

Safety and design in construction



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1. INTRODUCTION

1. 1. Background

Safe Design has always been an integral part of the design and construction process and hence has been known by the respected professionals since a long time. Safe design considerations are deeply rooted in the design process, it is not a clear cut path to be defined, and rather it varies from case to case and project to project. To understand the matters in concern, the aspects of consideration and the results each will yield, it is necessary to take into consideration all the aspects of safety right from the start of any project. (*Piatkowska , 2013, p. 2*)

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1. 2. What is Safe Design?

Safety and design is an essential part of the entire process of design and construction of any built structure. It begins from the very beginning, during the concept development when taking the purpose and intention of design into consideration, its materials, when methods of construction and operation, standards and codes are measured. It is about incorporating hazard identification and risk assessment methods such that casualties and accidents are eliminated or minimised to the maximum, safeguarding the lives of the workers and the users (including owners, designers, contractors and visitors) both. (Acumen Practice Notes, 2015, p. 6)

It is important in all the stages of construction, during the use and demolition of a structure, and measures should also be taken for its maintenance and renovation including the services and equipment in use. It can result in a number of benefits for example effective and better use of structures, prevention of accidents, good productivity and management of cost avoiding extra damages in terms of budget and costs, innovative creations to resolve hazards and constructive problem solving. It affects practicality, aesthetics, cost and functionality of any project. (*Safe works Australia, 2012, p. 5*)

A systematic approach to prospective Occupational Health and safety risks should be adopted and a thorough method of risk management be applied to all phases of design and documentation. It helps identify risks along with the person or company responsible. For example, a contractor is responsible for all the happenings on site. (Acumen Practice Notes, 2015, p. 8) For the designers part they have to run the risk assessment analysis and ensure that

all the drawings and details during documentation are updated and let the concerned individuals know of any discrepancies. (Acumen Practice Notes, 2015, p. 9)

2. SAFETY AND DESIGN IN CONSTRUCTION

2. 1. Safety and Design Considerations

The design describes the system and elements of a building and thus affects the construction of the project

and the consequent safety risks to a big extent. Building safety design also involves addressing the safety of building employees and workers involved in designing and construction of any project. A substantial amount of injury incidents arise during the planning, scheduling and design phase. Hence, essential methods and precautions should be taken beforehand. (

Gambatese, 2000, p. 1)

State acts on occupational health and safety differ significantly with regard to designers' commitments.

The Building and Construction (Workplace Health and Safety) Taskforce in Queensland does not involve designers

to guarantee buildings can be constructed securely. The taskforce is of the view that the duty to construct securely should stay with the main contractor as opposed to the other states of Australia. (Acumen Practice Notes, 2015, p. 3)

2. Build-ability

Building designers must bear in mind the construction procedure when making shape, form and material choices, but the choice of one material over another or one technique over the other, while being affected by safety issues should not prevent architectural inventions and the creative thought process. The decisions for material and structural liability in the shape and form are made on the basis of their assembly and cost, simultaneously keeping in mind the safety provisions. (Acumen Practice Notes, 2015, p. 10)

The duty of the designer, contractor or the person ensuring safety should take into account the probability of the hazard, the extent of the harm it may cause, knowledge about the hazard and ways to eradicate or reduce its effects, accessibility to the resources in case of emergency and the assumed costs for rectification. Though the designers alone cannot control the happenings during the construction phase but can manage it well with coordination and cooperation with consultants, contractors and site engineers. (*Safe works Australia, 2012, p. 7*)

A method for the assessment of hazards and risks in a project along with the identification of people responsible and involved at the different stages of building called as “The CHAIR” is developed. However, its productivity depends on the complexity and scale of the project. It may be too time consuming and not suitable for smaller projects. It can be done at the different stages of the design, construction, maintenance and demolition of a project. The analysis is taken over mostly during the design and documentation phase. The stake holders involved include the project architect, the owner of the architectural firm, contractors, service

consultants and engineers, owner and the representatives of the user community. (Acumen Practice Notes, 2015, p. 11)

3. METHODS AND PRACTICE

3. 1. Relevant approaches and Systems in practice

Australian Workplace Health and Safety (WHS) legislations were developed and are in practice since 2011, which require consideration of safety during the design and construction phase. It is based on good and responsible design rather than relying on mechanical equipment. The legislations by the WHS ask for the ‘ Safety Report’ which specifies the risk involved during the construction to the workers and measures in design to prevent and control the risks. (*Eastaughffe, 2015, p. 1*)

The key elements for safe design include;

- Risk Management approach- It is an efficient way of making the workplace safe by assessing the risks involved, reviewing the control measures and taking preventive measures to eliminate the threats and hazards. (*Safe works Australia, 2012, p. 8*)
- Knowledge and Capability- A designer should have beforehand knowledge of all the workplace health and safety laws and legislations, codes of practice and regulatory requirements along with the risk managing procedures, technical standards, construction methods and their effects. (*Safe works Australia, 2012, p. 8*)
- Consideration of the Life Cycle- Designers should also take into consideration the impacts of design on the health and safety of the users who will interact with it. (*Safe works Australia-WHS act , s 22, 2012, p. 8*)
- Consultation, co-operation and co-ordination- The risk management becomes several times easy and less prone to accidents if all the responsible persons including the designer, consultants, engineers and

other stake holders work collaboratively. (*Safe works Australia-WHS act, s 46 47 & 48, 2012, p. 9*)

- Information Transfer– Significant information and material should be documented, verified and passed on to the people involved in the later stages of design and construction. This should include information and knowledge about materials and their characteristics (flammability, weight, toxicity, accessibility, vibrancy, volume, noise etc.) *Safe works Australia-WHS act(, s 22, 2012, p. 10)*

