Lecture # 3.3

Surface Roughness

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Surface Roughness

Surface roughness or surface finish is of great importance in the parts to be assembled.

The surfaces of various parts are produced by various machining operations such as turning, milling, shaping, planing, grinding and so on.

Each one of them gives a different surface finish and when compared they show a marked variations.

The variation is judged by the degree of smoothness.

The surface produced by superfinishing is the smoothest while that produced by planing is the roughest.

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Surface Roughness

In order to express the surface roughness numerically, the following two methods are used:

1. Centre line average method (CLA method)

2. Root mean square method (RMS method)

In both the methods the surface roughness is measured as the average deviation from a nominal surface.

The centre line average method is defined as the average value of the ordinates between the surfaces and the mean line, measured on both sides of it.

According to Indian Standards, the surface roughness is measured in terms of CLA value and is denoted by Ra.

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Surface Roughness

Mathematically, CLA value or Ra (microns).

$$CLA = \frac{y_1 + y_2 + y_3 + \ldots . y_n}{n}$$

where y_1, y_2, etc. are the ordinates measured on both sides of the mean line and

n are the number of ordinates.

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Surface Roughness

The root mean square method is defined as the square root of the arithmetic mean of the square of the ordinates.

Mathematically, RMS value (in microns)

$$rms = \sqrt{\frac{y_1^2 + y_2^2 + y_3^2 + ...y_n^2}{n}}$$

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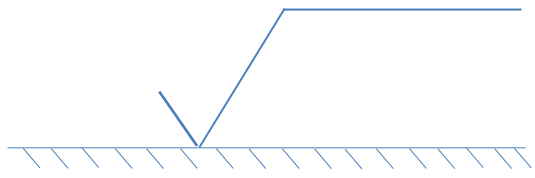
Surface Roughness

According to Indian Standards the surface roughness is represented as shown in the Figure below.



Symbol Indicating the Surface

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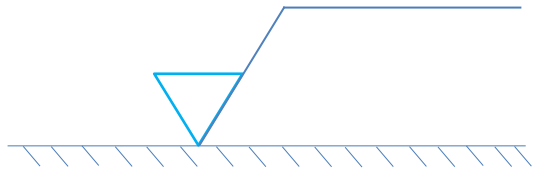
Surface Roughness

According to Indian Standards the surface roughness is represented as shown in the Figure below.



Symbol Indicating a Surface that requires Material removal

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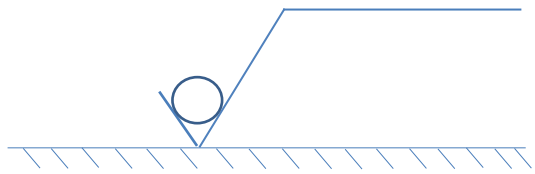
Surface Roughness

According to Indian Standards the surface roughness is represented as shown in the Figure below.



Symbol Indicating a Surface that does not requires Material removal

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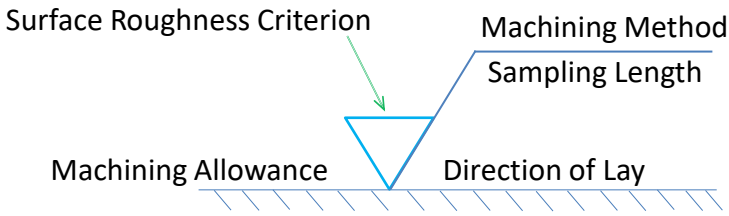
Surface Roughness

According to Indian Standards the surface roughness is represented as shown in the Figure below.



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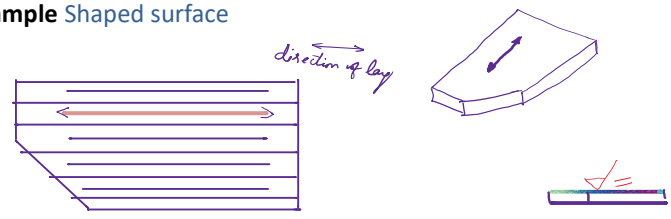
Surface Roughness

The direction of lay (Crease) is represented by the following symbols:

= Lay parallel to the line representing the surface to which the symbol is applied.

(The creases made by an edged tool during machining are parallel with the surface captured in the diagram in which the symbol is written.)

