Analysis of RC frame building with different types of braces in various seismic zones

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***Abstract*: In the present work, I have carried the analysis of a Structural model by using software ETABS 2016. In the model considered the building model with different bracing systems based on the journals I have come across with, so the project concentrated with some of the design factors like Storey Displacement, Drifts and Modal Participation Mass Ratios in different zones. So that from results after analysis gives the formal view of the project to understand the parameters considered, bracings like X and V and INV V used in model and the stiffness factor have been tried to reduced and later structure can absorb the shocks because of the bracings. So that overall performance of the building improved with the greater stability and flexibility of the building.**

***Keywords*: Seismic; Bracing system; Storey displacement; Storey drift; Modal mass participating factor, Inv V Bracing, etc**

1. INTRODUCTION

Structures are constructed to give the specific performance of various activities connected with residential, offices, educational field, healthcares unit, sports and recreation transportations, storage bins, electric generation, etc. Every one of the structures ought to maintain the heaps going ahead them amid their administration life by having satisfactory quality and furthermore confine the miss happening by having enough solidness. Quality of a structure relies upon attributes of the material with which it developed and Stiffness relies on the cross sectional and geometrical property of the structure. Tall building or multi - storied building characterized as ideals of its stature (in excess of 30 m), is influenced by horizontal powers because of wind or seismic tremor or both to a degree that they assume a critical part in the basic plan. Auxiliary examination manages the instrument of recovery of burdens connected on the framework into nearby component drive, utilizing different hypotheses and hypotheses articulated by famous specialists and agents.

It likewise manages the calculation of distortions these individuals endure under the activity of initiated powers. The fundamental work of individuals from confined structure is to exchanges the gravity burdens and sidelong loads to the establishment of structure, after that to the earth . The fundamental burdens comes in the structure is gravity loads comprises dead load , live loads and some administration n loads . Close to this there is likelihood of structure e may experience through parallel powers caused because of seismic movement, wind powers, fire , and impacts and so on . Here the sections and light emissions structures are utilized to exchanges the real part of the gravity burdens and some bit of sidelong loads however that isn't huge to the steadiness of structure . So we give propping frameworks, shear dividers, dampers and so forth to oppose or exchange these sidelong powers to the structure consistently without influencing the solidness and quality of the structure.

Moment resisting frames resisting edges without supporting, inelastic reaction disappointment by and large happens at shaft and section associations. They oppose sidelong powers by flexure and shear in shafts and sections i.e. by outline activity. Under serious quake stacking malleable crack at bars and sections associations are normal. Minute opposing edges have low versatile solidness. P-Δ impact is an another issue related with such structures in tall structure So, to build the structure reaction to horizontal stacking and great malleability properties to perform well under seismic stacking concentric bracings can be given. Shafts, segments and bracings are orchestrated to shape a vertical truss and after that sidelong stacking is opposed by truss activity. Bracings enable the framework to get an awesome increment in horizontal firmness with negligible included weight. In this way, they increment the regular recurrence and more often than not diminish the parallel float. They create pliability through inelastic activity in supports. Disappointment happens due to yielding of truss under pressure or clasping of truss under pressure. These disappointments can be remunerated by utilization of Buckling Reinforced Braced edge (BRBs) or Self Centering Energy Dissipating outlines (SCEDs).

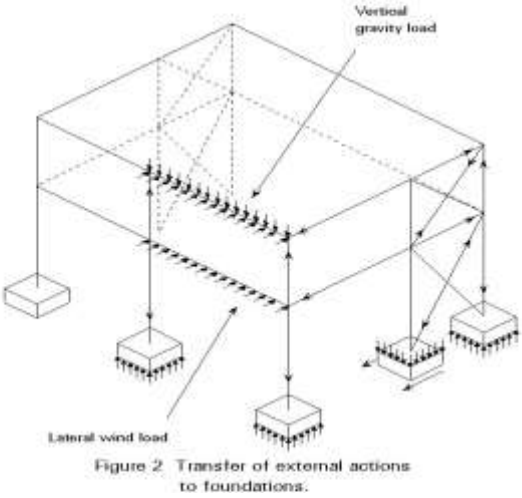


Fig 1.1 Bracing Effect

1.1Existing structures:

A] John Hancock Center

John Hancock center is a 100 -story , 1,128-foot supertall skyscraper at 875 North Michigan Avenue, 175 E. Delaware Pl., 170 E. Chestnut St. Chicago, Illinois , United States. It was the second tallest building in the world and the tallest outside New York City which was constructed in 1968.

B]Bank of China

The **Bank of China Tower** (curtailed BOC Tower) is a standout amongst the most unmistakable high rises in Central , Hong Kong . It houses the central station for the Bank of China (Hong Kong) Limited. The building is situated at Garden Road , in Central and Western District on Hong Kong Island and auxiliary highlights that control the reaction of concentrically supported edges , and to recognize .

C] Auckland city Hospital

The **Auckland City Hospital** is one of the biggest healing centers in New Zealand [2] and in addition one of the most seasoned restorative offices of the nation . It is an openly supported clinic , keep running by the Auckland District Health Board since 2001 . Situated in the suburb of Grafton , east of the CBD , it has 3,500 rooms and gives an aggregate of 710 beds .

D] Matsuya Department Store:

Structural steel bracing to strengthen building against earthquakes retrofitted to Matsuya Department Store in Ginza Tokyo Japan .

2. LITERATURE REVIEW

Surender Kumar et al (2017) [1] A seismic study of steel braced RC frame with different arrangements Steel buildings. Seismic coefficient technique (direct static examination) has been led to appraise the impact of various arranging of supporting individuals in the building edge and impact of the distinctive steel cross-segment. Exhibit think about is a fifteen-story building thought to be situated in seismic zone IV according to the seismic zone guide of India. Two steel profiles ISA, ISMC were used as supporting individuals by thinking about same cross-sectional zone. The propping was accommodating fringe segments. A four-story building was broke down for seismic zone IV according to IS 1893: 2002 utilizing STAAD Pro programming. The adequacy of different kinds of steel supporting in restoring a G +15 story building was analyzed. It was discovered that the X kind of steel propping altogether adds to the basic firmness. It is additionally discovered that the different plans of propping frameworks had awesome

effect on seismic show of the building casing and point area gives better outcome as analyzed ISMC segment.

S.M Hashmi (2016) [2] Seismic analysis of RC Building Frame with Different Bracing Systems this examination G+15 building outline is dissected with various supporting frameworks under seismic stacking in seismic zones III, IV, V. according to IS 1893-2002. E-TABS Software is utilized for the investigation of the building outline. The aftereffects of different supporting frameworks (X-Bracing , V-Bracing , K Bracing, Inverted V-Bracing, and Inverted K-Bracing) are contrasted and exposed edge show examination. The viability of different kinds of supporting frameworks is contemplated with a specific end goal to control the parallel dislodging, story float and part powers in the casing. It is discovered that all the propping frameworks control the horizontal removal adequately. Hence the question of the examination is to decide the level of viability of various supporting game plans to build the maintainability of the RC outline against the impacts of Earthquake.

