COMPARISON OF ANALYSIS AND DESIGN OF REGULAR AND IRREGULAR CONFIGURATION OF MULTI-STORY BUILDINGS IN VARIOUS SEISMIC ZONES AND VARIOUS TYPES OF SOIL

[1]RAJASHREE ACHARYA,

Gandhi Institute of Excellent Technocrats, Bhubaneswar, India

[2]PRATYUSH KUMAR SETHI,

Gurukula Institute of Technology, Bhubaneswar, Odisha, India

----------***----------

Abstract – *Today's world faces some of the major problems caused by nature. One of the biggest natural disasters is earthquakes. Multi-story RC construction, subject to the most dangerous earthquakes. It has been found that the main reason for the decay of RC buildings is the incorrect distribution of mass, stiffness, and strength and due to incorrect geometric configurations and different types of soil. Due to improper construction of the plan, the settlement is also diverse compared to the construction with the correct shape.*

However, previous records of earthquakes show poor seismic characteristics of the structure. This is due to ignorance of the aspect of irregularity in the formulation of methodologies for seismic design through seismic codes (IS 1893: 2002). These analyzes are performed by examining multi-story G + 11 buildings with different seismic zones 3 and 4 and for each zone, the behavior is assessed by taking two different soil types, namely solid and medium different reactions such as plot deviation, displacement and baseline shear are applied to different zones and different types of soils from the seismic regulations proposed in IS 1893-2002, using the equivalent static method and software STAAD Pro V8i.

Key Words*: *Regular and irregular configuration, static analysis

1. INTRODUCTION

Much of India is vulnerable to damaging levels of seismic hazards. So it is necessary to take into account the seismic load when designing the structure. In buildings, lateral loads due to earthquakes are a problem. These lateral forces can cause critical stresses in the structure, cause unwanted vibrations or cause excessive lateral rocking of the structure. The swing or drift is the amount of lateral displacement in the upper part of the building relative to its base.

The limit state may correspond to the intensity of the earthquake, equal to the strongest experienced or predicted at the site. In the present study, the results were examined for equivalent static load.

Now the daily population of India is increasing day by day, therefore the demand for buildings, houses and apartments in row houses is also increasing. Due to the larger population, tall buildings are being built. While the construction of tall buildings, some factors are influenced by the building such as soil layers or soil type, earthquake zone, wind load, etc. Side forces force the building to move or shake, which is why earthquake analysis is much more important in high-rise buildings.

The forces of the earthquake are arbitrary and unpredictable, and static and dynamic analysis of the structure has become a major concern of civil engineers. The main part of a multi-story building is the column, the beam and the foundation. In our project, we analyze G + 11 buildings in different earthquake zones with different types of soils (medium, hard) with different irregularities in the plan such as rectangular, c-shaped, and l-shaped buildings. SBC for medium soil is 245 KN.M ^ 2, and for hard soil is from 300 KN / M ^ 2 to 440 KN / M ^ 2.

BUILDING DETAILS:-

- Number of stories: 11
- Column size 300 mm X 750 mm
- Height of a typical floor: 3 m
- Beam size: 300 mm X 450 mm
- Plate thickness: 125 mm
- thickness: 230 mm, 150 mm, 100 mm
- Live load: 2Kn / m2
- Floor covering: 1Kn / m2
- Steel grade (Fe): 500N / mm2 & 415 N / mm2
- Density of concrete: 25N / mm2
- all columns are fixed at the base.
- Density of brick masonry: 20KN / m2
- Ratio of poisons in concrete: 0.3
- Ratio of bricks of brickwork: 0.2
- Modulus of elasticity of concrete: 2500N / mm2.

BUILDING FORM: -

Rectangular building: - In a building with a regular shape, the number of bays in the X and Y directions is 9.

C-shaped building: - The socket number in the X direction is 13 and the socket number in the z direction is 6.

L-shaped building: - The socket number in the X direction is 14 and the socket number in the Y direction is 6.

