



Methods for fire tests on building materials, components and structures

Part 4: Fire-resistance tests for elements of construction



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- Australasian Fire and Emergency Service Authorities Council
- Australian Building Codes Board
- Australian Industry Group
- Australian Institute of Building
- AWTa Product Testing
- Building Research Association of New Zealand
- Bureau of Steel Manufacturers of Australia
- CSIRO Manufacturing and Infrastructure Technology
- Engineers Australia
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- Fire Protection Association New Zealand
- Forest and Wood Products Australia
- Insulated Panel Council Australasia
- Insulation Australasia
- Insurance Council of Australia
- Plastics and Chemicals Industries Association
- Society of Fire Protection Engineers Australasian Chapter

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- Testing Interests (Australia)
-

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Australian Standard[®]

Methods for fire tests on building materials, components and structures

Part 4: Fire-resistance tests for elements of construction

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PREFACE

General

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee FP-018, Fire Tests on Building Components, Materials and Structures, to supersede AS 1530.4—2005.

After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian Standard rather than an Australian/New Zealand Standard.

Development and International Standards

This Standard aligns with the general principles and procedures set out in the ISO 834 series, *Fire-resistance tests—Elements of building construction*, of Standards and other related ISO documents. This Standard also includes references to relevant European Standards, as appropriate.

This Standard references normative and informative documents. Normative referenced documents are listed in Clause 1.5, and informative referenced documents are listed in the Bibliography.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of the Standard, whereas an ‘informative’ appendix is only for information and guidance.

The use of Notes in this Standard is of an advisory nature only. They provide explanations and guidance on recommended design consideration or technical procedures, as well as an informative cross-reference to other documents or publications.

This Standard incorporates a Commentary on some clauses. The Commentary directly follows the relevant clause, is designated by ‘C’ preceding the clause number and is printed in italics in a panel. The Commentary is for information only and does not need to be followed for compliance with the Standard.

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STANDARDS AUSTRALIA

Australian Standard

Methods for fire tests on building materials, components and structures

Part 4: Fire-resistance tests for elements of construction

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard provides methods for determining the fire resistance of various elements of construction when subjected to standard fire exposure conditions.

NOTES:

- 1 Radiant heat measurements are given in Appendix A.
- 2 Alternative heating and radiation exposure conditions, which may be used for evaluation of alternative solutions, voluntary upgrades and other applications where the standard heating regime may not be applicable, and recommended means for meeting special requirements are given in Appendix B.
- 3 Unless one of the alternative heating regimes is specifically required, the standard time temperature curve applies (see Figure 2.11.1).
- 4 AS 1720.4, AS 3600, AS 3700 and AS 4100 may also be used to determine the fire resistance of an element of construction.
- 5 The assessment of smoke production and smoke spread when testing specimens is outside the scope of this Standard. Significant smoke spread or smoke production can occur even though an element of construction may have achieved a high fire resistance level (FRL). Other test methods, such as AS 1530.7, may be considered when evaluating the potential for smoke spread.

1.2 OBJECTIVE

The objective of this Standard is to provide building designers, manufacturers, test laboratories and regulatory authorities with a set of uniform requirements for heating conditions, test procedures, and criteria for the determination of fire resistance of an element of building construction.

NOTE: Test reports include information that may assist building designers. Records of temperature at critical times may be used by a designer to assess the fire resistance of a variant of the tested prototype, where the procedure for such an assessment is defined in the appropriate design Standard or code. The test methods given herein provide means for the determination of—

- (a) resistance to the incipient spread of fire through ceiling systems;
- (b) safe distances for the spacing of combustible materials from elements that provide a separating function;
- (c) radiant heat flux from doorsets, shutter assemblies and glazing; and
- (d) the cross-sectional area of air ducts to provide functional operation while providing fire resistance.

1.3 PRINCIPLE

A representative specimen of an element of construction is exposed to heat under controlled conditions in a furnace, which is operated to satisfy a specified time-temperature curve. Observations are made on the performance of the specimen while it is subjected to thermal and, where applicable, physical loading. The elapsed times at which various failures occur are recorded.

NOTES:

- 1 Where it is not possible to model the element or system of construction satisfactorily with one specimen, it may be necessary to test more than one specimen.
- 2 Where a specimen has been tested under a particular set of test conditions, an identical specimen should not be resubmitted for test without modification, unless the test is carried out for surveillance on similar purposes to confirm the original performance.

1.4 APPLICATION

Each test shall be performed in accordance with the general requirements of Section 2 and the following sections, as appropriate:

- (a) Walls Section 3.
- (b) Floors, roofs and ceilings Section 4.
- (c) Columns Section 5.
- (d) Beams, girders and trusses Section 6.
- (e) Doorsets and shutter assemblies Section 7.
- (f) Uninsulated glazing Section 8.
- (g) Air ducts Section 9.
- (h) Service penetrations and control joints Section 10.
- (i) Fire damper and air transfer grille assemblies Section 11.
- (j) Critical services Section 12.

The requirements of Sections 3 to 12 shall take precedence over the general requirements of Section 2.

NOTES:

- 1 The results of the fire tests may be used to directly assess fire hazard, but should be recognised that a single test method will not provide a full assessment of fire hazard under all fire conditions.
- 2 The test methods follow the basic principles and procedures contained in international Standards, including the ISO 834 series.

1.5 NORMATIVE REFERENCES

The following are the normative documents that are referenced in this Standard.

NOTE: Documents referenced for informative purposes are listed in the Bibliography.

AS

- | | |
|--------|---|
| 1530 | Methods for fire tests on building materials, components and structures |
| 1530.1 | Part 1: Combustibility test for materials |
| 1905 | Components for the protection of openings in fire-resistant walls |
| 1905.1 | Part 1: Fire-resistant doorsets |
| 1905.2 | Part 2: Fire-resistant roller shutters |

AS

3013 Electrical installations—Classification of the fire and mechanical performance of wiring system elements

4072 Components for the protection of openings in fire-resistant separating elements

4072.1 Part 1: Service penetrations and control joints

ISA

MC96.1 Temperature measurement thermocouples

IEC

60584 Thermocouples

60584-1 Part 1: EMF specifications and tolerances

ISO

5167 Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section running full

5167-1 Part 1: General principles and requirements

5221 Air distribution and air diffusion—Rules to methods of measuring air flow rate in an air-handling duct

1.6 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

1.6.1 Access panels

A removable component protecting an opening in a fire-resistant vertical or horizontal separating element used to access services, and the like, and may be either fixed or hinged.

1.6.2 Alternative solution

A building solution that complies with the performance requirements of the National Construction Code (NCC) other than by reason of satisfying the deemed-to-satisfy provisions.

1.6.3 Applicant

A company, corporation, organization, association, partnership, individual, entity or entities who seek a particular test service in accordance with this Standard.

1.6.4 Approved

Accepted for use by the regulatory authority or other authority having jurisdiction.

1.6.5 Blank penetration seal

A component that seals an aperture of specified size in a fire-separating element but does not incorporate any penetrating services.

1.6.6 Combustible

The classification of a material based on its reaction to defined elevated temperature conditions, which—

- (a) has been deemed combustible in accordance with the NCC; and
- (b) has been subjected to the test conditions of AS 1530.1 and has exceeded flaming or temperature rise limits specified in that Standard.

1.6.7 Connecting duct

The duct section between the damper or separating element and the flow-measuring station.

1.6.8 Control joint

A joint, between or within discrete elements of construction, which allows for relative movement of the elements.

1.6.9 Criteria of failure

1.6.9.1 *Structural adequacy*

The ability of a loadbearing element of construction to support a load, when tested in accordance with this Standard.

1.6.9.2 *Integrity*

The ability of an element of construction to resist the passage of flames and hot gases from one space to another, when tested in accordance with this Standard.

1.6.9.3 *Insulation*

The ability of the surface of an element of construction not exposed to the furnace to maintain a temperature below the specified limits, when tested in accordance with this Standard.

1.6.10 Critical service

A system or component that operates to identify an emergency or intended to operate during an emergency, and is primarily associated with—

- (a) the safety of persons evacuating a building;
- (b) firefighting operations; or
- (c) fire suppression.

1.6.11 Damper-actuating system

The system that causes the damper to change from the 'open' to the 'closed' position.

1.6.12 Damper assembly

A movable closure in a duct or opening for the passage of air, which operates automatically to restrict the passage of fire or products of combustion past the damper.

1.6.13 Damper, insulated

A damper that satisfies the integrity, leakage and insulation (temperature rise) requirements of this Standard.

1.6.14 Damper, intumescent fire

A closure that operates by intumescent (swelling on application of heat), designed to prevent the passage of fire through the duct.

1.6.15 Damper, mechanical fire

A mechanical closure operated automatically or manually, designed to prevent the passage of fire through the duct.

1.6.16 Damper, smoke

A closure designed to prevent the passage of smoke through a duct.

1.6.17 Damper, uninsulated

A damper that satisfies the integrity and leakage requirements of this Standard.

1.6.18 Doorset

A complete assembly as defined in AS 1905.1.

NOTE: See also definitions of terms related to fire-resistant doorsets in AS 1905.1.

1.6.19 Element of construction

Either—

- (a) a distinct part of a building constructed by assembling material or materials; or
- (b) a test specimen representing such a part.

1.6.20 Exhaust equipment

Equipment, consisting of a flow-measuring station and exhaust fan system, to apply and maintain the under-pressure in the connecting duct.

1.6.21 Fire damper/fire damper assembly

A closure device (mechanical or intumescent) that is located within or forms part of a separating element that may have reticulation ducting on one or both sides of the damper or damper assembly.

1.6.22 Fire exposure

The thermal actions, differential pressures and products of combustion to which an element of construction is exposed as the result of a fire.

1.6.23 Fire resistance

The ability of an element of construction, component or structure to fulfil, for a stated period of time, the required structural adequacy, integrity, thermal insulation or other expected duty specified during exposure to a fire.

1.6.24 Fire resistance level (FRL)

The nominal grading period, in minutes, that is determined by subjecting a specimen to the standard time temperature curve regime set out in this Standard, to specify—

- (a) structural adequacy;
 - (b) integrity; and
 - (c) insulation,
- and expressed in that order.

1.6.25 Fire-stopping

The system or materials used to maintain the fire resistance of the fire-separating element at joints or where services pass through the element.

1.6.26 Flow-measuring station

An area where equipment is installed to measure the gas flow rate through the duct/damper system.

1.6.27 Glazing

An element or elements of construction intended for the transmission of light.

1.6.28 Heat flux

The quantity of heat energy per unit area incident on the target of the measuring device (includes heat transferred by convection and radiation).

1.6.29 Lift-landing doorset

A complete assembly comprising multiple leaves (or single leaf) door that open(s) and close(s) the landing entrance together with associated frame and supports and other hardware and furniture.

1.6.30 Loading

The load applied to an element of construction during a loadbearing test.

1.6.31 Loadbearing wall

A wall designed to support an externally applied vertical load or a load transferred from other components.

1.6.32 Multiple penetration systems

Systems where large service openings are provided in a fire-separating element and are filled with infill material through which the services penetrate and sealed individually or in groups to the infill material rather than to the parent element.

1.6.33 Non-loadbearing wall

A wall not designed to be subjected to an external load, other than its self-weight.

1.6.34 Penetration

An aperture through a fire-separating element for the passage of a service or services.

1.6.35 Penetration seal

The system used to maintain the fire resistance of the fire-separating element at the position where there is provision for services to pass through the element.

1.6.36 Penetration system

The assembly for test consisting of the penetrating service or services and the penetration seal, media or devices, together with any service-supporting construction.

1.6.37 Radiation

Total heat flux as measured by a total heat flux meter.

1.6.38 Resistance to the incipient spread of fire (in respect of a ceiling membrane)

The ability of the membrane to insulate the space between the ceiling and roof, or ceiling and floor above, so as to limit the temperature rise of materials in this space to a level that will not permit the rapid and general spread of fire throughout the space to adjoining fire compartments.

1.6.39 Restraint

The constraint to expansion, shrinkage or rotation (induced by thermal or mechanical actions) afforded by the conditions at the ends, edges or supports of a test specimen.

1.6.40 Registered testing authority

An organization that—

- (a) is described in the NCC as a registered testing authority; and
- (b) conducts a fire-resistance test in accordance with this Standard.

1.6.41 Separating elements (horizontal and vertical)

Elements, such as horizontal (floors) and vertical (walls), that divide buildings into fire compartments or zones or separate a building from an adjoining building to resist the spread of fire.

1.6.42 Service

A system or element used for the functioning of a building (e.g. a cable, conduit, pipe, duct, flue, or similar element).

1.6.43 Service-supporting construction

Mechanical support provided in the form of clips, ties, hangers, ladder racks or trays, or any device designed to carry the load of the penetrating service.

1.6.44 Shall

Indicates that a statement is mandatory.

1.6.45 Should

Indicates a recommendation.

1.6.46 Shutter assembly

A complete assembly defined in AS 1905.2 as a 'fire-resistant roller shutter'.

1.6.47 Structurally critical temperatures

Temperatures at locations that are judged to be critical to the structural adequacy of a loadbearing element.

1.6.48 Supporting construction

The construction that may be required for the testing of some building elements into which the test specimen is assembled, such as the wall into which the door is fitted or the support structure for a ceiling system.

1.6.49 Surface, exposed

In relation to fire resistance testing, the surface that is subjected to the heating regime contained in this Standard.

1.6.50 Surface, unexposed

In relation to fire resistance testing, the external surface that is exposed to the ambient temperature within the test laboratory.

1.6.51 Test assembly

The test specimen together with its supporting construction.

1.6.52 Test load

The load applied to the element when tested in accordance with this Standard.

1.6.53 Test construction

The complete assembly, consisting of the separating element, damper and duct sections and penetration seals (if any).

1.6.54 Test specimen

An element (or part) of building construction, including hangers, fixtures, insulating materials and features such as lighting, ventilation ducts, joints and penetrations, provided for the purpose of determining either its fire resistance or its contribution to the fire resistance of another building element.

1.6.55 Uninsulated assembly

An assembly that satisfies the integrity and, where required, the structural adequacy criteria for the anticipated fire-resistance period, but not intended to provide insulation.

