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Design and Analysis of a Multistory Building Reinforced Concrete Frame in Different Seismic Zone's

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Abstract: ***This study work focuses on comparison of steel quantity of different seismic zones. The structural performance of the building is analyzed for consideration of gravity loads and seismic loads in zone-II, Zone-III, Zone-IV, Zone-V. The study includes understanding the most occurred issues that lead to poor performance of the structure throughout earthquake, to achieve their applicable behavior in event of future earthquakes. The analyzed structure was symmetrical, G+15, Ordinary RC Moment-resisting frame (OMRF). Modeling of the structure was done using Staad pro.V8i software. Time period for the structure along different directions was retrieved from the software and as per IS 1893:2002-05. The lateral seismic forces in reinforced concrete frame were calculated as per IS 1893:2002-05. Based on research work the variation in behavior of the structure under the gravity and seismic loads for different zones was predicted. The results show the changes in the magnitude of Reactions, displacements, moments and the results also shows the variations in quantity of the materials.***

Keywords: Seismic Analysis, Comparison, Reinforced Concrete Frame, Seismic Design, Seismic Zone

1. Introduction

1.1. General

An earthquake (also known as a quake, tremor or temblor) is the shaking of the surface of the Earth, resulting from the sudden release of energy in the Earth's lithosphere that creates seismic waves. Earthquakes can range in size from those that are so weak that they cannot be felt to those violent enough to toss people around and destroy whole cities. The seismicity or seismic activity of an area refers to the frequency, type and size of earthquakes experienced over a period of time. The word tremor is also used for non-earthquake seismic rumbling. In the present scenario earthquake engineering attracts major attention of scientist because this is the event which cannot be accurately predicted it is the sadden event which happens due to various reasons such as;

1) Movement of tectonic plates.
2) Sudden slips at the faults.
3) Building of dams.
4) Volcanic earthquakes.
5) Due to explosive.
6) Due to mining etc.

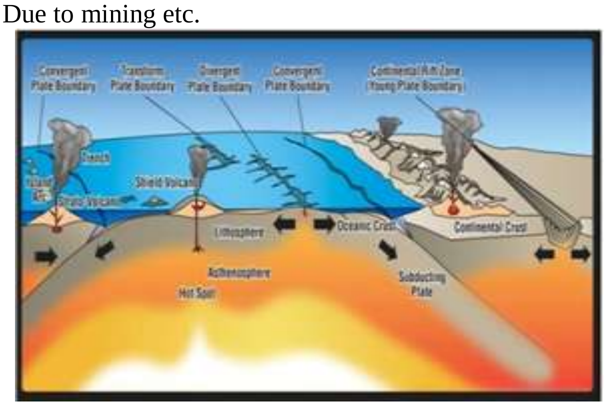

Figure 1: Details of Earth Crust

1.2. Zones

The Indian subcontinent has a background marked by pulverizing tremors. The real explanation behind the high recurrence and power of the seismic tremors is that the Indian plate is crashing into Asia at a rate of around 47 mm/year.

Geographical measurements of India demonstrate that just about 59% of the land is defenseless against quakes. A World Bank and United Nations report indicates gauges that around 200 million city inhabitants in India will be presented to tempests and tremors by 2050.

The most recent adaptation of seismic zoning guide of India given in the quake safe plan code of India [IS 1893 (Part 1) 2002] allots four levels of seismicity for India as far as zone components. As it were, the tremor zoning guide of India partitions India into 4 seismic zones (Zone 2, 3, 4 and 5) dissimilar to its past variant, which comprised of five or six zones for the nation. As indicated by the present zoning map, Zone 5 expects the most abnormal amount of seismicity while Zone 2 is related with the least level of seismicity.

