Analysis and Design of G+6 Building System Using STAAD Pro Software

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ABSTRACT
The main aim of structural engineering design is to design the structures for a safe technology in the computing field; the structural engineer can dare to tackle much more large and complex structure subjected to various type of loading condition. Earlier the loads acting on the structure are considered are static, but strictly speaking, with the exception of the self -weight (dead load) no structure load is static one.
This project attempts to understand the structural analysis and designing of G+6 apartment thereby depending on the suitability of plan, layout of beams and positions of columns are fixed. Dead loads are calculated based on material properties and live loads are considered according to the code IS 875-part 2, footings are designed based on safe bearing capacity of soil. For the design of columns and beams frame analysis is done by limit state method to know the moments they are acted upon. Slab designing is done depending upon the type of slab (one way or two way), end condition and loading. From the slab the loads are transferred to the beams, thereafter the loads from the beams are taken up by the columns and then to the footing. The section is checked for the components manually using STAAD PRO v8i software for the post analysis of the structure maximum shear force, bending moment and maximum storey displacement are computed. The quantitative estimation has been worked out.

I. INTRODUCTION

Now a days due to overpopulation and high cost of land, multistoried building is more essential for metropolitan city. Multistoried residential building is the perfect solution for living of high populated area.

High rise buildings are used for densely populated area whereas uses high rise buildings including commercial and uses because of systems have various advantages.

The design process of structural planning and design requires not only imagination and conceptual thinking but also sound knowledge of science of structural engineering besides the knowledge of practice aspects, such as recent design codes, bye laws, backed up by ample experiences, intuition and judgement. The purpose of standards is to ensure and enhance the safety, keeping careful balance between economy and safety. The process of design commences with planning of the structure, primarily to meet its functional requirements. It is emphasized that any structure to be constructed must satisfy the need efficiently for which it is intended and shall be durable for its desired life span. In every aspect of human civilization we needed structures to live in or to get what we need. But it is not only building structures but to build efficient structures so that it can fulfill the main purpose for what it was made for. Here comes the role of civil engineering and more precisely the role of analysis of structure. The design consists of G+6 residential apartment building. The building is designed for the four residential flats on each floor. Residential flat consists of four 2BHK on each floor. The floor to floor distance is 3m. There are many classical methods to solve design problem, and with time new software's also coming into play. Here in this project work based on software named "STAAD. Pro" has been used.

II. LITERATURE REVIEW

A. Sivaji , N. Madhava Reddy , T. Yeswanth Kumar : *Analysis & Design of Multistory Building using Staad Pro and E-Tabs.*This paper represents the 5-storey building using STAAD Pro and ETABS. The beams , columns and slabs are designed using software and by manual procedure and also reinforcement details also compared. The foundation is designed by using STAAD Foundation software. The load usedin the analysis are dead load (IS

875-1987 part 3), seismic load (IS 1893-1984 part 1) and 25 load combination are considered as per 1987 code book.

A. D. Bhosale , Archit Pradip Hatkhambhar : *Analysis and Design of multi-storey Building by using STAAD Pro-V8i.*In this paper G+3 structure is consider and dead , live , combination , wind are applied. Then result are studied and compared by manual calculations. In the STAAD Pro the designing is done by better technique for creating geometry , defining the cross sections for columns and beams etc. After that the model is analyzed for 'run analysis'.

S.K. Saleen , B. Ravi Kumar : *Analysis and Design multi-storeyed building by using STAAD Pro.*In this paper the design involves load calculations manually and analysing the structure by STAAD Pro. The design methods used in STAAD Pro analysis are limit state design conforming to Indian standard code of practice. The final work was the proper analysis and design of a G+5 3D RCC frame under various load combinations. STAAD Pro feature the state-of-the-art user interface , visualization tools , powerful analysis and design engines with advanced finite elements and dynamic analysis capabilities.

B. Pradeep Kumar, Sk. Yusuf Basha : *Planning Analysis and Design of residential building, quantity survey.*The primary objective of this project is to gain sufficient knowledge in planning, analysis and design of building and quantity surveying. It is reinforced concrete framed structure consist of G+6 using IS 456-200. The planning will be recognized by NBC. The ceiling height is provided as 3.2 m.

