SEISMIC DESIGN AND EARTHQUAKE RESISTANT BUILDINGS: A REVIEW

Prince Hooda[1], Abhishek Sharma[2]

[1]M. Tech. Scholar, [2]Assistant Professor
CBS Group of Institutions, Jhajjar, Haryana
Maharishi Dayanand University, Rohtak.

***Abstract*: Earthquake resistant buildings are the need of the hour because of India's extreme vulnerability to extensive seismic activities. This paper provides a survey study on the seismic design and analysis of an earthquake resistant (G+4) storey R.C. Framed structure with a stilt floor, a residential building, under various load combinations. Also, this work includes seismic load calculations following IS 1893: 2002. The supports at the base of the structure are also specified as pinned. The codes of practice for the design are also specified along with other important details. The residential buildings taken into consideration to check for all the loading and its different floor load in various sections of the plan is shown in the survey paper.**

***Keywords:* Earthquake Resistant Buildings, Seismic Design, Residential Building**

Introduction

Structures like residential buildings are considered as critical infrastructure due to their important role in the aftereffects of any natural or man-made disaster. Seismic analysis and design of a residential building in Zone-III earthquake region consists of the planning of the residential building, to the framing of the structure, to the appropriate application of suitable loads that would be applied on the structure, to the analysis and finally completion of the design of the residential building structure and evaluation of the design consequences using STAAD PRO V8i software .

Seismic Zones In India

The country has been split into various zones demonstrating the power of damage or regularity of seismic activity events. These zoning maps show comprehensively coefficient that could be received for design of structures in various parts of the country. These drawings depend on subjective evaluations of intensity from accessible data on earthquake event, geography and tectonic plates of the country.

The zone maps are revised at regular intervals to incorporate the data accumulated over the period of time on earthquakes, the seismic-tectonics and the seismic movement in India. Seismic zone map in the protruding region has been reworked subsequently. Chennai has been brought under the zone 3. The 2002 zone map is a continuing document on seismic hazard of the country, constantly undergoing modification as more and more data becomes available.

Considering the previous earthquakes of the country, seismologists have characterized 59% of the area of India as inclined to tremors of numerous magnitudes – 11 percent in high risk zone 5, 18 percent in elevated hazard zone 4 and 30 percent moderate risk zone 3. The urban areas of capitals Guwahati and Srinagar lie in the seismic zone 5 while national capital of Delhi is located in zone 4 and the super urban communities of Mumbai, Kolkata and Chennai are located in zone 3. 38 urban communities with population of a 5,00,000 or more each and a joined population of a 10,00,000 are situated in these 3 regions.

Effect of Seismic Forces on Building

Earthquake causes arbitrary vibrations on the ground and a building erect on it wi1l undergo random motions through the base. The vibratory wave experience by the base is transferred to the roof of the building via walls, columns and the floors of these structure. The movement of the roof starts from its rest point (inertia) and hence, in the beginning, its movement is different than the movement of the base of the structure due to the earthquake. In buildings, the seismic load or energy produced at the base of the structure is dispersed throughout the structure with the aid of walls or columns.

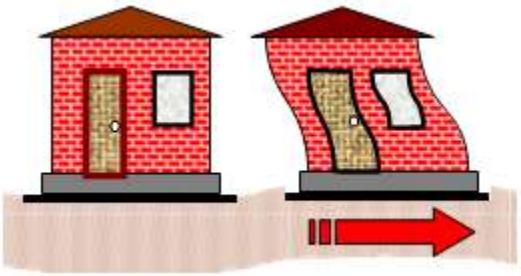

Figure Effect of Inertia on Building

Ruminate a building with the roof held on columns. When the ground moves due to a seismic incident, the entire building is flung backwards and starts moving from the default position. The roof of the building also undergoes an equivalent sudden force due to its inertia. Consider that the roof has a mass *M* and it moves with the resulting acceleration *a*, then the inertial force on the roof be calculated by multiplying tis mass to the resulting acceleration of the movement in the direction opposite to that of the acceleration. Evidently, higher mass of the structure generates higher inertia force. Therefore, it be concluded that the lighter structures experience lower the earthquake loads.

Literature Review

The literature available on the topic of Seismic Design and Analysis of Structures is vast and covers a lot of things. The topic originated from the requirement of planning, designing and constructing structures which are to an extent earthquake resistant and may ensure that massive loss of life and property does ot occur during earthquake disasters. India has been hit buy numerous earthquakes over the recent years, resulting in huge loss of life. Earthquake ot only causes shaking of earth but also brings with it numerous injuries, fatalities and mental to the people affected by it.Various research and projects have been done to provide for the various concepts of behaviour of earthquake on buildings, including the earthquake behaviour, analysis and design. One of the researcher in his review of the Indian Seismic Code IS 1893 Part I has tried to point out the numerous up gradations that have been done in the code since 1984. And he has also provided us with the up gradations that are required of the code to made in future revisions like the necessities of twisting in the building have developed too unwieldly and needs to be simplified; the code tranquil absences the adequate provision on handling of buildings with brickwork infill ramparts and a few other revisions.

