Seismic Evaluation of Multi Stored Rcc Structures With And Without Bracings

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Abstract- *In the present study to find the seismic effects on RCC buildings four G+10 structure models without bracings, with diagonal, with x bracings and with v bracings are considered by modeling of structure having material properties Fe415 steel and M30 concrete and structure dimensions height is 36m from the foundation or footing top, length of building is 60m and width of building is 30m, column to column distance in shed is 6m. Support conditions are taken as fixed base and structures are modeled using ETABS in seismic zone II, III, IV and V as per IS 1893-2002. Structure-1: G+10 RCC building without bracings, Structure-2: G+10 RCC building with diagonal bracings, Structure-3: G+10 RCC building with X bracings, Structure-4: G+10 RCC building with V bracings. It observed the structure having x bracings are providing good seismic resistance.*

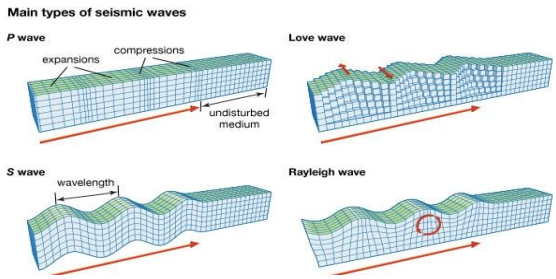
I. INTRODUCTION

Earthquake originates due to sudden slip of fault planes below the earth crest, energy is released in the form of waves and the waves will travel along all the mutually perpendicular and orthogonal directions in all the a soil layers. various seismic waves are produced such as primary(P), secondary(S) waves these two waves are termed as the body waves and love and stoneley waves these are known as surface waves. Waves moves with a velocity of 2-13km/s are has the ability to shake the structures resting on the ground surface. the magnitude of the earthquake is measured using the richter scale or modified mercalli scale. P waves are called compression waves they travel fast and reach surface earlier. S waves are shear waves that are transverse in nature these waves travel slower than the P waves and reach the earth surface later. Earthquake is non avoidable, in the past earthquake affected areas it is observed that the infrastructure is damaged which are not designed for lateral loading, shear walls and bracings are used in multistoried structures to resist the lateral seismic forces.

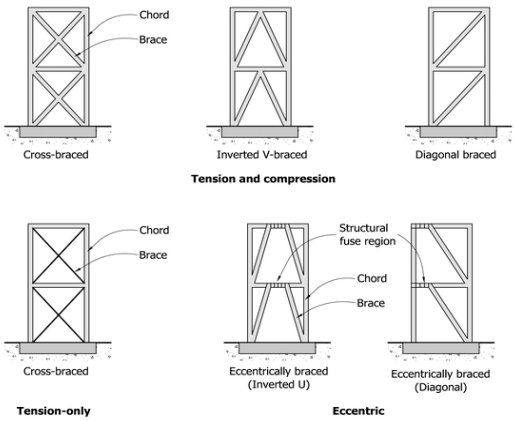
1.2 Seismic waves

Waves are produced from the epicenter or origin of earthquake, this waves travels in all directions, soil layers and water bodies reaches the surface these waves are termed as seismic waves, seismic waves have energy stored and have ability to shake the structures resting on and above the ground this phenomena is called earthquake. Earthquake is also generated due to volcanic eruptions, landslides and heavy vehicular movements and manmade explosions and also due to lesser frequency acoustic source energy. the magnitude of the earthquake or seismic waves are measured in richter scale and mercallis scale, accelometer and seismometer are also used to measure the seismic waves directions

1. **Body waves**
   - Primary waves
   - Secondary waves
2. **Surface waves**
   - Love waves
   - Stoneley waves



1.4 Types of Bracings



1.5 Advantages of Bracings

1. Provision of bracing systems reduces lateral displacement of floors thus reduction of forces in forces on columns.
2. Bracing system can be provided in various forms and configurations and locations in structures.
3. bracings can be erected using different materials steel, rcc etc
4. Bracing systems reduces storey drifts of floors thus reduction of forces in forces on columns.

