

DEPARTMENT OF AGRICULTURE, FOOD & RURAL DEVELOPMENT

Grain Storage on Farm S.109

S109

MINIMUM SPECIFICATION FOR STRUCTURES FOR GRAIN STORAGE ON FARM January 2002

1. GENERAL

This specification covers the construction of storage and allied facilities for cereal grains produced on the farm. It does not cover specialised stores for use by a group of producers.

A grain store shall be a dry, well-ventilated, and vermin-proof structure. It shall have reinforced concrete walls constructed to Clause 6.1 below. The design of any new grain store should, where possible, allow for future extension(s), and alternative possible methods of handling and conditioning grains.

2. SITE

The chosen site shall be dry; not subject to flooding in any circumstances; and shall facilitate access to the public road. It shall be sited at least 20 metres from any septic tank, and at least 20 metres from any stored animal waste.

3. STRUCTURAL DESIGN

The superstructure of any produce store shall normally conform to the current edition of FDS Specification S.101, or to S.101 Supplement for portal-frame structures. Any framed structure which is not in accord with S.101 or S.101 Supplement shall require a detailed design by a qualified structural engineer, to be submitted with relevant structural calculations to the Department for prior acceptance.

4. CONCRETE WORK

4.1 Concrete

Concrete shall be purchased on the basis of a characteristic 28 day crushing strength of 30 N/mm². Minimum cement content shall be 285 kg/m³. Slump of unplasticised concrete shall not exceed 100mm, and maximum aggregate size shall be 20mm.

4.2 Certificates

A numbered certificate signed and stamped, shall be required for all concrete delivered on site. The certificate, the 'Concrete Manufacturers Specification Certificate' is produced in triplicate. The top certificate printed on light blue paper shall be retained by applicant and given to the Department of Agriculture, Food and Rural Development (DAFRD) Inspector for inspection upon completion of works.

4.3 Fibre Concrete

Polypropylene fibres can be incorporated into the concrete mix to improve the properties of fresh concrete. The use of fibres helps in the reduction of plastic cracking

and crazing, and may also improve surface durability. However, they are not a substitute for structural reinforcement. Where fibres are used in concrete they shall be used in strict compliance with manufacturers' instructions and shall only be added at the Concrete Manufacturers Mixing Plant.

The Concrete Certificate (4.2 above) shall clearly show the amount and type of fibre added. The mix design, placing, compacting and curing of fibre concrete shall be as for concrete specified in 4.1.

5. FOUNDATIONS

5.1 Foundations to Reinforced Walls

Foundations to reinforced concrete walls shall be reinforced, and be installed in accordance with the details shown in Fig. 1. Reinforcement details for both walls and foundation/footings are given in Table 1, and in Fig. 1.

5.2 Foundations under large Proprietary Storage Bins

Foundations under large proprietary storage bins shall be strengthened according either to the detailed specifications by the manufacturer, or to the detailed design of a qualified structural engineer.

6. WALLS

6.1 Wall Heights

To facilitate easy loading and unloading of grain, the recommended minimum height of the side walls at the eaves is 4.5m. A preferred height for general purposes is 5.5m, and higher for specialist stores.

6.2 Reinforced Side and Rear Walls

Reinforced side and rear walls shall be mandatory for all houses for loose-stored grain stacked to a height of more than 1.4m. Reinforcement details for walls and associated footings are given in Table 1 and Table 2 for walls up to 3.0m high. To avoid the need for construction joints, reinforced walls shall be built into the web of roof stanchions, but not affixed to them. Any space between the top of the wall and the eaves shall be enclosed by cladding (Clause 8).

Where it is proposed to install reinforced concrete walls higher than 3.0m, then a detailed design for these walls shall be prepared by a qualified structural engineer, and submitted to the Department, with relevant structural calculations, for prior acceptance.

