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Specification for surface plates

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Contents

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This document comprises a front cover, an inside front cover, pages i to ii, pages 1 to 16, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI and came into effect on 30 November 2008. It was prepared by Technical Committee TDW/4, *Technical product realization*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 817:1988, which is withdrawn.

Information about this document

This British Standard has been revised to bring it up to date.

The tolerances are given in metric units, including those for the inch sizes of surface plate, and the intended use of plates of each of the four grades of accuracy specified is included for information.

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.

1 Scope

This British Standard specifies the construction, and dimensions and tolerances, for rectangular and square surface plates for use as working planes for engineering purposes, made of cast iron or granite, in two size ranges, from 160 mm × 100 mm to 2 500 mm × 1 600 mm and from 12 in × 12 in to 96 in × 48 in, and in four grades of accuracy.

The standard is applicable to new surface plates and to plates that are being resurfaced after they have become worn.

In addition to the definitive requirements, this standard also requires the items detailed in Clause **4** to be documented. For compliance with this standard, both the definitive requirements and the documented items have to be met.

NOTE 1 The inch sizes are given as this information is still required by industry. Attention is drawn to the fact that metric dimensions are not necessarily direct conversions of the imperial dimensions.

NOTE 2 General information on the care and use of surface plates is given in Annex A.

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 1133-19, *Packaging code — Section 19: Use of desiccants in packaging*

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

3 Terms and definitions

For the purposes of this British Standard the following terms and definitions apply.

NOTE The components of a surface plate are illustrated in Figure 1, which also gives the nomenclature.

3.1 surface plate

iron casting or block of granite with a worked surface which is used as a working plane and a datum

NOTE Surface plates of larger sizes which are mounted on a stand are usually known as "surface tables" but for simplicity the term "surface plate" is used throughout this standard.

3.2 deviation from flatness of the working surface

minimum distance separating the parallel planes between which the whole of the working surface can just be contained

3.3 variation of the working surface

variation in the indicator reading when the working surface is explored with the variation gauge

*NOTE See **3.4** and Figure 2.*

3.4 variation gauge

freely moving base with three coplanar pads for bearing on the surface being tested, and carrying an indicator measuring variations of that surface through a fourth pad

NOTE This is as shown in Figure 2.

4 Information to be supplied and items to be agreed

4.1 Information to be supplied by the purchaser

The following information to be supplied by the purchaser shall be fully documented. For compliance with the standard both the definitive requirements specified throughout the standard and the following documented items shall be satisfied:

a) the size of the plate, if other than one of the nominal sizes specified in Table 1 (see **7.1**);

b) if a particular working height is required (see Note to **7.4**);

c) if projections are required on cast iron surface plates smaller than 400 mm × 250 mm or 12 in × 12 in or on granite surface plates (see **7.5**);

d) if handles are required on the surface plate (see **7.7**).

4.2 Items to be agreed between the contracting parties

The following items to be agreed between the contracting parties are specified in the clauses referred to and shall be fully documented. For compliance with the standard both the definitive requirements specified throughout the standard and the following documented items shall be satisfied:

a) the number of primary supporting feet, and the manner of setting, if more than three primary supporting feet are required (see **7.3**);

NOTE Large plates for special purposes might need to be supported on more than three primary feet.

b) the tolerances on the lengths of the sides if the purchaser requires the sides to be finished straight, parallel and mutually square (see **7.6**).

5 Classification

Surface plates shall be classified as Grade 0, 1, 2 or 3 according to their accuracy as specified in Clause **10**.

NOTE Grade 0 is necessary for measurements to a high accuracy. Grade 1 is intended for general inspection purposes. Grade 2 is intended for

marking out purposes. Grade 3 is suitable for lower grade marking out or as a general support plate.

