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# Examination of Performance of Seismically Isolated and Non-Isolated RC Structure using Lead Elastic Bearing Isolators

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**ABSTRACT**
In Reinforced Cement Concrete structures lateral loads are first which will grow proportionally with growth in floor height of the structure as a result of which lateral loads more effective in the top story in contrast to the bottom story due to which the structures are likely to react as cantilever and that forces develop high stresses, produce sway movement leads to serious damages and hence at last results in failure of the structure. Each of these causes form the study of the effect of lateral loads very dominant. Column is the most critical member in the building subjected to earthquake loading because failure of a column can affect the stability of the whole building. Column may fails due to lack of ductility, strength and weak beam column joint. A model of a 14 storey structure is made on ETABS Software and analysis of reinforced concrete framed structure under earthquake excitation has been carried using the linear static analysis methods as per the guidelines provided in IS1893:2016 codes to simulate seismic analysis. In order to study the effect seismic force on LRB system zone II of India a multi-storey hotel building of G +13 of Square and L Shape configuration is taken in zone II with and without having a lead rubber bearing (LRB) at its base is analyses using linear static method. Supports has been removed at base and assigned as spring and different parameters like storey displacement, storey drift, base shear, and storey shear for all cases are evaluated and presented in the form of charts Based on results and comparing the parameters of different cases namely Asymmetric & Symmetric buildings with and without base isolation the conclusion can be made that Base isolation is very effective in reducing the storey drift in Symmetrical building & Asymmetrical building. For Asymmetrical building the base shear in X direction is reduced after the implementation of LRB system and in Y direction the same is reduced.

***KEYWORDS:*** *RC structure, Base isolation, Lead Rubber Bearings, Base Shear, ETABS, Story displacement*

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## 1. INTRODUCTION:

Now-a-days the demand of area for construction is going on increasing everywhere. The shortage of place in different regions has guided to the evolution of vertical growth restoring from low-rise to average-rise and high-rise or tall structures. For High-rise structures Reinforced Cement Concrete is preferred. R.C.C. structures are always subjected to gravity loads (i.e. vertical loads) and lateral loads (i.e. horizontal loads), gravity loads consider live load, dead load, superimposed load, and lateral loads consider earthquake load and wind load. Previously structures were designed and drafted for only gravity loads that may not have protection against lateral or horizontal loads due to low height of structure (Pallavi Badry, 2018). In Reinforced Cement Concrete structures lateral loads are first which will grow proportionally with growth in floor height of the structure as a result of which lateral loads more effective in the top story in contrast to the bottom story due to which the structures are likely to react as cantilever and that forces develop high stresses, produce sway movement leads to serious damages and hence at last results in failure of the structure. Each of these causes form the study of the effect of lateral loads very dominant (Sohan Lal et al. 2018).

Buildings oscillate during earthquake shaking. The oscillation causes inertia force to be induced in the building. The power and term of swaying, and the measure of dormancy power actuated in a structure rely upon highlights of structures, called their dynamic qualities, notwithstanding the attributes of the seismic tremor shaking itself. The significant unique attributes of structures are methods of swaying and damping. A method of wavering of a structure is characterized by related Natural Period and Deformed Shape in which it sways.

## 2. METHODOLOGY

In this work, the analysis based on linear static method is used to investigate "**Examination of Performance of Seismically Isolated and Non-Isolated RC Structure Using Lead Elastic Bearing Isolators**" as per IS-standards. In order to study the effect seismic force on LRB system zone II of India is considered.

**BUILDING MODEL**

Cases of a Building Models which has been considered in the study are given below-

**Table 2.1: Cases under consideration**

| Software used | Configuration of Building | Model Dimensions | Number of Stories | Remarks |
|---|---|---|---|---|
| ETABS | Asymmetrical (L Shaped) | 32 m X 24 m | 14 | Seismic forces of Zone II as per IS: 1893:2002. |
| ETABS | symmetrical (Square Shaped) | 24 m X 24 m | 14 | Seismic forces of Zone II as per IS: 1893:2002. |

**Table 2.2: Specifications of Conventional Slab Structure**

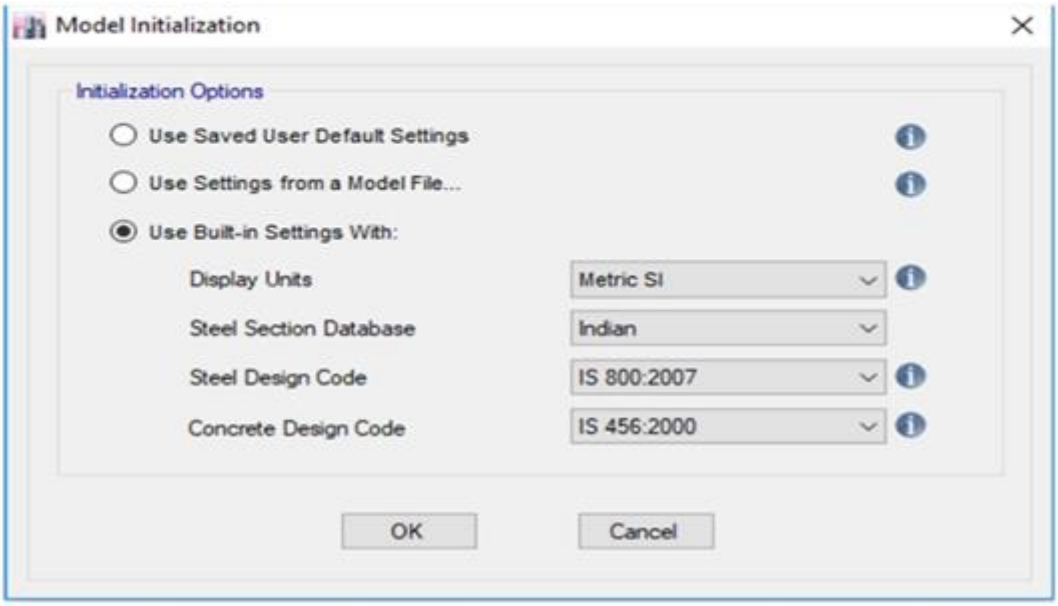
| Specifications | Data |
|---|---|
| Typical Storey Height | 3 m |
| Base Storey Height | 3.0 m |
| No. of_Bays along X-Direction | 5 |
| No. of_Bays along Y-Direction | 5 |
| Bay Length along X-Direction | 6 m (for Square) & 8 m (for L ) |
| Bay Length along Y-Direction | 6 m (for Square) & 8 m (for L ) |
| Concrete Grade | M-25 |
| Density of R.C.C. | 25 KN/$m^3$ |
| Density of Masonry | 20 KN/$m^3$ |
| Columns (perimeter) | 400 mm x 400 mm |
| Columns (interior) | 400 mm x 400 mm |
| Beams | 250 mm x 450 mm |
| Slab Thickness | 130 mm |
| Bottom Support Conditions | Fixed (for non-isolated) & Spring (for Isolated) |
| Live Load-<br>Roof of top floor<br>Roof of Rest of the structure | <br>1.5 KN/$m^2$<br>3.5 KN/$m^2$ |
| Soil Conditions | Type 2 Soil (medium) |
| Damping Ratio | 5%, asper IS-1893: 2002 (Part-1) |
| Poisson Ratio | 0.2 |
| Response Reduction Factor | 5 |
| Importance Factor | 1 |
| Zone Factor | As per IS1893- 2002 (Part 1) for different_Seismic_Zones |

The foundation depth is taken at 1.5 m below ground level.

**LINEAR STATIC ANALYSIS**

Following sequence has been followed to analyse the structure by using ETABS:

