

The Electrical Installation Design of Multi Storey Office Building

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Abstract—The main objective of this project is to design the electrical installation and all power requirements for a sixteen storey office building comprises four storey commercial building including three storey parking lot basements by using the AUTOCAD software design tools. This project applies the technique of electrical wiring installation design for high rise building. The scope of this project includes the technical specification, the layout design and designing the electrical schematic for that particular building. While completing this design, IEE Wiring Regulations and JKR Specification can be made as reference and guideline during the planning, design, implementation and construction.

Keywords—Electric Installation Design, AutoCAD software, High Rise Building, IEE Wiring Regulations, JKR Specifications.

I. INTRODUCTION

The building construction project consist of one block of sixteen storey office building comprises four level commercial building and three level parking storey parking lot basements. The electrical installation design of this building was according to the JKR specs and IEE wiring regulations.

Electrical installation requires the electrical engineer to have a thorough understanding of the basic electrical principles, the knowledge of the tools and material used in installations, yet familiar with commonly installed equipment and the specific wiring requirements of the equipment, the ability to interpret the electrical construction drawings, hence design the electrical installation

Nowadays, electrical installation design in building and residential houses is no longer efficient due to the lack of experience of the designer itself. Designer nowadays usually used material that does not meet the requirement of the electrical design. Due to this fact, this technical paper main objective is to overcome all sort of problems in designing the electrical installation.

The requirements of IEE Regulations make it clear that circuits must be designed and the design data made readily available. Calculations of cable size are of little value unless the type of cable and its method of installation are known. At the same time, the supply that will be used either single phase or three phases, the type of earthing arrangements, and so on must be determined. Having ascertained all the necessary details the method of installation, the type of cable and protection against electrical shock and

overcurrents can be determined. The maximum demand of an installation, expressed in amperes, shall be assessed.

II. METHODOLOGY

This project follows a methodology in designing electrical installation. This methodology is initiated purposely to guide designer in designing the electrical installation. This methodology steps can be summarized in the flow chart given in Figure 1.

A. Electrical Load Requirements

The main concern in designing the electrical installation in multi storey office building is the electrical load requirement. In a modern office building there will be a large variety of loads, some of each will be more sensitive to fluctuations in the electricity supply [1].The procedures generally involved in these aspects of the load requirement design is the estimating and drawing of electrical installation in this project. In its simplest terms the design of electrical installation involves the laying out of electrical equipments such as light fittings, socket outlets, switches, fans, and making up the associated circuitry or schematic wiring diagrams showing how they are connected to the incoming supply and also how they are interconnected.

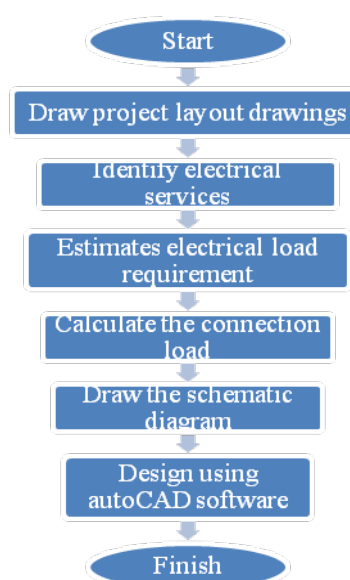


Figure 1: Flow chart of methodology

B. Lighting Design

Nowadays there are various types of illumination. Rules and the regulation is important in designing the lights. Tubular fluorescent and discharge lighting are non linear loads taking a rich content of odd harmonics current [2]. The lights that are chosen are depending on environments and area in the particular floor of the building. Therefore, the Lux table from the JKR Standard is used to calculate the number and types of lighting required. The standard formula to calculate the number of lighting by Equation (1):

$$n = \frac{A \times \text{Lux}}{U_f \times M_f \times \text{No. of fitting} \times \text{Lumen/Watt}} \dots\dots\dots(1)$$

Where:

n : number of light fitting

A : area

Lux : Lux value (refer LUX regulation table) (Appendix 1)

U_f : utilization factor

M_f : maintenance factor

Lumen/Watt : Recommended by manufacture

For JKR standard, we need to refer LUX regulations (Appendix 1) provide by JKR for general building.

C. Switch Socket Outlet

It is common that every room must have switch socket outlet for electrical appliances. For a multi storey building switch socket outlet design must be compatible with the standard supply in Malaysia 240 Vrms 50 Hz. The common load is usually are linear load and un-linear load. In Malaysia the standard rating switch socket outlet are 250Watt for 13A Switch Socket Outlet and 500Watt for 15A Switch Socket Outlet.

D. Fan

The important of fans is to provide the ventilations for close room. Fans can be considered as a load that using motor. Hence, several considerations must be taken in designing fans for particular room in the building. It is compulsory for a room that does not install any air-conditioning system.

E. Total Connected Load

All Total Connected Load (TCL) that connect to DB must be calculated. From the resulting value of the Total Connected Load (TCL), it will decide whether the system is operating in High Voltage (275kV/132kV), Medium Voltage (33kV/11kV) or Low Voltage (415V).

