One Day Seminar on Power Distribution in Building (Part 1)

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On 7th May, the IEM Electrical Engineering Technical Division (EETD) has successfully organised a One Day Seminar on "Power Distribution in Building" at Wisma IEM. The speaker was Mr. Sanjay Aggarwal who is the head of Larrsen & Toubro Switchgear Training Center Delhi. The seminar was attended by more than 80 participants.

Industries are machine and production oriented while buildings are people and public oriented. According to Mr. Sanjay, building design should always be designed by considering safety first, comfort second.

General requirements in a building are:

1. Lighting
2. Air conditioning
3. Heating systems
4. CCTV, security surveillance system
5. Fire protection
6. Transportation (lift)
7. Data processing
8. Food processing
9. Miscellaneous applications
10. Special loads

Estimation of maximum demand as per IEEE241-1990 have several relevant terms namely connected load, maximum demand, demand factor and diversity factor. Connected load is the sum of continuous ratings of all power consuming apparatus to supply system in kW, horse-powers or Watts. Maximum demand is the greatest of all demands that have occurred during a specified period of time. Demand factor is the ratio of maximum demand of a system to total connected load. It cannot be greater than unity. The lower the demand factor, the less system capacity required to serve the connected load.

Demand factors have various uses such as ampacity of feeder conductors, sizing of the sub-main which is feeding a sub panel or a fixed load like a motor. This factor must be applied to each individual load, with particular attention to electric motors which are very rarely operated at full load. Demand factors for buildings typically range between 50 and 80% of the connected load. In an industrial installation, this factor may be estimated on an average at 0.75 for motors. For incandescent lighting loads, the factor always equals 1. As per NEC code, the demand factor permits a feeder ampacity to be less than 100% of all the branch-circuit loads connected to it.

Diversity factor is the ratio of sum of individual maximum demand of subdivisions of the systems to maximum demand of complete system. It will always be equal to or greater than unity. Diversity is the reciprocal of diversity factor. It gives an indication of the simultaneous maximum demand of a system considering various loads operating at a time and the highest coincident maximum demand of all those loads.

Procedure for load estimation:

1. Determine quantity of load units and power requirement of each load
2. Determine the demand factor of each load or group of loads by definition
3. Determine max demand for present and future operating conditions
4. Estimate the power factor of particular load when operating at its intended rated capacity
5. The various loads divided by their respective power factor will determine the required source capacity in kVA
6. Compute the gross maximum demand of the building which is equal to the sum of max demand of individual and group loads
7. Determine the diversity factor of the system by estimation from previous references.
8. Estimate the spare capacity to be followed for load growth and future load. Use a blanket percentage against gross max load or apply an estimated percentage against each load
9. Determine the required capacity from above steps
10. Select the system with capacity which will satisfy the required capacity.

Considerations when designing lighting system is as follows:

1. Planning the brightness pattern from the point of view of visual performance, safety and amenity and surroundings
2. Form of texture in the task area and surroundings
3. Controlling glare, stroboscopic effect and flicker
4. Colour rendering
5. Lighting for movement
6. Provision for emergency
7. Maintenance factors in lighting installation
8. Max energy effectiveness of the lighting system used consistent with the specific neds of visual tasks performed.

The level of illumination for a particular occupation depends on:

1. Adequacy for realising maximum visual capacity
2. Adequacy for pleasantness or visualisation of the amenity

To ensure energy efficiency in lighting systems:

1. Select the most efficient light source possible in order to minimise power costs and energy consumption
2. Matching the proper lamp type too the intended work task or aesthetic application, consistent with colour, brightness control and other requirements
3. Establishing adequate light levels to maintain productivity, improve security and increase safety

Luminous flux is the quantity of light emitted by a light source. It is a measure of a lamp's economic efficiency. The most common measurement or unit of luminous flux is the lumen (lm). Lumen rating of a lamp is a measure of the total light output of the lamp. Light sources are labelled with an output rating in lumens.

On the other hand, illuminance is the quotient of the luminous flux incident on an element of the surface at a point of surface containing the point, by the area of that element. Lightning level produced by a lighting installation is usually qualified by the illuminance produced on a specified plane. In most cases, this plane is the major plane of the tasks in the interior and is commonly called the working plane. The illuminance provided by an installation affects both the performance of the tasks and the appearance of the space. Lux is the metric unit of measure for illuminance of a surface. One lux is equal to one lumen per square meter. Illuminance decreases by the square of the distance (inverse square law). Luminous efficacy (lm/W) is the ratio of luminous flux emitted by a lamp to the power consumed by the lamp. It is a reflection of efficiency of energy conversion from electricity to light. Installed power density is the installed power density per 100 lux is the power needed per square meter of floor area to achieve 100 lux of average maintained illuminance on a horizontal working plane with general lighting of an interior. The unit is $W/m^2/100$ lux. Average maintained illuminance is the average of illuminance (lux) levels measured at various points in a defined area. Circuit Watts is the total power drawn by lamps and ballasts in a lighting circuit under assessment.

Colour rendering index (CRI) is the measure of the effect of light on the perceived colour of objects. To determine the CRI of a lamp, the colour appearances of a set of standard colour chips are measured with special equipment under a reference light source with the same correlated colour temperature as the lamp being evaluated. If the lamp renders the colour of the chips identical to the reference light source, its CRI is 100. If the colour rendering differs from the reference light source, the CRI is less than 100. A low CRI indicates that some colours may appear unnatural when illuminated by the lamp.

While deciding the light source, consider:

1. CRI of lamp
2. Usable Lumen per watt for the fitting
3. Glaring index for fixture
4. Life of lamp
5. Efficacy of the light source

The first half of the seminar ended here. The second half shall be elaborated in the subsequent article.