BRITISH STANDARD

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Metric units

Methods of test for resistance to air and water penetration —

Part 2: Permeable walling constructions (water penetration)

Confirmed January 2010

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Co-operating organizations

The Committee responsible for the preparation of this British Standard includes representatives from the following Government departments and scientific and industrial organizations:

Agrément Board
Asbestos Cement Manufacturers' Association
British Ceramic Research Association
British Precast Concrete Federation
British Stone Federation
British Woodwork Manufacturers' Association
Cement and Concrete Association
Insulation Glazing Association
Metal Window Association Limited
Ministry of Public Building and Works
Ministry of Public Building and Works — Building Research Station
National Federation of Building Trades Employers
National Federation of Roofing Contractors
Royal Institute of British Architects
Timber Research and Development Association
Welwyn Hall Research Association

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Contents

Foreword

This standard makes reference to the following British Standards:

BS 3763, *International system (SI) units.*

BS 6232, *Thermal insulation of cavity walls by filling with blown man-made mineral fibre — Part 1: Specification for the performance of installation systems.*

This Part of this British Standard, prepared under the authority of the Building Divisional Council, sets out methods of test for measuring the resistance to water penetration of permeable walling constructions without open joints.

The pressure-box type of test chamber as specified in Part 1 of this standard, "Windows and gasket glazing systems", was chosen partly because of its simplicity and partly because this type of apparatus was being used by the laboratories associated in the Working Group on Rain Penetration of the Conseil Internationale du Bâtiment (C.I.B.).

Test procedures should be selected to give results which can be related to those obtained under natural exposure. A pressure for test purposes is specified but for further guidance reference should be made to BRE Digest No. 127, "An index of exposure to driving rain" should other test pressures be required.

These test methods should not be used to compare the relative merits of walls constructed with materials having different absorption capacities. For example, walls constructed with high absorption fired-clay bricks may give worse results than would be found in practice, whereas the converse may be true for walls constructed with low absorption fired-clay bricks. It is also difficult to apply the results of the test to walls of considerably greater height than the test panels.

In general, test method C (see **6.4**) is appropriate when the apparatus is used to assess the resistance to water penetration of the external leaf of a test panel of cavity construction.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 8 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Part of this British Standard specifies methods of test for measuring the resistance to water penetration of permeable walling constructions without open joints under static air pressure. The methods are applicable to constructions which can be built in or fixed into a rigid steel frame by means of which the wall panel can be transported and secured to the pressure-box test equipment. The first method is also applicable to walling constructions, not built into a steel frame, provided an air-tight seal can be made between the pressure-box and the front face of the panel.

Three methods of recording the extent of water penetration are specified, i.e.:

Method A. Recording, by time-lapse photography, the increase in area of dampness.

Method B. Recording the change in weight of the specimen.

Method C. Collecting and recording the amount of leakage through the specimen.

Much of the test apparatus and procedure is common to all three methods but where it is particular to one or two of them only, the letters A, B or C are inserted after the relevant clause numbers to indicate their ability to a particular method of recording water penetration (see above).

These test methods are not recommended for comparing the relative merits of walls constructed with materials having different absorption capacities (see foreword).

2 Definitions

For the purposes of this Part of this British Standard the following definitions apply:

2.1
open joint

a deliberate open discontinuity between two units in a walling construction

2.2
specimen

the test panel, which may either consist of a single unit or a series of units without open joints. The front face of the specimen is that facing the pressure chamber

2.3
test area

that part of the specimen, together with masking material and in-fill material where used, exposed to the test conditions

3 Apparatus

3.1 *Pressure chamber*. The test chamber shall be an airtight box capable of withstanding the test pressure. One of its vertical sides shall be left open so that the specimen can be secured to this side with the front face of the specimen towards the inside of the chamber. The attachment between the specimen and the chamber shall be made with bolts or any other suitable means which can withstand the test pressure. If the specimen is in a steel frame, the test chamber shall be attached to the flange of the steel frame. A gasket between the box and the steel frame or between the box and the face of the free-standing panel shall ensure an air-tight joint.

3.1.1 At least one observation window shall be provided in the test chamber to enable the front face of the specimen under test to be viewed. A door may be fitted to the side of the test chamber to provide access to allow any necessary adjustment; alternatively, the adjustments can be made through the observation windows if they can be opened.

