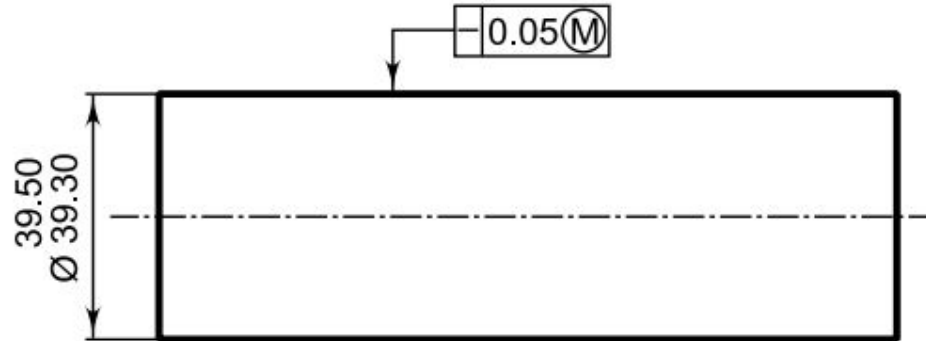




# Machine Drawing

Class 5 : Surface Finish

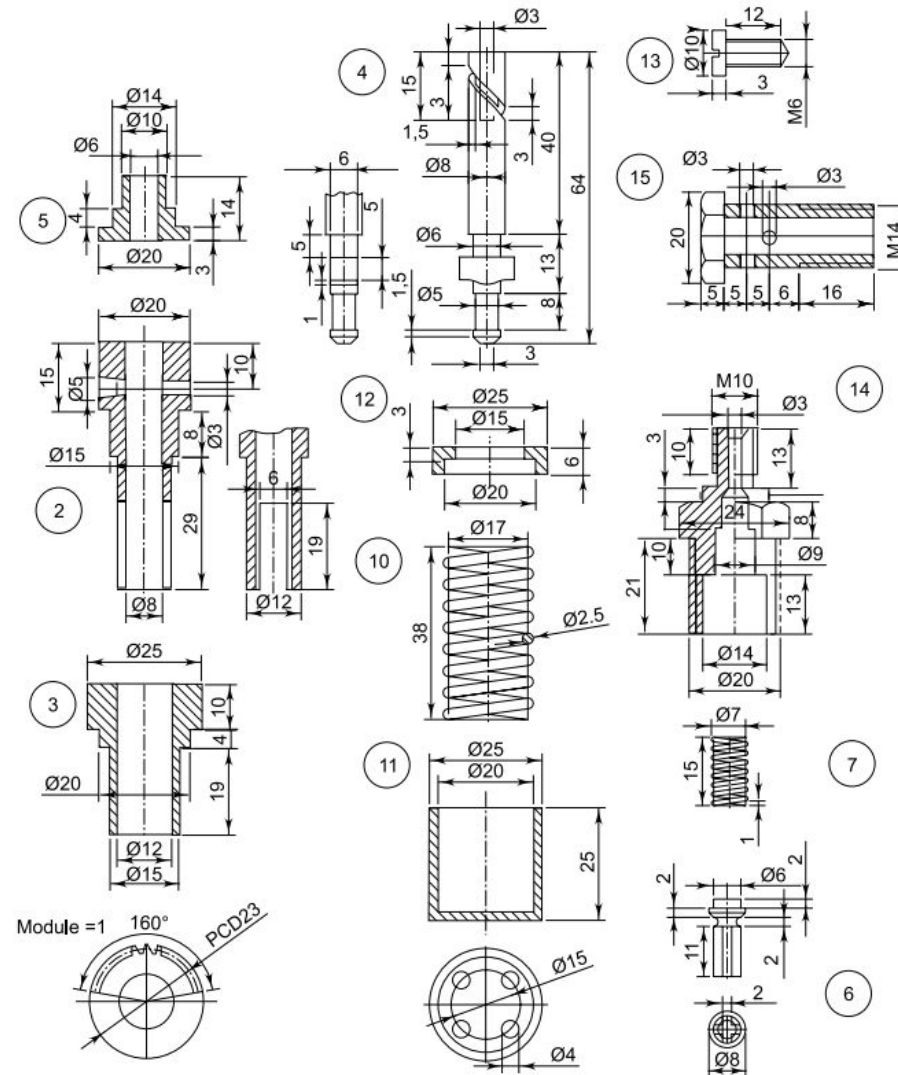


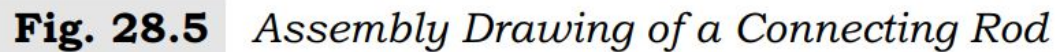
**Fig. 20.P12**

**Fig. 28.19A** *Assembly Drawings of a Diesel Fuel Pump*

**Fig. 28.19B** *Part Drawings of a Diesel Fuel Pump...Contd.*

S.N.	Part name	Material	Qty
1	Body	Cast iron	1
2	Barrel	C.Steel	1
3	Pinion	C.Steel	1
4	Plunger	C.Steel	1
5	Valve seat	M.S.	1
6	Valve	M.S.	1
7	Valve spring	Sp.S.	1
8	Washer	Copper	1
9	Rack	C.steel	1
10	Return spring	Sp.steel	1
11	Cam follower	C.steel	1
12	Spring seat	M.S.	1
13	Bleed screw	M.S.	1
14	Outlet nipple	M.S.	1
15	Banjo bolt	M.S.	1

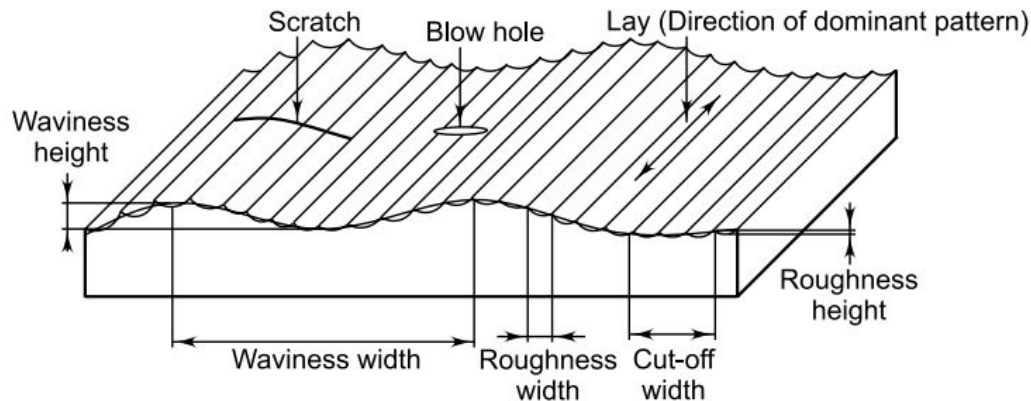




# Textbooks and References

- *Singh, Ajeet. Machine Drawing, Tata McGraw-Hill, 2007.*

- Surface texture includes surface **roughness**, **waviness**, **lays**, **flaws**, etc.
  - **No surface is smooth**. Every surface has some roughness of microstructure.
  - Even for polished surfaces there are **peaks** and **valleys** if seen under a microscope.
  - An actual surface, if exaggerated is as shown in Fig. 20.27.
- **Roughness** is the fine **irregularity** in the **surface**. For machined surfaces, **roughness** is caused by the **cutting edge of the tool**. Lesser the feed rate, lesser is the roughness.
  - **Roughness width** is the distance between two adjacent peaks or two adjacent valleys.



