CERTIFICATE

Certified that the internship report entitled "**DESIGN, AND CONSTRUCTION OF 2-3 STORIED RESEDENTIAL BUILDING"** carried out by me, **CHARAN GM, USN 1RN20CV007,** a bonafide student of Civil Engineering Department, RNS Institute of Technology, in partial fulfillment for the award of the degree of **BACHELOR OF ENGINEERING IN CIVIL ENGINEERING** of the **Visvesvaraya Technological University, Belagavi- 590 018** during the year 2023. To the best of my knowledge, the work reported has not been submitted by me elsewhere for the award of the degree and is not a repetition of the work carried out by others.

ACKNOWLEDGEMENT

I take this opportunity to express our sincere gratitude to the people who have been helpful in the completion of our training. I would like to show our greatest appreciation to the highly esteemed and devoted design staff of SPACE STRUCTURES. I'm thankful to them for their tremendous support and help during the training period.

I express my deep and sincere gratitude to Mr. HEMANTH (managing director), Mr. NAVEEN (managing director) and Mr. Abhishek (Site Engineer) whose guidance and suggestions have contributed immensely to the evolution of our ideas during the training period.

With deep sense of gratitude and respect, I acknowledge the support and guidance extended by my Guide at all stages of internship program.

DECLARATION

I the undersigned solemnly declare that the internship report on “Design analysis and construction of 2-3 Storied Residential Buildings”, is based on my own work carried out during the course of our study under the guidance of the above team assert the statements made and conclusions drawn are an outcome of my work.

I further certify that,

i. The work contained in the report is original and has been done by me under the guidance of my supervisor.
ii. The work has not been submitted to any other Institution for any other degree/diploma/certificate in this university or any other University of India or abroad.
iii. We have followed the guidelines provided by the college in writing the report.

INDEX

INTRODUCTION

SPACE STRUCTURES

Space Structures is a Structural Design Service firm based in Bangalore (Karnataka). Space Structures has a rich history of significant, enduring and well resolved projects since 2013. This legacy continues to be demonstrated in the architectural innovation, diversity and complexity of its consistently awarded work.

The only consultants equipped and trained in the use of first the generation software design, detailing & drawings, BOQ & BBS. Output from structural models can be exported to BIM.

Having a team of young and enthusiastic engineers with excellent academic record and openness with favour for exploring and adopting state-of-the-art technology tools and experienced professional associates and Consultants, gives Space structure an edge over the orthodox competition.

Basically, they are Structural Engineers providing the Structural Engineering Services to various clients. They provide turnkey services to the Industrial clients willing to establish Manufacturing Facilities.

STUDYING THE DRAWINGS

On our first week of internship, residential building drawings were given to read and understand as much as possible.

Drawings were including :-

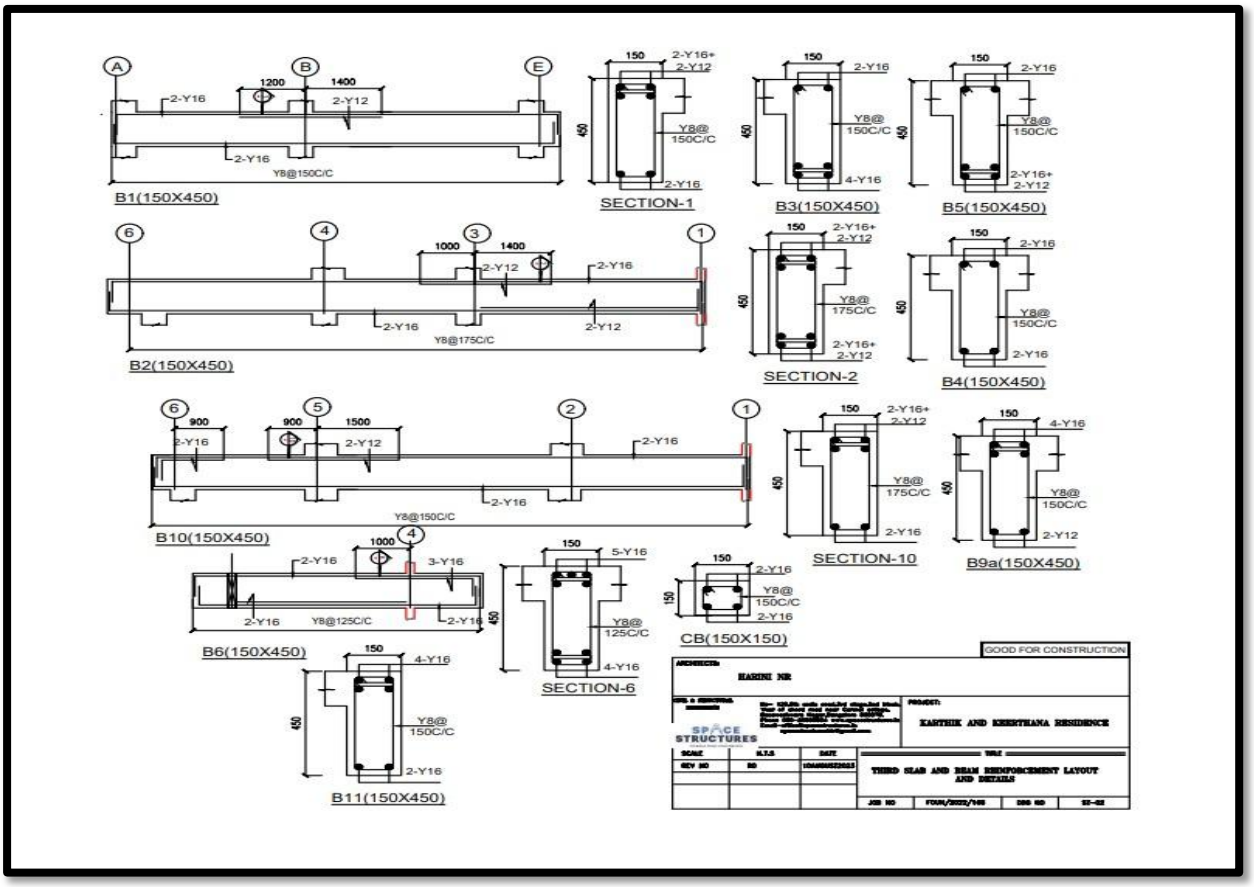
- Beams drawing
- Slabs drawing
- Footing drawing
- Plan and elevation of building

