International Journal of Multidisciplinary Engineering in Current Research - IJMEC

Volume 9, Issue 6, June-2024, http://ijmec.com/, ISSN: 2456-4265

# DESIGN AND ANALYSIS OF COMMERICAL BUILIDING USING ETABS G+5

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**Abstract:** In this Commercial building we are doing G+5 office building. It consists of 4 floors. A four stored office building having a regular layout and which can be divided in to a number of similar vertical plane frames has been considered in this project to illustrate the analysis and design of a rigid jointed plane

Structural planning, Estimation of load, Analysis of structure, Member design, Drawing, Preparation of schedules. Structural planning: Involves determination of Form of the structure, Material of the structure, Structural system, Layout of components, Method of analysis, Philosophy of structural design. In Estimation of loads we are taking dead loads, live loads according to code IS: 875 To Analysis the structure we are using ETABS. Member design: Slabs, Beams, Columns, Footings. Designing process is doing by the Limit state method & Analysis is by using ETABS.Condition of a structure just before failure is called Limit state method. The structure should have same load carrying capacity, serviceability throughout the life time.

## INTRODUCTION

In this Commercial building we are doing G+5 office building. . A five stored office building having a regular layout and which can be divided in to a number of similar vertical plane frames has been considered in this project to illustrate the analysis and design of a rigid jointed plane frame.

**PROCESS OF STRUCTURE DESIGN INVOLVES:**

Structural planning, Estimation of load, Analysis of structure, Member design, Drawing Detailing & Preparation of schedules

Structural planning: They are Form of the structure, Material of the structure, Structural system, Layout of components, Method of analysis, Philosophy of structural design.

Estimation of loads: In Estimation of loads we are taking dead loads, live loads according to code IS: 875. Analysis the structure: To Analysis the structure we are using moment distribution method. Member design: They are Slabs, Beams, Column, and Footings.

The multistoried structure, with the increase in height, the effect of horizontal loads requires consideration. Therefore, such structures are provided with rigid frames having rigid joints. In a rigid frame force get distributed between the component members due to rigidity of connection and hence analysis of the structure as a whole becomes necessary. Therefore, a five storied office building having a regular layout and which can be divided in to a number of similar vertical plane frames has been considered in this project to illustrate the analysis and design of a rigid jointed plane frame.

The analysis of one intermediate floor frame has been illustrated giving detailed calculations for all the substitute frames floor frame, bay frame, beam-column systems used in the analysis. The results obtained by the methods have been compared to examine the relative merits and demerits of each in regards to simplicity and degree of accuracy. Analyses of top story frame and bottom story frame have been done. Frame package prepared by the authors for personal computer. Design of members of only one frame that is analyses has been presented. The purpose of this project is to illustrate the design of building.

## LITERATURE REVIEWS:

Method of analysis of statically indeterminate portal frame.

- Method of Flexibility Coefficients.
- Slope Displacement Methods (Iterative Methods)
- Moment Distribution Method.
- Kani's Method (Approximate Method).
- Cantilever Method.
- Portal Method.
- Matrix Method.
- STAAD.Pro.
- ETABS

**Moment distribution method:**

This method of analyzing beams and multi-storied 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 in which one goes on carrying on the cycle to reach to a desired degree of accuracy. To start off with this 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, meeting at the same joint, 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 applying large structures, and is therefore preferred over the slope-deflection method.

**Kani's method:**

This method was first developed by "Prof. Gasper Kani" of Germany in the year "1947". The method is named after him. 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

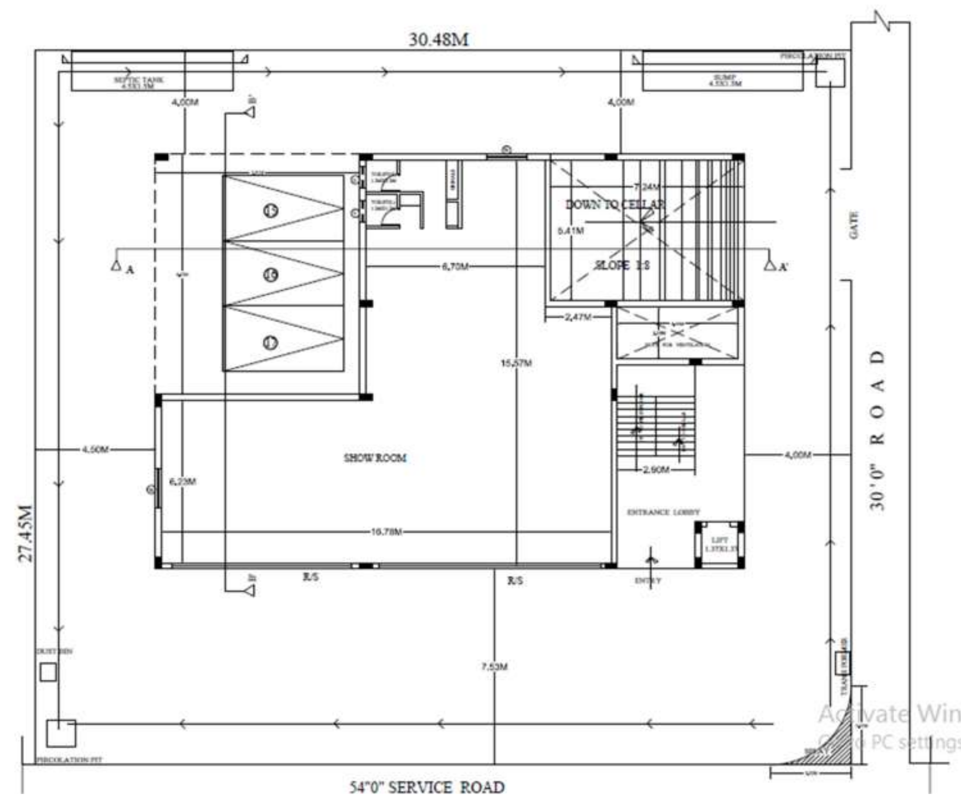
Volume 9, Issue 6, June-2024, http://ijmec.com/, ISSN: 2456-4265

