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Seismic Comparison of Commercial Building between Equivalent Static Analysis and Response Spectrum Analysis

Prof. N. N. Shinde[1] , Prasad R. Gayaki[2]

[1] N. N. Shinde, Professor, Civil Engineering Department, PLIT Engineering College Buldana, Maharashtra, India

[2] P. R. Gayaki, Student at PLIT Engineering College Buldana, Maharashtr, India

ABSTRACT

Earthquake is very severe problem nowadays. As the commercial building are having large amount of rush daily so such type of the building should be earthquake resistant. We are going to study the behaviour of commercial building against seismic load. A comparison is done using ETABS software in different seismic zones using response spectrum method and equivalent static analysis method, then it is finally concluded that which method is effective and economic. Different parameters are compared using graphical and tabular form.
Keyword: - ETABS, Equivalent Static Analysis, Response Spectrum Analysis, Commercial Building

I. INTRODUCTION

As earthquake has become a severe problem nowadays it is important to protect buildings and structures from the effect of the earthquake. As we all know the commercial buildings are having large amount of rush daily as compared to the residential building. So the safety of the public is required. So such type of structures should be earthquake resistant so that there should not be any loss to the structure as well as to human life. So we are going to study the analysis of commercial building in different seismic zones using response spectrum method and equivalent static analysis method.

II. METHODS AND MATERIAL

2. Objectives

A- To study the effect of earthquake of different seismic zones on commercial building using ETABS software.
B- To study that which of method is effective and economic for seismic analysis.

3. Building Description

The analysis is done on R.C. moment resisting frame structure. The floor wise plan layout of the building is shown in Figure 3.1, 3.2 and 3.3. The building taken is the shopping mall which carries G+5 stories. The size of the structure is 55X33.4m. Height is 4m for each storey. The details of all middles are mentioned below. Other relevant data is tabulated in table.

Model I: Building in earthquake zone II
Model I: Building in earthquake zone III
Model I: Building in earthquake zone IV
Model I: Building in earthquake zone V

Table 1. Modelling Data Selected

Structure size	55 X 33.4m
Total height	25 m
Storey height	4.0 m
Parapet wall	1.0 m
Foundation depth	1.0 m
Primary beam size	300mmX600mm
Secondary beam size	300mmX450mm
Size of columns	300mmX750mm
Thickness of slab	150mm
External wall thickness	230mm
Earthquake zone	II,III, IV & V
Type of soil	Medium
Live load at staircase, lobby and passage area	5.0 kN/m^2
Density of brick masonry	20 kN/m^3

4. Modelling of building

The model is analysed using the ETABS 9.7.4. Brick wall load is uniformly distributed over beams. In the modelling, material is considered as an isotropic material. The 3D model generated in ETABS is shown in figure.

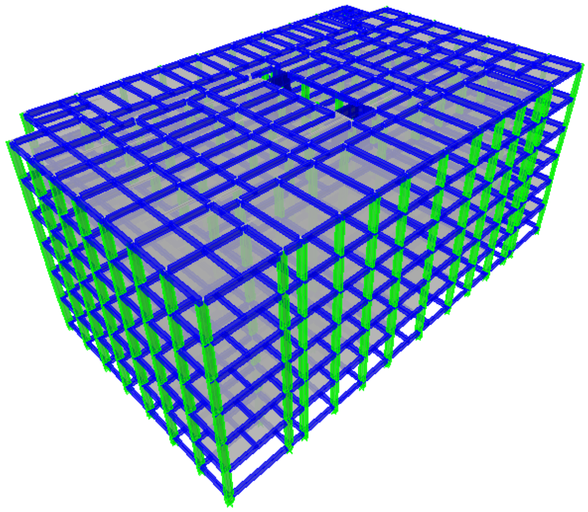

Figure1. Model of building generated in ETABS

5. Analysis of building

The code recommends following method of analysis.
1. Equivalent static analysis

6. Load combinations used

For the analysis, following seven load combinations specified by the IS 1893: 2002 as per clause 6.3.1.2 are used.

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

III. RESULTS AND DISCUSSION

Equivalent static and response spectrum analysis is carried out on all the models. The results are presented in the form of graphs. Results in the tabular form are given in appendix.