✓ **Beam drawings**

In this drawing we got to know how:-

- Bars are placed at different lengths
- Diameter of bars will vary at negative bending moment and positve bending moment
- Bars are provided in 2 layers at required area to avoid negative moment or to resist high loads
- Stirrups spacing vary in the section of beam
- Stirrups legs vary according to the reinforcement

Here are some of the few drawings which were given to study:-



Fig{1.1}

Detailed drawing of beams of residential building

- ✓ **Slab drawings**

In these drawings we got to know how:-

- ✓ Bars are provided in top and bottom direction
- ✓ Spacing between bars will vary according to different load conditions
- ✓ Cranking of bars and cranking length

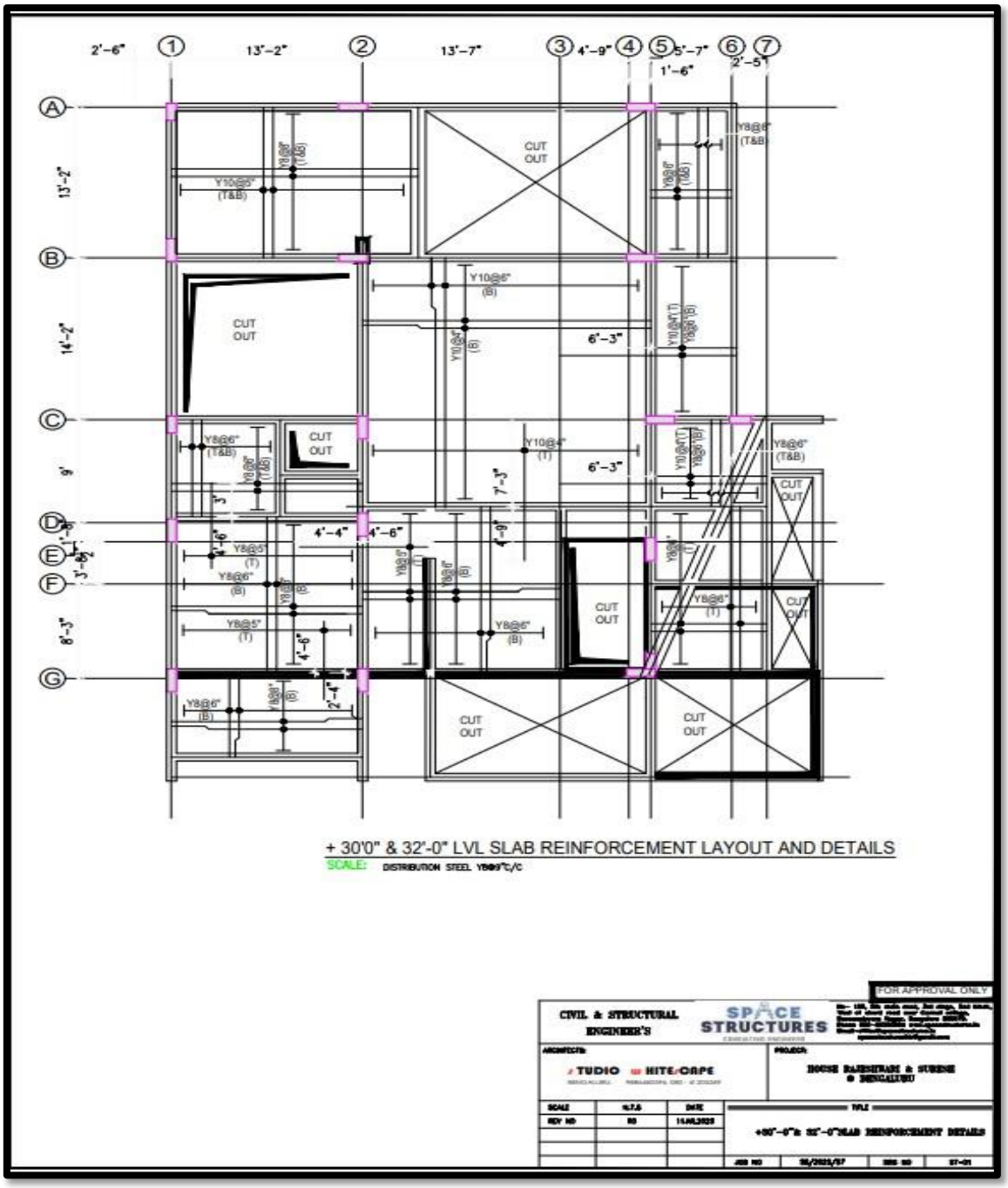


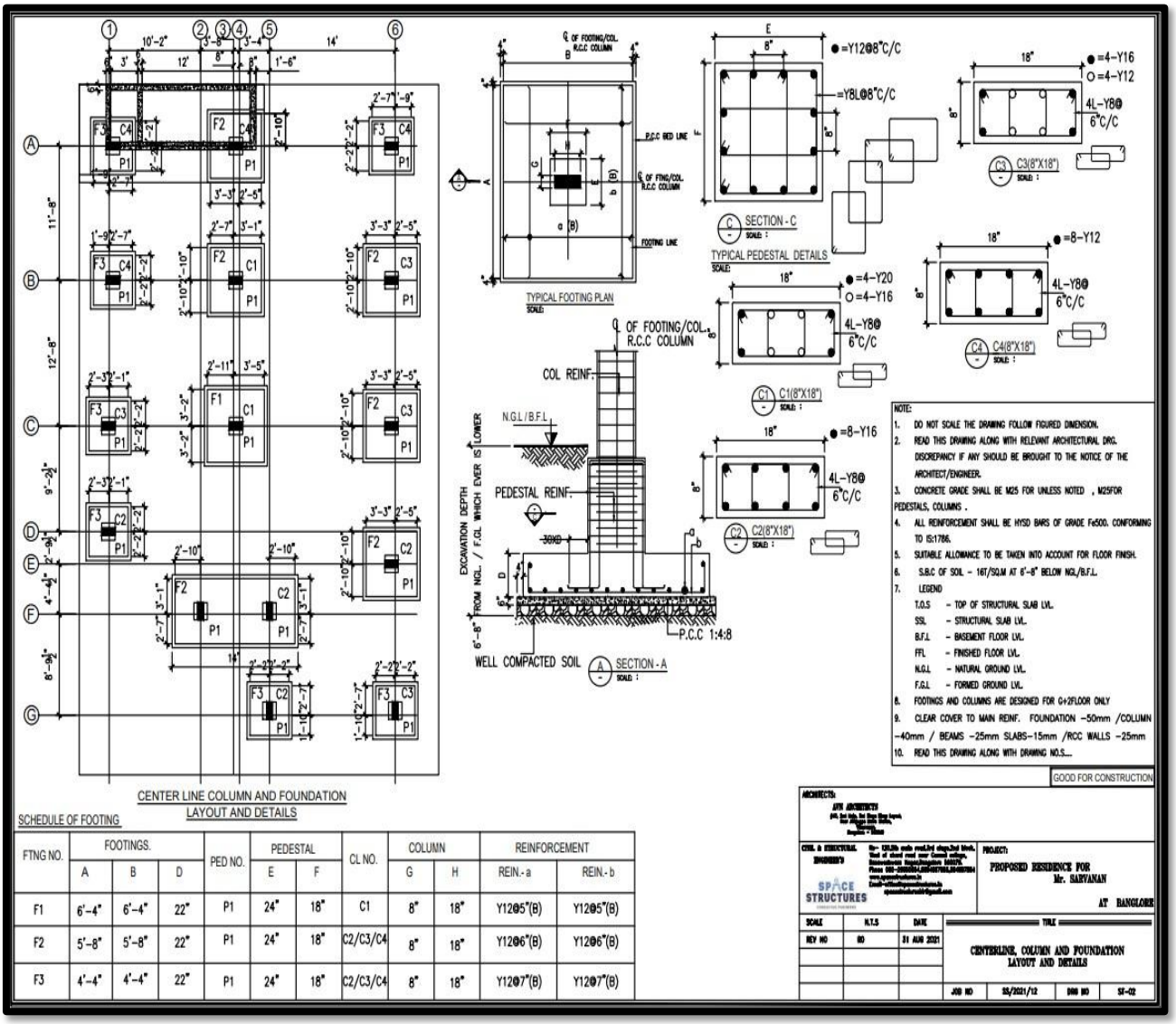
Fig {1.2}

Detailed drawing of slab of resedential building

✓ Footing drawings

In these drawings we got to learn how :-

- Minimum depth should be given for the footing
- Footing depth and size varies according to the loading conditions
- Columns orientation are given depending upon major axis and minor axis.
- Reinforcement details in the footing
- Pedestal requirement upon the footing



FTNG NO.	FOOTINGS.			PED NO.	PEDESTAL		CL NO.	COLUMN		REINFORCEMENT	
	A	B	D		E	F		G	H	REIN.- a	REIN.- b
F1	6'-4"	6'-4"	22"	P1	24"	18"	C1	8"	18"	Y12@5"(B)	Y12@5"(B)
F2	5'-8"	5'-8"	22"	P1	24"	18"	C2/C3/C4	8"	18"	Y12@6"(B)	Y12@6"(B)
F3	4'-4"	4'-4"	22"	P1	24"	18"	C2/C3/C4	8"	18"	Y12@7"(B)	Y12@7"(B)

