3D Printing Design Comparison of Manual and Staadpro of G+3 Residential Building

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Abstract: *Design in civil engineering is related to structures and the civil structural engineers does the structure analysis of the proposed structural building. The software's used for designing and modelling the building are STAADPRO, 3DS MAX. The building area being designed is having area of approximately187.73m^2(15.697m x 11.96m) each floor and total plot area is 426.42m2 (23.15m x 18.42m). By using STAADPRO results and MANUAL results we compared the steel reinforcement of beams, columns and footings. In this project, a small prototype has been created by using Fused Deposition Modelling (FDM) technology through 3D printers (CREALITY CR-X 10-MAX), where the design of the building is taken from the 3DS MAX software in STL format. The dimension of the prototype is (18.6cm x 14.1cm).This project includes 3D printing design, comparision of STAADPRO and manual results of (G+3) residential building.*

Keywords: STAADPRO, AUTOCAD, 3DS MAX, V-RAY, 3D printing

I. INTRODUCTION

As a civil engineer it is important to design a building that satisfy the requirements like strength, economical, ventilation serviceability, comfort, and convenience. **3D printing** is the construction of a three-dimensional object from a CAD model or a digital 3D model. It can be done in a variety. **STAAD**. **Pro** to automate previously manual design tasks and analyses saved nearly 30% in resource hours, lowering project costs. Bentley's structural design.

1.1 Necessity

Due to the development and increase in the population, it is important for the civil engineer to try new technologies and techniques to reduce the workload and increase the efficiency of the work.

1.2 Objective
- To try different civil related software'slike (AUTOCAD, STAADPRO & 3DS MAX).
- To build the buildings using 3d printing machines.

1.3 Layout Planning

The layout area of land is 426.42m^2 (23.15m x 18.42m).The size of plot is187.73m^2 (15.697m x 11.96m) of G+3 residential building. Each flat area is around (6.05m X 10.74m) 63.36m^2.

1.4 Planning Of Built-Up Area

All the rooms in the plan plotted are as per Norms of municipal administration and urban development department.

1.5 Building Plan from the Autocad Software

AutoCAD is a computer-aided design software, which is built by Autodesk. It is the software which is used for designing and drafting. This software allows a user to implement the ideas, product designs and drawing to the required level of technical accuracy, perform rapid design calculation. It admits you to draw and refine or edit in digital 2D and 3D designs

faster and without difficulty than, manual drawing which usually take a lot of time. The civil engineers and architects use the software for the purpose of making plans, elevations, and sections of the building or other projects with accuracy. The software gives easy access to other software's like STAADPRO and 3ds max to simplify the work and more detailing to the work in structural designing and 3d animations and views.
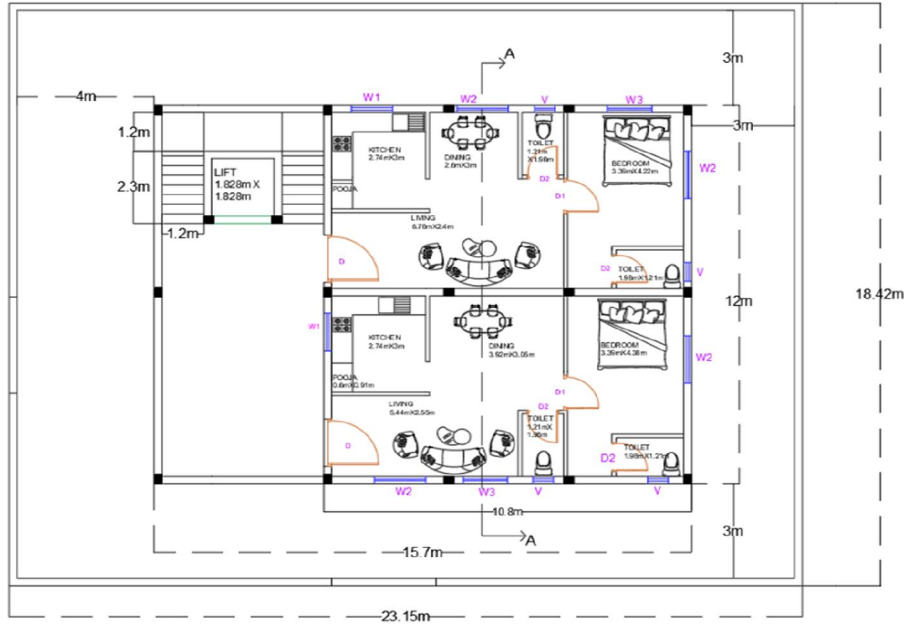

