

Structural Evaluation of G+5 Building Frames: A Software-Based Comparison Between Build Master and STAAD.Pro

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ABSTRACT

After the bifurcation of Andhra Pradesh and Telangana states, a new capital of Andhra Pradesh was declared as Amravati. Due to the rapid growth of urbanization and industrialization in the capital region, the land consumption is more.

This project involves the planning, design, analysis, and cost estimation of a G+5 residential building located in Kanuru, Vijayawada. The layout of the proposed G+ 5 residential building is based on a plot of size 26.5mx53.5m. The ground floor of the building will be used as parking. While the remaining 5 floors will be divided into 30 flats each having an area of 87sq.m each apartment is of 2BHK configuration.

The planning of the building is done according to Andhra Pradesh G.O:119 and Building Bye laws. All the drafting was done using AUTOCAD. Also these drawings made on AUTOCAD also served as a base for transfer of the structure for analysis and design into STAAD Pro and BUILD-MASTER.

The analysis and design of the entire structure has been completed using STAAD Pro and the BUILD –MASTER. The results include the various forces acting on various members as well as various schedules for various members.

Keywords: Autocad, Build Master, Building, Design, Staad Pro., Plan.

I. INTRODUCTION

Buildings are an important indicator of social progress of the state. A building frame is a three dimensional structure or space structure consist of column, beams and slabs. It serve several societal needs – primarily as shelter from weather, security, living space, privacy, to store belongings, and to comfortably live and work. A building as a shelter represents a physical division of the human habitat (a place of comfort and safety) and the outside (a place that at times may be harsh and harmful). In recent years, interest in sustainable planning and building practices has also become an intentional part of the design process of many new building.

The analysis and design of multi storied building requires not only imagination and conceptual thinking but also sound knowledge of science of structural engineering. 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. Earlier, modeling and structural analysis of buildings was carried out using hand calculation method based on simplified assumptions and understanding the whole behavior of the structure. For analyzing a multi storied building one has to consider all the possible loadings and see that the structure is safe against all possible loading conditions. There are many classical methods to solve design problem. There are several methods for analysis of different frames like kani's method, cantilever method, portal method, and Matrix method. But it seems to be time consuming and complicated for multi storied buildings. In order to compete in the ever growing competent market it is very important for a structural engineer to save time. At present, computer hardware's and software's for modeling and analysis of structure is widely available. Also in manual design all the loads are considered as static, but strictly speaking, with the exception of the software's in the self weight no structural load is static. All the software's in the civil engineering are developed on the basis of advanced finite element analysis which includes the effect of dynamic load such as wind effect, earth quake effect etc. As a attempt "Planning, Analysis, and Design of multi storied residential building" by using two software's named STAAD Pro and BUILD MASTER rather than manual method. Few standard problems also have been solved to show how "STAAD Pro" AND "BUILD MASTER" can be used in different cases. To perform an accurate analysis a structural engineer must determine such information as structural loads, geometry, support conditions, and materials properties. The results of such an analysis typically include support reactions, stresses and displacements. These typical problems have been solved using basic concept of loading, analysis, condition as per IS code. This

information is then compared to criteria that indicate the conditions of failure. Design of all structural components are carried out with using IS codes as per limit state method. These basic techniques may be found useful for further analysis of problems.

Site Details

- The site is located at kanuru village of 100 feet road of Vijayawada district.
- The site is of area 1417.75 m² (1695.629 sq yards of dimensions 26.5m (86.942') X 53.5m (175.525'))
- The site is east faced with a 100 feet road and 3.75m road at south.
- The boundary dimensions are as follows
 - EAST : 26.5 m (86.942')
 - WEST : 26.5m (86.942')
 - SOUTH : 53.5m (175.525')
 - NORTH : 53.5m (175.525')

Basic Steps Involved in The Project

- Planning of the building using AP G.O.No.119.
- Drafting using AUTO CAD software (2012).
- Analysis, drags and Estimation using STAD, PRO V8i&SS6 and BUILD MASTER software (2016) .

II. PLANNING

The planning is the primary and most important part of the construction.

The term planning of building by an engineer is used to mean the groping and arrangement of all components of a building in a systematic manner on all floors and at all levels and it not only includes the horizontal layout but also it takes into consideration the height and level to accommodate the space enclosed by walls, floors, and roofs. During building planning, it is important to keep in mind, the general purpose of building. Each type of building has its own requirements to suit its purpose in the best possible manner. There should be proper thinking on the functional or utility aspect of building. Main considerations of planning are:

- Human habitations and their requirements.
- Climatic condition and effects.
- Bye – laws or G.O's for planning and construction.
- Available finance.
- Comfort, safety and economy.

