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ISSN 2249-3352 (P) 2278-0505 (E)
Cosmos Impact Factor-5.86

DESIGN AND ANALYSIS OF G+7 EARTHQUAKE RESISTANT STRUCTURE

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ABSTRACT

The earthquake is a natural occurrence that may produce the most devastating effects on structures. As a result, buildings should be safe for people by having adequate design and specification of structural parts in order to have a ductile form of failure, so that the structure is safe against seismic force of multistory functioning. Seismic evaluation studies and earthquake protection structure planning are required. The purpose of seismic resistance building is to build structures that perform better than conventional structures during seismic activity. Earthquake analysis and design of a G+7 RCC building are included in the project report. A G+7-story building seismic investigation structure located in India's zone II (Hyderabad). The present project deals with seismic analysis of multistoried residential building G+7. The dead load, wind load, seismic load and live load applied and design for beams, columns are obtained. Total structure was analyzed by computer by using STAAD-PRO software. Various software now-a-day are available & STAAD-PRO is most common used for analysis and designing of a building by considering the earthquake forces and to review & study the behavior of multistoried building by Equivalent Static Lateral Force Method.

Key words: R.C structural system, R.C building of G+7 storey, IS 1893.

I. INTRODUCTION

1.GENERAL

Day-by-day increase in population growth in cities of India for several acceptable reasons and deficiency of land area so that there is a requirement of design and seismic analysis of multistoried building before construction work starts. Multistoried buildings are designed for the basic need of people. These buildings are the shelter for all the human beings and help grown up the infrastructure to the city. So, we need a residential building to serve the people. The main object of the project is to modify the general design of multi storied building with seismic effect. Seismology is the study of vibration of earth mainly caused by earthquakes and seismic waves that move through and around the earth.

A seismic wave causesthe sudden breaking of rock within the earth or an explosion. They are the energy in the form of waves that travels through the beneath of earth and is recorded on seismographs. The study of these waves by various techniques, understanding there nature and various physical processes that generate there from the major part of the seismology. A seismic design of high-rise building has assumed considerable important in recent times. In traditional method adopted based on fundamental mode of the structure and distribution of earthquake forces as static forces at various stories may be adequate for structure of small height subjected to earthquake of very low intensity but as the number of the stories increases the seismic design demand more rigorous.

The basic needs of human life are food, clothing's& shelter. From times immemorial man has been making efforts in improve your living standards. The point of his effort has been to provide and economic and efficient shelter. The owner of sheltered settlements is giving a sense of origin, use, responsibility, security and shows the social status of human. Permanent or temporary structure enclosed with in outer walls and ceiling, and all attached equipment, and fixtures which cannot be removed without cutting in the ceiling, floor and walls. This is a method by which we find the safe and affordable specification of one member of sufficient structure to structure or load. Search in other words need of cross section dimension, grade of material, reinforcement etc. is required. We face internal structures that meet us with structural analysis. Seismic analysis is the calculation of the response to a building structure for earthquake is a subset of structural analysis. A Quick and easy way to set consolidation of overburden. The law is based on the principle that shock waves different speed and accompanying sound travel through different sub surface content different paths. By this method the operator can determine whether the burden can be broken or not whether it needs drill and expansion. Structural design is the technical analysing and designing of any structure ultimate strength economy, safety and serviceability. It does not only requires imagination and conceptual thinking but also the chasten to maintain design standards specified by the IS codes.

1.1 Stages in Structural Design

Each components of building follows their own specific path from its initiation to ultimate design as follows:

- Structural Planning of building
- Applied load calculations
- Structural analysis of building
- As per analysis design of building
- Detailing and drawing of structural members
- Preparation of schedule

1.2 Introduction to STAAD-Pro

This project involves analysis and design of multistoried (7-story) using a worldwide most common used designing software STAAD-Pro.

i. Advantages of STAAD-Pro:

- Confirmation with Indian standard Codes,
- Versatile nature of solving any type of problem,
- Easy to use interface,
- Accuracy of the solution.

ii. Features:

