BS 939:2007

BRITISH STANDARD

Engineers' squares (including cylindrical and block squares) – Specification

ICS 25.060.01

BSI
British Standards

Publishing and copyright information

ISBN 978 0 580 58628 6

The following BSI references relate to the work on this standard:
Committee reference MTE/1
Draft for comment 07/30163789 DC

Publication history

First published January 1941
First revision, November 1962
Second revision, September 1977
Third revision, October 2007

Amendments issued since publication

Amd. no.	Date	Text affected

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 26, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI and came into effect on 31 October 2007. It was prepared by Technical Committee MTE/1, *Machine tools*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 939:1977, which is withdrawn.

Information about this document

This is a full revision of the standard.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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Section 1: General

1 Scope

This British Standard specifies requirements for engineers' try squares (excluding adjustable squares), cylindrical squares and block squares of solid or open form.

Section 1 specifies general requirements applicable to all types of square.

Section 2 specifies requirements for engineers' try squares in three grades of accuracy, AA, A and B, with inner lengths of blade from 50 mm up to and including 1 000 mm.

Section 3 specifies requirements for cylindrical squares in accuracy grade AA in sizes from 75 mm up to and including 750 mm.

Section 4 specifies requirements for solid form block squares in accuracy grades AA and A in sizes from 50 mm × 40 mm up to and including 1 000 mm × 1 000 mm.

Section 5 specifies requirements for open form block squares in accuracy grades A and B in sizes from 150 mm × 100 mm up to and including 600 mm × 400 mm.

NOTE While the standard provides for squares in various grades of accuracy, it should be noted that their accuracy in use is dependent upon the flatness of the surfaces on which they are used.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 1134-1, A*ssessment of surface texture – Part 1: Methods and instrumentation*

BS EN 1561:1997, *Founding – Grey cast irons*

BS 3643-1:1981, *ISO metric screw threads – Principles and basic data*

BS 3643-2:1981, *ISO metric screw threads – Specification for selected limits of size*

3 Terms and definitions

For the purposes of this British Standard the nomenclature given in Figure 2a), Figure 6, Figure 7 and Figure 8, and the following terms and definitions apply.

3.1 deviation from straightness and flatness
minimum distance between two parallel planes that just enclose the surface under consideration

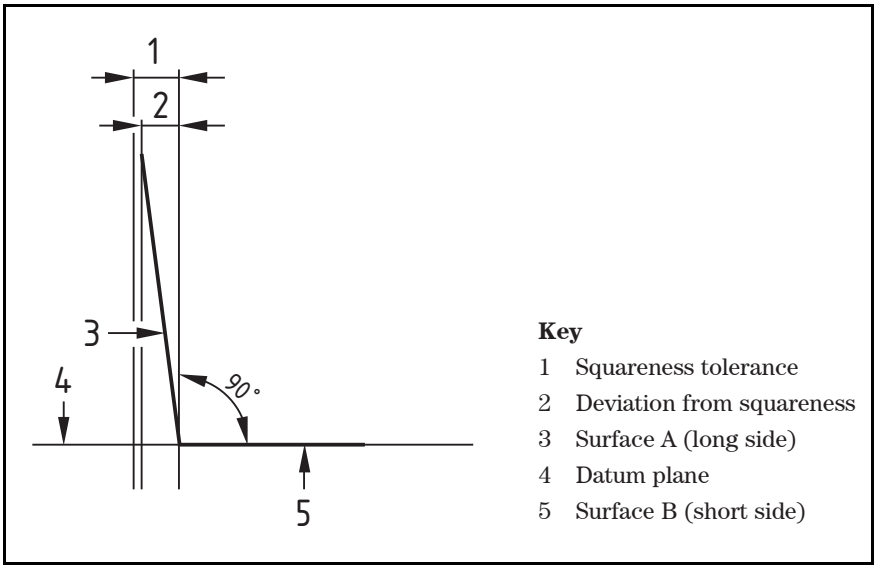
3.2 deviation from parallelism
difference between the maximum and minimum distances separating the surfaces or edges under consideration

3.3 Squareness of two surfaces

3.3.1 deviation from squareness
minimum distance between two parallel planes that will just enclose one surface (A), including any straightness error of surface (A), and that are perpendicular to a datum plane in contact with the other surface (B) (see Figure 1)

3.3.2 squareness tolerance
maximum permissible deviation from squareness (see Figure 1)

Figure 1 **Exaggerated illustration of deviation from squareness and squareness tolerance**



3.4 tolerances
maximum permissible deviations from straightness, flatness, parallelism and squareness

4 Protection against climatic conditions

All surfaces of the squares shall be protected against climatic conditions by being covered with a suitable corrosion preventative preparation or a paper impregnated with a vapour phase inhibitor (VPI).

NOTE 1 Temporary (easily removable) corrosion preventatives are dealt with fully in BS 1133-6.2.

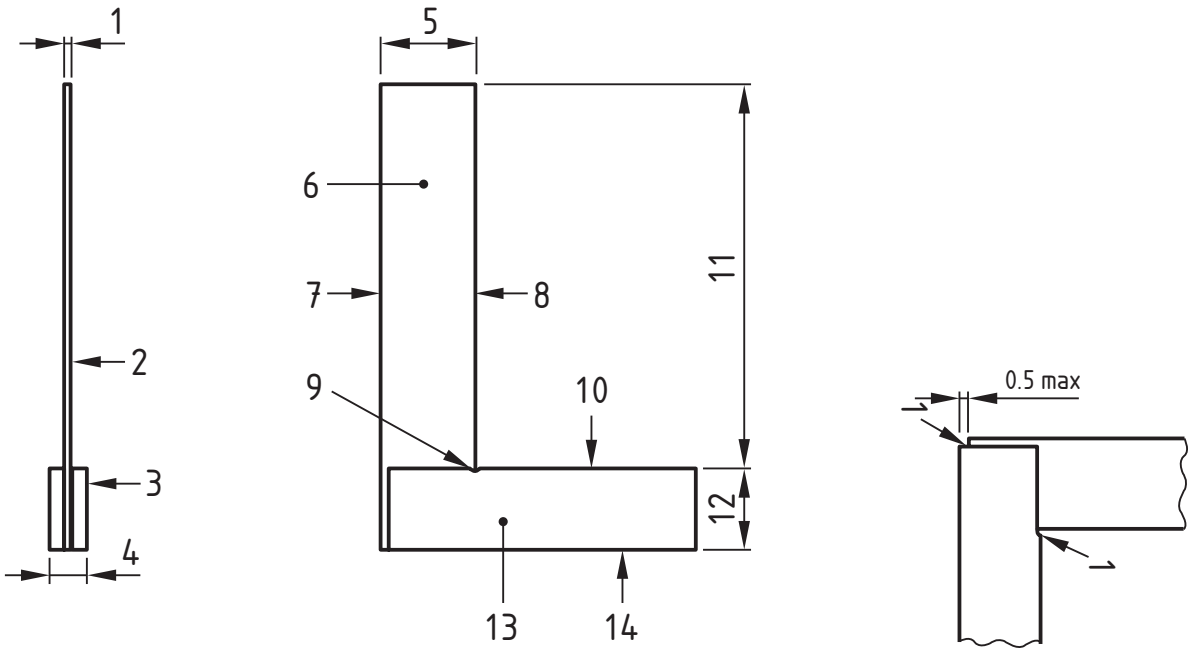
NOTE 2 Guidance on sealed packs with desiccants is given in BS 1133-19.

