



INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

DESIGNING, ESTIMATION, BAR BENDING SCHEDULE, SCHEDULING OF ACTIVITIES FOR A COMMERCIAL BUILDING

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Abstract- It is important to find the pre-construction cost of Commercial buildings so that the owner of the business can analyse the profit/loss margins. The construction manager and the owner should always keep in mind that the investment cost should not precede the future income. It is important to maintain a balance between planned costs, both direct and overhead, and wished profit. Through this project we aim to calculate and analyse the Abstract of cost of a commercial building. Moreover, we also aim to prepare and analyse the Bar Bending Schedule and Construction Schedule.

The type of estimation used is Detailed Estimation by Total quantity method. The calculation of material quantity and Bar bending Schedule is done by MS Excel. While the Construction Scheduling is done using GanttPro.

KEYWORDS:

- **Autodesk Revit:** It is a modelling software for structural engineers, electrical and mechanical engineers, architects, contractors, designers and landscape architects.
- **Contingencies:** The sum of money set aside to cover any miscellaneous or unexpected costs.
- **Estimate:** The calculation of quantities of various particulars of work and the likely expenses that are expected to incur on the work is called an estimate.
- **GanttPRO:** It is a software which is used for task and project management. It is also used for cost, deadline and resource management.
- **Rates:** The cost of various construction materials per unit and labour (skilled and unskilled) cost should be available for preparing an estimate. The transportation cost should also be taken into consideration.

- **Reinforcement drawing:** It demonstrates material of reinforcement, position of reinforcing bars, and shape, number and dimension of reinforcing elements.
- **Specifications:** It describes the class and nature of materials and work, to be used in workmanship and construction project.
- **Task:** The capacity of doing work by the labour in a set period of time. It can be in the form of quantity.

I. INTRODUCTION

The fluctuating prices of construction materials, especially in the COVID19 hit market, may affect the construction plan and pocket of the owner. So it becomes necessary to estimate the pre-construction cost of the project.

For total abstract of cost, the parameters required are current market rate of materials, drawings and the duration of each activity, which we will find out in the Project Scheduling part of the Paper.

While the Bar Bending Schedule helps the quantity surveyor to consolidate the number of bars required of each bar type.

A. Objectives of the Paper

- To prepare the AutoCAD drawing.
- To collect cost of materials and cost of labour.
- To prepare and analyse the Abstract of Cost of whole building, Bar bending Schedule, and Construction Project Schedule.

B. Estimation

The calculation of various quantities of a construction project and the expected expenditure that can incur on a specific project is called Estimation. Sometimes, a situation may arise that funds available are less than the estimated cost. Then the work is done in part or by reducing and altering the specifications. Also, this gives a clear picture why pre-construction estimation becomes necessary.

C. Requirements of Estimation

- An estimate helps decide whether the proposed plan coordinate with the available funds or not.
- It is additionally needed to control the expenditure during the execution of work.
- It is important for time management during the execution of work and for the completion of project.
- An estimate is important for formally getting into a contract by inviting tenders.

D. Data required

(i) **Rates:** It will include rates of

- labour, carpenter, plumber, electrician etc.
- the rate of various construction materials.

It is to be kept in mind that the cost of materials and labour cost may vary place to place and time to time.

(ii) **Specifications:**

- **General:** It gives a general idea of class, nature, quality, work and materials to be used in the project work.
- **Detailed:** It gives the description in a detailed manner of the different items of work with regards to qualities and quantities of materials, workmanship, method of preparation, and execution of work.

(iii) **Drawing:** It is basically the plan of the project that will include the drawings for staircase, foundation work, Electrical/Plumbing plan, RCC & Steel work in columns, beam, slab etc.

E. Bar Bending Schedule

A broad list that outlines the type, location, length, mark, size and number, and bending details of each bar in a Reinforcement drawing of a structure is called a Bar Bending Schedule or "BBS".

This process of listing the location, type and size, number of and all other details is called "Scheduling". Bar Scheduling is the same thing in context of Bars. Detailed reinforcement requirements are provided for each structural unit.

F. Importance of BBS

1. It serves as a control document for structural engineers, detailers etc. on reinforcement.

2. It helps quantity surveyor with measurement of materials during pre and post contract operations.

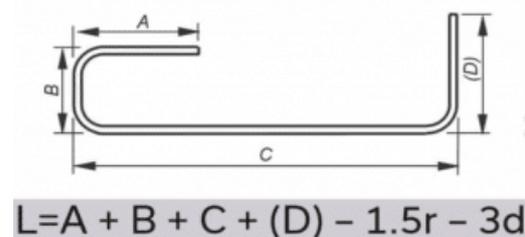
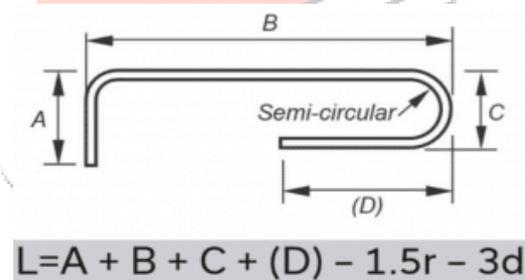
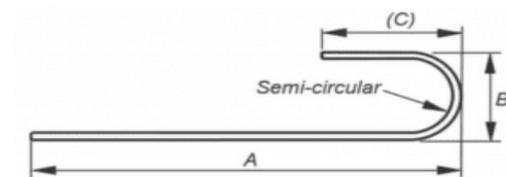
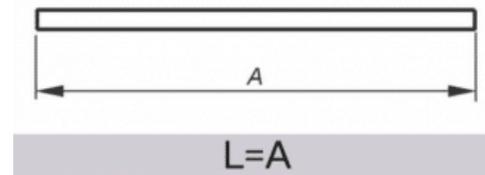
3. It helps assist the steel bender and fixer.