6.3 Reinforcing steel bars

Reinforcing steel bars shall be high yield (HY) with ribbed finish or equivalent; shall be free from mill scale and heavy deposits of rust; and shall not be straightened and rebent. Where bars are lapped, the overlap shall be at least 40 times the bar diameter. Standard tying wire, or tack welding, shall be used to ensure firm positioning of steel during concreting, and standard patent spacers shall be secured to steel to provide the

minimum concrete cover of 40mm. When the wall-floor joint incorporates a water bar, top cover to steel shall be 75mm.

The junction between the wall and the wall footing shall incorporate a 150mm water bar placed at the centre of the wall as shown in Fig. 1. Alternatively a key shall be formed in the freshly-poured floor slab by using a splayed oiled timber runner withdrawn before final set [shown in Fig. 2].

All dirt and debris shall be removed from within shuttering before concrete is placed in layers not more than 600mm deep. Poker vibrators, diameter not less than 50mm, shall be used after placing to eliminate air-voids and to compact concrete.

Shuttering shall not be removed from walls for at least 12 hours in warm weather, and longer in cold weather. Any blemishes or honeycombing shall be repaired with a sand:cement mortar incorporating S.B.R. (Styrene Butane Rubber) in accordance with manufacturer's instructions.

Concrete shall be cured by keeping it damp for a minimum of 7 days or by using a proprietary curing agent. Walls shall not be subject to loading until 28 days after concrete has been cast. [For more detailed information on the construction of reinforced walls, see Specification S.120: Concrete Walled Silos.]

6.4 Wall Finishes

Internal finishes shall comply with the requirements of the Food Hygiene Regulations. Masonry walls externally shall be scudded with slurry 1 part sand to 1 part cement and rendered 2 coat to full 18mm thickness. First coat of rendering shall be 7:1:2 sand: cement: lime or 6:1 sand: cement with plasticiser. Where internal plaster finish is a requirement, walls shall be rendered 2 coat, 12mm and 6mm respectively with 3:1 sand: cement incorporating a plasticiser or 1/4 part lime, to a smooth steel trowel finish.

The finish to mass concrete walls may be acceptable provided any small blemishes and honeycombing, should they occur, are repaired with a 1.5/1 washed sharp sand:cement mortar when the formwork is removed.

6.5 Insulated walls

Insulated walls are not normally required for grain stores. If installed, the recommended insulation on blockwork/concrete walls is 40mm extruded polystyrene or polyurethane board nailed to the internal face, covered with expanded metal and plastered with two coats, as above.

Insulated cavity walls may also be used, provided that the inner leaf itself complies with the full requirements of 6.2 or 6.3 above.

7. FLOORS

7.1 Standard floors

Standard floors shall be a minimum 125mm concrete. A 150mm hardcore base shall be provided, compacted with vibrating or heavy roller, and topped with fine sand. All floors shall incorporate 1000 gauge polythene D.P.C. membrane with 600mm overlaps

laid on the sand under concrete, and taken up along walls to meet D.P.C., where this has been installed, or to finish 150mm above external ground level.

In grain stores with floors subject to heavy mechanised traffic, reinforced floors shall be installed. The design shall meet the requirements of the specific loading. In the absence of specific design data an A393 mesh to BS4482/BS 4483 [10mm @ 200mm c/c : 6.16 kg/m²] shall be placed 40mm below the finished floor surface.

Depending on specific requirements the top surfaces of floors may require proprietary hardeners and/or sealing agents.

7.2 Underfloor Ducting

Stores for grain may require underfloor ducting. Design of ducting (size, spacing, and construction) is specific to the type of produce stored and the mechanical plant installed. Lay-out and design details shall be provided by the mechanical plant supplier or consultant. Prior approval is required. (See also Clause 16.)

7.3 Laying of Concrete Floors

Laying of concrete floors shall be done in alternate bays measuring not more than 4.5m wide by 6m long where there is no fibre additive, and not more than 4.5m wide by 8m long with fibre additive. In the case of mesh reinforced floors joint spacing can be extended to 12m by 8m. Concrete shall be placed about 20mm proud of the shuttering and tamped to the correct level using a tamper or vibrating screed. Concrete may also be laid in one operation as above and bays to the dimensions specified shall be cut by concrete saw 25mm deep x 12mm wide in the hardened concrete within 24 hours of pouring. All joints shall be brushed out and filled with mastic as per manufacturers' instructions.