1.7 LINEAR DIMENSIONS

All linear dimensions given in this Standard are nominal values, unless tolerances are specified.

1.8 UNCERTAINTY OF MEASUREMENT OF FIRE RESISTANCE

Many factors may affect the result of a fire resistance test. The factors concerned with the variability of the specimen, including its materials, manufacture and installation, are not related to the uncertainty of measurement.

1.9 SAFETY PRECAUTIONS

Fire testing may be hazardous and there is the possibility that toxic and/or harmful smoke and gas may evolve during the test. Mechanical and operational hazards may also arise during the construction of the test elements or structures, their testing and disposal of test residues.

An assessment of all potential hazards and risks to health shall be made and safety precautions identified and provided. Written safety instructions shall be issued. Appropriate training shall be given to relevant personnel. Laboratory personnel shall ensure that written safety instructions are followed at all times.

SECTION 2 GENERAL REQUIREMENTS

2.1 FURNACE LININGS

Furnace linings shall consist of materials with densities less than 1000 kg/m^3 . Such lining materials shall have a minimum thickness of 50 mm and shall constitute at least 70% of the internally exposed surface of the furnace.

Where to accommodate a particular specimen it is necessary to extend the furnace chamber, the lining of the extension shall comply with the above requirements.

2.2 MEASUREMENT OF TEMPERATURE

2.2.1 Thermocouples

All thermocouples used to measure temperature shall be Type K, in 'standard' tolerance (i.e. $\pm 2.2^\circ\text{C}$ or 0.75%), whichever is the greater, complying with ISA MC96.1 or IEC 60584-1. Each batch of thermocouples shall be calibrated by a laboratory accredited by a signatory to the International Laboratory Accreditation Corporation (ILAC) through their Mutual Recognition Agreement (MRA). Calibration shall be at least single point at 200°C for specimen thermocouples and 900°C for furnace thermocouples.

NOTE: In Australia, an ILAC MRA signatory is the National Association of Testing Authorities (NATA).

The thermocouple insulation material shall be suitable for application; that is, consideration shall be taken of the melting temperature or moisture resistance of the insulation.

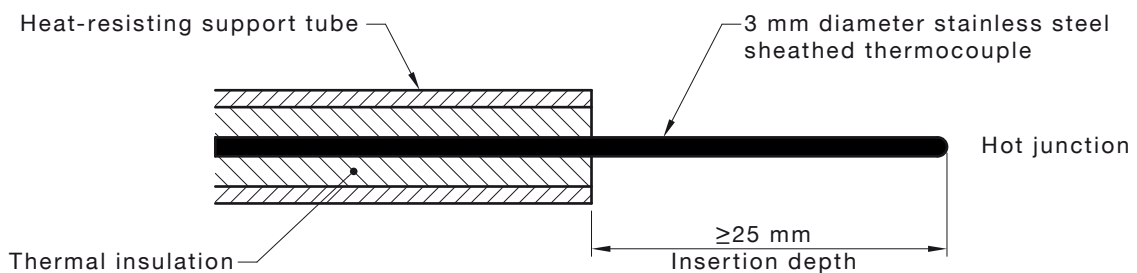
2.2.2 Furnace temperature measurement

2.2.2.1 General

The furnace thermocouples shall be mineral insulated metal sheathed (MIMS) with a stainless steel sheath having wire diameter less than 1.0 mm and an overall diameter of 3 mm, with the measuring junction insulated from the sheath to minimize ground-loop problems. The MIMS thermocouple shall be supported by a heat-resisting tube with or without additional insulation with the measuring junction protruding a minimum of 25 mm as shown in Figure 2.2.2.1. The thermocouples shall be replaced every 40 h.

A visual inspection of thermocouples shall be made and any damaged thermocouples likely to affect the accuracy of the measurement shall be discarded.

NOTE: If the plate thermometer is to be included in the test, reference should be made to Appendix B.



NOTE: Thermal insulation is optional.

FIGURE 2.2.2.1 FURNACE THERMOCOUPLE ASSEMBLY

2.2.2.2 *Number and location of thermocouples*

The minimum number of thermocouples used to measure furnace temperature shall be the greater of four or—

- (a) for planar or multiple specimen tests, the nearest whole number to the area of the furnace opening in square metres multiplied by 0.6; and
- (b) for columns, beams, trusses and girders, two per linear metre of specimen.

2.2.2.3 *Thermocouple arrangement*

Thermocouples shall be arranged symmetrically relative to the face of the test specimen(s), and shall be as follows:

- (a) Initially 100 ± 10 mm from the face of the test specimen and maintained, where practicable, at a distance of 50 to 150 mm during the test. The thermocouples used to measure the temperature of the furnace shall be uniformly distributed so as to give a reliable indication of the average temperature in the vicinity of the test specimen. The number and position of thermocouples for each type of element shall be as specified in Sections 3 to 12 in this Standard. The method of support shall ensure that thermocouples do not fall away or become dislodged during the test.
- (b) Not closer than 100 mm to the furnace wall or the burner flames.

NOTES:

- 1 Furnace thermocouples should be used at a single insertion depth only, as significant errors can result from a change in the position of the temperature gradient on the thermocouple.
- 2 The insertion depth may be increased.

If reduction in insertion depth is required due to specimen configuration, a new set of thermocouples shall be used. On initial use, the insertion depth shall be marked on each MIMS thermocouple.

2.2.3 Measurement of temperature on elements providing a separating function

2.2.3.1 *Thermocouples*

In addition to the requirement of Clause 2.2.1, thermocouples used for insulation measurement shall have a wire diameter not exceeding 0.5 mm.

Each thermocouple shall have the tail of its measuring junction attached by silver soldering to the face of a 12 mm diameter by 0.2 mm copper disc. The wires shall be arranged as shown in Figure 2.2.3.1.

Each thermocouple shall be covered with a 30 ± 0.5 mm $\times$ 30 ± 0.5 mm $\times$ 2.0 ± 0.5 mm thick inorganic insulating pad (such as asbestos-free millboard), unless specified otherwise for specific elements. The pad material shall have a density of 900 ± 100 kg/m³. The insulation pads shall be cut to accommodate the thermocouple wires. The measuring and recording equipment shall be capable of operating within the specified limits.

The disc and pad shall be pressed against the surface in such a way as will ensure that the disc is in firm contact with the surface of the test specimen. For portable thermocouples positioned during the heating period, the disc shall be in firm contact with the specimen surface for at least 90 s.

The attached thermocouple wires shall be on the disc surface away from the surface of the test specimen.

If the unexposed face thermocouples become heated by hot gases passing through the specimen (e.g. through a crack that develops during the test under the pad), then data from that thermocouple shall be excluded.

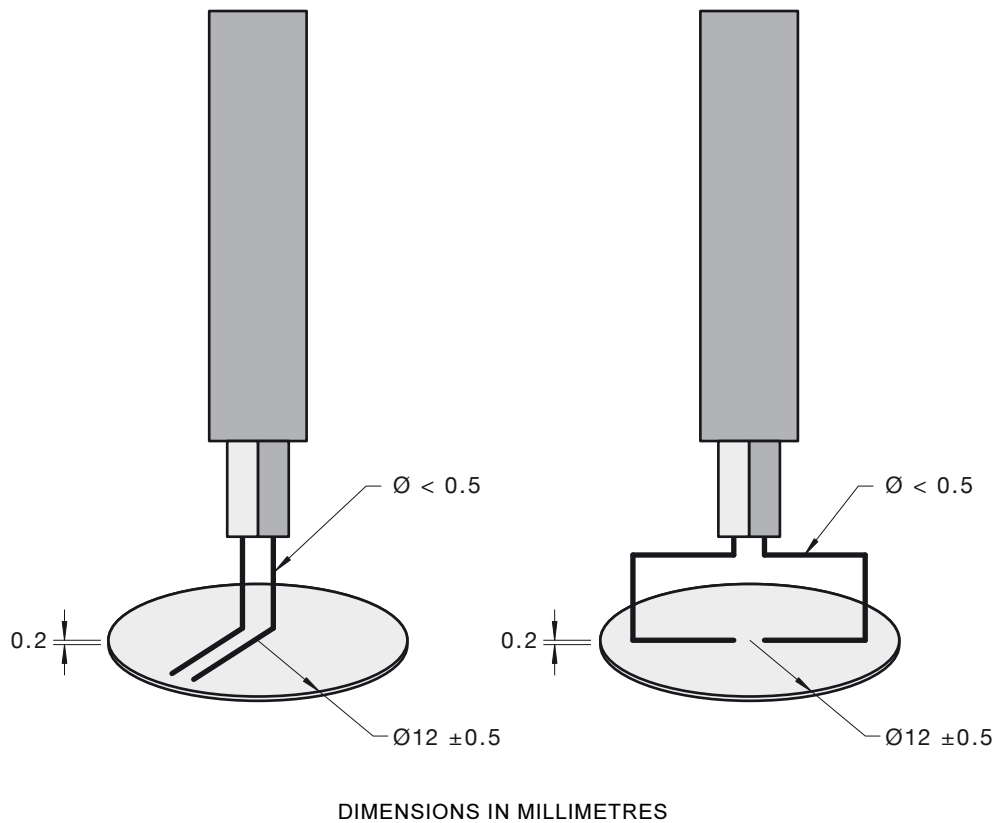


FIGURE 2.2.3.1 SPECIMEN THERMOCOUPLE CONSTRUCTION

2.2.3.2 Attachment of thermocouples

Thermocouples shall be attached to the surface of the specimen by—

- (a) heat-resistant adhesive, with no adhesive between the copper disc and the specimen or between the copper disc and the pad, taking care to ensure that the air gap between them is minimal; or
- (b) pins, screws or clips that are only in contact with those parts of a pad that are not over the disc.

NOTE: For guidelines on attachment for the various materials and surfaces, see Appendix C.

2.2.3.3 Positioning of the thermocouples

The positioning of the thermocouples used for insulation measurement shall be as follows:

- (a) The thermocouples shall be positioned on the unexposed face of the test specimen, excluding any glazing and as specified in Item (b) below.
- (b) Thermocouples shall not be positioned opposite or on top of fasteners such as screws, nails or staples if—
 - (i) the aggregate area of any part of such fasteners, projected to the unexposed face, is less than 125 mm^2 within any 125 mm^2 area; and
 - (ii) the fasteners do not extend through the assembly.
- (c) When the unexposed surface comprises a compressible material such as thermal insulation, the thermocouples, as specified in Clause 2.2.3.1, shall be fixed so that the thickness of the material is not reduced by more than 5%.

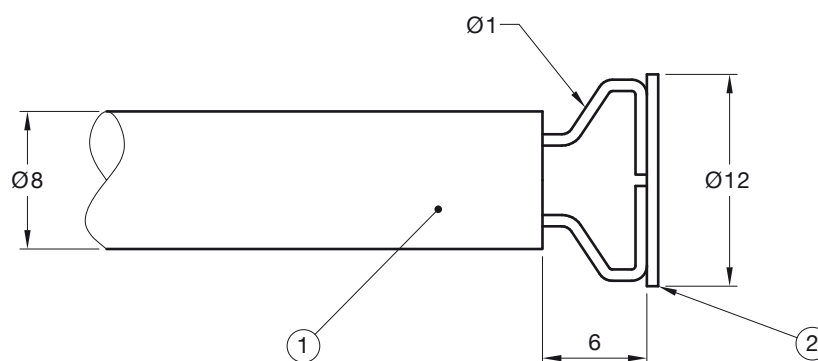
- (d) Thermocouples attached to intumescent materials, sealants, thermoplastics, foams, fibrous insulated materials and similar surfaces, subject to swelling shrinkage, flowing and melting, shall be secured in such a manner that they are free to follow the surface movement and conform to the surface curvature.
- (e) In the case of non-planar surfaces, the disc and pad shall be deformed to follow the surface profile. If there is difficulty in fixing the standard pad, the size of the pad, shall be reduced subject to a minimum diameter of 12 mm.

2.2.3.4 Roving thermocouples

One or more roving thermocouples of the design shown in Figure 2.2.3.4 or alternative temperature-measuring devices, which can be shown to have at least the accuracy and a response time equal to or less than the design illustrated by Figure 2.2.3.4, shall be available to measure the unexposed surface temperature during a test for a minimum period of 90 s in positions where higher temperatures are suspected. If the temperature rise after 90 s exceeds 175 K, the roving thermocouple(s) shall continue to be applied for a further 90 s and then removed.

The measuring junction of the thermocouple shall consist of 1.0 mm diameter thermocouple wires soldered or welded to a 12 mm diameter, 0.5 mm thick copper disc, as shown in Figure 2.2.3.4. The thermocouple assembly shall be provided with a handle so that it can be applied over any point on the unexposed surface of the test specimen.

The roving thermocouple shall not be placed at locations where it will be heated by hot gases passing through the specimen (e.g. through a crack that develops during the test).



LEGEND:

1 = Twin bore ceramic

2 = 0.5 mm thick copper disc

DIMENSIONS IN MILLIMETRES

FIGURE 2.2.3.4 ROVING THERMOCOUPLE DEVICE

2.2.4 Thermocouples for structurally critical temperatures

In addition to the requirements of Clause 2.2.1, thermocouples used for measuring structurally critical temperatures in appropriate elements shall have a diameter not exceeding 0.5 mm.

Each thermocouple shall be fitted, as follows:

- (a) The thermocouple wires shall be spot-welded or discharge-welded so that the two wires are not more than 5 mm apart.

