

Buildings and structures for agriculture —

Part 22: Code of practice for design, construction and loading

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Committees responsible for this British Standard

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Cold Rolled Sections Association

DEFRA

Northern Ireland Department of Agriculture and Rural Development

Environment Agency

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Galvanizers' Association

Health and Safety Executive

Institution of Structural Engineers

Royal Institute of British Architects

Royal Institution of Chartered Surveyors

Rural Design and Building Association

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Foreword

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution.

This British Standard has been prepared by Committee B/549.
BS 5502-22:2003+A1:2013 supersedes BS 5502-22:2003, which is withdrawn.

Text introduced or altered by Amendment No. 1 is indicated in the text by tags **Δ** **Δ**. Minor editorial changes are not tagged.

BS 5502-22:2003 was a full revision of the standard and incorporated the following principal changes. BS 5502 was restructured into the following broad subject areas:

- *Part 0: Introduction;*
- *Parts 10 to 19: Reference information and legislation;*
- *Parts 20 to 39: General design;*
- *Parts 40 to 59: Livestock buildings;*
- *Parts 60 to 79: Crop buildings;*
- *Parts 80 to 99: Ancillary buildings.*

More specifically, the general design series comprises:

- *Part 20: Code of practice for general design considerations;*
- *Part 21: Code of practice for selection and use of construction materials;*
- *Part 22: Code of practice for design, construction and loading;*
- *Part 23: Code of practice for fire precautions;*
- *Part 25: Code of practice for services and facilities;*
- *Part 30: Code of practice for control of infestation;*
- *Part 31: Code of practice for the management of waste (storage and handling);*
- *Part 32: Guide to noise attenuation;*
- *Part 33: Guide to control of odour pollution.*

A more detailed description of the new structure of BS 5502 is given in Part 0.

The object of introducing the structure was to allow subject areas to be broadly characterized, and related subject matter, whether in the form of recommendations, guidance or supporting data, to be rationalized and brought together. It also allows sufficient flexibility to enable BS 5502 to be expanded and developed in a logical way in the future.

For the design and construction of, and the loadings for, agricultural buildings and structures, reference is to be made to the relevant material and loading codes of practice, some of the recommendations contained in these codes have been modified by this Part of BS 5502 for classified agricultural buildings and structures. This Part of BS 5502 also contains special provisions peculiar to agricultural buildings and structures that should be taken into account during their design.

It has been assumed in the drafting of this Part of BS 5502 that the execution of its provisions is entrusted to appropriately qualified and experienced people, for whose guidance it has been prepared.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to ii, pages 1 to 25 and a back cover.

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1 Scope

This Part of BS 5502 gives recommendations for the design and construction of, and the loading for, agricultural buildings and structures.

2 Normative references

The following referenced documents are indispensable for the application 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.

BS 4008, *Specification for cattle grids*.

BS 5061, *Specification for cylindrical forage tower silos and recommendations for their use* (obsolescent).

BS 5502-21, *Buildings and structures for agriculture — Code of practice for selection and use of construction materials*.

BS 5502-40, *Buildings and structures for agriculture — Code of practice for design and construction of cattle buildings*.

BS 5502-41, *Buildings and structures for agriculture — Code of practice for design and construction of sheep buildings and pens*.

BS 5502-42, *Buildings and structures for agriculture — Code of practice for design and construction of pig buildings*.

BS 5502-43, *Buildings and structures for agriculture — Code of practice for design and construction of poultry buildings*.

BS 5502-49, *Buildings and structures for agriculture — Code of practice for design and construction of milking premises*.

BS 5502-50, *Buildings and structures for agriculture — Code of practice for design, construction and use of storage tanks and reception pits for livestock slurry*.

BS 5502-51, *Buildings and structures for agriculture — Code of practice for design and construction of slatted, perforated and mesh floors for livestock*.

BS 5502-60, *Buildings and structures for agriculture — Code of practice for design and construction of buildings for mushrooms*.

BS 5502-65, *Buildings and structures for agriculture — Code of practice for design and construction of crop processing buildings*.

BS 5502-66, *Buildings and structures for agriculture — Code of practice for design and construction of chitting houses*.

