Volume 3, Issue , 2024
PP 451-463

International Journal of Futuristic Innovation in Arts, Humanities and Management (IJFIAHM)

SOFTWARE-ASSISTED MULTI-STOREY HOSPITAL BUILDING ARCHITECTURAL AND STRUCTURAL DESIGN

Dhiraj Chaudhari
dhirajchaudharir@gmail.com
Department of Civil Engineering
Shri Sai College of Engg. & Tech., Bhadrawati,
Dist. Chandrapur 442902 (M.S.), India

Shreyas R. Shende
shendeshreyas7@gmail.com
Department of Civil Engineering
Shri Sai College of Engg. & Tech., Bhadrawati,
Dist. Chandrapur 442902 (M.S.), India

Shivani A. Khanke
shivanikhanke24@gmail.com
Department of Civil Engineering
Shri Sai College of Engg. & Tech., Bhadrawati,
Dist. Chandrapur 442902 (M.S.), India

ABSTRACT

As everyone is aware, there are generalizations about civil engineering all around the world. Furthermore, it has been widely disseminated recently.In India, the concept of civil engineering is important to development. Building components like beams, columns, slabs, etc. must be able to be analyzed and designed by civil engineers. Many building projects have recently been started in Padoli village, which has led to an increase in the population of the community. To build the Hospital Building, we have selected an 852.057 sq. m. construction site. The plan for the location of the building and some of its components were created and we made the decision to design the layout of a G+4 hospital building,we used Revit and AutoCAD 2D software for planning. We utilized STAAD Pro software to analyze and design the structure's components after compiling all of its details. To determine loads of different sections at different storeys, we have taken into consideration the Indian Standard Codes. We concluded from the data that almost all of the structural elements passed the shear forces, deflection, and bending moment tests that were conducted on them. The list of rejected segments was displayed by STAAD Pro software, and a more suitable segment was selected.Following a repeat analysis with immediate results, we designed a new beam cross-section with dimensions of 230 mm by 450 mm. Construction of this building is possible up to G+8 storeys.

Keywords: Hospital Building, AutoCAD, Revit, STAAD Pro, Architecture, Design

INTRODUCTION:

This study aims to investigate and assess a multi-storey hospital in Padoli, near the Kanda Petrol Pump (Chandrapur District). Architectural Planning is important for the design of the layout and elevation of the building. The structural design of the building should ensure that it can be safely supported and that its performance and structural integrity are maintained without experiencing undue movement or deformation, which could lead to the wear and tear or failure of structural elements such as fixtures, fittings, partitions, or other components. The widely used structural analysis and design program STAAD Pro allows engineers to model, analyze, and design complex structures.

The project entails analyzing a G+4 storey structure for different load combinations using STAAD Pro. Plans, elevations, and sections can be instantly revised, and AutoCAD and Revit are also used for scheduling, sketching, sharing, and visualizing with tools. The frame of the structure is composed of several storeys and bays. A multi-storey, multipaneled frame is a complex intermediate structure. The design of the G+4 story structure has begun. The columns on the bottom level are 450 mm by 600 mm in size, and the columns on the second through fourth floors are 370 mm by 500 mm. The beams are 600 mm by 300 mm in size.

The structure is subject to loads that are applied from the sides and the top. A dead load is made up of structural elements like beams, columns, slabs, etc., and a live load makes up the vertical load. The building is engineered for dead load, live load, and wind load, according to IS 875, since wind forces make up the horizontal load.

Using STAAD Pro for hospital construction analysis and design has numerous benefits. The features of the software allow for the creation of intricate 3D models, analysis of the behavior of the structure under various loads, performance evaluation, and efficiency and safety optimization in design. By leveraging STAAD Pro's capabilities, we can ensure that the hospital building meets all necessary structural requirements and provides a safe and stable environment for patients, staff, and equipment.

