

Buildings and structures for agriculture —

Part 21: Code of practice for selection and use of construction materials

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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
- Environment Agency
- Fibre Cement Manufacturers' Association Ltd.
- Galvanizers' Association
- Health and Safety Executive
- Institution of Structural Engineers
- Northern Ireland Department of Agriculture and Rural Development
- Royal Institute of British Architects
- Royal Institution of Chartered Surveyors
- Rural Design and Building Association
- Scottish Executive Environment and Rural Affairs Department
- Silsoe Research Institute
- Steel Construction Institute
- Water UK

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Foreword

This Part of BS 5502 has been prepared under the direction of the Farm and Horticultural Buildings Standards Policy Committee and comprises a revision of BS 5502-1.1 and BS 5502-3.2, which are withdrawn.

The start and finish of text introduced or altered by Amendments Nos. 1 and 2 is indicated in the text by tags **A1** **A1** for Amendment No.1 and **A2** **A2** for Amendment No.2.

While BS 5502 is being revised and added to, the opportunity is being taken to restructure the standard into the following broad subject areas:

- *Part 0: Introduction and consolidated index;*
- *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 will comprise:

- *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 design and installation of services and facilities;*
- *Part 30: Code of practice for control of infestation;*
- *Part 31: Guide to the storage and handling of waste;*
- *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 new structure is 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 will also allow sufficient flexibility to allow the standard to be expanded and developed in a logical way in the future. Parts 20 to 39 relating to general design will follow broadly the existing structure of BS 5502-1.0 to -1.7.

It has been assumed in the drafting of this British Standard 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 does not of itself 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 29 and a back cover.

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1 Scope

This Part of BS 5502 gives recommendations on the selection, performance and use of materials in the construction of agricultural buildings and structures.

NOTE The titles of the publications referred to in this standard are listed on page 27.

2 Definitions

For the purposes of this standard, the definitions given in BS 6100 apply.

NOTE Work has commenced on a further Part of BS 5502-10 which will be a glossary of terms for buildings and structures for agriculture.

3 Selection of materials

3.1 General

3.1.1 Materials used in the construction and for the modification of farm buildings should be selected to satisfy the building design classification (see Table 1 and Clause 14 of BS 5502-22:2003).

NOTE All buildings should carry a sign giving the date of erection and classification.

3.1.2 The use of any material or any method of mixing or preparing materials, or of applying or fixing materials should be in accordance with the provisions of the relevant British Standard specification or British Standard code of practice covering the quality of material, installation and workmanship, unless otherwise recommended in this code.

The recommendations given in this British Standard are not intended to preclude the use, where appropriate, of alternative materials providing that those materials have the required durability and strength, are suited to their intended function, and are applied and fixed in accordance with the requirements of the relevant British Standard.

NOTE 1 Alternative materials include those covered by BBA¹⁾ certificates.

NOTE 2 For further information on performance and loading criteria for profiled sheeting see BS 5427.

3.1.3 All materials, surfaces and fittings that under normal operations may be likely to come into contact with persons and/or livestock should be free from projections, sharp edges or perforations that could cause damage or injury. The materials used for internal surfaces should be selected so as to avoid any toxic hazard arising from contact or chewing, and to facilitate cleaning and the maintenance of general hygiene. All surfaces and exposed materials in the vicinity of crops should be free of toxic hazard.

3.1.4 For evaluating new or used materials or fixing methods for which there is no British Standard, the attributes listed in Appendix A should be considered.

NOTE In general, materials used in the construction of farm buildings should be new, but the use of second-hand materials may be acceptable if they comply with the performance standards required.

3.1.5 Materials used in internal and external services should be in accordance with the recommendations given in BS 5502-25.

A2 **3.1.6** Materials for roofs should result in the roof being non-fragile. **A2**

3.2 Durability of materials

3.2.1 *Durability life*

Durability life may be different from design life. Where required, guidance should be sought on durability life of materials.

