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Seismic Evaluation of Existing Un-reinforced Masonry Building: A Review

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A B S T R A C T

It is commonly known that earthquakes cause severe damage to masonry structures, resulting in significant loss of life. The collapse of structures is responsible for about three fourth of the deathhappens due to earthquakes in the previous decade, with masonry buildings accounting for the majority (more than 70%). In India, the bulk of tenements is un-reinforced masonry structures, which are not very strong and dangerous even in less intensity earthquake. When these buildings are analysed and designed properly, they gives all serviceability, safety, and the basic aspects requirements in the structure. The stability of the structure depends on loads acting on it, so it is required to pay attention to the analysis of the various loads like: Live load, Dead load, Seismic load, wind load, etc.

Keywords:Un-reinforced masonry: Base shear: Seismic design: framed structure: STAAD Pro

1. Introduction

According to the scenario, the population is increasing day by day which causes an industrial revolution in cities so people living in the village area tend to move to the city area for employment. If people are moving from village to city so it is necessary to construct a residential building for their living and also for office purpose. If multi-storied buildings are not designed according to IS code for consideration of lateral forces it causes complete collapse of the structure. The factor on which the design of a building depends is the damping factor, type, the importance of the building foundation used in the structure, ductility of the structure, etc. For providing better resistance to the moment it is necessary to design for ductility and also for lateral forces. The above-mentioned factor is depending on the response reduction factor which varies for a different type of structure and it is denoted by R. Based on results of seismology it has been found that about 90% of earthquake happens due to tectonic plates. From a civil engineer's point of view, an engineer has to provide maximum safety to the structures designed and maintain the economy. From the studies on earthquakes in multi-storied buildings, it is concluded that if buildings are not well designed as per IS code and not properly constructed with actual design strength it causes complete collapse of the structure.

To provide safety to the building which is constructed in the seismic zone it is required to analyze the earthquake forces for constructing a building that resists earthquake forces. To analyze the seismic design of the structure the person should have good knowledge about the geophysical process which causes earthquakes and the effects due to earthquakes. To design an earthquake resistance building it is necessary to have a sound understanding of the ground motion. Ground motion can be recorded in terms of ground acceleration, displacement, and velocity. The design requires collecting the various data required for the analysis purpose which involves the calculation part also. After the collection of the data and

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parameters, they are entered into the software, and the safety of the structure is ensured through the analysis work. Stone and brick Other than woodwork, masonry is the most commonly used construction style in ancient buildings. In the last thousands of years, stone/brick masonry has been used in a wide variety of public and domestic constructions. From the Tower of "Babylon," which, had it been completed, would have reached the sky, to the Great Wall of China, which is the only man-made monument visible from the Moon.

There are still a large number of well-protected historic masonry structures, indicating that masonry can efficiently handle weights and environmental stresses, providing shelter for people and their belongings for extended periods if well thought out and constructed. In recognition of their importance and value, a large number of those structures have been included in the most important categorization of humanity's historical and cultural legacy. Six moderate-intensity earthquakes have struck India, and despite their low magnitude, these earthquakes have resulted in massive property damage, highlighting the vulnerability of India's infrastructure to earthquakes. The tremors of 1993 and the Bhuj quake of 2001, both of which caused significant property damage, underscored the importance of focusing on long-term seismic enhancement and attention to reducing the money-spinning losses caused by earthquakes. The Bhuj earthquake on January 26th was the most catastrophic, reaching an all-time high in terms of property loss. This is the first major earthquake to hit an Indian city in the previous 50 years. Several heritage sites in Ahmedabad, Kutch, Bhuj, Anjar, and Bachau, as well as nearby villages, were severely destroyed.