2. METHODOLOGY

Seismic weight of the building: - The seismic weight of the construction tools is calculated on the total floor weight of the building. Basic natural period according to IS 1893 (part 1): 2002.

The approximate basic natural period of vibration:
Ta = 0.075h ^ 0.75 for a building with an RC frame
Ta = 0.085h ^ 0.75 for a building with a steel frame
Billy, h = height of the building.

LOAD COMBINATIONS:-

1. 1.5(DL+IL)
2. 1.2(DL+IL+EL)
3. 1.5(DL+EL)
4. 0.9DL+1.5EL

THREE TYPES OF EARTHQUAKE ANALYSIS METHODS:

i. Equivalent static analysis
ii. Response spectrum analysis
iii. Time history analysis

MODELING OF STRUCTURE

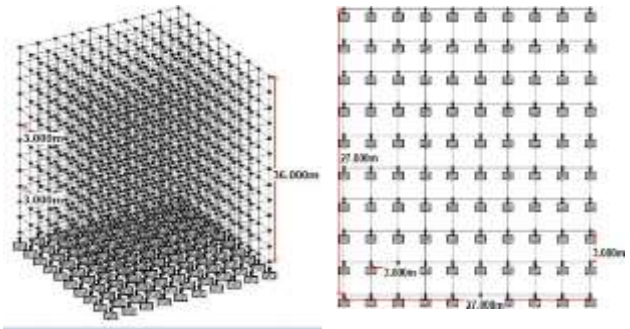


Fig 1. 3D ELEVATION AND PLAN OF RECTANGULAR BUILDING

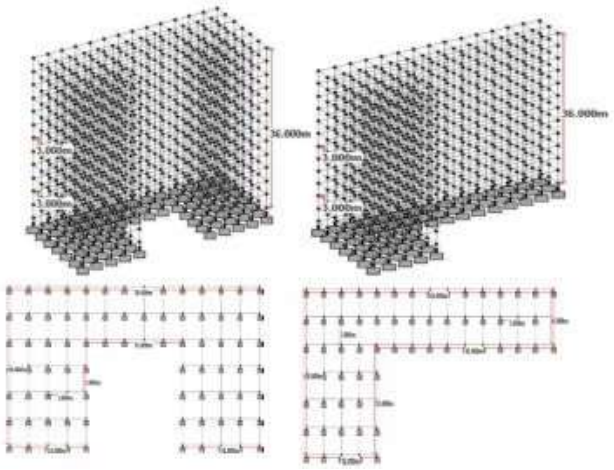


Fig 2 & 3. 3D ELEVATION AND PLAN OF C & L SHAPE OF BUILDING

LOAD CASE DETAILS:-

Earthquake load: There are two types of earthquakes in the X and Z directionsdirection (i.e. EQX and EQZ).

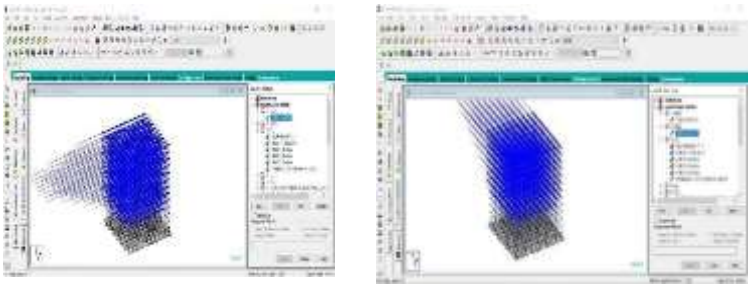


Fig 4 & 5. EARTHQUAKE LOAD IN X AND Z DIRECTION

Dead Load:

Self-weight: Automatically defined by software.

