

The Importance of Design in the Prevention of Accidents in the Construction

Alfredo Soeiro

Universidade do Porto, FEUP, DEC, Gequaltec, avsoeiro@fe.up.pt

"Safety is to apply common sense and the accidents happen when the common sense is absent".

Motivation to Prevent Accidents in Pre-Construction Phase

The anguish, the affliction and the sadness suffered by a wife, mother, family and friends in losing a husband or a son or a friend in an accident in construction are traumatic and touch feelings strongly. An image of a person that died or was seriously wounded when is working provokes interrogations and perplexities for those that, in a modern world, have no answer or acceptable comment from the moral or social point of view.

The world of construction is dangerous and it has many potential risks of life and of corporal damages. The exposure to risks of accidents is high and practically constant. For the betterment of society a Culture of Safety has to be created in all phases and processes of construction. The minimum requirements of prevention of accidents should be accomplished by all that are intervening in the construction process. To assure safety in a construction site is a complex challenge. For that reason there should be created a culture of safety. Human life and corporal integrity are precious goods and health is an essential condition of the quality of life.

The activities of construction are, essentially, different from the other industries in what concerns the mobility of the workplace and the repetition of conditions in tasks implemented. For instance, the environment of the operation in construction sites changes constantly due to weather changes and to location of the site. This diversity is considered one of the main conditions that induce the insecure behaviour and that can hinder prevention measures. Therefore it is difficult to legislate and to standardize practices for the enormous variety of size and of complexity of the construction projects. The variety of construction organizations and of working structures also contributes as additional difficulty for acting, via legislation or practice, effectively in preventing accidents in construction.

Culture of Safety in Construction Environment

The current legislation has a character that is essentially descriptive. The development of the role of safety's coordination in the design phase and in the execution phase was created by national laws in each country of the European Union as a consequence of the European directive no. 97 of 1992. The legislation intends to improve the safety and the patterns of health in construction sites. These rules impose a concept of safety and health based on a linkage of responsibilities that includes the owner. These responsibilities in conception, administration and verification of the prevention measures involve all that are intervening. The owners are the ones that have the need

to start the prevention procedures in all phases including the design phase. Safety's coordinators are the nuclei of the articulation of these measures even in the design phase.

Need for Implementation of Safety in Design Phase

Historically, the duties of implementing safety were assigned to contractors as an executioner of the construction work. This is a current situation in other industries. The legislation changed this situation and the execution of the prevention measures doesn't only depend on the contractor but of the work owner and of designers. This partition of duties is consecrated in the legislation and all that are intervening have a share-part of the responsibility.

The construction owner and the designers should assure the safe implementation of the construction works. It is safety's coordinator's legal competence in the design phase of approving the architectural options and techniques to minimize the risks of accidents in the execution phase. It is a difficult task since it collides, in many cases, with the creative and technical options of the designers and, above all, for suggesting more expensive options to the construction owner. But the safety and the prevention have to begin in the design phase as a way to minimize the risks for the contractors and to adapt the works to who executes it.

The big improvements in preventing accidents while designing can be reached to avoid future risks and dangers. In agreement with the preamble of the European directive about 60% of the fatal accidents in construction could be avoided with the adoption of appropriate measures in the design or preparation phases. There should be made larger efforts to identify the risks in the design phase by architects and by engineers. The designers have a fundamental role in the choice of the safest options and they should consider the relative risks to the execution when they conceive the construction works. The construction owner and the designers should integrate safety's coordinator's activities along the elaboration of the designs.

This integration is justified for two reasons. The first reason, for questions of effectiveness, has to do with the safety's need to be integrated since the beginning of the creation of the design. This is justified because the decisions taken at level of the design could lead to condition the effectiveness of prevention measures. The second reason, of intrinsic nature to the coordination activity, is linked with the fact that the activity of safety's coordination in the design phase should be coordinated with the other design specialities.

Construction Safety Coordinator Profile

Construction safety coordinator in the design phase should be a qualified technician capable of articulating activities of designers and the construction owner's requirements. This qualification should guarantee the technical, professional and personal competencies necessary to acting effectively in these activities. Some of the competences, knowledge and aptitudes will be:

- To read and to interpret the several pieces of the construction designs;
- To coordinate the prevention with designers and with the construction owner;
- To identify and prioritize the risks of accidents;
- To evaluate the current risks of the architectural solutions and adopted techniques;
- To present and to justify solutions to seek the prevention of professional risks;
- To understand the techniques and the constructive processes;
- To know to apply techniques of administration of conflicts;
- To present and to justify, in the extent of the elaboration of the list of responsibilities, specifications that seek to prevent the risks of accidents;
- To analyze the proposals in the environment of the construction site to verify if they consecrate the prevention of accidents;
- To esteem the inherent costs of prevention in the execution of the work.

These competences for the qualification of professionals in the area of construction safety have been defined by national agencies and by professional organizations. At the European level ISHCCO (International Safety and Health Construction Coordinators Organization) has defined a framework accepted by the national professional organizations of construction safety coordinators. This framework defines competences for levels 5, 6 and 7 of the European Qualification Framework in terms of knowledge, skills and attitudes. This framework intends to be a reference that will facilitate mobility of professionals and improvement of the quality of professionals working in the sector.

At another level the legislation imposes that the construction owner will also have to pay to assure that the design, and above all the construction, is carried out with safety. The lack of appropriate prevention measures will increase the costs that the construction owner, the contractor and the society will have to support. The costs will be, among other, owed at repairing costs, production loss, loss of materials, medical treatments, legal procedures and increase of insurance fees.

