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Seismic Analysis of RCC Building (G+2) Using Staad Pro

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ABSTRACT-Earthquakes signal a change in the earth's internal structure. Seismic activity is frequent in most places of the world, albeit the frequency with which it occurs is dependent on the tectonic configuration of the area. Previous earthquakes have resulted in significant loss of life and property, impacting a country's social and economic conditions. Though an earthquake cannot be avoided, the least that can be done to minimise damage is to make buildings earthquake resistant. As our understanding of earthquakes has improved, most countries have enforced the inclusion of seismic precautions in building design and architecture. In the event of an earthquake, seismic waves from the epicentre are propagated across the entire region. The effects of lateral loads like as earthquake loads, wind loads, and blast forces have been a major issue in recent years. One of the key issues that every designer faces is providing sufficient strength and stability in the face of lateral stresses. As a result, structural engineers must have a thorough understanding of the seismic performance of various types of shear walls in order to protect the structure against lateral loads. For (G+20) story's, the current paper compares the seismic performance of high-rise structures and optimizes the thickness of RCC shear wall, Steel Plate Shear Wall (SPSW), and composite shear wall. The design and analysis of the building with RCC shear wall, steel plate shear wall and composite shear wall is carried out using software ETABS or STAADPRO. Effect of varying thickness of shear panels and comparison of the results of story drift and story shear is presented. The main goal of this project is to use STAAD Pro to study and design a multi-story structure [G + 2 (3 dimensional frame)]. The design entails load calculations and a STAAD Pro analysis of the entire structure. Limit State Design, as defined by the Indian Standard Code of Practice, was employed in the STAAD.Pro analysis. STAAD.Pro comes with a cutting-edge user interface, visualization tools, and sophisticated analysis and design engines that can do complex finite element and dynamic analysis. STAAD.Pro is the professional's choice for model generation, analysis, and design, as well as visualisation and result verification. Initially, we evaluated and constructed a G + 1 story building [2-D Frame] for all load combinations [dead and live].STAAD.Pro offers a very user-friendly interface that allows users to sketch the frame and enter load values and dimensions. The structure is then analyzed and members with reinforcement details for RCC frames are designed based on the supplied criteria. The accurate analysis and design of a G + 2 3-D RCC frame under various load combinations is the final job. A 3-D RCC frame with three bays has been considered. G + 2 floors made up the y-axis. Each floor has 137 beams and 140 columns, for a total of 137 beams and 140 columns. The ground floor was 3.5 meters tall, and the other two story's were also 3.5 meters tall. Under self-weight, dead load, and live load conditions, the structure was tested. The ground floor height was 3.5m and rest of the 2 floors had a height of 3.5m.The structure was subjected to self weight, dead load, live load under the load case details of STAAD.Pro. The materials were specified and cross-sections of the beam and column members were assigned.The fixed supports at the structure's base were also defined. For design purposes, the codes of practice to be followed were also stated, along with other relevant aspects. The structure was then analyzed and the members were designed using STAAD.Pro. After completing the design, we may work on the structure and investigate the bending moment and shear force values using the generated diagrams in the post-processing mode. We've also looked at the deflection of different parts under various loading scenarios. The building's design is dictated by the minimum standards set forth in the Indian Standard Codes. Building structural safety regulations are set to the bare minimum. Are being covered by way of laying down minimum design loads which have to be assumed for dead loads, imposed loads, and other external loads, the structure would be required to bear. Strict conformity to loading standards recommended in this code, it is hoped, will ensure the structural safety of the buildings which are being designed. Structure and structural elements were normally designed by Limit State Method. Complicated and high-rise structures need very time taking and cumbersome calculations using conventional manual methods. STAAD.Pro provides us a fast, efficient, easy to use and accurate platform for analysing and designing structure.

