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# मानक

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भारतीय मानक

इंजीनियरी माप विज्ञान — मापने का उपस्कर — ग्रेनाइट  
सतह प्लेटें — विशिष्टि

( दूसरा पुनरीक्षण )

*Indian Standard*

ENGINEERING METROLOGY — MEASURING  
EQUIPMENT — GRANITE SURFACE  
PLATES — SPECIFICATION

( *Second Revision* )

ICS 17.040.30

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**BUREAU OF INDIAN STANDARDS**

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## NATIONAL FOREWORD

This Indian Standard ( Second Revision ) which is identical with ISO 8512-2 : 1990 'Surface plates — Part 2 : Granite' issued by the International Organization for Standardization ( ISO ) was adopted by the Bureau of Indian Standards on the recommendations of the Engineering Metrology Sectional Committee and approval of the Basic and Production Engineering Division Council.

This standard was originally published in 1974 and revised in 1991 by restructuring and modifying to suit the needs at that time. The revision of this standard has again been taken up to harmonize it with ISO Standard.

For many practical purposes, surface plates serve the user as a plane or datum surface. Surface plates are usually of cast iron or granite; other materials may be used provided they comply with the requirements for quality and accuracy specified in this standard. Cast iron surface plates are covered in IS 2285 : 2003 'Engineering metrology — Measuring equipment — Cast iron surface plates — Specification ( *third revision* )' and harmonized with the International Standard ISO 8512-1 : 1990 'Surface plates — Part 1 : Cast iron'.

The choice between cast iron and granite surface plates depends on the conditions of use; some general information about care and use, testing and moderation in loading of plates is given in Annex A, B, and C respectively. IS 12937 : 1990 'Engineering metrology — Methods of testing straightness, flatness and perpendicularity' may be referred for accuracy testing of surface plate.

The text of ISO Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

- a) Wherever the words 'International Standard' appear, referring to this standard, they should be read as 'Indian Standard'; and
- b) Comma ( , ) has been used as a decimal marker while in Indian Standards, the current practice is to use a point ( . ) as the decimal marker.

## BIS CERTIFICATION MARKING

Details available with the Bureau of Indian Standards.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values ( *revised* )'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard*

**ENGINEERING METROLOGY — MEASURING  
EQUIPMENT — GRANITE SURFACE  
PLATES — SPECIFICATION**

*( Second Revision )*

## 1 Scope

This part of ISO 8512 specifies requirements for rectangular or square granite surface plates ranging from 160 mm × 100 mm to 2 500 mm × 1 600 mm, as preferred sizes, in four grades of accuracy 0, 1, 2 and 3.

NOTE 1 "Granite" is a commonly used description; a more specific description is given in clause 4.

This part of ISO 8512 applies to new granite surface plates, granite surface plates in use, and those re-conditioned according to their grade.

## 2 Definition

For the purposes of this part of ISO 8512, the following definition applies.

**deviation from flatness of the working surface:** The minimum distance separating two parallel planes between which the working surface can just be contained.

## 3 Nomenclature

For the purposes of this part of ISO 8512, the nomenclature shown in figure 1 applies.

## 4 Material

Surface plates complying with this part of ISO 8512 shall be made from stable, workable rock presenting a wear-resistant surface which does not tend to scratch steel surfaces. Igneous rocks such as diabase, gabbro and various other granites have been found suitable; they are commonly referred to

as "granite" for the purposes of this part of ISO 8512.

Rock used for surface plates shall be close-grained and of uniform texture, sound and free from flaws and fissures and from inclusions of softer materials. Repair of defects in the top surface is not permitted.

The colour of the granite, which is dependent on the mineral composition, is of no importance, but the colour of any individual plate shall be uniform.

NOTE 2 Some of the physical properties of granite used for surface plates are given in annex E.

## 5 Preferred sizes

The preferred sizes for granite plates are given in table 1. If plates of other sizes are required, the requirements of this part of ISO 8512 shall nevertheless apply.

The lengths of faces of plates shall be within  $\pm 5\%$  of the nominal size.

NOTE 3 It will be seen that the nominal lengths of faces, with one exception, are taken from the R5 series of preferred numbers; one plate, size 2 000 mm × 1 000 mm, is included because it is an established and widely used size, although 2 000 is not an R5 preferred number.

