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CORRECTION IN THUMB RULE FOR SANITARY AND WATER SUPPLY AND ELECTRICAL COST IN MODERN CONSTRUCTION PROJECTS

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Abstract: *As communities and regulators place build up demand on maintaining and make better infrastructure in cost effective and socially acceptable ways, there is an improved trend in the development and usage of technologies to provide the alternate solutions with advancement of technology.Therefore, this research aims to determine the percentage of Sanitary and Water Supply and Electrification cost with respect to the total percentage of the project cost by the collection of drawings of plans by consulting various architectures. We have done the market survey for current rate determination and evaluated quantities to prepare "Abstract and Measurement" sheet, for exact percentage as on date. The empirical relations prevailing today are getting modified in our study.*

Keywords:*Architecture Plan, Building Estimation, Electrical Cost, Plumbing Cost, Estimated Project Cost*

I. INTRODUCTION

An estimate is the anticipated or probable cost of a work and is usually prepared before the construction is taken up. Before undertaking any work or project it is necessary to know its probable cost which is obtained or derived by estimating. The estimate is prepared by computing or calculating the quantities required and then calculating the cost at suitable rates, to get the expenditure likely to be incurred in the construction of the work or structure. To make out an estimate for a work the following data are necessary – Drawing (plan, section, etc.), Specifications, and Item rates.

The primary object of an estimate is to enable one to know beforehand the cost of work.

The actual cost is known only after the completion of the work from the account of the completed work. If the estimate is prepared carefully and correctly there will not be much difference in between the estimated cost and the actual cost.
Account of all expenditure is maintained day-to-day during the execution of work in the account section and at the end of the completion of the work when the account is completed, the actual cost is known. The actual cost should not differ much from the estimated cost worked out at the beginning.

In building work for internal Electrification, Sanitary and Water Supply work a percentage of about 20% of the estimated cost of the building is provided. The provision is usually made an given below –

For Sanitary and Water Supply Works .... 8% of the estimated cost of the building works
For Electrification .... 8% of the estimated cost of the building works

A detailed estimate is usually prepared subsequently. A detailed estimate of Electrification and Sanitary and Water Supply Works may also prepare initially while preparing the estimate of building work.

The primary objective of this paper is to determine the percentage of Sanitary and Water Supply and Electrification cost with respect to the total percentage of the project cost by the collection of drawings of plans by consulting various architectures. Therefore, this paper aims to decide the thumb rule for sanitary and water supply works and electric work cost in modern construction projects.

II.LITERATURE REVIEW AND STUDY

From the literatures of many researchers it has been found that the commercial construction industry, efforts have been made to develop a uniform standard classification for various building elements known as UNIFORMAT originally developed by the American Institute of Architects and General Services Administration in 1972 for estimating and design cost analysis for commercial and Residential buildings. A second generation of the UNIFORMAT system known as

UNIFORMAT II defines a standard classification for building elements and related site work and was released in 1993 by the American Society for Testing and Materials under ASTM standard E1557. The UNIFORMAT II standard utilizes elements that are traditionally defined as major construction system components, common to most buildings that perform a given function regardless of the design specification, construction method or materials used.

The reliability of project cost estimates at every stage in the project development process is necessary for responsible financial management. Unreliable cost estimates result in severe problems in programming, budgeting, and planning. This, in turn, affects Engineering Services relations with the other divisions within Public Works & Utilities, other agencies, and the public, and ultimately results in loss of credibility.

Project cost estimating is not an exact science; however, estimators are expected to prepare reasonable project cost estimates that represent the cost to complete the project. These costs include those required not only for the contractor to construct the project but, also includes the costs for the purchase of right of way, mitigation ofenvironmental issues and any other costs that will be incurred to complete the project.

