Straightness Measurement

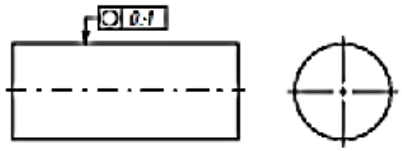
Example

A Shaft of length 500 mm was tested for straightness error by using a dial indicator. The shaft was divided into 10 equal spaces of 50 mm apart, and the dial readings were observed at each position (11 readings). The readings were as follows:

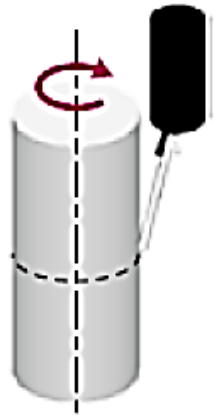
Determine the maximum out of straightness in microns, and Plot the contour of the shaft

x_i Position (mm)	y_i Height (mm)	x_i^2	$x_i y_i$	Y_i'	$\delta = Y_i - Y_i'$ (μm)
0	0.01				
50	0.10				
100	0.15				
150	0.15				
200	0.25				
250	0.25				
300	0.45				
350	0.60				
400	0.70				
450	0.85				
500	0.95				

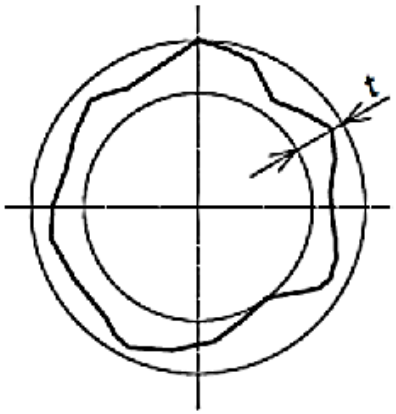
Roundness Measurement



Notation example

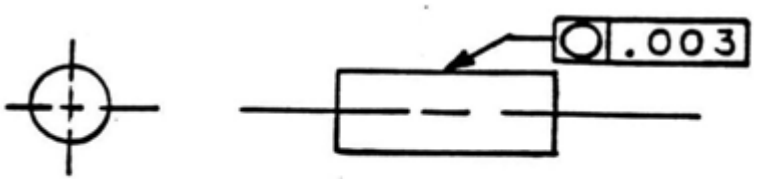


Inspection example

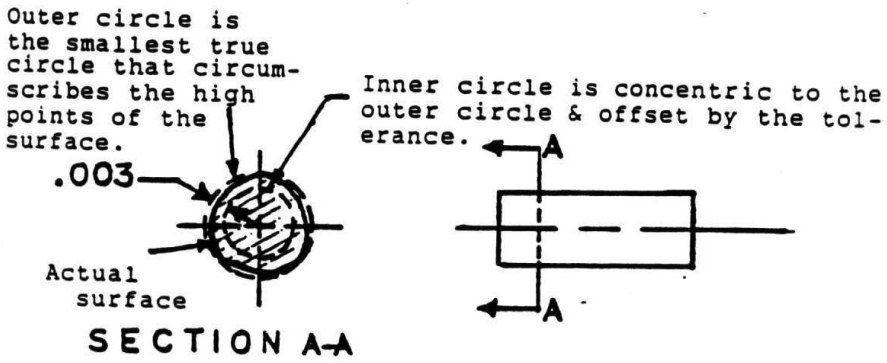


Tolerance zone

Roundness: any circumferential line must be contained within the tolerance zone formed between two coplanar circular with a difference in radii of t