## 6 Rigidity

The thickness of granite surface plates shall be such that when a concentrated load is applied about the centre of the plate, the loaded area shall not deflect below the remaining area of the plate by more than 1  $\mu\text{m}/200\text{ N}$ . The limiting value for deflection applies to surface plates of size 400 mm × 250 mm and larger.

NOTE 4 A test method is given in annex B.

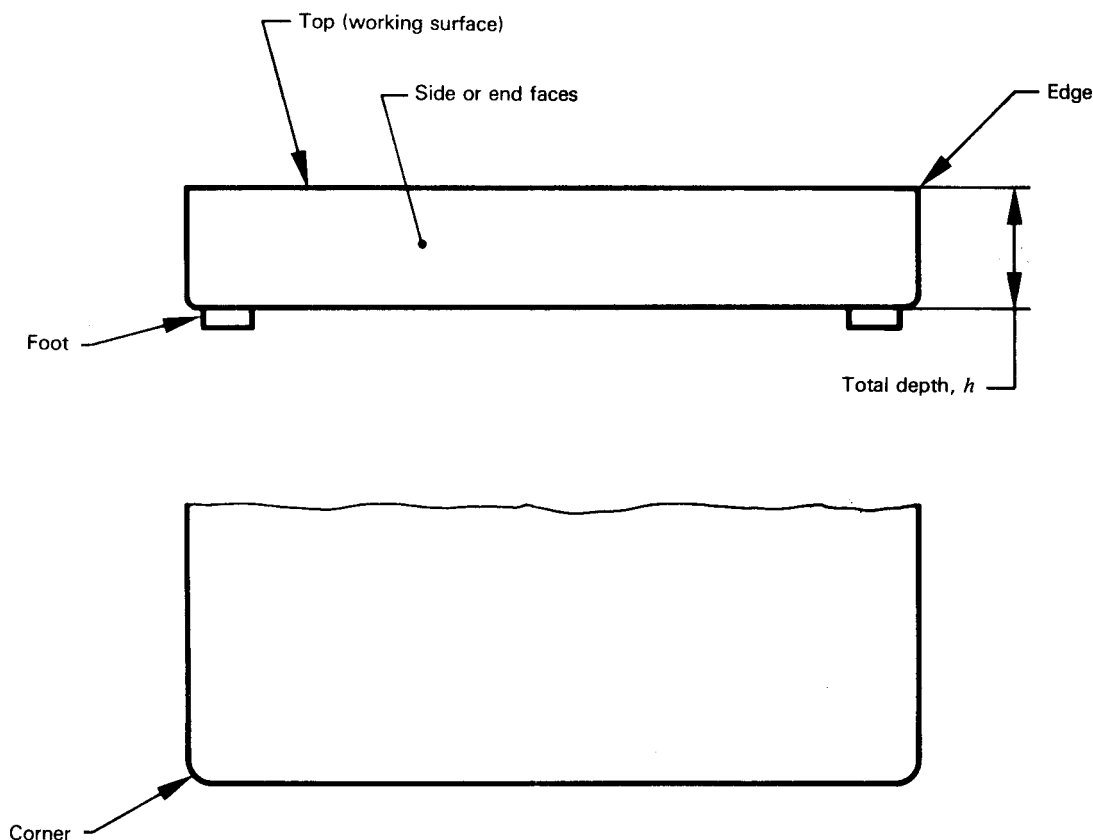


Figure 1 — Nomenclature

## 7 Finish of the working surface

The top (working surface) of grades 0 and 1 plates shall be finished by lapping, whereas grades 2 and 3 plates may be finished by lapping or left as ground. However, an item placed on it shall not wring to the surface of the plate.

## 8 General features

### 8.1 Supporting feet of surface plates

All surface plates shall be supported on three feet. Plates larger than size 1000 mm x 630 mm shall have safety feet. Feet shall be positioned within the boundary of the working surface to minimize deflection.

**NOTE 5** The setting of adjustable feet may affect the deviation from flatness of the working surface; specific instructions for adjusting the feet are given in footnote 3 to table 1.

The feet shall be smoothly machined, but machining of the supporting feet into a plane parallel to the working surface is optional.