BS 5502-70, *Buildings and structures for agriculture — Code of practice for design and construction of ventilated on floor stores for combinable crops*.

BS 5502-71, *Buildings and structures for agriculture — Code of practice for design and construction of ventilated stores for potatoes and onions*.

BS 5502-72, *Buildings and structures for agriculture — Code of practice for design and construction of controlled environment stores for vegetables, fruit and flowers*.

BS 5502-74, *Buildings and structures for agriculture — Code of practice for design and construction of bins and silos for combinable crops*.

BS 5502-75, *Buildings and structures for agriculture — Code of practice for design and construction of forage stores*.

BS 5502-80, *Buildings and structures for agriculture — Code of practice for design and construction of workshops, maintenance and inspection facilities*.

BS 5502-81, *Buildings and structures for agriculture — Code of practice for design and construction of chemical stores*.

BS 5502-82, *Buildings and structures for agriculture — Code of practice for design of amenity buildings*.

BS 5930, *Code of practice for site investigations*

BS 6100 (all parts), *Glossary of building and civil engineering terms*.

BS 6180, *Barriers in and about buildings — Code of practice*

BS 7543, *Guide to durability of buildings and building elements, products and components*.

BS 8500-1:2006+A1:2012, *Concrete – Complementary British Standard to BS EN 206-1 – Part 1: Method of specifying and guidance for the specifier*

BS 8500-2, *Concrete – Complementary British Standard to BS EN 206-1 – Part 2: Specification for constituent materials and concrete*

BS EN 1990:2002+A1:2005, *Eurocode – Basis of structural design*

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

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

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

BS EN 1992-1-1, *Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings*

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

BS EN 1993-1-3:2006, *Eurocode 3: Design of steel structures – Part 1-3: General rules – Supplementary rules for cold-formed members and sheeting*

BS EN 1993-4-1, *Eurocode 3: Design of steel structures – Part 4-1: Silos*

BS EN 1995-1-1, *Eurocode 5: Design of timber structures – Part 1-1: General – Common rules and rules for buildings*

BS EN 1996-1-1, *Eurocode 6: Design of masonry structures – Part 1-1: General rules for reinforced and unreinforced masonry structures*

BS EN 1996-1-2, *Eurocode 6: Design of masonry structures – Part 1-2: General rules – Structural fire design*

BS EN 1996-2, *Eurocode 6: Design of masonry structures – Part 2: Design considerations, selection of materials and execution of masonry*

BS EN 1997-1, *Eurocode 7: Geotechnical design – Part 1: General rules*

BS EN 10346, *Continuously hotdip coated steel flat products – Technical delivery conditions*

BS EN 13031-1, *Greenhouses – Design and construction – Commercial production greenhouses*

NA to BS EN 1991-1-1, *UK National Annex to Eurocode 1: Actions on structures – Part 1-1: General actions – Densities, self-weight, imposed loads for buildings*

NA to BS EN 1991-1-3, *UK National Annex to Eurocode 1: Actions on structures – Part 1-3: General actions – Snow loads*

NA to BS EN 1993-1-1, *UK National Annex to Eurocode 3: Design of steel structures – Part 1-1: General rules and rules for buildings*

NA to BS EN 1993-1-3, *UK National Annex to Eurocode 3: Design of steel structures – Part 1-3: General rules – Supplementary rules for cold-formed members and sheeting*

NA to BS EN 1995-1-1, *UK National Annex to Eurocode 5: Design of timber structures – Part 1-1: General – Common rules and rules for buildings*

NA to BS EN 1996-1-1, *UK National Annex to Eurocode 6: Design of masonry structures – Part 1-1: General rules for reinforced and unreinforced masonry structures*

PD 6697, *Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2* 

3 Terms and definitions

 For the purposes of this Part of BS 5502, the terms and definitions given in BS 6100, BS 7543, BS 8500-1, BS EN 1992-1-1, BS EN 1993-1-1, BS EN 1993-1-3, BS EN 1995-1-1, BS EN 1996-1-1, BS EN 1996-1-2 and BS EN 1996-2 and the following apply. 

3.1

zone of effect

area around a retaining structure extending a distance 1.5 times its height (h) above ground or its depth (d) below ground, whichever is greater, beyond the retaining structure's real or projected ground perimeter

4 Symbols and abbreviations

For the purposes of this Part of BS 5502, the following symbols apply.

