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# Analysis and Design of Multistoried Earthquake Resistant Hospital Building in Zone Ii And Zone V (G+10)

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**Abstract**: -

Reinforced concrete (RC) buildings are routinely designed and detailed to have somewhat higherstrengths than those required for actual service load conditions. Generally, the members are provided with larger sizes and greater material strengths than the minimum design requirements as stipulated in the building design codes. The present design procedures for seismic design also results in greater strengths. Moreover, the redundancy in the structure on account of in redistribution of stresses will also lead to increased overall strength. This study deals with the comparison of percentage longitudinal steel, reinforcement detailing and design base shear of RC framed buildings with heights in different Indian seismic zones.
In the present study a Multistoried Hospital building is analyzed for seismic load IS Code 1893- 2016. In this Analysis, G+10 storied Hospital building is considered and applied various loads likeseismic load, static load and results are studied.

**KEYWORDS: -** Reinforced concrete, buildings, strengths, building design, stresses, seismic zones, G+10 storied

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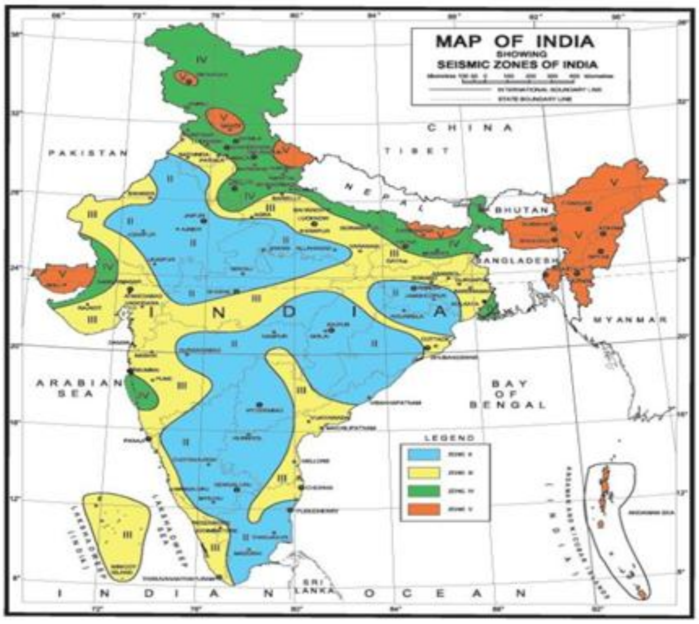
## 1. INTRODUCTION

A severe earthquake is one of the most destructive phenomena of nature. It is quite impossible to precisely predict and prevent an earthquake, but the damage to a structure can be reduced by its proper design. Hence it is prudent to do the seismic analysis and design to prevent structures against any catastrophe. The

**SEISMIC ZONE IN INDIA**




severity of the damage depends on the combination of several factors such as- earthquake magnitude, proximity to epicenter, and the local geological conditions, which affect the seismic wave propagation. The lateral forces due to earthquake cause the maximum problem for structures. Earthquake resistant design is thereby primarily concerned with limiting the seismic risk associated with man-made structures to socio-economically acceptable levels. It aims to foresee the potential consequences of an earthquake on civil infrastructure and to ensure the design & construction of buildings complies with design codes in order to maintain a reasonable level of performance with some accepted level of damage during an earthquake exposure. The ductility of a structure acts like a shock absorber and helps in dissipating a certain amount of seismic energy.

## BACKGROUND AND MOTIVATION OF THE PRESENT STUDY

The present work in its utmost sense, tries to delineate that what will be the changes in the structural design of buildings with variation in the seismic zones. It helps in giving a generalized sense of design and detailing differences that will be taking place with the increment in probable severity of ground motions. Thereby, aiding in developing a general perception about the design of regular RC buildings particularly in India. Jain et al. (2008), has done the detailing comparison for some selected members of a six-storey building, considering it once as an OMRF and once as an SMRF. The similar idea has been used in this work as well, the buildings in zone II have been considered SMRF and detailed as per IS 456 and IS 13920, and those in higher seismic zones have been considered as SMRF and detailed as per IS 456 and IS 13920. This study moreover, attempts to do a comparison of the base shear, percentage reinforcement in beams and columns for all the various zones. so as to give further insights into the design aspects. Kumar et al. (2013) has carried out such comparison for all components of a G+6 building. This work in addition to all such comparison, includes pushover analysis of the designed buildings followed by comparison of the obtained over-strength factors.