NOTE This information may normally be obtained from the manufacturer or supplier.

Unless otherwise stated, the structural components and the external envelope should, with reasonable maintenance, remain efficient for the appropriate design life.

¹⁾ British Board of Agrément.

3.2.2 Weathering

Materials exposed to the weather should be able, with normal maintenance, to withstand the local climatic conditions for the expected design life of the material concerned. Climatic conditions include wind and snow loadings, variations in temperature and moisture content, the effects of rain, hail and frost, atmospheric pollution and ultraviolet radiation.

3.2.3 Chemical attack

Chemical attack on building materials may result from contact with sprayed or stored chemicals, with farm products, with wastes containing active chemical components, or from electrolytic action between different metals in moist conditions. In such circumstances, materials should be selected that are not likely to be affected significantly by the chemicals or they should be painted, coated with a resistant material or otherwise protected.

3.2.4 Biological attack

Wood and wood-based materials may be attacked and degraded by fungi and insects under certain conditions and rot may develop in timbers used in damp or wet environments (i.e. where the moisture content of the timber remains above 20 % for significant periods). The time taken for the rot to become established and the rate of degradation is dependent upon the inherent durability of the timber concerned and the prevailing conditions. For timbers of a low natural durability a wood preservative should be used where such a hazard is recognized (see 4.2).

3.2.5 Accidental impact

When sizing and placing materials, the risk of accidental damage from livestock or rough usage in farming operations, should be considered.

3.2.6 Strength

Materials should be of sufficient inherent strength and should be so sized and be of such configuration as to perform adequately the functions for which they are intended. If any materials are not self-supporting they should be provided with an adequate supporting framework. The loadings for various aspects of farm building design should be in accordance with BS 5502-22.

3.3 Corrosion effects

3.3.1 General

Reference should be made to the relevant British Standard code of practice covering the design of buildings and structures for the material for suitable methods of protection from corrosion.

NOTE For protection of concrete see also CIRIA TN 310 Protection of reinforced concrete by surface treatments.

3.3.2 Metals in contact with preserved timber

Precautions should be taken to avoid contact between uncoated aluminium sheeting and copper-containing preservative treated timber, such as isolating the area of contact with a suitable tape or bituminous layer.

Under some conditions, metal fastenings may become corroded through contact with timber treated with preservatives containing copper and the preservative manufacturer should be consulted about any possible interactions of this kind (see BS 4072-2).

Provided the timber remains dry there is little risk of interaction of treated wood with ferrous metal fittings. Where corrosion of steel or galvanized steel may be expected to occur, even with untreated timbers, corrosion is more severe in the presence of copper-based preservatives. No metal fittings should be applied until the period of fixation of the preservatives is complete.

There is very little service evidence on which to base advice on the interaction of preservative-treated wood with other metals.

3.3.3 Metals in contact with cement and concrete

Both aluminium and zinc are subject to attack by alkaline solutions and by fresh workable concrete. The attack by concrete is reduced and may cease altogether after it has hardened and while it remains dry. If the concrete becomes damp, the attack may recommence.

Where aluminium is used externally in contact with concrete it should be anodized or suitably protected.

3.3.4 *Metals in contact with one another*

For any two metals in contact, the metal uppermost in the following list corrodes. The further apart the metals are in this list, the greater is the corrosion.

- a) Magnesium
- b) Zinc, cadmium
- c) Chromium, aluminium
- d) Steel, iron
- e) Stainless steel
- f) Lead, tin
- g) Low-copper brass
- h) Nickel
- i) Copper, high-copper brass

To prevent corrosion, the contact surfaces of both metals should be painted, or that of the metal lower in the list, never that of the higher metal alone, as in this case there would be extreme current density on a small area should any small holes occur in the paint layer.

3.3.5 *Certain chemicals and wastes in contact with steel and concrete*

The corrosive reactions described in Table 1 should be considered when using steel and concrete in the agricultural environment.