A. Moein Amini (2016) [3] A Study on the Impact of Bracing Arrangement in the Seismic Behavior Buildings with Various Concentric Bracings by Nonlinear Static and Dynamic Analyses The course of action of bracings in structures influences their seismic conduct, as past investigations appear, while this reality isn't considered in seismic outline codes . In this examination an arrangement of general multi-story steel structures were considered with three sorts of X, V and chevron propping , in two positions of 'two neighboring bayous' and 'two non-nearby inlet s' along the building stature, and their seismic practices were explored . To begin with, the structures were planned in light of the code , and after that they were assessed by both sucker and nonlinear time history examinations , and their exhibitions were contrasted and the standard execution levels (PLs). Results demonstrate that in all cases , propping course of action in non-nearby coves prompts bring down solidness however higher quality than in neighboring sounds, and that for Immediate Occupancy PL, plastic zones show up for the most part in bring down stories, while for Life Safety and Collapse Prevention PLs they seem just in few lower stories .

A. Rahai, (2016) [4] Journal has Concentric steel supporting give a magnificent way to deal with reinforcing and solidifying existing RC structures. Utilizing these props the creator can scarcely modify the firmness together with pliability as required as a result of locking of supports in pressure. Encased supporting (clasping limited propping) can allow planner picking required firmness and quality together with high malleability free of powerlessness to clasping. These supports are made out of steel center part encased in concrete-filled square steel tube. In this examination the utilization of steel supporting and clasping limited propping (BRB) for retrofitting a deficient strengthened solid building are researched. The effectiveness of these two frameworks in restoring a mid-ascent nine-story strengthened cement (RC) building were analyzed utilizing execution based outline and nonlinear static investigation as indicated by FEMA-356 seismic recovery rules. Results demonstrate that the two frameworks enhance the quality and solidness of the first structure however because of astounding conduct of BRBs in nonlinear stage and under compressive powers this framework indicates much preferred execution over the restoration arrangement of concentric propping.

Viswanath K.G (2015) [5]Seismic Analysis of Steel Braced Reinforced Concrete Frames Steel supporting is practical , simple to erect, possesses less space and has adaptability to outline for meeting the required quality and solidness. In the present examination , the seismic execution of fortified cement (RC) structures restored utilizing concentric steel propping is researched. The supporting is accommodated fringe sections. A four storey building is examined for seismic zone IV according to IS 1893 : 2002 4 utilizing STAAD Pro programming . The adequacy of different sorts of steel propping in restoring a four storey building is inspected . The impact of the conveyance of the steel supporting along the tallness of the RC outline on the seismic execution of the restored fabricating is considered . The execution of the building is assessed as far as worldwide and story floats. The examination is reached out to eight storied, twelve storied and sixteen storied building . The rate decrease in parallel removal is discovered . It is discovered that the X kind of steel supporting essentially adds to the auxiliary firmness and lessens the most extreme interstorey float of the edges .

Rishi Misra et al (2014) [6] Analysis of RC Building frames for seismic loading utilizing diverse sorts of Bracing frameworks in this investigation examination of skyscraper RC building outlines have been done with g+10 floors in STAAD programming and the aftereffects of various kind of supporting framework (x, v, k,& upset v) are contrasted and uncovered casing and expressed that inverted v have been more productive and practical.

Kevadka r, Kodag et al (2013) [7] concluded that the structure in heavy susceptible to lateral forces might be worry to serious harm . In this they said alongside gravity stack (dead load , live load) the casings ready to withstand to sidelong load (stacks because of seismic tremor , wind , impact , fire risks and so forth) which can grow high worries for that reason they utilized shear divider and steel propping framework to oppose the such kind of stacking like quake , wind , impact and so on . In examine as indicated by creator R.C.C. building is displayed and broke down in STADD and results are looked at as far as Lateral Displacement , Story Shear and Story Drifts , Base shear and Demand Capacity (Performance point).

R.K. Gajjar , Dhaval P. Advani (2011 [8] Investigated, the design of multi -storeyed steel building is to have great parallel load opposing framework alongside gravity stack framework since it additionally administers the plan . They exhibited to demonstrate the impact of various sorts of supporting frameworks in multi storied steel structures . For this reason the 20 stories steel structures display is utilized with same setup and diverse bracings frameworks, for example, knee support, X prop and V prop is utilized . A business bundle STADD Pro is utilize d for the investigation and plan and diverse parameters are analyzed.

P .Jayachandran (2009), [9]carried out the study to enables optimizing of starting auxiliary frame works for float and stresses , in light of gravity and side long loads. The plan issues are proficiency of frameworks, inflexibility, part profundities, adjusts between sizes of pillar and section, bracings, and dividing of segments, and supports, and territories and dormancies of individuals. Float and increasing speeds ought to be kept inside breaking points. Great preparatory outline and optimizing prompts better manufacture and erection expenses, and better development. The cost of frame works relies upon their structure weight . This relies upon proficient starting outline. The auxiliary steel weight is appeared to be a critical parameter for the planners , development engineers and for creation and get together enhancement .

Mahmoud R . Maher , R. Akbari (2003),[10] carried out the study for the earthquake behaviour factor (R) for steel X-supported and knee- propped RC structures. The R factor parts including pliability lessening factor and over quality factor are extricated from inelastic weakling examinations of support outline frameworks of various statures and setups . The impacts of a few parameters affecting the estimation of R factor , including the tallness of the casing , offer of supporting framework from the connected load and the kind of propping framework are researched . The stature of this kind of sidelong load -opposing framework profoundly affects the R factor, as it specifically influences the flexibility limit of the double framework. At long last, in view of the discoveries displayed, speculative R esteems are proposed for steel-supported minute opposing RC outline double frameworks for various malleability requests.

Sabelli et al. **(1999) [11]** investigated to distinguish ground movement and basic highlights that control the reaction of concentrically propped outlines , and to recognize enhanced plan techniques and code arrangements. The focal point of this paper is on the quake reaction of three and six story concentrically supported edges using clasping controlled props. A concise dialog is given in regards to the mechanical properties of such supports and the advantage of their utilization. Aftereffects of point by point nonlinear dynamic investigations are then inspected for particular cases and in addition measurably for a few suites of ground movements to describe the impact on key reaction parameters of different auxiliary arrangements and extents .

2.1 Objectives of present study

Following are the objectives of the project adopted from the various literature review done

1 To Analyse the multistoried building with various bracing systems under seismic condition using E-TABS
2 Comparing the results of Displacement, Drift and model Mass participating factor under Zone II & Zone V

3. METHODOLOGY

3.1 Introduction

In the present study, bare frame building of G+9storey with various bracing system is considered, and analysis is done and compared with results of various frames. Complete analysis is done by ETABS 2016 software by response spectrum method. By comparing the results obtained by the analysis of various and also considering the parameters such as storey displacements, storey drift & modal mass participating factor.