3.1.2 The bottom of the test chamber shall be fitted with an outlet which will allow the water to run away to waste. The outlet shall incorporate a trap so as to provide a depth of water seal at least sufficient to maintain the desired air pressure within the chamber.

3.1.3 The size of the chamber shall be such as to provide a test area of at least 1 m × 1 m. An apparatus suitable for testing a wide range of walling constructions is shown in Figure 1.

Where the apparatus is used to test resistance to water penetration of blown man-made mineral fibre cavity insulation, the panel area shall be at least 3.5 m high by 3.0 m wide. (See BS 6232-1).

3.2 *Air supply system*

3.2.1 Air shall be passed into the chamber to maintain the specified pressure (see Clause **5**). Direct draught on the face of the test specimen shall be avoided and to accomplish this it may be necessary to fit a baffle over the end of the air inlet pipe.

3.2.2 Provision shall be made to measure the air pressure difference between the inside and the outside of the test chamber, that is, across the test area, to an accuracy of ± 10 N/m^2 (± 1 mmH_2O).

3.3 *Water spray system*

3.3.1 The water spray system shall be designed to apply a uniform horizontal band of spray not more than 250 mm deep at the top and across the width of the test panel. The band of spray can be obtained from spray jets placed along a horizontal feed pipe set at a suitable distance from the wall face.

3.3.2 A valve shall be inserted into the supply pipe so that the rate of flow of water can be controlled. The rate of flow and the quantity of water used shall both be measured.

3.3.3 To obtain intermittent spraying, the flow of water shall be controlled by a second valve, which is time operated, for example by an electromagnetic valve operated by a time switch.

3.3.4 A fine filter shall be included in the line to prevent particles from blocking the spray jets.

3.4 *Steel frame*

3.4.1 The frame shall consist of steel channel bolted together and with supports welded to the bottom frame member to which channel section feet are bolted to hold the specimen vertical. The frame shall consist of steel channel bolted together (e.g. 152 mm × 76 mm channel for specimens up to 150 mm thick or 229 mm × 76 mm channel for specimens up to 225 mm thick) and shall incorporate a means of retaining it in a vertical position, e.g. by channel section feet fixed to the bottom member. Thicker specimens can be accommodated by bolting two frames together or by bolting an additional steel section to the bottom frame member only. If attachment between the test chamber and the frame is with bolts, the flanges of the frame shall be suitably drilled. Sufficient clearance shall be provided in the holes to ensure that the test chamber shall fit any frame.

3.4.2 Rings shall be attached to the top member of the frame to enable the wall to be lifted and weighed. They also enable the top frame member to be removed after un-bolting since this may be necessary during the final stages of building the walling in the frame. Where provision is made for lifting the wall by an attachment to the top of the frame, it is essential to provide a top frame member rigid enough to withstand distortion.

3.5 *Photographic equipment (Method A).* The equipment shall comprise a recording camera and suitable lighting to record the extent of water penetration by time-lapse photography. A clock and a board on which are given details of the test, including the time and date of starting the test, shall be placed so as to appear in the photographs. The clock should preferably be a direct reading digital clock indicating a 24 hour day and show the day of the week and/or the date. The camera and lighting shall be controlled by time switches.

3.6 *Weighing equipment (Method B)*

3.6.1 Sufficient lifting and manoeuvring facilities shall be provided for moving, placing and weighing the frames and wall panels. All movements shall be so gentle as not to damage the panels. Care must also be taken to avoid racking when setting down specimens.

3.6.2 The weight can be measured by, for example, a crane-hook weighing machine of the steelyard type. The weighing equipment shall be capable of recording a change in weight of 1 % of the total increase in weight expected in the course of the test. If it is necessary to follow the absorption of water during the course of the test, the weighing machine should be capable of weighing the walling in its frame and the test chamber also, unless the test chamber is easily and quickly detachable from the specimen. When the specimen and the test chamber is weighed during the course of the test, it is essential that it is kept vertical and a rigging screw device shall be provided between the hook and the test chamber to permit correction of the eccentric load put on the frame and specimen by the test chamber.

3.7 *Collection and measurement of leakage (Method C).* Provision shall be made for collecting and measuring the amount of water penetrating the specimen.

4 Preparation of specimens

In all cases the construction of the walling shall be adapted to the material under test. The test specimen should preferably be of such size that it can be constructed by the method normally used for the material. For brickwork and blockwork the dimensions of the area of the specimen exposed to the spray shall be not less than 1 m × 1 m. For other walling constructions a similar area of specimen exposure should be selected whenever possible.

