SLOVENSKI STANDARD
SIST EN 13031-2:2025

01-februar-2025

Rastlinjaki: Projektiranje in gradnja - 2. del: Rastlinjaki v vrtnih centrih

Greenhouses: Design and construction - Part 2: Greenhouses in garden centres open to the public

Gewächshäuser - Bemessung und Konstruktion - Teil 2: Verkaufsgewächshäuser

Serres - Calcul et construction - Partie 2: Serres dans les jardineries ouvertes au public

Ta slovenski standard je istoveten z: **EN 13031-2:2024**

ICS:

65.040.30	Rastlinjaki in druge naprave	Greenhouses and other installations

SIST EN 13031-2:2025 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13031-2

December 2024

ICS 65.040.30

English Version

Greenhouses - Design and construction - Part 2: Greenhouses open to the public

Serres - Calcul et construction - Partie 2 : Serres dans les jardineries ouvertes au public

Gewächshäuser - Bemessung und Konstruktion - Teil 2: Gewächshäuser mit Zugang für die Öffentlichkeit

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Ref. No. EN 13031-2:2024 E

Contents

Page

European foreword ... **3**

Introduction ... **4**

1 Scope ... **6**

2 Normative references ... **6**

3 Terms and definitions ... **6**

4 Symbols and abbreviations ... **7**

5 Snow actions ... **9**
5.1 General ... **9**
5.2 Requirements for heated greenhouses with controlled snow loads ... **10**
5.3 Special heat transmittance (U_o value according to ISO 4355:2013, Annex D) ... **11**
5.4 Snow load distribution ... **13**

Annex A (informative) **Thermal coefficients C_t according to ISO 4355:2013, Annex D** ... **14**

Annex B (informative) **Controlled snow loads according to ISO 4355:2013, Annex F** ... **18**
B.1 General ... **18**
B.2 Application for single short-term snowfall events in the Mediterranean ... **20**

Bibliography ... **22**

European foreword

This document (EN 13031-2:2024) has been prepared by Technical Committee CEN/TC 284 “Greenhouses”, the secretariat of which is held by NEN.

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of an identical text or by endorsement, at the latest by June 2025, and conflicting national standards shall be withdrawn at the latest by June 2025.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document is related to greenhouses open to the public used for the exhibition, presentation and / or retail of plants.

The Eurocodes recognize the responsibility of each Member State and have safeguarded their right to determine values related to regulatory safety matters at national level through the use of National Annexes.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

Introduction

This document relates specifically to greenhouses open to the public, used for the exhibition, presentation and / or sale of plants, such as greenhouses in garden centers or expositions in botanical gardens. Part 1 of this document is related to commercial production greenhouses used for the professional production of plants with limited access for authorized personnel only.

The structural design of greenhouses open to the public is carried out using EN 1990 and the relevant parts of EN 1991-series to EN 1999-series (Eurocodes 1 to 9) and any further parts, which may follow (e.g. for glass), regarding the general principles and basic requirements for actions, structural resistance and stability, serviceability, durability and robustness. National Application Documents (NAD) are considered for each of the parts.

This document gives additional non-contradictory rules and complementary information for snow actions on the transparent claddings of greenhouses, where special methods are used, to remove snow and optimize the transmission of solar radiation, which would otherwise not permit the climate for a successful growth of plants.

The snow load on the roof can be controlled by removing snow, for example by melting snow with a system for controlled heating. Controlled snow load is the difference between the initial snow load expected when heavy snowfall starts, and the snow load removed by a device whose performance is guaranteed even during heavy snowfall, see ISO 4355. With this document the values for controlled snow loads can be calculated, taking into account the thermal coefficient C_t for roof claddings with high thermal transmittance.

For wind loads on greenhouses with multi-span roofs, EN 1991-1-4 gives conservative values for aerodynamic force and pressure coefficients and structural factors. In supplement to calculations according EN 1991-1-4, wind tunnel tests and proven and/or properly validated numerical methods may be used to obtain load and response information.

As long as a structural Eurocode part on glass is not available, it is recommended to specify the glazing and the relevant design regulations in the National Annex to this part of the standard. For flat glass panels uniformly loaded perpendicular to their surface, simply supported along the edges and with nominal thickness not less than 4 mm, EN 13031-1 can be used.

National choices are allowed in EN 13031-2 through the following clauses:

— Glazing and design method for the structural safety of glass panels (as long as the Eurocode Glass or other regulations (NAD) are not available) (see above)

— 5.1 (1) for characteristic values of snow actions

— 5.1 (3) for the determination of thermal coefficients $C_t < 1$

— 5.2 (3) for minimum air temperature under the roof for controlled heating

— 5.2 (5) for safety measures for controlled heating

— 5.4 (2) for appropriate snow load distributions for sliding snow on slippery surfaces

National choice is allowed in EN 13031-2 on the use of the informative annexes:

— Annex A for the minimum roof snow load min $s_{i,t}$ and the calculation of C_t using the formulae and the appropriate limitations within the given parameter ranges

— Annex B for the determination of $C_{t,0}$ or C_t based on statistical evaluation of data of snowfall rates, calculation of the heat energy flux and melt rates

When no national choice is given, the default values given in this document can be used. The National Annex can contain, directly or by reference, further non-contradictory complementary information, in line with the verbal forms “shall”, “should”, “may” and “can”, as they are used in the Eurocode.

1 Scope

This document specifies principles and requirements for the determination of controlled snow loads on the transparent cladding of greenhouses open to the public.

This document can be applied either to the greenhouse or only to the transparent cladding system.