### 8.2 Projection of top

If the purchaser so requires, the top of each plate may extend beyond the faces by at least 20 mm on plates of diagonal length up to 400 mm and by at least 25 mm for larger plates. The underside of the projecting surface shall be reasonably flat for accommodating clamps.

### 8.3 Surfaces other than the working surface

If the purchaser requires the faces to be finished straight, mutually parallel and square, the tolerances shall be specified in the purchasing order.

Side and end faces shall be finished smooth. All edges and corners shall be rounded with a radius of at least 2 mm. Alternatively, the edges and corners may be chamfered at an angle of approximately 45° using the value given above.

## 8.4 Handling

Granite plates shall not be supplied with handles.

NOTE 6 Handling may be facilitated by providing a projecting surface on the top (see 8.2).

## 8.5 Clamping methods (i.e. tapped holes or slots)

The use of tapped inserts in the plate for clamping purposes can cause distortion of the working surface if high clamping pressures are applied, and metal inserts in granite plates can cause distortion due to differential expansion. The onus is on the purchaser whether or not tapped holes or slots in plates are to be provided.

If ordered, tapped inserts shall be fixed before the working surface is finished.

NOTE 7 As a measure of protection, it is recommended that the size of tapped holes should not exceed M8.

## 9 Accuracy — Flatness tolerances

### 9.1 General

Two flatness tolerances are applied, one for the working surface overall and one for any local area of 250 mm × 250 mm of the working surface.

A border zone, the width of which shall not exceed 2 % of the shorter side with a maximum of 20 mm, may be excluded from these requirements for accuracy provided that no point on the border zone projects higher than the remainder of the working surface of the plate.

### 9.2 Flatness of the working surface overall

The flatness deviation of the working surface overall shall not exceed the appropriate tolerance for size and grade of accuracy specified in table 1.

NOTE 8 Test methods are given in annex B.

In the case of sizes which differ from those in the preferred range, the tolerance on deviation from flatness overall should be calculated in accordance with annex D.

### 9.3 Flatness of any local area of the working surface

The flatness deviation of any local area of 250 mm × 250 mm of the working surface shall not exceed

- 3,5 µm for plates of grade 0;
- 7 µm for plates of grade 1;

Table 1 — Tolerances on deviation from flatness overall

Dimensions in millimetres; tolerances in micrometres

Size of plate	Diagonal length (approx.)	Border zone	Tolerance on deviation from flatness overall <sup>1) 2)</sup> for plates of grade			
			0	1	2	3
<b>Rectangular</b>						
160 × 100	188	2	3	6	12	25
250 × 160	296	3	3,5	7	14	27
400 × 250	471	5	4	8	16	32
630 × 400	745	8	5	10	20	39
1 000 × 630	1 180	13	6	12	24	49
1 600 × 1 000 <sup>3)</sup>	1 880	20	8	16	33	66
2 000 × 1 000 <sup>3)</sup>	2 236	20	9,5	19	38	75
2 500 × 1 600 <sup>3)</sup>	2 960	20	11,5	23	46	92
<b>Square</b>						
250 × 250	354	5	3,5	7	15	30
400 × 400	566	8	4,5	9	17	34
630 × 630	891	13	5	10	21	42
1 000 × 1 000 <sup>3)</sup>	1 414	20	7	14	28	56

1) The bases of the tolerances specified are given in annex D.

2) Tolerances on deviation from flatness overall are expressed to the nearest

0,5 µm for plates of grade 0,

1 µm for plates of grades 1, 2 and 3.

3) These plates are supplied with more than three feet. Typically, after the plate has been carefully levelled by the three primary levelling screws, then the remaining supports may be adjusted either so that they are just in contact without disturbing the setting of the level or to give a minimum deviation from flatness. The tolerance applies after the supports have been adjusted and set in the manner agreed between the purchaser and manufacturer. These plates should be checked regularly to ensure that the setting has not been disturbed.



- c) 15  $\mu\text{m}$  for plates of grade 2;
- d) 30  $\mu\text{m}$  for plates of grade 3.

#### NOTES

9 The tolerances specified above are the same as those applied to the flatness overall of a 250 mm  $\times$  250 mm surface plate (see table 1).

10 Plates with a diagonal length smaller than 354 mm do not permit a 250 mm  $\times$  250 mm search area and in these cases the test on flatness overall serves to reveal local deviations from flatness.

