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DYNAMICS ANALYSIS OF STRUCTURES SUBJECTED TO EARTHQUAKE LOAD

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ABSTRACT: The main objective of earthquake engineering is to design and build a structure in such a way that the damage to the structure and its structural component during an earthquake is minimized. Dynamic analysis shall be performed to obtain the design seismic force, and its distribution to different levels along the height of the building. It should be performed for both regular and irregular building.
To perform dynamic analysis this are provision laid down in IS 1893 (part 1) 2002, with respect to height of building and according to irregularity of the building.
In regular building greater than 40m height in zone IV and V is required and greater than 90m height in zone II and III.
In irregular building greater than 12m height in zone IV and V is required and greater than 40m height in zone II and III.
Dynamic analysis may be performed either by Time History Method or by Response Spectrum Method.
In present study, multi-story irregular buildings with 20 stories have been modeled using software STAAD PRO for seismic zone IV in India. Dynamic responses of building under actual earthquake, DELINA (ALASKA) 2002 have been investigated. These papers highlight the comparison of Time History Method and Response Spectrum Method.

Keywords – Time History Method, Response Spectrum Method, Reinforced concrete building, displacement.

I. INTRODUCTION

Because of the nature of earthquake, a dual design philosophy has been adopted for the design of building in earthquake prone regions. The buildings which do not fulfill the requirements of seismic design, may suffer extensive damage or collapse if shaken by a severe ground motion. The seismic evaluation reflects the seismic capacity of earthquake vulnerable buildings for the future use. Therefore, it is necessary to study variation in seismic behavior of multistoried RC building in terms of various responses such as displacement and base shear.
The main objective of this paper is to study the seismic behavior of concrete reinforced building. Also, analysis of structure by using time history method and response spectrum method. The story displacement result has been obtained by using both method of dynamic analysis. The pertaining structure of 20 stories residential building has been modeled. The story mass is changing in the different floors. The building has been analyzed by using the time history method and response spectrum based on IS codes; the results obtained are compared to determine the structural performance.

II. LITERATURE REVIEW

In PayamTehrani [2006] study, he equated the nonlinearstatic (pushover) and nonlinear dynamic processes in thepurpose of maximum displacements of apresent steelstructure retrofitted with different methods [1].
In A.R.Touqan[2008] a assessment of the Response spectrum analysis andEquivalent Static Lateral Load with the more elegantResponse Spectrum Method of analysis as they apply to arange of different structural models [2].
In ProfDr.QaiseruzZaman Khan's [2010] paperResponse spectrumanalysis of 20 story building has been conferred in detail andcomparison of static and dynamic analysis and design resultsof buildings up to 400 feet height (40story) in relations ofpercentage decrease in bending moments and shear force of beams, bending moments of columns, top story deflection andsupport reaction are conferred [3].
Romy Mohan [2011] paperhighlights the exactnessof Time Historyanalysis in comparison with the utmost commonly adoptedresponse spectrum analysis and equivalent static analysisconsidering different shape of shear walls [4].

III. METHODS OF DYNAMIC ANALYSIS

Methods of Dynamic Analysis
The methods of dynamic analysis used here are TimeHistory Method and Response Spectrum Method.
Time History Method
It is an analysis of the dynamic response of the structure at each increment of a time, when its base subjected to a specific ground motion time history. It is also known as nonlinear dynamic analysis. To perform such an analysis a representative earthquake time history is required for structure being evaluated. There are two problem associated with it. First it is difficult

to use an appropriate earthquake to use as the loading, while the second is that it is generally too computer-intensive to be practical especially if inelastic analysis.

Response Spectrum Method

The representation of the maximum response of idealized SDOF having certain period and damping during earthquake ground motion. It is also known as linear dynamic analysis. In this method peak response of structure during an earthquake is obtained directly from the earthquake response. This peak response is then combined to estimate a total response. A typical combination method is the square root of the sum of the squares if the modal frequencies are not closed. The main limitation of response spectra is that they are only universally applicable for linear system.