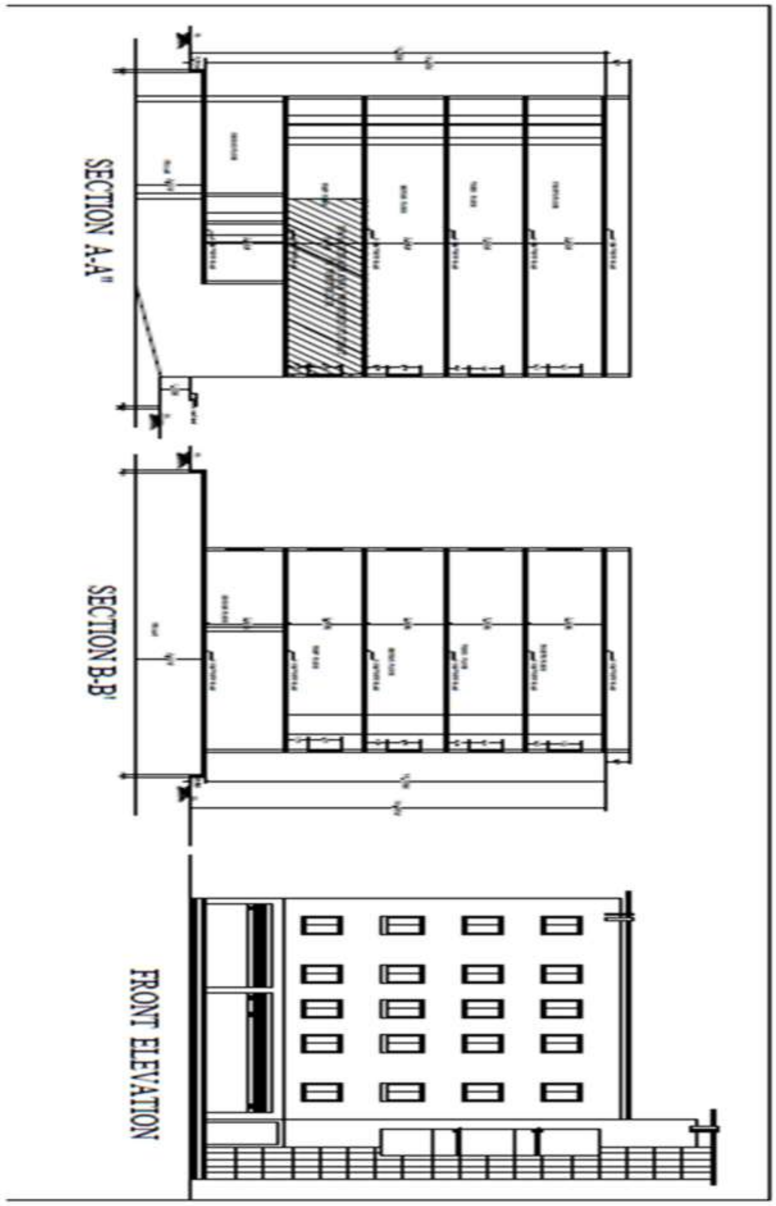
equal to the number of translator displacements, the number of equations needed is zero in case of the Kani's method. This method may be considered as a further simplification of moment distribution method wherein the problems involving sway were attempted in a tabular form thrice (for double story frames) and two shear coefficients had to be determined which when inserted in end moments gave us the final end moments. All this effort can be cut short very considerably by using this method.

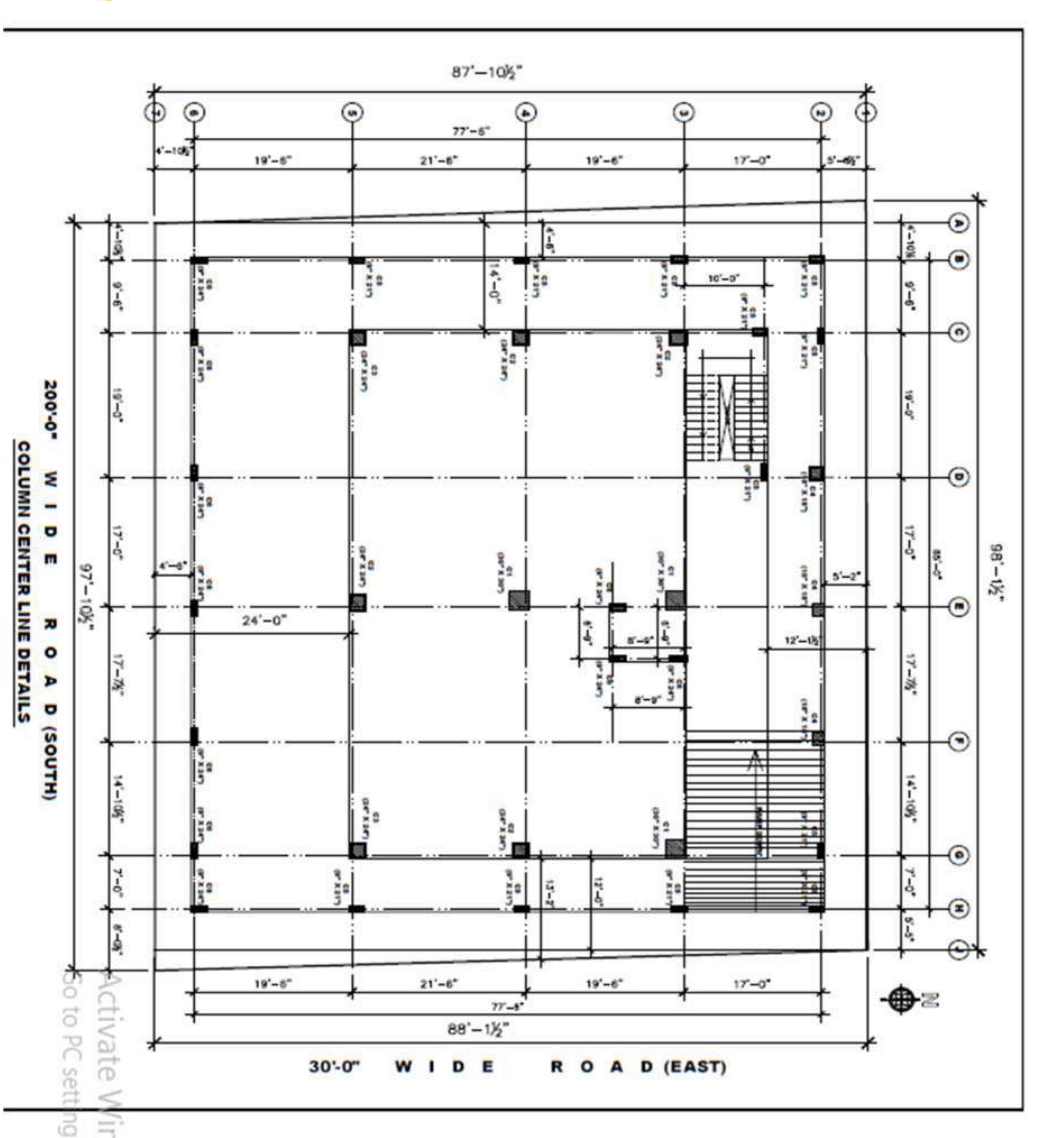
- Frame analysis is carried out by solving the slope–deflection equations by successive approximations. Useful in case of side sway as well.
- Operation is simple, as it is carried out in a specific direction. If some error is committed, it will be eliminated in subsequent cycles if the restraining moments and distribution factors have been determined correctly

