

# Comprehensive Cost Analysis and Quantity Survey of a G+1 Residential Structure

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**Abstract** — This paper presents a comprehensive cost estimation, quantity survey, bill of quantities (BOQ), and bar bending schedule (BBS) for a G+1 residential building with a total built-up area of 1350 sq.ft (27' × 25' per floor). The study encompasses all phases of pre-construction planning including architectural drawing interpretation, structural component analysis, material take-off calculations, and reinforcement detailing. AutoCAD was used for preparing structural layouts while Microsoft Excel facilitated systematic computation of material quantities. The total estimated quantities include 34,150 bricks, 840 bags of cement (50 kg each), 2,480 cubic feet of sand, 2,050 cubic feet of coarse aggregate, and 6,120 kg of steel reinforcement bars. The Bill of Quantities was prepared referencing Schedule of Rates (SOR), Bhopal, arriving at a total project cost of approximately Rs. 26,40,000. This paper also includes a detailed bar bending schedule for all RCC components such as footings, columns, beams, and slabs. The findings highlight the significance of systematic pre-construction estimation in ensuring cost efficiency, optimal resource allocation, and timely project completion.

**Keywords:** Bar Bending Schedule, Bill of Quantities, Cost Estimation, Quantity Survey, Residential Building, and Reinforcement

## I. INTRODUCTION

Pre-construction planning is the backbone of any successful construction project. Accurate cost estimation and quantity surveying not only determine the financial feasibility of a project but also guide the procurement strategy and construction scheduling. For residential buildings in India, where construction involves a wide range of materials and labour inputs, a systematic approach to estimation helps project stakeholders avoid cost overruns and delays.

The present study focuses on a G+1 residential building located in an urban area of Bhopal, Madhya Pradesh, with a total plinth area of 1350 sq.ft (27' × 25' footprint per floor). The objectives of this work are: (i) to prepare a complete set of structural drawings using AutoCAD, (ii) to estimate the quantities of all major construction materials, (iii) to compile a detailed Bill of Quantities using current Schedule of Rates, and (iv) to develop a Bar Bending Schedule for all RCC structural elements.

The methodology adopted in this study follows the standard practices prescribed by the Bureau of Indian Standards (BIS) and the Public Works Department (PWD) guidelines for residential construction. All material quantities have been computed using centre-line and long-wall short-wall methods as applicable.

## II. LITERATURE REVIEW

1) Dutta (2012) outlined systematic procedures for estimating building materials in Indian construction

scenarios, emphasising the importance of correct unit selection and the application of PWD SOR rates. His work remains a foundational reference for civil engineering students and practitioners undertaking quantity survey exercises.

- 2) Seeley (1997) established that an accurate bill of quantities not only assists in budget formulation but also serves as a contractual document ensuring fair payment to contractors. He highlighted that ambiguities in BOQ preparation often lead to disputes during project execution.
- 3) Kim et al. (2004) conducted a comparative analysis of cost estimation models—multiple regression analysis (MRA), neural networks (NN), and case-based reasoning (CBR)—using data from 530 residential building projects. Their results demonstrated that neural network models provided superior estimation accuracy, especially for projects with complex variable interactions.
- 4) Hwang et al. (2011) studied the influence of time gaps between cost estimation and actual on-site operations. Using time-series index models, they demonstrated that construction cost indices fluctuate significantly over short intervals, and estimation models must account for these temporal variations to remain valid.
- 5) Bansal (2011) provided a comprehensive reference for bar bending schedules and reinforcement quantity estimation, detailing procedures for computing cutting lengths, bending allowances, and weight calculations for various bar diameters conforming to IS 1786.