- STAAD-Pro features a user interface, visualization tools, powerful analysis and design appliance with advanced limited element and dynamic analysis efficiency.
- From model generation, analysis and design to output visualization and result verification, STAAD-Pro is the specialist's best choice for concrete, steel, aluminum, timber and cold-formed steel design of low and high-raised multistoried buildings, culverts, petrochemical plants, tunnels, bridge, piles and much more.

iii. Standard Design Codes

The design should be done to ensure:

1) Plain and reinforced cement concrete- IS 456: 2000 (IV revision)

2) National Building Code 2005

3) Loading Standard IS 875(Part 1-5):1987- codes of practice for design load and earthquake for building and structure (II revision)

• Part I: Dead loads

• Part II: Imposed (live) loads

• Part III: Special loads and load combinations

4) Design Handbooks

• SP 16: 1980 – Design aids (for Reinforced Concrete) to IS 456: 1978

• SP 34: 1987 – Handbooks On Concrete Reinforced And Detailing.

Earthquake engineering plays an important role in today's infrastructure design process. An earthquake might have a very low possibility of occurrence in some region, but the probability should not be neglected when a structure is constructed, because even if there is one shock due to Earthquake in the buildings life it can be a risk to the resident of the building. As the construction of multi-storeyed has increased in the recent years and the number of occupants in a building has being increasing, Structural designers have been given more importance to Earthquake induced loads[seismic loads] for designing a building along with taking into consideration the Dead, Live and Wind loads[static loads]. The analysis consists of G+7 RCC building.

In this project, analysed the effect of earthquake on the RCC building on different seismic zones (Zone II & Zone III) of India and their effect has been compared & studied. There are many classical methods to solve analysis problem, and with time passing new software are also coming into picture. Here in this project work is based on software named "STAAD. Pro

II. LITRATURE REVIEW

Akshay R. Kohli, Prof. N.G. Gore, "Analysis and design of an earthquake resistance using STAAD Pro." In this paper, they study that, the main purpose of this letter is to make and earthquake resistant by the structure of the seismic study structure of the static equivalent method analyse and complete the analysis and design of building using STAAD. The structural safety of building is ensured by calculating all the acting load on it structure, which includes lateral load due to ventilated load and seismic stimulation, they the conclusion is that, as a result, inter-story dript should be obtained within the specified limit. For minimum specified lateral force with partial safety factor of 1.0, the inter-story drift should be under 0.04 x Hs, where (Hs) is the story height (Clause 7.11.1, IS 1893:2002 (part 1)). For 3300 mm floor height, inter-story drift = 0.04 x 3300 = 13.2 mm. The actual relative displacement between every story in the structure is below the inter-story drift limit and hence safe. It undergoes static as well as dynamic analysis of the structure and gives accurate results.

K Aparnashrivatav:- " seismic analysis and design of G+5 residential building." In this paper, the study that, the structure analyzed with various combination as per code IS 1893:2002(part I). (DL,LL,WL,EL) with 10 primary loads and 26 loads combination analyzed and theworst load combination is deducted and design moved to bad load combination using STAAD Pro. Creating the same structure without considering the lateral load to perform and show investigation of steel and solid quantity variation and structure for both structure downstream using STAAD Pro. They conclude that, (i) In earthquake resistant design the steel quantity increased by 1.517% to the conventional concrete design. The steel quantity increased in the structure ground floor level to higher floor level of the structure. (ii) In this study of G+5 building, seismic load dominates the wind load under the seismic zone III. Basically the wind pressures are high for high rise building based on weather condition such as coastal areas, hilly station. For building prominently seismic forces create the major cause of damage to the structure. (iii) The storey drift condition for considered G+5 building, the base drift =0.0 at every storey. This says that the structure is safe under the drift condition. Hence shear walls, Braced columns are not necessary to be provided. Hence storey drift condition is check for the G+5 building. (iv) The structure design for worst load combinations namely 25, 27, 24, 11 of 36 load combinations.

