Squares

1 Scope This Japanese Industrial Standard specifies the steel squares of the construction as indicated in Figs. 1, 2, 3 and 4 (hereafter referred to as "squares").

Remarks 1 The normative references are as follows.

JIS B 7503 *Dial gauges*

JIS B 7506 *Gauge blocks*

JIS B 7513 *Precision surface plates*

JIS B 7514 *Steel straightedges*

JIS G 4303 *Stainless steel bars*

JIS G 4304 *Hot rolled stainless steel plates, sheets and strip*

JIS G 4305 *Cold rolled stainless steel plates, sheets and strip*

JIS G 4401 *Carbon tool steels*

2 The units and numerical values in { } in this Standard are based on the traditional units and are appended for informative reference.

2 Terms for principal parts The terms given for the principal parts of squares shall conform to those given in Figs. 1, 2, 3 and 4.

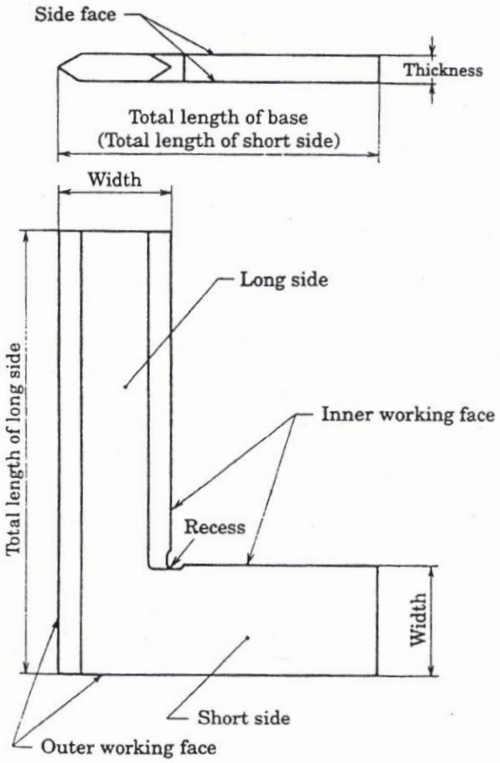


Fig. 1 Beveled edge squares

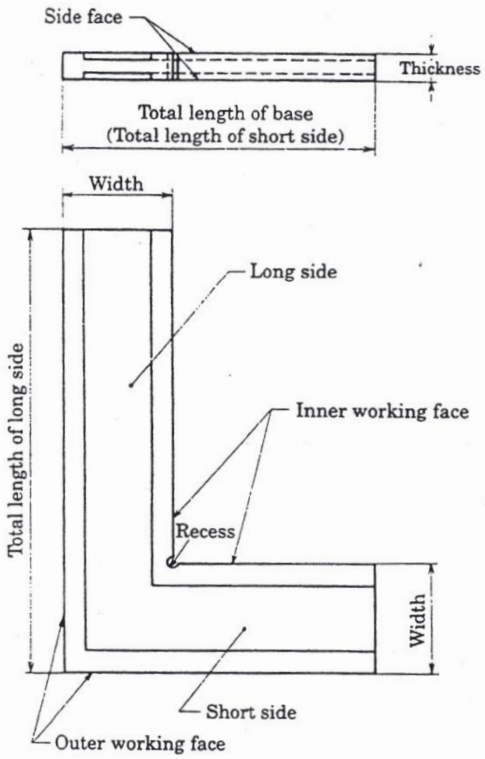


Fig. 2 I-Section squares

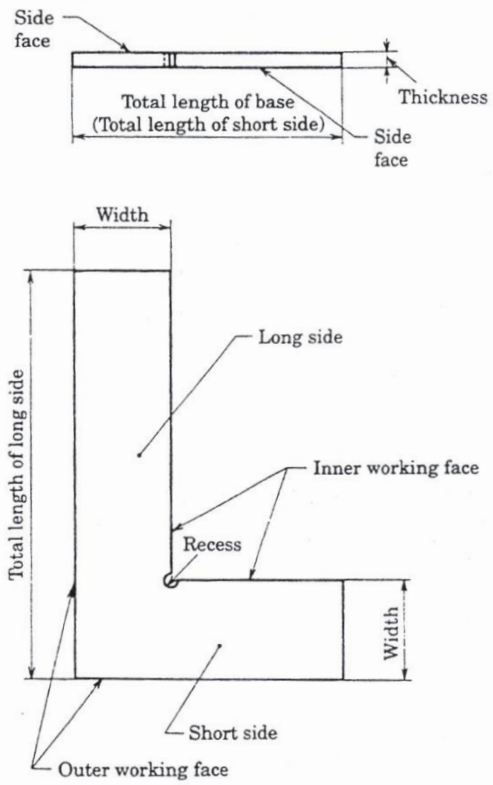


Fig. 3 Flat section squares

