SLOVENSKI STANDARD
SIST EN 13201-3:2004

01-september-2004

Cestna razsvetljava ï 3. del: Izraļ un lastnosti

Road lighting - Part 3: Calculation of performance

Straßenbeleuchtung - Teil 3: Berechnung der Gütemerkmale

Eclairage public - Partie 3: Calcul des performances

Ta slovenski standard je istoveten z: EN 13201-3:2003

<u>**ICS:**</u>

93.080.40	Cestna razsvetljava in pripadajoļ a oprema	Street lighting and related equipment

SIST EN 13201-3:2004 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13201-3

November 2003

ICS 93.080.40

English version

Road lighting - Part 3: Calculation of performance

Eclairage public - Partie 3: Calcul des performances

Straßenbeleuchtung - Teil 3: Berechnung der Gütemerkmale

This European Standard was approved by CEN on 1 September 2003.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 13201-3:2003 E

Contents

page

Foreword

This document (EN 13201-3:2003) has been prepared by Technical Committee CEN/TC 169 "Light and lighting", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2004, and conflicting national standards shall be withdrawn at the latest by May 2004.

This European Standard was worked out by the Joint Working Group of CEN/TC 169 "Light and lighting" and CEN/TC 226 "Road Equipment", the secretariat of which is held by AFNOR.

This document includes a Bibliography.

This standard, EN 13201 *Road lighting*, consists of three parts. This document is:

Part 3: *Calculation of performance*

The other parts of EN 13201 are:

Part 2: *Performance requirements*

Part 4: *Methods of measuring lighting performance*

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

The calculation methods described in this Part of this European Standard enable road lighting quality characteristics to be calculated by agreed procedures so that results obtained from different sources will have a uniform basis.

1 Scope

This European Standard defines and describes the conventions and mathematical procedures to be adopted in calculating the photometric performance of road lighting installations designed in accordance with EN 13201-2.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

prEN 13032-1, *Light and lighting — Measurement and presentation of photometric data of lamps and luminaires — Part 1: Measurement and file format.*

EN 13201-2, *Road lighting — Part 2: Performance requirements.*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply.

3.1.1
vertical photometric angle (of a light path) (γ)
angle between the light path and the first photometric axis of the luminaire

NOTE 1 Unit °(degrees).

NOTE 2 See Figure 1.

3.1.2
azimuth (of a light path) (*C*)
angle between the vertical half-plane passing through the light path and the zero reference half-plane through the first photometric axis of a luminaire, when the luminaire is at its tilt during measurement

NOTE 1 Unit ° (degrees).

NOTE 2 See Figure 1.

3.1.3
angle of incidence (of a light path at a point on a surface) (ε)
angle between the light path and the normal to the surface

NOTE 1 Unit ° (degrees).

NOTE 2 See Figure 4, Figure 13 and Figure 14.

3.1.4
angle of deviation (with respect to luminance coefficient) (β)
supplementary angle between the vertical plane through the luminaire and point of observation and the vertical plane through the observer and the point of observation

NOTE 1 Unit °(degrees).

NOTE 2 See Figure 4.

3.1.5
luminance coefficient (at a surface element, in a given direction, under specified conditions of illumination) (*q*)
quotient of the luminance of the surface element in the given direction by the illuminance on the medium

NOTE 1 Unit sr^{-1}

NOTE 2 $q = \frac{L}{E}$ (1)

where:

q is the luminance coefficient, in reciprocal steradians

L is the luminance, in candelas per square metre

E is the illuminance, in lux

3.1.6
reduced luminance coefficient (for a point on a surface) (*r*)
luminance coefficient multiplied by the cube of the cosine of the angle of incidence of the light on the point

NOTE 1 Unit sr^{-1}

NOTE 2 This can be expressed by the equation: $r = q \cos^3 \varepsilon$ (2)

where:

q is the luminance coefficient, in reciprocal steradians

ε is the angle of incidence, in degrees

NOTE 3 The angle of observation, α in Figure 4, affects the value of *r*. By convention this angle is fixed at 1° for road lighting calculations. *r* is reasonably constant for values of α between 0,5° and 1,5°, the angles over which luminance calculations for the road surface are generally required.

3.1.7
tilt during measurement (of a luminaire) (θ_m)
angle between a defined datum axis on the luminaire and the horizontal when the luminaire is mounted for photometric measurement

NOTE 1 Unit °(degrees).