Fig{1.3}

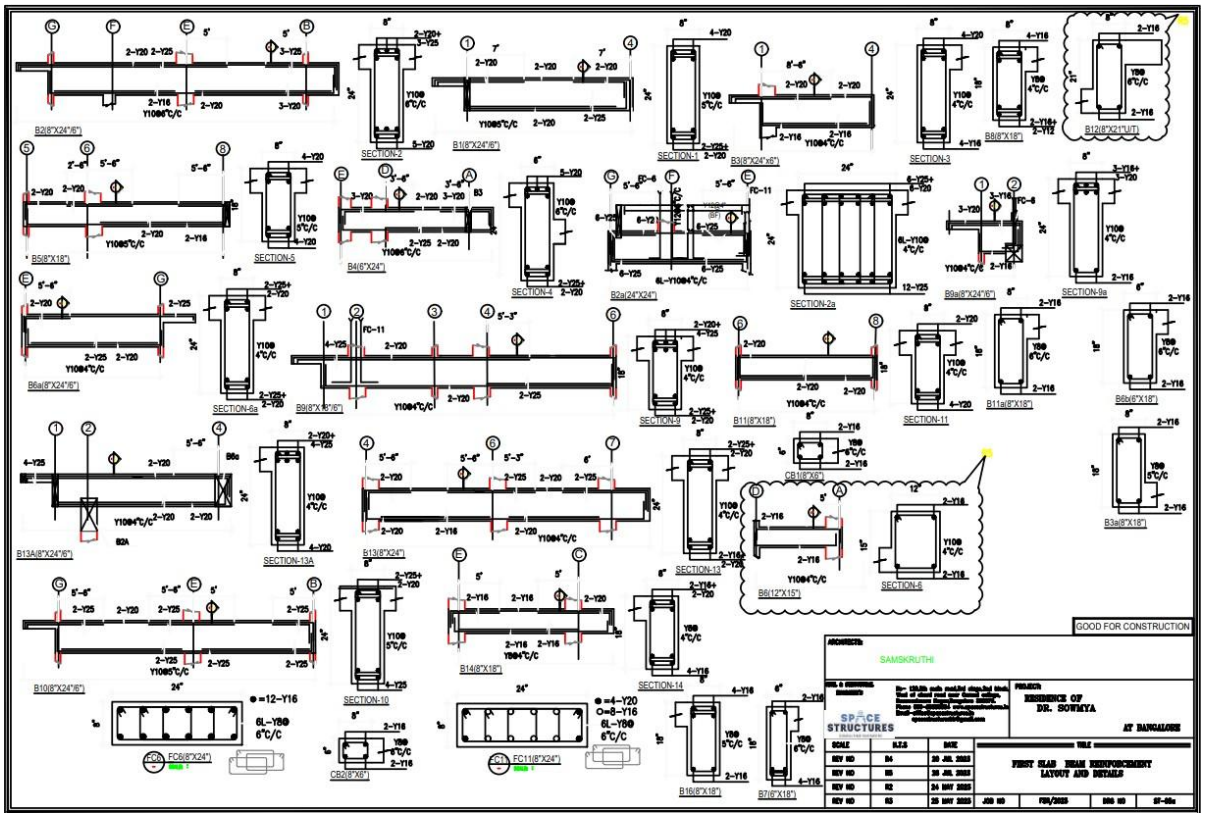
Detailed drawing of footing of residential building

ESTIMATION OF STEEL QUANTITY OF SLAB AND BEAM:-

On our second week estimation of steel quantity for slab and beam were given of ongoing projects

Project was given on residential buildings

- Beam steel quantity estimation



Fig{1.4}

Detailed beam drawing were given to estimate steel quantity

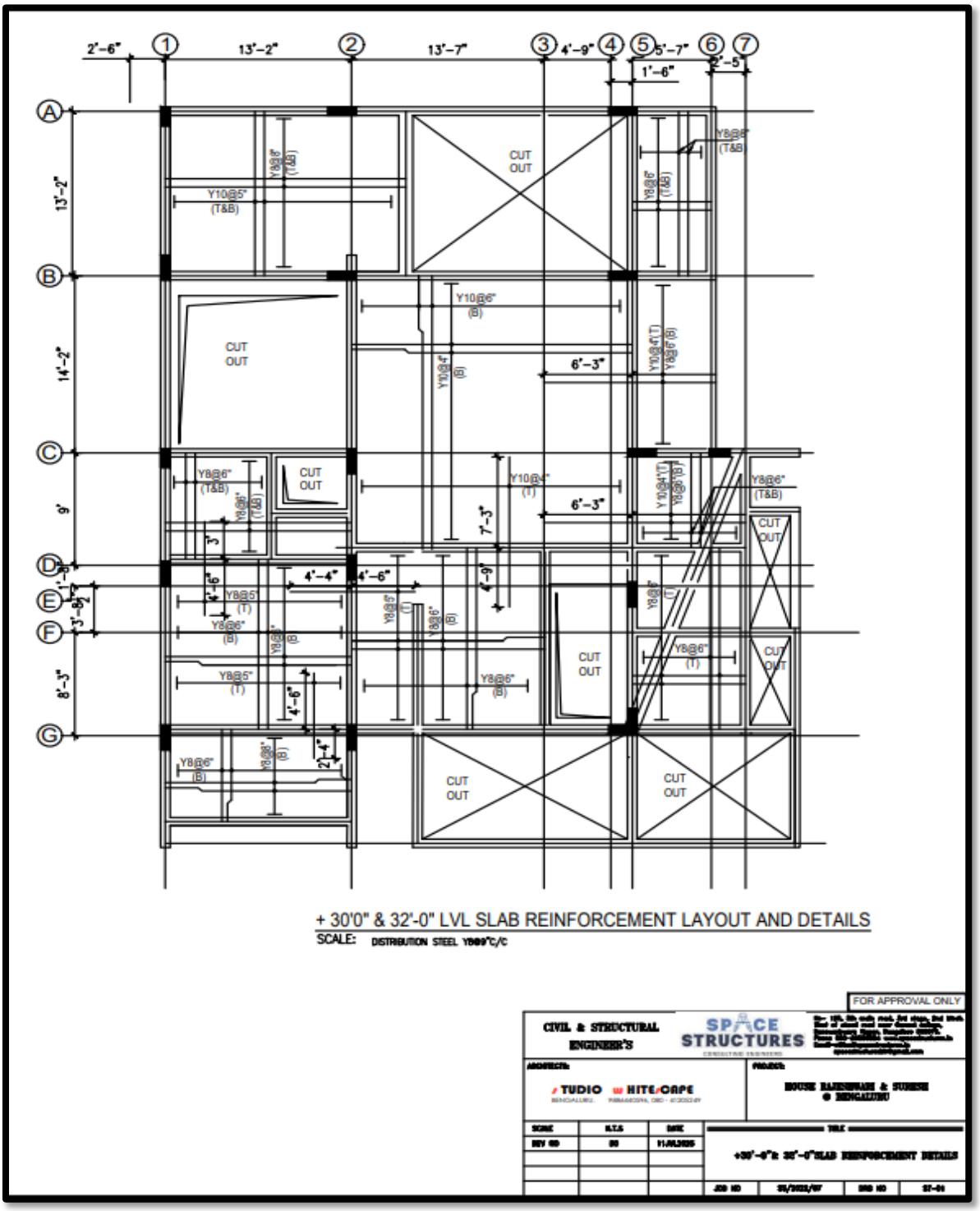
ESTIMATION OF STEEL QUANTIY FOR BEAMS USING MS-EXCEL