Fig. 1.5: Building plan

II. COMPARISON OFMANUAL AND STAADPRO RESULTS

2.1 Design Specifications

Structural design is carried as per the following R.C.C elements: As per IS:456-2000 & SP16-1978 Reinforcement. Characteristic strength of concrete,

- F_{ck}=25 N/mm^2
- Grade of steel Fy=500 N/mm2(HYSD bars)
- SBC-250 KN/mm^2
- Clear cover to reinforcement bar
- Beams-25mm
- Columns - 40mm
- Slabs-20mm
- Foundations-50mm

2.2 Comparison of Single Reinforced Beam (B84)

- L=3.5m
- DIM:230X300mm
- A_{st} req=640mm^2

Table.2.2: Beam steel reinforcement details

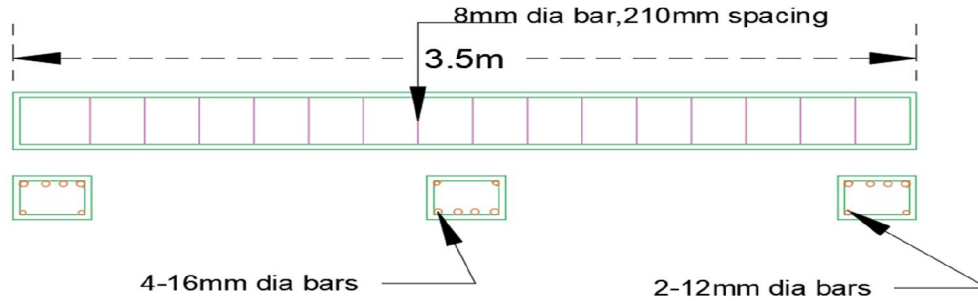| DESCRIPTION	Top. Reinforcement	Bottom. Reinforcement	AREA OF STEEL (mm^2)
MANUAL	2-12Ø	4-16Ø	1030
STAADPRO	3-12Ø	3-12Ø	680

Fig. 2.2: Single reinforced beam

2.3 Comparison of Double Reinforced Beam (B85)

- L=5.8m
- DIM:230X300mm
- $A_{st}req=1220mm^2$

Table 2.3: Beam steel reinforcement details

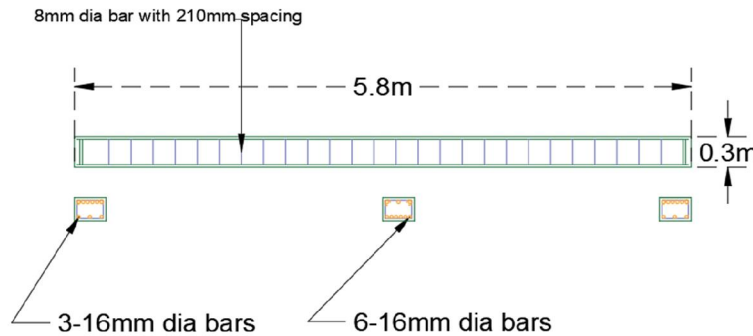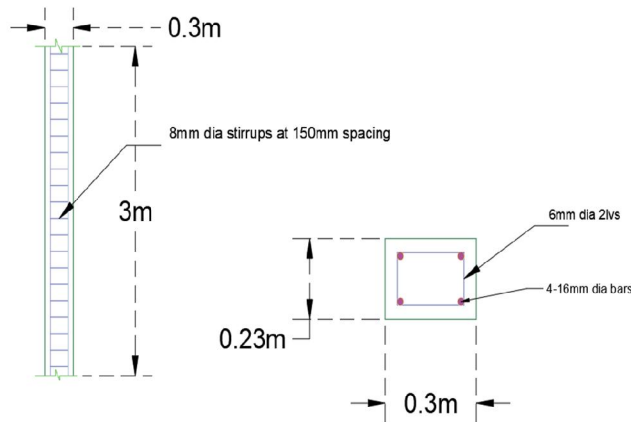| DESCRIPTION	Top. Reinforcement	Bottom. Reinforcement	AREA OF STEEL (mm²)
MANUAL	3-16Ø	6-16Ø	1800
STAADPRO	3-20Ø	5-12Ø	1500