The Specification

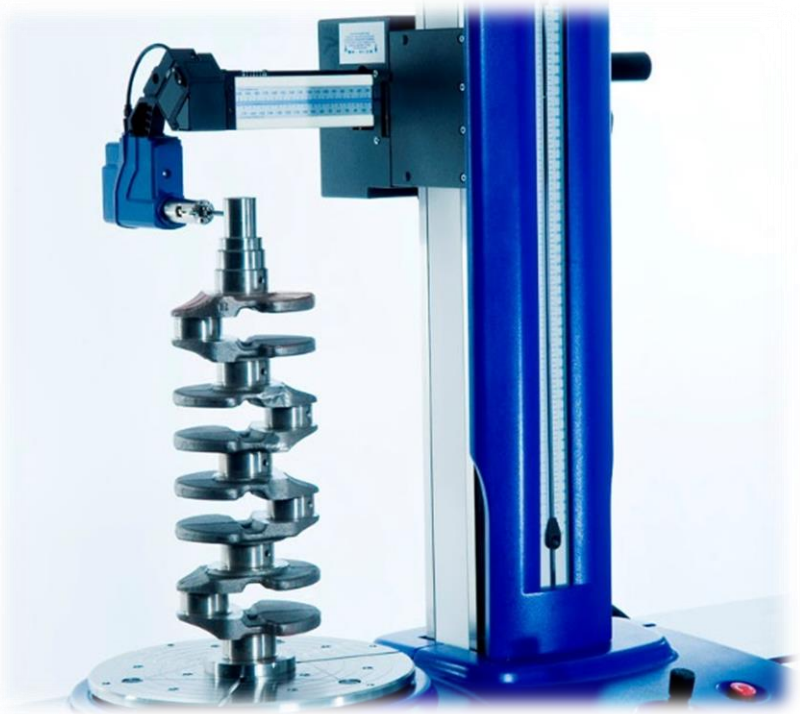


The Tolerance Zone
(Area between two concentric circles)

Roundness Measurement

Two fundamental methods for measuring roundness are:

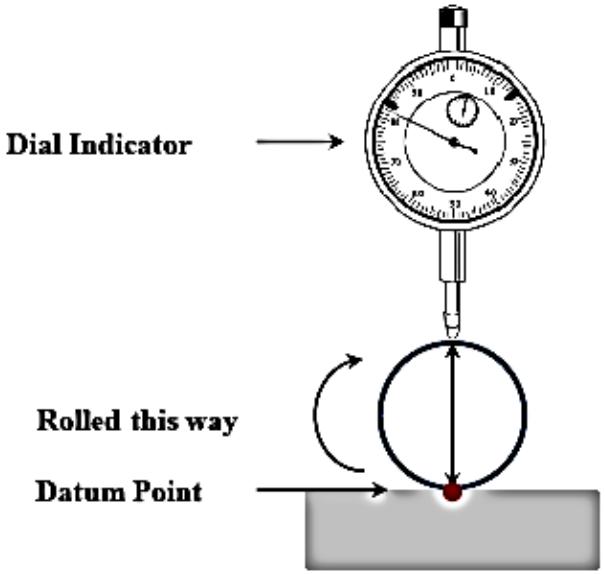
1) **Intrinsic:** uses points on the round surface to measure from
2) **Extrinsic:** uses a separate round surface for a reference (e.g., a precision bearing)



Roundness Measurement

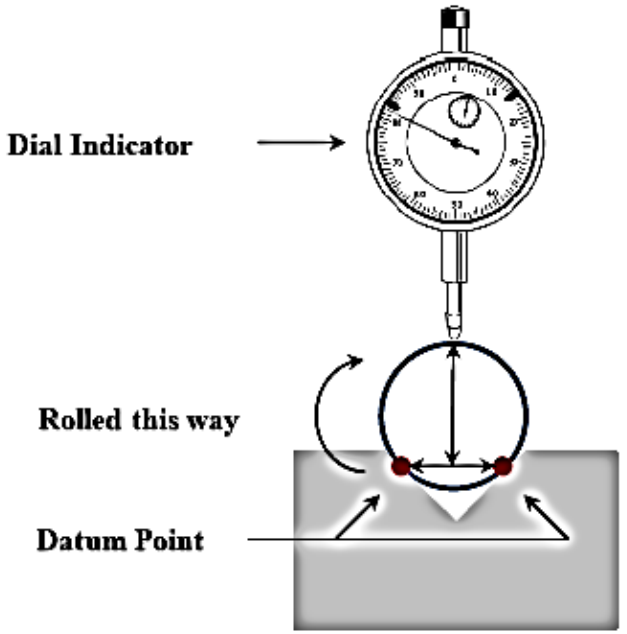
1) Intrinsic Roundness Testing

Diametrical Intrinsic Method



A dial indicator is positioned over the surface to a reference height. The part is then rolled underneath. The peak height can then be compared to other readings