7.1 Equivalent Static Analysis

Equivalent static analysis is performed on all the models. Loads are calculated and distributed as per the code IS1893:2002 and the results obtained are compared with respect to the following parameters. The results are presented in the form of tables and graphs.

7.1.1 Lateral displacement

A graph is plotted taking floor level as the abscissa and the displacement as the ordinate, for different models in the transverse and longitudinal direction as shown in figures below. The lateral displacement values in tabular form for longitudinal direction and for transverse direction are given in tables below.

Table 2: Displacement values in longitudinal direction (ESA)

Storey/Model	Z-II	Z-III	Z-IV	Z-V
5	15.1	24.1	36.2	54.3
4	12.9	20.6	30.9	46.3
3	10.2	16.3	24.4	36.6
2	7.3	11.7	17.5	26.3
1	4.6	7.4	11.1	16.6

Table 3: Displacement values in transverse direction (ESA)

Storey/Model	Z-II	Z-III	Z-IV	Z-V
5	22.5	35.9	53.9	80.8
4	19.1	30.6	45.9	68.8
3	15.2	24.3	36.5	54.7
2	10.8	17.4	26	39
1	6.4	10.2	15.3	23

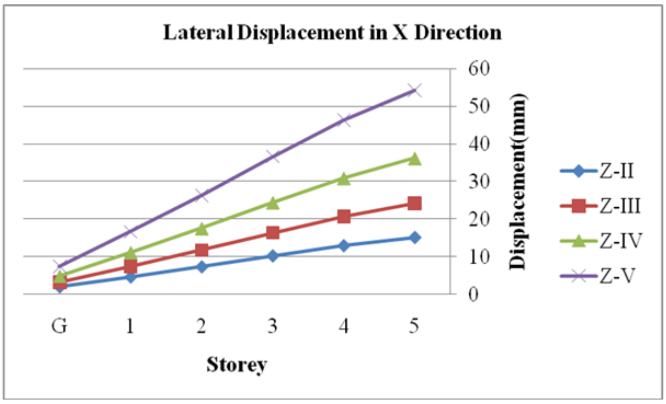

Figure 2: Displacement profile in longitudinal direction (ESA)

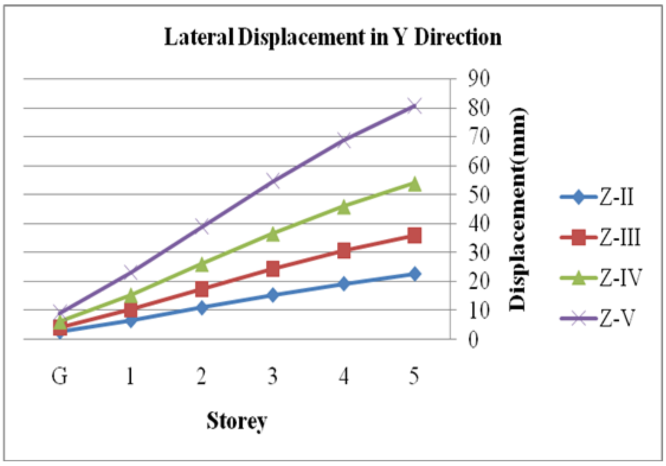

Figure 3: Displacement profile in transverse direction (ESA)

It is seen that there is increment in lateral displacement in longitudinal as well as transverse direction for increasing in seismic zones from II to V. For model II (EQZ-III) increment in lateral displacement is up to 90% as compared with model I (EQZ-II) in both longitudinal and transverse direction. For model III (EQZ-IV) increment in lateral displacement is up to 185% as compared with model I (EQZ-II) in both longitudinal and transverse direction. For model IV (EQZ-V) increment in lateral displacement is up to 325% as compared with model I (EQZ-II) in both longitudinal and transverse direction. Also it is observed that from zone II to zone III this increment is 60% whereas from zone III to zone IV and from zone IV to zone V it is 50%. This shows that consideration of proper seismic zone highly influence the analysis and design of structure.

