Electrification of Residential Buildings

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Abstract **- Electricity exists in a form that is useful to exploit, however, it will also be important to install electricity as efficiently as possible, and design of the power distribution system should be convenient so as to minimize power losses. Electrical wiring is an electrical installation of cabling and associated devices such as switches, distribution boards, sockets, and light fittings in a structure. Wiring is subjected to safety standards and purpose for designs and installations. Electrical installation is the combination of low voltage wire, fixing elements, supports, and other constructions that combines the lighting network, power system, or electric circuits of control. The task of a practical assignment is to do analysis of wiring for a residential building and to include a building in our plan. In this paper, we will be doing a study on the electrification of residential buildings. We will see how electric wiring is done, how much load is to be carried out, electricity board intake, earthing and estimation and costing in residential plans.**

Index Terms **- electrification, load, estimation and costing.**

I.INTRODUCTION

Every electrical installation be it residential, commercial, or
industrial building is preceded by a careful plan and design. Designs for building installation involves various calculations based on several factors and conditions which includes types of buildings, purpose of buildings, physical building parameters. Electrical design is the process that involves planning, creating, testing, and installation of electrical equipment in accordance with the approved regulations. This research is basically related to the role of an electrical contractor who takes proper measures, follow guidelines, and execute plans accordingly while doing installation of residential buildings. Many factors were put into considerations during the design. Some of this includes safety, durability, flexibility of installation, and cost of installation. The important areas covered in this paper are load estimation and calculation, how energy meters are installed according to the loads and how earthing is done and calculated.

II. OBJECTIVE

The main objective of this paper is to understand how electrical wiring and installations are done in a residential building. So we have demonstrated this with an example of a normal 1 BHK room in which we will develop a general plan ,calculate the total lighting load, size of the wire ,length of the conduit required, calculate the total labour charges and other electrical accessories required. Along with that we will also get to know how installation and commissioning of energy meter is done in which we will know about the various procedures and necessary documents which are required for the commissioning of the energy meter and finally what will discuss about the earthing, what type of earthing should be recommended for our general plan what will be the cost of earthing and how earthing is done.

III.ADVANTAGES

Some of the advantages are:
1. human Safety
2. No damage to the electrical appliances.
3. minimized power loss.
4. there is no risk of electric shock.
5. easy maintenance
6. long durable system.

IV.DISADVANTAGES

1. Installation is difficult.
2. Risk of mechanical injury.

V.METHODOLOGY

Research methodology is basically the procedure which is used to evaluate a topic which includes:

A.Step 1: House wiring, estimation and costing of a plan:

We have made a general plan of a 1 BHK room and calculated total lighting loads and number of circuits and that is shown in the table below:

Table 1

S.NO.	LOCATION	LIGHTS	FANS	SOCKETS
1.	VERANDAH	1×60		
2.	ROOM	1×40,1×60	1×80	1×60
3.	HALL	2×40,1×60	1×80	1×60
4.	KITCHEN	2×40,1×60		PS =2000
5.	PASSAGE	1×60		
6.	BATHROOM	1×60		PS=1000
	TOTAL LOAD =	480 W	160 W	

Step 2: Calculations of load:

Total load of installation = total heating circuit load + total lighting circuit load.

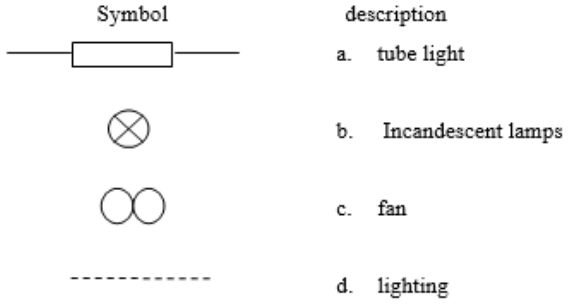
Hence, total load of installation = 3760 W

Number of lighting circuit = total lighting circuit load/800

Hence, number of lighting circuit = 760/800=0.95.