Fig. 2.3: (B) Double reinforced beam

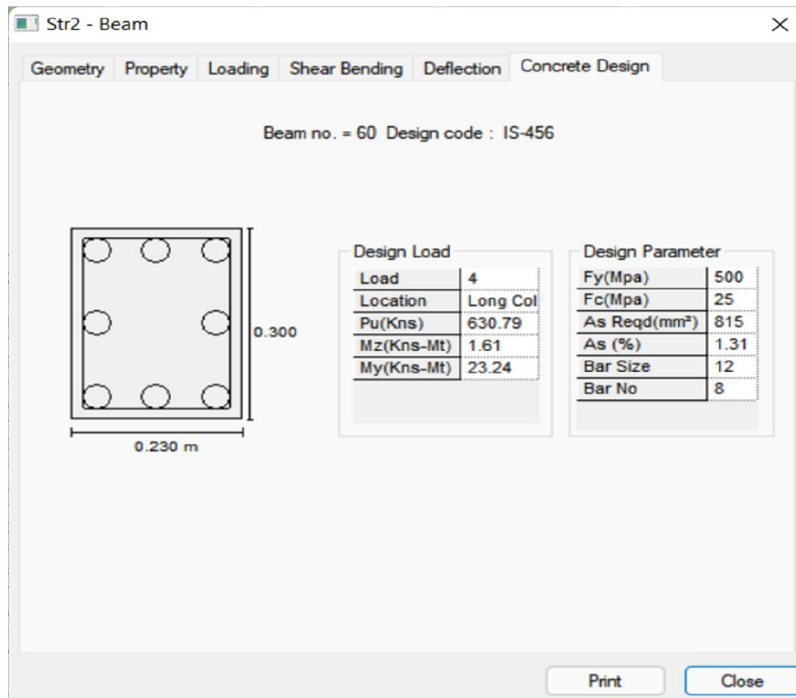### 2.4 Comparison of Short Column (C5)

- L=3m
- DIM:(230X300) mm
- $A_{st}req=690mm^2$

Table 2.4: Column steel reinforcement details

DESCRIPTION	STEEL REINFORCEMENT	AREA OF STEEL (mm²)
MANUAL	4-16Ø	804
STAADPRO	8-12Ø	904

Fig. 2.4: (A) Column reinforcement (MANUAL)
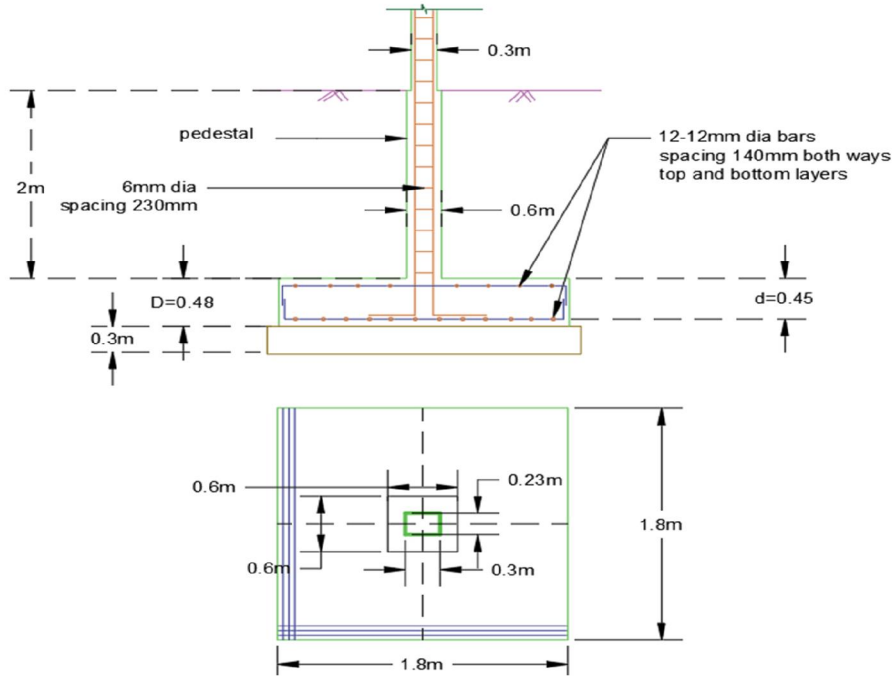
Fig. 2.4: (B) Column reinforcement (STAADPRO)