Nasreen M. Khan : *Analysis and Design of Apartment Building.*Practical knowledge is an important and essential skill required by every engineer. For obtaining this skill , an apartment building is analysed and designed , located at thrissure with B+G+8 storeys having a car parking facility provided at basement and ground floor. The building have a shear wall around the lift pit. The modelling and analysis of structure is done by using STAAD Pro 2007 and detailing is done using AutoCAD 2016 and designing was done manually.

Aman, Manjunath Nalwadgi : *Analysis and Design of multi-storey Building by using STAAD Pro.*The main aim of structural engineer is to design the structures for safe technology in the computing field. This project belongs to the utility builders to be executed in the Gulbarga city. The name of the project is Bharat pride. The design consists of C+G+5 residential and commercial building. Residential flat consists of one 3BHK and three 2BHK. Here in this project work based on software named "STAAD Pro" has been used.

Anoop A, Fousiga Hussain, Neeraja R. : *Planning Analysis and Design of multi storied building by STAAD Pro V8i.*The aim of this project is to design a multi storied building of G+6 floors, at Kalakoda about 4 km from Paravoor. The design is done by taking into account the requirements and standards recommended by IS code, Kerala building rules and national building rules. Planning is done using the 3D modelling software SketchUp 2011with the help of AutoCAD 2014. The structure analysis and design is done using STAAD Pro V8i and a cross check is done for selected members using limit state method of design as per IS 456-2000.

III. METHODOLOGY

3.1 ANALYSIS AND DESIGN OF G + 6 BUILDING USING STAAD PRO
Step - 1: Creation of Grid points & Generation of structure After getting opened with STAAD PRO we select a new model and a window appears where we had entered the grid dimensions and story dimensions of our building. Here itself we had generated our 3D structure by specifying the building details.
Step - 2: Defining of property Here we had first defined the material property by selecting define menu, material properties. We add new material for our structural components (beams, columns, slabs) by giving the specified details in defining. After that we define section size by selecting frame sections as shown below & added the required section for beams, columns etc.
Step - 3: Assigning of Property After defining the property we draw the structural components using command menu Draw line for beam for beams and create columns in region for columns by which property assigning is completed for beams and columns.
Step - 4: Assigning of Supports By keeping the selection at the base of the structure and selecting all the columns we assigned supports by going to assign menu, joint\frame, Restraints (supports), fixed.
Step - 5: Defining of loads The loads in STAAD PRO are defined as using static load cases command in define menu
Step - 6: Assigning of Dead loads After defining all the loads dead loads are assigned for external walls, internal walls
Step - 7: Assigning of Live loads Live loads are assigned for the entire structure including floor finishing.
Step - 8: Assigning of load combinations Load combinations is based on IS 875 1987 PART 5 using load combinations command in define menu
Step - 9: Analysis After the completion of all the above steps we have performed the analysis and checked for errors.
Step - 10: Design After the completion of analysis we had performed concrete design on the structure as per IS