Wiring symbols:

Here are some of the wiring symbols which are used in our wiring diagram.



step 3: calculation of size of wire:

size of the wire can be calculated by finding the load current and current rating and according to that suitable wire is taken. Wire table is shown below:

Table 2. wire table

Size of conductor		Two cables DC or single phase AC		Three or four cables balanced three phase AC	
Nominal area in mm2	Number and diameter of wire in mm	Current ratings in amperes	Approx length of run 1V drop in metres	Current rating in amperes	Approximate Length for run of one volt in metres
1.0	1/1.12	5	4.9	5	5.8
1.5	3/0.737	10	3.0	10	3.7
2.5	3/1.06	15	3.4	13	4.3
4.0	7/0.737	20	3.7	15	5.2
6.0	7/1.06	28	4.0	25	5.8
8.0	7/1.12	36	4.9	32	6.1
10.0	7/1.40	43	5.5	39	7.0
15.0	7/1.63	52	7.0	48	8.8
20.0	19/1.12	62	7.6	56	9.8
25.0	19/1.40	74	8.8	67	11.3
30.0	19/1.63	97	10.0	88	12.8
50.0	19/1.80	160	19.4	155	13.4

For the conduit system, we will be using concealed conduit system of wiring because it helps in protection against fire. These can be easily identified according to their colors.

Step 4: Total length of wire required:

We have calculated the total length of the wire required:

Total length of the wire required = length of the wire (1.5 sq mm copper wire) = 41×3 = 123 meter.

Step 5: total number of wood screws required:

wood screws (assorted size) = 4 (number of MB +SB) here, MB refers to mains board and SB refers to the switch board)

=4(1+5) = 24+5% wastage.

=25.95 Nos.

Step 6: accessories required:

These accessories are a very vital part in our electric wiring. Some of the accessories required in the installation of our appliances are:

ICDP SWITCH or MCB
ICDP switch stands for iron clad double pole switch and it is normally used in single phase supply system.
Load current =3.30×2 =6.60 amps
Switches = number of lamps + fans + sockets
=12 +2 =14
A 250 V, 5A , 3-pin sockets =2.
Number of fan regulators = 2.
Number of pendent holders = 6.
Number of angle holders =4.
Number of ceiling roses = number of fans + number of pendents = 2+6 = 8.
Fluoroscent fitting = 230V, 5a, =4 set
Ceiling fans, 230 V,2 set.
Incandescent fitting = 6 set.
Number of tees = 4.
Meter board = 1.
These are the required number of our electrical accessories in our residential plan.

Step 7 labour charge :
the labour charge depends upon the number of points
number of points = (lights+ fans+ sockets) +MB
= 10+2+2+1 = 15.
Labour cost = cost per point*number of points
= 195*15 = Rs. 2970

Fig .1. Electrical accessories

Step 8: costing table
Costing table helps us to calculate the total costs of all the electrical accessories required in the installation. the table mentioned below is the costing table of our general plan:

Table 3. costing table

S. NO.	PARTICULARS	UNIT	QUANTITY	RATE	COST(Rs)
1.	3/22 SWG copper wire	m	123	6.00	738.00
2	19mm PVC pipe	m	41	8.00	328.00
3	ICDP,250V,15A	No	1	350.00	350.00
4	switches	No	14	15.00	210.00
5	3-pin sockets	No	2	20.00	40.00
6	Fan regulators	No	2	35.00	70.00
7	Pendent holders	No	6	15.00	90.00
8	Angle holder	No	4	20.00	80.00
9	Ceiling roses	No	8	15.00	120.00
10	Number of tees 19 mm	No	4	7.00	28.00
11	Number of elbow	No	5	4.00	20.00
12	Switch board	No	4	25.00	100.00
13	Labor cost				2970.00
14	Miscellaneous materials	LS			300.95
			Total cost		6508.9
			contingency		254

Calculations of heating circuit:
Load current = total heating circuit/voltage
=3000/230 = 13.04 Amps.
Current rating = load current × factor safety
=13.04×2 = 26.08 Amps.
By preceding further and looking back into the wire table, 6 sq mm copper wire will be required in this case.