NOTE 2 See Figure 8.

NOTE 3 The defined datum axis can be any feature of the luminaire, but generally for a side-mounted luminaire it lies in the mouth of the luminaire canopy, in line with the spigot axis. Another commonly used feature is the spigot entry axis.

3.1.8
tilt in application (of a luminaire) (θ_f)
angle between a defined datum axis on the luminaire and the horizontal when the luminaire is mounted for field use

NOTE 1 Unit °(degrees).

NOTE 2 See Figure 1 and Figure 8.

NOTE 3 The defined datum axis can be any feature of the luminaire but generally for a side-mounted luminaire it lies in the mouth of the luminaire canopy, in line with the spigot axis. Another commonly used feature is the spigot entry axis.

3.1.9
orientation (of a luminaire) (ν)
angle a chosen reference direction makes with the C = 0°, γ = 90° measurement direction of the luminaire when the first photometric axis of the luminaire is vertical

NOTE 1 Unit °(degrees).

NOTE 2 When the road is straight the reference direction is longitudinal.

NOTE 3 See Figure 7, which illustrates the sign conventions.

3.1.10
rotation (of a luminaire) (ψ)
angle the first photometic axis of the luminaire makes with the nadir of the luminaire, when the tilt during measurement is zero

NOTE 1 Unit °(degrees).

NOTE 2 See Figure 7, which illustrates the sign conventions.

3.1.11
first photometric axis (of a luminaire when measured in the (C, γ) coordinate system)
vertical axis through the photometric centre of a luminaire when it is at its tilt during measurement

NOTE 1 The poles of the (C,γ) coordinate system lie in this axis. See Figure 1.

NOTE 2 This axis is tilted when the luminaire is tilted from its tilt during measurement.

3.1.12
longitudinal direction
direction parallel to the axis of the road

3.1.13
transverse direction
direction at right angles to the axis of the road

NOTE On a curved road the transverse direction is that of the radius of curvature at the point of interest on the road.

3.1.14

installation azimuth (with respect to a given point on the road surface and a given luminaire at its tilt during measurement) (φ)

angle a chosen reference direction (which is longitudinal for a straight road) makes with the vertical plane through the given point and the first photometric axis of the luminaire, when the luminaire is at its tilt during measurement

NOTE 1 Unit °(degrees).

NOTE 2 See Figure 4.

3.2 List of symbols and abbreviations

The symbols and abbreviations used in this standard are listed in Table 1.

Table 1 — Symbols and abbreviations

Quantity		
Symbol	Name or description	Unit
C	Photometric azimuth (Figure 1)	°(degrees)
D	Spacing between calculation points in the longitudinal direction	m
d	Spacing between calculation points in the transverse direction	m
E	Illuminance	lx
H	Mounting height of a luminaire	m
j,m	Integers indicating the row or column of a table	-
L	Luminance	cd/rn^2
I	Luminous intensity per kilolumen	cd/klm
L_p	Total luminance at a point P	cd/m^2
MF	Product of the lamp flux maintenance factor and the luminaire maintenance factor	-
N	Number of points in the longitudinal direction	-
n	Number of luminaires considered in the calculation	-
q	Luminance coefficient	sr^{-1}
Q_0	Average luminance coefficient	sr^{-1}
r	Reduced luminance coefficient	sr^{-1}
S	Spacing between luminaires	m
TI	Threshold increment	%
L_v	Equivalent veiling luminance	cd/m^2
W_L	Width of driving lane	m
W_r	Width of relevant area	m
W_S	Width of strip	m
x	Abscissa in *(x,y)* coordinate system (Figure 6)	m
y	Ordinate in *(x,y)* coordinate system (Figure 6)	m
Φ	Luminous flux of lamp or lamps in a luminaire	klm
α	Angle between the incident light path and the normal to the flat surface of the semicylinder used for measuring semicylindrical illuminance (Figure 13), or the designated vertical plane used for vertical illuminance (Figure 14)	° (degrees)
β	Angle of deviation (Figure 4)	° (degrees)
γ	Vertical photometric angle (Figure 1)	° (degrees)
δ	Tilt for calculation (Figure 8)	° (degrees)
ε	Angle of incidence (Figure 4)	° (degrees)
θ_1	Tilt in application (Figure 8)	° (degrees)
θ_m	Tilt during measurement (Figure 8)	° (degrees)
v	Orientation of luminaire (Figure 7)	° (degrees)
σ	Angle of observation (Figure 4)	° (degrees)
φ	Installation azimuth (Figure 4)	° (degrees)
Ψ	Rotation of a luminaire (Figure 1)	° (degrees)