**Step 1:** Model Initialization:



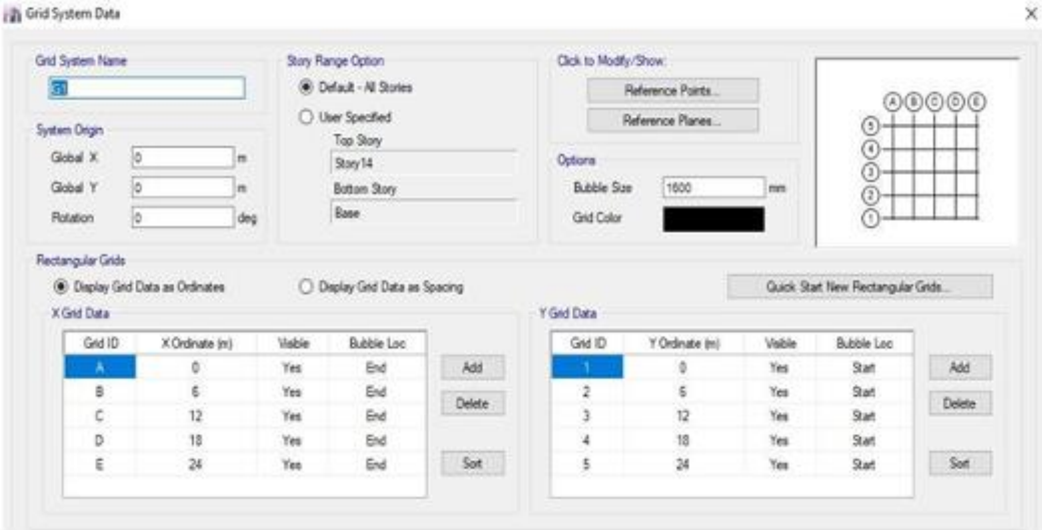



**Fig. 2.1(a): Model Initialization for Square Shaped Structure**

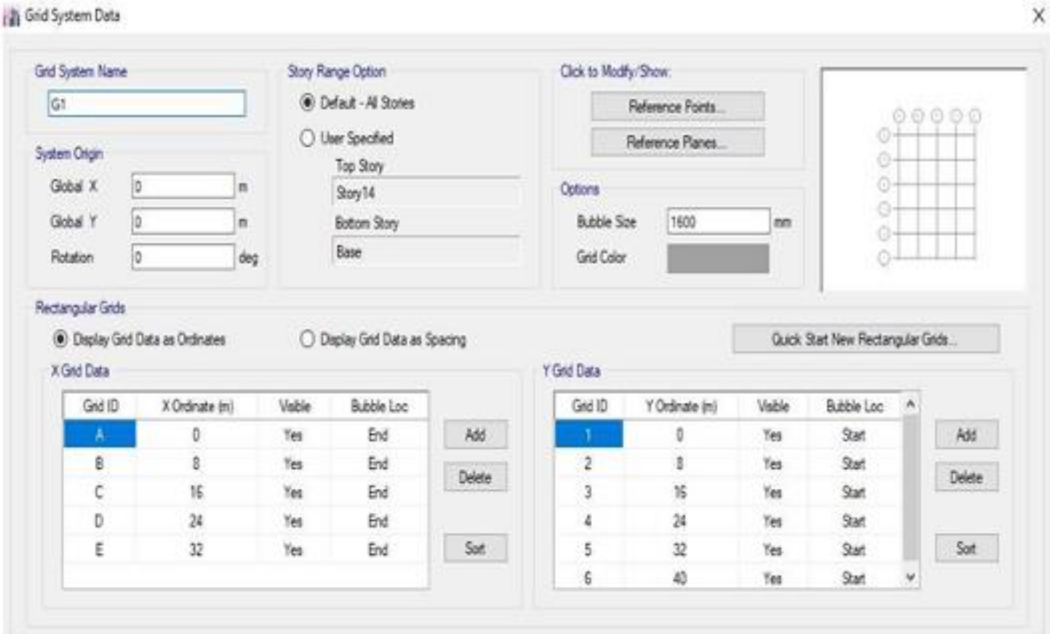



**Fig. 2.1(b): Model Initialization for L Shaped Structure**

**Step 2: Preparing the model of building frame**

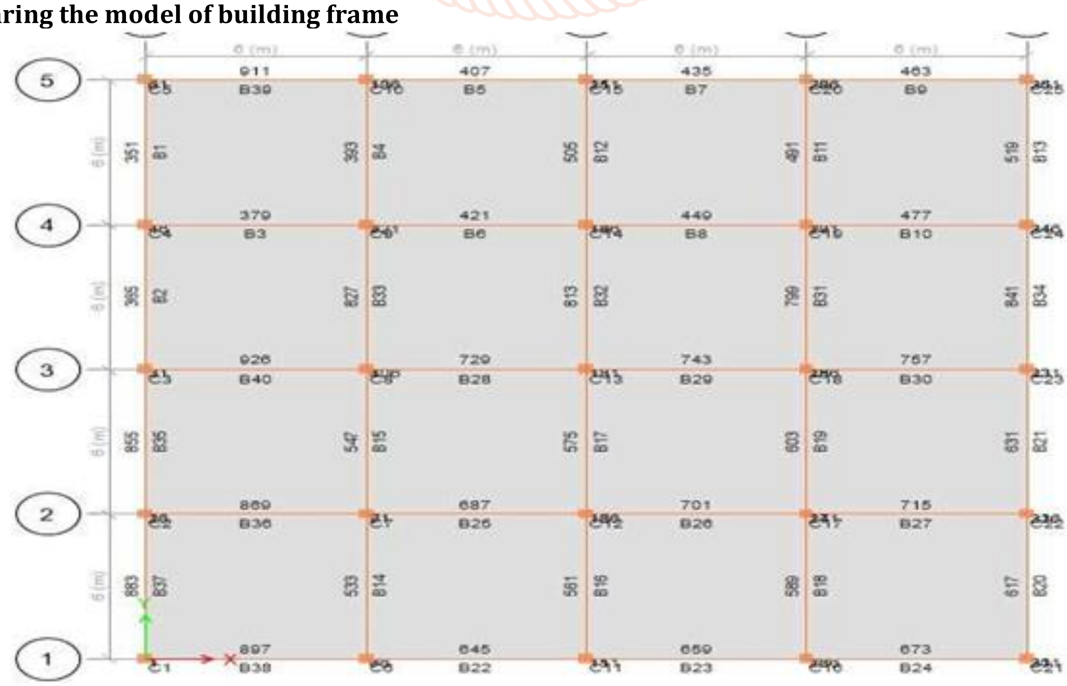



**Fig. 2.2(a): Plan for Square Structure**

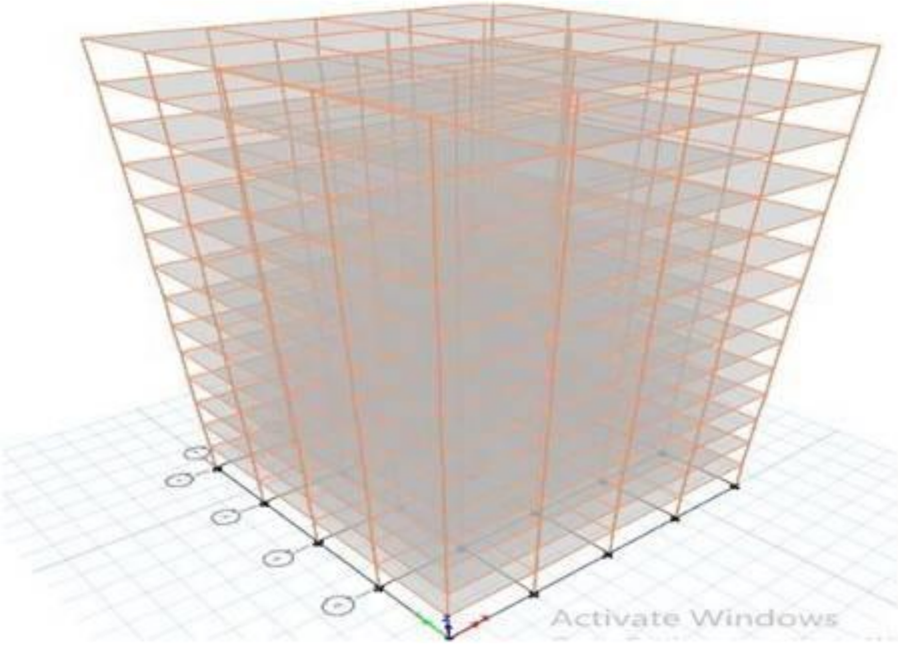



**Fig. 2.2(b): 3-D view for Square Structure**

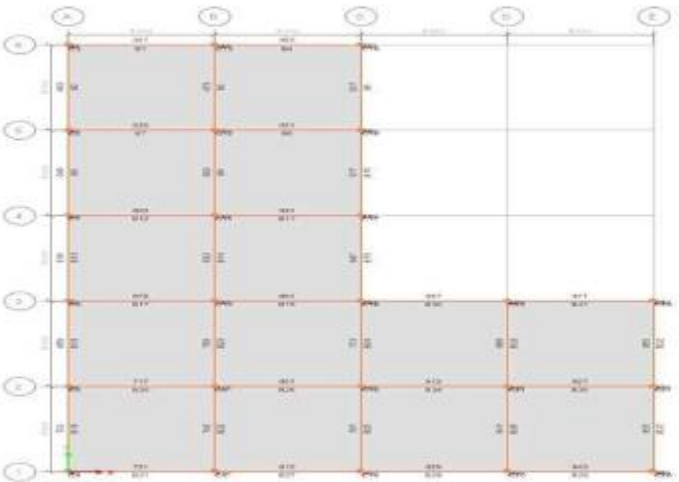


**Fig. 2.3(a): Plan of structure for L shaped Structure**

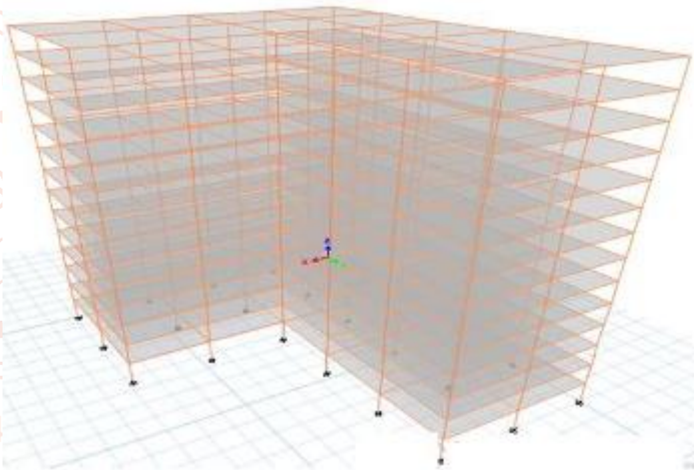


**Fig. 2.3(b): 3 D View for L shaped Structure**

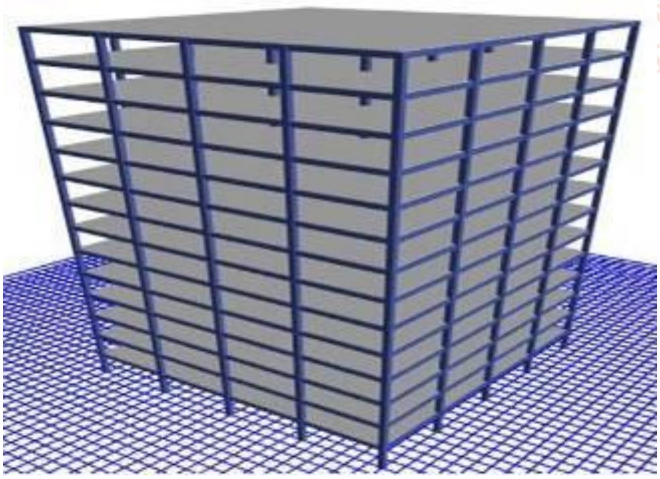


**Fig. 2.4(a): Rendered view of Square structure**

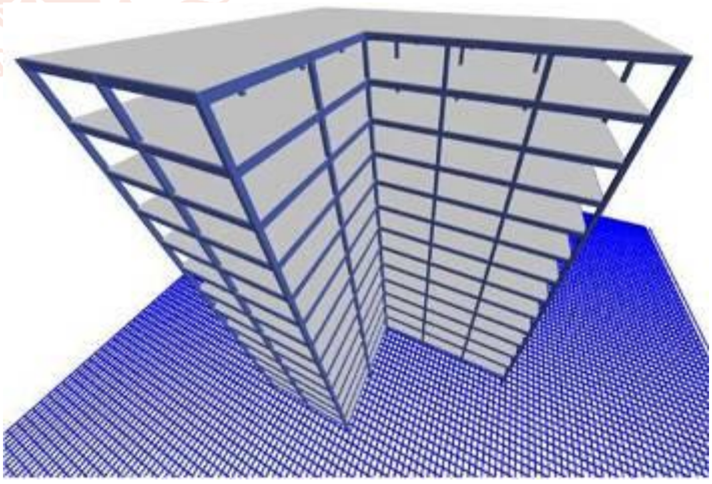


**Fig. 2.4(b): Rendered view of L Shaped structure**

**Step 3: Defining material and sectional property:**

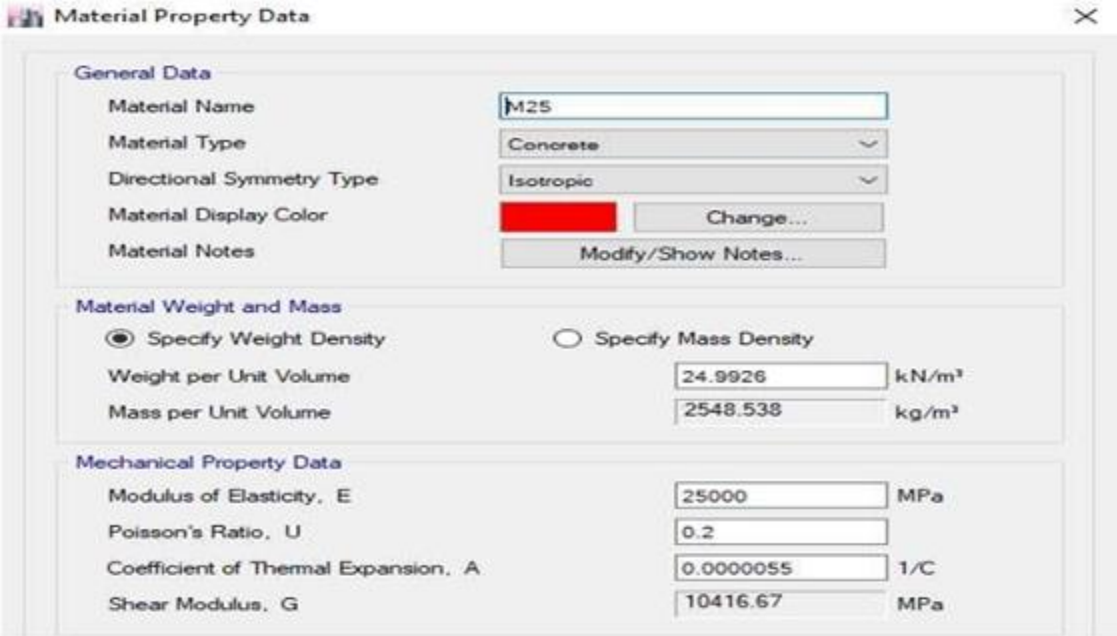



**Figure 2.5 (a): Defining concrete properties**

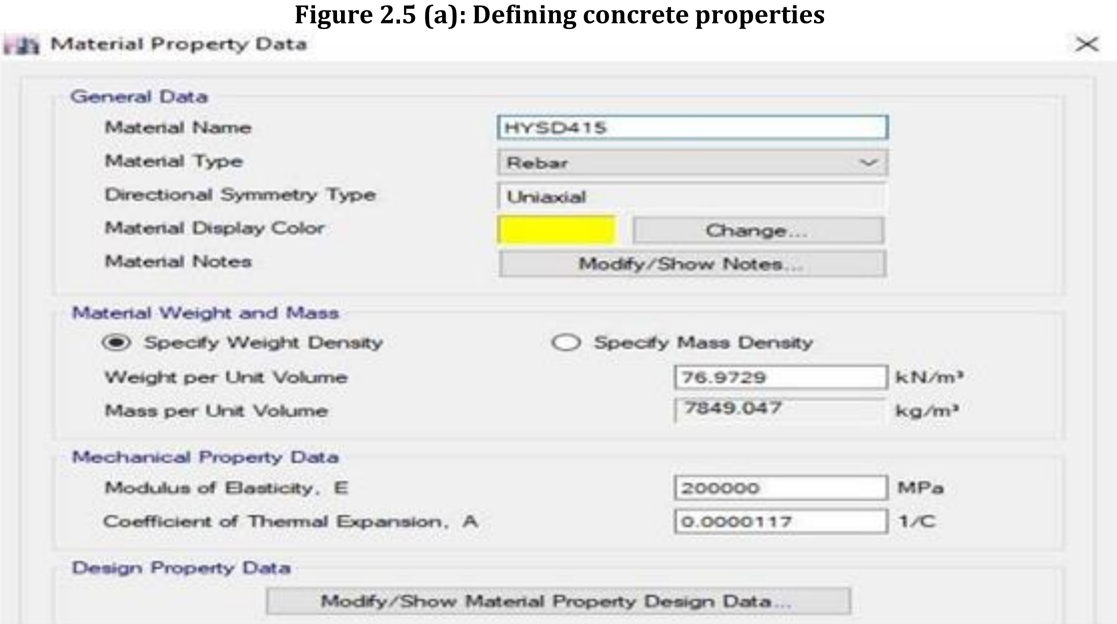



**Figure 2.5 (b): Defining reinforcement properties**

**Step 4: Select the section properties:**


**Figure 2.6 (a): Section of Beam provided 250mmX 450mm**

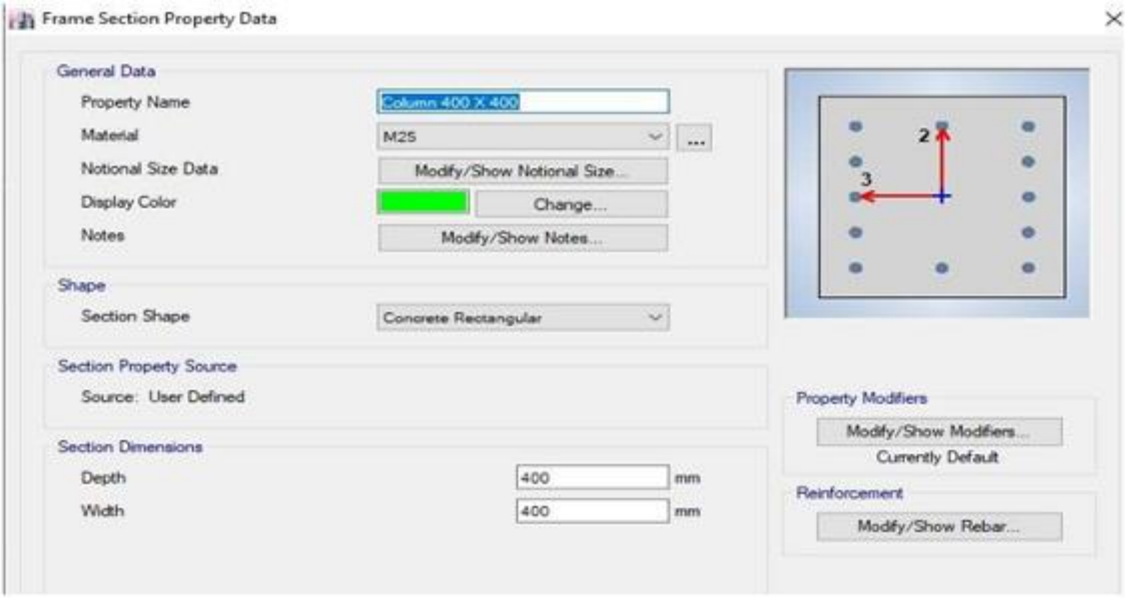



**Figure 2.6 (b): Section properties of column provided 400mm X 400mm**

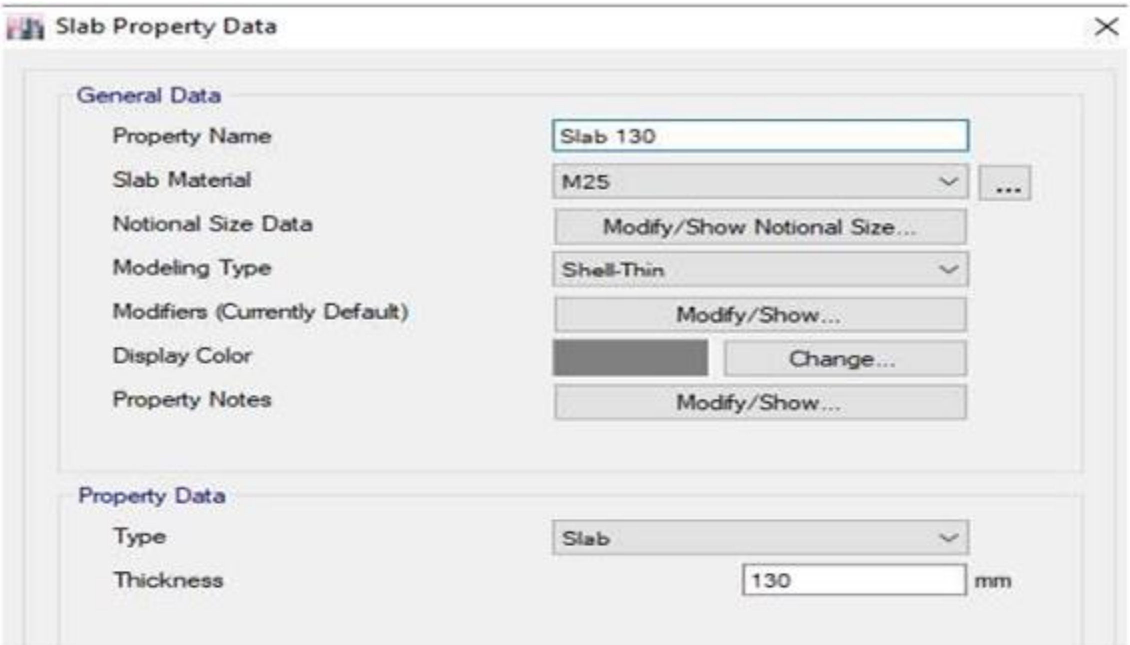



**Figure 2.6 (c): Slab properties definition**

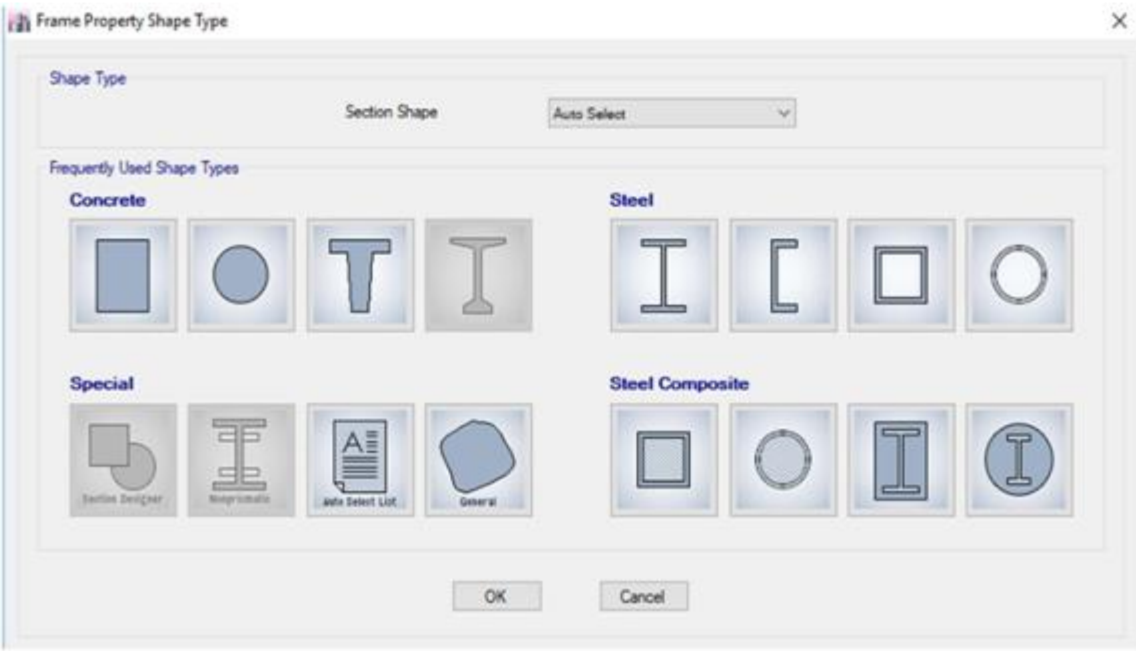



**Figure 2.7: Types of Building frame sections**

**Step 5: Select the support conditions for different loading conditions:**

As we are aware that the structure is always restrained at the bottom, so in this study also we have considered column ends at the ground level to be fixed.

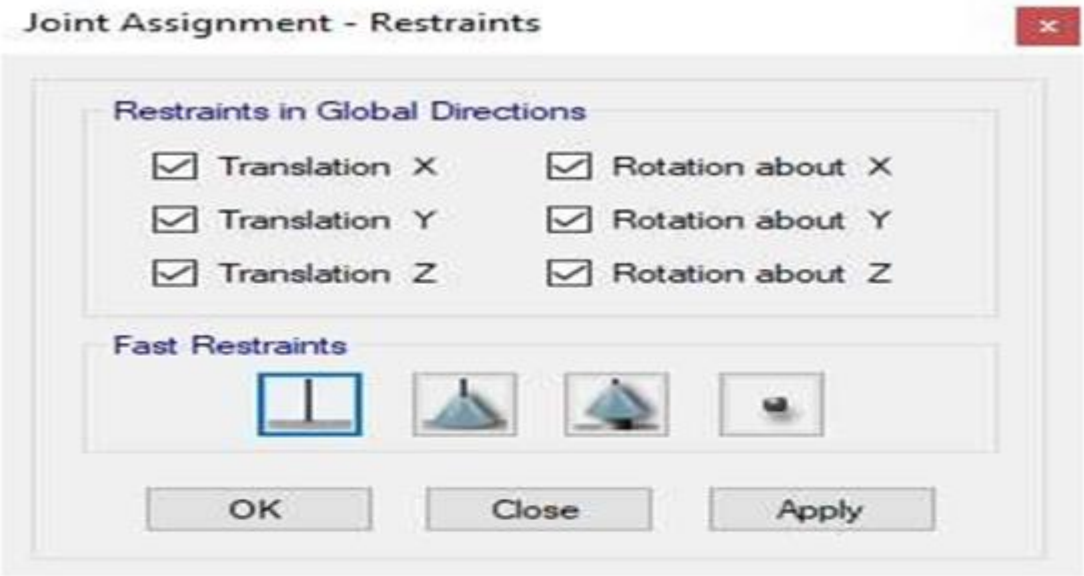



**Figure 2.8 (a): Assigning Fixed supports without LRB**

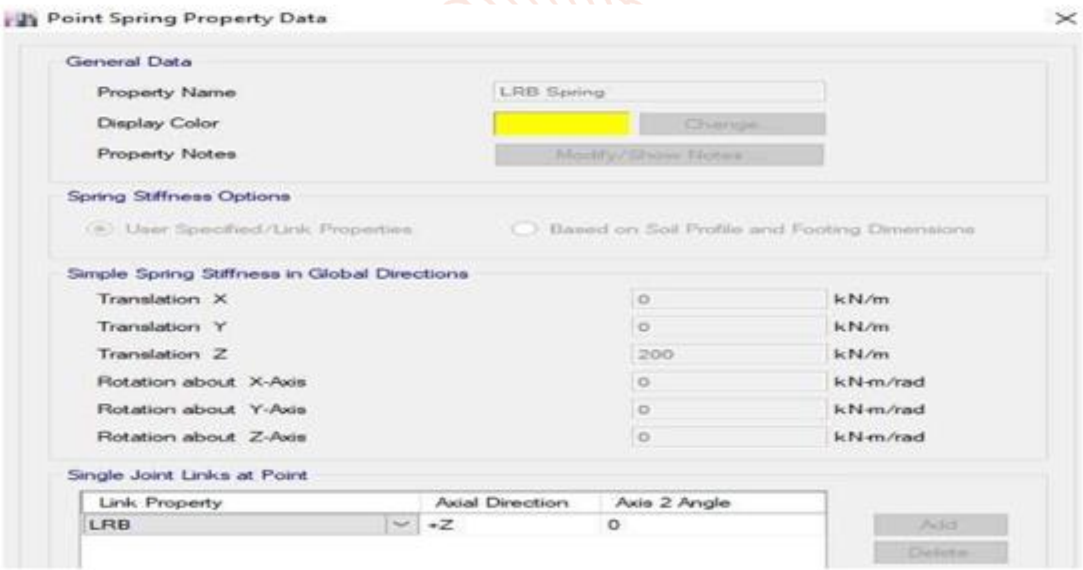



**Figure 2.8 (b): Assigning Spring supports with LRB**

**Step 6: Selection of Modal case type:**

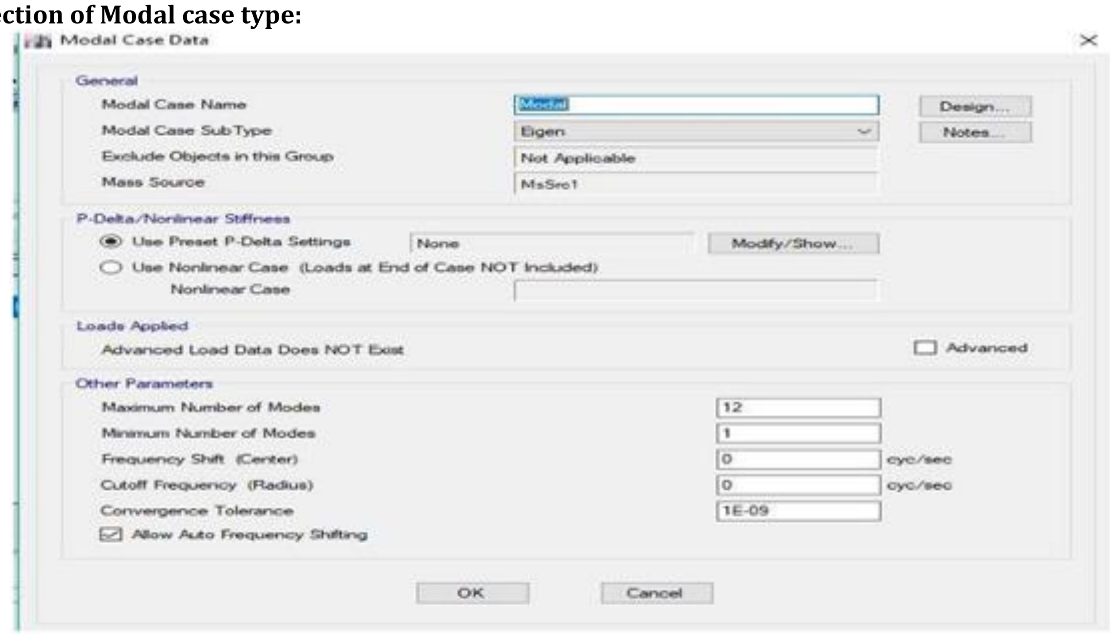



**Figure 2.9: Window showing modal case**

**Step 7: Defining the load parameter and its magnitude.**

**Defining load cases**

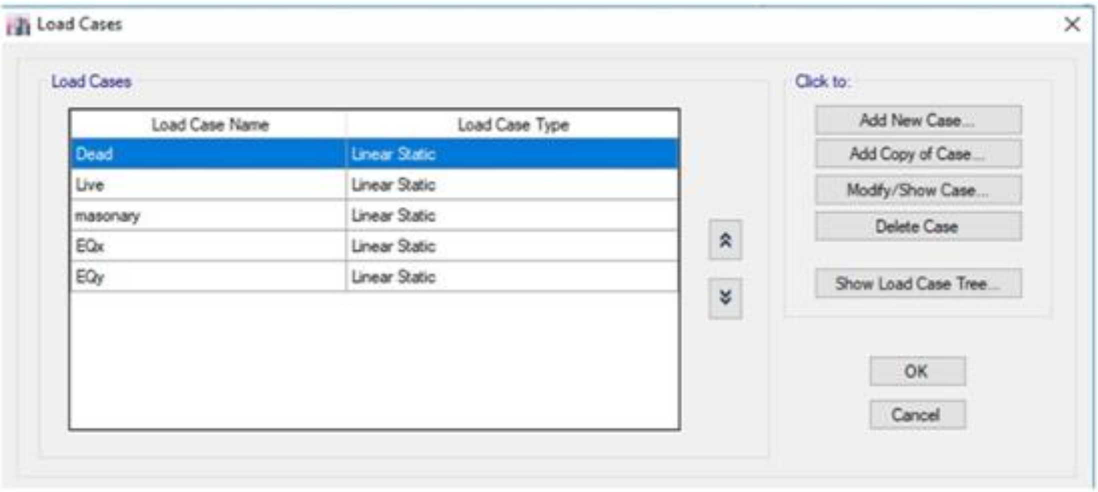



**Fig. 2.10: Load cases details**

**Defining Load Patterns**

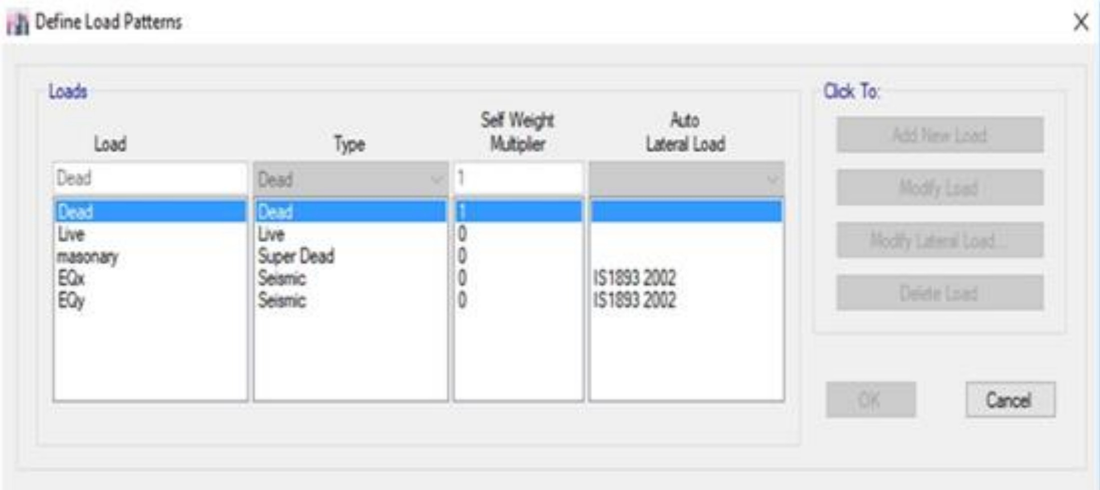



**Fig. 2.11: Load Pattern Details**

**Defining load combinations**

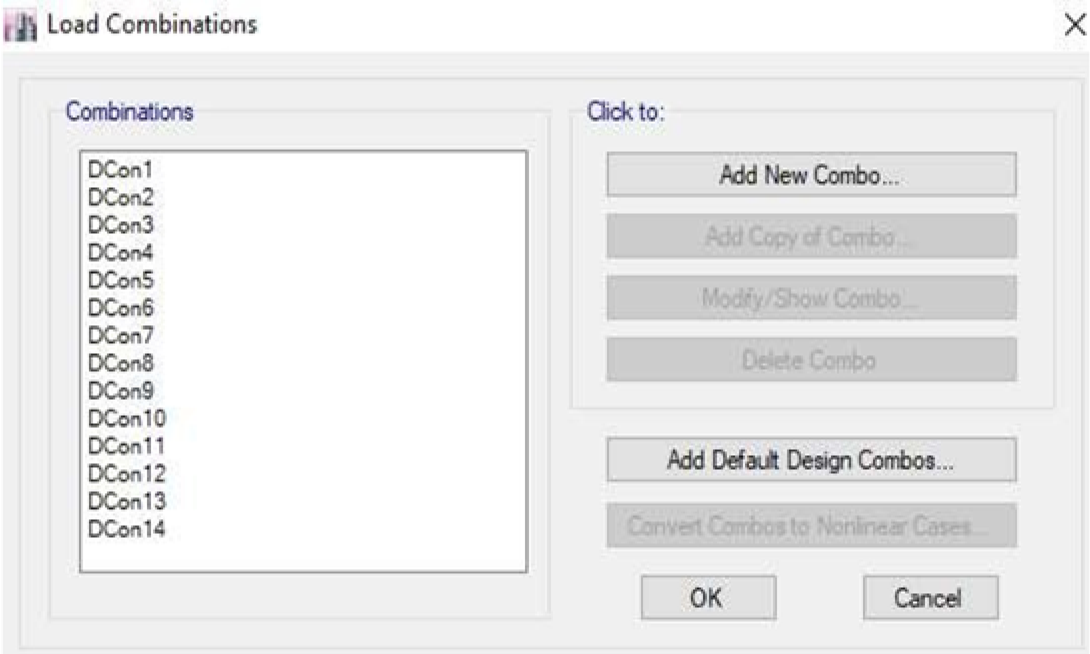



**Fig. 2.12: Combinations of load cases**

**Step 8: Structural analysis of building frames for above loading conditions.**

**Step 9: Comparative analysis of outcomes in terms of Maximum Reactions, Maximum Story Displacement and Maximum Overturning Moments, Story Shear and Base Shear**

**Step 10: Critical study of results.**

## LOAD CASE SPECIFICATIONS

In the analysis of structure, various types of loading conditions are studied and as given below:

### A. Static or Dead Load:

These are the heaps which acts vertically descending and emerges because of oneself load of the structure. Dead loads incorporate mass of the basic part, for example, radiates, segments, sections and so on just as that of non-auxiliary components, for example, floor covers, bogus roofs, stone work dividers and so forth Dead burden is assessed according to its cross-sectional zone increase with the thickness of material utilized. Density of following material:

Density of RCC member = 25 KN/$m^3$.