456:2000. For this go to Design menu, concrete design, select design combo. After this again goes to design menu, concrete frame design, start design \ check of structure then STAAD PRO performs the design for every structural element.
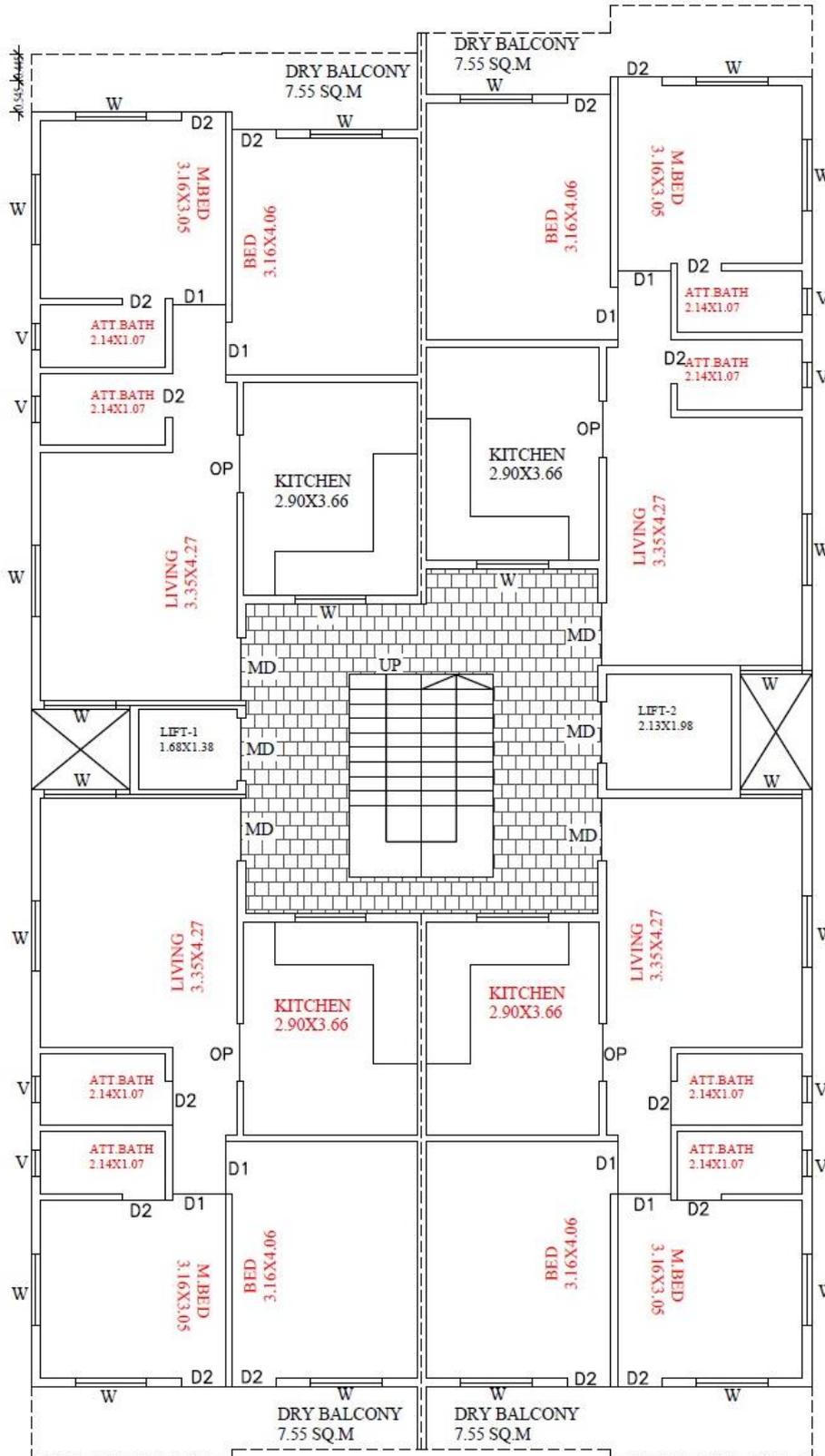
IV. AUTOCAD PLANS

**Fig 4.1 AutoCad Plan**

1.   Material Property

Grade of concrete (for all structural elements): M25, Unit weight of concrete: 25kN/m3, Unit weight of cement mortar: 24kN/m3, Unit weight of water: 10kN/m3, Unit weight of Brick: 20kN/m3, Grade of concrete: M20, Grade of steel: Fe 415, Beam Size: 230X300 mm, 230X380 mm, 230X450 mm, 230X530 mm, 230X600 mm, Column Size: 230X600 mm, 300X450 mm300X600 mm.

