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Seismic & Wind Analysis of Multistory Building: A Review

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Abstract: ***Now a day the tall structures like skyscrapers are widely adopted in major cities in India. Many major cities are very closer to the coastal area & almost all of them comes under the live seismic zone which is big problem for high rise multistorey buildings. The manual analysis of such a complex structure are too hectic & time consuming. It is very necessary to find the solution on this issue instantly. So the wind & seismic analysis of the structures done by the advance software CSI ETABS. In this proposed study four different shapes of same area multistorey model is generated & tested by the ETABS under the guideline of IS-875-Part3 & IS1893-2002-Part1. The behavior of 15, 30 & 45 storey building has been studied. The Dynamic effects also find by Response spectrum method. All the parameters like Story displacement, Story drift, Base shear, Overturning moments, Acceleration & Time period are calculated. After comparing the all building shape results we can conclude that which section is convenient & either seismic or wind effect is critical.***

Keywords: Seismic analysis, Wind analysis, Response spectrum method, ETABS

1. Introduction

Many researches and studies have been done in order to mitigate excitations and improve the performance of tall building against wind loads & earthquake loads. An extremely important and effective design approach among these methods is aerodynamic modifications, including, modifications of buildings corner geometry and its cross-sectional shape. Tall buildings are gigantic projects demanding incredible logistics and management, and requires enormous financial investment. A careful coordination of the structural elements and the shape of a building which minimize the lateral displacement, may offer considerable savings. Nowadays, the challenge of designing an efficient tall building has considerable changed. The conventional approach to tall building design in the past was to limit the forms of the building to a rectangular shape mostly, but today, much more complicated building geometries could be utilized. [1]

A building should possess four main attributes, mainly having simple and regular configuration, adequate lateral strength, stiffness and ductility. Buildings having simple regular geometry in plan as well as in elevation, suffer much less damage than the irregular configuration. A building shall be considered as irregular as per is 1893-2002, if it lacks symmetry and has discontinuity in geometry, mass or load resisting elements. These irregularities may cause problem in continuity of force flow and stress concentrations. [2]

Structural analysis is mainly concerned with finding out the behavior of a structure when subjected to some action. The dynamic loads include wind, waves, traffic, earthquakes, and blasts. Any structure can be subjected to dynamic loading. Structural symmetry can be a major reason for buildings poor performance under severe seismic loading, asymmetry contributes significantly to increased lateral deflections, increased member forces and ultimately the buildings collapse.

Concept of regular and irregular configuration

To perform well in an earth, quake a building should possess four main attributes namely simple and regular configuration and adequate lateral Strength, stiffness and ductility. Current earthquake codes define structural configuration as either regular or irregular in terms of size and shape of the building, arrangement of the structural and non-structural elements within the structure, distribution of mass in the building etc. A building shall be considered as irregular for the purposes of this standard, if at least one of the conditions is applicable as per IS 1893(part1):2002

Plan Irregularity

Asymmetric or plan irregular structures are those in which seismic response is not only translational but also torsional, and is a result of stiffness and/or mass eccentricity in the structure. Asymmetry may in fact exist in a nominally symmetric structure because of uncertainty in the evaluation of center of mass and stiffness, inaccuracy in the measurement of the dimensions of structural elements. [2]

Vertical Irregularity

Vertical irregularity results from the uneven distribution of mass, strength or stiffness along the elevation of a building structure. Mass and Stiffness irregularity results from a sudden change in mass and stiffness between adjacent floors respectively. [2]

2. Review of Literature

Sanhik Kar Majumder, Prof. Priyabrata Guha et. al. (2014) Analyzed and designed Different Types of Building Structures [G + 7] using design software STAAD.ProV8i. In this study the both seismic & wind effects were considered and compared according to the Code IS: 875(PART - 3) and

IS: -1893-2002(PART-1) and IS:875(PART-1 AND PART-2). A software program was developed to analyzed the different types of structures under wind pressure and earthquake effect considering all factors from the codes. Concluded 1. Wind forces affect any building are as well as the intensity of wind defined by the code according to its the location. 2. For any building, earthquake forces as well as the intensity of earth quake defined by the zone factor through its location, the importance of the building, the structural element, the period coefficient which depends on the dimensions and weight of the building and the soil coefficient. 3. When basic wind speed and zone factor in any region of India will be changed, which structures will be more economy for those cases, that will be further analyzed. [3]

Anupam Rajmani, Prof. Priyabrata Guha et. al. (2015) Discussed an analytical study which was carried out on a multistory building of 15, 30 & 45 stories for four different shaped buildings are generally studied namely circular, rectangular, square and triangular. Then the results were interpreted for different shaped buildings and of different stories thereby concluding as to which shaped high rise building is most stable for different conditions. [1]

Pardeshi sameer, Prof. N. G. Gore et. al. (2016) Discussed a study on 3D analytical model of G+15 storied buildings were generated for symmetric and asymmetric building models and analyzed using structural analysis tool ETABS software. This paper is concerned with the effects of various vertical irregularities on the seismic response of a structure. The objective of this study to carry out Response spectrum analysis (RSA) of regular and irregular RC building frames and Time history Analysis (THA) of regular RC building frames and carry out the ductility based design using IS 13920 corresponding to response spectrum analysis. [2]