M.S. Alpha Sheath:-"use intermediate RC movement frames in moderate seismic zone". Indian concrete magazine, in this letter, the author argues that simplification of humility details in field III will encourage very detailed spread implementation.IS 13920:1993 removes the need for a specific special design and explanation reinforce concrete, moment resistant frame (SMRF) to give them enough crush and flexibility to cover without facing severe earthquake and emerging medium with same non-structural damage. The code suggest the same dummy description required for zone III, IV & V the area was very little shaking in III cities.to compensate for the reduction in cruelty due to exemption dummy norms, decrease in reaction factor the special RC moment should be less than the value of 5 for the resistive frame, but may be more than 3 for RC moment resistant frame. Same of the provisions have been explained for flexural members, pillars and structural walls etc. in this letter the author suggested that the conclusion is that, in the field II and III, the building may be less rigid flexibility can be designed with retail sales, but with the increase in seismic design force.

III. METHODOLOGY

1. Planning

Methodology consists of the following steps, each accompanied by detailed explanations of the AutoCAD commands utilized:

Step 1: Project Setup

- Objective: Open a new drawing in AutoCAD and set the appropriate units.
- Commands Used: 'NEW', 'UNITS'
- Explanation: The 'NEW' command creates a new drawing file, while the 'UNITS' command allows users to specify the unit type and precision settings for dimensions.

Step 2: Drawing Walls

- Objective: Use the 'LINE' command to draw the walls of the floor plan.
- Command Used: 'LINE'
- Explanation: The 'LINE' command creates straight line segments between specified points, allowing users to outline the walls of the floor plan with precision.

Step 3: Trimming and Extending Walls

- Objective: Adjust the lengths of walls and ensure proper connections.
- Commands Used: 'TRIM', 'EXTEND'
- Explanation: The 'TRIM' command removes portions of objects that extend beyond specified cutting edges, while the 'EXTEND' command lengthens objects to meet other objects or boundaries, helping to refine the wall layout.

Step 4: Adding Doors and Windows

- Objective: Insert predefined door and window blocks or create custom shapes.
- Command Used: 'INSERT', 'RECTANGLE'
- Explanation: The 'INSERT' command allows users to insert predefined blocks representing doors

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and windows, while the 'RECTANGLE' command can be used to draw custom door and window shapes.

Step 5: Inserting Dimensions

- Objective: Add linear dimensions to indicate wall lengths, door widths, and other measurements.
- Command Used: 'DIMENSION'
- Explanation: The 'DIMENSION' command creates dimension lines and associated dimension text, providing essential measurements for construction and remodeling purposes.

Step 6: Adding Text and Annotations

- Objective: Incorporate text labels and annotations to provide additional information on the floor plan.
- Command Used: 'TEXT'
- Explanation: The 'TEXT' command allows users to add text anywhere in the drawing, specifying the content, size, font, and alignment of text annotations.

Step 7: Layer Management

- Objective: Organize drawing elements into separate layers for better visualization and editing.
- Command Used: 'LAYER'
- Explanation: The 'LAYER' command creates and manages layers, allowing users to assign different objects to specific layers and control their visibility and properties.

Step 8: Quality Assurance

- Objective: Review the floor plan for accuracy, consistency, and adherence to design specifications.
- Commands Used: 'ZOOM', 'PAN'
- Explanation: The 'ZOOM' and 'PAN' commands facilitate navigation and inspection of the drawing, allowing users to zoom in and out and pan across the drawing area to check details and make necessary adjustments.

Step 9: Saving and Printing

- Objective: Save the drawing file and prepare it for printing or plotting.
- Commands Used: 'SAVE', 'PLOT'
- Explanation: The 'SAVE' command saves the drawing file to a specified location, while the 'PLOT' command prepares the floor plan for printing or plotting, configuring print settings such as paper size, scale, and plot style.

