BRITISH STANDARD

BS 5080-1: 1993

Structural fixings in concrete and masonry —

Part 1: Method of test for tensile loading

Confirmed October 2008

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee B/514, Access and support equipment, to Subcommittee B/514/41, Tests for fixings, upon which the following bodies were represented:

Association of Building Component Manufacturers
British Board of Agrement
British Precast Concrete Federation Ltd.
Concrete Society
Construction Fixings Association
Department of the Environment
Institution of Civil Engineers
Institution of Structural Engineers
London District Surveyors Association
National Association of Scaffolding Contractors
Stainless Steel Fabricators Association of Great Britain
Suspended Access Equipment Manufacturers Association
Suspended Ceilings Association

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Contents

		Page
Committees responsible		Inside front cover
Foreword		ii
1	Scope	1
2	References	1
3	Definitions	1
4	Base materials	1
5	Installation of fixing	6
6	Apparatus	7
7	Procedure	7
8	Presentation of results	8
9	Test report	8
Figure 1 — Under cut anchors: alternative profiles of undercuts in the base material		1
Figure 2 — Types of fixing to show the dimensions required for reporting their description		3
Figure 3 — A suitable form of loading apparatus		9
List of references		Inside back cover

Foreword

This Part of BS 5080 has been prepared under the direction of Technical Committee B/514, Access and support equipment. This edition introduces technical changes but it does not reflect a full review or revision of the standard which will be undertaken in due course. It supersedes BS 5080-1:1974 which is withdrawn.

The principle changes from the 1974 edition are as follows:

a) a restriction has been added on the location of any reinforcement in the standard specimen;

b) precautions have been included when using resin adhesives for bonding fixings;

c) modifications have been made to the load application procedure;

d) a new figure has been included to clarify the definition of an undercut anchor.

This Part of BS 5080 describes a standard method for conducting tests under axial tensile forces on structural fixings installed in concrete or masonry materials used in building and civil engineering construction. Part 2 describes a standard method for conducting tests under shear forces on structural fixings.

A structural fixing joins, supports or retains components, and is designed to resist some form of loading since its failure will have structural significance.

This method of test applies to fixings installed according to the supplier's recommended procedure in a solid base material. This test applies to the fixing assembly comprising the fixing and the base material and not just the fixing itself. Failure of a fixing assembly under an axial tensile force may be due to failure of the material from which the fixing was manufactured, failure of the base material in which it was installed or loss of adhesion between them.

This test does not apply to fixings used in conjunction with woodscrews, e.g. small plugs of metal, plastics or fibrous composition, or fixings used with thin rigid sheet materials, e.g. walls, roofs, partitions, or cavity fixings for use with hollow clay or concrete block masonry.

Displacement fixings (pins or studs inserted by a cartridge operated tool) are not included, as the method of test is not appropriate to their use. However, should a design demand structural considerations and testing, the procedures given in this standard should be followed as far as possible.

The test does not cover fixings when used in timber.

If this method of test is used for proof testing the applied load and/or relative movement limits should be specified by the user.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 10, an inside back cover 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 BS 5080 specifies a method for conducting tests under axial tensile forces on structural fixings installed in concrete or masonry used in building and civil engineering.

The test applies to the following types of fixing installed in concrete, natural stone, cast stone or brick or block masonry.

a) *Expanding anchors.* Anchors held in drilled holes by friction or wedging action.

b) *Bonded fixings.* Fixings held in drilled holes by grout or other bonding material.

c) *Cast-in fixings.* Anchor bolts and sockets cast into the material during construction.

d) *Channel inserts.* Slots and channels cast into the material during construction.

e) *Undercut anchors.* Anchors held in drilled holes by interlocking in under-reamed shapes formed during drilling or setting (see Figure 1).

The two distinct situations in which the test can be applied are as follows:

1) for comparative or reference purposes, for which a standard specimen of base material is specified in **4.1**;

2) for a specific application, for which the base material should be appropriate to the intended use of the fixing. In this situation the base material may be either a specimen manufactured for the purpose or a representative section of the base material in place.

