A Study on Risk Assessment and Safety Management in the Construction of High-Rise Buildings

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Abstract- High-rise structures are also called "vertical cities", having the potential to decongest urban sprawl. Indian cities are witnessing immense demographic expansion due to migration from surrounding villages, leading to urban sprawl, housing demand, rise in cost of land. Housing has developed into an economy generating industry. The construction projects are one of the most important one which plays a vital role in development of the country. It is estimated that the High-rise (or) multi storey buildings are the most important part of the construction for the greater development. Given this demand, while high-rise residential structures have become a solution in the metropolitan cities, they remain eluded in tier II cities in India. Low-rise or mid-rise high-density dwelling types have developed in these cities. . Construction risks can be minimized only when their cause are identified. The objective of this study was to study the risk assessment in the construction of high rise buildings. This study was carried out based on literature review and a questionnaire survey. Most of the high-rise projects remain as proposals. An investigation in this case study reveal that high rise structures are not preferred due to user perception of insecurity in case of fire and high cost of the building. The paper aims at studying the availability and use of fly ash in various proportions, which can be used in Indian high-rise residential buildings.

Keywords- high-rise residential buildings. Safety management , Risk analysis.

1. INTRODUCTION

The statistics from Indian Government says that the area of the country is about 3,287,590 sq.km and the population about 1,250,193,422.This makes land resource very precious to the India. A high-rise structure can provide space and work for people in such a case. A high-rise is just a tall structure. They first became possible due to the invention of the elevator and a cheap building material. Reinforced concrete and steel are used for their structural system. Steel Frames are used for most American style skyscrapers and concrete for residential tower blocks. Construction projects are always unique and risks raises from a number of different sources. Risk is defined as any action or occurrence which will affect the achievement of project objectives .Risk management is a technique which is used in many other industries from, IT related to business, automobile, pharmaceutical industry, to the construction sector. Risks and uncertainties inherent in the construction industry are more than any other industries. Many industries have become more proactive about using risk management techniques in project. However, with respect to the construction industry, the same is not used commonly. Risk is an integral component of any project.

If risks are not properly analyzed and strategies are not trained to deal with them, the project is likely to lead to failures. In practice, these new rates would often be valued after the work was executed based on the actual costs.

There are number of reason for the introduction of changes on construction works including:

Inadequate briefing from the client

- Inconsistent and late instructions from the client
- Incomplete design
- Lack of meticulous planning at the design stage
- Lack of co-ordination of specialist design work
- Late clarification of complex details

Additionally on civil engineering works there are many cases where changes and new rates are necessary because of the nature of the ground. Further more changes may occur due to the client‟s desire to incorporate the latest technology into the project which will led to deviations of time.

Risk is defined as an exposure to the consequences of uncertainty. Risk is usually considered as an unwanted event that can be identified and quantified through its impact and probability of occurrence. The classical definition of risk states that

Risk = Probability x Impact

- A probability of occurrence of that event.
- Impact of the event occurring (Magnitude of amount loss/gain).

A project risk uncertain event (or) condition that, if it occurs, has a positive or a negative effect on at least one project objective. A risk may have one or more causes and, if it occurs, one or more impacts which are inevitable in projects and because of this uncertainty influence project performance. In which the chance of something happening that will have an impact upon project objectives

Traditional methods of coping with project risks and uncertainties mainly consist of establishing a contingency budget which is estimated as a percentage of the various project components. This method of calculating contingencies for risk has a low level of confidence and reliability. Probabilistic risk assessment techniques can provide an analytical basis for establishing contingency budgets by modeling the impact of risk factors using data ranges. The goal of risk assessment and risk management is to minimize cost overruns and scheduling problems. It has been shown that cost overruns are positively related to project size, engineering uncertainty, inflation, project scope increase, the length of time between planning and completion of a project, delays, and the inexperience of administrative personnel. Many systems exist for categorizing risks into different categories but the one presented here is fairly simple. In this system each risk item is qualified on two scales likelihood and impact. Each scale is divided into two categories of "low" (or) "high" and risks are rated according to each scale.