1.6 Disadvantages of Bracings

1. costly and skilled labour are required fir erections
2. Increased support reactions due to transfer of brace forces.
3. required higher foundation systems

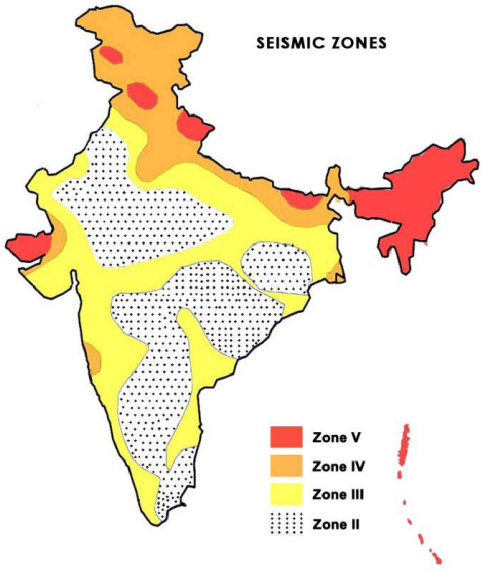
1.7 Seismic Data

Based on magnitude of the earthquake India is classified into four zones (II, III, IV, and V) where zone V is high severity zone

Table 2 Zone Factor, *Z*

(*Clause* 6.4.2)

Seismic Zone	II	III	IV	V
Seismic Intensity	Low	Moderate	Severe	Very Severe
Z	0.10	0.16	0.24	0.36



II. LITERATURE REVIEW

Nitin N. Shinde, R. M. Phuke made Study of Braced RCC Building with unsymmetrical braces the bracings considered are made of rolled steel sections and the bracings considered in the analysis of the structures are cross braced, x shape bracing, V shape and inverted V shape steel bracings are considered at different floor levels . rolled steel sections mostly used in the analysis are angle sections, I sections and channel sections type of the section to be adopted depends on the force and the intensity and magnitude of the earthquake to be resisted by the structural system at the different floor levels and from the analysis results the authors concluded that the the lateral storey displacement is reduced based on the type of bracing system and the cross sectional shape and size of the bracing. the storey drift means the relative displacement is found to be decreasing when compared with unbraced structures in different seismic zones and also shown that the overall response of the structures is decreased with the provision of braces at different floor levels and also concluded that with the increase of the section sizes of the braces the results are decreased and by comparing the structures with cross braced, x shape bracing, V shape and inverted V shape, X braced building is better than other braced buildings.

Rakshith K L, Smitha investigated the Effect of reinforced concrete structures with braces under the dynamic loading bracing system are found to be more effective than other lateral systems for resisting dynamic loadings in concrete, steel and composite structures. bracing system resists lateral loads by transferring the forces both in compression and tension forces. Bracing system increases the stiffness of the structure and reduces the structure forces displacements,

deformations, drifts, shear and bending moments. braces also support gravity loads dead and loads, wind and seismic forces. Braces acts as resisting supporting system for columns and beams thus reduces the effect of failure of the members. in this work authors carried out analysis by response spectrum method , the structure results are found to be reduced in both regular structures and irregular structures with x type bracing system, the displacements, drifts, shear and bending moments are reduced using x bracings.

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A. Moein Amini & M. Majd, M. Hosseini made a report on bracing arrangement to find the seismic behavior of structures by nonlinear analysis in both static and dynamic analysis. in there study authors tried regular bay structures of 4m and 6m and the structures heights considered are G+3, G+5 and G+7 and the bracing system adopted are X, V and chevron bracings are placed at the adjacent and alternate layers along the structure heights, analysis is carried out using the push over analysis and the results are compared with standard values. the braces are placed at the adjacent and non adjacent bays. Structures with three different types of bracing systems X, V and chevron non adjacent bracing placement shows lower structural stiffness when compared with other placement of bracings but higher strength and the other two braces placement had shown nearly same stiffness. The lateral load résistance capacity of chevron type bracing is higher when compared to other types of bracing systems X, V and the chevron is almost 50% higher than the x bracing and the authors concluded that using the same seismic response modification factors for all types of bracing systems is not applicable and the seismic codes to be revised conservative designs should be avoided in the upper floors to avoid failures due to lateral seismic loadings and this effects is more higher in high intensity zones and also the effects are more in soft, medium and hard soils, so the previous provisions are to be changed in codes.

III. METHODOLOGY

3.1 Modeling of Structures

In the present study to find the seismic effects on RCC buildings four G+10 structure models without bracings, with diagonal, with x bracings and with v bracings are considered in modeling of structures having material properties M30 concrete and Fe415 steel and structure dimensions height is 36m from the foundation or footing top, length of building is 60m and width of building is 30m, column to column distance in shed is 6m. Support conditions are considered as fixed base and structures are modeled using ETABS in seismic zone II, III, IV and V as per IS 1893-2002 Figures are shown below.