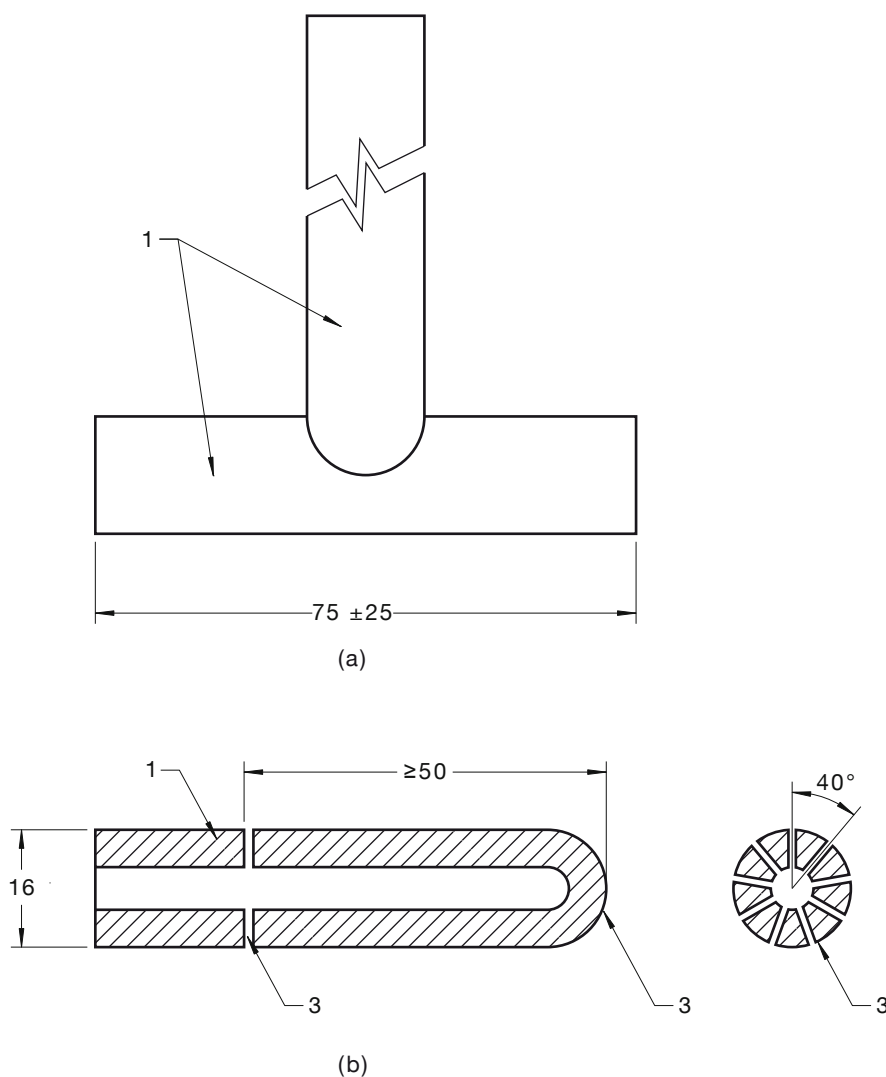
- (b) Where spot welding or discharge welding cannot be adopted, the measuring junction shall be fixed in such a way as will ensure that it remains in position throughout the test.

NOTES:

- 1 When information concerning the internal temperature of a test specimen or particular component is required, it should be obtained by means of thermocouples having characteristics appropriate to the range of temperatures to be measured as well as being suitable for the type of materials in the test specimen.
- 2 For concrete specimens, the thermocouple wires should be tied to the reinforcement, to ensure that the thermocouple remains in position during placement of the concrete or if MIMS thermocouples are used, the overall sheath diameter should not exceed 3.0 mm.

2.3 MEASUREMENT OF PRESSURE

The pressure in the furnace shall be measured by means of one of the sensors described in Figure 2.3. The measuring and recording equipment shall be capable of operating within the limits specified in Clause 2.8.



LEGEND:

(a) 'T' sensor

1 Stainless steel tube (inside diameter 7.5 ± 2.5 mm)

(b) Tube sensor

1 Stainless steel pipe

2 Welded end

3 1.2 mm diameter holes

DIMENSIONS IN MILLIMETRES

FIGURE 2.3 PRESSURE SENSORS

2.4 MEASUREMENT OF TIME

The elapsed time during the test shall be measured.

2.5 MEASUREMENT OF DEFLECTION

The relevant deflection of the test specimen shall be measured and recorded throughout the test, at intervals adequate to present a history of movement during the test to an accuracy of ± 2 mm.

2.6 MEASUREMENT OF RECEIVED TOTAL HEAT FLUX

2.6.1 General

A total heat flux meter shall be used to measure the total heat flux received at a point near the specimen or any particular feature of the specimen as required in the relevant section of this Standard.

2.6.2 Positioning of heat flux meter

The heat flux meter shall be positioned at a distance of 1 m along an axis normal to the centre of the specimen, and shall have the field of vision modified so as not to receive heat flux from sources other than the specimen.

NOTE: Where a particular feature of the specimen is to be tested, the term 'specimen' in this Clause refers to that feature.

The following applies to the heat flux meter:

- (a) The target of the instrument shall not be shielded by a window or subject to a gas purge; that is, it shall be subject to convection as well as radiation.
- (b) The suggested range shall be 0 to 50 kW/m².
- (c) The accuracy shall be $\pm 5\%$ of maximum in range.
- (d) The time constant (time to reach 64% of target value) shall be < 10 s.
- (e) The view angle may vary, depending on the specimen size.

2.6.3 Procedure

2.6.3.1 General

Each heat flux meter shall be positioned 1.0 m from the unexposed surface of the test specimen.

At the start of the test, the target of each heat flux meter shall be parallel ($\pm 5^\circ$) to the plane of the unexposed surface of the test specimen. The target shall be pointing towards the unexposed surface of the test specimen.

There shall be no significant radiating surfaces other than the specimen within the field of vision.

2.6.3.2 Specific locations

Measurements shall be taken at either one of the following locations for the determination of the average and maximum heat flux:

- (a) For the average heat flux—the measurement shall be taken opposite the geometric centre of the specimen.
- (b) For the maximum heat flux—the measurement shall be taken at the point at which the maximum heat flux can be expected.

NOTE: Often this follows logically or can be calculated from the geometry of the specimen.

If the specimen is symmetrical about its centre and a uniform radiator, this will coincide with position specified in Item (a).

If the specimen has areas of differing insulation and/or transmission, it may be difficult to predict the point of maximum intensity with any degree of certainty. In these cases, the following procedure shall be used:

- (i) Identify all areas where it is anticipated that the temperature will exceed 300°C and that also have an area in excess of 0.1 m² (or 65 000 mm² for doorsets). Measure the heat flux opposite the notional centre of each such area.

Two or more identical parts of the specimen having the same height or width, separated by less than 0.1 m, may be treated as a single radiation surface.

- (ii) Treat the area or sub-area as a single radiating surface if the area, or sub-area, of the specimen that is expected to remain below 300°C is less than 10% of the total area, or sub-area, under consideration.

NOTE: This allows for breaks such as glazing bars.

2.6.3.3 Measurement data

Measurements taken at each of the locations specified in Clauses 2.6.3.1 and 2.6.3.2 shall be recorded throughout the test at intervals not exceeding 1 min.

2.7 MEASUREMENT OF INTEGRITY

2.7.1 Cotton pad

The cotton pad used in the measurement of integrity shall consist of 100% new, undyed and soft cotton fibres—

- (a) 20 mm thick × 100 mm square, weighing between 3 g and 4 g for the standard cotton pad; or
- (b) 20 mm thick × 30 mm square, weighing between 0.27 g and 0.36 g for the reduced size cotton pad specified in Clause 10.6.

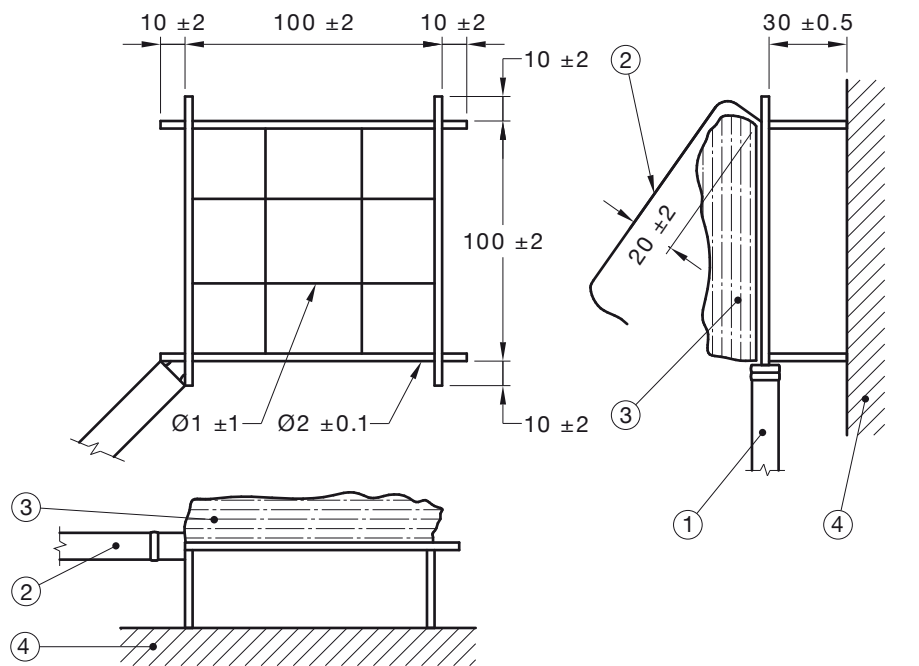
The cotton pad shall be conditioned prior to use by drying in an oven at $100 \pm 5^\circ\text{C}$ for at least 30 min and stored in a desiccator or other moisture-proof container until required.

The cotton pad shall be mounted in a wire frame, as shown in Figure 2.7.1.

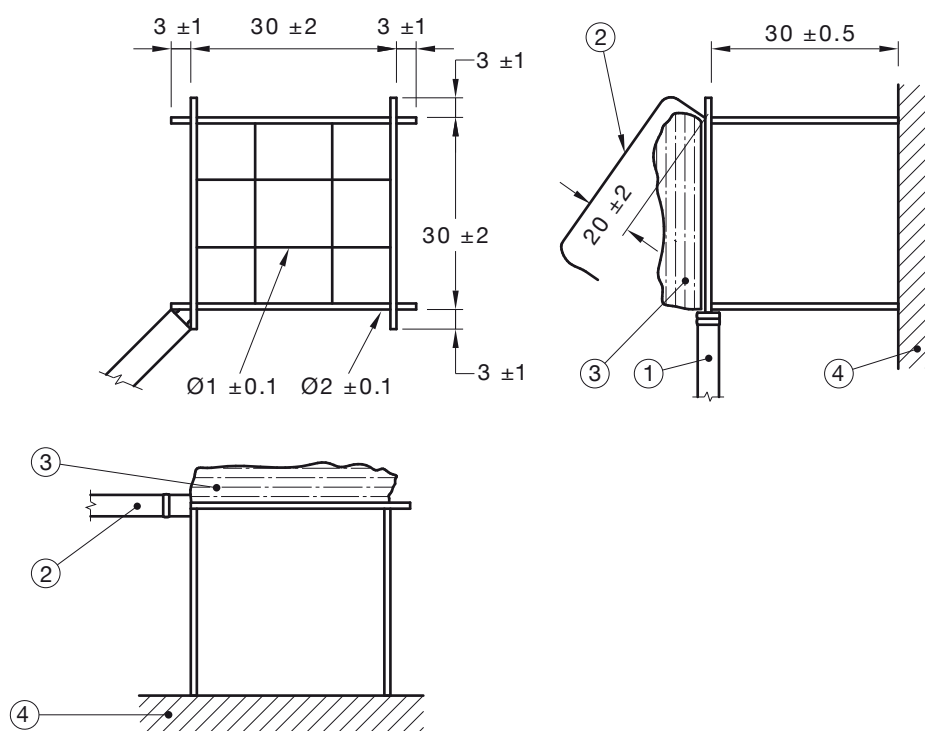
2.7.2 Gap gauges

Two types of gap gauges shall be available for the measurement of integrity.

NOTE: A typical gap gauge construction is shown in Figure 2.7.2.



a) Standard



b) Reduced size

LEGEND:

1 = Handle

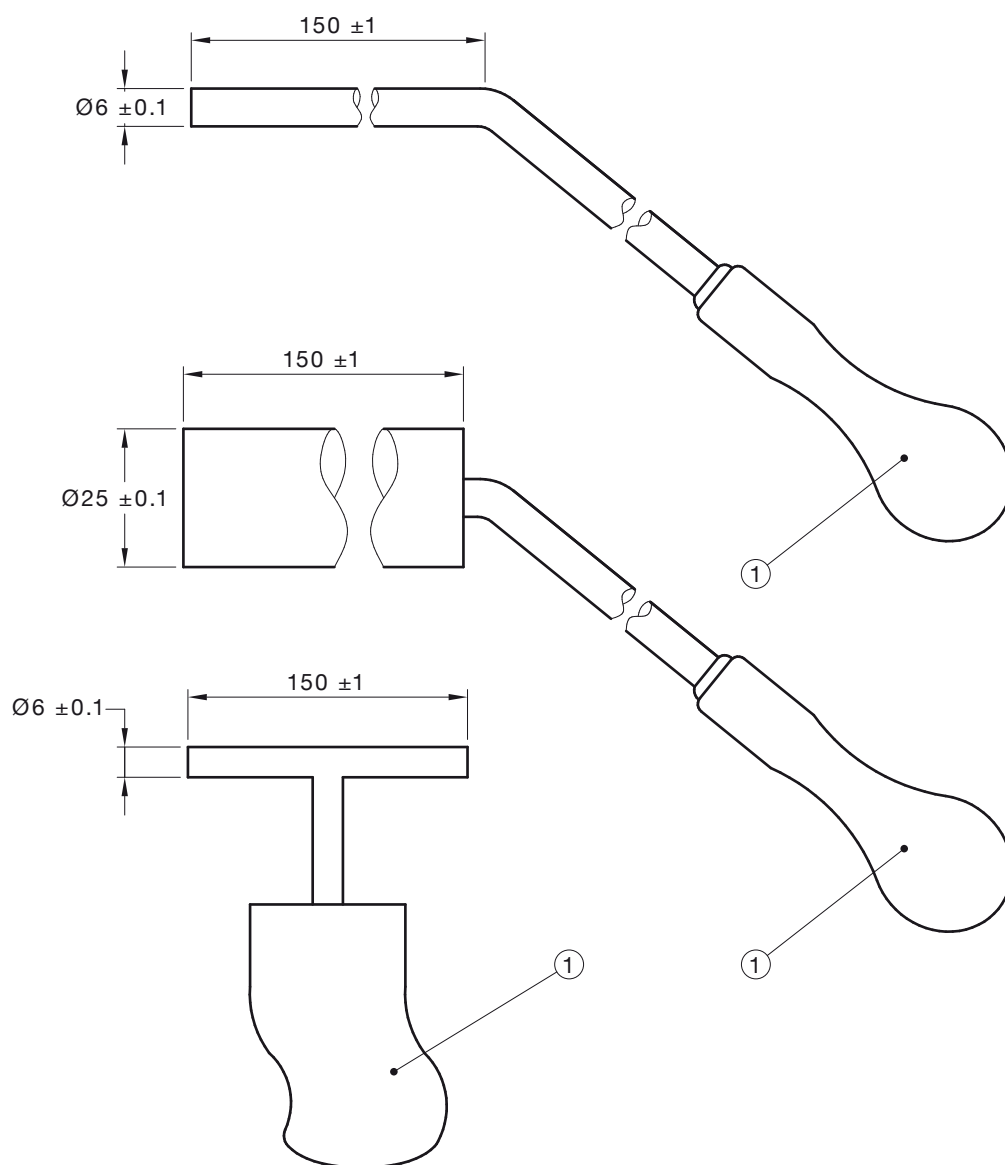
2 = Clip (open)