## III. METHODOLOGY

The study followed a structured eight-step methodology:

- 1) Architectural and structural drawings of the G+1 building were prepared using AutoCAD 2022, including ground floor plan, first floor plan, foundation cross-section, ground beam layout, and slab-beam layout.
- 2) Structural member sizes were finalised based on IS 456:2000 guidelines: columns (230 mm × 300 mm), beams (230 mm × 350 mm), slab thickness (125 mm), and isolated footings (1.2 m × 1.2 m × 0.350 m).
- 3) Quantities of earthwork, brickwork, concrete (sub-structure and super-structure), formwork, plastering, flooring, and painting were computed using standard formulas and the centre-line method.
- 4) Material quantities were tabulated in an abstraction sheet, consolidating individual element quantities into category totals.
- 5) The Bill of Quantities was prepared using Schedule of Rates, PWD Bhopal (2023 revision), covering all items from site preparation to finishing work.
- 6) Bar Bending Schedules were prepared for all RCC components (footings, columns, beams, slabs, and

staircase) detailing diameter, number of bars, cutting length, and total weight.

- 7) All calculations were validated by cross-checking through independent computation using Excel spreadsheets.
- 8) A final review was conducted by faculty members of the Department of Civil Engineering, OIST Bhopal.

#### IV. BUILDING DESCRIPTION AND STRUCTURAL DETAILS

The residential building under study is a G+1 load-bearing cum RCC framed structure with the following key parameters:

Parameter	Description
Type of Structure	RCC Framed (G+1)
Total Plinth Area	1350 sq.ft (27' × 25' per floor)
Floor to Floor Height	3.0 m
Foundation Type	Isolated Footing (RCC M20)
Column Size	230 mm × 300 mm
Beam Size	230 mm × 350 mm
Slab Thickness	125 mm (Two-way)
Wall Thickness	230 mm (Outer), 115 mm (Inner)
Concrete Grade	M20 (1:1.5:3) for all RCC works
Steel Grade	Fe-415 (TMT Bars as per IS 1786)
Mortar Grade	CM 1:4 for plastering; CM 1:6 for brickwork

#### V. QUANTITY ESTIMATION AND ABSTRACTION SHEET

Quantities for all construction activities were estimated from the AutoCAD drawings. Table 2 presents a consolidated abstraction sheet showing item-wise quantities for the ground floor substructure. The estimation covers site clearing, excavation, sand filling, PCC, footing concrete, columns, beams, brickwork, plastering, flooring, and painting.

