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# Earthquake Analysis of Multistoried Residential Building

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**ABSTRACT:** The ground vibration along with seismic tremors is the reason to the breakdown of structures. So as to spare loss of life and property; the structures should be planned against the powers originating from ground vibration. In this work A RCC encircled five-storied structure has been broke down and intended to endure the quakes in which the Indian seismic zone IV is inclined to, the site of structure is in Jalandhar. Device utilized for calculations is STAAD-pro 2000. The investigation has been done for quake and According to Indian Standard codes 1893:2002 (section 1) and IS-875:1987 (section 3) individually. Fortified solid structure is finished with point of confinement state technique complying with IS-456:2000 built in the STAAD.pro. The plan results are confirmed additionally alongside handbook structure arbitrarily. At last, the fortification specifying is done carefully according to Seems to be 13920:1993 in order to give flexibility to auxiliary individuals including joints. The fortifications of different individuals are as illustrations. The loads have been dissected utilizing technique for fixity and intended for irrefutably the greatest responses at section bases. The structure was investigated without block infill boards which may have caused underestimation of parallel solidness of the structure making the plan more secure. To the extent of further work is concerned, the infill boards might be associated with examination and progressively efficient plan can be gotten.

**KEYWORDS:** Earthquake, STAAD PRO, Seismic coefficient Method, Time history analysis

## I. INTRODUCTION

Building improvement is the planning courses of action with the advancement of structure, for instance, private houses. In a clear structure can be portray as an encase space by dividers with housetop, nourishment, fabric and the essential needs of people. In the early old events individuals lived in natural hollows, over trees or under trees to shield themselves from wild animals, downpour, sun, etc as the events go as individuals being started living in cabins made of timber branches. The asylums of those old have been shaped nowadays into stunning houses. Rich people live in present day condition houses

Structures are the noteworthy pointer of social headway of the territory. Every human needs to have pleasant homes on a typical generally one experiences his two)third time on earth times in the houses. The security city feeling of the

commitment. These are the few reasons which are able that the individual do most extraordinary effort and spend hard earned saving in owning houses.

Nowadays the house building is genuine work of the social headway of the area.

Step by step new strategies are being created for the improvement of houses monetarily quickly and fulfilling the necessities of the system authorities and artists do the structure work masterminding and plan, etc of the structures. Originator is responsible for doing the outline works of structure as for the heading of pros and designers. The Draftsman must know his and should have the ability to hold fast to the direction of the planner and should have the ability to draw the required delineation of the structure site plans and organization designs, etc regarding the essentials' The arrangement is made using programming on helper examination structure (STAAD PRO) The structure presented to both the vertical loads similarly as even loads. The vertical weight includes dead stack of helper parts, for instance, bars, segments, pieces, etc and live loads.

The dimension trouble contains the breeze controls consequently collecting is proposed for dead weight, live weight and wind load as indicated by IS 875 The structure is arranged as two dimensional vertical edge and dismembered for the most outrageous and least bending minutes and shear controls by experimentation procedures as per IS 456-2000 (The help is taken by programming available in foundation and the computations of weights minutes and shear controls and obtained from this item.

## OBJECTIVE:

- Analysis and Design of Earthquake resistant of multistory building.
- To analyse the seismic response of a structure using the following
- two methods with the help of software STAAD.Pro 2000.
- Seismic coefficient Method

## II. LITERATURE REVIEW

**UmamaheswaraRao et.al [1]** In this study model of G+7 Structure is analysed under seismic load by using STAAD.Pro software in different seismic zones (II, III, IV, V) of India. Consideration is done for all the basic parameters of earthquake responsible to affect Multi-storey building and analysed with Different Load combinations and try to fill the void of IS:1893-2002 doesn't provide the variations in steel quantity from zone to zone. Result shows comparison of Base shear, Floor Displacements, support Reactions and variation of steel quantity by zone to zone. Result declare that Base shear, Displacements, support reactions and steel quantity are Depends on zone factor, so these values are more in zone-V, zone-V is critical for the G+7 structure. Support reactions zone-V as higher value as compare to zone-II, zone-III, zone-IV. 6. Steel quantity of seismic zone-V is higher than 53.84%, 13.89% and 8.31 % as compared to zone II, zone-III and zone-IV.

