DESIGN OF A THREE-STOREY TERRACE ELECTRICAL INSTALLATION

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Abstract
Electric current is the fastest and most efficient method of delivering energy, and buildings require a lot of equipment and devices that run on it. The power of electricity, on the other hand, makes it dangerous when not properly used, thus electrical systems must be safe and dependable. This project aimed to show a minimal standard for electrical installations in a residential multistory terraced house, based on Institutes of Electrotechnical Commission IEC provisions, which included lighting, power points, cable sizing, panelboard sizing, cable routing, schematic diagrams, load-balanced analysis, and generator sizing. The entire study and design were completed using the AutoCAD software, and the required outcomes were reached. The findings show the exact sizing of cables, panelboards, lamps, generator size, and nominal ratings of protective devices required for each circuit and the complete installation, all by applicable standards and regulations.

Keywords: Design, AutoCAD, Electrical, Ratings, Installation, Protective

Introduction

Building electrical engineering services are designed to ensure that the installation work is perfectly safe for the people who live in and around the building. The term "safe" refers to the protection of people and property(NESIS, 2014).

The Institute of Electrotechnical Commission (IEC) is one of the regulatory bodies that govern and supervise the standards for Electrical and Electronic Engineering Installations in Residential Buildings, Multistoried Apartment

Buildings, Commercial Buildings, Office Buildings, Rail Stations, Airport Buildings, Factory Buildings, Warehouses, Jetties, Container Yards, Other Yards, Parking lots and similar places. These installations include Lighting and Illumination, Fans Cooling/Heating system, Normal and Standby power supply system, Supply system for the Lifts, Telecommunications Systems, Data Communication Systems, Fire Alarm System, CCTV monitoring System, Cable Television Distribution System, Electronic Access Control System, Burglar Alarm System (Khan et al., 2011).

Aside from the IEC, there are several other standards and regulatory bodies that regulate electrical service design, including the IEE (Institute of Electrical Engineers), BSS (British Standard Specification), NEC (National Electrical Code), NERC (Nigerian Electricity Regulatory Commission), IES (Illuminating Engineering Society), and NESIS (Nigerian Electricity Supply and Installation Standards), among others. (Adelakun et al., 2020).

Electrical installations must all meet two requirements: first, they must be able to transmit enough power to all connected electrical devices while maintaining a steady voltage, and second, they must operate safely without exposing occupants to electric shock or providing a fire threat. Wiring and other components can overheat in an undersized installation, resulting in early failure and possibly electrical issues. Voltage drop difficulties are also caused by undersized wiring, which might damage various equipment. A large electrical system, on the other hand, is more costly than necessary. There's no use in oversizing unless you plan to add more electrical loads to the system in the future(Engineers, 2021).

Methodology

This section breaks down the design analysis and how the design was achieved.

Building Plan Description

A three-story terrace was chosen for this research, two main terraced buildings of which one has four houses and the other has three. Each occupancy contains four bedrooms that are identical in size, capacity, and features and is split across three floors (ground, first, and second). This allows for the design of a single apartment and then multiplying the result by the number of units in each terrace plus the external/outdoor or compound loads to obtain an accurate load schedule. Figure 12 depicts the site plan and cable routes.

Lighting Design

The lighting design took into account all aspects of an effective lighting system, such as enough illumination of work surfaces, glare control, shadow avoidance, visual comfort, and ease of maintenance.

The lumen technique was utilized to determine the number of lamps and luminaries required for each area. Tables 1 show the acceptable levels of illumination for residential structures dependent on activities. Because the illuminance will surely decrease below this value by the end of the cleaning and replacing time, the initial illuminance was higher than the suggested value. The formulas used to calculate the number of fixtures required in each building area is listed below. Finding the area/dimensions (height, length, and width) of every working area of the building, including site plan external activities, is one of the most important parameters in calculating the number of fixtures.

Total wattage of fixtures $= Number\ of\ lamps\ \times each\ lamp's\ watt.$

Lumen per fixtures $= Lumen\ efficiency\ (Lumen\ per\ Watt)\ \times each\ fixture's\ watt$

Number of fixtures for each area: $= \frac{Required\ Lux \times Room\ area}{MF \times UF \times Lumen\ per\ fixture}$

Where;

- Utilization Factor or Co-efficient of utilization: It may be defined as "the ratio of total lumens received on the working plane to the total lumens emitted by the light source". i.e.

  $$Utilization\ factor\ = \frac{Lumens\ received\ on\ the\ working\ plane}{Lumens\ emitted\ by\ the\ lamp}$$

  Factor affecting utilization factor includes type of light, light fitting, surface color of walls and ceiling, mounting height of lamps, area to be illuminated. Its value lies between 0.4 and 0.6 for direct fittings it varies from 0.1 to 0.35 for indirect fittings.
- Depreciation or Maintenance factor: It may be defined as "the ratio of illumination under the normal working condition to the illumination when everything is clean or new" i.e.

$$M.F = \frac{Illumination\ under\ normal\ working\ conditions}{Illumination\ when\ everything\ is\ clean}$$