4.1 Preparation of specimen for time-lapse photography assessment (Method A)

4.1.1 A transportable panel of unit masonry built in a steel frame as described in **3.5** or a precast panel erected in a frame shall be built or erected on a damp-proof course sealed to the bottom frame member with mastic. Penetration at the edges of the panel shall be prevented as far as possible by, for example, two strip (divided) mortar joints up the sides and across the top. For panels of unit masonry built in a frame, the top member of the frame shall be removed to lay the final courses of masonry, etc., and shall be replaced and bedded down on the divided mortar joint at the top of the specimen. Where precast panels are to be tested the top frame member shall be removable for panel erection purposes and subsequent sealing between the top of the panel and the frame. The seal around the edges on the front face can be completed by covering with a strip of mastic impregnated fabric tape or other sealing tape and for this the mortar joint between the specimen and the frame is left flush at the front. This sealing tape should be about 50 mm wide and overlap the steel frame by about 12.5 mm and the masonry units by about 25 mm. Alternatively the seal can be completed with a fillet of bituminous or other suitable mastic and for this the front edges of joints should be raked out to a depth of from 8 mm to 10 mm. If the specimen does not occupy the whole of the area within the frame, the remaining space should be filled with some impermeable in-fill material, and suitable seals should be made between the specimen, the in-fill and the frame.

4.1.2 Transportable panels of sufficient intrinsic strength may not require to be built into steel frames. The test is applicable to these and to other free-standing wall panels provided a sufficiently airtight seal can be made between the pressure-box test equipment and the front face of the test area.

4.1.3 Sub-division of a panel is not desirable but when a panel is sub-divided so that two or more materials can be examined in the same test, these shall be separated as completely as possible vertically with, for example, a damp-proof course or other impervious membrane.

4.1.4 Specimens shall be allowed to dry naturally in the laboratory at a temperature of from 10 °C to 25 °C and from 40 % to 70 % relative humidity for at least 14 days before testing.

4.1.5 The back of the specimen shall be whitewashed with a thin coating of limewash of the consistency of thin cream or a thin coating of cement based paint and allowed to dry before the test to show up any water than may penetrate in the course of the test. Dampness shows up as a darkening of the distemper.

NOTE A thick layer of limewash or paint may reduce the surface permeability of the specimen.

4.2 Preparation of specimen for change in weight assessment (Method B)

4.2.1 The specimen shall be built into a steel frame as described in **4.1.1**.

4.2.2 Specimens shall be allowed to dry naturally in the laboratory at a temperature of from 10 °C to 25 °C and from 40 % to 70 % relative humidity for at least 14 days before testing.

4.3 Preparation of specimen for measurement of leakage (Method C)

4.3.1 The specimen shall be built into a steel frame as described in **4.1.1**.

4.3.2 Sub-division of a panel is not desirable but where it is unavoidable and the intention is to examine two or more materials in the same test, these shall be separated completely by a vertical damp-proof course or other impervious membrane. This dividing material should protrude from the back of the specimen so as to allow the water which has penetrated the different sections to be collected separately.

For single-leaf test panels a gutter shall be installed at the base of each section, suitably sealed to the back face, to enable the collection of water which penetrates the panel (see Figure 2). The gutter shall be fixed at a height of 100 mm from the base of the panel and shall extend to not less than 150 mm from the edge of the test section so that any water leaking between the edge of the sample and the frame, or the edge of the sample and the vertical damp-proof course shall not be collected. A slight end-to-fall of the gutter will facilitate drainage and the collection of water.

For test panels of cavity construction, provision shall be made for the collection of water which penetrates the cavity, e.g. by installing a cavity tray at the base of the wall to divert water across the cavity through weep holes into a gutter.

4.3.3 Specimens shall be allowed to dry naturally in the laboratory at a temperature of from 10 °C to 25 °C and from 40 % to 70 % relative humidity for at least 14 days before the test.

5 Test procedures

5.1 General. Either of the test procedures described in **5.2** and **5.3** shall be used when assessing the behaviour of the specimen by change in weight (method B). The less severe test procedure described in **5.2** shall be used to assess the behaviour of the specimen in terms of the formation of damp areas over the back of the specimen (method A). The test procedure described in **5.3** shall be used to assess the behaviour of the specimen in terms of the rate of leakage measured by collecting the water which runs down the back of a single-leaf panel or down the cavity of a double-leaf panel (method C).

