

Quantity and Quality of Lighting in Underground Roadway Applications

Many factors need to be considered when specifying lighting for underground roadways and tunnels and many are difficult to determine. While the standards provide guidance, they should be used carefully to ensure an installation meets real needs.

Quantity and Quality of Lighting

The quantity of light falling on a surface (road) is measured in lux and is dependent upon the distance between the light source and the working plane. The numerical value is an inverse square relationship. The quality of the light can be considered as the uniformity, the difference between maximum and minimum illuminance. This is directly related to the spacing between the lights. Uniformity is important as it can be perceived as flicker as travel speeds increase beyond walking pace. In lighting science, uniformity is defined as the ratio of minimum to average illuminance.

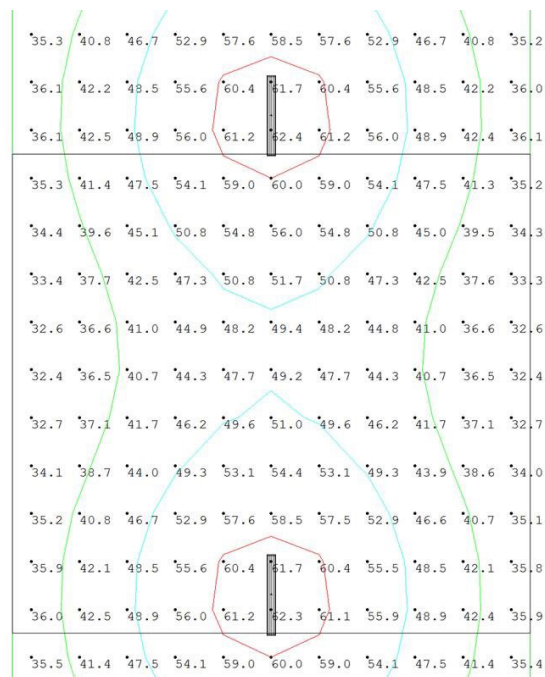
AS/NZS 1158 Part 5 is written for Tunnels and Underpasses. While there a number of zones depending on the location of the point of interest, the interior zone is away from the access and transition zones. It nominates average luminance $L > 6 \text{ Cd/m}^2$ (Candelas per sq metre) for SSD (Stopping Sight Distance) $\leq 60\text{m}$ which is applicable for road speeds of 40km/hr. Calculation and compliance requires accurate nomination of surface reflectances. Walls and fixed objects can be readily calculated with reflectances between 0.4 and 0.8. Road surface reflectances are below 0.1, so compliance will result in very high illuminance and cost in providing the required number of luminaires.

AS/NZS 1680 provides information for Lighting Interiors and Workplaces. It indicates a minimum illuminance of 40 lux for corridors and walkways. Guidance for uniformity in circulation spaces is ≥ 0.3 and general lighting ≥ 0.5 .

The two standards address lighting in two ways. AS/NZS 1158 considers the luminance or brightness of objects in the field of view whereas AS/NZS 1680 considers the illuminance or amount of light falling on objects. These are related by the surface reflectance. For our considerations, the illuminance method is preferred.

Based on a roadway 5400mm wide with AlphaLite Max 18W lights mounted 3500mm above the working plane and spaced at 5m centres, the isolux plot below was produced. This shows the illuminance at a number of points. Lines of equal illuminance are also shown. The lighting design program also produces numerical values for performance checking. Uniformity is defined as minimum/average hence the inverse of Avg/Min Ratio stated, i.e. 0.71 .

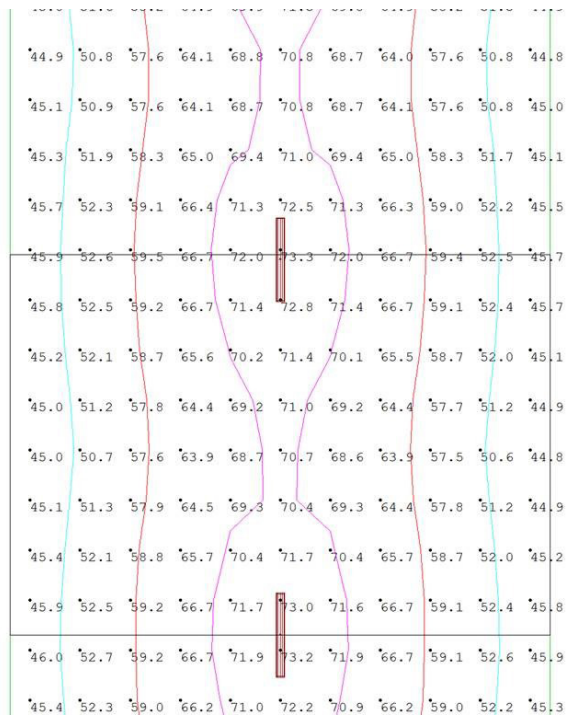
While the uniformity is greater than that indicated in AS/NZS 1680, the illuminance is lower than the guidance.



- Roadway 5400x3500
- AL Max 18W Mounting H 3.5m, Spacing 5m
- Illuminance (Lux)
 - ▶ Average = 45.5
 - ▶ Maximum = 62.3
 - ▶ Minimum = 32.4
 - ▶ Avg/Min Ratio = 1.4
 - ▶ Max/Min Ratio = 1.9

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To improve the minimum illuminance, we would recommend a reduced spacing of 3.75m. This produces the following results.



- Roadway 5400x3500
- AL Max 18W Mounting H 3.5m, Spacing 3.75
- Illuminance (Lux)
 - ▶ Average = 59.4
 - ▶ Maximum = 73.0
 - ▶ Minimum = 44.8
 - ▶ Avg/Min Ratio = 1.3
 - ▶ Max/Min Ratio = 1.6

The minimum illuminance is 44 lux and uniformity over the entire tunnel is 0.77. Of note is the longitudinal uniformity evidenced by the almost parallel isolux lines. Longitudinal uniformity is > 0.97 . This is of importance when considering visual discomfort of observers moving through the space, particularly along the tunnel.

As a point of interest, if a road reflectance of 0.1 is assumed and illuminance of 73 lux, i.e. immediately under a light, the luminance of the road is 2.3 Cd/m². To meet 6 Cd/m², the illuminance would need to be more than doubled.

+ Based upon wattage, spacing of the lights, mounting heights, cavity dimensions, wall and floor reflectance, Ampcontrol can provide luminance calculations and photorealistic simulations for your specific roadway lighting installation.

Contact us today 1300 267 373