The following steps have been adopted as the methodology process for obtaining the anticipated objectives.

1. Structure parameters such as bracings type, structure dimensions, floor plans and was worked out, In this case, only three bracings were chosen.
2. Foundation type and ground conditions are assumed prior to modeling.
3. Drafting and modelling of the structure is done on ETABS using corresponding material selections. Indian standards codes for concrete and steel are adopted for the analysis.
4. Importing the architectural grid data into ETABS for modelling of structure
   Modeling as per IS-1893:2002(Part-I)
5. Modeling of frame structure without bracing
6. Modeling of frame structure with various types of Bracing structure
7. Loads are applied for gravity, earthquake and wind condition.
8. The analysis is run on the model in the software. Dynamic analysis is carried out. The performance of the structure is checked on parameters such as storey displacements, storey drift, and mass participating factor.
9. Results will be obtained and the behavior of the model is studied and necessary adjustments are made to give optimum conditions for the structure to stay safe. The results are further represented in graphical and tabular forms.
10. Analysis and comparing the structure in various seismic zones with different parameters
11. The seismic responses like base shear, Displacements, Modal participating factor are obtained by analysis are tabulated & Conclusions are drawn

3.2 Modelling using ETABS 2016

The modelling of the structure was done using the software ETABS 2016. ETABS which stands for Extended Three-dimensional Analysis of Building System is commonly used software for the primary purpose of modelling structures of any form or shape in order to analyze the same in a real scenario.

It is simple to use and its user friendly in nature, and also it having a capacity to deliver a whole spectrum of a work that which involves in a process of the structure analysis the building systems can be analyzed & also suitable for multistorey structures. The entire input statistics are produced by a typing English language or by a graphical or by a command base. It also presuming with a making algorithms by the state of an art graphics &and its environmental friendly in nature.

3.3 Model Description:

The concrete framed structure with G+9 storeys of 7100sqft area build for commercial purpose located at Bangalore east. Here model mainly concentrated on response spectrum analysis by varying parameters like bracing & zones.
By considering the loading system mainly lateral loads like earthquake and wind load. Finally results extracted and study made over the parameters like displacement and drift. Along with some of the calculations done purpose based on report.

Materials & Member Dimensions

- Concrete – M25, Reinforcement Steel – HYSD Fe 500
- Plan Dimensions – 34m x 25m
- Column Size – 760 x 760mm, 300 x 200mm
- Beam Size – 450 x 600, 300 x 600, 200 x 600, 200 x 450, 200 x 150mm
- Slab thickness – 230mm
- Height of each storey – 3.m
- Number of stories – 10
- Total Height of Building – 31m

3.4 Response Spectrum Method

The response spectrum constitute a interaction between the spectral system and the ground acceleration through a many various dissimilar ground motions and records to the seismic analysis, A design spectrum IS 1893: 2000(part 1) is used and the natural period in the abscissa is used for a system and also a ordinate is an maximal response, A function the damping and .the response spectrum design is provided by an IS 1893:2002 for the five percent damping system.

3.5 Modelling

The structural model under consideration is a G+9 storey RC building with storey height of 3m. The building has 5 bays along both X and 5bays along Y directions and the width of each bay is 4 m
Modeling

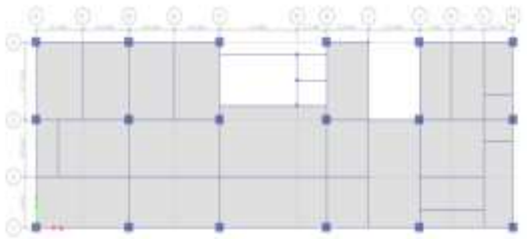


Fig 3.2 Building plan of bare frame

3.6 Loading Cases

The kinds of loads that impose on buildings and other structures can be classified broadly as vertical, horizontal and longitudinal loads. The vertical load consists of dead, live and impact loads. Horizontal loads consist of wind and seismic load. In this case of outrigger structure all the aforementioned loads have been taken into consideration. The anticipated types of loads imposing on the structure are dead, live, wind and seismic loads. Based upon these loads, load combinations have been generated with the model created in ETABS.

3.6.1 Dead Loads

Dead loads are vertical loads that are permanent and stationary during the lifespan of structure. Dead load is majorly because of self-weight of structural elements, fixed partition walls, fixed equipment and weight of various materials. It mostly comprises the weight of roofs, beams, walls and column etc. which otherwise are the permanent components of the structure. In this particular project the estimated dead loads are mentioned below.

1. Self-weight of members
2. Floor and finishing loads = 1.5 kN/m^2
3. Wall load used according to codes

3.6.2 Live Loads

The next loads taken for design of structure are live loads are imposed loads. Live loads are both movable and moving loads except occurrence of acceleration or impact. These loads are presumed to be formed by the purposeful use and occupancy of the building incorporating weight of portable furniture and partitions. Live loads keep on altering at certain time periods. All these loads are to be presumed by the structural designer since it is one of the crucial loads in the design. Since the project is according to Indian standards, the least values of live loads as given in IS 875 (Part 2):1987.

1. Live load on floors/slabs = 4 kN/m^2

3.6.3 Earthquake Load

Furtherly earthquake forces are engendered by inertial virtue of buildings as they respond dynamically to ground motion. This natural dynamic response keeps earthquake loads pointed distinctly from other variant building loads. Seismic loads upon the structure is computed specified in the design memorandum and conforming to the terms of IS 1893-2002 (Part 1). The analysis is executed by Response Spectrum Method in ETABS 2015. The structure is analyzed with other loads with seismic combination in both transverse and longitudinal directions and also in the opposite sense by reversing the sign in the load combination. Based on the Indian code of practice for earthquake loads, the seismic parameters looked into the analysis process are as follows.

Seismic Zone

Seismic zone is a certain zone wherein the rate of seismic function prevails quite consistant. This means that seismic activity is immensely peculiar, or that it is accutely common. The main zones in India are four and they are called Zone II, III, IV and V.

Seismic Zone Factor (Z)

This parameter obtains the spectrum design dependent on discerned superlative seismic threat constituted by Maximum Considered Earthquake (MCE) in zones where structures are present. Effective peak ground acceleration is of a standard reasonable estimate wherein the basic zone factors are included.

Response Reduction Factor(R)

This factor by which the actual base shear force, that will be generated if the structure is to stay elastic during its response to the Design Basis – Earthquake (DBE) shaking should be contained to obtain design lateral force.

Importance Factor (I)

This factories used to achieve the design seismic force which is dependent on functional use of structure, constituted by dangerous repercussions of its failure, its post-earthquake function, historic and economic importance.