NOTE For special types of constructions, different spraying rates and air pressure differences across the specimen may be required.

5.2 One-minute intermittent spray. Water shall be applied for one minute at half-hourly intervals at a rate of 0.5 L/min for each square metre of panel area. The test shall be made with a constant air pressure difference of 250 N/m^2 (25 mmH_2O)[1)] continuously applied across the specimen.

NOTE The duration of the test should normally be 48 h but may be curtailed or extended according to the extent of penetration.

5.3 Six-hour continuous spray. Water shall be applied for a continuous period of 6 h/day over a number of consecutive days at a rate of 0.5 L/min for each square metre of panel area. The test shall be made with a constant air pressure difference of 250 N/m^2 (25 mmH_2O)[1)] continuously applied across the specimen. The test shall be continued until the rates of leakage, measured by the collection of water from the back face of the panel over the final hour of consecutive 6 h spray periods, agree to within 5 % or to within 100 $mL/(h\ m^2)$, whichever is the greater.

NOTE If required, this method may be used on the same specimen which has been subjected to the test procedure described in **5.2**.

6 Recording of results

6.1 General. The following details of the test specimens shall be recorded:

1) type of masonry unit used;
2) strength of masonry unit used;
3) type and designation of mortar used;
4) type and grade of sand used in mortar mix;
5) method of laying masonry units;
6) method of jointing masonry units.

6.2 Time lapse photography (Method A). Photographs of the back of the wall shall normally be taken immediately before the application of the water spray and at half-hourly intervals afterwards. If penetration is rapid the photographs can be taken at more frequent intervals and, especially in the early stages, photographs may be necessary at even 1 min or 2 min intervals after spraying. When penetration is not very rapid, the time between the application of the water and the photographing of the back wall is not critical during the later stages of the test.

The criterion of water penetration is the rate at which the back of the specimen becomes damp as shown by the successive photographs of damp area.

The test area of the specimen or subdivisions shall be recorded. The damp area measured from photographs shall be calculated as a percentage of the area but ignoring a band, at least 150 mm wide, around the perimeter of the panel, in order to avoid the inclusion of fortuitous leakage of water at the edge of the specimen. Different constructions may be compared either by the rate of increase in damp area or by the percentage damp area at a fixed time, usually one or two days.

The results may be tabulated as follows:

Time	% wetted sub-division 1	% wetted sub-division 2
h		
½		
1		

6.3 Change in weight (Method B). The change in weight of the wall construction with time shall be expressed as a percentage of the initial total weight of the specimen excluding the steel frame, etc. Comparisons between different walling constructions may be made by plotting increasing weight against time. This provides a measure of the absorptive capacity of the walling construction.

When using the test procedure described in **5.2**, readings shall be taken at intervals of not less than ½ h.

NOTE For low absorption rates, the interval may be extended to 1 h, 2 h or 4 h.

When using the test procedure described in **5.3**, readings shall be taken at the end of each 6 h spray period.

[1)] Approximately equivalent to the dynamic pressure head of a 20 m/s wind.

The results may be tabulated as follows:

Time	Weight of specimen	Absorption (%)
h		
0	W_o	—
½	W_1	$100\frac{(W_1 - W_2)}{W_0}$
1	W_2	$100\frac{(W_2 - W_0)}{W_0}$
		etc.

For comparing water absorptions of materials of different densities the results should be recorded on a weight/volume or volume/volume basis.

6.4 Measurement of leakage (Method C). This method shall normally be used in conjunction with the test procedure described in **5.3**. The water passing through the specimen (or subdivision where appropriate) and gathering at the base of the wall can be measured at suitable times from the start of the test.

When calculating the rate of leakage per unit area, the test area of the specimen shall be taken as the projected area above the collecting gutter.

Where the test procedure described in **5.2** is used, each period shall start (and end) just before the application of the spray. Until the specimen is saturated, however, some of the water which passes through the specimen may be re-absorbed before it reaches the collecting trough, so introducing an unknown error.

Where the test procedure described in **5.3** is used, the water shall be collected over the last hour of each 6 h spray. The test shall be continued until the consecutive readings agree to within 5 % or to within 100 mL(h m^2), whichever is greater.