Section 2: Engineers' try squares

5 Designating size

The designating size of an engineers' try square shall be the length of the blade from its tip to the inner working face of the stock (see Figure 2).

Figure 2 **Engineers' try squares**



Key

1 Thickness of blade
2 Side face of blade
3 Side face of stock
4 Thickness of stock
5 Width
6 Blade
7 Outer edge of blade
8 Inner edge of blade
9 Relief
10 Inner working face of stock
11 Inner length of blade and designating size of square
12 Depth
13 Stock
14 Outer working face of stock

a) Nomenclature

Key

1 Relief

b) Other forms of relief

6 Recommended sizes

Recommended sizes (in mm) of engineers' try squares are: 50, 75, 100, 150, 200, 300, 450, 600, 800 and 1 000; squares of other sizes shall be ordered only when it is not practicable to adopt one of the recommended sizes. If squares of intermediate sizes are supplied they shall be made to the same tolerances as those specified for the next smaller recommended size.

7 Material and manufacture

All engineers' try squares shall be made of good quality steel. The working surfaces of grades AA and A squares shall be hardened to a value of not less than 600 HV and subjected to an appropriate stabilization process.

8 General features of design

8.1 When the blade and stock of a try square are built up from separate parts, the blade shall be rigidly and permanently fixed in the stock.

Grade AA try squares shall have the inner and outer edges of the blade bevelled so that the approximate width of the reduced edge is as follows (see also Annex A):

Size of square	**Approximate width of bevelled edge**
mm	mm
50 and 75	0.25
100 and 150	0.40
200 and 300	0.65
450	0.75
600	1.00
800 and 1 000	1.50

8.2 For all three grades of try square the stock shall be relieved at the junction of the inner edge of the blade and the inner working face of the stock [see Figure 2a)].

The inner working face of the stock may be terminated at its junction with the inner edge of the blade, in which case the area of the working face of the stock, which projects along both sides of the blade, shall be relieved below the plane of the working face of the stock [see Figure 2b)].

NOTE The blade may be recessed from the outer working face of the stock by not more than 0.5 mm [see Figure 2b)].

9 Finish

All working surfaces of the blade and stock of the three grades of engineers' try square shall have a lapped, finely ground or polished finish, having a surface roughness value of 1.0 µm R_a maximum according to BS 1134-1, and all sharp edges shall be removed.

10 Accuracy

10.1 Straightness of inner and outer edges of blade

Each edge of the blade shall be straight to within the tolerance specified in Table 1 when the outer working face or side face of the stock is resting on a horizontal surface.

Table 1 **Tolerances on straightness of blade edges**

Size of square	**Tolerance**		
	Grade AA	**Grade A**	**Grade B**
mm	µm	µm	µm
50, 75	2	4	8
100, 150	2	4	8
200	2	4	8
300	3	6	12
450	4	8	16
600	6	12	24
800	8	16	32
1 000	10	20	40

10.2 Parallelism of blade edges

The blade edges shall be parallel to each other to within the tolerances specified in Table 2.

Table 2 **Tolerances on parallelism of blade edges**

Size of square	**Tolerance**		
	Grade AA	**Grade A**	**Grade B**
mm	µm	µm	µm
Up to 150	3	5	8
200, 300	3	8	12
450, 600	7	12	18
800, 1 000	12	18	24

10.3 Flatness of working faces of stock

Each working face of the stock shall be flat to within the tolerance specified in Table 3. Deviations from flatness shall be of concave nature to prevent rock.

Table 3 **Tolerances on flatness of working faces of stock**

Size of square	**Tolerance**		
	Grade AA	**Grade A**	**Grade B**
mm	µm	µm	µm
50, 75	1	2	4
100, 150	1.5	3	6
200	2	4	8
300	2	4	8
450	2.5	5	10
600	4	8	16
800	5	10	20
1 000	6	12	24

10.4 Parallelism of working faces of stock

The working faces of the stock shall be parallel to within the tolerances specified in Table 4.

Table 4 **Tolerances on parallelism of working faces of stock**

Size of square	**Tolerance**		
	Grade AA	**Grade A**	**Grade B**
mm	µm	µm	µm
Up to 150	2	3.5	5
200, 300	3	5	8
450, 600	5	8	12
800, 1 000	8	12	16

10.5 Parallelism of side faces of stock

The side faces of the stock shall be parallel to within the tolerance specified in Table 5.

Table 5 **Tolerances on parallelism of side faces of stock**

Size of square	**Tolerance**
	All grades
mm	µm
Up to 150	25
200, 300	50
450, 600	100
800, 1 000	150

10.6 Squareness of side faces of stock to working faces of stock

The side faces of the stock shall be square to the working faces as follows:

- Grade AA to within 1 µm/mm
- Grade A to within 2 µm/mm
- Grade B to within 3 µm/mm

10.7 Squareness of edges of blade to side faces of stock

The inner and outer edges of the blade shall be square to the side faces of the stock to within 15 µm over the thickness of the edges.