2. Literature Review

Earthquakes of moderate to large magnitude have claimed many lives and caused major economic damage throughout the world in the previous two decades. Seismic vulnerability of loadbearing unreinforced masonry (URM) structures has been highlighted by earthquakes in Bhuj, Kashmir, and Sikim, also very past earthquakes many of which have been seriously damaged. Most current unreinforced masonry buildings do not exceed the earthquake-resistant standards of the newest Indian code, according to surveys and assessments are undertaken in certain cities in earthquake-prone zones in India (**IS 1893 Part 1: 2002**). Furthermore, there are no particular requirements for earthquake resistance URM structures in the design code. Unreinforced masonry structures (URM) components have been the subject of several experimental investigations across the world. Various researchers, for example, have conducted a study on isolated shear walls and piers (**Epperson and Abrams 1989, Craig et al., 2002, Franklin et al., 2003**). Additionally, (**Simsir et al., 2002**) investigated the external wall of un-reinforced building.

In this investigation rigorous work is done to understand the response or behavior of the framed structure during the wind force and seismic force. Various literature surveys are done to know the behavior of different shapes and sizes of the structure under the effect of wind load and seismic load. A study based on the effect of various wind zones and the seismic zone is pointed out here. If any failure occurred due to the different loading conditions at that stage what are the precautions necessary is considered to avoid the same size or shape during the design procedure. **Aman et al., (2016)** performed the design and analysis of the G+6 building. In that work, they considered the design and analysis of footings, columns, beams, and slabs and performed its analysis using STAAD Pro software. They also take into consideration of dead load, live load as well as their load combination using the same software.**Anoop et al., (2016)** also worked on the area design and analysis of a multi-storied building having G+5 floors. They examined the needs and standards indicated by the Indian standard code of practice, Kerala building regulations, and national building rules when designing the building.

Analysis and seismic response of a structure are done in which damage to the structure and its components due to earthquake is minimized. The study aims to analyze the dynamic structural behavior in simple configurations and complex configurations. The analysis work is done on the structures which have a different number of floors with a simple and complex configuration of the floor with floating columns. For the analysis purpose, ETABS and STAAD Pro are used. Both the software determines the base shear, storey-shear and drift, bending moment, and lateral forces. For the analysis work response spectrum method is used. A study is performed to know the various cross-section effects of rectangular column, square column, and circular column on the symmetrical RCC framed structure (**Harman and Sood 2017)**. To perform the analysis work G+3, G+7 and G+11storey framed structure is selected. The designing procedure is done on the leading structural analysis software STAAD PRO. The analysis is done for the gravity load and seismic load as per the Indian standard code of practice. The result obtained from the software is compared and the result is recorded in terms of cost. The analysis work shows that the total cost of the building was less for the square cross-section for each structure.

Static and dynamic analysis of the G+30 storey structure was performed using STAAD Pro by the researchers (**Sharma and Maru 2014)**. They used the plan area of the structure as 25 m x 45 m with a storey height of 3.6 m each. The depth of the foundation is taken as 2.4 m and the total height of the structure is 114 m. Seismic analysis is done for zone II and zone III and reported the result that the structure at zone III is more vulnerable to earthquakes. **Patel and Singh (2017)** studied the wind load effect and the response due to each building components of the whole building situated at inclined surfaces and analyzed it. Various geometry of frame structure is considered and static and wind loads are taken into account. The findings of analyzing ten examples of distinct wind zones in terms of shear force, bending moment, axial force, storey drift, and displacement are gathered. The study is done with STAAD Pro software, and the findings are gathered in terms of shear and axial force, storey-drift, displacement and bending moment, that are then rigorously assessed to measure the impacts on different structureat various height. The seismic performance of an RCC structure with mass irregularity is investigated at various floor levels. The research reveals how irregularity affects the different floors of the RCC construction. STAAD Pro is used to do response spectrum analysis on both regular and irregular masses of structure. The result found that irregularity in the mass experiences large base shear than regular mass in structure.

