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Falls from height during the floor slab formwork of buildings: Current situation in Spain

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ABSTRACT

Problem: One of the phases with the highest risk of falls from a height in the construction of a building is during the floor slab formwork stage. This paper analyzes this particular risk, as well as the most frequently used fall-protection systems. *Method:* A survey was carried out to define the current situation in Spain with regard to falls from a height during floor slab formwork and the fall-protection systems used to prevent such a risk. *Results:* The results of the survey clarified the current situation in Spain with regard to this risk, and made it clear that there is considerable risk of falling from a height during the floor slab formwork stage. *Discussion:* All the safety systems analyzed presented a series of weak points that should be studied in detail before they can be used on building sites. *Impact on industry:* The risk of falling associated with floor slab formwork and the most frequently used protection systems are analyzed. As no research had been carried out to date on this type of risk, we consider the research presented in this article to be a pioneer in the field.

1. Introduction

Due to its particular nature, the construction industry is among those with the highest risk of accidents in the world (Jannadi & Assaf, 1998; Jannadi & Bu-Khamsin, 2002), and in most countries the rate of fatal accidents in the construction industry is higher than in any other sector (Alves, 1999; Suraji, Duff, & Peckitt, 2001).

According to data gathered by Camino López, Ritzel, Fontaneda, and González Alcántara (2008) and Müngen and Gürcanli (2005), Spain has some of the highest accident rates in the European Union. The most recent data available in Spain (Instituto Nacional de Seguridad e Higiene en el Trabajo, 2007) show that the construction industry accounts for 27.3% of occupational accidents in this country and that 34.6% of all serious accidents and 33.9% of all fatal accidents in Spain occur in the construction sector.

Camino López et al. (2008) analyzed the factors involved in the Spanish situation. Seventy-four percent of the construction work in Spain involves the construction of buildings (Instituto Nacional de Seguridad e Higiene en el Trabajo, 2003), which is where the majority of fatal accidents occur, accounting for 43% of all accidents and 35.2% of fatalities (Instituto Nacional de Seguridad e Higiene en el Trabajo, 2003). The problem, of course, is not only confined to Spain but exists on a worldwide scale. This hazard has been studied by various authors (e.g., Hinze, Pedersen, & Fredley, 1998; Janicak, 1998; Jeong, 1998; Kines, 2002; Larsson & Field, 2002; Huang & Hinze, 2003; Macedo & Silva, 2005; Müngen & Gürcanli, 2005), all of whom agree that falls from a height are among the most frequent accidents in the construction industry and a major cause of fatalities.

Jannadi and Assaf (1998) and Zambianchi (2007) concluded that the preparation of formwork for concrete structures was the most dangerous stage in relation to falls, and Adam, Pallares, Calderon and Payá (2007) found that the highest risk of all occurred during the preparation of the floor slab formwork. As no research has to date examined the danger of falls from a height during the floor slab formwork stage, a study was carried out with the objective of reducing this risk as far as is practically possible.

2. Risk of falls from a height during the laying of floor slab formwork

2.1. General

Of all the fatal accidents caused by falls in China in 1999, a total of 34 cases were identified as having occurred during the preparation of formwork for concrete structures, accounting for 6% of all fatalities attributed to falls (Tam, Zeng, & Deng, 2004).

Huang and Hinze (2003) pointed out that the risk of falling is often present when provisional / temporary structures are being used, such as when floor slab formwork is being laid. Jannadi and Assaf (1998) and Zambianchi (2007) also identify the setting up of formwork as one of the stages with the highest risk of accidents, especially falls. This risk is more apparent during the formwork stage prior to the reinforcement and pouring of concrete for the floor slab of a building (Adam, Pallarés, Calderón & Payá, 2007). The work involved in laying out formwork is described in the following sub-section, where the

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construction process is explained; many of these actions involve a high risk of a fall.

A total of 161,136,800 m^2 of concrete formwork were constructed in Spain in 2006 (Asociación de Empresas Constructoras de Ámbito Nacional, 2006). It is therefore evident that there is a great risk of falls for workers that are engaged in the floor slab formwork process.

2.2. Description of the floor slab formwork process

The assembly of floor slab formwork that is common in Spain includes the stages described in Fig. 1. There are other methods for the construction of slabs, but they are not used a great deal in Spain. The most commonly used method in Spain includes the following stages:

1) Assembly of shores and steel beams.
2) Positioning of steel beams (laid over the structure built in Stage 1).
3) Assembly of the formwork boards on auxiliary metal structures (shores and steel beams).
4) When the formwork is complete, the reinforcement is assembled and the floor slab concrete is poured.