Density of PCC member = 20 KN/$m^3$.

### B. Live load (IS 875: Part II and IV):

Live loads are those which may change in position and magnitude. According to IS 1893, table 8, Percentage of Imposed Loads which is to be evaluated in Seismic Mass Calculation are manifested as

**Table 2.3: Percentage of Imposed Load**

| Imposed Uniformity Distributed Floor Loads (KN/ $m^2$) | Percentage of Imposed Load |
|---|---|
| Up to and including 3 | 25 |
| Above 3 | 50 |

### C. Load Combinations:

As indicated by IS 1893 (Part 1): 2002, Clause 6.3.1.2the following burden blends of gravity and horizontal burdens with inexact Partial wellbeing factors for limit state plan of fortified solid structures and prestressed solid structures are-

1. 1.5 (D.L. + I.L.)
2. 1.2 (D.L. + I.L. ±E.L.)
3. 1.5 (D.L. ±E.L.)
4. 0.9 D.L. ±1.5 E.L.

Here, 1.5, 1.2 and 0.9 are incomplete security components and DL, IL and EL represent the reaction amounts because of dead burden, forced burden and assigned tremor load individually. The structure is then examined and intended for the mix that yields the most basic worth.

In this thesis works following above cases are expanded and applied in the respective directions as-

1. 1.5 (D.L. + M.L. + I.L.)
2. 1.2 (D.L. + M.L. + I.L. + EQX)
3. 1.2 (D.L. + M.L. + I.L. - EQX)
4. 1.2 (D.L. + M.L. + I.L. + EQY)
5. 1.2 (D.L. + M.L. + I.L. - EQY)
6. 1.5 (D.L. + M.L. + EQX)
7. 1.5 (D.L. + M.L. - EQX)
8. 1.5 (D.L. + M.L. + EQY)
9. 1.5 (D.L. + M.L. - EQY)
10. 0.9 (D.L. + M.L.) + 1.5 EQX
11. 0.9 (D.L. + M.L.) - 1.5 EQX
12. 0.9 (D.L. + M.L.) + 1.5 EQY
13. 0.9 (D.L. + M.L.) - 1.5 EQY
14. Modal Combination.

**Table 2.4: Details of Load Combinations**

| S.NO. | Combination Names in ETABS Software | Corresponding Combination considered in this Research Work as per IS-1893 :2002 |
|---|---|---|
| **1** | UDCon.1 | 1.5 (D.L. + M.L. + I.L.) |
| **2** | UDCon.2 | 1.2 (D.L. + M.L. + I.L. + EQX) |
| **3** | UDCon.3 | 1.2 (D.L. + M.L. + I.L. - EQX) |
| **4** | UDCon.4 | 1.2 (D.L. + M.L. + I.L. + EQY) |
| **5** | UDCon.5 | 1.2 (D.L. + M.L. + I.L. - EQY) |
| **6** | UDCon.6 | 1.5 (D.L. + M.L. + EQX) |
| **7** | UDCon.7 | 1.5 (D.L. + M.L. – EQX) |
| **8** | UDCon.8 | 1.5 (D.L. + M.L. + EQY) |
| **9** | UDCon.9 | 1.5 (D.L. + M.L. – EQY) |
| **10** | UDCon.10 | 0.9 (D.L. + M.L.) + 1.5 EQX |
| **11** | UDCon.11 | 0.9 (D.L. + M.L.) - 1.5 EQX |
| **12** | UDCon.12 | 0.9 (D.L. + M.L.) + 1.5 EQY |
| **13** | UDCon.13 | 0.9 (D.L. + M.L.) - 1.5 EQY |
| **14** | Modal | Modal Combination |

**D. Seismic Loads (IS 1893: 2002)**

At the point when a structure is exposed to ground movement or ground vibration it reacts in shaking style. The irregular blending of structure is conceivable in all potential ways for example in Horizontal (X) and (Y) heading and furthermore in Vertical (Z) course. This movement makes the structure vibrate in each of the three headings. These seismic powers are assessed from IS: 1893:2002.

**FLOW CHART DIAGRAM**

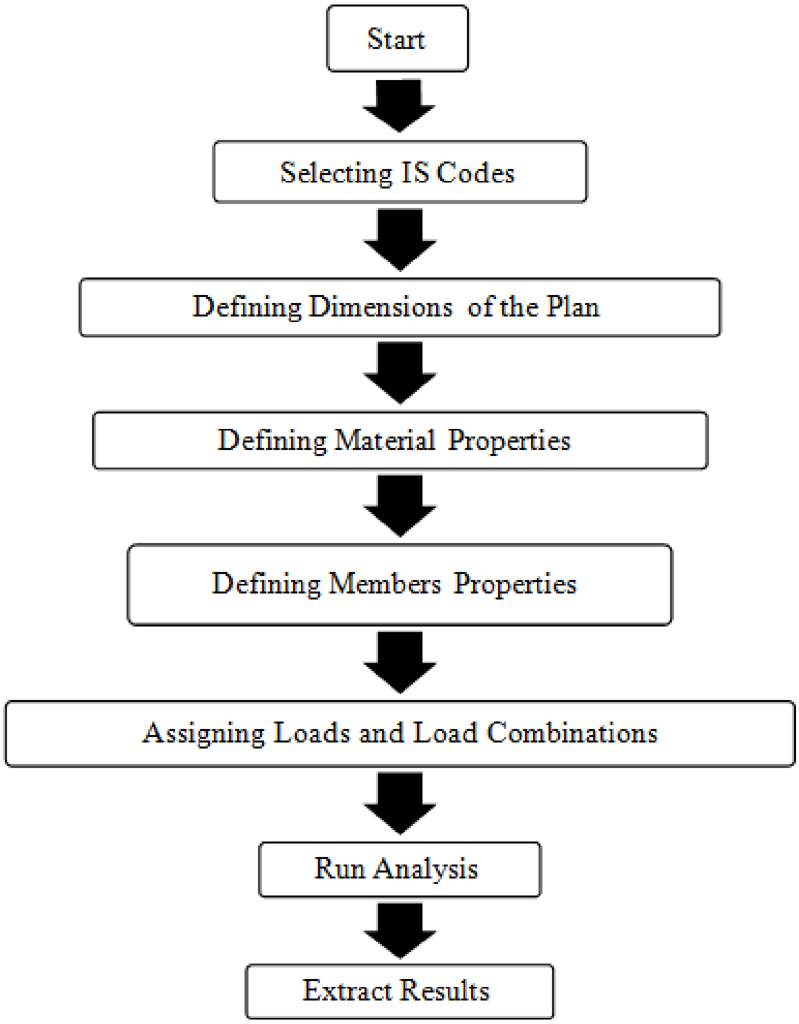



**Figure 2.11 Flowchart of procedure on ETABS**

**PROCEDURE FOR LINEAR STATIC ANALYSIS IN ETABS SOFTWARE:**

This examination is generally major and the least complex sort for reformist breakdown investigation.

It includes of major basic components. Since this strategy is generally fundamental and practically exact, most ordinary burden conditions are applied with exceptionally moderate appraisal conditions. Following technique as under,

Step: - 1 Establish the limited component model;

Step:- 2 First, the structure is broke down with gravity load (Dead burden, live burden) and Seismic burdens to acquire the yield results for second and shear without Using LRB.

Step:- 3 Now, a similar structure is investigated with gravity load (Dead burden, live burden) and Seismic burdens to get the yield results for second and shear Using LRB(Lead Rubber Bearing) Isolator.

Step:- 4 the static burden blends were gone into ETABS v16.2.1 program and a model of the structure was created and for each instance of various cases the PC re enactment was executed utilizing ETABS programming and the outcome are inspected.

Step:- 5 Further, from investigation results acquired, if for any part end association or along the range it is surpassed as far as possible dependent on shear power, pivotal burden and twisting second, the part is normal as a bombed part.

**MODEL DEFINITION:**

**Model Geometry**

For the investigation, G+14 story building is thought of. The structure has 4 sounds in X- course and 4 coves in Y-bearing with the arrangement measurement of 24 m x 24 m (for Square) and 24m x 32 m (for L Shaped) Structure and story tallness of 3 m in common story and 3 m in base story. To examine the impact under parallel power, building is kept Symmetric and Asymmetric both in plan. The state of the section in plan is kept square and size of the segment is kept consistent through the tallness of structure.

The structure consider in the examination is to be situated in seismic Zone II, and expected for Commercial use (Hotel). Building is established medium quality soil. The segments at base are thought to be given Mat balance. Reaction decrease factor for the exceptional second resting outline without shear divider and casing with shear divider has taken as 5 (Ductile itemizing is accepted). The completion load on the floor is taken as 1.5 KN/m2. Live burden on the floor is taken as 3.5 KN/m2. In seismic weight estimation, 25% of the floor live loads are considered in the examination. The beams and columns are designed as per ordinary requirements of a building .following tables explain the detailing of beams and columns-

**Table 2.5: Details of Column**

| Type of column | Outer (perimeter) column | Interior column |
|---|---|---|
| Size and shape | 400mm X 400mm | 400mm X 400mm |
| Cover | 60mm | 60mm |
| Diameter of main bars | 20mm | 20mm |
| Diameter of tie bars | 10mm | 10mm |

**Table 2.6: Scheduling for Beams (250mm x 450mm)**

| Storey | Reinforcement | | | | Stirrups | |
|---|---|---|---|---|---|---|
| | Bottom steel | | Top steel | | End Region (mm) | Mid region-2d (mm) |
| | continue | Curtails | Continue | Extra top | Dia (Spacing) | Dia (Spacing) |
| Interior long frame beams reinforcement | | | | | | |
| $11^{th}$ and$12^{th}$ | 2#16+1#10 | - | 2#16+1#10 | - | 8 (75 ) | 8 (250) |
| $9^{th}$ and $10^{th}$ | 2#16+1#10 | - | 2#16+1#10 | 1#16 | 8 (75 ) | 8 (250) |
| $7^{th}$ and $8^{th}$ | 2#16+1#12 | 2#16 | 2#12+2#10 | 3#16 | 8 (75 ) | 8 (250) |
| Below $6^{th}$ | 3#16 | - | 2#16+1#10 | 2#16 | 8 (75 ) | 8 (250) |
| Exterior long frame beam reinforcement | | | | | | |
| $11^{th}$ &$12^{th}$ | 2#16+1#10 | - | 2#16+1#10 | - | 8 (75 ) | 8 (250) |
| $7^{th}$ and $10^{th}$ | 2#16+1#12 | - | 2#16+1#10 | 1#16+1#12 | 8 (75 ) | 8 (250) |
| Below $6^{th}$ | 2#16+1#10 | - | 2#16+1#10 | 1#16+1#12 | 8 (75 ) | 8 (250) |
| Exterior short frame beam reinforcement | | | | | | |
| $10^{th}$ and $12^{th}$ | 2#16+1#12 | - | 2#16+1#10 | 1#16+1#12 | 8 (75 ) | 8 (250) |
| $8^{th}$ and $9^{th}$ | 2#16+1#10 | 1#12 | 2#16+1#10 | 3#16 | 8 (75 ) | 8 (250) |
| $7^{th}$ and $6^{th}$ | 3#16 | - | 2#16+1#10 | 3#16 | 8 (75 ) | 8 (250) |
| Below $5^{th}$ | 3#16 | | 2#16+1#12 | 3#16 | 8 (75 ) | 8 (250) |
| Interior short direction frame beam reinforcement | | | | | | |
| $10^{th}$ and $12^{th}$ | 3#16 | 1#16+1#10 | 2#16+1#10 | 3#16 | 8 (75 ) | 8 (250) |
| $8^{th}$ and $9^{th}$ | 3#16 | 1#16+1#12 | 3#16 | 3#16 | 8 (75 ) | 8 (250) |
| $7^{nd}$ and $6^{th}$ | 3#16 | 1#16+1#10 | 3#16 | 3#16+1#12 | 8 (75 ) | 8 (250) |
| Below $5^{th}$ | 3#16 | 1#16 | 2#16+1#10 | 3#16+1#12 | 8 (75 ) | 8 (250) |

**Cases Considered for analysis**

The following cases has been considered for the analysis of work. Modeling has been carried out using ETAB 16.2.1.

**Case (1) Symmetrical building subjected to Seismic forces in general condition (Square Shaped G+13)**

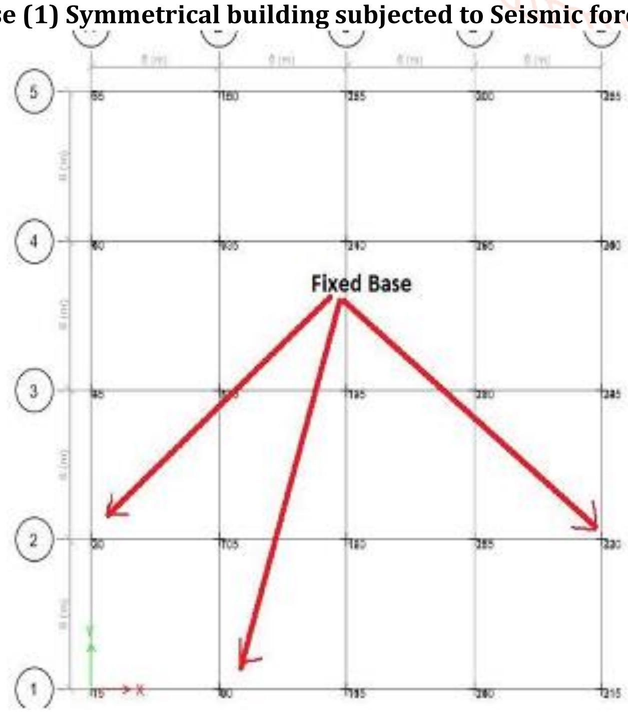



Figure 2.12 Plan View of G+13 Square Shaped Structure without LRB

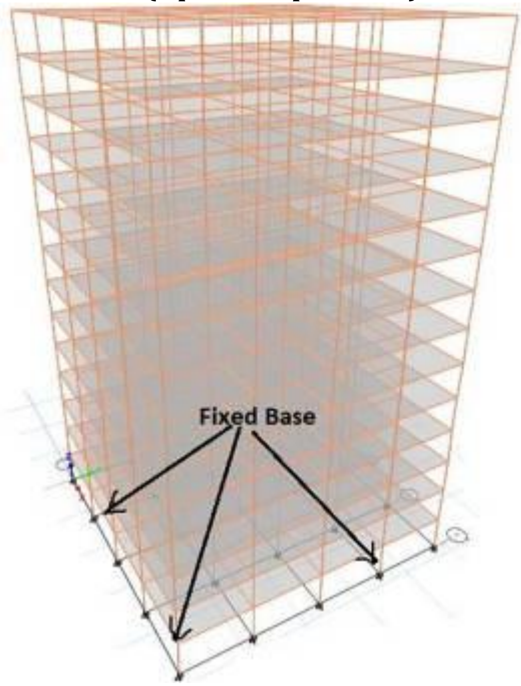



Figure 2.13 3-D View of G+13 Square Shaped Structure without LRB

**Case (2) Symmetrical building subjected to Seismic forces with Lead Rubber Bearing Isolator at base (Square Shaped G+13)**