KEYWORDS: Loads, Shear wall, Steel walls,STAAD Pro, ETABS,

I. INTRODUCTION

Earthquakes are known to have a high potential for wreaking havoc on both the built environment and human life. Between 1990 and 2010, India was struck by nine major earthquakes, with a death toll of roughly 30000 people, according to reports. Although certain regions of the country are more earthquake-prone than others (seismic zone V of IS 1893(Part 1)-2016), no place can be termed earthquake-free. Multiple microearthquakes are observed on a daily basis in the subduction zone (Himalayan belt) in India, although few large earthquakes have occurred in the intraplate region (Deccanplateau) over the years. The built environment's vulnerability has been proved by its performance during previous earthquakes, prompting engineers and architects to strive for seismically efficient structures. The vast bulk of India's landmass (about 60%) is vulnerable to moderate to catastrophic earthquakes. When compared to a moderate earthquake in a heavily populated area, a large earthquake in an unoccupied location may do minor damage.. The majority of casualties reported were caused by building collapse, according to all field survey studies undertaken after a major earthquake. Building failure is caused by a lack of seismic understanding and its application into building design and implementation. Low-rise, non-engineered buildings make up a substantial portion of rural and urban residences, and they take the brunt of the damage. Seismic waves propagate in all directions during an earthquake. However, horizontal vibration is thought to be the most important component in generating structural failure among the other components. Seismic waves displace a building's foundation, causing inertial forces in various structural parts.The overall shape, size, geometry, and nature of the load path all affect a structure's seismic performance during an earthquake. The goal of the seismic design philosophy is to keep structural components and people safe. It says that in the event of (regular) minor shaking, load-bearing structural elements must survive no damage, sustain reparable damage in the event of (occasional) moderate shaking, and withstand severe damage without collapse in the event of (rare) heavy shaking. The current research examines the various building types found on the Indian subcontinent, as well as their performance during previous earthquakes.It was attempted to have a look at current earthquake-safe construction procedures. A brief summary of future trends in making buildings more earthquake-resistant has also been presented. Overall, precise code-compliant structural design and construction procedures are required in addition to effective and efficient seismic design concepts. About a third of the housing units are in seismic zones IV and V. These rural building units are mostly made of locally available materials like mud and unburnt bricks, stone walls, or burnt brick walls, all of which are prone to poor construction and upkeep (BMTPC,2006)). A rapid expansion in the urban population has been observed over the last decade, in addition to a higher percentage of housing stock in the rural area. According to India's census, the urban population increased by 32% from 286 million in 2001 to 377 million in 2011. By 2030, the urban population is expected to reach approximately 590 million people. According to data, 50 percent of the demand for construction The private sector in India is the source of most activities. The rest comes from industrial activity, residential and commercial development, and other sources (Make India, 2015). Infrastructure, required basic utilities, residential design, and community development are all in high demand as a result of this fast urbanisation. The effects of lateral loads like as earthquake loads, wind loads, and blast forces have been a major issue in recent years. One of the key issues that every designer faces is providing sufficient strength and stability in the face of lateral stresses.. As a result, structural engineers must have a thorough understanding of the seismic performance of various types of shear walls in order to protect the structure against lateral loads. For (G+20) storeys, the current paper compares the seismic performance of high-rise structures and optimises the thickness of RCC shear wall, Steel Plate Shear Wall (SPSW), and composite shear wall. The software ETABS was used to design and analyse the building with RCC shear wall, steel plate shear wall, and composite shear wall.. The effects of different shear panel thicknesses are discussed, as well as a comparison of the results of tale drift and storey shear.A shear wall is one of the key elements used in high-rise structures to resist the lateral stresses exerted by earthquakes all over the world. According to previous study, the reinforced concrete (RC) Shear walls undergo a quick loss of lateral capacity due to wall corner and web crushing in the plastic zone.