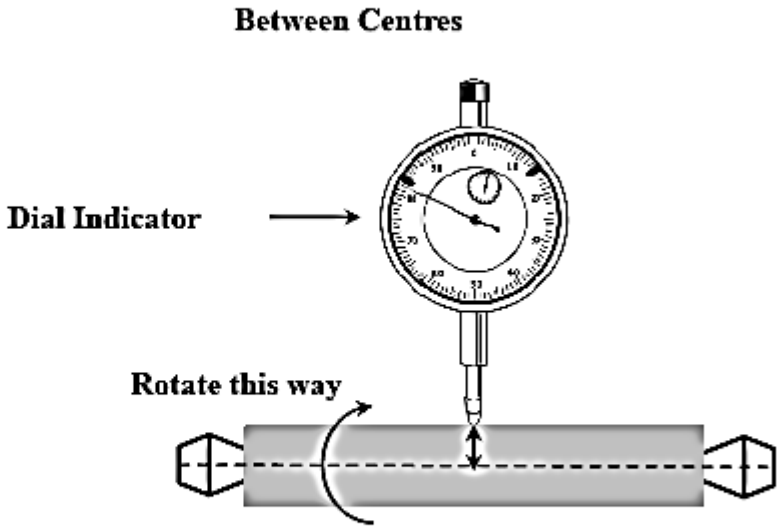
Vee Support Intrinsic Method



A dial indicator is positioned over the surface to a reference height. The part is then rolled underneath. The peak height can then be compared to other reading. The Vee support reduces the effect of a single datum point

Roundness Measurement

1) Intrinsic Roundness Testing



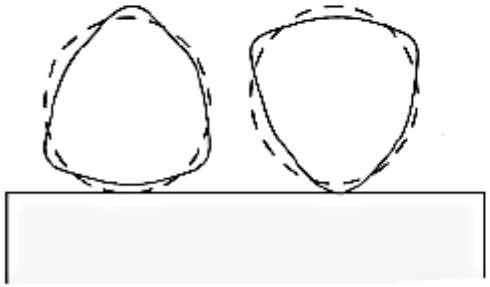
A dial indicator is positioned over the surface to a reference height. The part is then rotated on centres. The variations in the readings are then used to evaluate the part. Location of the centre may lead to problems.

Roundness Measurement

1) Intrinsic Roundness Testing

All three of the intrinsic methods are **inexpensive**

The intrinsic methods all have an important limitation. In particular, if the deformation of the round is small, the methods will deal with it reasonably, but if the deformation is large enough to make the shape non-cylindrical, then the results will err significantly



With this test the two readings shown would indicate roundness, when in fact this is not true

This test would exaggerate the roundness error such that it would be greater than the actual error

Roundness Measurement

1) Intrinsic Roundness Testing

When using The Flat Plane, or the Centre to intrinsically measure roundness, the diameters can be directly obtained, but when using the Vee block, some additional calculations are required !!!