7.4 Curing of Concrete Floors

As soon as concrete surface is firm enough (within about 1 hour) the slab shall be sprayed lightly with water and maintained in a damp condition for seven days. This is best achieved by covering the wetted slab with a polythene sheet. Care should be taken to ensure that polythene firmly fixed at the edges of the slab to avoid wind draught between the polythene and the concrete surface.

8. ROOF AND SIDE CLADDING

8.1 Single Sheet Roof and Side Cladding

Single sheet roof and side cladding shall conform to the current edition of F.D.S. Specification S.102.

8.2 Proprietary insulated Cladding Sheets

Proprietary insulated cladding sheets with a double metal skin may also be used for roof and side cladding. Where produce is loose-stored, or where there is any danger of mechanical damage, such cladding shall only be installed above blockwork/concrete walls.

Double skin roof panels are strongly recommended, but panels with bonded insulation with a smooth hardened washable surface may also be accepted, if there is no risk of mechanical damage. Roofing felt, or other loose insulation, or wire netting shall not be installed.

9. VERMIN-PROOFING

Produce store shall be constructed, and openings designed, so that no access is possible by farmyard or domestic animals, or any animal vermin. As far as is possible, all insect vermin shall also be excluded.

10. DOORS AND WINDOWS

All doors wider than 1.2m shall be sliding or roller shutter type. Doors shall incorporate such details [tracks, brushes, etc.] as are necessary for vermin proofing (Clause 9). The recommended minimum height of the main door(s) is 4.0m. A door at each end of the building can facilitate management. Windows, treated timber, uPVC or aluminium, where provided, shall be fitted within opens on standard concrete cills laid on damp proof course taken up at backs and along sides.

Note: Roof lights and windows should normally not be installed, as a dark interior discourages any access by birds through open doors.

11. ELECTRICAL INSTALLATION

Wiring and fittings shall be installed, and be carried out in accordance with the Second Edition of the National Rules for Electrical Installations, ET 101/1991 and specifically section 705 - Electrical Installations for Agricultural and Horticultural Premises. A completion certificate shall be required signed by the Electrical Contractor(s) or a person duly authorised to act on his/her behalf to certify that the electrical installation has been constructed and/or has been tested according to the National Rules of Electrical Installations and has been found to be satisfactory. An associate certificate, specifically for agricultural work, shall also be signed by the Electrical Contractors or authorised persons. The signed printed "Supplementary Agricultural Certification Form" shall be given to the DAFRD Inspector before grant aid is finally certified.

12. LIGHTING

Artificial Lighting shall be provided by florescent tubes in hose proof, impact proof (polycarbonate) fittings. The lighting shall be a minimum 200 lux.

13. PROTECTION OF STRUCTURAL STEEL

SYSTEM I

Hot dip galvanised coating shall be applied after fabrication in accordance with B.S. 729: 1971 to a minimum average coating weight for any individual test area of 610/gr./mm².

Small areas of galvanised coating damaged by any subsequent welding, cutting, or by excessively rough treatment during transit and erection may be renovated by the use of

at least 2 coats of zinc-rich paint complying with BS 4652: 1971 (Appendix D, BS 729: 1971)

SYSTEM II

Preparation

Any oil or grease shall be removed by thorough cleaning with detergents. Mill scale and rust shall be removed by shot blasting to Sa 2.5 or ISP 8501 : 1980.

Primers

Epoxy zinc-rich primer complying with BS 4652: 1971 shall be applied to a total dried thickness of 75 microns. A holding primer of 25 microns shall be applied within 12 hours of shot-blasting. After fabrication all welds shall be wire brushed and re-primed. The remaining 50 micron dried film thickness must be achieved with the remaining coat(s).

Finishing Coat

Apply an epoxy micaceous iron oxide paint-coat, minimum 50 micron dried film thickness.

As an alternative to primer and finishing coats to shot-blasted steel, ZINGA may be applied in two coats to a minimum dry-finished thickness of 80 microns.