Risks and other uncertainties can cause losses, which lead to increased costs and time delays, during the currency of projects and at their end. The need to prevent failures in the construction process and other losses relating to projects has been highlighted many times over the years and figures strongly in a recent major report.

2. OBJECTIVES

To determine the most suitable technique for high rise development by studying various techniques, comparing them, analyzing them and determining best way to manage the project along with cost efficiency. Construction risks can be minimized only when their cause are identified. The objective of this study was to study the risk assessment in the construction of high rise buildings.

3. NEED OF THE STUDY

The normal storied buildings and high rise buildings are very different. So, the activities involved starting from the planning stage will impact the completion of the project. It will require planning of urban infrastructure around the structure. A detailed planning will be required for the building services and utilities in all the stages of construction. The safety requirements, the management requirement all increases drastically. Other factors that favour this are:

1. Rapidly growing urban population that increased demand for tall buildings
2. At the expense of quality of life, the human factors being neglected.
3. To establish priorities for new research in this particular field.
4. The professionals must have the new information on high-rise buildings.

Above points justify considering high rise building construction management different than the normal

4. METHODOLOGY

4.1 RISK IDENTIFICATION TECHNIQUES

Risk Identification can be done by the following methods:

Brain storming: This is one of the most popular techniques. Generally, it is used for idea generation; it is also very useful for risk identification. All relevant persons associated with project gather at one place. There is one facilitator who is briefing about various aspects with the participants and then after note down the factors. Before closing it the facilitator review the factors eliminate the unnecessary ones.

Delphi technique: This technique is similar to brainstorming but the participants in this do not know each other and they are not at the same place. They will identify the factors without consulting other participants. The facilitator like in brain storming sums up the identified factors.

Interview /expert opinion: Experts or personnel with sufficient experience in a project can be a great help in avoiding/solving similar problems over and over again. All the participants or the relevant persons in the project can be interviewed for the identification of factors affecting risk.

Past experience: Past experience from the same kind of project, the analogy can be formed for identification of the factors. When comparing the characteristics of projects will provide insight about the common factors.

Check lists: these are simple but very useful predetermined lists of factors that are possible for the project. the check list which contains a list of the risks identified in projects undertaken in the past and the responses to those risks provides a head start in risk identification.

Influence diagram: it is a graphical representation containing nodes representing the decision variables of a problem. a traditional influence diagram is formed by three types of nodes: utility, decision and informational. the causal relationship occurs between utility an

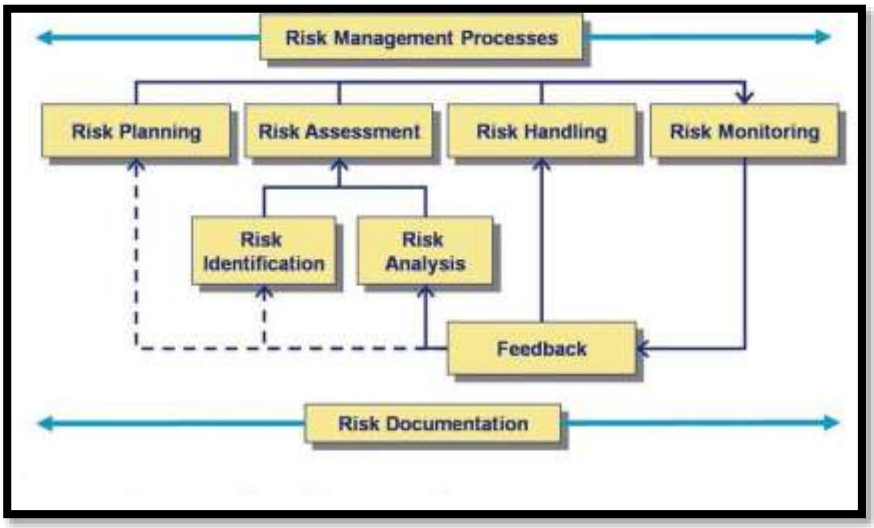

Fig.1 Risk Management Process

4.2 Safety in design and construction – Necessity or luxury?

In many countries, concept of safety is still not part of the professionals' imperative. There is also the deeply ingrained feeling myth that safety concerns will lead to greater cost and reduced productivity.