IR = change in centre height + change in radii

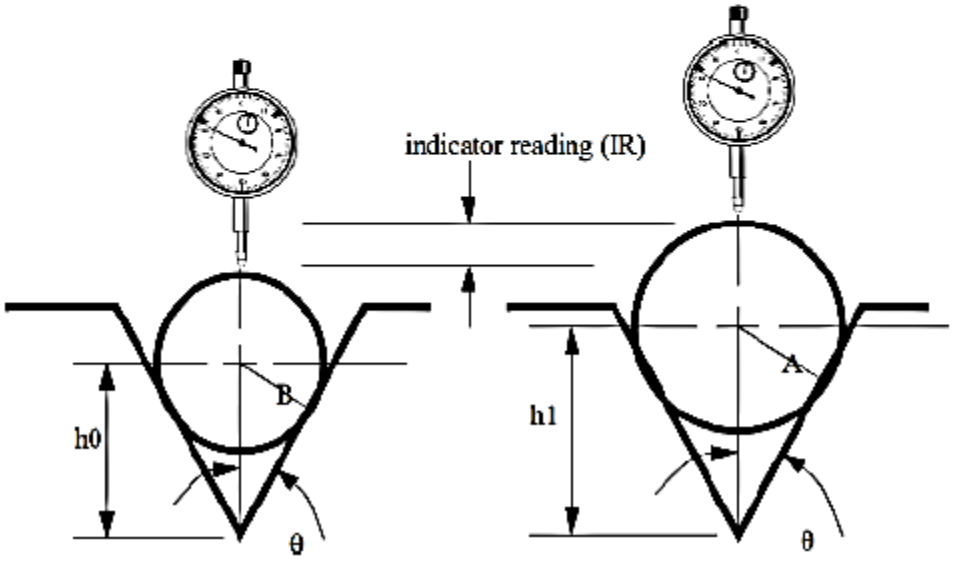
$$\therefore \quad = (h_1 - h_0) + (A - B) = \frac{A}{\sin\theta} - \frac{B}{\sin\theta} + (A - B)$$

$$\therefore \quad = A - B(\csc\theta) + (A - B)$$

$$\therefore IR = A - B(1 + \csc\theta)$$

where,

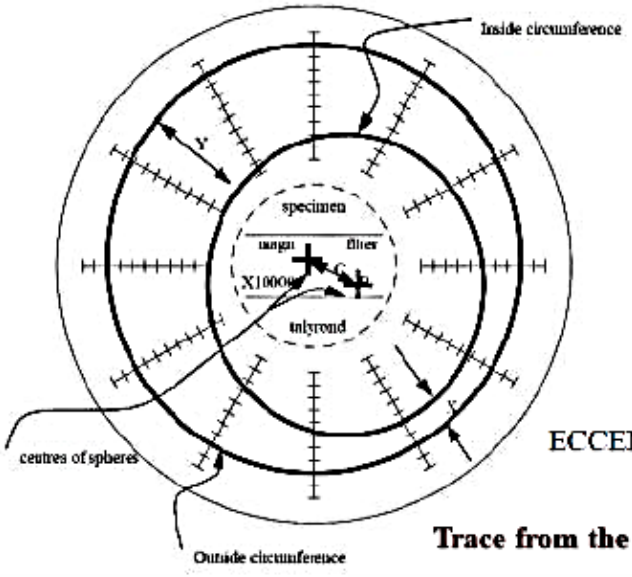
θ = 1/2 vee block angle



Roundness Measurement

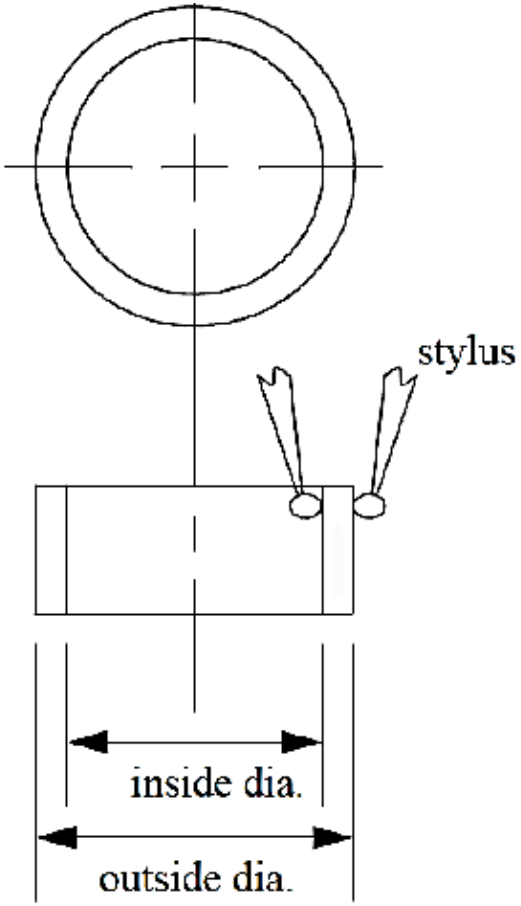
2) Extrinsic Roundness Testing

A simple example is a bearing race
The stylus measures the profile for both the **inside** and **outside** and then these can be compared to determine concentricity