Structural Response Factor (Sa/g)

This parameter denotes the acceleration response spectrum of structure exposed to earthquake ground vibrations, even dependent on natural period of vibration and damping.

Damping (%)

Results of internalized friction and imperfections in material elasticity, sliding and slipping in decreasing the amplitude of vibration is furthermore characterized as damping percentage

Natural Period (T)

Natural period of structure is defined as time period of undamped free vibration.

3.6.4 Wind Load

The anticipated wind loads acting on the proposed building are discussed further in this section. Wind loads constitute dynamic and static components. Loads given in code are the corresponding static wind loads; under the static deformation of structure is equivalent to the sum of dynamic and static deformations introduced by wind. The final wind load over the principle load bearing system of the structure is equivalent to vector total of all wind loads exploiting on all surfaces of the structure. Calculations for wind loads for the project was done in precedence with clauses of IS 875:1987 (Part 3).

3.7 Codes & Standards

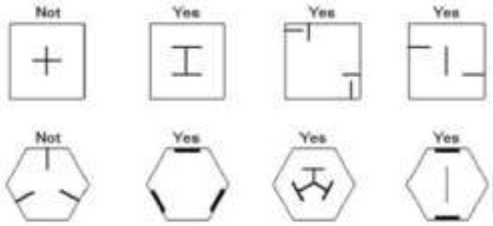
The various codes and standards referred for the analysis of the project are listed below in Table 3.1.

Table 3.1 List of standards and codes adopted for the structure

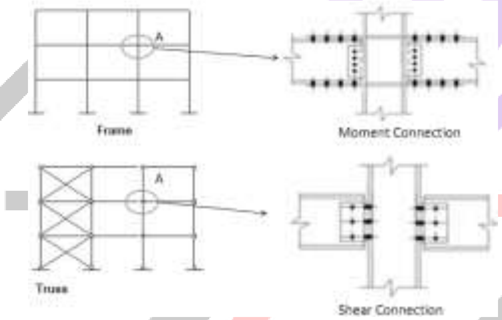
STANDARD	DESCRIPTION
IS 456:2000	Plain and Reinforced Concrete - Code of Practice
IS 800:2007	General Construction in Steel – Code of Practice
IS 875(Part 2) - 1987	Code Of Practice For Design Loads (Other Than Earthquake) For Buildings And Structures. Part 2: Imposed Loads
IS 875(Part 3) - 1987	Code Of Practice For Design Loads (Other Than Earthquake) For Buildings And Structures. Part 3: Wind Loads
IS 1893(Part 1) - 2002	Criteria for Earthquake Resistant Design of Structures Part 1 General Provisions And Buildings

3.8 Introduction to Bracings

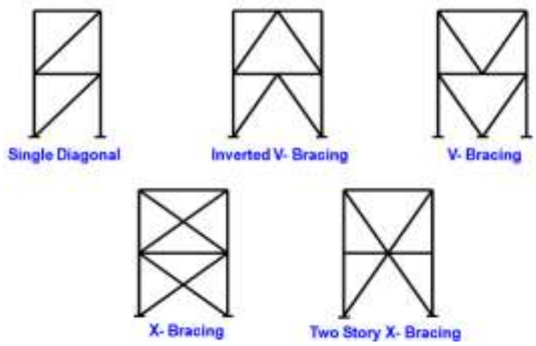
3.8.1 Bracing System Location



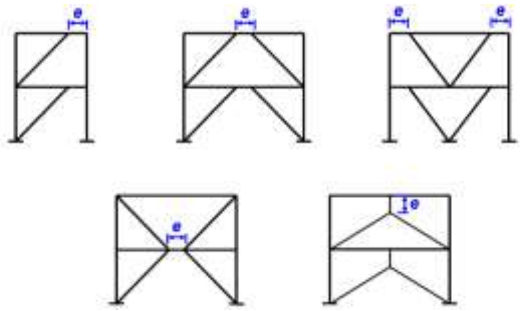
3.8.2 Connection Classification



3.8.3 Concentrically Braced Frames



3.8.4 Eccentrically Braced Frames :



X-BRACING:

X-bracing is an auxiliary designing practice where the parallel load on a building is diminished by moving the heap into the outside sections. X-supporting was utilized as a part of the development of the 1908 Singer Building, at that point the tallest working on the planet.

V BRACING OR CHEVRON BRACING SYSTEM:

This includes diagonal elements extending from the top portion corners of a horizontal member and intersecting at a centre point at the lower horizontal member, in the shape of a V.

INV V OR CHEVRON BRACING SYSTEM:

Inverted V-bracings system (also known as chevron bracing) involve s the two members meeting at a centre point on the upper horizontal component .

3.8.5 Design Criteria for Multi-storeyed Buildings

a) The criteria for design of multi-storeyed buildings &ail be as In case of buildings with floors capable of providing rigid horizontal diaphragm action, a separate building or any block of a building between two separation sections shall be analyzed as a whole for seismic forces as per 3.1.4. The total shear in any horizontal plane shall be distributed to various elements of lateral forces resisting system assuming the floors to be infinitely rigid in the horizontal plane, In buildings having shear walls together with frames, the frames shall be designed for at least 25 percent of the seismic shear.

b) In case of buildings where floors are not able to provide the diaphragm action as independently; in (a) above the building frames behave and may be analyzed frame by frame with tributary masses for seismic forces as per 3.1.4.

3.8.6 Drift

The maximum horizontal relative displacement due to earthquake forces between two successive floors shall not exceed 0.004 times the difference in Levels between these floors.

3.8.7 Torsion of Buildings

Provision shall be made for the increase in shear resulting from the horizontal torsion due to an eccentricity between the centre of mass and the centre of rigidity. The design eccentricity shall be taken as 1.5 times the computed eccentricity between the centre of mass and the centre of rigidity. Negative torsional shears shall be neglected.

3.8.8 SRSS

Square Root of Sum of Squares option. A directional combination technique that is independent of the direction of loading. Summation of the absolute values of the results caused by different directions of loading. Specify an *ABS Scale Factor* smaller than one to consider scaled sums. For example, if a value of 0.3 is specified, the program will consider the worst of 100% loading in one direction plus 30% in the other direction(s), and so on for each of the two or three loaded directions.

3.8.9 CQC – (Complete Quadratic Computation)

An extension of the SRSS method for finding the maximum response when the horizontal (U1 and U2) directions of loading use the same response spectrum function but have different scale factors. The critical angle of loading is determined automatically independent of the angle specified for the loading. The vertical response is combined with the maximum horizontal response using the SRSS method. If different response-spectrum functions are used for U1 and U2, the results must be interpreted carefully by the engineer.

3.8.10 STORY DISPLACEMENT:

It is total displacement of i^{th} storey with respect to ground and there is maximum permissible limit prescribed in IS codes for buildings. Storey displacement is displacement with respect to base of the structure.