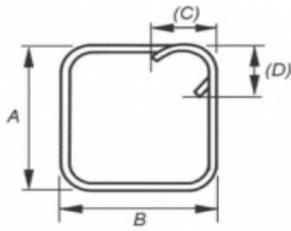
4. It becomes very useful in helping detect inconsistencies.

5. Fast tracks construction and supervision.

6. It can help save cost by handling reinforcement.

G. Different types of Bar Bending Shape Code





$$L=2(A + B + (C)) - 2.5r - 5d$$

source: civil query

H. Scheduling in Project Management

It is the process of formulating of activities, tasks, and milestones within a time frame. All these tasks and activities will have a planned start and finish date. Project Scheduling ensures that a project is completed within time and budget.

The following are some of the advantages if you properly create your project schedule.

- Scheduling of a project when done properly, makes the whole project run uninterruptedly.
- It gives you a rather clear picture of the requirement you need to meet, from the beginning to avoid any sudden adventures.
- A proper schedule gives you an opportunity to catch issues early and alert clients if a timeline isn't feasible
- Other managers can allocate resources efficiently for your project, and they'll be able to anticipate when resources will be available for other projects.
- Everyone knows what to expect and when. Everyone is being held accountable for the same due dates.

A. Description of the project:

The plan of building used for this research purpose is a Commercial building plan, which is located in Jhotwara, Jaipur. The building will operate as an IT Office centre of various far off institutes and businesses, which may be located in different states. Each institute and business will have its individual cabin or office.

The building is a double storey building, and also have a basement. Total area of the premise of the building is 30' X 90' 3".

table I: size and height of particulars

S.No.	Names	Size	Height
1.	Office	2.48m x 3.27m	3.35m
2.	Display	4.54m x 4.11m	3.35m
3.	Toilet 1	1.18m x 2.74m	3.35m
4.	Showroom	4.54m x 12.19m	3.35m
5.	Toilet 2	1.18m x 2.01m	3.32m
6.	Pantry	1.82m x 1.56m	3.32m
7.	Bedroom	3.93m x 2.66m	3.32m

B. Preparation of Building layout

The layout for the proposed plan was prepared using AutoCAD. The dimensions of the plan are in feet.

The layout drawing contains all the necessary detail to complete the estimation, Scheduling of activities and the BBS.

Here we have provided the architectural plan of Basement, First floor, Second Floor, Third Floor and Terrace.