**Pavan Kumar et.al [2]** In these research the residential building of G+ 15 storey structure is analyse for seismic load by using method of static and dynamic analysis by considering ordinary moment resisting frame and special moment resisting frame in zone II. Equivalent static analysis and response spectrum analysis are the methods used in structural seismic analysis. The total structure were analyzed by using STAAD.PRO software. The result shows that response reduction of cases ordinary moment resisting frame and special moment resisting frame values with deflection diagrams in static and dynamic analysis. The special moment of resisting frame structured is good in resisting the seismic loads. Final result concludes that the results of static analysis in OMRF & SMRF values are low when comparing to that of dynamic analysis in OMRF & SMRF values. Hence the performance of dynamic analysis SMRF structure is quiet good in resisting the earthquake forces compared to that of the static analysis OMRF & SMRF.

**Prof.Komal S. Meshramet.al [3]** The present study deals with seismic analysis of multistoried residential building G+7. The dead load and live load applied and design for beam, column, slab and footing are obtained by analyzed Total structure by using STAADPro software. thebehavior of multistoried building by Equivalent Static Lateral Force Method is examined. The result shows the variation in calculation of base shear by manually and using STAAD.Pro Design Base Shear (Manually) = 2345.71 KN Design Base Shear (STAAD Pro)= 1634.43 KN . Finally, Conclude STADD. Pro is versatile software having the ability to determine the reinforcement required for any concrete section based on its loading and determine the nodal deflections against lateral forces and To consider Seismic forces and designed it as an earthquake resistant structure.

## III. DESIGN OF STRUCTURE ELEMENTS

The design of any structure is arranged into the accompanying two fundamental sorts;

- i. Functional Design
- ii. Structural Design

The procedure of auxiliary structure includes the accompanying stages:

- Structural arranging
- Action of Forces and calculation of burdens
- Method of investigation
- Member Design
- Detailing, drawing and readiness of calendars

#### IV. INTERFACE OF STAAD PRO SOFTWARE

##### 4.1 GENERAL

In each part of human development we required structures to live in or to get what we need. In any case, it isn't just structure structures however to fabricate proficient structures with the goal that it can satisfy the principle reason for what it was made for. Here comes the job of structural designing and all the more exactly the job of investigation of structure.

There are numerous established strategies to take care of plan issue, and with time new programming's additionally becoming an integral factor. Here in this undertaking work dependent on programming named Staad professional has been used. Few standard issues likewise have been unraveled to demonstrate how Staad star can be utilized in various cases.

These ordinary issues have been settled utilizing essential idea of stacking, examination, condition according to IS code. These essential strategies might be discovered helpful for further investigation of issues .

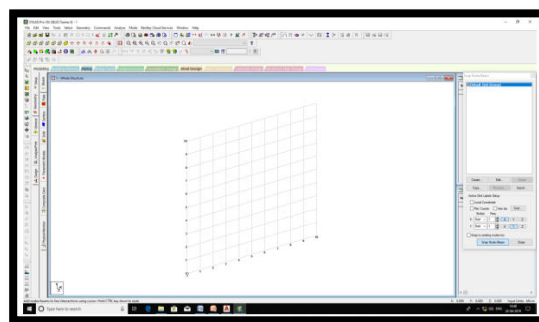
Examination of the structure intends to assurance of the inside powers like hub pressure bowing minute, shear constrain and so on in the segment part for which the part are to be planned under the activity of given outside burden. The plan is procedure of segment percussion from the examination results by utilizing appropriate investigation method. The point of configuration is to accomplishment of a satisfactory likelihood that structures being planned will perform agreeably amid their proposed life.

##### 4.2 STAAD PRO

STAAD or (STAAD.Pro) is a structural analysis and design software application originally developed by Research Engineers International in 1997. In late 2005, Research Engineers International was bought by Bentley Systems.

STAAD.Pro is one of the most widely used structural analysis and design software products worldwide. It supports over 90 international steel, concrete, timber & aluminium design codes.

It can make use of various forms of analysis from the traditional static analysis to more recent analysis methods like p-delta analysis, geometric non-linear analysis, Pushover analysis (Static-Non Linear Analysis) or a buckling analysis. It can also make use of various forms of dynamic analysis methods from time history analysis to response spectrum analysis. The response spectrum analysis feature is supported for both user defined spectra as well as a number of international code specified spectra.



