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ANALYSIS AND DESIGN OF RC BUILDINGS USING LATEST IS CODES FOR EARTHQUAKE AND WIND-A REVIEW

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ABSTRACT

High rise construction has become a necessity for the urban development. As the demand for multi-story structures has increased tremendously as a solution for the growing population and increased demand for the requirement of dwelling for the increased population. As the height of the structure increases the forces acting on the structure also increases along with the height of the building increases like wind and earthquake forces.

Wind load is one of the important design loads for civil engineering; it controls the structural design of the high-rise structures. Therefore knowledge of the dynamic characteristics of a high - rise structure under wind loading becomes a requirement in engineering design and in academic study. In high risk seismic zone the seismic performance of structures are considered as the primary importance on the other hand which influence seismic performance , may be the effect of impact forces resulting from earth movement greater than the forces caused by wind loads and consequently, Seismic loading determines form and final design of the structure.

Earthquakes and cyclones are unexpected events which cannot be predicted earlier. The only way to survive through this disaster is by taking careful considerations while planning and designing buildings in urban areas. A structure because of its height is affected by lateral forces due to wind or earthquake actions to an extent that they play an important role in the structural design. A high rise building has to resist to overturning moment and lateral deflection caused by lateral forces like earthquake and wind forces.

The aim of this project is to presents a study results of building modeling by using latest IS codes of earthquake and wind forces (IS 1893 part 1 2016 and IS 875 part 3 2015 respectively) on a RC buildings. It is very essential to consider the effects of lateral loads in the design of reinforced concrete structures. It determines the critical design loading for a multistory buildings subjected to different basic wind speeds (39, 44, 47, 50, 55 m/s) and earthquake zones (II,III,IV,V).

Keywords:
Response spectrum method, ETABS 19, STAAD.Pro CONNECT Edition

1. INTRODUCTION

Engineering principles and practices undergo constant experiments, innovations and improvements to suit the demands and required needs of the time. Every new code is a response to review of a prior failure. Natural and manmade disasters have revealed our underestimation of safety requirements and compelled us to formulate ways to improve. The addressal of experienced inadequacies, over the years, has led to evolution of codes. This has helped to prevent mass casualties arising out of structural failures, inadequate lighting, inadequate ventilation, fires, and flooding. As society moves forward, standard codes for civil structures shall continue to evolve too, reflecting the lessons learned about the materials used / practices followed and the way it is to be re-implemented. The code, being adopted as Standards by jurisdiction, may or may not be implemented with intent to serve as regulatory requirements.

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The Indian Standard codes for civil engineering practices are being revised by the BIS as per basic design and engineering requirements, new inventions, latest design concepts, improved materials and environmental happenings. Hence it is pertinent to spell out the major changes that are reflecting in the revised or latest codes with respect to the previous ones. The modifications, additions, eliminations and revisions in IS codes definitely reflect the modified requirements for existing structures and revisions to be admissible for designing new structures. The design and construction of all the structures must comply with the latest relevant codes. In the fitness of the context, a comparative study has been made between IS: 1893 – 2002 and 2016 (Code of Practice – Criteria for Earthquake Resistant Design of Structures), and IS: 875 – 1987 and 2015 (Code of Practice– Design loads [Other than earthquake] Wind load for buildings and structures).

2. LITERATURE REVIEW

Technical articles published in the proceedings and other journals have been referred to determine the scope of work and to understand the present status of such project undertaken.

Narayan Malviya, Sumit Pahwa [1] focused on the Seismic Analysis of High Rise Building With IS Code 1893-2002 and IS Code 1893-2016. In this work they have studied of seismic analysis and design of high-rise building and the structural analysis of high rise multistory storey reinforced concrete symmetrical and asymmetrical frame building is done with the help of SAP software. In the present study, The Response spectrum analysis (RSA) of regular RC building frames is compare with Response spectrum analysis of regular building and carry out the ductility based design. as per IS 1893:2002 and IS 1893:2016.

Prakash Channappagoudar, Vineetha Palankar [2] Parametric comparison study on the performance of building under lateral loads as per is 875(part3):1987 and revised code of IS 875(part 3):2015. This paper deals with one such computation where a building in Pune is taken into consideration for analysis with respect to wind loads for different number of floors. Analysis is done for both codes of IS 875(Part 3):1987 and IS 875(Part 3):2015 for different parameters affecting the stability of building. This paper also includes important points of IS 16700:2017 which takes both the previous codes of Wind and Earthquake into consideration and specifies a new code of conduct for design of tall buildings ranging from 50 – 250 meters.