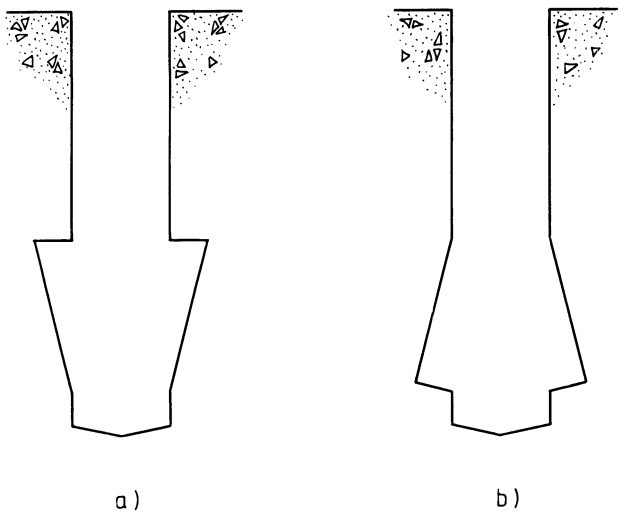


Figure 1 — Undercut anchors: alternative profiles of undercuts in the base material

2 References

2.1 Normative references

This Part of BS 5080 incorporates, by reference, provisions from specific editions of other publications. These normative references are cited at the appropriate points in the text and the publications are listed on the inside back cover. Subsequent amendments to, or revisions of, any of these publications apply to this Part of BS 5080 only when incorporated in it by updating or revision.

2.2 Informative references

This Part of BS 5080 refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions

For the purposes of this Part of BS 5080 the following definitions apply.

3.1
supplier

person who supplies or sells the fixing, and who may be the manufacturer, a selling agent or retailer

3.2
user

person who specifies the fixing for installation and who may be the architect, consulting engineer, contractor or subcontractor, according to the circumstances of the project

3.3
testing agent

person who carries out the tests described in this standard, and who is responsible for ensuring compliance with the standard

NOTE It is assumed in this standard that the test is commissioned by the user although it may be commissioned by the supplier who then becomes the user in this context.

4 Base materials

4.1 General

The dimensional criteria given in this clause are intended to ensure that the behaviour under test of any one fixing does not affect that of adjacent fixings. The dimensions given are not to be taken in any sense as guidance for field installation.

The standard specimen of base material shall be manufactured from concrete in accordance with the dimensional and casting requirements given below.

4.2 Standard specimen of base material

4.2.1 *Specimen size*

A single specimen may be used for the installation and testing of any number of fixings, provided that the dimensional conditions are met. The dimensions for the different types of fixing are given in Figure 2. These are based on a characteristic dimension *A* of the fixing defined and shall be as follows:

a) *expanding and undercut anchors*, the hole diameter or ¼ of the embedded length, whichever is the greater;

b) *bonded fixings*, the maximum diameter of the fixing or ¼ of the embedded length, whichever is the greater;

c) *cast-in fixings*, the maximum dimension perpendicular to the axis or ¼ of the maximum embedded depth, whichever is the greater.

The dimensions of the specimen shall be such that:

1) there shall be a minimum of 4*A* below the maximum depth of the fixing or of the hole into which it is inserted;

2) there shall be a minimum of 12*A* between the centre of any fixing and a free edge;

3) there shall be a minimum of 20*A* between the centres of any two fixings. Where fixings of two different sizes are considered their distance shall be taken as the sum of 10*A* for each fixing.

NOTE For channel inserts it is not practicable to define a characteristic dimension *A*, but the dimensions of the specimen should, as far as possible, comply with the criteria for other fixings. Allowance should be made for projecting ties or lugs.

The fixing shall be located in the specimen on any cast face, i.e. not on the top, trowelled face.

4.2.2 *Concrete*

The concrete from which the standard specimen is prepared shall have the mix proportions specified below. The quantities and proportions of material given will produce approximately 0.28 m^3 of fully compacted concrete. The batch weights should be calculated as follows to suit the size of the mixer and the actual quantity of concrete required.

a) Portland cement; class 42.5 (conforming to BS 12:1991): 100 kg.

b) Total aggregate (conforming to BS 882:1983): 510 kg (dry weight):

1) coarse aggregate: flint gravel graded 20 mm to 5 mm;

2) sand: natural sand as a proportion by mass of the total aggregated content:

grading C: 40 %

grading M: 35 %

grading F: 30 %

c) Water content: the water content of each batch should be adjusted to give a concrete medium workability, equivalent to a slump of 25 mm to 75 mm.

d) Compaction: mechanical vibration (applied externally or internally) shall be used to compact the concrete.

e) Curing: the specimen(s) shall be stored in moist air of at least 90 % r.h. and 20 °C for the first two days after casting.