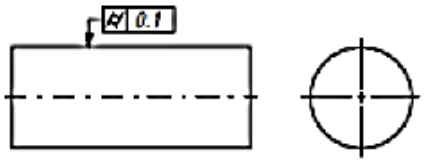


Trace from the Talyrond

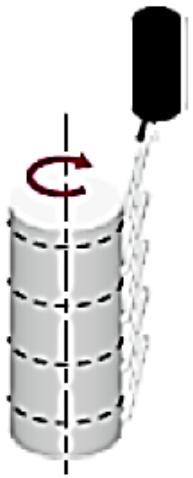
$$\text{ECCENTRICITY} = \frac{Y-X}{2} \times \frac{1}{magn} = \frac{C}{magn}$$



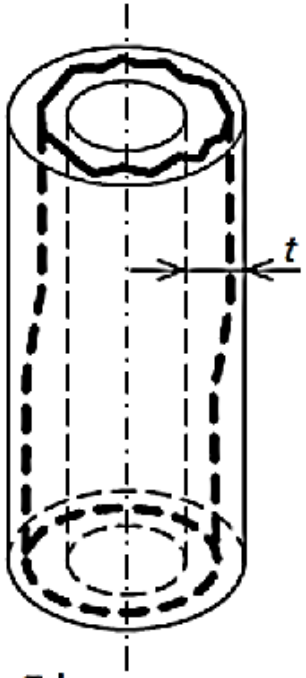
Cylindricity Measurement



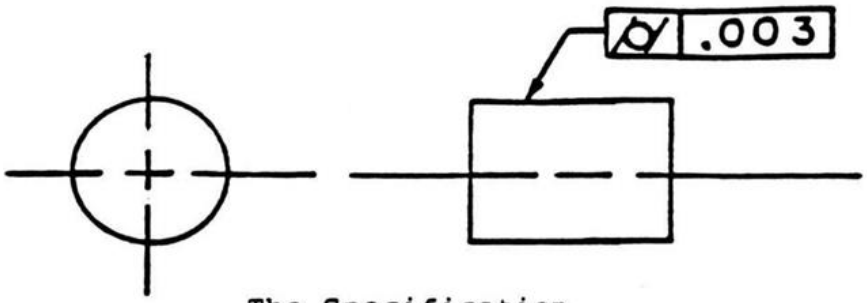
Notation example



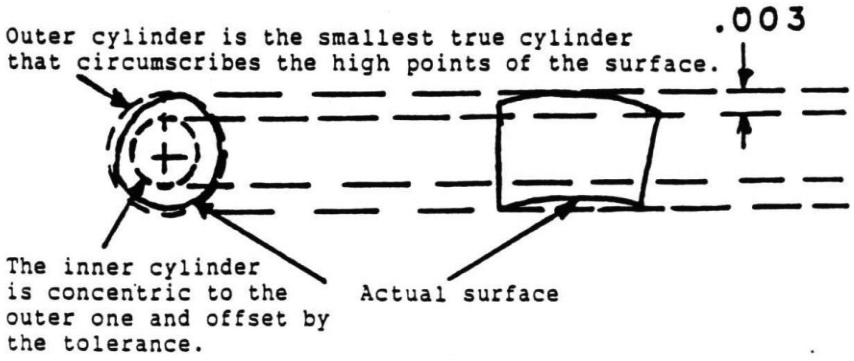
Inspection example



Tolerance zone



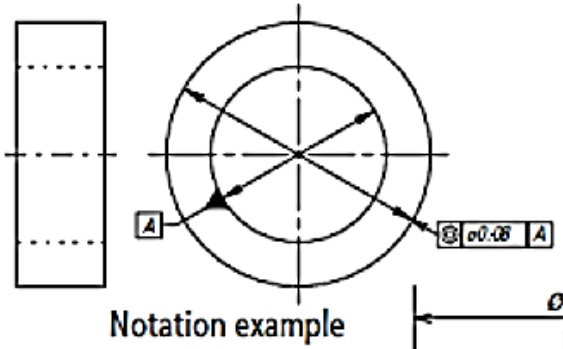
The Specification

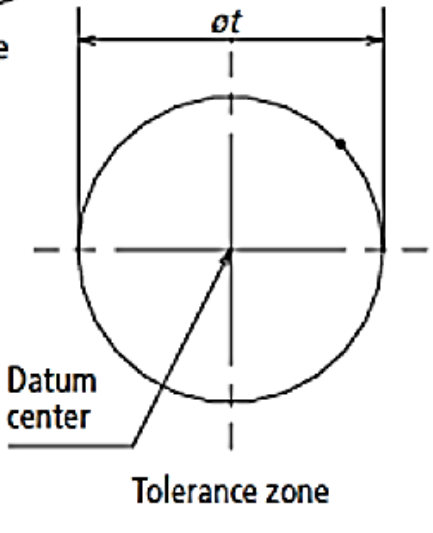


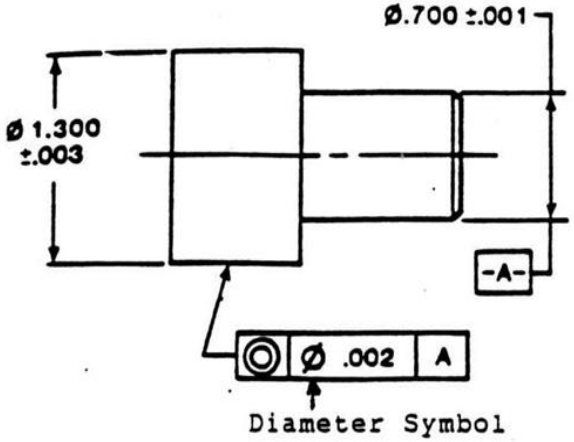