10.8 Squareness of edges of blade to working faces of stock

When the square is placed upright on a horizontal surface the maximum departure from squareness of:

a) the outer edge of the blade to the outer working face of the stock; and

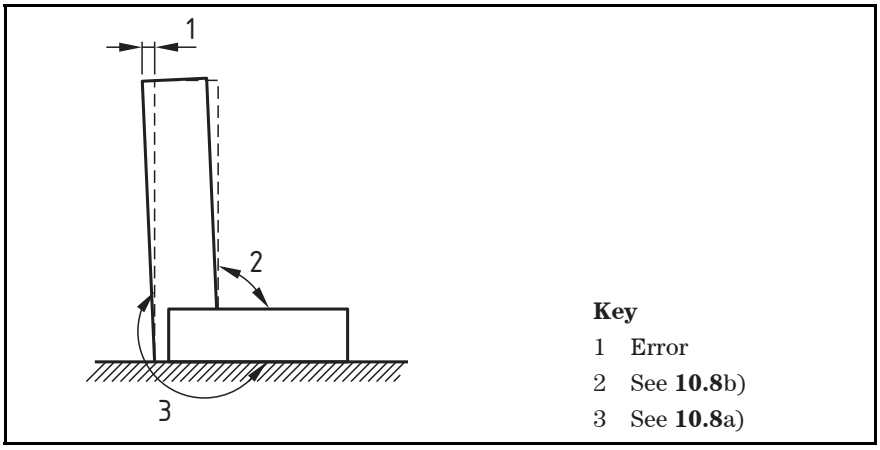
b) the inner edge of the blade to the inner working face of the stock;

shall not exceed the tolerance specified in Table 6 (see Figure 3).

Table 6 **Tolerances on squareness of blade edges to working faces of stock**

Size of square	**Tolerance measured at tip of blade**		
	Grade AA	**Grade A**	**Grade B**
mm	µm	µm	µm
50, 75	4	8	16
100, 150	4	8	16
200	4	8	16
300	6	12	24
450	8	16	32
600	12	24	48
800	16	32	64
1 000	20	40	80

Figure 3 **Squareness of blade edges to working faces of stock**



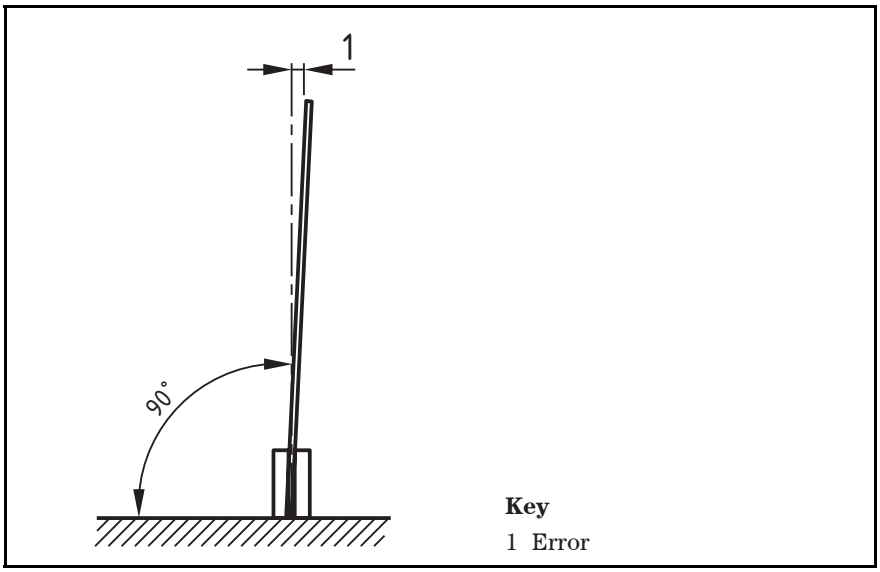
10.9 Lateral squareness of blade

The blade shall be laterally square to the base of the stock to within the tolerances specified in Table 7 (see Figure 4).

Table 7 **Tolerance on lateral squareness of blade to base of stock**

Size of square	**Tolerance measured at tip of blade**		
	Grade AA	**Grade A**	**Grade B**
mm	µm	µm	µm
50, 75	50	75	125
100, 150	75	125	250
200, 300	125	200	375
450	200	300	500
600	250	300	500
800	300	375	600
1 000	300	375	650

Figure 4 **Lateral squareness of blade**

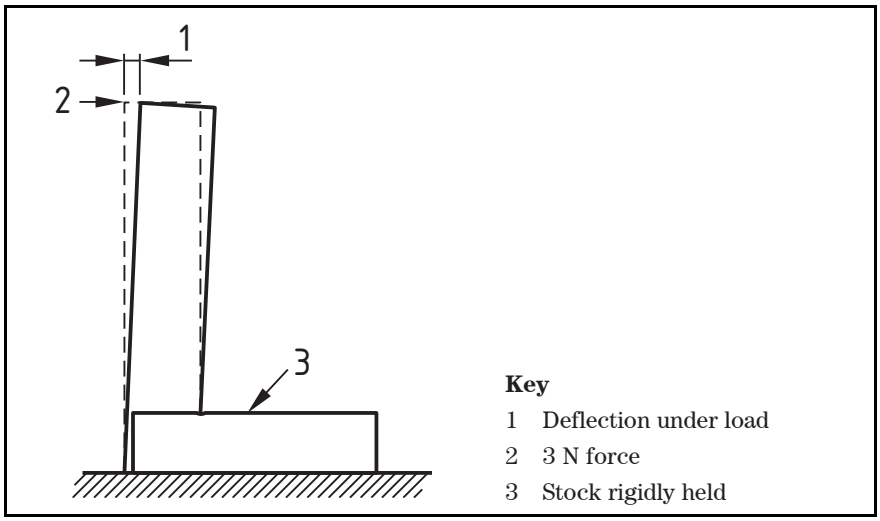


11 Rigidity

When the stock of the try square is rigidly clamped and a force of 3 N is applied to the free end of the blade in a horizontal direction parallel to the length of the stock, the end of the blade shall not deflect in this direction by an amount greater than the tolerance specified in Table 6 (see Figure 5).

NOTE This test is independent of any errors in the try square in its "free" condition.