A	altitude of site above mean sea level (in m)
b_c	breadth of compression face of a concrete beam (T and inverted L purlins and sheeting rails) measured midway between restraints (see A1 BS EN 1992-1-1 A1)
b_t	breadth of tension face of a concrete beam (T and inverted L purlins and sheeting rails) measured midway between restraints (see A1 BS EN 1992-1-1 A1)
d	depth below ground for zone of effect
d_a	alternative depth below ground for zone of effect (Figure 1)
E1, E2, E2, E4	classification of exposure situations in accordance with A1 BS EN 1990 A1
GL	ground level
h	height above ground for zone of effect
h_a	alternative height above ground for zone of effect (Figure 1)
H_s	point load applied horizontally at the surface of a single slat from livestock (in kN)
l_e	effective length of section (see A1 BS EN 1993-1-1 A1)
l_p	span of a purlin, centre to centre of support (in mm)
l_s	effective span of a multi-slat unit
n	number of slats in a multi-slat unit
N	return period for loading (in years)
P_B	characteristic load from bedding (including allowance for livestock) acting horizontally to a wall (in kN/m ²)
P_G	concentrated tractor load on a wall for grass silage (part load) (in kN)
P_L	vertical load on a floor from livestock applied on any square with a 300 mm side (in kN)
P_s	vertical load from livestock applied on a single slat (in kN/m)
P_v	vertical load on a floor from a vehicle applied on any square with a 300 mm side (in kN)
r	least radius of gyration of a section
s_{alt}	coefficient used in correcting the basic snow load on the ground for altitude
s_b	basic snow load (on the ground)
s_d	snow load on a roof
$s_{d(N)}$	snow load on a roof with a return period of N years
s_o	site snow load (on the ground)
SC2, SC3, SC4, SC6	strength class of timber as given in A1 BS EN 1990 A1
T_G	horizontal load on a wall from grass silage (part load) which increases uniformly with depth z (in kN/m ²)
v_c	design concrete shear stress as given in A1 BS EN 1992-1-1 A1
V_s	design wind speed as given in A1 BS EN 1991-1-4 A1 (in m/s)
W_G	uniform horizontal load from grass silage (part load) (in kN/m ²)
W_L	uniformly distributed vertical load over the gross floor area from livestock (in kN/m ²)
W_p	classified load on a purlin (in kN)
W_s	vertical load on the gross floor area to be used in the design of slat supports (in kN/m ²)
W_v	uniformly distributed vertical load over the gross floor area from vehicles (in kN/m ²)
Y_s	specified minimum yield strength of steel as given in A1 BS EN 1993-1-1 A1
z	depth below rolled surface of grass silage or the compacted surface of bedding (in m)
γ_c	classification factor for agricultural buildings and structures
γ_f	partial safety factor for load as given in A1 BS EN 1990 A1
μ	snow load shape coefficient
ω	conversion factor for return periods for snow loads based on 50 years return as unity

5 Preparation of site

5.1 Sites should be prepared in accordance with BS 5930.

5.2 If any drains are severed during the excavations in connection with the building or structure, its drains or services, remedial measures should be taken to secure the continued passage of the below-ground water through or around the site and to deal with any surface water which may run on to the site.

6 Service life

6.1 As service life may be different from design life (see BS 7543), where required, guidance should be sought on durability limits of materials.

NOTE Information on predicted service life might be available from the manufacturer or supplier.

6.2 Unless otherwise stated, the structural components and the external envelope should be such that, with reasonable maintenance, they remain effective for the design life.

7 Foundations

7.1 For the design and construction of foundations of a building or structure, reference should be made to [\[A\]](#) BS EN 1992-1-1 and BS EN 1997-1 [\[A\]](#).

Attention should be paid to the possibility of attack by sulfates or any other deleterious matter which may be present in the soil.