(Figure4.1 : STAAD PRO working Interface)

##### 4.2.1 Advantages of STAAD PRO software

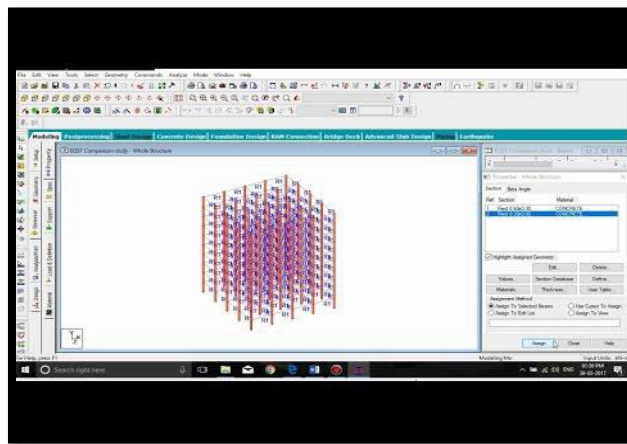
- i) Flexible modeling environment
  - ii) Availability of wide ranges for designing code
  - iii) Open architecture
  - iv) All feature of structural engineering
  - v) Report and documentation
  - vi) Quality assurances
  - vii) International code
- Investigation of structure of different components of structure.

- i) Planning of different parts of a structure with section situating
- ii) Introduction of STAAD.Pro
- iii) Modeling of the structure in the STAAD.Pro giving all limit conditions (Underpins, stacking and so on)
- iv) Analysis and Design of different basic parts of the modular structure
- v) Study of investigation Data of the product
- vi) Detailing of shafts, segments, piece with area proportioning and fortification.

#### 4.2.2 Aim of STAAD PRO

This undertaking goes for relearning of idea of basic plan with the assistance of PC helps. Quickly we have experienced finishing calls attention to of the venture work

- i) Comprehension of plan and itemizing idea.
- ii) Main goal for example learning of STAAD.Pro programming bundle.
- iii) Learning of examination and plan procedure which can be valuable in the field.
- iv) Understanding of seismic tremor obstruction plan idea.
- v) Approach for expert practice in the field of basic designing



(Figure 4.2: Seismic Analysis of RCC Building Using Staad Pro V8i)

### V. SEISMIC COEFFICIENT METHOD

As per IS-1893-2002 For calculating the equivalent lateral loads on multistoried buildings are using seismic coefficient method.

As the level of seismic coefficients India has been separated into four zones as to level For critical structures these coefficient can be expanded by half. The flat quake power ought to be determined for dead loads and some level of live loads.

The natural moment period of multistoried building in clause 7.6 of IS 1893 (part 1); 2000.

$T_a = 0.075h/0.75$  for share walls or moment resisting frame without bracing.  $T_a = 0.09h/\sqrt{d}$  for share walls or all Multistory building including moment resisting frame or structure along with bracing.

$d$  = Base length of structure in m, along with considered path of lateral force

$h$  = total height of buildings in m. Where,  $n$  = number of storey's counting basement

The formula used for calculating the base shear is;

$V_B = KCahW$ .  $a_h$  = seismic design coefficient  $= \beta I a_0$ ,  $W$  = Total weight of multistory Building including dead load and live load with appropriate percentages.

$C$  = a coefficient defining the flexibility of the structure which is not more than 1.

$I$  = Importance factor depending upon the purpose of the structure

$K$  = performance factor depending on the structural frame arrangement system and brittleness or ductility of construction.

Total design lateral force can be calculated by, clause 7.5 of IS 1893 (PART1): 2000.  $V_b = A_h W$   $A_h$  = design horizontal seismic coefficient for a structure

$W$  = seismic weight of building.  $A_h = (Z/2)(I/R)(S_a/g)$   $Z$  = Zone factor

$I$  = Importance factor  $R$  = Response reduction factor

$S_a/g$  = Spectral acceleration ( $S_a/g=1/T$  For hard soil)  
 Distribution of forces along the height of building is given by  
 $Q_i = V_B (W_i h_i^2 / \sum W_i h_i^2)$  Where,  $V_B$  = Base share  
 $Q_i$  = lateral forces at the floor  $i$   $V_B$  = Base share  
 $h_i$  = height measured from the base of the building to the floor  
 $n$  = number of storey's including the basement.  
 $W_i$  = load of the floor  $i$ .