1. **Overview**

The Chandrapur district includes the village of Padoli. If a hospital is built here, people won't have to travel far to Chandrapur. As a result, we have decided to design and evaluate the hospital that will be built near Padoli. The hospital's total size is 852.057 square meters, measuring 30 by 55 meters. Every facility required for a hospital building is in place. All of the components, including the slab, beams, columns, and footing, have been analyzed using STAAD Pro.

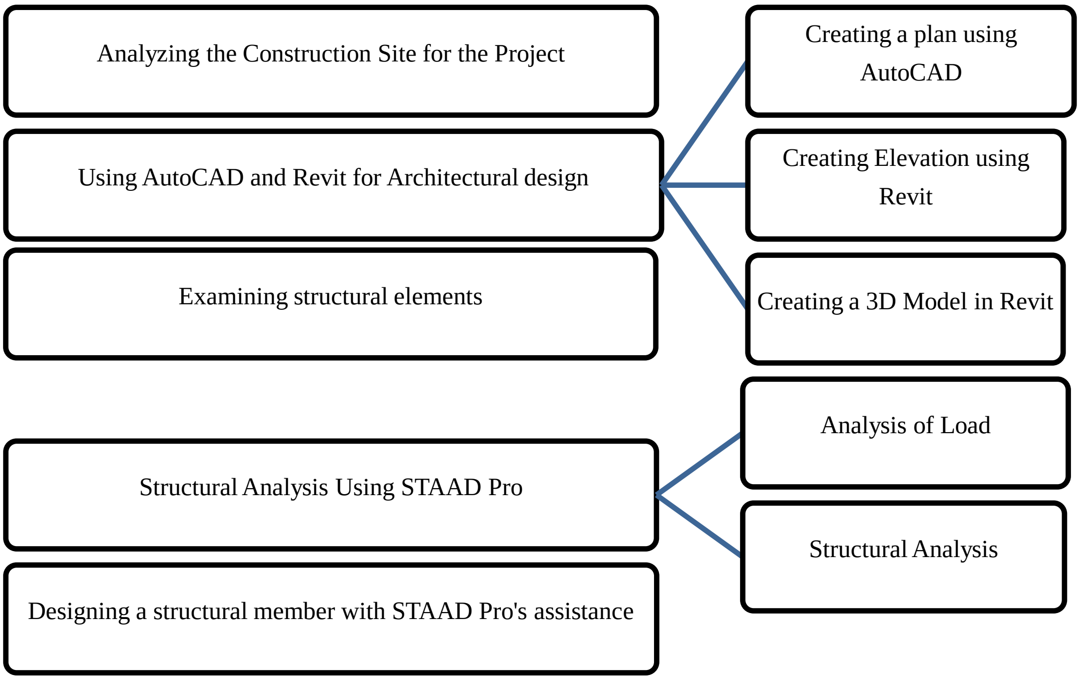
2. Objective

1. TocreatethemodelinAutoCAD.
2. Tocreatea 3DmodelinRevit
3. To examine a building's structural design. (Inside STAAD Pro)
4. To design the building's structure. (Inside STAAD Pro)

EXAMINING THE BUILDING LOCATION:

Construction projects intended for commercial use are typically larger in scope than those intended for residential use. They could include new construction, remodeling, and extension. A range of locations, including hotels, restaurants, retail stores, and office buildings, are home to commercial projects. Commercial projects often require the expertise of licensed general contractors due to their complexity. Drainage was accomplished with the use of Hume Concrete pipes. Given that our construction site is situated in a hot and humid area, hospital design ought to employ appropriate theories and methodologies to achieve the objectives of energy conservation and passive design. In light of these ideas and the necessity for patient care, this study has examined the general layout, utilization of the surrounding environment, and humanization of hospital architecture. Based on a significant amount of research and projects, the study has provided several recommendations for lowering energy use in hospital design.