7.1.2 Drift

A graph is plotted taking floor level as the abscissa and the storey drift as the ordinate for different models in the transverse and longitudinal direction as shown in figures below. The storey drift values in tabular form for longitudinal direction and for transverse direction are given in tables below.

Table 4 : Storey drifts values in longitudinal direction (ESA)

Storey/ Model	Z-II	Z-III	Z-IV	Z-V	Allowab -le limit	Re m- ark
5	2.256	3.608	5.412	8.116	16	OK
4	2.696	4.312	6.464	9.7	16	OK
3	2.88	4.612	6.916	10.37 6	16	OK
2	3.024	4.836	7.256	10.88 4	16	OK
1	2.632	4.212	6.316	9.472	16	OK

Table 5: Storey drifts values in transverse direction (ESA)

Storey/ Model	Z-II	Z-III	Z-IV	Z-V	Allowa -ble limit	Re ma- rk
5	3.352	5.36	8.044	12.064	16	OK
4	3.92	6.272	9.408	14.112	16	OK
3	4.36	6.98	10.468	15.7	16	OK
2	4.484	7.176	10.764	16.148	16	OK
1	3.888	6.224	9.332	14	16	OK

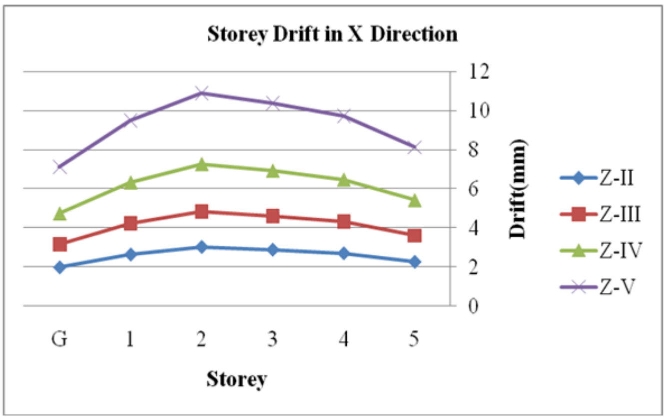

Figure 4: Storey drift profile in longitudinal direction(ESA)

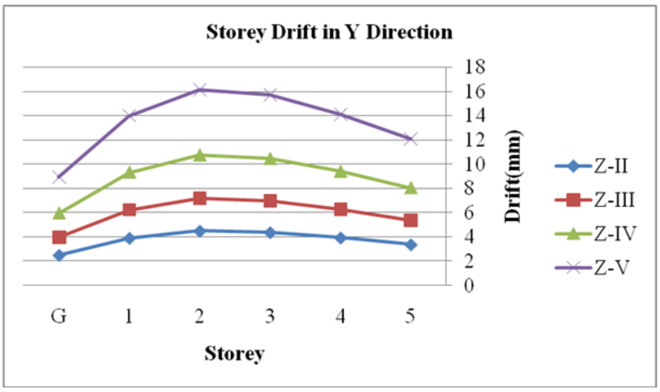

Figure 5: Storey drift profile in transverse direction (ESA)

It is seen that there is storey drift is within limit prescribed by the IS 1893:2002 for all seismic zones in longitudinal as well as transverse direction, also there is increment in storey drift from zone II to zone V. For model II (EQZ-III) increment in storey drift is up to 85% as compared with model I(EQZ-II) in both longitudinal and transverse direction. For model III (EQZ-IV) increment in storey drift is up to 180% as compared with model I(EQZ-II) in both longitudinal and transverse direction. For model IV (EQZ-V) increment in storey drift is up to 320% as compared with model I(EQZ-II) in both longitudinal and transverse direction. Also it is observed that from zone II to zone III this increment is 60% whereas from zone III to zone IV and from zone IV to zone V it is 50%.

7.1.3 Bending moment in columns

The maximum bending moments in the columns in longitudinal and transverse direction are shown in figure. The Bending moment values in bottom storey column in longitudinal and transverse direction are given in table.