PVC conduit required:
Horizontal run = 4+2+4+1+2+1.5+3+2.5 = 18 meter.
Vertical drop = 1+1 = 2 meter.
Wall crossing = 0.33*4=1.32 meter.
Total PVC conduit = 21.32 = 22(25mm, 2mm thick)
So , total PVC conduit we will be using is 22.

B. Procedure of installation of single-phase commercial energy meter:

After the electric wiring is done, all the electrical equipment gets installed, then there comes the role of energy meter. It is mostly recommended for domestic settings and it is normally connected at 230 volts via active and neutral wires. one of the major advantages of these energy meters is that they are very lightweight and compact and one can easily rely on accuracy of this meter. The energy meter is based on the load, whatever load is calculated, it is done on the basis of square meter or square feet. Below mentioned are the prerequisites for the installation of a single-phase energy meter:

1. A1 FORM (MSEDCL)
2. Survey report
3. Appendix 2
4. Index 2
5. Tax receipt
6. Nearest customer number
7. Aadhar card/PAN card (as we are providing the plan of an Indian residential building so these two major documents are very necessary as per Indian citizen)
8. 100rs stamp paper
9. Electrical contractor's test report

The process for Sanctioning the energy meter is as follows

1. We have to attach all the documents of the owner which is necessary
2. We have to fill the application form with correct Name, Address, Mobile no, Nearest consumer no, Consumer category, Service requested (as it is residential so it will be L.T. Supply), Type of premises, Category and the load (in kw and kva).
3. After filling all the details we get a otp on the Mobile no whichever is given.
4. After entering the OTP, we will get an application no and we have to write the application no on the A1 form which have to attach with the documents.
5. The application is filled on the distribution company website.

Where should we submit all the documents ?

1. It is submitted at Sub-Division Office of the distribution Company.
2. The given loads are submitted at the following offices.
3. The load below 20kw is submitted at the sub-division office to the Assistant Engineer.
4. The load between 20 to 50 KW is submitted to the Additional Executive Engineer.
5. The load above 50 KW is submitted to the Division office.
6. The documents will be verified by the assistant engineer.
7. After verifying the documents, The Assistant Engineer or the Technician will visit the site.
8. If there is no remark the Assistant Engineer will make a Firm Quotation.
9. We have to pay the firm quotation either on site or pay by cash.
10. The firm Quotation of the single-phase energy meter will be around 960 rs /-

When and who will install the energy meter?

1. After paying the firm quotation the energy meter is installed within 15 days minimum or maximum 1 month from the date or on the availability of the meter.
2. The meter will be available at the sub-division office and after the availability the Technician will visit and install the meter.
3. It is installed in such place, where it will be the easy way to take readings.

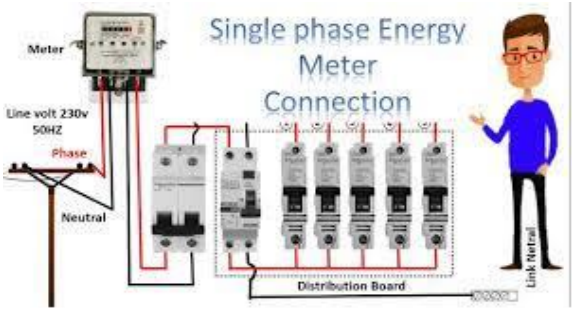


Fig. 2. single phase energy meter connection.

some of the reasons why previous meters are not used by the distribution company are: they cannot detect or record any tampering attempt, they gives only unidirectional information, they are less accurate, they includes mechanical components

C.EARTHING:

It is the process of transferring the instantaneous discharge of the electrical energy into the earth with the help of a low resistance wire is known as earthing. This energy can be discharged by connecting a metal device to the vast mass of the earth, the resistance of

the wire is negligible. This helps us in preventing shock from the leakage current. A good ground connection must have low impedance to ensure sufficient current flows through the safety device for it to disconnect the supply.