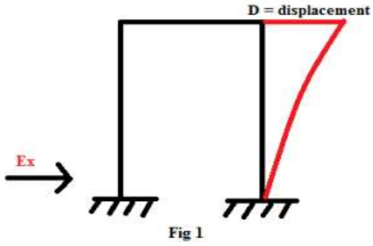


Fig 3.3: Storey Displacement

3.8.11 STORY DRIFT:

Inter-story drift is one of the particularly useful engineering response quantity and indicator of structural performance , especially for high -rise buildings .Drift is defined as the lateral displacement . Storey drift is the drift of one level of a multistory building relative to the level below . Inter-story drift is the difference between the roof and floor displacements of any given story as the building sways during the earthquake , normalized by the story height .

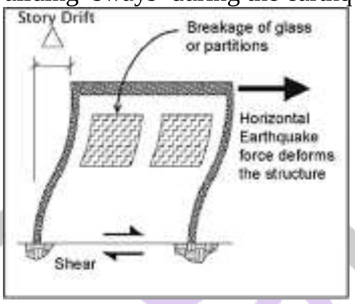


Fig 3.4: Storey Drift

3.9ARCHITECTURAL &STRUCTURAL DETAILS

Fig 3.5: Basement Plan

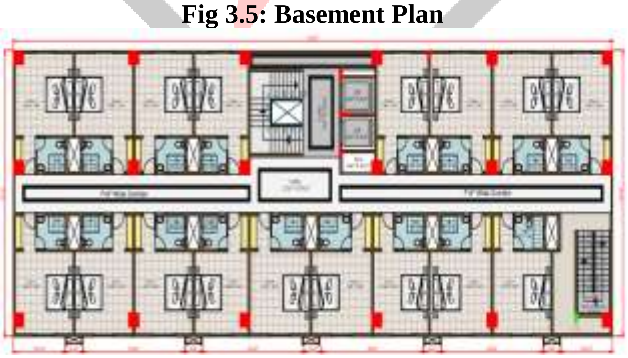


Fig 3.6: Typical Floor Plan

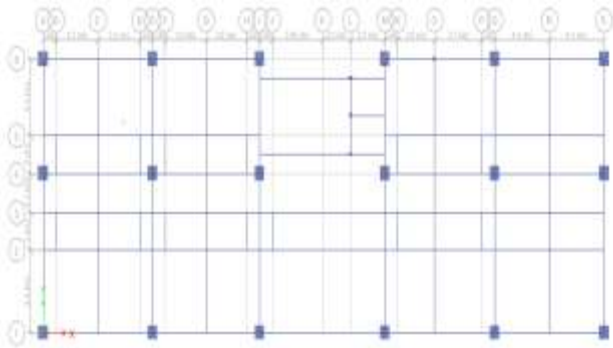


Fig 3.7: Beam-Column Layout ETABS

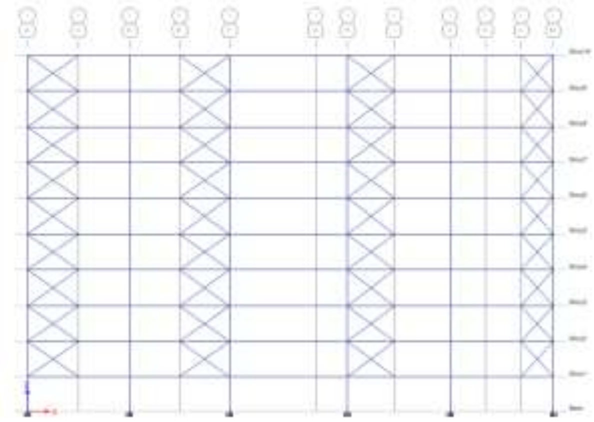


Fig 3.8: X-Bracing from ETABS

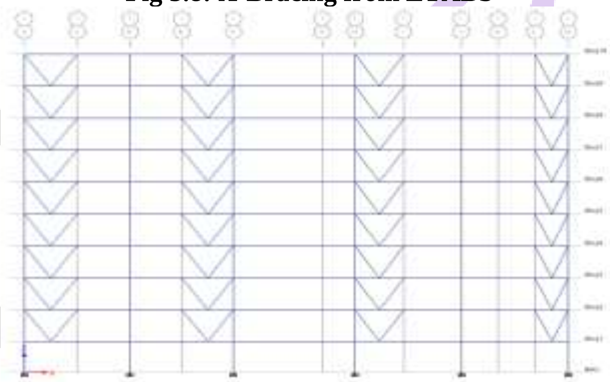


Fig 3.9: V Bracing from ETABS

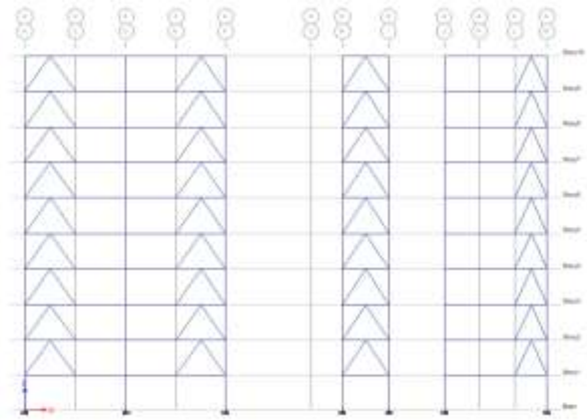


Fig 3.10: Inv V Bracing from ETABS

Fig 3.11: 3D view X Bracing from ETABS

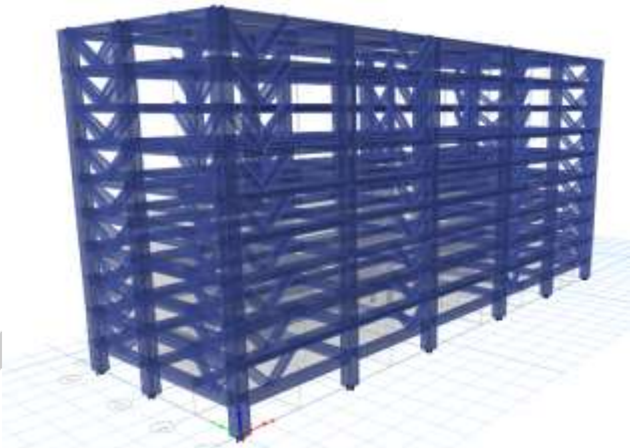


Fig 3.12: 3D view V Bracing from ETABS

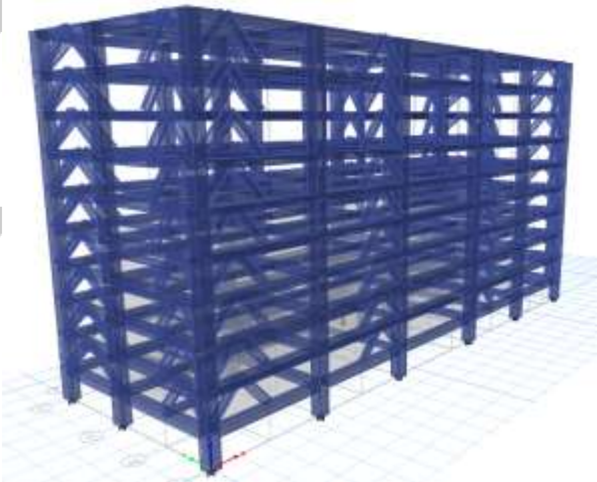


Fig 3.13: 3D view inverted V Bracing from ETABS

3.10 Analysing and Design Details

In this phase the Loads which are applied on slabs and frames are analyzed by using E-tabs software. In this phase, all bending moment, Shear Force, axial forces are obtained at each and every point of element and also its maximum value. Following data should be considered for the analysis of this structure.