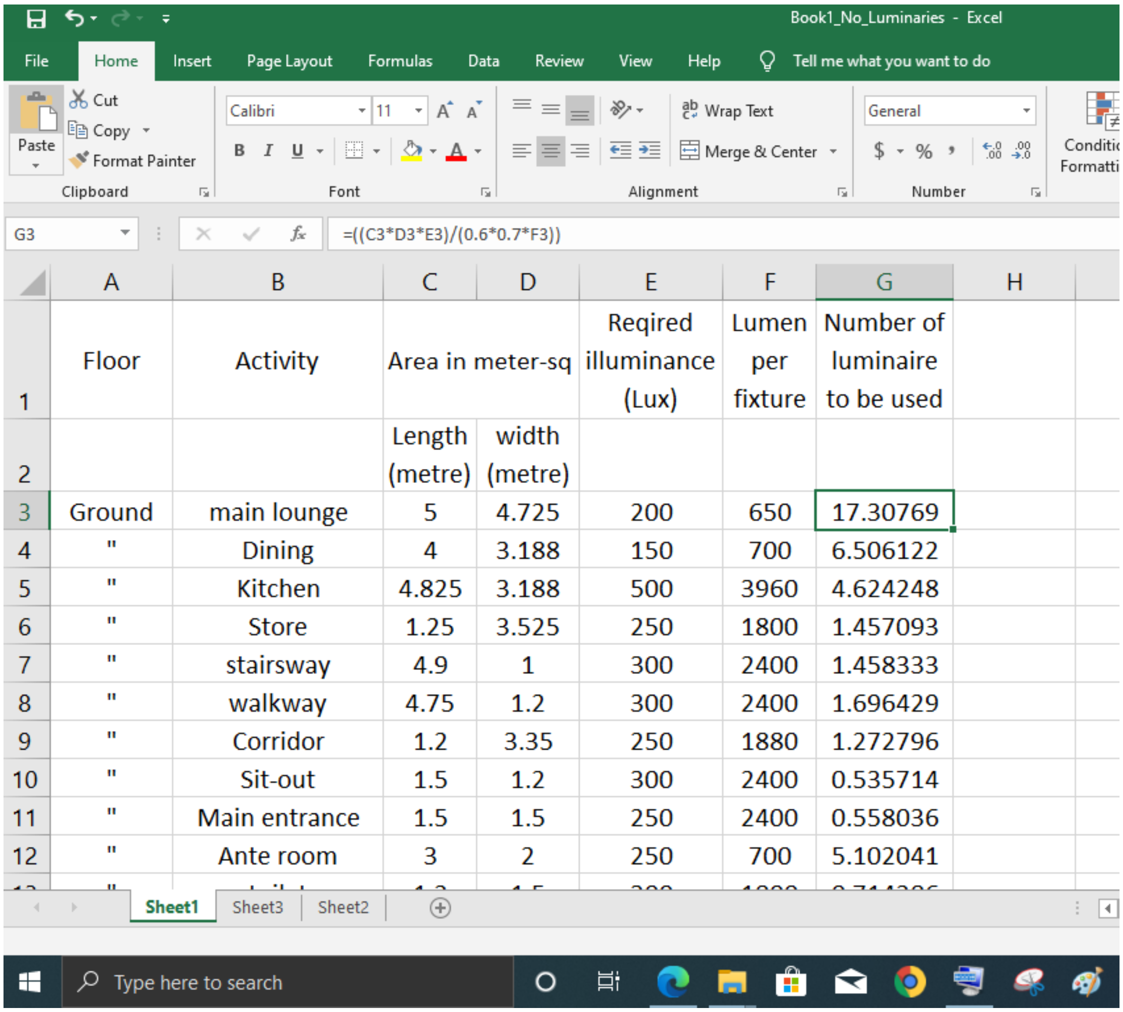
The frequency with which the lights are cleaned and replaced determines the maintenance factor. Also, its factors decrease by the effectiveness with age, dust collection within the fitting, and reflectance degradation as walls and ceilings age. It is commonly presented as three alternatives for ease of use: Good is equal to 0.70, Medium is equal to 0.65, and Poor is equal to 0.55. (EEP, 2021); (Standard, 2002).

Table 1: Recommended Values of Illumination for Residential Buildings(EEP, 2021);(Standard, 2002);(Zumtobel, 2018) see also (Adelakun et al., 2020)

Area of Activity	**Illuminance (lux)**
Bedrooms	150-500
Living room/ Lounges	150-250
Bed-head, Dressing table	200-300
Kitchens	200-500
Dining rooms (tables)	150-300
Bathrooms/toilet	100-500
Stairway, landing	100-300
Reading (casual)/writing room (tables)	150-500
Garages & Porsche	100-500
Stores	100-250
Corridors, lobby, balcony	150-350
Reception/ante room	300-500
Entrances	150-300
Working areas	250-500
Laundries	200-500
Above mirror in the bathroom	300

*Note: Information compiled from multiple sources see reference list

Figure 1 shows the area type with the calculations of how the number of luminaires to be used is determined using a spreadsheet, and the type of luminaire used is an LED Lamp (also known as an LED bulb). In this design, nine major types of wattages are used: 5.5W, (650 lumen); 3+3W 2-in-1, (400 lumen); 7W, (700 lumen); 10W, (1100 lumen); 12W, (1800 lumen); 24W, (2400 lumen); 36W, (3960 lumen); 100W, (9000 lumen); and 200W, 27900 lumen respectively.



Floor	Activity	Area in meter-sq		Reqired illuminance (Lux)	Lumen per fixture	Number of luminaire to be used
		Length (metre)	width (metre)			
Ground	main lounge	5	4.725	200	650	17.30769
"	Dining	4	3.188	150	700	6.506122
"	Kitchen	4.825	3.188	500	3960	4.624248
"	Store	1.25	3.525	250	1800	1.457093
"	stairsway	4.9	1	300	2400	1.458333
"	walkway	4.75	1.2	300	2400	1.696429
"	Corridor	1.2	3.35	250	1880	1.272796
"	Sit-out	1.5	1.2	300	2400	0.535714
"	Main entrance	1.5	1.5	250	2400	0.558036
"	Ante room	3	2	250	700	5.102041

Figure 1: Spreadsheet View (screenshot) of Luminaries Computation

Outdoor lighting: For the illumination of squares, parks, Kiosk buildings, and facades, the following considerations were made:

- Placing switches in locations where dripping or falling rainwater is unlikely to occur. Otherwise, weatherproof/waterproof covered switches can be mounted with care.
- Even distribution of brightness and avoidance of stark dark-light contrasts

- Selecting a complementary light color and color rendering, as well as limiting the glare effect for residents and passers-by

PowerPoint Design

This is the design of power metering equipment that allows electrical power to be supplied and distributed via a network to the required load. A sufficient number of 13 A switched flat pin (rectangular cross-section pin) shuttered socket outlets were provided and distributed throughout the building to meet the occupancy's actual needs. Cooker units, 13A Socket outlets, Water heater outlets, Air Conditioner connections points, Distribution boards, Telephone outlets, TV / Satellite receiver outlets, Data cable outlets, and so on are all included in the power design layout e.t.c. Table 2 specifies the minimum 13A plugs necessary for each room, as well as at least one outlet on the balcony and a kitchen cooking unit.

