

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.

4. RESEARCH RESULTS AND CONCLUSIONS

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 water systems): 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.

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