Cross section details:
Beam: 450 x 600, 300 x 600, 200 x 600, 200 x 450, 200 x 150
Column: 760 x 760, 300 x 200

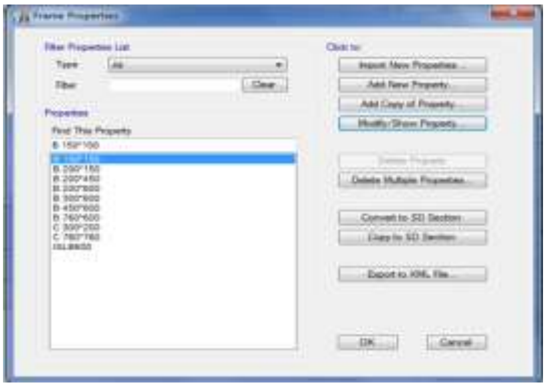


Fig 3.14: Different Frames Section

Fig 3.15: Different Load Procedures

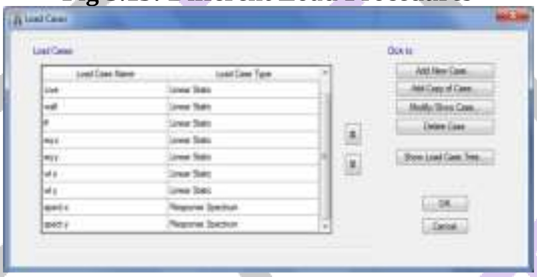


Fig 3.16: Load Cases

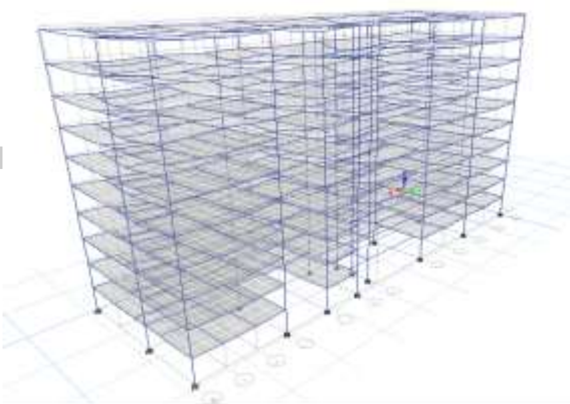


Fig 3.17: 3D-Deformed shape from ETABS

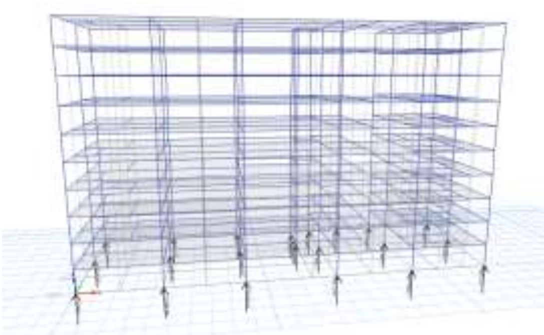
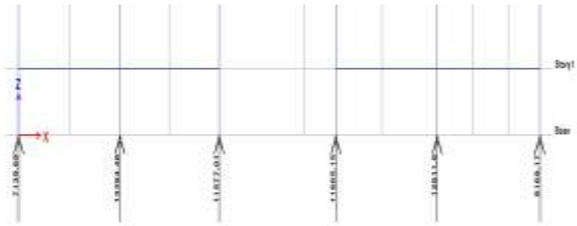


Fig 3.18: Support reactions from ETABS



13394.45

Fig 3.19: Support reactions from ETABS [grid 3-3] max value

4. RESULTS AND DISCUSSION

This particular chapter deals with results found from the many analysis run. These results are represented in graphical and tubular forms. These results include the comparing the results of displacement, story shear (story drift), model mass participating factor under Zone II& Zone 5. All the parameters were checked for spectrum, earthquake loads and wind loads

4.1 Storey Displacement

The first criteria that was checked was the storey displacements that are the major concerns in tall structures. Below the results for earthquake and wind loads are given in graphical form.

4.2 Storey Drift

The next criteria that was checked was the drift. Storey drift is drift of a storey of a multi storey building relative to the storey below. Difference between the roof and floor displacement of any given storey is inter storey drift and occurs as building sways during the earthquake, normalize by the story height. Results for earthquake and wind loads are given in graphical form.

4.3 Modal mass participating factor

The modal mass participation is building behavior or participation for the loading occur instantly the building reacts and mainly the excitation of base, same content will be notified as different modes. The earthquake will strike building and 60% of such lateral load should go out from building as per IS 1893.

4.4 Comparative Results of all Models

This section deals with the various results obtained from each models under all kinds of loading.

4.4.1 Storey Displacement

The storey displacement of models X, V & INV-V models under Zone II & Zone V for different loads are shown below. Seismic displacements due to seismic and wind loads are graphically represented below.

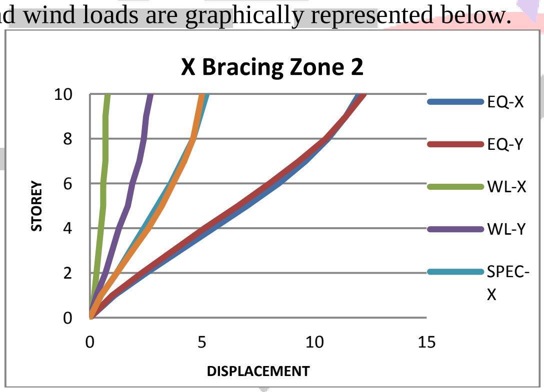


Fig 4.25: Variation in Displacements for **X-** braced model in Zone 2 for all the loads