The Tolerance Zone
(Area between two concentric cylinders)

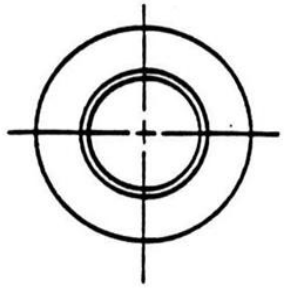
Cylindricity: the surface must be contained within the tolerance zone formed between two coaxial cylinders with a difference in radii of t

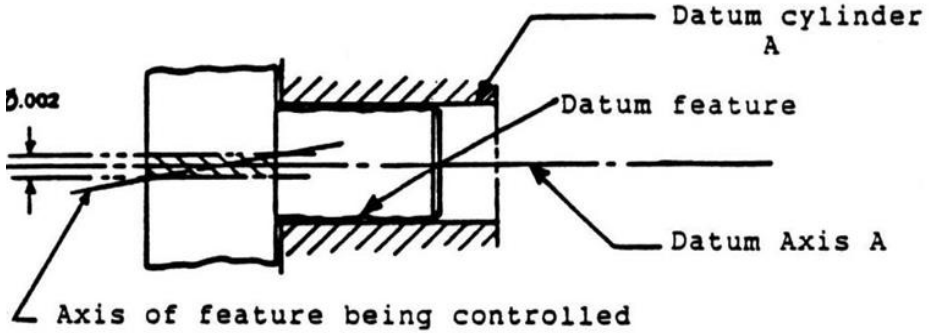
Concentricity Measurement











Concentricity: the centre point must be contained within the tolerance zone formed by a circle of diameter *t* concentric with the datum

The Tolerance Zone
(A cylindrical area about the datum axis)