3.4 Thermal insulation

3.4.1 *General*

Recommendations on insulation are given in the Parts of BS 5502 for specific types of building.

3.4.2 *Insulating materials*

The thermal insulating properties of a structure, such as a wall or a roof, depend mainly upon the proportion of still air present between its inner and outer faces. This can be increased either by the introduction of air cavities or by the inclusion of layers of insulating material which themselves contain entrapped air or other gases in the thickness of the structure. Insulating materials may be structural, such as hollow or lightweight concrete blocks, or no-fines concrete; or non-structural, such as loose fill material, quilts and semi-rigid slabs and boards.

Insulating materials used in farm building construction should be selected and installed with regard to possible hazards, including:

- a) physical damage from impact by stock, vehicles, operatives and their handtools (brooms, shovels, etc.), and from birds and pests, or from biodegradation;
- b) compression of the insulating material to less than its original thickness as a result of the method of installation, or of loads subsequently imposed;
- c) reduction of thermal insulation value due to wetting of insulating materials, either by direct entry of liquid water or by internal condensation of water vapour;
- d) chemical damage, such as that caused to some foamed plastics by organic solvents which may be found in fuels, lubricants, adhesives and agricultural sprays, including disinfectants.

Materials with a bright reflective exposed surface also provide thermal insulation, as long as they are kept clean, since they are able to reflect most of the radiant heat reaching the surface and do not emit much radiant energy.

Table 1 — Corrosive reactions of certain chemicals and wastes in contact with concrete and steel

Corrosive agency	Corrosive environment ^a	Chemicals	Reactions with concrete	Reactions with steel
Liquid fertilizers				
Slurry ^b	Mild	Mixture may vary from neutral to slightly acid	Special precautions are not normally needed (see BS 5502-50)	Special precautions are not normally needed (see BS 5502-50)
Nitrogenous solutions	Moderate	Ammonium nitrate Urea	Prolonged or frequent contact results in surface etching and can lead to surface disruption	Slow reaction (e.g. in tanks, particularly at welds, bolt holes, etc.)
Phosphate solutions	Moderate	Ammonium phosphate		No adverse reaction Tends to form a protective coating which can protect against subsequent attack by nitrogenous solutions
Sulphate solutions	Severe	Ammonium sulphate	Prolonged or frequent contact can results in severe surface disruption Concrete subject to contact with ammonium sulphate should be designed as for contact with silage effluent	Slow reaction (e.g. in tanks, particularly at welds, bolt holes, etc.)
Effluents				
Silage effluent	Very severe	Lactic acid Acetic acid Butyric acid	Immediate contact will result in limited surface reaction	Reacts and surfaces should be suitably protected
Milk wastes	Very severe	Lactic acid	Prolonged or frequent contact can result in severe surface disruption Concrete subject to contact by silage acids should be designed to the requirements of BS 5502-22:1987, Table 15 and Table16	

^a The classification of corrosivity is not definitive. The guidance given is a measure of the relative corrosivity. The classification relates to the material most prone to damage.
^b Silage should not be mixed with slurry as dangerous concentrations of hydrogen sulphide may be given off.

3.4.3 Installation

Insulating materials should be installed and fixed so as to provide an insulation value as uniform as possible over the whole area concerned. The design thickness of any insulating layer should be maintained throughout and cold bridges through the insulation should be avoided. Where an insulating material is inserted into spaces between framing members or other preformed cavities, it should occupy the whole area of such spaces. Owing to the risk of settlement it is preferable to use loose-fill insulating materials on horizontal surfaces only.

Some insulating materials are little affected by moisture (e.g. closed cell types, hollow blocks, loose-fill hardcore), but the great majority are seriously affected, and should be protected from moisture from any source, such as rain water, washing water, groundwater, etc. Insulating material used in ground contact should be such that its thermal properties are unaffected by the action of soil and water.

Any insulating material liable to damage from farming operations should be suitably protected and adequately supported on battens, etc. The height above ground of the protection depends on the circumstances under which it is used, but should be not less than 1200 mm.