## VI. PROPOSED METHODOLOGY

### 6.1 History of Structural Analysis

A structure refers to a system of two or more connected parts used to support a load. It may be considered as an assembly of two or more basic components connected to each other so that they carry the design loads safely without causing any serviceability failure. Once a preliminary design of a structure is fixed, the structure then must be analyzed to make sure that it has its required strength and rigidity. The loadings are supposed to be taken from respective design codes and local specifications, if any. The forces in the members and the displacements of the joints are found using the theory of structural analysis. The whole structural system and its loading conditions might be of complex nature, so to make the analysis simpler, certain simplifying assumptions related to the material quality, member geometry, nature of applied loads, their distribution, the type of connections at the joints and the support conditions are used. This shall help making the process of structural analysis simpler to quite an extent.

### 6.2 Methods of structural analysis

When the number of unknown reactions or the number of internal forces exceeds the number of equilibrium equations available for the purpose of analysis, the structure is called a statically indeterminate structure. Many structures are statically indeterminate. This indeterminacy may be as a result of added supports or extra members, or by the general form of the structure. While analyzing any indeterminate structure, it is essential to satisfy equilibrium, compatibility, and force-displacement conditions for the structure. The fundamental methods to analyze the statically indeterminate structures are discussed below.

#### 6.2.1 Force method

The force method developed first by James Clerk Maxwell and further developed later by Otto Mohr and Heinrich Muller-Breslau was one of the first methods available for analysis of statically indeterminate structures. This method is also called compatibility method or the method of consistent displacements. In this method, the compatibility and force displacement requirements for the given structure are first defined in order to determine the redundant forces. Once these forces are determined, the remaining reactive forces on the given structure are found out by satisfying the equilibrium requirements.

#### 6.2.2 Displacement method

In the displacement method, first load-displacement relations for the members of the structure are written and then the equilibrium requirements for the same are satisfied. The unknowns in the equations are displacements. Unknown displacements are written in terms of the loads or forces by using the load-displacement relations and then these equations are solved to determine the displacements. As the displacements are determined, the loads are found out from the compatibility and load-displacement equations. Some classical techniques used to apply the displacement method are discussed.

#### 6.2.3 Slope deflection method

This method was first devised by Heinrich Manderla and Otto Mohr to study the secondary stresses in trusses and was further developed by G. A. Maney in order to extend its application to analyze indeterminate beams and framed structures. The basic assumption of this method is to consider the deformations caused only by bending moments. It is assumed that the effects of shear force or axial force deformations are negligible in indeterminate beams or frames. The fundamental slope-deflection equation expresses the moment at the end of a member as the superposition of the end moments caused due to the external loads on the member, with the ends being assumed as restrained, and the end moments caused by the displacements and actual end rotations. Slope-deflection equations are applied to each of the members of the structure. Using appropriate equations of equilibrium for the joints along with the slope-deflection equations of each member, a set of simultaneous equations with unknowns as the displacements are obtained. Once the values of these displacements are found, the end moments are found using the slope-deflection equations.

#### 6.2.4 Moment distribution method

This method of analyzing beams and multi-storey frames using moment distribution was introduced by Prof. Hardy Cross in 1930, and is also sometimes referred to as Hardy Cross method. It is an iterative method. Initially all the joints are temporarily restrained against rotation and fixed end moments for all the members are written down. Each joint is then released one by one in succession and the unbalanced moment is distributed to the ends of the members in the ratio of their distribution factors. These distributed moments are then carried over to the far ends of the joints. Again the joint is temporarily restrained before moving on to the next joint. Same set of operations are performed at each joint till all the joints are completed and the results obtained are up to desired accuracy. The method does not involve solving a number of simultaneous equations, which may get quite complicated while dealing with large structures, and is therefore preferred over the slope-deflection method.

#### 6.2.5 Kani's method

This method was first developed by Prof. Gasper Kani of Germany in the year 1947. This is an indirect extension of slope deflection method. This is an efficient method due to simplicity of moment distribution. The method offers an iterative scheme for applying slope deflection method of structural analysis. Whereas the moment distribution method reduces the number of linear simultaneous equations and such equations needed are equal to the number of translator displacements, the number of equations needed is zero in case of the Kani's method.