Our site is located in urban limits As per APCRDA. So we use G.O.MS.NO.119 (Municipal administration and urban development department) for planning.

Steps Involved In Planning:

The following are the sequential steps involved in planning:

Building Height

It is the vertical distance measured from upper level of plinth and continuance to the highest point of the building excluding the parapet wall and water tank.

Height of the building is limited by the plot area of site.

In G.O 119 permissible height is given in table 17 of page 112

Table -1 permissible height of a building

Plot Area	Permissible Height (Mts)	Selected Height
1000-1500 sqm	7	15
	12	
	15	

	18	
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For high rise building (18 m) minimum plot area is 2000sqm. So in our case we cannot take 18m as height because of our plot area (1417.75 m²).

This permissible height is excluded from the stilt floor (from 57.3 of pg no 113). So we can consider this permissible height to all floors excluding stilt or ground floor and parapet wall. This 15m was divided in to 5 floors, each floor consisting of 3m height.

Setbacks

Setbacks mean the space to be left open to sky from the edge of the building to the property line or boundary of the street. No built –up space shall be provided within the setback.

It depends on the width of the road. Our site has 100 feet road on front side and 3.75 m road on south side. If the plot consists of two roads each on either side the maximum width of road should be taken. In our case we take 100feet road width for selection of setbacks.

Table -2 setbacks

S.No	Side	Permissible Set Back (M)	Selected Set Back (M)
1.	Front	7.5	7.5
2.	Back	5	5
3.	Left	5	5
4.	Right	5	5

The above values are from table 17 of page 112 of G.O.119

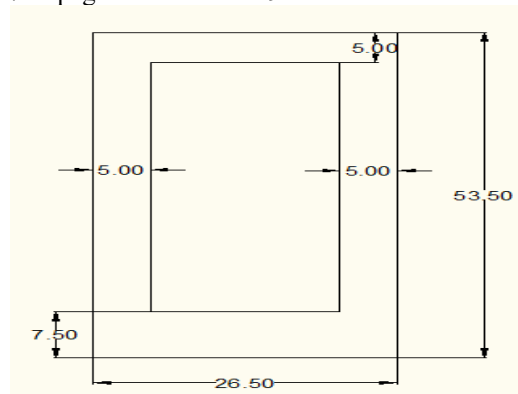


Fig.1 plot area with setbacks

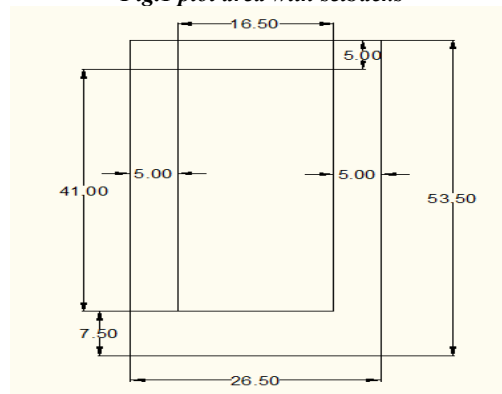


Fig.2 plinth area

After leaving the front, back and right and left side setbacks the plinth area is 16.5 m (54.133') X 41m (134.52').

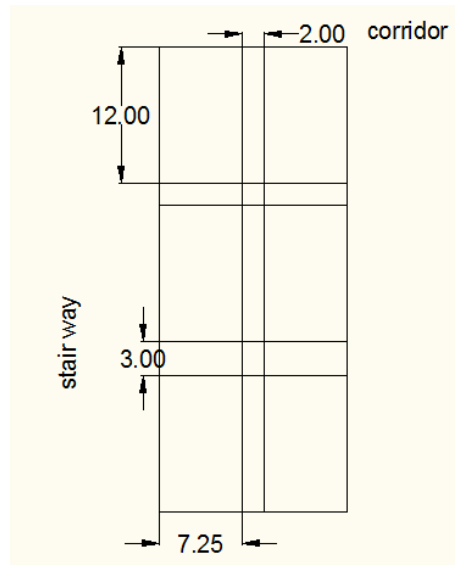


Fig 3 plinth area with corridor and stairway width

After leaving the corridor width and stair case width the remaining plinth area should be divided into 6 flats of each area 7.25 m (23.786') x12 m (39.37') for each floor.

Structural Plan

This structural plan is useful in input data plan for STAAD Pro and BUILD MASTER.