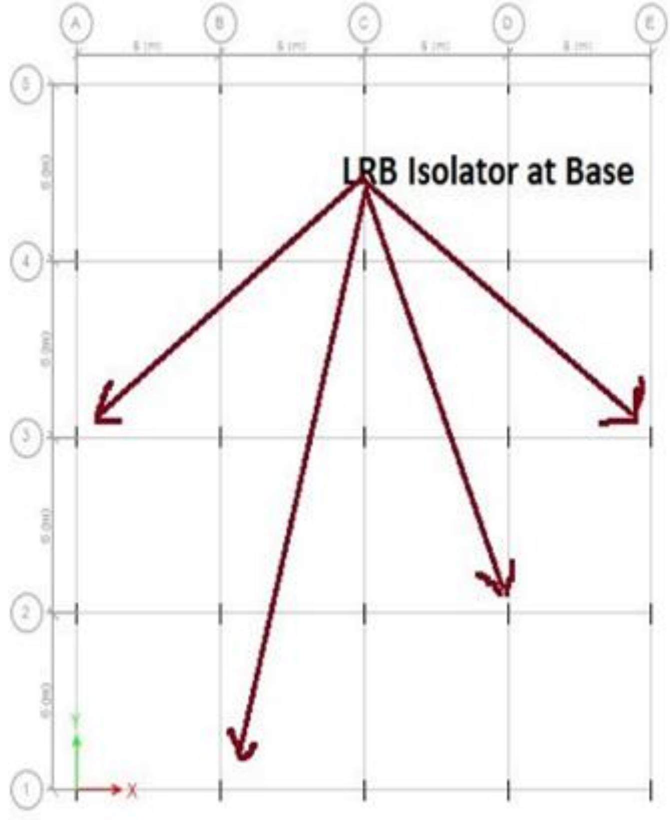



**Figure 2.14 Plan View of G+13 Square Shaped Structure**

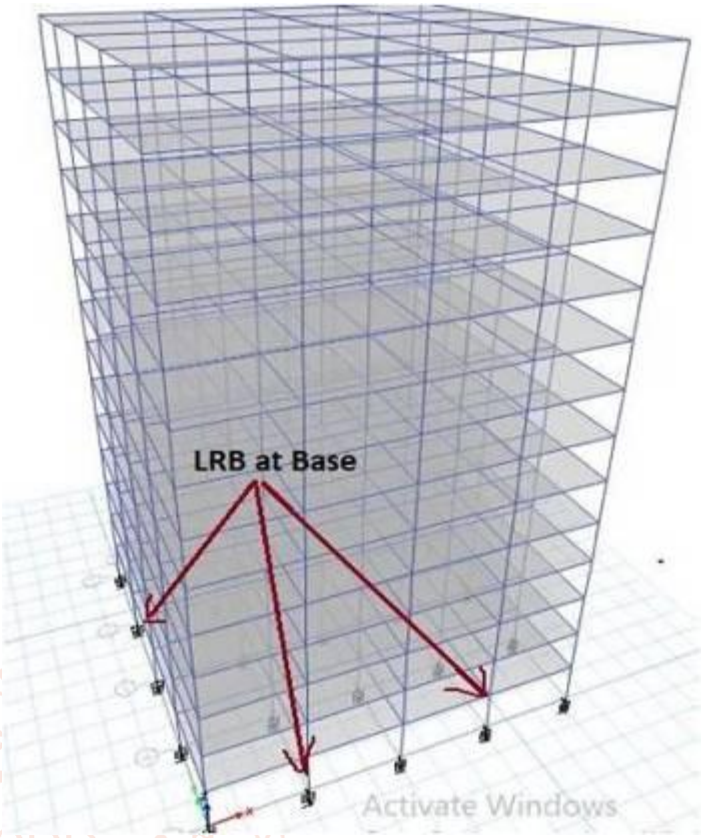



**Figure 2.15 3-D View of G+13 Square Shaped Structure with LRB at Base**

**Case (3) Asymmetrical building subjected to Seismic forces in General Conditions (L Shaped G+13)**

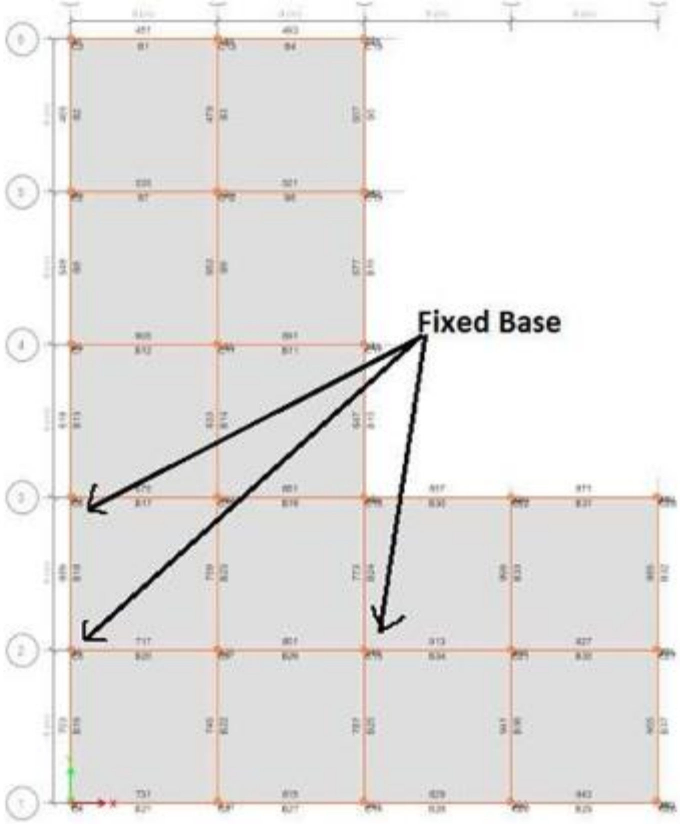



**Figure 2.16 Plan View of G+13 L Shaped Structure**

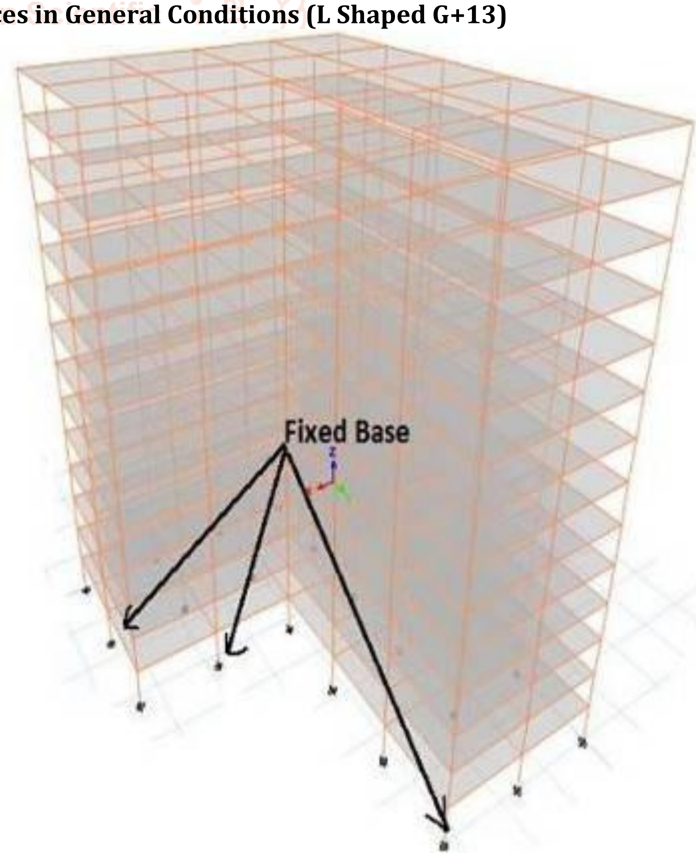



**Figure 2.17 3-D View of G+13 L Shaped Structure**

**Case (4) Asymmetrical building subjected to Seismic forces With LRB at Base (L Shaped G+13)**

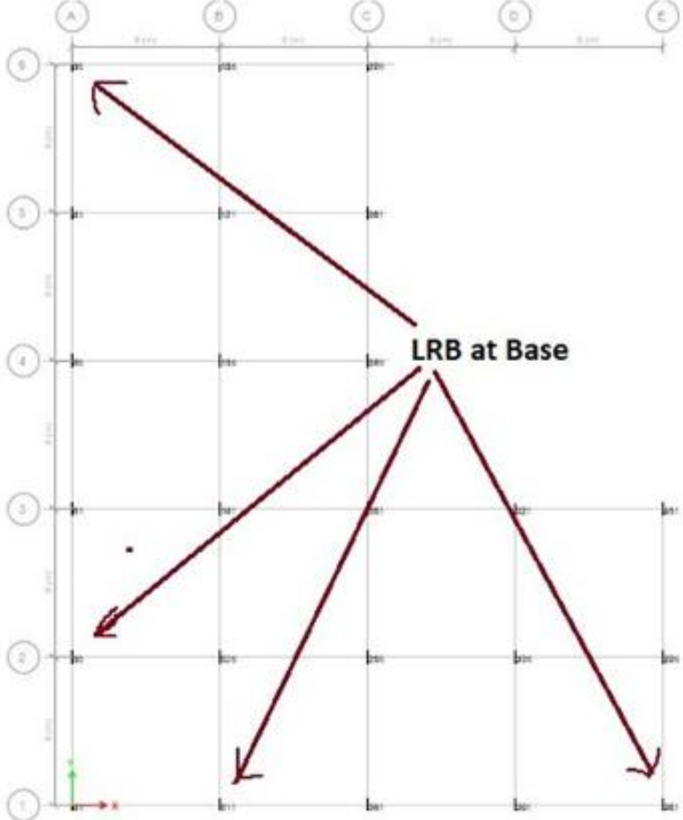



**Figure 2.18 Plan View of G+13 L Shaped Structure with LRB at Base**

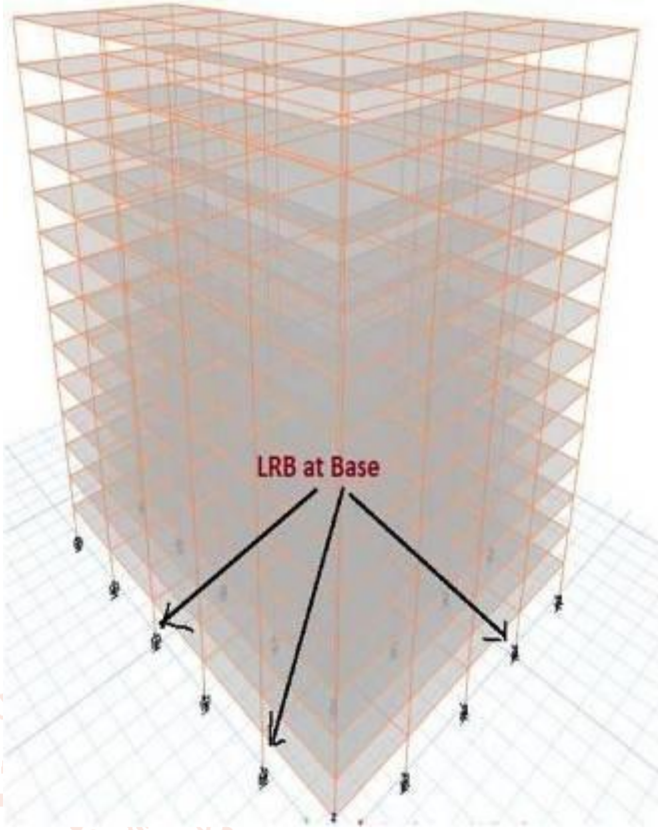



**Figure 2.19 3-D View of G+13 L Shaped Structure with LRB at Base**

## 3. RESULTS AND DISCUSSIONS

**Introduction:**

In this Chapter, to investigate "**Examination of Performance of Seismically Isolated and Non- Isolated RC Structure Using Lead Elastic Bearing Isolators"** as per IS-standards. In order to study the effect seismic force on LRB system zone II of India a multistory hotel building of G +13 of Square and L Shape configuration is taken in zone II with and without having a lead rubber bearing (LRB) at its base is analyses using linear static method. Following four cases were considered –

1. Symmetrical (Square) building subjected to seismic forces in normal conditions for Zone II without any base isolation.
2. Symmetrical (Square) building subjected to seismic forces in normal conditions for Zone II with LRB at its base.
3. Asymmetrical (L) building subjected to seismic forces in normal conditions for Zone II without any base isolation.
4. Asymmetrical (L) building subjected to seismic forces in normal conditions for Zone II with LRB at its base.

In this chapter the results are to be discussed in the following parameters

- DETERMINATION OF STOREY DISPLACEMENT FOR DIFFERENT CASES
- DETERMINATION OF STOREY DRIFT FOR DIFFERENT CASES
- CALCULATION OF BASE SHEAR FOR DIFFERENT CASES
- DISTRIBUTION OF STOREY SHEAR (SHEAR FORCE)
- DEFORMED SHAPE REPRESENTATION FOR ALL THE STRUCTURES

**Determination of storey displacement for different cases:**

**Symmetrical Building without base isolation –**

In this case we consider a square shaped 14 storey building with fixed base. The effect of loading as per IS 1893:2002 is explained in the form of parameters discussed below.

**Storey displacement in X direction**

**Table No. 3.1 Storey Height with storey displacement in X direction**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| Story | Elevation | Location | X-Dir | Y-Dir |
| | m | | mm | mm |
| Story14 | 42 | Top | 34.416 | 0.034 |
| Story13 | 39 | Top | 33.607 | 0.007 |
| Story12 | 36 | Top | 32.335 | 0.002 |
| Story11 | 33 | Top | 30.619 | 0.001 |
| Story10 | 30 | Top | 28.523 | 0.001 |
| Story9 | 27 | Top | 26.116 | 0.001 |

| | | | | |
|---|---|---|---|---|
| Story8 | 24 | Top | 23.458 | 0.001 |
| Story7 | 21 | Top | 20.605 | 0.001 |
| Story6 | 18 | Top | 17.606 | 0.001 |
| Story5 | 15 | Top | 14.506 | 0.001 |
| Story4 | 12 | Top | 11.341 | 0.001 |
| Story3 | 9 | Top | 8.146 | 0.002 |
| Story2 | 6 | Top | 4.962 | 0.001 |
| Story1 | 3 | Top | 1.945 | 0.011 |
| Base | 0 | Top | 0 | 0 |

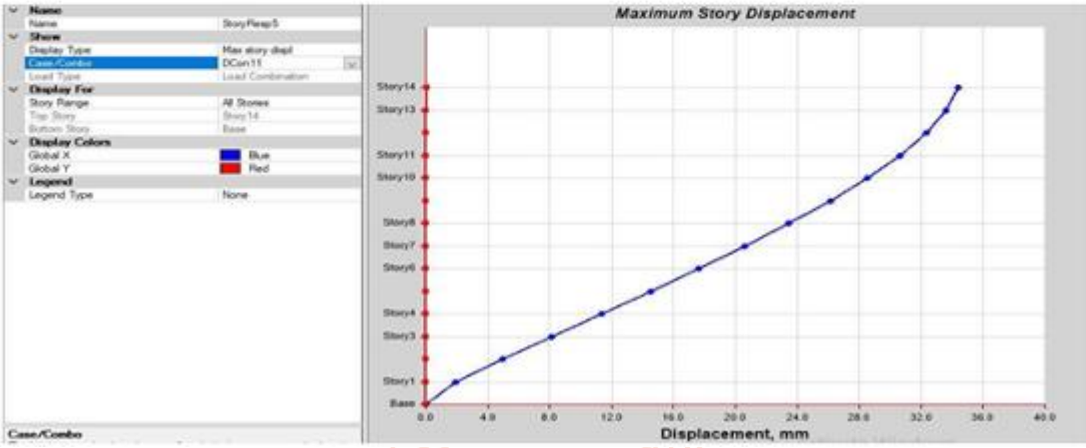



Fig 3.1 Storey Response plot in X direction

**Storey displacement in Y direction**

**Table No. 3.2 Storey Height with storey displacement in Y direction**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| Story | Elevation | Location | X-Dir | Y-Dir |
| | m | | mm | mm |
| Story14 | 42 | Top | 0.033 | 21.522 |
| Story13 | 39 | Top | 0.006 | 21.006 |
| Story12 | 36 | Top | 0.001 | 20.209 |
| Story11 | 33 | Top | 0.001 | 19.137 |
| Story10 | 30 | Top | 0.001 | 17.827 |
| Story9 | 27 | Top | 0.001 | 16.323 |
| Story8 | 24 | Top | 0.001 | 14.661 |
| Story7 | 21 | Top | 0.001 | 12.878 |
| Story6 | 18 | Top | 0.001 | 11.004 |
| Story5 | 15 | Top | 0.001 | 9.066 |
| Story4 | 12 | Top | 0.001 | 7.089 |
| Story3 | 9 | Top | 0.002 | 5.092 |
| Story2 | 6 | Top | 0.001 | 3.102 |
| Story1 | 3 | Top | 0.01 | 1.219 |
| Base | 0 | Top | 0 | 0 |

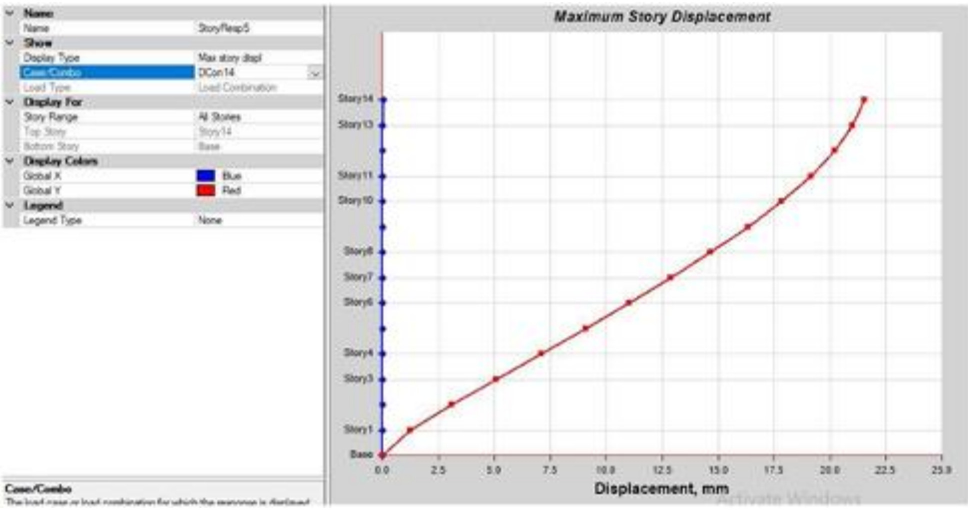



Fig 3.2 Storey Response plot in Y direction

**Symmetrical Building with LRB –**

In this case we consider a square shaped 14 storey building its base having spring links due to base isolation (LRB). The effect of loading as per IS 1893:2002 is explained in the form of parameters discussed below.

**Storey displacement in X direction**

**Table No. 3.3 Storey Height with storey displacement in X direction**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| Story | Elevation | Location | X-Dir | Y-Dir |
| | m | | mm | mm |
| Story14 | 42 | Top | 25.001 | 0.035 |
| Story13 | 39 | Top | 24.632 | 0.006 |
| Story12 | 36 | Top | 24.083 | 0.001 |
| Story11 | 33 | Top | 23.352 | 0.001 |
| Story10 | 30 | Top | 22.463 | 0.001 |
| Story9 | 27 | Top | 21.443 | 0.001 |
| Story8 | 24 | Top | 20.318 | 0.001 |
| Story7 | 21 | Top | 19.111 | 0.001 |
| Story6 | 18 | Top | 17.844 | 0.001 |
| Story5 | 15 | Top | 16.534 | 0.001 |
| Story4 | 12 | Top | 15.196 | 0.001 |
| Story3 | 9 | Top | 13.841 | 0.003 |
| Story2 | 6 | Top | 12.459 | 0.006 |
| Story1 | 3 | Top | 10.883 | 0.027 |
| **Base** | **0** | **Top** | **9.517** | **1.876** |

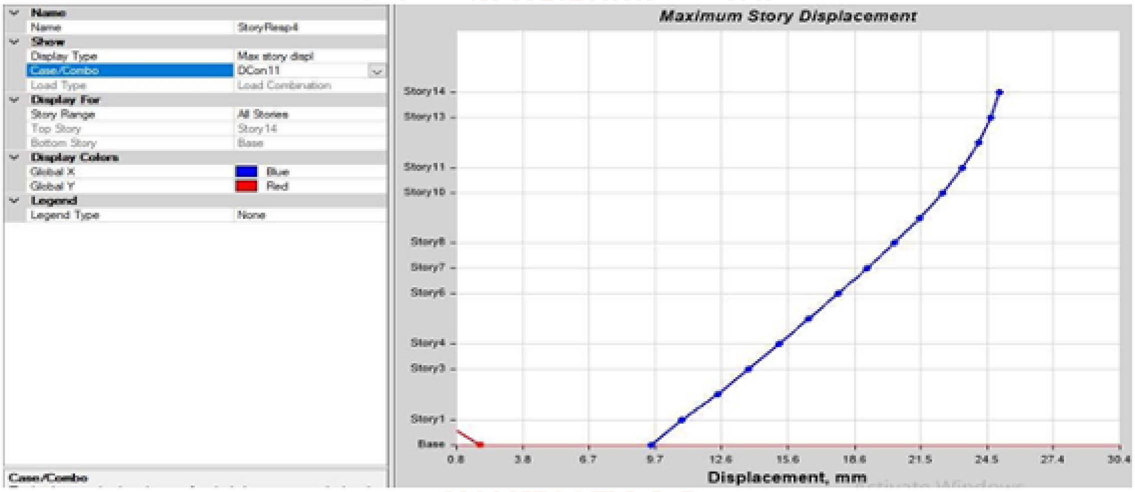



**Fig 3.3 Storey Response plot in X direction**

**Storey displacement in Y direction**

**Table No. 3.4 Storey Height with storey displacement in Y direction**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| Story | Elevation | Location | X-Dir | Y-Dir |
| | m | | mm | mm |
| Story14 | 42 | Top | 0.058 | 25.024 |
| Story13 | 39 | Top | 0.01 | 24.636 |
| Story12 | 36 | Top | 0.001 | 24.084 |
| Story11 | 33 | Top | 0.001 | 23.352 |
| Story10 | 30 | Top | 0.001 | 22.463 |
| Story9 | 27 | Top | 0.001 | 21.443 |
| Story8 | 24 | Top | 0.001 | 20.318 |
| Story7 | 21 | Top | 0.002 | 19.112 |
| Story6 | 18 | Top | 0.002 | 17.844 |
| Story5 | 15 | Top | 0.002 | 16.534 |
| Story4 | 12 | Top | 0.002 | 15.196 |
| Story3 | 9 | Top | 0.004 | 13.842 |
| Story2 | 6 | Top | 0.009 | 12.462 |
| Story1 | 3 | Top | 0.043 | 10.899 |
| Base | 0 | Top | 3.122 | 10.764 |

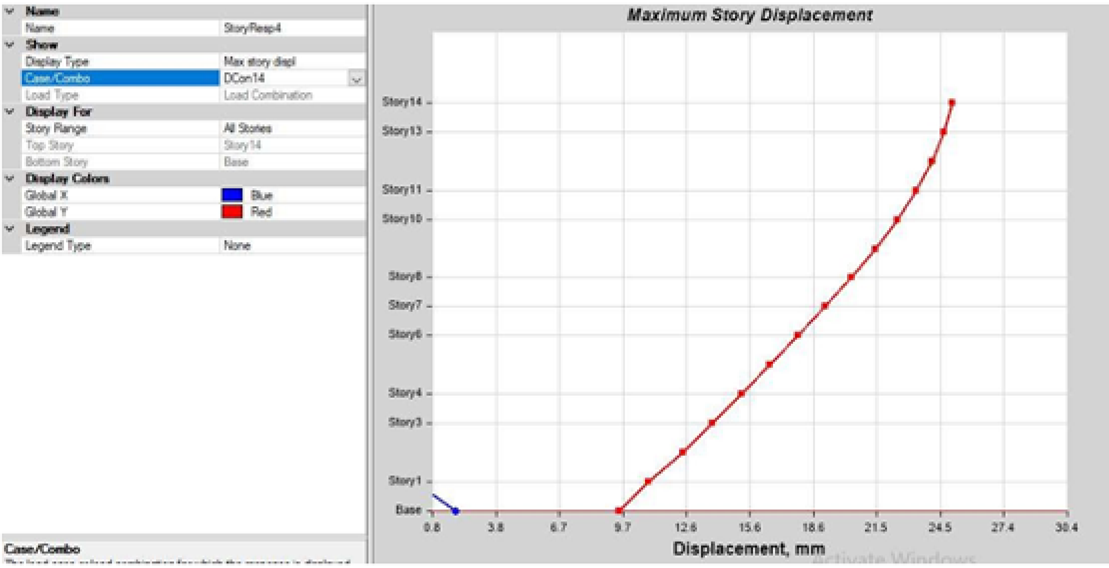



Fig 3.4 Storey Response plot in Y direction

**Asymmetrical (L Shaped) Building without base isolation –**

In this case we consider a L shaped 14 storey building with fixed base. The effect of loading as per IS 1893:2002 is explained in the form of parameters discussed below.