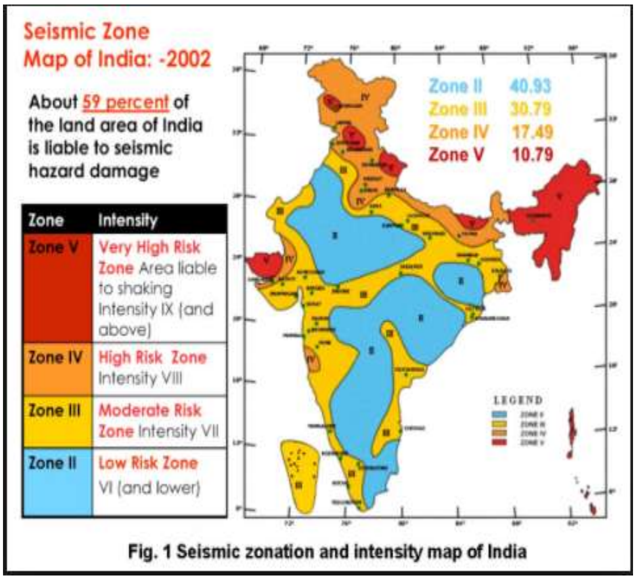

Figure 2: Seismic Map Of India (IS1983-2002)

2. Literature Review

Purnachandra Saha, P.Prabhu Teja &,P Vijay Kumar this research is mainly focuses on variation in percentage of steel when building is designed for seismic zones. As per their research work they concluded that percentage variation of steel in beams are not varying much as compared to columns. Variation is around 0.07% in columns and overall variation is around 0.91% from Zone II to Zone V.

Perla Karunakar the author put his efforts to find out the performance and variation in steel percentage and concrete quantities in various seismic zones and impact on overall cost of construction. According to his analysis work the quantity of concrete are increased in exterior and edge columns due to increase in support reactions however variation is very small in interior column footings. Reinforcement variation for the whole Rc frame structure For gravity and seismic loads are 12.96, 18.35, 41.39, 89.05%.the cost variation for ductile vs. non ductile detailing are 4.06%.

G Papa Rao and Kiran Kumar the author‟s researches on the changes in the percentage of steel and volume of concrete for the RCC framed structure for various seismic zones of India. They have designed the structure for gravity load and seismic forces which might be effect on building. According to him that the variation in support reactions for exterior columns increased from 11.59% to 41.71% and in case of edge columns it is 17.72% to 63.7% from Zone II to Zone V, and as in the case of interior columns it is very less. In case of total concrete quantities, volume of concrete has been higher for exterior and edge columns from Zone III to Zone V because of higher values of support reactions with the effect of lateral forces and variation is very small in interior columns.

Jun Huang; Shaobin Dai; Jixiong Liu the study was conducted Through pseudo static test, the earthquake resistant capability of 3 L-shaped special-shaped concrete-filled rectangular composite steel tubular columns,3 L-shaped improved special-shaped concrete-filled rectangular composite steel tubular columns and 3 L-shaped improved special-shaped concrete-filled rectangular composite steel tubular columns with restrain sticks is studied under low cycle repeated load, and their failure mode, failure mode test phenomenon and failure mechanism is described. The results indicate that the hysteresis curves of the specimens have long and narrow hysteresis circles in elastic stage while begin to bend in elastic-plastic stage, and the shape become full; the specimens own good energy dissipation capacity. Specimen displacement ductility index can meet the requirements of seismic design. The equivalent viscous damping coefficient of all specimens are greater than ordinary concrete structures', the energy dissipation of special-shaped concrete filled rectangular composite steel tubular column is much larger than ordinary concrete structures'; in general, rate of specimen stiffness degradation is relative slow, all specimens possess good lateral resistance ability.

Li Tian; Zhang Z, The Study on Earthquake Resistance of Electric Power System Based on System ReliabilityThis the paper discusses the seismic reliability analysis of electric power system. In the paper, through the analysis of properties of the power system and power network system characteristics, some suggestions are put forward that it is not only need to consider site selection, power substations buildings, power structure analysis in individually in the seismic reliability analysis of power system, but to guarantee the reliability of the power system. Therefore it is necessary to ensure the connecting reliability from the plants to the users (substations). Based on this, it can be done the electric power system the seismic design, maintenance and modification.