STAAD-pro 2000 used to analyses the multistory building.

The given input data

- Geometry of the structure
- Materials Properties are beams, columns, and slabs are given.
- At Base Nodes Fixed supports are provided
- As per IS-456:2000 and IS-875:1987 Part-5 Loads combinations data are to be adopted.

#### 6.2 Plan of the project:

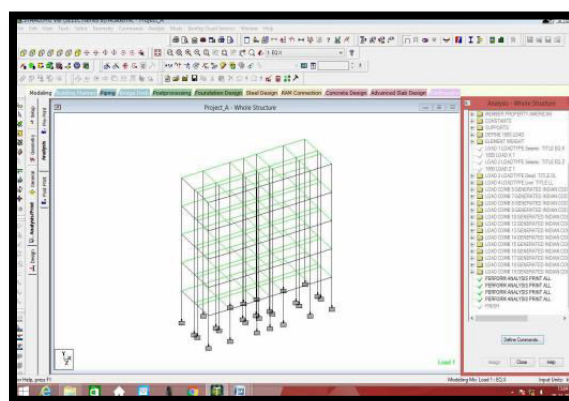
One of the major problem in the Indian country and world also facing the rapidly growth Of population this can be solved to certain extent with the construction of building

And apartment which can be live many people in available area.

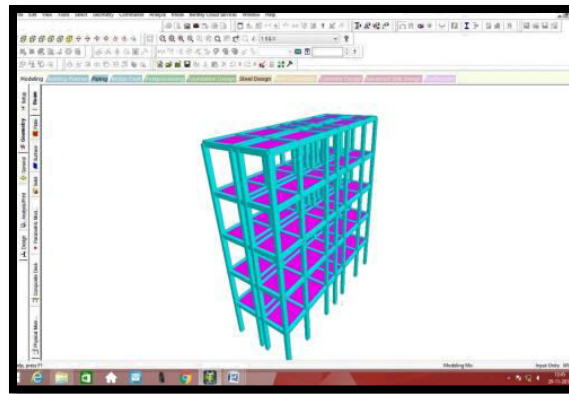
The project consist of two living\dining room (5625 X 3100), two bathroom (2100 X 1500), Kitchen (2400 X1800), bedroom (3050 X 3435) and with all basic

Amenities as shown in figure 3.1.

And other figure are shown in fig 2.2,2.3, and 2.4 view from z, y, and 3d view axis  
In STAAD.Pro.



(Figure 6.1: View from -z axis)



(Figure6.2: 3-D View in STADD PRO)

A 3-D RCC (Reinforced Cement Concrete) frame an area contain of 86.75m x 65.0m in XZ plane, and y direction consisted of G+5 for multistory building for residential.

Buildings serve several collective needs – primarily need as shelter from climate condition, safety/security, living space, privacy/ space to yourself , to store property, and to comfortably live and work. A building as a shelter represents a physical division of the human being (a place for comfort and safety).

**Table 6.1: Design data considered**

|                   |                                                                                   |
|-------------------|-----------------------------------------------------------------------------------|
| Live load         | 4.0 KN/m <sup>2</sup>                                                             |
| Roof load         | 1.0 KN/m <sup>2</sup>                                                             |
| Floor finish      | 1.0 KN/m <sup>2</sup>                                                             |
| Location          | jalandhar                                                                         |
| Wind load         | As per IS: 875-Not designed for wind load, since earthquake loads only considered |
| Earthquake load   | As per IS-1893 (Part 1) – 2002                                                    |
| Damping ratio     | 5%                                                                                |
| Type of soil      | Type II, Medium as per IS:1893                                                    |
| Storey height     | 3.66 m                                                                            |
| Thickness of slab | 180mm                                                                             |
| Size of beam      | 250mm×400mm                                                                       |
| Size of column    | 400mm×300mm                                                                       |
| Walls             | 230 mm thick brick masonry walls                                                  |

### 6.3Property of Materials

#### Concrete:

For design: M25 grade all  
 $E_c = 5000 (f_{ck})^{0.5} \text{ N/mm}^2$   
 $= 25000 \text{ N/mm}^2$

#### Steel:

HYSD (High Yield Strength Deformation) reinforcement of grade Fe 450 confirm to IS: 1786 is used all through.  
 Loads Considered

**Dead Loads:** Dead loads are stationary or permanent load which are transfer to structure for the period of the life expectancy. Dead burden is fundamentally because of self load of basic individuals, lasting segment dividers, fixed changeless gears and weight of various materials. It significantly comprises of the heaviness of rooftops, walls, beams and columns section and so on which are generally the continuous parts of the structure. Dead load cab be calculated by following IS 875 (Part 1) – 1987.