IV. ANALYSIS AND RESULT

In this paper G+20 storied irregular building modal has been analyzed by dynamic. This building has the plan area of 24.5 m x 21 m with a storey height 3.0 m and depth of foundation is 2.0 m. All the analyses are performed on computer with the help of STAAD.pro using the parameters for the designing as per the IS 1893 (Part 1): 2002. The post processing result obtained are presented in the form of tables and compared in form of bar charts to get some important concluding remarks.

- **DESIGN PARAMETER-:**

Here analysis is being done for - G+20 multistory (rigid joint frame) building by computer software using STAAD-Pro by taking preliminary data required as below-

1. Type of structure-- Multistory rigid jointed 3-D frames
2. No of storey-- G+20, twenty stories
3. Seismic Zones- IV
4. Floor height-- 3.0m.

4b. Depth of foundation 2.0m

5. Building height-- 60.00m
6. Plan size-- 24.50 x 21.00m
7. Total area-- 514.5sqm
8. Size of columns-- 0.50m x 0.50 m
9. Size of beams-- 0.30m x 0.60m
10. Walls- (a) External- 0.20m
    (b) Internal 0.10m

11 Thickness of slab- 125 mm

12. Imposed load- 4.00kN/ m^2
13. Floor finish - 1.00kN/ m^2
14. Specific wt. of RCC-- 25.00 KN/ m^3
15. Specific wt. of infill - 20.00 KN/ m^3
16. Material used - Concrete M-30 and Reinforcement Fe-415(HYSD Confirming to IS-1786)

17 Earthquake load - As per IS-1893-2002

18 Type of soil - Type -III, Soft soil as per IS-1893

19 E_c - $=5000\sqrt{fck}$ N/ mm^2
(E_c is short term static modulus of elasticity in N/ mm^2

20 $F_{cr}= 0.7\sqrt{fck}$ N/ mm^2
(F_{ck} is characteristic cube strength of concrete in N/ mm^2

21 Dynamic analysis - (a) Response spectrum method
(b) Time history analysis

22 Software used - STAAD-Pro dynamic analysis

23 Specified characteristic compressive
Strength of 150mm cube at 28 days
For M-25 grade concrete - - 25 N/ mm^2

24 Reinforcement used - - 415 High strength deformed steel
Confirming to IS-1786.It is having modulus of
Elasticity as 2 00 KN/ mm^2

25 Fundamental natural period of building $Ta = 0.075\, h^{0.75}$ for moment resisting RC frame building without infill's $Ta = 0.09 h \sqrt{d}$ for all other building
I/c moment resisting RC frame building with brick infill walls Where h = height of buildingd = base dimension of building at plinth level in m along the considered direction of lateral forces.

26 Zone factor Z--- as per Is-189-2002 Part -1 for different. Zone as per clause 6.4.2.

Table 4.1

seismic zone	II	III	IV	V
Z	0.1	0.16	0.24	0.36
seismic intensity	Low	Moderate	severe	very severe

In present study analyzed for zone –IV

27 **I**-Importance factor- depending upon the fundamental use of the Structures and economic importance.

All other buildings = 1.0

Importance service and community building as I = 1.5.

In present study importance factor = 1

28 R-Response reduction factor:-Depending on the perceived seismic Damage performance of the structure.

(I) for ordinary RC moment resisting Frame (OMRF) is = 3.00

(II) Special RC moment resisting Frame (SMRF) is = 5.0

In present study reduction factor = 3

29 Average Response acceleration Coefficient Sa/g - -for medium soil sites

Sa/g = 1+15T = 0.00≤T≤0.1

2.5 = 0.1≤T≤0.55

1.36/T = 0.55≤T≤4.00

30 Design horizontal seismic coefficient Ah for structure: - Ah =Z /2 x I R x Sa / g

31 Seismic wt. of building- -- Sum of the seismic wt. of floors

32 Design lateral force or design base Shear along any principal directions = A_h W

Where Ah = (Z/2) x (I/R) x (Sa/g)