Any reinforcement in the standard specimen shall be so positioned as to offer no additional strength in the zone of interaction between the concrete and the fixings.

4.2.3 *Specimen report*

The report of the standard specimen shall comprise the following:

a) the dimensions of the specimen;

b) the location in the specimen of the fixing(s) being tested;

c) the specification of the concrete mix, together with the following additional information:

1) a description of the aggregates used in accordance with the method given in BS 812-1:1975;

2) the quantity of water added, expressed as a water/cement ratio based on aggregates in the saturated surface dry condition;

3) the slump achieved;

4) a description of the compaction method;

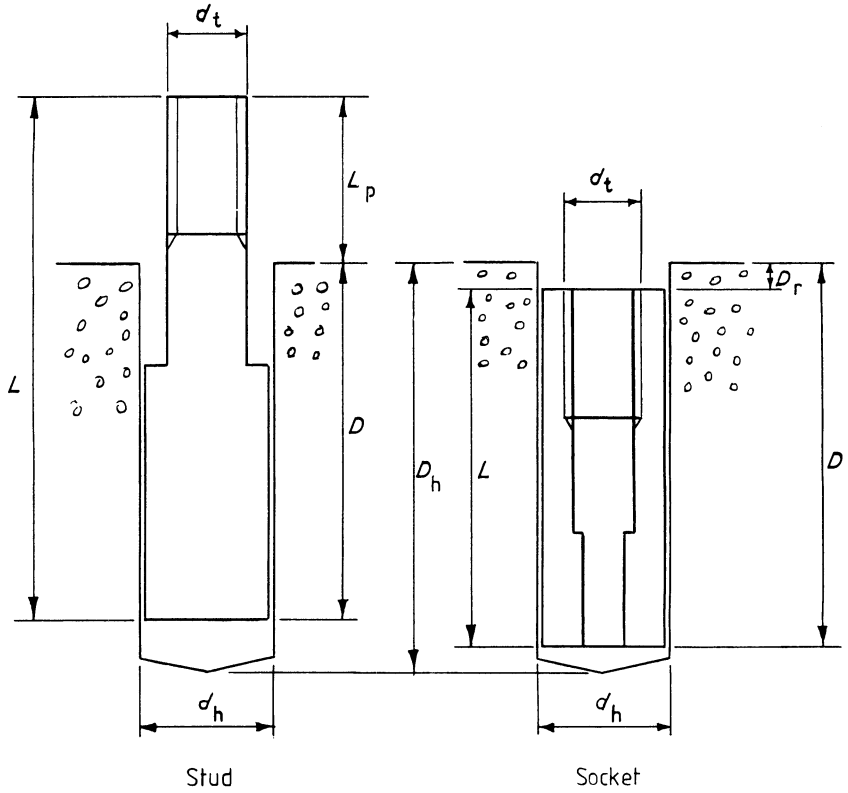
5) a description of the curing method;

6) at the time of testing, the concrete age, compressive strength and density; the compressive strength and the density shall be determined according to the method given in BS 1881-116:1983 and BS 1881-114:1983 respectively, (see **6.4**).

4.3 Standard specimen of other base materials

4.3.1 *Concrete*

The report shall comprise the description of its mix proportions, including the type of cement and aggregate, the location and type of any reinforcement, the shape and dimensions of the cast unit, and, when the fixing is tested, the concrete age, compressive strength and density. If the concrete is an autoclaved aerated proprietary type, the manufacturer's description of it shall be given. The compressive strength shall be determined according to the method given in BS 1881-116:1983 either on specimens cast from the same batch as that in which the fixing is installed, or on cores cut from the concrete or by other suitable methods.