Purpose:
The purpose of the earthing is to prevent shock from the leakage current. It helps in protecting buildings, machinery and electrical equipment in the event of faulty conditions. It provides a safe path to dissipate lightning and short circuit currents. It also provides protection from static electricity from friction, over voltage protection and helps in voltage stabilization.

Types of earthing:
1.) Plate earthing:
Size-
For cast iron plate = 600 mm×600mm×12mm
For copper plate = 600mm×600mm×1.5mm
For galvanized iron plate = 600mm×600mm×6.3mm

2.) pipe earthing: it is one of the cheapest earhing. If the pipe electrode is made up of galvanized iron, then
a.) size of the inner diameter should not be less than 38mm
b.) size of hole = 12mm.

3.) rod earthing:
This type of earthing is suitable for areas that are sandy, and the diameter of copper rod should be 12.5mm and for solid rod diameter should be12.5mm. There is a hollow section of 25mm GI pipe with the length not less than 3 meters.

4.) strip earthing:
In this type of earthing system, copper wire is used or cross section strip of not less than 25mm×1. 6mm.The strip of wires are buried in horizontal trenches.
Some of the factors affecting earth resistivity are-

- Soil resistivity
- Moisture
- Presence of salt

The value of earthing resistance for domestic application is 1Ω.

Costing of earthing:

ITEM DESCRIPTION (1×1)	PRICE (Rs)
COPPER PLATE (2×2)	700
COPPER PLATE	1500
COPPER WIRE	150
SLAT	300
COAL	150
FUNNEL	200
TOTAL	1500

in case for domestic purposes, plate earthing is highly recommended.

CONCLUSION

In this paper, we have done the analysis on the electrification of a residential building and illustrated it with a general plan of a 1BHK room. This paper was divided into three parts which are one of the most essential requirements while doing electric installation for residential house or building. In the first section, house wiring, estimation and costing of a residential building is done where several calculations were performed. The results of these calculations helps to make vital decisions for selecting the various electrical equipment and accessories. In the second section, connection of a single-phase energy meter was shown, in which all the procedures and required documents for installation of energy meter was mentioned. In the last section, earthing was discussed, in this part, what type of earthing should be used and cost of earthing. Hence, by following above methodologies, a simple and safe electric connection can be established.

REFERENCES

[1] Brian scaddan (2008) 17th edition IEE wiring regulations: explained and illustrated eight editions.
[2] John hauck (2009) electricsl design of commercial and industrial building, jones and bartlett publishers
[3] Thereja, B.L. and thereja AK (2005). A textbook of electrical technology, first multicolour edition, s. chand and company limited, ram nagar, new delhi
[4] Electrical wiring, estimation and costing, S.L. uppal, JM laroia, khanna publishers, 1987
[5] Electricity metering in easy steps, Dr. shashi kant bakre
[6] https://en.wikipedia.org/wiki/Electrical_wiring [Retrieved October 8, 2019]
[7] learn.org/articles/What_is_Electrical_Design.html [Retrieved September 18,2019]

[8] John Hauck (2009) Electrical Design of commercial and Industrial building, Jones and Bartlett Publishers, LLC. https:// plainhelp .com/purpose-earthing-electrical-installation/
[9] https://www.electricaltechnology.org/2012/11/how-to-wire-single-phase-kwh-meter.html
[10] Fred Hall and Roger Greeno (2007). Building Services Handbook, fourth edition, Published by Elsevier Limited.
[11] schneider electric. Electric installation guide, according to IEC international standard,2016, 580p., ISBN-978.2.9531643.3.6.
[12] paddock, J.O and galvin, R.A.W. (1982). Electrical installation technology and practice 13th impression, London.