3 = Cotton pad 100 x 100 mm, mass 3.5 ± 0.5 g,
30 mm x 30 mm, mass 0.315 ± 0.044 g

4 = Surface of specimen

DIMENSIONS IN MILLIMETRES

FIGURE 2.7.1 COTTON PAD FRAME



LEGEND:
1 = Insulated handle

DIMENSIONS IN MILLIMETRES

FIGURE 2.7.2 TYPICAL GAP GAUGE CONSTRUCTION

2.8 ACCURACY OF MEASURING EQUIPMENT

For conducting fire tests, the measuring equipment shall meet the following levels of precision:

- (a) Temperature measurement:
 - (i) Furnace $\pm 15^{\circ}\text{C}$.
 - (ii) Ambient and unexposed face $\pm 4^{\circ}\text{C}$.
 - (iii) Other $\pm 10^{\circ}\text{C}$.
- (b) Pressure measurement..... $\pm 2\text{ Pa}$.
- (c) Load level..... $\pm 2.5\%$ of test load.

- (d) Axial contraction or expansion measurement ± 0.5 mm.
- (e) Other deformation measurements..... ± 2 mm.
- (f) Heat flux measurement $\pm 5\%$.
- (g) Time..... ± 1 s/h.

2.9 TEST SPECIMEN

2.9.1 Verification

In order for the test laboratory to verify the test specimen, the applicant shall provide the following information to the testing laboratory, prior to testing:

- (a) All constructional details.
- (b) Drawings.
- (c) Schedule of major components.
- (d) Name of the manufacturer or supplier.
- (e) Assembly procedures.

NOTE: The information should be supplied sufficiently in advance of the test to assist the laboratory in preparing for the test.

The testing laboratory shall verify the conformity of the test specimen from the information provided, as far as reasonably practicable, and any area of discrepancy shall be resolved by the laboratory prior to testing.

The testing laboratory shall either verify the fabrication of the element or request one or more additional test specimens in order to ensure that the description of the element, and in particular its construction, is in conformity with the element to be tested.

The testing laboratory shall state clearly in the test report the circumstances where it has been necessary to rely on information provided by the applicant.

2.9.2 Size

The specimen shall be full size. Where the dimensions of the full size specimen exceed that of the furnace opening, the minimum dimensions of the specimen shall be 3000 mm $\times$ 3000 mm for vertical specimens and 4000 mm $\times$ 3000 mm for horizontal specimens.

If the full-size specimen is less than 3000 mm $\times$ 3000 mm for vertical specimens and 3000 mm $\times$ 4000 mm for horizontal specimens, a smaller specimen may be tested, provided the specimen is full size and the installation complies with the clearance specified in Clause 2.9.6.

2.9.3 Form and composition

The test specimen shall be constructed in accordance with the supplied documentation.

2.9.4 Properties of materials

The testing laboratory may request or carry out tests to establish those properties of the materials that may be necessary for interpretation of the results of a fire resistance test.

2.9.5 Conditioning

At the time of the test, the strength and moisture content of the test specimen shall approximate the conditions expected in normal service. If the test specimen contains or is liable to absorb moisture, it shall not be tested until it has reached an air-dry condition.

Accelerated conditioning may be carried out, provided the method does not alter the properties of component materials or the moisture distribution in the specimen so that it has influence on the fire behaviour of the specimen. High temperature conditioning shall be below temperatures critical for the materials.

NOTES:

- 1 Conditioning temperatures above 60°C are not recommended, unless it can be demonstrated that the material properties are not significantly modified.
- 2 It is desirable that the moisture content of timber be between 10% and 15%.
- 3 It is desirable that the moisture content of concrete be less than 5%.

2.9.6 Specimen clearances inside the furnace

A minimum clearance of 200 mm shall be maintained between the wall, floor and ceiling of the furnace and any specimen or part of the specimen internal to the furnace chamber (e.g. service penetrations and the like).

2.9.7 Specimen orientation

For vertical elements, where the fire risk can be identified as being from one nominated side only, or the specimen is fully symmetrical, the specimen shall be tested with the appropriate face exposed to the furnace.

For asymmetrical constructions, where it can be clearly established that there is a weaker direction of exposure, the specimen shall be tested with the weaker face exposed to the furnace. A full justification for the adopted procedure shall be included in the test report or letter of opinion obtained from the registered testing authority.

In all other cases, not less than two tests shall be carried out, with at least one being from each direction of exposure.

For horizontal elements, the test specimen shall be exposed to heating from the underside only.

2.10 LOADING AND RESTRAINT

2.10.1 General

The loading system shall be capable of compensating for the maximum allowable deformation of the test specimen, as defined in this Standard.

The loading system shall not inhibit the free movement of air at the unexposed surface and, other than at the loading point, no part of the loading apparatus shall be closer than 60 mm from the surface.

A loadbearing element shall be subjected to the test load determined in accordance with Clause 2.10.2 and restrained in accordance with Clause 2.10.3 for a total time comprising the following:

- (a) A pre-loading period of not less than 15 min and imposed at such a rate as to avoid any dynamic effects.
- (b) The heating period.

2.10.2 Determination of test load

The test load shall be determined on the basis of one of the following:

- (a) The actual material properties of the test specimen and a design method specified in the appropriate Australian Standard or, where this does not exist, in a recognized structural Standard.

- (b) The characteristic material properties of the test specimen and a design method specified in the appropriate Australian Standard or, where this does not exist, in a recognized structural Standard. The relationship between the actual material properties and the characteristic material properties of the test specimen shall be given or shall be experimentally determined.
- (c) A load nominated by the applicant.

2.10.3 Application of restraint

The role of the elements in service shall be considered so that the methods adopted for supporting or restraining the ends or sides of a test specimen during a test are, as far as practicable, similar in nature to those that would be applied to a similar element in service. If restraint is applied in the test, the restraint conditions shall be specified with regard to free movements of the element and, as far as practicable, those external forces and moments that are transmitted to the element by restraint during the test. Where the result is intended for general application, the specimen shall be tested in the least favourable condition, as specified in the relevant section.

2.11 TEST PROCEDURE

2.11.1 Standard heating conditions

The temperature of the furnace shall be controlled to vary with time, as close as possible, in accordance with the following relationship:

$$T = 345 \log_{10}(8t + 1) + 20$$

where

T = furnace temperature at time (t), in degrees centigrade

t = time into the test, measured from the ignition of the furnace, in minutes

NOTE: The relationship is given by the following, calculated by means of the above equation to give the standard time-temperature rise curve (see Figure 2.11.1):

Time (t) min	Prescribed furnace temperature (T), °C
0	20
5	576
10	679
15	738
30	841
60	945
90	1006
120	1049
180	1110
240	1153
360	1213

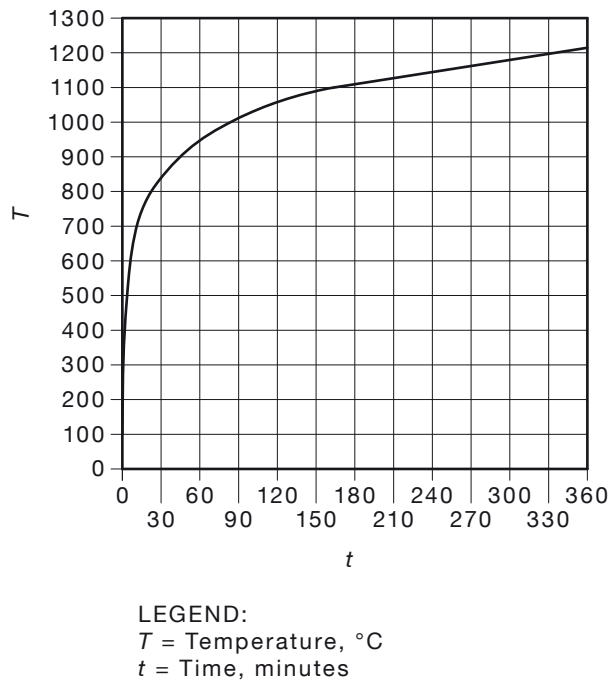


FIGURE 2.11.1 STANDARD TIME VERSUS TEMPERATURE CURVE

2.11.2 Control of furnace temperature

2.11.2.1 Measurement

The furnace temperature shall be measured at intervals not exceeding 1 min.

2.11.2.2 Accuracy of control

The following applies to the accuracy of furnace control:

- (a) At any time after the first 10 min, the average furnace temperature shall not differ from the standard curve by more than ± 100 K.
- (b) For test specimens incorporating a significant amount of combustible material, the deviation may be exceeded for a period not in excess of 10 min, provided the deviation is clearly identified as being associated with the sudden ignition of significant quantities of combustible materials increasing the average furnace temperature.

The percentage deviation in the area of the curve of the average temperature recorded by the specified furnace thermocouples versus time from the standard time-temperature curve shall be within the following parameters:

- (i) For $5 < t \leq 10$ 15%.
- (ii) For $10 < t \leq 30$ $15 - 0.5(t - 10)\%$.
- (iii) For $30 < t \leq 60$ $5 - 0.083(t - 30)\%$.
- (iv) For $t > 60$ 2.5%,

where t = time into the test, measured from the ignition of the furnace, in minutes.

All areas shall be computed by the same method, that is, by the summation of areas at intervals not exceeding 1 min for Item (i) and 5 min for Items (ii), (iii) and (iv), and shall be calculated above an axis of 0°C from time zero.

2.11.3 Furnace pressure differential

2.11.3.1 General

A linear pressure gradient exists over the height of the furnace, and although the gradient will vary slightly as a function of the furnace temperature, an average value of 8.0 Pa per metre height shall be assumed in assessing the furnace pressure conditions.

The value of the furnace pressure shall be—

- (a) the average value disregarding fluctuations of pressure associated with turbulence and other disturbances;
- (b) established relative to the pressure outside the furnace; and
- (c) controlled so that the calculated pressure at the sensor location does not deviate by more than—
 - (i) for $5 < t < 10$ ± 5 Pa.
 - (ii) for $t \geq 10$ ± 3 Pa,

where t = time from the commencement of the test, in minutes.

2.11.3.2 Vertical elements

The furnace shall be operated such that a pressure of zero is established at a height of 500 mm above the notional floor level for the specimen.

2.11.3.3 Horizontal elements

The furnace shall be operated such that a pressure of 20 Pa is established at a position 100 mm below the underside of the test specimen above that of the laboratory atmosphere.

2.11.4 Deviation from required test condition

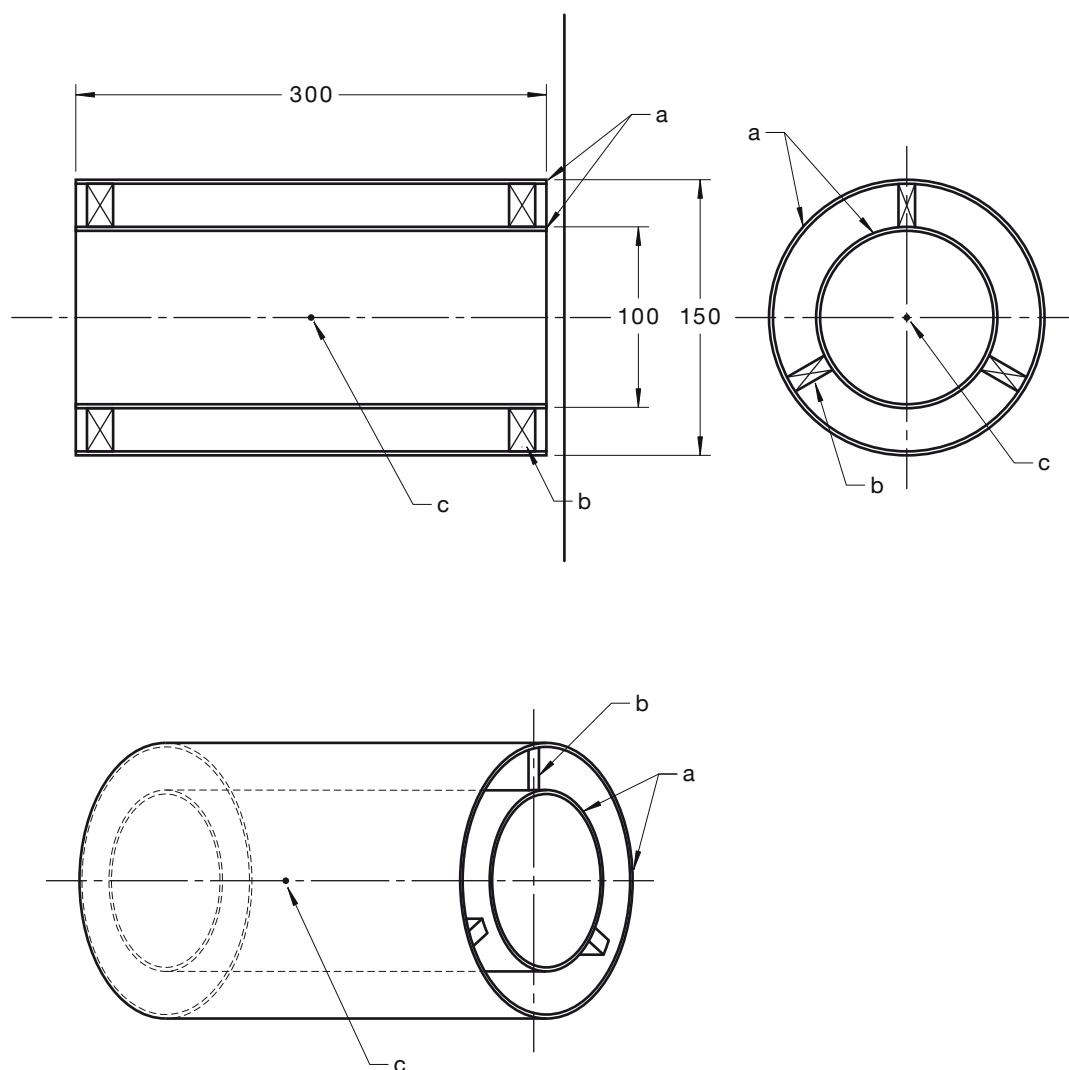
Where the average furnace temperature, pressure conditions and ambient conditions in the testing laboratory create more severe conditions than those specified in Clauses 2.11.1, 2.11.2 and 2.11.3, the actual test results can be validated. Such variations shall be fully described in the test report.