Key

The following notation is used in figures 2*a*, 2*b*, 2*c* and 2*d*:

D	Embedded depth
D_h	Depth of hole
D_r	Recess depth of socket below surface of base material
d_h	Hole diameter
d_t	Thread diameter
L	Overall length of stud or socket
L_c	Length of channel insert
L_p	Length of stud projecting above surface of base material

For studs, $D = L - L_p$

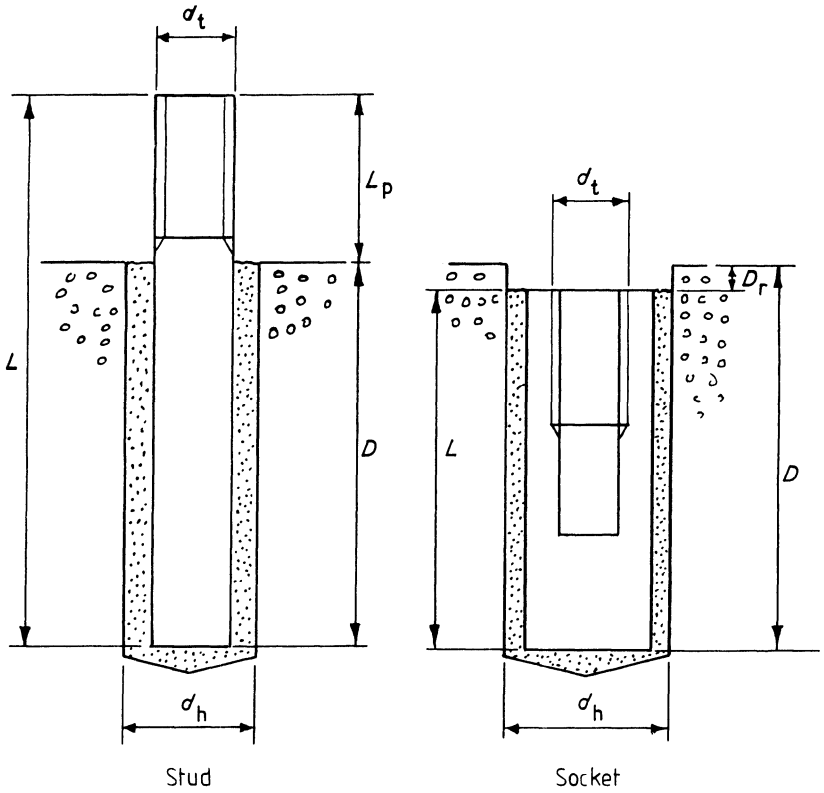
For sockets, $D = L + D_p$

NOTE 1 D_r may be zero

NOTE 2 The type of thread, e.g. ISO metric, should be stated.

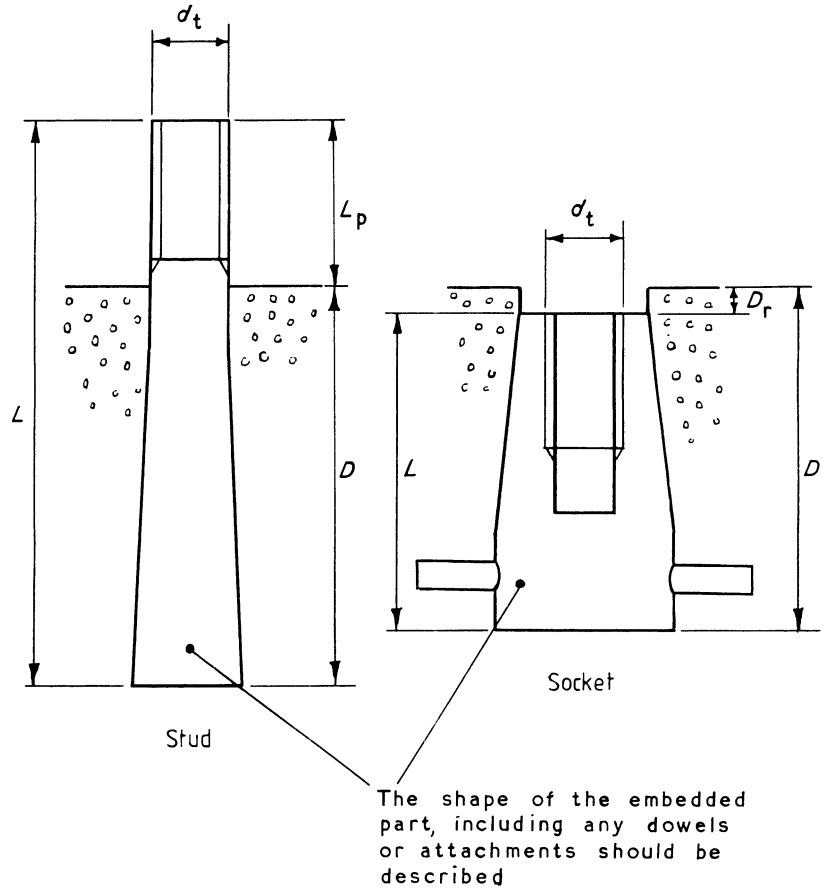
a) Expanding and undercut anchors

Figure 2 — Types of fixing to show the dimensions required for reporting their description