**Scope:**
Architectural is an interdisciplinary field, drawing upon mathematics, science, art technology, social sciences, politics, history and philosophy. Vitrifies states: "architecture is a science, arising out of many other sciences, and adorned with much and varied learning: by the help of which is judgment t is formed of those works which are result of other arts".

**ARCHITECTURAL LAYOUT DRAWINGS**




SECTION A-A'
SECTION B-B'
FRONT ELEVATION


87'–10½"
77'–6"
19'–6"
21'–6"
19'–6"
17'–0"
200'-0" W I D E R O A D (SOUTH)
COLUMN CENTER LINE DETAILS
97'–10½"
24'–0"
98'–1½"
88'–1½"
30'-0" W I D E R O A D (EAST)

International Journal of Multidisciplinary Engineering in Current Research - IJMEC
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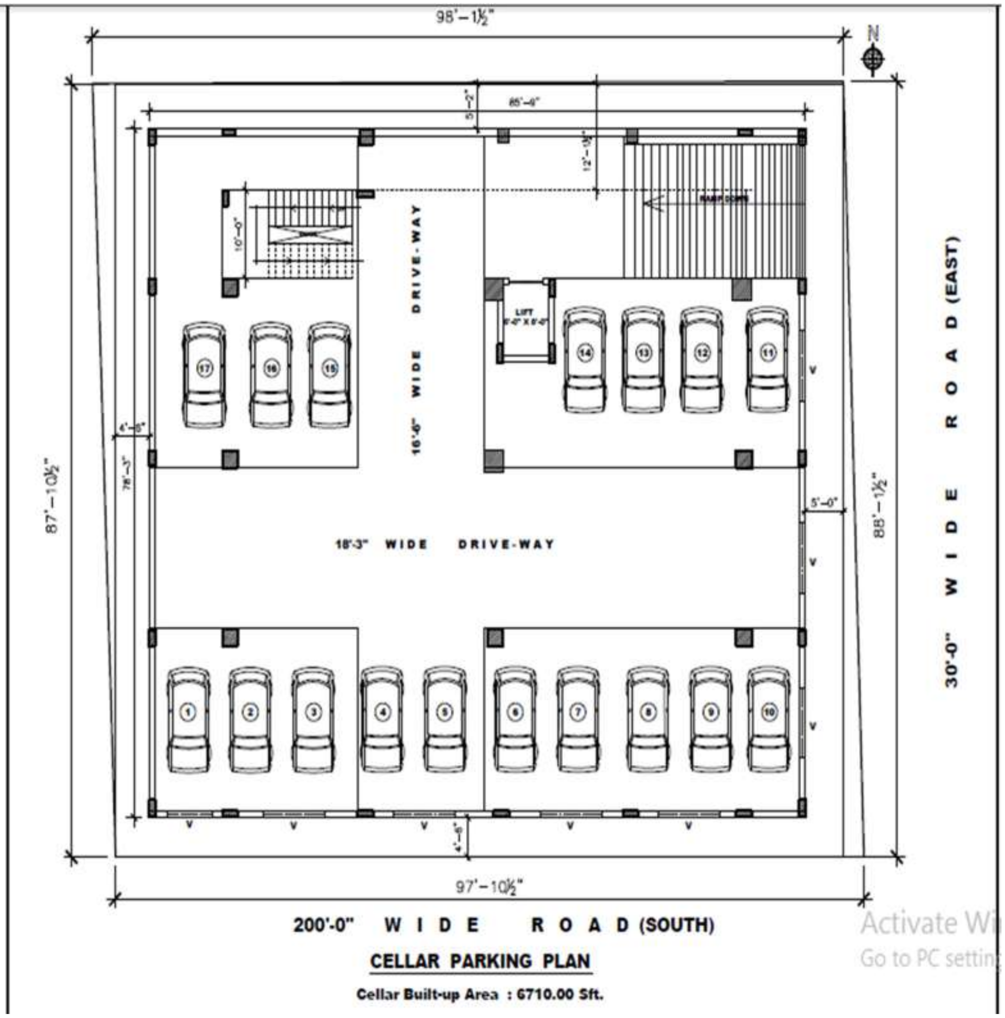


## INTRODUCTION TO STRUCTURAL ANALYSIS

### STRUCTURAL ANALYSIS

The procedure of structural analysis is simple in concept but complex. In detail it involves the analysis of a proposed structure to show that its resist an shear strength will meet or exceed a reasonable expectation.