2.5 Comparison of Isolated Footing

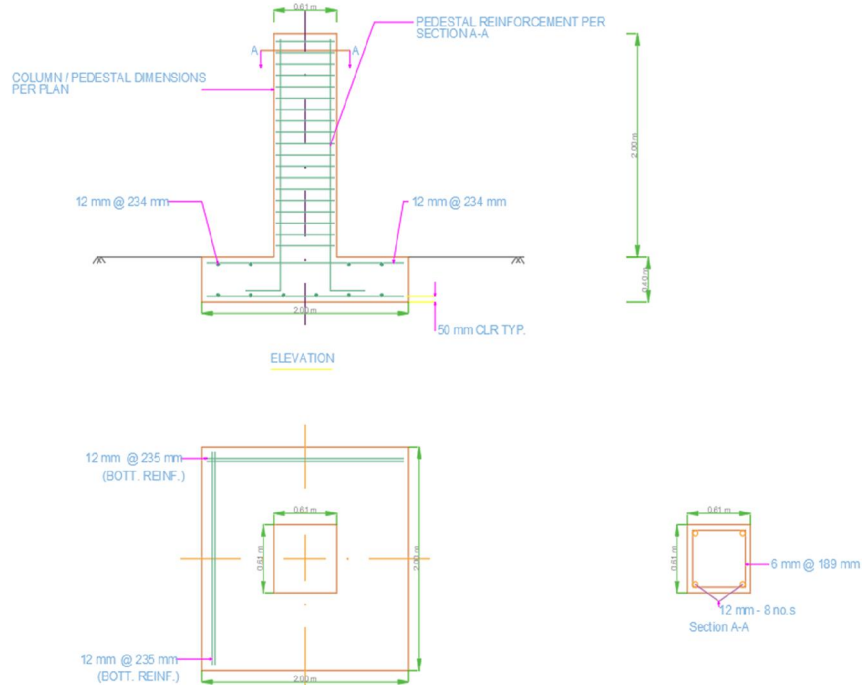- MANUAL FOOTING: (1.8X1.8) m.
- STAADPRO FOOTING: (2X2) m.

Table 2.5: Isolated footing steel reinforcement details

DESCRIPTION	T.M.S.R	T.B.S.R	S.S.T.R	S.S.B.R	STEELAREAm m²
MANUAL	12-12mmØ @140mm spacing	12-12mmØ @140mm spacing	12-12mmØ @140mm spacing	12-12mmØ @140mm spacing	5400

STAADPRO	9-12mmØ @235mm spacing	9-12mmØ @235mm spacing	9-12mmØ @235mm spacing	9-12mmØ @235mm spacing	4100