Figure 5 **Rigidity**



12 Marking

Each try square shall have legibly and permanently marked upon it the following:

a) the number of this British Standard, i.e. BS 939;

b) the grade designation, e.g. A;

c) an identification number for grade AA try squares; and

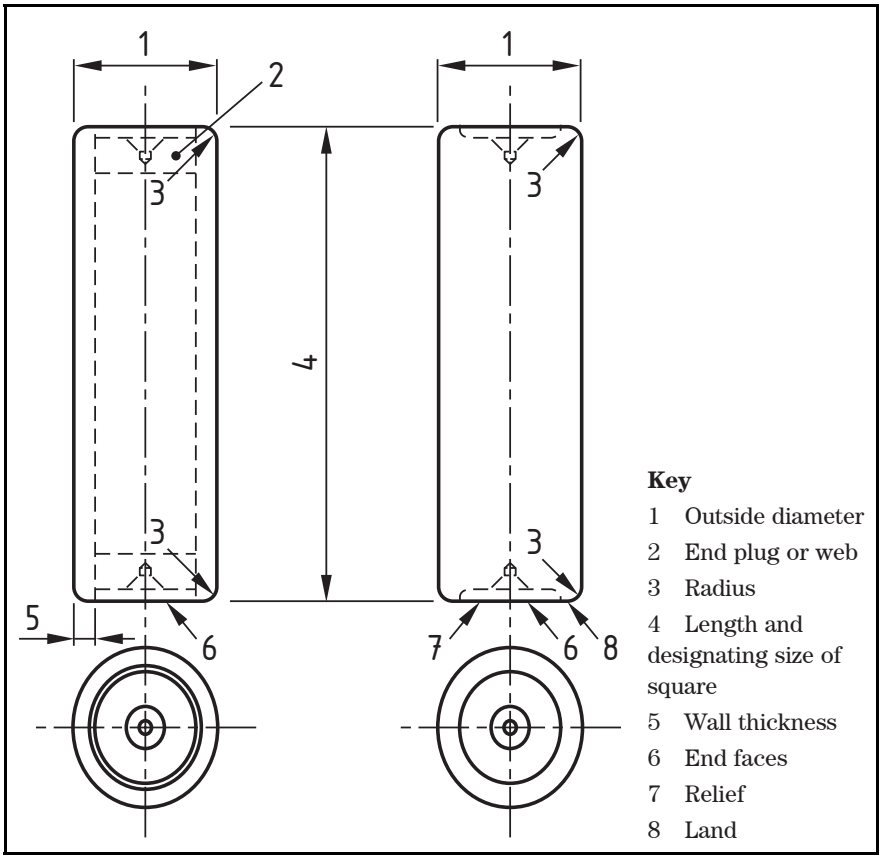
d) the manufacturer's name or trade mark.

Section 3: Cylindrical squares

13 Designating size

The designating size of a cylindrical square shall its length (see Figure 6).

Figure 6 **Nomenclature for cylindrical squares**



14 Recommended sizes and dimensions

Recommended sizes and dimensions of cylindrical squares are specified in Table 8. Squares of other sizes shall be ordered only when it is not practicable to adopt one of the recommended sizes. If squares of intermediate sizes are supplied they shall be made to the same tolerances as those specified for the next smaller recommended size.

Table 8 **Recommended sizes and dimensions of cylindrical squares**

Length	Outside diameter	Wall thickness (hollow section, see 16.1)
mm	mm	mm
75	50	—
150	70	—
220	90	—
300	95	12
450	120	16
600	140	20
750	160	22

15 Material and manufacture

15.1 Material

Cylindrical squares shall be made of high quality steel, or cast iron, or granite.

15.2 Steel squares

The external surfaces of steel squares shall be hardened to a value of not less than 600 HV and the squares shall be subjected to an appropriate stabilization process.

15.3 Cast iron squares

Cast iron squares shall be made of close grained plain, or alloy cast iron in conformance with the minimum requirements for material designation EN-GJL-200 as specified in BS EN 1561:1997.

The material shall be sound and free from blowholes and porosity. Minor defects may, however, be repaired by plugging with material of a similar composition to that from which the squares are made.

It is recommended that cast iron squares should be hardened to a value of not less than 500 HV and subjected to an appropriate stabilization process, but cast iron squares may be unhardened.

NOTE Higher grades of cast iron are available that would be more resistant to gross mishandling than EN-GJL-200, but EN-GJL-200 is specified because it offers the best combination of wear resistance and rigidity.

15.4 Granite (diabase) squares

Granite may be used as a material for squares and is particularly suitable for the larger sizes as its weight is approximately half that of the equivalent size in steel or solid-type cast iron. The rock shall be close grained and of uniform texture, free from flaws and fissures and from inclusions of softer materials. The colour of the granite, which is dependent on the mineral composition, is of no importance, but the colour of any individual square should be uniform.

16 General features of design

16.1 In order to reduce weight it is recommended that steel or cast iron cylindrical squares of 300 mm length and greater should be of hollow section.

16.2 The end faces of solid cylindrical squares shall be relieved and provided with lands having a minimum width of 10 mm.

16.3 Hollow squares shall be provided with permanent conical centres for purposes of manufacture and reconditioning.

16.4 All cylindrical squares shall have an outside radius R of 1 mm or a 45° chamfer of 0.5 mm to 1.0 mm.

It is recommended that cylindrical squares, particularly in the larger sizes, be provided with suitable lifting handles.

17 Finish

External surfaces of cylindrical squares shall have a lapped or finely ground finish.

18 Accuracy

18.1 General

Cylindrical squares shall be accurate to within the tolerances specified in Table 9.

18.2 Straightness of sides

The sides of the cylinder shall be straight when the square is standing on its base, or when supported horizontally at the positions of minimum flexure, to within the tolerances specified in column two of Table 9.

18.3 Flatness of ends

The ends shall be flat within the tolerances specified in column three of Table 9. Any departure from flatness shall be of a concave configuration.

18.4 Squareness of cylindrical surface to end faces

The squareness of the cylindrical surface shall be tested by placing the cylinder on a grade AA or A surface plate, first on one end face and then on the other[1)]. The maximum error found in the squareness of the cylindrical surface along any generator to the surface plate shall not exceed the tolerances specified in column four of Table 9.

Table 9 **Tolerances on cylindrical squares**

Size of square	**Straightness of sides of cylinder**	**Flatness of end faces**	**Squareness of end faces with cylindrical surface over length of cylinder**
mm	µm	µm	µm
75	1	1	1.5
150	1.5	1.5	2
220	2	2	3
300	3	2.5	5
450	4.5	4	7
600	6	5	9
750	7.5	6	11

[1)] Granite cylindrical squares may be designated “square to base end only”, one end being required for marking purposes.