3. Methodology

For thorough seismic evaluation of structures, the following procedures are recommended: Linear dynamic, linear static, and non-linear static analysis. For a thorough assessment of a building's seismic risk, all of the approaches listed above should be used in order. It should be emphasised that a more thorough study (nonlinear dynamic time history analysis) is available, but it is not suggested for routine building because it is more difficult and time consuming. The linear static and linear dynamic analyses as required by Indian Standard IS 1893: 2002 are briefly explained in this section. From the standpoint of seismic evaluation, the primary goal of these evaluations is to determine the demand-to-capacity ratios of the building components and, as a result, code compliance. In the following section, we'll go through nonlinear static analysis (pushover analysis). This section explains the two distinct linear analysis methods proposed in IS 1893: 2002. To calculate the predicted seismic demands on the lateral load resisting components, any of these approaches can be employed.

3.1. Seismic design approach

All seismic codes recommend that all designer design the structure in such a way that the structure should withstand earthquake forces without any loss. There are separate seismic codes for different seismic zones of India. They consider following factors for analysis which are local seismology, properties of available materials, accepted level of seismic risk, used as building construction methods. After that they show progress level of country in field of construction in earthquake engineering. Recommendations provided by IS code mostly they based on observations of past earthquakes and experimental work done by scientist, seismologist etc. first Indian code which is IS: 1893 was published in year 1962. As due to analysis of behavior of structure based on past earthquake and analysis made by researchers in earthquake resistant building considerable changes are made in Indian standard code. So it is concluded that there is requirement of revision of Indian code with time IS: 1893-2002 is revised after 18 year gap revision is published in year 2002 (IS: 1893-1984).

When designing a building comparison is made that the building is designed by existing recommendation or revised version or building is safe for existing code or safe for revised edition. Structural analysis is the process of prediction of behavior of structure on the basis of physics law and mathematics. Structural analysis is a process in which we briefly explain that how to handle the engineering design process which prove the engineering design process to be sound without any testing. For finding accurate results it is necessary to find out such important information such as properties of material, loads at supports, geometry of the structure etc.

3.1.1 Calculation for the seismic load analysis as per IS-1893 (2002)

To analyze the seismic behavior of the structure required seismic parameter is gathered from the IS-1893:2002 such as: damping ratio, zone factor, importance factor, rock/soil type, response reduction factor, etc.

Design Seismic Base Shear (V_b)

It is also known as lateral force (design) that can be measured in any mutual perpendicular direction and may determine using equation:

$$V_b = W \times A_h$$

Where,

A_h is the acceleration in horizontal direction, and W is the total weight of all the storeys due to seismic loading.

3.2 Wind load (WL) on building

It is the first horizontal stress on the structure, and it is caused mostly by air movement relative to the ground. The wind load is taken into account while designing a high-rise construction. The velocity of the wind and the height of the structure are the two most important parameters in calculating the wind load. The wind load calculation is detailed in section III of IS-875. Basic wind speed 'Vb' that is required for the calculation of wind load is given in zoning map of India (Fig. 1) for different wind zone. As per the location of structure in this zoning map designermay adopt basic wind speed value. Below equation can be used to measure velocity of wind at any height (z):

$$\mathbf{V_z = V_b \times k_1 \times k_2 \times k_3}$$

Where k_1 denotes probability factor or risk coefficient, k_2 is a coefficient that depends on size of the structure, height, and terrain and k_3 denotes topography factor

The pressure due to wind at height (z) can be measured using equation: $\mathbf{p_z = 0.6\, V^2_z}$

