ELECTRICAL DOMESTIC INSTALLATIONS FOR HIGH RISE DWELLINGS

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ABSTRACT

This paper is about electrical domestic installations for high rise dwellings. The scope includes wiring system the whole building with all equipment and facilities needed in building such as compound lighting, fan, lift and electrical accessories (plugs and socket outlet).The design involved equipments design, size and type of cable design and lastly safety and protection design.

The first part is introduction and background of the design. The second part is the design of electrical equipment designs such as lighting, socket outlet, low voltage power supply.

1.0 INTRODUCTION

In these electrical installations, the flat house has a four type of houses consist of Type A, Type B, Type C and Type D. For Type A and Type B, consist of master bedroom, bedroom 1, bedroom 2, bedroom 3, bathroom 1, bathroom 2, living room, dining, kitchen, foyer, yard and balcony. But the difference between these two houses is the area. For Type A, the total area is 79.63m^2 and for Type B are 72.17m^2.

Type C and Type D consist of master bedroom, bedroom 1, bedroom 2, bedroom 3, bedroom 4, bathroom 1, bathroom 2,bathroom 3, wardrobe, utility, living room, dining, breakfast bar, entrance hall, kitchen, foyer, yard and balcony. The total area for Type C is 160.16m^2 and Type D is 143.79m^2.

Type A and Type B houses starting at ground floor up to seventh floor. For Type C and Type D houses on the top floor. The area of corridor at ground floor is 161.412m^2, at first floor to fifth floor is 161.412 m^2 each floors, at sixth to seventh floor is 110.23 m^2 and eight floor is 70.63 m^2. The area for lift lobby each floor is 103.2 m^2.

For the ground floor, the Type A houses has 14 units and Type B houses have 2 units.

There is a square at the middle of the building which is the area for this square is 119.9 m^2. The overall area for ground floor is 1643.67 m^2.

For the first floor to fifth floor, the Type A houses has 14 units and Type B houses have 2 units. The overall area for these floors is 1523.77 m^2. For the sixth floor to seventh floor, the Type A houses has 10 units and Type B houses have 2 units. The overall area for these floors is 1154.07 m^2. For the eight floor, the Type A houses has 1 units, Type B houses has 1 units house, Type C houses have 2 units and for Type D houses has 1 unit. The overall area for these floors is 789.74 m^2.

Then the total demand for four type houses depend on Table 1; Guide to power demand estimate and Table 2; Typical range of maximum demand (MD) for domestic customer sub-classes or premises. The total demand of Type A houses is 3.336 kW, Type B houses is 3.064 kW, Type C houses is 7.465 kW, Type D houses is 6.684 kW. The total demand for this building is 700kW.

This building also was installed with three lifts which the power of each of lifts is 15kW and it can carry the consumers at least 15 persons or load weight is least than 1000kg at certain times.

Before start the installation, first thing to consider it is to determine the size of cable to be used. The factors which affect the ability of a cable to lose heat are ambient temperature, class of excess-current protection, cable grouping, disposition and thermal insulation. Besides, the voltage drop must be considered to determine the size of cable. A voltage drop should not exceeding 4 percent of the nominal voltage of the supply (240 V), below 9.6 V. If the voltage drop is below 9.6 V, the size of cable is suitable to use.

Lastly, grounding system must be considered in the electrical installation. The purpose of grounding is to connect all metal part which over-current to earth. So, all electrical equipments would save from damage cause of the differences potential cannot exist either between different metal parts or between different metal parts or between metal parts and earth. The miniature circuit breaker (MCB) and fuse are commonly used as protective device to protect electrical equipments against over current. The MCB is preferred to be use because it is easier to do maintenance.