Table 5: Bending moment values in bottom storey column in longitudinal and transverse direction (ESA)

Direction/Model	Z-II	Z-III	Z-IV	Z-V
Longitudinal	63.34	101.35	152.03	228.04
Transverse	78.1	125	187.45	281.18

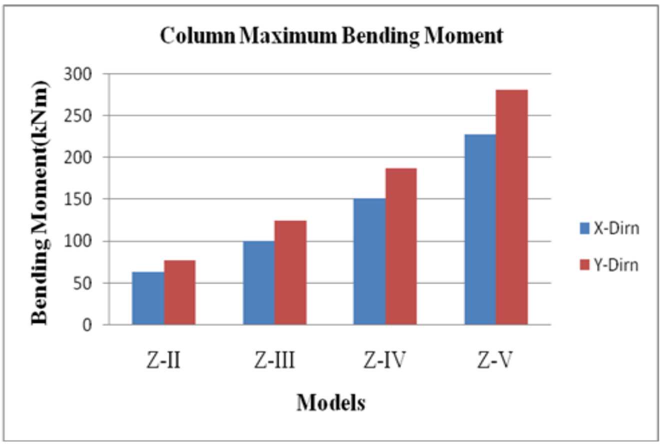

Figure 6: Comparison of maximum bending moment in longitudinal and transverse direction (ESA)

Bending moment is one of the important parameter for designing of any structure. For comparison purpose here bending moment of bottom storey is considered. It is seen that there is increment in bending moment in bottom storey columns in longitudinal as well as transverse direction for increasing in seismic zones from II to V. For model II (EQZ-III) increment in bending moment is up to 60% as compared with model I(EQZ-II) in both longitudinal and transverse direction. For model III (EQZ-IV) increment in bending moment is up to 145% as compared with model I(EQZ-II) in both longitudinal and transverse direction. For model IV (EQZ-V) increment in bending moment is up to 267% as compared with model I(EQZ-II) in both longitudinal and transverse direction. Also it is observed that from zone II to zone III this increment is 60% whereas from zone III to zone IV and from zone IV to zone V it is 50%.

7.1.4 Base Shear

A graph is plotted between different building models and the base shear as shown in figure. The Base shear values in longitudinal and transverse direction are given in table.

Table 6: Base shear values in longitudinal and transverse direction (ESA)

Direction/ Model	Z-II	Z-III	Z-IV	Z-V
Longitudinal	4604.06	7366.5	11049.75	16574.62
Transverse	4604.06	7366.5	11049.75	16574.62

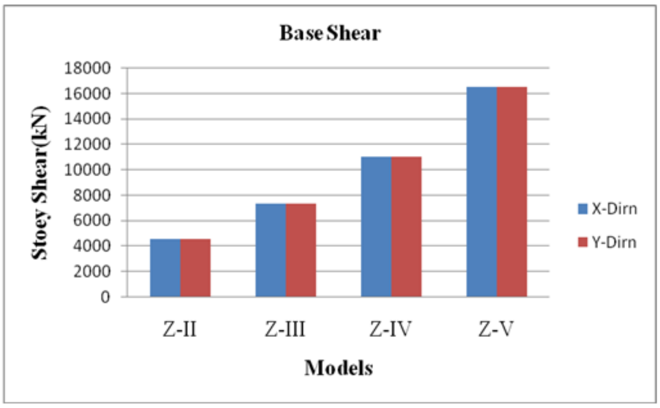

Figure 7: Base Shear in longitudinal and transverse direction (ESA)

It is seen that there is increment in base shear in longitudinal as well as transverse direction for increasing in seismic zones from II to V. For model II (EQZ-III) increment in base shear is up to 60% as compared with model I (EQZ-II) in both longitudinal and transverse direction. For model III (EQZ-IV) increment in base shear is up to 140% as compared with model I (EQZ-II) in both longitudinal and transverse direction. For model IV (EQZ-V) increment in base shear is up to 260% as compared with model I (EQZ-II) in both longitudinal and transverse direction. Also it is observed that from zone II to zone III this increment is 60% whereas from zone III to zone IV and from zone IV to zone V it is 50%.

7.1.5 Storey Shear

A graph is plotted between different building models and the base shear as shown in figure. The storey shear values in tabular form for longitudinal direction and for transverse direction are given in tables below.

