

## Lighting of underpasses for pedestrians and cyclists in Norway, Sweden, Finland and Denmark

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### Introduction and summary

As a part of the work on road and tunnel lighting within the NMF, it has been decided to compare the lighting levels of the lighting of underpasses for pedestrians and cyclists in Norway, Sweden, Finland, and Denmark.

The lighting is expressed by means of the C-, P- and HS-classes for pedestrians and cyclists in EN 13201-2: 2015 "Road lighting - Part 2: Performance requirements". These classes, and D-classes for discomfort glare from luminaires, are presented in section 1. Only Norway and Denmark specify the D-class.

The lighting of underpasses is briefly accounted for in sections 2, 3, 4 and 5 for respectively Norway, Sweden, Finland, and Denmark.

Table 1 gives an overview of the lighting levels in underpasses for daytime and nighttime.

Note: The Finnish levels of 100 lx for railway underpasses is not included in table 1.

For daytime, the levels are 15 lx, 20 lx and 25 lx for respectively Norway, Finland and Denmark. When taking the note 1) in the table into account, the levels are close to each other. The Swedish requirement for 100 lx is much higher.

The note 2) in table 1 points to the matter that only the Danish handbook and the Swedish requirements offer criteria for the need for lighting in daytime. However, the intentions are probably the same all the Nordic countries.

For nighttime, two levels are offered by Finland and Denmark. The criteria for choosing between the two levels are different, but the intentions are probably the same. The lighting levels are close between Finland and Denmark.

**Table 1: Daytime lighting levels and classes for underpasses in the Nordic countries.**

(Lighting of underpasses by daytime and nighttime indicated by respectively a **fat** and an *italic* font)

Lighting level	Average horizontal illuminance (lx)	Norge	Sverige	Finland	Denmark
			<b>100 lx <sup>2)</sup></b>		
11	50				
10	30				<b>25 lx <sup>2)</sup></b>
9	20			<b>C2</b>	
8	15	<b>C3 <sup>1)</sup></b>			
7	10			<i>C4</i>	
6	7,50				<i>8 lx</i>
5	5,00			<i>P4</i>	
4	4,00				<i>4 lx</i>
3	3,00				
2	2,00				
1	1,50				
<sup>1)</sup> In underpasses intended for pedestrians and cyclists, the need to choose a lighting class that provides a higher lighting level is to be considered.					
<sup>2)</sup> When necessary, in accordance with criteria.					

# 1. Relevant classes in EN 13201 Part 2: 2015 "Road lighting - Part 2: Performance requirements"

Lighting of underpasses for pedestrians and cyclists in the Nordic countries involve the C-, P- and HS-classes, and the D glare index classes of discomfort glare from the luminaires. The requirements are shown in tables 2, 3, 4 and 5. The C- and P-classes are based on the horizontal illuminance, while the HS classes are based on hemispherical illuminance.

A current revision of EN 13201-2 will probably result in the introduction of a minimum overall uniformity of 0,20 for the P-classes and HS+ classes of a minimum overall uniformity of 0,25.

**Table 2: C-classes defined in EN 13201-2.**

Class	Horizontal illuminance	
	$\bar{E}$ [minimum maintained] lx	$U_o$ [minimum]
C0	50	0,40
C1	30	0,40
C2	20,0	0,40
C3	15,0	0,40
C4	10,0	0,40
C5	7,50	0,40

**Table 3: P-classes defined in EN 13201-2.**

Class	Horizontal illuminance		Additional requirement if facial recognition is necessary	
	$\bar{E}^a$ [minimum maintained] lx	$E_{min}$ [maintained] lx	$E_{v,min}$ [maintained] lx	$E_{sc,min}$ [maintained] lx
P1	15,0	3,00	5,0	5,0
P2	10,0	2,00	3,0	2,0
P3	7,50	1,50	2,5	1,5
P4	5,00	1,00	1,5	1,0
P5	3,00	0,60	1,0	0,6
P6	2,00	0,40	0,6	0,2
P7	performance not determined	performance not determined		

<sup>a</sup> To provide for uniformity, the actual value of the maintained average illuminance shall not exceed 1,5 times the minimum  $\bar{E}$  value indicated for the class.

