Unit-5

1. Introduction to Surface Roughness

Surface roughness is the collection of small irregularities present on a machined surface. These irregularities are produced during manufacturing processes such as turning, milling, grinding, casting, and forging.

Importance of Surface Roughness

Affects friction and wear.

Influences fatigue strength.

Determines lubrication effectiveness.

Affects corrosion resistance.

Controls dimensional accuracy and fit between mating parts.

2. Surface Texture

Surface texture consists of:

1. Roughness

Small closely spaced irregularities caused by machining.

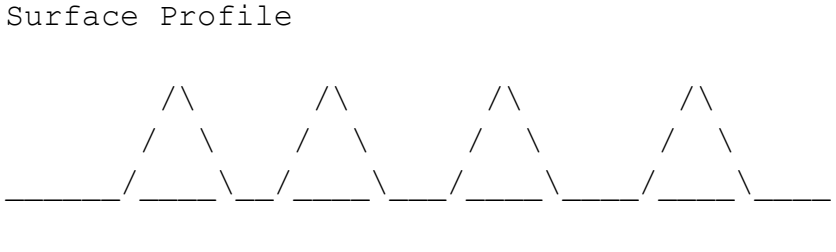
2. Waviness

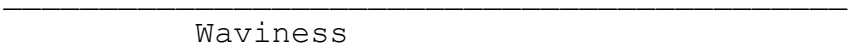
Larger irregularities caused by machine vibrations, tool deflection, etc.

3. Flaws

Scratches, cracks, pits, and holes.

Surface Texture Diagram





3. Terminology

Actual Surface

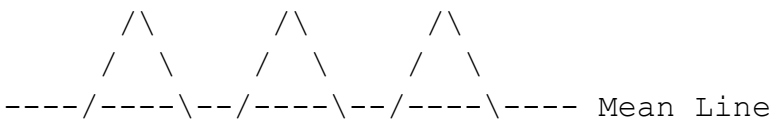
The real surface obtained after machining.

Nominal Surface

The ideal surface represented in drawings.

Datum Line (Mean Line)

Reference line from which roughness measurements are made.



4. Surface Roughness Parameters

(A) Arithmetic Mean Roughness (Ra)

Most widely used parameter.

Formula:

$Ra=|y1|+|y2|+|y3|+\cdots+|yn|nRa=\frac{|y_1|+|y_2|+|y_3|+\cdots+|y_n|}{n}Ra=n|y1|+|y2|+|y3|+\cdots+|yn|$

Where:

yyy = deviation from mean line

nnn = number of observations

Advantages

Easy to calculate.

Internationally accepted.

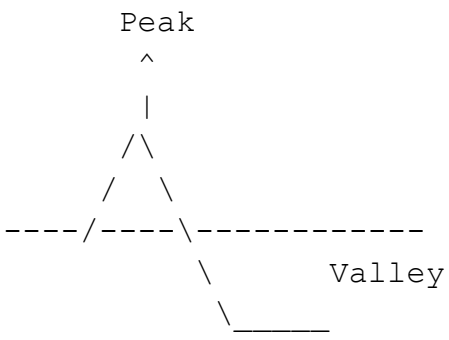
(B) Root Mean Square Roughness (Rq)

Rq=y12+y22+y32+⋯+yn2nRq=\sqrt{\frac{y_1^2+y_2^2+y_3^2+\cdots+y_n^2}{n}}Rq=ny12+y22+y32+⋯+yn2

Provides more weight to larger deviations.

(C) Maximum Peak-to-Valley Height (Rt)

Difference between highest peak and deepest valley.



Rt=Peak−ValleyRt = Peak - ValleyRt=Peak−Valley

5. Methods of Surface Roughness Measurement

1. Comparison Method

Surface is compared with standard specimens.

Procedure

Standard roughness samples are provided.

Workpiece is visually or tactilely compared.

Advantages

Simple.

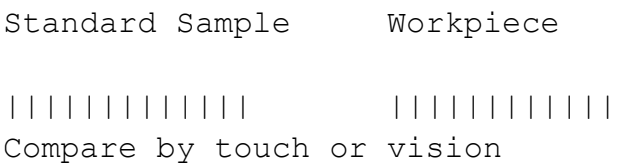
Low cost.

Disadvantages

Less accurate.

Depends on operator skill.

Diagram

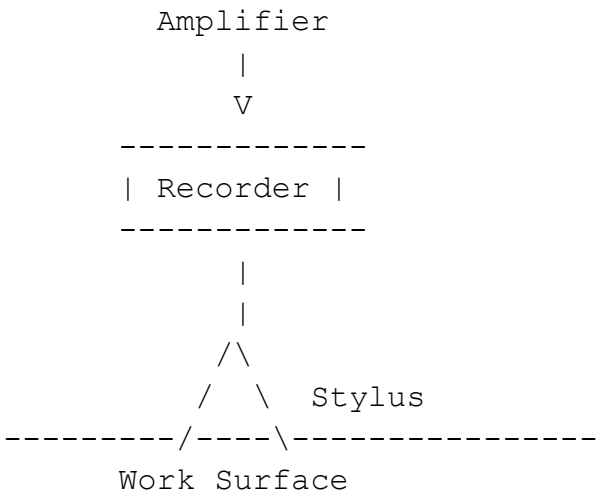


2. Stylus Method

Most common method.