3. 2. Safety attributes in different phases of Design

A method which incorporates risk management within the design strategies and encourages cooperation between a client, designer and contractor is highly fruitful. The phases of design where these attributes are considered include:

- Pre Design– This stage involves understanding the context and complexity of the project where it is essential to establish a conception of the scope of the project, site, rules and regulations, codes of practice and standards that need to be considered. Also, keeping in mind the role of the key stake holders and individuals responsible. (*Safe works Australia, 2012, p. 12*)
- Conceptual and Schematics Phase– Hazard identification should be done as early as the conceptual phase where measures can be made to avoid or minimize the risk. The framework of the hazard identification include analysis of the location and siting of the structure, storage and handling of biologically hazardous materials, systems of works involving human interaction with the structure,

construction techniques, materials used in construction, exposure to height, noise levels, accessibility, maintenance, environmental impacts and strengths for recovery after any mishap. (*Safe works Australia, 2012, p. 14*)

- Design Development– This phase involves conversion of concepts into detail drawings and documentation. Hence, standards and construction codes are used. The best solutions are optimised. At this stage the design undergoes trial and error, it is redesigned to manage and control any risk and safety reports are established and solutions are found for hazards assuming their maximum limit. (*Safe works Australia, 2012, p. 16*)
- Construction– Risk of Hazards and accidents can be reduced during the construction phase. Ensure that alterations which affect design do not increase the risk factor. The most constructive control measure involves eliminating the risks and hazards associated. Hazardous materials can be substituted with less harmful materials. (*Safe works Australia, 2012, p. 17*)

The design should be such that it keeps the hazardous parts away in isolation such that it reduces the disturbance which might occur. Keep the maintenance equipment and control within height such that repairs are easy and accessible. (*Safe works Australia, 2012, p. 18*)

Warning signs and administrative controls should be added during the construction phase. Proper training should be given to the workers and safety protective gear to be provided to all those working on the construction

sites. All the updates and changes and risk factors need to be communicated well to the concerned individuals. (*Safe works Australia, 2012, p. 19*)

At a number of intervals in design and construction phase the safety measures are run again by the safety experts and the design is reviewed to make it less prone to risks. The design's health and safety aspects should be reflected in the contract documentation for the construction stage. (*Safe works Australia, 2012, p. 19*)

- Post Construction- After the successful construction of the design, it needs to be evaluated and verified. The data and information assembled will help in future projects. (*Safe works Australia, 2012, p. 19*)

3. 3. Design Considerations for safe Construction-Examples

There are a number of design options which help control measures for the hazards associated with building structures. A few of them include:

- Use of non-hazardous materials
- Providing adequate clearance in terms of height from the structure and electric cabling such that they don't interact when using cranes.
- Using prefabricated components or assembling on ground to avoid falls when erecting parts at a height.
- Designing parapets according to standards to prevent accidental falls
- Using support beams for stability of temporary structures
- Designing and constructing stairways at the start of construction making vertical circulation less dangerous.

- Use of paints and finishes which have a low volatile compound emission.
- Reducing the internal space between the roof trusses to avoid internal falls.

3. 4. Case Studies

Example1: Commercial Centre, Melbourne

The initial design method had a number of hazards with the construction and maintenance of the building at a commercial project in Melbourne. A central glazed atrium covered all the nine floors. The concern here was the construction and maintenance of the glazing parts and access to the facilities mounted on the ceiling. The initial design consisted of a railing with access to the rope which was unsafe.

The design was modified after assessing the hazards and risks and a purpose designed gantry was installed across the atrium. The platform was mounted on hydraulic lifts allowing secure access to the high ceiling space facilities. It was retracted when the platform was not in use and placed on top of the gantry. It not only provided a safe routine maintenance but the gantry was used during the construction of atrium and roofing. It also contributed to cost savings, time savings and improved atrium and roof constructability. (*Safe works Australia, 2012, p. 29*)

Example 2: Coles Myer Somerton, South Australia

The building area is approximately 75, 000 square metres in total; an equivalent amount of external space was to be completed over a thirteen month construction program. To guarantee safety in both design and

construction, an extensive system of pre-construction and construction safety planning was done which became the key feature.

Communication strategies between the constructor, client, designer and contractors were developed to ensure site safety. Risk mitigation plans were established considering heights to be a major risk on site. Safety gears for the workers, safety banners and high visibility messages were installed on site. Review systems such as the ROAD (Risk, Opportunity, and Design) were used to assess design with regular site meetings and audits. This project was selected by the taskforce for its low injury rates. (*Brown, Rachel, Charles, 2007, p. 74*)

4. CONCLUSION

4. 1. Executive Summary

The *Work Health and Safety act 2012 (cop) s 274* states that eliminating hazards is often simpler and cheaper to accomplish at the design and planning phase rather than making modifications later when it becomes actual workplace risk. The requirement to incorporate safety into the design phase of


a project to improve the safety of building workers has been suggested as an extra measure to improve the safety and health of building workers.

(Gambatese, 2005, p. 8) This idea of thinking as dictated by the design can generate beneficial outcomes in both safety related demands and decreased project expenses through the hazards associated with multiple means and techniques of building. The specific requirements of the quality and finish should be written in the contract. Regular onsite visits ensure that all things

are in place. Communication and cooperation between the owner, contractor, site supervisor and consultant makes certain that all matters are done smoothly without any casualty. (Queensland Building and Construction Commission, 2015, p. 19)

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