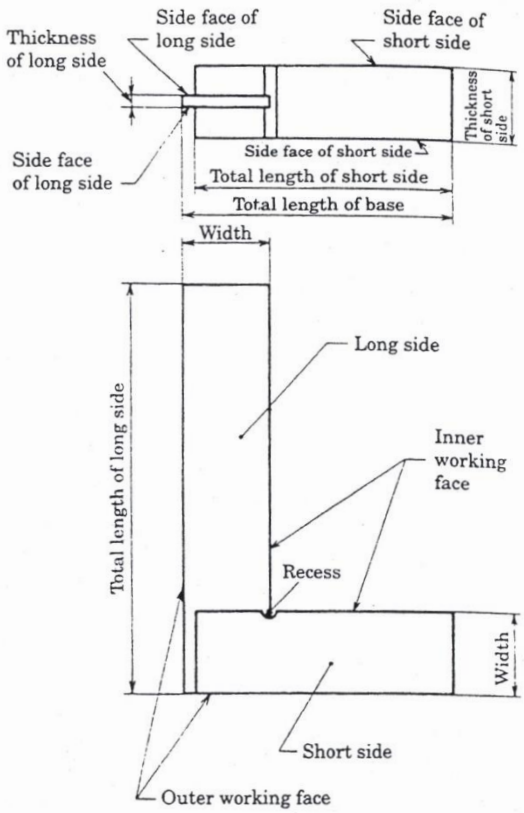


Fig. 4 Beam squares

3 Kind of squares and grade The kind of squares and grade shall be as given in Table 1.

Table 1

Kind of square	Grade	Where used (informative)
Beveled edge square	—	Used as standard square
I-section square	Grade 1	
	Grade 2	For inspection use
Flat section square Beam square	Grade 1, Grade 2	For workshop use

4 Squareness

4.1 Squareness of outside and inside working faces The tolerances on squareness of outside and inside working faces shall conform to Table 2, and signs indicating error values shall be in accordance with Fig. 5.

Table 2

Unit : μm

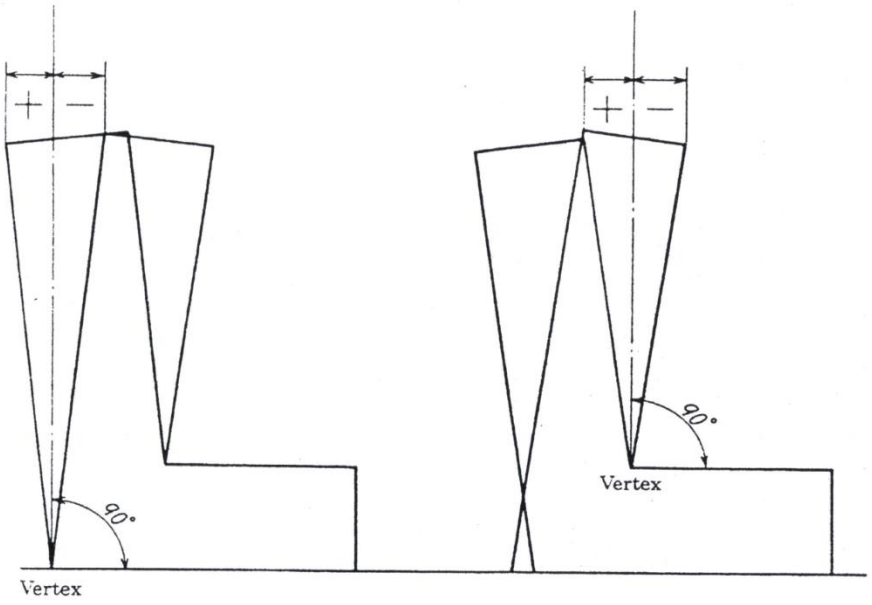
Nominal size (mm)	Tolerance on right angle					
	Beveled edge square	I-section square		Flat section and beam squares		Special grade (informative)(1)
		Grade 1	Grade 2	Grade 1	Grade 2	
75	—	—	—	±14	± 28	—
100	±3.0	±3.0	± 7	±15	± 30	—
150	±3.5	±3.5	± 8	±18	± 35	—
200	±4.0	±4.0	± 9	±20	± 40	±3.0
300	±5.0	±5.0	±11	±25	± 50	±3.5
500	—	±7.0	±15	±35	± 70	±4.5
750	—	—	—	±48	± 95	—
1 000	—	—	—	±60	±120	—