Table 2: Minimum Number of13A Flat Pin Outlet Socket (Khan et al., 2011)

Location	**No. of Switch Socket Outlets**
Bedroom	2
Living room	3
Drawing room	3
Dining room	1
Toaster / Snack Toaster	1
Kitchen	1
Bathroom	0
Verandah	1
Refrigerator	1
Air-conditioner	one for each room

*Source: Electrical and Electronic Engineering Services for Buildings, BNBC

The placement of two plug outlets in a room fed from two separate phases was avoided. In unavoidable situations, however, the minimum distance between two such socket outlets in a room fed by two separate phases must never be less than 2 m. All outdoor socket outlets were positioned where there was no risk of rainwater leaking or falling (Dave, 2013).

Distribution Board (DB) and Panelboard Analysis

The electrical distribution system distributes all load to the final sub-circuit. All distribution boards receive electricity from the serving panel boards, and all connected panel boards receive power from the secondary distribution transformer through the central panelboard/feeder pillar. At each level of the load calculation, the practical value of relevant diversity factors was applied. Table 3 shows the diversity factor according to circuit function (IEC 60439)

Table 3: Diversity factor according to circuit function

Circuits Function	**Diversity Factor**
Lighting	1
Heating and Air conditioning	1
Socket-outlets	0.8
Most powerful motor	1
Second most powerful motor	0.75
For all motors	0.8

- Calculating Load in KW, KVA, and Amperes: Initial load estimation is required to determine design total demand (generator size and utility service supply), and afterward, to maintain track of load growth. On a modest scale, estimating loads entails estimating watts or kilowatts. On a larger scale, the KVA is evaluated alongside the power factor. The selection of breakers/fuses and current-carrying cables will thereafter be based on a current calculation.

  Converting watts to kVA (kilovolt-amps): $kVA = \frac{Watt}{1000 \times power\ factor, PF}$

- Converting real power, (Watts) to Current (Amps):

  $Real\ power, P = \sqrt{3} \times VI \times PF$ and

  Current, I (Amps): $I = \frac{Real\ power, P\ (Watt)}{\sqrt{3} \times 415 \times power\ factor, PF}$

  $Where;\ Power\ factor, PF = 0.8 \quad and \quad V = 415 volts$

- Panel Sizing Panels must not be loaded up more than 80% of the main breaker rating. Load must be balanced so that the main bus currents are about equal + 5% variation in currents.
- The generator must be sized to supply maximum starting (SkVA), steady-state running (RkVA), non-linear (GkW) demands of connected and future load. Other factors include Voltage ratings, power factor, and Future load. (Todd, 2020)

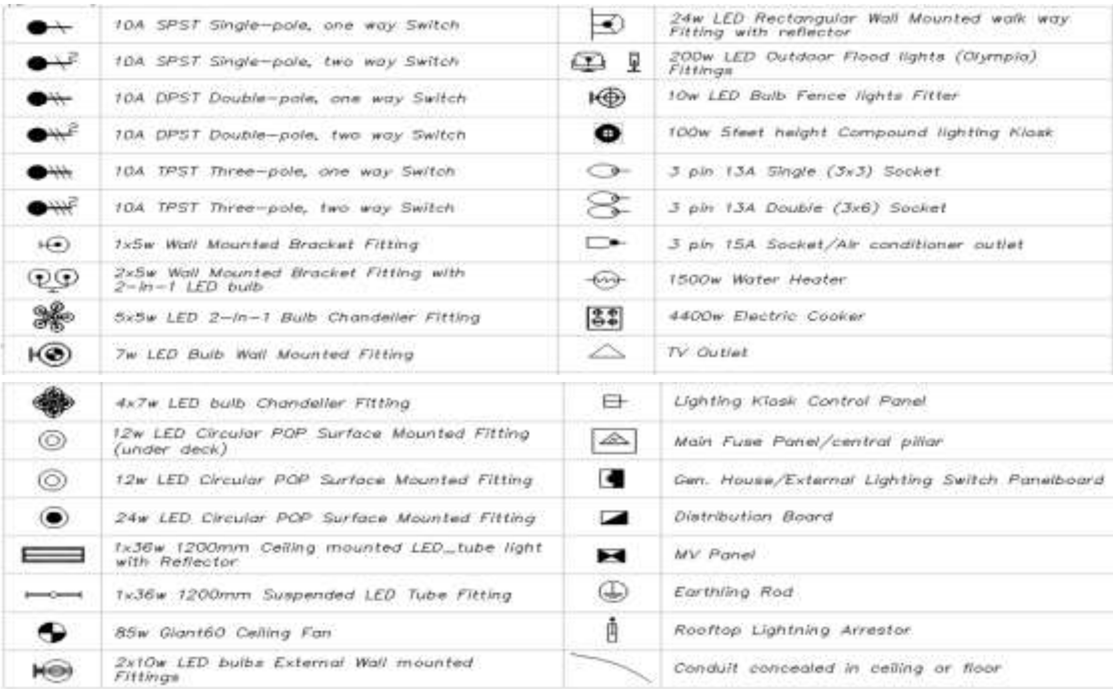
Results and Discussion

The goal and objectives of the paper were met after performing the necessary calculations following the needed norms and standards. The analysis of the results is explained in the following parts.