6 Materials

6.1 Cast iron plates

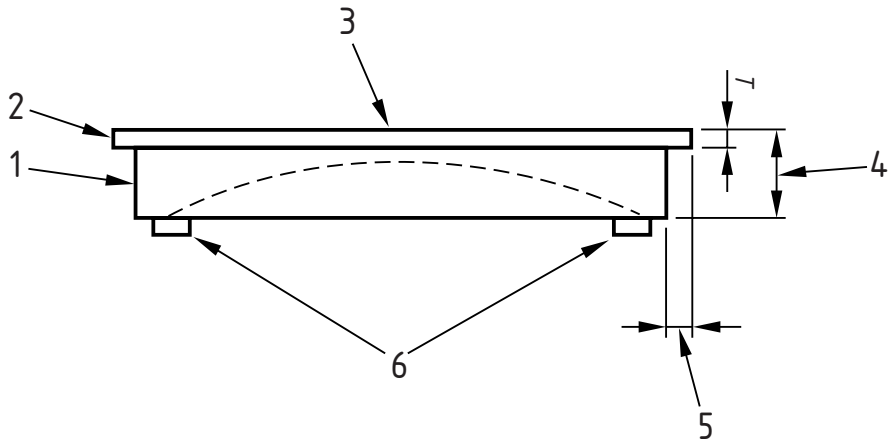
6.1.1 General

Close-grained cast iron not inferior to material designation EN-GJL-100 (number: EN-JL1020) in BS EN 1561:1997, Table 1, shall be used. The castings, when inspected visually, shall be free from blowholes or porous patches that might affect stability or accuracy.

NOTE The plugging of blowholes or porous patches in the working surface with material of a similar composition is permitted provided that such a repair does not affect stability or accuracy.

Figure 1 **Components of a surface plate**

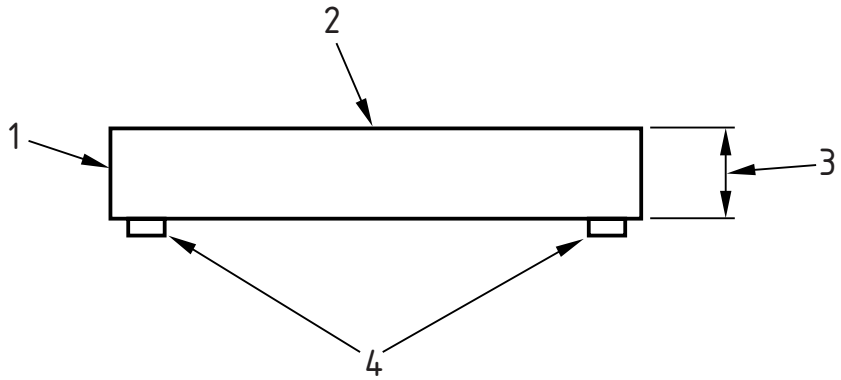
a) Typical cast iron surface plate



Key

1 Framing and ribbing
2 Side
3 Working surface
4 Total depth
5 Projection
6 Supporting feet

b) Typical granite surface plate



Key

1 Side
2 Working surface
3 Total depth
4 Supporting feet

6.1.2 Stress relief

After being cast and rough machined, Grades 0 and 1 surface plates shall be subjected to a stress relief process before being finished.

