BRITISH STANDARD

BS 5502-22:
2003+A1:2013

Buildings and structures for agriculture —

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

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British Standards

Committees responsible for this British Standard

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British Commercial Glasshouse Manufacturers' Association

British Precast Concrete Federation Ltd.

British Veterinary Association

Cold Rolled Sections Association

DEFRA

Northern Ireland Department of Agriculture and Rural Development

Environment Agency

Fibre Cement Manufacturers' Association Ltd.

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

The Scottish Executive Environment and Rural Affairs Department

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Contents

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BS 5502-22:2003+A1:2013 supersedes BS 5502-22:2003, which is withdrawn.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 ▮A1⟩ ⟨A1▮. 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.*

〉A1〈 BS 5930, *Code of practice for site investigations* 〉A1〈

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

〉A1〈 BS 6180, *Barriers in and about buildings – Code of practice* 〉A1〈

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

〉A1〈 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* 〉A1〈

3 Terms and definitions

〉A1〈 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. 〉A1〈

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 ▮A1⟩ BS EN 1992-1-1 and BS EN 1997-1 ⟨A1▮.

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 m^3 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 ⟩A1⟩ 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.

12 Protection of roofs

12.1 All roofs should be non-fragile.

12.2 Except as stated in **12.3**, the roof of any building or structure should be weatherproof and so constructed that it does not transmit moisture to any part of the structure or its contents which would be adversely affected by such moisture.

12.3 The recommendations in **12.2** should not be applied to those buildings and structures where, because of internal environmental requirements, it is necessary to provide openings in the roof for the entry of fresh air or the exhaust of foul air. Where air from such vents may cause corrosion of the surrounding materials, precautions should be taken to protect those materials against corrosion or decay (see BS 5502-21).

13 Balustrades and safety rails

Balustrades and/or safety rails should be provided for any workplace or walkway which is situated more than 1.5 m above floor or ground level. They should conform to BS 6180 and A1 NA to BS EN 1991-1-1 A1 (see also BS 5502-80, regarding working platforms).

14 Design classification

A1 **14.1** Agricultural buildings and structures should be designed in accordance with one of the two classes given in Table 1. All drawings and written reference should include information on the class upon which the design is based.

Table 1 – Design classifications

Class [a]	Maximum normal human occupancy within a building or structure or its zone of effect where applicable person h/year	Minimum allowable distance to a classified highway or human habitation [b] m	Minimum design life years
1	Unrestricted	Unrestricted	50
2	Not exceeding 6 h/day at a maximum density of 1 person/ 100 m^2 up to a maximum of 10 people at any one time	Either 10 or a limit of zone of effect if greater than 10	20

[a] The consequence of collapse is greater in buildings or structures of larger classification number.

[b] Distance from a structure to a classified highway or human habitation means the distance to the edge of highway (including footway) or nearest point of human habitation.

NOTE 1 The designer and client might decide that the risks of collapse are low enough that greater than 10 people can work safely in the building for a short period of time. For example, if the greatest risk of collapse is from snow, it might be acceptable for greater numbers to work in the building for a few weeks during the summer. (See Clause **18**.)

NOTE 2 For CE marking of steel frames to BS EN 1090 it is recommended that Class 1 agricultural buildings are fabricated to EXC 2 and Classes 2 are fabricated to EXC 1.

Agricultural buildings should generally be designed as Class 2, subject to the limits given in Table 1, with the exception of the following, which should be designed as Class 1:

a) agricultural buildings that have loads applied other than the normal environmental loads, such as grain stores, silage clamps, etc;

b) multi-storey agricultural buildings. This does not include mezzanine floors of less than 50% of the total floor area;

c) agricultural buildings that are located more than 200 m above ordinance datum (sea level). A1

14.2 Buildings and structures should be designated according to the density of human occupancy, the location of the building and the return period of loadings (design life) on all structural members (including purlins and sheeting rails).

NOTE The design life does not necessarily relate to the durability limits of materials of construction (see **6.1**).

A1 If it is known that the occupancy might for short periods (i.e. less than 70 days) be of higher density or a larger number of hours per day, then the cumulative effect over a year of all occupancy within a 100 m^2 area should be aggregated. If the cumulative effect exceeds the person hours per year figure for Class 2 then the building should be designed as a Class 1 structure. A1

14.3 For retaining structures or buildings containing a retaining element, the density of occupancy should apply within the structure's zone of effect (see **3.1** and Figure 1).

14.4 The design classification of a building should be determined so that it satisfies both he occupancy and distance recommendations stated for the class.

14.5 Care should be taken when siting buildings and structures to ensure that the classification of existing buildings and structures is not infringed.