Electrical Legend: It is a standard symbol that depicts a collection of graphical representations with full records of all electrical components and accessories used in a design, such as lights, fans, cooker control units, switches, and air conditioners, among others. The electrical legend of all symbols utilized in this design is shown in Figure 2.

Lighting Design Layout: This is an electrical system design that displays the lighting arrangement positions and how they are interconnected. Lighting fixtures, ceiling fans, extractor fans, switches, and other items are included in the lighting design layout. Electrical lighting layout designs for the ground level, first floor, and second floor were shown in Figures 3a, 4a, and 5a, respectively.

Power Design Layout: This is the design of power metering equipment that allows electrical power to be supplied and distributed via a network to the required load. The following elements are included in a powerful design layout: Socket outlets, water heater outlets, air conditioner connection points, distribution boards, telephone outlets, TV/SAT receiver outlets, data cable outlets, and so on. Electrical power layout designs for the ground level, first floor, and second floor were shown in Figures 3b, 4b, and 5b, respectively.



	10A SPST Single-pole, one way Switch		24w LED Rectangular Wall Mounted walk way Fitting with reflector
	10A SPST Single-pole, two way Switch		200w LED Outdoor Flood lights (Olympia) Fittings
	10A DPST Double-pole, one way Switch		10w LED Bulb Fence lights Fitter
	10A DPST Double-pole, two way Switch		100w Steet height Compound lighting Kiosk
	10A TPST Three-pole, one way Switch		3 pin 13A Single (3x3) Socket
	10A TPST Three-pole, two way Switch		3 pin 13A Double (3x6) Socket
	1x5w Wall Mounted Bracket Fitting		3 pin 15A Socket/Air conditioner outlet
	2x5w Wall Mounted Bracket Fitting with 2-in-1 LED bulb		1500w Water Heater
	5x5w LED 2-in-1 Bulb Chandelier Fitting		4400w Electric Cooker
	7w LED Bulb Wall Mounted Fitting		TV Outlet
	4x7w LED bulb Chandelier Fitting		Lighting Kiosk Control Panel
	12w LED Circular POP Surface Mounted Fitting (under deck)		Main Fuse Panel/central pillar
	12w LED Circular POP Surface Mounted Fitting		Gen. House/External Lighting Switch Panelboard
	24w LED Circular POP Surface Mounted Fitting		Distribution Board
	1x36w 1200mm Ceiling mounted LED_tube light with Reflector		MV Panel
	1x36w 1200mm Suspended LED Tube Fitting		Earthing Rod
	85w Giant60 Ceiling Fan		Rooftop Lightning Arrestor
	2x10w LED bulbs External Wall mounted Fittings		Conduit concealed in ceiling or floor

Figure 2: Electrical Legend

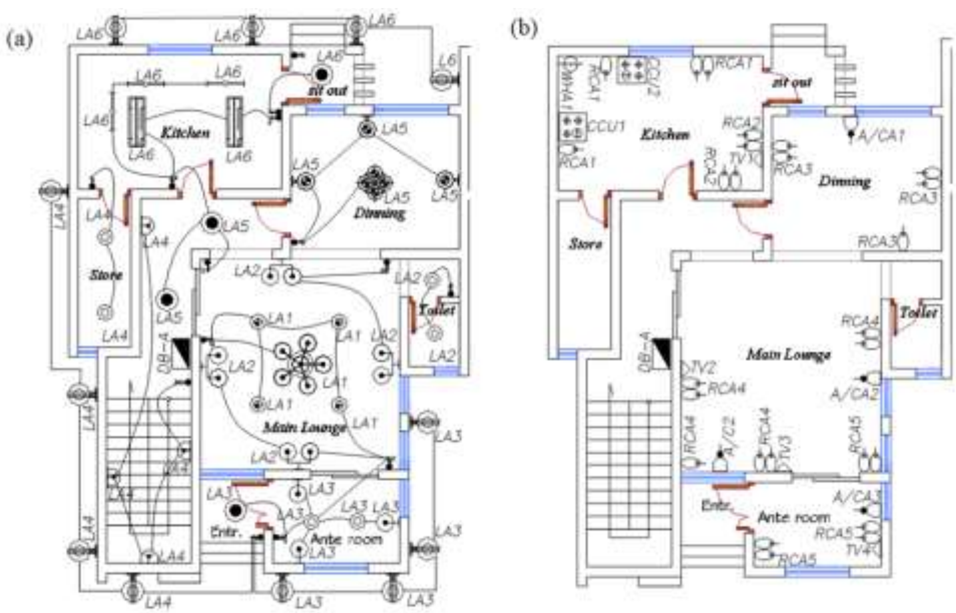


Figure 3: Electrical Layout on the Ground Floor (a) Lighting Point and (b) PowerPoint

