

Cam and Crank shaft measurement – a brief overview

This document is not a complete formal report. It is just to provide an introductory summary.

1 Introduction

As with gear or roundness measurements, it is possible to apply general metrology methods to cam and crank shafts, but in practice special purpose instruments give greater speed, and often greater accuracy too. Special instruments are made by Adcole, Hemmelwerke, Mahr, amongst others.

2 General principles

2.1 Cam inspection machines

The shaft to be measured is placed between centres. A cam follower on a linear encoder is spring loaded against the cam to be inspected. The cam shaft is driven round and the angular positions of the shaft and the linear position of the follower are logged and compared with the designed lift of cam. Results are commonly displayed on a radial graph similar to a roundness chart.

The next picture shows some mechanics of a rather old cam inspection machine, the cam follower in on the right. The spring force is provided by the weight on the left, through a system of wires and pulleys. A pair of encoder reading heads can be seen just to the right of the centre.



2.2 Differences for crankshaft measurement

Similar machines are often used for both cam and crank measurement. For crank measurement, the follower is replaced by a straight bar wider than the total throw of the crank. This bar forms a wide probe tip that will contact the crank pin whatever the angular position of the shaft. The following photo shows the probe bar on the left of the crank shaft. The latest instruments of this type are very sophisticated, having multi-axis laser interferometers to monitor error motions and software compensation for mapped form errors of the probe bar. They have some sensitivity in the axial direction (e.g. by using strain gauges to detect bending of the probe support) to locate axial reference features.



2.3 Roundness instruments

Crank pins may be measured for roundness and cylindricity (usually with higher accuracy) on roundness instruments. Special tooling is needed to position the shaft eccentrically so that the pin is on axis. Usually such an arrangement fails to provide accurate measurement of the throws and angular relationships of the crank pins. The Mahr Primar is an exception, having controlled X,Y displacement of the chuck on its rotary axis, as shown below.



2.4 Multi-point gauging

Marposs offer an alternative system with very large numbers of gauges set up for a specific shaft – this allows fast throughput for 100% inspection of production, but is not really appropriate for a general metrology operation such as might be offered by an EVIGeM member.

3 Features to measure

Nomenclature:

Journals are cylindrical surfaces for bearings co-axial with the shaft. There are usually several of these spaced along the shaft.

Pins are the cylindrical bearing surfaces eccentric to the main shaft, attached to the pistons through con(necting) rods.

3.1 Crank shafts

Journals

Roundness,
Alignment to other journals,
Cylindricity,
Diameter,
Thrust face at end of journals

Pins

Roundness,
Alignment to journals,
Cylindricity,
Diameter,
Throw,
Angular position

3.2 Cams

Angular reference feature,
Journals, as for cranks,
Cam profiles, relative to journals,
Compare profile with specified tolerance zones