33 Vertical distribution of base shear to To different floors levels Qi = $V_b \times W_i h_i^2 / \sum W_i h_i^2$

Where Q_i = Design lateral force at floor i

W_i = seismic wt. of floor i

H_i = height of floor hi measured from base

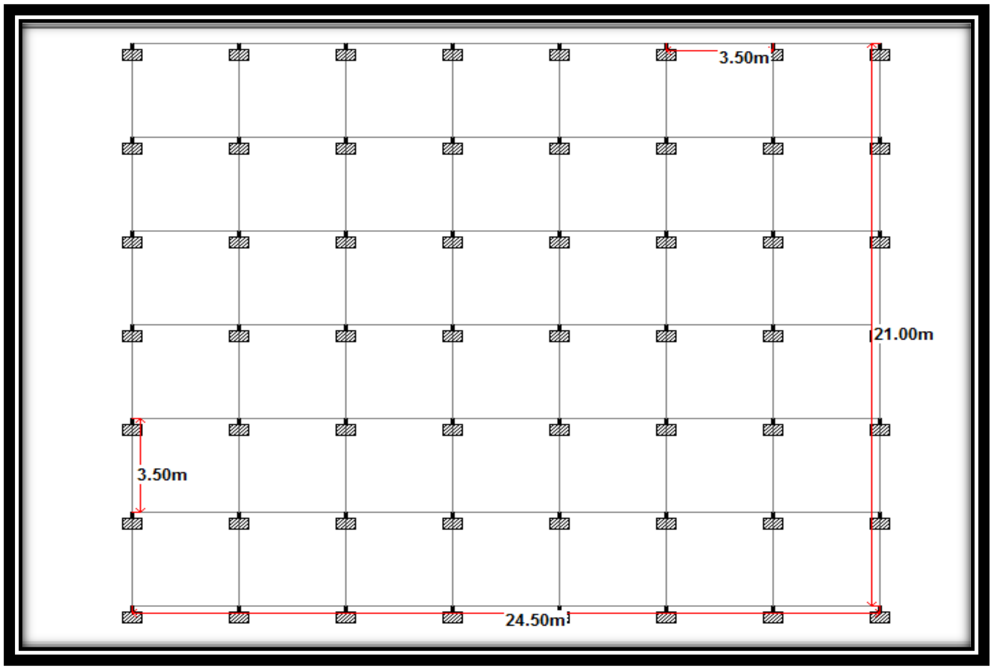
N= number of stories in the building in the no of levels at which masses are located.

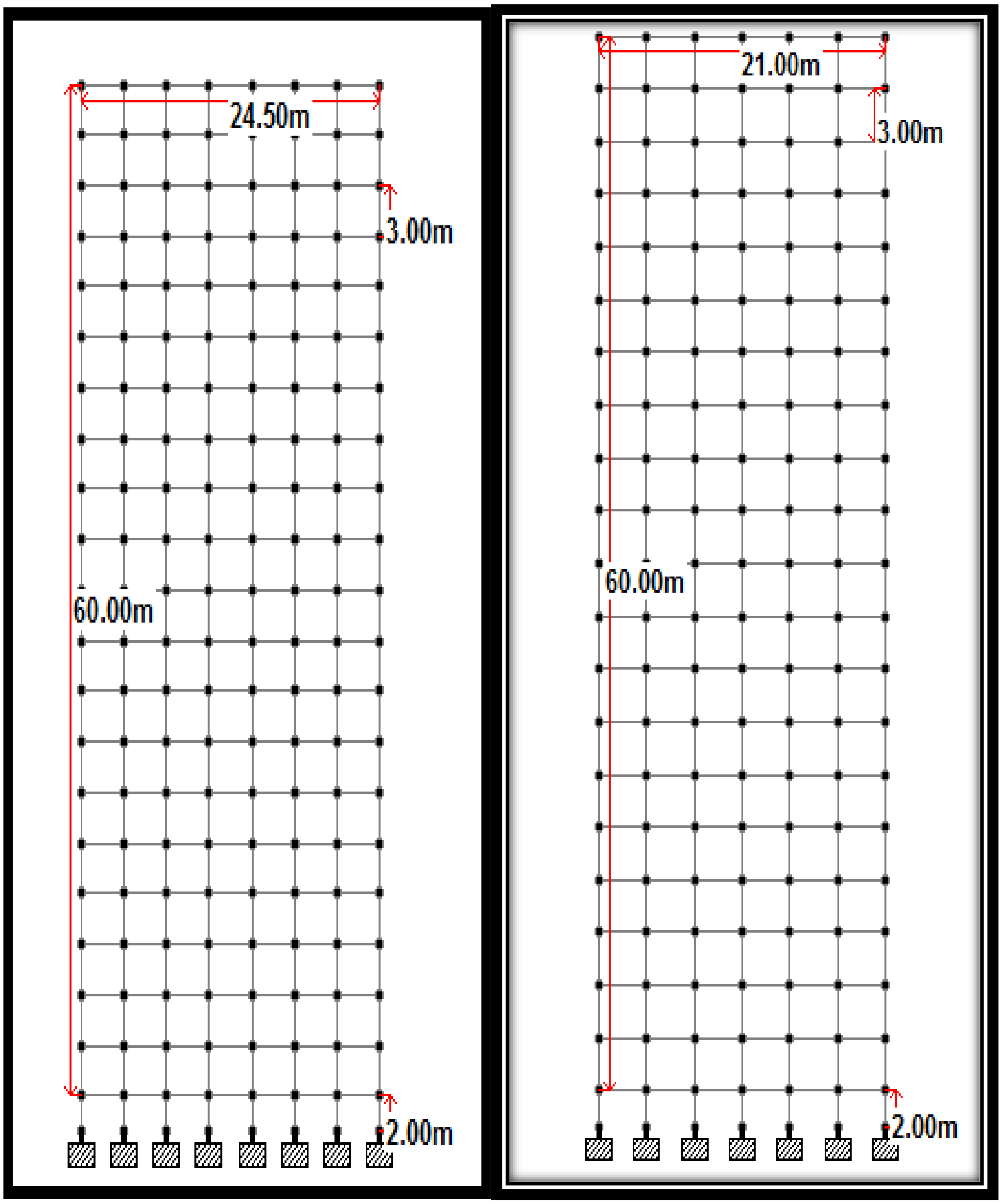
LOAD CASES FOR DYNAMIC ANALYSIS:

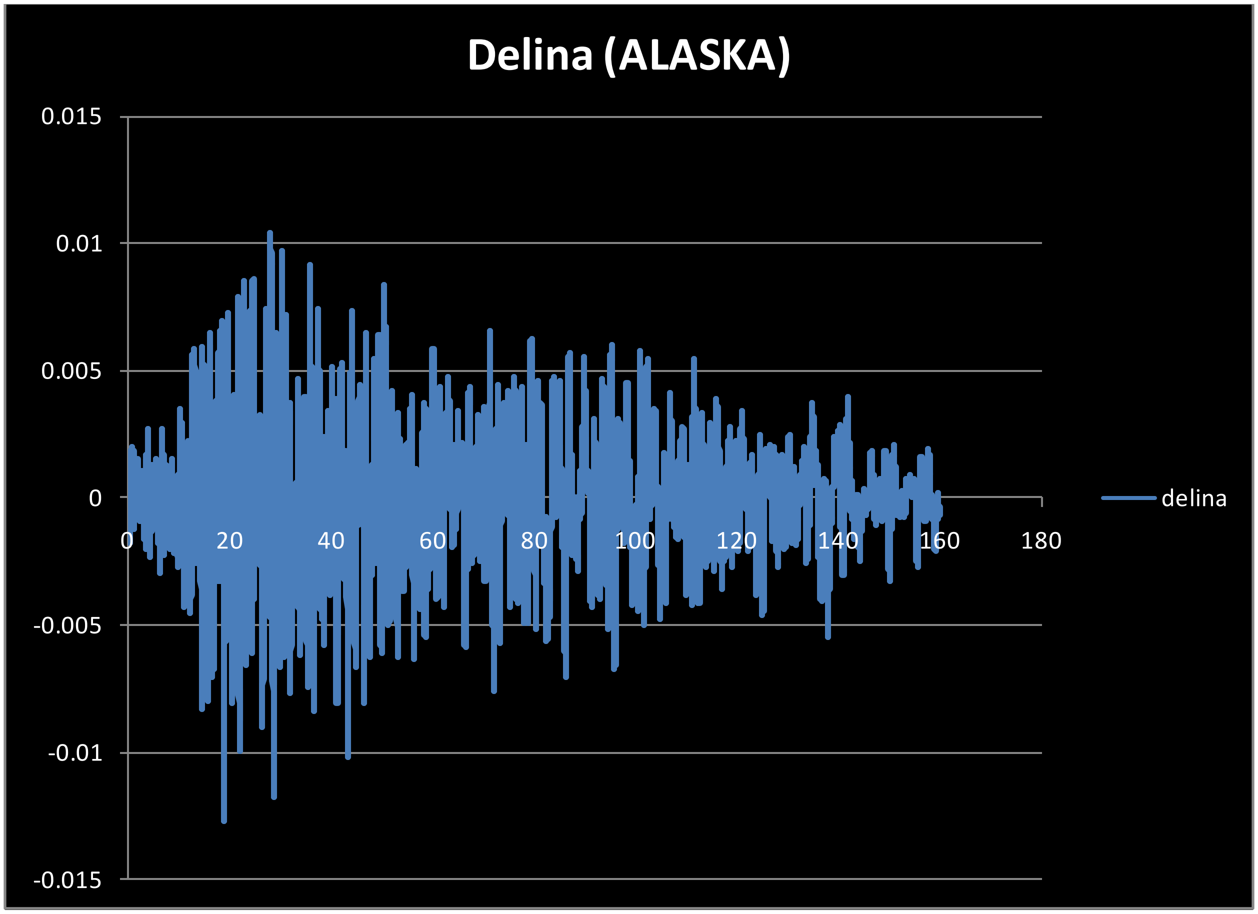
- 1-----EQX
- 2-----EQZ
- 3-----DEAD LOAD (D.L)
- 4-----LIVE LOAD (L.L)
- 5-----[1.5{D.L+L.L}]
- 6-----[1.2{D.L+0.5L.L+EQ_X}]
- 7-----[1.2{D.L+0.5L.L-EQ_X}]
- 8-----[1.2{D.L+0.25L.L+EQ_Z}]
- 9-----[1.2{D.L+0.25L.L-EQ_Z}]
- 10----[1.5{DL+EQ_X}]
- 11----[1.5{DL-EQ_X}]
- 12----[1.5{DL+EQ_Z}]
- 13----[1.5{DL-EQ_Z}]
- 14----[0.9DL+1.5EQ_X]
- 15----[0.9DL-1.5EQ_X]
- 16----[0.9DL+1.5EQ_Z]