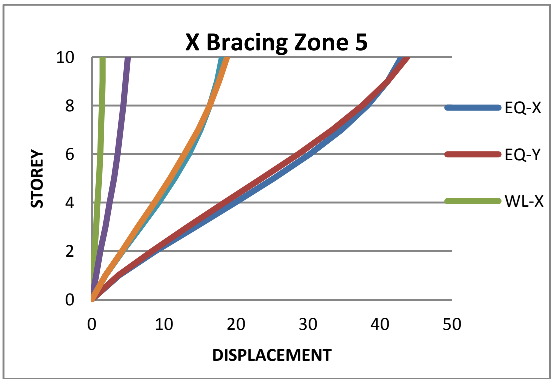


Fig 4.26: Variation in Displacements for **X-** braced model in Zone 5 for all the loads

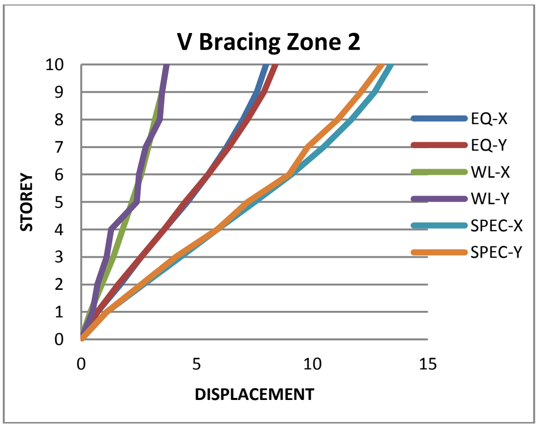


Fig 4.27: Variation in Displacements for **V-** braced model in Zone 2 for all the loads

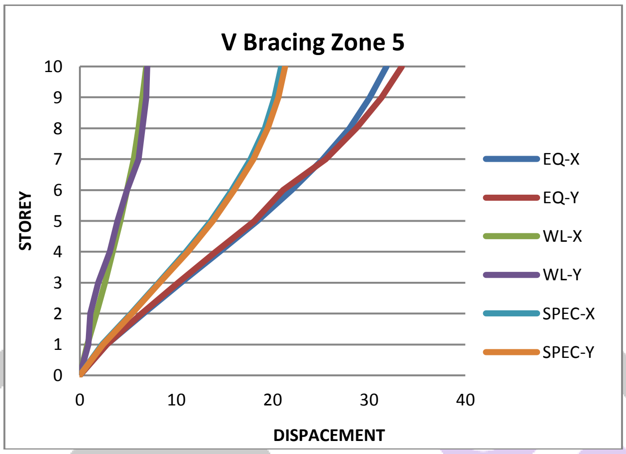


Fig 4.28: Variation in Displacements for **V-** braced model in Zone 5 for all the loads

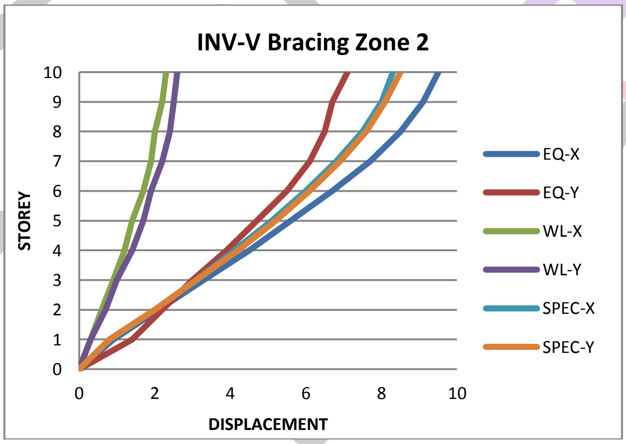


Fig 4.29: Variation in Displacements for **INV-V-** braced model in Zone 2 for all the loads

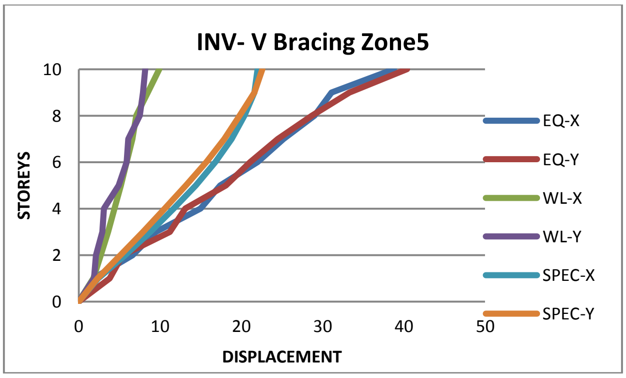


Fig 4.30: Variation in Displacements for **INV-V-** braced model in Zone 2 for all the loads

4.4.2 Storey Drift

The storey drift of models X, V & INV-V models under Zone II & Zone V for different loads are shown below. Drift displacements due to seismic and wind loads are graphically represented below.

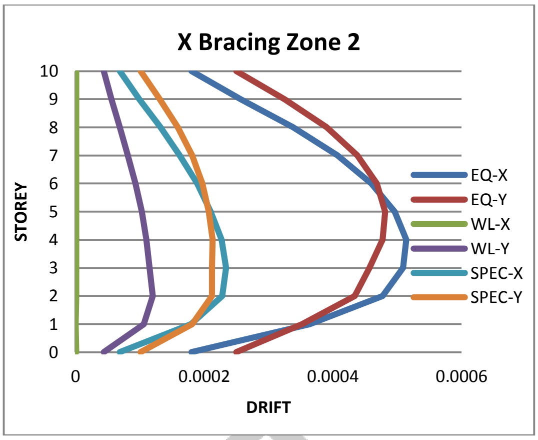


Fig 4.31: Variation in Drift for **X-** braced model in Zone 2 for all the loads

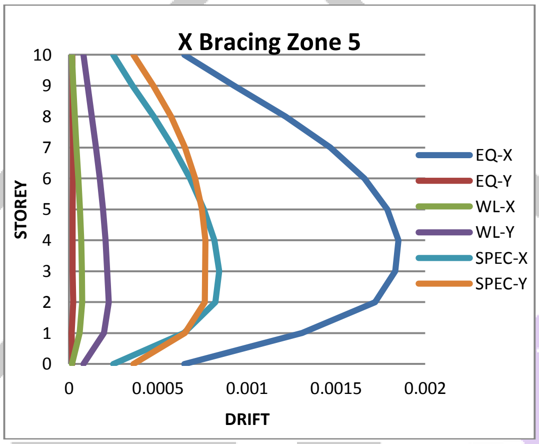


Fig 4.32: Variation in Drift for **X-** braced model in Zone 5 for all the loads

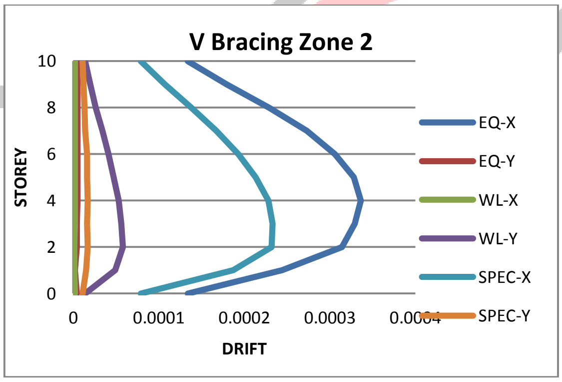


Fig 4.33: Variation in Displacements for **V-** braced model in Zone 2 for all the loads