The TCL can be calculated by obtaining the power of the electrical equipment that will be used. TCL for lighting calculation by Equation (2):

$$TCL (kW) = \frac{\text{No. of Fitting} \times \text{fitting} (kW) \times 1.8}{1000} \dots\dots\dots(2)$$

Where:

No. of Fitting : numbers of the lighting to be installed

Fitting : power of light (kW)

Ballast Factor : 1.8

The different types of light have a different value of ballast factor.

Ballast factor for street lighting=1.3

Ballast factor for fluorescent light and down light=1.8

Emergency light and exit light have no ballast factor.

F. Cable Size

The safety in electrical design has to be maximized. The selection of size of a cable must be properly done. In designing electrical installation system, all the cable sizes in the schematic diagram need to be calculated. Voltage drop of the cable size calculation must be taken into a special consideration and it is depend on the electrical appliances.

Cable structure comprises two parts: the conductor or conductors and the sheathing and insulation. Types of cable are available in wide range of types. Unless otherwise specified service cables to the building shall be PVC insulated hard drawn aluminum conductors complying to BS 6485 [3].The cable size can be selected by calculating the current capacity by using Equation (3):

$$I_t \geq \frac{I_n}{C_g \times C_a \times C_i} \dots\dots\dots(3)$$

Where;

I_t = Current carrying capacity

I_n = nominal current of the protective device

C_g = Correction factor for grouping

C_a = Correction factor for ambient temperature

C_i = Correction factor for thermal insulation

G. Protection System

All electrical regulations, both advisory and statutory are largely concerned with preventing fire and shock. Statistics reveal that there are at least a hundred deaths and thousands of accidents each year from electric shock. Personnel concerned with the installation and maintenance of electric wiring must have adequate knowledge of safety measures.

H. Distribution Board

A distribution board known as a circuit breaker panel, panel board, or load center is a mounting enclosure for multiple electrical circuit breakers. These are generally placed in two rows. Small single-phase boxes, with the breakers in just one row, are known as consumer units. Distribution boards are typically found in central location inside buildings and often serve as the point at which electricity is distributed within a building. A consumer unit is a unit box of fuses or breakers usually arranged in a single row. This can be contrasted with a distribution board which has multiple rows of fuses or breakers and usually serves two or three phases.

I. Voltage Drop

All cables have resistance, and when current flows in them, this will result in voltage drop. Hence the voltage at the load is lower than the supply voltage by the amount of the voltage drop. Excessive falls in voltage affect the efficiency of lamps, heaters, motors and other electrical appliances. Maximum allowable voltage drop between origin of a consumer's installation and the equipments is 4%. The voltage drop must be calculated a maximum demand of the installation. Voltage drop can be calculated by using Equation (4):

$$\text{Voltage Drop, (V)} = \frac{\text{Vd}((\text{mV/A/m}) \times \text{IL} \times \text{L})}{1000} \dots\dots\dots(4)$$

Where:

V_d = voltage drop in millivolts per ampere per meter of run (from cable manufacture's specifications table)

I_L = Actual load current flows in the cable

L = Length of run in meters

J. Circuit Breakers

A circuit breaker is an automatically-operated electrical switch which is designed to protect an electrical circuit from damage cause by overload or short circuit. Circuit breaker main function is to provide protection against leakage current. Electrical protection of installation has just one basic aim, which is to regulate the dissipation of electrical energy [4]. Unlike a fuse which operates once and then need to be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation. Circuit breakers are made in various sizes, from small devices to protect an individual household appliances up to large switchgear intended to protect high voltage circuits feeding an entire city. For protection against indirect contact basic measures shall be used in accordance with the relevant

requirements specified in section 471 IEE wiring regulations [5].

K. Schematic Diagram

Schematic diagram needs to be draw according to the lighting, fans, air-conditioning system, switch socket outlet, lifts; fire alarm system has been fully design. Schematic diagram must be draw according to its specification and dimension of the building. A complete schematic diagram must be draw from Main Switch Board (MSB) to Sub Switch Boards (SSB) the function of MSB is to receive electrical power in bulk to dispense it by means of conductors generally bus bars, to branch circuit loads [6]. From Sub Switch Board to Distribution Boards (DB). From distribution boards to loads (electrical appliances). Distribution board should be located as close as possible to the center of the gravity of the loads to minimize installation costs and running losses [7]. Total Connected Load (TCL), Maximum Demand (MD), switchgear rating, cable size and other. All these important parameter need to be calculating and is being specified in the schematic diagram.

III. RESULTS AND DISCUSSION

All of the following procedures have been applied into a 16 multi-storey building. The loads have been designed in each floor. All the loads include lighting, fans, air conditioning and electrical appliances switch socket outlet. The finalized load calculation will be discussed in the next section.

A. Demand Estimation

Supply schemes and networks are to be designed precisely. The initial demand growth of an individual customer or group of customers should be obtain and are being studied. The demand estimates are based upon the load declared by customer and TNB's own information on load profile characteristics for various customer classes. Accurate data of the individual and group demand of customers are critical for correcting the dimension of network or facilities in meeting the initial and future demand of customer as imposed on the network. Table I shows the demand estimation load sizes.