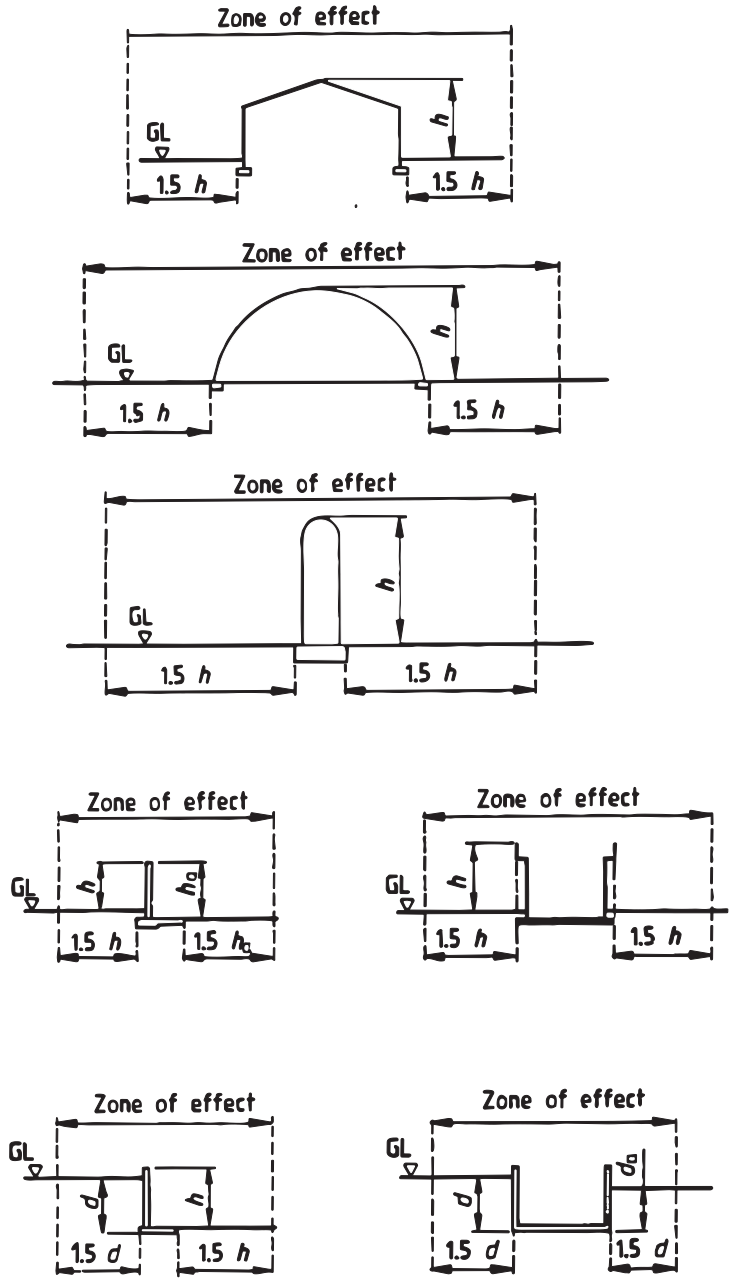

Figure 1 — Examples of zone of effect for retaining structures or buildings containing a retaining element

15 Loadings

15.1 General

15.1.1 *Characteristic loads*

A characteristic value of load should be evaluated from a mean load, together with a factored standard deviation from that mean value, for example, the wind loads given in ⟩A1⟨ BS EN 1991-1-4 ⟩A1⟨ are characteristic loads since they are statistically based.

NOTE This clause provides characteristic loads for use in the design of agricultural buildings and structures. Not all the values given have been obtained from statistical studies, but they are based upon figures used by engineering designers for many years, and the values given may be considered as characteristic values for the purposes of limit state calculations and working stress design. Classified loads are derived from characteristic loads as described in **16.1.2**.

15.1.2 *Dead and imposed loads*

Dead and imposed loads should be taken as the loads as defined in, and calculated in accordance with, ⟩A1⟨ BS EN 1991-1-1 ⟩A1⟨, except as given in **15.3** to **15.10**.

All stored materials, including Silage, and any bales that may be stacked upon it, shall be taken as and calculated in accordance with the requirements for imposed loads.

15.1.3 *Loads from stored materials*

Loads and pressures exerted by agricultural products should be assessed using calculation procedures which take account of the physical characteristics to the products, method of storage and dynamic effects.

In assessing loads, consideration should be given to the available height, the method of storage and the physical properties of the material being stored (see BS 5502-65, BS 5502-66, BS 5502-70, BS 5502-71; BS 5502-72, BS 5502-74 and BS 5502-75). For materials such as silage, compaction loads should also be considered.

Where there is the possibility of exceeding the design parameters (such as available height being greater than design height), suitable notices stating the design limitations should be clearly displayed.

The characteristic values of the densities, angle of repose and shearing resistance of stored materials given in Table 5 should be used for the material as stored.

NOTE No account has been taken of any variation of moisture content or chemical composition during the time that the material is in storage, and it is assumed that (unless stated) no mechanical or other means of consolidation are applied during or following the deposition of the material.

Where the properties of a material can be affected by absorption or loss of moisture, or unusual packing, this should be considered in the design.

15.1.4 *Service loads*

The necessity of allowing an extra load to cater for services and/or contingencies, particularly when the total load (dead plus imposed) is low, should be considered and such extra load should be based upon the anticipated normal use of the building.

15.1.5 *Impact loads*

Due consideration should be given to impact loads from machinery and animals, especially in regard to walls used as loading blocks and barriers used to retain animals.

NOTE Loading blocks are defined as walls which machinery such as fore-end loaders may drive against when filling the bucket.

15.1.6 *Dynamic loads*

Where loads arising from machinery (moving or static), runways and other plant producing dynamic loads are supported by, or transferred to, the framework, allowance should be made for such dynamic effects.

NOTE Information on specific loadings should be available from the supplier or manufacturer.

15.2 Wind loads

15.2.1 *General*

Wind loads should be taken as the wind loads defined in, and calculated in accordance with, ⟩A1⟨ BS EN 1991-1-4 ⟩A1⟨, but with the additional provisions given in **15.2.2** and **15.2.3**.

