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# **NPR 3860** (en)

Greenhouses - Recommendations for and examples of constructional performance based on NEN 3859 (unofficial translation)

ICS 65.040.30; 91.080.01; 91.080.10

December 1985

The Netherlands Codes of practice are publications of an informative nature, such as explanatory notes on standards, construction techniques, working procedures and manufacturing data. They should not be regarded to be of a standardizing nature.

This publication is a translation of Netherlands standard NEN 3859 "Tuinbouwkassen. Aanbevelingen voor en voorbeelden van de constructieve uitvoering gebaseerd op NEN 3859". Whilst every effort has been made to ensure the accuracy of the translation, no responsibility, legal or otherwise, is accepted by NNI for any errors, omissions or inaccuracies in this unofficial publication. In case of doubt or dispute, only the current Dutch language text is valid.

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Standards Committee 351 37 "Greenhouses"

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**Nederlands Normalisatie-instituut**  
Kalfjeslaan 2, Postbus 5059, 2600 GB Delft, telefoon (015) 690 390, telefax 690 190, telex 38144, postbank 25301

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## Contents

	page
Introduction	4
<b>1 Foundation</b>	<b>11</b>
1.1 Methods of foundation	11
1.2 Quality of concrete intended for greenhouse foundations	14
1.3 Maximum dimensional tolerances allowed for foundations	15
1.4 Anchorage	16
1.5 Slope of foundations	19
1.6 Durability of foundations	19
<b>2 Substructure</b>	<b>20</b>
2.1 Support structure	20
2.2 Stability bracings	20
2.3 Gutters, purlins, ridge beams	22
2.4 Deflection (to prevent breakage of glass)	24
2.5 Connections of rafters and clamping battens to stanchions	25
2.6 Durability	25
2.7 Steel stanchion base plates	25
2.8 Thermal deformations of structural components	27
<b>3 Envelope</b>	<b>28</b>
3.1 Single-glazed envelope	28
3.2 Insulating envelopes	33
<b>4 Loads</b>	<b>42</b>
4.1 Wind load on deviating types	42
4.2 Snow load on greenhouses	42
4.3 Loads on ventilating mechanism in wider-span and Venlo houses	44
4.4 Additional loads due to installations	44
4.5 Load due to crop support and irrigation pipe wires	44

## Introduction

Origin and scope of the Netherlands Code of Practice (NPR) for Greenhouses.

### Nature of a standard

A standard is a technical document containing requirements, in this case for a greenhouse. The standard is of importance to greenhouse builders, constructors, suppliers, clients, users and to those whose work is related to advice or verification.

A standard has a number of characteristics:

- it is accessible to the public;
- it shall be suitable to be used in the interaction among the social groups mentioned above;
- it has been drafted in cooperation and generally been approved by all groups concerned;
- it is based on the collected results of science, research, technology and experience;
- it aims at furthering the optimum benefit to society;
- it has been approved by an authority that enjoys national, regional or international acknowledgement.

For the Netherlands this official authority is the Netherlands Standardization Institution (NNI) in Delft. Netherlands standards are indicated with the abbreviation NEN plus a number and a title, e.g. NEN 3859 "Greenhouses -- Structural requirements".

### Nature of a code of practice

Essentially a Netherlands code of practice (NPR) is a technical document of an informative character, unlike the Netherlands standard, which is prescriptive. Essentially, too, a standard committee is related to the code of practice. Items that can be dealt with in a code of practice are:

- explanations of a (related) standard;
- a selection of practical cases with data for the structural performance based on the application of one or more standards;
- data for calculations, which can go together with examples;
- treatment of aspects not dealt with in the related standard.

The user of the code of practice shall be sufficiently expert at the range of application to be able to judge whether there are any conditions in the application that prevent the observance of the guidelines in the code of practice.

### Aims of the Code of Practice for Greenhouses, and how it originated

This Code of Practice explains and adds information to Standard NEN 3859 which was published in June 1978. Committee 351 37 "Greenhouse structures", who drafted Standard NEN 3859, has also drafted this Code of Practice, practically in the same composition, and in accordance with the appropriate procedure.

This means that the Code of Practice will explain several chapters of the Standard or parts thereof. Also for a number of problems not touched upon in Standard NEN 3859 additional guidelines have been included; for Standard NEN 3859 only provides information on single-glazed greenhouses with gable roofs of certain limits indicated. When drafting the texts it was tried to provide practical information, especially to the grower. All in all, this Code of Practice is meant to contribute to the proper application of Standard NEN 3859 and to be a useful tool for greenhouse designs, calculations and building.