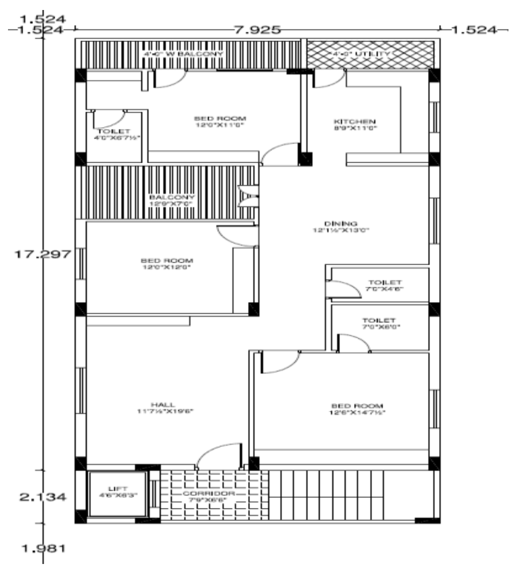

Fig 3.1: AutoCAD plan (ground floor)

2. Elevation

Step 1 : Project Setup

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- Open AutoCAD software.
- Create a new drawing file by selecting 'New' from the File menu or typing 'NEW' in the command line.

Step 2 : Setting Units

- Command: 'UNITS'
- Explanation: The 'UNITS' command sets the unit type and precision for the drawing.
- Usage: Type 'UNITS', select the desired unit type (e.g., Architectural), and specify precision.
- Example: 'UNITS' - Select 'Architectural' - Specify precision (e.g., 0'0 1/8").

Step 3 : Drawing Elevation Lines

- Command: 'LINE'
- Explanation: Use the 'LINE' command to draw outlines of walls, doors, windows, etc.
- Usage: Type 'LINE', specify start and end points by clicking on the screen.
- Example: 'LINE' - Click start point - Click end point.

Step 4 : Adding Height Dimension

- Command: 'DIMENSION'
- Explanation: The 'DIMENSION' command adds height dimensions to elements in the elevation plan.
- Usage: Type 'DIMENSION', select objects to dimension.
- Example: 'DIMENSION' - Select object - Specify dimension location.

Step 5 : Inserting Doors and Windows

- Command: 'INSERT' or Drawing Commands
- Explanation: Use 'INSERT' to add predefined door/window blocks or draw custom shapes.
- Usage: Type 'INSERT', select block or use drawing commands.
- Example: 'INSERT' - Select block - Specify insertion point, scale, rotation.

Step 6 : Adding Text Annotations

- Command: 'TEXT'
- Explanation: The 'TEXT' command adds text annotations to label architectural elements.
- Usage: Type 'TEXT', specify insertion point, enter text content.
- Example: 'TEXT' - Specify insertion point - Enter text.

Step 7 : Applying Layers

- Command: 'LAYER'
- Explanation: Use 'LAYER' to organize drawing elements into separate layers.
- Usage: Type 'LAYER', create new layers and assign objects.
- Example: 'LAYER' - Create layers (e.g., Walls, Doors) - Assign objects.

Step 8 : Review and Quality Assurance

- Command: Visual Inspection
- Explanation: Review the elevation plan for accuracy and consistency.
- Usage: Zoom and pan using mouse or keyboard shortcuts.
- Example: Use 'ZOOM' to magnify specific areas for inspection.

Step 9 : Saving and Printing

- Command: 'SAVE' and 'PLOT'
- Explanation: Save the drawing and prepare for printing or plotting.

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- Usage: Type 'SAVE' to save, 'PLOT' to configure print settings.
- Example: 'SAVE' - Save drawing file. 'PLOT' - Configure print settings.

Fig 3.2: Elevation

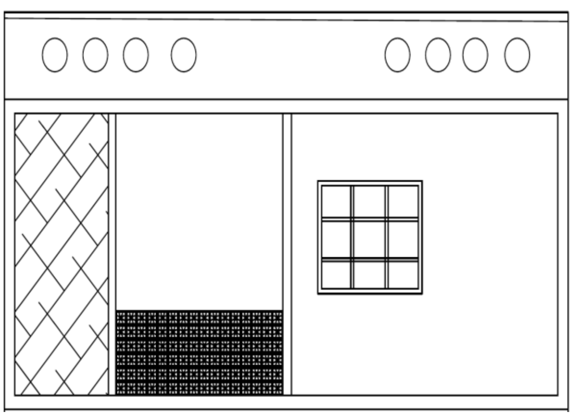

Fig 3.3 7th floor elevation

3. Staad pro

Step 1- With the help of co-ordinate system, firstly we provide the nodes and connect them by using the command "ADD BEAM" to make the plan

Step 2- By selecting all the nodes, use of translation repeat with step spacing= -1.5m, and global direction as Y, No. of steps = 1.