FEATURE	DEMAND IN VOLT-AMPERE PER AREA(VA / M^2)
LIGHTING OFFICE OTHERS (STORE, CORRIDOR)	25 – 30
AIR-CONDITIONING	90 - 130
GPO (GENERAL POWER OUTLET)	40 - 50
LIFTS	10
AMENITIES HOT WATER, ETC	5 - 10

Table 1 The power demand estimate for TNB's Electricity Supply Application Handbook

CUSTOMER CLASSES	GROUP DIVERSITY FACTORS
Domestic Less than 10 customers More than 10 customers	0.80 0.75
Commercial or industrial Less than 10 customers More than 10 customers	0.80 0.75

Table 2 The value of group diversity factor applied in the computation of final demand

2.0 SPECIFICATION ELECTRICAL

2.1 Lighting System

To bring out the beauty of home furnishing and to make a house a pleasant place in which to live, light source and fixtures should be carefully planned.

Lighting for the residence can be divided into three main categories: general lighting, task lighting, and decorative lighting. Each of these has particular areas of application keyed to light sources, fixtures, specific needs and ways of conserving energy. A possible fourth category of lighting is illumination connected with home security. Light sources used in the modern residence include incandescent, fluorescent, quartz (tungsten halogen), and mercury vapor lamps.

The first and most important decision is the selection of lamps. Criteria for selection is type of area, lighting requirements, space dimensions, color requirements, relative lamp efficacies, glare properties, dimming properties, starting and restarting characteristics, range of wattages, lamp life labour costs in lamp replacement, price and availability. Lighting level defined in terms of average luminance on working plane.

2.1.1 Procedure to calculate number of lamp

1. Room length and room width must be considered to find the room area. The height of the room also must be considered.
2. By using the equation 1, the room index value is calculated.
   $$RI = \frac{(L\times W)}{Hm\times(L\times W)} \qquad (1)$$
3. Base on the value of room index that has been calculated in step 2, the coefficient of the utilization from the table of coefficient of utilization of lamp is defined.
4. From the lumen table below, the desired lumen of the room is defined.
5. By using the equation 2, the installed flux is calculated in this case the maintenance factor is set to 0.8.
   $$IF = \frac{Eav\times A}{Uf\times Mf} \qquad (2)$$
6. From the table of the illumination which shown in table 2, the lumen of

the desired lamp is select and the number of lamp use is calculates by using the equation 3.

$$IF = \frac{If}{LDL} \quad (3)$$

3.0 METHODOLOGY

Basically there are eight stages in such a procedure. These are the same whatever the type of installation, be it a cooker or a sub main cable feeding a distribution board in a factory. Here than are the eight basic steps in a simplified form:

i. Determine the design current *Ib.*
ii. Select the rating of the protection *In*.
iii. Select the relevant correction factors (CFs).
iv. Divided In by the relevant CFs to give tabulated cable current-carrying capacity *It*.
v. Choose a cable size to suit *It*.
vi. Check the voltage drop.
vii. Check for shock risk constraints.
viii. Check for thermal constraint.

4.0 Result and Discussion

Type A House

One unit house for Type A house

Demand estimation for one unit house (Pf =0.85)
= 5232.59 VA/ unit $\times$ 0.85
= 4.448 kW
Diversity factor for domestic (more than 10 customer)
= 0.75
Max. Demand = 4.317 kW $\times$ 0.75
= 3.336 kW

$$Ib = \frac{3336}{240}$$
= 13.89 A
Ring Circuit is 30 A minimum
Ib >> In
In = 30 A
Circuit breaker type is MCB
MCB = 40 A
Type of cable is conduit or enclosed (multi-core 70°C thermoplastic PVC)

	Description	Appropriate Reference Method for determining current-carrying capacity
Open and clipped direct	Sheathed cables clipped direct to or lying on a non-metallic surface	Method 1
Cables embedded direct in buiding materials	Sheathed cables embedded directly in masonry, brickwork, concrete, plaster or the like (other than thermally insulating materials)	Method 1
In condiut	Single core non-sheathed cables in metallic or non-metallic conduit on a wall or ceiling	Method 3
	Single core non-sheathed cables in metallic or metallic conduit in a thermally insulating wall or above a thermally insulating ceiling, the conduit being in contact with a thermally conductive surface on one side.	Method 4
	Multi-core cables having non-metallic or non-metallic conduit on a wall or ceiling	Method 3
	Sheathed cables in conduit in a thermally insulating wall etc. (otherwise as References Method 4)	Method 4 or Method 6 for cable type covered by Table 4D5A
	Cables in conduit embedded in masonry, brickwork, concrete, plaster or the like (other than thermally insulating materials)	Method 3
In trunking	Cables in trunking on a wall or suspended in the air	Method 3
	Cables in flush floor trunking	Method 3
	Single core cables in skirting trunking	Method 3
Cables in building voids	Sheathed cables installed directly in a thermally insulating ceiling, the cable being in contact with a thermally conductive surface on one side (otherwise as Reference Method 4)	Method 4 or Method 14 for cable type covered by Table 4D5A.