3. Methodology

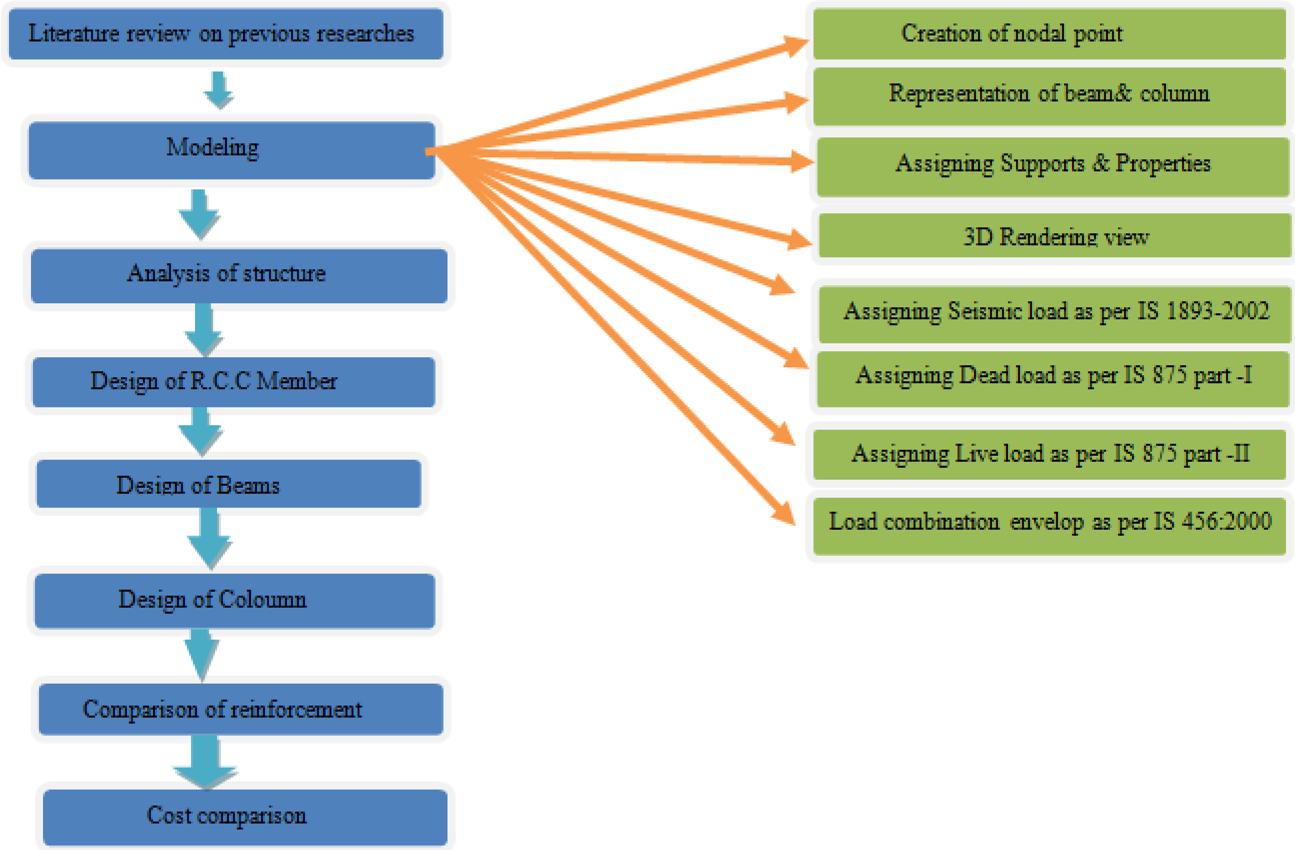

Figure 3: Flow Chart Methodlogy

3.1. Modeling

In the investigation work four models of reinforced concrete frame. Tall structure G+15 floors are made to know the reasonable conduct of working amid tremor. The length of the building frame is 20m and width is 21m. Tallness of the individual story is 3m. Building is situated in zone II, III, IV & V. Building is created according to IS 456-2000. Concrete material of grade M25 is used, while steel Fe 415 and Fe 415 are utilized. Brick masonry having density 20 KN/m3 is utilized. Direct properties of material are considered. For the investigation work Staad pro. Software is utilized. The column sections are thought to be settled at the ground level.