II. METHODOLOGY

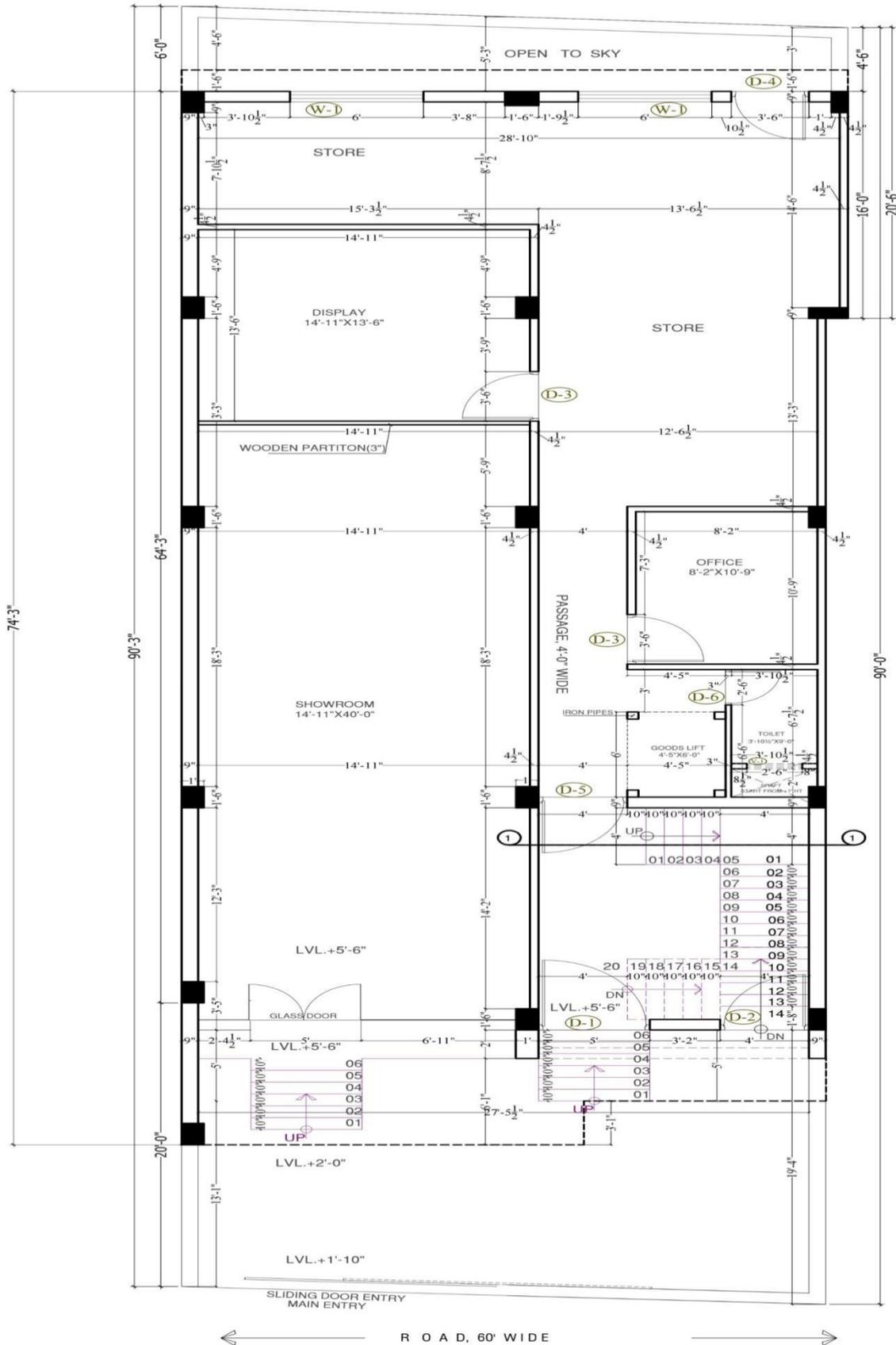


fig 2: ground floor

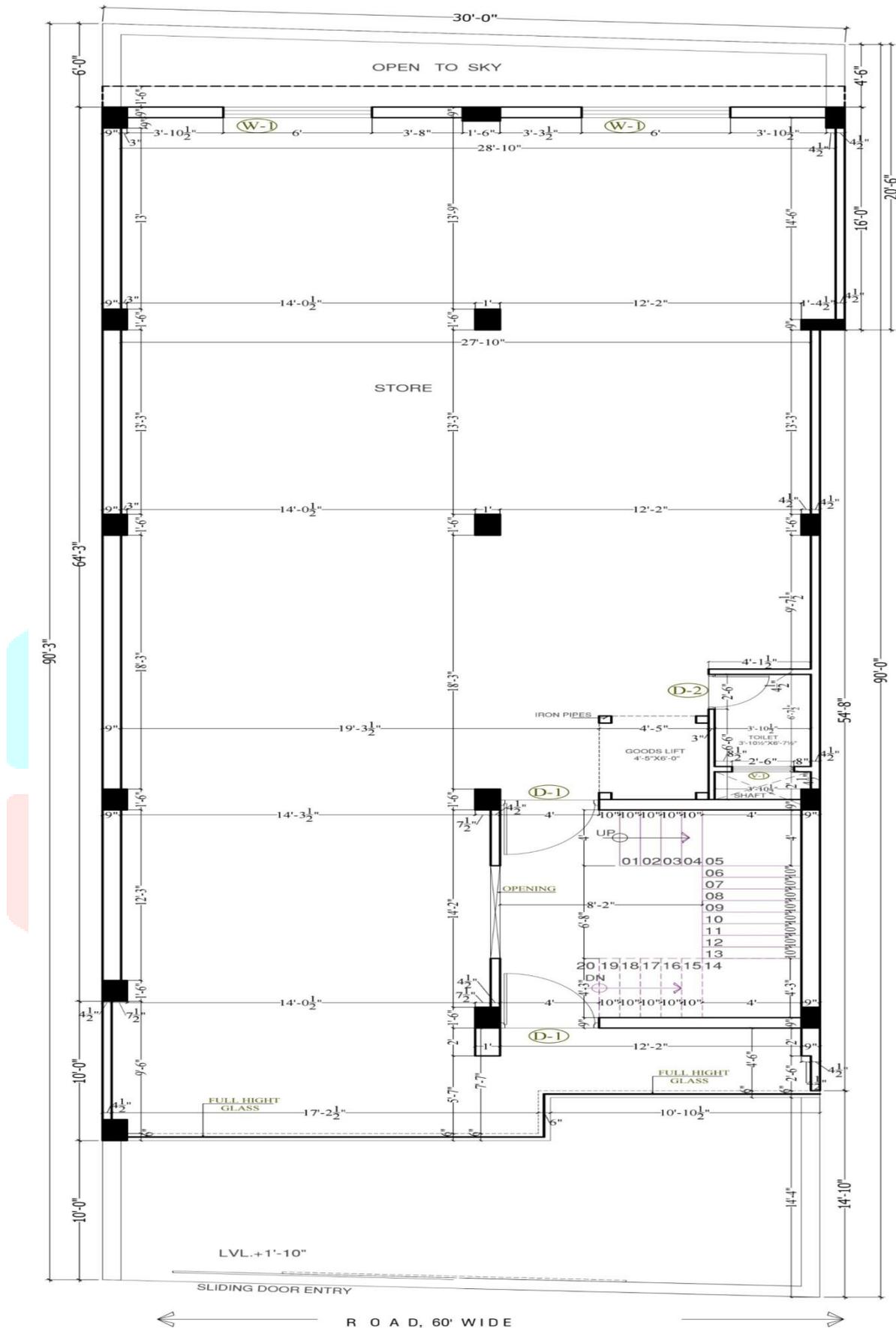


fig 3: first floor

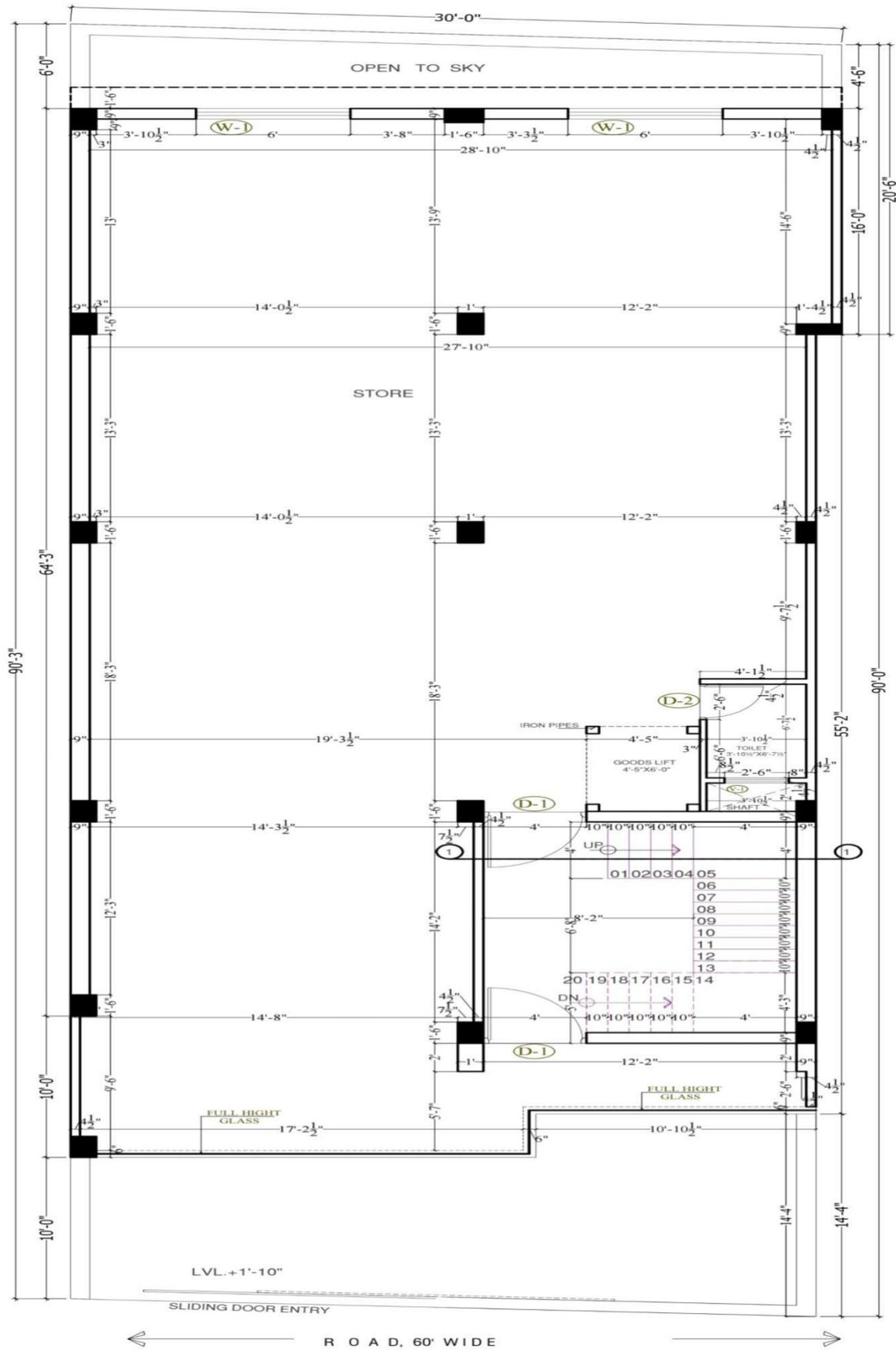


fig 4: second floor

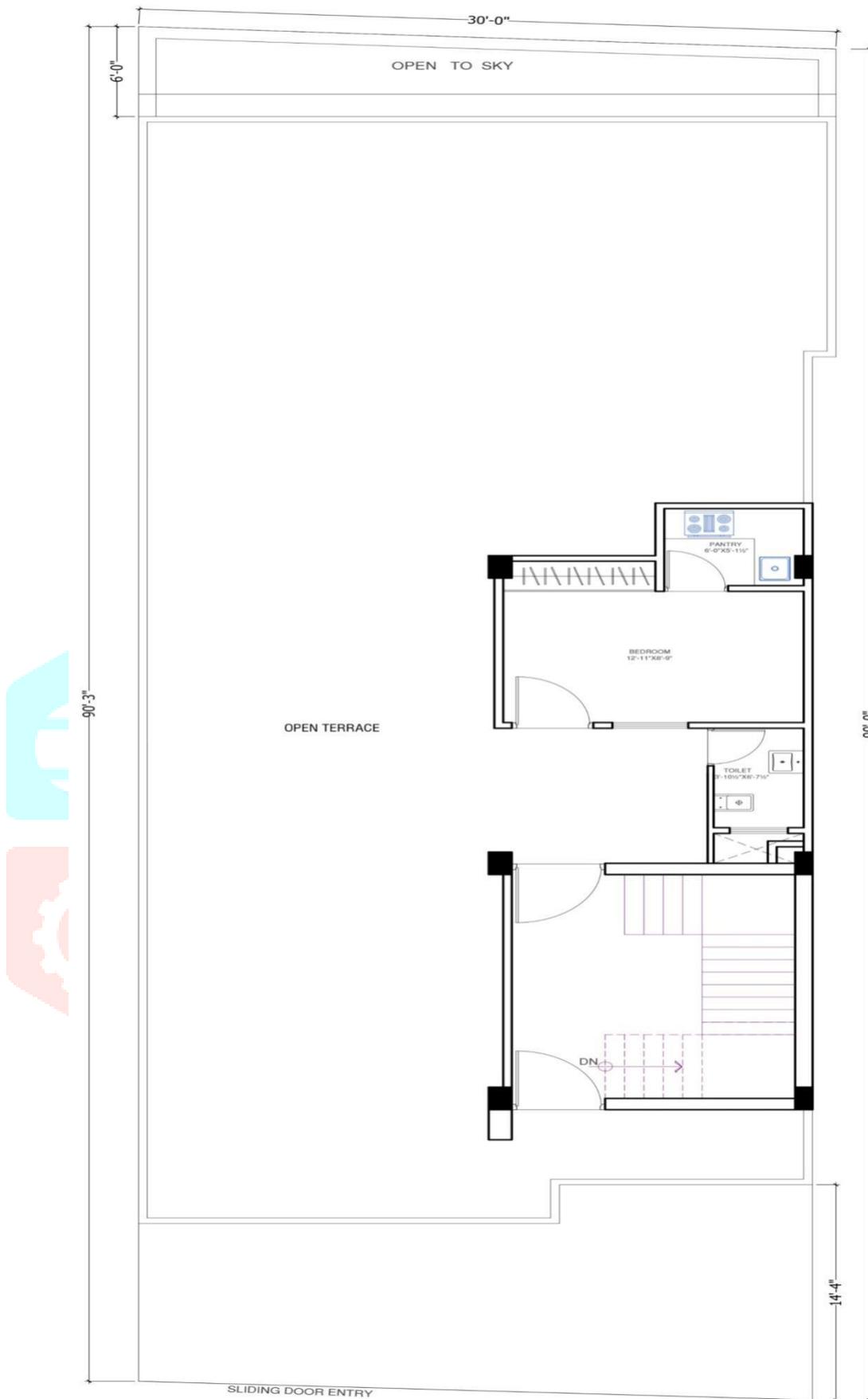


fig 5: terrace

- *3D Modelling using Auto desk Revit*



fig 6(a): front view



fig 7(a): top view



fig 6(b): front view



fig 7(b): top view

C. *Quantity/Cost Estimation*

Quantity estimation is the calculation of various building materials and other particulars which are needed to complete a construction project. Materials include Steel, Bricks, Cement, gravel, paint etc. While other particulars include Excavation, back-filling etc. The quantity estimated is further used to calculate the cost of each material. The rate of material/ labour may vary place to place.

- *Labour Rates*

Table II: Builder's Association of India (Southern Centre), Exclusive of Taxes, 2018