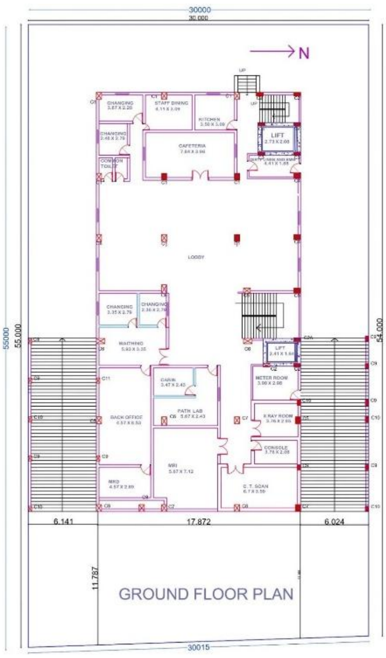
METHODOLOGY:



ARCHITECTURAL DESIGNIN AUTOCAD AND REVIT :

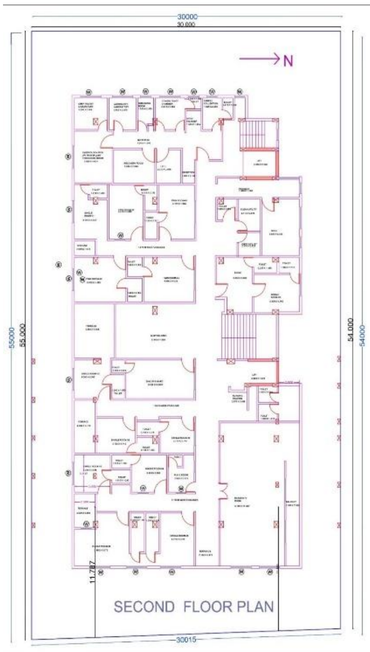
2D MODEL IN AUTOCAD SOFTWARE

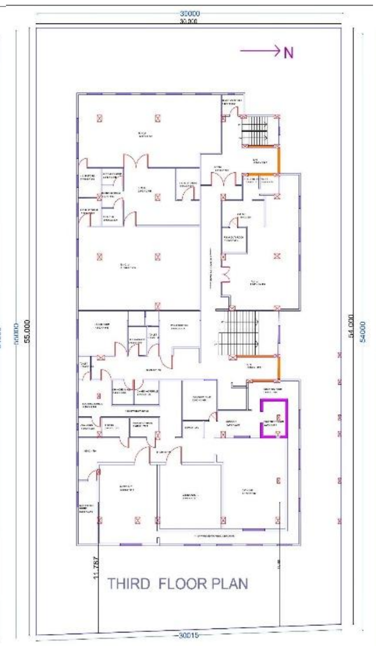
The Plans of the Ground floor to the Fourth Floor of the Multi-storey Hospital Building are shown below

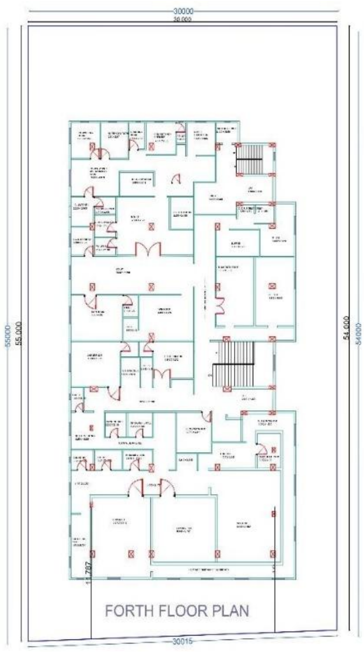


Plan 1: Ground Floor

Plan 2: First Floor







Plan3: Second Floor Plan4: Third Floor Plan5: Fourth Floor

ELEVATIONINREVITSOFTWARE

Figure 1: ElevationinREVITSoftware

STRUCTURAL DESIGN :

We investigated and designed a four-story hospital building as part of our project. Its measurements are 18 meters in height, 37 meters in length, and 18 meters in width. The total built-up area of the building is 833.87 m². The primary steel grade is FE 500, and the concrete grade used was M25. Table No. 1 provides the structure's geometry.