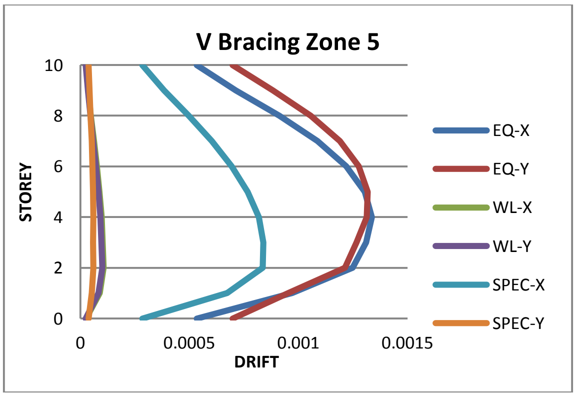


Fig 4.34: Variation in Displacements for **V-** braced model in Zone 5 for all the loads

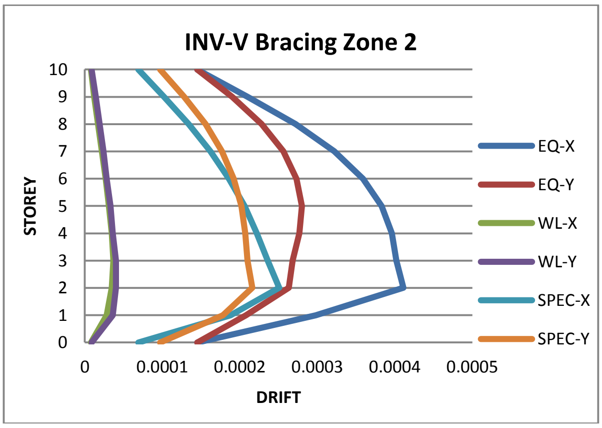


Fig 4.35: Variation in Displacements for **INV-V-** braced model in Zone 2 for all the loads

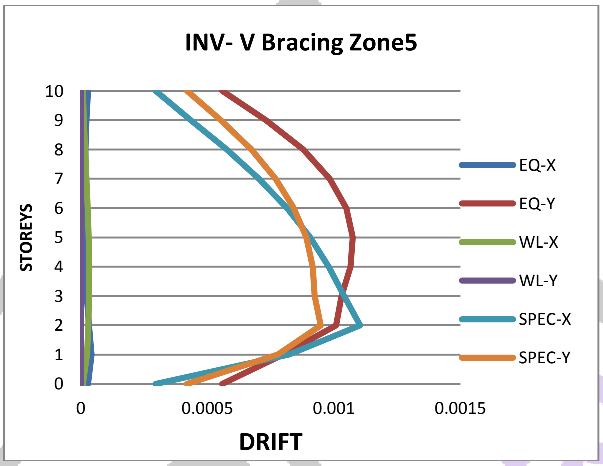


Fig 4.36: Variation in Displacements for **INV-V-** braced model in Zone 5 for all the loads

4.4.3 Modal Mass Participating Factor: Comparative Results for different models at different zones

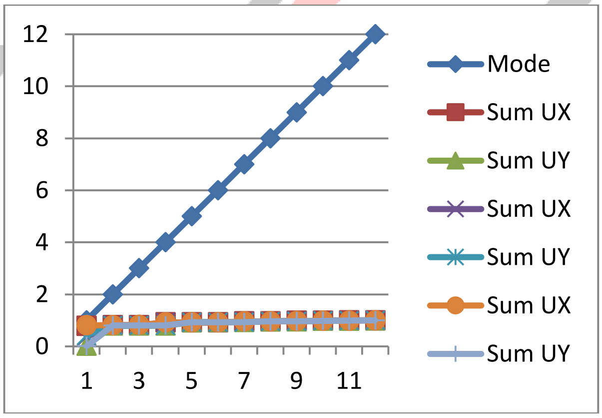


Fig 4.37: Variation in Modal Mass Participation factor for **X, V & INV V**-braced model in Zone 2 respectively.

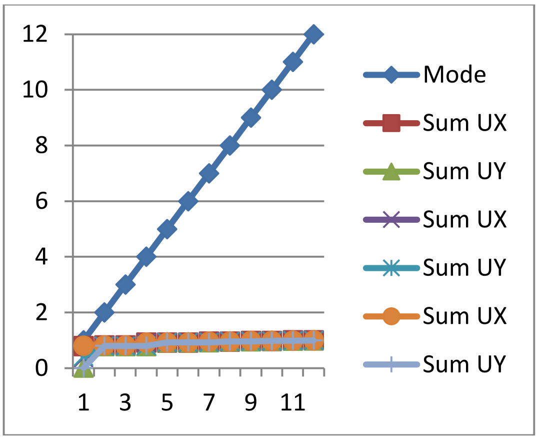


Fig 4.38: Variation in Modal Mass Participation factor for **X, V & INV V**-braced model in Zone 5 respectively.

5. CONCLUSIONS AND SCOPE FOR FUTURE WORK

5.1 CONCLUSIONS

1] Strength of the building will increases on adding of the bracings, more in X bracing compared to others. Stiffness will be less so that behave flexibly so that safe condition achieved.
2] The displacement factor in X bracing is less on Spec X loading condition. So that in extreme condition like Zone 5 region advised to bracing incorporation.
3] The minimum storey displacement for lateral loading, happened in Zone 2 V bracing 8 mm lesser compared to code IS -1893 2002 it is [H/250 = 120 mm] for Earthquake load.
4] The maximum storey displacement happened in X bracing 42 mm lesser than [H/250 = 120 mm] as per standards.
5] All the storey displacement values are in limitations as per IS codes, for the different bracing conditions.
6] For Wind loading displacement is maximum in Inv V bracing 9 mm and minimum in X bracing which are in the limits as per mentioned IS Codes.
7] The other parameter studied is Modal Mass Participating factor, should be greater than 60% as per codes in 3rd mode. Here all the bracing models given with limiting values.
8] Story drift minimum for X braced model at zone 2 which is less than 0.004 times height and such that almost values gives same at top and bottom.
9] Story drift maximum at V braced model for Zone 5 at earthquake loading and drift can be observe at the middle portion of the building and about same values at top and bottom, so that estimated to be 63% more compare to all other drift values observed.
10] Such that building design safely done based on parameters studied as per codal standards and ideology obtained from knowledge as per incorporation of different bracing systems in single model systematically.

5.2 SCOPE FOR FUTURE WORK

1. The models can be analyzed for different soil conditions.
2. The models can be analyzed for different type of buildings and for different heights.
3. The bending moments and shear force of the different models can be compared.

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