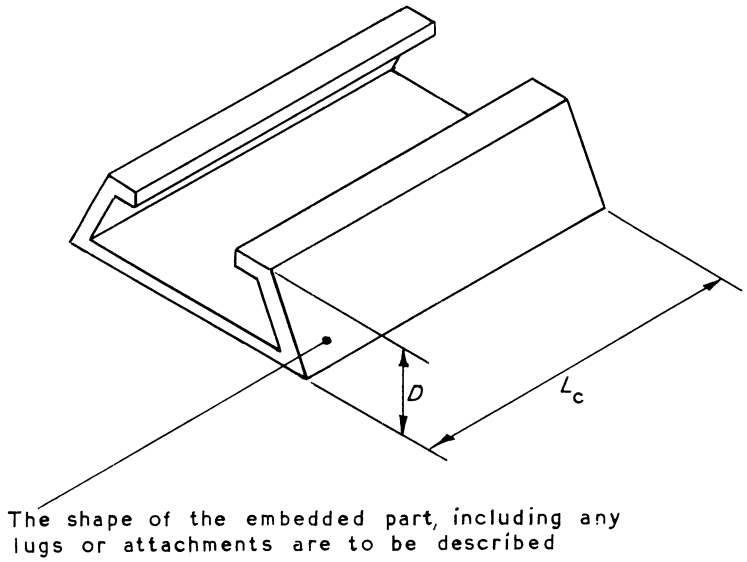


b) Bonded fixings

Figure 2 — Types of fixing to show the dimensions required for reporting their description *(continued)*



c) Cast-in fixings



d) Channel inserts

Figure 2 — Types of fixing to show the dimensions required for reporting their description *(concluded)*

4.3.2 *Natural stone*

The report shall comprise the description of its rock name, taken from BS 6100-5.2:1984 or BS 812-1:1975, its compressive strength, including the manner in which this was measured, the shape and dimensions of the block and the angle of the fixing relative to any natural bedding plane.

4.3.3 *Cast stone*

The report shall be the same as that for concrete in **4.3.1** except that its compressive strength shall be measured in accordance with BS 1217:1986. Where the cast stone consists partly of a facing material and partly of a structural concrete both parts shall be described.

4.3.4 *Brick or block masonry*

The report shall comprise the description of the variety and type of unit, as defined in BS 187:1978, BS 3921:1985 or BS 6073-1:1981, together with the size and compressive strength measured according to the relevant British Standard.

The thickness and bonding of the wall and the mix proportions and strength, in accordance with BS 4551:1980, of the mortar shall be given.

5 Installation of fixing

5.1 Expanding and undercut anchors

The hole shall be drilled and the anchor installed to the supplier's recommended procedure. Where this is incomplete a specified procedure shall be agreed between the supplier, the user and the testing agent. The hole shall be normal to the base material surface. The diameter of the drill bit and any other special feature used shall be as specified by the supplier of the fixing.

The report of installation shall comprise the following:

a) the supplier's name and reference number for the fixing including the nominal hole diameter for which the fixing is intended and the nominal diameter and thread type of the threaded portion;

b) the specification of the material from which the fixing is made and its finish;

c) the actual diameter of the bit used to drill the hole, measured to the nearest 0.1 mm before starting and after completion, and the type of drill employed, i.e. rotary, rotary-percussive or hammer;

d) the embedded length and, where relevant for impact expanded anchors, the hole depth, both to the nearest millimetre;

e) the location of the fixing in the sample or specimen of base material;

f) a copy of the supplier's recommended installation procedure with any additional observations on this procedure including the tightening torque where relevant.

5.2 Bonded fixings

The hole shall be drilled and proprietary systems installed to the supplier's recommended procedure. Non-proprietary systems, whether using resin adhesive or cement grout, shall be installed to the user's specification. The diameter of the drill bit used shall be as specified either by the supplier of the fixing for proprietary systems or by the user of non-proprietary systems. The hole shall be normal to the base material surface. The fixing shall be secured so that the axis of the threaded portion remains normal to the surface of the base material during the placing and hardening of the bonding material. As curing times for resin adhesives are dependent on the formulation of the constituents and the surrounding temperature, the test in **6.2** and **6.3** shall not be carried out until the adhesive has fully cured in accordance with the supplier's recommendations.