Step 3- By selecting all beams of plan, use of translation repeat with step spacing = 3m, global direction = Y, No. steps = 5.

Step 4- Assigning supports to the structure.

Step 5-Assigning properties to the structure i.e. giving dimension to the beam and column.

Step 6- Seismic Load Definitions: In seismic Load Definitions we input the intensity details i.e., seismic intensities.

Step 7- Wind Load Definitions: In Wind Load Definitions we input the intensity details i.e., Wind intensities with respect to height.

Step 8- Load case details-

- Dead Load (DL)
- Live Load (LL)
- Wind Load (WL+X , WL-X, WL+Z and WL-Z)
- Seismic Load (EQ+X , EQ-X, EQ+Z and EQ-Z) (in 2 different zones)

Step 8- Assigning loads to the structure.

Step 9- Analysis

Step 10- Design

Note : Designing is done as per IS 456:2000

IV. ANALYSIS AND DESIGN OF G+7 BUILDING

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1 .GEOMETRY

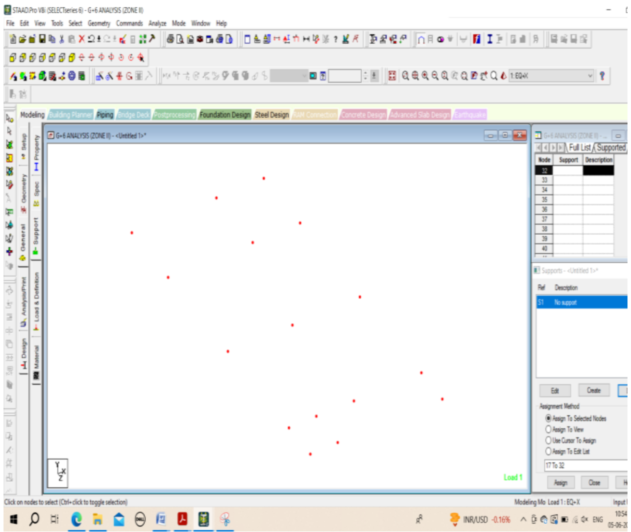


Fig 5.1: Geometry (import plan in terms of nodes)