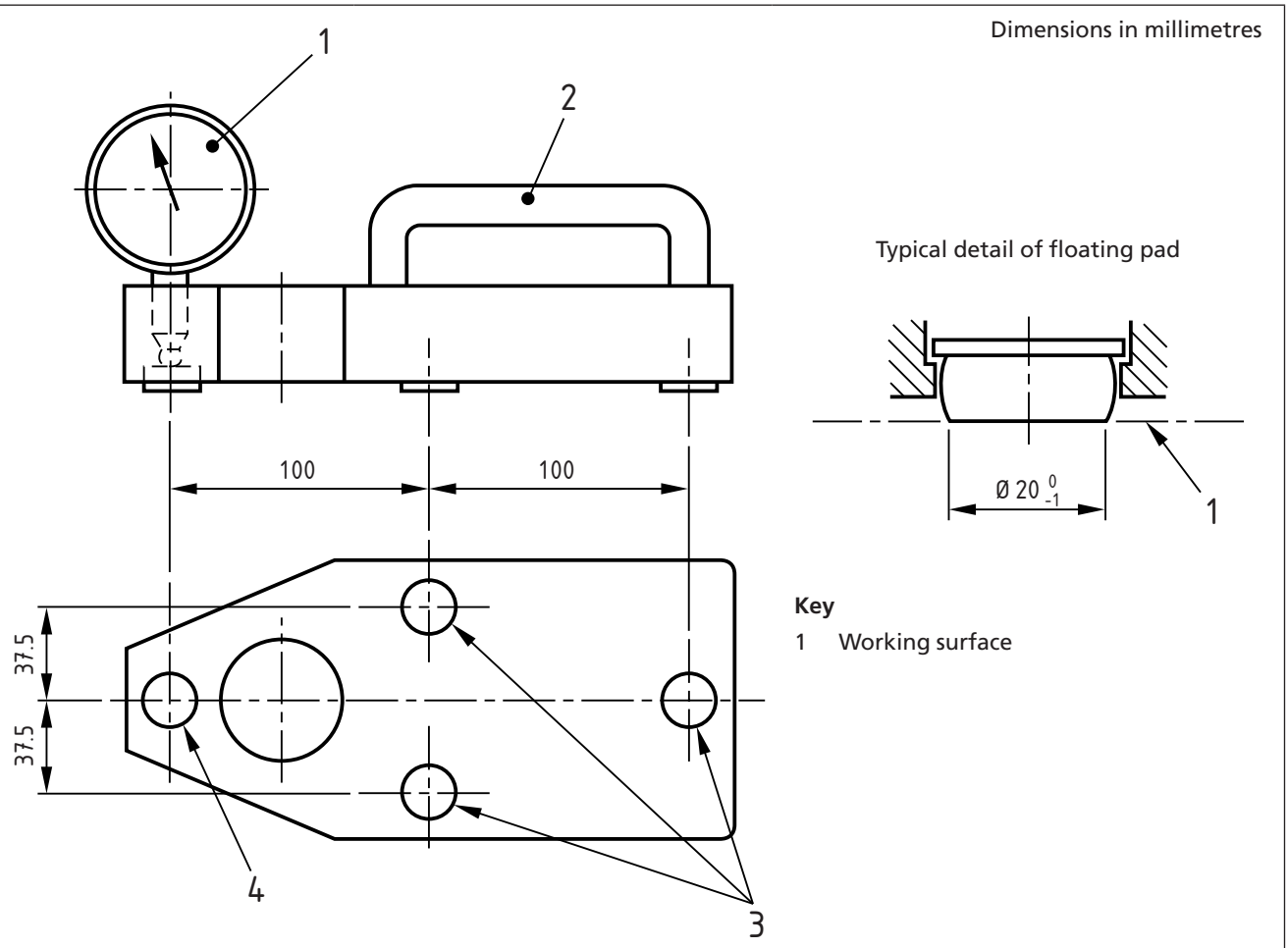
NOTE Details of the stess relief process to which the plates have been subjected should be made available to the purchaser on request.

6.2 Granite plates

The granite shall be close-grained and of uniform texture, sound, and free from flaws and fissures and from inclusions of softer materials.

NOTE Repair of defects in the working surface is not permitted.

Figure 2 **Variation gauge**



NOTE Tolerance is ± 1 mm, except where otherwise state.

Key

1 Sensitive indicator (minimum magnification 2 500)

2 Handle

3 Fixed pads Ø 20^{0}_{-1}, flat and coplanar to 1 µm

4 Ø 20^{0}_{-1} floating indicator pad, free to follow working surface

7 Construction

7.1 Size of plate

Unless otherwise specified by the purchaser [see **4.1**a)], the plate shall be of one of the nominal sizes specified in Table 1.

7.2 Border zone

If the working surface is surrounded by a border zone, the width of the border zone shall not exceed the value specified in Table 1.

For sizes of plates not specified in Table 1 [see **4.1**a)] the width of the border zone shall not exceed 2% of the length of the shorter side of the plate, or 10 mm, whichever is the smaller.

7.3 Supporting feet

Unless otherwise agreed between the contracting parties [see **4.2**a)], surface plates shall be provided with three primary supporting feet; one at the centre of one short side and one at each end of the other short side. To limit tipping, two safety feet shall be provided at the single foot end of surface plates (toward the ends of the short side) of 400 mm × 250 mm or 18 in × 12 in and larger.

Supporting feet shall be machined.

7.4 Stand

The surface plate shall be supplied with a stand which shall be constructed and braced in such a way that it rigidly supports the surface plate. The support surfaces on the stand shall be machined and means of leveling the surface plate shall be provided together with means of resisting accidental displacement of the surface plate from the stand.

*NOTE Unless a particular working height is specified by the purchaser [see **4.1**b)], the overall height of a surface plate on its stand, i.e. the height of the working surface above the floor, should be approximately 850 mm.*

7.5 Projection of top

Projections shall be provided on cast iron surface plates of 400 mm × 250 mm or 12 in × 12 in and larger.