Table No. 1: Details of Floors

Count of Levels	G+4
Ground floor's Height	5.2 m
Each Floor's Height,excluding the ground floor	3.2 m
Height of the structure	18 m

Column and Beam's Design:

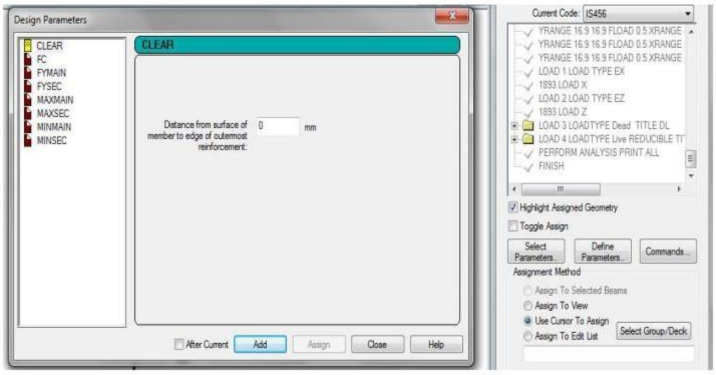


Figure 2: Input Window for Parameter

We used the IS 456 2000 code for building design to specify the material grade. Thus, the column's clear cover measures 0.04 meters, while the beam's is 0.025 meters. The F_c compressive strength of M25 is 2500 KN/sq.m. The main reinforcement, Fe 500, has an F_Y main yield strength of 500000 KN/sq.m. For slab, it is employed in both directions. Then, give a maximum reinforcement bar size of 60 mm and a minimum reinforcement bar size of 12 mm. Next, arrange the reinforcement in two faces distributed about a minor axis using RFACE. Finally, assign the steel requirement for the entire structure to TRACK 1 + RFACE. This completes the secondary yield strength of Fe 500.

Subsequently, instruct them to design columns, beams, and takeoff before sending them on a final run for analysis. Once the entire structure has been analyzed and designed, we must ensure that the output, result, warning, errors, etc.

Even with the use of Excel sheets, performing analytical calculations for columns in daily design practice is very time-consuming. The FEA is significant in this situation. A wide range of tools are available in STAAD for designing structural members as separate parts of a structure that has been studied. The column's length, the loading circumstances, the boundary restrictions, the steel and concrete grades, etc. are the determining factors. M25 grade concrete and Fe500 grade steel have been used for modeling.

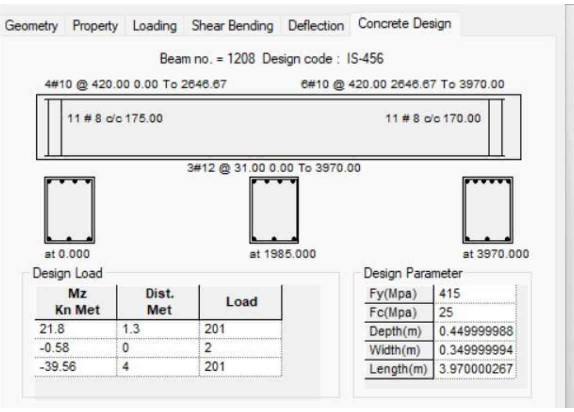


Figure 3: Beam Design

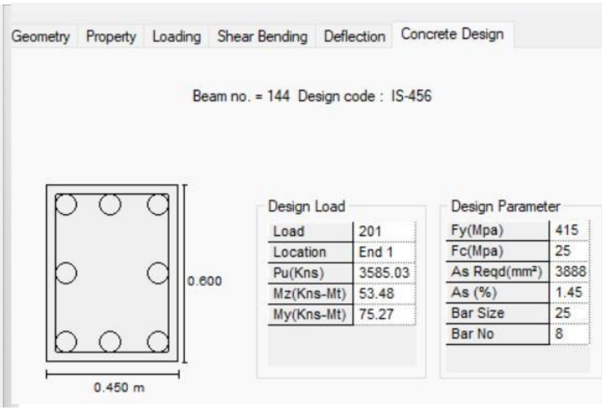


Figure 4: Column Design

Foundation Design:

We can do effective foundation design and documentation with STAAD Pro's assistance by utilizing plant-specific design tools, multiple design codes with both metric and Indian bar sizes, design optimization, and automatically generated drawings.