K. Rama Raju, M.I. Shereef [3] Published a paper Analysis of tall building subjected to wind and sesimic loads. In this paper, the response of tall buildings under wind and seismic load as per IS codes of practice is studied. Seismic analysis with response spectrum method and wind load analysis with gust factor method are used for analysis of a 3B+G+40-storey RCC high rise building as per IS 1893(Part1):2002 and IS 875(Part3):1987codes respectively. The building is modeled in 3D using STAAD.Pro software. Safety of the structure is checked against allowable limits prescribed for inter-storey drifts, base shear, accelerations and roof displacements in codes of practice and other literature for earthquake and wind.

Ravi Singh [4] Analysis and Design of G+ 7 Storey's Residential Building by using IS Code Methods and by Software's. They work on the design of the structure using limit state methods and analysis using by staad pro and manual calculation. After analyzing the G+7 storey building structure, concluded that structure is safe in loading like dead load, live load, and seismic load. Member dimensions (Beam, Column, Slab, and Footing) are changed by calculating the load type and its quantity applied on it. Manual calculations give min. 1) All the analysis can be repeated by changing plan dimensions and height of the structure. 2) A comparison of cost may be studied by changing different grade of steel and concrete. 3) Analysis and design of frames with dual systems. 4) Analysis and design of frames with dual systems (moment resisting frames with shear walls) 5) A comparison of cost may be studied by changing different grade of steel and concrete.

Vikrant Trivedi, Sumit Pahwa [5] Wind Analysis and Design of G+11 Storied Building Using STAAD-Pro. In this study the author presents a comparative study of wind loads to decide the design loads of a G+11 building. The significance of this examination is to estimate the design loads for a structure which is subjected to wind loads in a particular region. It is well known fact that the wind loads may be estimated in particular zone with a specified zone factor. Then the wind load of that zone can also be estimated based on the basic wind speed and other factors of that particular region. However, the wind velocity is stochastic and time dependent. In the present study a multi-storied building is analyzed for wind loads using IS 875 code. In this Analysis, G+11 storied building is considered and applied various loads like wind load, static load and results are studied and compared between with wind load or without wind load.

Arjun P., Dharmesh N. [6] Dynamic Analysis of RCC Framed Structure using different Shear Wall Locations. This paper presented the study of the multi-storey building, the whole building should effectively resist lateral loads such as earthquakes and wind loads acting on them. The main reason for the horizontal movement and the development of high stresses in buildings is these lateral loads. Therefore, buildings should have more strength and stiffness to resist lateral loads acting on them. To have both these, one of the most efficient structural systems is the shear wall structures. In the present study, a 13 storey RCC structure with different shear wall locations is analyzed and designed by IS: 456-2000 using ETABS software. The equivalent static lateral force method for zone-IV, soil type medium as per IS 1893:2016, part-1, and time history analysis using the Bhuj earthquake data are considered for seismic analysis. The following response quantities, such as mode period, storey displacement, and base shear using equivalent static lateral force method, and time history analysis results are tabulated and discussed. Proper location of the shear wall gives better lateral load resisting capacity in RCC buildings. These shear walls need to be provided at suitable locations to increase the stiffness and reduce the building displacement due to earthquakes.

Aly Mousaad Aly [7] Design of buildings for wind and earthquake. Author focused on the understanding of wind and earthquake effects on high-rise buildings in order to apply such knowledge to the design of such structures. A reduction in the worst peak acceleration is shown to be more than 20%, by changing the building orientation. This reduction is achieved without any additional cost to the building which confirms the advantage of rotating the building to a suggested orientation and also shows the importance of the response prediction in tall buildings during the preliminary design stages and before the real construction stage. In addition, for the response prediction under wind loads, general agreements between the results of the pressure integration technique and the aero elastic experiment exist.

Suchana S. Telrandhe, A.M. Pande [8] Dynamic wind analysis for high rise building – typical observations. In this paper, along wind effect on both directions i.e. along shorter as well as longer direction located in category IV having varying base dimensions with same width along shorter direction with varying height of building from 42 to 60 m have been computed as per Indian Standard code IS 875(part 3): 2015 by the Gust Factor Method by developing excel sheets. Base dimension plays critical role, with the increase in dimension in the direction of wind, the response of building reduces.

Mohit Sharma, Dr. Savita Maru [9] Dynamic Analysis of Multistoried Regular Building. This paper presents analysis and design of buildings for static forces is a routine affair these days because of availability of affordable computers and specialized programs which can be used for the analysis. On the other hand, dynamic analysis is a time consuming process and requires additional input related to mass of the structure, and an understanding of structural dynamics for interpretation of analytical results. Reinforced concrete (RC) frame buildings are most common type of constructions in urban India, which are subjected to several types of forces during their lifetime, such as static forces due to dead and live loads and dynamic forces due to the wind and earthquake. They present works (problem taken) are on a G+30 storied regular building. Buildings have the plan area of 25m x 45m with a storey height 3.6m each and depth of foundation is 2.4 m. & total height of chosen building including depth of foundation is 114 m. The static and dynamic analysis has done on computer with the help of STAAD-Pro software using the parameters for the design as per the IS-1893- 2002-Part-1 for the zones- 2 and 3 and the post processing result obtained has summarized.