## 1.2 OBJECTIVE OF THE STUDY

The objectives of the present study are as follows:
This work attempts to evaluate effect of change of seismic zones on the design, detailing and performance of the building. The work includes comparison of base shear, percentage steel in columns and beams, and detailing of selected members. Moreover, it includes a performance comparison of the designed buildings on the basis of over-strength factors obtained from
pushover analysis of the buildings.

## SCOPE OF WORK

The following are scopes of the present work-
- All the modelling and analysis has been done for only RC structures.
- The beams and columns have been modelled as frame elements.
- Soil-structure interaction is not being taken into consideration.

• Foundation is modelled as a fixed support at the level of footing and the building design & material estimation exclude foundation.
• Infill walls have not been considered.

## 2.1 LITERATURE REVIEW

1. Ms. Priyanka Soni.et.al; (2016): has studied on Shear walls are structural system which provide stability to structures from lateral loads like wind, seismic lo These structural systems are constructed by reinforced concrete, plywood/timber unreinforced masonry, reinforced masonry at which these systems these structural systems are constructed by reinforced concrete, plywood staggered walls. The present paper work was made in the interest of study and analysis of various research works involved in enhancement of shear w and their behavior towards lateral loads. As shear walls resists major port of lateral
loads in the lower portion of the buildings and the frame support the lateral loads in the upper portion of building which is suited for soft storey high rise building. Building which are similar in nature constructed in India As in India base floors are used for parking and garages or officers and upper floors are used for residential purposes.

2. K. Rama Raju.et; (2013); Consideration of site-specific lateral loading due to wind or earthquake loads along with vertical gravity loads is important for finding the behavior of the tall buildings. As the height of a building become taller, the amount of structural material required to resist lateral loads in drastically. The design of tall buildings essentially involves a conceptual de approximate analysis, preliminary design and
optimization, to safely carry gravity and lateral loads. The design criteria are strength, serviceability and human comfort. The aim of the structural engineer is to arrive at suitable structural schemes, to satisfy these criteria. In the present study, the limit method of analysis and design of a 3B+G+40- story reinforced concrete HiRISE 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-story drifts, accelerations prescribed in codes of practice and other relevant references in
literature on effects earthquake and wind loads on buildings.

3. Vikrant Trivedi.et.al; (2018): This study 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 subject to wind loads in a particular region. It is well known fact that the wind load be estimated in particular zone with a specified zone factor. Then the wind load of that zone can also be esteemed 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 multistoried building is analyzed for wind loads using IS code 875 and results are studied and compared between with and without wind load.

4. Aman.et.al;(2016): The main aim of structural engineer is to design the structure for a safe technology in the computing field; the structural engineer can tackle much larger and complex structure subjected to various type o loading condition. Earlier the loads acting on the structure are considered static, but strictly speaking, with the exception of the self-weight (dead load no structure load is static one now a day large number of application software are available in the civil engineering field. All this software's are developing the basis of advanced. Finite element analysis which includes the effect of dynamic load such
as wind effect, earth quake effect bets etc. in the preset work, an attempt has been made to study the efficiency of certain civil engineering application software's for this purpose an on-going project has been selected. This project belongs to the unity builders to be executed in Gulbarga City. The name of the project is Bharat pride.