### 10 Cover

Each plate of grade 0 or 1 shall be supplied with a suitable cover to protect both the working surface and the side and end faces of the plate.

### 11 •Marking

Each plate shall bear a designation plate attached to one face; the following information, in characters not less than 3 mm high, shall be included:

- a) the manufacturer's name or trade-mark;
- b) the number of this part of ISO 8512;
- c) the grade of accuracy.

#### DESIGNATION EXAMPLE

**X & Co. ISO 8512-2 Grade 0**

## **Annex A** (informative)

### **Use and care of granite surface plates**

**A.1** A surface plate should be located in a circulated atmosphere under constant temperature and humidity control. Accordingly it should be protected from direct sunlight or draughts; in particular, it is important that these should not cause a vertical gradient of temperature such that the working surface and underside of the plate are at different temperatures. For example, if there is a persistent difference of 1 °C between the working surface and underside of a plate 1000 mm long and 250 mm thick, there can be a distortion of about 1 µm: this is 16 % of the total manufacturing tolerance in a 1000 mm × 630 mm plate of grade 0.

**NOTE 11** The substantial thickness of a granite surface plate and its low thermal conductivity make acclimatization slow when the ambient temperature returns to uniformity.

**A.2** The plate should be supported firmly and levelled. Stands should be located on a stable foundation.

**A.3** Attention is drawn to the procedure for setting surface plates (see footnote 3 to table 1).

**A.4** Clause 6 and clause B.3 refer to the rigidity of a surface plate; care should be taken not to overload a plate. Suggestions regarding reasonable loading are given in annex C.

**A.5** Point contact to surface plates is not permissible because of local irregularities of the surface.

Contact should be made through either an intermediate precision gauge block, preferably not more than 10 mm high, or a similar precision distance piece.

**A.6** Use should be made of the available area of the plate and should not always be concentrated in one area.

**A.7** The 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 wiping cloth should be spread on the plate for small tools and gauge blocks.

**A.8** A common sign of damage is cuts in the surface. When the plate is not in use the top should always be kept covered.

**A.9** Plates wear as a result of use. The user can detect evidence of wear by rubbing the plate with a superior grade plate and studying the rubbed appearance and/or by checking straightness along lines on the plate and/or by using the datum gauge (see the tests described in annex B).

**A.10** Users are advised to take advantage of the specialist services of surface plate manufacturers to have plates reconditioned.

## **Annex B** (informative)

### **Testing of surface plates**

**NOTE 12** Various test methods are available and details can be found in technical books; selected typical methods are outlined below.

#### **B.1 Deviations from flatness overall**

**B.1.1** Surface plates with a ground finish may be tested by comparison with a superior accuracy grade plate of larger area.

A robust comparator stand is moved on a region of the working surface of the larger plate selected for minimum deviation from flatness. The measuring head having light operating force is carried in a right extension arm from the stand and is in contact with a gauge block or similar distance piece (see clause A.5) which is moved on the plate under test. This method is suitable for small plates.

**B.1.2** Larger surface plates with a ground finish may be tested by measuring deviations from straightness along various lines parallel to the faces, and along the diagonals, by comparison with a reference straight edge. The results are then integrated into deviation from flatness by relating the results at the centrepoint of the plate where the two diagonal surveys cross and at other points where lines of test intersect.

**B.1.3** Plates may also be tested by checking straightness along various lines on the plate using a block which, as it is moved along a line step by step, tilts according to the deviations from straightness.

The tilts may be measured by means of a spirit level or an electronic level where the block is of an appropriate size for testing the plate in some detail, but also large enough to carry the instrument. The plate should itself be solid enough not to be deflected by the load of the level and block, and the foundation should be stable enough to remain untilted by the movements of observer and apparatus.

Alternatively, an optical instrument, namely an autocollimator, is suitable for observing the tilts of an exploring block on any of the surface plates complying with this part of ISO 8512. Plates of

grade 0 require a sensitivity of reading of 1 second of arc; less sensitive instruments may be used more conveniently on coarser grades of plate.

#### **B.2 Deviations from flatness locally**

**B.2.1** Inspection of a new plate for deviation from flatness locally is recommended; moreover it is also particularly necessary if wear is suspected and/or if the working surface is not a consistent datum.