If specified by the purchaser, projections shall be provided on cast iron surface plates smaller than 400 mm × 250 mm or 12 in × 12 in and on granite surface plates [see **4.1**c)].

NOTE The provision of projections on cast iron surface plates smaller than these sizes or on granite surface plates is optional.

Where provided, projections shall be at least 25 mm for surface plates of 400 mm × 250 mm or 12 in × 12 in and larger and at least 20 mm for surface plates smaller than these sizes. The undersides of projections shall be finished such that they can accommodate clamps.

7.6 Sides and edges

The four sides of the surface plate shall be machined and, unless otherwise agreed between the contracting parties [see **4.2**b)], the lengths of the sides shall each be within ±2% of the nominal size specified in Table 1 and the edges shall be rounded.

7.7 Handles

If specified by the purchaser, cast iron surface plates shall be provided with handles [see **4.1**d)].

Granite surface plates shall not be provided with handles.

7.8 Tapped holes or inserts

Where tapped holes or inserts are required the necessary work shall be carried out before the working surface is finished (see Note 1). The holes or inserts shall be counterbored.

NOTE 1 Tapped holes or inserts are only provided if requested by the purchaser.

NOTE 2 The preferred size thread is M6, but smaller sizes are acceptable (see BS 3643-1).

NOTE 3 The use, for clamping purposes, of tapped holes in cast iron surface plates or tapped inserts in granite surface plates can give rise to distortion of the working surface if high clamping pressures are applied. Metal inserts in granite surface plates can cause distortion due to differential expansion.

8 Finish

8.1 Cast iron surface plates

The working surface of Grades 0 and 1 surface plates shall be finished either by scraping or by another process that results in a surface such as that obtained by scraping. The working surface of Grades 2 and 3 surface plates shall be finished either by one of the same processes or by machining.

The proportion of bearing area shall be not less than 20% for Grades 0 and 1 surface plates, and not less than 10% for Grades 2 and 3 surface plates (see Note). High spots on scraped surfaces shall be uniformly distributed and the percentage of bearing area shall not be so high as to cause wringing.

Unmachined surfaces of cast iron surface plates shall be finished by painting.

NOTE A suitable method of test for assessing the bearing area is given in Annex C. Other proven methods may also be used.

8.2 Granite surface plates

The working surface of Grades 0 and 1 surface plates shall be finished by lapping. The working surface of Grades 2 and 3 surface plates shall be finished by lapping or left as ground.

8.3 Finished working surface

The finished working surface of new surface plates shall be free from any defects that might affect their stability or accuracy.

9 Rigidity of surface plates of 400 mm × 250 mm or 12 in × 12 in, and larger

When the surface plate is tested in accordance with Annex B, the deflection of the loaded area shall be not more than 1 µm/200 N.

10 Accuracy

10.1 Working surface

The working surface, excluding a border zone, shall conform to **10.2** and **10.3**.

The width of the border zone shall not exceed 2% of the length of the shorter side, or 10 mm, whichever is the smaller, and no point on the border shall project above the working surface.

10.2 Deviation from flatness of the working surface

The flatness of the working surface shall not exceed the permitted deviations specified in Table 1.

Table 1 **Permitted deviations from flatness of the working surface**

Metric sizes					
Nominal size of plate[A)]	**Permitted border zone**	**Permitted deviations from flatness**			
		Grade 0	**Grade 1**	**Grade 2**	**Grade 3**
mm	mm	µm	µm	µm	µm
160 × 100	2	3.0	6	12	24
250 × 160	3	3.5	7	14	28
400 × 250	5	4.0	8	16	32
630 × 400	8	4.5	9	18	36
1 000 × 630	10	5.5	11	22	44
1 600 × 1 000[B)]	10	7.5	15	30	60
2 000 × 1 000[B)]	10	8.5	17	34	68
2 500 × 1 600[B)]	10	10.0	20	40	80
250 × 250	5	3.5	7	14	28
400 × 400	8	4.0	8	16	32
630 × 630	10	5.0	10	20	40
1 000 × 1 000[B)]	10	6.5	13	26	52
Inch sizes					
Nominal size of plate	**Permitted border zone**	**Permitted deviations from flatness**			
		Grade 0	**Grade 1**	**Grade 2**	**Grade 3**
in	mm	µm	µm	µm	µm
18 × 12	6	4.0	8	16	32
24 × 18	9	4.5	9	18	36
36 × 24	10	5.5	11	22	44
48 × 36[B)]	10	6.5	13	26	52
60 × 36[B)]	10	7.0	14	28	56
72 × 36[B)]	10	8.0	16	32	64
72 × 48[B)]	10	8.0	16	32	64
96 × 48[B)]	10	9.5	19	38	76
12 × 12	6	4.0	8	16	32
18 × 18	9	4.5	9	18	36
24 × 24	10	5.0	10	20	40
36 × 36	10	6.0	12	24	48

A) The nominal metric sizes given in Column 1 are preferred. Other sizes should only be ordered when it is not practicable to adopt one of these. The permitted deviations from flatness of unlisted sizes should be calculated in accordance with the formula given in Annex D.

