SLOVENSKI STANDARD
SIST EN 13031-1:2020

01-februar-2020

Nadomešča:
SIST EN 13031-1:2004

Rastlinjaki - Projektiranje in gradnja - 1. del: Proizvodni rastlinjaki

Greenhouses - Design and construction - Part 1: Commercial production greenhouses

Gewächshäuser - Bemessung und Konstruktion - Teil 1: Kulturgewächshäuser

Serres - Calcul et construction - Partie 1: Serres de production

Ta slovenski standard je istoveten z: **EN 13031-1:2019**

ICS:

65.040.30	Rastlinjaki in druge naprave	Greenhouses and other installations

SIST EN 13031-1:2020 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13031-1

December 2019

ICS 65.040.30

Supersedes EN 13031-1:2001

English Version

Greenhouses - Design and construction - Part 1: Commercial production greenhouses

Serres - Calcul et construction - Partie 1 : Serres de production

Gewächshäuser - Bemessung und Konstruktion - Teil 1: Produktionsgewächshäuser

This European Standard was approved by CEN on 19 May 2019.

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

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Ref. No. EN 13031-1:2019 E

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European foreword

This document (EN 13031-1:2019) 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of an identical text or by endorsement, at the latest by June 2020, and conflicting national standards shall be withdrawn at the latest by June 2020.

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 will supersede EN 13031-1:2001.

National document: National choices are allowed in EN 13031-1 through:

- 5.2.3 for Design working life of the structure;
- 5.3.1 for Classification of Consequence Classes CC;
- 5.3.2 for Differentiation of Partial Factors;
- 5.3.3 and 10.3 for Combinations of actions and related ψ-coefficients;
- 5.3.4 for Reference Periods for related Probabilities of Exceedance;
- 10.2.2 and 10.2.3 for Adjustment Factors for Reference Periods according to 5.3.4;
- 10.2.2.6 for Temperature ranges for gutters and other structural components;
- 10.3 Combination of actions;
- Annex A for Glass design calculation;
- Annex B for Wind: Size Factors, Correlation Coefficients, Aerodynamic Coefficients;
- Annex C for Snow: Surface Material Coefficients, Thermal Coefficients, Shape Coefficients;
- Annex E for Earthquake: Classification of Importance Categories IC, Importance Factors γ_I, Return Periods, probabilities of Exceedance and Adjustment Factors;
- Annex F for Owner's manual and identification plate.

As a guidance, the recommended values in tables are shown in grey fields.

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, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Part 1 of this document relates specifically to commercial production greenhouses used for the professional production of plants (crops) where human occupancy is restricted to authorized personnel, concerning low levels in number and duration. Other parts of this European standard are to be prepared that relate to greenhouses where general access by the public is permitted (such as those in garden centres or expositions).

This document gives specific rules and information, such as load distributions, deformation criteria and limitations to tolerances, for structural design and construction of greenhouses to enable adequate structural safety.

The structural design is based on EN 1990 and the relevant parts of EN 1991 to EN 1999 (Eurocodes 1 to 9) regarding the general principles and basic requirements for actions, mechanical resistance and stability, serviceability and durability. National Application Documents (NAD) are considered.

Recommended values for structural design in this document are given in accordance with the classification of greenhouses in EN 1990. This takes into account, that for commercial production greenhouses the consequences and nature of failure and the importance for public safety are lower than for normal buildings. The design working life is small. The potential economic loss is limited to the owner and the impact on the environment is low.

Non-contradictory, complementary information is provided to account for the particular requirements, functions and forms of commercial production greenhouses that distinguish them from ordinary buildings. A distinguishing functional requirement is the optimization of solar radiation transmission to create and maintain an optimal environment for the growth of plants (crops). This has implications on the form and structural design of commercial greenhouses.

As rules and requirements of this standard may become adopted by other European standards, for example the Structural Eurocodes or codes for Glass in Building – Design of glass panes, these will be replaced by a reference to this document.

1 Scope

This document specifies principles and requirements for the mechanical resistance and stability, serviceability and durability for design and construction of commercial production greenhouse structures, including their foundations, irrespective of the material used, for the professional production of plants (crops).

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 572-1, *Glass in building — Basic soda lime silicate glass products — Part 1: Definitions and general physical and mechanical properties*

EN 572-6, *Glass in building — Basic soda lime silicate glass products — Part 6: Wired patterned glass*

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

EN 1090-1, *Execution of steel structures and aluminium structures — Part 1: Requirements for conformity assessment of structural components*

EN 1096-1, *Glass in building — Coated glass — Part 1: Definitions and classification*

EN 1279-1, *Glass in Building — Insulating glass units — Part 1: Generalities, system description, rules for substitution, tolerances and visual quality*

EN 1990, *Eurocode — Basis of structural design*

EN 1991-1-1, *Eurocode 1: Actions on structures — Part 1-1: General actions — Densities, self-weight, imposed loads for buildings*

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

EN 1991-1-4, *Eurocode 1: Actions on structures — Part 1-4: General actions — Wind actions*

EN 1993-1-1, *Eurocode 3: Design of steel structures — Part 1-1: General rules and rules for buildings*

EN 1998-1, *Eurocode 8: Design of structures for earthquake resistance — Part 1: General rules, seismic actions and rules for buildings*

EN 12150-1, *Glass in building — Thermally toughened soda lime silicate safety glass — Part 1: Definition and description*

prEN 16612:2017, *Glass in building — Determination of the lateral load resistance of glass panes by calculation*

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

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)*

EN ISO 12543-5, *Glass in building — Laminated glass and laminated safety glass — Part 5: Dimensions and edge finishing (ISO 12543-5)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1990, EN 1090-1 and the following apply.

