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Effect of wind and earthquake forces on different aspect ratio of building

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ABSTRACT

The rapid increase of the urban population in developing countries such as India has forced the revaluation of the importance of high rise buildings with different size and shape which leads to the different aspect ratio of the buildings. The structural systems of high rise buildings are usually sensitive to the effects of wind & earthquake, the wind-earthquake-structure interactions and then determines the wind loads & earthquake loads as equivalent static loads. It has been proved that the aspect ratio of the building affects the effect of wind and earthquake forces on the building. These thesis study the different cases of the aspect ratio of the building and effect of wind and earthquake forces on the building.

Keywords: *Aspect Ratio, Wind Load, Earthquake Forces, SAP, ETABS.*

1. INTRODUCTION

In these thesis, the study of wind and earthquake forces on the different aspect ratio of the building will be carried out. All type of effects will be considered which cause due to the wind and earthquake forces are. This thesis will force to consider aspect ratio of building as an important parameter while designing.

2. LITERATURE REVIEW

Sanjay Kumar Sadh, Dr. Umesh Pendharkar. (2016) [1], studied the behavior of a building during earthquakes depends critically on its overall shape, size, and geometry. Earthquake resistant design of buildings depends upon providing the building with strength, stiffness and inelastic deformation capacity which are great enough to withstand a given level of earthquake-generated force. This is generally accomplished through the selection of an appropriate building configuration and the careful detailing of structural members. Configuration is critical to the good seismic performance of buildings. The important aspects affecting the seismic configuration of buildings are overall geometry, structural systems, and load paths. The building slenderness ratio and the building core size are the key drivers for the efficient structural design. This paper focuses on the effect of both Vertical Aspect Ratio (H/B ratio i.e. Slenderness Ratio) and Horizontal or Plan Aspect Ratio (L/B ratio), where H is the total Height of the building frame, B is the Base width and L is the Length of the building frame with different Plan Configurations on the Seismic Analysis of Multistoried Regular R.C.C. Buildings. The test structures are kept regular in elevation and in the plan. Here, height and the base dimension of the buildings are varied according to the Aspect Ratios. The values of Aspect Ratios are so assigned that it provides different configurations for Low, Medium and High-rise building models. In the present study, four building models having different Horizontal Aspect ratios viz. 1, 4, 6 & 8 ranging from 12m.to 96m.length of different Vertical Aspect ratios (slenderness ratios) viz. 1, 4, 6 & 8 of varying 4, 16, 24 & 32 storeys have been considered and their influence on the behavior of the RCC Multistoreyed buildings is demonstrated, using the parameters for the design as per the IS-1893- 2002-Part-1 for the seismic zone- 3. In this way, total 16 building models are analyzed for different load combinations by Linear Elastic Dynamic Analysis (Response Spectrum analysis) with the help of ETABS-2015 software and the results obtained on seismic response of buildings have been summarized.

Md. Nazmul Haq, Wahid Hassan, Md. Arman Chowdhury. (2013) [2] studied over the past decades, earthquake resistant design of building structures has been largely based on ductility design concept worldwide. The performance of the intended ductile structures during major earthquakes (e.g. Northridge, 1994; Kobe, 1995; Chi-Chi, 1999…etc) however have proven to be unsatisfactory and indeed far below expectation. So, performance-based seismic design philosophies in seismic design have become the cardinal point of interest in civil engineering structures Due to the vulnerability of Bangladesh to the earthquake, the dynamic analysis should be introduced in a major earthquake zone to ensure the seismic performance. To see the dynamic behavior of the structure, the dynamic analysis should be performed for building with varying height. Dynamic

analysis can take the form of a dynamic time history analysis or a linear response spectrum analysis. In this present study, a building of 15 stories with varying floor height has been modeled using software packages SAP2000 v15 for the seismic zone of Bangladesh. Dynamic response of building under actual earthquakes, chi-chi, Taiwan, 1999, El centro and Northridge have been investigated. This paper highlights the effect of varying height in a high-rise building with Time History Analysis.

Abhay Guleria. (2014) [3] ETABS stands for Extended Three-dimensional Analysis of Building Systems. ETABS is commonly used to analyze: Skyscrapers, parking garages, steel & concrete structures, low and high rise buildings, and portal frame structures. The case study in this paper mainly emphasizes on the structural behavior of multi-storey building for different plan configurations like rectangular, C, L and I-shape. Modeling of 15- storeys R.C.C. framed building is done on the ETABS software for analysis. Post analysis of the structure, maximum shear forces, bending moments, and maximum storey displacement is computed and then compared for all the analyzed cases.

Anupam Rajmani, Prof Priyabrata Guha. (2015) [4] Modern tall buildings have efficient structural systems, and utilize high-strength materials, resulting in reduced building height, and thus, become more slender and flexible with low damping. These flexible buildings are very sensitive to wind excitation and earthquake load causing discomfort to the building occupants. Therefore, in order to mitigate such an excitation and to improve the performance of tall buildings against wind loads and earthquake loads, many types of research and studies have been performed. Early integration of aerodynamic shaping, wind engineering considerations, and structural system selections play a major role in the architectural design of a tall building in order to mitigate the building response to the wind excitations. A tall building, whose shape is unsuitable, often requires a great deal of steel or a special damping mechanism to reduce its dynamic displacement within the limits of the criterion level for the design wind speed. Understandably, an appropriate choice of building shape and architectural modifications are also extremely important and effective design approaches to reduce wind and earthquake-induced motion by altering the flow pattern around the building, hence for this research work four different shaped buildings are generally studied namely circular, rectangular, square and triangular. To achieve these purposes, firstly, a literature survey, which includes the definition, design parameters, and lateral load considerations of tall buildings, is presented. Then the results are interpreted for different shaped buildings and of different stories thereby concluding as to which shaped high rise building is most stable for different conditions.