The report of installation shall comprise the following:

a) the supplier's name and reference number for the system or other full description where appropriate including the nominal hole diameter for which the fixing is intended and the nominal diameter of the threaded portion;

b) the specification of the material from which the fixing is made and its finish;

c) the actual diameter of the bit used to drill the hole, measured to the nearest 0.1 mm before starting and after completion, and the type of drill employed, i.e. rotary, rotary-percussive or hammer;

d) the embedded length and the hole depth to the nearest millimetre;

e) the location of the fixing in the sample or specimen of base material;

f) for resin systems, the type, source and adhesive used;

g) for cement grouts, the proportions of the material used, including, if required by the user, its strength at the time of test, determined in accordance with BS 4551:1980;

h) a copy of the supplier's recommended installation procedure with any additional observations on this procedure or the user's specification.

5.3 Cast-in fixings

The fixing shall be installed according to the supplier's recommended procedure or the user's specification. The fixing shall be secured so that the axis of the threaded portion remains normal to the surface of the base material while it hardens.

The report of installation shall comprise the following:

a) the supplier's name and reference number for the fixing or other full description where appropriate;

b) the size and shape of the fixing including a diagram where possible;

c) the specification of the material from which the fixing is made and its finish;

d) the embedded length of the fixing to the nearest millimetre and details of any attachment of the fixing to reinforcement in the base material;

e) the location of the fixing in the sample or specimen of base material;

f) the specification of the bolts used in socket type fixings.

5.4 Channel inserts

The insert shall be installed according to the supplier's recommended procedure. The fixing shall be secured so that it remains parallel to the surface of the base material while it hardens.

The report of installation shall comprise the following:

a) the supplier's name and reference number for the insert including details and location of any lugs attached to it;

b) the specification of the material from which the insert is made and its finish;

c) the length of the insert to the nearest millimetre;

d) the embedded depth to the nearest millimetre;

e) the location of the fixing in the sample or specimen of base material.

6 Apparatus

An axial tensile force shall be applied to the fixing by means of a loading frame acting through an attachment designed to suit the fixing. The reaction of the loading frame shall be applied to the base material at least 8*A* (see **4.1.1**) from the axis of the fixing. The loading frame shall be aligned to ensure axial application of the tensile force, which shall be measured to within an accuracy of 5 % by means of a pressure gauge, proving ring, load cell or other suitable device.

Relative movement between the fixing and the base material shall be measured to an accuracy of 0.02 mm. The measuring instrument shall be supported on one or more reference points, independent of the loading frame, fixed to the base material at least 12*A* from the axis of the fixing and shall be arranged to read directly the movement of the head of the fixing.

An example of a suitable form of the apparatus is shown in Figure 3.

NOTE Where tests are carried out for a specific application it may not be possible to comply with these dimensional requirements. In such situations every effort should be made to prevent the reaction forces from influencing the load-carrying performance of the fixing assembly. For example, the base material should not be restrained in such a way that a normal failure mode is prevented.

7 Procedure

7.1 Load application

7.1.1 *General*

Initially a force sufficient to take up any slack in the apparatus and attachment shall be applied. This force shall not exceed 1 % of the anticipated ultimate force. Readings taken at this stage constitute the base from which subsequent relative movement shall be measured. The load shall be applied either continuously or incrementally.

NOTE The measuring instruments may require protection from impact in the event of sudden fixing or base material failure.

7.1.2 *Continuous loading*

The rate of load application shall be such that the stress on the core diameter area increases at a rate of between 9 N/(mm^2·s) and 11 N/(mm^2·s). A simultaneously recorded graph of applied force and relative movement shall be made.

Loading shall continue until failure of the fixing device or base material, or until the device has pulled at least 5 mm past the point at which the applied force reaches a maximum at which stage the test can be terminated.

7.1.3 *Incremental loading*

Loading shall be increased by substantially equal increments, the applied force and relative movement being recorded at each increment. Sufficient readings shall be taken to enable a graph of applied force and relative movement to be drawn. Loading shall continue until failure of the fixing device or base materials or until the device has pulled at least 5 mm past the point of maximum applied force at which point the test may be terminated.