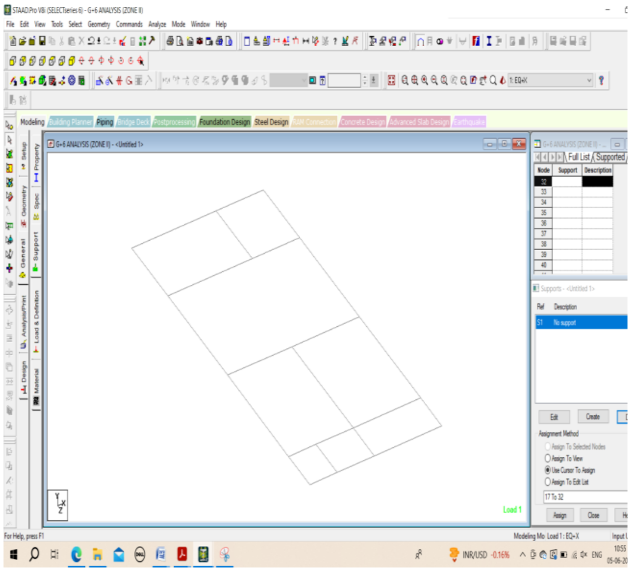


Fig 5.2: Add beams by point to point

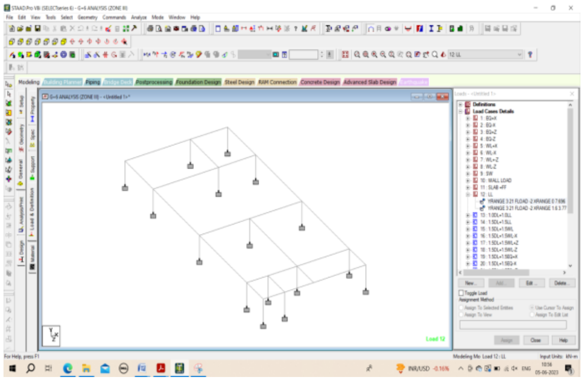


Fig 5.3: Plinth level generation

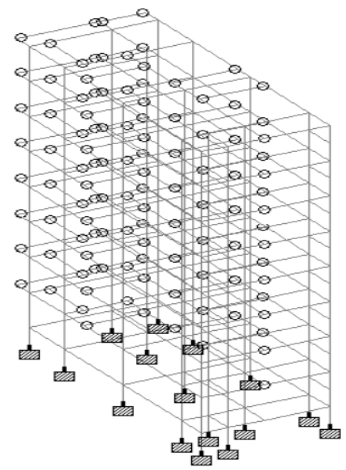


Fig 5.4: Generation of G+7

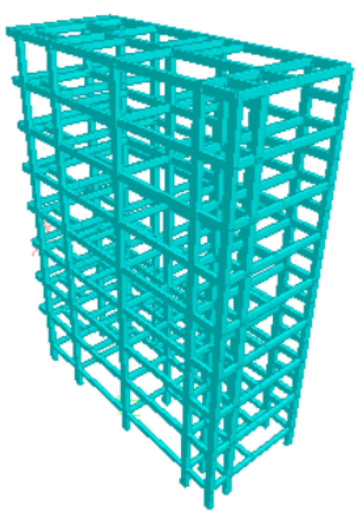


Fig 5.5: 3-d view

2.GENERATION OF MEMBER PROPERTY

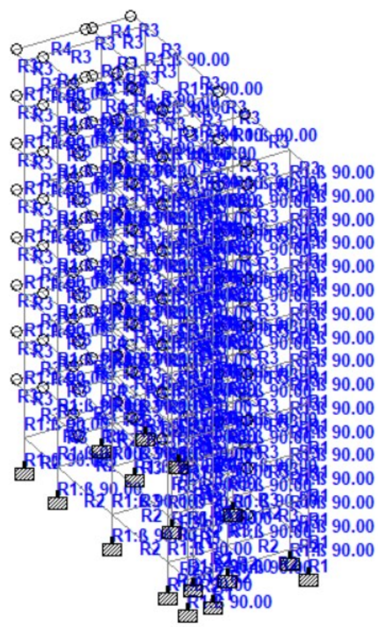


Fig 5.5: Generation of member property

Generation of member property can be done in STAAD.Pro by using the window as shown above. The member selection is selected and the dimension have been specified.

3. SPECIFICATION

Releasing end moments to the secondary beams both at starting and end of the beams.

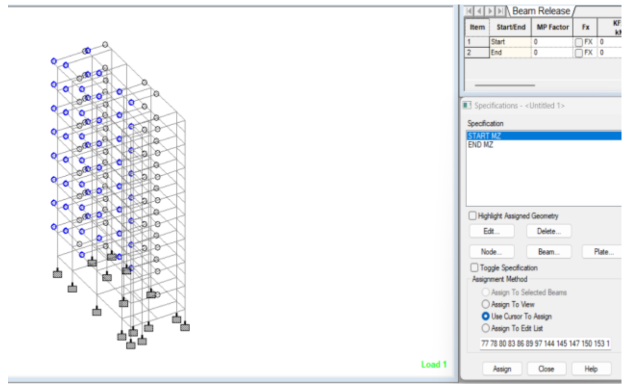


Fig 5.6: Releasing end movements

4. SUPPORT

The base support of the structure was assigned as Fixed. The support was generated using the STAAD.Pro support generator

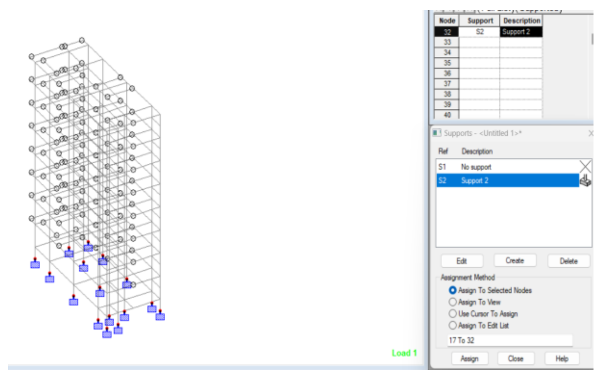


Fig 5.7: Support assigning

5. MATERIALS FOR THE STRUCTRE

The materials for the structure were specified as concrete with their various constant as per standard IS code of practice.