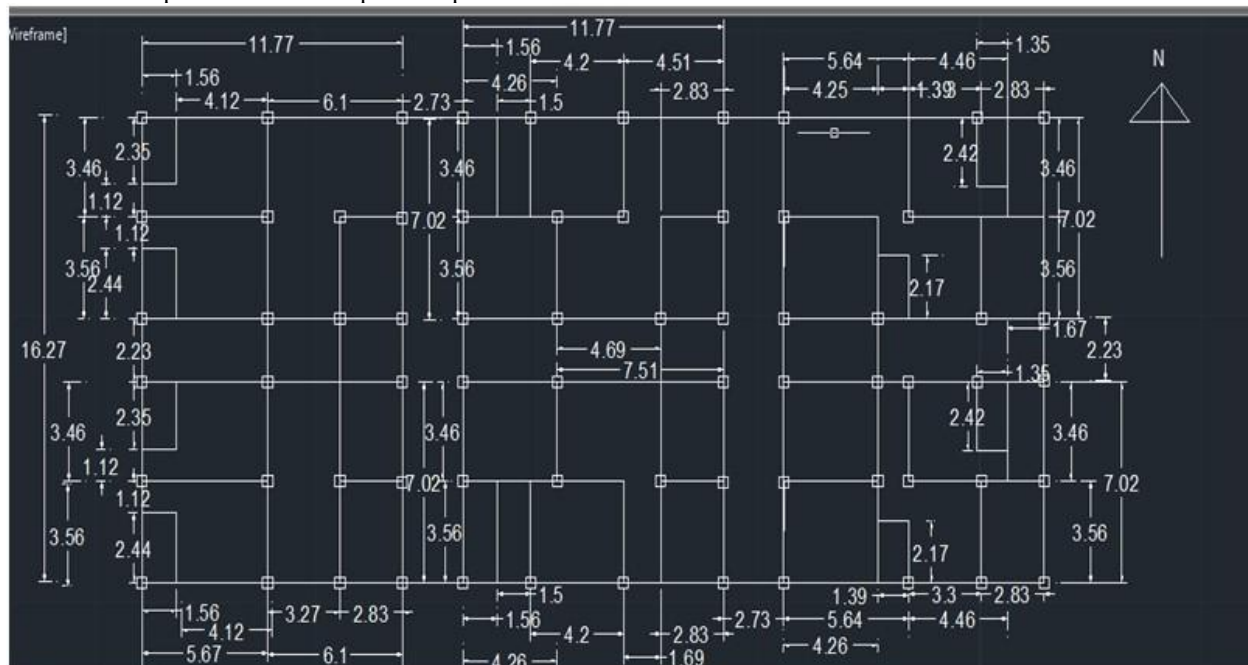


Fig 4 structural plan

III. ANALYSIS

Steps Involved In Staad Pro

STEP 1: For creating or developing a structure in modeling mode

1. Grid:

In this a graphical user interface like a grid appears. By using snap mode cursor is used to create the geometry.

2. Geometry:

In this mode a dialogue box appears on the right side of the screen containing x, y, z coordinates. By using this dialogue box we can give x, y, z values according to the position of the node. The nodes are connected each other either by using node member or beam connection formed end to end.

3. Structure wizard:

In this type it contains some standard models. By directly taking this structure wizard we can create a structure.

STEP 2: Steps after creating a structure

1. Property:

It means the cross sectional data for the member is created by selecting the type of the material and assigned for that particular member.

2. Support:

It means the end condition of the columns. The supports are created and assigned to the existing columns.

3. Load case details:

In this loads are created and assigned to the particular member. The loads that created are dead load, live load, wind load, earthquake load etc. After the creation of all load Generate load combinations.

4. Analysis:

The analysis is done for the defined load and load combinations. In this we get the maximum and minimum bending moments, shear forces, axial forces and deflections.

5. Design:

The design is done for the structure by assigning the code according to the material. The strength of the materials also created and assigned to that particular member. The design parameters are also defined.

6. Verification:

The verification is done by checking whether there are duplicate nodes, overlapped members and improperly connected plates.

Modeling

The entire modeling procedure in the STAAD Pro is attached as APPENDIX-1. The modelling of the structure is taken out as the STAAD editor file. The STAAD editor file gives the data regarding the formation of nodes, beams, columns and slabs. It provides the data regarding the section properties assigned to it. It even provides the numbers of node, beams, and slabs and their connectivity. Any errors regarding the modeling data can be analyzed using the STAAD editor file