Table 4A1 Schedule of Installation Methods of Cables (including Reference Method)

Correction Factors

Cg from table 4B1 = 0.8 (2 number of circuit in single phase)
Ca from table 4C1 = 0.87 (at 40̊ C ambient temperature)

It = $\frac{30}{0.8\times0.87}$ = 43.10 A

From table 4D1A,
The size of cable is 10 mm² = 52 A current-carrying capacity of conductor.
Length of cable is 50 m.

Voltage drop = $\frac{Vd\times Ib\times L}{1000}$ (Vd-refer table 4D2B)

= $\frac{4.4\times13.89\times50}{1000}$

= 3.06 V (<9.6 V)

Voltage drop should not more than 4% of 240 V; below 9.6 V

Shock Risk

The requirement is to ensure that Zs is of a sufficiently low value to allow fault current flow and protection will be operating.
The PVC associated with a 10 mm² is 4 mm² for protective conductor and assume that the external lop impedance Ze is measured at 0.3 Ω

Zs = Ze + $\frac{(R1+R2)\times1.38\times Length}{1000}$

= 0.3 + $\frac{6.44\times1.38\times50}{1000}$

= 0.74 Ω

Refer to table 41B2 from IEE Regulation, only Type C circuit breaker (BS EN 60898) is suitable use to allow fault current at 0.75 Ω.

Thermal Constraints

The size of protective conductor also needs to check whether is large enough to withstand damage under earth fault condition.

Fault current, If = $\frac{Uoc}{Zs}$ where Uoc is voltage between conductors at supply point.

= $\frac{240}{0.74}$

= 324.32 A

From the appropriate curve for the Type C circuit breaker, obtain a disconnection time t of 0.02s. From table 54C of IEE Regulation, k = 115. Therefore the minimum size of PVC is given by:

S = $\frac{\sqrt{(I^2\times t)}}{k}$

= $\frac{\sqrt{(324.32^2\times0.02)}}{115}$

= 0.4 mm²

So, the size 10 mm² of cable is suitable to use.

One unit house for Type B houses

Max. Demand = 3.064 kW
Ib = 12.77 A, Ib >> In, In = 30 A; MCB = 40 A
Type C circuit breaker (BS EN 60898)
Type of cable is conduit or enclosed (multi-core 70̊C thermoplastic PVC)
From table 4D1A, the size of cable is 10 mm² = 52 A current-carrying capacity of conductor.
Voltage drop = 4.36 V (<9.6 V)
Voltage drop should not more than 4% of 240 V; below 9.6 V
So, the size 10 mm² of cable is suitable to use.

One unit house for Type C houses

Max. Demand = 7.465 kW
Ib = 31.11 A, In >> Ib , In = 32 A; MCB = 40 A
Type C circuit breaker (BS EN 60898)
Type of cable is conduit or enclosed (multi-core 70̊C thermoplastic PVC)
From table 4D1A, the size of cable is 16 mm² = 69 A current-carrying capacity of conductor.
Voltage drop = 3.89 V (<9.6 V)
Voltage drop should not more than 4% of 240 V; below 9.6 V
So, the size 16 mm² of cable is suitable to use.

One unit house for Type D houses

Max. Demand = 6.684 kW
Ib = 27.85 A, In >> Ib, In = 32 A; MCB = 40 A
Type C circuit breaker (BS EN 60898)
Type of cable is conduit or enclosed (multi-core 70̊C thermoplastic PVC)
From table 4D1A, the size of cable is 16 mm² = 69 A current-carrying capacity of conductor.
Voltage drop = 2.81 V (<9.6 V)
Voltage drop should not more than 4% of 240 V; below 9.6 V
So, the size 16 mm² of cable is suitable to use.