Table 4: HS-classes defined in EN 13201-2.

Class	Hemispherical illuminance	
	$\bar{E}_{hs}$ [minimum maintained] lx	$U_o$ [minimum]
HS1	5,00	0,15
HS2	2,50	0,15
HS3	1,00	0,15
HS4	performance not determined	performance not determined

Table 5: Glare index classes for discomfort glare defined in EN 13201-2.

Class	D0	D1	D2	D3	D4	D5	D6
Glare index maximum	–	7 000	5 500	4 000	2 000	1 000	500

## 2. Lighting of underpasses for pedestrians and cyclists in Norway

The Norwegian requirements are given in “*Teknisk planlegging av veg- og tunnelbelysning, Håndbok V124* (Technical planning of road and tunnel lighting, Handbook V124 - in Norwegian).

[https://files.motocross.io/trafikksiden/HB\\_V124\\_Planlegging\\_veg\\_tunnelbelysning\\_2021.pdf](https://files.motocross.io/trafikksiden/HB_V124_Planlegging_veg_tunnelbelysning_2021.pdf)

The requirements are simple and found in a clause 3.7 “*Illumination for pedestrian and cycle ways*”. This is a translation:

Underpasses are illuminated according to the C lighting classes. In underpasses intended only for pedestrians, lighting class C3 is used. In underpasses intended for pedestrians and cyclists, the need to choose a lighting class that provides a higher lighting level is to be considered.

Additionally, there is a general requirement that the glare index class of the luminaires is D6 to avoid discomfort glare for pedestrians and cyclists.

The C- and D-classes are introduced in section 1.

Lighting class C3 corresponds to a minimum maintained average horizontal illuminance of 15 lx. The glare index class D6 is the most demanding of the D-classes.

## 3. Lighting of underpasses for pedestrians and cyclists in Sweden

Illuminated underpass shall have the same lighting class as connecting parts, however, at least lighting class P4.

*Note: Night lighting refers to lighting that follows the lighting control from adjacent pedestrian and cycle path lighting.*

If the length of the underpass in road direction exceeds 5 times the width of the opening across the pedestrian and cyclist path shall the underpass be provided with daylight.

Day lighting shall be at least maintained average value of 100 lux of the horizontal ground level.

Day lighting must be controlled so that at nighttime lighting has the same lighting class as the connecting pedestrian and cyclist path

*Note: Day lighting refers to lighting that switches on when lighting on the connecting pedestrian and cycle path goes out and vice versa.*

*Note: For daylighting, the average illuminance on the wall from 1.2 m and up should be at least 250 lux.*

*Note: Tunnels with daylight should be dimmed during the night, partly to save energy and partly to balance the light level inside and outside the tunnel. Lighting in tunnels with few pedestrians and cyclists should also be presence-controlled. The control should be performed so that the tunnel is never completely extinguished but goes from low level to high level in the presence.*

*Note: It is advisable to use luminaires that are shielded in the direction of the view but provide light on the walls and ceiling.*

*Note: By illuminating the walls of the passage, the contrast between the wall and the wing wall is reduced.*

*Note: Crucial to the feeling of security on a pedestrian and bicycle path in underpasses is the possibility to look through the tunnel so it is important to take glare under account. The luminaires should be placed in the ceiling or high up on the wall. By lighting up walls and ceilings, the contrast with visible light points is*

reduced. The surfaces directly outside the mouth are often poorly lit in contrast to the interior lighting. If it is bright outside, more light is needed in the passage.

*Note: Too much light in the passage at night obscures the surroundings and makes it difficult to see beyond the entrance.*

*Note: The ideal from a safety and maintenance point of view is a wide straight passage without internal steps and clean open entrances. Regular inspection of the installation is required to minimize the effects of vandalism and destruction. The luminaires should be impact-resistant and easy to wash. If glass breaks, there should be no easily accessible live parts behind.*

#### 4. Lighting of underpasses for pedestrians and cyclists in Finland

Aleksanteri Ekrias has provided the information that is arranged in table 6.