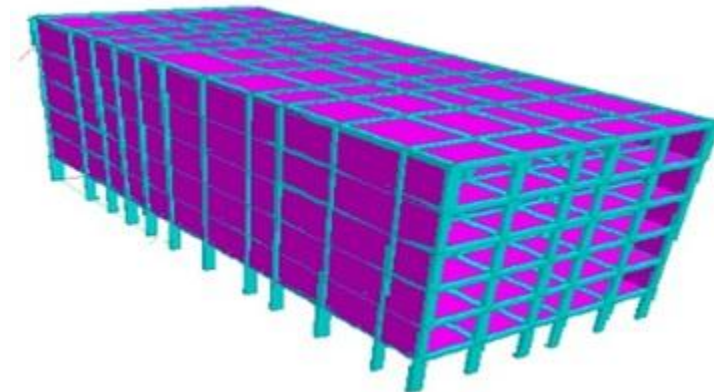


Fig 5 rendered view in 3D from STAAD Pro

Structure Created in Staad Pro

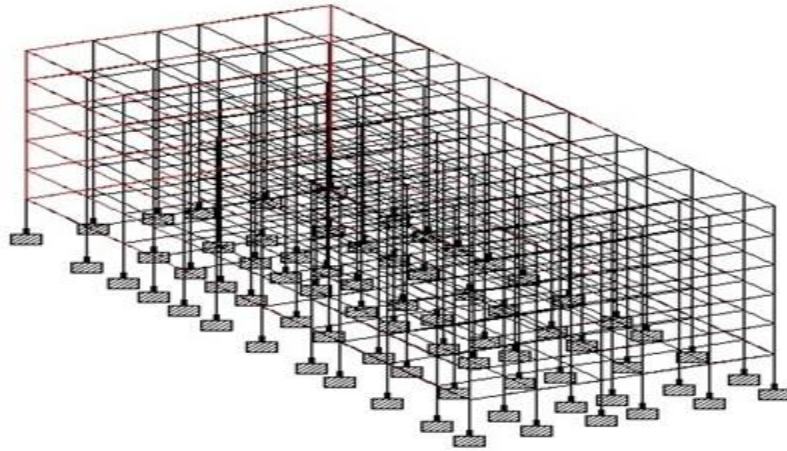


Fig 6 Structure created in STAAD Pro

Bending Moment Diagram

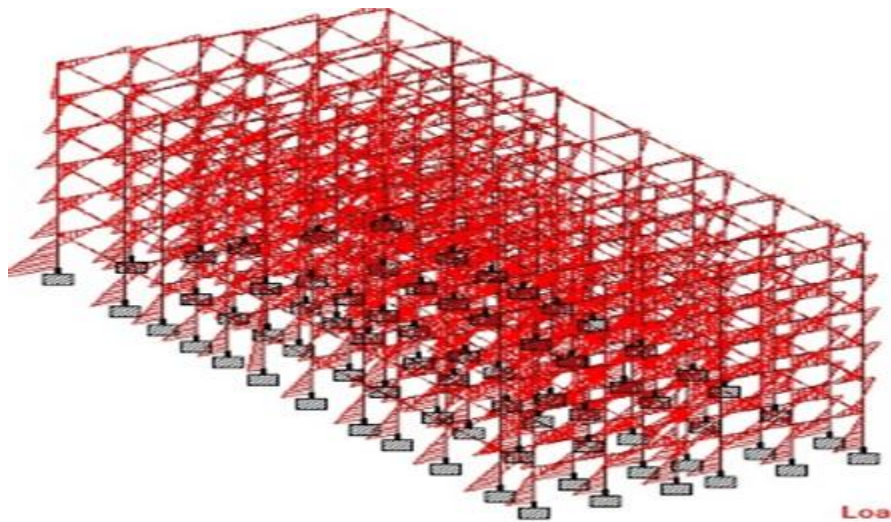


Fig 7 Bending moment diagram

Shear Force Diagram

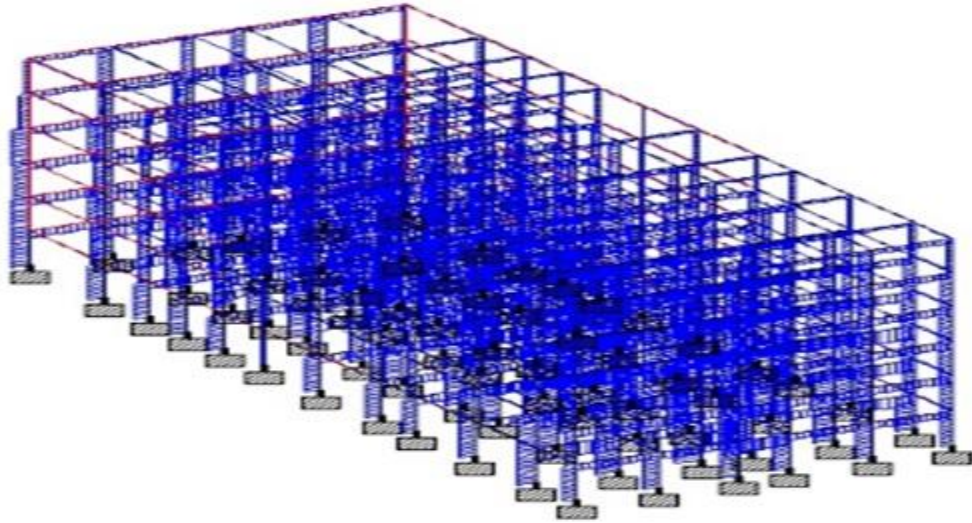


Fig 8 Shear force diagram

Axial Force Diagram

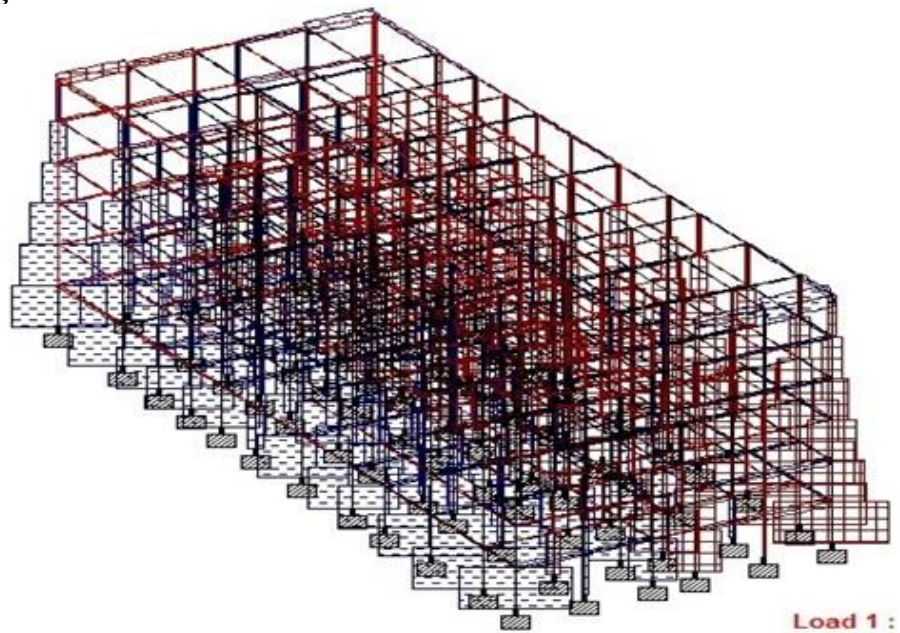


Fig 9 Axial force diagram

Deflection Diagram

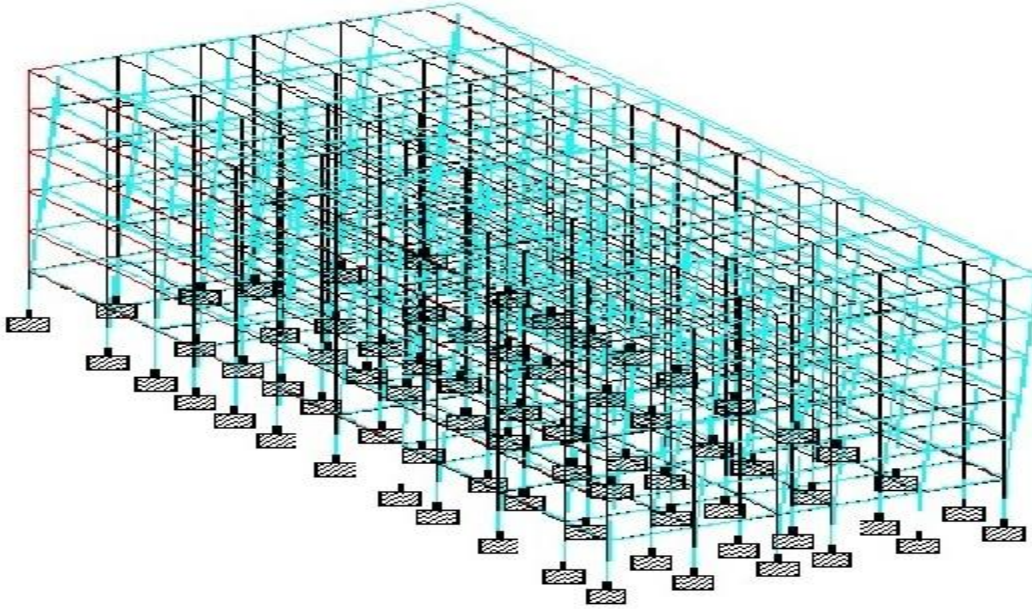


Fig 10 Deflection diagram

Build – Master

Build master is the flagship software of Ensoft. It is a complete package for RCC building Analysis, Design, Drawing and Estimation. Data for building is entered floor wise, in the form of graphical sketch. Program will generate 3D frame model with earthquake and wind loads. It designs RCC beams and slabs at all levels and also the columns and footings. It generates working drawings of floor plans, design schedules and beam details in DXF format, which can be read by CAD packages. It also estimates quantities of concrete, reinforcement, brickwork, plaster etc., automatically from floor plans without entering data in L×B×D format.