2.   Description of Loads

Live load (on floors): 3.5kN/m2, (IS 875:2015 – Part -2) Live load (on roof): 2 kN/m2, (IS 875:2015 – Part -2) Floor Finishes (on floors): 1.5kN/m2
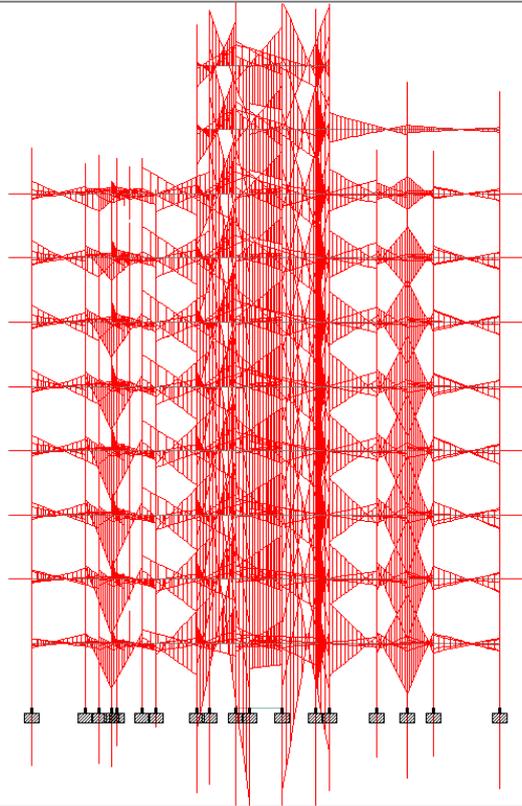
V.   STAAD PRO ANALYSIS RESULTS
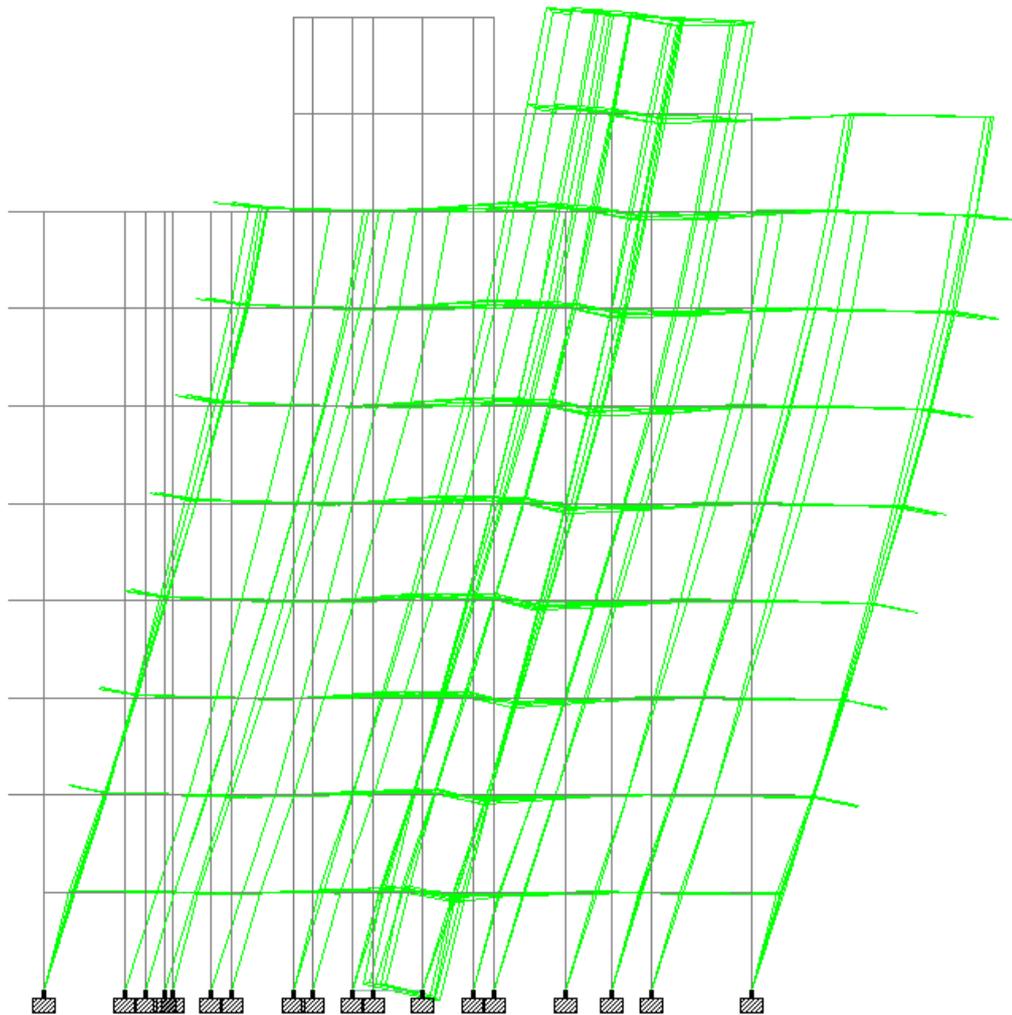
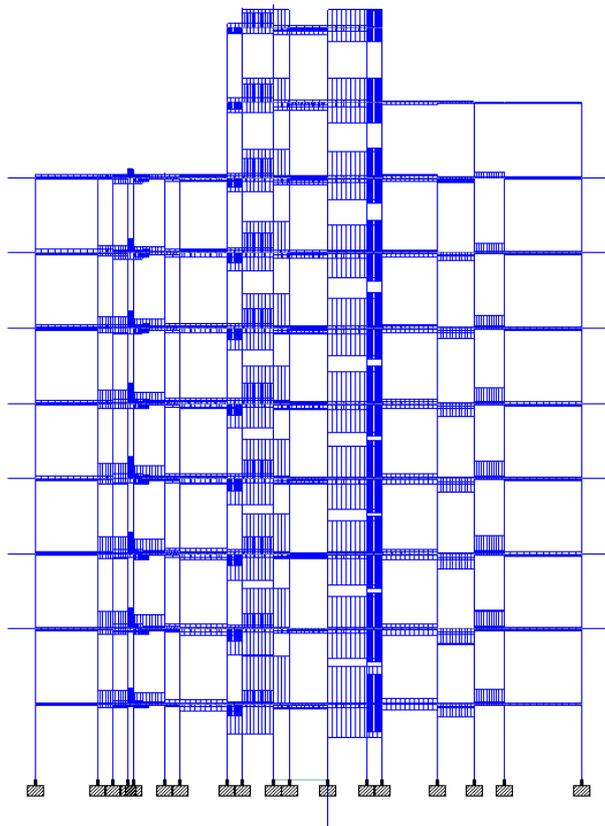Postprocessing Workflow | Load : 6: EQ Z+