B) These surface plates are often provided with a stand having more than three support points. The permitted deviation applies after the supports have been adjusted and set as follows. The plate is to be levelled on the stand by adjustments under the three primary feet. Any remaining supports are then adjusted into contact without disturbing the setting of the level. These plates should be checked regularly and the correct setting maintained.

10.3 Variation of the working surface

The variation of the working surface of a surface plate of 250 mm × 250 mm or 12 in × 12 in and larger (see Annex D) shall not exceed the permitted variations specified in Table 2.

NOTE 1 Smaller sizes have not been included as their permitted deviations from flatness do not allow significant variation.

NOTE 2 It is important to limit variations of the working surface as abrupt local changes in form could cause excessive variations in work measurements using different positions on the working surface.

Table 2 **Permitted variations of the working surface**

Grade	Permitted variation, t_1
	µm
0	3
1	6
2	12
3	24

11 Cover and other protection

Each Grade 0 or 1 surface plate shall be supplied with a cover to protect the working surface and the edges of the surface plate.

During storage and transit the finished surfaces of cast iron surface plates shall be protected against climatic conditions by a corrosion-resistant preparation, such as plasticized resin, petroleum or mineral jelly or oil-based grease, and by using desiccants as described in BS 1133-19.

12 Marking

Each surface plate shall be either legibly and permanently marked, or shall bear a designation plate attached to one side, with the following information in characters not less than 3 mm high:

a) the manufacturer's name or trade mark;

b) the number and date of this British Standard, i.e. BS 817:2008[1)];

c) the grade of accuracy;

d) the year of manufacture;

e) a unique identification number.

1) Marking BS 817:2008 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity.

Annex A (informative) Recommendations on the care and use of surface plates

A.1 A surface plate is a datum and should be protected against damage. The top should be frequently wiped clean from dust and other particles. When measurements are being made, a cloth should be spread on the surface plate on which small tools and gauges can be placed when not in use. When the surface plate is not in use the top should always be kept covered.

A.2 A Grade 0 or Grade 1 surface plate should be placed in a location where there is a circulation of air which is under constant temperature control. The plate should be in a location away from direct sunlight and sources of draughts which could cause a vertical gradient of temperature such that the top and underside of the surface plate are at different temperatures.

A.3 Stands should be located on a stable foundation. The surface plate should be supported firmly and levelled (see Note B to Table 1).

A.4 Care should be taken that, wherever possible, the load on a surface plate is distributed over the working surface.

A.5 Point contact should not be made with scraped or machined surface plates because of the high proportion of low, unrepresentative areas of the working surface. Contact should be made through an intermediate gauge block, preferably not more than 10 mm in length, or a distance piece of similar precision and surface area.

A.6 Use should be made of the full available area of the working surface and not concentrated on any one area.

A.7 A common form of damage to cast iron surface plates is burrs on the working surface. The excess metal may be stoned away by attention confined to the burr. This operation should be followed by thorough cleaning with abrasive dust.

If the surface plate is not required for some days, the surface should be coated with a corrosion preventive, such as petroleum jelly.

Rusting is a sign of neglect and misuse. Its effects can be reduced by frequently wiping the top when in use and by occasionally gently rubbing with another surface plate using a paste made of jewellers' rouge and paraffin as a lubricant.

A.8 A common form of damage to granite surface plates is cuts in the working surface: these can be minimized only by care in the use of the plates.

A.9 Surface plates wear as a result of use. The user can detect evidence of wear by rubbing the plate with a higher grade surface plate and studying the rubbed appearance, by testing for deviation from straightness along lines on the surface plate, and/or by using a varation gauge.

A.10 Users are advised to take advantage of the specialized services of surface plate manufacturers to have surface plates reconditioned (i.e. restored to their original condition).