Note (1) As the squares of special grade are used for the purpose of measurement of high precision work, particular attention shall be paid to the selection of shape, size, construction and material against the effect of temperature and distortion.

Remarks : The values given in the Table are obtained from the following formulas. Where L indicates the nominal size in mm.

Unit : μm

Kind of squares	Grade	Formula for calculation of tolerance on right angle
Beveled edge squares	—	$\pm\left(2+\frac{L}{100}\right)$
I-section squares	Grade 1	
	Grade 2	$\pm\left(5+\frac{L}{50}\right)$
Flat section squares Beam squares	Grade 1	$\pm\left(10+\frac{L}{20}\right)$
	Grade 2	$\pm\left(20+\frac{L}{10}\right)$
Special grade (informative)		$\pm\left(2+\frac{L}{200}\right)$



Measurement for outer working face **Measurement for inner working face**

Fig. 5

Obliquity of side face The obliquity of side face shall be not more than ten ıes the values given in Table 2 (see Fig. 6), provided that it is applied to the obliquity long side only in beveled edge square and beam square.

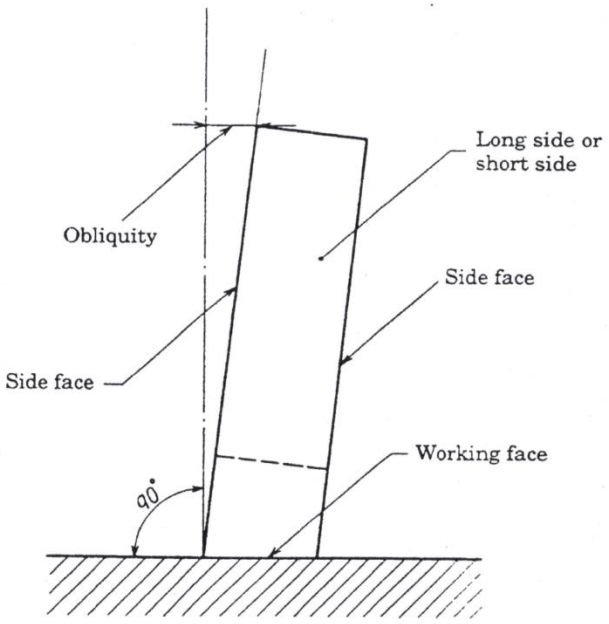


Fig. 6

5 Straightness and parallelism

5.1 Straightness The tolerances on straightness of working face of squares shall conform to Table 3.

Table 3

Unit : μm

Total length of working face (mm)	Tolerance on straightness				
	Beveled edge squares	I-section squares		Flat section and beam squares	
		Grade 1	Grade 2	Grade 1	Grade 2
100 and under	1.5	1.5	3.5	8	15
Over 100 up to and incl. 200	2.0	2.0	4.5	10	20
Over 200 up to and incl. 300	2.5	2.5	5.5	13	25
Over 300 up to and incl. 400	—	3.0	6.5	15	30
Over 400 up to and incl. 500	—	3.5	7.5	18	35
Over 500 up to and incl. 600	—	—	—	20	40
Over 600 up to and incl. 700	—	—	—	23	45
Over 700 up to and incl. 800	—	—	—	25	50
Over 800 up to and incl. 900	—	—	—	28	55
Over 900 up to and incl. 1 000	—	—	—	30	60

Remarks : The values given in the Table are obtained from the following formulas. Where L indicates the total length of working face in mm.