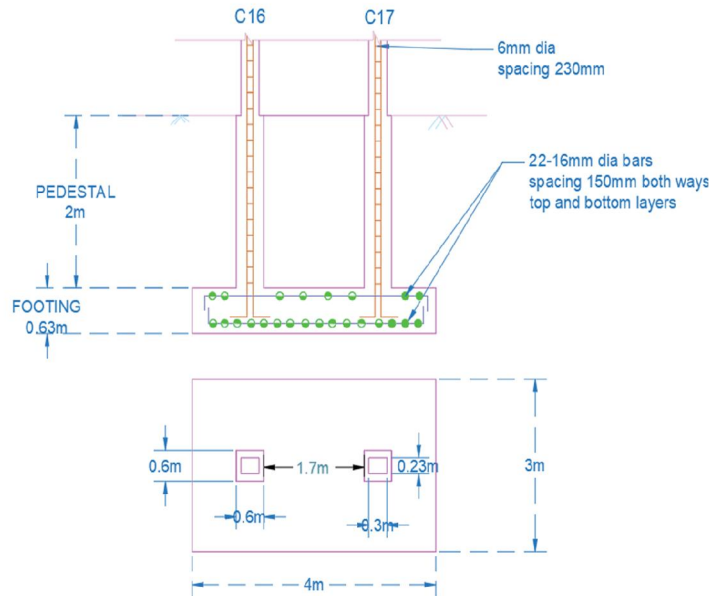**Fig. 2.5: (A) Isolated footing reinforcement(MANUAL).**

Fig. 2.5: (B) Isolated footing reinforcement(STAADPRO).

Impact Factor: 6.252

2.6 Comparison of Combined Footing
**SIZE OF FOOTINGS**

- MANUAL FOOTING: (4X3) m.
- STAADPRO FOOTING: (4.3X2.8) m.

Table 2.6: Combined footing steel reinforcement details

DESCRIPTION	T.M.S.R	T.B.S.R	S.S.T.R	S.S.B.R	STEEL AREA mm²
MANUAL	22-16mmØ @150mm spacing	22-16mmØ @150mm spacing	22-16mmØ @150mm spacing	22-16mmØ @150mm spacing	17684
STAADPRO	14-20mmØ @355mm spacing	22-16mmØ @210mm spacing	22-16mmØ @210mm spacing	22-16mmØ @210mm spacing	17659

Fig. 2.6: (A) Combined footing reinforcement (MANUAL).
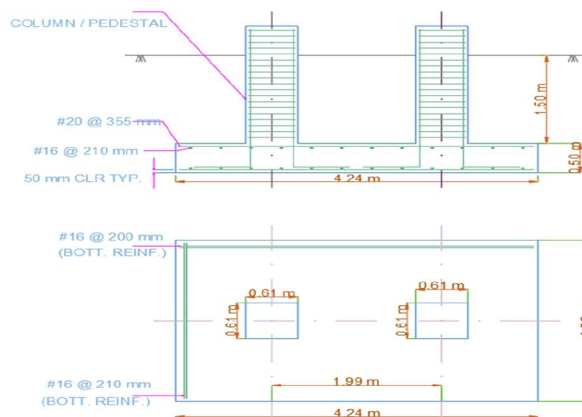
Fig. 2.6: (B) Combined footing reinforcement (STAADPRO).

III. 3D DESIGN AND PRINTING OF G+3 RESIDENTIAL BUILDING

3.1 3DS MAX

3ds Max is broadly used by civil engineers and architects for 3D design visualization. 3ds Max helps the designers to render drawings in photo-realistic visualization that are created using AutoCAD or any other CAD software.3DsMax is a professional 3D modeling and rendering program for design visualization and animation. V-ray is the additional software, or the plugin used for rendering and animation for higher quality.

**Fig. 3.1: (A) Exterior design of G+3 residential building**

Fig. 3.1: (B) Interior design of bedroom

Fig. 3.1: (C) Interior design of hall

3.2 3D PRINTING

3D printing is a process of creating a model or prototype of visualised image, which is created by using different software's. The 3D printing technology in construction building will reduce the construction cost, time and it gives the required architectural output of the building.
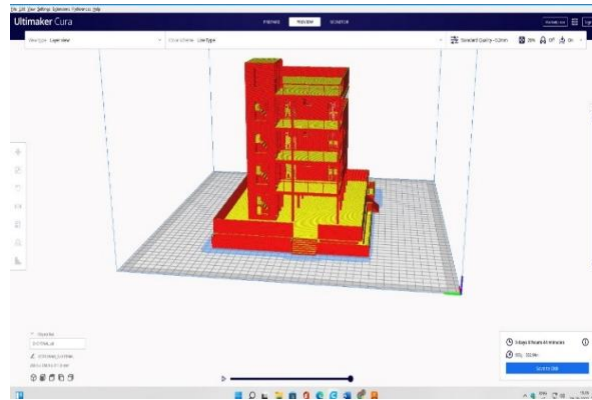
Fig. 3.2: (A) 3D modelling of G+3 residential building

The 3D printing reduces the labour work and material waste. There are different types of machines for 3D printing, and it uses different materials for printing the object required. The material used for printing for this project is PLA, as a prototype of the required building. The printing is done in layers and the dimension of the prototype is (18.6cm x 14.1cm).