4 Mathematical conventions

The basic conventions made in the mathematical procedures described in this standard are:

— the luminaire is regarded as a point source of light;

— light reflected from the surrounds and interreflected light is disregarded;

— obstruction to the light from luminaires by trees and other objects is disregarded;

— the atmospheric absorption is zero;

— the road surface is flat and level and has uniform reflecting properties over the area considered.

5 Photometric data

5.1 General

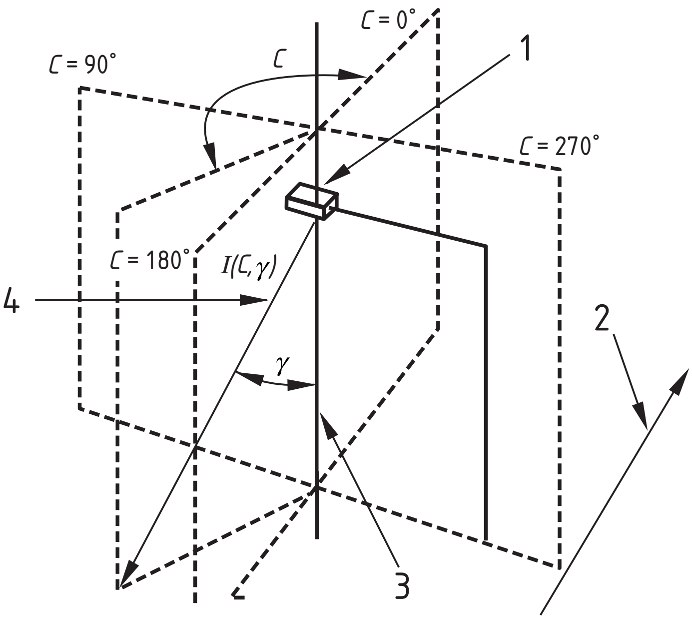
Photometric data for the light distribution of the luminaires used in the lighting installation are needed for calculating the lighting quality characteristics in this standard. These data are in the form of an intensity table ($\mathcal{I}$-table) which gives the distribution of luminous intensity emitted by the luminaire in all relevant directions. When luminance calculations are to be made, photometric data for the light reflecting properties of the road surface are required in the form of an *r*-table.

Interpolation will be needed in using both these tables to enable values to be estimated for directions between the tabulated angles.

5.2 The $\mathcal{I}$-table

For calculations made to this standard, an intensity table *($\mathcal{I}$-table)* prepared in accordance with prEN 13032-1 is required. The coordinate system used for road lighting luminaires is the *(C, γ),* shown in Figure 1, although the (*B, β*) coordinate system may be used for floodlights. In the figure, the luminaire is shown at its tilt during measurement.

Luminous intensity shall be expressed in candelas per kilolumen (cd/klm) from all the light sources in the luminaire.



Key

1 Luminaire at tilt during measurement

2 Longitudinal direction

3 First photometric axis

4 Direction of luminous intensity

Figure 1 — Orientation of *C*,γ coordinate system in relation to longitudinal direction of carriageway

Maximum angular intervals stipulated in this standard have been selected to give acceptable levels of interpolation accuracy when the recommended interpolation procedures are used.

In the (*C*,γ) system of coordinates, luminous intensities shall be provided at the angular intervals stated below.

For all luminaires the angular intervals in vertical planes (γ) shall at most be 2,5° from 0° to 180°. In azimuth the intervals shall be varied according to the symmetry of the light distribution from the luminaire as follows:

a) luminaires with no symmetry about the *C* = 0° plane: the intervals shall at most be 5°, starting at 0°, when the luminaire is at its tilt during measurement, and ending at 355°;

b) luminaires with nominal symmetry about the *C* = 270° - 90° plane: the intervals shall at most be 5°, starting at 270°, when the luminaire is at its tilt during measurement, and ending at 90°;

c) luminaires with nominal symmetry about the *C* = 270° - 90° and *C* = 0° - 180° planes: the intervals shall at most be 5°, starting at 0°, when the luminaire is at its tilt during measurement, and ending at 90°;