19 Marking

Each square shall have legibly and permanently marked upon it the following, and the marking shall not protrude above the working surfaces of the square:

a) the number of this British Standard, i.e. BS 939;

b) the designating size and grade, e.g. 450 mm AA;

c) an identification number;

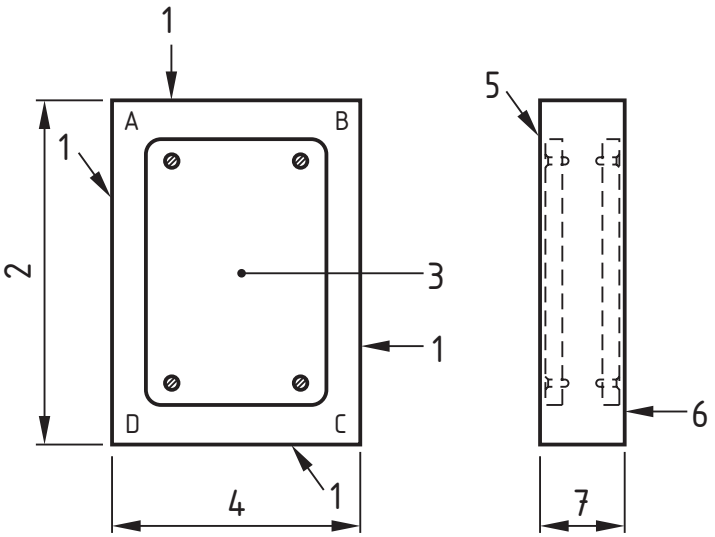
d) the manufacturer's name or trade mark.

Section 4: Solid form block squares

20 Designating size

The designating size of a solid form block square is its length by its width in millimetres, e.g. 150 mm × 100 mm (see Figure 7).

Figure 7 **Nomenclature for solid form block squares**



Key

1 Working faces
2 Length
3 Heat insulating insert
4 Width
5 Steel back surface
6 Steel front surface
7 Depth

21 Recommended sizes and dimensions

Recommended sizes and dimensions of solid form block squares are specified in Table 10. Squares of other sizes shall be ordered only when it is not practicable to adopt one of the recommended sizes. If squares of intermediate sizes are supplied they shall be made to the same tolerances as those specified for the next smaller recommended size.

Table 10 **Recommended sizes and dimensions of solid form block squares**

	Length	Width	Depth
	mm	mm	mm
Steel squares	50	40	12
	75	50	14
	100	75	20
	150	100	22
Granite (diabase) or cast iron squares	150	150	50
	250	250	75
	350	350	75
	450	450	75
	600	600	100
	750	750	100
	1 000	1 000	100

22 Material and manufacture

22.1 Material

Solid form block squares shall be made of high quality steel, or cast iron, or granite.

22.2 Steel squares

All working surfaces shall be hardened to a value of not less than 750 HV and subjected to an appropriate stabilization process.

22.3 Cast iron squares

Cast iron squares shall be made of close grained plain, or alloy cast iron in conformance with the minimum requirements for material designation EN-GJL-200 as specified in BS EN 1561:1997.

The material shall be sound and free from blowholes and porosity. Minor defects may, however, be repaired by plugging with material of a similar composition to that from which the squares are made.

It is recommended that cast iron squares should be hardened to a value of not less than 500 HV and subjected to an appropriate stabilization process, but cast iron squares may be unhardened.

NOTE Higher grades of cast iron are available that would be more resistant to gross mishandling than EN-GJL-200, but EN-GJL-200 is specified because it offers the best combination of wear resistance and rigidity.

22.4 Granite (diabase) squares

Granite may be used as a material for block squares and is particularly suitable for large precision squares as its weight is approximately half that of the equivalent size in steel. The rock shall be close grained and of uniform texture, free from flaws and fissures and from inclusions of softer materials. The colour of the granite, which is dependent on the mineral composition, is of no importance but the colour of any individual square should be uniform.

23 General features of design

23.1 The front and back surfaces of each solid form steel block square shall be recessed and fitted with a heat insulating material. This heat insulating material and the heads of any securing screws shall not stand proud of the surfaces (see Figure 7).

23.2 The front and back surfaces of granite squares may be relieved or recessed. Granite block squares 250 mm and larger may be provided with holes for lifting or lightening purposes. Inserts threaded in accordance with BS 3643-1:1981 and BS 3643-2:1981 may be fitted for clamping purposes or to accommodate lifting handles or rings.

When fitted for clamping purposes the inserts shall be M6 or M10, class 6H tolerance. The position of the inserts may be specified by the manufacturer or as requested by the customer, but no insert periphery shall be nearer than 20 mm to any edge.

24 Finish

24.1 All working faces of solid form steel block squares shall have a lapped finish, preferably of high reflectivity, suitable for optical applications. The front and back surfaces shall have a lapped or finely ground finish.

24.2 All working faces of solid form granite or cast iron block squares shall have a lapped or finely ground finish and shall be free from surface defects.

24.3 All sharp edges shall be removed and corners shall be rounded.

25 Accuracy

All working faces of solid form block squares shall be accurate to within the tolerances specified in Table 11 and Table 12.

Table 11 **Tolerances on flatness, parallelism and squareness of working faces (solid iron block squares)**

Size of square	**Tolerance**					
	Grade AA			**Grade A**		
	Flatness	**Parallelism**	**Squareness over length**	**Flatness**	**Parallelism**	**Squareness over length**
mm	µm	µm	µm	µm	µm	µm
50 × 40	0.5	0.8	1.5	1.0	1.5	3.0
75 × 50	0.5	0.8	1.5	1.0	1.5	3.0
100 × 75	1.0	1.0	1.5	2.0	2.0	3.0
150 × 100	1.5	1.5	2.0	3.0	3.0	4.0
150 × 150	1.5	1.5	2.0	3.0	3.0	4.0
250 × 250	2.5	2.5	4.0	5.0	5.0	8.0
350 × 350	3.5	3.5	5.0	7.0	7.0	10.0
450 × 450	4.5	4.5	7.0	9.0	9.0	14.0
600 × 600	6.0	6.0	9.0	12.0	12.0	18.0
750 × 750	7.5	7.5	11.0	15.0	15.0	22.0
1 000 × 1 000	10.0	10.0	15.0	20.0	20.0	30.0

Table 12 **Tolerances on flatness and squareness of front and back surfaces (solid iron block squares)**

Size of square	**Tolerance**			
	Grade AA		**Grade A**	
	Overall flatness of front and back surfaces	**Squareness over depth of working face**	**Overall flatness of front and back surfaces**	**Squareness over depth of working face**
mm	µm	µm	µm	µm
Up to 150 × 100	5	3	10	6
Above 150 × 100 up to 450 × 450	8	5	16	10
Above 450 × 450	12	10	24	20

26 Marking

Each solid form block square shall have legibly and permanently marked on it the following; the marking may be on the front heat insulating insert of steel squares or on an insert in a recess on granite squares. The marking or insert shall not protrude above the front surface:

a) the number of this British Standard, i.e. BS 939;

b) the designating size;

c) the grade designation (AA or A, as appropriate);

d) an identification number for grade AA squares;

e) the manufacturer's name or trade mark.