Demand for Ground Floors

14 unit house for Type A and 2 unit house for Type B

The demand estimation for Type A houses for ground floors
Maximum Demand = 46.7 kW
The demand estimation for ground floor for Type B houses
Maximum Demand = 6.128 kW

Demand for First to Fifth Floor

14 unit house for Type A and 2 unit house for Type B each floor (1 to 5)
The demand estimation for Type A houses for 1 to 5 floors
Maximum Demand = 233.504 kW
The demand estimation for Type B houses for 1 to 5 floors
Maximum Demand = 30.639 kW

Demand for Sixth and Seventh Floor

10 unit house for Type A and 2 unit house for Type B
The demand estimation for Type A house for 6 to 7 floors
Maximum Demand = 66.715 kW
The demand estimation for Type B houses for 6 to 7 floors
Maximum Demand = 12.256 kW

Demand for Eight Floors

1 unit houses for Type A, 1 unit houses for Type B, 2 unit house for Type C and 1 unit houses for Type D
The demand estimation for Type A house for 8 floors
Maximum Demand = 3.558 kW

Corridor

Ground floor to fifth floor (6 floors)
Max. Demand = 15.435 kW
Type B circuit breaker (BS EN 60898)
Type of cable is conduit or enclosed (multi-core 70°C thermoplastic PVC)
From table 4D1A, the size of cable is 16 mm^2 = 62 A current-carrying capacity of conductor.
Voltage drop = 2.57 V (<9.6 V)
Voltage drop should not more than 4% of 240 V; below 9.6 V
So, the size 16 mm^2 of cable is suitable to use.

Sixth floor to seven floor (2 floors)
Max. Demand = 4.216 kW
Type B circuit breaker (BS EN 60898)
Type of cable is conduit or enclosed (multi-core 70°C thermoplastic PVC)
From table 4D1A, the size of cable is 16 mm^2 = 69 A current-carrying capacity of conductor.
Voltage drop = 2.57 V (<9.6 V)
Voltage drop should not more than 4% of 240 V; below 9.6 V
So, the size 16 mm^2 of cable is suitable to use.
Eight floor (1 floor)
Max. Demand = 1.351 kW
Type B circuit breaker (BS EN 60898)
Type of cable is conduit or enclosed (multi-core 70°C thermoplastic PVC)
From table 4D1A, the size of cable is 16 mm^2 = 69 A current-carrying capacity of conductor.
Voltage drop = 1.35 V (<9.6 V)
Voltage drop should not more than 4% of 240 V; below 9.6 V
So, the size 16 mm^2 of cable is suitable to use.

Square
Max. Demand = 2.293 kW
Type B circuit breaker (BS EN 60898)
Type of cable is conduit or enclosed (multi-core 70°C thermoplastic PVC)
From table 4D1A, the size of cable is 16 mm^2 = 69 A current-carrying capacity of conductor.
Voltage drop = 2.292 V (<9.6 V)
Voltage drop should not more than 4% of 240 V; below 9.6 V
So, the size 16 mm^2 of cable is suitable to use.

Stairs
Max. Demand = 17.763 kW
Type B circuit breaker (BS EN 60898
Type of cable is conduit or enclosed (multi-core 70°C thermoplastic PVC)
From table 4D1A, the size of cable is 16 mm^2 = 69 A current-carrying capacity of conductor.
Voltage drop = 2.22 V (<9.6 V)
Voltage drop should not more than 4% of 240 V; below 9.6 V
So, the size 16 mm^2 of cable is suitable to use.

Lift Lobby
Max. Demand = 15.789kW
Type B circuit breaker (BS EN 60898)
Type of cable is conduit or enclosed (multi-core 70°C thermoplastic PVC)
From table 4D1A, the size of cable is 16 mm^2 = 69 A current-carrying capacity of conductor.
Voltage drop = 1.973 V (<9.6 V)
Voltage drop should not more than 4% of 240 V; below 9.6 V
So, the size 16 mm^2 of cable is suitable to use.