2.11.5 Ambient laboratory temperature conditions

The ambient air temperature shall be 5–40°C at the commencement of the test and shall be monitored at a distance of between 1 m and 3 m horizontally away from the unexposed face under conditions such that the sensor is not affected by thermal radiation from the test construction and/or furnace. The ambient thermocouples shall be mineral insulated, metal sheathed (MIMS) with a stainless steel sheath having wire diameter less than 1.0 mm and an overall diameter of 3 mm, with the measuring junction insulated from the sheath to minimize ground-loop problems.

NOTE: A suitable screening device positioned horizontally comprising two 300 ± 5 mm long lengths of plastic pipe nominally 100 ± 2 mm and 150 ± 2 mm in diameter is shown in Figure 2.11.5.

During the test, the temperature in the testing laboratory shall not decrease more than 10°C or increase by more than 20°C for all insulated separating elements while they are still satisfying the insulation criterion.



LEGEND:

a Concentric pipes

b Spacer

c Position of ambient temperature thermocouple

DIMENSIONS IN MILLIMETRES

FIGURE 2.11.5 SCREENING DEVICE FOR AMBIENT TEMPERATURE MEASUREMENT

2.11.6 Duration of test

The test shall be terminated for one or more of the following reasons:

- (a) Safety of personnel or impending damage to equipment.
- (b) Attainment of selected criteria.
- (c) Request of the applicant.

2.12 MEASUREMENTS, OBSERVATIONS AND RECORDS

2.12.1 General

Throughout the course of the test, observations shall be made of the behaviour of the specimen with particular emphasis on structural adequacy, integrity and insulation. All significant events shall be recorded, and the time of their occurrence shall be noted. Measurements shall be recorded at sufficient frequency to produce a plot that will permit reliable interpolation.

2.12.2 Structural adequacy

The following aspects of structural adequacy shall be recorded:

- (a) The deflection of the specimen following the commencement of heating.
NOTE: The relevant sections of this Standard indicate the locations where deflection is to be measured in each particular case.
- (b) Dislodgment or detachment of any part.
- (c) Collapse or deflection in excess of that specified in the relevant sections of this Standard.
- (d) Any other factor that could affect structural adequacy.

2.12.3 Integrity

In elements that have a separating function, the presence of cracks, fissures, other openings or other relevant occurrences shall be noted.

2.12.4 Insulation

The following requirements apply to elements that have a separating function:

- (a) The temperature of the unexposed face shall be recorded at intervals not exceeding 1 min.
- (b) When emitted radiant heat flux is to be measured, the heat flux meter readings shall be recorded at intervals not exceeding 1 min.

2.12.5 Structurally critical temperatures

Where design Standards specify methods of assessment of fire resistance based on temperature, the temperature shall be measured at locations that are judged to be critical to the structural adequacy of loadbearing elements, subject to the following:

- (a) The applicant and the testing laboratory shall determine, prior to the test, the particular steel bars, tendons and the like whose temperatures are to be monitored throughout the test.
- (b) The procedures shall be carried out as detailed in the applicable section of this Standard.

These temperatures shall be recorded at intervals not exceeding 1 min.

NOTE: By reference to the appropriate design code, the fire resistance of a column or beam may be deduced, account being taken of the particular grade of steel used, the degree of applied loading, the condition of support and other relevant factors.

2.12.6 Additional observations

During loading and throughout the test, observations shall be made of changes and occurrences, which, although not criteria of performance, could create hazards or impair performance.

NOTE: Examples of such effects include cracking, fusing, change of colour, falling of material, spalling, explosive spalling, melting, flaming, charring, and the emission of appreciable volumes of smoke or noxious vapours from the unexposed face of a separating element.

2.12.7 Computation of radiant heat reflux

Where required, the average intensity of radiant heat flux emitted by the specimen shall be determined by the following equation:

$$I_r = \phi \cdot I_o \quad \dots 2.12.7$$

where

I_o = average intensity of radiant heat flux emitted by the specimens, in kilowatts per square metre

I_r = intensity of radiant heat flux recorded by the heat flux meter, in kilowatts per square metre

ϕ = configuration factor applicable to the measurement

NOTE: For radiant heat flux measurement, see Appendix A.

2.13 CRITERIA OF FAILURE

2.13.1 Structural adequacy (loadbearing capacity)

Failure in relation to structural adequacy shall be deemed to have occurred upon collapse, or when the following occurs:

- (a) The criteria for axially loaded elements has been exceeded:

$$\text{Limiting axial contraction, } C = \frac{h}{100} \text{ mm; and} \quad \dots 2.13.1(1)$$

$$\text{Limiting rate of axial contraction, } \frac{dC}{dt} = \frac{3h}{1000} \text{ mm/min} \quad \dots 2.13.1(2)$$

where

h = initial height

- (b) When the following criteria for laterally loaded elements has been exceeded:

$$\text{Deflection of } L^2/400d \text{ mm} \quad \dots 2.13.1(3)$$

Where the rate of deflection (in millimetres per minute) is calculated over 1 min intervals, starting at 1 min from the commencement of the heating period, exceeds the limit set by—

$$\text{Rate of deflection} = L^2/9000d \text{ mm/min} \quad \dots 2.13.1(4)$$

where

L = clear span of the specimen, in millimetres

d = distance from the top of the structural section to the bottom of the design tension zone, in millimetres

Since relatively rapid deflections can occur before stable conditions are reached, the rate of deflection limit shall not apply before a deflection of $L/30$ is exceeded.

2.13.2 Integrity

2.13.2.1 General

Failure in relation to integrity shall be deemed to have occurred when evaluated in accordance with Clauses 2.13.2.2 to 2.13.2.4.

The measurement of the integrity of the test specimen shall be made by cotton pad, gap gauges or sustained flaming. For uninsulated assemblies other than service penetrations, the use of the cotton pad is inappropriate and the gap gauges shall be used to determine failure. If a specimen contains elements of different thermal resistance, the cotton pad may be used against those parts deemed to be insulating. Except for penetration systems, the use of the cotton pad shall be discontinued over areas where the temperature exceeds 300°C measured by a thermocouple (fixed or roving) with the edge of the pad aligned with the edge of the gap.

***C2.13.2.1** The radiant heat transfer from uninsulated specimens is likely to be sufficient to cause unpiloted ignition of the cotton pad and, therefore, its use is not considered appropriate. Users of this Standard should be aware that fire spread due to radiant heat transfer could occur prior to the stated integrity period for uninsulated specimens.*

2.13.2.2 Cotton pad

The cotton pad in its frame shall be applied against the surface of the test specimen over the crack, fissure or flaming under examination, until ignition of the cotton pad (defined as glowing or flaming) or for a period of 30 ± 2 s. A small adjustment in the position of the cotton pad may be made to achieve the maximum effect from the hot gases.

Where there are irregularities in the surface of the test specimen, the legs of the support frame shall be located such as to maintain clearance between the cotton pad and any part of the test specimen surface during the measurement.

Integrity failure shall be deemed to have occurred upon ignition of the cotton pad (defined as glowing or flaming).

2.13.2.3 Gap gauges

Gap gauges shall be used to evaluate the size of any opening in the surface of the test specimen at time intervals that will be determined by the apparent rate of the specimen deterioration. Two gap gauges shall be employed in turn and without undue force. Integrity failure shall be deemed to occur when—

- (a) a 6 mm gap gauge can be passed through the specimen so that the gap gauge projects into the furnace and can be moved a distance of 150 mm along the gap; or
- (b) a 25 mm gap gauge can be passed through the specimen so that the gap gauge projects into the furnace.

Any small interruptions to the passage of the gap gauge, which would have little or no effect upon the transmission of hot gases through the opening, shall not be taken into account; for example, small fastenings across a construction joint that has opened due to distortion.

2.13.2.4 Flaming

Sustained flaming on the surface of the unexposed face for 10 s or longer shall be deemed to be integrity failure.

2.13.3 Insulation

The measurement of insulation performance is made by thermocouples on the unexposed face compared to the initial temperature. The initial temperature is defined as the average temperature on the unexposed face measured less than 5 min before commencement of the test.

The specimen shall be deemed to have failed when—

- (a) the average temperature of the unexposed face of the test specimen, as measured by the thermocouples specified in Clause 2.2.3.1, exceeds the initial temperature by more than 140 K; or
- (b) the temperature at any location on the unexposed face of the test specimen exceeds the initial temperature by more than 180 K.

2.13.4 Radiation

Failure in relation to radiation shall be deemed to have occurred when the calculated total heat flux at a distance of 365 mm exceeds 10 kW/m².

2.14 TEST RESULTS

The test results shall be stated in terms of the time in elapsed whole minutes, from the start of the test until failure has occurred under each or any of the criteria in Clause 2.13, as applicable or, if no failure has occurred, until the test is terminated.

NOTE: The following test results would indicate that a floor/ceiling system failed in respect of resistance to incipient spread of fire, insulation and integrity after the stated times, but complied with the requirements for structural adequacy when the test was terminated at 136 min:

Test results example	
Structural adequacy	No failure at 136 min
Integrity	118 min
Insulation	106 min
Resistance to incipient spread of fire	65 min

2.15 FIRE RESISTANCE LEVEL (FRL)

The fire resistant level of an element shall be assigned in the form, structural adequacy/integrity/insulation with the values rounded down to the appropriate regulatory values.

NOTE: For some elements, all of the criteria of failure are not applicable and, in these cases, the value is indicated by a dash, for example for a structural beam or column, xx/—/—, or for a non-loadbearing wall, —/yy/zz.

2.16 REPORTING RESULTS

2.16.1 General

The test report, regulatory information report and the test certificate shall include the following statement:

THE RESULTS OF THESE FIRE TESTS MAY BE USED TO DIRECTLY ASSESS FIRE HAZARD, BUT IT SHOULD BE RECOGNIZED THAT A SINGLE TEST METHOD WILL NOT PROVIDE A FULL ASSESSMENT OF FIRE HAZARD UNDER ALL FIRE CONDITIONS.

2.16.2 Test report

A test report shall be prepared and shall include the description of the test specimen and the drawings. As far as practicable, the description and the drawings shall be based on information provided by the applicant and verified by a survey of the test specimen. When full and detailed drawings are not produced by the testing laboratory for inclusion in the report, the applicant's drawing(s) of the test specimen shall be authenticated by the testing laboratory and at least one copy of the authenticated drawing(s) shall be included in the report. The report shall state that the drawings are those provided by the applicant.

The test report shall include the following information:

- (a) The name and address of the testing authority.
- (b) The name and address of the applicant.
- (c) The date of the test.
- (d) The unique reference number of the test
- (e) The name of the manufacturer (if known) of the test specimen and of the products and components used in the construction, together with identification marks and trade names.
- (f) The construction details of the test specimen, including product name or product identifier, description and drawings and principal details of the components.
- (g) The relevant properties of materials or components that have a bearing on the fire performance of the test specimen. Where it is impracticable to measure some of these properties, this shall be reported.
- (h) The method of assembly and installation of the test specimen.
- (i) Details of pre-test conditioning of the test specimen.
- (j) A statement concerning the testing laboratory's involvement in the selection of the test specimen.
- (k) For loadbearing elements, the load applied to the test specimen, the basis for its calculation as provided by the applicant and the method of loading.
- (l) The support and restraint conditions employed and the rationale for their selection.
- (m) For asymmetrical separating elements, the direction in which the specimen was tested and the reason for this choice.
- (n) Information concerning the location of all thermocouples specified in Clauses 2.2.3 and 2.2.4, pressure measurement and deflection measurement devices, including drawings that clearly illustrate the positions of the various devices and identify them relative to the data provided.
- (o) The ambient temperature of the laboratory at the commencement of the test.
- (p) The location of the pressure sensor.
- (q) Temperature curves of the furnace heating conditions.
- (r) The reasons for validating the test in the event of the tolerances on the temperature/time curve, pressure conditions or ambient laboratory conditions being inadvertently exceeded.
- (s) The result stated in terms of time, in elapsed whole minutes, between the commencement of heating and the time of failure with respect to the relevant criteria, including—
 - (i) the rate of deflection when this is the criterion used to assess loadbearing capacity, including the value of d (see Clause 2.13.1) used in calculating the limiting rate of deflection for flexural members;
 - (ii) the maximum deflection and the time and position at which it occurred, supported by adequate graphical data;
 - (iii) the mode of failure with respect to all integrity criteria;
 - (iv) the position(s) at which the maximum temperature rise was measured should this be the case of insulation failure; and
 - (v) any alternative and additional tests (e.g. plate thermometers).

NOTE: Guidance on alternative means of testing is given in Appendix B.

- (t) Tabulation or graphical depiction of the output from all pressure-measuring devices, deflection-measuring devices, heat flux meters, unexposed face thermocouples and, where applicable, internal thermocouples.