Large shear distortions in shear walls were also discovered to have a low energy dissipation capability. Steel plate shear walls (SPSW) and SteelRC composite shear walls have emerged as a result of these factors, to compensate for the deficiencies of RC shear walls. A steel plate shear wall system is stiff enough to control structure movement, has a ductile failure process, and absorbs a lot of energy. A steel plate shear wall system is defined as a steel plate wall with two boundary columns and horizontal floor beams.The steel plate wall and the two boundary columns work together to form a vertical plate girder. Due to buckling in the compression zone of the wall, the most apparent drawback of a steel shear wall is a reduction in energy dissipation capacity, reduced shear strength, and a decrease in system stiffness. Composite shear walls, on the other hand, are made out of steel plates attached to reinforced concrete panels on one or both sides of the steel infill plates using bolts at regular intervals, and are believed to combine the benefits of steel and concrete shear walls. The pre-cast or cast-in-situ reinforced concrete panel layer helps to protect against fire, explosions, and other hazards. The nonlinear behaviour of a concrete stiffened steel plate shear wall (CSPSW) with an aperture was investigated by Soheil Shafaeia et al(1).In comparison to its SPSW counterpart, CSPSW has a larger shear capacity and energy dissipation, according to the report. Sina Nassernia and Hossein Showkati [2] investigate the theoretical and experimental aspects of tensile braced mid-span steel plate shear walls, as well as the impacts of circular opening on the system. Shear walls are installed in the middle of the span to prevent the requirement to reinforce the surrounding primary columns. Even at high levels of drift, the results show that the system behaves appropriately and acceptably. On composite steel–concrete shear walls with steel enclosed profiles, D. Dan et al [3] conducted practical testing and a theoretical investigation (CSRCW).The system was subjected to a nonlinear analysis with a focus on the steel profile to concrete connection, as well as a comparison of the performance of shear walls with varied steel shape encased profiles and typical shear walls with reinforced concrete. Natalia Egorova et al. [4] investigated the ring-shaped steel plate shear wall, which has a unique pattern of cut-outs that results in ring forms and is effective at preventing plate buckling.. In compared to the unstiffened thin steel plate shear wall, the load deformation response of the resulting RS-SPSW structure is observed to exhibit full hysteretic behaviour and also imparts much enhanced stiffness, according to the study. S.A.A. Hosseinzadeh and Mohsen Tehranizadeh [5] examined the nonlinear behaviour of steel plate shear walls (SPSWs) strengthened with large rectangular shaped openings used as windows or doors in constructions. The results indicated that creating stiffened apertures in various SPSWs improves the structure's ultimate strength and stiffness while also decreasing the ductility ratio. Masoud Hoseinzadeh Asla and Mahna Safarkhanib [6] investigated a unique reduced beam section for a steel plate shear wall (SPSW). The author arrived to the conclusion that decreasing the height to length ratio of the wall leads to a decrease in ductility by using the schemed slotted beam model in shear walls with varied storey height to length ratios and assessing the results. Using a finite element (FE) programme, Nam H. Nguyen and Andrew S. Whittaker[7] investigated composite walls, which are essentially a steel-plate concrete (SC) wall. ABAQUS. The findings from four large-scale SC wall piers with an aspect ratio of 1.0 were compared to the results from reversed cyclic, inelastic testing. Nonlinear seismic responses of a 4-storey and 6-storey composite plate shear wall (C-PSW) were examined by Sandip Dey and Anjan K. Bhowmick[8]. According to the results of the nonlinear seismic analysis, composite plate shear walls work in a stable and ductile manner even in seismically active locations. The numerical findings of computational research on the in-plane monotonic response of steel-plate concrete (SC) composite shear wall piers are presented by Siamak Epackachi et al [9]. Data from reversed cyclic, inelastic in-plane testing of four large-scale SC wall piers were used to validate the baseline FEM model. The experimental investigation on three-story composite shear wall specimens was investigated by Qiuhong Zhao and Abolhassan Astaneh-Asl[10]. The figure 1 shows the Shear wall of concrete and steel and whereas Figure 2 shows the shear wall design..