S. No.	Labour	Unit of Work	Cost
1.	Mason	Per day	Rs.800/-
2.	Men	Per day	Rs.550/-
3.	Women	Per day	Rs.450/-
4.	Painter/Plumber	Per day	Rs.800/-
5.	Carpenter	Per day	Rs.750/-

- Construction Material Rates

Table II: Construction Building Material Rates in Dehradun (in ₹), Source: Property.todaypricerates

S. No.	Particular Name	Per Unit	Average Cost
1.	Cement	50 kg Bag	414.7
2.	River Sand	-----	3646.5
3.	Gravel	Per kg	25.3
4.	TMT Steel	Metric Ton	65076
5.	MCB	-----	190.3
6.	Switches High Range	-----	166.1
7.	Pipes PVC	Per piece	190.3
8.	Teak Wood	Cubic feet	1424.5
9.	Marble	Sq. feet	516.35
10.	Painting Rate	Per sq. feet	46.44
11.	Tiles	Per sq. feet	97.75

D. Methods of Estimate

1. Long wall – Short wall method: The wall along the length of room is considered to be long wall while the wall perpendicular to long wall is said to be short wall.

2. Centre Line method: The total centre line length of walls in a building is first calculated, then the centre line length is multiplied with the breadth and depth of respective item to get the total quantity at a time.

The method we used to do the estimate is Centre Line Method. Calculation can be done manually and using MS Excel as well. MS Excel reduces the chances of calculation errors and is time efficient also.

E. Types of Estimate

1. Approximate method: It is a rough estimate made in the initial stage of project. Its motive is to give an idea to the client regarding the amount of cost needed and for acquiring approval from the sanctioning bodies, for example, banks.

Approximate estimate = Rate of 1m² (already known value) X proposed area (m²)

2. Plinth Area Estimate: It is calculated by multiplying the values of plinth width, plinth length and plinth area rate.

Plinth area estimate = Plinth area X plinth area rate.