NOTE: The report only needs to include a selection of the measured data sufficient to provide a history of the performance of the test specimen. For example, it is not necessary to tabulate the temperature of every thermocouple fixed to a beam at 1 min intervals for the whole duration of a 90 min test; however, it is recommended that all of the measurements be included at around the time of failure of all the criteria being considered. Before and after this period, the interval at which measured data needs to be included in the report may be longer, for example, 5 to 10 min.

- (u) A description of any significant behaviour of the test specimen.
- (v) The field of direct application of the results for the specimen.

NOTE: For example, the direction of fire exposure.

- (w) The following statements:

THIS REPORT DETAILS METHODS OF CONSTRUCTION, THE TEST CONDITIONS AND THE RESULTS OBTAINED WHEN THE SPECIFIC ELEMENT OF CONSTRUCTION DESCRIBED HEREIN WAS TESTED FOLLOWING THE PROCEDURE OUTLINED IN AS 1530.4. ANY SIGNIFICANT VARIATION WITH RESPECT TO SIZE, CONSTRUCTION DETAILS, LOADS, STRESSES, EDGE OR END CONDITIONS, OTHER THAN THAT ALLOWED UNDER THE FIELD OF DIRECT APPLICATION IN THE RELEVANT TEST METHOD, IS NOT COVERED BY THIS REPORT.

BECAUSE OF THE NATURE OF FIRE RESISTANCE TESTING AND THE CONSEQUENT DIFFICULTY IN QUANTIFYING THE UNCERTAINTY OF MEASUREMENT OF FIRE RESISTANCE, IT IS NOT POSSIBLE TO PROVIDE A STATED DEGREE OF ACCURACY OF THE RESULT.

NOTE: For guidelines on the measurement of radiant heat flux, see Appendix A.

- (x) The FRL assigned to the test specimen.

2.16.3 Regulatory information report

In addition to the full test report, the laboratory may, upon request, issue a regulatory information report. This provides the minimum information required for regulatory compliance.

The regulatory information report shall contain the following:

- (a) The name and address of the testing authority.
- (b) The name and address of the applicant.
- (c) The date of the test.
- (d) The unique reference number of the test.
- (e) The name of the manufacturer (if known) of the test specimen and of the products and components used in the construction, together with identification marks and trade names.
- (f) The construction details of the test specimen, including description, product name or product identifier and drawings and principal details of the components.
- (g) The relevant properties of materials or components that have a bearing on the fire performance of the test specimen. Where it is impracticable to measure some of these properties, this shall be reported.
- (h) The method of assembly and installation of the test specimen.
- (i) For loadbearing elements, the load applied to the test specimen.

- (j) The support and restraint conditions employed and the rationale for their selection.
- (k) For asymmetrical separating elements, the direction in which the specimen was tested and the reason for this choice.
- (l) Statement that conditions complied with the Standard.
- (m) The result stated in terms of time, in elapsed whole minutes, between the commencement of heating and the time of failure with respect to the relevant criteria.
- (n) A description of any significant behaviour of the test specimen.
- (o) The field of direct applicability of the results for the specimen to be evaluated.
NOTE: For example, fire exposure from direction tested.
- (p) The following statement:

THIS REPORT DETAILS THE METHODS OF CONSTRUCTION, TEST CONDITIONS AND THE RESULTS OBTAINED WHEN THE SPECIFIC ELEMENT OF CONSTRUCTION DESCRIBED HEREIN WAS TESTED FOLLOWING THE PROCEDURE OUTLINED IN AS 1530.4. ANY SIGNIFICANT VARIATION WITH RESPECT TO SIZE, CONSTRUCTIONAL DETAILS, LOADS, STRESSES, EDGE OR END CONDITIONS, OTHER THAN THAT ALLOWED UNDER THE FIELD OF DIRECT APPLICATION IN THE RELEVANT TEST METHOD, IS NOT COVERED BY THIS REPORT.

BECAUSE OF THE NATURE OF FIRE RESISTANCE TESTING AND THE CONSEQUENT DIFFICULTY IN QUANTIFYING THE UNCERTAINTY OF MEASUREMENT OF FIRE RESISTANCE, IT IS NOT POSSIBLE TO PROVIDE A STATED DEGREE OF ACCURACY OF THE RESULT.

- (q) The FRL assigned to the test specimen.

2.16.4 Test certificate

In addition to the full test report and the regulatory information report, an abbreviated version may be provided for commercial purposes, at the specific request of the applicant. The abbreviated version shall include the following:

- (a) Description of specimen (attach a drawing where appropriate).
- (b) Test results, including the FRL.
- (c) The following statement:

THIS CERTIFICATE IS PROVIDED FOR GENERAL INFORMATION ONLY AND DOES NOT COMPLY WITH THE REGULATORY REQUIREMENTS FOR EVIDENCE OF COMPLIANCE.
- (d) Reference to the relevant test report or regulatory information report and a statement that reference should be made to the relevant test report or regulatory information report to determine the applicability of the test result to a proposed installation.

NOTE: For some specimens, multiple certificates may be provided; for example, where the specimen contains multiple penetrations.

SECTION 3 WALLS — VERTICAL SEPARATING ELEMENTS

3.1 GENERAL

3.1.1 Application

This Section sets out the procedures for determining the fire resistance of masonry, prefabricated and framed walls, access panels, and insulated glazed elements when forming part of a wall. It shall be read in conjunction with Section 2.

NOTES:

- 1 Access panels and insulated glazed elements are considered part of the separating elements and are subject to the relevant criteria of failure.
- 2 This Section does not apply to the performance of doorsets, uninsulated glazing, dampers, service penetrations and similar components, often found in walls.

3.1.2 Vertical separating elements

A vertical element is a construction serving as an enclosure, barrier, division, support, protection, or the like, and may be solid, framed or a combination thereof. Vertically separating elements include the following:

- (a) *Masonry wall* A wall that is generally constructed from identical units. Where a bonding material is used, it is of a type generally used with the masonry unit.

NOTE: A masonry wall may be brickwork, concrete or blockwork. For examples, see Figure 3.3.1.1(A) and Figure 3.3.1.1(C).

- (b) *Prefabricated wall* Discrete prefabricated panels that are fixed to each other along the long edges.

NOTE: A prefabricated wall may be of gypsum board with a paper honeycomb core, wood-based panels, strawboard panels or laminated sheets with tongued and grooved edges. For examples, see Figure 3.3.1.1(E) and Figure 3.3.1.1(G).

- (c) *Framed wall* Wall comprising framing members clad with board, which may be framed product such as steel, wood or aluminium whilst the board may be typically gypsum board, calcium silicate board, cement particle board, wood composite board, steel or mineral fibre board. A framed wall has a cavity that may be wholly or partially filled with an insulating material.

NOTE: For examples, see Figure 3.3.1.1(I) and Figure 3.3.1.1(L).

3.2 TEST SPECIMEN

3.2.1 General

The wall system shall be installed and tested in a manner representative of the intended application.

3.2.2 Size

The specimen size shall comply with Clause 2.9.2.

3.2.3 Construction

3.2.3.1 Configuration

Walls shall be tested with horizontal or vertical joints where these form part of the wall in practice. Stiffeners, or the like, that form part of the wall shall be incorporated in the test specimen.

NOTE: In-built features such as access panels, light fittings, power outlets and any other openings should be included in the specimen.

All loadbearing walls shall be constructed with the vertical edges unrestrained.

When simulating a non-loadbearing wall intended to be greater than 3000 mm in length, it shall be fixed at one vertical edge and be free at the other edge. At the free edge, a nominal gap shall be left and packed with a non-restraining and non-combustible material, such as mineral fibre, so that it does not restrict the freedom of movement due to frictional forces.

NOTE: For framed walls, a gap of 25 mm is usually sufficient but for masonry walls, a gap of 50 mm may be required.

3.2.3.2 *Prefabricated walls*

Where the size of the prefabricated panels are less than half the width of the furnace opening, the outside edge of the full size panel shall be unrestrained.

Where the difference between the size of the furnace opening and the full width of the panel is less than 1000 mm, one small panel shall be attached to the restrained edge of the specimen. Where the difference is greater than 1000 mm, the full size panel shall be fixed in the centre of the specimen with smaller panels of equal width on both sides.

NOTE: For examples, see Figures 3.2.3.2(A) and 3.2.3.2(B).

Where through-joints occur in practice, at least one vertical joint in the test specimen shall be arranged to simulate this condition.

3.2.3.3 *Masonry walls*

A masonry wall (e.g. brickwork, concrete block work, and gypsum blocks) shall generally be constructed from identical units. Where a bonding material is used, it shall be of a type used with the masonry unit.

3.2.3.4 *Framed walls*

Where sheets are vertically installed, there shall be at least two vertical joints and one horizontal joint in the specimen, if these are intended to be used in practice. Where sheets are horizontally installed, there shall be at least two horizontal joints and one vertical joint in the specimen, if these are intended to be used in practice.

Where the test specimen can incorporate at least two full width sheets, the outside edge of the full size board on the exposed face shall be unrestrained.

Where the difference between the size of the furnace opening and the full width of the sheet is less than 1000 mm, one small sheet shall be attached to the restrained edge of the specimen on the exposed face. Where the difference is greater than 1000 mm, the full size sheet shall be fixed in the centre of the specimen with smaller sheets of equal width on both sides.

NOTE: For examples, see Figures 3.2.3.2(A) and 3.2.3.2(B).