5. Varikuppala Krishna, Chandrashekar.et.al;(2015): Structural Engineers are the challenge of striving for the most efficient and economical design with accuracy in solution while ensuring that the final design of a building must be serviceable for its intended function over its design life & ndash; time. Project presents (parking floor +5) upper stories RCC framed building analyzed and designed under the lateral loading effects of wind and earthquake usi ETABS (Extended Three Dimensional Analysis of Building system). ETABS is incorporated with all the major analysis engines that is static, dynamic, Lin and non & ndash: linear, etc., and this software is used to analyze and design especially the buildings. Because of the facilities provided in this software modeling stage, the buildings can be modeled as per the arrangement of t members of the project in practical, and this
software considers the beam columns as Line member; slabs, Ramps/staircases, walls are as area member Taking the horizontal loading effects of wind amp: seismic forces; In the
doff this project, I take dynamic loading along with the static loading and Livloads as per IS code; And almost all the members of the project can be Annand designed as per Indian

code using this software, where ever requirement the members using excel sheets which are prepared by me in this phase.

6. M B Vikram.et.al; (2017): Structural analysis is mainly concerned with finding the behavior of the structure when subjected to some action. In this project residential of (G+5) multi -storey building is studied for earthquake loads u ETABS software. Assuming that the material property, the linear static an is performed. These linear static analyses are carried out by considering se seismic zones (zone-II, zone-III, zone-IV, and
zone- V) and the behavior is assessed by taking types II soil condition. Different responses like bending moment, axial forces of various load combination and zones are studied. Seismic load has significant impact on bending moment and axial force.

## 3. METHODOLOGY

This project is mostly based on software and it is essential to know the details about this software's.
List of software's used
1. Staad Pro (V8i ss6)
2. Staad Foundation Advanced.
3. Staad RCDC.
4. Autocad.

STAAD
Staad is powerful design software licensed by Bentley. Staad stands for structural analysis and design Any object which is stable under a given loading can be considered as structure. So first find the outline of the structure, whereas analysis is the estimation of what are the type of loads that acts on the beam and calculation of shear force and bending moment comes under analysis stage. Design phase is designing the type of materials and its dimensions to resist the load. this we do after the analysis. To calculate S.F.D and B.M.D of a complex loading beam it takes about an hour. So when it comes into the building with several members it will take a week. Staad pro is a very powerful tool which does this job in just an hour's staad is a best alternative for high rise buildings. Now a day most of the high - rise buildings are designed by staad which makes a compulsion for a civil engineer to know about this software. This software can be used to carry rcc, steel, bridge, truss etc according to various country codes.

**ALTERNATIVES FOR STAAD**

Struts, robot, sap, adds pro, Prota structure which gives details very clearly regarding reinforcement and manual calculations. But this software's are restricted to some designs only whereas staad can deal with several types of structure.

**STAAD EDITOR**

Staad has very great advantage to other software's i.e., staad editor. staad editor is the programming. For the structure we created and loads we taken all details are presented in programming format in staad editor. This program can be used to analyze another structures also by just making some modifications, but this require some programming skills. So load cases created for a structure can be used for another structure using Staad editor.

LIMITATION OF STAAD PRO
1. Huge output data
2. Even analysis of a small beam creates large output.
3. Unable to show plinth beams

STAAD FOUNDATION
Staad foundation is a powerful tool used to calculate different types of foundations. It is also licensed by Bentley software's. All Bentley software's cost about 10 lakhs and so all engineers
can't use it due to heavy cost. Analysis and design carried in Staad and post processing in staad gives the load at various supports. These supports are to be imported into this software to calculate the footing details i.e., regarding the geometry and reinforcement details.
This software can deal different types of foundations
1. Isolated (Spread) Footing
2.Combined (Strip) Footing
3.Mat (Raft) Foundation

## 4. DESIGN

In order to fulfill the objectives, a hospital building geometry with number of stories is chosen and designed as per different Indian seismic zones followed by a comparison of the design
and detailing is presented in the Chapter.