At higher loads, when displacement may occur with little corresponding increase in applied force, readings should be taken at increments of movement rather than load. Relaxation of load may also occur; the load level and the resulting movement has to stabilize before readings are taken and before the next increment is applied.

NOTE In order to produce a graph it will be necessary to obtain about 10 readings of applied force and relative movement.

7.2 Variations in load application

The test procedure described in **7.1** may be modified for axial tension under different loading conditions such as sustained loading, cyclic loading and impact loading. Until more specific guidance is available the test procedure should be agreed between the user and the testing agent, but should as far as possible follow the procedure given in this standard.

7.3 Base material strength at time of test

Tests in the standard specimen of base material shall be carried out when the concrete has attained a compressive strength of 30 $N/mm^2 \pm 3$ N/mm^2.

NOTE 1 This strength will be achieved at an age approximately 7 to 10 days with the mix prescribed.

NOTE 2 For tests in other base materials, the strength that the material should attain before the tests are carried out should be agreed between the user and the testing agent.

7.4 Number of tests

For tests in the standard specimen of base material, five samples of each type and size of fixing device shall be tested.

NOTE For other applications, the number of tests should be agreed between the user and the testing agent, but preferably at least five of each type and size should be tested.

8 Presentation of results

Each test shall be reported individually by plotting a graph of the force applied to the fixing against relative movement. It is recommended that the same unit length on the scales should represent 5 kN applied force and 1 mm relative movement.

The graph should be annotated to describe fully the behaviour of the fixing assembly throughout the test. Behavioural characteristics may include the following:

a) movement of expanding anchors or bonded fixings by slipping in their pre-drilled hole;

b) onset of cracking in the base material;

c) rupture of base material, differentiating between the characteristic mode of failure in which a roughly conical block of material surrounding the fixing is pulled away and splitting of the material through the plane of the fixing;

d) tensile fracture of the fixing device;

e) deformation of the component parts of the fixing device, e.g. thread stripping;

f) tensile or bond failure of bars or lugs attached to cast-in fixings or channel inserts.

For each series of tests with a given type and size of fixing, the mean and standard deviation for the applied force at a relative movement of 0.2 mm and at the ultimate force shall be calculated.

The standard deviation (S) is given by the following:

$$S = \sqrt{\frac{\Sigma(x - \bar{x})^2}{n - 1}}$$

where

S is the standard deviation;

x is the individual test result;

$\bar{x}$ is the arithmetic mean of the results;

n is the number of tests.

The fixing and the base material should be examined wherever possible after completion of the test and any significant features noted.

9 Test report

The testing agent shall provide a report giving the following information for each type and size of fixing:

a) confirmation that the test has been carried out in accordance with this Part of BS 5080. If tests are carried out on site then any deviation from the requirements of this standard shall be detailed;

b) the name and location of the testing authority and the date the test was carried out;

c) the specification and description of the base material as defined in clause **4**;