Structure-1: G+10 RCC building without bracings
Structure-2: G+10 RCC building with diagonal bracings
Structure-3: G+10 RCC building with X bracings
Structure-4: G+10 RCC building with V bracings

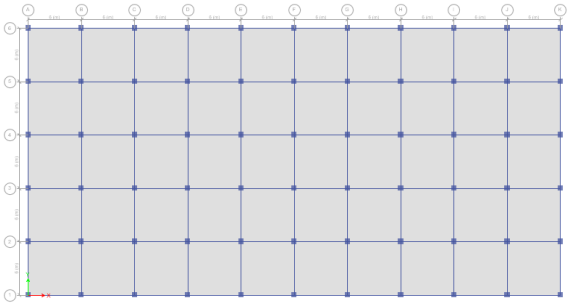

Fig 3.1: plan of structures

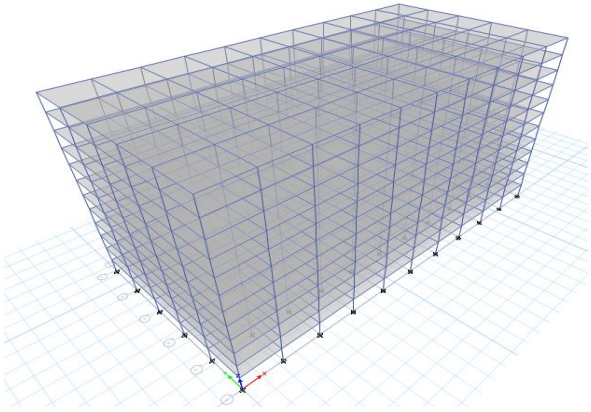

Fig 3.2: 3d view of structure

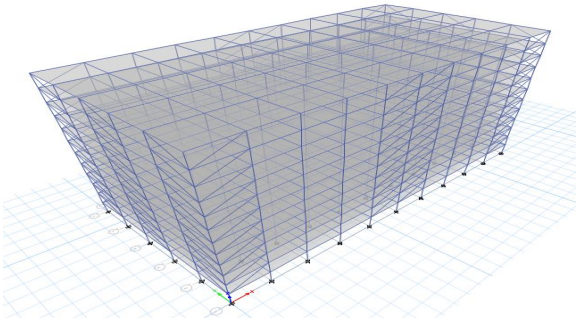

Fig 3.4: 3d view of structure-2

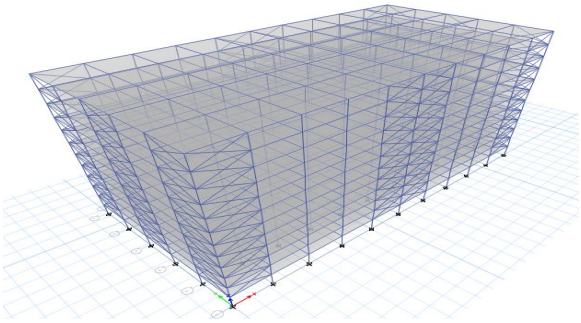

Fig 3.6: 3d view of structure-3

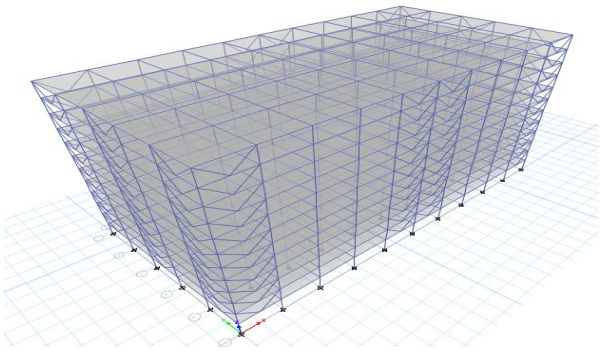

Fig 3.8: 3d view of structure-4

Table 3.1: design parameters considered

Materials	M30, Fe415
Loadings	Dead, live, earthquake
Heights of building	G+10
Length	6x10 = 60m
Width	6x5 = 30m
Foundation depth	3.0m
Floor to floor height	3.0m
Zones	II,III,IV,V
Software	ETABS
Size of column	600x600
Beam size	300x600
Soil type	Hard
Types of bracings	Diagonal, X,V
Geometry of Building	Symmetric