Before designing the footings, we must ascertain the column reactions, as illustrated in Figure 5. These responses were then sent to STAAD Foundation Advanced to calculate the area needed for the footing and the amount of steel that was needed. If two separate footings overlap, give one combined footing.

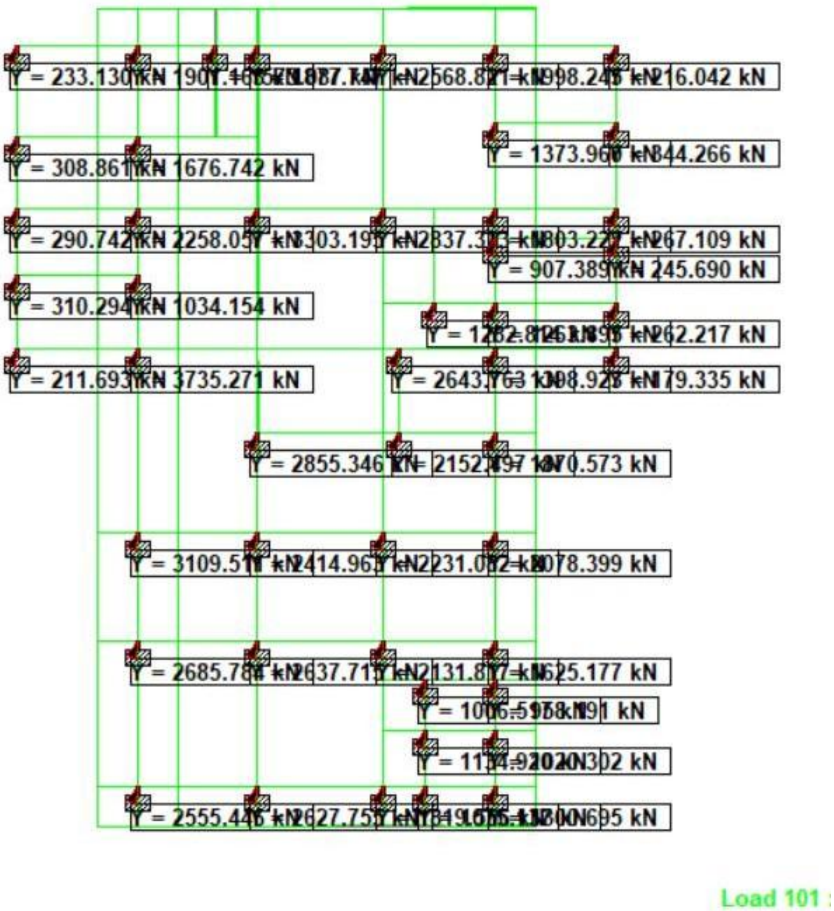


Figure 5: Column Reaction

RESULT:

The building failed when we applied load conditions to the beam's design of 230 mm by 350 mm cross-section, to counter this scenario, we will apply a beam cross-section of 230 mm by 450 mm, making the structure safe. Thus, we conclude that a beam size of 230 mm by 450 mm will be used.