Fire resistance-related aspects are not covered in this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 673, *Glass in building — Determination of thermal transmittance (U value) — Calculation method*

EN 674, *Glass in building — Determination of thermal transmittance (U value) — Guarded hot plate method*

EN 675, *Glass in building — Determination of thermal transmittance (U value) — Heat flow meter method*

EN 1990, *Eurocode — Basis of structural and geotechnical design*

EN 1991 (all parts), *Eurocode 1 — Actions on structures*

EN 1991-1-3, *Eurocode 1 — Actions on structures — Part 1-3: General actions - Snow loads*

EN ISO 6946, *Building components and building elements — Thermal resistance and thermal transmittance — Calculation methods (ISO 6946)*

EN ISO 10077-1, *Thermal performance of windows, doors and shutters — Calculation of thermal transmittance — Part 1: General (ISO 10077-1)*

EN ISO 10077-2, *Thermal performance of windows, doors and shutters — Calculation of thermal transmittance — Part 2: Numerical method for frames (ISO 10077-2)*

ISO 4355, *Bases for design of structures — Determination of snow loads on roofs*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1990, EN 1991 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp/

— IEC Electropedia: available at https://www.electropedia.org/

3.1
greenhouse
building structure that optimizes solar radiation transmission used for plants requiring regulated climatic conditions

3.2
greenhouse open to the public
greenhouse (3.1) used for the professional presentation and / or sale of plants, such as garden centers or expositions in botanical gardens, where people can have access to certain areas (traffic areas)

3.3
commercial production greenhouse
greenhouse (3.1) for professional production and / or protection of plants, where human occupancy is restricted to authorized personnel, concerning low levels in number and duration

Note 1 to entry: Other persons shall be accompanied by authorized personnel.

3.4
transparent cladding
cladding, that allows transmission of solar radiation, required for the growth of plants

Note 1 to entry: Transparent cladding makes snow accumulation visible (impaired solar radiation); immediate measures can be taken for removal of the snow.

3.5
controlled snow load
difference between the initial snow load expected during a heavy snowfall and the snow load removed by a device whose performance is guaranteed even during heavy snowfall

3.6
controlled heating
heating operation with devices that are intended and capable of melting and / or removing an amount of snow, to limit the roof snow load as fast as required

4 Symbols and abbreviations

4.1 For the purposes of this document, the following symbols and abbreviations apply.

4.2 Abbreviations:

NAD	National Application Documents, e.g. National Annex to Eurocode, also National Code or Standard or National Regulation of an Authority
ETFE	Ethylene-Tetrafluoroethylene
PE	Polyethylene
SWE	Snow-water-equivalent
WMO	World Meteorological Organization

4.3 Symbols:

NOTE The following symbols used in this document are based on EN 1990 and EN 1991.

Latin upper-case letters:

C_e	exposure coefficient
$C_{e,c}$	special exposure coefficient for controlled snow loads
C_t	thermal coefficient

min C_t	minimum value for C_t according to Annex A (model threshold)
$C_{t,0}$	basic value of the thermal coefficient (without roof angle influence f(α))
L_f	latent heat of fusion of water (for ice, snow) in kJ/kg at melt temperature $\theta_{s,m}$ = 0,01 °C
$L_{f,c}$	corrected latent heat of fusion in kJ/kg including the warming of snow
Q_o	heat energy flux density (rate) in W/m² from the warm roof below to the melt layer
$Q_{s,e}$	heat energy flux density (rate) in W/m² from the melt layer via the snow to the air outside
R_T	overall thermal resistance of the cladding in m²K/W
R_{si}	internal surface resistance (internal air to surface) in m²K/W
$R_{si,sw}$	internal surface resistance for heat flow sideways in m²K/W
$R_{si,up}$	internal surface resistance for heat flow upwards in m²K/W
R_{se}	external surface resistance (surface to external air) in m²K/W
$R_{\lambda,j}$	thermal resistance of the material layer j in m²K/W
R_f	thermal resistance of the frame, e.g. gladding bars and gutter, in m²K/W
$R_{g,k}$	thermal resistance of the gas space k in m²K/W
$R_{ts,m}$	equivalent thermal resistance of the (thermal) screen space m in m²K/W
U	overall heat transmittance in W/(m²K)
U_g	heat transmittance of the transparent part of the cladding in W/(m²K)
U_f	heat transmittance of the frame in W/(m²K)
U_o	special heat transmittance in W/(m²K) for snowmelt conditions for heat energy flux from the internal air to the melt layer on the external roof surface excluding the external heat transfer into the air
min U_o	minimum value U_o for the calculation of C_t according to Annex A (model threshold)
max U_o	maximum value U_o for the calculation of C_t according to Annex A (model threshold)
$U_{s,e}$	special heat transmittance in W/(m²K) for snowmelt conditions from the melt layer through the roof snow layer into the external air

Latin lower-case letters:

$c_{pi,s}$	specific heat capacity of snow in kJ/(kg · K)
d_j	depth of layer j in a multi-layer glass unit
d_s	depth of the roof snow layer
f(α)	roof angle function for the thermal coefficient C_t
f(θ_i)	influence of the heating (internal air temperature) on the thermal coefficient C_t
f(U_o)	influence of the thermal transmittance of the cladding on the thermal coefficient C_t
f(s_k)	influence of the snowfall rate (related to the snow load) on the thermal coefficient C_t
$h_{s,k}$	heat transfer coefficient of the gas space k
$h_{c,i}$	heat transfer coefficient for convection
$m_r(\Delta t_i)$	melt rate in kg/m² within a certain time interval Δt_i
s_k	characteristic snow load on the ground in kN/m²