		B-3						B-4		
dia	L	NO	CONST	TOTAL IN KG		dia in mm	L	NO	CONST	TOTAL IN KG
16	10	2	1.58	31.6		16	15.2	2	1.58	48.032
	3.24	2	1.58	10.2384			15.2	2	1.58	48.032
	1.73	2	1.58	5.4668			1.2	2	1.58	3.792
	4.86	2	1.58	15.3576			2.5	2	1.58	7.9
			TOTAL	62.6628			3.6	2	1.58	11.376
8mm	1.45	64	0.39	36.192					TOTAL	119.132
						12	0.8	2	0.89	1.424
							3.3	2	0.89	5.874
							3.6	2	0.89	6.408
		B-5							TOTAL	13.706
dia in mm	L	NO	CONST	TOTAL IN KG						
20	10	2	2.46	49.2						
	9.8	2	2.46	48.216		20	2.6	4	2.46	25.584
	1.5	2	2.46	7.38			3.6	2	2.46	17.712
	1.8	2	2.46	8.856					TOTAL	43.296
	3.2	2	2.46	15.744						
	3.66	2	2.46	18.0072		8	1.45	102	0.39	57.681
	4.53	2	2.46	22.2876						
			TOTAL	169.6908						
						B-13				
10	1.45	100	0.61	88.45		dia	L	NO	CONST	TOTAL WT IN KG
						16	6.5	5	1.58	51.35
							6.4	5	1.58	50.56
b-8										101.91

b-8										101.91		
dia	L	NO	CONST	TOTAL WT IN KG								
16	15.1	4	1.58	95.432		20	2.7	5	2.46	33.21		
	1.37	2	1.58	4.3292								
	1.1	2	1.58	3.476		12	2.2	5	0.89	9.79		
	2.5	2	1.58	7.9			3.8	5	0.89	16.91		
				111.1372						26.7		
20	7.4	2	2.46	36.408		8-4L	2.4	65	0.39	60.84		
	2.5	2	2.46	12.3								
				48.708								
12	3.3	2	0.89	5.874								
	3.6	2	0.89	6.408								
				12.282								
8	1.45	101	0.39	57.1155		B-12						
						dia	L	NO	CONST	TOTAL WT IN KG		
						20	8	2	2.46	39.36		
							7.8	2	2.46	38.376		
B-9							2.5	3	2.46	18.45		
dia	L	NO	CONST	TOTAL WT IN KG			1.5	2	2.46	7.38		
20	5.6	2	2.46	27.552			4.7	3	2.46	34.686	Total Weight	
	5.8	2	2.46	28.536						138.252	Dia	weight in kg
	5	2	2.46	24.6							12	89.14
				80.688		10	1.45	80	0.61	70.76	16	401.162
											8	211.82
16	2	2	1.58	6.32							10	208.742
											20	513.8
10	1.45	56	0.61	49.532								

