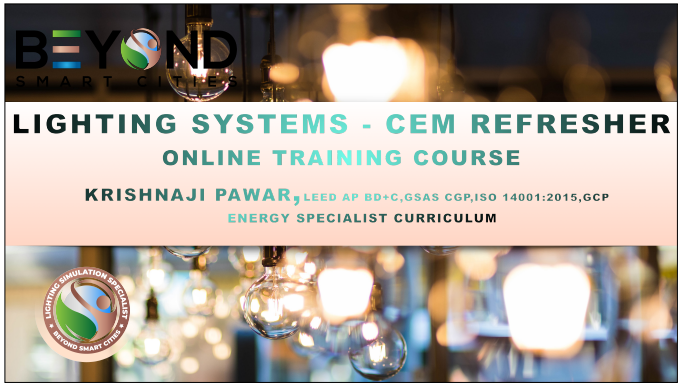
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SMART CITIES
LIGHTING SYSTEMS - CEM REFRESHER
ONLINE TRAINING COURSE
KRISHNAJI PAWAR, LEED AP BD+C,GSAS CGP,ISO 14001:2015,GCP
ENERGY SPECIALIST CURRICULUM

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LIGHTING SYSTEM DESIGN METHODS
FOR ENERGY PROFESSIONALS
KRISHNAJI PAWAR, LEED AP BD+C,GSAS CGP,ISO 14001:2015,GCP
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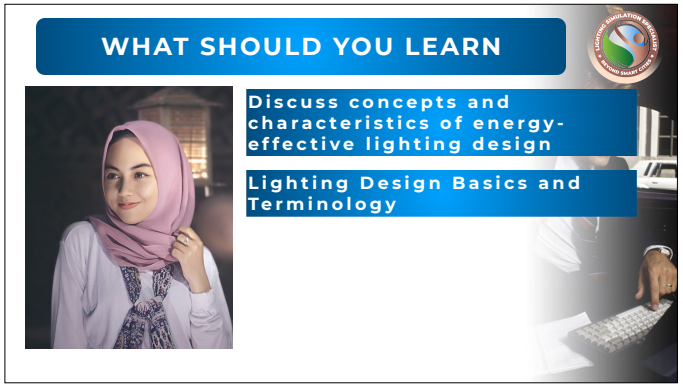

WHAT SHOULD YOU LEARN
Discuss concepts and characteristics of energy-effective lighting design
Lighting Design Basics and Terminology

LIGHTING SYSTEM DESIGN METHODS

Lumen Method

- ☑ Assumes an equal foot candle level throughout the area.
- ☑ This method has been used frequently since it is simple.

Point by Point Method

- ☑ The current method of design based on the Fundamental Law of Illumination.
- ☑ Requires a computer program and extensive computation.

LUMEN METHOD FORMULA

$$N = F1 \times A / Lu \times LLF \times Cu$$

where

N = the number of lamps required
F1 = the required Lux level at the task
A = area of the room in square metres
Lu = the lumen output per lamp
Cu = the coefficient of utilization
LLF = the combined light loss factor

EXAMPLE OF LUMEN METHOD

Find the number of lamps required to provide a uniform 500 Lux on the working surface in a 15 x 10 room. Assume two 3000 lumen lamps each per fixture, and assume that LLF is 0.65 and CU is 70%.

$$N = 500 \times 150 / 3000 \times 0.65 \times 0.7$$

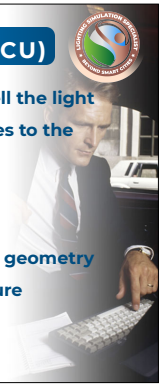
$$= 55$$

The number of two-lamp fixtures needed is 28.

ENERGY COST INDEX EXAMPLE

- For the 10,000 square metre office building looked at earlier, the cost of electricity is $153,200 per year, and the cost of gas is $52,500 per year.
- The ECI is then $ divided by 10,000 square metres, for an ECI of $ /square metre/year.
- It is another simple benchmark that can be used.
- It is another simple benchmark that can be used.