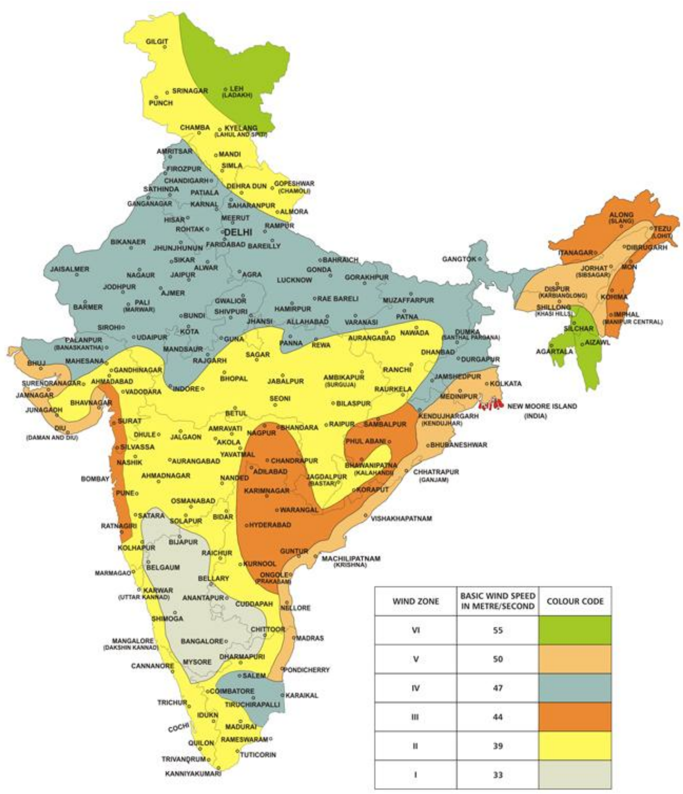

Fig. 1 - Wind zone of India showing basic wind speed

4. Conclusions

Many academics have researched various stresses operating on high-rise structures in an attempt to improve their performance. Soft stories, floating columns, mass irregularities, and poor quality of building materials, bad construction procedures, soil, and foundation have all been identified as major causes of failure. Due to increasing urbanization and population, there is a significant demand for high-rise building development all over the world, and these loads have the potential to cause the most damage to high-rise structures. Because these forces are unpredictable, engineering methods must be practiced to thoroughly analyze structures under their influence.Engineers require to keenly observe the response of structures against various load and load combination so that the different structural parameter can be accurately examined and designing of structure can be done with the help of STAAD PRO software to the desired accuracy.

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References

Aman, A., Nalwadgi, M., &Gajendra, T.V., (2016). Analysis and Design of Multi-storeyed Building by using STAAD Pro, International Research journal of Engineering and Technology, 3(6)

Anoop, A., Hussian, F., Neeraja, R., Chandran, R., Shabina, S., Varsha, S., (2016). Planning Analysis and Design of Multi-storeyed Building by STAAD Pro V8i, International journal of scientific & engineering research, 7(4)

Craig, J., Goodno, B., Towashiraporn, P., Park, J., (2002). Fragility reduction estimations for URM buildings using response modification, Paper No. 805, 12th European Conference on Earthquake Engineering Research, September 9-13

Epperson, G.S., Abrams, D.P., (1989). Nondestructive Evaluation of Masonry Buildings, Rep. No. 89-26-03, College of Engineering, University of Illinois at Urbana-Champaign, Advanced Construction Technology Center, Urbana, IL

Franklin, S., Lynch, J., Abrams, D.P., (2003). Performance of Rehabilitated URM Shear Walls: Flexural Behavior of Piers (CD-ROM), Mid-America Earthquake Center, University of Illinois at Urbana-Champaign, Urbana, IL

Harman, and Sood, H., (2017). Analyzing the Effect of Cross-Sectional Change of Column on Symmetrical R.C.C. Frame Structure, IJERT, 06(06), pp. 381-386, http://dx.doi.org/10.17577/IJERTV6IS060211

Patel, M.R., Singh, R.C., (2017). Analysis of a tall structure using STAAD Pro providing different wind intensities as per 875 part-III, international journal of engineering sciences and research technology

Sharma, M., Maru, S., (2014). Dynamic Analysis of Multistoried Regular Building, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), 11(1), PP 37-42

Simsir, C., Aschheim, M., Abrams, D., (2002). Influence of diaphragm flexibility on the out-of-plane response of unreinforced masonry bearing walls, Proc., 9th North American Masonry Conf. (CD-ROM), Clemson, SC