- 17----[0.9DL-1.5EQ_Z]

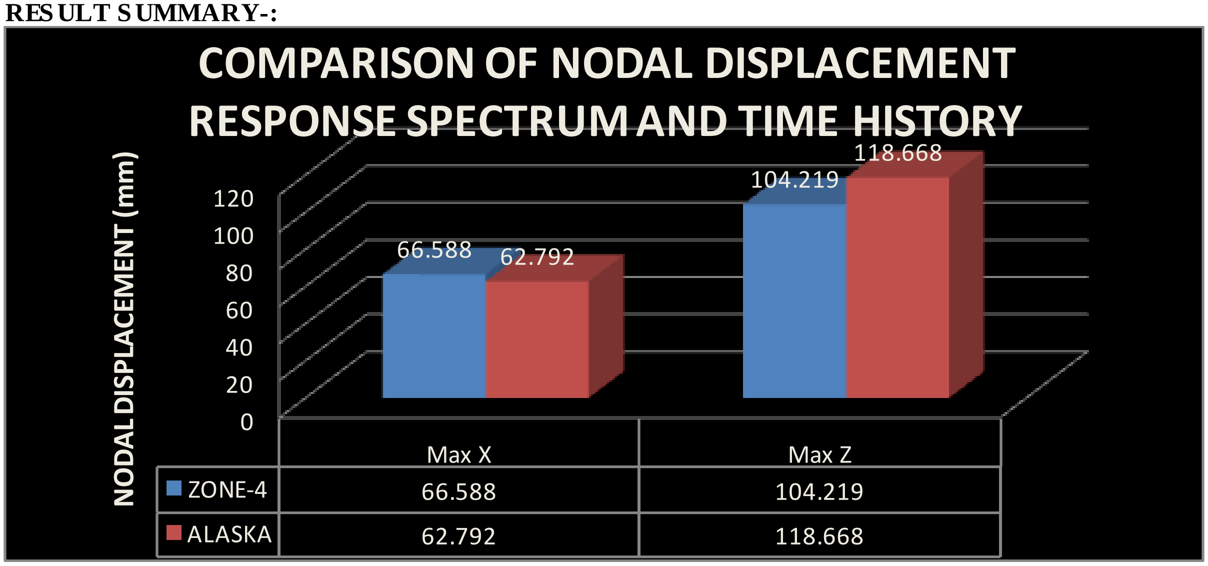
WORKING PLAN

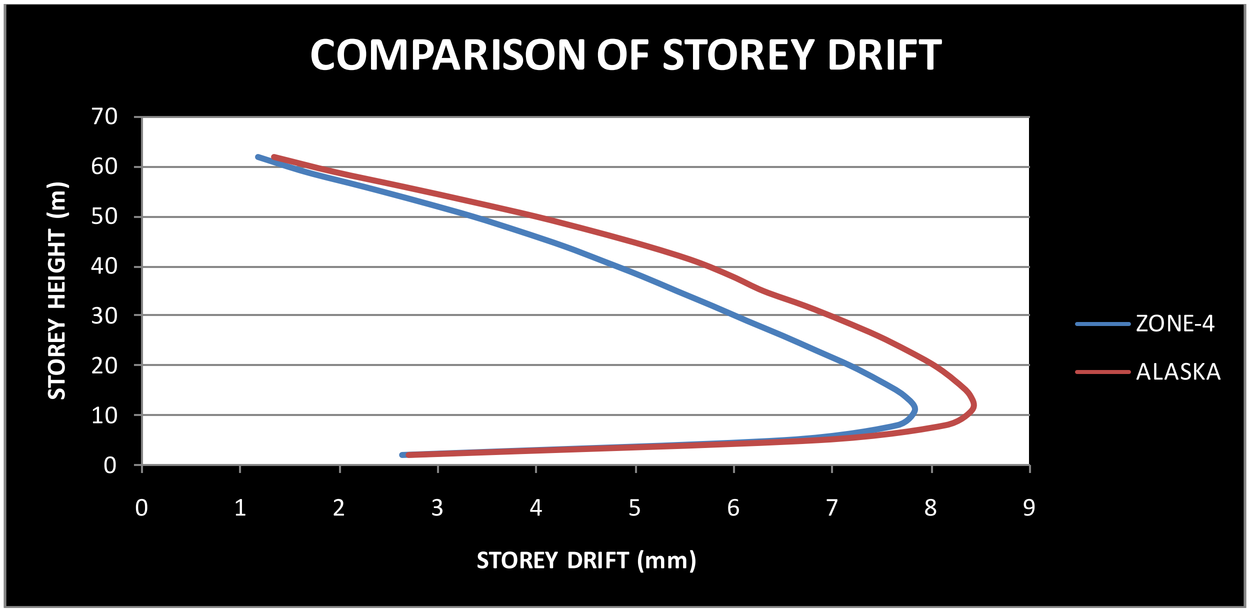