3. Detailed estimate: This type is calculated in two phases. First the quantities of different works such as excavation & earthwork, masonry, reinforcement, concrete work, plumbing, electrical work etc. is estimated. Afterwards, the cost of all particulars of work is calculated and summarized in an Abstract of Cost.

We have completed estimation by detail method, so as to prepare the Abstract of Cost. This Abstract of Cost provides detailed quantity of construction materials required alongwith their costs.

F. Abstract of Cost

It is prepared in a tabular form by multiplying quantity of each and every individual item estimated by the specified rate. Then the cost of all the work is added to get the total cost of work.

4% of estimated Cost is allowed for Petty Supervision, contingencies and unforeseen items.

6% of estimated cost is added for electrification and sanitation. Abstract of Cost is given in Fig1.

G. Preparation of Bar Bending Schedule

All the information or detail regarding to a BBS can be found in reinforcement drawings. These details include diameter, bar shape, length and spacing.

BBS is given in Fig2.

A. Project Scheduling process

1. Plan Schedule Management: The base of a fine project scheduling is to determine/establish the way, procedure, policies of the company, and the instruction of documentation that will control/guide the project.

2. Define the project activities: This can be created by simply listing all the tasks to be delivered for the completion of the project.

3. Determine dependencies: After all the activities are listed, find the tasks which rely on the completion of others or are related to each other.

4. Sequence activities: After establishing the dependencies among various activities, order them in the manner you want them to finish.

5. Estimate resources: Estimate the resources which will be needed at each activity.

6. Estimate Durations: Estimating duration is important, you should overestimate as well as underestimate the time required for the completion of each activity.

7. Develop the project Schedule: After getting all the necessary information , a schedule is need to be developed, taking into account all the necessary considerations.

8. Monitor and Control: As a project manager this step is ongoing and you will be monitoring and controlling all the Knitty gritty of the project.

Schedule of Activities given in Fig3.



	A	B	C	D	E	F	G
5	LOCATION	PARTICULARS	SPECIFICATION	UOM	AREA	RATE	AMOUNT
6							
7	BASEMENT						
8		Carpet Area for Vit. Tile flooring	Providing full body vitrified tile flooring work with all materials, labour T&P etc.with proper completion of work.	Sq m	186.00	1700.00	316200.00
9		Bricks	M-150 Brick work 1:6 (one cement : 6coarse sand) mortar in super structure brick 9" thick wall, supply of all materials, labour and T&P etc. required for proper completion of work.	cu.m.	7.60	6700.00	50920.00
10		Plaster	Providing 12mm thick plaster work with one part cement and 4 parts of fine sand including supply of all material & labour T&P etc.required for proper completion of the work.	sq.m.	280.00	280.00	78400.00
11		Paint	Providing paint work on walls and ceiling to complete the work.	Sq m	465.00	150.00	69750.00
12		Marble Staircase	Providing Marble flooring work with grinding ,including all materials, labour T&P etc. with proper completion of the work	Sq m	14.00	1950.00	27300.00
13		NETT AMOUNT					542570.00
14	GROUND FLOOR						
15		Carpet Area for Vit. Tile flooring	Providing full body vitrified tile flooring work with all materials, labour T&P etc.with proper completion of work.	Sq m	270.00	1700.00	459000.00
16		Bricks	M-150 Brick work 1:6 (one cement : 6coarse sand) mortar in super structure brick 9" thick wall, supply of all materials, labour and T&P etc. required for proper completion of work.	cu.m.	50.00	6700.00	335000.00
17		Plaster	Providing 12mm thick plaster work with one part cement and 4 parts of fine sand including supply of all material & labour T&P etc.required for proper completion of the work.	sq.m.	635.00	280.00	177800.00
18		Paint	Providing paint work on walls and ceiling to complete the work.	Sq m	855.00	150.00	128250.00
19		Marble Staircase	Providing Marble flooring work with grinding ,including all materials, labour T&P etc. with proper completion of the work	Sq m	14.00	1950.00	27300.00
20		NETT AMOUNT					1127350.00
21	FIRST FLOOR						
22		Carpet Area for Vit. Tile flooring	Providing full body vitrified tile flooring work with all materials, labour T&P etc.with proper completion of work.	Sq m	235.00	1700.00	399500.00
23		Bricks	M-150 Brick work 1:6 (one cement : 6coarse sand) mortar in super structure brick 9" thick wall, supply of all materials, labour and T&P etc. required for proper completion of work.	cu.m.	52.00	6700.00	348400.00
24		Plaster	Providing 12mm thick plaster work with one part cement and 4 parts of fine sand including supply of all material & labour T&P etc.required for proper completion of the work.	sq.m.	585.00	280.00	163800.00
25		Paint	Providing paint work on walls and ceiling to complete the work.	Sq m	785.00	150.00	117750.00
26		Marble Staircase	Providing Marble flooring work with grinding ,including all materials, labour T&P etc. with proper completion of the work	Sq m	14.00	1950.00	27300.00
27		NETT AMOUNT					1056750.00

