COMPARASION OF PUSHOVER CURVES FOR BUILDING DESIGNED FOR EARTHQUAKE LOADING AND GRAVITY LOADING FOR ASPECT RATIO 2 AND 4

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Abstract - *In this experimentation an investigation was done by comparing four 2-D frames with different aspect ratios. The aspect ratios which were considered were 2 and 4. The number of bays depended on the aspect ratio. The frames were designed for gravity loading as well as for earthquake loading. A total of four models were compared with each other. Designing and analysis was done using ETabs 2016 software and the required results were noted down. The results included Roof Displacement, Base Shear, Story Response Pots (Maximum Story Drift), Yield Points of Structures following ASCE 41-13 NSP, Performance points of various structures following FEMA equivalent linearization method and development of hinges were observed. The graphs were plotted for the obtained results and respective graphs were plotted. Based on the graphs the conclusions were derived.*

KEY WORDS:: **E-TABS, SEISMIC LOADS, E-STATIC ANALYSIS, DISPLACEMENT / STOREY DRIFT / BASE SHEAR / TIME PERIOD.**

1. INTRODUCTION

Pushover analysis have become progressively prominent as a basic technique for seismic implementation valuation of structures. An ever increasing no. of individuals are endeavouring to learn and utilize this technique in analysis to RC outline, RC divider, RC outline divider, and steel and also masonry constructions recently.

Static pushover analysis technique is a shortened elastic plastic analysis following quite a while of innovative work. Pushover analysis technique is an adopted code in numerous nations, for example, United States, Japan, China et al, and also as a fundamental strategy in elastic plastic analysis of a buildings below earthquake.

The Indian continent is no more peculiar to earthquakes because of the rate at which Indian plates are lashing into Asia. 54% of land is helpless against earthquakes and it is this measurement that makes seismic design of a structure, a main part player in basic designing in India. While most structures are moderately strong toward gravity it is their horizontal stiffness which is of higher significance at times of an earthquake. Because of a fracture at the faults substantial energy is discharged which goes through crust and gets shifted to the structures. The virtue of a building by which it tries to stay very still prompts inertial forces in building and this force makes more harm for structural and non-structural segments which leads harm of human life and economic damages. Subsequently appropriate design techniques are essential to protect these structures which thus ensures human life which is tending to seismic activities.

Most building codes provides us a straight strategy for analysis for earthquake loads in spite of the circumstance that structures move into a non-linear behavior during earthquake and henceforth these linear methods neglect to provide us estimation of a structures demands during an earthquake. Nonlinear static pushover system is said to be shortened non-linear analysis strategy in which dynamic load is replaced by a step by slowly increasing (static) lateral load.

With height of structures rising continually, its horizontal solidness lessens and it is this firmness which plays a main part during a seismic action. Seismic loads are horizontal in nature & if the structure isn't firm on a horizontal plane it can prompt vast displacements which thus cause gigantic structural harm. This harm can't be estimated utilizing elastic methods and subsequent importance of nonlinear analysis. Shear walls assume a main part in taking up lateral loads and lessening roof displacement alongside these lines reducing structural and non-structural damage. Nonlinear static analysis encourages us find the fragile points in building for the period of seismic action and measure amount of damage induced. The substantial lateral stiffness of shear wall pulls in lot of load in this manner lessening the stress on the frames.

2. BUILDING DESCRIPTION

The structural elements are columns, beams and slabs with adaptable sections are stated below. Also, various shapes of construction are taken in account while keeping the total area unchanged.

Depiction of members utilized (Design according to gravity loading):-

For Aspect ratio 4: Total length x Aspect ratio

9 x 4 = 36m

Height of floors = 3m

No. of stories = $^{36}{}_{3}$ = 12 stories

For Aspect ratio 2: Total length x Aspect ratio

18 x 2 = 36m

Height of floors = 3m

No. of stories = $^{36}{}_{3}$ = 12 stories

No. of stories = 12

Beam sizes for aspect ratio 2 and 4:

Depth of beam = 400 mm

Overall depth of beam = 400 + 50

= 450mm

The depth of beam must not be more than $^{1}{}_{4}$ x L = $^{1}{}_{4}$ × 4500 = 1125 mm

Hence it is ok.