Highlights Of Build-Master

- Single line floor plan input. Auto numbering of beams and slabs.
- Concept of defining building project with floors at different levels.
- Generation 3D space frame model from plans.
- Auto calculation of walls and slab loads on beams.
- Generation of earthquake / wind forces from plans.
- Loading, BMD, SFD and Deflection diagrams.
- RCC design of beams and slabs at all levels, columns and footings.
- Generate RCC plan, Centre line plan, architectural plan.
- 3-D building elevation without any extra efforts.
- Create beam reinforcement details along with sections.
- Bar bending schedule of with diameter wise break- up.
- Quantities of concrete, brickwork, plaster, flooring, formwork.

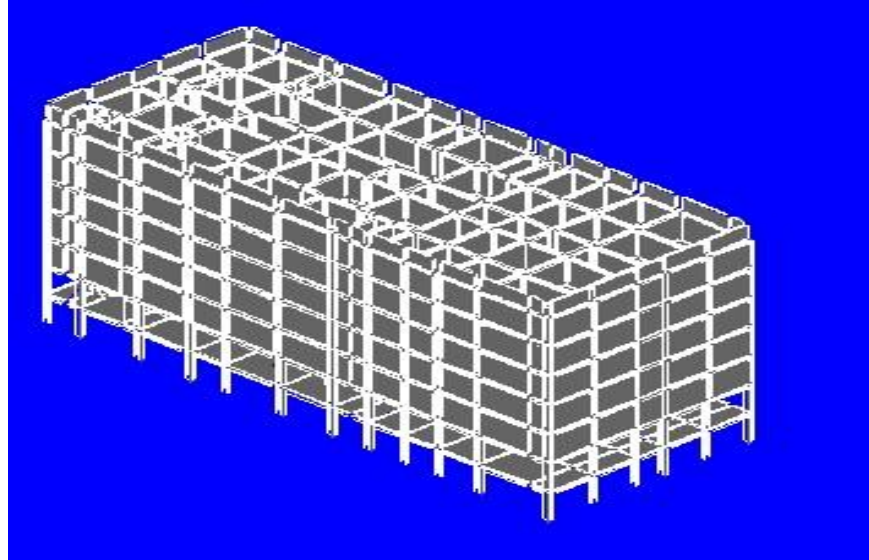


Fig 11 3D elevation in BUILD MASTER

Loading Diadram

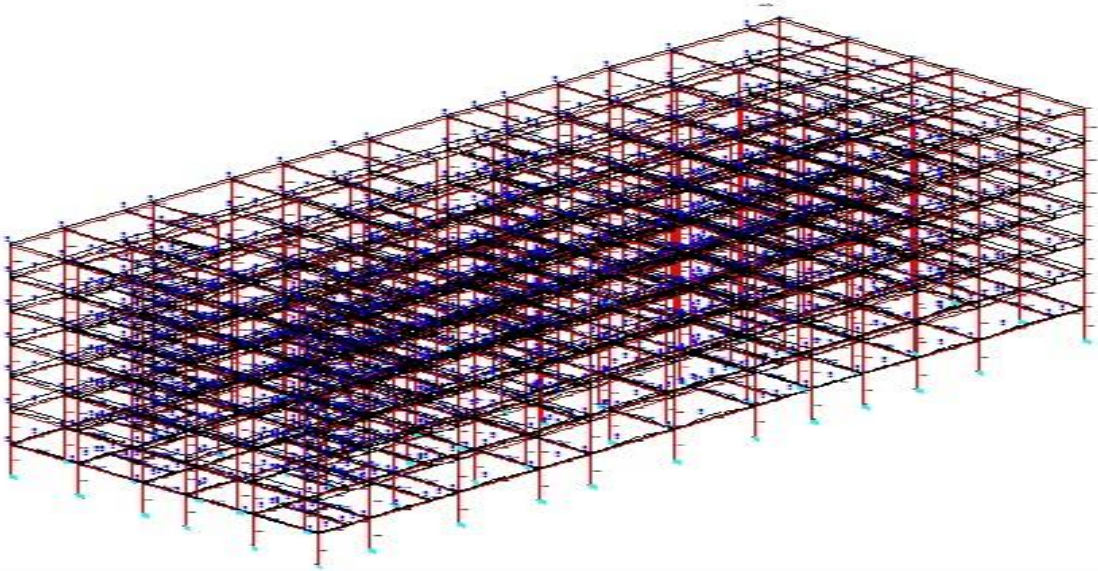


Fig 12 Loading diagram from BUILD MASTER

Bending Moment Diagram

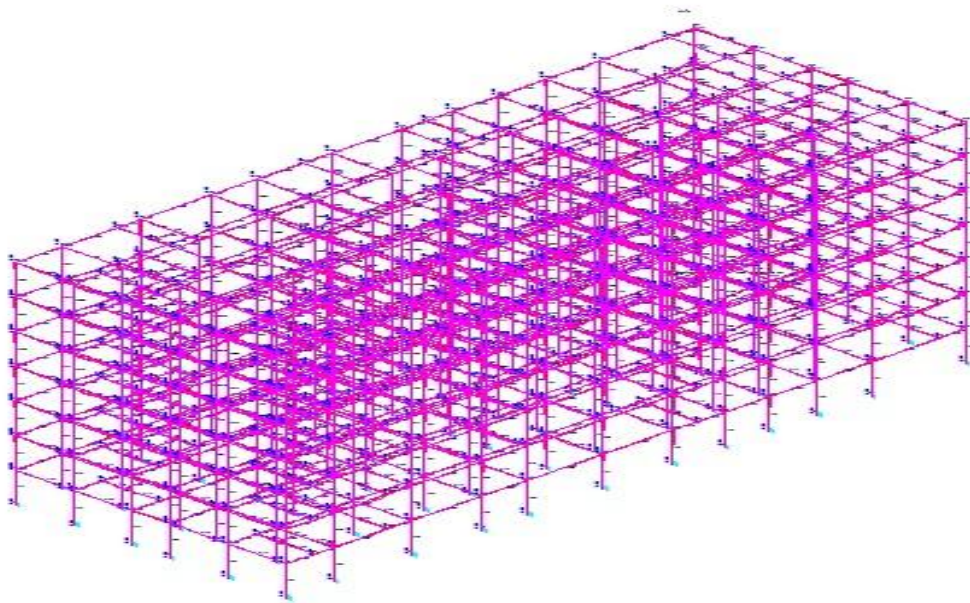


Fig 13 Bending diagram from BUILD MASTER

Shear Force Diagram

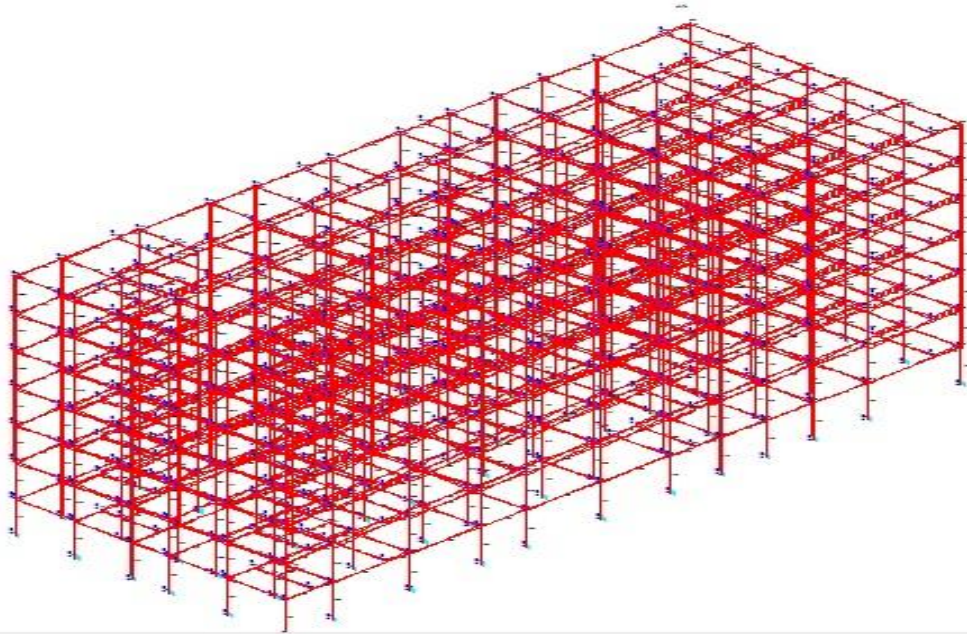


Fig 14 Shear force diagram

Deflection Diagram

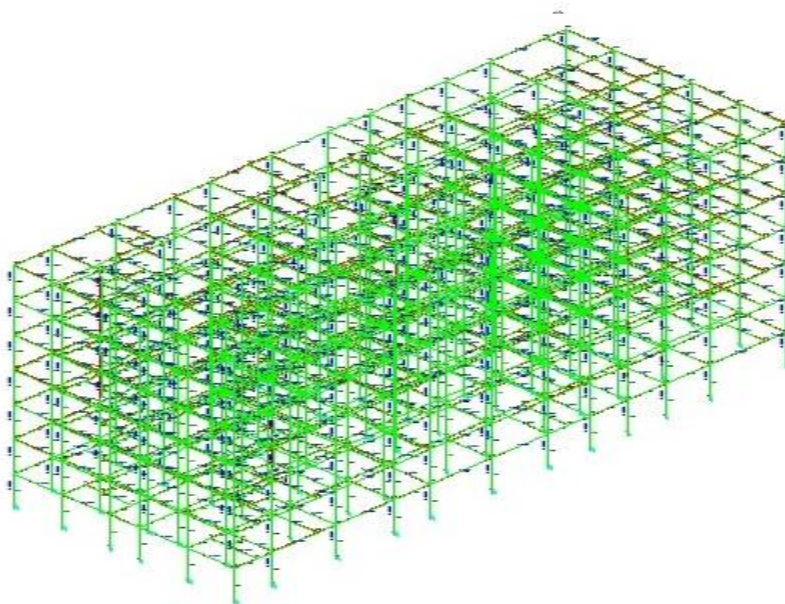


Fig 15 Deflection diagram

IV. COMPARISON OF STAAD PRO AND BUILD MASTER

Table -3 comparisons of STAAD Pro and BUILD - MASTER

S.	Point of	Software	Remark
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No	comparisons	STAAD Pro.	Build Master	
1.	Time	It takes more time.	It takes less time.	Build master is easy to learn as it contains three level of learning's like starter, intermediate, expert.