2.3. Analysis of the risk of falls

During assembly of the floor slab formwork, there is a stage during which the risk of falling is significantly high. This is when the metal structure supporting the formwork (i.e., shores and steel beams) has been assembled and workers have to climb onto the structure to position the boards that make up the formwork (Stage 3 in Fig. 1). This risk is shown in Fig. 2.

Since the risk of falling during this process is clearly apparent, it follows that workers should use a safety system when carrying out these tasks, so as to eliminate, or at least minimize, the risk of falling.

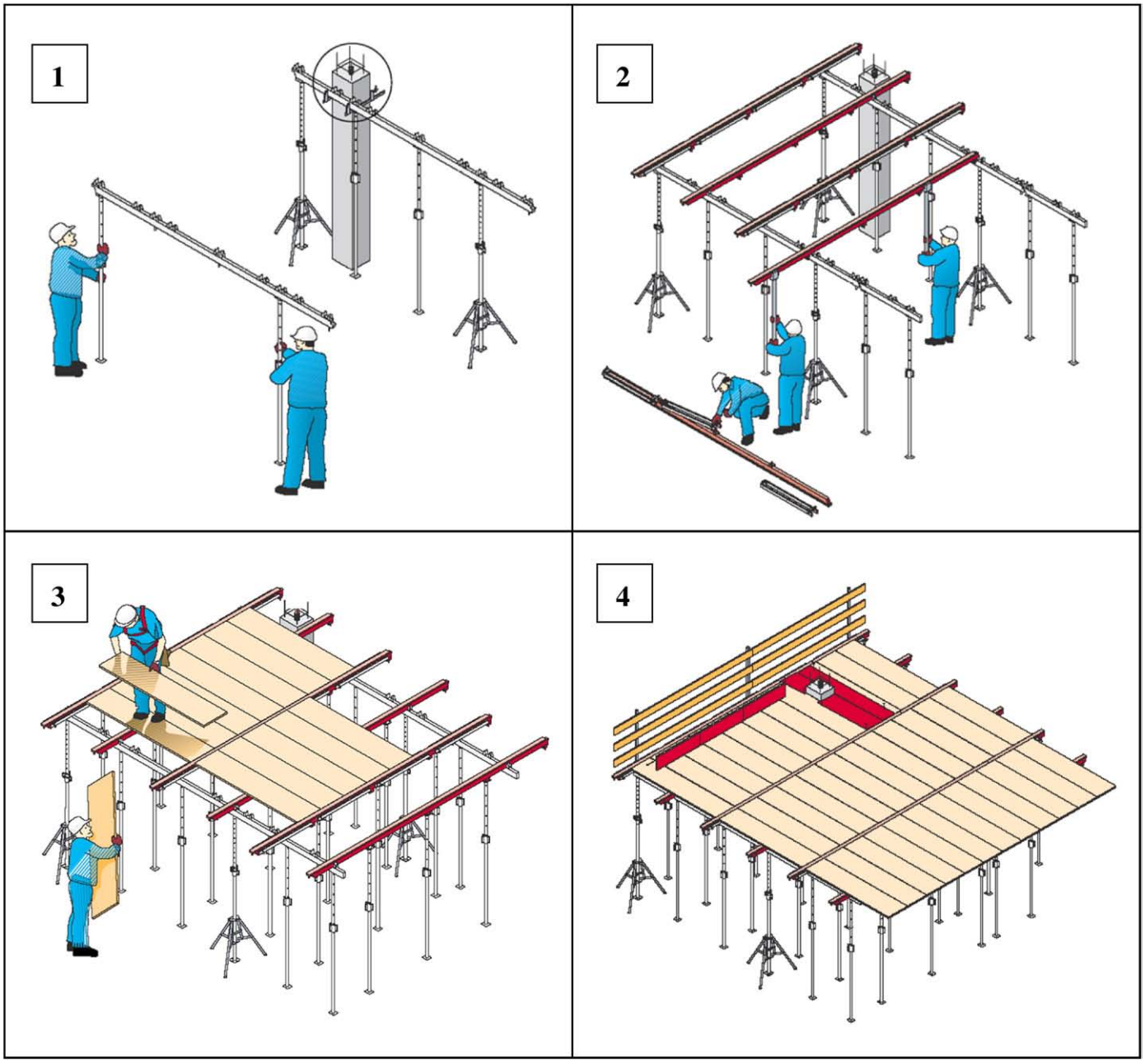

Fig. 1. Assembly process of floor slab formwork.