IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Comparative Study For Asymmetrical Building With And Without Bracings

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Abstract: The primary objective of this report is to carry out pushover analysis of an asymmetrical building with and without bracings. We have taken into consideration of RCC framed structure or building which is asymmetrical one. The building consists of a G+ 10 floors whose length is 30 m and width is 40 m. Floor to floor height is considered as 3 m. Hence the total height of the building is 33 m. Brick is considered as the construction material for walls. Slab is 150 mm thick. The building is considered as an office building. The imposed loads are considered accordingly as per IS 875 part 2. After performing the analysis the results are tabulated in the form of tables and in the form of graphs and charts also.

***Index Terms* – Structures, lateral displacements, pushover analysis, bracing system, base shear.**

I. INTRODUCTION

Frame bracing systems are commonly made used in order to face the side way forces however these can become obstruction with reference to architectural features if they are not provided at suitable places from the architectural point of view. Steel bracing system would be normally provided in vertical spans. This system generally helps in providing for increasing the complete stiffness in the picture and at the same time weight of the whole system will be much lesser in comparison with any other process system with different materials. This system could be utilized for an existing structure which will have poor stiffness when it comes to sideway forces. This system could also be used in the structure which is yet to be constructed. However in such situations bracing systems types' placement position are to be decided in the beginning of the design itself by keeping in mind the architectural elevations etc. Any bracing system will generally be provided to enhance the stability of the structure by reducing any lateral sway this way it ensures in increasing the stiffness of the structure. This will helps in introducing the displacement in lateral direction significantly. Concentric bracing system will help in increasing the stiffness in lateral direction but it has to be kept in mind that increasing the structural stiffness will also result in increasing inertia force due to natural occurring calamities like earthquake or wind forces.

II. BUILDING MODELING

In our project we have modeled 4 buildings as office occupancy assumed to be located in zone IV of earthquake map of IS 1893-2002. We have accomplished the modeling work by keeping an asymmetrical building in mind.

A usual Concrete special moment-resisting frame (SMRF) is modelled and the shape of the building is asymmetrical & all dimensions are exhibited on subsequent pages. Loads like DL, IL and wind load according to IS-875 part 3 (1987) & earthquake loads according to IS: 1893-2002 are considered. Analysis is run using equivalent lateral load & pushover methods for seismic zone-IV with Zone-Factor of 0.24. The complete structure of entire model is described in depth in the successive pages. Importance-factor of 1, response-reduction factor: 5 & damping: 5% are taken into account.

During this procedure a few assumptions were made or the site data collected & the same are listed below. This is done in-order to keep the likeness for all the 4 models/buildings.

- Number of Stories: G+10
- Length of each building: 50 m
- Width of each building: 40 m
- Height of each building: 33 m
- Floor height: 3.0 m
- Wall thickness: 230 mm
- Slab Thickness: 150 mm
- Grade of concrete: M30

- Grade of steel: Fe500
- Thickness of shear wall: 250 mm
- Column sizes: 600mm X 600mm
- Beam sizes 230mm X 600mm
- At lower most level only grade beams were considered & slabs were not provided since this level will be sitting directly on the soil.
- All the structural beams will be sitting exactly at the centre of structural columns to stay away from eccentricity. SAP software will do it automatically.
- At foundation height support conditions are considered as fixed.
- Earthquake consequence is deemed only two flat and perpendicular planes & any earthquake loads in vertical direction is deemed as not important.

II. RESULTS

The design life span of any office block needs to be 60 years. The building needs to design by accounting the most crucial load combinations. The load combination should include own weight of the whole structure, live/ imposed load, super-imposed load, wind load, earthquake load & any stressed that are developed because of any change in temperature, creep & shrinkage of cement concrete & dynamic loads need to be accounted if any.

III. PUSHOVER CURVES

1. CONCRETE

A pushover curve is a non liner curve that denotes the displacement in X & the base shear in Y co-ordinate. Using these curve one can obtain the max displacement and the corresponding base shear.