3.2 Load Calculations as per IS: 1893-2002

These frames are analyzed for load combinations suggested by IS 1893, i.e,

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

IV. RESULTS AND DISCUSSION

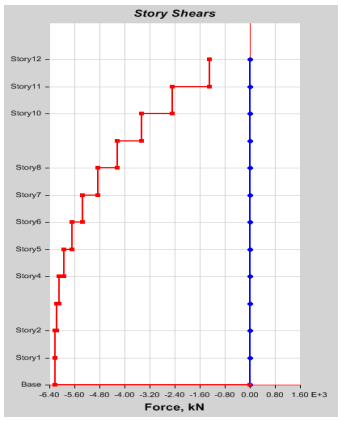

Fig 4.4:storey shear in structure-1

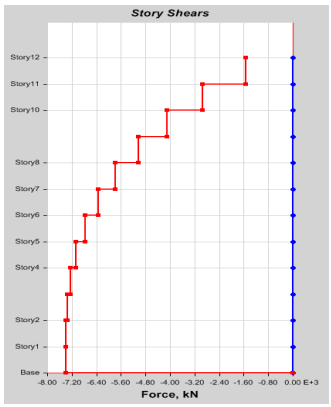

Fig 4.6:storey shear in structure-2

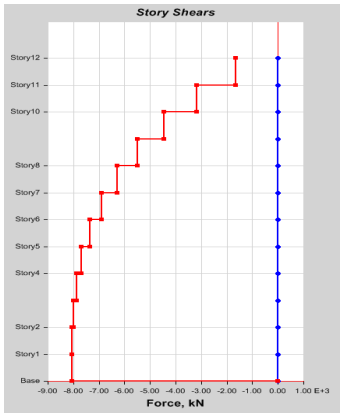

Fig 4.12:storey shear in structure-3

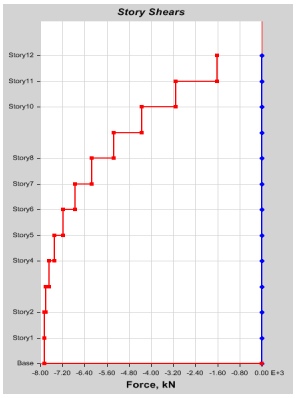

Fig 4.16:storey shear in structure-4

Table 4.1: support reactions in different structures

Type of Structure	Support reaction, kN
Structure-1	135877
Structure-2	137702
Structure-3	139527
Structure-4	138186