S. Cherry, H. S. Ward [10] Earthquake and wind loads in building design. In this paper they work on the comparison with wind, earthquake requirements govern the design of buildings lower than a certain critical height, which varies from below five to more than 30 storeys, depending on the building and its location. Wind requirements dominate for the lower part of buildings which are over this critical height, although a substantial upper part may still be governed by earthquake.

N R Shwetha, Naveen [11] Analysis and design of multi storey building subjected to seismic load using E-TABS. This paper presents the results from a parametric study carried in order to quantify how far errors in the design stage related to the consideration of the wind action may put at risk the response and safety of reinforced concrete buildings. Using an architectural model as reference and varying the number of floors of the building, the structural safety was evaluated as a function of the wind action intensity. Results showed that even for low-rise buildings, with 10 floors, ignoring the wind action can significantly jeopardize their behaviour and safety. Yet, for slenderer buildings, up to 30 floors, it can lead to catastrophic results, as the ruin of the structure by progressive collapse.

Mr. Mahendra Balasaheb Shelke, Prof. (Dr.) D. P. Joshi [12] Effect of Wind and Earthquake Force on Different Aspect Ratio of Building. This paper focused on the study of the different cases of aspect ratio of the building and effect of wind and earthquake forces on building. This paper deals with the concluding remarks drawn from the results of all the analysis and design made for the G+30 storey building with the different type of aspect ratio having same floor area (1000 Sq. m) is considered for analysis. The results have been presented in tabular form along with the graphical mode in previous chapter. This chapter contains only the conclusions drawn on the basis of results drawn in previous chapter. The conclusions are valid under the consideration of different aspect ratio of building and analysis is static.

Romy Mohan, C Prabha [13] Dynamic Analysis of RCC Buildings with Shear Wall. In this paper they considered, two multi storey buildings, one of six and other of eleven storey have been modeled using software package SAP 2000 12 for earthquake zone V in India. Six different types of shear walls with its variation in shape are considered for studying their effectiveness in resisting lateral forces. The paper also deals with the effect of the variation of the building height on the structural response of the shear wall. Dynamic responses under prominent earthquake, El-Centro have been investigated. This paper highlights the accuracy and exactness of Time History analysis in comparison with the most commonly adopted Response Spectrum Analysis and Equivalent Static Analysis. From this study they concluded that Equivalent Static Method can be used effectively for symmetric buildings up to 25 m height. For higher and unsymmetrical buildings Response Spectrum Method should be used. For important structures Time History Analysis should be performed as it predicts the structural response more accurately in comparison with other two methods since it incorporates p - Δ effects and material non linearity which is true in real structures.

Madhurima Dutta [14] Wind analysis and design of a multi storied structural frame considering using staad pro. In this study a tall G+28 storied building is designed and analysed by design software STAAD pro v8i.The combination of static and wind loads are taken into account. The post processing results in terms of bending moment, support reaction, shear force, axial force are analysed. Due to effect of wind load on the structure, the story wise variation of the result with respect to different parameters are compared and a detailed design of reinforcement is also calculated that will ensure the structural safety of the building.

Anoj Surwase, Dr. Sanjay K. Kulkarni [15] Seismic Analysis and Comparison of IS 1893 (Part-1) 2002 and 2016 of (G+4) Regular and Irregular Building. This paper presents the seismic load estimation for multi storey buildings as per IS: 1893-2002 and IS: 1893-2016 recommendations. The method of analysis and design of multi-storey (G+4) residential building located in zone III, IV. The scope behind presenting this project is to learn relevant Indian standard codes are used for design of various building element such as beam, column, slab, foundation and stair case using a software E-tab under the seismic load and wind load acting the structure. We have to find out the values in project base shear, time period, maximum story displacement.

3. CONCLUSION

- The paper includes brief discussion of past results and conclusions made by other authors over the analysis and design using various software's like STAAD.Pro, ETABS, SAP etc.
- Various modeling and designing methods are reviewed on the basis of different principles, with their individual merits and demerits are characterized in the paper.
- The use and application of latest building codes has been instrumental in safeguarding the health, safety and welfare of the people.
- The building code requirements for RCC building provides minimum requirements for the materials, design and detailing.
- Such code conclude parameters like design for strength, serviceability, durability, load combinations, load factors and reduction factor, deflection criteria, structural analysis method etc.

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