6. LOADING

The loadings were calculated partially manually and rest was generated using STAAD.Pro generator.

The loading cases were categorized as:

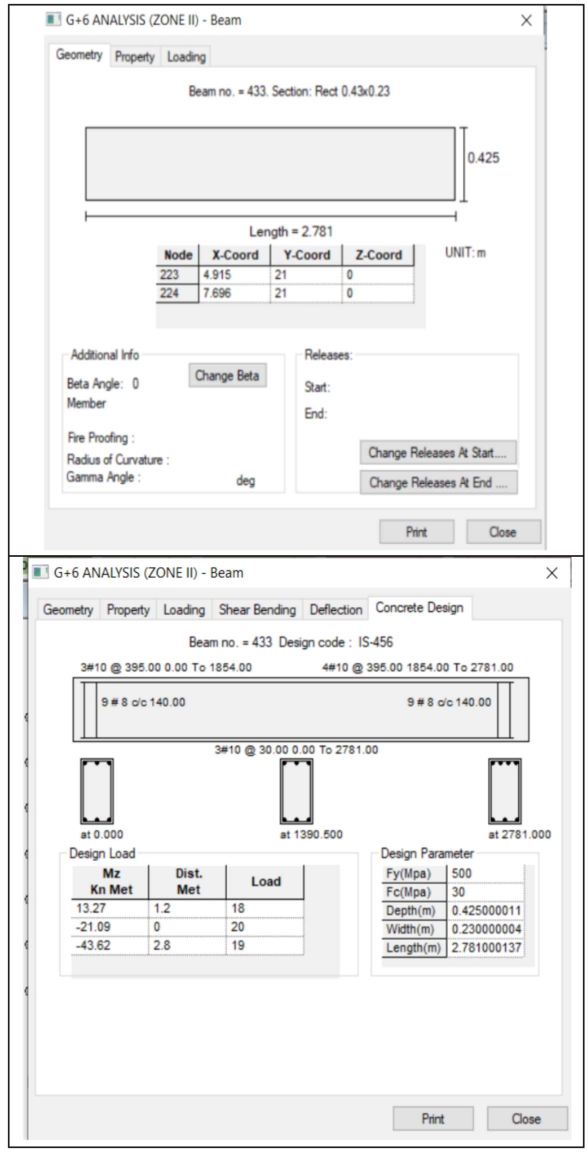
- ✓ Self-weight
- ✓ Dead load
- ✓ Live load
- ✓ Wind load
- ✓ Seismic load
- ✓ Load combinations
- ✓

V.RESULTS

1. Results Summary

The seismic analysis of zone II the output summary mentioned below, considered example of beam number 6918.

Zone II
Area: Hyderabad
Seismic Zone factor = 0.1
Response reduction factor = 3
Importance factor = 1
Rock and soil factor = 1
Damping ratio = 0.05
Basic wind speed = 44m/s
Design wind pressure = 1.16 kN/m^2



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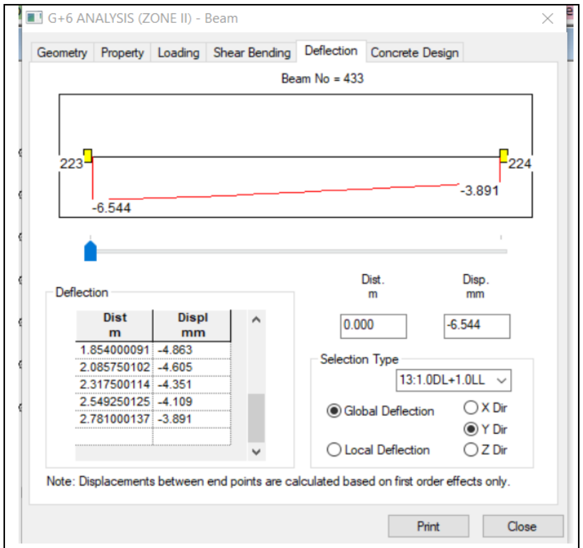