This expectation is usually expressed by a specified load or the demand and an accept able margined of safety that constitutes as performance goal for a structure. The performance goals structural design is multi-faceted. For most, a structure must perform its intended function safely over its useful life.

The concept of useful life implies consideration of durability and established the basis for considering the cumulative exposure to time varying risks (i.e. corrosive environments, that performance is in extricable linked to cost, owners, builders, and designer must considers economic limit to the primary goal of safety and durability.

In the view of the above discussion, structural designer may appear to have little control over the fundamental goals of structural design except to comply with or exceed the minimum limits established by law. While this is generally true, a designer can still do much to optimize the design through alternative means and methods that Canfor more efficient analysis techniques, creative design detailing, and the use of innovative construction materials and methods.

In summary the goal of structural design are defined by law and reflect the collective interpretation of general public welfare by those involved in the development and local adoption of building could.

It is advantage of when kinematic indeterminacy < static indeterminacy. Alex Bender first formulated this procedure in 1914 based on the applications of compatibility and equilibrium of compatibility and equilibrium conditions.

This method derives its name from the facts that supports and displacements are explicitly computed. Setup simultaneous equation is formed from the solution of these parameters and the join moment in each or computed from these values

**ETABS**

This chapter reviews about some of the fundamental concepts of structural design and present them in a manner relevant to the design of light frame residential structures. The concepts from the basis for understanding the design procedures and overall design approach addressed in the remaining chapter of the guide. With this conceptual background, it is hoped that the designer will gain a greater appreciation for creative and efficient design of home, particularly the many assumptions that must be made.

The world is leading Structural Analysis and Design package for Structural Engineers.

- Starting the Program.
- Creating a New Structure.
- Creating Joints and Members.
- Switching On Node and Beam Labels.
- Specifying Member Properties.
- Specifying Material Constants.
- Specifying Member Offsets.
- Printing Member Information.
- Specifying Supports.
- Specifying Loads.
- Specifying the Analysis type.
- Specifying Post-Analysis Print Commands.
- Specifying Steel Design Parameters.
- Performing Analysis and Design.

## ANALYSIS AND RESULT

**GENERAL**

Structure having G+10 story is analyzed for gravity and lateral loads (seismic and wind load). The effect of axial force, out of plane moments, lateral loads, shear force, story drift, story shear and tensile force are observed for different stories. The analysis is carried out using ETABS and data base is prepared for different story levels as follows.

LOAD CASES AND LOAD COMBINATIONS

In this present work consider both gravity and lateral load case (SESIMIC AND WIND). The load combinations as per the Indian standards are considered. The primary load cases and the load combinations are shown following tables respectively.

**Table: Primary load cases**

| LOAD CASE NUMBER | LOAD TYPE | LOAD CASE NUMBER | LOAD TYPE |
|---|---|---|---|
| 1 | SW | 6 | EQX |
| 2 | WL | 7 | EQY |
| 3 | FFL | | |
| 4 | PARTITION | | |
| 5 | LIVE | | |

- Table: Load combinations
-

| COMBINATION NUMBER | LOAD COMBINATION |
|---|---|
| | |
| COMB1 | 1.5(D.L+L.L) |
| COMB2 | 1.5(D.L+EQX) |
| COMB3 | 1.5(D.L+EQY) |
| COMB4 | 1.5(D.L-EQX) |
| COMB5 | 1.5(D.L-EQY) |
| COMB7 | 1.2(D.L.+L.L+EQX) |
| COMB8 | 1.2(D.L.+L.L+EQY) |
| COMB9 | 1.2(D.L.+L.L-EQX) |
| COMB10 | 1.2(D.L.+L.L-EQY) |
| COMB11 | 1.0(D.L+L.L) |
| COMB12 | 1.0(D.L+EQX) |
| COMB13 | 1.0(D.L+EQY) |
| COMB14 | 1.0(D.L-EQX) |
| COMB15 | 1.0(D.L-EQY) |
| COMB16 | 1.0D.L.+0.8L.L+0.8EQX |
| COMB17 | 1.0D.L.+0.8L.L-0.8EQX |
| COMB18 | 1.0D.L.+0.8L.L+0.8EQY |
| COMB19 | 1.0D.L.+0.8L.L-0.8EQY |
| | |
| | |

Design spectrum calculations

The design horizontal seismic coefficient Ah for a structure shall be determined by the following expression:

$$A_h = \frac{ZIS_a}{2Rg}$$

Where

Zone Factor (Z) = It is a factor to obtain the design spectrum depending on the perceived maximum seismic risk characterized by Maximum Considered Earthquake (MCE) in the zone in which the structure is located. The basic zone factor included in this standard is reasonable estimate of effective peak ground accelerations. Zone factor is for the Maximum Considered Earthquake (MCE) and service life of structure in a zone. The factor 2 in the denominator of Z is used so as to reduce the Maximum Considered Earthquake (MCE) zone factor to the factor for Design Basis Earthquake (DBE).

Importance factor (I) = It is a factor used to obtain the design seismic force depending on the functional use of the structure, characterized by hazardous consequences of its failure, its post-earthquake functional need, historic value, or economic importance. Importance factor, depending upon the functional use of the structures, characterized by. Hazardous consequences of its failure, post-earthquake functional needs, historical value.

Response Reduction Factor (R) it is the factor by which the actual base shear force, that would be generated if the structure were to remain elastic during its response to the Design Basis Earthquake (DBE) shaking, shall be reduced to obtain the design lateral force. Response reduction factor, depending on the perceived seismic damage performance of the structure, characterized by ductile or brittle deformations. However, the ratio (I/R) shall not be greater than 1.0.