Wall Load:

- External Wall: 20 x 1 x 0.23 x 3 = 13.8 kN/m
- Internal Wall: 20 x 1 x 0.15 x 3 = 9 kN/m
- Parapet Wall: 20 x 1 x 0.1 x 1 = 2 kN/m

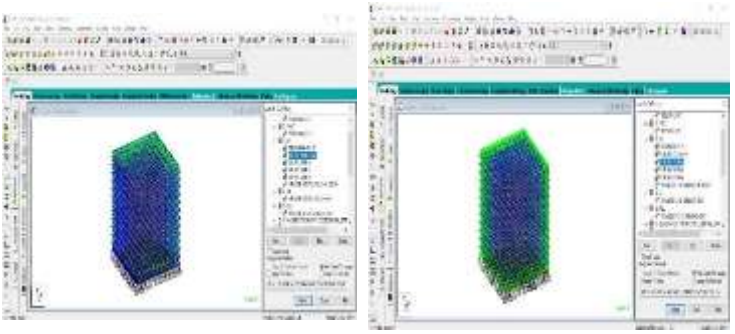


Fig 6 & 7. DEAD & WALL LOAD IN X AND Z DIRECTION

Slab load: 4.125 KN/m2

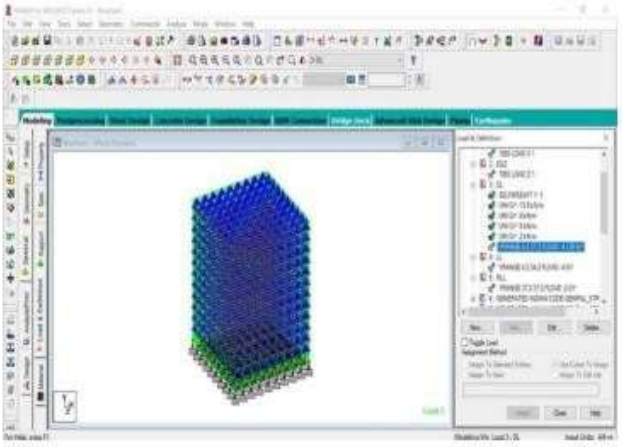


Fig 8. SLAB LOAD IN X AND Z DIRECTION

Live load: 3+1(floor finish)= 4 kN/m (Table 1, IS 875(Part2): 1987)

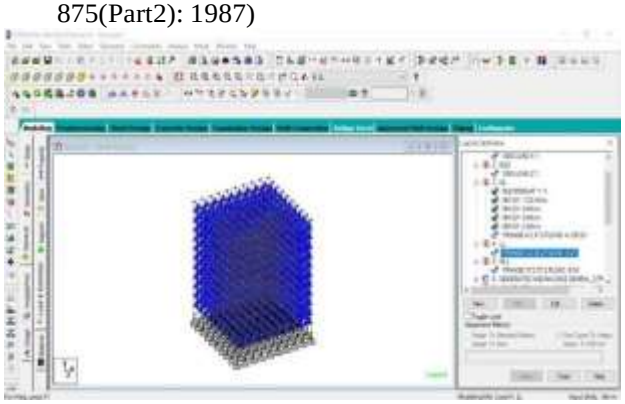


Fig 9. LIVE LOAD IN X AND Z DIRECTION

Roof Live Load: 2 kN/m (Table 8, IS 1893(Part 1):2002)

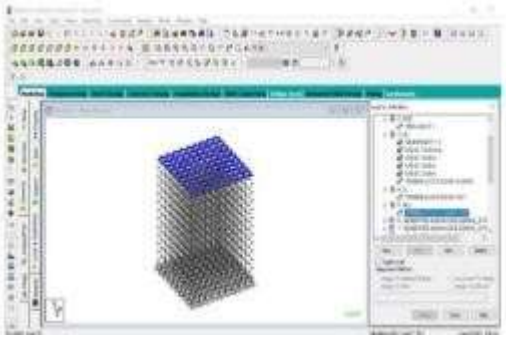


Fig 10.ROOF LIVE LOAD IN X AND Z DIRECTION

Load combination based on IS 1893:2002

- 1.5 (DL + LL)
- 1.2 (DL + LL ± EQX)
- 1.2 (DL + LL ± EQZ)
- 1.5 (DL ± EQX)
- 1.5 (DL ± EQZ)
- 0.9 DL ± 1.5 EQX
- 0.9 DL ± 1.5 EQZ