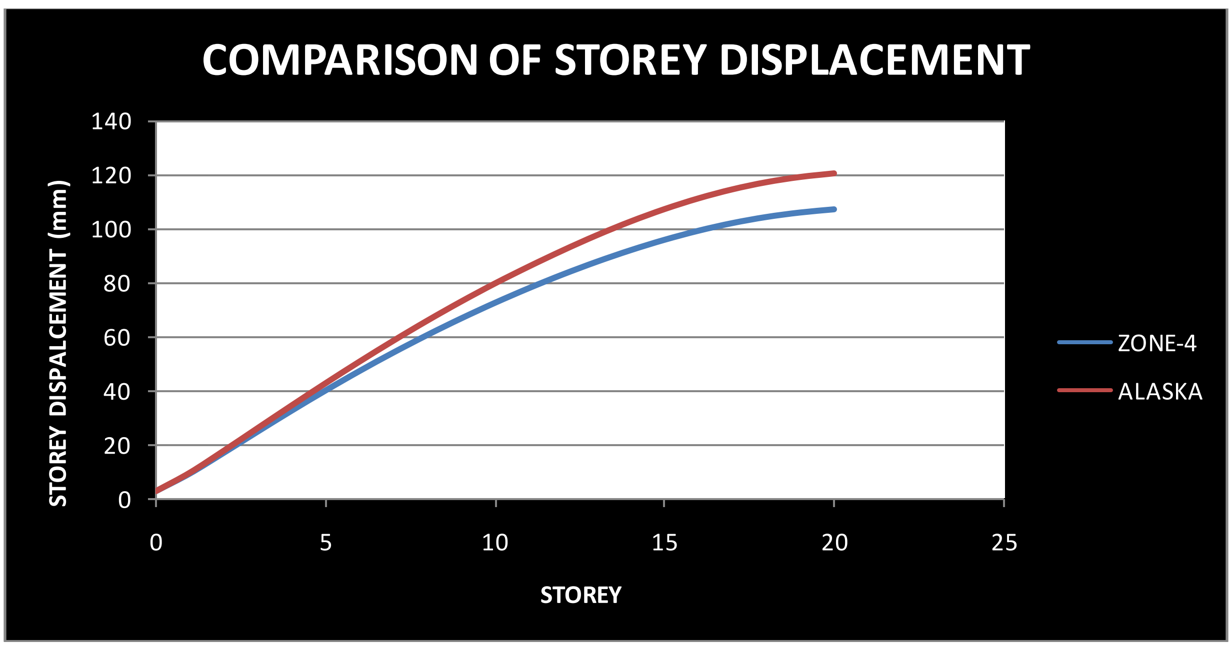

24.50m
3.00m
60.00m
2.00m
21.00m
3.00m
60.00m
2.00m

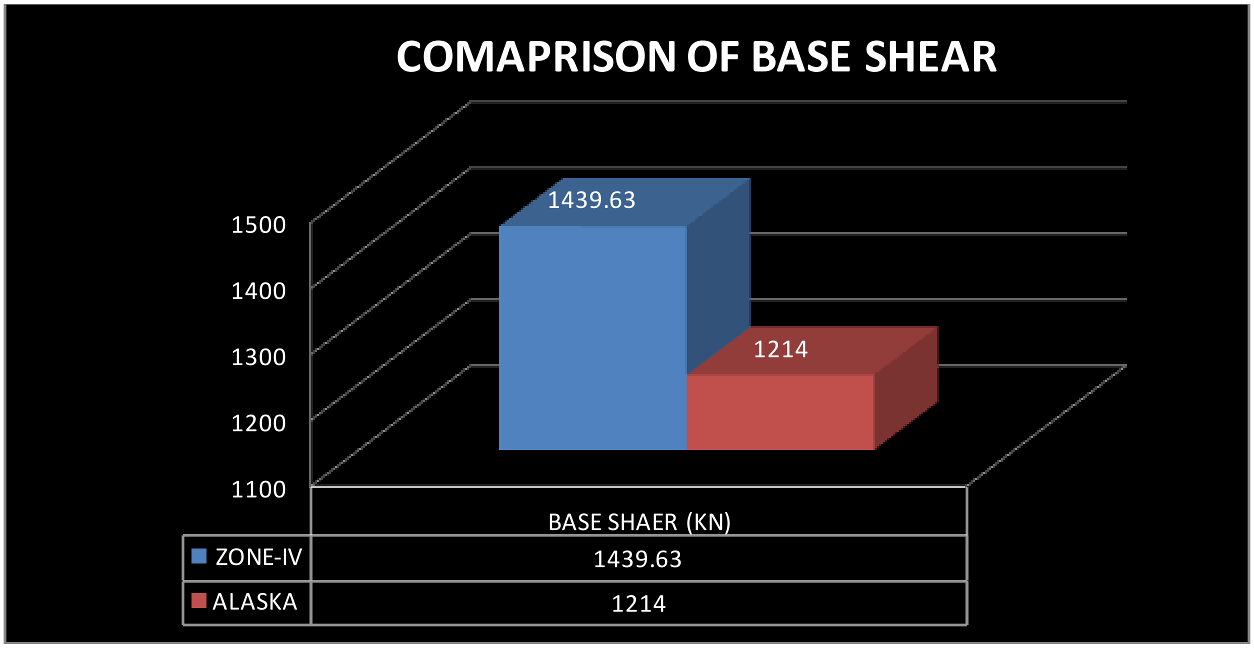


RESULT SUMMARY-:




COMPARISON OF STOREY DRIFT
STOREY HEIGHT (m)
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
STOREY DRIFT (mm)
ZONE-4
ALASKA


COMPARISON OF STOREY DISPLACEMENT
STOREY DISPALCEMENT (mm)
140
120
100
80
60
40
20
0
0
5
10
15
20
25
STOREY
ZONE-4
ALASKA



- Maximum Displacement in Z direction and the numerical values is 1.14 times more for Times history analysis as compared to Response spectrum analysis.
- Maximum Storey Drift in case of Time history analysis is 1.02 times greater than Response spectrum analysis.
- Maximum base shear in case of Response spectrum analysis is 1.18 times greater than Time history analysis.

CONCLUSIONS

1) Storey drift in Time History analysis is found to be 2 to 8 percent higher than that of Response Spectrum Analysis in both types of buildings i.e. regular & irregular.
2) For high rise building it is necessary to provide dynamic analysis (Response spectrum analysis or Time history analysis) because of nonlinear distribution of forces.
3) For important structure time history analysis should be performed it predicts the structural response more accurately.
4) The displacement value will depend upon frequency of earthquake and natural frequency of the structure.
5) The base shear value obtained in case of Response spectrum analysis are more as compared to Time history analysis as its depends on the frequency content of the earthquake data.
6) Storey displacement greater in Time history analysis as compared to Response spectrum analysis.

It is observed that the base shear is greater in Response spectrum analysis compared to Time history analysis thus it can be concluded that Time history analysis is economically better for designing.

REFERENCES

[1]. PayamTehrani and ShahrokhMaalek, Comparison of non-linear static and non-linear dynamic analyses in the estimation of the maximum displacement for structures equipped with various damping device, 4th International Conference On Earthquake Engineering, Taipei, Taiwan, October 12-13, 2006, paper No. 129
[2]. A.R. Touqan, A scrutiny of the Equivalent Static Lateral Load Method of Design for Multistory Masonry Structures, American Institute of Physics, AIP conference proceedings vol. 1020, pp 151-1158, 7/8/2008
[3]. Prof. Dr. QaiseruzZaman Khan (2010), "Evaluation Of Effects Of Response Spectrum Analysis On Height Of Building" International Conference on Sustainable Built Environment (ICSBE-2010) Kandy, 13-14 December 2010
[4]. Romy Mohan, C Prabha (2011), "Dynamic Analysis of RCC Buildings with Shear Wall" International Journal of Earth Sciences and Engineering ISSN 0974-5904, Volume 04, No 06 SPL, October 2011, pp 659-662
[5]. Haselton C B and Whittaker A S (2012), "Selecting and Scaling Earthquake Ground Motions for Performing Response-History Analyses", The 15th World Conference on Earthquake Engineering
[6]. Mr.ParvathaneniSubash, Mr.S.Elavenil (2012), "Time History Response Prediction For Multi-Storey Buildings Under Earthquake Ground Motions" Journal of Civil, Structural, Environmental, Water resources and Infrastructure Engineering Research (JCSEWIER) Vol.2, Issue 2 June 2012 16 23
[7]. IS: 875 (Part 1), (1987), Code of practice for design loads (other than earthquake) for buildings and structures, dead loads, Bureau of Indian Standards, New Delhi.

[8]. IS: 1893 (Part 1) 2002- Indian standard- “Criteria for earthquake resistant design of structures”, Bureau of Indian Standards, New Delhi
[9]. PankajAgrawal, Manish Shrikhande, ‘Earthquake Resistant Design of Structures’, Prentice Hall India Publication.
[10]. Staad. Pro Help Menu & Bentley Student Server.
[11]. Pacific Earthquake Engineering Research Centre (PEER): NGA Database, http://peer.berkeley.edu/.