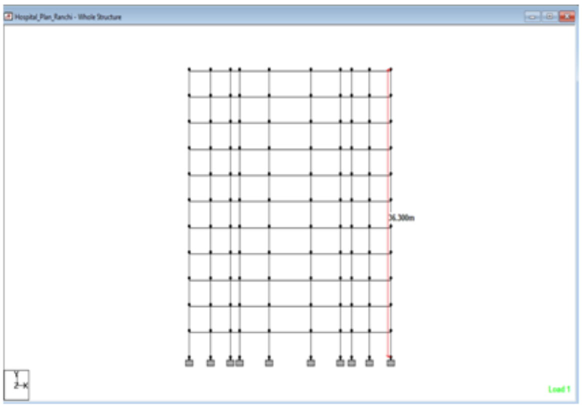
### 4.1BUILDING DESIGN AND RESULT CONSIDERATIONS

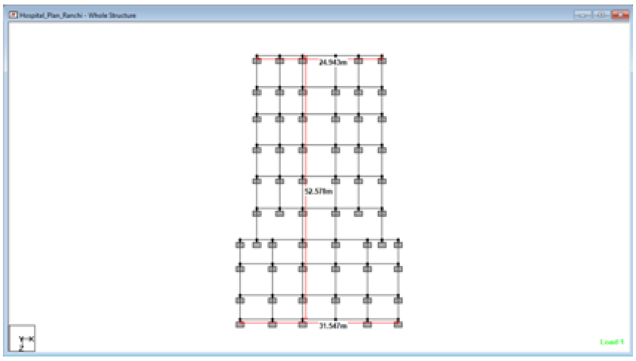
The plan of the building frame considered the present study is shown in fig. The building with the plan shown in this figure is considered for ten number of storeys. Each of the building with their specific height are designed for all the seismic zones. The designation represents G+10 building designed for seismic zone II and seismic zone IV. The buildings are designed as per IS 1893 (2016) considering medium soil conditions. The buildings in this study have column 3m, slab thickness 125mm and plinth level as 0.6m as observed from the study of typical existing hospital buildings. Considering unit weight of concrete as 25 KN/m3 and weight of floor finishes to be 1KN/m2, the slab dead load comes out to be 4.125kN/m2. Taking the Live Load intensity as 3Kn/m2 for floor slabs and 1.5kN/m2 for roof slabs into account, and the earthquake loads as per IS 1893(part-1); all the Five load combinations have been considered for analysis (as in the code IS 1893(part-1). Buildings in zone II and Zone IV are designed considering them as SMRF and detailed according to IS:456 and IS:13920, The characteristic strength of concrete and steel are taken as 25MPa and 500MPa respectively.
In order to study the design and detailing of the buildings selected, structural analysis is carried out for vertical and lateral loads. The comparison of design base shear, percentage of longitudinal steel in columns and beams are presented in the following sections. For all the RC buildings,
the following assumptions are made in this work-
• There is a common plan for all the buildings of dimensions 52.5 x 33.5m located on medium soil.
• The effect of finite size of joint width (e.g., rigid offsets at member ends) is not considered in the analysis.
• The floor diaphragms are assumed to be rigid.
• For analysis and design the Centre-line dimensions are considered.