Fig 5.1 Deflection due to EQ forces

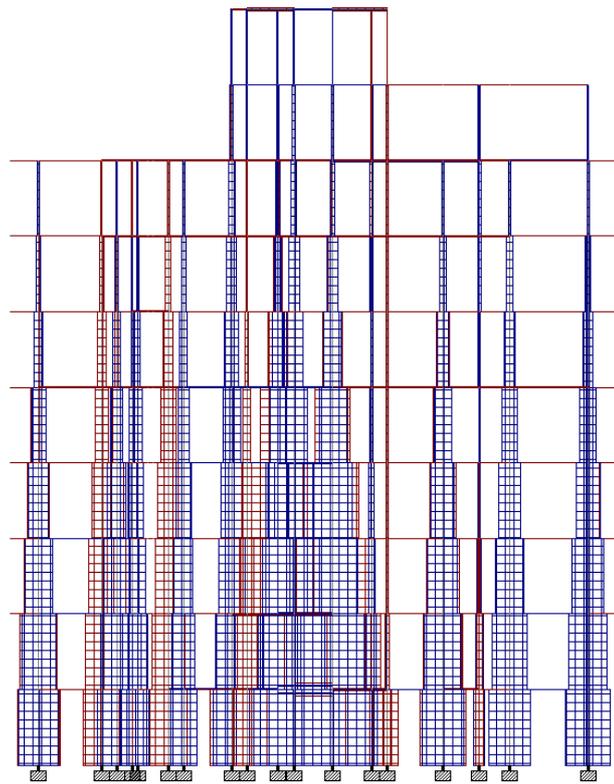Postprocessing Workflow   Load : 4: EQ X+