Job Information

	Engineer	**Checked**	**Approved**
Name:			
Date:	24-Apr-23		

StructureTypeSPACEFRAME

NumberofNodes	529	Highest Node	587
Numberof Elements	1032	HighestBeam	1248

Numberof BasicLoad Cases	9

NumberofCombinationLoad Cases	2

This printout contains information for the Whole Structure

The load case results are included in this printout:

Type	L/C	Name
Primary	1	SELFWEIGHT
Primary	2	WALLLOAD
Primary	3	SLAB DL
Primary	5	SLABLL
Primary	6	ROOFLL
Primary	51	TOTALDL
Primary	52	TOTAL LL
Primary	7	WLX
Primary	8	WLZ
Combination	101	1(DL+LL)
Combination	201	(1.5DL+1.5LL)

PrimaryLoadCases

Number	**Name**	**Type**
1	SELF WEIGHT	Dead
2	WALLLOAD	Dead
3	SLAB DL	Dead
5	SLABLL	Live
6	ROOF LL	Live
51	TOTALDL	Dead
52	TOTALLL	Live
7	WLX	Wind
8	WLZ	Wind

CombinationLoadCases

Comb.	CombinationL/CName	Primary	PrimaryL/C Name	Factor
101	1(DL+LL)	51	TOTALDL	1.00
		52	TOTAL LL	1.00
201	(1.5DL+1.5LL)	51	TOTALDL	1.50
		52	TOTAL LL	1.50

WindLoadDefinition:Type1

Intensity (N/mm2)	Height (m)
0.001	10.000
0.001	15.000
0.001	20.000

Exposure Factor	Range	Nodes/HeightRange (m)
0.900	Nodes	6-54, 64 - 161, 163 -182,187 -194, 201-210, 212 - 231,
		236-243, 250 -259, 261-280,285 -292, 299 -308, 310 - 329,
		334 -341, 348 –587

SELFWEIGHT:Self-weight

Direction	Factor	AssignedGeometry
Y	-1.000	ALL

WALLLOAD:BeamLoads

Below shown are some of the Reactions on several Beams

Beam	Type	Direction	Fa	Da (m)	Fb	Db	Ecc. (m)
388	UNIkN/m	GY	-14.000	-	-	-	-
389	UNI kN/m	GY	-14.000	-	-	-	-
390	UNI kN/m	GY	-14.000	-	-	-	-
391	UNI kN/m	GY	-14.000	-	-	-	-
392	UNI kN/m	GY	-14.000	-	-	-	-
393	UNI kN/m	GY	-14.000	-	-	-	-
394	UNI kN/m	GY	-14.000	-	-	-	-
395	UNI kN/m	GY	-14.000	-	-	-	-
396	UNI kN/m	GY	-14.000	-	-	-	-
397	UNI kN/m	GY	-14.000	-	-	-	-
398	UNI kN/m	GY	-14.000	-	-	-	-
399	UNI kN/m	GY	-14.000	-	-	-	-
400	UNI kN/m	GY	-14.000	-	-	-	-
401	UNI kN/m	GY	-14.000	-	-	-	-
402	UNI kN/m	GY	-14.000	-	-	-	-
403	UNI kN/m	GY	-14.000	-	-	-	-
404	UNI kN/m	GY	-14.000	-	-	-	-
405	UNI kN/m	GY	-14.000	-	-	-	-
406	UNI kN/m	GY	-14.000	-	-	-	-
407	UNI kN/m	GY	-9.000	-	-	-	-
408	UNI kN/m	GY	-9.000	-	-	-	-
409	UNI kN/m	GY	-9.000	-	-	-	-
410	UNI kN/m	GY	-9.000	-	-	-	-
411	UNI kN/m	GY	-9.000	-	-	-	-
412	UNI kN/m	GY	-9.000	-	-	-	-

SLABDL:FloorLoads

Load (N/mm^2)	MinHt. (m)	MaxHt. (m)	MinX (m)	MaxX (m)	MinY (m)	Max Y (m)
-0.004	3.200	18.000	-	-	-	-

SLABLL:FloorLoads

Load (N/mm^2)	MinHt. (m)	MaxHt. (m)	MinX (m)	MaxX (m)	MinY (m)	MaxY (m)
-0.002	3.200	14.800	-	-	-	-