Table 7: Storey Shear Values in Longitudinal Direction (ESA)

Storey/Model	Z-II	Z-III	Z-IV	Z-V
5	1224.66	1959.45	2939.18	4408.77
4	2743.82	4390.11	6585.16	9877.74
3	3739.37	5982.98	8974.48	13461.72
2	4321.54	6914.46	10371.69	15557.53
1	4536.06	7257.7	10886.54	16329.82

Table 8: Storey Shear Values in Transverse Direction (ESA)

Storey/Model	Z-II	Z-III	Z-IV	Z-V
5	1224.66	1959.45	2939.18	4408.77
4	2743.82	4390.11	6585.16	9877.74
3	3739.37	5982.98	8974.48	13461.71
2	4321.54	6914.46	10371.69	15557.53
1	4536.06	7257.7	10886.54	16329.81

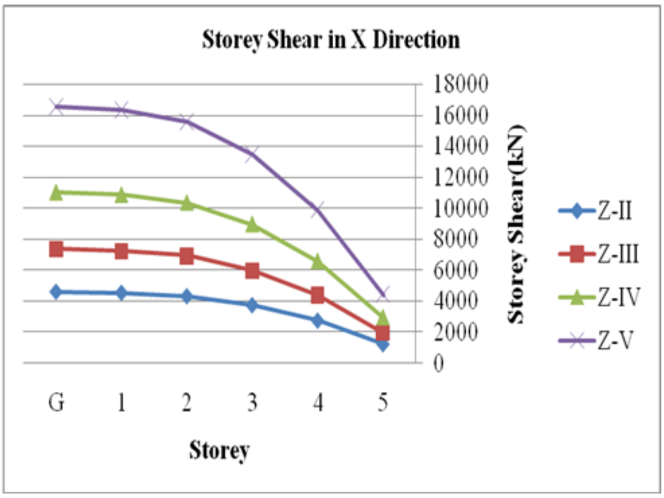

Figure 8: Storey Shear in longitudinal direction (ESA)

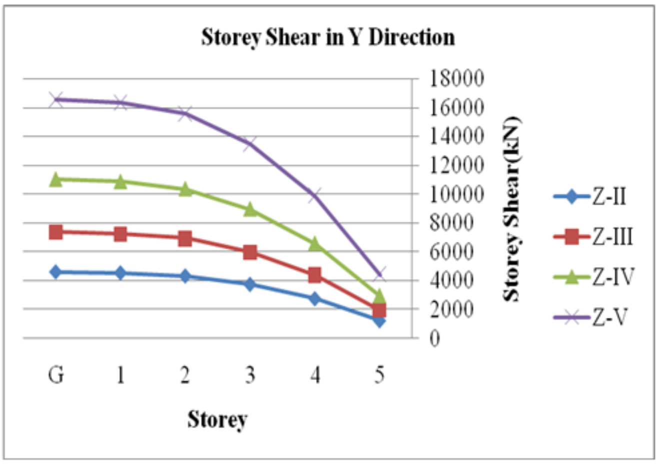

Figure 9: Storey Shear in transverse direction (ESA)

It is seen that there is increment in storey shear in longitudinal as well as transverse direction for increasing in seismic zones from II to V. For model II (EQZ-III) increment in storey shear is up to 60% as compared with model I(EQZ-II) in both longitudinal and transverse direction. For model III (EQZ-IV) increment in storey shear is up to 140% as compared with model I(EQZ-II) in both longitudinal and transverse direction. For model IV (EQZ-V) increment in storey shear is up to 260% as compared with model I(EQZ-II) in both longitudinal and transverse direction. Also it is observed that from zone II to zone III this increment is 60% whereas from zone III to zone IV and from zone IV to zone V it is 50%.

7.1.6 Time period

A graph is plotted taking modes on the X axis and time period in second on Y axis for all the building models as shown in the figures below. The time period values in tabular form are given in table.