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

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

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

3.2
commercial production greenhouse
greenhouse (3.1) for professional production and/-or protection of plants (crops), 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.

3.3
clearance
free space in the rabbet, between the cut-size of a cladding panel and two opposite cladding bars

3.4
permanent opening
opening which cannot be closed under extreme wind conditions and which has a significant influence on the internal pressure

3.5
cladding
outer skin of roof and wall attached to the structural framework of the greenhouse

Note 1 to entry: It is made of panels of glass or plastic sheets or of plastic film and may include further metal components, such as cladding bars, ridge bar and gutter. The gutter can also be as well a component of the structural framework.

4 Symbols and abbreviations

Abbreviations:

NAD	National Application Documents, e.g. National Annex to Eurocode or Euronorm, also National Code or National Regulation by the Authority
SLS	serviceability limit states
ULS	ultimate limit states
NCR	non collapse requirements
DLS	damage limitation states
CC	consequence class
IC	earthquake importance category
Luv	windward side of the structure
Lee	leeward side of the structure
0°-Wind	wind direction perpendicular to ridge and gutter, side walls, inclined windward and leeward roof surface
90°-Wind	wind direction parallel to ridge and gutter, perpendicular to the gable walls

Symbols:

NOTE The following symbols used in this document are based on EN 1990, EN 1991 and EN 1998.

Latin upper-case letters:

A	altitude of the building site above sea level in m
A_i	accidental action
A_k	characteristic value of accidental action
A_{gr}	ground area of the greenhouse
A_{ap}	aperture area of the greenhouse
A_{li}	light interception area of the greenhouse
B	width
B_{gh}	width of the greenhouse
C_{esl}	exceptional snow load coefficient
C_e	exposure coefficient
C_m	surface material coefficient
C_t	thermal coefficient
D	cross sectional dimension of the foundation hole
E	modulus of elasticity
F_{wire}	horizontal force per wire
G	shear modulus
G_i; g_i	permanent action
G_k; g_k	characteristic value of a permanent action

H	height of the greenhouse ridge above ground level
K	shape parameter dependent on the coefficient or variation of the maximum annual wind data (speed or pressure)
K_{FI}	consequence factor dependent on the consequence class
L	length; span
L_{gh}	length of the greenhouse
M	moment
N	normal or membrane force
P_1	annual probability of exceedance of variable or of earthquake actions
P_n	probability of exceedance of variable or of earthquake actions with reference to n years
$P_{T,50}$	target value of the probability of exceedance of the earthquake action with reference to n = 50 years and the associated return period $T_{NCR}(50)$
Q_i; q_i	variable action
Q_k; q_k	characteristic value of a variable action
R_T	thermal resistance of a component
R_{si}	internal surface resistance (surface to internal air)
$R_{si,sw}$	internal surface resistance for heat flow sideways
$R_{si,up}$	internal surface resistance for heat flow upwards
R_{se}	external surface resistance (surface to external air)
$R_{\lambda,j}$	thermal resistance of the material layer j
R_f	thermal resistance of the frame, e.g. gladding bars and gutter
$R_{g,k}$	thermal resistance of the gas space k
$R_{ts,m}$	thermal resistance of the (thermal) screen m
$T_{NCR}(n)$	target value for the earthquake return period in years for NCR in reference to n years
$T_{NCR}(50)$	target value for the earthquake return period in years for NCR in reference to 50 years
U	overall heat transmittance in W/(m²K)
U_o	special heat transmittance in W/(m²K) for snowmelt conditions excluding the external heat transfer into the air
V	coefficient of variation of the annual maximum snow load

Latin lower-case letters:

a	largest span of a glass panel, distance between wires
a_{gR}	reference peak ground acceleration for earthquake
a_g	design ground acceleration for earthquake
b	smallest span of a glass panel; distance in width direction
b_{cb}	distance between the column bases
c	clearance; coefficient
c_{fr}	coefficient of friction