15.2.2 *Canopy roof structures*

Canopy roof structures should be designed in accordance with [A1] BS EN 1991-1-4 [A1]. Wind loads arising from all possible blockage configurations, including the building being empty, should be considered.

15.2.3 *Tunnel-shaped buildings*

For the calculation of wind loads on tunnel-shaped buildings, the pressure coefficients given in BS EN 13031-1 should be used.

15.3 Imposed roof loads other than wind loads

[A1] 15.3.1 *Modifications to imposed roof loads derived from BS EN 1991*

15.3.1.1 For class 1 buildings and structures and for buildings and structures of Class 2 where there is access to the roof, the minimum imposed load on a roof should be in accordance with BS EN 1991-1-1 and NA to BS EN 1991-1-1. For agricultural structures of Class 2, where there is no access to the roof except for that necessary for cleaning and repair, the minimum uniformly distributed imposed load on the roof should not be taken as more than the value of 0.4 kN/m^2 recommended in BS EN 1991-1-1.

15.3.1.2 Snow loads should be obtained from BS EN 1991-1-3 and NA to BS EN 1991-1-3.

15.3.1.3 Concentrated loads should be obtained from BS EN 1991-1-1 and NA to BS EN 1991-1-1.

15.3.1.4 For tunnel-shaped buildings with no eaves, the shape coefficients given in BS EN 13031-1 should be used. [A1]

[A1] *Tables deleted* [A1]

15.3.2 *Greenhouses*

For the design of greenhouses, reference should be made to BS EN 13031-1.

15.4 Floor loads

15.4.1 *Floors for livestock*

Floors intended to carry livestock and capable of lateral distribution of point loads should be designed to sustain the characteristic imposed livestock loads given in Table 2.

The design loading should be based on either W_L or P_L, whichever produces the greater stress.

When there is access other than purely for maintenance, the minimum loading should be calculated in accordance with **15.4.7**.

Table 2 — Characteristic imposed livestock loads for floors capable of lateral distribution of point loads

Livestock	Mass of animal (max.)	Loads	
		W_L	P_L
	kg	kN/m^2	kN
Cattle			
heavy dairy, adult bulls	800	5.8[a]	7.0[a]
light dairy, beef	550	4.0	5.0
calves	200	2.2	2.0
Pigs			
heavy hogs, sows	180	2.5	1.5
fatteners	100	2.5	1.0
weaners	30	2.2[a]	0.8[a]
Sheep			
rams	100	2.5	1.0
ewes	80	2.0	0.8
Poultry			
heavy birds	15	0.7	0.3
light birds	3	0.5	0.25

[a] Extrapolated value subject to verification

15.4.2 ***Slatted floors for livestock***

Slatted floors should be prepared in accordance with BS 5502-51. They should be made up either from single slats, or from multiple slat units comprising two or more slats permanently linked transversely and placed in position as one unit (see Figure 2).

The load H_s should be considered as capable of acting at any point on the surface of a single slat, and as being coexistent with the load P_s.

The characteristic imposed livestock loads for slatted floors should be those given in Table 3.

Any slat should be capable of sustaining a load equivalent to the weight of one animal, anywhere on its surface, over an area equal to the width of the slat × 150 mm.

Where special loads on slatted floors, such as bulk tanks, have to be considered, the design should be checked to ensure that this loading case is adequately covered.

It is permissible for multiple slat units comprising two or more slats, provided that they act together structurally, to be designed for a vertical load on each slat of $1.7P_s/n$ kN/m, and for a horizontal load of H_s acting at any point on the surface of the multiple slat.

The width covered by n slats in any multiple slat unit for the purpose of design should not exceed $0.2l_s$.

NOTE When there is access other than purely for maintenance, the minimum loading should be calculated in accordance with **15.4.7**.

