Surface Finish Measurement
Objectives

• Interpret the surface finish symbols that appear on a drawing
• Use a surface finish indicator to measure the surface finish of a part
Surface Finish Measurement

• Modern technology demanding improved surface finishes
  • Often require additional operations: lapping or honing
• System of symbols devised by ASA
  • Provide standard system of determining and indicating surface finish
  • Inch unit is microinch (μin)
  • Metric unit is micrometer (μm)
Surface Indicator

• Tracer head and amplifier
• Tracer head has diamond stylus, point radius .0005 µin that bears against work surface
• Movement caused by surface irregularities converted into electrical fluctuations
• Signals magnified by amplifier and registered on meter
• Reading indicates average height of surface
Either arithmetic average roughness height (Ra) or root mean square (Rq)

\[ a = 3 \quad a^2 = 9 \\
\quad b = 19 \quad b^2 = 361 \\
\quad c = 22 \quad c^2 = 484 \\
\quad d = 15 \quad d^2 = 225 \\
\quad e = 30 \quad e^2 = 900 \\
\quad f = 19 \quad f^2 = 361 \\
\quad g = 27 \quad g^2 = 729 \\
\quad h = 19 \quad h^2 = 361 \\
\quad i = 30 \quad i^2 = 900 \\
\quad j = 12 \quad j^2 = 144 \\
\quad k = 22 \quad k^2 = 484 \\
\quad l = 14 \quad l^2 = 196 \\
\quad m = 5 \quad m^2 = 25 \\
\text{Totals} \quad 237 \quad 5179 \\

Ra = \frac{237}{13} = 18.2 \ \mu\text{in.} \\
Rq = \sqrt{\frac{5179}{13}} = 19.9 \ \mu\text{in.}
Symbols Used to Identify Surface Finishes and Characteristics
Surface Finish Definitions

• Surface deviations: departures from nominal surface in form of waviness, roughness, flaws, lay, and profile

• Waviness: surface irregularities that deviate from mean surface in form of waves

• Waviness height: peak-to-valley distance in inches or millimeters

• Waviness width: distance between successive waviness peaks or valleys in inches or millimeters
Surface Finish Definitions

• Roughness: relatively finely spaced irregularities superimposed on waviness pattern
  • Caused by cutting tool or abrasive grain action
  • Irregularities narrower than waviness pattern
• Roughness height: Ra deviation measured normal to centerline in microinches or µm
• Roughness width: distance between successive roughness peaks parallel to nominal surface in inches or millimeters
• Profile: contour of specified section through a surface
Surface Finish Definitions

• Roughness width cutoff: greatest spacing of repetitive surface irregularities included in measurement of roughness height
  • Must be greater than roughness width
• Flaws: irregularities such as scratches, holes, cracks, ridges, or hollows that do not follow regular pattern
• Lay: direction of predominant surface pattern caused by machining process
Symbols that Indicate Direction of Lay

|| Parallel to boundary line of surface indicated by symbol

_|_ Perpendicular to boundary line of surface indicated by symbol

X Angular in both directions on surface indicated by symbol

M Multidirectional

C Approximately circular to center of the surface indicated by symbol

R Approximately radial in relation to the center of surface indicated by symbol
### Average surface roughness produced by standard machining processes

<table>
<thead>
<tr>
<th>Process</th>
<th>Microinches</th>
<th>Micrometers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turning</td>
<td>100–250</td>
<td>2.5–6.3</td>
</tr>
<tr>
<td>Drilling</td>
<td>100–200</td>
<td>2.5–5.1</td>
</tr>
<tr>
<td>Reaming</td>
<td>50–150</td>
<td>1.3–3.8</td>
</tr>
<tr>
<td>Grinding</td>
<td>20–100</td>
<td>0.5–2.5</td>
</tr>
<tr>
<td>Honing</td>
<td>5–20</td>
<td>0.13–0.5</td>
</tr>
<tr>
<td>Lapping</td>
<td>1–10</td>
<td>0.025–0.254</td>
</tr>
</tbody>
</table>
To Measure Surface Finish with a Surface Indicator

1. Turn on, allow instrument to warm up
2. Check machine calibration by moving stylus over test block
3. Adjust calibration control if necessary
4. Use .030-in cutoff range for surface roughness of 30 µin or more. For less, use the .010 in. cutoff range
   • Unless specified otherwise
To Measure Surface Finish with a Surface Indicator

5. Thoroughly clean surface to be measured
   • Ensures accurate readings
   • Reduces wear on rider cap protecting stylus

6. Using smooth, steady movement of stylus, trace work surface at approximately .125 in./s

7. Note reading from meter scale
Other Methods

• Surface analyzer
  • Uses recording device to reproduce surface irregularities on graduated chart, providing ink-line record

• Comparison blocks
  • Used for comparing finish on workpiece with calibrated finish on test block using fingernail test

• Commercial sets of standard finished specimens
  • Up to 25 different surface finish samples