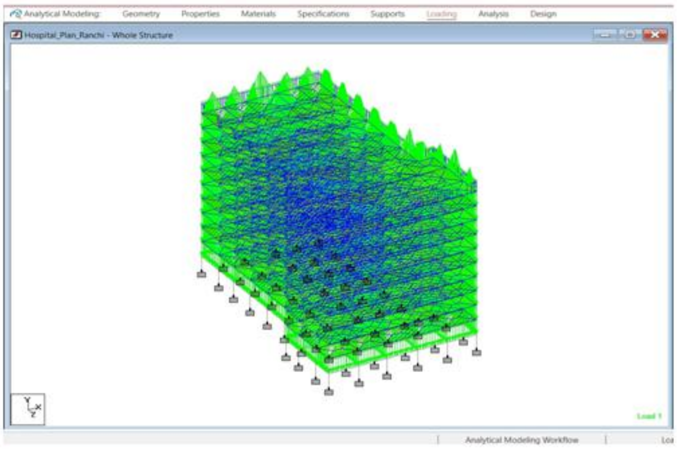
### BUILDING SPECIFICATION

| | |
|---|---|
| Column | 1.2m X 0.40m, |
| Beam | 0.50m X 0.3m |
| Slabs | 0.125mm |
| Parapet Wall | 0.9m |
| Live Load | 3Kn/m2 |
| Grade of Concrete | M30 |
| Grade of Steel | Fe 500 |
| No of Storey | 10 |
| Total Height | 36.30m |
| Floor to Floor Height | 3.3m |
| Spacing of frame along length | 6.22m |
| Spacing of frame along width | 6.4m |
| No of Stairs | 1 Nos |
| No of lifts | 2 Nos |

**Supports:**
The base supports of the structure are assigned as fixed.







Loads applied on Building.

**Load Combinations:**

These load combinations are used for Analysis and Design purpose for the building1. 1.5 D.L +1.5L.L
2. 1.2D.L + 1.2L.L + 1.2 EQ(+X)

3. 1.2D.L + 1.2L.L + 1.2 EQ(-X)

4. 1.2D.L + 1.2L.L + 1.2 EQ(+Z)

5. 1.2D.L + 1.2L.L + 1.2 EQ(-Z)

**5. RESULT**

Planning, analysis and design of G+10 multi-storey hospital building was done. It's a G+10 storied building. All the structural components were designed and detailed using STAAD RCDC. The analysis and design were done according to standard specifications using STAAD.Pro forstatic and dynamic loads. The dimensions of structural members are specified and the loads suchas dead load, live load are applied. Deflection and shear tests are checked for beams, columns andslabs. The tests proved to be safe. Both theoretical and practical work has been done. Hence, Iconclude that we can gain more knowledge in practical work when compared to theoretical work.**Design**

**Calculation and Design Summary for Zone II – Ranchi Jharkhand.**

1. Beam Design Calculation.
2. Beam Design Summary.
3. Column Design Summary.
4. Column Design calculation.

**Design Calculation and Design Summary for Zone V – Bhuj Gujarat.**

1. Beam Design Calculation.
2. Beam Design Summary.
3. Column Design Calculation.
4. Column Design Summary.

## 6. CONCLUSIONS.

The following are the major conclusions that can be made based on present work carried upon thetwo RC buildings designed for earthquake forces the seismic zones-II and Zone V.

1. There is significant increase in base shear as we move from zone II to zone V, indicating theincrease in severity of earthquakes occurring in these regions.
2. Moreover, from the Base Shear curves, it is evident that magnitude of Base Shear increases withthe increase in height of a building.

3. As far as steel requirement in columns is concerned, it almost increased to 43%(for exterior aswell as interior columns) on average when we move from zone II to Zone V.
4. The variation of percentage of longitudinal steel at support sections in external beams is approximately 0.54% to 1.23% and in internal beams is 0.78% to 1.4%.
5. In the external and internal beams, the percentage of bottom middle reinforcement underwent comparatively lesser increment to about 15-20% for different earthquake zones.
6. There has been a steady rise in overall steel requirements in the building to about 35%, as wemove from zone II to zone V.

## SCOPE OF FUTURE WORK

On the basis of the present work done, the scope for future study is identified on the following aspects-

- In the present study, seismic design of buildings is carried out using Equivalent Static analysis. Similar studies may be taken up with other methods such Response-spectrum Analysis, Time-History Analysis and Pushover Analysis.
- In this work, only the Indian Seismic design codes have been taken into account, the workcan be further extended by incorporation of British, American and other design codes as well.
- The present study considers only the over-strength factor obtained from the Pushover Analysis output. Several other parameters such as- Capacity spectrum, hinge-backbone results, etc., can also be augmented to it.
- Efforts may be made to take the soil-structure interaction into account as well.
- The present study is carried out on RC buildings. Similar studies may be taken up with Steel structures as well.
- Efforts may be made to study the pushover analysis using different software tools or someother procedures to validate the results.

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