Unit : μm

Kind of squares	Grade	Formula for calculation of tolerance on straightness
Beveled edge squares	—	$\left(1+\frac{L}{200}\right)$
I-section squares	Grade 1	
	Grade 2	$\left(2.5+\frac{L}{100}\right)$
Flat section squares Beam squares	Grade 1	$\left(5+\frac{L}{40}\right)$
	Grade 2	$\left(10+\frac{L}{20}\right)$

5.2 Parallelism The tolerances on parallelism of outer working face and inner working face shall be twice the value given in Table 3.

6 Rigidity Fix the short side of the square as indicated in Fig. 7, and when apply a force of 2.45 N {250 gf} to the end of the long side in the direction of the length of short side, the deflection of the end of the long side shall not exceed 1/2 the value given in Table 2.

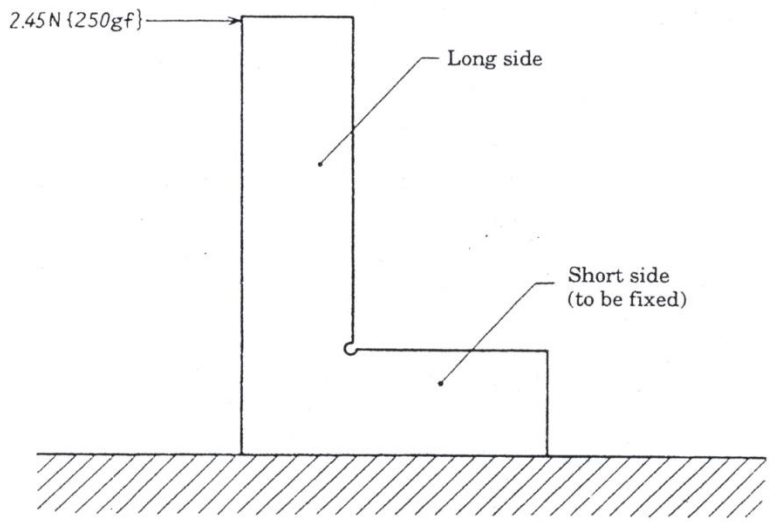


Fig. 7

7 **Surface roughness** The surface roughness of working face shall be as given in Table 4.

Table 4

Unit : mm

Kind of squares	Grade	Nominal size	Surface roughness
Beveled edge squares	—	100, 150, 200, 300	0.8*S*
I-section squares	Grade 1	100, 150, 200, 300, 500	
	Grade 2	100, 150, 200, 300	
		500	1.6*S*
Flat section squares Beam squares	Grade 1	75, 100, 150, 200, 300, 500	
	Grade 2	75, 100, 150, 200, 300	
	Grade 1	750, 1 000	3.2*S*
	Grade 2	500, 750, 1 000	

8 Shape, dimensions and construction

8.1 **Shape** The shape of the squares shall conform to those given in Figs. 1 to 4. The portion where the two inside working faces terminate in a point should preferably be provided with a recess having a suitable shape.

Further, the edges of beveled edge squares should be slightly rounded or chamfered.

8.2 **Dimensions** The dimensions of squares shall conform to Tables 5, 6, 7 and 8.

Table 5 Beveled edge squares

Unit : mm

Nominal size		100	150	200	300
Total length of long side		100	150	200	300
Total length of base face		70	100	130	200
Long side and short side	Width	25	30	35	40
	Thickness	6	8	10	15

Table 6 I-Section squares

Unit : mm

Nominal size		100	150	200	300	500
Total length of long side		100	150	200	300	500
Total length of base face		70	100	130	200	300
Long side and short side	Width	25	30	35	40	55
	Thickness	6	8	10	15	20

Table 7 Flat section squares

Unit : mm

Nominal size		75	100	150	200	300	500	750	1 000
Total length of long side		75	100	150	200	300	500	750	1 000
Total length of base face		50	70	100	130	200	300	400	550
Long side and short side	Width	18	20	25	25	30	40	50	60
	Thickness	3	4	5	6	6	8	10	12