Table 9: Time period values

Mode	Z-II	Z-III	Z-IV	Z-V
1	1.6398	1.6398	1.6398	1.6398
2	1.31277	1.31277	1.31277	1.31277
3	1.07893	1.07893	1.07893	1.07893
4	0.51709	0.51709	0.51709	0.51709
5	0.3362	0.3362	0.3362	0.3362
6	0.31342	0.31342	0.31342	0.31342
7	0.30153	0.30153	0.30153	0.30153
8	0.20594	0.20594	0.20594	0.20594
9	0.20107	0.20107	0.20107	0.20107
10	0.1614	0.1614	0.1614	0.1614
11	0.1614	0.1614	0.1614	0.1614
12	0.16135	0.16135	0.16135	0.16135
13	0.16135	0.16135	0.16135	0.16135
14	0.15991	0.15991	0.15991	0.15991
15	0.15961	0.15961	0.15961	0.15961
16	0.15952	0.15952	0.15952	0.15952
17	0.15952	0.15952	0.15952	0.15952
18	0.15888	0.15888	0.15888	0.15888
19	0.15887	0.15887	0.15887	0.15887
20	0.15886	0.15886	0.15886	0.15886
21	0.15776	0.15776	0.15776	0.15776
22	0.15734	0.15734	0.15734	0.15734
23	0.15723	0.15723	0.15723	0.15723
24	0.13441	0.13441	0.13441	0.13441
25	0.12573	0.12573	0.12573	0.12573
26	0.10208	0.10208	0.10208	0.10208

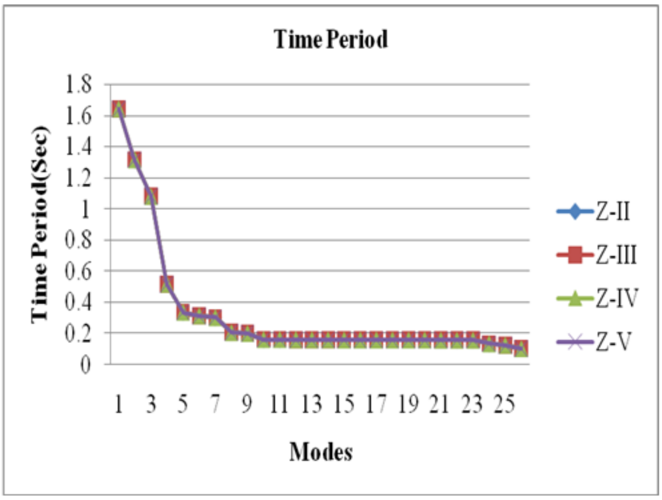

Figure 10: Comparison of time period for different modes

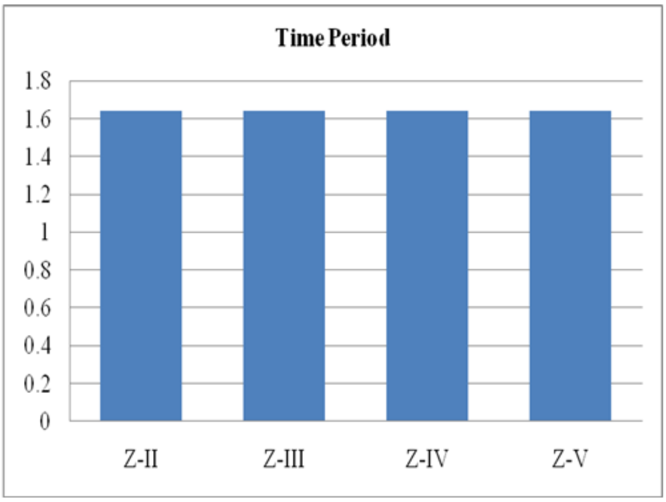

Figure 11 Comparison of time period for different modes

7.2 Comparison of analysis results for all zones.

The analysis results of all the building models are compared for all zones II, III, IV and V. The observations are as follows

- It is observed that mostly all the comparisons parameters are increase 0.6 times, 1.4 times and 2.6 times for zone III, zone IV and zone V respectively.
- It is observed that from zone II to zone III increment in response of building is 60% whereas from zone III to zone IV and from zone IV to zone V it is 50%.
- There is no change fundamental time period of structure in first mode.

IV. CONCLUSION

The proposed payment system combines the Iris recognition with the visual cryptography by which customer data privacy can be obtained and prevents theft through phishing attack [8]. This method provides best for legitimate user identification. This method can also be implemented in computers using external iris recognition devices.

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