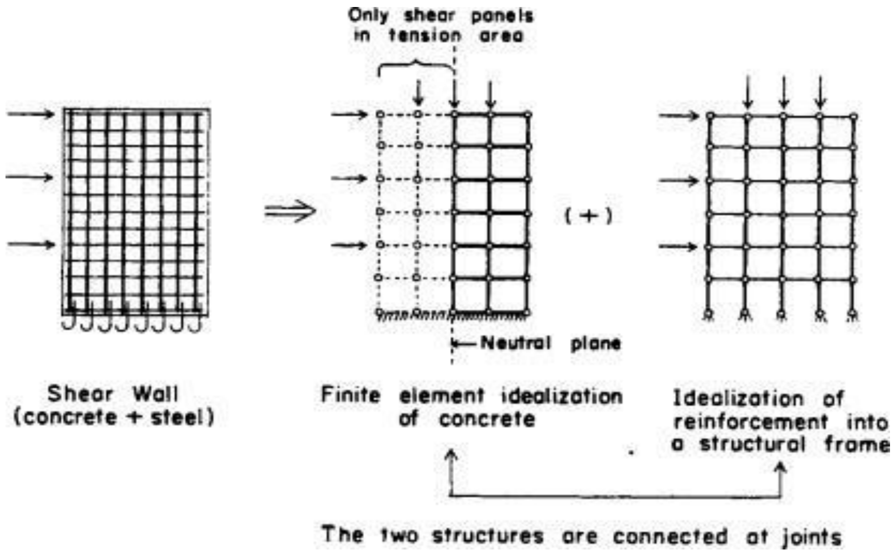

Figure1: Shear wall of Concrete & Steel

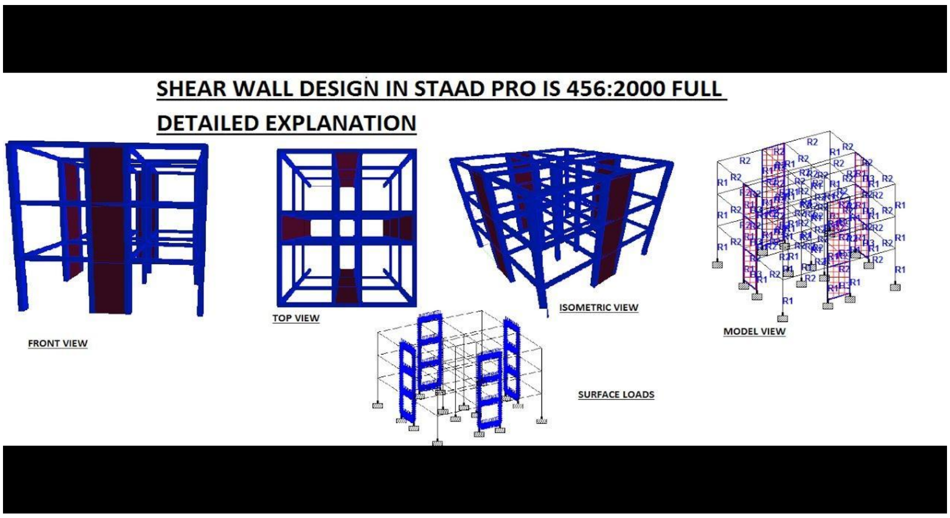

Figure 2: Shear wall Design

II. OBJECTIVES

The main objectives of this study are-The study of the primary factors that determine a building's seismic performance. The main goal of this project is to use STAAD Pro to study and design a multi-story structure [G + 2 (3 dimensional frame).Analyze and design a structure based on its seismic reaction using STAAD-Pro software. STAAD-Pro software was used to design and perform seismic analysis on a multistory building prior to construction. Structure modelling and application of various loads on STAAD Pro, load calculations owing to various loading combinations, structural analysis and design on STAAD-Pro.

III. RESULTS AND DISCUSSION

In this Figure 3 shows the shear force diagram, Figure 4 shows the Bending moment diagram, Figure 5 shows the Deflection diagram, Figure 6 shows the Geometry of beam and Figure 7 shows the Detail of beam design. These are some of the important results which describes the need for providing the adequate reinforced sections mentioned as 1. Design for Flexure 2. Design for Shear 3. Beam Design Output 4. Column Design

1. Maximum sagging (creating tensile stress at the bottom face of the beam) and hogging (creating tensile stress at the top face) moments are calculated for all active load cases at each of the above mentioned sections. Each of these sections are designed to resist both of these critical sagging and hogging moments. Where ever the rectangular section is inadequate as singly reinforced section, doubly reinforced section is tried.