The computer-based residential cost estimation process of the present invention allows the ability to vary the selections related to design decisions, components of construction, quality of construction components, size of the home, quantities of materials and other variables within dynamically linked logical arguments in the computer program, resulting in instant recalculation of quantities and cost. This feature provides the ability to model numerous design and construction quality options, and to determine the cost impact of those options, so that a consumer may determine the cost of a residence or define the design parameters of a residence to meet a predetermined budget.

III. ESTIMATION PROCESS

The dimensions, length, breadth, and height or depth are to be taken out from the drawing – plan, elevation, and section. From the study of the drawing, the building is to be imagined and pictured in the mind and the dimensions are to be taken out correctly. There is no hard and fast rule for finding out dimensions from the drawing but the dimensions are to be taken out accurately. Junctions of the wall at the corners and at the meeting point of walls required special attention.

For symmetrical foundation which is the usual case, earthwork in an excavation in the foundation, foundation concrete, brickwork in foundation and plinth, and brickwork in superstructure may be estimated by either of the following two methods :

I) Separate or Individual Wall Method
II) Centre Line Method

I. Separate or Individual wall method

In this method, measure or find out the external length of walls running in the longitudinal direction generally the long walls out-to-out, and the internal lengths of walls running in the transverse direction in-to-in *i.e.* of the cross or short wall in-to-in, and calculate quantities multiplying the length by the breadth and the height of the wall. The same rule applies to the excavation in the foundation, to concrete in the foundation and to masonry. Care should be taken to note the difference in dimensions at a different height due to offset or footings. It is convenient to imagine plans at a different level of heights as foundation trench plan, foundation concrete plans of each footing, etc. and dealing each plan or part separately.

This method is simple and accurate and there is no chance of any mistake. This method may be named as Long-wall and Short-wall or general method.

II.Centre line method

In this method known as centreline method sum-total length of centre lines of walls, long and short, has to be found out. Find the total length of centre lines of walls, of the same type, long and short having the same type of foundations and footings and then find the quantities by multiplying the total centre length by the respective breadth and the height. In this method, the length will remain same for excavation in the foundation, for concrete in the foundation, for all footings and for superstructure(with a slight difference when there are cross walls or a number of junctions). This method is quick but requires special attention and consideration at the junctions, meeting points of partition or cross walls, etc.

For buildings having cross or partition walls, for every junction of partition or cross walls with main walls, special consideration shall have to be made to find the correct quantity. For each junction, half breadth of the respective item or footing is to be deducted from the total centre length. For rectangular, circular polygon (hexagonal, octagonal, etc.) building having no inner or cross wall, this method is quite simple.

3.1 Estimation for Building Works

Actually, we use both methods for calculating quantities of all required items in building construction *i.e.* Excavation in foundation, P.C.C. work, Brickwork, plasterwork, Floor Finishing work, etc. items are calculating by Centre line method and R.C.C. work, Mild steel, Door, and Window shuttering, colour work, etc. items are calculating by Separate wall method.

We preferred IS Codes as a reference in calculation and all code names listed below:

1) IS 1200-1 (1992): Methods of measurement of building and civil engineering works, Part 1: Earthwork
2) IS 1200-2 (1974): Method of measurement of building and civil engineering works, Part 2: concrete works
3) IS 1200-3 (1976): Method of Measurement of Building and Civil Engineering Works, Part III: Brickwork
4) IS 1200-4 (1976): Method of measurement of building and civil engineering works, Part 4: stone masonry
5) IS 1200-5 (1982): Method of measurement of building and civil engineering works, Part 5: form work
6) IS 1200-8 (1993): Method of measurement of building and civil engineering works, Part 8: steel work and iron work
7) IS 1200-9 (1973): Method of measurement of building and civil engineering works, Part 9: roof covering
8) IS 1200-10 (1973): Method of measurement of building and civil engineering works, Part 10: ceiling and linings
9) IS 1200-11 (1977): Method of measurement of building and civil engineering works: Part11 paving, floor finishes dado and skirting
10) IS 1200-12 (1976): Method of Measurement of Building and Civil Engineering Works, Part XII: Plastering and Pointing
11) IS 1200-13 (1994): Method of measurement of building and civil engineering works, Part 13: Whitewashing, Color Washing, distempering and painting of building surfaces