Example Shaped surface



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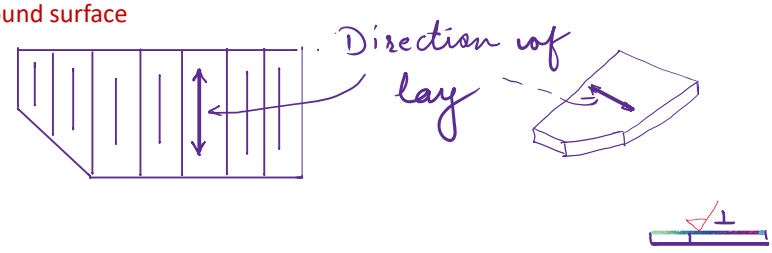
Surface Roughness

The direction of lay (Crease) is represented by the following symbols:

⊥ Lay perpendicular to the line representing the surface to which the symbol is applied.

The creases made by the edged tool during machining are perpendicular to the surface captured in the diagram in which the symbol is written.

Example Shaped surface (turned on a lathe; seen from the side), cylindrically ground surface



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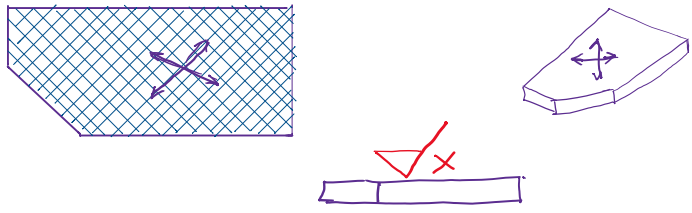
Surface Roughness

The direction of lay (Crease) is represented by the following symbols:

x Lay angular in both directions to line representing the surface to which symbol is applied.

The creases made by the edged tool during machining are at an angle and cross each other on the surface captured in the diagram in which the symbol is written.

Example Honing finished surface



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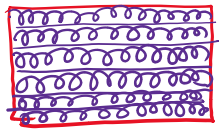
Surface Roughness

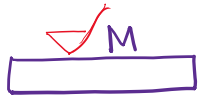
The direction of lay (Crease) is represented by the following symbols:

M Lay multi-directional.

The creases made by the edged tool during machining cross multiple times or have no set direction.

Example Lapped surface, super-finished surface, face-milled or end-milled surface that has been cross fed





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Surface Roughness

The direction of lay (Crease) is represented by the following symbols:

C Lay approximately circular relative to the centre of the surface to which the symbol is applied.

The creases made by the edged tool during machining form mostly concentric circles in relation to the center of the surface on which the symbol is written.

Example Faced surface

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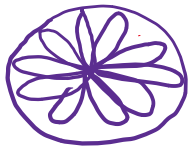
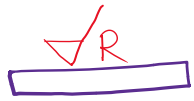
Surface Roughness

The direction of lay (Crease) is represented by the following symbols:

R Lay approximately radial relative to the centre of the surface to which the symbol is applied.

The creases made by the edged tool during machining form mostly a radial pattern in relation to the center of the surface on which the symbol is written.





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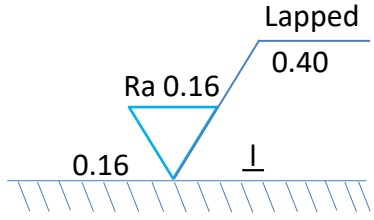
Surface Roughness

As an example, Figure below represents symbolically the surface roughness.



This means, the value of Ra is 0.16 with cut of length 0.40 and the direction of lay being perpendicular, and the method of machining is lapping.

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Surface Roughness

According to Indian Standards the various degree of roughness is represented by the following symbols.

Symbols	Surface Roughness (Ra) in microns
	8 to 25
	1.6 to 8
	0.025 to 1.6
	Less than 0.025

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Surface Roughness

Sr. No.	Manufacturing Processes	Surface Roughness in microns
1	Lapping	0.012 to 0.016
2	Honing	0.025 to 0.40
3	Cylindrical Grinding	0.063 to 5
4	Surface Grinding	0.063 to 5
5	Broaching	0.04 to 3.2
6	Reaming	0.32 to 25
7	Turning	0.32 to 25
8	Hot Rolling	2.5 to 50
9	Extrusion	0.16 to 5
10	Boring	0.4 to 6.3

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Surface Roughness

Sr. No.	Manufacturing Processes	Surface Roughness in microns
11	Milling	0.32 to 25
12	Planing and Shaping	1.6 to 25
13	Drilling	1.6 to 20
14	Sand Casting	5 to 50
15	Die Casting	0.8 to 3.2
16	Forging	1.6 to 2.5

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References

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V. B. Bhandari, Design of Machine Elements, Third Ed., The McGraw-Hills Companies, New Delhi

R. S. KHURMI and J.K.GUPTA, A Text Book of Machine Design, S.Chand and company ltd., New Delhi, 2000.

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