2. Shear reinforcement is calculated to resist both shear forces and torsional moments. Shear capacity calculation at different sections without the shear reinforcement is based on the actual tensile reinforcement provided by STAAD program. Two-legged stirrups are provided to take care of the balance shear forces acting on these sections.

3. The default design output of the beam contains flexural and shear reinforcement provided along the length of the beam.

4. Columns are designed for axial forces and biaxial moments at the ends. All active load cases are tested to calculate reinforcement. The loading which yield maximum reinforcement is called the critical load. Column design is done for square section. Square columns are designed with reinforcement distributed on each side equally for the sections under biaxial moments and with reinforcement distributed equally in two faces for sections under uni-axial moment. All major criteria for selecting longitudinal and transverse reinforcement as stipulated by IS: 456 have been taken care of in the column design of STAAD.

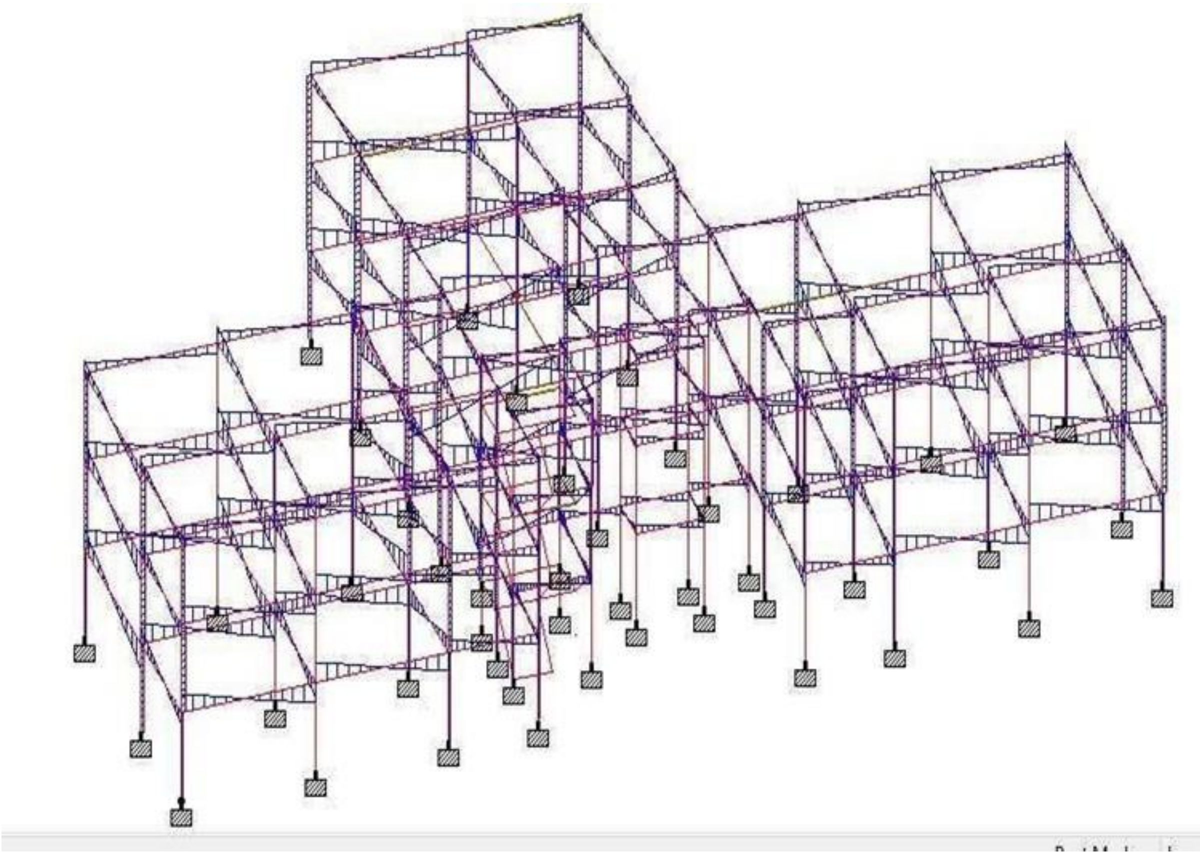

Figure 3: Shear force diagram

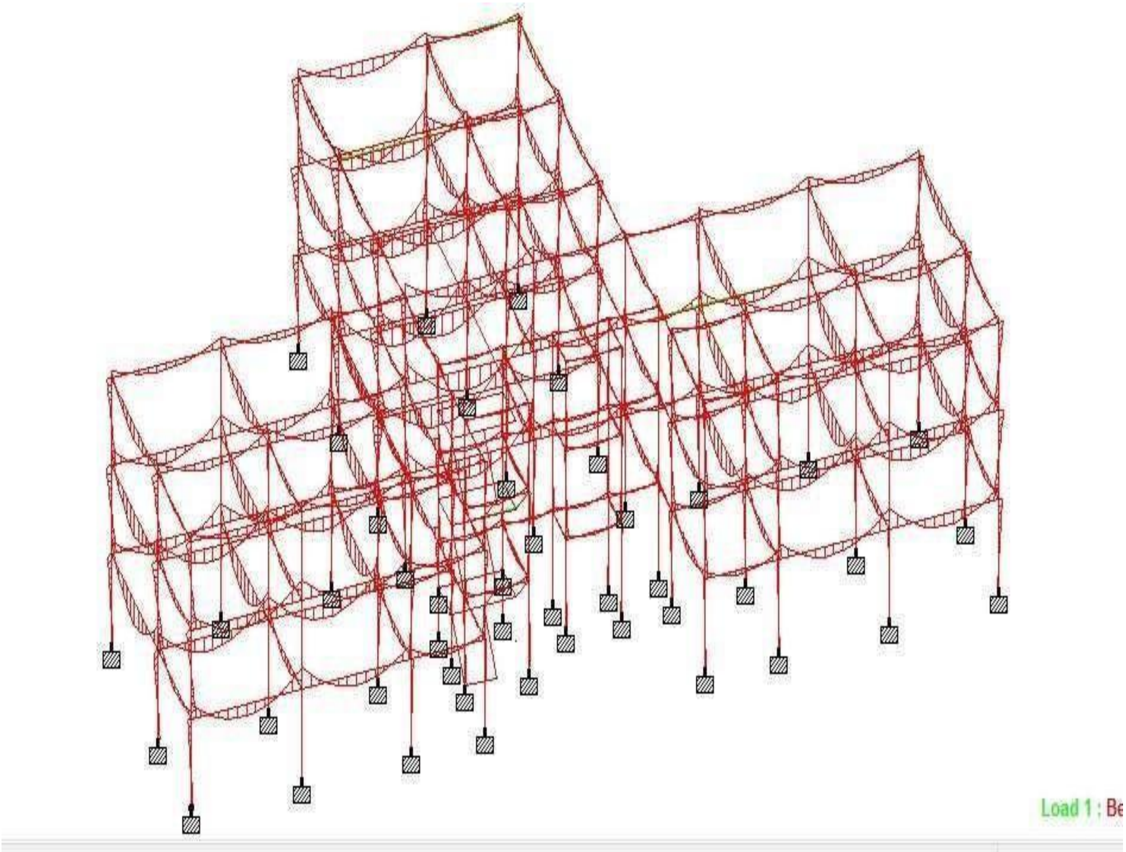

Figure 4: Bending Moment Diagram

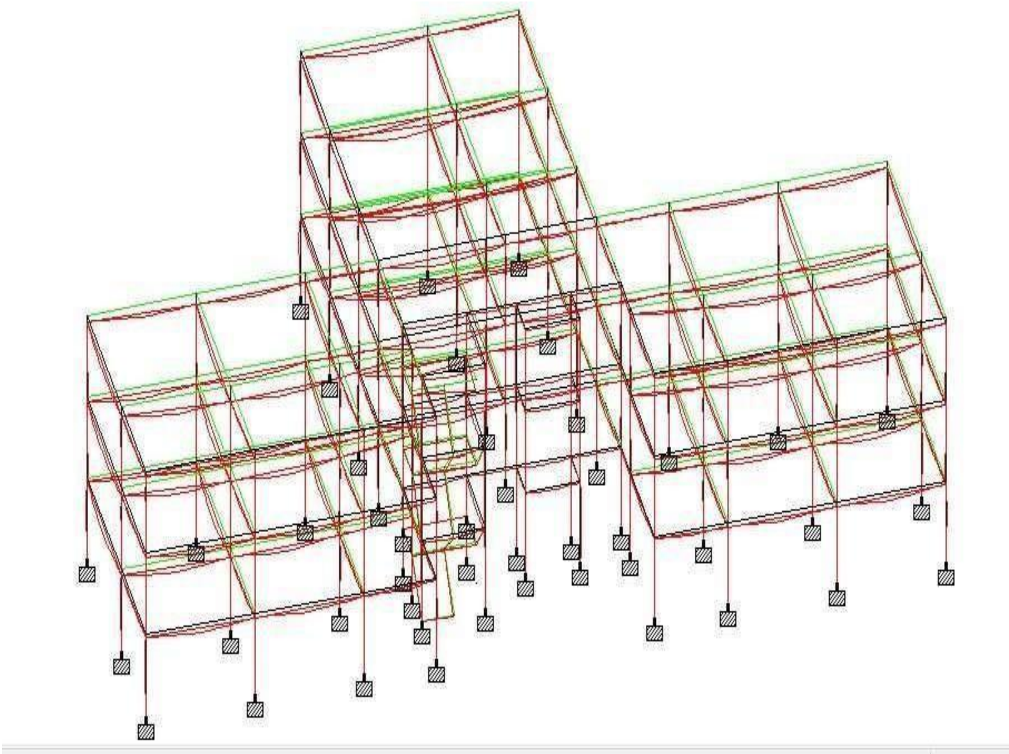

Figure 5: Deflection Diagram

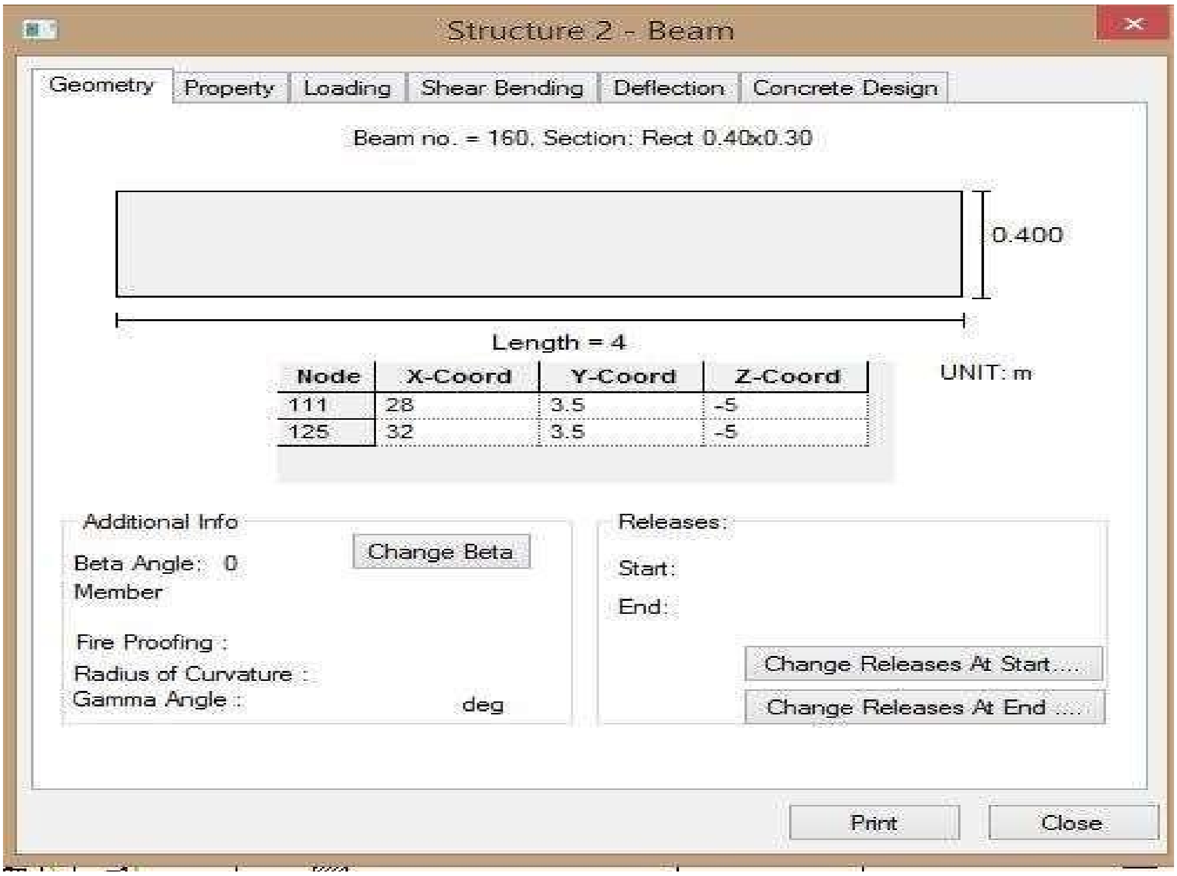

Figure 6: Geometry of A Beam

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                B E A M   N O.     56   D E S I G N   R E S U L T S

       M25                      Fe415 (Main)                Fe415 (Sec.)

     LENGTH:  7000.0 mm      SIZE:   300.0 mm X  700.0 mm   COVER: 25.0 mm


                      SUMMARY OF REINF. AREA (Sq.mm)
  ----------------------------------------------------------------------------
  SECTION       0.0 mm     1750.0 mm     3500.0 mm     5250.0 mm     7000.0 mm
  ----------------------------------------------------------------------------
   TOP          649.09        0.00          0.00          0.00       1173.74