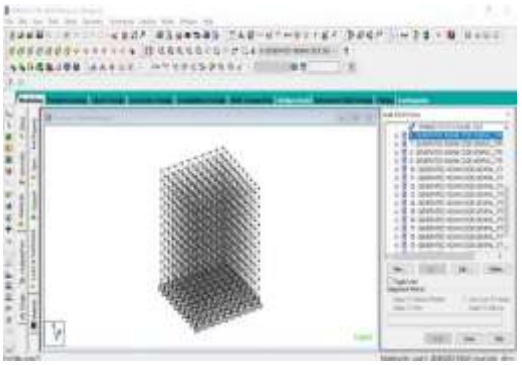


fig no 11.

Output for analysis and design in STAAD pro: After entering all values and some values are automatically taken from on software such as own weight, SBC on soil, etc. After this, on the result is given below.

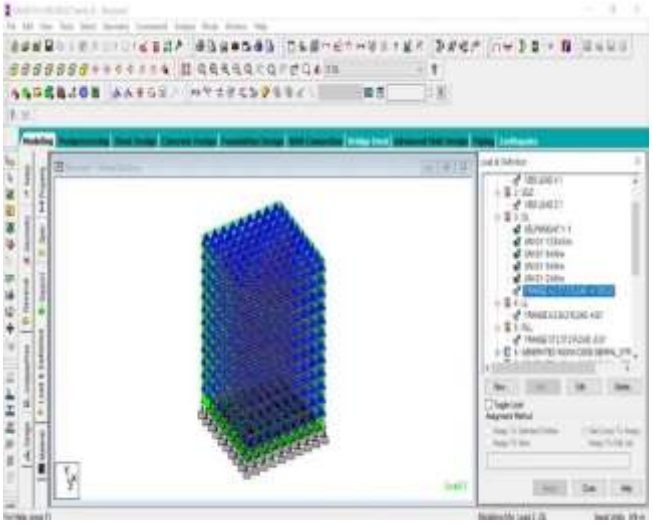


Fig 12

SEISMIC ZONE MAP (IS 1893-2002)

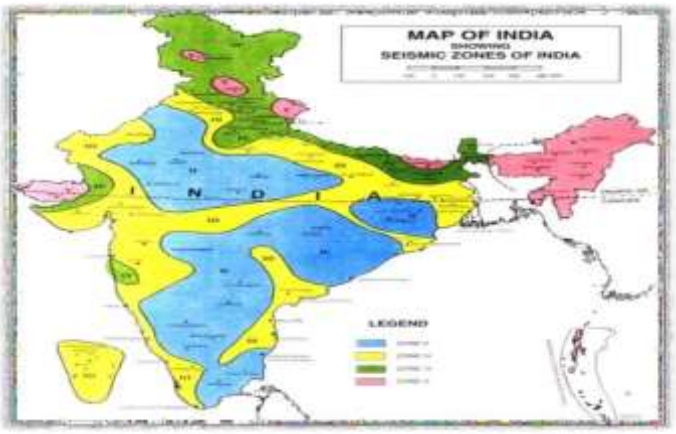
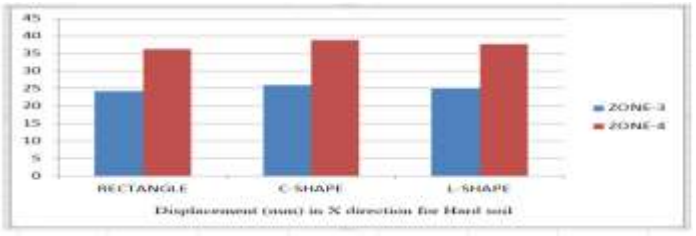


Fig no 13

3: RESULTS AND DISCUSSIONS

Shape/Direction/Zone	Hard soil					
	Rect. shape		C-shape		L-shape	
	X-dir.	Z-dir.	X-dir.	Z-dir.	X-dir.	Z-dir.
Zone-3	24.23	43.78	25.93	47.05	25.17	55.90
Zone-4	36.29	65.63	38.82	70.43	37.70	83.81

Table 1. COMPARISON OF LATERAL DISPLACEMENT IN X AND Z DIRECTION IN HARD SOIL.