Structural response factor (Sa /g) = It is a factor denoting the acceleration response spectrum of the structure subjected to earthquake ground vibrations, and depends on natural period of vibration and damping of the structure. Average response acceleration coefficient.

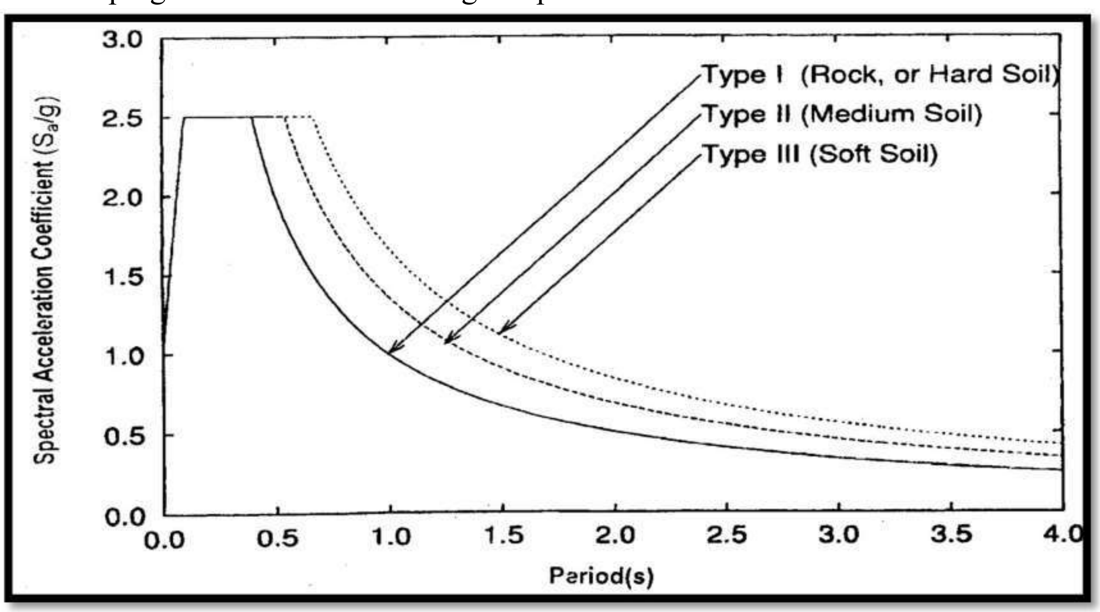


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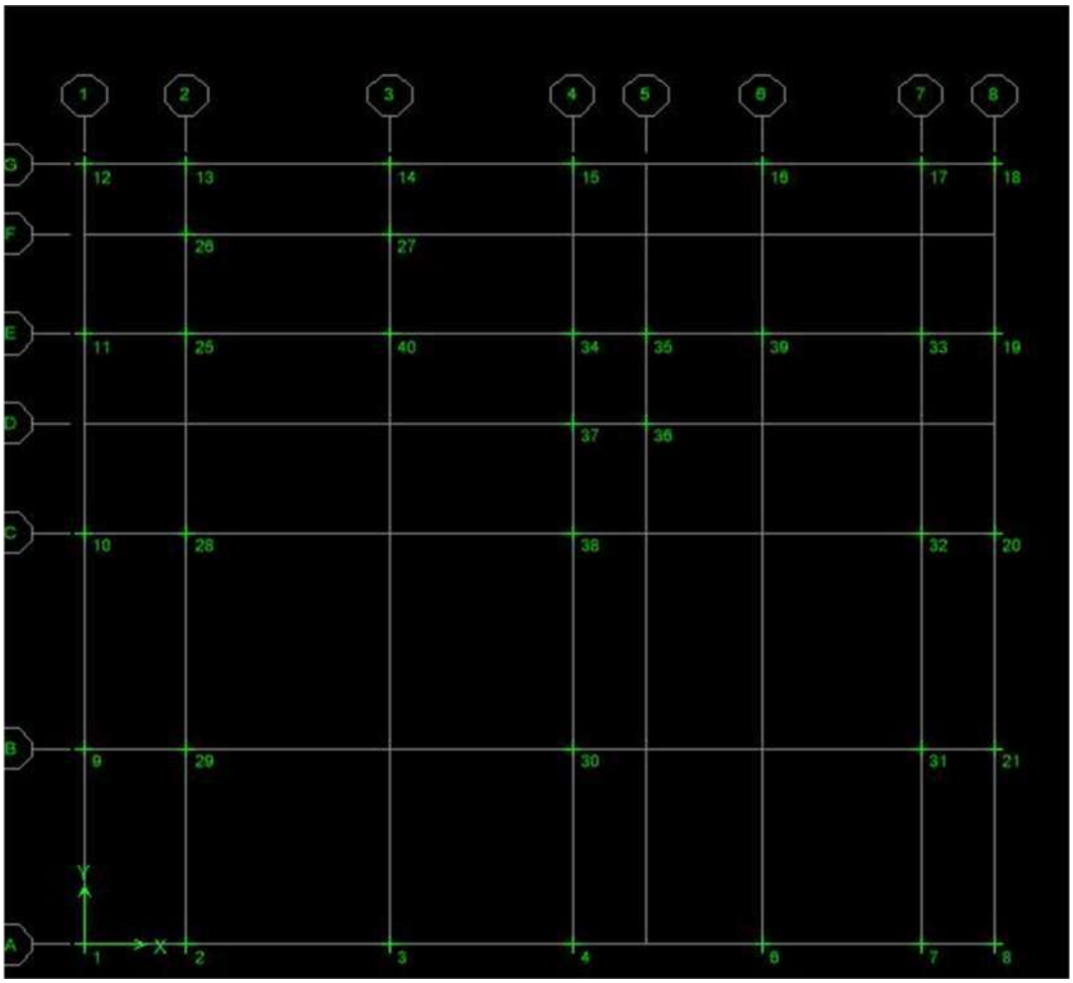
**Fig: Response spectrum for rock and soil for 5 percent damping**