Table 8 Beam squares

Unit : mm

Nominal size		75	100	150	200	300	500	750	1 000
Total length of long side		75	100	150	200	300	500	750	1 000
Total length of base face		50	70	100	130	200	300	400	550
Total length of short side		48	67	97	126	196	295	393	540
Long side	Width	16	20	24	29	35	46	58	65
	Thickness	2	2.5	3	3.5	4	5	7	10
Short side	Width	15	18	22	26	32	45	63	80
	Thickness	13	15	18	22	27	35	50	65

8.3 Construction The side face of squares may be optionally scooped out.

The long and short sides of the beam squares must be rigidly secured together to withstand knocks.

9 Material and hardness The material and hardness of working face of the squares shall conform to Table 9.

Table 9

Division	Material	Hardness of working face	
		Quenched	Not quenched
Steel	SK5 in **JIS G 4401** or those having qualities equal or superior thereto	Not less than HV450 (HS60)	HV170 (HS25) to HV235 (HS35)
Stainless steel	SUS420J2 in **JIS G 4303** SUS403 in **JIS G 4304** SUS403 in **JIS G 4305** or those having qualities equal or superior thereto	Not less than HV360 (HS50)	

All above materials shall be heat-treated properly to prevent distortion.

10 Measuring method

10.1 Scope of measurement The measurement of squareness, straightness and parallelism of squares shall be carried out excluding the space "*a*" given in Table 10 from each end in the longitudinal direction of the surface to be measured.

Table 10

Unit : mm

Nominal size	Dimension of "*a*" to be excluded
75	about 2
100	
150	about 5
200	
300	
500	about 10
750	
1 000	

10.2 Accuracy of measuring instruments The accuracy of measuring instruments is as follows:

(1) As standard squares, cylindrical squares, rectangular squares and I-section squares are ordinarily used. The standard squares to be used for inspection of beveled

edge squares and I-section squares shall be the ones whose accuracy of squareness is definitely known, and the standard squares used for the inspection of flat-section squares and beam squares, as a rule, are the ones with the squareness of not greater than 1/5 the value of the squares being measured.

(2) The surface plates shall conform to grade 1 in **JIS B 7513**. In the case of measuring beveled edge squares or I-section squares, the surface plate of definitely known flatness can be substituted.

(3) Gauge blocks shall conform to grade 2 in **JIS B 7506**.

(4) Dial gauges shall conform to **JIS B 7503**.

(5) The autocollimator shall be capable of measuring accurately to the nearest of one second.

10.3 Squareness of outer working faces The measurement of squareness of outer working face is usually done by one of the following methods:

(1) **Method by standard square and gauge block** Stand two gauge blocks of the same dimension A·A′ on a surface plate in close contact with the working face of standard square as shown in Fig. 8, and place the square to be measured on two gauge blocks of the same size B·B′ on the surface plate.

Bring the working face of the square to be measured lightly against the gauge blocks A·A′, then if the light placed opposite to the eye becomes invisible through the points of contact, the squareness of the square can be considered correct. When any gap is produced at either contact point, change the dimensions of B·B′ until there is no longer a gap. From the difference of sizes of B·B′ and the distance between the blocks apart, the squareness can be calculated by the following formula:

(a) **Short side placed at bottom**

$$\text{Squareness} = (\text{Difference of gauge block sizes}) \times \frac{\text{Total length of long side}}{\text{Total length of base face}}$$

(b) **Long side placed at bottom**

Squareness = (Difference of gauge block sizes)