Fazia Ali-Toudert, Helmut Mayer. (2006) [5] studied the contribution of street design, i.e. aspect ratio (or height-to-width ratio, H/W) and solar orientation, towards the development of a comfortable microclimate at street level for pedestrians. The investigation is carried out by using the three-dimensional numerical model ENVI-met, which simulates the microclimatic changes within urban environments in a high spatial and temporal resolution. Model calculations are run for a typical summer day in Ghardaia, Algeria (32.401N, 3.801E, and 469ma.s.l.), a region characterized by a hot and dry climate. Symmetrical urban canyons, with various height-to-width ratios (i.e. H/W ¼ 0.5, 1, 2 and 4) and different solar orientations (i.e. E–W, N–S, NE–SW and NW–SE), have been studied. Special emphasis is placed on a human bio-meteorological assessment of these microclimates by using the physiologically equivalent temperature (PET). The results show contrasting patterns of thermal comfort between shallow and deep urban streets as well as between the various orientations studied. A comparison of all case studies reveals that the time and period of the day during which extreme heat stress occurs, as well as the spatial distribution of PETs at street level, depend strongly on aspect ratio and street orientation. This is crucial since it will directly influence the design choices in relation to street usage, e.g. streets planned exclusively for pedestrian use or including motor traffic, and also the time of frequentation of urban spaces. Both investigated urban factors can mitigate extreme heat stress if appropriately combined. The solar access indoors has been briefly discussed as an additional criterion in designing the street by including winter needs for solar energy.

Philip McKeen, Alan S. Fung. (2014) [6] studied the energy consumption of varying aspect ratio in multi-unit residential buildings in Canadian cities. The aspect ratio of a building is one of the most important determinants of energy efficiency. It defines the building surface area by which heat is transferred between the interior and exterior environment. It also defines the amount of building area that is subject to solar gain. The extent to which this can be beneficial or detrimental depends on the aspect ratio and climate. This paper evaluates the relationship between the geometry of buildings and location to identify a design vernacular for energy-efficient designs across Canada.

Shmuel Wimer, Israel Koren, and Israel Cederbaum. (1988) [7] studied regarding the aspect ratio of building blocks in terms of VLSI are mentioned. This paper discusses the problems on selecting on optimal implementation for each building block so that the area of the final layout is minimized. A polynomial algorithm that solves this problem for both slicing floor plan and non-slicing floor plan and it has been proved (non-slicing).This both slicing and non-slicing floor plans are combined with algorithm to handle efficiently very large general problem of floor plans to be shown in this paper In non-slicing floor plans and several possible physical implementations for each building block this paper present a practical algorithm that determines the implementation of each building block such that the entire layout is minimized The suggested branch and bond algorithm handles diccessfully large floor plans. It was shown that one can take advantage of the slicing structures which are usually found in general floor plans by combining both the branch and known as polynomial algorithm for the slicing case. Further, the combination increased the size of the problems that can be solved.

3. NEED FOR THE STUDY

From various experimental investigations, it is observed that dimensions of buildings significantly affects the wind pressure and earthquake forces on different faces of the buildings. This study shows that certain shapes are prone to wind and EQ Force phenomena which can generate high dynamic loads and govern the design. This study will ignite an interest in the use of Aspect ratio to the wind and EQ Force. It would be useful in showing the importance of Aspect ratio to the wind and EQ Force on high rise Structure.

4. OBJECTIVES OF THE PRESENT STUDY

- To study the behavior of tall structures when subjected to along wind loads and Earthquake force.
- To study the effect of the shape of the building in the plan on the behavior of the structure.
- To study Same floor area of the building with different Aspect ratio.
- To determine the effect of wind load and Earthquake force on various parameters like storey drifts, lateral displacements in the building.
- To define the most efficient Aspect ratio in high rise buildings which can provide sound wind loading and Earthquake force by observing the comparative studies.
- To model high rise structure in SAP Software.

5. THEORETICAL METHODOLOGY

The methodology worked out to achieve the above-mentioned objectives is as follows:

- An extensive literature survey by referring books, technical papers or research papers carried out to understand the basic concept of the topic.
- Identification of need of research.
- Formulation of stages in analytical work which is to be carried out.
- Data collection.
- 30 storey building is considered for the analysis.
- The model has prepared on SAP for the various Aspect ratio of the buildings.
- Manual calculation of wind loads and Earthquake load for the building according to IS has done by using the various parameters.
- Application of calculated wind loads and Earthquake load on the modeled buildings is to be done.
- Comparative studies done for axial loads on the column, storey shear, lateral story displacement, story drift, wind intensity for the various aspect ratio of buildings and determination of structurally efficient of the building is to be done. Interpretation of results and conclusion.

6. EXPECTED CONCLUSION

1) As the aspect ratio increase the building become more critical.
2) Effect of wind and earthquake force increase for the higher aspect ratio.
3) The tall building should have small aspect ratio i.e sides of the building should be nearly equal in size, which will make it less critical.
4) The building should square in shape as far as design is a concern.

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