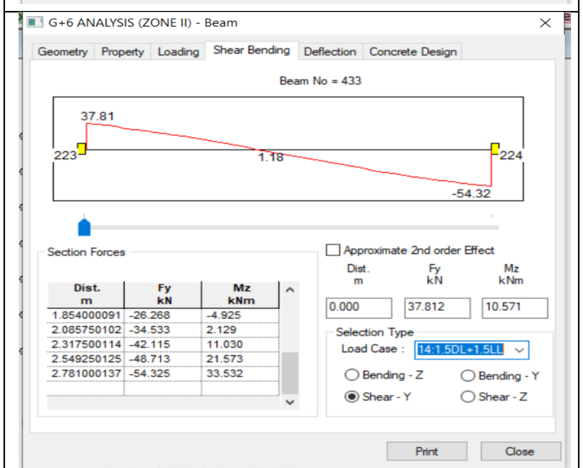


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REINFORCING STEEL IN PLATES IS NOT INCLUDED IN THE REPORTED QUANTI

TOTAL VOLUME OF CONCRETE =      154.6 CU.METER

              BAR DIA          WEIGHT
              (in mm)         (in New)
              --------        --------

                  8             41143
                 10             21733
                 12             52154
                 16             28671
                 20             16677
                 25              6246
                              ------------
             *** TOTAL=        166624

336. FINISH


       *********** END OF THE STAAD.Pro RUN ***********

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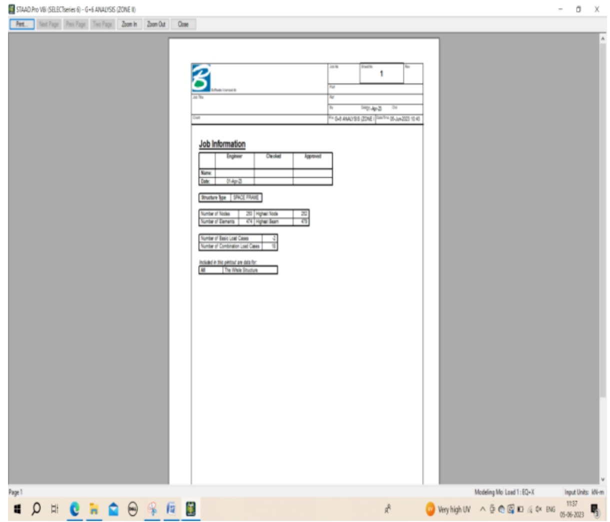

Fig 6.1: Print preview report

VI. CONCLUSION

This analysis various studies carried out over planning, designing and analyzing a structure with the help of different software. All the studies considered above gives a suggestion of adopting STAAD.Pro over other software for analyzing a building structure. Due to its flexibility and its provision for economic sections both in terms of steel and concrete, STAAD.Pro is adopted for further analysis procedure. The analysis and design is done for hospital building and various results of bending moment, shearforce, torsion and stresses etc,. are discussed. The analysis and design were done according to standard specifications using STAAD.Pro for static and dynamic loads. The dimensions of structural members are specified and the loads such as dead load, live load, earthquake loads and wind load are applied. Deflection and shear tests are checked for beams and columns. The tests proved to be safe. Staad pro is versatile software having the ability to determine the reinforcement required for any concrete section based on its loading and determine the nodal deflection against lateral forces. Hence, I conclude that I can gain more knowledge in practical work when compared to theoretical work. The oberservations was mentioned below:

1. To make our structure safe against seismic loading, we have to increase the percentage of steel.

2. As we go on higher side of earthquake zones, the deflection value increase.

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