**B.2.2** Although the methods described in clause B.1 may use 50 or more located positions of measurement for the contour map of a plate, there nevertheless remain local positions, and on large plates, local areas, which may not be covered in the overall survey. Accordingly, an exploration of flatness of local areas is necessary, and, for this purpose, the methods described in clause B.1 can be applied to many more positions of measurement. However, this approach is cumbersome. Alternatively, since local deviations from flatness affect the surface plate as a datum, they may be traced by a datum gauge. A typical example of a datum gauge is shown in figure B.1; it is a freely moved, scribing block base with three fixed contacts representing a datum; an extension carries a sensitive indicator in contact with a pad in spring contact with the surface plate. It is recommended that insulated handles be fitted to isolate the warmth of the hand from the device and to facilitate its use.

**B.2.3** The following procedure is recommended.

- a) First visually inspect the working surface to note any irregularities of appearance. The results of measurement of deviation of flatness overall should be studied to identify where abrupt or large changes in contour occur. A rapid sweep of the whole plate can be made with the datum gauge to identify the areas of greatest variation.
- b) Check areas where the datum gauge shows variations of reading exceeding the tolerance on local deviation using the methods described in clause B.1.

### B.3 Rigidity test

**B.3.1** A surface plate being subjected to a rigidity test is illustrated in figure B.2a); the apparatus used comprises essentially

- a beam comparator ① incorporating a sensitive indicator ②;
- a central mass support ③, independent of the beam;
- the requisite number of masses ④ [only one mass is shown in figure B.2a)].

An end-on view of the apparatus, with the central support ③ unloaded, is illustrated in figure B.2b); the plate is standing on its three feet.

The beam comparator is a rigid structure which is supported on two feet ⑤, each of which can be positioned along the length of the beam. A third foot ⑥ [see figure B.2b)], which is positioned centrally along the beam and offset, is provided to keep the beam stable. A sensitive indicator ②, with its contact tip pressed against the surface plate, is rigidly clamped to the centre of the beam.