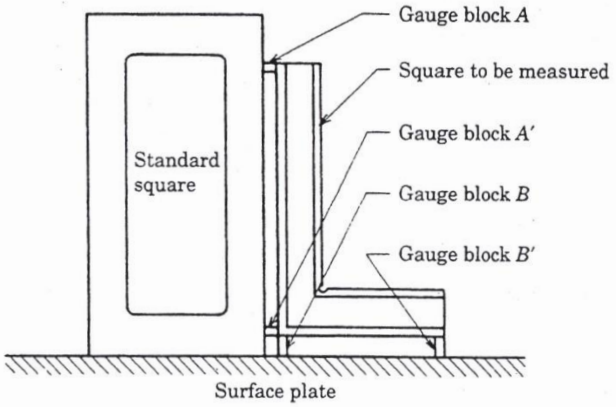
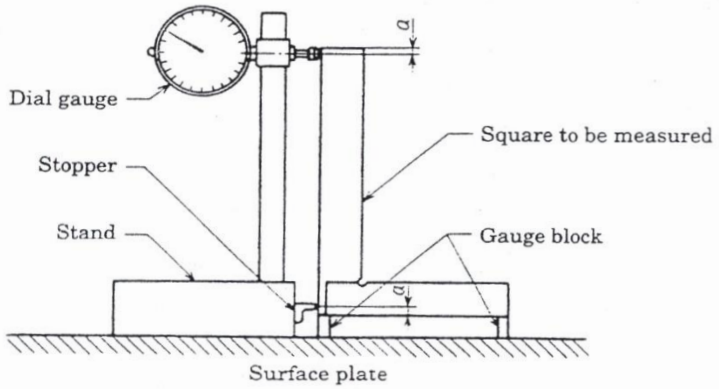


Fig. 8

Method by standard square and dial gauge Fix a dial gauge on a stand as indicated in Fig. 9, and take the reading of the dial gauge when it is brought along the face of surface plate until the stopper on the stand comes lightly against the standard square, and then against the square to be measured in the same manner.

This method requires the consideration of the deflection of the square under measurement due to the measuring force of the dial gauge, and it is preferable to apply only where the deflection is comparatively small against the permissible error in squareness.

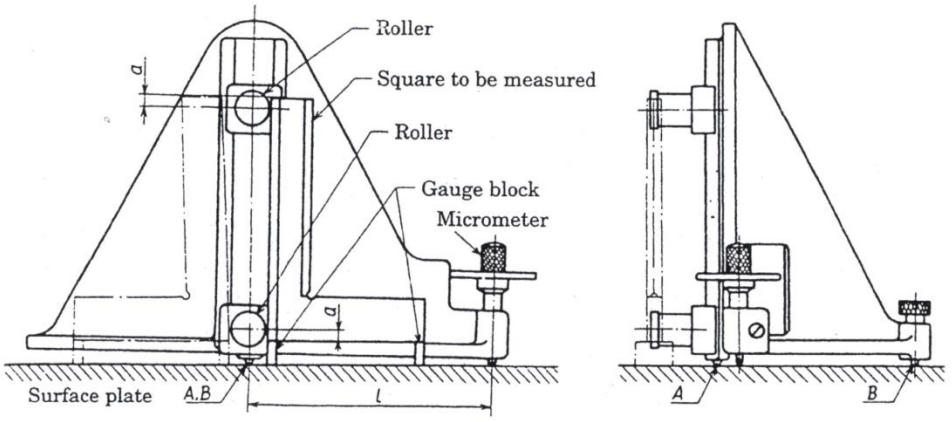


Remarks : For "a" in the figure, see Table 10.

Fig. 9

Method by squareness tester Fig. 10 gives an example of the testing arrangement. The instrument is arranged on a base supported at three points of A, B and the spindle point of micrometer, and mounted with two rollers of the same size parallel to each other and also parallel to AB in a way that the base can be tilted around the axes of A, B by the micrometer point. Place the whole on a surface plate, bring the long side of the square to be measured lightly in contact with the rollers as shown in Fig. 10, and adjust by the micrometer until the gaps at top and bottom contact points become equal. Next, leaving the instrument as it were, transfer the square under measurement and block gauges to the opposite side, and repeat the same procedure. If the gaps at two points are found equal, the square can be considered correct. If not, readjust the micrometer until the gaps are equal. In this case, the squareness can be calculated by the following formula:

$$\text{Squareness} = \begin{pmatrix}\text{1/2 the difference of} \\ \text{micrometer reading}\end{pmatrix} \times \frac{\text{Total length of long side}}{l}$$