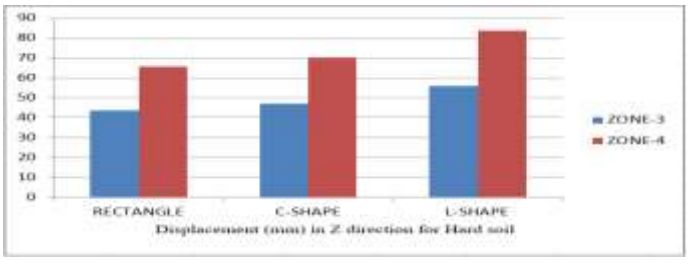
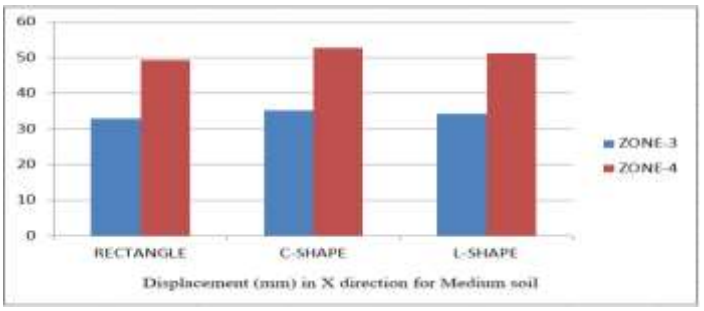


Table 2. Comparison of lateral displacement (mm) in X and Z-direction for Medium soil.

Shape /Direction	Medium soil					
	Rect. shape		C-shape		L-shape	
	X-dir.	Z-dir.	X-dir.	Z-dir.	X-dir.	Z-dir.
Zone-3	32.91	59.52	35.21	63.88	34.19	76.00
Zone-4	49.32	89.24	52.74	95.69	51.24	113.9



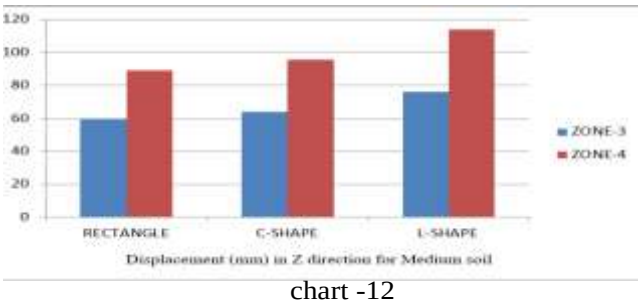


chart -12

1. The above diagram and table show the X and Z offset for Mean and Hard soil.

2. I can observe that displacement in Z-direction is bigger than on displacement in direction X for medium and hard soil.

3. For solid soil type, the displacement is 30.14% minimum compared to the average type of soil.

4. Given the solid soil, the more stable or minimal displacement of the shape of the building is a rectangle and maximum displacement in an L-shaped building. And also the same for medium soil.

5. Also we observe that on displacement in zone 3 is 16.95% minimum and displacement in the area 4 e More ▼ in the X and Z directions.

Base shear: The following table shows the value of base shear in hard, medium soil and zone 3, zone 4. The values of base shear in the X and Z direction are the same as per software output.