Annex B (normative) Test for rigidity of surface plates

B.1 **Apparatus** (see Figure B.1 and Figure B.2)

B.1.1 *Beam comparator* incorporating a sensitive indicator. The beam comparator is a rigid structure which is supported on two feet, the positions of which can be adjusted along the length of the beam. A third foot, which is positioned centrally along the beam and slightly offset, is provided to keep the beam stable (see Figure B.2). The sensitive indicator, with its contact tip pressed against the surface plate, is rigidly clamped to the centre of the beam. (If the indicator is very slightly offset from the centre line of the two supporting feet, the offset central foot can, in addition to its principal function as a stabilizer, also serve as a useful fine adjustment for setting the zero of the instrument. This offset has to be very small relative to the offset of the central foot if inaccuracies in measurement are to be minimized.)

B.1.2 *Central mass support* which is independent of the beam and can be moved, within limits, on the surface plate relative to the beam. The load is applied over a central area ranging from 120 mm diameter for the smaller surface plates to 300 mm diameter for the larger sizes.

B.1.3 *Requisite mass* to form the applied load.

NOTE Figure B.2 illustrates an end-on view of the apparatus with the central support unloaded.

B.2 **Procedure**

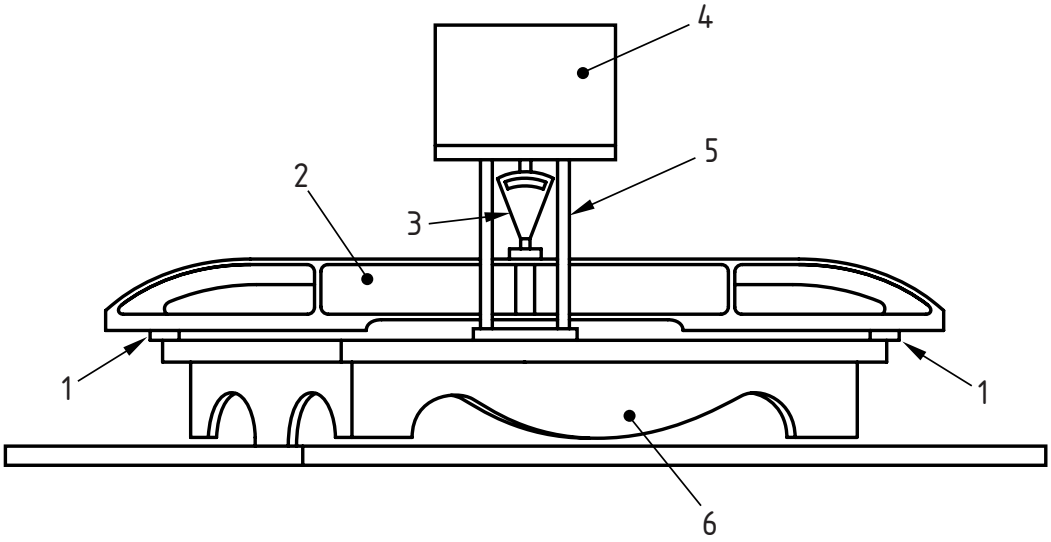
Using the formula of 1 µm per 200 N calculate the load that should not deflect a Grade 0 surface plate of the size under test by more than the permitted deviation from flatness (see Table 1).

NOTE 1 This optimum load would also apply to a Grade 1 surface plate.

With the surface plate supported on its primary feet, adjust the supporting feet of the beam comparator lengthwise to span the diagonal length of the surface plate. With the central mass support and the beam comparator in position (see Figure B.1 and Figure B.2) set the indicator to read on the working surfaces and note the reading. Apply the calculated load to the central mass support and again note the reading. Repeat both the unloaded and loaded readings. The difference between the mean indicator readings for the unloaded and loaded states is the deflection for the applied load. Calculate the deflection per 200 N.

NOTE 2 In the UK, using brass or iron weights of 20 kg may be taken as equivalent to 196 N with sufficient accuracy for this test.