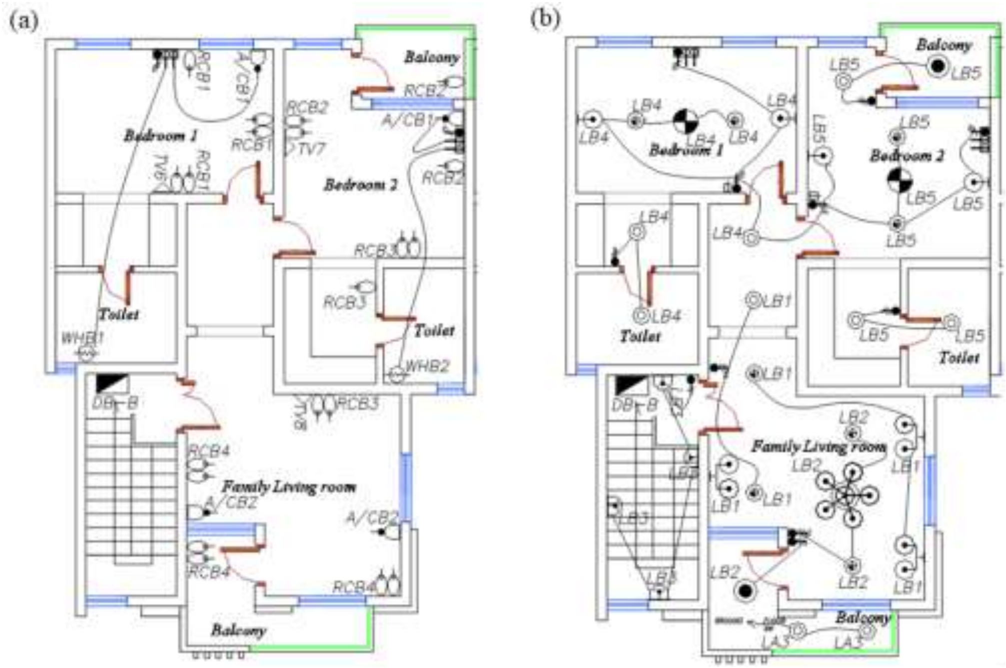


Figure 4: Electrical Layout of (a) PowerPoint and (b) Lighting Point on First Floor

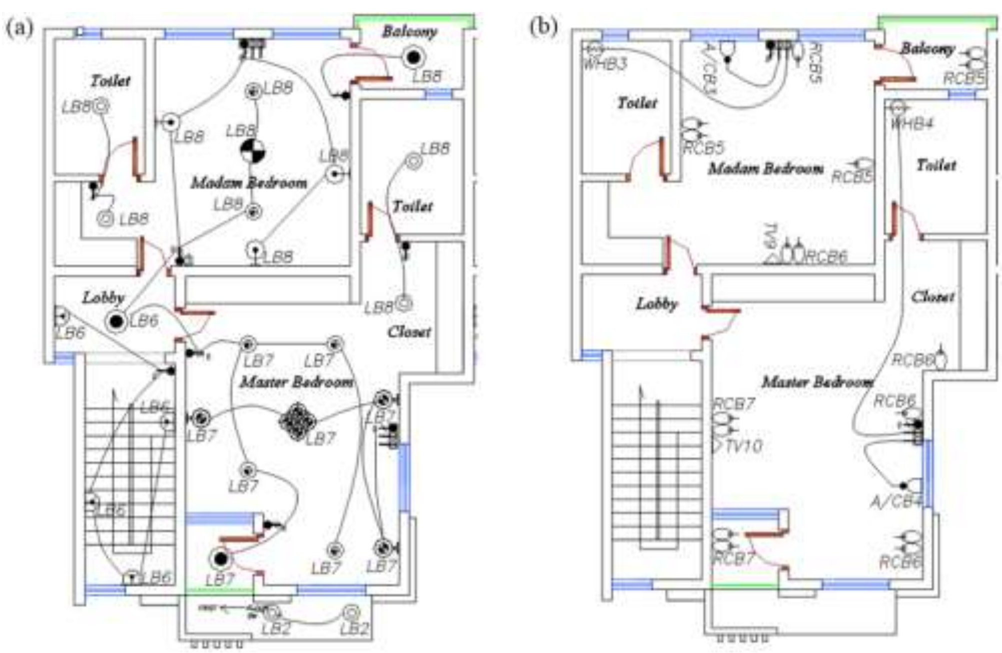


Figure 5: Electrical Layout of (a) Lighting Point and (b) PowerPoint on Second Floor

The site plan lighting arrangements, underground cable path, and cable sizes are shown in the diagram below. In compliance with IEC standards and other associated agencies, all cables offered for usage were calculated to the stated standard.

Balanced Load Analysis: Quantifying the entire load, which aids in load balancing and suitable selection of permitted distribution boards and panel boards, is a part of the distribution system design process. These calculations illustrate the overall electrical demand requirements of each terrace house.