**Storey displacement in X direction**

**Table No. 3.5 Storey Height with storey displacement in X direction**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| Story | Elevation | Location | X-Dir | Y-Dir |
| | m | | mm | mm |
| Story14 | 42 | Top | 40.187 | 1.255 |
| Story13 | 39 | Top | 39.444 | 1.094 |
| Story12 | 36 | Top | 38.283 | 0.976 |
| Story11 | 33 | Top | 36.738 | 0.869 |
| Story10 | 30 | Top | 34.867 | 0.759 |
| Story9 | 27 | Top | 32.726 | 0.65 |
| Story8 | 24 | Top | 30.369 | 0.544 |
| Story7 | 21 | Top | 27.845 | 0.441 |
| Story6 | 18 | Top | 25.198 | 0.343 |
| Story5 | 15 | Top | 22.466 | 0.253 |
| Story4 | 12 | Top | 19.683 | 0.172 |
| Story3 | 9 | Top | 16.882 | 0.102 |
| Story2 | 6 | Top | 14.111 | 0.043 |
| Story1 | 3 | Top | 1.548 | 0.028 |
| Base | 0 | Top | 0 | 0 |

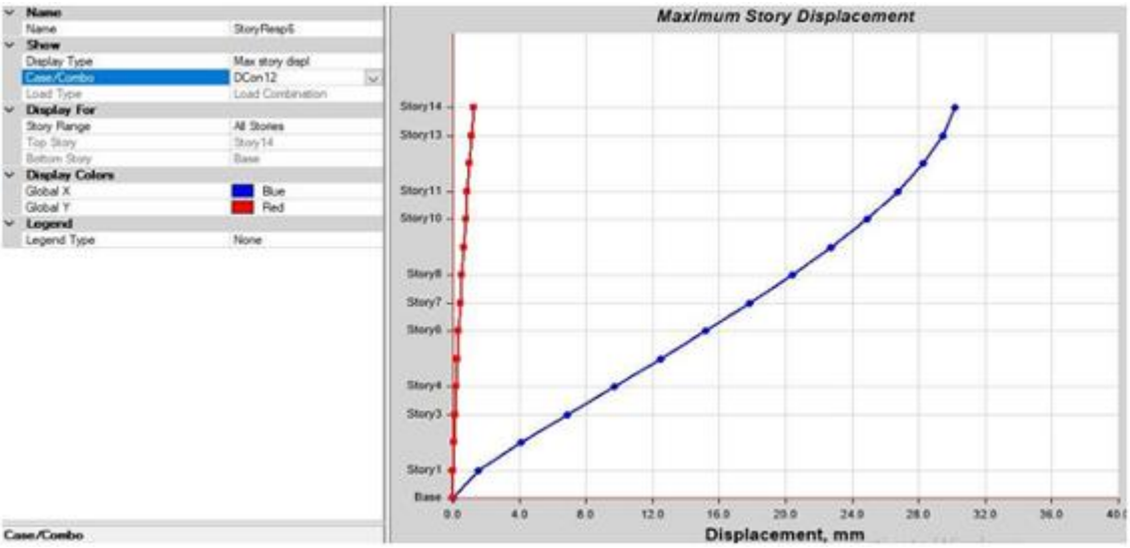



Fig 3.5 Storey Response plot in X direction

**Storey displacement in Y direction**

**Table No. 3.6 Storey Height with storey displacement in Y direction**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| Story | Elevation | Location | X-Dir | Y-Dir |
| | m | | mm | mm |
| Story14 | 42 | Top | 2.504 | 40.187 |
| Story13 | 39 | Top | 2.174 | 39.444 |
| Story12 | 36 | Top | 1.911 | 38.283 |
| Story11 | 33 | Top | 1.665 | 36.738 |
| Story10 | 30 | Top | 1.424 | 34.867 |
| Story9 | 27 | Top | 1.192 | 32.726 |
| Story8 | 24 | Top | 0.971 | 30.369 |
| Story7 | 21 | Top | 0.766 | 27.845 |
| Story6 | 18 | Top | 0.577 | 25.198 |
| Story5 | 15 | Top | 0.409 | 22.466 |
| Story4 | 12 | Top | 0.264 | 19.683 |
| Story3 | 9 | Top | 0.147 | 16.882 |
| Story2 | 6 | Top | 0.058 | 14.111 |
| Story1 | 3 | Top | 0.035 | 1.548 |
| Base | 0 | Top | 0 | 0 |

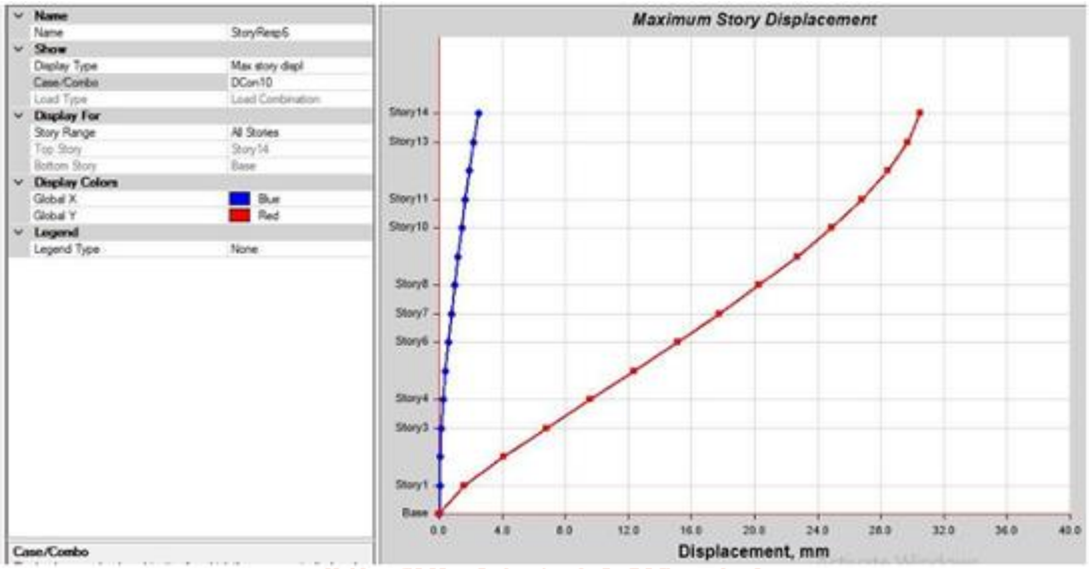



**Fig 3.6 Storey Response plot in Y direction**

**Asymmetrical (L Shaped) Building with LRB–**

In this case we consider a L shaped 14 storey building its base having spring links due to base isolation (LRB). The effect of loading as per IS 1893:2002 is explained in the form of parameters discussed below.

**Storey displacement in X direction**

**Table No. 3.7 Storey Height with storey displacement in X direction**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| Story | Elevation | Location | X-Dir | Y-Dir |
| | m | | mm | mm |
| Story14 | 42 | Top | 37.439 | 1.254 |
| Story13 | 39 | Top | 36.825 | 1.079 |
| Story12 | 36 | Top | 35.883 | 0.95 |
| Story11 | 33 | Top | 34.648 | 0.834 |
| Story10 | 30 | Top | 33.163 | 0.716 |
| Story9 | 27 | Top | 31.471 | 0.599 |
| Story8 | 24 | Top | 29.615 | 0.485 |
| Story7 | 21 | Top | 27.632 | 0.375 |
| Story6 | 18 | Top | 25.59 | 0.302 |
| Story5 | 15 | Top | 23.515 | 0.258 |
| Story4 | 12 | Top | 21.403 | 0.227 |
| Story3 | 9 | Top | 19.273 | 0.212 |
| Story2 | 6 | Top | 17.108 | 0.22 |
| Story1 | 3 | Top | 14.63 | 0.276 |
| Base | 0 | Top | 13.795 | 4.021 |

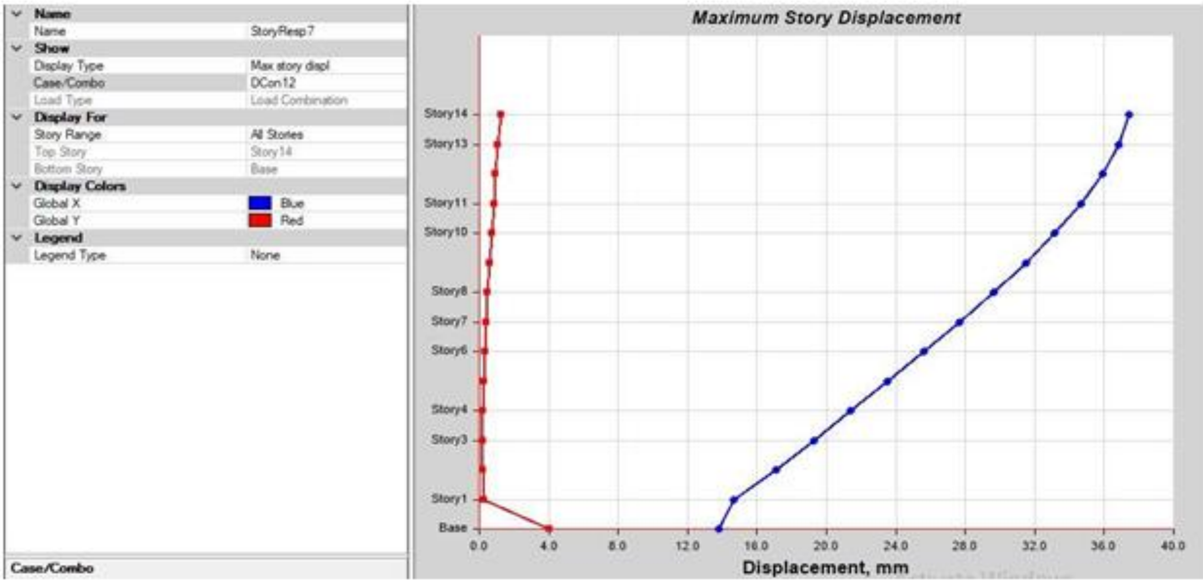


Fig 3.7 Storey Response plot in X direction

**Storey displacement in Y direction**

**Table No. 3.8 Storey Height with storey displacement in Y direction**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| Story | Elevation | Location | X-Dir | Y-Dir |
| | m | | mm | mm |
| Story14 | 42 | Top | 1.761 | 36.804 |
| Story13 | 39 | Top | 1.53 | 36.195 |
| Story12 | 36 | Top | 1.34 | 35.25 |
| Story11 | 33 | Top | 1.159 | 34.021 |
| Story10 | 30 | Top | 0.982 | 32.554 |
| Story9 | 27 | Top | 0.81 | 30.891 |
| Story8 | 24 | Top | 0.644 | 29.072 |
| Story7 | 21 | Top | 0.488 | 27.134 |
| Story6 | 18 | Top | 0.342 | 25.11 |
| Story5 | 15 | Top | 0.253 | 23.061 |
| Story4 | 12 | Top | 0.248 | 21.036 |
| Story3 | 9 | Top | 0.255 | 18.986 |
| Story2 | 6 | Top | 0.277 | 16.896 |
| Story1 | 3 | Top | 0.325 | 14.505 |
| Base | 0 | Top | 4.055 | 13.742 |

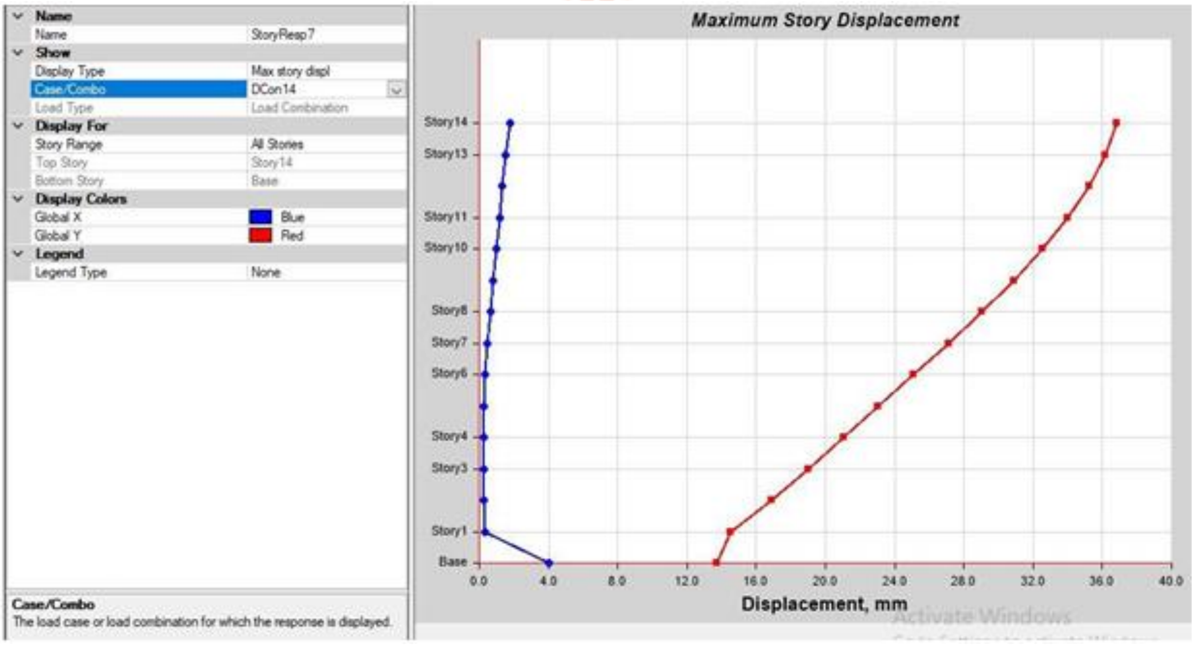


Fig 3.8 Storey Response plot in Y direction

**Determination of storey drift for different cases:**

**Storey Drift for Symmetrical Building in without base isolation**

**Table No. 3.9 Storey Height with storey drift in X direction**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| Story | Elevation | Location | X-Dir | Y-Dir |
| | m | | | |
| Story14 | 42 | Top | 0.00027 | 0.000013 |
| Story13 | 39 | Top | 0.00042 | 0.000002 |
| Story12 | 36 | Top | 0.00057 | 3.64E-07 |
| Story11 | 33 | Top | 0.0007 | 5.89E-08 |
| Story10 | 30 | Top | 0.0008 | 9.89E-08 |
| Story9 | 27 | Top | 0.00089 | 8.7E-08 |
| Story8 | 24 | Top | 0.00095 | 8.36E-08 |
| Story7 | 21 | Top | 0.001 | 7.85E-08 |
| Story6 | 18 | Top | 0.00103 | 7.68E-08 |
| Story5 | 15 | Top | 0.00106 | 5.68E-08 |
| Story4 | 12 | Top | 0.00107 | 1.36E-07 |
| Story3 | 9 | Top | 0.00106 | 4.33E-07 |
| Story2 | 6 | Top | 0.00101 | 0.000003 |
| Story1 | 3 | Top | 0.00065 | 0.000004 |
| Base | 0 | Top | 0 | 0 |

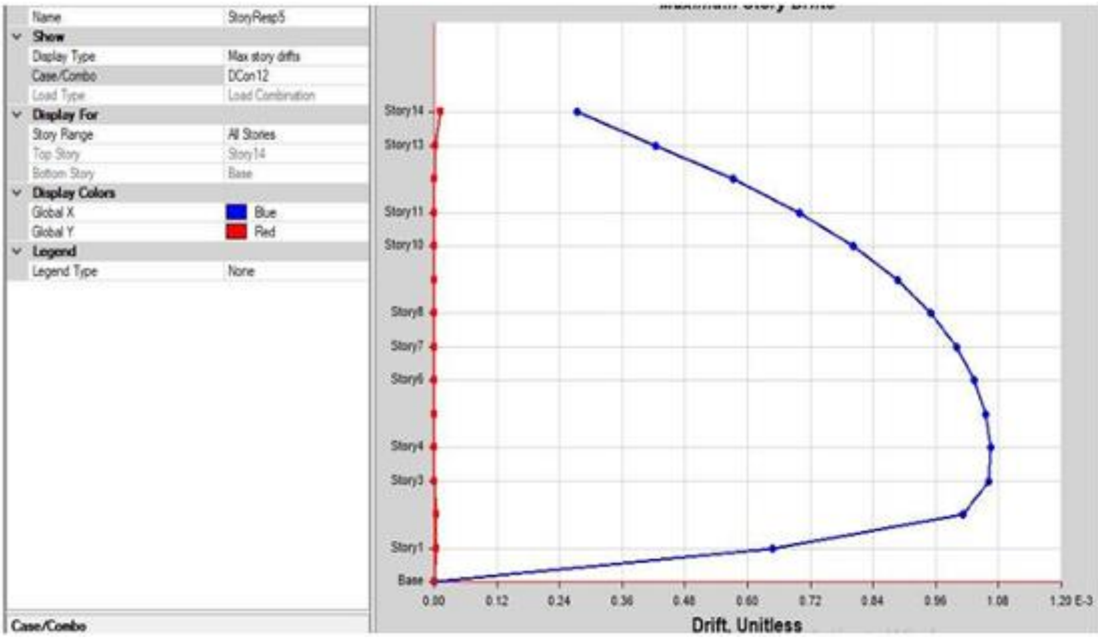



**Fig 3.9 Storey Response plot in X direction**

**Table No. 3.10 Storey Height with storey drift in Y direction**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| Story | Elevation | Location | X-Dir | Y-Dir |
| | m | | | |
| Story14 | 42 | Top | 0.000013 | 0.00018 |
| Story13 | 39 | Top | 0.000002 | 0.00027 |
| Story12 | 36 | Top | 3.46E-07 | 0.00036 |
| Story11 | 33 | Top | 3.84E-08 | 0.00044 |
| Story10 | 30 | Top | 8.09E-08 | 0.0005 |
| Story9 | 27 | Top | 7.1E-08 | 0.00055 |
| Story8 | 24 | Top | 6.97E-08 | 0.00059 |
| Story7 | 21 | Top | 6.66E-08 | 0.00063 |
| Story6 | 18 | Top | 6.7E-08 | 0.00065 |
| Story5 | 15 | Top | 4.92E-08 | 0.00066 |
| Story4 | 12 | Top | 1.32E-07 | 0.00067 |
| Story3 | 9 | Top | 4.25E-07 | 0.00066 |
| Story2 | 6 | Top | 0.000003 | 0.00063 |
| Story1 | 3 | Top | 0.000003 | 0.00041 |
| Base | 0 | Top | 0 | 0 |

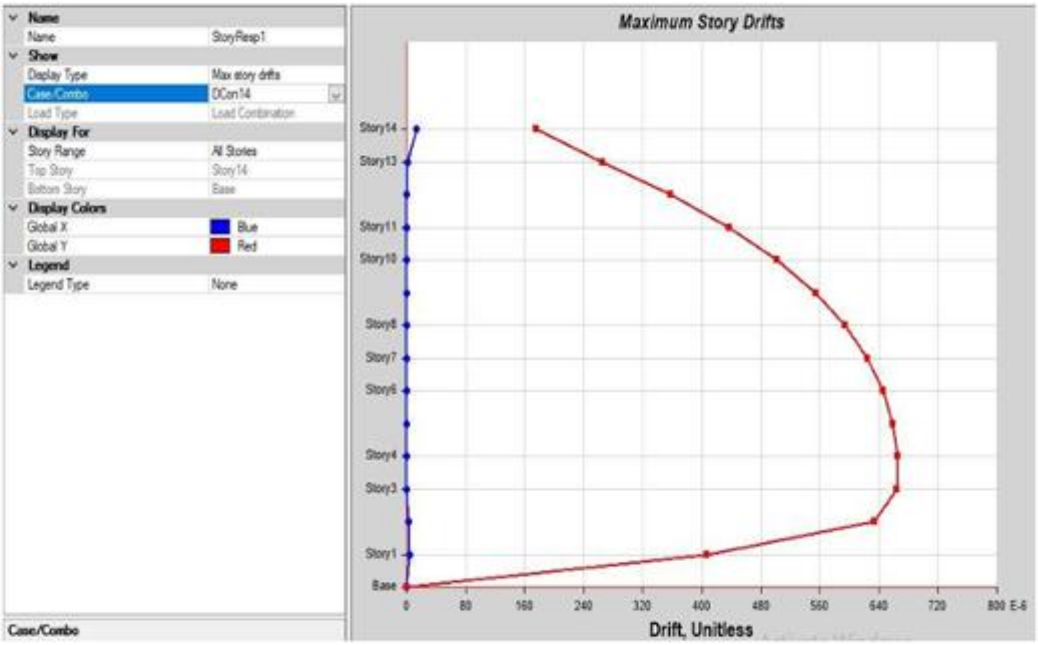



Fig 3.10 Storey Response plot in Y direction

**Storey Drift for Symmetrical Building in with LRB**

**Table No. 3.11 Storey Height with storey drift in X direction**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| Story | Elevation m | Location | X-Dir | Y-Dir |
| Story14 | 42 | Top | 0.00013 | 0.000014 |
| Story13 | 39 | Top | 0.00018 | 0.000002 |
| Story12 | 36 | Top | 0.00024 | 3.64E-07 |
| Story11 | 33 | Top | 0.0003 | 2.47E-08 |
| Story10 | 30 | Top | 0.00034 | 7.01E-08 |
| Story9 | 27 | Top | 0.00038 | 6.05E-08 |
| Story8 | 24 | Top | 0.0004 | 6.07E-08 |
| Story7 | 21 | Top | 0.00042 | 5.67E-08 |
| Story6 | 18 | Top | 0.00044 | 6.95E-08 |
| Story5 | 15 | Top | 0.00045 | 3.74E-08 |
| Story4 | 12 | Top | 0.00045 | 5E-07 |
| Story3 | 9 | Top | 0.00047 | 0.000003 |
| Story2 | 6 | Top | 0.00054 | 0.000011 |
| Story1 | 3 | Top | 0.00169 | 0.000617 |
| Base | 0 | Top | 0 | 0 |