14. FINISH

Wall finishes other than specified in Clause 6.3 shall be such that they can be readily washed, and comply with the Food Hygiene Regulations. Any exposed ungalvanised iron other than structural steel shall be given 3 coats of anti-rust paint. All timber joinery shall be given a priming coat, 2 undercoats, and a hardgloss finish coat of paint.

15. VENTILATION

Annex 1: "Guidelines for Grain Ventilation Systems" shall be followed in the selection and installation of the appropriate ventilation system.

16. SPECIALIST SERVICES

16.1 Air Extraction and Cooling Systems

Grain stores shall require mechanical air extraction and/or specialised cooling systems. Such systems shall require a detailed design by mechanical plant manufacturer or qualified consultant, submitted for prior approval. Systems shall be installed to manufacturers' exact instructions.

16.2 Proprietary Storage Bins

Proprietary storage bins including any mechanised filling and extraction systems shall be installed in strict accordance with manufacturer's recommendations and instructions. Foundations suitable for the intensity of loading encountered shall be provided under all storage bins (see Clause 5.2).

17. CLEAN WATER DRAINAGE

All roof water from grain stores or associated clean yards shall be piped directly either to an existing clean water disposal system or to an adjacent water course.

Table 1 Reinforcement for External Retaining Walls (225mm wide)

Wall Height	Vertical Steel (inside face)	Horiz. Steel (inside face)
up to 2.1m	12mm @ 200mm centres	12mm @ 400mm centres
up to 3.0m	16mm @ 200mm centres	12mm @ 400mm centres

Note: Steel to be cut, bent, and fixed as in Fig. 1.

Table 2 Reinforcement for Internal Retaining Walls (225mm wide)

Wall Height	Vertical Steel (both faces)	Horiz. Steel (both faces)
up to 2.1m	12mm @ 200mm centres	12mm @ 400mm centres
up to 3.0m	16mm @ 200mm centres	12mm @ 400mm centres

Note: Steel to be cut, bent, and fixed as in Fig. 2.

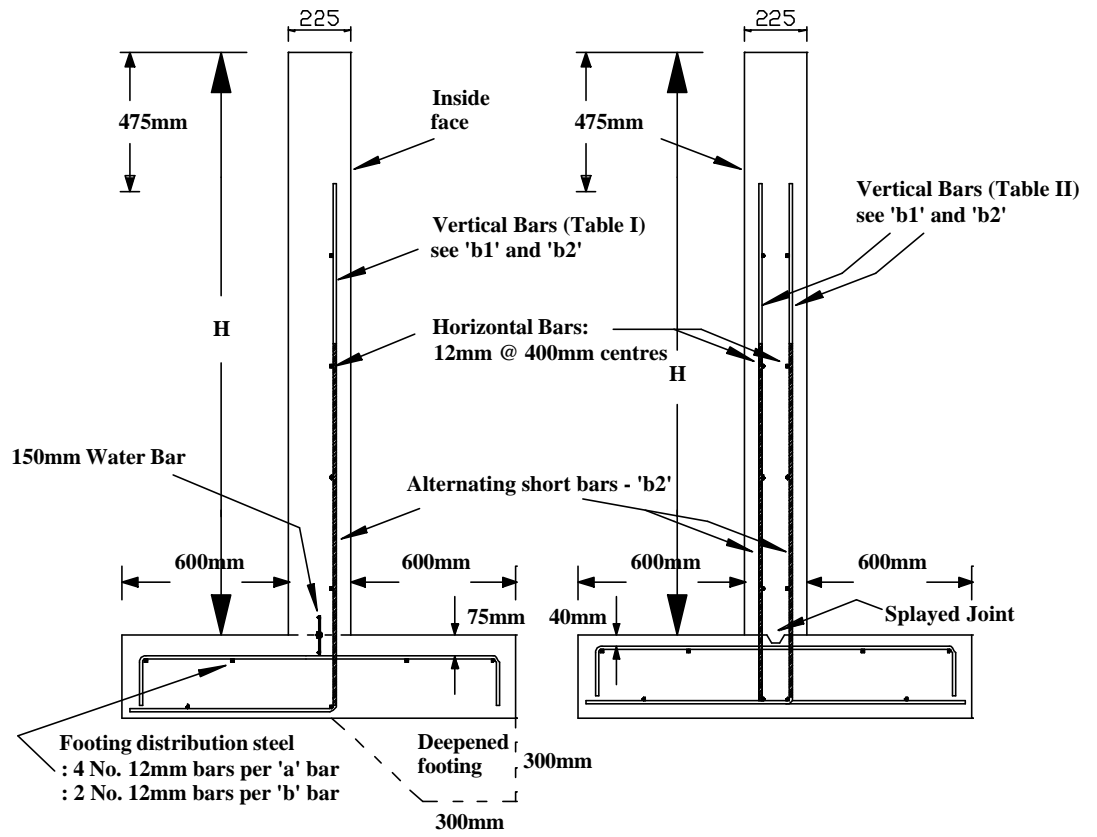
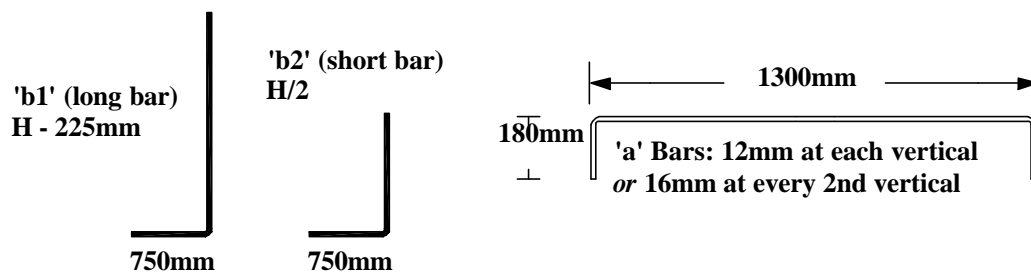


