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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

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

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Bibliography
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of an identical text or by endorsement, at the latest by June 2020, and conflicting national standards shall be withdrawn at the latest by June 2020.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 $\psi$-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 $\gamma_I$, 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 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)
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:

- ISO Online browsing platform: available at [http://www.iso.org/obp](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
Ai accidental action
Ak characteristic value of accidental action
Ar ground area of the greenhouse
Ap aperture area of the greenhouse
Ai light interception area of the greenhouse
B width
Bgh width of the greenhouse
cesl exceptional snow load coefficient
c exposure coefficient
cm surface material coefficient
c thermal coefficient
D cross sectional dimension of the foundation hole
E modulus of elasticity
Fwire horizontal force per wire
G shear modulus
Gi; gi permanent action
Gk; gk characteristic value of a permanent action
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$H$  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)
$K_{EF}$  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
$R_{sl}$  internal surface resistance (surface to internal air)
$R_{sl,w} $  internal surface resistance for heat flow sideways
$R_{sl,up}$  internal surface resistance for heat flow upwards
$R_{se}$  external surface resistance (surface to external air)
$R_{sj}$  thermal resistance of the material layer $j$
$R_t$  thermal resistance of the frame, e.g. gladding bars and gutter
$R_{g,k}$  thermal resistance of the gas space $k$
$R_{s,m}$  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 $W/(m^2K)$
$U_o$  special heat transmittance in $W/(m^2K)$ 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} \quad \text{aerodynamic coefficient for global external pressure}

c_{pe,L} \quad \text{aerodynamic coefficient for local external pressure}

c_i \quad \text{aerodynamic coefficient for internal pressure}

c_{prob} \quad \text{probability factor the adjustment of the wind speed dependent on the return period } n

c_s \quad \text{size factor}

c_{cor} \quad \text{correlation factor}

d \quad \text{distance; diameter; depth}

f_y \quad \text{characteristic yield strength of steel}

f_{GLD} \quad \text{design value of the ultimate bending strength of a glass pane}

f_{GLU} \quad \text{characteristic value of the ultimate bending strength of a glass pane}

f(\alpha) \quad \text{roof angle function for the thermal coefficient } C_t

f(\theta_i) \quad \text{influence of the heating (internal air temperature) on the thermal coefficient } C_t

f(U_o) \quad \text{influence of the thermal transmittance of the gladding on the thermal coefficient } C_t

f(S_{k,n}) \quad \text{influence of the snowfall rate (snow load) on the thermal coefficient } C_t

f_t(n) \quad \text{adjustment factor for the characteristic value of the snow load dependent on the reference period } n

f_w(n) \quad \text{adjustment factor for the characteristic value of the wind load dependent on the reference period } n

f_e(n) \quad \text{adjustment factor for the earthquake ground acceleration dependent on the reference period } n

h \quad \text{length of column (between foundation and gutter); height (usually above ground level)}

h_e \quad \text{eaves height above ground level}

h_g \quad \text{gutter height above ground level}

h_r \quad \text{roof height; for multi-span roofs also depth of the inner troughs}

h_{sk} \quad \text{heat transfer coefficient of the gas space } k

k \quad \text{seismic coefficient}

k_n \quad \text{quantile of the negative inverse standard normal distribution for the annual probability } P_1(n) \text{ for a reference period of } n \text{ years}

k_{mod} \quad \text{modification factor for the load duration for glass}

k_{ed} \quad \text{strength reduction factor dependent on the edge finish of glass panes}

k_{sp} \quad \text{strength reduction factor dependent on the surface profile of glass panes}

l \quad \text{span; distance in longitudinal direction}

l_{cb} \quad \text{distance between the column bases}

n \quad \text{number}

n \quad \text{return period in years}

n_d \quad \text{design working life in years}

P_{T,1} \quad \text{target value of the annual probability of failure}