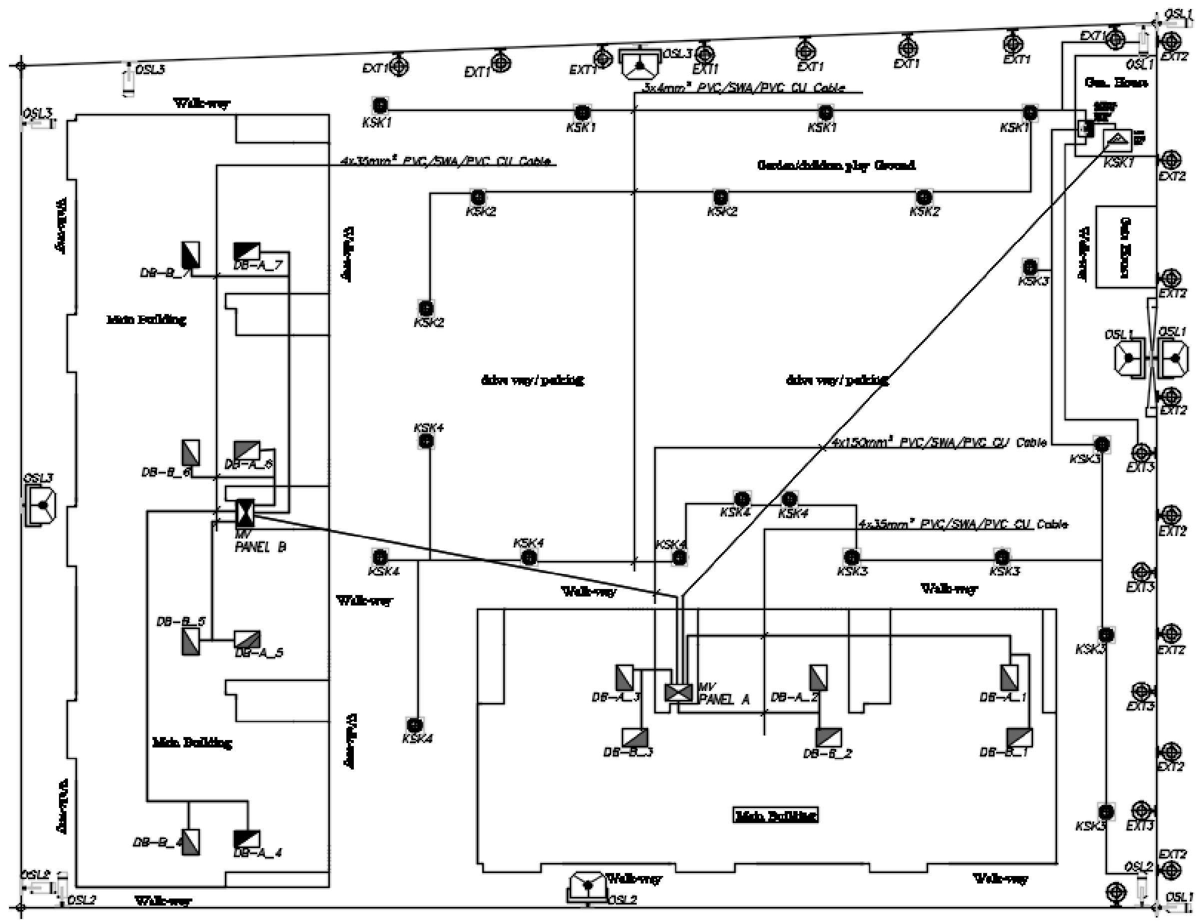


Figure 6: Site Plan-Underground Cables Routes and Outdoor Lighting Layouts

A load study of balanced distribution boards and panel boards was shown in Figure 7-11 below.

100A, 6 WAYS TP & N MCCB DISTRIBUTION BOARD–A
WITH 100A TP & N ELCB (DB–A, GROUND FLOOR)
4x16mm² PVC/SWA/PVC CU Cable

NO WAYS		1			2			3			4			5			6				
CONNECTED CCT		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
CCT		LA1	LA2	LA3	LA4	LA5	LA6	RCA1	CCU1	RCA2	CCU2	RCA3	RCA4	RCA5	A/CA1	A/CA2	A/CA3	WHA1	NC		
MCCB RATING (A)		5A	5A	5A	5A	5A	5A	15A	25A	20A	25A	15A	15A	15A	20A	20A	20A	25A	30A		
PEAK LOAD (W)		49	64	167	200	83	284	4500	4400	3000	4400	4000	6000	4500	1500	3000	1500	1500	NC		TOTAL LOAD PER PHASE
DIVERSITY FACTOR		1	1	1	1	1	1	0.8	1	0.8	1	0.8	0.8	0.8	1	0.5	1	1	NC		
PHASE	RED	49			200			3600			4400			3600			1500				13,349
	YELLOW		64			83			4400			3200			1500			1500			10,747
	BLUE			167			284			2400			4800			1500			NC		9,151
FINAL SUB–CIRCUIT WIRING CABLE SIZE		LIGHTING 3x1.5mm² Copper Cable						13A SOCKET 3x2.5mm² Copper Cable						15A AC/WH SOCKET 3x4.0mm² Copper Cable					15A CCU/WH SOCKET 3x6.0mm² Copper Cable	TOTAL	33,247
DISTRIBUTION BOARD–GROUND FLOOR (DB–A)																					
MAXIMUM DEMAND = 33,247(W)																					
CURRENT (I) = 57.82(A)																					

Figure 7: Load Balanced Analysis of Distribution Board-A (Ground floor)

100A, 8 WAYS TP & N MCCB DISTRIBUTION BOARD–B
WITH 100A TP & N ELCB (DB–B, FIRST FLOOR)
4x16mm² PVC/SWA/PVC CU Cable

NO WAYS		1			2			3			4			5			6			7			8				
CONNECTED CCT		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		
CCT		LB1	LB2	LB3	LB4	LB5	RCB1	RCB2	RCB3	RCB4	A/CB1	A/CB2	WHB1	WHB2	LB6	LB7	LB8	RCB5	RCB6	RCB7	A/CB3	A/CB4	WHB3	WHB4	NC		
MCCB RATING (A)		5A	5A	5A	5A	5A	15A	15A	15A	15A	25A	20A	25A	25A	5A	5A	5A	15A	15A	15A	20A	20A	25A	25A	20A		
PEAK LOAD (W)		54	85	96	143	167	4000	3500	4000	4500	3000	3000	1500	1500	120	63	184	5000	5000	3000	1500	1500	1500	1500	NC		TOTAL LOAD PER PHASE
DIVERSITY FACTOR		1	1	1	1	1	0.8	0.8	0.8	0.8	1	0.5	0.8	0.8	1	1	1	0.8	0.8	0.8	1	1	0.8	0.8			
PHASE	RED	54			143			2800			3000			1200			184			2400			1200				10,981
	YELLOW		85			167			3200			1500			120			4000			1500			1200			11,772
	BLUE			96			3200			3600			1200			63			4000			1500			NC		13,679
FINAL SUB–CIRCUIT WIRING CABLE SIZE		LIGHTING 3x1.5mm² Copper Cable						13A SOCKET 3x2.5mm² Copper Cable						15A AC/WH SOCKET 3x4.0mm² Copper Cable						15A CCU/WH SOCKET 3x6.0mm² Copper Cable						TOTAL	36,432
DISTRIBUTION BOARD–FIRST FLOOR (DB–B)																											
MAXIMUM DEMAND = 36,432(W)																											
CURRENT (I) = 63.36(A)																											