Where appropriate, insulating material should be protected against birds or pests (see BS 5502-30).

Pipework and other equipment to be insulated should be fitted with wrap, sectional, sprayed or trowelled material, etc., as appropriate to the conditions. Where necessary, insulation should be provided with a waterproof finish.

3.4.4 Vapour barriers

A vapour barrier should be provided to insulating layers near or adjacent to the side subjected to the higher vapour pressure (normally the “warm” side) to minimize the movement of water or water vapour into the insulating material. Vapour barriers should as far as possible be gas tight and continuous over the insulating layer. Where flexible sheet material is used, sheets should be lapped or sealed. For general purposes the vapour resistance should be not less than 100 MN·s/g.

Where an insulating layer is provided in a floor construction in contact with the ground, a damp-proof membrane should be provided beneath that layer unless the insulating material used is relatively unaffected by moisture, e.g. no-fines lightweight aggregate concrete. Floor finishes should be as impervious to moisture as possible. Any damage to a vapour barrier, including that caused by vermin or machinery, will render it useless.

3.5 Fixings

Fixing accessories should be sufficient in number and the supporting framework structurally adequate to resist the design wind, snow or other imposed loads which may be applied to the claddings. ^{A2} All fixing should be corrosion resistant and, where necessary, be treated to achieve this. Steel fixings should be treated in accordance with 7.2. ^{A2} They should be of a type suitable for securing the supporting framework, and should be provided with properly fitted washers where appropriate.

3.6 Surface finishes

3.6.1 General

Lead based or other toxic paints should not be used on agricultural buildings.

3.6.2 Roof finishes

Finishes should resist weathering, and be properly bonded to or firmly fixed to, and supported by, the substructure.

3.6.3 External wall finishes

Finishes, in addition to resisting weathering, should be capable of withstanding damage during usage, i.e. impact and abrasive forces, without deterioration in their performance. Material should be securely bonded or fixed to the substructure and have similar thermal and moisture movement properties to those of the substructure unless provision is made in the fixings to accommodate such movement.

3.6.4 Internal wall finishes

Finishes should be capable of withstanding the anticipated dead and impact loadings and abrasive forces without undue damage, i.e. damage which could cause a deterioration in the performance of the finish. Finishes should be easy to clean, securely bonded or fixed to the substructure and have similar thermal and moisture movement properties to those of the substructure, unless provision is made in the fixings to accommodate differences in thermal and moisture movement. Where applicable, wall surfaces should be in accordance with the surface spread of flame recommendations given in BS 5502-23.

3.6.5 Ceiling finishes

Finishes should be easy to clean, unaffected by high humidity, and properly bonded to or fixed to, and supported by, the substructure. Where applicable, ceiling surfaces should comply with the surface spread of flame recommendations given in BS 5502-23.

3.6.6 Floor finishes

Where appropriate, finishes should not be significantly affected by the chemicals with which they are likely to come into contact in normal farming practice and should, where necessary, be impervious to liquids.

Floors should be given a slip-resisting texture but the texture should not be such as to harm personnel or animals.

4 Timber and plywood

4.1 General

4.1.1 Timber when used for structural applications should be in accordance with BS 5502-22.

4.1.2 Plywood should comply with **A2** BS EN 314-1 and -2, and may be modified by BS 5502-22. Bonding should be Class 3. **A2**

4.2 Preservation

4.2.1 *Preservative treatment*

Timber other than the heartwood of a durable species (see Appendix B) which is either:

- a) in contact with the ground or other damp material; or
- b) enclosed and inadequately ventilated; or
- c) exposed to the weather or other source of moisture (e.g. periodic condensation) but is not liable to remain damp for long periods of time,

should be preserved by one of the treatments appropriate to the timber species. Other factors which should be considered are its intended situation and design life as listed in Appendix B and given in section three of BS 5589. Such treatment should be carried out irrespective of any subsequent painting or other applied decoration.