Over the last few decades, it has been proved that safety evaluation and control save money provided, professionals place worker injury and death at the top of their list. Otherwise, it may become (and remain) a legal necessity and an industry statistic. The truth however is that investment in safety is like planting a tree close to the compound wall: The fruit will be slow in coming, not immediate; and the branches will grow beyond the property, not just one-on-one. Which should be quite acceptable for the industry and the nation.

4.2.1 When design intervention is effective

Current philosophy is to integrate all the activities over the life span of a structure: Planning, design (and drafting), construction, use and maintenance, and decommissioning. It can be shown that over the life cycle of a structure, implementation of safety is easiest and least expensive at the concept stage, and most difficult and expensive after the construction stage. (Fig. 2.) Thus the designer is an early player, and must be an integral part of the life cycle!

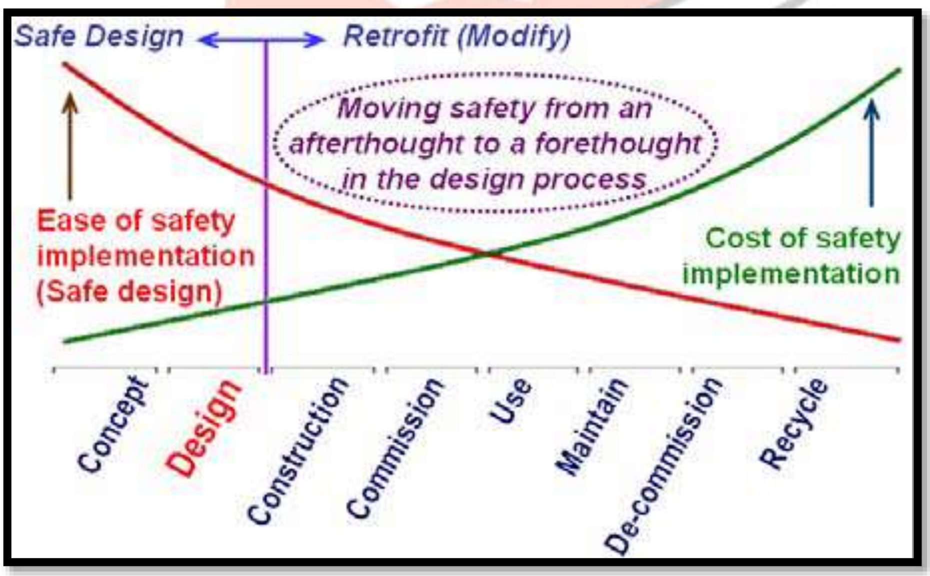

Fig.2. Effectiveness of safety measures

4.2.2 Barriers to designing for safety

Incorporation of safety into design will not be easy however. Many obstacles will slow down the process or wipe it out. Some of the barriers, apart from the cost at front end are:

- Fear of liability
- Designers' lack of safety expertise
- Designers' lack of understanding of construction processes
- Increase in professional fees
- Rigid contract terms (– Presently forbidding designer intervention, in some codes!)

- All barriers would of course have to be overcome, if people are to have a safe high-rise building.

4.3 REALISTIC MODELING

(a) Centre-line modelling:

Modelling of eccentricity, step, and haunch in structures with large-size members is often done in *ad-hoc* manner, taking the easy way out by neglecting what is perceived to be insignificant variations along the centre lines. Consequences, while generally minor, may become cumulatively adverse. (Fig. 3.)