Prof Tanveer Asif Zerdi, Mohammad Tayyab Ali, Mohammed Shahid Ali Aejaz & Mudassar Jamal et. al. (2016) Studied a multistorey reinforced concrete building has been modelled and performed by using software ETABS program with different plan shapes regular (Rectangular shaped) and irregular (T –shaped) and plane dimension (16X15) m with 15 storeys resting on plan ground. The models have been conducted and analyzed by using equivalent linear static method and response spectrum method for comparing and investigating the changes in structural behavior and the irregularity effect in plan. Concluded the plan configurations of structure has significant impact on the seismic response of structure in terms of displacement, story drift, story shear & Large displacement was observed in the T shape. [4]

Dr. Raghvendra Singh, Prof. Sumit Pahwa, Ambar Gupta et. al. (2014) Discussed & compare the seismic behavior of regular building frame with vertically irregular building frame at different positions. For this purpose, four frames of multi-storey buildings are considered. For study the behavior the response parameters selected are lateral displacement and storey drift. All the frames are assumed to be located in zone II, zone III, zone IV and zone V. For analysis STAAD Pro software is used. Observation shows that for all the frames considered, drift values follow a similar path along storey height with maximum value lying somewhere near the thirteenth to fifteenth storey. [5]

C.M. Ravi Kumar, K.S. Babu Narayan, M.H. Prashanth, H.B Manjunatha and D. Venkat Reddy et. al. (2012) discussed the performance evaluation of RC (Reinforced Concrete) Buildings with vertical irregularity. The study as a whole makes an effort to evaluate the effect of vertical irregularity on RC buildings, in terms of dynamic characteristics and identifies the influencing parameters which can regulate the effect on Base Shear, Time Period, Story Displacement & Story Drift. Also, the analysis has been carried out for various zones of India and soil conditions taken in to consideration. [6]

K. Rama Raju, M.I. Shereef, Nagesh R Iyer, S. Gopalakrishnan et. al. (2013) Studied the limit state method of analysis and design of a 3B+G+40-storey reinforced concrete high rise building under wind and seismic loads as per IS codes of practice is described. Safety of the structure is checked against allowable limits prescribed for base shear, roof displacements, inter-storey drifts, accelerations prescribed in codes of practice and other relevant references in literature on effects of earthquake and wind loads on buildings. [7]

Dr. K. R. C. Reddy, Sandip A. Tupat et. al. (2014) Presented a comparative study of wind and earthquake loads to decide the design loads of a multistoried building. In that multistoried building is analyzed for earthquake loads in various zones based on IS 1893 and for wind loads IS 875 code is used. The wind loads are estimated based on the design wind speed of that zone with a variation of 20%. The wind loads so obtained on the building have been compared with that of earthquake loads. Finally, it is found the wind loads are more critical than the earthquake loads in most of the cases. [8]

Mr. S.Mahesh & Mr. Dr.B.Panduranga Rao et. al. (2014) Studied a residential of G+11 multistory building for earth quake and wind load using ETABS and STAAS PRO V8i. Assuming that material property is linear static and dynamic analysis are performed. These analysis are carried out by considering different seismic zones and for each zone the behavior is assessed by taking three different types of soils namely Hard, Medium and Soft. Different response like story drift, displacements base shear are plotted for different zones and different types of soils. [9]

E. Pavan Kumar, A. Naresh, M. Nagajyothi, M. Rajasekhar et. al. (2014) studied the seismic analysis of structure for static and dynamic analysis in ordinary moment resisting frame and special moment resisting frame. Equivalent static analysis and response spectrum analysis are the methods used in structural seismic analysis. We considered the residential building of G+15 storied structure for the seismic analysis and it is located in zone II. The total structure was analyzed by computer with using STAAD.PRO software. [10]

Prof. S.S. Patil, Miss. S.A. Ghadge, Prof. C.G. Konapure, Prof. Mrs. C.A. Ghadge et. al (2013)

Described seismic analysis of high-rise building using program in STAADPro. with various conditions of lateral stiffness system. Some models are prepared that is bare frame, brace frame and shear wall frame. Analysis is done with response spectrum method. This analysis will produce the effect of higher modes of vibration & actual distribution of forces in elastic range in a better way. Test results including base shear, story drift and story deflections are presented and get effective lateral load resisting system. [11]

3. Conclusions

For this study many investigation has been done to calculate all required wind & seismic data. Analysis of model comprises mainly linear static & dynamic analysis. Analysis of all model gives the results in the form of Story displacement, Story drift, Base shear, Overturning moments, Acceleration, Time period. According to the results obtained from 15, 30 & 45 storey square, rectangular, triangular & circular shaped building comparison has been done. It shows that wind effect is critical for 45 storey building & in other hand seismic shows critical at 15 storey & 30 storey building. Circular shape is more stable amongst the all four shapes in both seismic & wind effect. Finally conclude that wind effect is very critical than earthquake for more than 30 storey.

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