Fig. 5.2 Moment Diagram
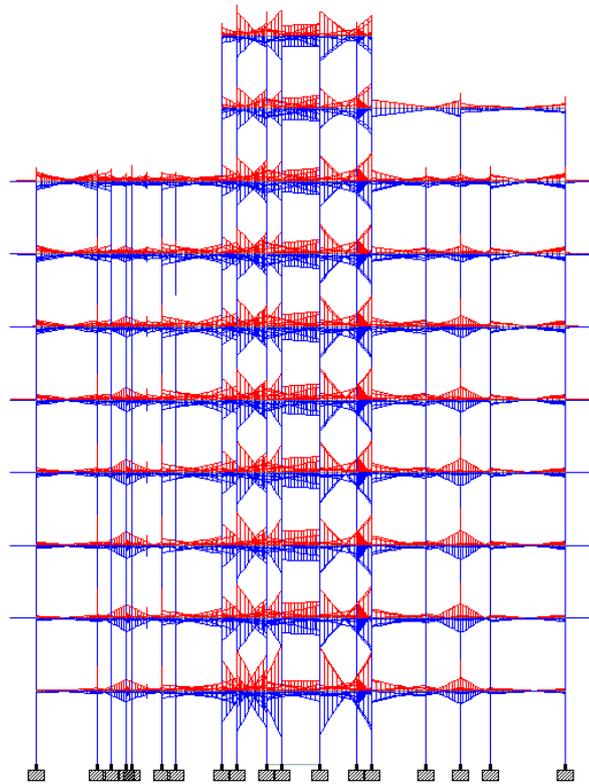

Postprocessing Workflow   Load : 4: EQ X+

Fig. 5.3 Shear Force Diagram

Postprocessing Workflow | Load : 4: EQ X+

Fig. 5.4 Axial Force Diagram

Postprocessing Workflow | Load : 4: EQ X+

Fig. 5.5 Beam Stress Diagram
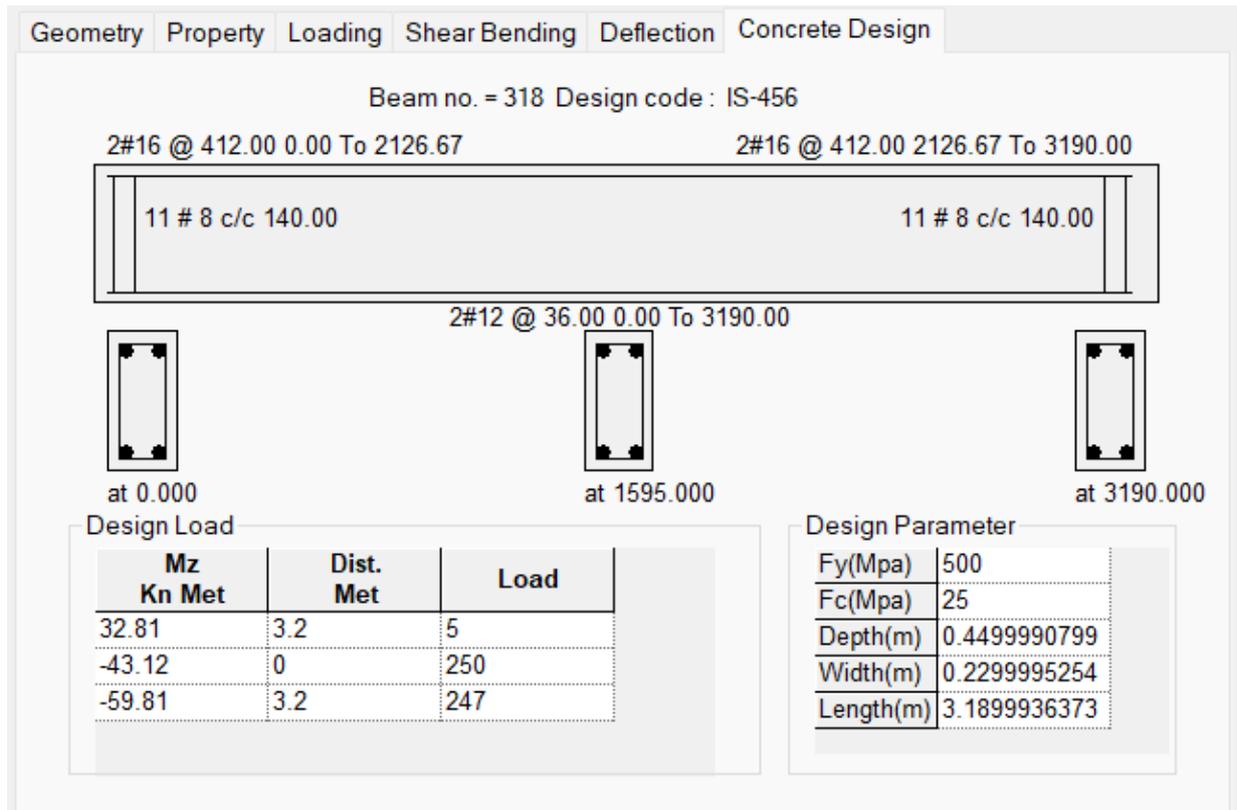
VI.   STAAD PRO DESIGN RESULT

