

Lighting Layout and Sound Index Calculation



[1010 Words]

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**ACBA4006 : Material Science and Building Services : Lighting Layout and Sound
Index Calculation**

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Lighting Layout and Sound Index Calculation

Task A :

Task A:

A production area in a factory measures 60 metres x 24 metres x 8 metres in height.

The factory's work benches are set at a height of 1m above the floor level.

The area's reflectances are 0.3 for the ceiling and 0.5 for the walls.

The lighting design specifies Fluorescent lamps in recessed louvre with DLOR of 50%. (The actual size of the luminaires is 1200mm (1.2m) in length and (0.2m) wide).

A Lighting Design Lumen (LDL) output is 18,000 lumens is required.

The lamination required for the factory area is 200 lux at the working plane.

Light Loss Factor = 0.75

1.1) The Room Index

$$\text{Room Index} = \frac{L \times W}{(H_m \times (L + W))}$$

Where: L = Length of room

W = Width of room

H_m = Height of the luminaire measured from the working plane

$$L = 60\text{m} \quad W = 24\text{m} \quad H_m = 8\text{m} - 1\text{m} = 7\text{m}$$

$$\text{Room Index} = \frac{60 \times 24}{(7 \times (60 + 24))}$$

$$\text{Room Index} = \frac{1440}{(7 \times 84)}$$

Room Index = 2.448...

$$= \underline{\underline{2.45}}$$

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1.2) Utilisation Factor

Room Index = 2.45 DLOR = 50% Ceiling reflectance = 0.3 Wall reflectance = 0.5

Description of fitting	Typical outline LOR	Basic downward LOR%	Ceiling	0.7			Reflectances			0.3		
			Walls	0.5	0.3	0.1	0.5	0.3	0.1	0.5	0.3	0.1
			Room index									
Aluminium industrial reflector, aluminium or enamel high-bay reflector		70	0.6	0.39	0.36	0.33	0.39	0.36	0.33	0.39	0.35	0.33
			0.8	0.48	0.43	0.40	0.46	0.43	0.40	0.46	0.43	0.40
			1.0	0.52	0.46	0.45	0.52	0.48	0.45	0.52	0.48	0.45
			1.25	0.56	0.53	0.50	0.56	0.53	0.49	0.56	0.52	0.42
			1.5	0.60	0.57	0.54	0.59	0.57	0.53	0.59	0.57	0.53
			2.0	0.65	0.62	0.59	0.63	0.60	0.58	0.63	0.59	0.57
			2.5	0.67	0.64	0.62	0.65	0.62	0.61	0.65	0.62	0.60
			3.0	0.69	0.66	0.64	0.67	0.64	0.63	0.67	0.64	0.62
			4.0	0.71	0.68	0.67	0.69	0.67	0.65	0.69	0.66	0.64
Near-spherical diffuser, open beneath		50	0.6	0.28	0.22	0.18	0.25	0.20	0.17	0.22	0.18	0.16
			0.8	0.39	0.30	0.26	0.33	0.28	0.23	0.27	0.25	0.22
			1.0	0.43	0.36	0.32	0.38	0.34	0.29	0.31	0.29	0.26
			1.25	0.48	0.41	0.37	0.42	0.38	0.33	0.34	0.32	0.29
			1.5	0.52	0.46	0.41	0.46	0.41	0.37	0.37	0.35	0.32
			2.0	0.58	0.52	0.47	0.50	0.48	0.43	0.42	0.39	0.36
			2.5	0.62	0.56	0.52	0.54	0.50	0.47	0.45	0.42	0.40
			3.0	0.65	0.60	0.56	0.57	0.53	0.50	0.48	0.45	0.43
			4.0	0.68	0.64	0.61	0.60	0.56	0.54	0.51	0.48	0.46
Recessed louvre 0.23 trough with optically designed reflecting surfaces		50	0.6	0.28	0.25		0.23	0.28	0.25	0.23	0.28	0.25
			0.8	0.34	0.31	0.28	0.33	0.30	0.28	0.33	0.30	0.28
			1.0	0.37	0.36	0.32	0.37	0.34	0.32	0.37	0.34	0.32
			1.25	0.40	0.38	0.35	0.40	0.37	0.35	0.40	0.37	0.35
			1.5	0.43	0.41	0.38	0.42	0.40	0.38	0.42	0.39	0.38
			2.0	0.46	0.44	0.42	0.45	0.43	0.41	0.44	0.42	0.41
			2.5	0.48	0.46	0.44	0.47	0.45	0.43	0.46	0.44	0.43
			3.0	0.49	0.47	0.46	0.48	0.46	0.45	0.47	0.45	0.44
			4.0	0.50	0.49	0.48	0.49	0.48	0.47	0.48	0.47	0.46
			5.0	0.51	0.50	0.49	0.50	0.49	0.48	0.49	0.48	0.47