NOTE Further information on preservative treatment is given in the BWPA Manual and, for structural timbers in particular, in BS 5268-5.

4.2.2 *Toxicity of preservatives and treatments*

All wood preservative formulations should be handled with care in accordance with the manufacturer's specific instructions.

NOTE 1 Attention is drawn to the Control of Pesticide Regulations 1986. All wood preservatives used in the UK are subject to the provisions of these Regulations, which cover safety and efficacy.

Where timber treated with a copper/chromium/arsenic preservative is used in positions where it can be reached by livestock, animals should not be allowed access before:

- a) 7 days after the date of treatment;
- b) the timber has been hosed down with clean water to remove surface deposits.

Timber treated with pentachlorophenol in heavy oil applied by a double vacuum process normally has a clean surface. However, if used in similar situations, any excess oils remaining on the surfaces of the timber within reach of the stock should be removed before the animals are allowed access. Pentachlorophenol in any solvent should not be used in proximity to growing plants.

Timber preserved by treatment with creosote should not be used in proximity to growing plants, and should be treated to minimize the bleeding when likely to come into regular contact with livestock.

NOTE 2 Where timber which has been treated with any preservatives is intended for use in direct contact with or close proximity to stored food products or growing plants, the manufacturer of the preservative concerned should be consulted as to its suitability for the intended purpose, and for advice on precautions to be taken.

Timber treated by boron diffusion treatment can be machined or worked without retreatment of cut edges except longitudinal conversion of timber more than 50 mm thick, and should be protected from prolonged exposure to wet conditions.

4.3 Fixings to timber purlins and rails

All fixings should be corrosion resistant **A2** (see 7.2) **A2**. Sheets should be fixed by means of screws or drive screws, or in the case of aluminium sheeting by nails of the nipple-head or spring-head type.

4.4 Claddings

4.4.1 General

For wall claddings, timber boarding and plywood should have an adequate thickness to perform their intended functions. Generally, timber and boarding should be not less than 16 mm thick and the thickness of feather edged boarding should be not less than 16 mm at the thicker edge and 6 mm at the thinner edge. Plywood should be not less than 6 mm thick.

4.4.2 Ventilated claddings

4.4.2.1 Yorkshire boarding (roofs)

Boards should be not less than 22 mm basic thickness and 150 mm or 175 mm basic width, grooved lengthwise along both edges on the upper surface, and fixed between 3 mm and 6 mm apart, supported on purlins with 6 mm thick spacers.

4.4.2.2 Spaced boarding (walls)

Boards should be not less than 16 mm actual thickness, fixed to cladding rails and spaced apart according to the degree of exposure of the wall concerned and the amount of internal ventilation required. For minimal rain penetration the gap width should not exceed the board thickness.

5 Fibre building board

5.1 General

Fibre building boards should be either tempered hardboard or medium board of types HMN, HME or LME and comply with BS 1142.

5.2 Cladding

5.2.1 Walls

5.2.1.1 Tempered hardboard should be not less than 6 mm thick.

5.2.1.2 Medium board should be not less than 9 mm thick. Any decoration of medium board wall cladding should be permeable to water vapour.

5.2.2 Roofs

When used, tempered hardboard should be not less than 8 mm thick with all joints sealed against entry of water.

5.3 Fixings

All fixings should be resistant to corrosion A_2 (see 7.2) A_2 .

6 Aluminium

6.1 General

Aluminium when used for normal structural uses should be in accordance with BS 5502-22 and CP 118.

6.2 Preservation

The recommendations given in CP 118 for the design and protection of aluminium structures should be followed. See also 3.3.2.

6.3 Cladding

6.3.1 Profiled and corrugated aluminium sheets should comply with BS 4868 except those limiting the profile and should have a thickness of 0.50 mm.

6.3.2 The end and side laps for profiled and corrugated aluminium sheets should be as given in Table 2 and Table 3.