

Buildings and structures for agriculture

Part 72. Code of practice for design and construction of controlled environment stores for vegetables, fruit and flowers

Bâtiments et constructions agricoles
Partie 72. Code de bonne pratique pour la
conception et la construction des silos à
atmosphère contrôlée pour légumes, fruits et
fleurs

Landwirtschaftliche Gebäude und Bauten
Teil 72. Bemessung und Ausführung von
klimatisierten Lagerräumen für Gemüse, Obst
und Blumen

Confirmed
December 2009

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Technical Sector Board for Building and Civil Engineering (B/-) to Technical Committee B/549, upon which the following bodies were represented:

British Cement Association
British Commercial Glasshouse Manufacturers' Association
British Precast Concrete Federation Ltd.
British Veterinary Association
Department of Agriculture Northern Ireland
Farm and Rural Buildings Centre
Farm Buildings Association
Health and Safety Executive
Institution of Civil Engineers
Ministry of Agriculture, Fisheries and Food
National Farmers' Union
Royal Institute of British Architects
Royal Institution of Chartered Surveyors
Scottish Office (Agriculture and Fisheries Department)
Silsoe Research Institute
Steel Construction Institute
Transport and General Workers' Union
Water Services Association of England and Wales

This British Standard, having been prepared under the direction of the Technical Sector Board for Building and Civil Engineering (B/-), was published under the authority of the Standards Board and comes into effect on 1 April 1992

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The following BSI references relate to the work on this standard:
Committee reference B/549
Draft for comment 90/14589 DC

ISBN 0 580 20558 4

Amendments issued since publication

Amd. No.	Date	Text affected

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Foreword

This Part of BS 5502 has been prepared under the direction of the Technical Sector Board for Building and Civil Engineering. It comprises a partial revision of BS 5502 : Section 2.3 : 1981 which is withdrawn.

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 and 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 crop building series will comprise:

Part 60	Code of practice for design and construction of buildings for mushrooms
Part 65	Code of practice for design and construction of crop processing buildings
Part 66	Code of practice for design and construction of chitting houses
Part 70	Code of practice for design and construction of ventilated on floor stores for combinable crops
Part 71	Code of practice for design and construction of ventilated stores for potatoes and onions
Part 72	Code of practice for design and construction of controlled environment stores for vegetables, fruit and flowers
Part 74	Code of practice for design and construction of bins and silos for combinable crops

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 enable BS 5502 to be expanded and developed in a logical way in the future.

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.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Code of practice

1 Scope

This Part of BS 5502 gives recommendations for the design and construction of buildings and structures for the storage of vegetables, fruit and flowers under controlled temperature, humidity and atmospheric conditions.

NOTE 1. For recommendations on the design and construction of ventilated stores for potatoes and onions see BS 5502 : Part 71.

NOTE 2. The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

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

3 General

3.1 Storage

3.1.1 The storage life of fruit and vegetables is determined by respiration rates. To reduce the respiration rate and control ripening, produce should be cooled immediately after harvest and stored in an environment where temperature and relative humidity is controlled. Additional control that results in a higher quality crop can be exercised by controlling the atmosphere within the store.

NOTE. Recommendations for storing produce using controlled or modified atmospheric storage conditions are confined to the limited range of crops where it is currently economically viable.

3.1.2 Rates of cooling and storage temperatures are controlled by the incorporation of refrigeration into forced air ventilation systems.

In ambient cool stores, ventilation inlets and extract ductwork are arranged so that the air within the store can be recirculated and mixed with external air.

In controlled atmosphere stores, the atmosphere is controlled by restricting the ventilation system to permit carbon dioxide levels to rise and oxygen levels to fall. These stores should be sealed to make them gas proof.

3.1.3 Efficiency will be determined by the store design, equipment, insulation and monitoring devices.

3.1.4 Heating can be required for use in treatment processes.

3.1.5 Weight loss can be reduced by controlling humidity levels.

3.2 Siting

Consideration should be given to the siting of stores (see BS 5502 : Part 20). In particular, consideration should be given to the following:

- (a) the availability of services;
- (b) ease of access for transport;
- (c) integration with grading and packing buildings.

3.3 Type of store

3.3.1 The design of controlled environment stores will be determined by the following factors:

- (a) type of produce stored;
- (b) storage duration;
- (c) scale of the enterprise;
- (d) handling method;
- (e) alternative uses.

A store can be a single freestanding unit or a block of units positioned within a building or externally.

3.3.2 Stores can be categorized into the following four types.

- (a) Controlled atmosphere stores where the atmosphere as well as temperature and humidity are controlled.