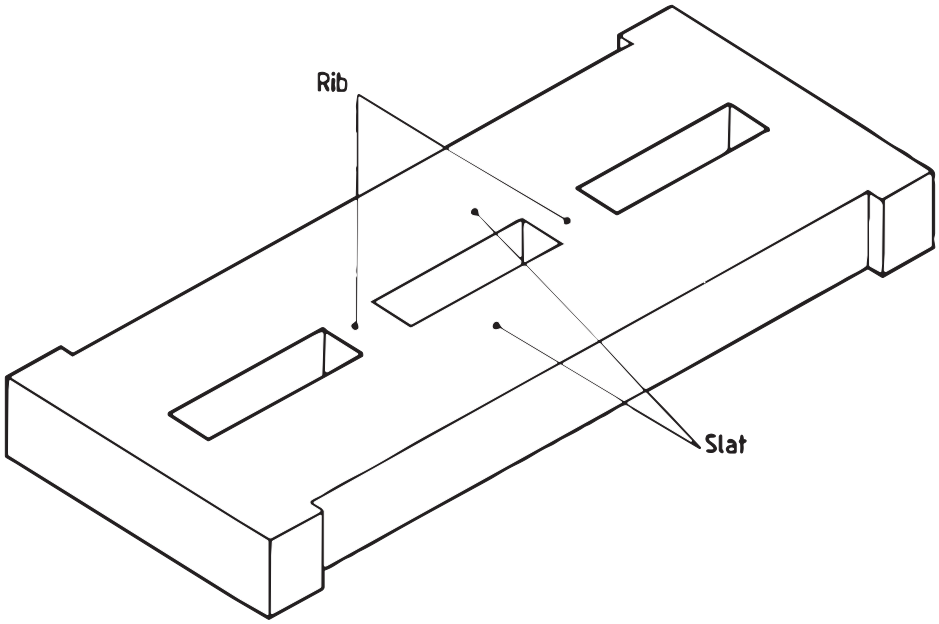

Figure 2 — Components of a typical multi-slat unit

Table 3 — Characteristic imposed livestock loads for slatted floors

Livestock	Mass of animal (max.)	Loads		
		W_s	P_s	H_s
	kg	kN/m²	kN/m	kN
Cattle				
heavy dairy, adult bulls	800	5.8[a]	5.8[a]	4.0[a]
light dairy, beef	550	4.0	4.0	2.75
calves	200	2.2	1.95	1.0
Pigs				
heavy hogs, sows	180	2.5	1.8	0.9
fatteners	100	2.5	1.3	0.5
weaners	30	2.2[a]	0.9[a]	0.25[a]
Sheep				
rams	100	2.5	1.3	0.5
ewes	80	2.0	1.0	0.4
Poultry				
heavy birds	15	0.7	0.35	0.15
light birds	3	0.5	0.30	0.12

[a] Extrapolated values subject to verification.

15.4.3 ***Vehicle loading for solid and slatted floors***

The characteristic imposed vehicle loads for floors should be taken as those given in Table 4.

Where it is not possible to restrict access, floors should be designed for the maximum loading given in Table 4.

Allowance should be made for specific vehicles and equipment that might give higher overall loading or more onerous contact areas (e.g. solid tyred fork lifts).

The design loading should be based on either W_v or P_v whichever produces the greater stress in the part of the floor member or support under consideration. For the design of beams acting independently, e.g. single slats, P_v should be considered to act coincidentally with similar loads at 1.5 m centres.

NOTE 1 These loads include allowance for any dynamic effect.

The horizontal loads resulting from braking or traction should be considered as 10 % of the vertical load P_v, and should be coexistent with P_v.

NOTE 2 The tractor masses given are gross masses including ballast, and they exclude equipment or trailers, unless otherwise stated.

Table 4 — Characteristic imposed vehicle loads for floors

Vehicle	Loads	
	W_v kN/m^2	P_v kN
Lightweight vehicles and tractors not exceeding 2 500 kg mass	5.0	10.0
Tractors not exceeding 4 000 kg, and tractors not exceeding 2 500 kg towing trailers or equipment, where the combination of tractor and trailer or equipment does not exceed 4 500 kg gross mass.	10.0	20.0
Tractors not exceeding 6 000 kg and tractors not exceeding 4 000 kg towing trailers and equipment not exceeding 6 500 kg gross mass	15.0	30.0
Other tractors and equipment up to and including normal permitted road vehicles as given in the Road Vehicles (Construction and Use) Regulations 1986 [2]	25.0	60.0
Attention is drawn to the fact that these loadings are in general lower than the public highway requirements and therefore should be used only in areas which are not subject to Highway Authority Regulations.		

15.4.4 *Bridges, cattle grids, covers and aprons*

A1 NOTE The characteristic imposed vehicle loads given in **15.4.3** may be used for the design of cattle grids, covers and aprons on agricultural land. Bridges designed to the appropriate Eurocode, e.g. BS EN 1993-2 for steel bridges, with partial safety factors obtained from BS EN 1990:2002+A1:2005, Annex A2. Alternatively, for shorter spans, bridges on agricultural land may be designed using the characteristic imposed vehicle loads given in **15.4.3** together with partial safety factors obtained from BS EN 1990:2002+A1:2005, Annex A1. A1

In assessing the characteristic load to be used, due consideration should be given to the wheelbase and axle spacing in relation to the size of the bridge grid, coves or apron, and to the possibility of the simultaneous presence of more than one vehicle.

15.4.5 *Storage floors*

Where storage floors are bounded by walls, so that the height of the highest boundary wall is not greater than 0.8 times the distance between the walls, the whole of the contents should be considered to be carried on the storage floor, with no allowance made for arching or frictional resistance between the contents and the walls. Densities of materials should be taken from those given in Table 5, which represent the upper-quartile values. In cases where the height of the boundary wall is greater than 0.8 times the distance between the walls, consideration should be given to arching of the material and possible frictional resistance of the walls. The values in this table should not be used to assess the volume capacity of storage structures. See BS 5502-50, BS 5502-60, BS 5502-65, BS 5502-66, BS 5502-70, BS 5502-71, BS 5502-72, BS 5502-74 and BS 5502-75.

15.4.6 *Combined loads*

Where appropriate, combinations of vehicle, livestock and storage should be considered.

15.4.7 *Minimum loading*

On all floors where there is access other than purely for maintenance, a minimum characteristic imposed load over the gross floor area of 1.5 kN/m^2 should be designed for. The minimum characteristic load on a slatted floor with human access should allow for one concentrated load of 1.5 kN acting at any position on a single slat. The minimum characteristic load on a solid floor with human access should allow for one concentrated load of 1.5 kN acting at any point on a square with 300 mm side.

For suspended floors which may be used as general storage areas, the characteristic imposed loads should be based on actual loads, but in no case should they be less than 5.0 kN/m^2.