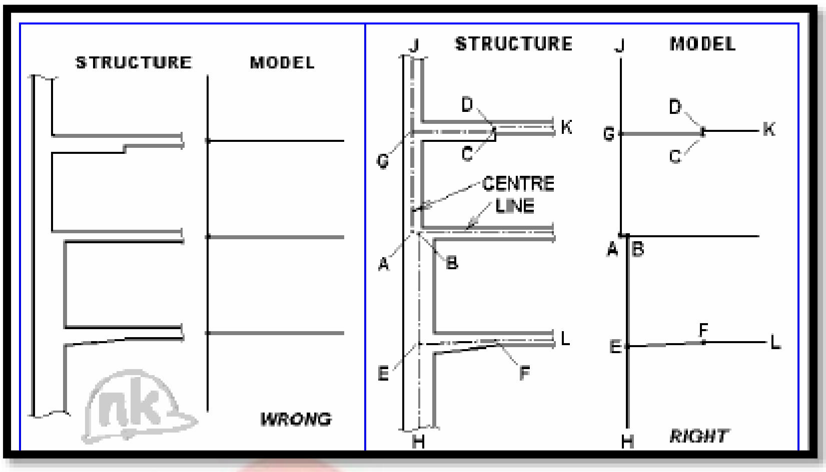

Fig.3 Realistic modeling

(b) Rigid joint zones:

Another common practice is (knowingly or unknowingly) to ignore the effect of modelling wide regions (such as RC beams and columns) by straight lines. (Fig. 4.) These may be generally conservative, but apart from decrease in economy, there may be loading combinations which may actually have an adverse impact.

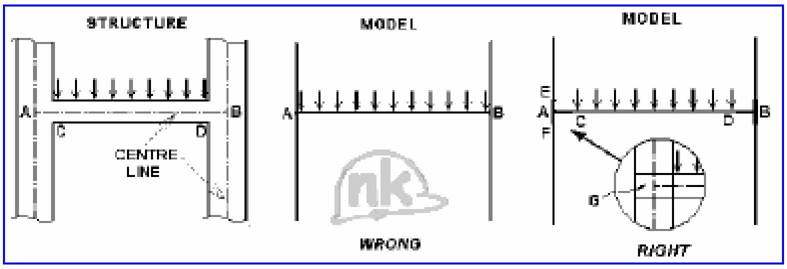

Fig.4 Rigid joint zone

5. CONCLUSION

According to the methodology, The risks factors are identification based on the literature collected and by consulting the experts, based on this the questionnaires were prepared. Totally for ten companies the questionnaires were given, out of which three had an effective reply. Thus the response rate is 60% which is considered a good response in this type of survey. According to them the major part of risks in high-rise buildings are caused due to technical, financial, physical and constructional problems. This paper has presented a general review of structural systems for tall buildings. Unlike the height-based classifications in the past, a system-based broad classification (i.e., exterior versus interior structures) has been proposed. Various structural systems within each category of the new classification have been described with emphasis on innovations. As far as the engineers concerned Lack of knowledge of arbitration has the maximum risk rating and other risks are material shortage, shortage in supply of electricity, poor quality of procured materials, loss due to fluctuation of interest rate, accident in site sub-contractor related problems, error in drawings, improper verification of contract documents, and competition from other companies. The least risk rating given by project engineer is environmental risk, relation with government departments, local protectionism and industrial disputes.

6 .FUTURE PROSPECTS

Development of new technology occurs based upon necessity, and the technology evolves towards enhanced efficiency. The development of braced frame structures to produce more rentable spaces in dense urban lands by constructing tall buildings in the past and their evolutionary paths up to the present towards even taller and more efficient structures to maximize land uses more economically are within this track. Tall buildings, which began from with 10-story office towers in the late nineteenth century, have evolved to mega structures like the Burj Dubai, which is over 150 stories and will be the tallest building in the world at the time of its completion in 2009.

There continues to be a need for building upward. Populations worldwide have grown rapidly, and migration of populations from rural areas to urban, has resulted in high-density mega cities. Denser cities with mega structures are more efficient in terms of energy consumption and land use. By making a city smaller and denser, the power grid becomes smaller, making the transfer of electrical energy more efficient. The need for automobile transportation declines as well as the need for personal transportation, which is a large contributor to the problems of efficient energy consumption and pollution. By creating denser cities with tall buildings, more natural green areas can be saved globally. However, compactness will result in crowding and hence a balance must be struck.

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