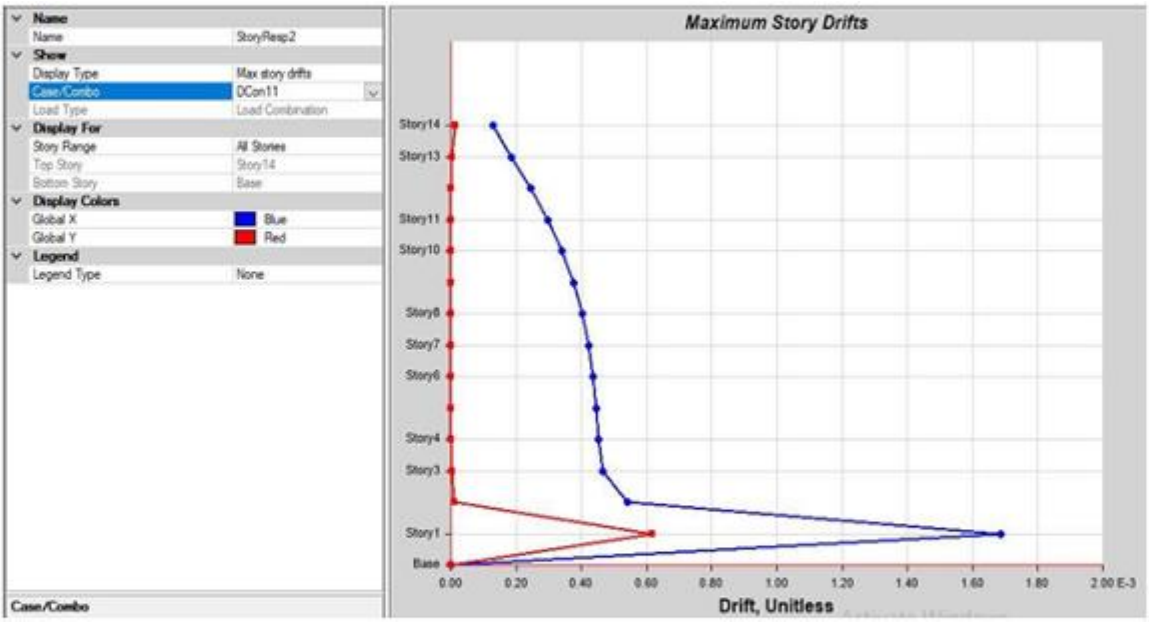



Fig 3.11 Storey Response plot in X direction

**Table No. 3.12 Storey Height with storey drift in Y direction**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| Story | Elevation | Location | X-Dir | Y-Dir |
| | m | | | |
| Story14 | 42 | Top | 0.000014 | 0.00013 |
| Story13 | 39 | Top | 0.000002 | 0.00018 |
| Story12 | 36 | Top | 3.64E-07 | 0.00024 |
| Story11 | 33 | Top | 2.47E-08 | 0.0003 |
| Story10 | 30 | Top | 7.01E-08 | 0.00034 |
| Story9 | 27 | Top | 6.05E-08 | 0.00038 |
| Story8 | 24 | Top | 6.07E-08 | 0.0004 |
| Story7 | 21 | Top | 5.67E-08 | 0.00042 |
| Story6 | 18 | Top | 6.95E-08 | 0.00044 |
| Story5 | 15 | Top | 3.74E-08 | 0.00045 |
| Story4 | 12 | Top | 5E-07 | 0.00045 |
| Story3 | 9 | Top | 0.000003 | 0.00047 |
| Story2 | 6 | Top | 0.000011 | 0.00054 |
| Story1 | 3 | Top | 0.000617 | 0.00169 |
| Base | 0 | Top | 0 | 0 |

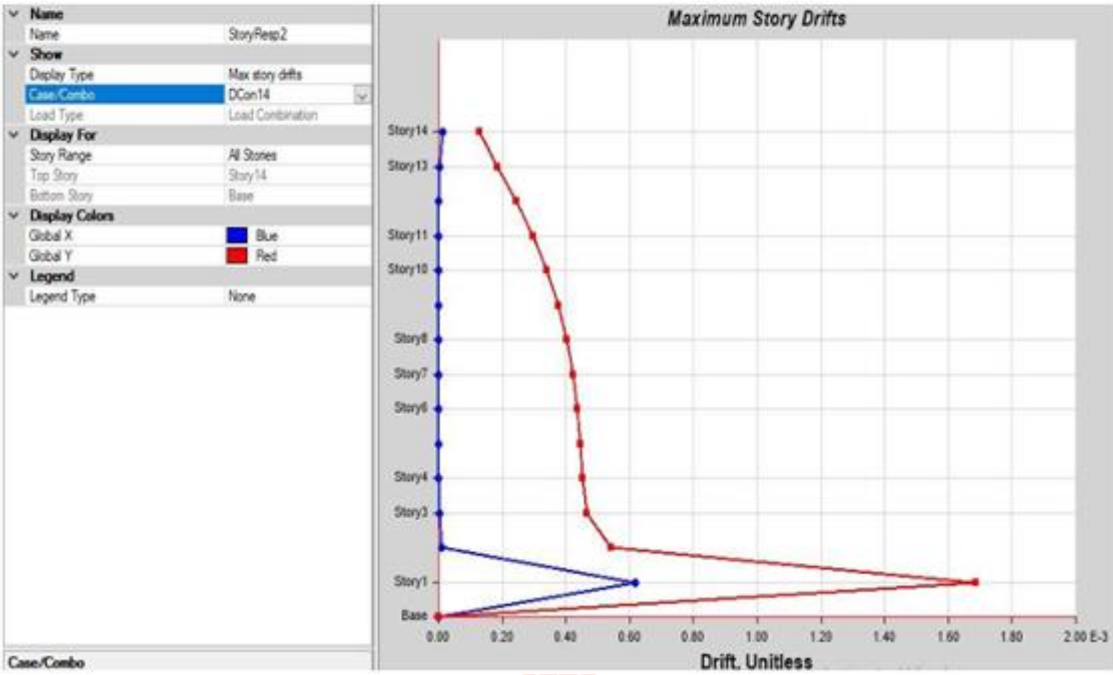



**Fig 3.12 Storey Response plot in Y direction**

**Storey Drift for Asymmetrical (L Shaped) Building in without base isolation**

**Table No. 3.13 Storey Height with storey drift in X direction**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| Story | Elevation | Location | X-Dir | Y-Dir |
| | m | | | |
| Story14 | 42 | Top | 0.00023 | 6.7E-05 |
| Story13 | 39 | Top | 0.00034 | 5.4E-05 |
| Story12 | 36 | Top | 0.00047 | 5.6E-05 |
| Story11 | 33 | Top | 0.00058 | 5.5E-05 |
| Story10 | 30 | Top | 0.00067 | 5.5E-05 |
| Story9 | 27 | Top | 0.00075 | 5.4E-05 |
| Story8 | 24 | Top | 0.00081 | 5.2E-05 |
| Story7 | 21 | Top | 0.00085 | 4.9E-05 |
| Story6 | 18 | Top | 0.00088 | 4.5E-05 |
| Story5 | 15 | Top | 0.00091 | 4.1E-05 |
| Story4 | 12 | Top | 0.00092 | 3.6E-05 |
| Story3 | 9 | Top | 0.00091 | 2.9E-05 |
| Story2 | 6 | Top | 0.00086 | 2.1E-05 |
| Story1 | 3 | Top | 0.00052 | 1.2E-05 |
| Base | 0 | Top | 0 | 0 |

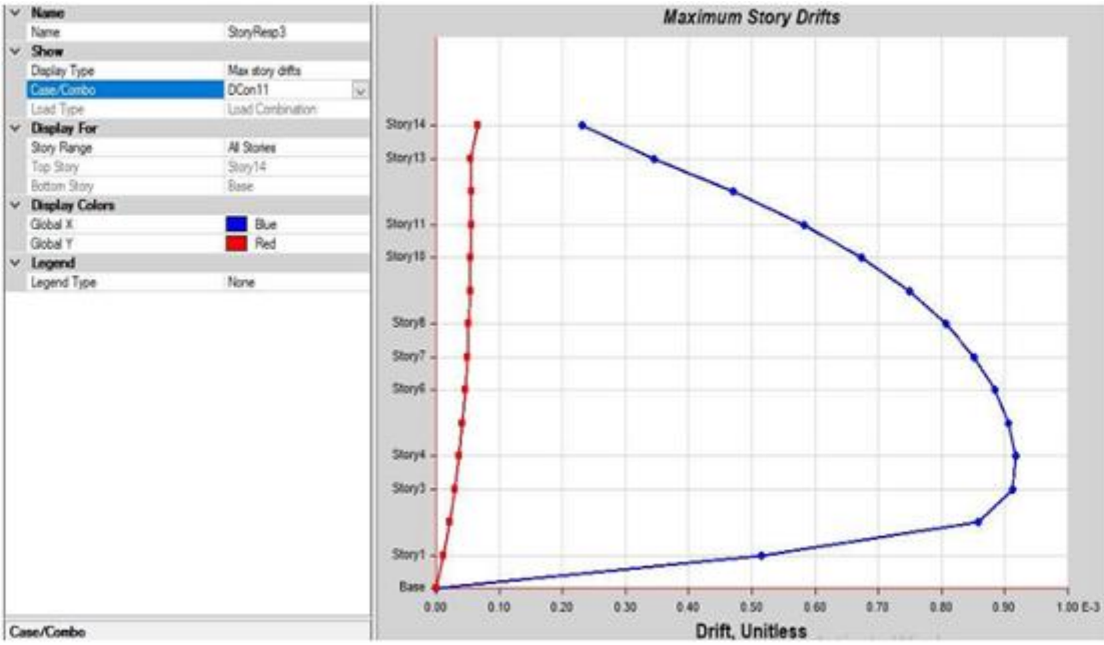



**Fig 3.13 Storey Response plot in X direction**

**Table No. 3.14 Storey Height with storey drift in Y direction**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| Story | Elevation | Location | X-Dir | Y-Dir |
| | m | | | |
| Story14 | 42 | Top | 7.8E-05 | 0.00027 |
| Story13 | 39 | Top | 5.8E-05 | 0.00039 |
| Story12 | 36 | Top | 5.5E-05 | 0.00051 |
| Story11 | 33 | Top | 5.3E-05 | 0.00062 |
| Story10 | 30 | Top | 5.2E-05 | 0.00071 |
| Story9 | 27 | Top | 0.00005 | 0.00078 |
| Story8 | 24 | Top | 4.7E-05 | 0.00083 |
| Story7 | 21 | Top | 4.3E-05 | 0.00087 |
| Story6 | 18 | Top | 3.9E-05 | 0.00089 |
| Story5 | 15 | Top | 3.4E-05 | 0.00091 |
| Story4 | 12 | Top | 2.9E-05 | 0.00092 |
| Story3 | 9 | Top | 2.3E-05 | 0.00091 |
| Story2 | 6 | Top | 2.1E-05 | 0.00085 |
| Story1 | 3 | Top | 7E-06 | 0.00052 |
| Base | 0 | Top | 0 | 0 |

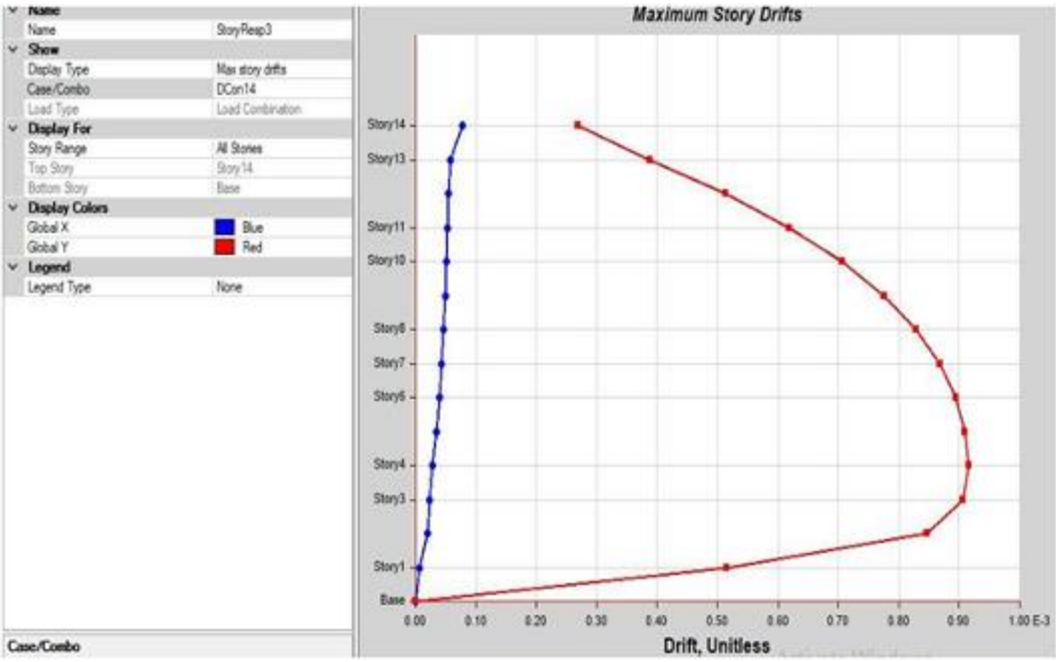



**Fig 3.14 Storey Response plot in Y direction**

**Storey Drift for Asymmetrical (L Shaped) Building in with LRB**

**Table No. 3.15 Storey Height with storey drift in X direction**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| Story | Elevation | Location | X-Dir | Y-Dir |
| | m | | | |
| Story14 | 42 | Top | 0.00018 | 7.5E-05 |
| Story13 | 39 | Top | 0.00026 | 0.00006 |
| Story12 | 36 | Top | 0.00036 | 6.1E-05 |
| Story11 | 33 | Top | 0.00045 | 0.00006 |
| Story10 | 30 | Top | 0.00052 | 5.9E-05 |
| Story9 | 27 | Top | 0.00057 | 5.8E-05 |
| Story8 | 24 | Top | 0.00062 | 5.6E-05 |
| Story7 | 21 | Top | 0.00065 | 5.3E-05 |
| Story6 | 18 | Top | 0.00068 | 4.9E-05 |
| Story5 | 15 | Top | 0.0007 | 4.5E-05 |
| Story4 | 12 | Top | 0.00071 | 4.2E-05 |
| Story3 | 9 | Top | 0.00074 | 4.2E-05 |
| Story2 | 6 | Top | 0.00088 | 4.5E-05 |
| Story1 | 3 | Top | 0.00281 | 0.00131 |
| Base | 0 | Top | 0 | 0 |

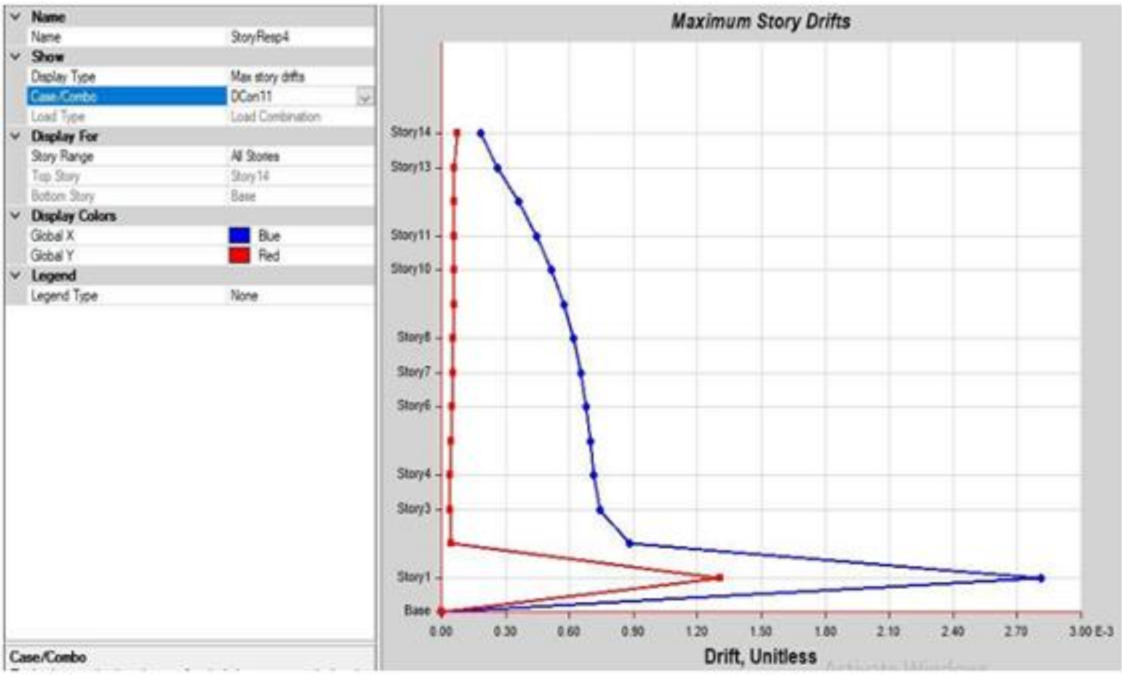



**Fig 3.15 Storey Response plot in X direction**

**Table No. 3.16 Storey Height with storey drift in Y direction**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| Story | Elevation | Location | X-Dir | Y-Dir |
| | m | | | |
| Story14 | 42 | Top | 8.5E-05 | 0.00023 |
| Story13 | 39 | Top | 6.4E-05 | 0.00032 |
| Story12 | 36 | Top | 6.1E-05 | 0.00041 |
| Story11 | 33 | Top | 5.9E-05 | 0.00049 |
| Story10 | 30 | Top | 5.7E-05 | 0.00055 |
| Story9 | 27 | Top | 5.5E-05 | 0.00061 |
| Story8 | 24 | Top | 5.2E-05 | 0.00065 |
| Story7 | 21 | Top | 4.9E-05 | 0.00068 |
| Story6 | 18 | Top | 4.5E-05 | 0.00069 |
| Story5 | 15 | Top | 0.00004 | 0.00071 |
| Story4 | 12 | Top | 3.6E-05 | 0.00071 |
| Story3 | 9 | Top | 3.6E-05 | 0.00073 |
| Story2 | 6 | Top | 5.2E-05 | 0.00085 |
| Story1 | 3 | Top | 0.0013 | 0.00282 |
| Base | 0 | Top | 0 | 0 |

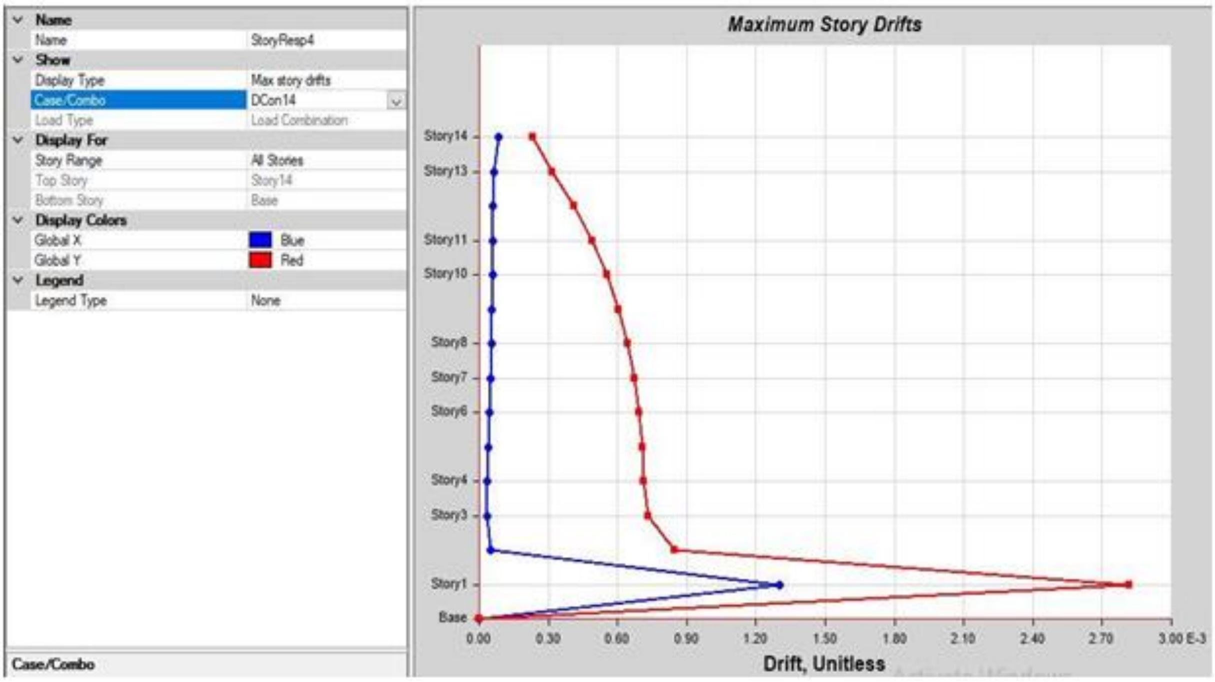



**Fig 3.16 Storey Response plot in Y direction**

**Calculation of Base Shear for different cases:**

**Table No. 3.17 Comparison of bases shear for different cases**

| S. No. | Case Considered | Base Shear (KN) in X direction | Base Shear (KN) in Y direction |
|---|---|---|---|
| 1 | Symmetrical (Square Shaped) Building Without Base Isolation | 235.42 | 231.70 |
| 2 | Symmetrical (Square Shaped) Building With LRB | 154.93 | 154.93 |
| 3 | Symmetrical (L Shaped) Building Without Base Isolation | 246.54 | 250.78 |
| 4 | Symmetrical (L Shaped) Building With LRB | 189.42 | 186.45 |