〈A1〉 Table 5 — Properties for stored material

Material	Density kN/m^3	Angle of repose ° degrees
Apples		
– loose	8.3	30
– boxed	6.5	N/A
Beans		
– general	8.1	35
– soya	7.4	30
Bedding material		
– dry	2.0	See **15.7**
– saturated	8.0	See **15.7**
Cabbages	4.0	35
Carrots	7.8	35
Cauliflower	6.0	35
Cherries (in trays)	7.8	N/A
Coal	11.0	30 to 35
Eggs (in trays)	4.5	N/A
Fertilizer		
– general	10.0	25 to 35
– crushed basic slag	13.7	35
– phosphates	12.3	30
– potash	12.5	28
Farmyard slurry [a)]	10.8	N/A
Farmyard manure [a)]	7.8	N/A
Flour (in bags)	5.0	N/A
Fodder loosely stacked (see also silage)	4.5	N/A
Grain		
– general (dry [b)])	7.8	30
– general (moist [b)])	7.5	35
– barley (dry [b)])	7.7	30
– barley (moist [b)])	7.0	40
– brewer's grain (wet [b)])	8.8	20
– herbage seeds	3.4	30
– linseed	7.5	20
– maize (in bulk)	7.4	30
– maize (in bags)	5.0	N/A
– oats	5.0	30
– oilseed rape	6.4	25
– rye	7.0	30
– wheat (dry [b)])	7.8	30
– wheat (moist [b)])	7.2	35
– wheat (in bags)	7.5	N/A

Table 5 — Properties for stored material *(continued)*

Material	Density kN/m^3	Angle of repose ° degrees
Grass cubes	7.8	40
Hay (baled)	3.0	N/A
Hops (in bags)	1.5	N/A
Lettuce (in trays)	5.0	N/A
Meal		
– ground	7.0	45
– cubes	7.0	40
Onions		
– in bulk	7.0	35
– in boxes	4.0	N/A
Pears (in boxes)	5.9	N/A
Peas	7.8	35
Peat		
– dry	5.0	35
– wet	9.5	N/A
Potatoes		
– in bulk	7.6	35
– in boxes	4.4	N/A
Raspberries	2.0	N/A
Red beet	7.4	40
Root vegetables (including sugar beet)	8.8	35
Silage	See **15.6**	See **15.6**
Sprouts	5.5	35
Straw		
– in bulk (dry)	0.7	N/A
– in bales	1.5	N/A
Strawberries (in trays)	1.2	N/A
Tomatoes	6.8	N/A
Turnips	7.0	35
Wool (in bulk)	3.0	N/A

a) Farmyard slurry is a mixture of faeces and minimal bedding diluted with urine and water such that it behaves as a liquid when mixed (maximum 20% dry matter by volume). Farmyard manure is a mixture of bedding (usually straw) and faeces with some absorbed urine which results in stackable waste (minimum 60% dry matter by volume).

b) For the purpose of this standard, reference to a grain as "dry" corresponds to a moisture content of 14% (m/m) or less, 'moist' to moisture content of ≥14% (m/m), ≤28% (m/m) and "wet" to a moisture content greater than 28% (m/m).

A1

15.5 Wall loads

15.5.1 *Walls for storage areas*

Wall loads should be calculated using recognized earth pressure theories. Densities, angles of repose and angles of shearing resistance should be as given in Table 5. Where the intended depth of storage exceeds 0.8 times the diameter of a cylindrical silo or 0.8 times the diameter of the largest circle which can be drawn inside a square or polygonal section silo, reference should be made to BS 5061 for forage storage.

For slurry storage tanks and reception pits, loads should be determined in accordance with BS 5502-50.

15.5.2 *Air ducts in on-floor stores*

Where air ducts, such as those used in on-floor grain or vegetable stores, are subjected to loading first on one side and then on both sides, active pressure conditions do not prevail, as such air ducts are subjected to crushing loads which are greater than the calculated active pressure design load. In the design of these air ducts, an over-pressure factor of 1.3 should be applied to the active pressure design load calculated, and in designing the framework the deflection from upright should be limited to not greater than 1 in 200 of the stored height.

15.6 Loads on bunkers or clamps for the storage of grass silage

15.6.1 *General*

Bunkers or clamps which contain not more than 8 m consolidated height of grass, and in which the deposited height is less than the distance between the walls, should be designed in accordance with **15.6.2** to **15.6.7**.

15.6.2 *Surcharging of silage*

The silage may be domed towards the centre of the bunker or clamp provided that the design depth of the silage is not exceeded within a horizontal distance from the wall equal to the wall height.

Bales may be stacked on top of the silage provided that, within a horizontal distance from the wall equal to the height of the wall, the depth of bales does not exceed a quarter of the design depth of the silage.

15.6.3 *Loads on retaining walls*

The minimum wall loading should be obtained by summing the following characteristic loads which act directly on the inner face of the wall:

a) a uniform horizontal load of W_G kN/m^2;

b) a horizontal load which increases uniformly with depth of $T_G z$ kN/m^2;

c) two concentrated loads, each of P_G kN, both acting horizontally on an area 0.6 m by 0.6 m, centred 0.6 m below the surface, with centroids 2 m apart along the wall, considered to be of short duration.

NOTE Values for W_G, T_G and P_G are given in Table 6.