Utilisation Factor = 0.46

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1.3) Number of lamps required

$$\text{Number of lamps required} = \frac{E \times A}{F \times UF \times LLF}$$

Where: E = Illuminance level required

A = Area of working plane height

F = Average luminous flux from each lamp

UF = Utilisation Factor

LLF = Light Loss Factor

$$E = 200 \text{ lux} \quad A = 60\text{m} \times 24\text{m} = 1,440\text{m}^2 \quad F = 18,000 \text{ lumens} \quad UF = 0.46 \quad LLF = 0.75$$

$$\text{Number of lamps required} = \frac{200 \times 1,440}{18,000 \times 0.46 \times 0.75}$$

$$\text{Number of lamps required} = 46.376$$

$$= \underline{\underline{47 \text{ lamps}}}$$

1.4) A suitable Layout

$$S_{\max} = 1.5 \times H_m$$

Where: H_m = Height of the luminaire measured from the working plane

$$H_m = 7\text{m}$$

$$S_{\max} = 1.5 \times 7$$

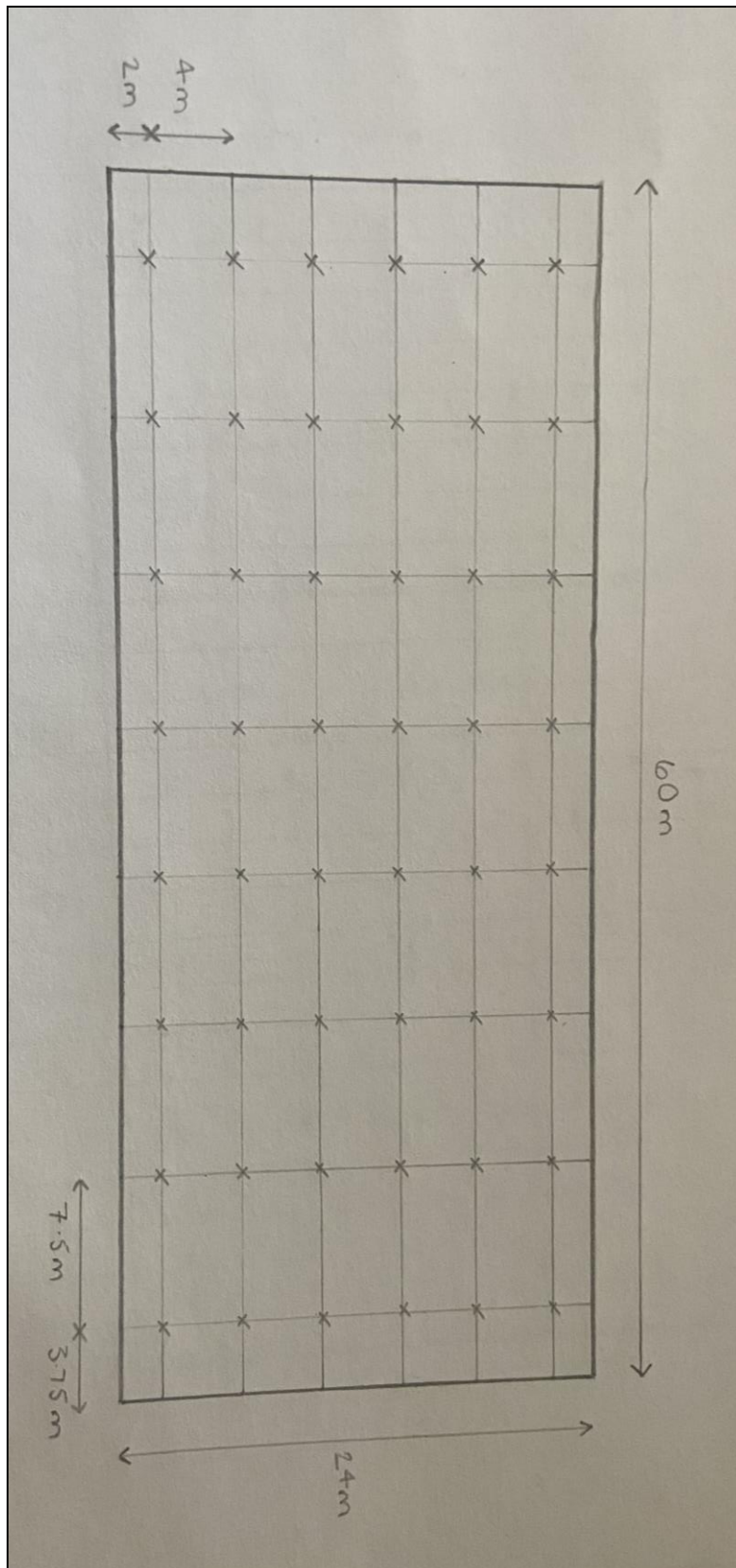
$$= \underline{\underline{10.5\text{m apart}}}$$