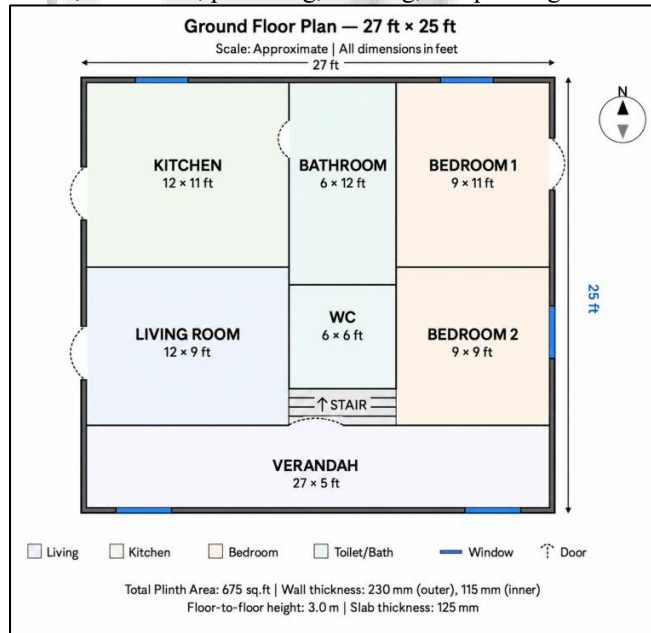


Fig. 1: Ground Floor Plan

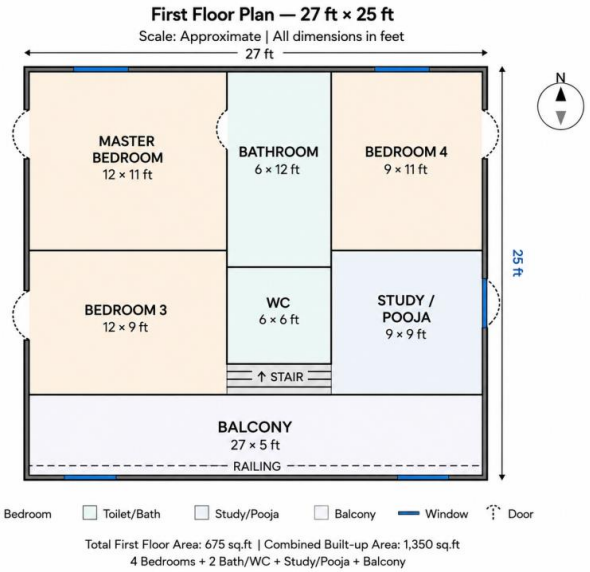


Fig. 2: First Floor Plan

S.No.	Item of Work	Quantity	Unit
1	Site Cleaning (Surface Dressing)	120.96	Sqm
2	Excavation for Foundation	5.10	Cum
3	Sand Filling below Footing	0.34	Cum
4	PCC M15 below Footing	0.34	Cum
5	Footing Concrete M20	0.412	Cum
6	Column Concrete (Sub-structure)	1.04	Cum
7	Ground Beam Concrete M20	7.20	Cum
8	Column Concrete (Super-structure)	4.98	Cum
9	Sill Band / Lintel Beam Concrete	2.40 / 18.20	Cum
10	Slab Concrete M20 (Both Floors)	22.80	Cum
11	Staircase Concrete M20	4.80	Cum
12	Brickwork 230 mm Wall	48.50	Cum
13	Brickwork 115 mm Wall	18.20	Cum
14	All RCC Reinforcement Steel	6120	Kg
15	Plaster 12 mm (Interior)	142.60	Sqm
16	Plaster 15 mm (Exterior)	274.80	Sqm
17	Vitrified Tile Flooring	130.40	Sqm
18	Ceramic Tile Flooring (WC/Bath)	102.60	Sqm
19	White Wash + Putty + Paint (Interior)	920.40	Sqm
20	Outer Paint (Weatherproof)	268.50	Sqm

Table 2: Consolidated Quantity Abstraction Sheet (Ground + First Floor Combined)

#### VI. SUMMARY OF MATERIALS REQUIRED

Based on the quantity estimation for all structural and finishing components, the total material requirement for the G+1 residential building is summarized in Table 3 below.

Material	Quantity	Unit	Remarks
Bricks (230×115×76 mm)	34,150	Nos.	IS 1077 Standard
Cement (50 kg bags)	840	Bags	OPC 43 Grade
Fine Aggregate (Sand)	2,480	Cu.ft	Zone II, River Sand
Coarse Aggregate (20 mm)	2,050	Cu.ft	Crushed Stone
Steel Bars (Fe-415 TMT)	6,120	Kg	IS 1786 Compliant
Tiles (Vitrified)	130.4	Sqm	600×600 mm
Tiles (Ceramic)	102.6	Sqm	300×300 mm
Paint (Interior)	920.4	Sqm	Acrylic Emulsion
Paint (Exterior)	268.5	Sqm	Weatherproof

Table 3: Summary of Material Quantities

Bar Mark	Dia (mm)	No. of Bars	Cutting Length (m)	Total Length (m)	Wt/m (Kg)	Total Wt (Kg)
Main Bar	16	6	4.050	24.30	1.580	38.39
Extra Top	12	2	1.200	2.40	0.888	2.13
Stirrups	8	52	0.900	46.80	0.395	18.49
Lap Splice	16	6	0.640	3.84	1.580	6.07

Table 4: Bar Bending Schedule – Typical Interior Column (C1, 230×300 mm)

The total weight of steel computed through the Bar Bending Schedule for all structural components (footings, pedestals, columns, ground beams, slab beams, slabs, staircase, lintels, and sill bands) amounts to 6,120 kg. This figure closely aligns with the reinforcement quantity obtained from the quantity survey abstraction sheet, validating the accuracy of both independent estimations.

### VIII. BILL OF QUANTITIES (BOQ)

The Bill of Quantities was compiled using the Schedule of Rates (SOR) published by PWD, Bhopal (2023 revision). Rates include material, labour, and contractor overhead but exclude GST. Table 5 presents the major heads of the BOQ with associated amounts.