| Geometry | Property | Loading | Shear Bending | Deflection | Concrete Design |

Beam no. = 318 Design code : IS-456

2#16 @ 412.00 0.00 To 2126.67   2#16 @ 412.00 2126.67 To 3190.00

11 # 8 c/c 140.00   11 # 8 c/c 140.00

2#12 @ 36.00 0.00 To 3190.00

at 0.000   at 1595.000   at 3190.000

Design Load

Mz Kn Met	Dist. Met	Load
32.81	3.2	5
-43.12	0	250
-59.81	3.2	247

Design Parameter

Fy(Mpa)	500
Fc(Mpa)	25
Depth(m)	0.4499990799
Width(m)	0.2299995254
Length(m)	3.1899936373

Fig. 6.1 Beam Design

| Geometry | Property | Loading | Shear Bending | Deflection | Concrete Design |

Beam no. = 450 Design code : IS-456

0.600

0.300 m

Design Load

Load	4
Location	End 1
Pu(Kns)	-0.83
Mz(Kns-Mt)	29.54
My(Kns-Mt)	0.18

Design Parameter

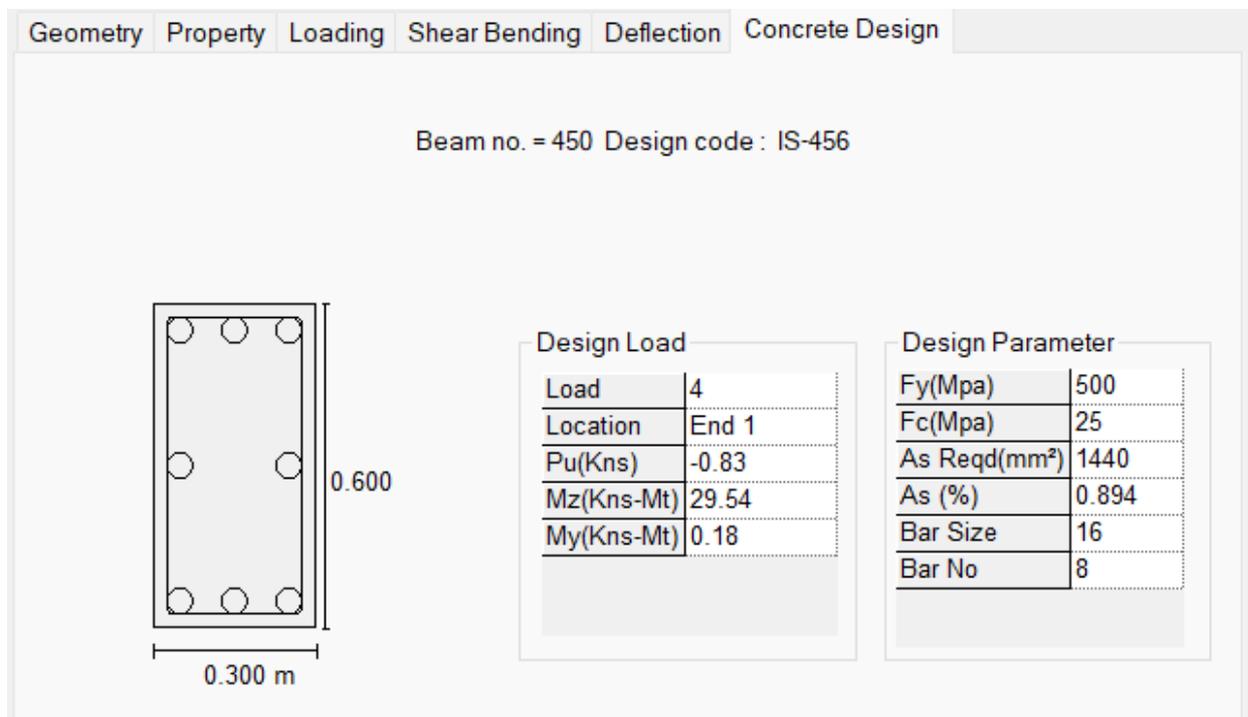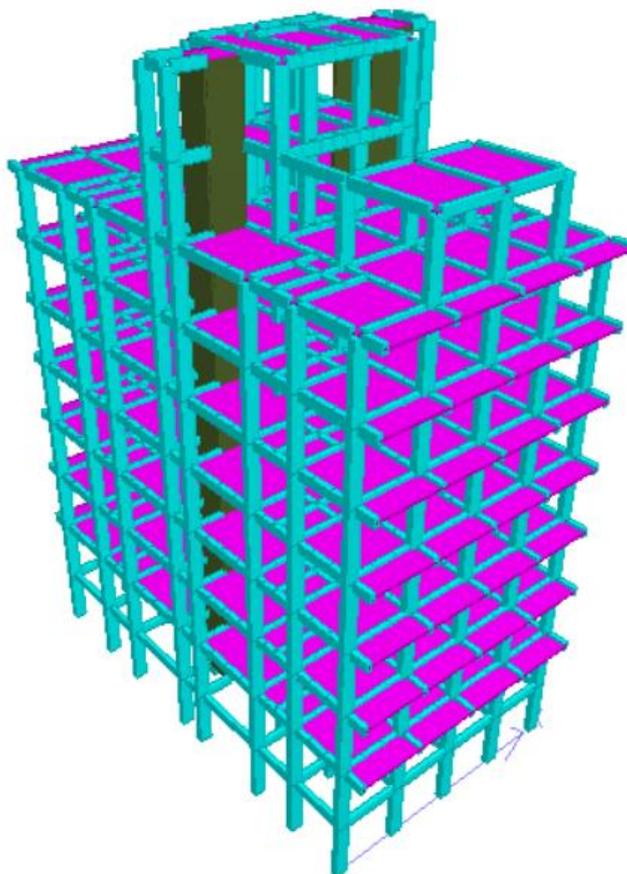| Fy(Mpa)	500
Fc(Mpa)	25
As Reqd(mm²)	1440
As (%)	0.894
Bar Size	16
Bar No	8

Fig. 6.2 Column Design

Fig. 6.3 3D MODEL OF THE BUILDING

VII. CONCLUSION

Planning, analysis and design of G+6 multi-storey residential building was done. It's a G+6 storied Apartment building with parking at the ground floor and the rest of the floors are occupied with apartments. Each floors are provided with four 2BHK apartments. All the structural components were designed manually and detailed using AutoCAD. The analysis and design were done according to standard 8 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, floor load and earthquake load are applied. Deflection and shear tests are checked for beams, columns and slabs. The tests proved to be safe. Theoretical work has been done. Hence, We conclude that todays technology upgraded much more and now we can do construction work fast as possible using the engineering softwares with less trouble and more accuracy. Today we can make the structure visualize in 3D even before constructed that is very much amazing and when we do so we can gain more knowledge in practical work when compared to theoretical work.

There are lots of people who cannot afford or satisfy after there dream homes being constructed in less space because they feel something missed so using that engineering software technology we can precisely and wisely visualize and construct structure. As the concrete structures are very much rigid, they are costly too so people/owners by preplanning there homes they can save there future renovation cost of there homes too.

1. Designing using Software's like STAAD Pro reduces lot of time in design work.
2. Details of each and every member can be obtained using STAAD pro.
3. All the List of failed beams can be obtained and also better section is given by the software.
4. Accuracy is Improved by using software.

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