- **Slab steel quantity estimation**

Ongoing resedential building slab was given to estimate the steel quantity



Fig{2.0}

Deatiled drawing of slab reinforcement

- **Estimated steel quantity of given slab details using MS-Excel**

		SLAB-1					SLAB 5			
						dia	L	NO	CONST	TOTAL IN KG
dia	L	NO	CONST	TOTAL IN KG		10	1.2	36	0.61	26.352
10	3.5	42	0.61	89.67			2.8	54	0.61	92.232
	5.2	20	0.61	63.44						
	2.4	42	0.61	61.488						
			t	214.598						
							SLAB 6			
						dia	L	NO	CONST	TOTAL IN KG
	SLAB 2					8	4.9	15	0.39	28.665
dia	L	NO	CONST	TOTAL IN KG			4.9	15	0.39	28.665
10	5.2	22	0.61	69.784						
	3.8	42	0.61	97.356			SLAB 7			
	2.9	35	0.61	61.915		dia	L	NO	CONST	TOTAL IN KG
				229.055		10	2.79	13	0.61	22.1247
							4.5	7	0.61	19.215
							3.4	4	0.61	8.296
	SLAB 3						2.4	24	0.61	35.136
dia	L	NO	CONST	TOTAL IN KG						
8	1.6	21	0.39	13.104						
	4.2	10	0.39	16.38						
10	4.2	13	0.61	33.306			TOTAL WIEGHT IN KG			
							dia	weight		
							10	601		
	SLAB 4						8	5		
dia	L	NO	CONST	TOTAL IN KG						
8	4.2	12	0.39	19.656						
	2	28	0.39	21.84						
10	4.85	32	0.61	94.672						
	3.95	39	0.61	93.9705						
10	2.054	32	0.61	40.09408						
8	0.65	20	0.39	5.07						

Providing reinforcement details to the given slab drawings and providing beam shuttering layout to the given plan of building

- ❖ Reinforcement details of slab drawing

Slab reinforcement details should be done by following the relevant code of practices and standards method of detailing of reinforcements.

Mainly, there are three types of slabs in cast-in-situ concrete.

- One way spanning slabs
- Two-way spanning slabs
- Cantilever slabs

Thickness of the slab is decided based on span to depth ratio specified in IS456-2000. Minimum reinforcement is 0.12% for HYSD bars and 0.15% for mild steel bars. The diameter of bar generally used in slabs are: 6 mm, 8 mm, 10 mm, 12mm and 16mm. The maximum diameter of bar used in slab should not exceed 1/8 of the total thickness of slab. Maximum spacing of main bar is restricted to 3 times effective depth or 300 mm whichever is less. For distribution bars the maximum spacing is specified as 5 times the effective depth or 450 mm whichever is less.

Minimum clear cover to reinforcements in slab depends on the durability criteria and this is specified in IS 456-200. Generally, 15mm to 20mm cover is provided for the main reinforcements.

Alternate main bars can be cranked near support or could be bent at 180^0 at the edge and then extended at the top inside the slab