We have done a market survey in a different city for to know the market rate at various locations and considered the least rate of items and calculate the required quantities in building construction and calculate the estimated cost of the building construction. Building Construction Measurement and Abstract sample sheet listed below:

[Table-1 Building Construction Measurement Sheet]

Sr no.	Description	Quantity	Unit	Rate	Per	Amount
1						
2						

Sr no.	Description	No.	Length(m)	Width(m)	Height(m)	Quantity	Unit	Explanatory notes
1								
2								

[Table-2 Building Construction Abstract Sheet]

3.2 Estimation for Sanitary and Water Supply Works

We are preferredIS 1200-19 (1981): Method of Measurement of Building and Civil Engineering Works, Part XIX: Water Supply, Plumbing and Drainsto calculate the quantities of item for sanitary and water supply work based on drawings of water supply and sanitary pipe, we calculate the required length of pipe and quantities of taps, valves, pillar cock, stop-cock, caps and linings, waste washers, bends, elbows, tees, branches, enlarged sockets, wash basins, commodes, etc.

Building Sanitary and Water supply Measurement and Abstract sample sheet listed below :

Sr no.	Description	No.	Per Floor	Calculation	Quantity	Unit
1						
2						

[Table-3 Plumbing Measurement Sheet]

Sr no.	Description	Quantity	Unit	Rate	Per	Amount
1						
2						

[Table-4 Plumbing Abstract Sheet]

3.3 Estimation for Electrification Works

Based on drawings of electric work, we calculate the required length mainline and quantities of theprimary point, secondary point, two way light point, TV point, AC point, 16A plug point, MCB, DB Box, etc. Building electric calculation sample sheet listed below :

Sr no.	Description	Quantity	Unit	Rate	Per	Amount

[Table-5 Electrical calculation sheet]