**Imposed Loads:** The minimum values of live loads to be assumed are given in IS 875 (Part 2)– 1987. Live load is formed by the proposed use or inhabitation of a structure including the heaviness of portable segments, conveyed and focused burdens, load because of effect and vibration and residue loads. These heaps are thought to be delivered by the proposed use or inhabitation of the structure including loads of portable furniture etc..

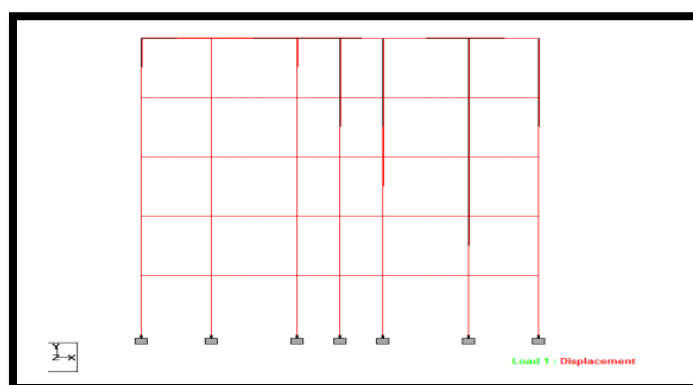
**Seismic Loads:** The seismic loads are determined in a way related to gravity loads. The heaviness of sections and dividers in any story will be similarly conveyed to the floors above and underneath the story. Subsequent reduced level are used for analysis of live loads (as per IS : 1893 (part 1): 2002) terrace 0%, and floor 50%.

## VII. RESULTS & DISCUSSION

### 7.1 Results for Seismic Coefficient Method

Table 7.1: Node Displacement of Seismic Coefficient Method

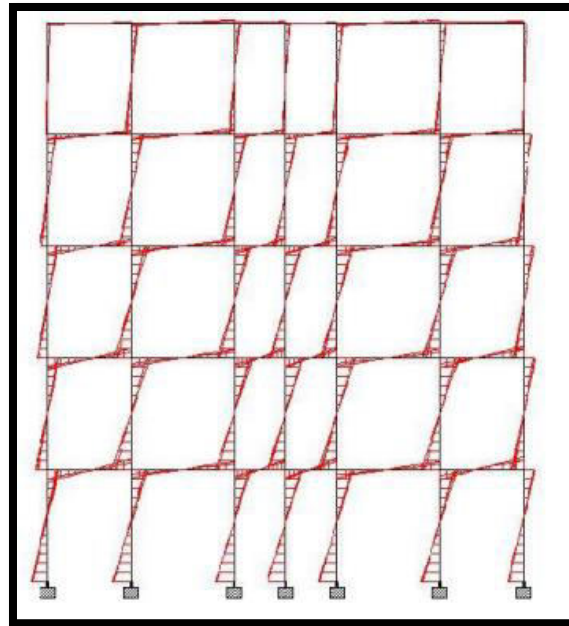
|        | Node | L/C        | Horizontal | Vertical | Horizontal | Resultant | Rotational |           |           |
|--------|------|------------|------------|----------|------------|-----------|------------|-----------|-----------|
|        |      |            | X<br>mm    | Y<br>mm  | Z<br>mm    | mm        | rX<br>rad  | rY<br>rad | rZ<br>rad |
| Max X  | 159  | 12 GENERAT | 33.406     | -3.080   | -1.105     | 33.566    | 0.000      | -0.000    | -0.001    |
| Min X  | 84   | 14 GENERAT | -33.406    | -3.080   | -1.105     | 33.566    | 0.000      | 0.000     | 0.001     |
| Max Y  | 83   | 2 EQ Z     | 0.003      | 0.757    | 36.171     | 36.179    | 0.000      | -0.000    | -0.000    |
| Min Y  | 83   | 15 GENERAT | -0.011     | -5.946   | -54.608    | 54.931    | -0.000     | 0.000     | 0.000     |
| Max Z  | 84   | 17 GENERAT | -0.002     | -1.264   | 54.049     | 54.064    | 0.001      | -0.000    | 0.000     |
| Min Z  | 96   | 15 GENERAT | -0.008     | -2.451   | -54.611    | 54.666    | -0.001     | -0.000    | 0.000     |
| Max rX | 20   | 13 GENERAT | -0.006     | -0.854   | 12.052     | 12.082    | 0.002      | 0.000     | -0.000    |
| Min rX | 32   | 15 GENERAT | -0.005     | -0.744   | -12.078    | 12.101    | -0.002     | -0.000    | -0.000    |
| Max rY | 84   | 14 GENERAT | -33.406    | -3.080   | -1.105     | 33.566    | 0.000      | 0.000     | 0.001     |
| Min rY | 159  | 12 GENERAT | 33.406     | -3.080   | -1.105     | 33.566    | 0.000      | -0.000    | -0.001    |
| Max rZ | 20   | 14 GENERAT | -7.369     | -0.969   | -0.174     | 7.435     | -0.000     | 0.000     | 0.002     |
| Min rZ | 111  | 12 GENERAT | 7.369      | -0.969   | -0.174     | 7.435     | -0.000     | -0.000    | -0.002    |
| Max Rs | 83   | 15 GENERAT | -0.011     | -5.946   | -54.608    | 54.931    | -0.000     | 0.000     | 0.000     |