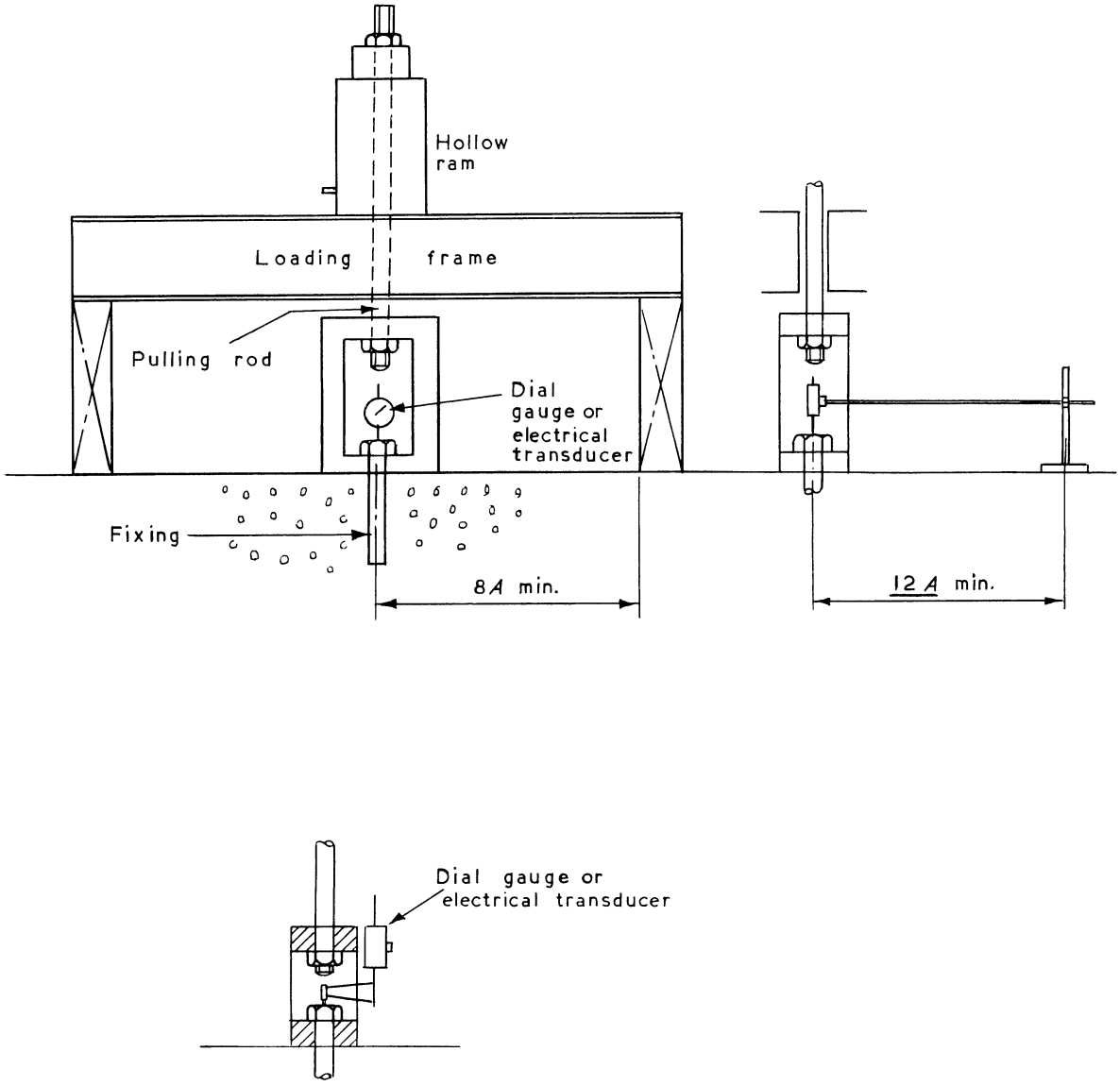
d) the description of the installation of the fixing as defined in clause **5**;

e) the method of loading, either continuous or incremental as defined in clause **7**;

f) where the dimensional requirements for clause **6** cannot be complied with, e.g. in tests described in the note to clause **6**, a description of the test layout with the dimensions adopted shall be reported;

g) the testing procedure if modified as allowed in **7.2**;

h) the presentation of results as defined in clause **8**.



Alternative location for the dial gauge or transducer

NOTE The dimension *A* is defined for each type of fixing in **4.2.1**

Figure 3 — A suitable form of loading apparatus

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List of references (see clause 2)

Normative references

BSI standards publications

BRITISH STANDARDS INSTITUTION, London

BS 12:1991, *Specification for Portland cement.*
BS 187:1978, *Specification for calcium silicate (sandlime and flintlime bricks).*
BS 812, *Testing aggregates.*
BS 812-1:1975, *Methods for determination of particle size and shape.*
BS 882:1983, *Specification for aggregates from natural sources for concrete.*
BS 1217:1986, *Specification for cast stone.*
BS 1881, *Testing concrete.*
BS 1881-114:1983, *Methods for determination of density of hardened concrete.*
BS 1881-116:1983, *Method for determination of compressive strength of concrete cubes.*
BS 3921:1985, *Specification for clay bricks.*
BS 4551:1980, *Methods of testing mortars, screeds and plasters.*
BS 6073, *Precast concrete masonry units.*
BS 6073-1:1981, *Specification for precast concrete masonry units.*
BS 6100, *Glossary of building and civil engineering terms.*
BS 6100-5, *Masonry.*
BS 6100-5.2:1984, *Stone.*

Informative references

BSI standards publications

BRITISH STANDARDS INSTITUTION, London

BS 5080, *Methods for test for structural fixings in concrete and masonry.*
BS 5080-2:1986, *Method for determination of resistance to loading in shear.*

BSI — British Standards Institution

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