TABLE I
DEMAND ESTIMATION LOAD SIZES

Floor	Total Demand Estimation (kW)Non-essential	Total Demand Estimation (kW)essential
Basement 3	6.95	0.15
Basement 2	6.95	0.15
Basement 1	9.53	0.15
Ground floor	31.63	0.56
Level 1	68.2	0.34
Level 2	71.77	0.45
Level 3	72.19	0.45
Level 4	46.8	0.29
Level 5	44.45	0.23
Level 6	43.97	0.23
Level 7	44.06	0.23
Level 8	43.97	0.23
Level 9	44.06	0.23
Level 10	43.97	0.23
Level 11	44.06	0.23
Level 12	43.97	0.23
Level 13	44.06	0.23
Level 14	41.25	0.28
Level 15	40.56	0.26
Roof Top	2.74	0
Total	795.14	5.15

B. Substation

In designing a substation the Electrical Engineer should follow the regulation and specification. In Malaysia, we should follow the regulation that has been provided by TNB. It is important to determine the suitable location to place the substation. Selection of the location of a substation is based on the key plan provided by architect. It should be located near the main road and entrance, in case for the maintenance and breakdown. There are 2 types of substation approved by TNB. The first type is double chamber that have 2 incoming for 1000kVA. The second type is the single chamber high tension direct system with single incoming to supply 800KW. In this project the total demand estimation for non-essential load and the total demand for essential load for the

whole office building is 1438.02kVA. Therefore it is suitable for this building to supply by 2 nos 750kVA TNB Transformer loaded at 750kVA each double chamber substation.

C. Supply Application

After all the load demands have been estimated, the total kVA rating should be submitted to the TNB for the process of supply application. Hence, the rating of the transformer rating should be calculated. The load for maximum power efficiency is about 75% of the transformer rated load. Transformer rating can be calculated by using Equation (5):

$$\begin{aligned}
 \text{Transformer rating} &= \frac{\text{Total demand (kVA)}}{\text{Transformer loading}} \dots\dots\dots(5) \\
 &= \frac{1078.52 \text{ kVA}}{0.75} \\
 &= 1438.02 \text{ kVA}
 \end{aligned}$$

In order to select the size of transformer, it must also consider the connected load for future installations. For this project the suitable substation is double chamber 2 nos 750kVA TNB Transformer loaded at 750kVA each.

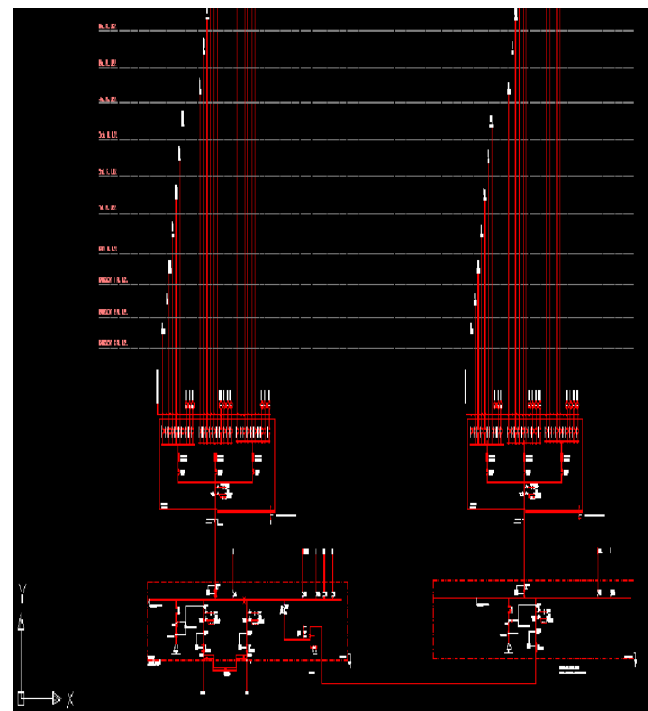


Figure 2: Final Circuit

IV. CONCLUSION

In conclusion, the aim of electrical installation is to supply building with the reliability of electrical power to consumer. Specification and installation guide must be followed in all calculation and in the estimation of the various types of loads. In designing the electrical schematic of the electrical installation is something that shouldn't be taken lightly. When it comes to the idea of electrical installation, always keep in mind the fact that there are a lot of procedures that must be undertaken. All of these procedures are different depend on the type of electrical appliances. There are certain factors that determine what sort of electrical appliances calculation needed in order to carry out the required task. The crucial factors are the regulations of electrical installation in practice must be followed. The intended use of the installation and power requirement for the entire building must be considered. The type of occupancy as well as the size of the building plays a significant part in determining the space to install the loads.

V. FUTURE DEVELOPMENT

For future development, this design can be expand with electrical appliances such as CCTV, Compound Lighting, Card Access System, and Artificial Intelligence Equipment. In the future this design can be programmed by using macros. This is to give a fast, precise, proper and well organized calculation in load estimation arrangement

VI. ACKNOWLEDGMENT

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