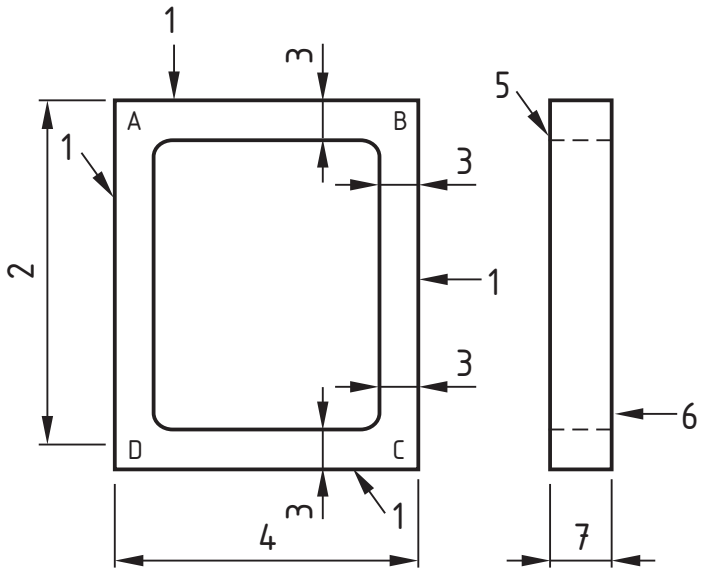
In addition, the four corners of the front surface shall be identified by the letters A, B, C and D respectively.

Section 5: Open form block squares

27 Designating size

The designating size of an open form block square shall be its length by its width in millimetres (see Figure 8).

Figure 8 **Nomenclature for open form block squares**



Key

1 Working faces
2 Length
3 Wall thickness
4 Width
5 Back surface
6 Front surface
7 Depth

28 Recommended sizes and dimensions

Recommended sizes and dimensions of open form block squares are given in Table 13.

Squares of other sizes should be ordered only when it is not practicable to adopt one of the recommended sizes. If squares of intermediate sizes are supplied they should be made to the same tolerances as those specified for the next smaller recommended size.

Table 13 **Recommended sizes and dimensions of open form block squares**

Length	**Width**	**Depth**	**Wall thickness**
mm	mm	mm	mm
150	100	50	20
200	125	50	25
250	150	50	30
300	200	50	35
450	300	75	40
600	400	75	45

29 Material

29.1 Open form block squares shall be made of close grained plain, or alloy cast iron in conformance with the minimum requirements for material designation EN-GJL-200 as specified in BS EN 1561:1997.

NOTE Higher grades of cast iron are available that would be more resistant to gross mishandling than EN-GJL-200, but EN-GJL-200 is specified because it offers the best combination of wear and rigidity.

29.2 The material shall be sound and free from blowholes and porosity. Minor defects may, however, be repaired by plugging with a material of similar composition to that from which the squares are made.

It is recommended that cast iron squares should be hardened to a value of not less than 500 HV and subjected to an appropriate stabilization process, but cast iron squares may be unhardened.

30 General features of design

The general shape of open form block squares shall be as shown in Figure 8.

31 Finish

The working faces and front and back surfaces of open form block squares shall have a lapped or finely ground finish.

All sharp edges shall be removed and corners shall be rounded.

The inside surfaces shall have the skin removed and shall be painted.

32 Accuracy

32.1 General

All working faces of open form block squares shall be accurate to within the tolerances specified in Table 14 and Table 15.

32.2 Open form block squares supplied in matched pairs

When open form block squares are supplied in matched pairs, their mean lengths and widths shall be respectively equal to within the following tolerances:

- Grade A: 5 μm for sizes up to 300 mm × 200 mm and 10 μm for larger sizes; and
- Grade B: 10 μm for sizes up to 300 mm × 200 mm and 20 μm for larger sizes.

Table 14 **Tolerances on flatness, parallelism and squareness of working faces (open form block squares)**

Size of square	Tolerance					
	Grade A			Grade B		
	Flatness	Parallelism	Squareness over length	Flatness	Parallelism	Squareness over length
mm	µm	µm	µm	µm	µm	µm
150 × 100	2.5	4	5	5	8	10
200 × 125	3	4.5	6	6	9	12
250 × 150	4	6	8	8	12	16
300 × 200	4.5	7	9	9	14	18
450 × 300	7	10	14	14	20	28
600 × 400	9	14	18	28	28	36

Table 15 **Tolerances on flatness and squareness of front and back surfaces (open form block squares)**

Size of square	Tolerances			
	Grade A		Grade B	
	Overall flatness of front and back surfaces	Squareness over depth of working face	Overall flatness of front and back surfaces	Squareness over depth of working face
mm	µm	µm	µm	µm
Up to 450 × 300	16	6	32	12
Above 450 × 300	24	20	48	40

33 Marking

Each open form block square shall be legibly and permanently marked on the front surface with the following:

a) the number of this British Standard, i.e. BS 939;

b) the designating size;

c) the grade designation (A or B, as appropriate);

d) an identification number[2)];

e) the manufacturer's name or trade mark.

In addition, the four corners on the front surface shall be marked with the letters A, B, C and D respectively.

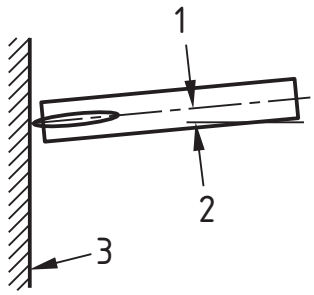
[2)] Matched pairs should have the same identification number followed by a suffix a or b, e.g. 312a, 312b.