Lift
Maximum demand = 15 kW
The fuse BS 3036
Type of cable is conduit or enclosed (multi-core 70°C thermoplastic PVC)

From table 4D1A, the size of cable is 25 mm² = 89 A current-carrying capacity of conductor.
Voltage drop = 7.77 V (<16.6 V)
Voltage drop should not more than 4% of 240 V; below 9.6 V
So, the size 25 mm² of cable is suitable to use.

Lighting

Type A House

House	Number of Lighting
Master Bedroom	**1**
Bedroom 2	**1**
Bedroom 3	**1**
Bathroom 1	**1**
Bathroom 2	**1**
Kitchen	**1**
Dining room	**1**
Living room	**1**
Corridor	**1**

Type B House

House	Number of Lighting
Master Bedroom	**1**
Bedroom 2	**1**
Bedroom 3	**1**
Bathroom 1	**1**
Bathroom 2	**1**
Kitchen	**1**
Dining room	**1**
Living room	**1**
Corridor	**1**

Lift Lobby Area
14 lamps

Corridor
Ground floor to fifth floor (6 floors)
1) 9 lamps (multiply by 6 for 6 floors); 54 lamps
2) 11 lamps (multiply by 6 for 6 floors); 66 lamps

Sixth floor to seven floor (2 floors)
1) 7 lamps (multiply by 2 for 2 floors); 14 lamps
2) 9 lamps (multiply by 2 for 2 floors); 18 lamps

Eight floor (1 floor)
1) 4 lamps
2) 7 lamps

Stairs
2 lamps
(Multiply by 8 for 8 floors and multiply by 3 for each floor has 3 stairs); 48 lamps

Type C Houses

House	Number of Lighting
Master Bedroom	**2**
Bedroom 2	**1**
Bedroom 3	**1**
Bedroom 4	**1**
Bathroom 1	**1**
Wardrobe	**1**
Bathroom 2	**1**
Bathroom 3	**1**
Kitchen	**1**
Utility	**1**
Living room	**1**
Dining	**1**
Breakfast Bar	**1**
Entrance Hall	**1**
Corridor	**1**

Type D Houses

House	Number of Lighting
Master Bedroom	**2**
Bedroom 2	**1**
Bedroom 3	**1**
Bedroom 4	**1**
Bathroom 1	**1**
Wardrobe	**1**
Bathroom 2	**1**
Bathroom 3	**1**
Kitchen	**1**
Utility	**1**
Living room	**1**
Dining	**1**
Breakfast Bar	**1**
Entrance Hall	**1**
Corridor	**1**
Balcony	**1**

5.0 CONCLUSION

From this technical paper, shows the basic concept of electrical installations or electrical wiring which is about the procedure or step of electrical installations.
Electrical wiring in general refers to conductors used to carry electricity and their accessories.
Domestic electrical installations were simple and only basic design planning was necessary.

Furthermore, this report will show details about electrical installation design circuit. The cable size selections should follow the suitable over current flow. That means the cable sizes have been selected taking into account the type and rating of the over current device.

This technical paper give students exposure to real life of working, expand knowledge and skills in engineering line and improve thinking skills and know how to solve the problem.

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REFERENCES

[1] I. Coker, A.J. II. Turner, W. III. Scaddan, Brian; “Electric Wiring: Domestic”, Tenth Edition 1995.
[2] A.L. Osbone; “Electricity in Building”, 1957.
[3] I.Nolte, Robert C. II. Ruel, Oliver J; “Residential Contruction Wiring”, 1979.
[4] Mullin, Ray C.; “Electrical Wiring Residential”, Thirteen Edition 1999.
[5] Part P of Approved Documents, The Building regulations 2000 : Electrical Safety
[6] Electrical Installation, Study Notes 3 (Basic Electrical Circuits)
[7] The Electricity at Work Regulations 1989
[8] http://en.wikipedia.org/wiki/Electrical wiring %28UK%29, Category: Electrical Wiring
[9] Electrical Wiring Domestic; Tenth edition 1995 by Brian Scaddan
[10] Installation Work; Third edition 1998 by Brian Scaddans