Details of the Structure

Table 1: Details of the Structure

s.no.	Particulars	values
1	Size of beam	0.7mX0.4m
2	Size of column	0.6mX0.6m
3	Plan size	21mx20m
4	Height of structure	48m
5	Height of individual story	3m
6	Density of brick masonry	$20KN/m^3$
7	Density of concrete	$25KN/m^3$
8	Grade of concrete	M 25
9	Grade of steel	415
10	Soil condition	Medium soil
11	Thickness of outer wall	0.2m
12	Thickness of inner wall	0.1m
13	Seismic zones	II, III, IV, V
14	Thickness of slab	0.15m
15	Importance factor	1

Reinforced Concrete Frame Model
Plan of the structure

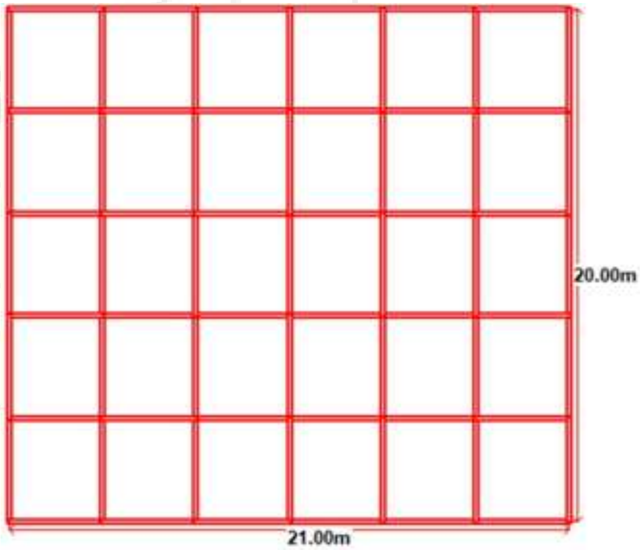

Figure 4: Plan of the Frame

3.2. Load Calculation

3.2.1. Dead load

Dead load consists of the permanent constructions material load compressing the beam, column, roof, floor, wall and foundations including claddings finishes and fixed equipment. Dead load is a total load of all of the components of the building that generally do not change over time.

Table 2: Calculation of Dead Load

S.N	Descriptions	Thickness of wall (m)	Height of wall (m)	Weight Density of Brick wall	Load Calculated (KN/m3)
	column.(1)	column. (2)	column. (3)	column. (4)	col.(2)* col.(3) *col.(4)
1	Outer wall load	0.2	2.4	20	9.6
2	Inner wall load	0.1	2.4	20	4.8
3	Parapet wall load	0.1	1	20	2
4	Floor load (SLAB) + floor finishing load= 4. KN/m^2 As per IS: 875 (part -I)				

3.2.2. Live load

These loads are not permanent or moving loads. The following loads includes in this type of loadings imposed load, fixed machinery, partitions wall these. Loads through fixed in positions cannot be re-lived upon to act permanently through-out the life of the structure.

As per IS: 875 (part –II)

Live load = 2.5 KN/m2

3.2.3. Seismic load

The design lateral force shall first be computed for the building as a whole. This design lateral force shall then be uniformly distributed to the different floor levels. The overall design seismic force thus obtained at each floor level shall then be distributed to individual lateral load resisting elements depending on the floor diaphragm action. Calculation of seismic load as per IS 1893 (Part 1):2002

We have taken all four seismic zones and in which we have selected one city from each.

Bhopal as zone II

Mumbai as zone III

Delhi as zone IV

Guwahati as Zone V

Table 3: Seismic Parameters for Different seismic Zones

Zone	Zone Value	Response reduction factor(RF)	Importance factor(I)	Rock and Soil Site Factor (SS)	Type of Structure (ST)	Damping Ratio (DM)
Zone II	0.1	5	1	3	1	0.05
zone III	0.16	5	1	3	1	0.05
Zone IV	0.24	5	1	3	1	0.05
zone V	0.36	5	1	3	1	0.05

Following parameter is taken as for different cities:

3.2.4. Load Combinations:-

The following Load Combinations are considered for the design

1. 1.5(DL+LL)
2. 1.2(DL+LL+EQL IN POSITIVE X DIRECTION)
3. 1.2(DL+LL+EQL IN NEGATIVE X DIRECTION)
4. 1.2(DL+LL+EQL IN POSITIVE Z DIRECTION)
5. 1.2(DL+LL+EQL IN NEGATIVE Z DIRECTION)
6. 1.5(DL+ EQL IN POSITIVE X DIRECTION)
7. 1.5(DL+ EQL IN NEGATIVE X DIRECTION)
8. 1.5(DL+ EQL IN POSITIVE Z DIRECTION)
9. 1.5(DL+ EQL IN NEGATIVE Z DIRECTION)
10. 0. 9DL+1.5EQL IN POSITIVE X DIRECTION
11. 0.9DL+1.5EQL IN POSITIVE Z DIRECTION

Stresses in Slab

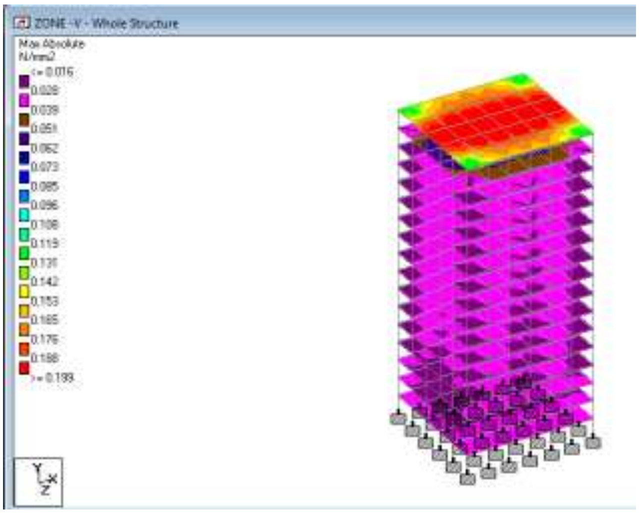

Figure 5: Stresses in Slab

Seismic loading in positive X-direction:-

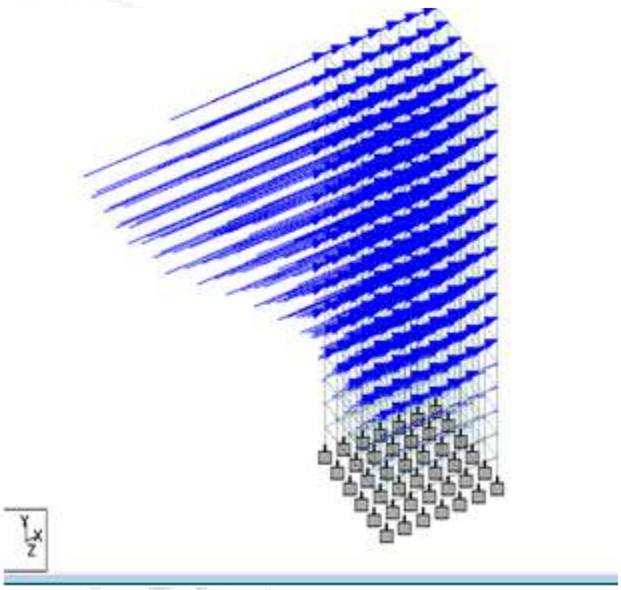

Figure 6: Seismic Loading In Positice X Difrection

Results

4.1. Comparison of Steel

Table 4: Steel Comparisons

Zones	WEIGHT OF STEEL(N)
DL+LL	845125.56
EQ ZONE -II	1177239.62
EQ ZONE -III	1186031.88
EQ ZONE-IV	1187202.50
EQ ZONE-V	1690251.12

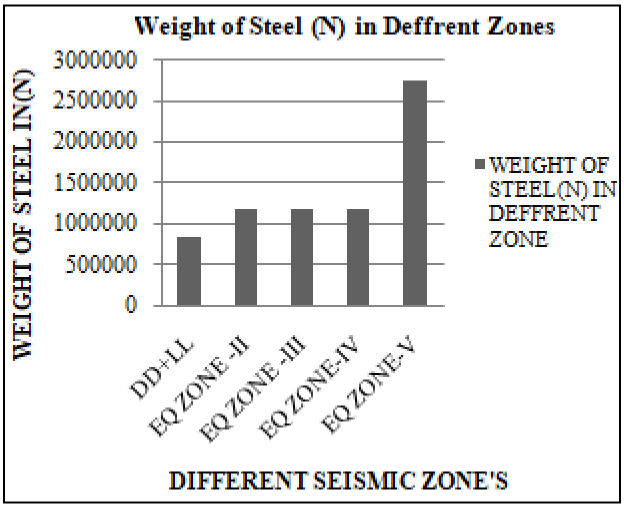

Figure 7: Comparison of Steel

Above results shows that in weight of steel in different seismic zones that steel quantity find out by using software STAAD Pro. V8i version