#### Development of Standard NEN 3859

In this country certain standards shall be observed for building projects as the Local Councils have declared applicable in the Local Council Building Regulations. Many of these standards are given in the

- "Technische grondslagen voor de berekening van bouwconstructies" (Regulations for the calculation of building structures) -- TGB 1972, which consist of Standards NEN 3850 "TGB -- Algemeen gedeelte en belastingen" (General part and loads), NEN 3851 "TGB -- Staal" (Steel), NEN 3852 "TGB -- Hout" (Timber), NEN 3853 "TGB -- Steen" (Structures of brickwork) and NEN 3854 "TGB -- Aluminium" (Design of aluminium structures), as well as
- NEN 3880 "Voorschriften Beton" (Regulations for Concrete) -- VB 1974/1984.

Building projects shall comply with these standards.

The "Greenhouses" Standard has been derived from these primary standards and provides further requirements and information specific for this sector; for the construction of greenhouses based solely on TGB 1972, which applies to dwellings and offices, would result in inefficient and heavy structures with an additional loss of light. Greenhouses often used to be built by feel, resulting in structures being either too heavy or too light. These tendencies were strengthened by developments in glasshouse construction and design, such as the need for more light inside the house, the use of aluminium glazing bars and the preference for wider strips of glass. For reasons of competitiveness greenhouse constructions could be badly designed and poorly balanced, resulting in damage, especially to roofs. This was only revealed, however, in bad weather, which demonstrated that so-called cheap glasshouses could be very expensive in the end because of damage to house and crops. This was the reason for drafting Standard NEN 3859, which provides a balanced package of requirements. In 1981 this Standard NEN 3859 was also declared applicable in the Basic Building Regulations.

The limited economic life of greenhouses and the low labour density per unit of area with persons who are familiar with the nature of the greenhouse have justified the laying down of structural requirements less stringent than those applicable to regular buildings. Safety has been guaranteed sufficiently now and the risk has been reduced to an acceptable level. The technical life of a greenhouse structure, including foundation and envelope, generally accepted and applied, is fifteen years.

### Scope of NEN 3859

Standard NEN 3859 provides the requirements that greenhouses shall meet; it gives directions to constructors and verifying authorities on how to calculate the structural strength, stiffness and stability of the greenhouse structure.

In short this Standard deals with the following items:

- general conditions;
- characteristic loads exerted on the structure;
- use of materials;
- safety ("load factors") with various materials;
- foundation requirements;
- deformations;
- references to other standards, both Dutch and foreign, and other publications.

The greenhouse in its entirety shall resist the loads; this applies to the entire structure, to components and to the connections. The Standard indicates which loads have to be considered, such as:

- permanent load (dead load or load of empty greenhouse);
- variable loads (snow, crops, climate and transport equipment, shelves);
- wind load.

The large differences in the use of horticultural greenhouses and the different natures of crops have caused that specific load values are given for a number of applications, e.g. for pot plants  $1000 \text{ N/m}^2$  ( $100 \text{ kgf/m}^2$ ), that is if and when the plants load on the greenhouse structure through shelves or in any other way. For tomatoes and cucumbers values of  $150 \text{ N/m}^2$  ( $15 \text{ kgf/m}^2$ ), or with interplanting  $200 \text{ N/m}^2$  ( $20 \text{ kgf/m}^2$ ), shall be assumed. With still more intensive utilization of the cultivated area a higher value shall be assumed.

It may be evident that when buying a greenhouse one should not only consider the above loads but also those caused by the heating system, especially by the supply and return lines. For example, a greenhouse laid out for tomatoes will not be suitable as it is, to grow pot plants with shelves hanging from the structure.

Generally, when constructing a greenhouse it has to be known which loads the greenhouse structure can stand (crop type, number and lay-out of main and secondary heating lines, air heating units, fans, rail trolleys with design loads, hanging shelves etc.). All information shall be provided on how these components will convey their loads to the greenhouse structure (direction and nature, e.g. vibrating).

Scope of Code of Practice NPR 3860

In principle it has been observed to restrict the scope to the structural aspects of greenhouses, i.e. no data or indications are in this Code of Practice referring to aspects of cultivation, to light or heat transmission problems, to climate control or to economic aspects.

The structural aspects which have been treated extensively in this code, include:

- foundations with structural criteria; also structure examples are given;
- stability in the various planes and details for stability stays;
- gutters and purlins as continuous units.

The chapter on envelopes is subdivided for the various materials:

- single glazing;
- insulating envelope structures on a glass basis;
- insulating envelope structures of rigid or soft plastics, such as sheet and foils.

The Code of Practice also provides instructions for wind load assumptions for greenhouses with geometric shapes different from the symmetric gable roof, and for snow load assumptions for greenhouses with insulated roofs. Instructions are also given for the calculation of additional loads due to the installation of technical equipment.

As far as the data for plastics are concerned, it has to be remarked that building with plastics is still being developed and that at the time of publishing the most relevant aspects (e.g. creepage and fastening of foils) could not be established. The relevant chapter was drafted mid-1983 and can be considered just a basis on which the constructor for his specific case can refer to material for further information.