Annex A (informative) Notes regarding bevelled edges on blades of grade AA engineers' try squares

The edges of the blades of grade AA engineers' try squares are reduced in width to a so-called "knife edge" (as specified in Clause **8**) to increase the sensitivity of the square in use.

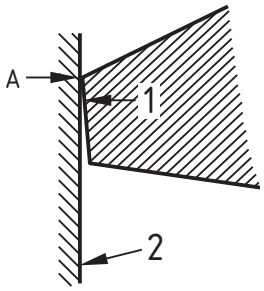
The operation of bevelling the edges of the blade of a square should be carried out with care, bearing in mind the possibility of the square being used in practice with its plane slightly out of the normal to the surface under test (see Figure A.1).

Figure A.1 **Using a bevelled edge**



Key
1 Plane of square
2 Normal to surface
3 Surface under test

a) Plan view of square



Key
1 Knife edge flat or slightly rounded
2 Surface under test

b) Enlarged view of contact between knife edge and surface under test

If the sharp edge, A, formed by the junction of the bevel and the reduced edge of the blade is not straight and/or laterally parallel to the plane of the square, the square will show erroneous results unless it is presented to the surface under test with its plane truly normal to that surface.

Squares with bevelled edge blades are unsuitable for testing cylindrical surfaces. For this purpose, an ordinary square with a flat edged blade or a block square should be used since the cylindrical surface itself provides the necessary sensitive line contact.

Annex B (informative) Notes on the manufacture and testing of squares

B.1 General

There are numerous recognized methods of testing squares, and further information may be found in appropriate test books. The recommendations given in this annex are offered for general guidance in the hope that they may prove helpful to users of the standard.

This annex deals with:

a) cylindrical and block squares;

b) testing of engineers' try squares; and

c) the rigidity and design of engineers' try squares.

B.2 Cylindrical and block squares

B.2.1 General

Cylindrical and block squares possess advantages in that they can be manufactured and tested initially from first principles by simple methods; the parallelism of their sides renders them, in a sense, self checking both during manufacture and during use at a later stage; finally, their form is such as to inspire confidence that their accuracy will be maintained with reasonable use, provided the material of which they are made has been stress relieved.

It therefore follows that one of the most satisfactory methods of testing the accuracy of an engineers' try square is by comparison with a known square of the cylindrical or block type.

B.2.2 Cylindrical squares

In manufacturing this type of square, the end faces and the cylindrical surface of the square should be ground at one setting with the cylinder mounted between centres. Care has to be taken to grind the cylindrical surface truly parallel. If true parallelism is achieved (and this may be readily checked with a comparator) it follows that the cylindrical surface should be truly square with the two end faces. However, should a small residual error in squareness remain, the effect of such an error may be eliminated in use by making observations on diametrically opposite generators of the cylinder.

B.2.3 Block squares

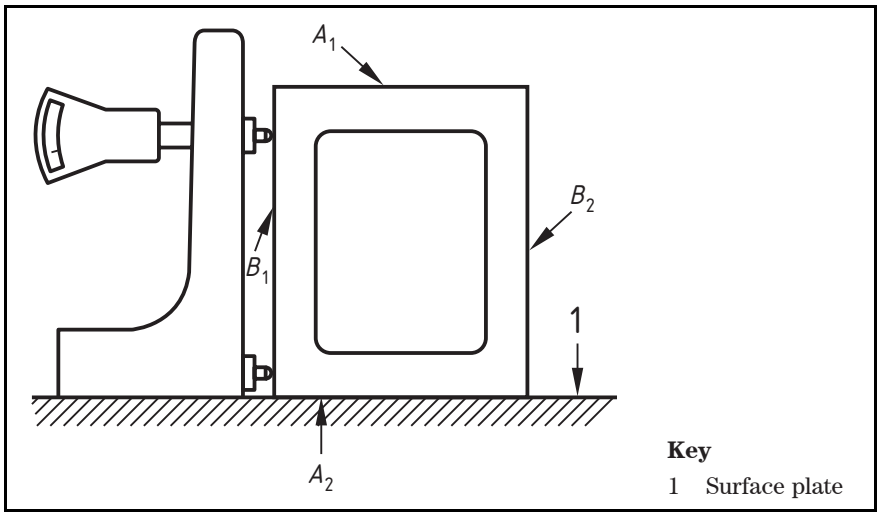
During manufacture, a pair of opposite faces of block squares, e.g. A_1 and A_2, can be "spot ground"[3)] so as to achieve accurate parallelism between the opposite faces. The accuracy of parallelism is checked by sliding the block square on a grade AA surface plate under a sensitive indicator.

[3)] The process of "spot grinding" consists of sliding the workpiece about by hand on a surface plate under the edge of a grinding wheel. This process is described in *Notes on Applied Science, No. 5. Gauge making and measuring* [1].

During the process of grinding the second pair of faces, B_1 and B_2, their squareness to faces A_1 and A_2 is tested on a grade A surface plate by means of a simple form of "squareness tester" (see Figure B.1). This consists of a rigid angle block, the vertical arm of which is fitted with a transverse straightedge near the bottom and a sensitive indicator towards the top. By this means, any out-of-squareness of face B_1 with respect to faces A_1 and A_2 can be determined by taking the mean of readings on B_1 with the block standing first on A_1 and then on A_2. After correcting B_1 for squareness, B_2 can readily be made parallel to B_1.

It is worth mentioning that any residual error in the squareness of the block is revealed two-fold by the indicator of the squareness tester.

Figure B.1 **Method of testing squareness of block squares**



B.3 Engineers' try squares

B.3.1 Testing an engineers' try square against a reference cylindrical square or block square

When testing an engineers' try square the reference cylinder (or block) and the square are stood side by side on a grade A surface plate. The square is slid gently into contact with one side of the cylinder (or block) and the fit between the latter and the outer edge of the square is sighted against a well illuminated background. If a tapering slit of light is seen, the magnitude of the error present in the square can be ascertained by tilting it with gauge blocks inserted under the two ends of the stock until a light-tight fit is achieved from top to bottom of the blade. The error can then be found from the difference between the two gauge blocks and their distance apart.

If the square under test has a knife-edge blade, it is preferable to use a block square with flat sides for a reference, as shown in Figure B.1. With flat-edged blades, however, the sensitivity of the test would be increased by using a cylindrical square for reference, as in Figure 6.