28	SECOND FLOOR						
29		Carpet Area for Vit. Tile flooring	Providing full body vitrified tile flooring work with all materials, labour T&P etc.with proper completion of work.	Sq m	235.00	1700.00	399500.00
30		Bricks	M-150 Brick work 1:6 (one cement : 6coarse sand) mortar in super structure brick 9" thick wall, supply of all materials, labour and T&P etc. required for proper completion of work.	cu.m.	52.00	6700.00	348400.00
31		Plaster	Providing 12mm thick plaster work with one part cement and 4 parts of fine sand including supply of all material & labour T&P etc.required for proper completion of the work.	sq.m.	585.00	280.00	163800.00
32		Paint	Providing paint work on walls and ceiling to complete the work.	Sq m	785.00	150.00	117750.00
33		Marble Staircase	Providing Marble flooring work with grinding ,including all materials, labour T&P etc. with proper completion of the work	Sq m	14.00	1950.00	27300.00
34		NETT AMOUNT					1056750.00
35	TERRACE						
36		Carpet Area for Vit. Tile flooring	Providing full body vitrified tile flooring work with all materials, labour T&P etc.with proper completion of work.	Sq m	225.00	1700.00	382500.00
37		Bricks	M-150 Brick work 1:6 (one cement : 6coarse sand) mortar in super structure brick 9" thick wall, supply of all materials, labour and T&P etc. required for proper completion of work.	cu.m.	11.50	6700.00	77050.00
38		Plaster	Providing 12mm thick plaster work with one part cement and 4 parts of fine sand including supply of all material & labour T&P etc.required for proper completion of the work.	sq.m.	224.00	280.00	62720.00
39		Paint	Providing paint work on walls and ceiling to complete the work.	Sq m	195.00	150.00	29250.00
40		NETT AMOUNT					551520.00
41							
42		GRAND TOTAL OF ALL FLOORS					4334940.00

fig 8: abstract of cost

B	C	D	E	F	G	H	I	J	K	L
Bar Mark	Dia. of Bar	Shape / Description	Nos. of Bars	Cutting Length (M)	Total Cutting Length in Metres respectively					
					8 mm	10 mm	12 mm	16 mm	20 mm	25 mm
F1 6 Nos 100 c/c (b/w)	10 100		108	1.900	-	205.2	-	-	-	-
1800 x 1800	10 100		108	1.900	-	205.2	-	-	-	-
F2 - 8 Nos 100 c/c (b/w)	10 100		160	2.100	-	336	-	-	-	-
2000 x 2000	10 100		160	2.100	-	336	-	-	-	-
F1 12 Nos 100 c/c (b/w)	10 100		276	2.400	-	662.4	-	-	-	-
2300 x 2300	10 100		276	2.400	-	662.4	-	-	-	-
F2 - 2 Nos 100 c/c (b/w)	10 100		50	2.600	-	130	-	-	-	-
2500 x 2500	10 100		50	2.600	-	130	-	-	-	-
					8 mm	10 mm	12 mm	16 mm	20 mm	25 mm
Total cutting length						2667.2	0	0		
Unit Weight					0.4	0.61	0.89	1.56	2.48	3.85
Total Weight						1627				