Figure 8: Load Balanced Analysis of Distribution Board-B (First floor)

60A, TPN RCBO MAIN SWITCH WITH 12 RCD, KIOSK/OUTDOOR SECURITY LIGHTS
CONTROL PANEL (GENERATOR HOUSE)
4x10mm² PVC/SWA/PVC CU Cable

NO WAY	1			2			3			4			TOTAL LOAD PER PHASE	
CONNECTED CCT	KSK1	OSL1	OSL2	OSL3	EXT1	EXT2	KSK2	KSK3	KSK4	EXT3	PUMP	GATE ROOM		
RCBO RATING (A)	15A	15A	15A	15A	15A	15A	15A	15A	15A	15A	25A	25A	RED	1,650
PEAK LOAD (W)	400	1000	800	800	80	80	400	600	700	50	2000	1685	YELLOW	3,680
DIVERSITY FACTOR	1	1	1	1	1	1	1	1	1	1			BLUE	3265
													TOTAL LOAD	8,595
WIRING CABLE SIZE	LED OUTDOOR SECURITY LIGHTS 3x2.5mm² Copper Cable						LIGHTING KIOSK 3x4.0mm² Copper XLPE Cable			OUTDOOR FENCE MOUNTED FITTING 3x1.5mm² Copper Cable				
EXTERNAL LIGHTS CONTROL PANEL–GENERATOR HOUSE														
MAXIMUM DEMAND = 8,595(W)														
CURRENT (I) = 14.95(A)														

Figure 9: Load Balanced Analysis of Exterior Lighting /Outdoor loads panel board

	6 TRIPLE POLE WAYS, 400A PANELBOARD WITH MCCB FRAME SIZES: 32–125A TRIPLE POLE									
	INCOMERS: 630A/800A: 4x150mm² PVC/SWA/PVC CU CABLES LUGGED VIA M16 HEXAGONAL BOLT EARTH: 1x70mm² PVC/SWA/PVC CU CABLES LUGGED VIA M12 HEXAGONAL BOLT									
PANEL BOARD A	BLOCK	E		F		G		NC		
	CONNECTED MCB	125A, 415V		125A, 415V		125A, 415V		125A, 415V		
	CONNECTED DB	DB1–A	DB1–B	DB2–A	DB2–B	DB3–A	DB3–B			TOTAL
	MAX. DEMAND (W)	33,247	36,432	33,247	36,432	33,247	36,432			209,037W
	CURRENT (A)	57.82	63.36	57.82	63.36	57.82	63.36			
	TOTAL CURRENT ON MCB (A)	121.18		121.18		121.18				363.54A

Figure 10: Load Balanced Analysis of Panel Board-A (Main Building A)

	6 TRIPLE POLE WAYS, 630A PANELBOARD WITH MCCB FRAME SIZES: 80–250A TRIPLE POLE									
	INCOMERS: 630A/800A: 4x150mm² PVC/SWA/PVC CU CABLES LUGGED VIA M16 HEXAGONAL BOLT EARTH: 1x70mm² PVC/SWA/PVC CU CABLES LUGGED VIA M12 HEXAGONAL BOLT									
PANEL BOARD B	BLOCK	A		B		C		D		
	CONNECTED MCB	125A, 415V		125A, 415V		125A, 415V		125A, 415V		
	CONNECTED DB	DB1–A	DB1–B	DB2–A	DB2–B	DB3–A	DB3–B	DB4–A	DB4–B	TOTAL
	MAX. DEMAND (W)	33,247	36,432	33,247	36,432	33,247	36,432	33,247	36,432	278,716W
	CURRENT (A)	57.82	63.36	57.82	63.36	57.82	63.36	57.82	63.36	
	TOTAL CURRENT ON MCB (A)	121.18		121.18		121.18		121.18		484.72A

Figure 11: Load Balanced Analysis of Panel Board-B (Main Building B)

Load Summary, Generator Size, and Utility Services Supply

Estimating the maximum demand of the two terraces was accomplished by aggregating the demands of all DBs linked to panelboards and estimating the total load connected to individual DBs. These procedures include calculating the loads in each room, each floor, each flat, and the total load of the building. In addition, a total building area / total complex account was computed. Water pump(s), exterior lighting systems, and any other equipment placed in the structure were all added to the list.

BUILDING OCCUPANCY TYPE: Residential (R-1)		SERVICE DESCRIPTION:		
BUILDING SQUARE FOOTAGE: 26,904.5		33/0.415kV, 3P		
LOAD DESCRIPTION		Connected KVA	Demand FACTOR	Demand KVA
PanelBoard-A	Distribution Board-A (4 Nos x 33,247W = 132,988W)	166.24	125%	207.80
	Distribution Board-B (4 Nos x 36,432W = 145,728W)	182.16	125%	227.70
PanelBoard-B	Distribution Board-A (3 Nos x 33,247W = 99,741W)	124.68	125%	155.85
	Distribution Board-B (3 Nos x 36,432 = 109,296W)	136.62	125%	170.78
Gate House/ Gen. Room PanelBoard	LED Outdoor Security Lights "Olympia Lights" (2,600W)	3.25	125%	4.06
	Lighting Kiosk's (2,100W)	2.63	125%	3.29
	Gate Room (1,685W)	2.11	125%	2.63
	Outdoor Fence Mounted Security Lights (210W)	0.26	125%	0.33
	Water Pump (2,000W)	2.50	100%	2.50
TOTAL LOAD	(496,348W)	620.44	KVA	774.94
TOTAL AMPACITY		863.15	AMPS	1078.09
SERVICE AMPACITY	= 1200Amps			
SPARE CAPACITY	= 121.09Amps (1200–1078.09)Amps			
TOTAL DEMAND	= 800kVA, 33/0.415kV			