Table 6 — Grass silage wall loading

Consolidation vehicle gross mass t	**Loads** (see Notes)		
	W_G kN/m^2	T_G kN/m^2	P_G kN
Up to and including 8	3.9	3.9	4.0
Greater than 8 up to and including 10	4.5	4.5	5.0

NOTE 1 These characteristic loads are applicable only if:

a) the material ensilaged is grass;

b) the consolidating machine is a wheeled or tracked vehicle with a gross mass not exceeding that stated;

c) adequate drainage of effluent from the silage is provided and maintained within a distance of 500 mm from the inside face of the wall at floor level;

d) the moisture content of the grass when ensilaged does not exceed 80 % (*m*/*m*);

e) the wheels of the consolidating vehicle do not come into contact with the face of the wall.

NOTE 2 No allowance has been made for impact loads.

15.6.4 *Special considerations*

15.6.4.1 When consolidation is to be carried out with machinery exceeding 10.0 t gross mass, or when the wheels of vehicle come into contact with the wall face, loadings become extremely high and special consideration should be given to the design of the walls.

15.6.4.2 When the moisture content or drainage conditions given in items c) and d) of the note to Table 6 do not apply, the walls of the bunker or clamp should be designed to carry the loading obtained by summing the characteristic loads given in items a), b) and c) of **15.6.3**, together with a horizontal load of 10 (z – 1) kN/m^2 which increases uniformly with depth and which commences 1 m below the rolled silage surface.

15.6.5 *Stability against overturning*

The mean bulk density of the silage should be taken as $(400 + 72z)$ kg/m^3.

The shearing resistance in a vertical plane within the silage may be taken into consideration in the assessment of the factor of safety against overturning. The average shear stress developed on a vertical plane should be taken as $(3.75 + 0.75z)$ kN/m^2.

15.6.6 *Wall friction*

Friction between the silage and the silo walls should be ignored.

15.6.7 *Snow loading*

When considering the combination of snow load and silage load on a roofed silage building, only 70 % of the characteristic silage load as determined in accordance with items a) and b) of **15.6.3** need be considered.

NOTE This relaxation similarly applies when the moisture content of the grass exceeds 80 % (*m*/*m*) (see **15.6.4.2**).

15.7 Loads from bedding material in stock buildings

Where the depth of compacted bedding does not exceed 1.2 m, the characteristic load in kN/m^2 acting on walls retaining bedding material should be derived using the following equation:

$$P_B = 2.0 + 2.0z$$

Friction effects between the bedding material and the walls should be ignored.

In the calculation of floor loads, densities should be as given in Table 5.

15.8 Suspended crop loads

Where structures support crops, allowance should be made for the associated loadings. In the absence of more specific data, the crop actions given in BS EN 13031-1 should be used.

Where crop loads are transmitted to the structure through wires, due allowance should be made for reaction of the structure to the wire forces.

A1 *Text and table deleted.* A1

16 Structural design (materials)

16.1 General

16.1.1 *Design*

Designs should conform to the relevant A1 Eurocodes A1 covering the structural materials being used, modified for classified agricultural buildings and structures in accordance with **16.1.2** and **16.1.3**. A1 Design loads should be obtained by combining the classified loads and multiplying them by the appropriate partial safety and combination factors obtained from BS EN 1990:2002+A1:2005, Annex A1. A1

16.1.2 *Classified loads*

Classified loads should be obtained from the characteristic loads given in Clause **15** by multiplying the characteristic loads by the appropriate classification factor γ_c given in Table 7. For parameters of classification, see Clause **14**.

Table 7 — Classification factors

Class	Factor γ_c
1	1.000
2	A1 0.90 A1

16.1.3 *Stability*

A1 The relevant structural Eurocodes should be applied when considering overturning and sliding, with load factors corresponding to Set A (EQU) from BS EN 1990:2002+A1:2005. For retaining structures, the safety factors should be obtained from Set B (STR) or Set C (GEO) in BS EN 1990:2002+A1:2005 as appropriate and from BS EN 1997. The factors are applied to the classified loads. A1

16.2 Structural use of timber

[A1] Timber should be designed in accordance with BS EN 1995-1-1 and NA to BS EN 1995-1-1. [A1]

[A1] *Tables deleted.* [A1]

16.3 Structural use of steelwork

16.3.1 *General*

[A1] The design of structural steelwork should be in accordance with BS EN 1993-1-1 and NA to BS EN 1993-1-1. The design of cold formed steel structures and members should be in accordance with BS EN 1993-1-3 and NA to BS EN 1993-1-3. [A1]

[A1] *Text and table deleted.* [A1]

16.3.4 *Purlins*

16.3.4.1 *General*

The purlin section adopted should conform to **16.3.4.2**, **16.3.4.3** or **16.3.4.4**. [A1] *Text deleted* [A1]

16.3.4.2 *Hot rolled sections*

Steel angle section purlins should be designed in accordance with [A1] BS EN 1993-1-1 [A1] modified as follows:

a) The section modulus of the purlin, in cubic centimetres, about the axis parallel to the routing, should be not less than $(W_p l_p)/1\,800$.

b) The depth of the purlin in the plane of action of the maximum component of the load should be not less than $l_p/52$.

c) The breadth of the purlin perpendicular to the plane of action of the maximum component of the load should be not less than $l_p/72$.

16.3.4.3 *Rectangular hollow section steel purlins*

Rectangular hollow section purlins should be designed in accordance with [A1] BS EN 1993-1-1 [A1], modified as follows.

a) The section modulus of the purlin, in cubic centimetres, about the axis parallel to the roofing should be not less than $(W_p l_p)/2\,000$.

b) The depth of the purlin in the plane of action of the maximum component of the load should be not less than $l_p/74$.

c) The ratio of breadth to depth should be not less than 1:25.