A diamond stylus moves over the surface and records irregularities.

Working Principle



Components

Diamond stylus

Pickup unit

Amplifier

Recorder/display

Advantages

High accuracy.

Direct reading.

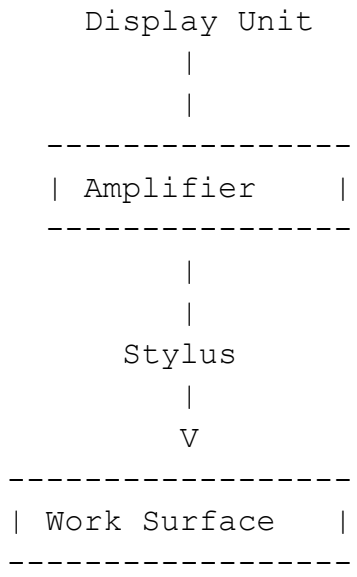
Disadvantages

Stylus may scratch soft surfaces.

6. Taylor Hobson Talysurf Instrument

Most widely used stylus-type instrument.

Construction



Working

Stylus traverses over the surface.

Vertical movement is converted into electrical signals.

Signals are amplified.

Roughness profile is displayed.

Features

Measures Ra, Rq, Rt.

High magnification.

Automatic recording.

Advantages

Very accurate.

Permanent record available.

---

7. Optical Methods

Used where contact measurement is not desirable.

Principle

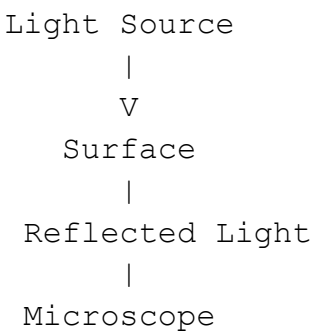
Light is reflected from the surface and analyzed.

Types

Interference microscope

Optical flat method

Diagram



Advantages

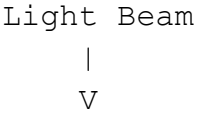
Non-contact method.

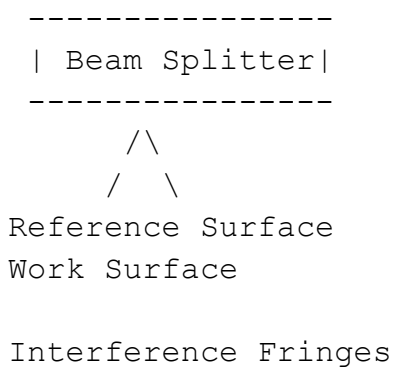
Suitable for delicate surfaces.

8. Interference Microscope

Uses light interference principle.

Working





Fringe patterns indicate surface roughness.

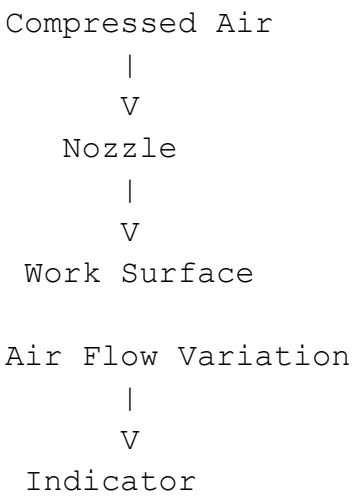
9. Pneumatic Method

Measures roughness using compressed air.

Principle

Change in air flow depends on surface irregularities.

Diagram



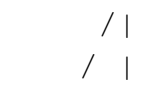
Advantages

No surface damage.

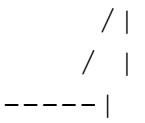
Suitable for finished parts.

10. Surface Roughness Symbols

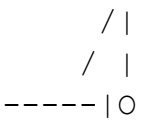
Basic Symbol



Machining Required

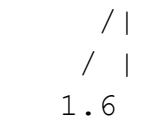


Machining Not Allowed



Roughness Value Indication

Example:



Means:

Ra=1.6 µmRa = 1.6 \,\mu mRa=1.6µm

11. Factors Affecting Surface Roughness

Machine Factors

Vibration

Rigidity

Alignment

Tool Factors

Tool geometry

Tool wear

Tool material

Cutting Conditions

Speed

Feed

Depth of cut

Work Material Factors

Hardness

Ductility

Grain structure

12. Applications of Surface Roughness Measurement

Automobile components

Bearings

Gears

Shafts

Aerospace parts

Precision instruments

Medical implants