Figure 12: Load Summary and Service Ampacity

The total wattage demand of the entire system is 496348W, with the total current calculated as

$$I = \frac{Real\ power, P\ (Watt)}{\sqrt{3} \times 415 \times power\ factor, PF} = \frac{496348\ (Watt)}{\sqrt{3} \times 415 \times 0.8} = 863.15 Amps$$

$$Total\ current + \ future\ load\ (25\%\ of\ current)$$

$$= 863.15 + (25\%\ of\ 863.15)$$

$$Total\ current = 863.15 + 214.94 = 1078.09 Amps$$

Total demand in Kilo-volts-Ampere: $kVA = \frac{Watt}{1000 \times power\ factor, PF} = \frac{496348}{1000 \times 0.8} = 620.44 kVA$

$$Total\ demand\ +\ future\ load\ (25\%\ of\ demand)$$

$$= 620.44 + (25\%\ of\ 620.44)$$

$$Total\ demand\ =\ 620.44 + 154.51 = 774.95 kVA$$

Generator size is 800kVA, 240/415V, 50Hz, 1200Amps 3P main circuit breaker Or 33/0.415kV, 800kVA Distribution Transformer.

General Schematic Diagram and Mounting Height

The main schematic showing the flow of power from sources to various distribution boards is shown in Figure 13 below

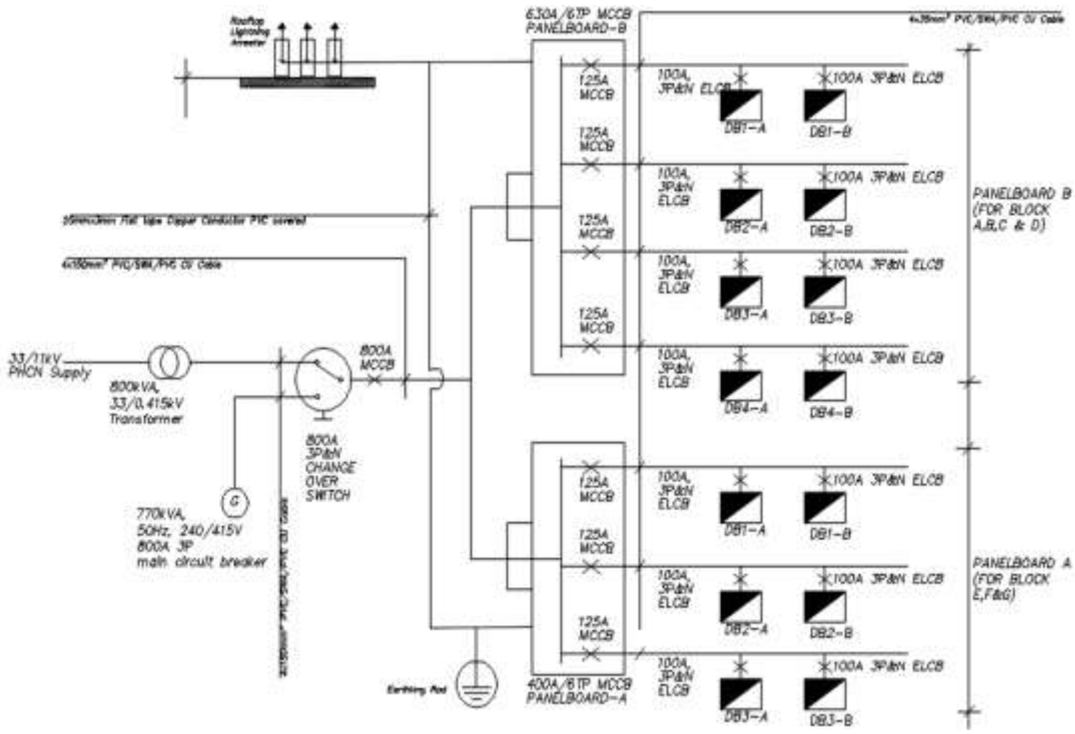


Figure 13: General Schematic Diagram

CONCLUSION

The lumen approach was utilized in this study to build the lighting arrangement, and the power layout was obtained by using a standard table for the minimum necessary power points of each activity as stipulated by the IEC regulation. Protective devices, cables, panel boards, and generators were all given appropriate ratings, and there is enough room for future development. The results of the calculations in the design aid in making critical decisions such as the types of luminaries, cable sizes, Panelboards, and nominal ratings of protective devices required by each circuit and by the entire installation following applicable standards and regulations. With this design, it is clear that the proposed building will be safe for those who live in and around it.

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Appendix

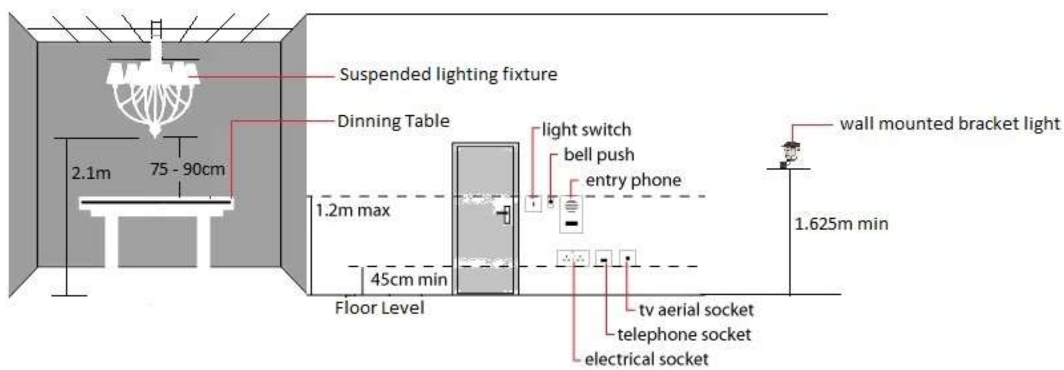

Figure 14: Recommended Mounting Height of Fittings