Fig. 3.2: (B) Output of the 3D printed building

IV. CONCLUSION

o STAAD Pro is used to calculate the reinforcement needed for any concrete section. The program contains number of parameters which are designed as per IS: 456(2000). The software is helpful in designing the complex structures in the less time than the manual method of designing.

o The design of slab is not done in STAAD PRO, but it is done in manual method.

o General methodology for analyzing the building by both Manual & STAAD Pro methods. We can choose better method for analysis and to design any type of structure.

o The design and development of the G+3 residential building is done through 3DS MAX & additional plugin V-RAY is used for higher quality in 3D walkthrough.

o We made 3D miniature of the building through 3D PRINTING from 3DS MAX output file. The dimension of the prototype is (18.6cm x 14.1cm).

o In future, we can extend this project by comparing the design procedures or by comparing the output results of some other software.

REFERENCES

[1]. IS 456(2000), Plain and Reinforced Concrete - Code of Practice Bureau of Indian Standards Manak Bhavan. 9 Bahadur Shah Zafar Marg New Delhi.

[2]. IS 800(2007) , General Construction Of Steel Bureau of Indian Standards Manak Bhavan. 9 Bahadur Shah Zafar Marg New Delhi.

[3]. IS 962 (1989): "ARCHITECTURAL AND BUILDING DRAWINGS" Code of Practice Bureau of Indian Standards Manak Bhavan. 9 Bahadur Shah Zafar Marg New Delhi.

[4]. IS 6403 (1981): "SOIL BEARING CAPACITY OF SHALLOW FOUNDATION Code of Practice Bureau of Indian Standards Manak Bhavan. 9 Bahadur Shah Zafar Marg New Delhi.

[5]. SP16 (1980): DESIGN AIDS FOR REINFORCEMENT CONCRETE" Code of Practice Bureau of Indian Standards Manak Bhavan. 9 Bahadur Shah Zafar Marg New Delhi.

[6]. IS 1893 PART 1 2002"LOAD COMBINATIONS" Code of Practice Bureau of Indian Standards Manak Bhavan. 9 Bahadur Shah Zafar Marg New Delhi.

[7]. IS 875-2 (1987): "LIVE LOAD, ROOF LOAD" Code of Practice Bureau of Indian Standards Manak Bhavan. 9 Bahadur Shah Zafar Marg New Delhi.

[8]. IS 1893 (2005): "SEISMIC LOAD" Code of Practice Bureau of Indian Standards Manak Bhavan. 9 Bahadur Shah Zafar Marg New Delhi.

[9]. IS 875-3 (2007): "WIND LOAD" Code of Practice Bureau of Indian Standards Manak Bhavan. 9 Bahadur Shah Zafar Marg New Delhi.

[10]. G.O.Ms.No.168 - ANDHRA PRADESH (2012).

[11]. GHMC regulations "set back rules for non – high rise residential buildings".

[12]. Design of R.C.C structural elements by S.S. Bhavikatti.

[13]. S. Ramamrutham, "Design of Reinforced Concrete Structures Dhan pat Rai Publishing Company, 2012

[14]. V. Varalakshmi, G. Shiva Kumar and R. Sunil Sarma, Analysis and Design of G+5 residential building, mini project report, Marri Laxman Reddy Institute of Technology and Management, Dundigal, Hyderabad, India-2014.

[15]. Design of beams, columns, slab, and footing BOOK, "Limit state design" by "Dr. B. C. Pumnia", "A. K. Jain".

[16]. Aspects, Prospects and Sizes, "National building code of India".