The test area of the specimen or subdivision shall be recorded.

The leakage results shall be recorded as follows.

1) *Using conditions as described in* **5.2**

Periods of collection from commencement of test	Water collected at gutter 1	Leakage through sub-division 1	Water collected at gutter 2	Leakage through sub-division 2
h	mL	mL/m^2 h)	mL	mL/m^2 h)
½ to 1				
1½ to 2				
2½ to 3				

2) *Using conditions as described in* **5.3**

Periods of collection from commencement of test	Water collected at gutter 1	Leakage through sub-division 1	Water collected at gutter 2	Leakage through sub-division 2
h	mL	mL/m^2 h)	mL	mL/m^2 h)
5 to 6				
29 to 30				
53 to 54				
etc.				

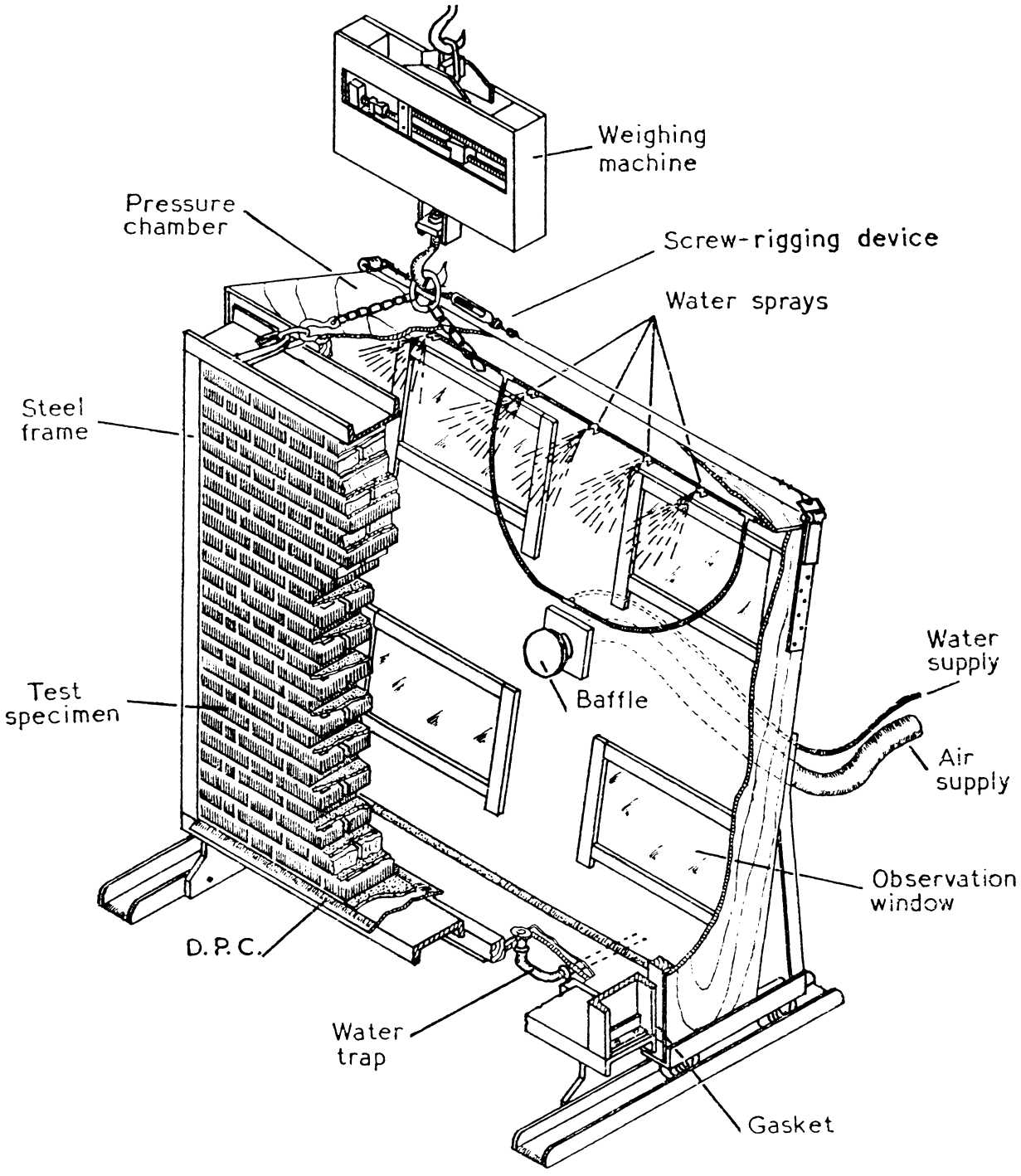

Figure 1 — Test apparatus

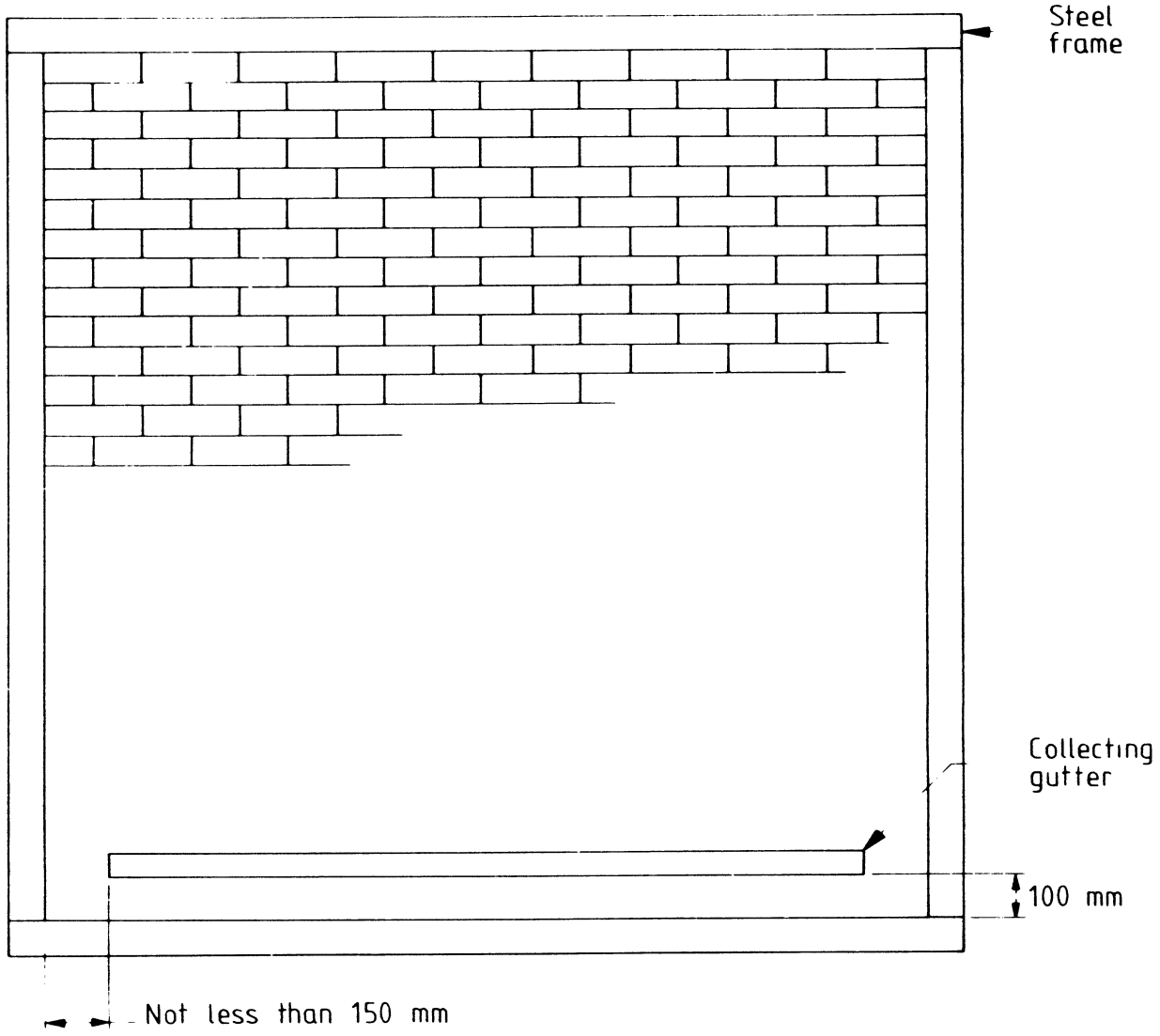

Figure 2 — Method of collecting leakage from single-leaf panels (Method C)

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