ROOFLL:FloorLoads

Load (N/mm^2)	MinHt. (m)	Max Ht. (m)	MinX (m)	MaxX (m)	MinY (m)	Max Y (m)
-0.002	14.800	18.000	-	-	-	-

WLX:WindLoading

Direction	Type	Factor
X	1	1.000

WLZ:WindLoading

Direction	Type	Factor
Z	1	1.000

TOTALDL:RepeatLoads

Ref	Name	Factor
1	SELFWEIGHT	1.000
2	WALLLOAD	1.000
3	SLAB DL	1.000

CONCLUSION

Thus, we deduced that nearly all of the structural elements passed the tests that were performed on them, including the bending moment, shear forces, and deflection, based on the comparison result that we obtained from STAAD Pro.The list of unsuccessful elements was displayed by STAAD Pro software, and better sections were selected.It was decided to use the new beam cross-section since it allowed for immediate results from a redo of the analysis and design of the new section.

REFERENCES

1. KunalWailkar,“AnalysisandDesignofaResidentialBuildingByUsingSTAADPro”,InternationalJournalofModernAgriculture,Volume10,Issue2,2021,pg.2543-2550
2. ManojU.Deosarkaret.al,“AnalysisAndDesignofMultistoriedBuildingbyUsingRevit BIM”,

International Journal of Innovative Research in Technology, Volume 8, Issue 1,June2021, pg. 1021-1026

3. MohdZohairet. al, “Analysis and Design of Multistorey Building G+4”, International Journal of Advance Research, Ideas, and Innovations in Technology, Volume 4, Issue 1, 2018, pg. 43-49
4. Pranay R. Girdeet. al, “Analysis And Design Of Multi-Storied Residential Building Using Staad.Pro And Manual Calculations”, International Research Journal of ModernizationinEngineering,Technology,andScience,Volume04,Issue05,May2022, pg. 259-263
5. Shreyas R. Shendeet. al. “A Review on Design of Public Transportation System in Chandrapur City”, Journal for Research, Volume 04, Issue 01, March 2018, pg. 41-47
6. SowravSahaet. al, “Design and Analysis of Multistorey (G+14) Residential Building Using Staad.Pro &Autocad”, International Journal of Scientific Research in Civil Engineering, Volume 5, Issue 3, May-June-2021, pg. 70-82
7. Dr.V.RameshBabuet.al,“DesignandAnalysis(G+5)ofResidentialBuilding”,Journal of EmergingTechnologies and Innovative Research (JETIR), Volume 7, Issue 3, March 2020, pg. 338-341
8. Amanet. Al, “Analysis and design of the multistorey building by using STAAD Pro”, InternationalResearchJournalofEngineeringandTechnology(IRJET)Volume03,Issue 06, June 2016, pg. 887-891
9. C. Priyankaet. al, “Planning, Analysis and Designing of Multi-Speciality Hospital Building”,IJSRD-InternationalJournalforScientificResearch&Development,Vol.6, Issue09,2018,pg.80-84
10. Gayatri B. Tajneet. al. “A Review on Manufacturing Process and Techniques of Hume Concrete”, International Journal of Research Publication and Reviews, Volume 3, Issue 11, November 2022, pg 3285-3287
11. RachanaArunGiriet. al. “A Review on Analysis and Design of Multistorey Hospital Building (G+4)”, International Journal of Research Publication and Reviews, Volume 4, Issue 3, March 2023, pg 4700-4705
12. SushantGuptaet.al,“StructureAnalysisAndDesignOfMultistoreyHospitalBuilding”, https://www.researchgate.net/publication/354058835
13. Sakib Salam Sofiet. al, “Analysis and Design of Multistorey Building by Using Staad Pro Software”, International Journal of Innovative Research in Engineering &

Management (IJIREM), Volume 9, Issue 2, April 2022, pg. 403-407