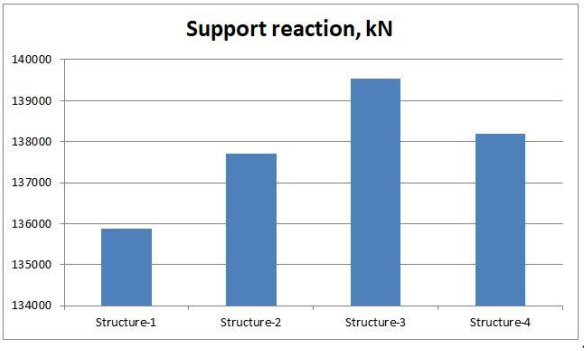

Chart 4.1: support reactions in different structures

Table 4.2: displacements in structure-1 in different zones

Type of Zone	Structure-1, displacement mm
Z2	12.07
Z3	19.25
Z4	28.83
Z5	43.17

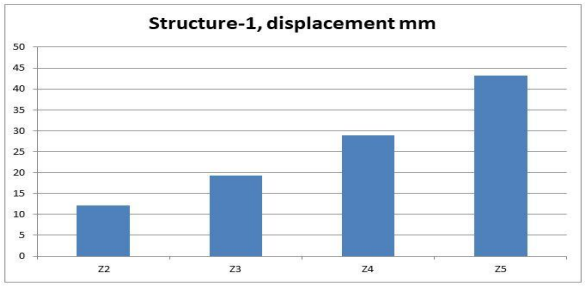

Chart 4.2: displacements in structure-1 in different zones

Table 4.3: displacements in structure-2 in different zones

Type of Zone	Structure-2, displacement mm
Z2	9.94
Z3	14.93
Z4	21.59
Z5	31.57

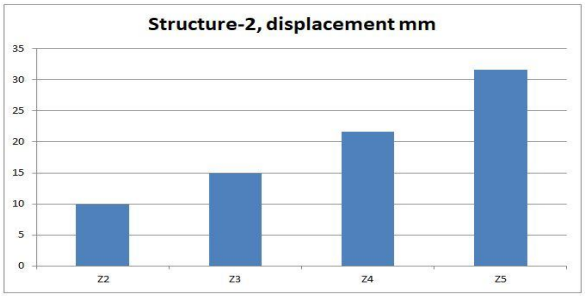

Chart 4.3: displacements in structure-2 in different zones

Table 4.4: displacements in structure-3 in different zones

Type of Zone	Structure-3, displacement mm
Z2	8.14
Z3	12.95
Z4	19.36
Z5	28.97

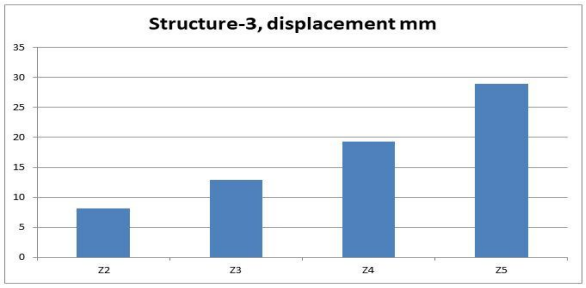

Chart 4.4: displacements in structure-3 in different zone

Table 4.5: displacements in structure-4 in different zones

Type of Zone	Structure-4, displacement mm
Z2	8.25
Z3	13.12
Z4	21.69
Z5	32.65

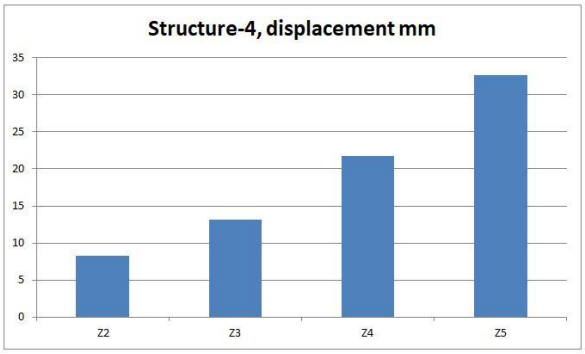

Chart 4.5: displacements in structure-4 in different zones

Table 4.6: displacements of all structures in different zones

Type of Zone	Structure-1	Structure-2	Structure-3	Structure-4
Z2	12.07	9.94	8.14	8.25
Z3	19.25	14.93	12.95	13.12
Z4	28.83	21.59	19.36	21.69
Z5	43.17	31.57	28.97	32.65

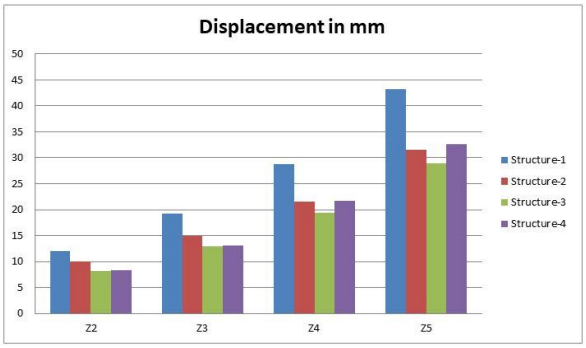

Chart 4.6: displacements of all structures in different zones

Table 4.7: axial forces in bracings of all structures in different zones

Type of structure	Brace force, KN
Structure-1	-
Structure-2	15.89
Structure-3	7.50
Structure-4	7.94

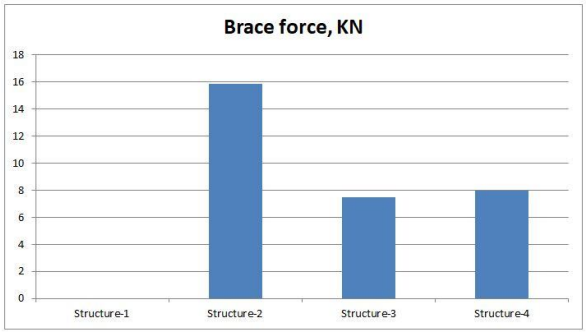

Chart 4.7: axial forces in bracings of all structures in different zones

Table 4.8: column forces of all structures in different zones

Type of structure	Column forces, KN
Structure-1	740
Structure-2	404
Structure-3	312
Structure-4	341