All Beams = 450mm X 300mm.

Column Sizes:

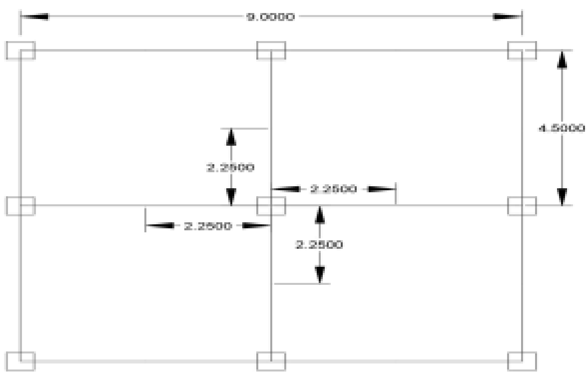

Fig.-1: Calculating the load on column for aspect ratio 4.

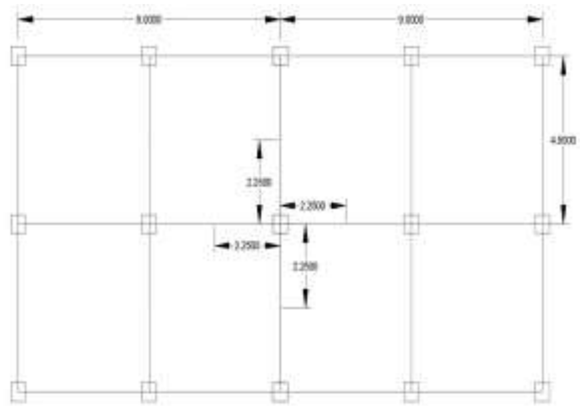

Fig.-2: Calculating the load on column for aspect ratio 2.

Load on beam = DL = 1.5 KN/m^2, LL = 3.5KN/m^2

Self weight of beam = 0.3 x 0.45 x 25 x 1 = 3.375 KN/m^2

Self weight of wall = 0.3 x 0.23 x 18 x 1 = 12.42 KN/m^2

Total load = 20.795 KN/m^2

Load on column = 1544.02 KN/m2

Factored load = 2316.03 KN/m2

Pu = 0.4fckAc + 0.67fyAsc

Assuming 0.8% steel

Ac = 0.8%A

Ac = A – Asc = A – 0.008A

=A(1-0.008)

=0.992A

2316 x 10^3 = (0.4 x 25 x 0.992A) + (0.67 x 500 x 0.008A)

A = 183811.904 mm

Assume the column as a square column.

WKT, A = L x B

183811.904 = L x B

L x B = √183811.904

L x B = 428.73 mm

L x B = 500 mm

Square Columns = 500mm X 500mm.