2.	Loads	Manually load calculations are required and assign loads to the structure.	Loads are calculated by the software itself as per IS 875 codes.	Using Build master makes rectification of the human errors in load calculations
3.	Method of design	Trial and error method i.e. initially properties are given to the members. If any member is failed then change the property of that member.	Automatic mode. Initially property is given to all members, if any one fails for initial property it takes another automatically.	Build master requires basic knowledge of IS 456.
4.	flexibility	User friendly	Learners choice	***
5.	materials	Concrete, steel and for timber structures .	Only for concrete structures.	***
6.	Present day status	Most of the designers are using this software	Not preferred like STTAD	STAAD is more preferred because of the flexibility
7.	Maximum dimensions	For beams depth is 0.6 and for columns the length is 0.65.	For beams depth is .55 and for columns it is 0.55.	***
8.	Maximum diameter of bar	25mm	20mm	***
9.	Slab design	STAAD will not give slab design as per IS code	BUILD MASTER will give slab design also as per IS code.	BUILD MASTER software is designed by Indians.
10.	Steel	191138.651 N	143709.594 N	***
11.	concrete	117.1 m ³	72.98 m ³	***

V. CONCLUSIONS

The study compares the STAAD Pro and BUILD- MASTER software's

- By using these software's, study identify the most preferable one-BUILD-MASTER is the most preferable, because all loads and load combinations are created /generated by the software itself.