THE COEFFICIENT OF UTILIZATION (CU)



The coefficient of utilization is a measure of how well the light coming out of the lamps and the fixture contributes to the useful light level at the work surface.

It may be given, or you may need to find it:

- Use Room Cavity Ratio (RCR) to incorporate room geometry
- Use Photometric Chart for specific lamp and fixture

ROOM CAVITY RATIO (RCR)

RCR = 2.5 x h x (Room Perimeter)/(Room Area)

Or, if the room is rectangular:

RCR = 5 x h x (L+W)/(LxW)
Where
L = room length
W = room width
h = height from lamp to top of working surface

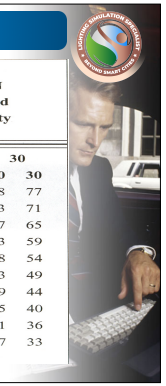
EXAMPLE

Find the RCR for a 10 by 15 rectangular room with lamps mounted on the ceiling at a height of 3 metres, and the work surface is a 60 cm bench.

h = 3.0 – 0.6
= 2.4 metres

RCR = 5 x h x (L+W)/(LxW)
= 5 x 2.4 x (10 + 15)/(10 x 15)
= 12 x 25/150
= 2

PHOTOMETRIC CHART



Report LS1 1101
Lamp: 400 Watt Clear
Lumens: 50,000
Mounting Surface/Pendant

COEFFICIENTS
OF UTILIZATION
Zonal Cavity Method
Effective Floor Cavity
Reflectance 0.20

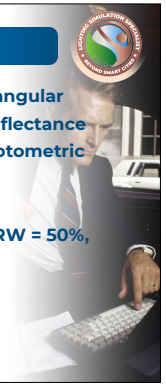
RCR	RC	80			70			50		30	
	RW	70	50	30	70	50	30	50	30	50	30
	1	94	91	89	91	88	86	83	81	78	77
	2	88	84	80	86	81	78	77	74	73	71
	3	83	77	72	80	75	70	71	67	67	65
	4	78	71	65	75	69	64	66	61	63	59
	5	73	65	59	70	63	58	60	56	58	54
	6	68	58	52	66	58	52	55	51	53	49
	7	63	54	48	61	53	47	51	46	49	44
	8	59	49	43	57	48	43	46	41	45	40
	9	55	45	39	53	44	38	42	37	41	36
	10	51	41	35	49	40	35	39	34	37	33

EXAMPLE

Find the Coefficient of Utilization for a 10 by 15 rectangular room with a ceiling height of 3 metres, a ceiling reflectance of 70% and a wall reflectance of 50% using the photometric chart on the previous page.

The RCR from before was 2.0. Using RC = 70% and RW = 50%, the CU is found as CU = 0.81, or 81%

ROOM CAVITY RATIO (RCR)



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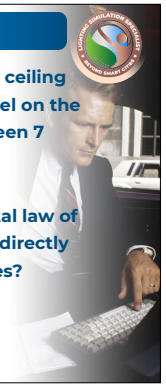
FUNDAMENTAL LAW OF ILLUMINATION OR INVERSE SQUARE LAW

$$E = I / d2$$

where
E = Illuminance in Lux
I = Luminous intensity in lum
ens
d = Distance from light source to surface area of interest in metres
One Lux is equal to one lumen per square metre)

(One footcandle is equal to one lumen per square foot)

EXAMPLE



In a high bay facility, the lights are mounted on the ceiling which is 13 metres above the floor. The lighting level on the floor is 500 Lux. No use is made of the space between 7 metres and 13 metres above the floor.

In a theoretical sense – that is, using the fundamental law of illumination – what would be the light level in Lux directly below a lamp if the lights were dropped to 7 metres?

Lux = 500 x (132/72) = 1725 Lux

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