16.3.4.4 *Cold formed light gauge steel purlins*

[A1] Cold formed light gauge steel purlins should be designed in accordance with BS EN 1993-1-3; where proprietary purlin systems are used, the resistance of the purlins may be obtained from the manufacturer's published load span tables. The published capacities should be determined by calculation, testing, or a combination of calculation and testing according to the methods in BS EN 1993-1-3.

If purlin resistance is calculated assuming restraint to the compression flange, the cladding should be capable of providing this restraint. Where non-restraining cladding is specified, the purlins should be designed as unrestrained beams.

NOTE Fibre cement sheeting might not provide full restraint to the compression flange of cold formed light gauge steel purlins and also requires a more stable platform when being installed.

Restraint ties should be used as follows:

- 1 tie at mid span on purlin spans 4.5 m–6.1 m.
- 2 ties at 1/3 points for purlin spans 6.1 m–7.5 m. [A1]

16.3.5 *Cold formed circular steel tubing*

Where thin-walled, cold formed circular steel tubing is used for the frameworks of tunnel-shaped buildings, the tubing may be considered as being a structural steel section provided:

〉A1〈 a) the steel from which the sections are rolled conforms to BS EN 10346; 〉A1〈

b) $D/t \leq 40$, where D is the outside diameter and t is the wall thickness and $t \geq 1.2$ mm;

〉A1〈 c) dimensional tolerances conform to BS EN 1993-1-3; 〉A1〈

d) adequate protection is provided against corrosion (see BS 5502-21).

〉A1〈 NOTE This clause refers to thin-walled tubes manufactured from light gauge cold-formed steel. The appropriate materials standard is, therefore, BS EN 10346 with coil tolerances given in BS EN 1993-1-3. BS EN 10346 replaced BS EN 10326, which is referenced in BS EN 1993-1-3:2006, Table 3.1. 〉A1〈

Structural connections provided between members should be capable of transmitting all relevant forces safely. Where a swaged connection is used, the capacity of the section to resist bending should be reduced by the factor $\{(D - 3t)/(D - t)\}^2$ at the position of a tube of outside diameter D and wall thickness t.

16.3.6 *Cladding*

Stiffening of the structure by the cladding may be taken into account provided this has been established by calculation or tests.

〉A1〈 16.4 Structural use of concrete

16.4.1 *General*

Design should be carried out in accordance with BS EN 1992.

NOTE Precast concrete elements might be subject to supplementary or alternative design clauses within relevant product standards.

16.4.2 *Durability*

16.4.2.1 *General*

Prior to the selection of the method of specifying, the specification requirements given in BS 8500-1:2006+A1:2012, Annex A should be taken into account.

NOTE Particular attention might be required where exposure to chemical attack is anticipated or where the guidance given in BS 8500-1:2006+A1:2012, Annex A is based largely on exposure to acidic solutions or solutions of sulphate salts from the ground.

16.4.2.2 *Cover to reinforcement*

The recommendations given in BS 8500-1:2006+A1:2012, Table A.4 should be followed for minimum cover, maximum water-cement ratio, minimum cement or combination content for normal weight concrete with 20 mm maximum aggregate size for reinforced or pre-stressed elements with an intended working life of 50 years. For an intended working life of 100 years, the recommendations given in BS 8500-1:2006+A1:2012, Table A.5 should be followed; these recommendations are based on consideration of corrosion induced by combinations of carbonation or by chlorides.

NOTE 1 The rate of carbonation and chloride ingress decreases with time and in simple terms doubling the cover increases the time for carbonation or chloride to reach the reinforcement, and hence increases corrosion initiation by a factor of four.

NOTE 2 Where an intended working life less than 50 years is required, the cover in BS 8500-1:2006+A1:2012, Table A.4 may be reduced accordingly, e.g. a reduction in cover from 40 mm to 30 mm equates to a reduction in service life from 50 years to around 28 years.

The nominal cover to the reinforcement should be not less than the maximum size of the aggregate or such that the cover to the main bar would be less than the size of the main bar, where bars are in groups, the equivalent size of that group.

For low covers to reinforcement special attention should be given to the positioning of reinforcement to ensure structural integrity is maintained.

16.4.2.3 *Unreinforced concrete*

Designated concretes in accordance with BS 8500-2 should be of an appropriate quality assured solution to specifying concrete for agricultural use. Table 8 sets out typical agricultural applications for designated concretes.

Table 8 — Designated concretes for agricultural applications

Typical application	Designated concrete	Recommended slump class	
		Hand compaction	Vibration equipment
Livestock and crop stores	RC28/35	S3	S2
Floors (and walls) for: silage, manure and slurry stores	RC30/37 [a]	S3	S2
Sugar beet storage areas, workshop floors and floors subject to small-wheel forklift trucks, mushroom sheds	RC32/40	S3	S2
Stable floors, brewers' grain stores	RC35/45	S3	S2
Toppings for floors such as parlours and dairies	RC35/45 [b]	S2	S2
External yards and roads subject even to occasional de-icing salts	PAV2	S3	S2

Notes

[a] Where concrete is subject to even occasional de-icing salts, designated concrete PAV2 is recommended.

[b] Care is required to ensure full compaction of the fresh concrete and adequate curing.