**Table 6: Lighting of underpasses for pedestrians and cyclists in Finland.**

<b>Underpasses that are illuminated during the day:</b>		
Railway underpasses	Average horizontal illuminance of minimum 100 lx	Overall uniformity of minimum 0,50
Other underpasses: Class C2	Average horizontal illuminance of minimum 20 lx	Overall uniformity of minimum 0,40
<b>Underpasses that are not illuminated during the day:</b>		
High traffic flow: Class C4	Average horizontal illuminance of minimum 10 lx	Overall uniformity of minimum 0,40
Low traffic flow: Class P4 *)	Average horizontal illuminance of minimum 5 lx	Overall uniformity of minimum 0,20
*) The lighting of the paths outside the underpass is to class P4, P5 or P6 (maximum class P4)		

Additionally, Aleksanteri Ekrias states that these criteria are applied in Finland:

*The underpass shall be illuminated during the day if the length of the underpass is at least six times the width or more than 25 m. Underpasses shorter than this shall be illuminated during the day if the underpass is optically long, the underpass height is low, or the walls are very dark. The need for lighting during the day shall always be defined on a project-by-project basis with the client. Factors influencing the decision include e.g. the location of the closest road lighting cabinet and the availability of electricity during the day.*

The C- and P-classes are introduced in section 1.

## 5. Lighting of underpasses for pedestrians and cyclists in Denmark

The Danish requirements are provided in "Håndbog for vejbelysning: oktober 2020" (Handbook for road lighting - in Danish).

<http://leverandorportal.vejdirektoratet.dk/Lists/TenderDocuments/Indk%C3%B8b%20af%20armaturer%20til%20vejbelysning/Udbudsdokumenter/HB%20Vejbelysning%20-%20IND-VB-DK-2020.PDF>

The requirements are given in a clause 5.15. This is a translation:

The primary purpose of lighting of underpasses for pedestrians and cyclists is to create safety and security. As with road underpasses, the lighting of these tunnels should, among other things, depend on their lengths.

Underpasses with paths that are parts of actual traffic systems are always to be lighted at night, even if the paths are not lighted outside of the underpasses. Consideration should be given to establishing lighting at both ends of the underpasses to increase safety.

There need for lighting during daytime depends on the area of the underpass opening. As a rule, underpasses should be lit during the day if:

- a) the length of the underpass is greater than 10 times the square root of the opening area,
- b) or the opening of the underpass lies low in relation to the surroundings, or are encircled by tall plants or buildings that make the opening appear smaller at a distance,
- c) or there is insufficient daylight into the underpass because of curvature.

The lighting in underpasses can be optimized by giving the walls light colors.

These are the requirements for minimum maintained horizontal illuminance:

**Table 7: Lighting of underpasses**

Minimum maintained average horizontal illuminance:	Daytime	Nighttime
Underpasses of paths that are not parts of a traffic system:	None/25 lx *)	4 lx
Underpasses of paths that are parts of a traffic system:	None/25 lx *)	8 lx
*) No lighting if the daylight is sufficient, else 25 lx		

Whenever lighting of underpasses is established, the overall uniformity shall be minimum 0,25 and the luminaires shall be of glare index class D5.

The HS- and the D-classes are introduced in section 1. In the Danish handbook for road lighting, the classes HS1, HS2, HS3 and HS4 are labelled respectively E1, E2, E3 and E4.

A path is a part of a traffic system if it is illuminated to class HS2 or higher, else it is not part of a traffic system.

The lighting requirements for the underpasses are in family with those of the C-classes of EN 13201-2 as described in section 1. However, compared to the C-classes, the overall uniformity is reduced from 0,40 to 0,25 to achieve longer spacing to mounting height ratios.

Additionally, the lighting levels defined by the minimum maintained average horizontal illuminance values of 4, 8 and 25 lx do not fit into the steps of the C-classes. The level of 4 lx is about half of the 7,5 lx of the lowest C-class (C5), 8 lx is about the level of 7,5 lx of class C5. Additionally, 25 lx is in between the two levels of 20 lx and 30 lx of classes C2 and C1.

The glare index class D5 of the luminaires is the next most demanding of the D-classes.