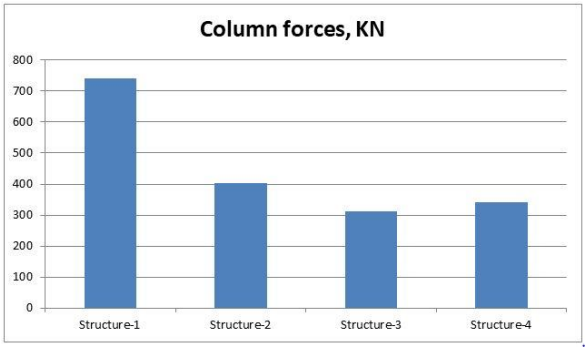

Chart 4.8: column forces of all structures in different zones

Table 4.9: shear forces of all structures in different zones

Type of structure	Shear forces, KN
Structure-1	26.66
Structure-2	30.96
Structure-3	29.05
Structure-4	31.12

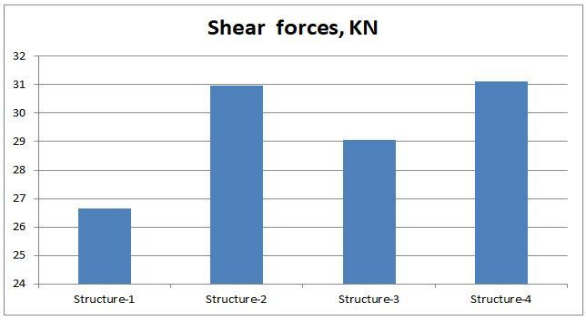

Chart 4.9: shear forces of all structures in different zones

Table 4.10: bending moments of all structures in different zones

Type of Structure	Bending Moment, KNm
Structure-1	18.24
Structure-2	28.14
Structure-3	27.72
Structure-4	27.76

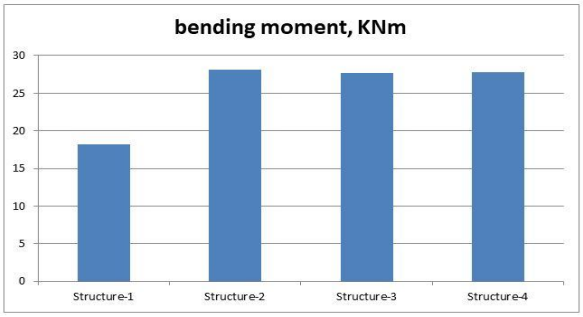

Chart 4.10: bending moments of all structures in different zones

V. CONCLUSIONS

The following are the conclusions drawn from the analysis results of buildings four G+10 structure models without bracings, with diagonal, with x bracings and with v bracings are considered in modeling of structures having material properties M30 concrete and Fe415 steel and structure dimensions height is 36m from the foundation or footing top, length of building is 60m and width of building is 30m, column to column distance in shed is 6m.

Structure-1: G+10 RCC building without bracings
Structure-2: G+10 RCC building with diagonal bracings
Structure-3: G+10 RCC building with X bracings
Structure-4: G+10 RCC building with V bracings

1. Maximum lateral load for structure-1, structure-2, structure-3 and structure-4 are 1100kN, 1400kN, 1500kN and 1500kN.
2. Maximum storey drifts for structure-1, structure-2, structure-3 and structure-4 are 0.0013, 0.0010, 0.0009 and 0.0010.
3. Displacements of the structures are found to be increasing with the increase of the seismic zone and the displacements for structure-3 is found to be lesser.
4. The maximum displacement for structure-1, structure-2, structure-3 and structure-4 are 43.17mm, 31.57mm, 28.97mm and 32.65mm.
5. Axial forces in bracings for structure-2, structure-3 and structure-4 are 15.89kN, 7.50kN and 7.94kN.
6. Shear forces for structure-1, structure-2, structure-3 and structure-4 are 26.66kN, 30.96kN, 29.05kN and 31.12kN.
7. Bending moments for structure-1, structure-2, structure-3 and structure-4 are 18.24kNm, 28.14kNm, 27.72kNm and 27.76kNm.
8. When compared with structure-1 the displacements are reduced by 26.87%, 32.89% and 24.36% for structure-2, structure-3 and structure-4.
9. Axial forces in bracings are reduced by 52.80% and 50.03% in structure-3 and structure-4 when compared with structure-2.
10. When compared with structure-1 bending moments are increased by 54.27%, 51.97% and 52.12% for structure-2, structure-3 and structure-4.
11. When compared with structure-1 shear forces are increased by 16.12%, 9.2% and 16.72% for structure-2, structure-3 and structure-4.
12. From the above results it is observed that structure with X bracing shown better results in seismic zones II, III, IV and V.

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