsafe acts of workers and (iv) Non-human-related events. Suraji (2001) introduced distal and proximal factors leading to construction accident causation. Among those factors are operative actions such as improper personal protective equipment, failure to follow instructions and compliance with working standards and careless as well as over confident which account for almost 29.8 % leading directly to accidents. Furthermore, Bentley (2006) found that causes of slip, trip and fall accidents are latent failure or extrinsic factors and active failures or intrinsic factors. Latent failures consist of design factors, organizational factors and enviromental factors. Design factors include environment design, plant and equipment, activity/ task and clothing/ footwear while organizational factors involve production presure, operational decisions, use of equipment decision, shift scheduling, safety culture, risk and safety management. Active failures cover age, fitness/ heath/ vision, perceptual skills, risk taking tendency, use of equipment and footwear.

Factors of accidents are very complex to structure since their interdepenence to lead to accident causation (Hu, 2009). Many research concluded that contributory factors may increase the risks of accident causation in construction due to environmental and socio-technical conditions such as wind, temperature, human behaviour, psychology of workers at work, education background and organizational issues including commitment and law enforcement and willingness of all stakeholders to mitigate any potential events leading to accidents (Hinze, 1997, Suraji, 2001).

The objective of this study is to find out factors leading to fall accidents in construction projects using two approaches which are event area breakdown structure and the nature of fall accident analysis. The event area breakdown structure uncovers factors related to personal and non-personal (non-human) as the main factor leading to fall accident.

For the sake of proper mitigation of any potential factors both existing at upstream and downstream level of construction projects, the factors leading to fall accidents are structured into 5 main factors, namely (i) human factors, (ii) equipment factors, (iii) management factors, (iv) organizational factors and (v) environmental factors. Human factors are related to human error such as the lack of work safety awareness, the lack of work competence, etc. Equipment factors are related to unreliable work equipments used including improper operations and its condition which is not adjusted with work safety. Organizational factors include organizational norms such as safety culture, team work, etc. Management factors include the commitment to work safety, training conducted by management, etc. environmental factors are related to the working environment such as extreme weather and the lack of lighting.

III. FALL ACCIDENTS IN INDONESIA

In Indonesia, in the last decade, the accident rate is fluctuative from year to year. It shows that this country is still one of countries having higher rate of accidents as shown in Figure 1

115405-2929 IJEE-IJENS © October 2011 IJENS
The number of accidents in construction projects is higher than other industries (Jurnas, 2009). Figure 2 shows that accidents in the construction sector accounts for almost 32% of all accidents in all sectors followed by manufacturing and transportation sector.

There are many accidents leading to fatal and serious injuries in construction. Table 1 shows strucks and hit by objects and trips are among the dominant type of accidents experienced by workers in construction. Though the number of fall accidents are less than these three types of accidents, the fall is perceived as the most dangerous accidents in the field since its consequences to kill workers (Latief, 2011).

<table>
<thead>
<tr>
<th>Main Factors</th>
<th>Number of Accidents</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>Non Personal</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Undetected</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Total Accident</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Fall accidents may occur in many different places in the highrise building projects. It was found that the fall accidents mainly take place on area of scaffoldings, area of ladders and area of working structure. It means that those workers working on the working platform supported by scaffolding/ steiger and working through or using ladders as well as working on top of structure under construction such as floor, plate and column expose to risk of fall accidents. The figure 3 below shows the evidences of where the fall accidents usually take place.
Fall accidents may occur in different time of during working hours. In this case, the data analysis was based on the number of accidents occurring every hour for a whole day or 24 hours since many building projects in Indonesia are working for a whole days. Table III shows that the fall accidents occurred during morning time (27%), afternoon time (42%) and evening time (21%). The afternoon time is the time in which workers working under fatigue and less concentration due to many potential distractions (Hinze, 1999).

<table>
<thead>
<tr>
<th>Working time</th>
<th>Number of fall accident cases</th>
<th>Total zone time cases</th>
<th>Total zone time Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>08.00 - 09.00 am</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>09.00 - 10.00 am</td>
<td>3</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>10.00 - 11.00 am</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.00 - 12.00 am</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.00 - 13.00 pm</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>13.00 - 14.00 pm</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.00 - 15.00 pm</td>
<td>16</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>15.00 - 16.00 pm</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.00 - 17.00 pm</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.00 - 21.00 pm</td>
<td>10</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>21.00 - 24 pm</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undetected</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Fall accidents also occurred in many types of working process. It was found that fall accidents mainly related to workers when working for structural framework/bekesting work (21.9780 %) and finishing works (17.8713 %) as shown in Figure 4.

Fall accidents also occurred in many types of working process. It was found that fall accidents mainly related to workers when working for structural framework/bekesting work (21.9780 %) and finishing works (17.8713 %) as shown in Figure 4.

V. CONCLUDING REMARKS

In this paper, the nature of fall accidents in highrise building projects construction in Indonesia is presented. The fall accidents involve different event area and factors. Indonesia experience shows that personal or human factors particularly worker behaviour are main factors leading to fall accident causation in highrise building projects occurring in...
the scaffolding area (52%). The fall accidents mostly occur at afternoon time (46%) and related to building structure works (22%) as well as involving many young workers (40%). These findings needs further works on investigating a causal structure of variables under each factor of personal and non-personal factors including assignment of their degree of possibility leading to fall accidents and their non-linearity of causal structure. It will assist in developing proper accident prevention strategy such as mitigating any root potential factors to lead to fall accidents while designating who will be fined if they fail to comply with their responsibility related to the identified variables under each factor proposed above.

ACKNOWLEDGMENT

This research is supported by the UI Research Fund. Thanks to PT Jamsostek in Jakarta for help in providing the accident database system through which the accident records can be retrieved.

REFERENCES