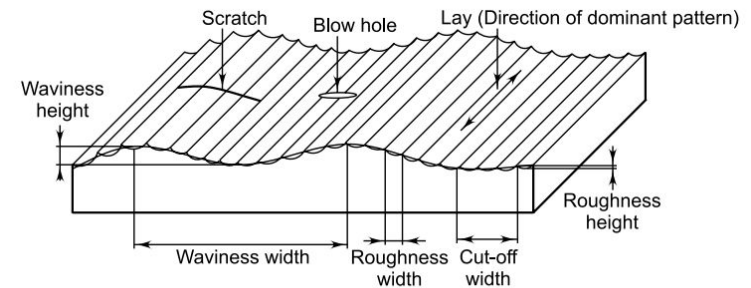
**Fig. 20.27** *Surface Texture*



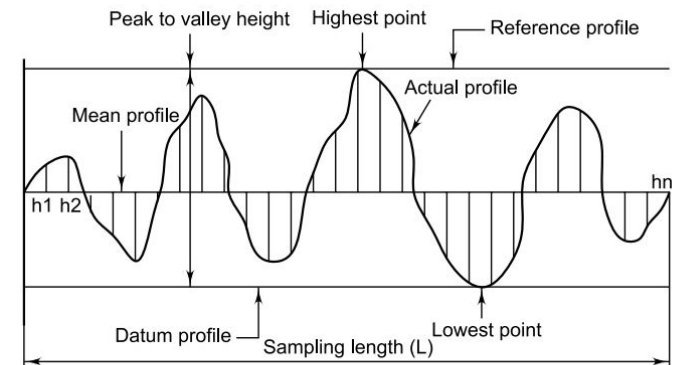
# Surface texture



- **Roughness height** is the arithmetic average deviation measured from the center line. It is indicated in microns.
- **Roughness cut off** is the width of the greatest spacing of repetitive surface irregularities to be included in the measurement of average roughness height. It is indicated in mm. Standard cut off widths are 0.075, 0.25, 0.75, 2.5, 7.5 and 25 mm.
- **Waviness** is the wider spacing than roughness cut-off width. It results from machine/work deflections, vibrations, chatter, heat treatment or warping.
- **Waviness height** is the peak to valley distance of the waviness curve.
- **Lay** is the direction of dominant surface pattern determined by the production methods. This is caused due to tool marks.
- **Flaws** are the irregularities that occur at a place or places such as scratches, blow holes, cracks, etc. Effect of flaw is not considered in measurement of surface roughness.



**Fig. 20.27** Surface Texture

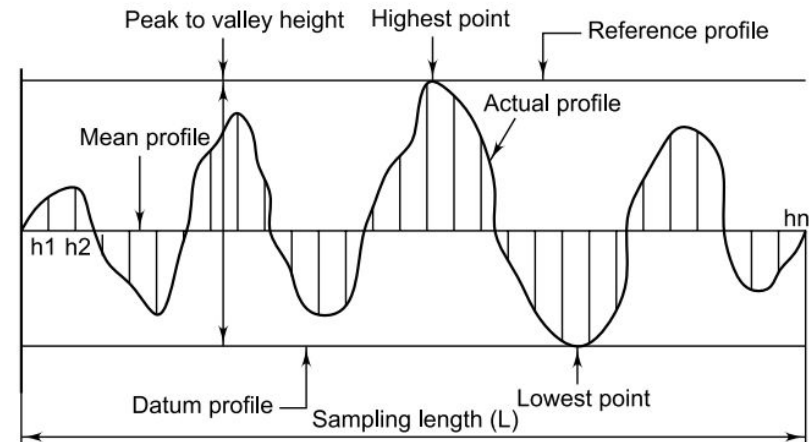


**Fig. 20.28** Profile Definitions Related to a Surface



# Surface texture

- **Datum profile** passes through the lowest point of the actual profile and is parallel to reference profile.
- **Reference profile** passes through the highest point of the actual profile. All irregularities are referred to this profile.
- **Mean roughness** index is the arithmetic mean of the absolute values of the heights  $h_1 + h_2 + h_3 + \dots + h_n$  between the actual and mean profiles.