3.4 Abstracting

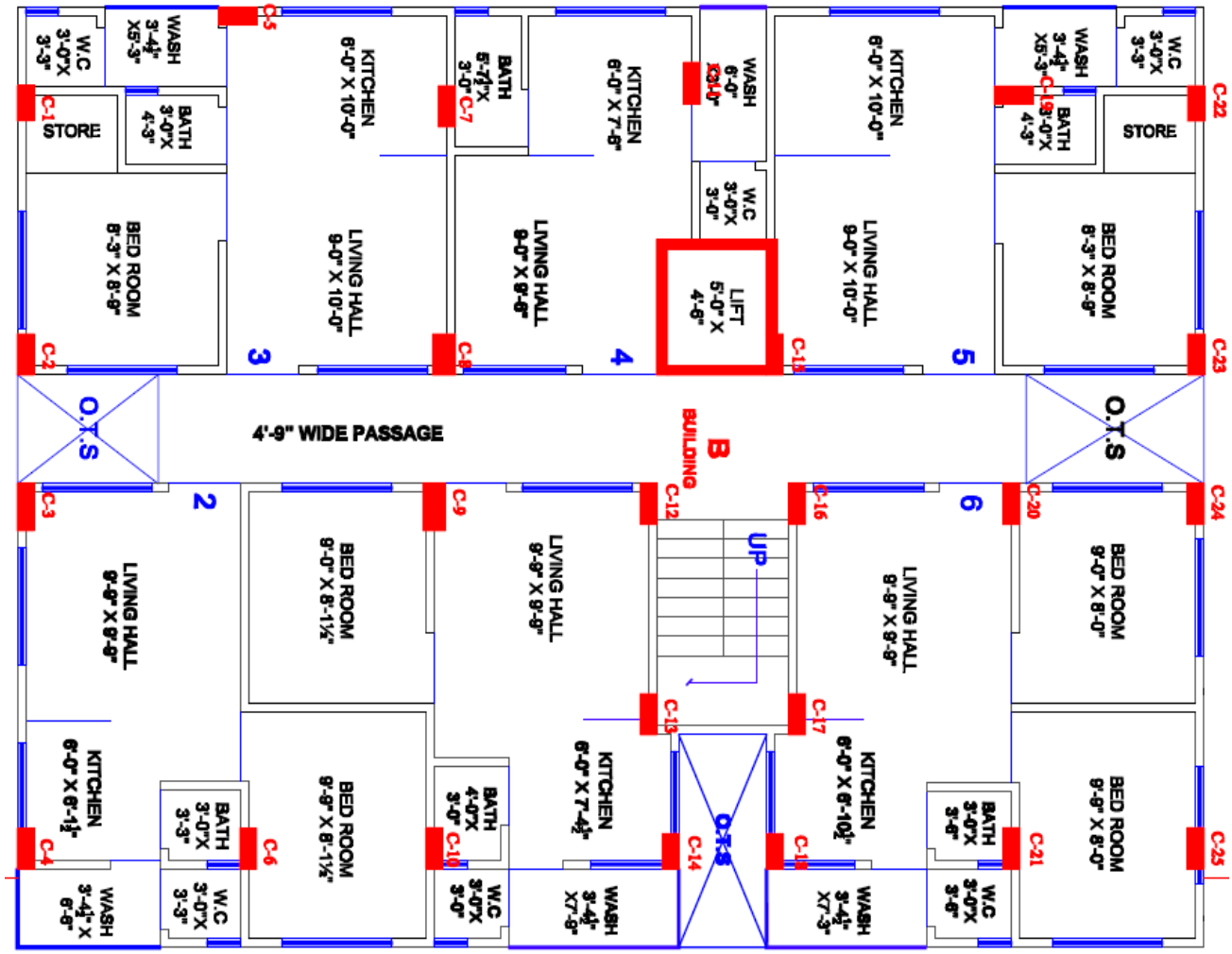
We have done a judicial decisions of market survey in three different cities and some item rates listed below :

Sr no.	Item	Surat	Rajkot	Ahmadabad
1	Cement	Rs.290/bag	Rs.280/bag	Rs.295/bag
2	Mild Steel	Rs.45/kg	Rs.41/kg	Rs.44/kg
3	Flooring	Rs.1175/sq m	Rs.1180/sq m	Rs.1177/sq m
4	Brickwork	Rs.3070/cu m	Rs.3055/cu m	Rs.3072/cu m
5	Light point	Rs.350/point	Rs.355/point	Rs.360/point
6	Colour Work	Rs.20/sq m	Rs.24/sq m	Rs.22/sq m
7	Water Supply Work	Rs.190/feet	Rs.195/feet	Rs.192/feet

[Table-6 Market Survey Rates]

IV. TYPICAL ESTIMATE

1) Typical Building Floor Plan



[Fig. 1 Typical Building Floor Plan]

[Fig. 2 Building Elevation Layout]

2) Building Construction Abstract Sheet

From the above typical building floor plan we have calculate the quantities of required items and calculate the estimated cost of building construction. Building abstract sheet listed below:

Building Construction Abstract Sheet

Sr no.	Description	Quantity	Unit	Rate	Per	Amount
1	Earthwork for excavation in foundation upto ground level	850.14	Cu m	490	Cu m	416568.6
2	Providing and Laying CC (1:4:8) for Foundation	10.46	Cu m	2425	Cu m	25365.5
3	R.C.C. Work 1:2:4 in Columns, Footing, beams and slab excluding steel reinforcement and its bending but including centering, shuttering and binding steel	1817.28	Cu m	3340	Cu m	6069715.2
4	Providing and fixed Mild steel including bending in reinforcement in R.C.C. Works	140928.21	kg	41	kg	5778056.61
5	Earthwork in Filling in foundation upto plinth	739.91	Cu m	750	Cu m	554932.5
6	Providing I - class brick work in 1:6 cement mortar (one brick 20cm thick) with all required materials and including labour cost	544	Cu m	3070	Cu m	1670080
7	Providing 12 mm plaster in 1:6 cement mortar with required materials and including labour cost	734.06	Cu m	95	Cu m	69735.7
8	Marble fitting and fixed in kitchen with required materials and specified diamensions and including labour cost	155.65	Sq m	875	Sq m	136193.75
9	Marble Fitting framed and fixed in door and windows chaukhat with required materials and specified diamensions and including labour cost	327.18	Sq m	900	Cu m	294462
10	Door Shutters 2 cm thick panelled of teak wood excluding fittings with painting with required materials and specified diamensions including labour cost	212.58	Sq m	945	Sq m	200888.1
11	Window shutters 2 cm thick excluding fitting and painting with required materials and specified diamensions and including labour cost	281.9	Sq m	2700	Sq m	761130
12	2.5 cm C.C. 1:2:4 over and including 7.5 cm L.C. Floor finished with neat cement floating with required materials and specified diamensions and including labour cost	811.65	Sq m	1175	Sq m	953688.75
13	2.5 cm C.C. 1:2:4 over and including floor Finished with cement floating with required materials and specified diamensions and including labour cost	154.13	Sq m	950	Sq m	146423.5
14	3 cm thick Water proofing over terrace with required materials and specified diamensions and including labour cost	154.13	Sq m	30	Sq m	4623.9
15	Tiles in Bathroom upto slab level with required materials and specified diamensions and including labour cost	166.8	Sq m	500	Sq m	83400
16	White washing 3 coats inside with required materials and including labour cost	4611.71	Sq m	20	Sq m	92234.2
17	Colour washing 2 coats over one coat whitee washing with required materials and including labour cost	1200.42	Sq m	75	Sq m	90031.5

18	Iron grill framed and fixed with required materials and including labour cost and specified diamensions and including labour cost	233.88	Sq m	4500	Sq m	1429266.66
19	Providing and laying into right position Water Tank including labour cost	10000	Liters	8	Liter	80000
					Total 1 =	18856796.5
20	Providing Water Boring including labour cost and other all required materials	200	feet	225	feet	45000
					Total 2 =	18901796.5
21	Providing and laying Lift into right position	max. 8	Pass.			350000
					Total 3 =	19251796.5

Note :	
	Total 1 = Low rise building total cost without water boring and lift
	Total 2 = Low rise building total cost with water boring and without lift
	Total 3 = Low rise building total cost with water boring and lift

[Fig. 3 Building Construction Abstract Sheet]

3) Typical Sanitary and Water Supply work

From the typical building drawings we have calculate the quantities of required items and calculate the estimated cost of sanitary and water supply work. Plumbing abstract sheet listed below:

Plumbing Abstract Sheet

Sr no.	Description	Quantity	Unit	Rate	Per	Amount
1	Providing and fixed Commode (W/C Indian Style -White by Parrywood) including labour cost and transportation cost	30	Nos.	700	Nos.	21000
2	Providing and fixed Q-Trap including labour cost and transportation cost	30	Nos.	120	Nos.	3600
3	Providing and fixed Wash basin (casket W/B table top 470 - white by Parrywood) including labour cost and transportation cost	6	Nos.	1500	Nos.	9000
4	Providing and fixed Kitchen sink (Stainless steel by Nirali Brand) including labour cost and transportation cost	30	Nos.	1475	Nos.	44250
5	Providing and fixed 4" Dia. Drainage Pipe (Orange Pipe) including labour cost and transportation cost	1187.75	feet	60	feet	71265
6	Providing and fixed Cold water pipe (1" Dia. cPVC Astral pipe) including labour cost and transportation cost	245.75	feet	25	feet	6143.75
7	Providing and fixed Hot water pipe (1" Dia. cPVC Astral pipe) including labour cost and transportation cost	562.5	feet	25	feet	14062.5
8	Providing and fixed Cross Angle (Astral) including labour cost and transportation cost					