Dimensions in millimetres

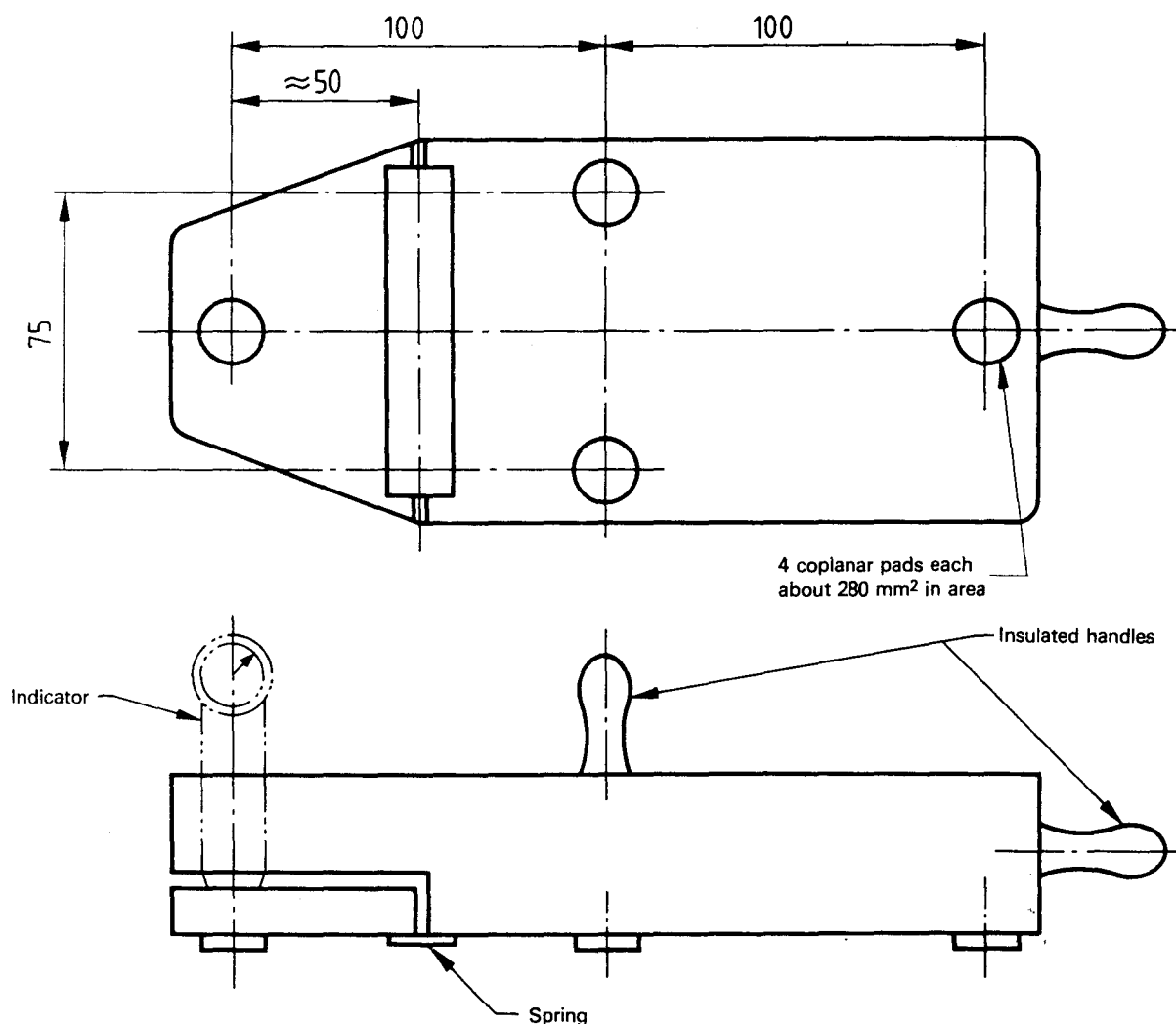