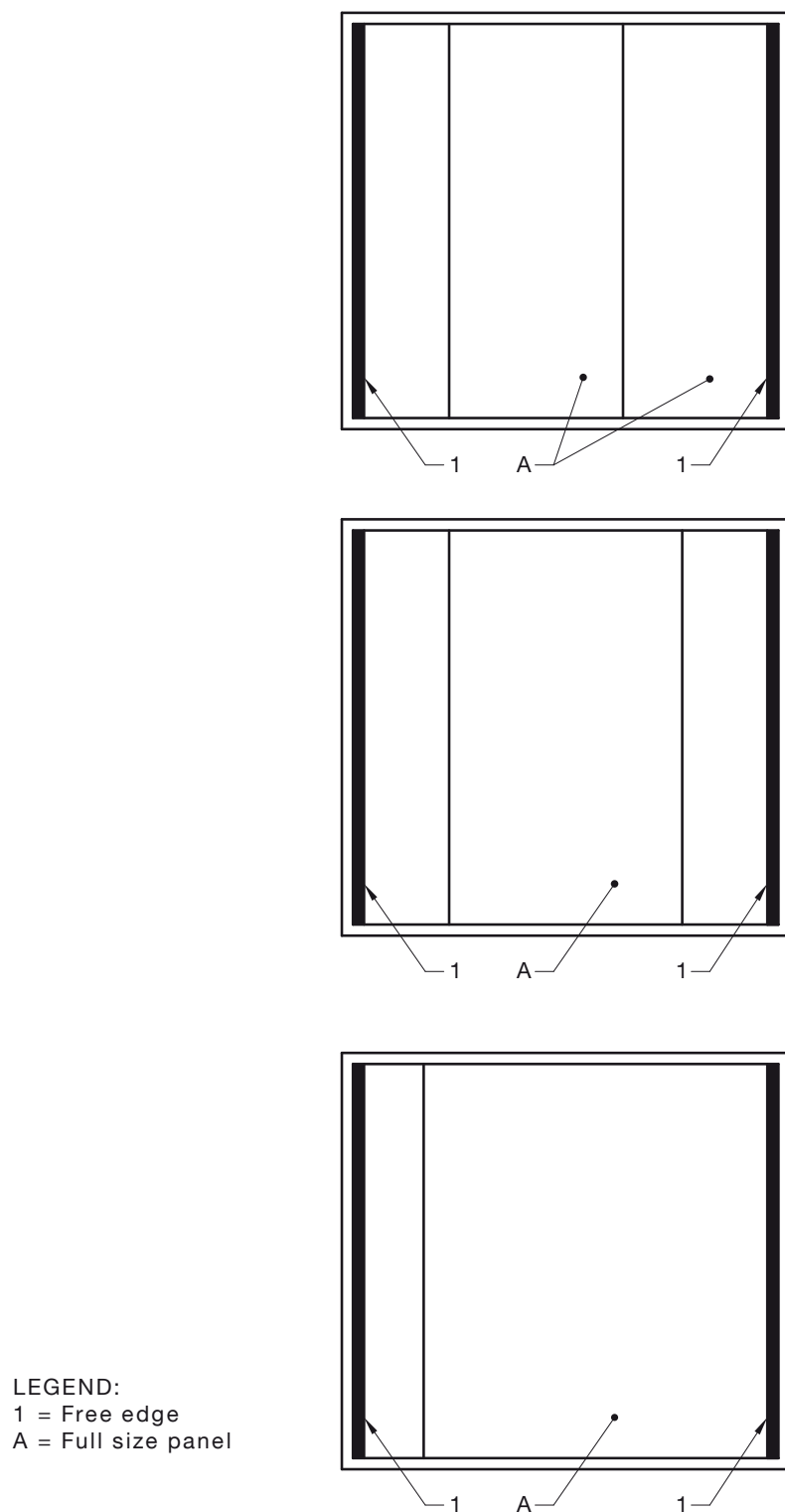


FIGURE 3.2.3.2(A) POSITION OF FREE EDGE—LOADBEARING FRAMED AND PREFABRICATED WALLS VIEWED FROM THE FURNACE-EXPOSED FACE

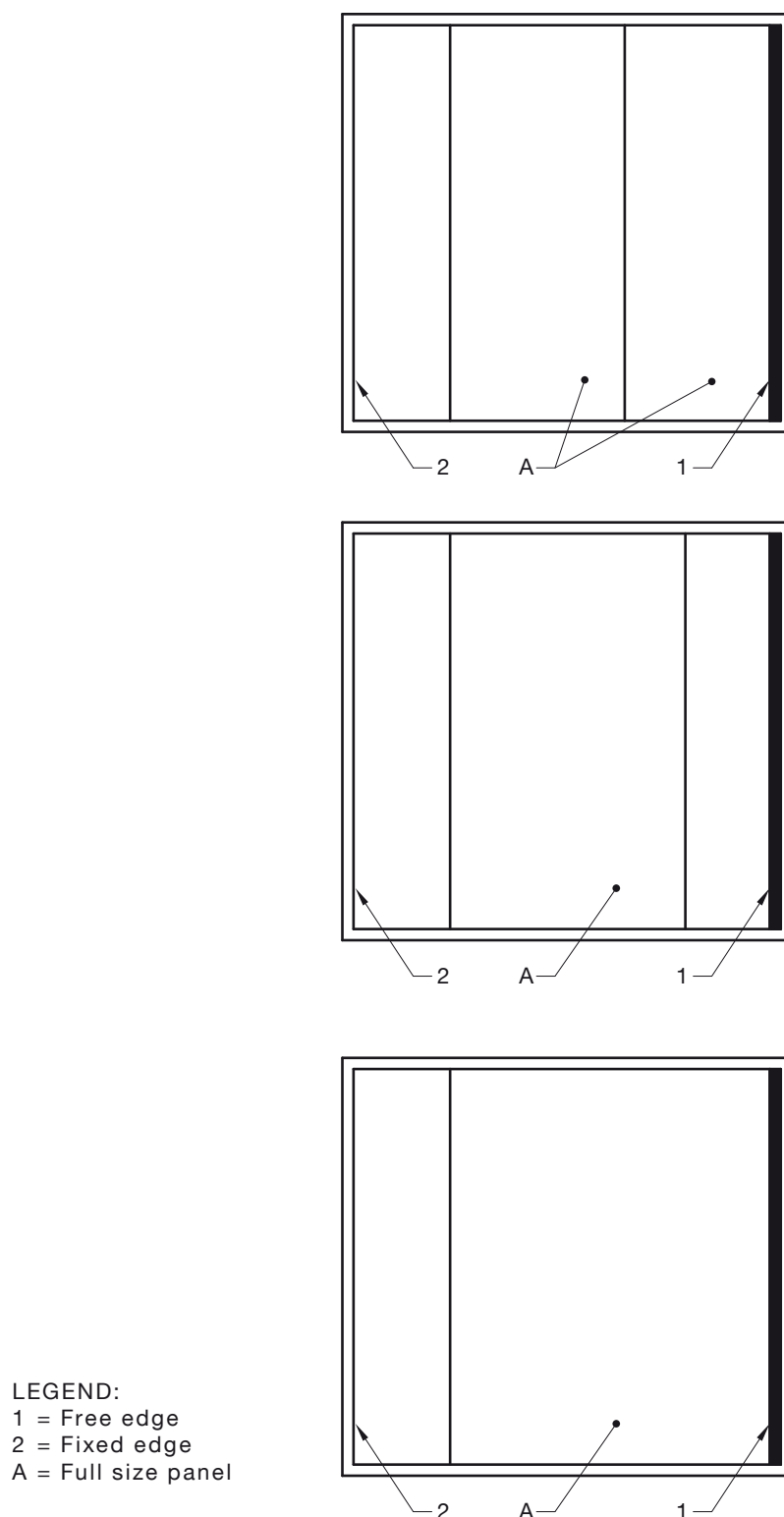


FIGURE 3.2.3.2(B) POSITION OF FREE EDGE—NON-LOADBEARING FRAMED AND PREFABRICATED WALLS VIEWED FROM THE FURNACE-EXPOSED FACE

3.3 INSTRUMENTATION

3.3.1 Measurement of temperature

3.3.1.1 General

Specimen thermocouples shall comply with Clause 2.2.3 and shall be positioned in accordance with Clauses 3.3.1.2 and 3.3.1.3.

NOTE: Typical configurations of thermocouples are shown in Figures 3.3.1.1(A) to 3.3.1.1(G).

3.3.1.2 Average temperature measurement

To measure the average temperature rise on the unexposed face of the specimen, five thermocouples shall be used. One thermocouple shall be placed close to the centre and the rest shall be placed close to the centre of each quarter section. These thermocouples shall not be attached to the specimen over thermal bridges, joints, junctions, through connections and fixings such as bolts, screws or nails. Thermocouples shall not be placed over a ridge or in a depression unless it is wide enough for a disc to make full contact.

For specimens of non-uniform thickness (for example, surfaces with corrugations or ribs), the thermocouples may be appropriately positioned in order to determine average temperatures.

For test specimens that contain discrete areas (such as access panels and insulated glazing) $\geq 100\,000\text{ mm}^2$ and expected to exhibit different levels of insulation performance, each discrete area, except for uninsulated glazing, shall be individually monitored for average temperature rise. The average temperature rise shall be measured by thermocouples distributed over each discrete area. One thermocouple shall be provided for every 1.5 m^2 , or part thereof, of the test specimen. A minimum of two thermocouples for each discrete area shall be provided.

When testing corrugated, profiled or ribbed wall construction, the number of thermocouples on the exposed surface of the wall shall be increased to at least six and an equal number of thermocouples shall be positioned at locations of maximum and minimum wall thickness measurements.

NOTE: See Figure 4.4.2.2.

3.3.1.3 Maximum temperature—General

Additional thermocouples complying with Clause 2.2.3 shall be attached to the specimen to measure the maximum temperature rise at locations that are considered to have a higher heat transfer.

A roving thermocouple shall be provided for measuring the maximum temperature at any point on the surface of the specimen during the test.

3.3.1.4 Maximum temperature—Loadbearing

Thermocouples shall be attached as follows:

- (a) At the head of the specimen at mid-width.
- (b) At the head of the specimen in line with a stud.
- (c) At the junction of a stud and nogging in a framed wall system.
- (d) At the mid-height of one free edge, 100 mm from the edge.
- (e) At mid-width, where possible, with the centre of the pad 15 mm from the edge of a horizontal joint (positive pressure zone).
- (f) At mid-height, where possible, with the centre of the pad 15 mm from the edge of a vertical joint (positive pressure zone).

NOTE: Examples of thermocouple positions (loadbearing) are shown in Figures 3.3.1.1(A), 3.3.1.1(C) and 3.3.1.1(E).

3.3.1.5 *Maximum temperature—Non-loadbearing*

Thermocouples shall be attached as follows:

- (a) At the head of the specimen at mid-width.
- (b) At the head of the specimen in line with a stud.
- (c) At the junction of a horizontal and vertical joint in a framed or prefabricated wall system.
- (d) At the mid-height of one fixed edge.
- (e) At the mid-height of one free edge, 100 mm from the edge.
- (f) At mid-width, where possible, with the centre of the pad 15 mm from the edge of a horizontal joint (positive pressure zone).
- (g) At mid-height, where possible, with the centre of the pad 15 mm from the edge of a vertical joint (positive pressure zone).

NOTE: Examples of thermocouple positions (non-loadbearing) are shown in Figures 3.3.1.1(B), 3.3.1.1(D), 3.3.1.1(F) and 3.3.1.1(G).

3.3.1.6 *Inside wall temperatures*

Thermocouples that are used to measure temperatures inside the wall for additional information or field of application purposes shall be attached at appropriate positions without damaging the specimen. Where practicable, the first 25 mm of each thermocouple shall be in the isothermal plane.

3.3.2 Measurement of deflection

3.3.2.1 *General*

Instrumentation complying with Clause 2.5 shall be used to measure horizontal and vertical deflection.

NOTE: See Figures 3.3.1.1(A) to 3.3.1.1(G).

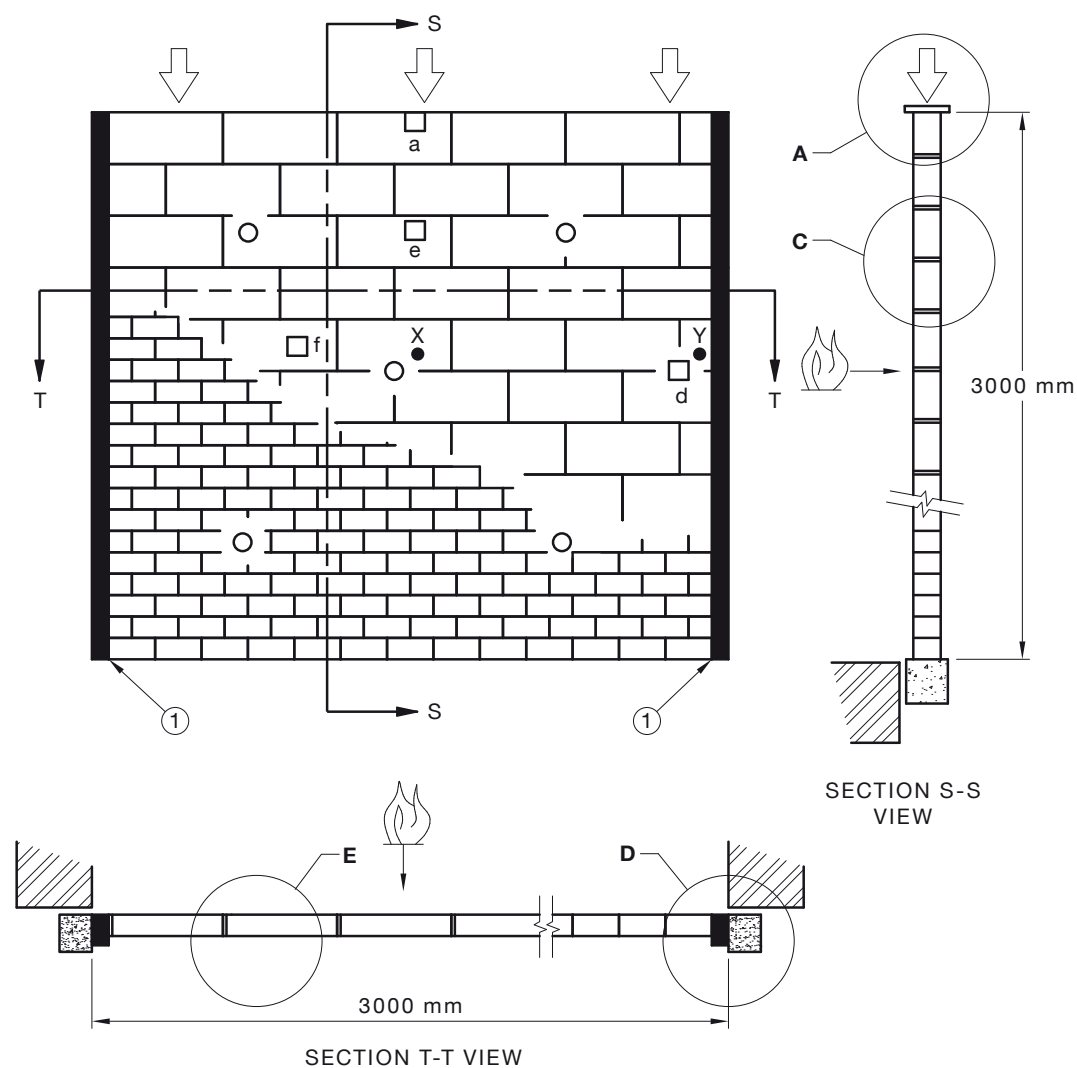
3.3.2.2 *Measurement of horizontal deflection—Both loadbearing and non-loadbearing*

Measurements shall be made at mid-height, at the centre of the specimen and 50 mm from the free edge.

NOTE: The information on the deformation of the walls may be used to extend the application of the test results.

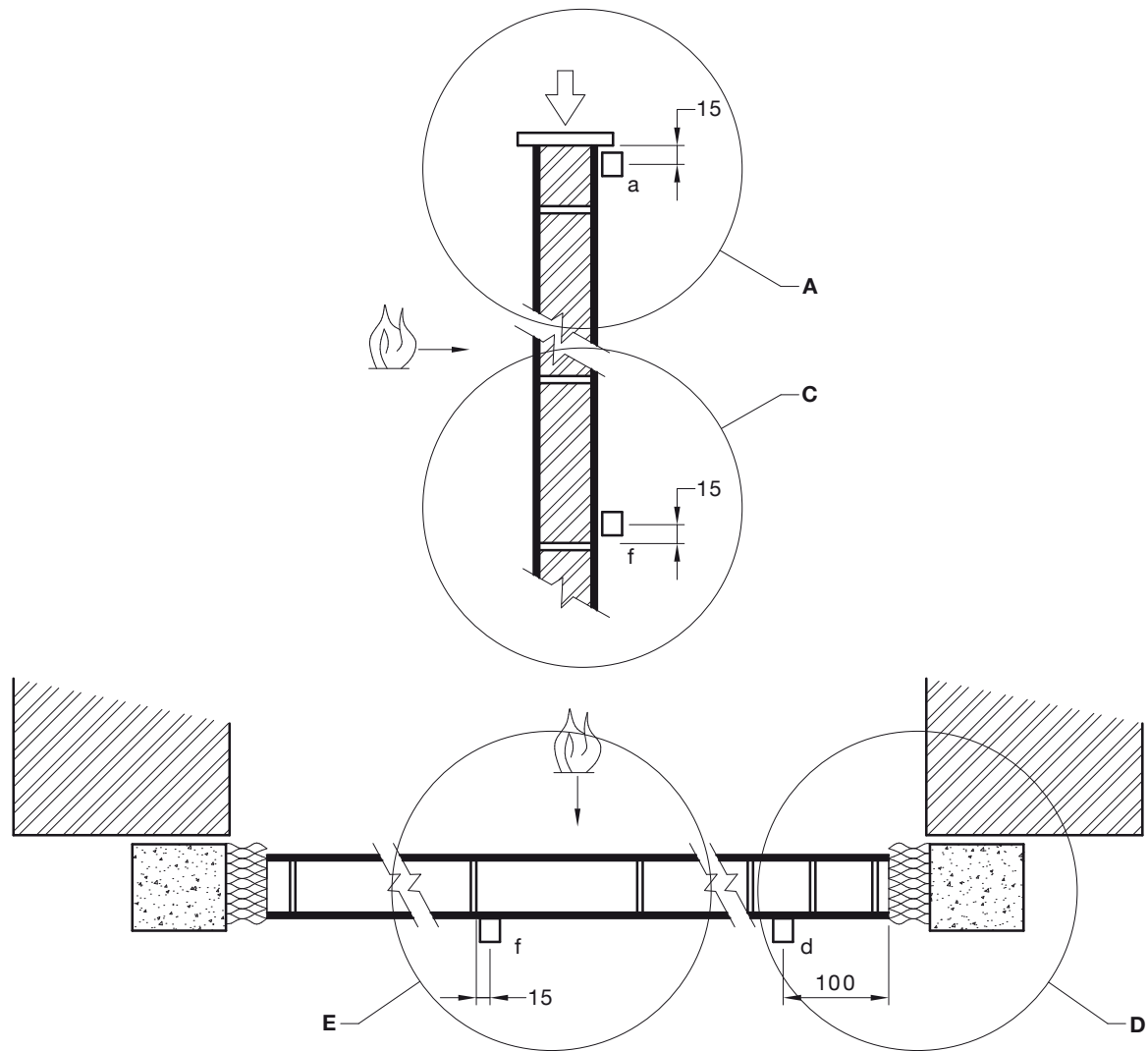
3.3.2.3 *Measurement of vertical deflection—Loadbearing only*

At least two measurements shall be made, one at each vertical edge of the specimen.