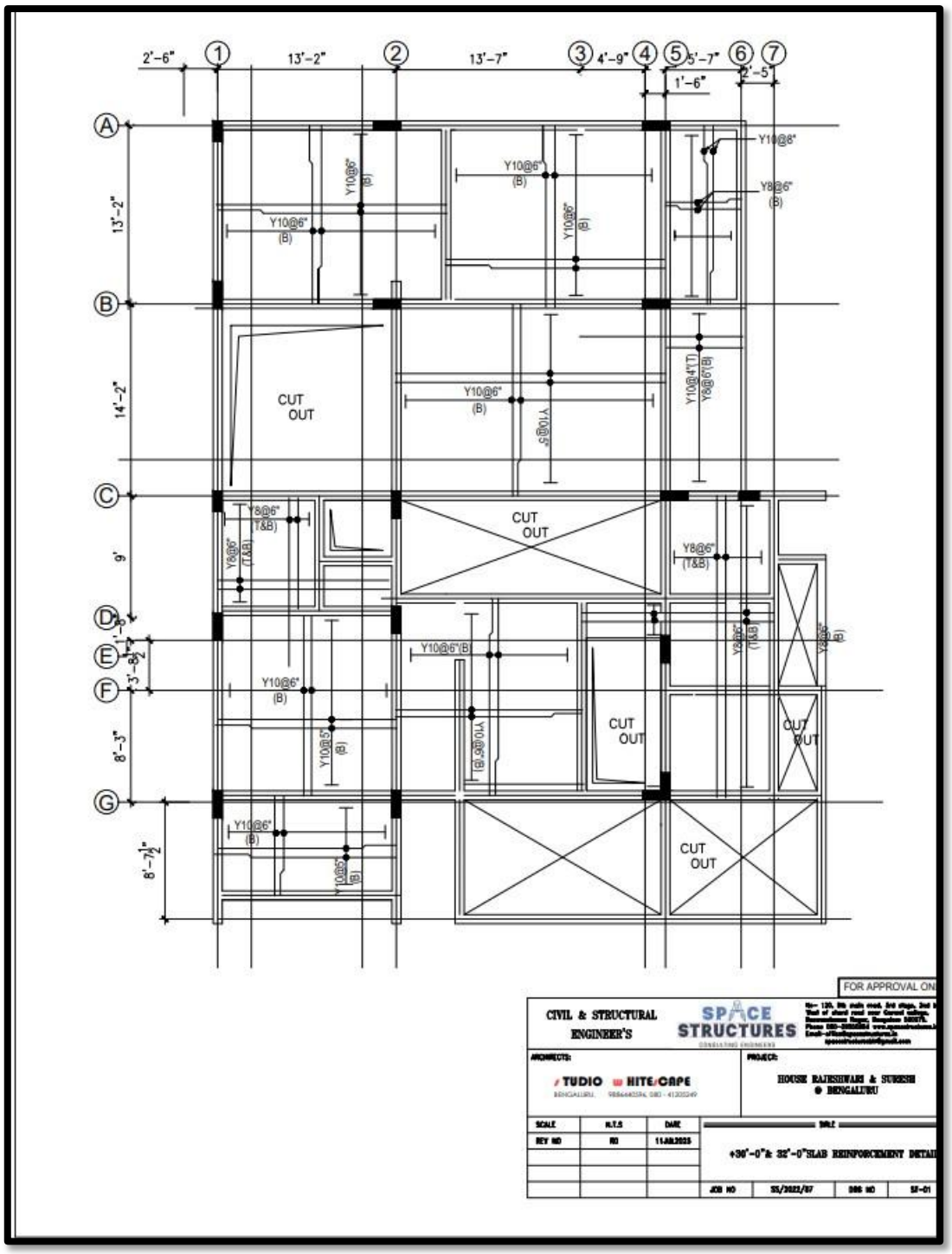


Fig {2.1}

Provided reinforcement details to the given plan layout

❖ Providing beam shuttering layout to the given plan layout

- Design and tolerance in construction

- Formwork is designed and constructed to the required dimensions, lines and shapes, shown on the drawings with the tolerances given below.
- Tolerance for cross-sectional dimensions of cast in-situ: +10 mm / -5 mm.
- For cast in-situ elements, the deviation of level of any point from the intended level: ± 10 mm.
- Tolerance for plumb: 3 mm / m, maximum 20 mm.

Shuttering in construction refers to temporary metal, plywood, timber, or other materials used to offer support to wet concrete mix till it gets strength for self-support. It offers support to inclined, vertical, and horizontal surfaces or to cast concrete as per required size and shape.

- It can be used as permanent or temporary molds that hold the poured concrete in shape until it gets hard and gains adequate strength to support itself.
- Execution of Shuttering work takes time, and it forms 23%-25% expenditure on the total building or structure cost.
- Shuttering should be sufficiently tight to avoid loss of water and mortar from cement concrete and should be rigid enough to avoid any deflection in the surface after laying cement concrete.

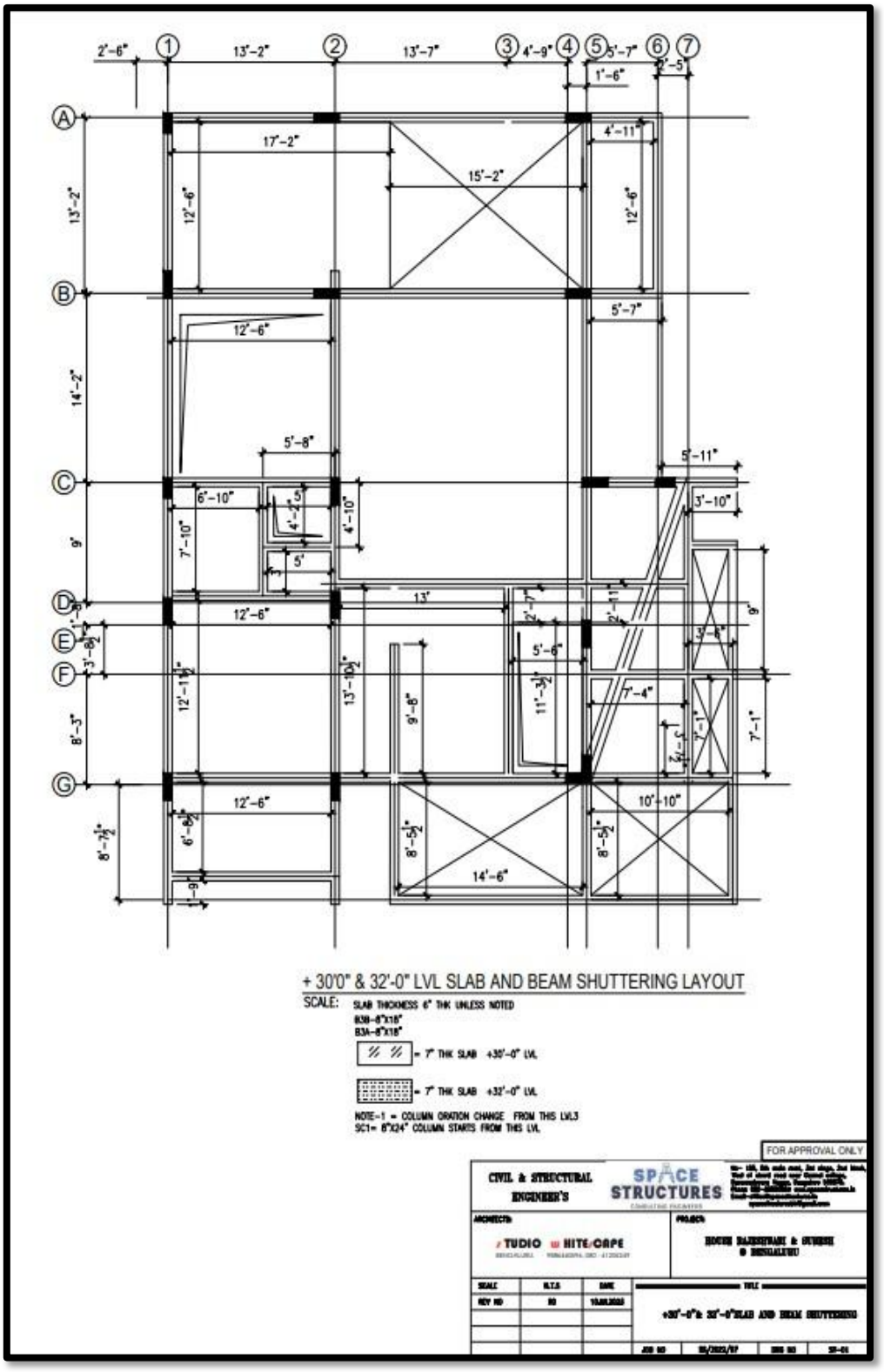


Fig {2.2}

Provided shuttering layout to the given plan layout

SITE VISITS

We visited 3-4 ongoing projects around Bangalore, in every site there was different stage of work was carried out like footing, slab reinforcement, plastering etc. Different types of building were constructed like residential and commercial.