Index Calculation

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2) Lighting Plan Layout

Due to the number of lamps being required equalling 47, and it being a prime number, I have elected to use 48 lamps in a six by eight grid as shown below:



Lighting Layout and Sound Index Calculation

Task B :

Task B :

A Brick wall of area 20m² contains a window of area 4m².

The values of sound reduction indexes are:

- 50dB for the brickwork
- 10dB for the window

1) Overall Sound Reduction Index

$$SRI = 10 \times (\log_{10} \times (1/T))$$

Brickwork:

$$T_1 = ?$$

$$A_1 = 20\text{m}^2 - 4\text{m}^2 = 16\text{m}^2 \quad SRI = 50\text{dB}$$

$$50 = 10 \times (\log_{10} \times (1/T_1))$$

$$5 = \log_{10} \times (1/T_1)$$

$$1/T_1 = 10^5$$

$$T_1 = 10^{-5}$$

$$= \underline{\underline{0.00001 \text{ transmission coefficient}}}$$

Log Definition:

If we have the expression: $X = \text{Log}_A \times Y$

Then: $Y = A^X$

Window:

$$T_2 = ?$$

$$A_2 = 4\text{m}^2 \quad SRI = 10\text{dB}$$

$$10 = 10 \times (\log_{10} \times (1/T_2))$$

$$1 = \log_{10} \times (1/T_2)$$

$$1/T_2 = 10^1$$

$$T_2 = 10^{-1}$$

$$= \underline{\underline{0.1 \text{ transmission coefficient}}}$$

$$T_0 = \frac{(T_1 \times A_1) + (T_2 \times A_2)}{A_1 + A_2}$$

$$T_1 = 10^{-5} \quad A_1 = 16\text{m}^2$$

$$T_2 = 10^{-1} \quad A_2 = 4\text{m}^2$$

$$T_0 = \frac{(10^{-5} \times 16) + (10^{-1} \times 4)}{16 + 4}$$

$T_0 =$ 0.020008 average transmission coefficient

$$SRI = 10 \times (\log_{10} \times (1/T))$$

$$SRI = 10 \times (\log_{10} \times (1/0.020008))$$

$$SRI = 10 \times (\log_{10} \times (49.980008))$$

$$SRI = 10 \times 1.698796321$$

$$SRI = 16.98796321$$

$$=$$
 17dB

2) Implications of frequency and wavelength

Sound is defined as the quickly varying pressure waves traveling through a medium. When sound travels through air, the atmospheric pressure varies periodically. The number of pressure variations passing a given point per second is called the frequency of sound, which is measured using the units Hertz (Hz) - 'cycles per second'.

During construction, designs plan to control and mitigate the levels of sound within buildings. This is done so by considering and addressing one the following factors:

- Acoustical treatment at the source of the noise.
- Acoustical treatment of the path it travels
- Acoustical treatment at the receiver

In the event that the noise produced at a source is not able to be controlled, the next best strategy is to consider its path. It should be noted that it is very expensive to address this after a building has been designed and construction has commenced. On the other hand, addressing this problem at the beginning of the project will be far more cost effective.

Structure borne sound travels along a path from source to receiver, similarly to what I have previously discussed. Sound waves are known to set walls and other structures into vibration. This motion travels through the structure and is re-radiated in the form of noise. The only way to reduce structure borne noise along its path is to put 'vibration brakes' into the structure.

Sound insulation is the process of soundproofing an enclosed space, in order to absorb the vibrations. Good quality sound proofing relies on the following principles:

- Weight:
Heavyweight construction increases the difficulty for the wave to cause vibrations to the wall.

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- **Completeness:**
This addresses the airtightness of a structure, as any gap that allows the transfer of air will allow sound to also pass.
- **Isolation:**
A minimum of physical contact between two surfaces or rooms provides the highest insulation.

The effectiveness of this insulation is measured using the difference in the two sound levels records on either side of the wall.