- In staad pro it is not possible to design slabs as per Indian standard codes. But in BUILD –MASTER slabs are designed as per Indian standard code.

- STAAD Pro gives the overall quantity of steel and concrete, whereas in BUILD -MASTER quantities of steel and concrete for beams and slabs are given separately.
- By the intensive study of analysis and design of G+5 residential building the economic sections were developed by BUILD - MASTER.
- While comparing the steel and concrete quantity from both the software's , STAAD Pro gives 23.8% of steel and 28.7% of concrete more than BUILD MASTER gives.

REFERENCES

1. *A.P G.O. Ms. No. 119 Municipal Administration And Urban Development Department - Model Building Byelaws 2016 Of Goi – Andhra Pradesh Building Rules, 2017.*
2. *Is: 456 - 2000, Code Of Practice For Plain And Reinforced Concrete.*
3. *Is: 875 (Part-1) – Code Of Practice For Design Loads (Other Than Earthquake) For Buildings And Structures (For Dead Loads).*
4. *Is: 875 (Part-2) – Code Of Practice For Design Loads (Other Than Earthquake) For Buildings And Structures (For Live Loads).*
5. *Is: 875(Part-3) – Code Of Practice For Design Loads (Other Than Earthquake) For Buildings And Structures (For Wind Loads).*
6. *Is: 1893 (Part-1) – Criteria For Earthquake Resistant Design Of Srtuctures (General Provisions And Buildings).*
7. *Rcc Design Manuals Provided By Ensoft Build-Master Software Package.*