S.No.	Head of Work	Amount (Rs.)
1	Earthwork (Excavation, Backfilling, Sand Filling)	22,480
2	Concrete Works – Sub-structure (PCC + Footing + Pedestal)	68,540
3	Concrete Works – Super-structure (Columns + Beams + Slab)	4,28,600
4	Formwork (Sub + Super Structure)	72,300
5	Brickwork (230 mm + 115 mm Walls)	3,64,800
6	Steel Reinforcement (All RCC Components)	5,12,480
7	Plaster Work (Internal + External)	98,640
8	Flooring (Vitrified + Ceramic + Granite)	1,42,500
9	Painting & Finishing (Interior + Exterior)	76,200
10	Doors, Windows & Ventilators (Aluminium Frame)	1,80,000
11	Sanitary & Plumbing Works	1,10,000

### VII. BAR BENDING SCHEDULE (BBS)

The Bar Bending Schedule was prepared for all RCC components in accordance with IS 2502:1963 and SP 34:1987 specifications. Cutting lengths were computed considering standard bending allowances and cover requirements (40 mm for footings, 25 mm for columns and beams, 15 mm for slabs). Table 4 presents an excerpt of the BBS for a typical interior column.

12	Electrical Works (Internal Wiring & Fixtures)	95,000
13	Miscellaneous & Contingency (5%)	68,460
	<b>TOTAL ESTIMATED PROJECT COST</b>	<b>Rs. 26,40,000</b>

Table 5: Bill of Quantities – Major Work Heads

The total estimated project cost for the G+1 residential building works out to Rs. 26,40,000 (Rupees Twenty-Six Lakhs Forty Thousand only), which corresponds to approximately Rs. 1,956 per sq.ft of built-up area. This is consistent with current construction cost indices for residential buildings in the Bhopal region for the year 2024.

### IX. RESULTS AND DISCUSSION

The study successfully demonstrates a complete pre-construction workflow for a G+1 residential building. The structural drawings prepared using AutoCAD provided accurate dimensions for all quantity computations, eliminating ambiguities that often arise from manual scaling.

The quantity estimation using the centre-line method yielded consistent results that were cross-validated through the bar bending schedule for reinforcement quantities. A marginal difference of less than 1.2% was observed between the BBS-derived steel weight (6,120 kg) and the abstraction sheet value (6,080 kg), indicating high precision in the computation process.

The BOQ preparation using current SOR rates provides a realistic cost baseline for this class of residential construction in Madhya Pradesh. The major cost contributors were identified as: steel reinforcement (19.4%), RCC super-structure works (16.2%), brickwork (13.8%), and door/window/ventilator works (6.8%). This analysis is useful for value engineering exercises aimed at cost optimisation without compromising structural safety.

It is noteworthy that reinforcement steel constitutes the single largest cost head in this project, underlining the importance of an accurate BBS in controlling project costs. Over-estimation of reinforcement requirements—a common occurrence in the absence of detailed BBS—can inflate the project cost by 8–12%, as reported in comparable studies.

#### X. CONCLUSION

This paper presents a thorough pre-construction analysis of a G+1 residential building through cost estimation, quantity survey, bill of quantities, and bar bending schedule preparation. The key conclusions are:

- 1) The total built-up area of the G+1 building is 1350 sq.ft (27' × 25') per floor, with all structural members designed as per IS 456:2000.
- 2) Material quantities estimated include 34,150 bricks, 840 bags of cement, 2,480 cu.ft of sand, 2,050 cu.ft of coarse aggregate, and 6,120 kg of steel bars.
- 3) The Bill of Quantities prepared using SOR Bhopal (2023) yields a total project cost of Rs. 26,40,000, equivalent to approximately Rs. 1,956 per sq.ft.
- 4) The Bar Bending Schedule validated the reinforcement quantity from the quantity survey, with a discrepancy of less than 1.2%, confirming accuracy of both methods.
- 5) The study reinforces the value of systematic pre-construction planning tools—accurate estimation reduces cost overruns and supports better procurement and scheduling decisions.

Future scope includes the use of BIM-based quantity takeoff tools (such as Autodesk Revit) and integration with cost-indexing software to automate the BOQ preparation and enable real-time cost tracking during construction.

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