Whichever type of square is used as a reference, it is important to set the plane of the blade of the engineers' try square normal to the surface of the reference (in plan view) in order to eliminate errors that might arise owing to the blade of the square being out-of-square laterally (see Figure 4).

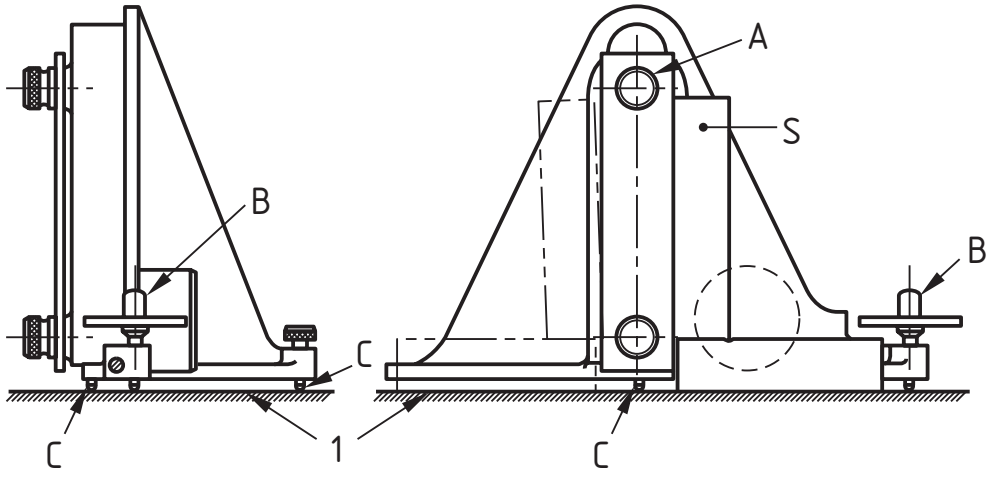
Assuming accurate parallelism between the opposite faces of the block square, the effect of any small residual error in its squareness may be eliminated by offering up in turn the opposite faces of the block square to the square under test and taking a mean of the results. This procedure is also applicable when a cylindrical square is used as the reference.

Besides their use for testing engineers' try squares, cylindrical and block squares can be used directly with advantage in assembling and testing the squareness of machine tool members and their movements and for checking squareness of tools and components in inspection rooms and workshops.

B.3.2 Tilting square-tester

A method of testing an engineers' try square without reference to a block square or master square of any sort is by means of a truly parallel-sided straightedge, A (see Figure B.2), held upright on a grade AA or A surface plate in a tiltable support that permits the straightedge to be slightly inclined in its own plane on either side of the perpendicular. The square, S, to be tested is stood alongside the straightedge and the perpendicularity of the latter is adjusted by a vertical micrometer screw, B, which forms one of the three feet of the support, until there is a light-tight fit between the outer edge of the blade and the adjacent side of the straightedge. The square is then transferred to the other edge of the straightedge. If a light-tight fit is also obtained against this edge of the straightedge, the square is quite true. On the other hand, if a tapered slit of light is seen against the second edge, the direction of the error in the square becomes immediately apparent. The magnitude of the error is shown twofold. It can be measured very accurately by readjusting the micrometer, B, so as to obtain a light-tight fit against the second edge of the straightedge and noting the difference between the micrometer reading in this position and that obtaining previously with the square in contact with the first edge. One half of this difference divided by the horizontal normal distance between the axis of the micrometer and the axis of the tilt of the ball-feet, C, of the support gives the angular error of the square per unit of length.

Figure B.2 **Tilting tester**



Key

1 Surface plate

B.3.3 Rigidity of engineers' try squares

When testing or using an engineers' try square, the blade should not be pressed heavily against the reference surface or the surface under test. If the blade should happen to make contact at its tip, there is a risk that undue pressure would bend the blade and so give rise to a false impression from the test.

B.3.4 Notes on design of engineers' try squares

If a force of P newtons is applied to the tip of the blade of a square, as shown in Figure B.3, a deflection of δ millimetres is produced according to

$$\delta = 2 \times 10^{-5} \times \frac{PL^3}{bh^3}$$

where

h is the width; and

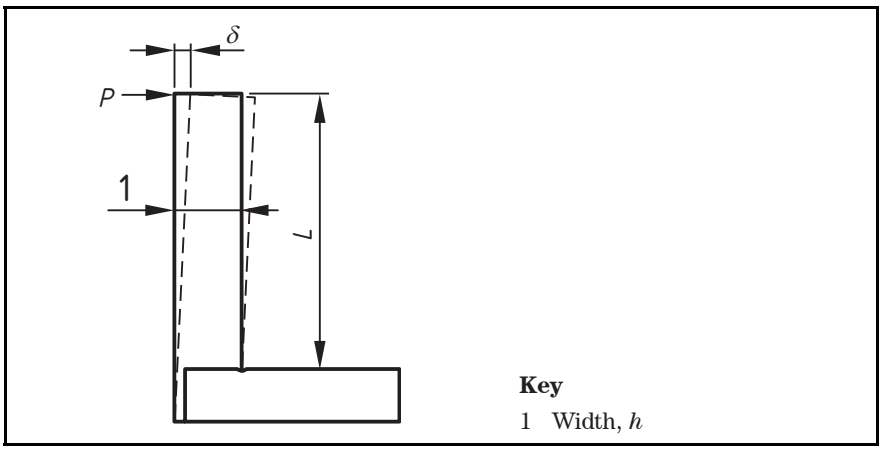
b is the thickness.

This deflection may be particularly noticeable in larger-sized squares where the blade dimensions ordinarily met with in practice may often not provide adequate stiffness in relation to the length of the blade.

For the reason just stated, engineers' try squares of ordinary design, with blade lengths above about 300 mm, are not best suited for accurate reference purposes. For preference, larger-sized reference squares should take the form of cylindrical or block squares, or else the ordinary design should be so modified as to provide the necessary rigidity.

One obvious suggestion towards improving the design of engineers' try squares is to make the blades of larger squares wider and of I-section. Another means of increasing the rigidity of the blade would be to add a stiffening member across the hypotenuse of the triangle. The addition of this member would tend to render the inside right-angle of the square useless, but in the case of squares above 300 mm this would probably not be a serious disadvantage, since they are used almost exclusively on the outside angle.

Figure B.3 **Testing for rigidity**



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[1] National Physical Laboratory. *Notes on Applied Science No. 5: Gauge Making and Measuring.* London: HMSO, 1967.

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