

1. Varieties of Surface Roughness Indicators

Definitions and presentations of arithmetic average roughness (Ra), maximum height (Ry), 10-spot average roughness (Rz), average concave-to-convex distance (Sm), average distance between local peaks (S) and load length rate (tp) are given as parameters indicating the surface roughness of an industrial product. Surface roughness is the arithmetic average of values at randomly extracted spots on the surface of an object.

[Center-line average roughness (Ra 75) is defined in the supplements to JIS B 0031 and JIS B 0601.]

Typical Calculations of Surface Roughness

<p>Arithmetical Average Roughness, Ra</p> <p>A portion stretching over a reference length in the direction in which the average line extends is cut out from the roughness curve. This portion is presented in a new graph with the X axis extending in the same direction as the average line and the Y axis representing the magnitude. Ra is represented by the equation shown at right, in microns (μm).</p>	$Ra = \frac{1}{l} \int_0^l f(x) dx$
<p>Maximum Height, Ry</p> <p>A portion stretching over a reference length in the direction in which the average line extends is cut out from the roughness curve. The gap between the peak line and the trough line is measured in the direction in which the magnitude axis extends, in microns (μm).</p> <p>Remark : A portion without an abnormally high peak or abnormally low trough, which may be regarded as a flaw, is cut out over the reference length.</p>	$Ry = Rp + Rv$
<p>Ten-Spot Average Roughness, Rz</p> <p>A portion stretching over a reference length in the direction in which the average line extends is cut out from the roughness curve. The average of the levels (Yp) of the highest peak to the fifth highest peak as measured from the average line and the average of the levels (Yv) of the lowest trough to the fifth lowest trough similarly measured in the said portion are added together. Rz is this sum, in microns (μm).</p>	$Rz = \frac{ Yp1 + Yp2 + Yp3 + Yp4 + Yp5 + Yv1 + Yv2 + Yv3 + Yv4 + Yv5 }{5}$ <p>Yp1, Yp2, Yp3, Yp4, Yp5 : Levels of the highest peak to the fifth highest peak in the said portion with the length l.</p> <p>Yv1, Yv2, Yv3, Yv4, Yv5 : Levels of the lowest trough to the fifth highest trough in the said portion with the length l.</p>

Reference : Relation between Arithmetic Average Roughness (Ra) and Conventional Parameters

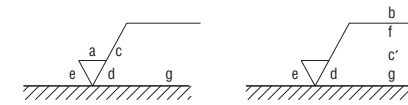
Arithmetic Average Roughness Ra		Graphical Representation of Surface Texture	Max. Height Ry	Ten-Spot Average Roughness Rz	Reference Ry/Rz Length l (mm)	Conventional Finish Symbol
Standard Series	Cut-Off Value λ_e (mm)		Standard Series	Standard Series	Standard Series	
0.012 a	0.08		0.05 s	0.05 z	0.08	
0.025 a			0.1 s	0.1 z		
0.05 a			0.2 s	0.2 z		
0.1 a			0.4 s	0.4 z		
0.2 a	0.25		0.8 s	0.8 z	0.25	
0.4 a			1.6 s	1.6 z		
0.8 a			3.2 s	3.2 z		
1.6 a	0.8		6.3 s	6.3 z	0.8	
3.2 a			12.5 s	12.5 z		
6.3 a			25 s	25 z		
12.5 a	2.5		50 s	50 z	2.5	
25 a			100 s	100 z		
50 a			200 s	200 z		
100 a	8		400 s	400 z	8	
200 a			800 s	800 z		
400 a	—		—	—	—	

* Interrelations among the three varieties shown here are not precise, and are presented for convenience only.
* Ra : The evaluated values of Ry and Rz are the cut-off values and the reference length each multiplied by five, respectively.

1. Positions of Auxiliary Symbols for Surface Symbol

A surface roughness value, cut-off value or reference length, processing method, grain direction, surface undulation, etc. are indicated around the surface symbol as shown in Fig. 1 below.

Fig. 1. Positions of Auxiliary Symbols



- a : Ra Value
- b : Machining Method
- c' : Cut-off Value, Evaluation Length
- c : Reference Length, Evaluation Length
- d : Grain Direction
- f : Parameter other than Ra (tp : Parameter/Cut-Off Level)
- g : Surface Undulation (according to JIS B 0610)

Remark : These symbols except a and f are provided when they are needed.

Remark : Under ISO 1302, a finish range should be indicated as e in Fig. 1.

Symbol	Meaning	Illustration
	The trace left by a cutting instrument is parallel to the projection plane in the drawing. Ex. Shaped Surface	
	The trace left by a cutting instrument is perpendicular to the projection plane in the drawing. Ex. Shaped Surface (Side View) Circular Cut, Cylindrical Cut	
	The pattern left by a cutting instrument diagonally crosses the projection plane in the drawing. Ex. Honed Surface	
	The pattern left by a cutting instrument crosses in various directions or has no grain direction. Ex. Lapped Surface, Superfinished Surface and Surface Finished with a Front Mill or End Mill	
	The pattern left by a cutting instrument is virtually concentric around the center of the plane in the drawing. Ex. Faced Surface	
	The pattern left by a cutting instrument is virtually radial around the center of the plane in the drawing.	

Examples

Surface Symbol

Removal of Material by Machining is Required

Removal of Material is Prohibited

Upper Limit of Ra

(a) 25/25, (b) 6.3/6.3, (c) 25/6.3

Grain Direction

Upper and Lower Limits of Ra

(a) 6.3/1.6, (b) 6.3/1.6

Machining Method

(a) 3.2 Milling, (b) 3.2 M