4.2. Percentage Increase Weight of Steel With Respect To Gravity Load

Table 5: Percentage Increament In Steel

ZONE	% INCREASE
ZONE- II	39.29
ZONE -III	40.33
ZONE -IV	40.47
ZONE- V	99.99

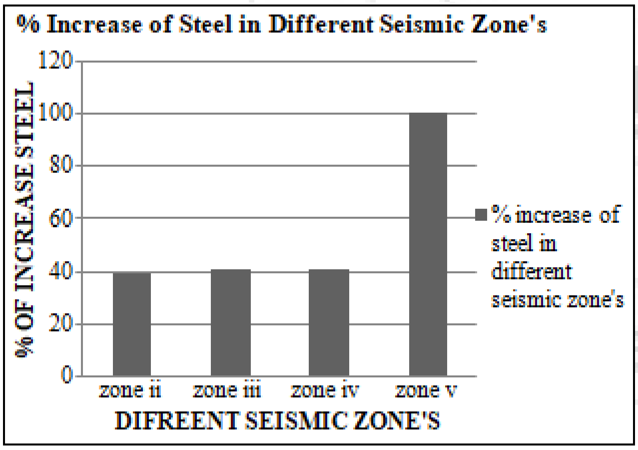

Figure 8: % Increase in Weight of Steel

% of Steel increment in different seismic zone with respect to DL+LL

Bending Moment Diagram of Whole Frame

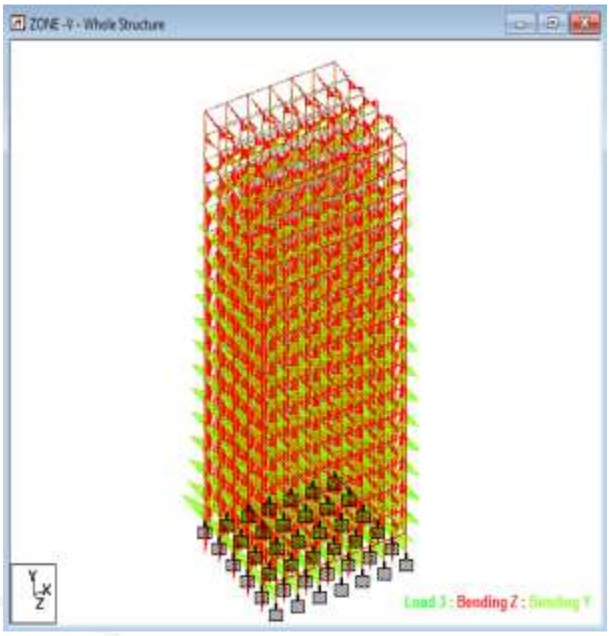

Figure 9: Bending Moment of Whole Frame

Conclusion

The present study helps us to understand the behavior of the reinforced concrete frame structure under the various type of seismic load applied in different seismic zones. There is a lack of awareness in the earthquake disaster mitigations avoiding non engineering structures with unskilled labour even in unimportant temporary construction. The builder and constructors' should adopt the codal provisions in all the future constructions, as prevention is better than cure. On the light of avoiding the risk this may not be an impossible task as earthquake resistant measures in building involves only 8%-10% additional cost depending upon the type of the building.

The whole structure is very much ductile. To resist the earthquake forces a good ductile structure is required

- The weight of the steel is increased with the seismic load intensity.
- The total applied load in all the horizontal direction is increased.
- The cost of the structure is increased.
- The area of steel in the column is increased.
- The weight of the structure is increases with the increase in the seismic load intensity.

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