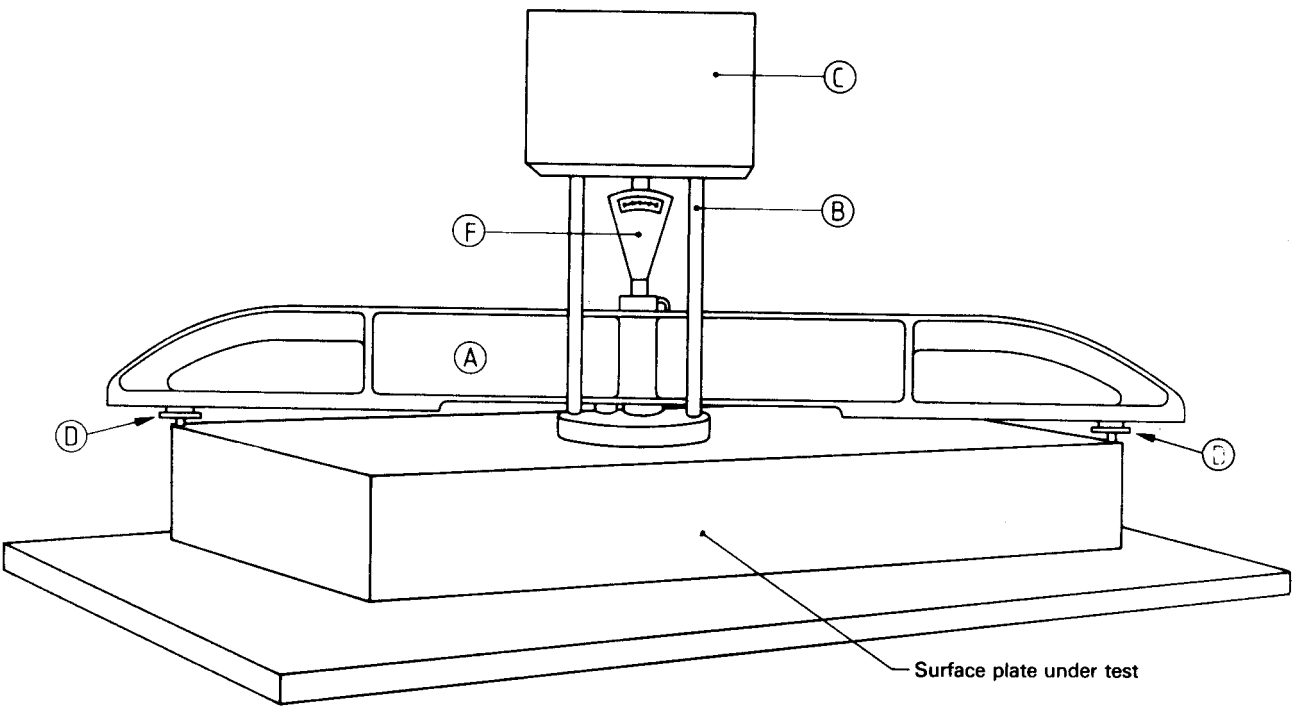
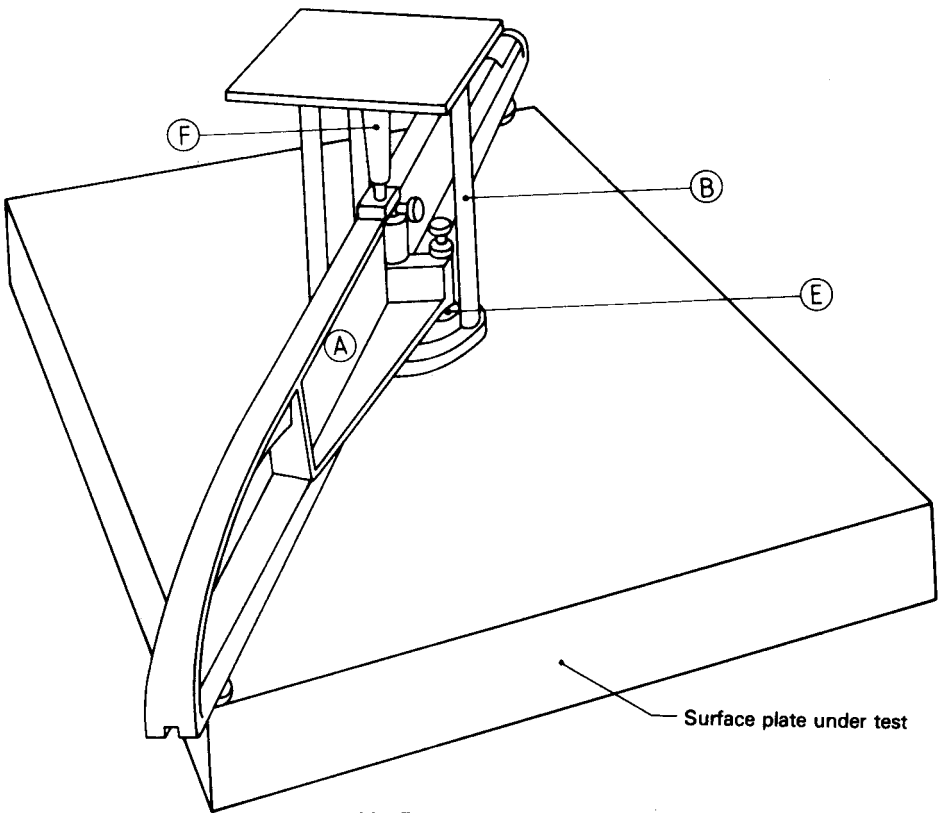