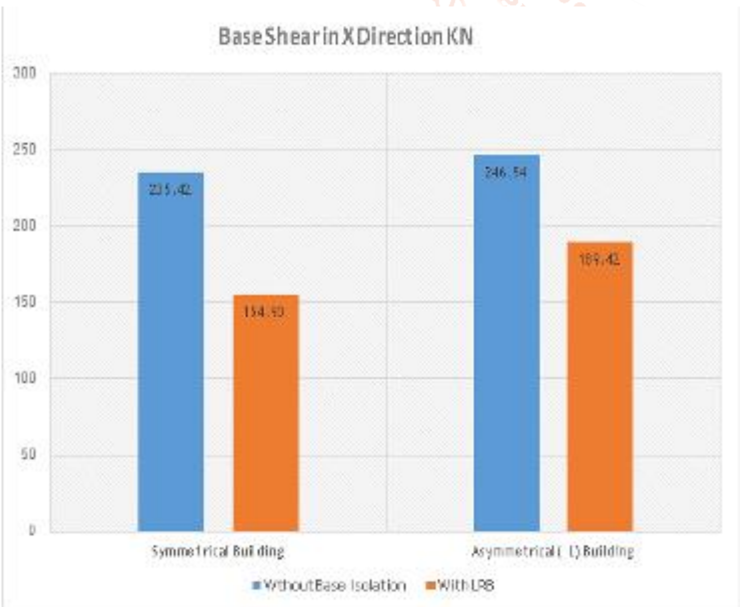



**Fig 3.17 Representation of Base Shear for different Cases in X direction**

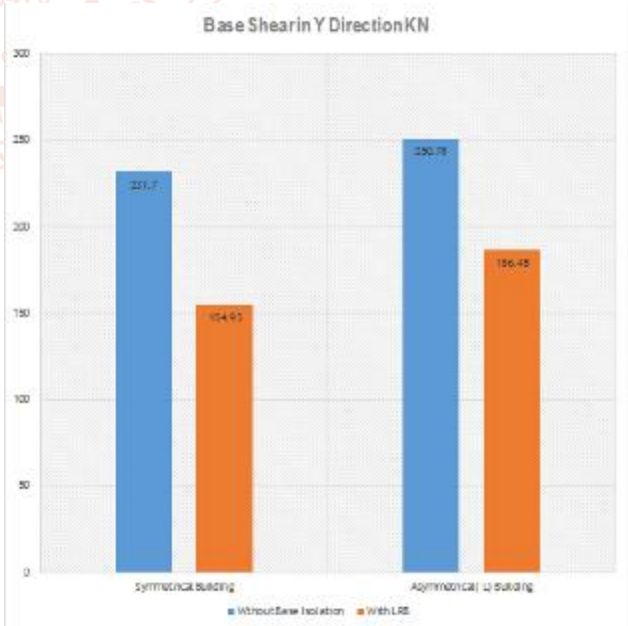



**Fig 3.18 Representation of Base Shear for different Cases in Y direction**

**Distribution of Storey Shear (Shear Force)**

**Storey Shear for Symmetrical Building in without base isolation**

**Table No. 3.18 Storey Shear with respect to height of building**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| **Story** | **Elevation** | **Location** | **X-Dir** | **Y-Dir** |
| | **m** | | **kN** | **kN** |
| Story14 | 42 | Top | -82.697 | 0 |
| | | Bottom | -82.697 | 0 |
| Story13 | 39 | Top | -96.255 | 0 |
| | | Bottom | -96.255 | 0 |
| Story12 | 36 | Top | -175.973 | 0 |
| | | Bottom | -175.973 | 0 |
| Story11 | 33 | Top | -142.958 | 0 |
| | | Bottom | -142.958 | 0 |
| Story10 | 30 | Top | -198.318 | 0 |
| | | Bottom | -198.318 | 0 |
| Story9 | 27 | Top | -243.16 | 0 |
| | | Bottom | -243.16 | 0 |
| Story8 | 24 | Top | -278.59 | 0 |
| | | Bottom | -278.59 | 0 |
| Story7 | 21 | Top | -305.716 | 0 |
| | | Bottom | -305.716 | 0 |
| Story6 | 18 | Top | -325.646 | 0 |
| | | Bottom | -325.646 | 0 |
| Story5 | 15 | Top | -339.486 | 0 |
| | | Bottom | -339.486 | 0 |
| Story4 | 12 | Top | -348.343 | 0 |
| | | Bottom | -348.343 | 0 |
| Story3 | 9 | Top | -353.326 | 0 |
| | | Bottom | -353.326 | 0 |
| Story2 | 6 | Top | -355.54 | 0 |
| | | Bottom | -355.54 | 0 |
| Story1 | 3 | Top | -356.094 | 0 |
| | | Bottom | -356.094 | 0 |
| Base | 0 | Top | 0 | 0 |
| | | Bottom | 0 | 0 |

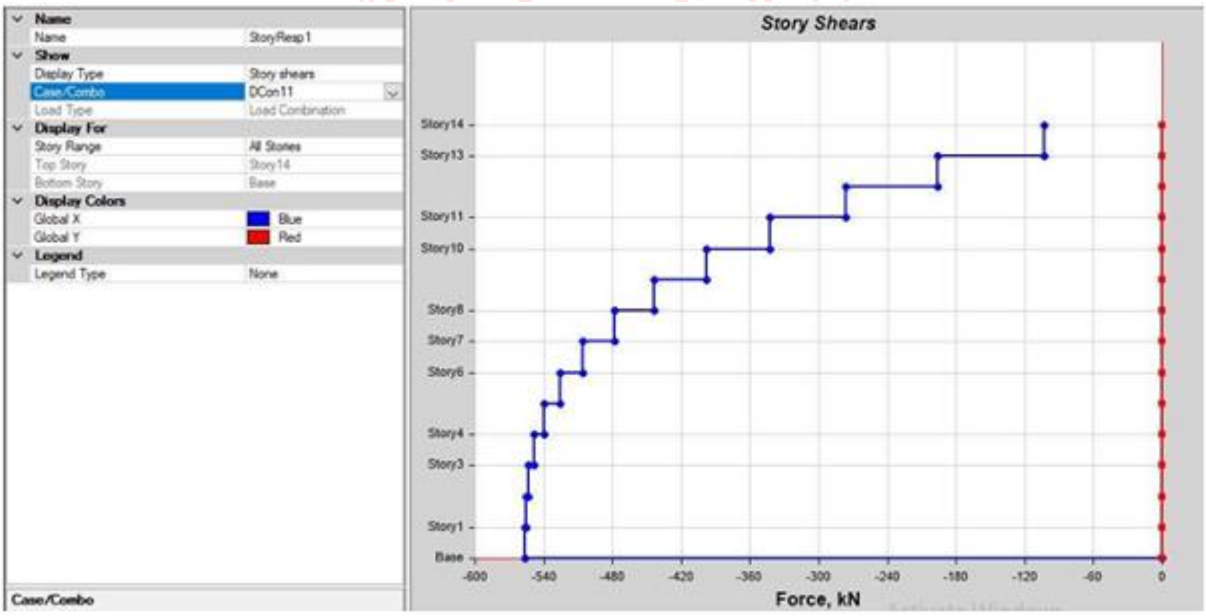



**Fig 3.19 Representation of Storey Shear in X direction**

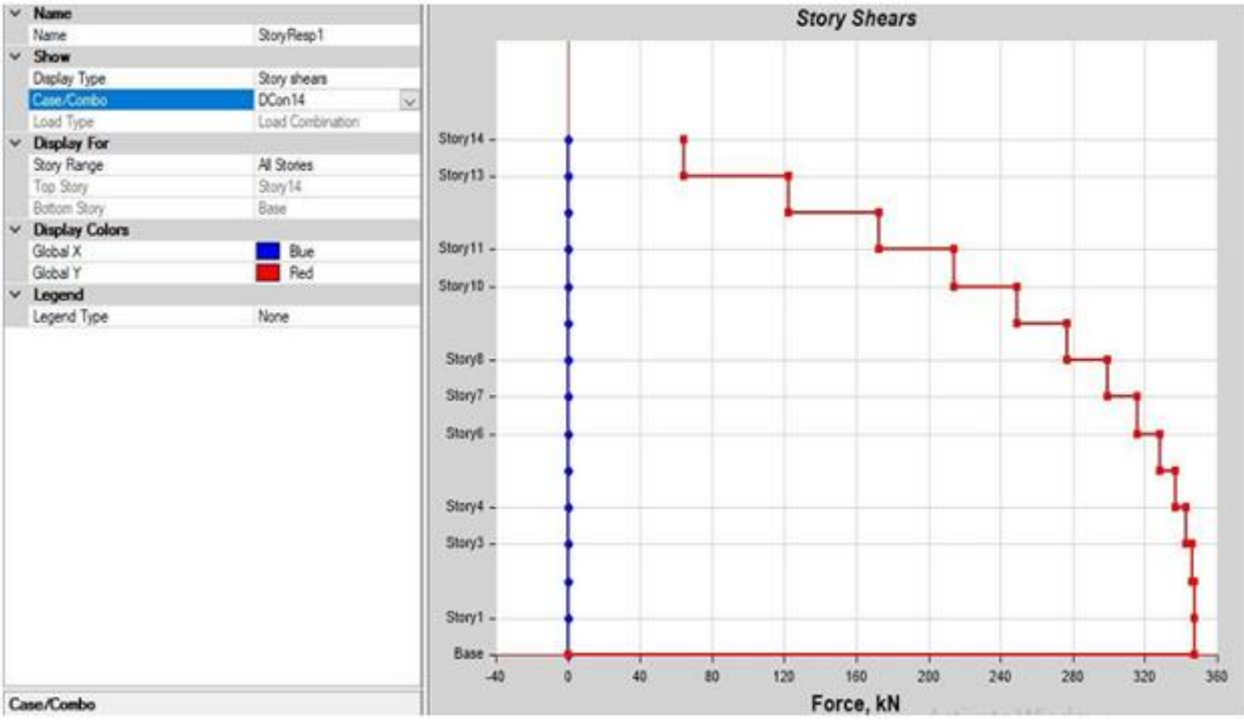



Fig 3.20 Representation of Storey Shear in Y direction

**Storey Shear for Symmetrical Building in with LRB**

**Table No. 3.19 Storey Shear with respect to height of building**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| Story | Elevation | Location | X-Dir | Y-Dir |
| | m | | kN | kN |
| Story14 | 42 | Top | -42.919 | 0 |
| | | Bottom | -42.919 | 0 |
| Story13 | 39 | Top | -82.0189 | 0 |
| | | Bottom | -82.0189 | 0 |
| Story12 | 36 | Top | -115.335 | 0 |
| | | Bottom | -115.335 | 0 |
| Story11 | 33 | Top | -143.329 | 0 |
| | | Bottom | -143.329 | 0 |
| Story10 | 30 | Top | -166.465 | 0 |
| | | Bottom | -166.465 | 0 |
| Story9 | 27 | Top | -185.206 | 0 |
| | | Bottom | -185.206 | 0 |
| Story8 | 24 | Top | -200.013 | 0 |
| | | Bottom | -200.013 | 0 |
| Story7 | 21 | Top | -211.349 | 0 |
| | | Bottom | -211.349 | 0 |
| Story6 | 18 | Top | -219.678 | 0 |
| | | Bottom | -219.678 | 0 |
| Story5 | 15 | Top | -225.462 | 0 |
| | | Bottom | -225.462 | 0 |
| Story4 | 12 | Top | -229.164 | 0 |
| | | Bottom | -229.164 | 0 |
| Story3 | 9 | Top | -231.246 | 0 |
| | | Bottom | -231.246 | 0 |
| Story2 | 6 | Top | -232.172 | 0 |
| | | Bottom | -232.172 | 0 |
| Story1 | 3 | Top | -232.403 | 0 |
| | | Bottom | -232.403 | 0 |
| Base | 0 | Top | 0 | 0 |
| | | Bottom | 0 | 0 |

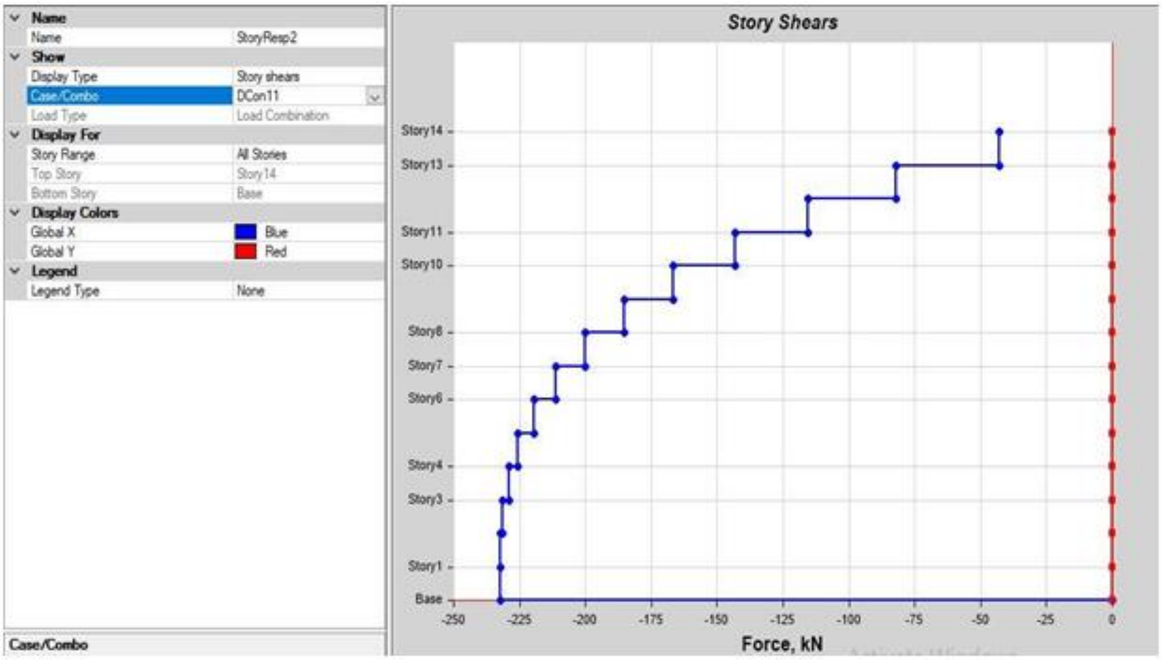



Fig 3.21 Representation of Storey Shear in X direction

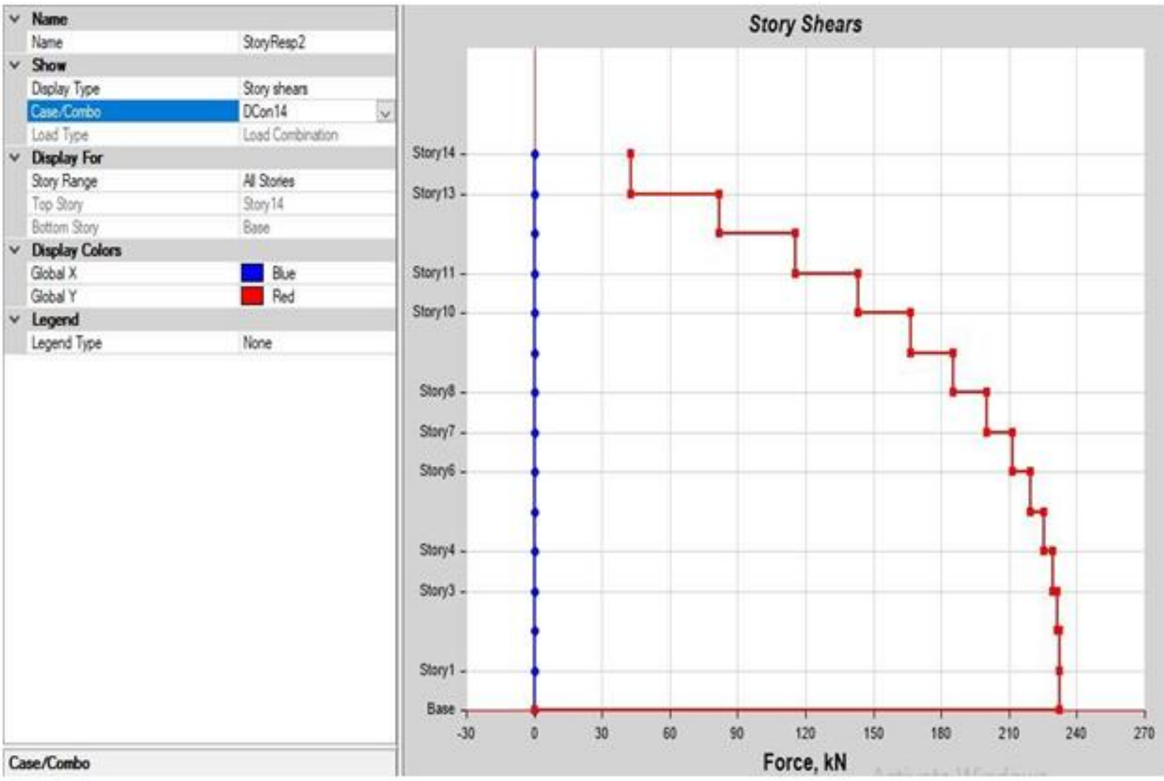



Fig 3.22 Representation of Storey Shear in Y direction

**Storey Shear for Asymmetrical (L Shaped) Building in without base isolation**

**Table No. 3.20 Storey Shear with respect to height of building**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| Story | Elevation | Location | X-Dir | Y-Dir |
| | m | | kN | kN |
| Story14 | 42 | Top | -69.3203 | 0 |
| | | Bottom | -69.3203 | 0 |
| Story13 | 39 | Top | -131.329 | 0 |
| | | Bottom | -131.329 | 0 |
| Story12 | 36 | Top | -184.164 | 0 |
| | | Bottom | -184.164 | 0 |
| Story11 | 33 | Top | -228.561 | 0 |
| | | Bottom | -228.561 | 0 |
| Story10 | 30 | Top | -265.252 | 0 |
| | | Bottom | -265.252 | 0 |

| | | | | |
|---|---|---|---|---|
| Story9 | 27 | Top | -294.972 | 0 |
| | | Bottom | -294.972 | 0 |
| Story8 | 24 | Top | -318.455 | 0 |
| | | Bottom | -318.455 | 0 |
| Story7 | 21 | Top | -336.434 | 0 |
| | | Bottom | -336.434 | 0 |
| Story6 | 18 | Top | -349.643 | 0 |
| | | Bottom | -349.643 | 0 |
| Story5 | 15 | Top | -358.815 | 0 |
| | | Bottom | -358.815 | 0 |
| Story4 | 12 | Top | -364.686 | 0 |
| | | Bottom | -364.686 | 0 |
| Story3 | 9 | Top | -367.988 | 0 |
| | | Bottom | -367.988 | 0 |
| Story2 | 6 | Top | -369.456 | 0 |
| | | Bottom | -369.456 | 0 |
| Story1 | 3 | Top | -369.823 | 0 |
| | | Bottom | -369.823 | 0 |
| Base | 0 | Top | 0 | 0 |
| | | Bottom | 0 | 0 |