	Drainage (4" Dia.)	20 Nos.	110 Nos.	2200
	Water Pipe	20 Nos.	90 Nos.	1800
9	Providing and fixed T Angle (Astral) including labour cost and transportation cost			
	Drainage	95 Nos.	75 Nos.	7125
	Water Pipe	155 Nos.	80 Nos.	12400
10	Providing and fixed Elbow (Astral) including labour cost and transportation cost			
	Drainage	170 Nos.	65 Nos.	11050
	Water Pipe	320 Nos.	80 Nos.	25600
11	Providing and fixed Bib cock (Jaquar) including labour cost and transportation cost	120 Nos.	525 Nos.	63000
12	Providing and fixed Angle cock (Jaquar) including labour cost and transportation cost	180 Nos.	275 Nos.	49500
13	Providing and fixed Pillar cock (Jaquar) including labour cost and transportation cost	90 Nos.	1375 Nos.	123750
14	Providing and fixed Shower (Jaquar) including labour cost and transportation cost	30 Nos.	1050 Nos.	31500
15	Providing and fixed Supply Pipe including labour cost and transportation cost	180 Nos.	50 Nos.	9000
16	Providing and fixed Fourway Diveter (Jaquar) including labour cost and transportation cost	30 Nos.	1650 Nos.	49500
17	Providing and fixed External Drainage 4" Dia. Pipe including labour cost and transportation cost	780 feet	60 feet	46800
18	Providing and fixed Cold water pipe (1.5" Dia. cPVC Astral pipe) including labour cost and transportation cost	450 feet	30 feet	13500
			Total =	616046.25

[Fig.4 Plumbing Abstract Sheet]

4) Typical Electric Work

From the typical building drawings we have calculate the quantities of required items and calculate the estimated cost of electric work. Electric work calculation sheet listed below:

Electrictical Calculation Sheet

Sr no.	Description	Quantity	Unit	Rate	Per	Amount
1	Providing and fixed primary light point (ISI Marked flush type switch, PVC box, Lamp holder, board panel and other all necessary materials with labour cost)	295	Nos.	350.00	Nos.	103250.00
2	Providing and fixed secondary light point (ISI Marked flush type switch, PVC box, Lamp holder, board panel and other all necessary materials with labour cost)	5	Nos.	195.00	Nos.	975.00
3	Providing and fixed two way light point (ISI Marked flush type switch, PVC box, Lamp holder, board panel and other all necessary materials with labour cost)	120	Nos.	750.00	Nos.	90000.00
4	Providing and fixed plug point (ISI Marked flush type switch, PVC box, Lamp holder, board panel and other all necessary materials with labour cost)	360	Nos.	220.00	Nos.	79200.00
5	Providing and fixed separate plug point (ISI Marked flush type switch, PVC box, Lamp holder, board panel and other all necessary materials with labour cost)	30	Nos.	410.00	Nos.	12300.00
6	Providing and fixed fan regulator (ISI Marked regulator, PVC box, Lamp holder, board panel and other all necessary materials with labour cost)	90	Nos.	480.00	Nos.	43200.00
7	Providing and fixed TV point	60	Nos.	225.00	Nos.	13500.00
8	Providing and fixed LAN point	30	Nos.	225.00	Nos.	6750.00
9	Providing and fixed Telephon point	30	Nos.	225.00	Nos.	6750.00
10	Providing and laying LAN Cable	100	MTR.	30.00	MTR.	3000.00
11	Providing and laying Telephon cable	100	MTR.	19.00	MTR.	1900.00
12	Providing and fixed Bell point (ISI Marked flush type switch, PVC box, Lamp holder, board panel and other all necessary materials with labour cost)	30	Nos.	440.00	Nos.	13200.00
13	Providing and fixed AC point	30	Nos.	940.00	Nos.	28200.00
14	Providing and fixed 16A plug point	120	Nos.	690.00	Nos.	82800.00
15	Dummey	60	Nos.	30.00	Nos.	1800.00
16	Providing and fixed American hook	90	Nos.	60.00	Nos.	5400.00
17	Providing and laying Fan pipe and pulley	90	Nos.	50.00	Nos.	4500.00
18	Providing and fixed pipe conduit	2400	MTR.	10.00	MTR.	24000.00
19	Providing and laying TV cable	100	MTR.	29.00	MTR.	2900.00
20	Providing and laying 2.5sq mm main line(5A Line cable)	2400	MTR.	25.00	MTR.	60000.00
21	Providing and laying 4.0sq mm main line(15A line cable)	1100	MTR.	35.00	MTR.	38500.00
22	Providing and fixed 16A MCB SP	90	Nos.	190.00	Nos.	17100.00
23	Providing and fixed 32A MCB SP	30	Nos.	390.00	Nos.	11700.00
24	Providing and fixed 8WAY DB BOX	30	Nos.	450.00	Nos.	13500.00
25	Earthing	1	Nos.	6000.00	Nos.	6000.00
26	Providing and fixed D/P MCB and Motor Starte	1	Nos.	850.00	Nos.	850.00
					Total =	647275.00