- **Site no -1 (Uttarahalli, Bangalore)**

Type of building -Residential building

Site dimesions-30 x 40 ft

No of floors- G+2

Stage of construction – Shuttering work of 1st floor slab

Lessons learned -

Study of Plan of the Project -The study of plan in civil engineering plays a crucial role in the successful execution of construction projects. A plan serves as a blueprint that guides engineers, architects, and contractors throughout the project lifecycle.

Chain link staircase – in this staircase soffit beam is avoided below staircase and each and every step acts as a beam connecting all together

Fig {3.1}

2 storied ongoing residential building

Fig {3.2}

Shuttering process

- **Site no -2 (Jayanagar 9th block, Bangalore)**

Type of building -Residential building

Site dimensions-60 x 40 ft

No of floors- G+3

Stage of construction – Wall construction till sill level, sunken slab construction

Shuttering removing in first floor after 12 days

Lessons learned –

Sunken slab construction

Step 1: leave the desired space for a sunken slab with a depth of about 30 cm.
Step 2: Apply formwork and install reinforcements as per the floor design.
Step 3: Pour the concrete and apply waterproofing and cement over the concrete surface for additional water protection from underneath.

Fig {3.3}

3 storied ongoing residential building

Fig {3.4}

Ongoing process of wall construction

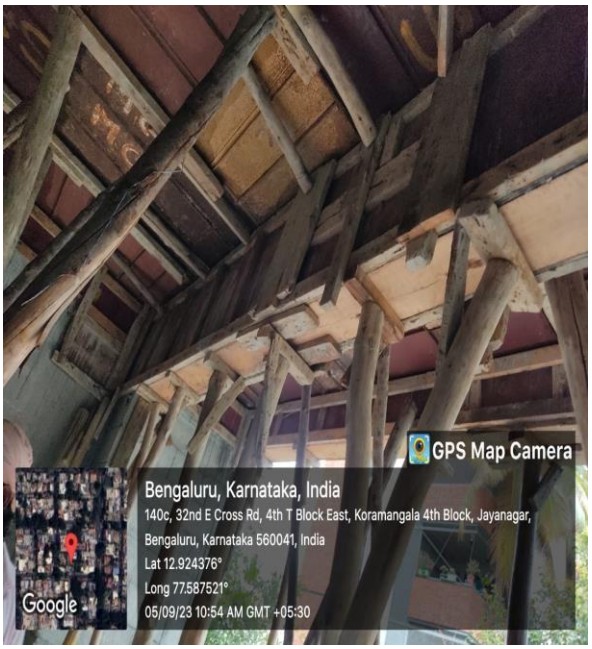


Fig {3.5}

shuttering laid for beam and slab construction

- **<u>Site no -3 (HSR Layout, Bangalore)</u>**

Type of building- Commercial building {Auditorium}

Site dimensions-60 x 80 ft

No of floors- G+2

Stage of construction – lift head room construction, reinforcement for head room slab, electrical wiring marking, plastering at first floor

Lessons learned –

Concept of post tension slab- Generally PT Slab are used when columns are not provided in between the larger spans, and also to reduce the depth of slab and achieve economical construction

Steel scaffolding (cup lock)- It helps in easy construction by having easy locking and unlocking system and it is light weight so that it can be easily transported

Redlines on Post tension slab- These lines help in identifying the placements of post tension wires in slab so that any drilling and electrical activities can be avoided so that wires inside the slab are not damaged

Fig {3.6}

Ongoing auditorium construction

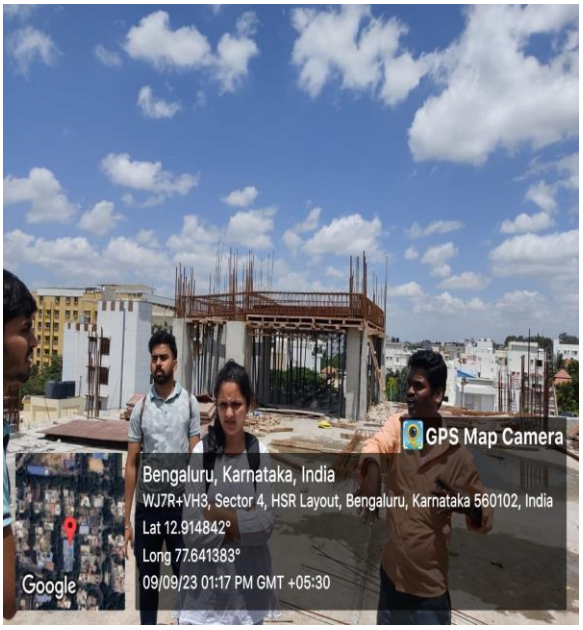


Fig {3.7}

Ongoing lift head room construction

Fig {3.8}

Shuttering construction under process

Learning outcomes

- I got to know about how loads are considered while designing the structural elements such as beams, columns, slabs etc.
- I got to know how the steel quantity are estimated for the reinforcement in slabs and beams
- I got to know parameters considered while providing reinforcement to any structural elements
- Learnt about various stages of designing process involved in analysis of structural considerations in buildings
- We got to know about the post tension slabs and what are its advantages
- During site visits, we got know about various stages of executing the project

REFRENCES

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