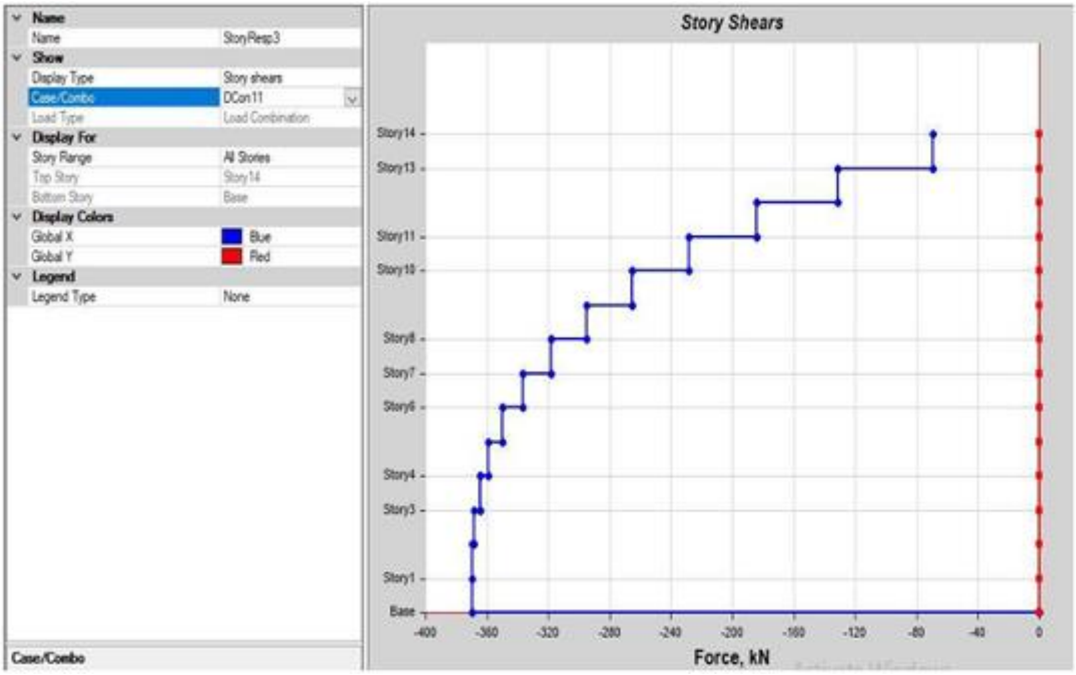



**Fig 3.23 Representation of Storey Shear in X direction**

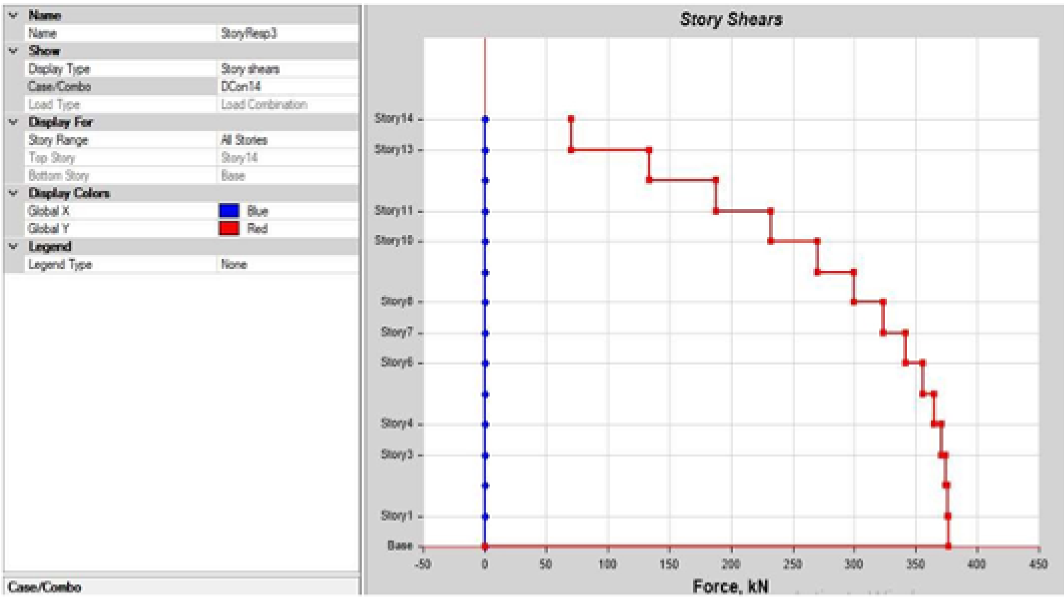



**Fig 3.24 Representation of Storey Shear in Y direction**

**Storey Shear for Asymmetrical (L Shaped) Building in with LRB**

**Table No. 3.21 Storey Shear with respect to height of building**

| TABLE: Story Response | | | | |
|---|---|---|---|---|
| Story | Elevation | Location | X-Dir | Y-Dir |
| | m | | kN | kN |
| Story14 | 42 | Top | -53.2579 | 0 |
| | | Bottom | -53.2579 | 0 |
| Story13 | 39 | Top | -100.898 | 0 |
| | | Bottom | -100.898 | 0 |
| Story12 | 36 | Top | -141.491 | 0 |
| | | Bottom | -141.491 | 0 |
| Story11 | 33 | Top | -175.601 | 0 |
| | | Bottom | -175.601 | 0 |
| Story10 | 30 | Top | -203.79 | 0 |
| | | Bottom | -203.79 | 0 |
| Story9 | 27 | Top | -226.624 | 0 |
| | | Bottom | -226.624 | 0 |
| Story8 | 24 | Top | -244.665 | 0 |
| | | Bottom | -244.665 | 0 |
| Story7 | 21 | Top | -258.478 | 0 |
| | | Bottom | -258.478 | 0 |
| Story6 | 18 | Top | -268.626 | 0 |
| | | Bottom | -268.626 | 0 |
| Story5 | 15 | Top | -275.673 | 0 |
| | | Bottom | -275.673 | 0 |
| Story4 | 12 | Top | -280.184 | 0 |
| | | Bottom | -280.184 | 0 |
| Story3 | 9 | Top | -282.721 | 0 |
| | | Bottom | -282.721 | 0 |
| Story2 | 6 | Top | -283.848 | 0 |
| | | Bottom | -283.848 | 0 |
| Story1 | 3 | Top | -284.13 | 0 |
| | | Bottom | -284.13 | 0 |
| Base | 0 | Top | 0 | 0 |
| | | Bottom | 0 | 0 |

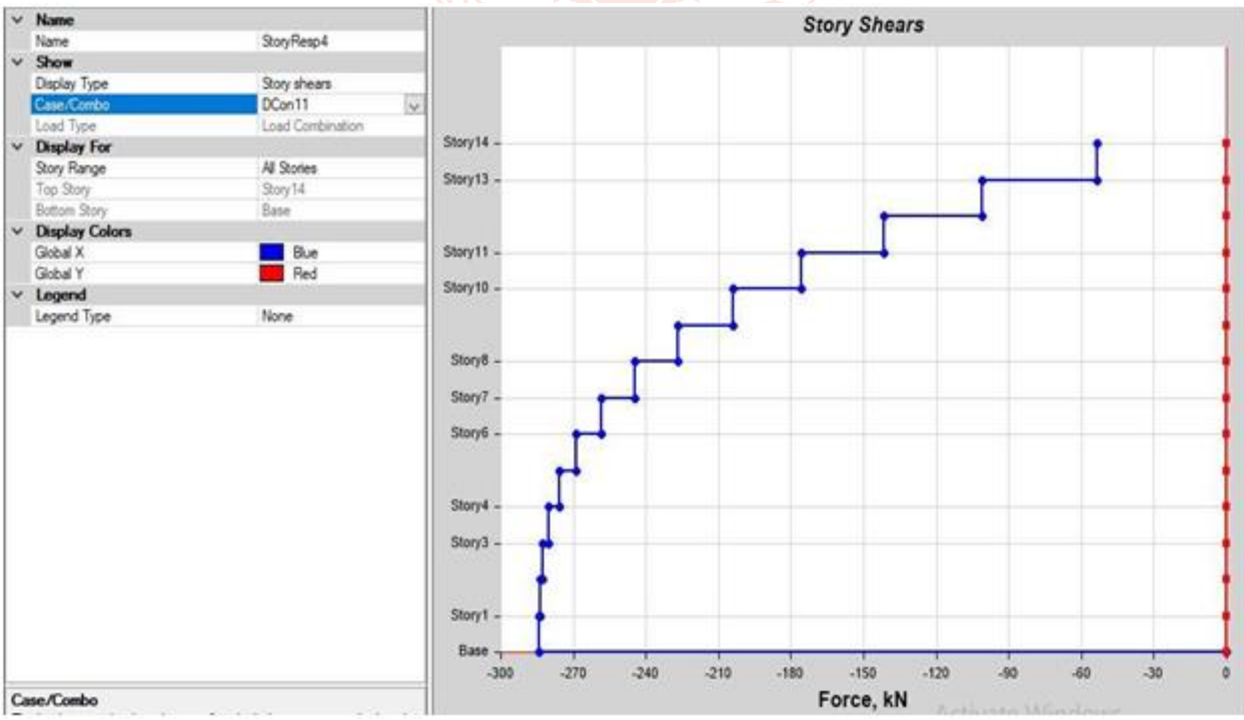



**Fig 3.25 Representation of Storey Shear in X direction**

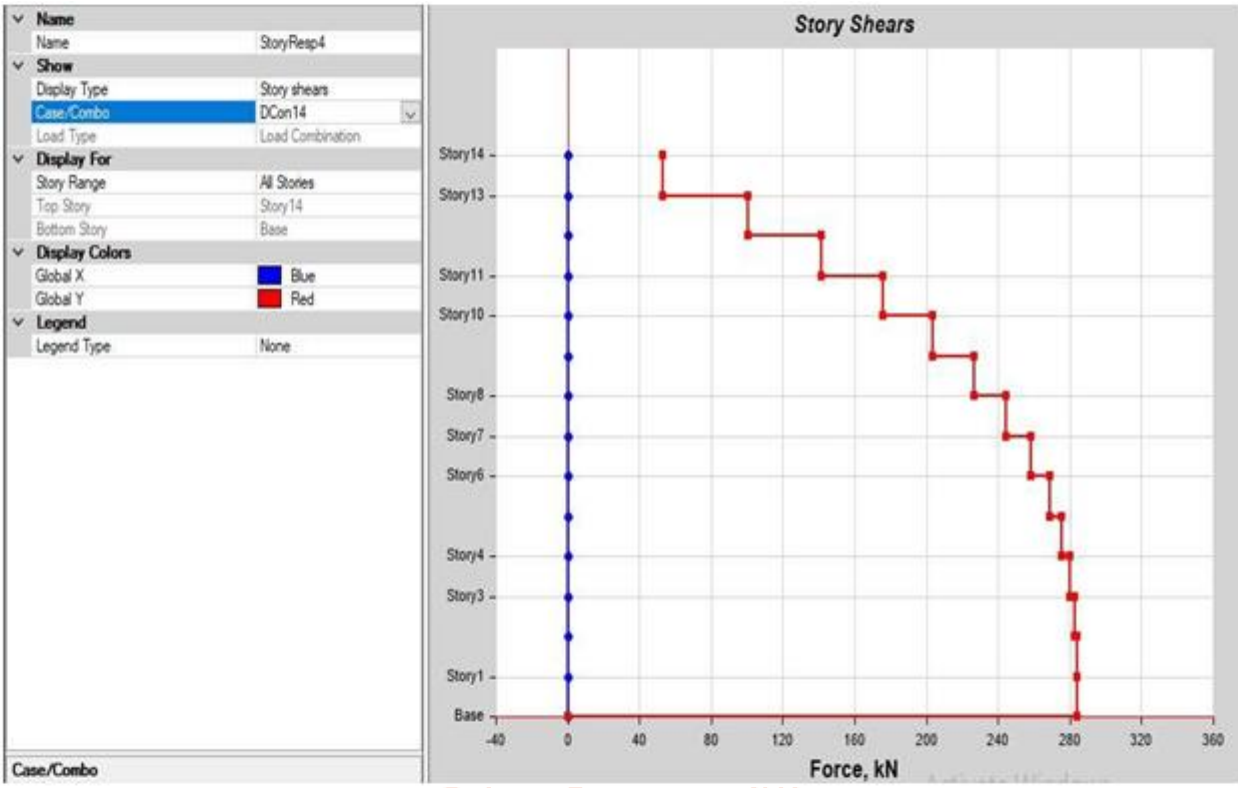



Fig 3.26 Representation of Storey Shear in Y direction

**Deformed shape representation for all the structures:**

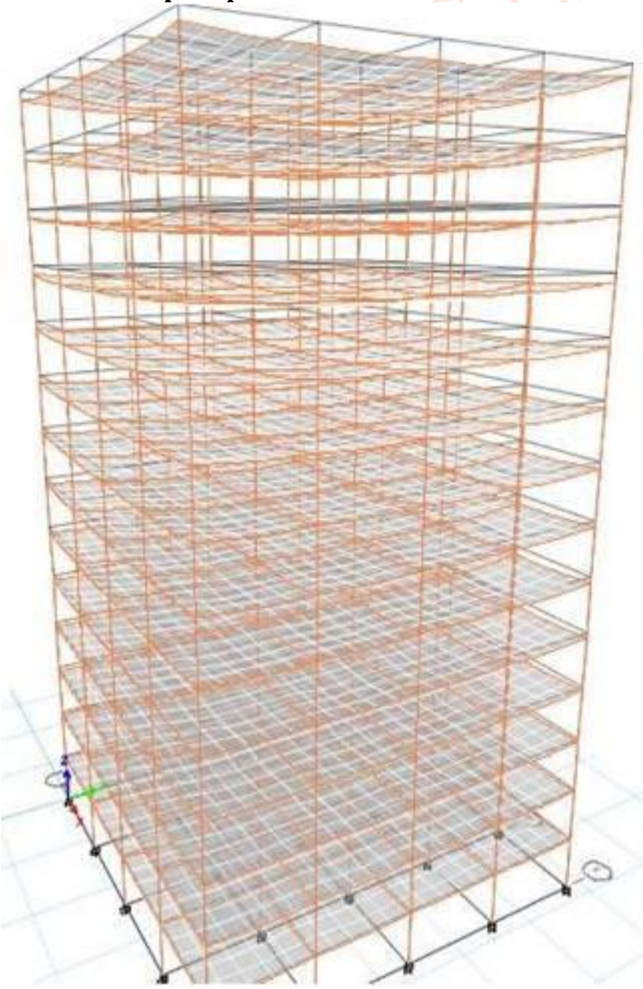


Fig 3.27 Deformed shape of Structure without Base Isolation

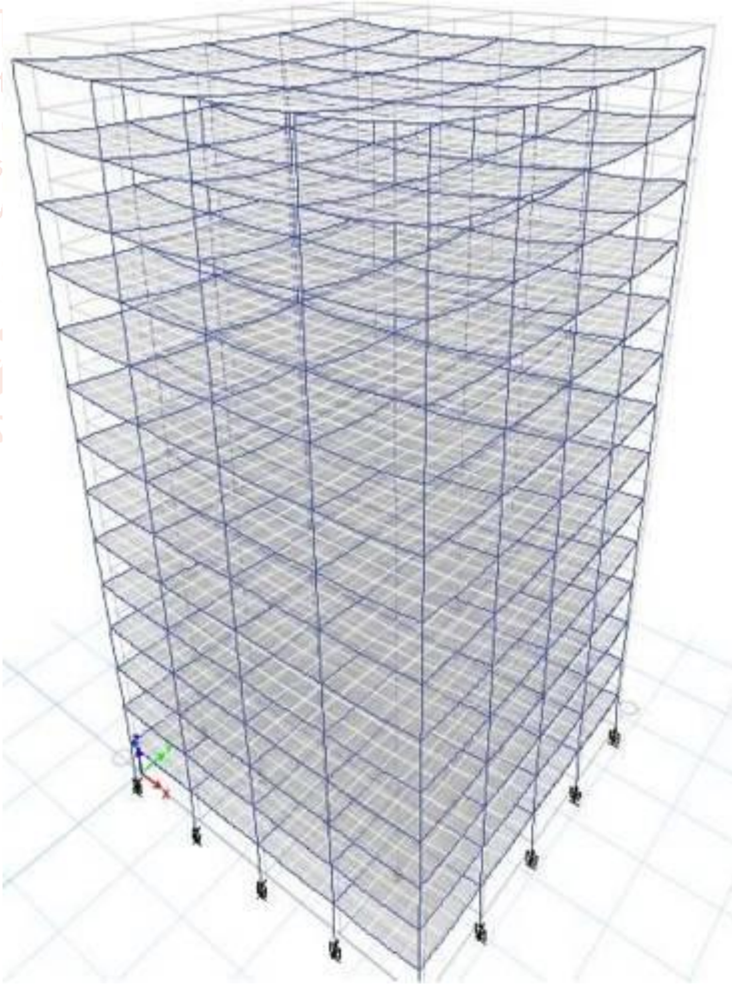


Fig 3.28 Deformed shape of Structure with LRB

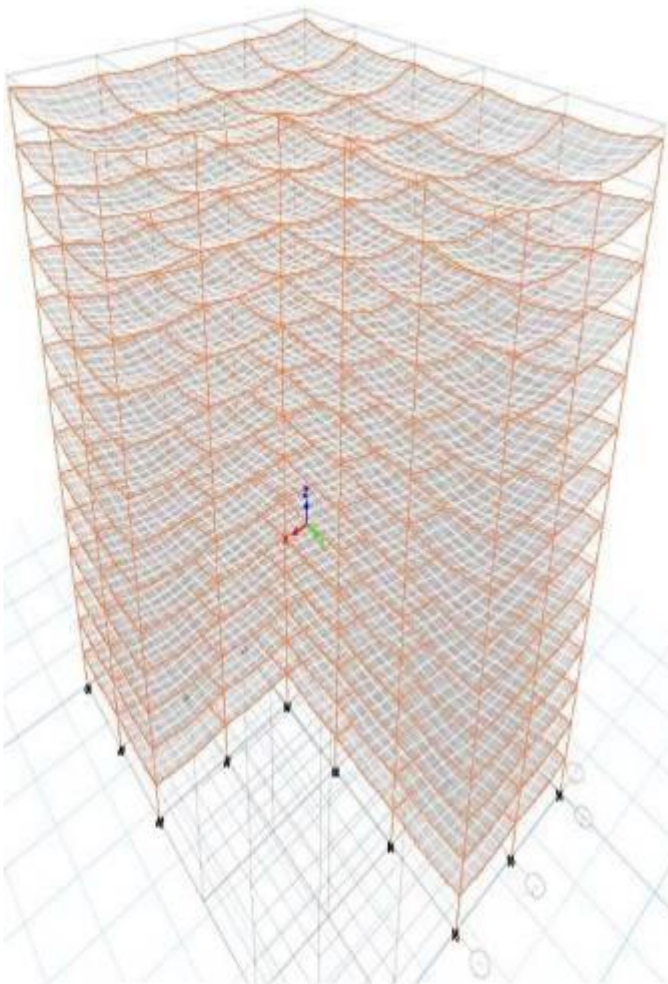


Fig 3.29 Deformed shape of Structure without Base Isolation

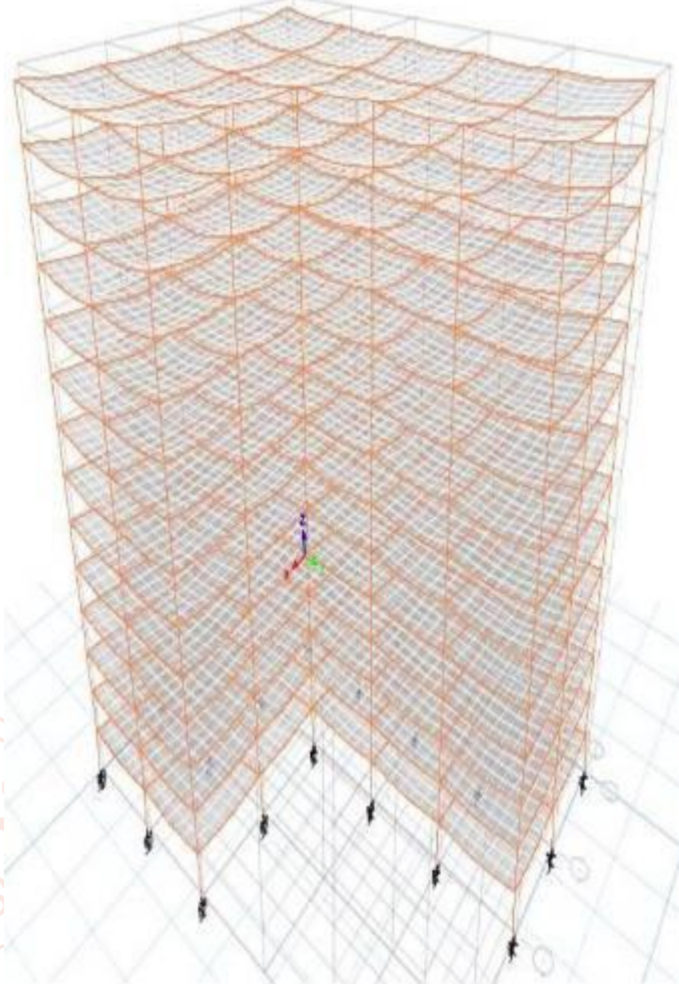


Fig 3.30 Deformed shape of Structure with LRB

**CONCLUSIONS AND FUTURE SCOPE OF THE STUDY**

**Conclusions:**

Linear static analysis for Seismic resistance of a 14 storey Symmetric & Asymmetric RC building has been done for cases namely without and with base isolation. Supports has been removed at base and assigned as spring and different parameters like storey displacement, storey drift, base shear, and storey shear for all cases are evaluated and presented in the form of charts. Based on results and comparing the values of different parameters with acceptance criteria following conclusion can be made:

- The maximum displacement in X direction are reduced by **36.14%** for symmetrical building and
- **8.01%** for Asymmetrical building respectively.
- From analytical study, it is observed that for both models of symmetric as well as asymmetric, fixed base building have zero displacement at base of building whereas, base isolated building models shows appreciable amount of lateral displacements at base.
- Base isolation is very effective in reducing the storey drift by an amount of **56.17%** inSymmetrical building & **21.73 %** in Asymmetrical building.
- At base more storey drift was observed for base isolated model as compared to model of fixed base building. As storey height increases, the storey drifts in base isolated building model drastically decreases as compared to model of fixed base building.
- For base isolated structure the upper stories are not much drifted as compared to non-isolated structure. Hence the base isolators are very useful in reducing the lateral dift.
- The base shear for symmetrical building in X direction is reduced by **51.09%** after the implementation of LBR system and in Y direction the same is reduced by **50.05%.**
- For Asymmetrical building the base shear in X direction is reduced by **30.15 %** after theimplementation of LRB system and in Y direction the same is reduced by **34.50%.**
- The maximum storey shear is reduced by **53.44%** after the implementation of LRB System in the symmetrical building while in case of asymmetrical building it is reduced by only **29.92%** after using same LRB system.
- The effect of asymmetry is considerable in the seismic performance of a multistoried building with and without base isolation system although the presence of LRB system is responsible for better performance of the structure against seismic loads.

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