3. RESULTS AND DISCUSSIONS

3.1. ROOF DISPLACEMENT V/S BASE SHEAR FOR LOAD CASE ACC (UNIFORM ACCELERATION)

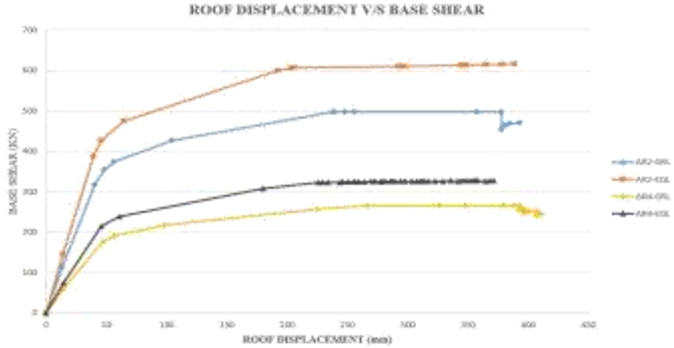

Fig.-3.1: Graph of roof displacement v/s base shear for ACC load case

3.2. ROOF DISPLACEMENT V/S BASE SHEAR FOR LOAD CASE EQ PAT (EARTHQUAKE)

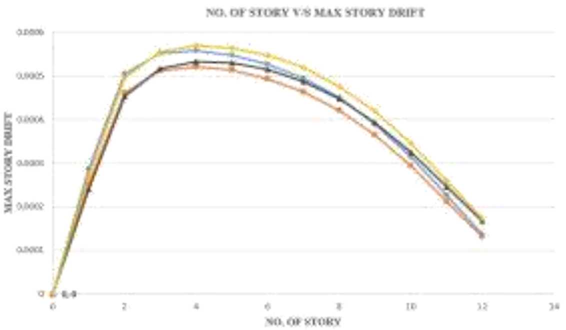

Fig.-3.2: Graph of roof displacement v/s base shear for EQ PAT load case

3.3. STORY RESPONSE PLOTS (MAXIMUM STORY DRIFT)

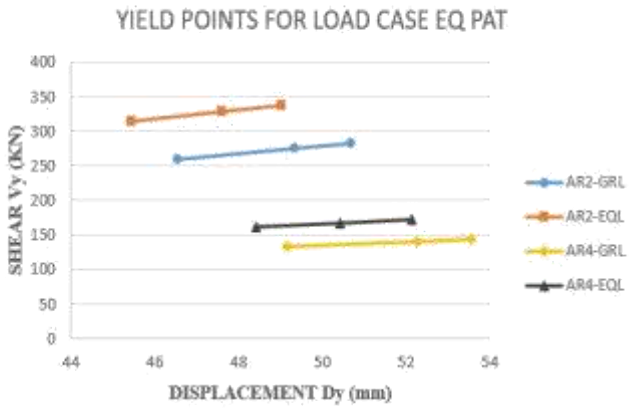

Fig.-3.3: No. of story v/s max story drift

3.4. YIELD POINTS OF VARIOUS STRUCTURES FOLLOWING THE "ASCE 41-13 NSP"

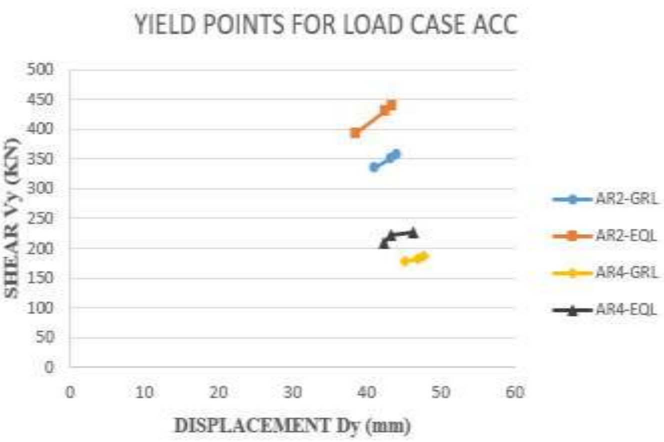

Fig.-3.4: Yield points for load case EQ PAT following ASCE 41-13 NSP

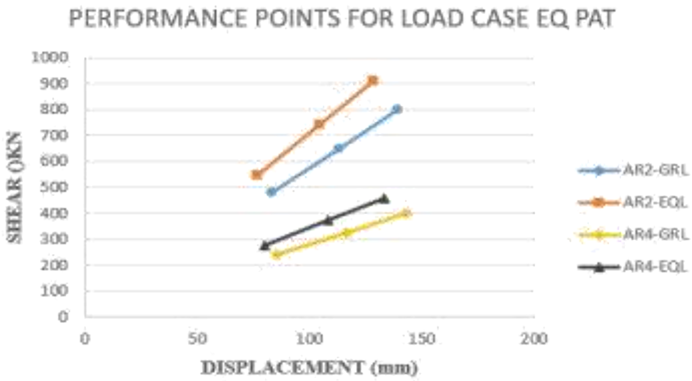

Fig.-3.5: Yield points for load case ACC following ASCE 41-13 NSP

3.5. PERFORMANCE POINTS OF VARIOUS STRUCTURES FOLLOWING THE "FEMA 440 – EQUIVALENT LINEARIZATION METHOD"

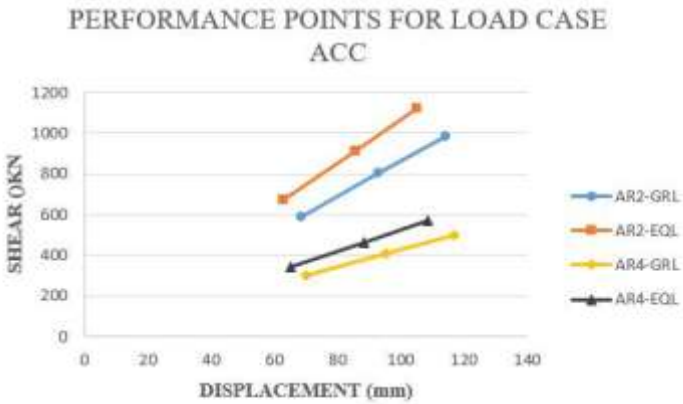

Fig.-3.6: Performance points for load case EQ PAT following FEMA 440-ELM

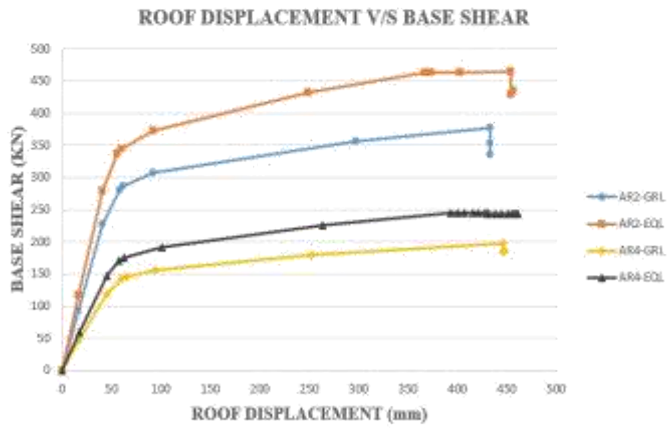

Fig.-3.7: Performance points for load case ACC following FEMA 440-ELM

4. CONCLUSION

1. Structures designed for EQ loading will yield at higher base shear in comparison to a structures designed for gravity loading only.
2. An increase in aspect ratio leads to the decrease in base shear and its corresponding roof displacement at performance points.
3. The base shear and its corresponding roof displacement at performance points for a given aspect ratio is the largest for soft soils followed by medium soils and hard soils.
4. For a given aspect ratio, the initial stiffness of the pushover curve is larger for structures designed for earthquake loading. This behavior is observed for both the lateral load patterns under study i.e. loading consistent with the code specified distribution of lateral loads (IS:1893, part 2) and the Uniform acceleration lateral load pattern.
5. Structures designed for earthquake loading yield at a higher base shear and corresponding roof displacement in comparison to structures designed for gravity loading only.
6. With an increase in the aspect ratio a corresponding increase in the Maximum story drift is observed.
7. The maximum story drift decreases for structures designed for earthquake loading in comparison to structures designed for gravity loading only.

FUTURE SCOPE OF WORK

Using nonlinear static pushover analysis further work can be carried out for

1. Evaluating RC frame structures by taking the effect of different aspect ratios considered in the study and comparison study can be done.
2. Evaluating the performance of the steel frames by varying the height of building and keeping base dimension of the building constant.
3. Evaluating performance of structure with infill as masonry wall and comparing the results with infill as equivalent diagonal strut.

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