**Fig. 20.28** *Profile Definitions Related to a Surface*

$$\overline{Ra} = \frac{1}{L} \int_{X=0}^{X=L} |h_i| dx$$

## Surface roughness number

$$Ra = \frac{h_1 + h_2 + h_3 + \dots + h_n}{n}$$

# Surface texture

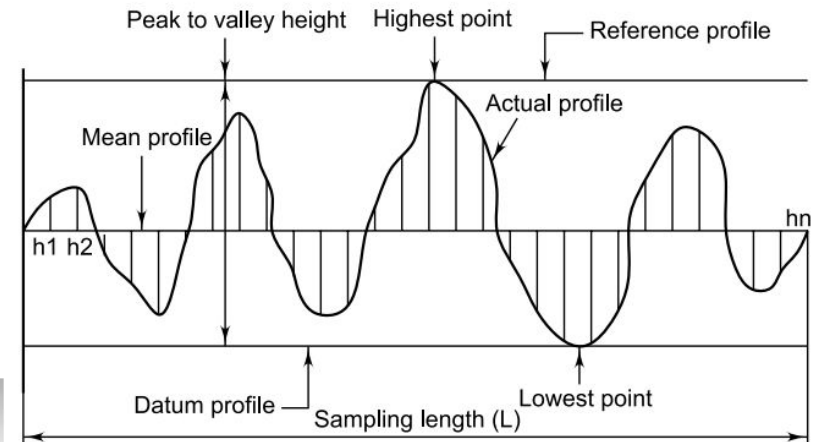


## Surface roughness number

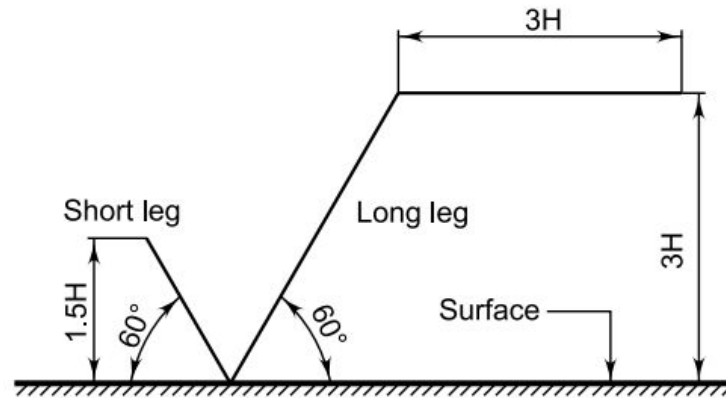
$$R_a = \frac{h_1 + h_2 + h_3 + \dots + h_n}{n}$$

**Table 20.3** Roughness grades and grade symbols

Roughness values— $R_a$ in microns	Roughness grade number	Roughness grade symbol
50	N12	
25 12.5	N11 N10	
6.3 3.2 1.6	N9 N8 N7	
0.8 0.4 0.2	N6 N5 N4	
0.1 0.05 0.025	N3 N2 N1	



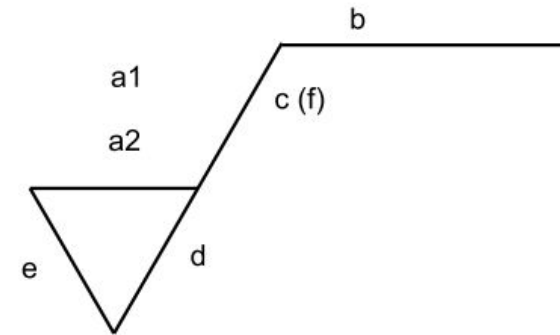
**Fig. 20.28** Profile Definitions Related to a Surface



(A) Basic symbol with proportions

Where:

- a1 – Maximum permissible roughness
- b – Production method
- d – Direction of lay
- f – Roughness criterion other than Ra



(B) Symbol with locations of specifications

- a2 – Minimum permissible roughness
- c – Sampling length
- e – Machining allowance

**Fig. 20.29** *Roughness Symbol with Various Specifications*

# Roughness Symbols



**Table 20.1** Roughness symbols and their meaning

No.	Roughness symbol	Meaning
A		Basic symbol without any specifications
B		Material removal prohibited
C		Machining required
D		Machining required. Maximum roughness is 'a'
E		Surface roughness should lie between a1 and a2.
F		Sampling length 'c' specified
G		Direction of lay 'd' specified as perpendicular
H		Machining allowance 'e' specified
I		Machining operation 'b' specified as milling
J		Treatment is indicated as chrome plating
K		Roughness criterion other than Ra in parentheses
L		A note for same roughness all over as 'a'
M		Named symbol X has same specifications as given on right hand side after equal to sign