NOTE Minimum percentages of flexural reinforcement given in BS EN 1992-1-1 may not be adequate to resist the effects of early thermal or long-term drying shrinkage and temperature variations or control cracking. ⟨A1⟩

16.5 Use of masonry

16.5.1 *General*

⟨A1⟩ When designing in accordance with this standard, BS EN 1996-1-1 and NA to BS EN 1996-1-1 should be modified in accordance with **16.5.2**, **16.5.3** and **16.5.4**.

Design loads should be taken as the classified loads obtained in accordance with **16.1.2**, multiplied by γ_f.

Values of γ_f for the ultimate limit state should be obtained from BS EN 1996-1-1 and NA to BS EN 1996-1-1.

When applying BS EN 1996-1-1 and NA to BS EN 1996-1-1, loads for stored materials should be treated as earth loads. ⟨A1⟩

16.5.2 *Durability*

Due consideration should be taken of all factors affecting the durability of masonry especially where chemical attack is expected (see ⟨A1⟩ BS EN 1996-2 and PD 6697 ⟨A1⟩). In these cases care should be taken when utilizing the modifications given in **16.5.3**.

16.5.3 *Cover to reinforcement*

Values for cover to reinforcement should conform to ⟨A1⟩ BS EN 1996-1-1 and NA to BS EN 1996-1-1 ⟨A1⟩ for permanent buildings. The values, which are given in Table 9, should be used conservatively for buildings with a nominal service life of 50 years.

NOTE Table 9 also contains reduced cover recommendations for a nominal design life of 10 years.

For a service life between 10 years and 50 years, the nominal cover should be obtained by linear interpolation between the values given.

The nominal cover to reinforcement should be not less than the nominal maximum size of aggregate plus 5 mm, nor such that the cover to main bar would be less than the size of the main bar or, where bars are in groups, the equivalent size of the group.

16.5.4 *Cladding*

Stiffening of the structure by the cladding may be taken into account provided that this has been established by calculation or tests.

17 Structures

17.1 Greenhouses

Greenhouses for agriculture and horticulture should be designed as classified buildings according to the provisions of BS EN 13031-1.

17.2 Slurry tanks slurry tank covers and reception pits

The design of slurry tanks, slurry tank covers, and reception pits should conform to BS 5502-50.

17.3 Tower silos for forage

The design of tower silos for forage should conform to A1 BS EN 1993-4-1 A1.

17.4 Livestock buildings

For additional information on the design of livestock buildings, BS 5502-40, BS 5502-41, BS 5502-42, BS 5502-43 and BS 5502-49 should be consulted.

Table 9 — Nominal concrete cover for plain carbon steel reinforcement in reinforced masonry where the concrete infill has to provide full service life protection

	Nominal 50 year service life					Nominal 10 year service life				
Grade of concrete as given in BS 5328-1:1997 (or equivalent mix)[a]	C30	C35	C40	C45	C50	C30	C35	C40	C45	C50
Minimum cement content kg/m^3	275	300	325	350	400	275	300	325	350	400
Maximum free water/cement ratio	0.65	0.60	0.55	0.50	0.45	0.65	0.60	0.55	0.50	0.45
Exposure situations	**Nominal concrete cover** mm									
E1[b]	20	20	20[c]	20[c]	20[c]	15	15	15	15	15
E2	—	35	30	25	20	25	20	20	15	15
E3	—	—	40	30	25	35	30	25	20	15
E4	—	—	—	60[d]	50	—	—	40[d]	35[d]	30

[a] These mixes and minimum cement contents are based on the use of normal-weight aggregate of 20 mm nominal maximum size.
[b] Alternatively, 1:0 to ½: 3:2 (cement: lime: sand: 10 mm nominal maximum sized aggregate) mix may be used to meet exposure situation E1, when the nominal cover to reinforcement is 15 mm minimum.
[c] These covers may be reduced to 15 mm minimum provided that the nominal maximum size of aggregate does not exceed 10 mm.
[d] Where the concrete infill may be subjected to freezing whilst wet, air entertainment should be used. The maximum size of aggregates should not be more than two-thirds of the cover.

17.5 Storage, conditioning and processing buildings

For additional information on the design of storage, conditioning and processing buildings, BS 5502-65, BS 5502-66, BS 5502-70, BS 5502-71, BS 5502-72, BS 5502-74 and BS 5502-75 should be consulted.

17.6 Crop production buildings

For additional information on the design of crop production buildings, BS 5502-60 should be consulted.

17.7 Ancillary buildings

For additional information on the design of ancillary buildings, BS 5502-80, BS 5502-81 and BS 5502-82 should be consulted.

17.8 Cattle grids (see **15.4.4**)

For additional information on the design of cattle grids BS 4008 should be consulted.

18 Identification Plate

〈A1〉 Buildings and structures conforming to this standard should be identified by a plate giving, as a minimum, the name of supplier, building use, retaining ability, if applicable, year of design, design life and class. 〈A1〉

The plate and its information should be durable for the design life of the building or structure and be fixed in a position that is clearly visible.

〈A1〉 Buildings that have been designed as Class 2 on the basis that they are normally only occupied during the summer months (or when snow is not expected) should have a sign placed by the entrance stating that the building should not be fully occupied in winter.

NOTE This would apply to buildings designed for seasonal use. 〈A1〉

Bibliography

A1 *Text deleted.* A1

A1 BS EN 1993-2, *Eurocode 3: Design of steel structures – Part 2: Steel bridges* A1

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[1] GREAT BRITAIN. Reservoirs Act 1975. London: HMSO.

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