  REINF.      (Sq. mm)     (Sq. mm)      (Sq. mm)      (Sq. mm)      (Sq. mm)

  BOTTOM          0.00      607.12       1079.93        411.07         0.00
  REINF.      (Sq. mm)     (Sq. mm)      (Sq. mm)      (Sq. mm)      (Sq. mm)
  ----------------------------------------------------------------------------

--------------------------------< PAGE 193 Ends Here >--------------------------
   STAAD SPACE                                              -- PAGE NO.   194


                      SUMMARY OF PROVIDED REINF. AREA
  ----------------------------------------------------------------------------
  SECTION       0.0 mm     1750.0 mm     3500.0 mm     5250.0 mm     7000.0 mm
  ----------------------------------------------------------------------------
   TOP         4-16í         3-16í         3-16í         3-16í         6-16í
  REINF.     1 layer(s)    1 layer(s)    1 layer(s)    1 layer(s)    1 layer(s)
```

Figure 7: Design Details of a Beam

IV. CONCLUSION

STAAD PRO has the capability to calculate the reinforcement needed for any concrete section. The program contains a number of parameters which are designed as per IS: 456(2000). Beams are designed for flexure, shear and torsion. While Analyzing the results we get suitable design elements for building a concrete structure without any error or corrections such as Beam design output of a beam containing flexure and shear Reinforcement are provided along the length of the beam.For Flexure Where ever the rectangular section is inadequate as singly reinforced section, doubly reinforced section is tried. For Shear Design two-legged stirrups are provided to take care of the balance shear forces acting on these sections. Analysis and design carried in STADD.Pro and post processing in STADD.Pro gives the load at various supports. These supports are to be imported into this software to calculate the footing details i.e., regarding the geometry and reinforcement details.

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