7.2 The foundations of a building or structure should:

- a) safely sustain and transmit to the ground the worst combination of dead load, imposed load and wind load so that it does not cause any settlement or other movement which would impair the stability or serviceability of, or cause damage to, the building or structure or any adjoining building or structure or works;
- b) be taken down to such a depth, or be so constructed, as to safeguard the building or structure against damage by swelling, shrinkage or freezing of the subsoil;
- c) be designed to resist overturning moments or sliding forces, especially where lateral imposed loads, induced by the storage of agricultural or other products against walls, are transferred to the foundations.

8 Works below ground

8.1 Ducts, tanks, hoppers and other works below ground should be so designed and built as to resist external ground pressures including, if relevant, the pressure due to the presence of ground water, nearby foundations and other loadings.

Where ducts, tanks, or other receptacles are to retain liquids, they should be so constructed as to prevent any contamination by the escape of the liquids into the subsoil and the entry of ground water into the duct, tank or other receptacle.

Where tanks are constructed in ground which has a high water table, adequate means of preventing flotation should be provided.

8.2 Covers to ducts, tanks, pits and similar constructions should be provided as necessary. These covers should conform to one of the following:

- a) be constructed to withstand all loads from livestock, stored materials, the transporting of materials over them, and all vehicles used in the building or structure or its environs;
- b) be provided with suitable barriers to prevent such access.

8.3 The construction of any duct, tank, receptacle or other underground works should be capable of resisting attack by sulfates, acids (such as are produced by the fermentation of silage), manure, washings, and any other deleterious matter present in the stored material or in the subsoil.

9 Works above foundations

The structural components of an agricultural building or structure above the foundations should safely sustain and transmit to the foundations or base the combined loads without such deflection or deformation as would impair the stability or serviceability of the whole or any part of the building or structure, or any other building or structure.

NOTE Attention is drawn to the Reservoirs Act 1975 [1] which applies to above-ground storage in reservoirs, lagoons and tanks and which requires all structures in excess of 25 000 m³ capacity above the lowest adjoining natural ground level to be designed and the construction to be supervised by a panel engineer. Lists of panel engineers are held by the Department of the Environment and by the Scottish Office Environment Department.

10 Protection of floors

10.1 Where floors of buildings or structures in contact with the ground are used for the storage of grain, seeds, concentrated feed stuffs, fertilizer or for the housing of livestock on insulated floors, they should be so constructed as to prevent the passage of moisture from the ground to the upper surface of the floor or the underside of the insulation.

10.2 Although moisture barriers are not usually required for the following:

- a) floors for crop production;
- b) livestock on a bedding of straw, wood shavings or other absorbent material;
- c) storage of fodder crops;
- d) storage of farm wastes;
- e) the housing of implements,

attention should be paid to the need to prevent the passage of slurries and wastes, especially silage effluent, to ground water. In addition, it should be taken into account that these buildings or structures may be used in the future for alternative uses.

10.3 Hardcore laid and compacted under any floor should contain no water-soluble sulfates or other deleterious substances in quantities that might cause damage to any part of the floor.

10.4 Concrete floors subject to attack by organic acids (see BS 5502-21 for the chemical composition of waste products) should be designed and constructed to resist very severe exposure conditions as given in of **EN** BS EN 1992-1-1:2004 **(A1)** (see also **16.4**). Such floors should be well compacted, cured and, where necessary, should be provided with a surface coating.

10.5 Where suspended timber floors are constructed, damp-proof courses should be provided to prevent moisture from the ground adversely affecting the timber or other materials in the floor.

10.6 For class 1 and class 2 buildings (see Clause **14**) where a timber floor is constructed as a suspended floor, other than above a pit or cellar for the storage of dung, the ground surface should be suitably sealed to prevent moisture transfers. The space between such a seal and any timber should be not less than 125 mm and this space should be clear of debris and have adequate through ventilation.

10.7 Where a suspended floor constructed from timber is placed over a cellar or pit specially designed for the storage of dung, reference should be made to BS 5502-21 for the relevant protective treatment against decay.

11 Protection of walls, piers and columns

11.1 Any wall, pier, or column of a building or structure should be designed and constructed so that it does not transmit moisture to any material which might be adversely affected by it.

11.2 Where the walls are regularly subjected to the application of water, e.g. for hygiene purposes, or where the walls may be subjected to moisture from stored products and where moisture may adversely affect the materials, a surface treatment should be applied to the walls to protect them from becoming damp.