Zone/Soil/ shape	HARD SOIL		
	Rec. Shape	C-Shape	L-Shape
Zone 3	2480.09	1918.34	1491.69
Zone 4	3720.13	2877.50	2237.53

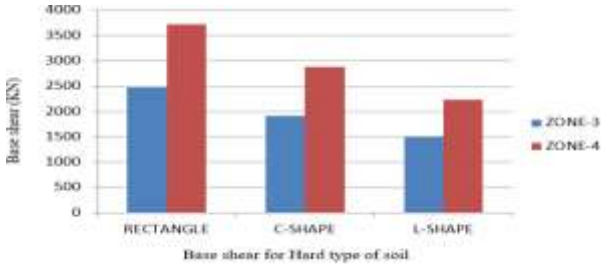


Chart 13.Comparison of Base shear in X and Z-direction for hard soil

Zone/Soil /Shape	Medium soil		
	Rec. Shape	C-Shape	L-Shape
Zone 3	3372.92	2608.94	2028.69
Zone 4	5059.38	3913.41	3043.04

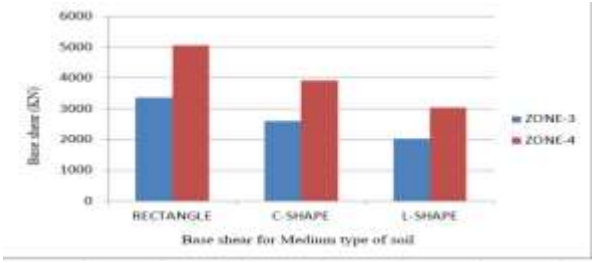


chart 14.Comparison of Base shear in X and Z-direction for medium soil

Discussion said such as follows:

1. We observe that in everything from building with and everything zones, on-b share is maximum in zone 4 in a rectangle form buildings. And at least in area 3 in an L-shaped building.
2. In everything from building on base share is 49,01% maximum in zone 4 in average soil such ascompared with zone 3 in hard soil.
3. C considering hard and average soil on minimum value on-base shearing is in zone 3, in L. form building

STEEL PERCENTAGE:

The requirement of steel for all buildings is given in the below table

Zone/Soil /Shape	Hard soil		
	Rec. Shape	C-Shape	L-Shape
Zone 3	14.19	7.42	14.08
Zone 4	14.21	14.12	14.11

Table 9. Comparison of steel percentage (%) for Hard soil

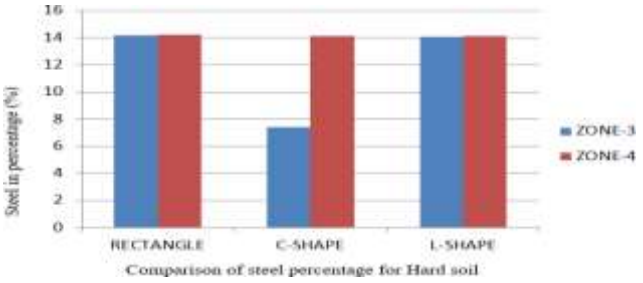


Chart 7. Comparison of steel percentage (%) for Hard soil

Comparison of steel percentage (%) for Medium soil

Zone/Soil /Shape	Medium soil		
	Rec. Shape	C-Shape	L-Shape
Zone 3	14.21	14.12	14.09
Zone 4	14.81	14.73	14.63

Table 9. Comparison of steel percentage (%) for medium soil

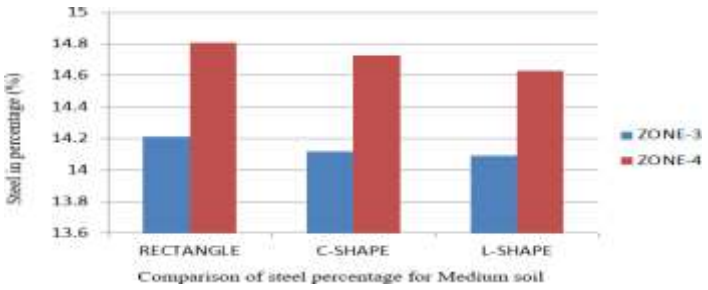


Chart 8. Comparison of steel percentage (%) for Medium soil

Discussion as follow:

1. In all Shape buildings (i.e. Rect., C and L shape) the steel percentage is more in zone 4, in medium soil, and minimum in zone 3 in hard soil.
2. The minimum steel (7.42%) is required for C shape building which is in zone 3 in hard soils and it is also economical.
3. The maximum steel (14.81%) is required for Rect. shape building which is in zone 4,in medium soil.