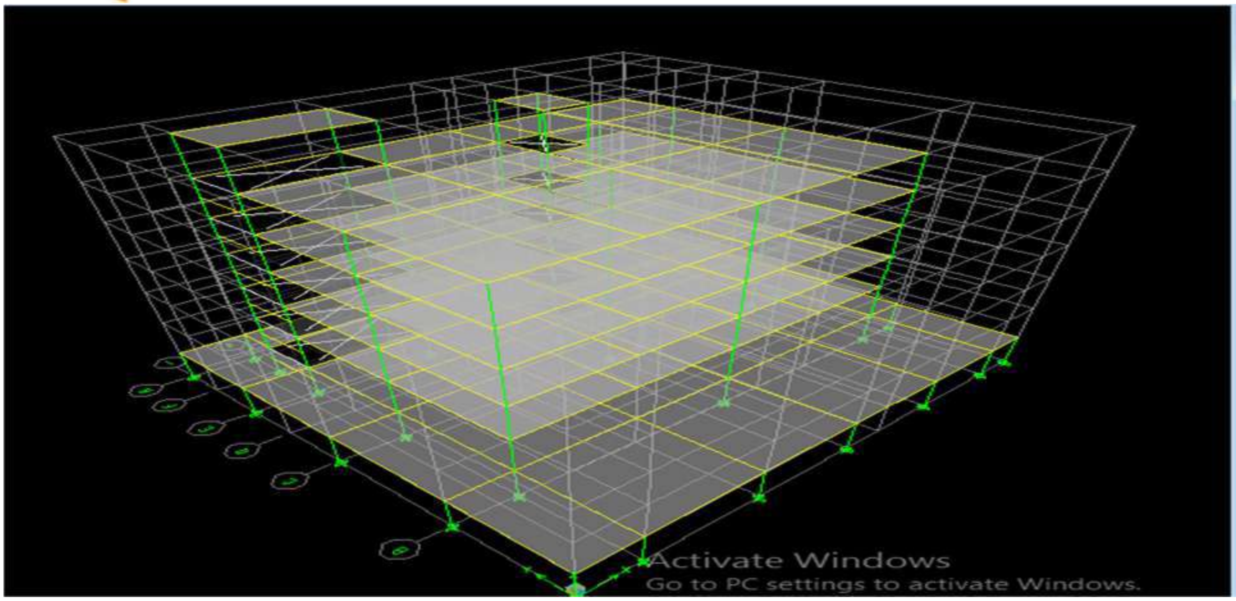
# SUPPORT REACTIONS:



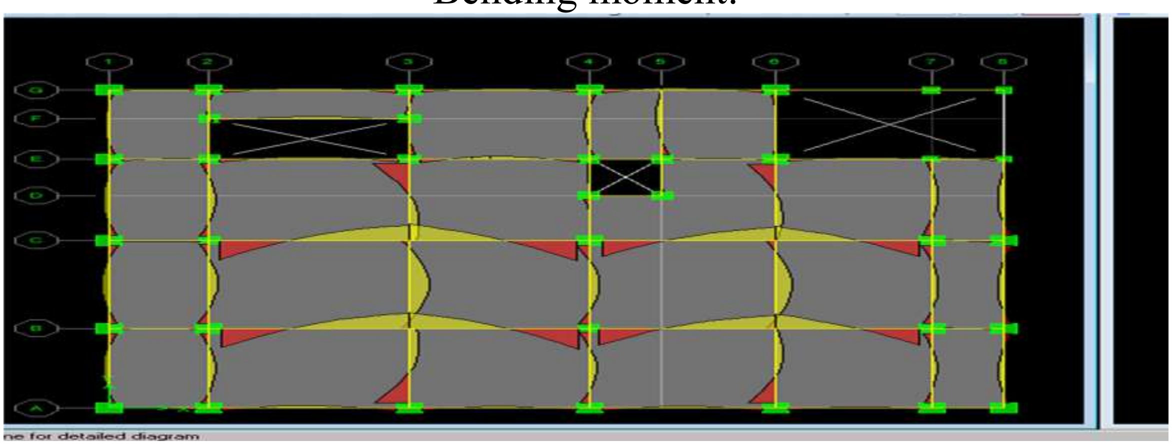
| Story | Point | Load | FX | FY | FZ | MX | MY | MZ |
|---|---|---|---|---|---|---|---|---|
| BASE | 1 | COMB10 | -0.14 | 44.32 | 157.12 | -21.512 | -9.085 | -0.78 |
| BASE | 2 | COMB10 | 33.13 | 57.75 | 288.68 | -28.064 | 14.595 | -1.809 |
| BASE | 3 | COMB10 | -27.14 | 208.72 | 422.2 | -124.049 | -26.237 | -0.417 |
| BASE | 4 | COMB10 | -0.02 | 66.15 | 327.6 | -24.55 | -5.265 | -0.044 |
| BASE | 6 | COMB10 | -26.97 | 156.21 | 368.92 | -84.221 | -23.07 | 0.088 |
| BASE | 7 | COMB10 | -23.98 | 41.55 | 225.44 | -6.221 | -19.71 | 1.238 |
| BASE | 8 | COMB10 | -6.19 | 31.14 | 142.41 | -0.103 | -6.992 | 0.534 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| BASE | 9 | COMB10 | 15.7 | 1.74 | 271.15 | 6.588 | 9.801 | -0.469 |
| BASE | 10 | COMB10 | 25.55 | -15.16 | 272.15 | 16.202 | 20.72 | -0.572 |
| BASE | 11 | COMB10 | 32.3 | -17.5 | 283.2 | 15.63 | 27.154 | -0.232 |
| BASE | 12 | COMB10 | 13.18 | -36.85 | 150.33 | 27.762 | 14.579 | -0.651 |
| BASE | 13 | COMB10 | 35.03 | -26.49 | 221.05 | 21.836 | 30.506 | 0.393 |
| BASE | 14 | COMB10 | -2.1 | -40.48 | 287.99 | 34.22 | 5.05 | 0.764 |
| BASE | 15 | COMB10 | 17 | -49.98 | 315.69 | 42.194 | 18.303 | -0.705 |
| BASE | 16 | COMB10 | -19.22 | -35.23 | 235.91 | 32.755 | -6.941 | 0.554 |
| BASE | 17 | COMB10 | -2.56 | -0.75 | 89.39 | 0.668 | -1.092 | 0.182 |
| BASE | 18 | COMB10 | 0.22 | 0.16 | 25.81 | -0.456 | 1.109 | 0.156 |
| BASE | 19 | COMB10 | -27.37 | -34.23 | 175.68 | 29.591 | -21.019 | -0.148 |
| BASE | 20 | COMB10 | -38.49 | -15.22 | 290.99 | 31.312 | -30.853 | -0.455 |
| BASE | 21 | COMB10 | -26.42 | -10.62 | 263.33 | 28.586 | -26.547 | 0.085 |
| BASE | 25 | COMB10 | 29.11 | -21.51 | 2024.64 | 20.66 | 24.032 | 0.221 |
| BASE | 26 | COMB10 | 22.08 | -39.75 | 1208.62 | 22.952 | 19.251 | 0.348 |
| BASE | 27 | COMB10 | -29.4 | -23.72 | 1945.93 | 20.573 | -19.675 | -0.189 |
| BASE | 28 | COMB10 | 131.85 | -26.54 | 3388.37 | 23.329 | 101.816 | -0.201 |
| BASE | 29 | COMB10 | 162.32 | -5.59 | 3063.94 | 13.911 | 116.467 | -1.132 |
| BASE | 30 | COMB10 | -15.83 | 25.62 | 4319.62 | -11.493 | -14.098 | -0.088 |
| BASE | 31 | COMB10 | -108.39 | 20.29 | 2750.4 | 6.307 | -86.655 | 0.049 |
| BASE | 32 | COMB10 | -123.7 | 1.45 | 3335.56 | 18.164 | -93.125 | -1.177 |
| BASE | 33 | COMB10 | -17.54 | -29.05 | 2187.44 | 25.192 | -13.262 | -0.154 |
| BASE | 34 | COMB10 | -19.22 | 0.51 | 2240.72 | 2.835 | -13.212 | -0.193 |
| BASE | 35 | COMB10 | 8.35 | 9.96 | 2128.62 | -4.505 | 8.071 | -0.146 |
| BASE | 36 | COMB10 | -0.95 | 10.8 | 988.05 | -4.078 | -0.124 | 0.114 |
| BASE | 37 | COMB10 | 2.16 | -1.06 | 1194.11 | 5.247 | 2.332 | -0.253 |
| BASE | 38 | COMB10 | -20.06 | -72.32 | 4132.82 | 67.036 | -15.656 | -0.739 |
| BASE | 39 | COMB10 | 9.86 | -85.15 | 3671.29 | 71.509 | 11.915 | -1.274 |
| BASE | 40 | COMB10 | -2.15 | -89.18 | 3076.39 | 71.775 | 0.153 | -0.237 |