Research Study with a Possible Solution

With the intention of answering some of the issues required to assist designers and construction owners directly, this research study was done with the aims of producing a model for the integration safety in the design process using a practical guide for designers. This analysis was based on the development of a risk assessment method for the design phase. The envisaged model aimed at contributing in the prevention of risks of accidents in construction during the lifetime of the project (planning, implementation, maintenance and deconstruction), taking into consideration design decisions, accident risks and control measures. The research study consisted of the following steps:

- a) Identification of key stakeholders (owner, co-ordinator, designers, etc.) and their respective duties in construction safety, specifically in the sub-sector of buildings;

- b) Analysis of the design process;
- c) Search for statistics on construction accidents in order to understand the underlying causes and respective risks that originated the accident;
- d) Analyse case studies in order to establish the possible links between the causes of the accident and the design decisions;
- e) Method to assess risks at the design stage that could be eliminated or alleviated;
- f) Guide for designer containing guidelines for preventing accidents at the design phase.

Proposed Methods for Designers

The number and sources of accidents analysed was diversified in terms of sources. The accidents were obtained directly from public sources and from construction companies. This data from public sources was obtained from reports of accidents available for the public and from consultation of the company records. This data obtained from the analysis of about two thousand fatal or serious accidents have shown that about 35% of the accidents could have been avoided if, during design phase, appropriate options were taken. The same percentage was 30% concerning decisions at the pre-construction phase, also known as planning stage.

The research study also produced two models valuable for different type of designs (infrastructures, superstructures, mechanical, electrical, HVAC, architecture and plumbing): MAARD (Method of Analysis for Accident Related Design) and MMPtD (Management Model for Prevention through Design) (Silva, 2013).

MAARD is composed by a matrix that relates the frequency and the gravity of accident with the possible preventive measures to be considered at the phase of design. These preventive measures were chosen based on the risks that created the accident analysed. The measures were identified as possible to be decided during the design phase. This tool allowed the conclusion of how many accidents could have been prevented at the design phase, planning phase and construction phase.

MMPtD (Management Model for Prevention through Design) is composed of four sets of checklists that are supposed to be used by designers according to the respective type of design: architecture, structures, infrastructures and mechanical/electrical installations. These four guides are practical tools that can be used by any designer without an enlarged knowledge about prevention of accidents. This guide is expected that, if widely used by designers, there will be a serious reduction of accidents in construction since more preventive measures will be undertaken at the design phase.

According to this research it is possible to include prevention measures that can reduce the risks that may create about the two thirds of the accidents verified in about two thousand accidents. It is certain that the cause-effect relationship between the proposed measures and the accidents occurred may not be unique. There are probably other causes that could not be identified in

that analysis of the reports that were not eliminated and the effectiveness of the proposed measures to eliminate the accident may be questionable. Nevertheless these are the best solutions according to the state of the art prevention culture. If these guides are followed by the designers in the design phase there will be a significant decrease of accidents in the related construction. One life saved is reason enough to apply these guides.

"Safety in construction is a subject of life or death".

References

- Construction Design and Management - CDM. (2010). Available: <<http://www.hse.gov.uk>>. Access: 10 January 2015.
- Creaser, W. (2008). Prevention through Design (PtD) Safe Design from an Australian Perspective. *Journal of Safety Research*. v.39, p. 131-134.
- Driscoll, T., Harrison, J., Bradley, C., Newson, R. (2008). The Role of Design Issues in Work-Related Fatal Injury in Australia. *Journal of Safety Research*. v.39, p. 209-214.
- European Agency for Safety and Health at Work - OSHA/EU - OSHA/EU (2009). Occupational safety and health and economic performance in small and medium-size enterprises: a review. Office for official publications of the European Communities. Luxembourg.
- European Foundation for the Improvement of Living and Working Conditions (1991). From drawing board to building site (EF/88/17/FR). European Foundation for the Improvement of Living and Working Conditions, Dublin.
- European Union (1992). Directiva 92/57/CEE do Conselho, de 24 de Junho de 1992. Available: <<http://europa.eu.in/eur-lex/>>. Access: 10 February 2014.
- Fernandes, M. and Soeiro. A. (2007). Analysis of the Profile of Competences of Safety Coordination. 7th International Congress of Safety and Hygiene at Work, Ordem dos Engenheiros, Porto.
- Gambatese, J., Hinze, J. (1999). Addressing construction worker safety in the design phase: Designing for construction worker safety. *Automation in Construction*, v.8, p. 643-649.
- Gambatese, J. A.; Hinze, J.; Haas, C.T. (1997). Tool to design for construction worker safety. *Journal of Architectural Engineering*, v. 3 (1), p. 32-41.
- ISHCCO - International Safety and Health Construction Coordinators Organization. www.ishcco.org. Access: 10 January 2015.
- National Institute for Occupational Safety and Health - NIOSH. The National Occupational Research Agenda. Available: <www.cdc.gov/niosh/nora>. Access: 30 May 2014.
- Oliveira, O. J. (2004). Gestão do processo de projecto na construção de edifícios. *Integração*, ano X, n. 38, p. 201-217.
- Reis, C. and Soeiro, A. (2003). Economic Analysis of Implementation of Safety Plans in Construction. *Journal K eramica*, n . 257, pp. 45-56.
- Soeiro, A. (2005). Safety in the Construction. Edi  es FEUP. Ebook. Porto. ISBN 972-752-072-3.
- Vasconcelos, B. (2013). Seguran a no Trabalho na Constru  o - Modelo de gest o de preven  o de acidentes para a fase de concep  o. Doctoral (Ph.D.) thesis. Porto: Universidade do Porto.