# Roughness Symbols



**Table 20.2** Symbols used for direction of lay

<i>Direction of lay</i>	<i>Graphical interpretation</i>	<i>Symbol</i>	<i>Indication</i>
Parallel to plane of projection of the view in which symbol is used		—	
Perpendicular to plane of projection of the view in which symbol is used		⊥	
Crossed in two slant directions relative to plane of projection of the view in which symbol is used		×	
Multi-directional		M	
Approximately circular relative to the center of the surface to which the symbol is applied		C	
Approximately radial relative to the center of the surface to which the symbol is applied		R	

# Range of Roughness



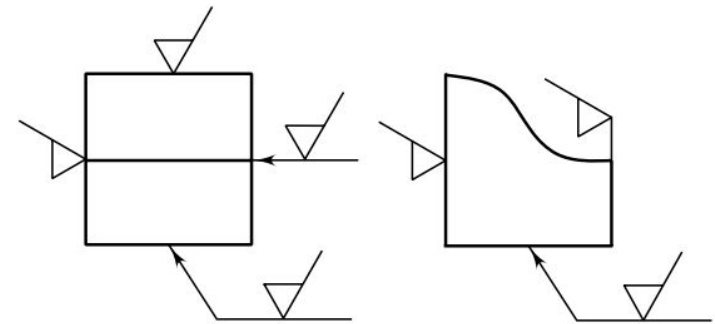
**Table 20.4** Range of roughness obtainable with different processes

<i>S.No.</i>	<i>Process</i>	<i>Minimum– Maximum</i>	<i>Average application range Minimum–Maximum</i>
1	Gas cutting	6.3 -100	12.5-25
2	Sand casting	6.3-50	12.5-25
3	Hot rolling	6.3-50	12.5-25
4	Sawing	1.6-25	1.6-12.5
5	Planing	1.6-25	1.6-12.5
6	Shaping	1.6-25	1.6-12.5
7	Forging	1.6-25	3.2-12.5
8	Turning	0.32-25	0.4-6.3
9	Milling	0.32-25	0.8-6.3
10	Filing	0.25-25	3.2-6.3
11	Drilling	1.6-20	1.6-6.3
12	Boring	0.2-25	0.4-6.3
13	Chemical milling	0.8-12.5	1.6-6.3
14	Electric discharge machining	0.8-12.5	1.6-6.3
15	Electron beam	0.2- 6.3	0.8-6.3
16	Laser	0.2-6.3	0.8-6.3



# Rules for putting roughness symbols

- If no surface control is specified, it is presumed that the surface produced by any manufacturing process will be acceptable.
- If roughness is important, it has to be indicated on a drawing.
- The symbol used is a check mark, whose conical point should touch the line indicating the surface.
- Wherever the symbol is used with dimension, it affects the entire surface defined by dimension.
- Transition areas such as fillets and chamfers normally have the same roughness as finished area next to them.
- If the roughness is indicated for a plated surface, it has to be mentioned whether it is before or after plating or both should be mentioned.
- The symbol is to be oriented such that it can be read either from bottom or from right side of the drawing (Fig. 20.30).



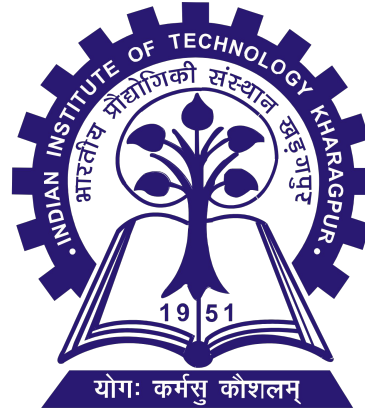
**Fig. 20.30** *Roughness Symbol Orientation and Placement*



# Rules for putting roughness symbols



- The symbol can be connected to the surface by a leader line terminating with an arrow.
- It can be put over the extension lines also.
- Symbol is to be used only once for a given surface, preferable where the surface is dimensioned.
- If same roughness applies to every surface, a note can be written.
- If same roughness applies to most of the surfaces except a few, a conditional note can be written.
- To avoid clumsiness of specifications over a symbol, a symbol with similar specifications can be named.
- For symmetrical surfaces, the symbol is to be put on both the sides.
- For cylindrical surfaces, the symbol is to be put only on one side.
- All over symbol (L in Table 20.1) can also be used if same roughness applies to all surfaces.



# Thank you !!!