(Figure 7.1: Nodal displacement of frame structure)

Table 4.2 Beam End Moment of Seismic Coefficient Method

|        | Beam | L/C        | Node | Fx<br>kN | Fy<br>kN | Fz<br>kN | Mx<br>kN-m | My<br>kN-m | Mz<br>kN-m |
|--------|------|------------|------|----------|----------|----------|------------|------------|------------|
| Max Fx | 27   | 15 GENERAT | 3    | 1532.063 | 1.317    | 46.938   | 0.010      | -92.013    | 1.623      |
| Min Fx | 27   | 2 EQ Z     | 3    | -224.557 | -0.090   | -30.255  | -0.007     | 60.063     | -0.129     |
| Max Fy | 54   | 15 GENERAT | 24   | -0.827   | 115.808  | -0.241   | 1.773      | 0.110      | 45.537     |
| Min Fy | 54   | 13 GENERAT | 28   | -0.434   | -114.923 | 0.260    | -1.764     | 0.111      | 44.224     |
| Max Fz | 75   | 15 GENERAT | 27   | 924.334  | 2.821    | 52.951   | -0.006     | -98.019    | 4.874      |
| Min Fz | 71   | 13 GENERAT | 23   | 907.629  | 2.709    | -53.985  | 0.008      | 99.733     | 4.665      |
| Max Mx | 239  | 13 GENERAT | 110  | 1.259    | 33.398   | -0.005   | 1.777      | 0.016      | 15.367     |
| Min Mx | 43   | 13 GENERAT | 19   | 1.259    | 33.398   | 0.005    | -1.777     | -0.016     | 15.367     |
| Max My | 71   | 13 GENERAT | 23   | 907.629  | 2.709    | -53.985  | 0.008      | 99.733     | 4.665      |
| Min My | 75   | 15 GENERAT | 27   | 924.334  | 2.821    | 52.951   | -0.006     | -98.019    | 4.874      |
| Max Mz | 71   | 12 GENERAT | 23   | 966.209  | 60.597   | -1.534   | 0.112      | 2.782      | 111.032    |
| Min Mz | 262  | 14 GENERAT | 113  | 966.209  | -60.597  | -1.534   | -0.112     | 2.782      | -111.032   |



(Figure 7.2: Beam End moment of seismic coefficient Method)

### VIII. CONCLUSION

The structure is completely investigated for seismic loads by seismic coefficient Method. The structure site lies in Seismic zone - IV. As the site is particularly tremor inclined so the fortification solid plan of the structure is done which can give enough flexibility to the structure as indicated by IS-456:2000 by farthest point state strategy. At that point building is examined basic burden mixes with the assistance of STAAD-PRO. After investigation, the outcomes were observed to be in cutoff points and solid.

### ACKNOWLEDGMENTS

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