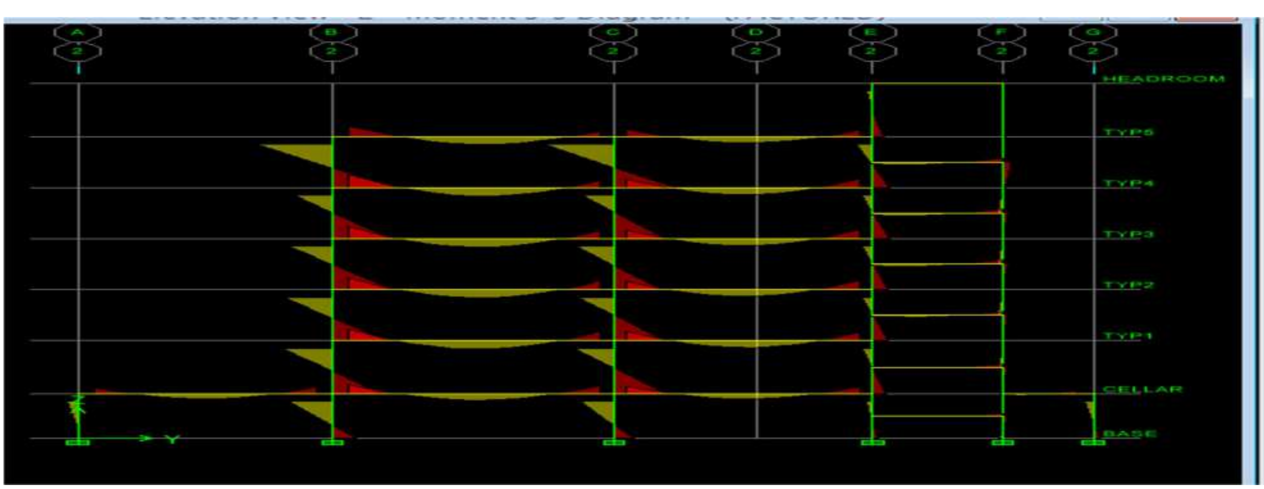
## LIST OF FIG:



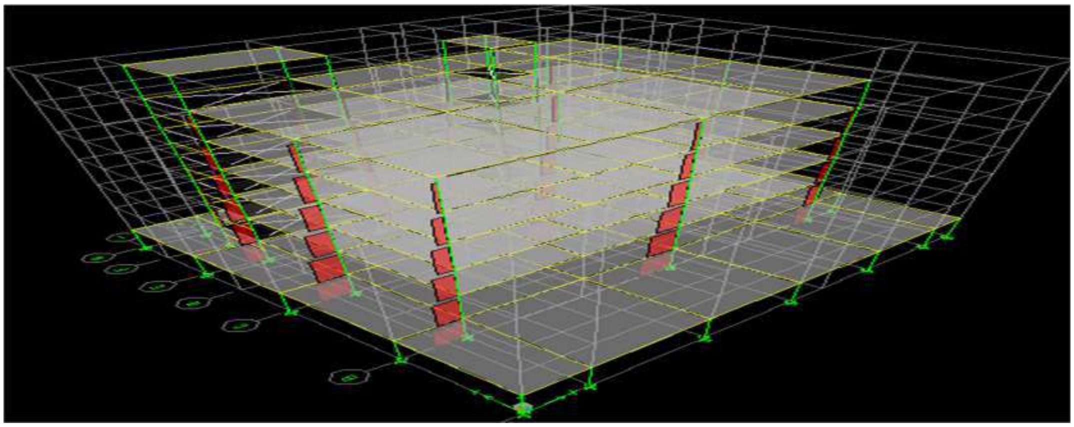

Bending moment:



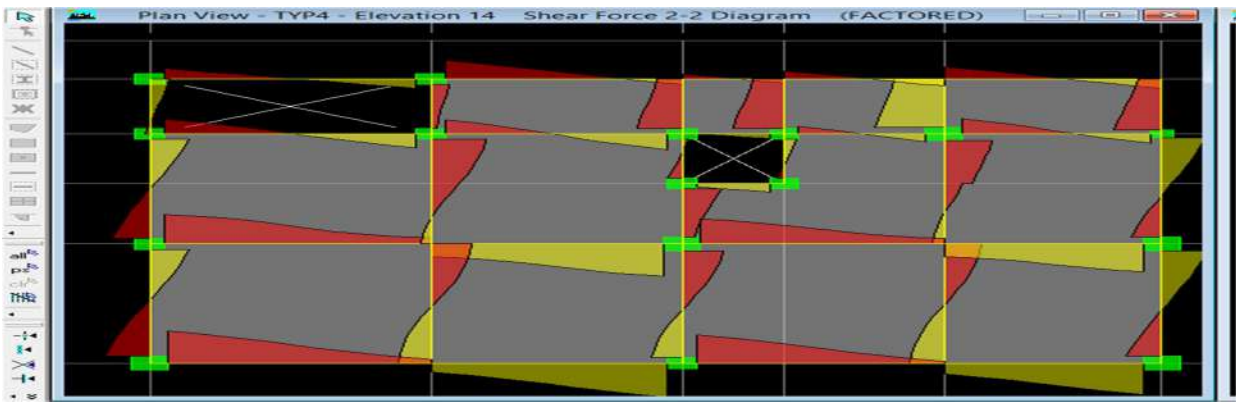

Bending moment: In elevation

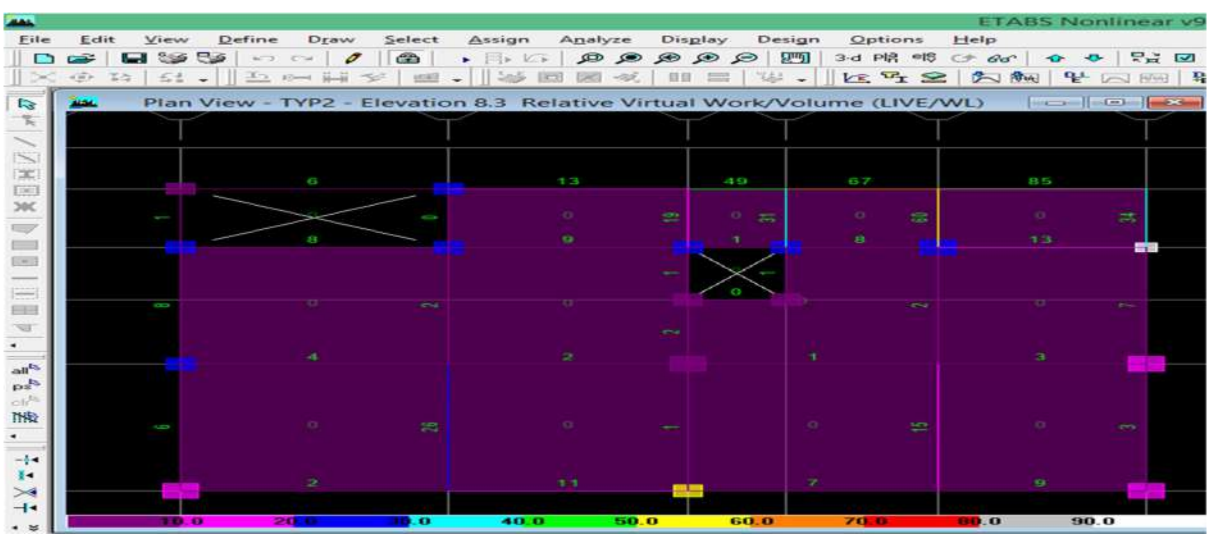


AXIAL FORCES



SHEAR FORCE:



## CONCLUSION

From the data revealed by the manual design as well as Software analysis for the structures following conclusions Are drawn:

- Analysis was done by using ETABS software and successfully verified manually as per IS456.
- Calculation by both manual work as well as software analysis gives almost same result.
- Further the work is extended for a 5 story building and found that the results are matching
- As per 5-story building has similar floors ETABS is the perfect software which can be adopted for Analysis and Design
- Usage of ETABS software minimizes the time required for analysis and design

## BIBLIOGRAPHY

We have used a number of books and code as a reference for carrying out this project work. Some of the books (s) that we refer are mentioned below. INDIAN STANDARD CODE


- IS CODE 456-2000
- IS CODE 875-1987 PART I
- IS CODE 875-1987 PART II
- IS CODE 875-1987 PART III
- DESIGN AIDS TO IS -456-2000 ( SP 16 )
- ARRANGEMENT OF REINFORCEMENT USING SP 34