3. CONCLUSION

1. In structure is analyzed in zone 3 and zone 4. I find on the result in Base shearing value is More ▼ in zone 4th century average soil (incorrect configuration).
2. Basis shearing value is More ▼ in zone 4 and that in on average soil (regular configuration).
3. Basis seismic shear 4 is higher than 73.53% compared to the Zone 3.
4. Compared to both regular and incorrect configuration basic shear value is more in the ordinary configuration as the structure is more symmetrical dimensions.
5. Reaching the displacements of the floor in zone 4 there are higher displacements than in the Zone 3.
6. Minimum Moving is meeting in rectangular format _ on the building.
7. Maximum history drift is meeting in the intermediate history of rectangle _ form building while the minimum drift story occurs in L-shape on the building.
8. When comparing the two on regular and irregular configuration is _ history drift value is More ▼ in regular configuration because on structure there are more _ dimensions.
9. Steel amount of seismic zone 4 is higher than Zone 3.
10. When comparing the two on regular and irregular configuration is _ the steel quantity is More in regular configuration.
11. From on above results zone 4 is critical for on G + 11 structure.
12. seismic zones zone 4 there is a higher zone factor than zone 3. Yes zone 4 values on Base shear, 13. 13. Relocations and the amount of steel are More than zone 3.
14. Basis shearing, displacement, and steel quantity are According On The area factor so these values are more in Zone 4.
15. Given rectangle C and _ L-shaped building. 16. An L-shaped building is More effective in Zone 3 and hard type soil.

An L-shaped building is more efficient for Base share, Floor Drift in seismic zone 3

REFERENCES

1) Mohd Abdul Aqib Farhan, Jagadish Bomizeti , "Seismic Analysis on Multi-storey RCC buildings with correct and incorrect plan ", IJERT , ISSN: 2278-0181, volume 8 Number November 11, 2019
2) M. Seetha , KEViswanathan , "Comparison of Multi-storey Building with Regular and irregular shape in different seismic zones ", IJRIAS, ISSN 2454-6194, vol III, no VI, June 2018
3) Mr. S. Mahesh , Dr. B. Panduranga Rao, "Comparison of analysis and design of the correct and incorrect configuration of a multi-storey building in different seismic zones and different types of soils using ETABS and STAAD ", IOSR-JMCE, p-ISSN: 2320- 334X, Sound volume 11, Issue 6, Ver. me, november December 2014
4) Pritam C. Pawade , Dr. PP Saklecha , Milind R. Nikhar , "Comparison and analysis of the correct and incorrect configuration of a multi-storey building in different seismic zones and different types of soil ", IARJSET, ISSN (Online) 2393-8021, SSN (Print) 2394- 1588, vol. 5, no June 6 2018
5) Girum Mindy , Dr. Shake Yajdani , "Seismic analysis of a multi-storey RC frame Construction in different seismic zones ", IJIRSET, ISSN (online): 2319-8753, ISSN (Print): 2347-6710, vol. 5, no September 9 , 2016
6) Asha, "Comparison of the seismic behavior of a typical multi-storey structure with Composite columns and steel columns ", International Journal of Civil and Structural Engineering Research (IJSER), vol. 3, pp. 360-367, September 2015
7) IS 1893 (part 1): 2002, "Criteria for earthquake resistant structures", part 1 General Provisions and Buildings, Fifth Revision, Bureau of Indian Standards, new Delhi.
8) IS 456: 2000, Ordinary and reinforced concrete - Code of Practice, Fourth Revision, desk on Indian standards, New Delhi.
9) IS 875 (Part 1): 1987, "Code on Practice for Design Loads for Building and constructions ", part 1 dead Loads - unit _ weight on building materials and preserved materials second revision, The Bureau of Indian Standards, New Delhi.

IS 875 (Part 2): 1987, "Code on Practice for Design Loads for Building and Structures", part 2 Load imposed, second revision, Bureau of Indian Standards,new Delhi.