NOTE. Where lime is used as the scrubber medium to control the store atmosphere, storage for the lime is required within a sealed building or chamber in close proximity to the store.

- (b) Conventional cool stores with systems for refrigeration.

- (c) Ambient cool stores where refrigeration is provided but is ancillary to ventilation with ambient air.

- (d) Jacketed cool stores where the holding area is separated from the cooling air to enable higher atmospheric humidity to be maintained.

The crop can be stored in bulk, in boxes, or in trays on pallets.

4 Design, materials and construction

4.1 General

4.1.1 The design, choice of materials and construction of cool stores should be in accordance with BS 5502 : Parts 20, 21, 22, 23 and 25.

4.1.2 Foundations, floors, walls and support structures should be designed and constructed to withstand loads from stored crops, equipment and machinery.

4.1.3 Structures should be designed to minimize differential settlement, deflection and structural movement that could cause fracturing of surfaces and permit moisture ingress or infestation, so putting the stored product at risk.

4.1.4 Store interiors require cleaning after the storage period and this should be considered in the choice of materials.

4.1.5 Materials and treatments used in the construction should not impart odour or taint to the crop.

4.1.6 For controlled atmosphere stores, all surfaces of the store including doors, hatches and pipe or cable entries in the structure should be sealed against the passage of atmospheric gases.

4.1.7 All parts of the structure should be constructed in accordance with the recommendations given in BS 8000.

4.2 Floors

4.2.1 Floors should be level with an even surface. Floors should be designed and constructed to withstand loads from the crop, (boxes or bulk), and dynamic loads from transport and equipment. The surface should be hard wearing, capable of being cleaned and not susceptible to cracking or crazing. A damp-proof membrane should be provided to prevent moisture ingress. Thermal and shrinkage movement should be minimized by the correct placing of construction, expansion and contraction joints.

4.2.2 Where provided, ventilation ducts below floor level should be constructed to resist soil pressure and the passage of moisture. Covers should be designed to withstand loads from the crop and vehicles.

4.2.3 Insulation should be considered.

NOTE. Perimeter insulation is more cost effective than whole slab insulation except when temperatures at or below 0 °C are likely to be maintained.

4.2.4 In controlled atmosphere stores, gas proofing should be by trowel applied coating. Care should be taken to repair any damaged or suspect areas prior to store loading to maintain a seal. The junction between floor and walls should be sealed.

4.3 Walls

4.3.1 Walling systems should provide thermal insulation, protect the crop from the weather and contain the bulk crop. The structural integrity of the wall should be maintained at all times and surcharging only permitted when the walling has been designed to withstand such forces.

4.3.2 In ambient cool stores, louvred outlets and inlets should be provided where required for ventilation.

4.3.3 In controlled atmosphere stores, the walls should be gas proof.

4.4 Roof and upper wall cladding

The roof and upper wall cladding should be weatherproof.

4.5 Ceilings

4.5.1 Ceilings may be the roof structure, may be suspended from the roof structure or may be self supporting from the walls of the store. They should be insulated.

4.5.2 In controlled atmosphere stores, the ceiling should be gas proof. Junctions between walls and ceiling should be sealed.

4.5.3 Natural light should be excluded.

4.6 Doors

4.6.1 Door openings should be large enough for access and to enable loading and unloading but no larger than necessary in order to avoid heat entry or atmosphere loss, where applicable. The number of doors should be kept to a minimum.

4.6.2 Doors should be insulated and should have an internal finish equivalent to that of the walls.

4.6.3 In cool stores, personnel doors can be required for inspection.

4.6.4 In controlled atmosphere stores, to achieve and maintain a gas proof seal, consideration should be given to the design of the door threshold, relative to the door and its sealing and locking method. Hatches for inspection purposes should be provided in the door and ceiling. They should be at least 750 mm square, sealable and lockable and finished in the same way as the door.

4.6.5 The position of doors should be determined by the loading pattern. External access areas should slope away from the doorway.

4.7 Thermal insulation

4.7.1 Stores should be insulated. The insulation should be continuous over all wall and ceiling surfaces, including air intake and exhaust vents when in recirculation mode for ambient cool stores and the scrubber chambers for controlled atmosphere stores. Recommended insulation levels are given in table 1.

Table 1. Cool stores: recommended insulation levels

Store operating temperature °C	Maximum thermal transmittance	
	Walls/ceiling or roof	Floor ¹⁾
	W/(m ² ·K)	W/(m ² ·K)
Above 4.5	0.6	N/A
3.5 to 4.5	0.45	N/A
Below 3.5	0.35	0.6
Below 3.5 where critical limits of ± 0.5 are essential	0.25	0.4

¹⁾N/A = not applicable within this temperature range.