This Netherlands Code of Practice has been drafted by the Working Group 351 37 001 "NPR Greenhouses" and been adopted by Committee 351 37 "Greenhouse structures".

Committee 351 37 "Greenhouse structures" when drafting this Code of Practice was composed of the following members:

Ing. J. Spek (chairman) <sup>1)</sup>	-- Instituut voor Mechanisatie, Arbeid en Gebouwen (IMAG; Institute of Agricultural Engineering), Wageningen
H. Baalbergen <sup>2)</sup>	-- Prins Dokkum NV, Dokkum
J. van de Bosch	-- Algemene Vereniging van Kassenbouwers (AVK; Association of Greenhouse Constructors), The Hague
Ing. J. Buys <sup>2)</sup>	-- Alcomij BV, 's-Gravenzande
Ir. F.S.K. Bijlaard <sup>2)</sup>	-- IBBC-TNO (TNO Institute for Building Materials and Building Structures), Rijswijk (ZH)
J.M.M. Geurts van Kessel <sup>2)</sup>	-- Technisch Fysische Dienst voor de Landbouw (TFDL; Technical and Physical Engineering Research Service), Wageningen
G.J. Koot <sup>2)</sup>	-- Vereniging van Nederlandse Tuinbouw Studieclubs (NTS; Association of Growers' Study Groups), Naaldwijk
Ing. L. Maaywee <sup>2)</sup>	-- Alcoa Nederland BV, Drunen
Ing. G. Reyneveld <sup>2)</sup>	-- Architectenbureau G. Reyneveld, Leiderdorp
C.J. Vis <sup>2)</sup>	-- Hagelunie Agrarische Verzekeringen, The Hague
Ing. J.W. Visser <sup>2)</sup>	-- AEGON Verzekeringen, The Hague
Ing. D. Waaijenberg <sup>3)</sup> (reporter)	-- Instituut voor Mechanisatie, Arbeid en Gebouwen (IMAG; Institute of Agricultural Engineering), Wageningen
Ir. Ph.A. Willemsen (secretary)	-- Nederlands Normalisatie-instituut (NNI; Netherlands Standards Institution), Delft.

Further members of working group 351 37 001 are:

G.Th. van der Arend	-- G.Th. van der Arend Nursery, Honselersdijk
Ing. R. Bakker	-- Consulentenschap voor de Tuinbouw (Horticultural Advisory Service), Aalsmeer
Ing. M. Boers	-- Boal BV, De Lier
Ing. C. de Groot	-- Voskamp en Vrijland BV, 's-Gravenzande
Ir. D.B. Paul	-- Technische Hogeschool (Delft Technical University), Delft
Ing. C. Middendorp	-- Consulentenschap voor de Tuinbouw (Horticultural Advisory Service), Naaldwijk.

1) also chairman of Working Group 351 37 001

2) also a member of Working Group 351 37 001

3) also reporter of Working Group 351 37 001



Titles of standards stated

Of standards referred to in NPR 3860 the most recent versions (at the time of issue) are meant.

- NEN 3502 Levering van beton door betonmortelbedrijven (Delivery of ready mixed concrete)
- NEN 3532 Hulpstoffen voor mortel en beton. Indeling, benamingen en definities (Admixtures for mortar and concrete. Classification and definitions)
- NEN 3550 Cement. Definities, eisen en keuring (Cement. Definitions, requirements and inspection)
- NEN 3661 Ramen. Luchtdoorlatendheid, waterdichtheid, stijfheid en sterkte. Eisen (Windows. Air permeability, water tightness, rigidity and strength)
- NEN 3850 Technische grondslagen voor de berekening van bouwconstructies -- TGB 1972. Algemeen gedeelte en belastingen /Technical principles for the design and calculation of building structures. General part and loads (unofficial translation in English)
- NEN 3851 Technische grondslagen voor de berekening van bouwconstructies -- TGB 1972. Staal. Staalconstructies/Technical principles for the design and calculation of building structures. Steel (unofficial translation in English)
- NEN 3852 Technische grondslagen voor de berekening van bouwconstructies -- TGB 1972. Hout. Houtconstructies (Regulations for the calculation of building structures. Timber structures; English translation withdrawn)
- NEN 3853 Technische grondslagen voor de berekening van bouwconstructies -- TGB 1972. Steen. Steenconstructies (Regulations for the calculation of building structures. Structures of brickwork)
- NEN 3854 Technische grondslagen voor de berekening van bouwconstructies -- TGB Aluminiumconstructies (Regulations for the calculation of building structures. Design of aluminium structures)
- NEN 3859 Tuinbouwkassen -- Constructieve eisen/Greenhouses. Structural requirements
- NEN 3880 Voorschriften Beton -- VB 1974/1984 (Regulations for concrete)

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