[Fig. 5 Typical Electric Calculation Sheet]

5) Final Statement Calculation

A. Estimated cost based on conventional method :

- Total building construction cost = Rs. 2.57 Cr.
- Building construction cost = Rs. 1,92,51,796
- Add 8% electrical cost = Rs. 15,40,143
- Add 8% plumbing cost = Rs. 15,40,143
- Total cost = Rs. 2,23,32,082
- Add 5% contingencies and workcharge establishment = Rs. 11,16,604
  Add 10% Contractor's Profit = Rs. 22,33,208
- Total building cost = Rs. 2,56,81,894

1. LOW RISE BUILDING TOTAL COST WITHOUT WATER BORING AND LIFT :

A. Estimated cost of building :

- Total building construction cost = Rs. 1,88,56,796

B. Estimated cost of plumbing work :

- Total plumbing work for building = Rs. 6,16,046
- % of total project cost = 6,16,046 * 100 / 1,88,56,796 = **3.26%**

C. Estimated cost of electrical work :

- Total electrical work for building = Rs. 6,47,275
- % of total project cost = 6,47,275 * 100 / 1,88,56,796 = **3.43%**

2. LOW RISE BUILDING TOTAL COST WITH WATER BORING AND WITHOUT LIFT :

D. Estimated cost of building :

- Total building construction cost = Rs. 1,89,01,796

E. Estimated cost of plumbing work :

- Total plumbing work for building = Rs. 6,16,046
- % of total project cost = 6,16,046 * 100 / 1,89,01,796 = **3.25%**

F. Estimated cost of electrical work :

- Total electrical work for building = Rs. 6,47,275
- % of total project cost = 6,47,275 * 100 / 1,89,01,796 = **3.42%**

3. LOW RISE BUILDING TOTAL COST WITH WATER BORING AND LIFT :

G. Estimated cost of building :

- Total building construction cost = Rs. 1,92,51,796

H. Estimated cost of plumbing work :

- Total plumbing work for building = Rs. 6,16,046
- % of total project cost = 6,16,046 * 100 / 1,92,51,796 = **3.19%**

I. Estimated cost of electrical work :

- Total electrical work for building = Rs. 6,47,275
- % of total project cost = 6,47,275 * 100 / 1,92,51,796 = **3.36%**

[Fig. 6 Final Statement Sheet]

V.CONCLUSION

As per conventional method of estimation the plumbing and electrical cost is directly added to 8% of total cost of the building. From the above calculation, we have observed that viable variation in percentage cost of plumbing and electrical cost due to modern construction instruments and techniques. By our calculation, percentage cost for plumbing and electrical works are a drop down from **8% to avg. 3.23% and avg. 3.40%** respectively.

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