Figure 1 External Retaining Wall
(see Table 1)

Figure 2 Central Retaining Wall
(see Table 2)



Annex 1

Guidelines for Grain Ventilation Systems

1. Ventilation system (in particular its capacity) should be planned to match the expected grain moisture, storage depth and building dimensions.
 - Ventilation rate should match expected intake moisture content as per Table 1.
 - Fans and ducting should be capable of delivering target ventilation rate.
 - Fans should be specified to match crop resistance roughly as per Table 2, with some additional allowance for duct pressure loss.
 - All ducting should be sized to keep air speeds below 10 m/s.

2. Storage of dried grain:
 - Is there adequate drying capacity for all the grain to be stored?
 - Overall ventilation rate should be at least 10 m³/h tonne (5 cfm/t)
 - Differential thermostat or time switch controls are recommended.
 - Some temperature monitoring capability is essential.
 - Pedestals are acceptable for this application, if they deliver the ventilation rate specified in Table 1. The ratio of pedestals to fans should be sufficient for easy management, but should not exceed four.

3. Air extraction from building:
 - All stores should make some provision for ventilation of the space above the grain. In most cases, stores should have an extraction fan in one gable wall and a matching air inlet in the opposite gable.
 - The extraction fan capacity should be sufficient to prevent condensation on grain surface and roof while ventilating.
 - The air inlet should have sufficient open area to facilitate the air change rate required to control condensation.

Table 1: Ventilation rates required to cope with expected intake moisture content

Intake moisture content (%)	Minimum ventilation rate needed	
	M ³ /h t	cfm/t
<16	10	5
16-20	35	20
20-22	70	40
22-24	150-180	80-100

Table 2: Approximate resistance to airflow in stored cereals.

Ventilation rate m ³ /h t	Grain depth (m)				
	2	3	4	5	6
	Airflow resistance (mm w.g.)				
10	2	4	8	13	18
20	4	9	17	27	39
30	6	14	26	42	62
40	8	20	36	59	88
50	11	25	47	77	116
60	13	31	59	97	147
70	16	37	71	118	180
80	18	44	84	140	215