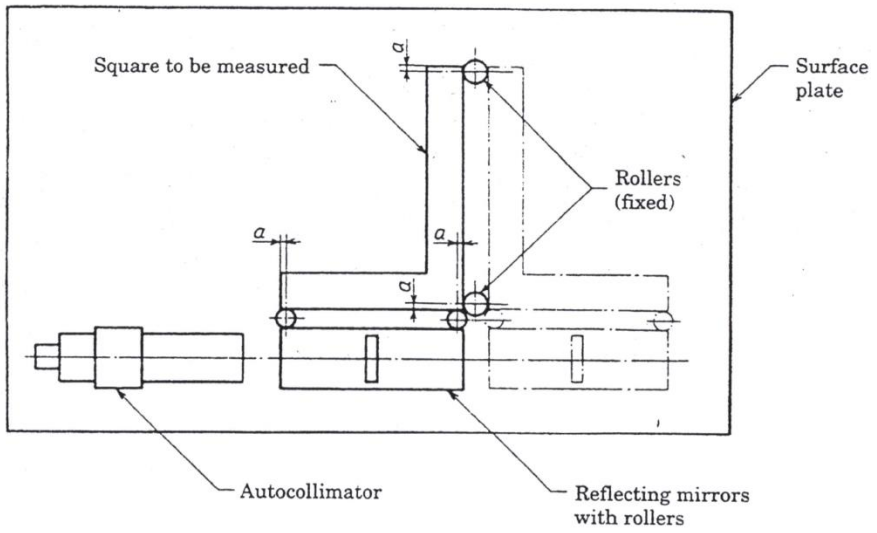
Remarks : The value "a" is based on Table 10.

Fig. 10

(4) **Method by autocollimator** Place the side of the square to be measured on a surface plate as indicated in Fig. 11, and bring the long side of working face in contact with the two rollers of the same size fixed to the surface plate, and the reading of autocollimator when a reflecting mirror on two rollers is applied to the short side of the working face of the square is made as θ_1 s. Next, transfer the square under measurement to the opposite side of the rollers, and carry out the same measurement. When the reading is made as θ_2 s, the squareness can be calculated by the following formula:

$$\text{Squareness } (\mu\text{m}) = \frac{5}{1\,000} \times \frac{\theta_2 - \theta_1}{2} \times L$$

where, L is the total length of the long side expressed in the units of mm.



Remarks : For "a" in the figure, see Table 10.

Fig. 11

).4 Squareness of inner working faces The squareness of inner working faces ıall be calculated from the squareness of outer working faces, parallelism of work-ıg faces and straightness of working face.

).5 Straightness and parallelism of working faces The measurement for ıraightness and parallelism of working faces of a square shall conform to **7.1** and .2 in **JIS B 7514**.

).6 Rigidity As indicated in Fig. 12, fix the short side of a square vertically to ıe square block, and apply the measuring point of dial gauge to the end of the long de, and take the readings of dial gauge when the load is not applied to the end of ıe long side, and when the load of 2.45 N {250 gf} is applied. In taking measure-ıent, care shall be taken to see that the reading is not influenced by the accompa-ying hysteresis error.

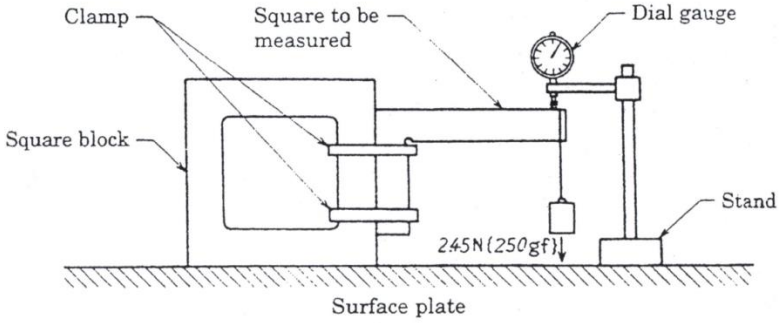


Fig. 12

1 **Inspection** The inspection of squares shall be made on squareness, straightness arallelism, rigidity, surface roughness, shape, dimensions, construction, material nd hardness and the results shall satisfy the requirements specified in **4**, **5**, **6**, **7**, **8**, nd **9**.

The measurement shall be made under the condition of uniform temperature.

2 **Marking** The manufacturer's name or abbreviation, serial number, year of manu-ıcture, nominal size and grade shall be marked clearly on the squares.