(a) Configuration

FIGURE 3.3.1.1(A) (in part) TYPICAL CONFIGURATION OF THERMOCOUPLES FOR MASONRY WALLS—LOADBEARING



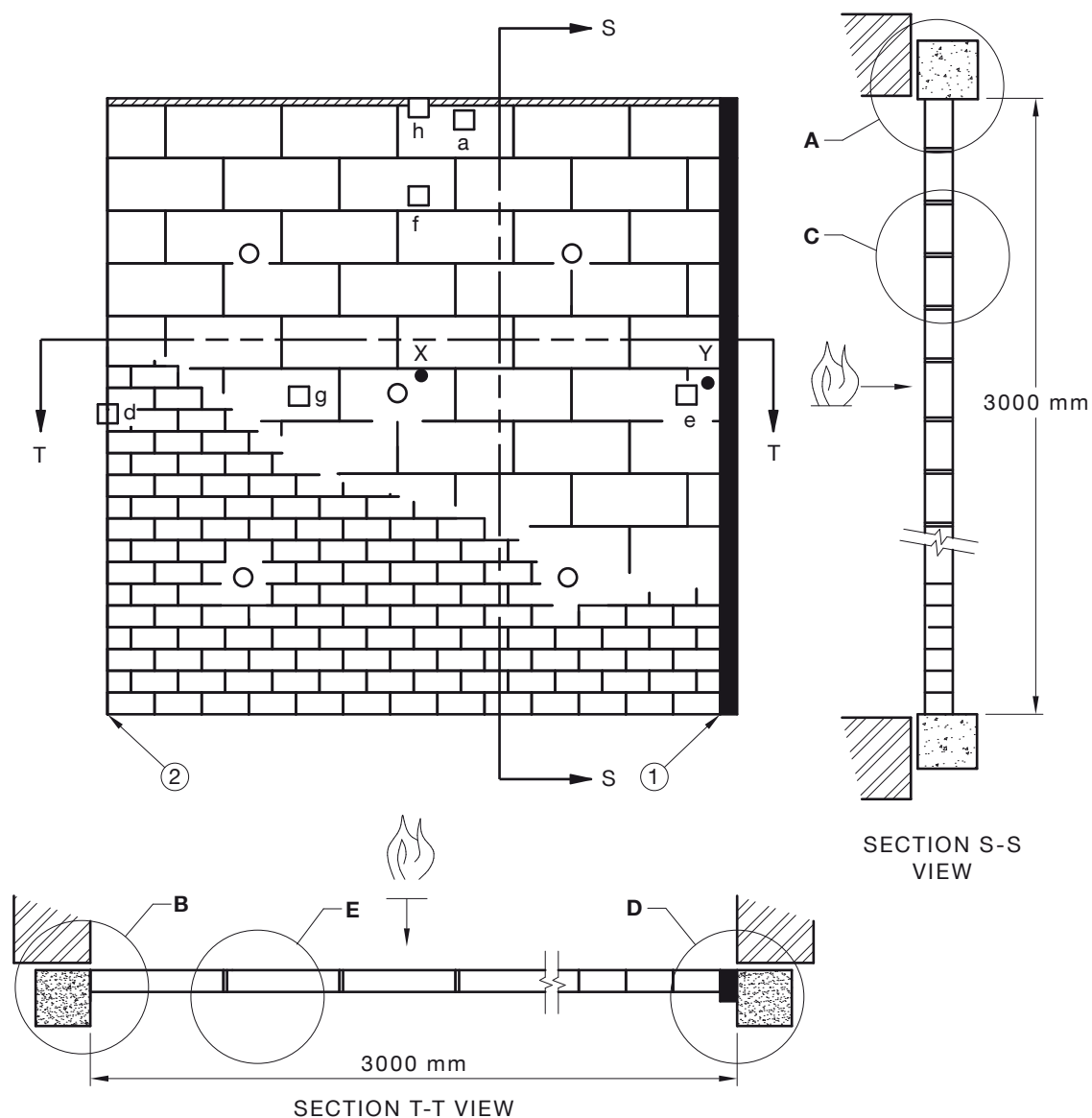
LEGEND:

□ = Positions for thermocouples for maximum temperature rise (see Clause 3.3.1.4)
(letters 'a' to 'f' refer to thermocouples)

NOTE: For overall location of thermocouples, see Figure 3.3.1.1(A)(a).

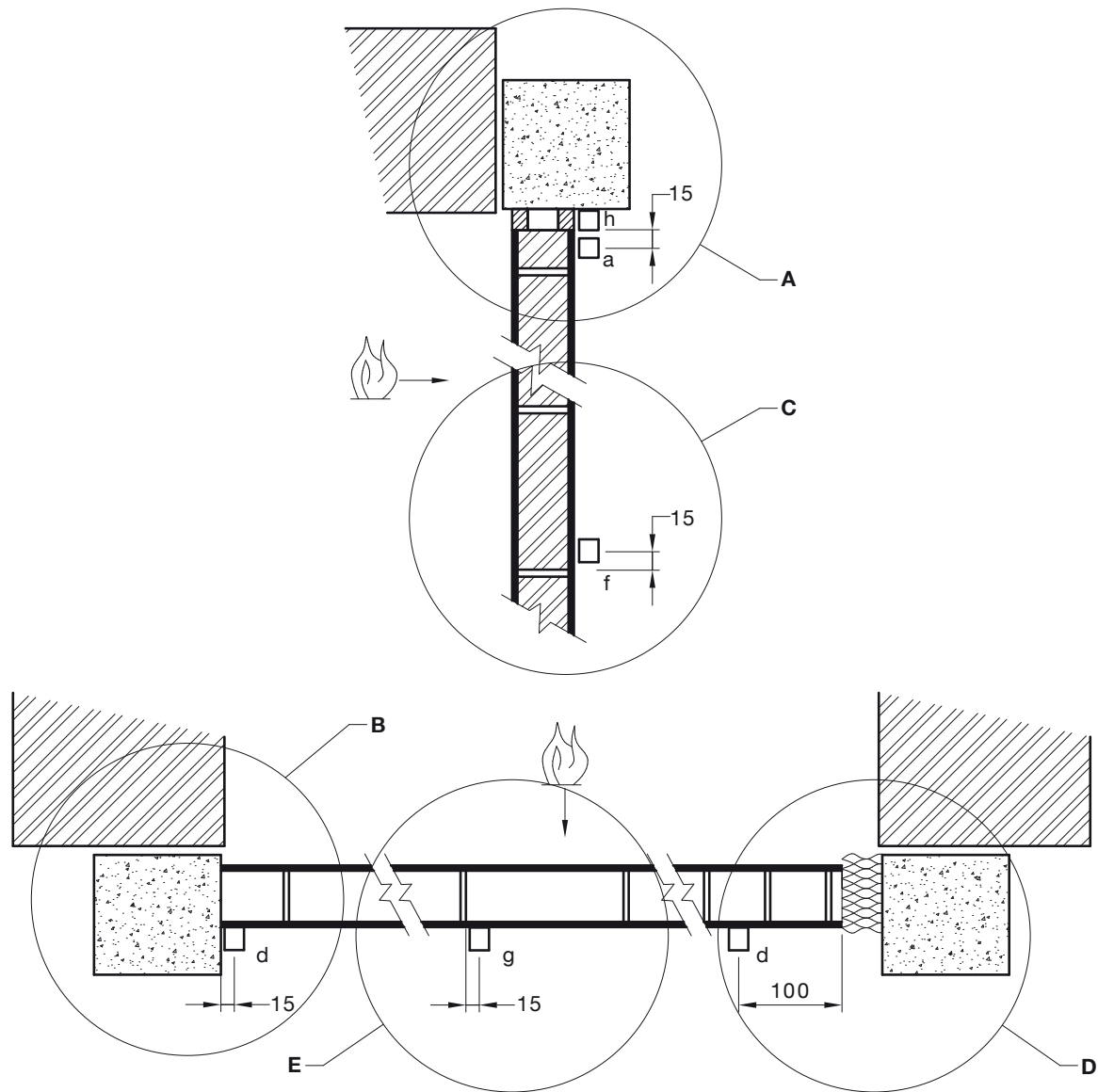
(b) Detail

FIGURE 3.3.1.1(A) (in part) TYPICAL CONFIGURATION OF THERMOCOUPLES
FOR MASONRY WALLS—LOADBEARING



(a) Configuration

FIGURE 3.3.1.1(B) (in part) TYPICAL CONFIGURATION OF THERMOCOUPLES FOR MASONRY WALLS—NON-LOADBEARING



LEGEND:

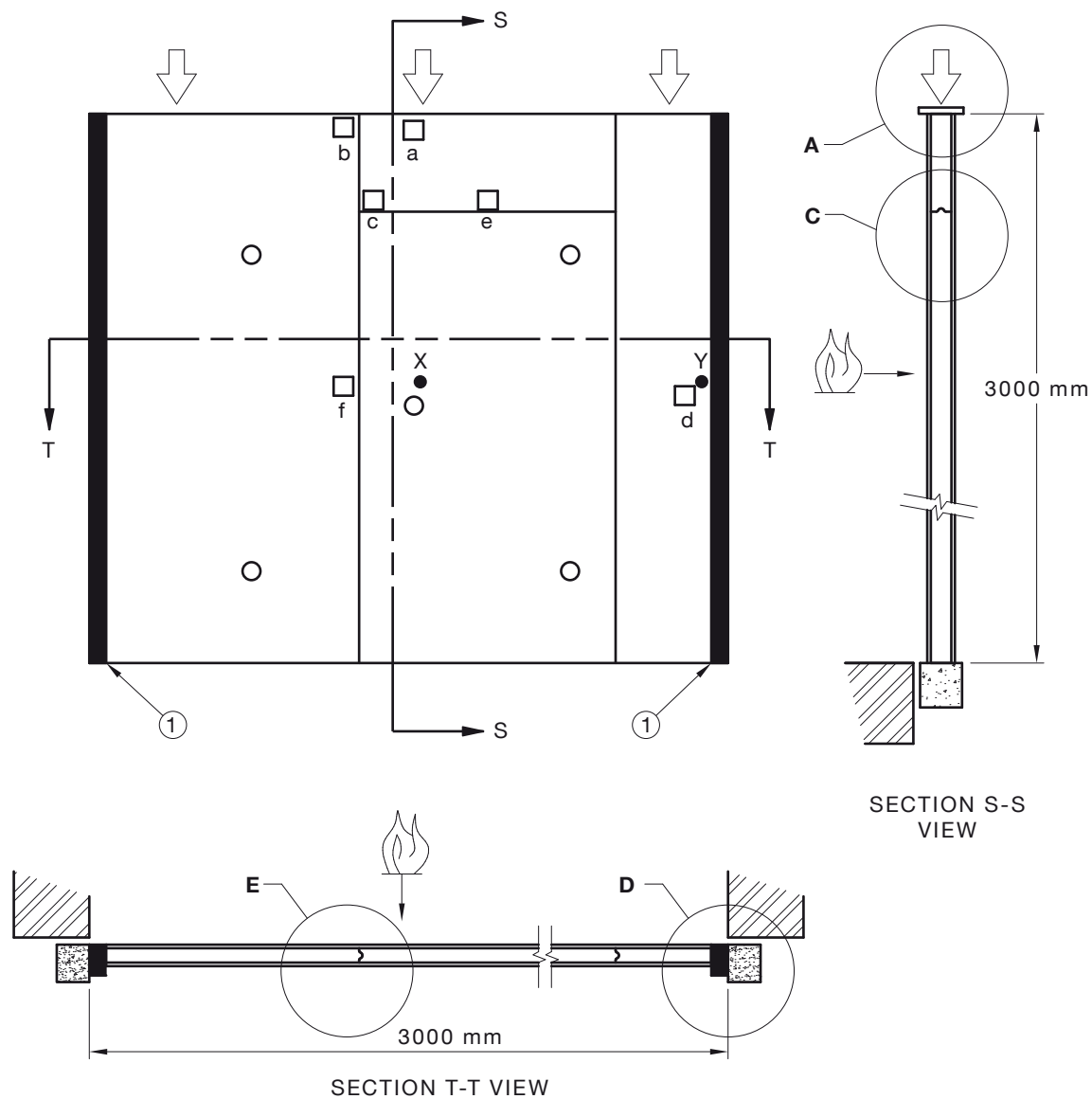
- = Positions for thermocouples for maximum temperature rise (see 3.3.1.5)
(letters 'a' to 'h' refer to thermocouples)

NOTE: For overall location of thermocouples, see Figure 3.3.1.1(B)(a).

(b) Detail

DIMENSIONS IN MILLIMETRES

FIGURE 3.3.1.1(B) (in part) TYPICAL CONFIGURATION OF THERMOCOUPLES
FOR MASONRY WALLS—NON-LOADBEARING



LEGEND:

1 = Free edge

○ = Positions for thermocouples for average temperature rise

□ = Positions for thermocouples for maximum temperature rise

● = Positions for deflection measurements X and Y

(a) Configuration

FIGURE 3.3.1.1(C) (in part) TYPICAL CONFIGURATION OF THERMOCOUPLES FOR PREFABRICATED WALLS—LOADBEARING