Figure B.1 — Example of typical datum gauge



a) Side-on view



b) End-on view

Key

- |                          |  |                         |
|--------------------------|--|-------------------------|
| (A) Beam comparator      | (C) Mass(es) (for application of load) | (E) Third foot (offset) |
| (B) Central mass support | (D) Supporting feet (two)              | (F) Sensitive indicator |

Figure B.2 — Test apparatus for rigidity test

The central mass support is independent of the beam, and it can be moved, within limits, on the surface plate relative to the beam. The offset foot ⑥, in addition to its principal function as a stabilizer, also serves as a useful fine adjustment for setting the zero of the instrument as the indicator ⑦ is very slightly offset from the centreline of the two feet ⑤. (This offset has to be very small relative to the offset of foot ⑥, if inaccuracies in measurement are to be minimized.)

The applied load should be reasonably proportional to the size of the plate and normally should not be so large as to deflect the plate by more than half the permitted tolerance on deviation from flatness overall.

The central area over which the load is applied should range from a circle about 120 mm in diameter for small plates to a circle 300 mm in diameter for large plates.

**B.3.2** Adjust the beam feet lengthwise so as to span the diagonal of the surface plate under test; set the indicator to read on the plate when the beam is in position and note its reading. Then load the central mass support and again note the indicator reading, after which repeat the initial unloaded reading.

**B.3.3** The difference between the indicator readings for the loaded and unloaded states will give the deflection of the plate under the load applied.

## Annex C (informative)

### Resistance to deflection of granite surface plates under load

The limiting value for deflection (i.e. 1  $\mu\text{m}/200\text{ N}$ ), as given in clause 6, applies to all grades of plate from size 400 mm  $\times$  250 mm and larger.

The thickness of granite surface plates should be designed to comply with the rigidity requirement. However, the user may well seek information on the reasonable load that a plate can withstand. The values in table C.1 give the approximate mass, in kilograms, of concentrated load that will cause a

maximum deflection of half the tolerance on deviation from flatness overall.

**NOTE 13** It should be understood that table C.1 is intended to control loading and to complement clause A.4. The relatively generous tolerances on deviation from flatness overall of coarse grade plates might encourage extreme loadings and consequently overload foundations: the maximum values in table C.1 have accordingly been limited to 500 kg. The recommendation to distribute loads over the available surface applies whenever conditions permit.

**Table C.1 — Maximum concentrated loading of granite surface plates (see also clause D.2)**

Dimensions in millimetres; masses in kilograms

Size of plate	Mass in concentrated load that will cause a maximum deflection of half the tolerance on deviation from flatness overall, specified in table 1, for plates of grade			
	0	1	2	3
<b>Rectangular</b>				
400 $\times$ 250	40	80	160	320
630 $\times$ 400	50	100	200	390
1 000 $\times$ 630	60	120	240	490
1 600 $\times$ 1 000	80	160	320	500
2 000 $\times$ 1 000	95	190	380	500
2 500 $\times$ 1 600	115	230	460	500
<b>Square</b>				
400 $\times$ 400	45	90	170	340
630 $\times$ 630	50	100	210	420
1 000 $\times$ 1 000	70	140	280	500

**Annex D**  
(informative)

**Bases of tolerances**

**D.1 Basis of tolerances in table 1**

**D.1.1** The values specified in table 1 are based on the following formula:

$$t = c_1 l + c_2$$

where

- $t$  is the tolerance on deviation from flatness overall, in micrometres;
- $l$  is the nominal length of the diagonal of the plate rounded up to the next 100 mm;
- $c_1$  and  $c_2$  are constants for the grade of plate and are given in table D.1.

**Table D.1 — Values for  $c_1$  and  $c_2$**

Grade of plate	$c_1$	$c_2$
0	0,003	2,5
1	0,006	5
2	0,012	10
3	0,024	20

**D.1.2** In the case of plate sizes which differ from those in the preferred range (i.e. those not given in table 1), the tolerance on deviation from flatness overall should be calculated using the formula given in D.1.1.

**D.2 Basis of table C.1**

Table C.1 gives the maximum load for a deflection not to exceed half the tolerance on deviation from flatness overall appropriate to the size and grade of plate.

**EXAMPLE**

From table 1, the tolerance on deviation from flatness overall of a 400 mm × 250 mm plate of grade 0 is 4 µm. When half the tolerance (i.e. 2 µm) is to be the maximum permitted deflection, it corresponds to a force of not more than 400 N (i.e. 2 × 200 N; see clause 6) or approximately 40 kg of mass acting as a load (see table C.1).



## **Annex E** **(informative)**

### **Physical properties of granites**

Granites used for surface plates should have the following physical properties:

- Density: from  $2,5 \times 10^3 \text{ kg/m}^3$  to  $3 \times 10^3 \text{ kg/m}^3$
- Tensile breaking stress: from  $7 \text{ N/mm}^2$  to  $35 \text{ N/mm}^2$
- Compression breaking stress: from  $100 \text{ N/mm}^2$  to  $300 \text{ N/mm}^2$
- Porosity coefficient: from 1 % to 1,5 %
- Imbibition coefficient: from 1 % to 3 %
- Coefficient of linear thermal expansion: from  $2 \times 10^{-6} \text{ K}^{-1}$  to  $5 \times 10^{-6} \text{ K}^{-1}$

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