fig 9: bar bending schedule

5	WBS Number	Task name / Title	Assigned to	Planned start	Planned end	Deadline	Progress	Duration
6	1	ZONING		13/05/2021	17/07/2021		0	65
7	1.1	Land Use		13/05/2021	12/07/2021		0	
8	1.2	Easements, Set Backs		16/05/2021	17/07/2021		0	
9	1.3	Access, Street Improvements		16/05/2021	17/07/2021		0	
10	1.4	Utilities Available		16/05/2021	17/07/2021		0	
11	2	HOUSE PLANS		20/05/2021	24/07/2021		0	65
12	2.1	Purchase Standard Plans		20/05/2021	19/07/2021		0	
13	2.2	Architect Original Drawings		20/05/2021	19/07/2021		0	
14	2.3	Specifications		20/05/2021	19/07/2021		0	
15	2.4	Architect Manage Job		23/05/2021	24/07/2021		0	
16	2.5	Engineer-Loads & Spans		23/05/2021	24/07/2021		0	
17	2.6	Draftsman		23/05/2021	24/07/2021		0	
18	3	LOT SURVEY		27/05/2021	31/07/2021		0	65
19	3.1	House & Driveway		27/05/2021	26/07/2021		0	
20	3.2	Well Locaton		27/05/2021	26/07/2021		0	
21	3.3	Septic Location		27/05/2021	26/07/2021		0	
22	3.4	Fire Hydrant & Truck Access		30/05/2021	31/07/2021		0	
23	3.5	Plot Plan		30/05/2021	31/07/2021		0	
24	4	FINANCIAL - LOAN		31/05/2021	02/08/2021		0	63
25	4.1	Land Cost		31/05/2021	01/08/2021		0	
26	4.2	Interest on Land		03/06/2021	02/08/2021		0	
27	4.3	Interest on Const. Loan		03/06/2021	02/08/2021		0	
28	4.4	Points, Etc.		03/06/2021	02/08/2021		0	
29	5	SEWER & WATER HOOKUP		06/06/2021	07/08/2021		0	
30	6	HEALTH PERMIT		06/06/2021	09/08/2021		0	64
31	6.1	Fees		06/06/2021	07/08/2021		0	
32	6.2	Percolation Test		07/06/2021	08/08/2021		0	
33	6.3	Soils Engineer		10/06/2021	09/08/2021		0	
34	7	INSURANCE		10/06/2021	09/08/2021		0	
35	8	LOT CLOSING COSTS		10/06/2021	09/08/2021		0	
36	9	BUILDING PERMITS		13/06/2021	14/08/2021		0	62
37	9.1	Fees		13/06/2021	14/08/2021		0	
38	9.2	Inspection Schedule		13/06/2021	14/08/2021		0	
39	10	PRELIMINARY LIST ONLY		14/06/2021	15/08/2021		0	
40	11	BUILD PHASE		17/06/2021	16/08/2021		0	
41	12	SPECIAL & DRY IN MATERIALS		17/06/2021	21/08/2021		0	65
42	12.1	Rough Hardware, Misc.		17/06/2021	16/08/2021		0	
43	12.2	Lolly Columns		20/06/2021	21/08/2021		0	
44	12.3	Steel Beams		20/06/2021	21/08/2021		0	
45	12.4	Rough Lumber, Trusses		20/06/2021	21/08/2021		0	
46	13	WINDOWS/OPENINGS		24/06/2021	23/08/2021		0	60
47	13.1	Windows, Grills, Screens		24/06/2021	23/08/2021		0	
48	13.2	Exterior Doors, Screens		24/06/2021	23/08/2021		0	
49	13.3	Skylights and Light Tubes		24/06/2021	23/08/2021		0	
50	14	DEMOLITION		27/06/2021	28/08/2021		0	
51	15	LOT CLEARING		27/06/2021	30/08/2021		0	64
52	15.1	Debris Removal & Clearing		27/06/2021	28/08/2021		0	
53	15.2	Dump Fee		28/06/2021	29/08/2021		0	
54	15.3	Bury Stumps, etc.		01/07/2021	30/08/2021		0	
55	16	DRIVEWAY, rough		01/07/2021	04/09/2021		0	65
56	16.1	Grade		01/07/2021	30/08/2021		0	
57	16.2	Base Rock, Culverts		04/07/2021	04/09/2021		0	
58	17	UTILITIES		04/07/2021	05/09/2021		0	63
59	17.1	Temporary at startup		04/07/2021	04/09/2021		0	
60	17.2	Transfer to permanent		05/07/2021	05/09/2021		0	
61	18	WELL or PUBLIC WATER		08/07/2021	06/09/2021		0	
62	19	SEPTIC or PUBLIC SEWER		08/07/2021	06/09/2021		0	
63	20	LAYOUT HOUSE FOOTPRINT		11/07/2021	11/09/2021		0	62
64	20.1	Establish Finish Floor Height		11/07/2021	11/09/2021		0	
65	20.2	Set Back Distances		11/07/2021	11/09/2021		0	
66	21	DIG FOUNDATION		11/07/2021	11/09/2021		0	
67	22	ROCK PROBLEM		12/07/2021	12/09/2021		0	
68	23	PREPARE FOR FOOTINGS		15/07/2021	13/09/2021		0	60
69	23.1	Lay out and excavate		15/07/2021	13/09/2021		0	
70	23.2	Form, Rebar, Grade Pegs		15/07/2021	13/09/2021		0	
71	24	POUR FOOTINGS & PADS		18/07/2021	18/09/2021		0	62
72	24.1	Yds. of Concrete		18/07/2021	18/09/2021		0	
73	25	SET BRICK POINTS		18/07/2021	18/09/2021		0	
74	26	TERMITE TREATMENT		19/07/2021	19/09/2021		0	
75	27	RADON CONTROL		22/07/2021	20/09/2021		0	
76	28	FOUNDATION WALLS		22/07/2021	27/09/2021		0	67
77	28.1	Block/Course		22/07/2021	20/09/2021		0	
78	28.2	Piers		25/07/2021	25/09/2021		0	
79	28.3	Pour Wall, Yds. Of Concrete		25/07/2021	25/09/2021		0	
80	28.4	Lintels, Rebar		25/07/2021	25/09/2021		0	
81	28.5	Parging		26/07/2021	26/09/2021		0	
82	28.6	Cement, Sand, etc.		29/07/2021	27/09/2021		0	
83	29	WATERPROOF FOUNDATION.		29/07/2021	27/09/2021		0	
84	30	COLUMNS/BEAMS SET		29/07/2021	27/09/2021		0	
85	31	UNDERGROUND PLUMBING		01/08/2021	02/10/2021		0	
86	32	BRICK/STONE, to finish grade		01/08/2021	02/10/2021		0	
87	33	GARAGE DOORS		02/08/2021	04/10/2021		0	63
88	33.1	Openers		02/08/2021	03/10/2021		0	
89	33.2	Trim, Backing, Weatherstrip		05/08/2021	04/10/2021		0	
90	34	DRAIN TILE		05/08/2021	04/10/2021		0	
91	35	FIRE PLACE - INTERIOR		08/08/2021	09/10/2021		0	62
92	35.1	Pour Hearth		08/08/2021	09/10/2021		0	
93	35.2	Firebox, or Set Prefab		08/08/2021	09/10/2021		0	
94	35.3	Brick or Stone Facing		08/08/2021	09/10/2021		0	

fig 10: schedule of activities

CONCLUSION

The estimation, BBS, and scheduling of activities is carried out successfully.

The Abstract of Cost and BBS is prepared using MS Excel. Scheduling of activities is done using GanttPro.

The quantities were estimated using the Centre line method. And the estimate prepared is a Detailed estimate.

- *Our findings:*

Project duration: 230 days

Total estimated cost: 48,49,152

We conclude that the project was made within the financial limit and within the duration.

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