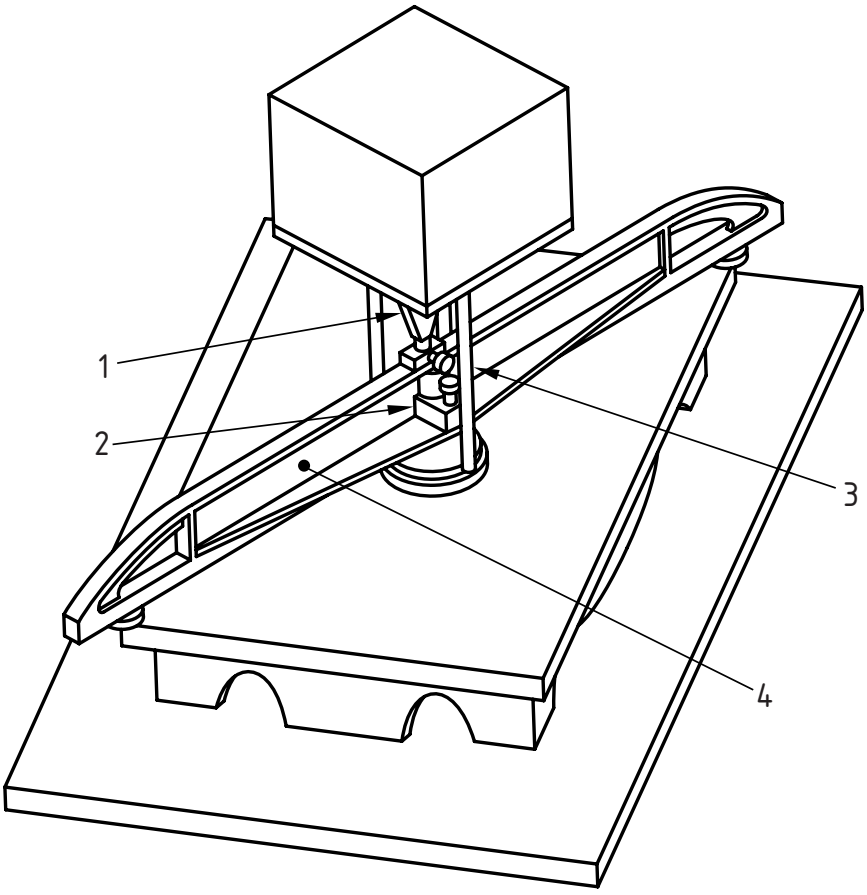
Figure B.1 **Cast iron surface plate being subjected to rigidity test**



Key

1 Foot supporting beam comparator
2 Beam comparator, incorporating a sensitive indicator
3 Sensitive indicator, minimum magnification 2 500
4 Requisite mass
5 Central mass support, independent of beam
6 Cast iron plate under test

Figure B.2 **End-on view of rigidity test apparatus**



Key

1 Sensitive indicator
2 Central third foot on beam conductor
3 Central mass support, independent of beam
4 Beam comparator, incorporating sensitive indicator

Annex C (informative) Assessment of bearing area of cast iron surface plates

C.1 Apparatus

C.1.1 *Special plate* of 160 mm × 100 mm with a lapped finish to within the Grade 1 permitted deviation from flatness.

C.1.2 *Engineer's blue*.

C.1.3 *Small glass plate* on which an area 50 mm × 50 mm has been ruled into 400 squares 2.5 mm × 2.5 mm.

C.2 Procedure

First, lightly blue the surface of the scraped surface plate and rub with the special plate so that the small bearing areas are brought clearly into view. Then place the small glass plate on the working surface. Observe each small square in turn and note the estimated fraction of its area (in tenths) which is occupied by a high spot of the working surface underneath.

Divide the sum of all these fractions by four to obtain the percentage of the bearing area of the working surface over the region tested.

NOTE After a few surface plates have been tested by this method, a comparison of the results obtained with the general appearance of the surface plates in terms of bearing area will enable a fairly close estimate of the proportion of bearing area of a surface plate to be made from its general appearance.

Annex D (informative)

Calculation of permitted deviation from flatness of the working surface

The permitted deviation t (in µm) from flatness of the working surface for Grade 0 surface plates, is calculated from the equation:

$t = 0.002\,5\,d + 2.5$

where:

d is the nominal length of the diagonal of the surface plate (in mm), rounded up to the nearest millimetre.

The result is rounded up to the nearest 0.5 µm.

Each succeeding grade has double the permitted deviation of the preceding grade:

Grade 0 $t \times 1$

Grade 1 $t \times 2$

Grade 2 $t \times 4$

Grade 3 $t \times 8$.

Example: Grade 1 is $0.002\,5 \times 2$.

Bibliography

Standards publications

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

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