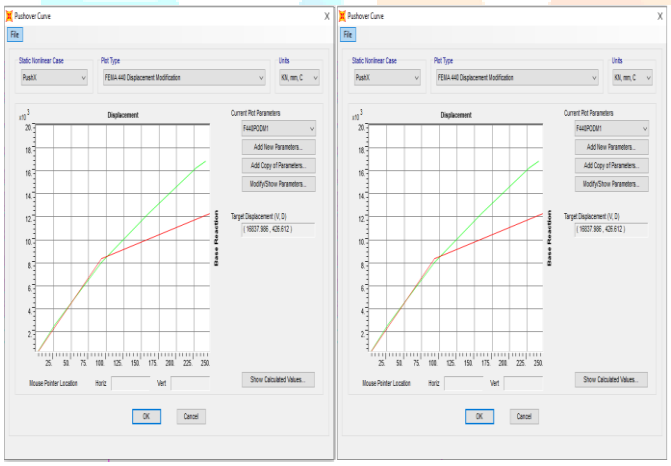

Fig.1) No bracing model

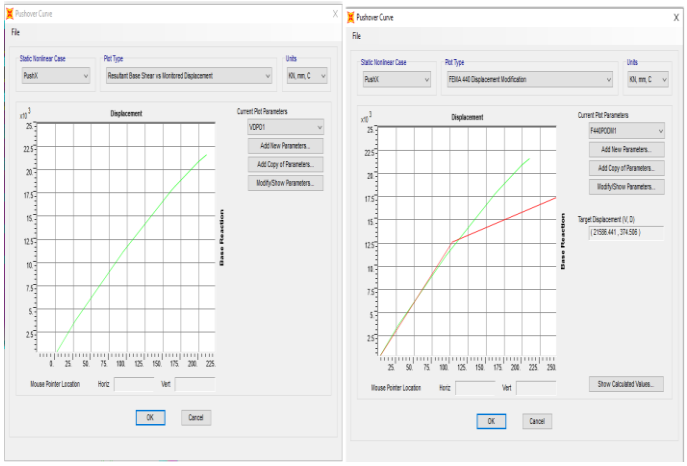

Fig.2) X bracing model

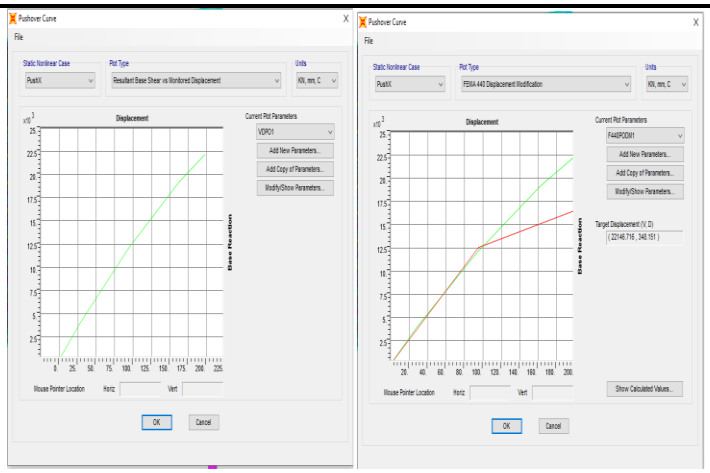

Fig.3) V bracing model

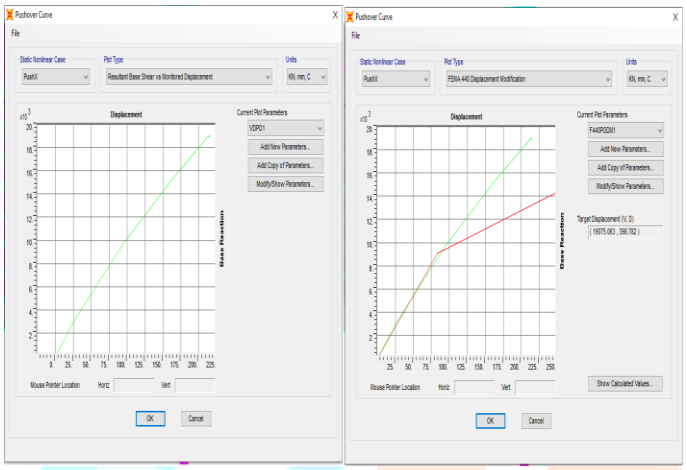

Fig.4) K bracing model

IV. DISCUSSIONS

In the above 4 graphs which represent pushover curve for the model without bracing, X bracing, V bracing & K bracings respectively. All the 4 graphs are showing almost similar curvature even though the values are different based on the bracing arrangements. Initially the curve is linear and slowly it starts to deviate for linear shape, this is because the structural members will start to behave non-elastically. The these structure is pushed into in-elastic range the graphical curve stats to became linear once again however it will have some slope associated with it.

From the graphs we can observe that for the model without bracing maximum base shear is 16837.986 kN and maximum displacement is 426.612 mm. Similarly for the model with X bracing maximum base shear is 21586.441 kN and maximum displacement is 374.506 mm. For V bracing model maximum base shear is 22146.716 kN and maximum displacement is 348.151 mm. For K bracing model maximum base shear is 19075.063 kN and maximum displacement is 398.782 mm.

Table-1: Max Base shear v/s Max Displacement

Sl. No	Model	Max Base shear, (V) kN	Max Displacement, (D), mm
	No bracing	16837.986	426.612
	X bracing	21586.441	374.506
	V bracing	22146.716	348.151
	K bracing	19075.063	398.782

From the above table it is evident that the displacements in all the four models are within the limit for when checked for earthquake zone IV. However X bracing will give a good result as the displacement is the least among all the four models.

V. CONCLUSIONS

The performance of all the four models with different types of bracings were checked with the help of various parameters like base shear, displacement using pushover analysis method. And the results were shown in the form of graphs and tables. At the end below conclusions were listed out.

1. From the above shown pushover curve it is evident that all the four buildings i.e., no bracing, X bracing, V bracing & K bracing models were able to take the shocks produced by the earthquake in zone IV.

2. Pushover curve of all the models with bracing system have demonstrated no reduction in load carrying strength of the models which demonstrates the good behaviour of the structure.
3. From the demand capacity curve of all the four models it can be observed that the demand & the capacity curve are intersecting within the Initial Occupancy (IO) point. Hence all the structural elements are within their elastic limits.
4. Collapse mechanism could be studied from the way the hinges were formed in the building. In all the four models the hinges formed were within the elastic region.
5. Base shear in model with no bracings, the base shear value is minimum and displacement is maximum even though it is within the limit. Whereas the base shear is maximum in V bracing model with minimum displacement. Here the base shear has increased due to additional bracing members and the displacement has reduced because of the increase in stiffness due to introduction of bracings. Other two types of bracing models values are between these two models values.
6. Pushover method of structural analysis is comparatively a simpler way to ascertain the nonlinear behavior of any structure.

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