c_{pe}	aerodynamic coefficient for global external pressure
$c_{pe,L}$	aerodynamic coefficient for local external pressure
c_{pi}	aerodynamic coefficient for internal pressure
c_{prob}	probability factor the adjustment of the wind speed dependent on the return period n
c_s	size factor
c_{cor}	correlation factor
d	distance; diameter; depth
f_y	characteristic yield strength of steel
$f_{gl;d}$	design value of the ultimate bending strength of a glass pane
$f_{gl;u}$	characteristic value of the ultimate bending strength of a glass pane
$f(\alpha)$	roof angle function for the thermal coefficient C_t
$f(\theta_i)$	influence of the heating (internal air temperature) on the thermal coefficient C_t
$f(U_o)$	influence of the thermal transmittance of the gladding on the thermal coefficient C_t
$f(s_{k,n})$	influence of the snowfall rate (snow load) on the thermal coefficient C_t
$f_s(n)$	adjustment factor for the characteristic value of the snow load dependent on the reference period n
$f_w(n)$	adjustment factor for the characteristic value of the wind load dependent on the reference period n
$f_E(n)$	adjustment factor for the earthquake ground acceleration dependent on the reference period n
h	length of column (between foundation and gutter); height (usually above ground level)
h_e	eaves height above ground level
h_g	gutter height above ground level
h_r	roof height; for multi-span roofs also depth of the inner troughs
$h_{s,k}$	heat transfer coefficient of the gas space k
k	seismic coefficient
k_n	quantile of the negative inverse standard normal distribution for the annual probability $P_1(n)$ for a reference period of n years
k_{mod}	modification factor for the load duration for glass
k_{ed}	strength reduction factor dependent on the edge finish of glass panes
k_{sp}	strength reduction factor dependent on the surface profile of glass panes
l	span; distance in longitudinal direction
l_{cb}	distance between the column bases
n	number
n	return period in years
n_d	design working life in years
$p_{T,1}$	target value of the annual probability of failure

$p_{T,50}$	target value of the failure probability accumulated to a reference period of n = 50 years
s	section length; roof span
$s_{k,n}$	characteristic ground snow load for the reference period n
$s_{i,n,t}$	characteristic roof snow load for the location i, the shape coefficient μ_i, the reference period n, the exposure coefficient C_e and the thermal coefficient C_t (Note: for $C_t < 1$; $C_e = 1$)
min $s_{1,n,t}$	minimum roof snow load with reference to the ground area in kN/m²
t	thickness
t	load duration
t_{nom}	nominal thickness of the glass panel
t_{pl}	design value of thickness of the glass panel
u	displacement or deflection
v_{int}	intended fall of the gutter
v_m	mean wind velocity
$v_{b,0}$	fundamental value of the basic wind velocity
v_b	basic wind velocity
w	width; overall width of multi-span roof; wind pressure
z_e, z_i	reference height of a greenhouse above ground for external or internal wind pressure
z_s	reference height for the gust wind response of the greenhouse structure
z_{min}	minimum height (onset of the wind profile)

Greek upper-case letters:

Φ	cumulative distribution function of the standard normal distribution
Δ	deviation from the intended position
$\Delta\varphi$	deviation from intended inclination

Greek lower-case letters:

α	angle of roof pitch; measured from the horizontal; coefficient of thermal expansion
α_{cr}	second-order elastic critical load factor
α_u	second-order elastic-plastic critical load factor
α_H	intended angle between the foundations of side wall and gable wall
β	angle between the horizontal and the tangent of arched roofs ($\beta = 0°$ = horizontal tangent; $\beta = 90°$ = vertical tangent)
$\beta_{T,1}$	target value of the reliability index of the annual failure probability
$\beta_{T,50}$	target value of the failure probability accumulated to a reference period of n = 50 years
γ_F	partial factor for actions (including variations and model uncertainties)
γ_M	partial factor for resistance (general)
γ_G; γ_Q; γ_A	partial factor for actions: permanent, variable and accidental action
γ_I	importance factor for earthquake actions dependent on the importance category

$\gamma_{s,equ}$	equivalent mean snow density by weight in kN/m^3
λ_j	thermal conductivity in W/(mK) for a material layer j; ($\lambda_{j,sup}$ - upper value; $\lambda_{j,inf}$ - lower value)
μ_i	shape coefficient at the location i for roof snow load distributions
θ	radial angle of an arched roof
θ_i	internal air temperature in °C
θ_e	external air temperature in °C
ρ	density
ν	Poisson ratio
φ	intended inclination
ϕ_x	rotation angle of the cladding bar
$\psi_{0;1;2}$	combination value, frequent value and quasi-permanent value of variable actions in load combinations

5 Basis of design for greenhouse structures

5.1 General

(1) Greenhouses shall be designed to have adequate structural resistance, serviceability and durability. Types and classes of greenhouses are specified in 5.2. Recommendations for the reliability of commercial production greenhouses are specified in 5.3.

(2) Ultimate limit states shall be verified in accordance with Clause 6, and serviceability limit states in accordance with Clause 7.

(3) The greenhouse design shall meet the requirements for tolerance, durability, maintenance and repair given in Clause 8 and Clause 9.

5.2 Classes of greenhouse structures

5.2.1 General

Commercial production greenhouses are classified dependent on the tolerance to frame displacement of the cladding system as given in 5.2.2 and the design working life for the structure as given in 5.2.3.

NOTE The recommended classes, categories, values and procedures in 5.2, 5.3 and Clause 10 of EN 13031-1:2019 are applicable for the greenhouse design, if not otherwise specified in the National Annex to EN 13031-1.