Similar to the concepts that had been discussed in Murty's book, Gregory also took into consideration various concepts and also additionally provided with various recommendations that should be take care of while designing Earthquake Resistant Structures.

Moreover, numerous IIT papers regarding the analysis and design of earthquake structures provided with the invaluable insight on how to design the structural members like beam and column with the help of analysis obtained from software. These papers helped a lot with the hand calculation for the designing of members. The literature data available on the subject is huge. While, numerous papers and books have been written, emphasizing and explaining the concepts of earthquake design as well as method of designing earthquake resistant structure. There is need to utilize to all the data available and design an actual structure of a residential building which be earthquake resistant and provide relief and shelter to the people struck by earthquake. Cater to their injuries, and mental trauma. And designing the residential building would fulfill this requirement.

Effect of Deformation On Structures

These inertial forces on the roof is transferred to the base of the structure through the pillars. These forces present in the columns be further explained the following way. However, if we imagine a free boundary condition for the co1umns, they would snap back to their original vertical position and resist the deformations. However, due to the attached structure, these columns undergo bending deformation and internal forces are developed. The greater is the comparative parallel displacement of top and bottom ends of the columns, the bigger will be the resulting internal forces in columns. Stiffness present in the columns restricts the movement of the column ends which is results in higher internal forces for the columns. Thus, the larger is the size of the columns (higher stiffness), the larger will the internal force (stiffness force) experienced by the column. Therefore, the stiffness of the columns is affected by its size, length and relative movement between its ends.

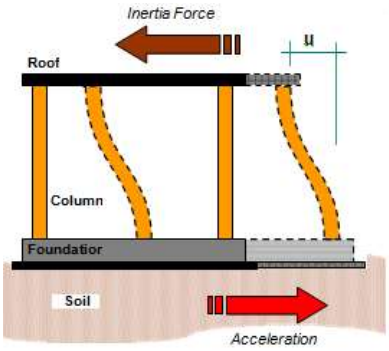

Figure Effects of Seismic Inertial Force on the Relative Motion of the Structure

Flow of Inertial Forces To Foundation

Beneath the horizontal vibrational movement of the surface, the building experiences horizontal inertial forces (usually the seismic forces are focused at the floor altitudes). These crosswise forces are move from end to end of the structure with the help of floor slabs to the walls and the supporting columns to the nitty-gritties and then to the soil. Thus, individually of the physical components (f1oor slabs, walls, columns, and foundations) and the influences among them should be premeditated to safeguard distribution of the inertial forces in the interior the structure.

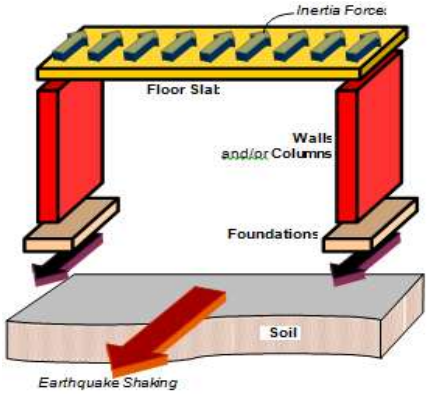

Figure Final transfer of seismic inertial forces to the structural components

Seismic design

There are two most important factors which factors to the seismic response of the buildings:

(i) Mass of the building

(ii) Stiffness of the building.

To reduce the effects of the seismic loading, engineers choose to design elastically deforming structures which may deform throughout the earthquake without any extreme brittle failure. However, introducing elasticity in the structure comes at the cost of reduced project economy.

HOW IS 1893: 2002 DIFFERENT FROM IS 456: 2000

IS 1893: 2000 (Part 1) pacts with calculation of seismic loads present on numerous buildings and tremor resilient strategy of structures, its rudimentary requirements apply to the structures, raised structures, engineering and heap like structures, connexions, tangible brickwork and earth blocks, etc. . It contains the materials, workmanship, inspection and testing requirements of concrete as well as the general design consideration and structural design procedure of R.C. members by Limit State Method of Design.

IS 1893: 2002 prescribes the value of various factors responsible for calculation of seismic loads such as seismic weight of the structure, Zone factor, Design Base Shear, etc. as stated in the further sections of the report. The code also encompasses all the design terms related to earthquake, the assumptions made while designing an earthquake resisting structure and zone factors for various cities in India.

Conclusions

Earthquake resistant buildings are the need of the hour because of India's extreme vulnerability to extensive seismic activities. We worked on the seismic design and analysis of an earthquake resistant (G+4) storey R.C. framed structure with a stilt floor, a residential building, under various load combinations. Seismic load calculations were done following IS 1893: 2002. The supports at the base of the structure were also specified as pinned. The codes of practice for the design were also specified along with other important details. The Residential Building was well planned (architecturally) taking into consideration all the loading a Residential Building and its different floor loads in various sections of the plan as show in the report.

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