Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 69 (2014) 247 – 254

Procedia Engineering

www.elsevier.com/locate/procedia

24th DAAAM International Symposium on Intelligent Manufacturing and Automation, 2013

Measurement of Diameter and Roundness on Incomplete Outline of Element with Three-Lobbing Deviation

Bartosz Gapinski*, Michal Wieczorowski

Poznan University of Technology, M. Sklodowskiej-Curie 5 sq., PL-60965 Poznan, Poland

Abstract

One of the most often produced and controlled elements in the engineering are shafts and holes. In many cases, they are responsible connections, requiring precise control. Measurement of a diameter or roundness deviation for the full profile are well known and commonly used process . However, in many cases it is necessary to measure an element with a incomplete contour . This paper presents results of research on the impact of the incomplete contour length on a diameter and form deviations. We studied the roundness of standard ring with deviation around 0.9 µm and an element of three-lobbing deviation of 37 µm. In both cases, the nominal diameter of the ring was 100 mm.

The study was conducted in two stages. The first one was connected with measurement of the roundness deviation for sections 180°, 90°, 45° while the reference was 36°. Measurements were carried out on a CMM and a formtester (FMM). Results show that for the standard ring with decreasing length of the incomplete contour followed by a decrease of roundness. In the case of the three - lobbing ring the section 180° has a form difference value coincides with the value for full profile, while for shorter angular sections those values are greatly diminished.

In the second stage, detailed studies that apply measuring sections from 360° to 10° grading in 1° were conducted. Measurements were made for different positions of measuring sections according to the extremes of the outline. The values obtained for the ring with three - lobbing character of form deviation allow to conclude that the diameter remains practically constant for sections up to 210°. Then there is a change in their value which depends on the position of the outline section in relation to extremes. Also the roundness deviation value is constant up to about 210° and then falls and the around 36° reaches value below 1 µm. The studies lead to the conclusion that there is a strong influence of angular measurement section and its position relative to the outlines extremes on achieved the diameter and form deviations.

Keywords: diameter measurement; form deviation, roundness; accuracy of measurement; incomplete contour

* Corresponding author. Tel.: +48 61 665 35 67; fax: +48 61 665 35 95.
E-mail address: bartosz.gapinski@put.poznan.pl

doi:10.1016/j.proeng.2014.02.229

1. Introduction

Consumer's requirements for various types of product are connected with continuous improvement of product quality. The issue of quality can be widely treated in this case – starting from a correctness of manufacturing of particular subassemblies, manufactured mechanisms and ending on a service, trainings or operation costs. The offered prices should not be higher than previous consumer prices. This forces the manufacturer to solve the difficult task which is a connection of two contradictory requirements. This situation exacts the use of innovative solutions which allow for a cost reduction on each stage of designing and manufacturing. In connection with this situation, composite materials, manufacturing processes which reduce the waste materials and etc. should be used. In order to confirm the rightness of made activities, it is necessary to conduct different types of control-measuring works. In addition, the general increase of requirements causes that full control of particular geometrical features is needed [1, 2, 3]. The measurement of elements which are circular sectors exacts this control too.

The measurement of the part of a circle is not a trivial task – in case of both cylinder and hole. Depending on the type of measuring task, it is required to give a position of circle centre or origin of radius, diameter or radius of circle/arc and the value of form deviation [4].

2. The possibilities of measurement of a circle with incomplete contour

There are many possibilities of measurement of the part of a circle, i.e. the measurement of an arc [5, 6]. Workshop methods for the verification of radius are based on e.g. contour masters. These tools allow to fit the arc contour to the master and to estimate the approximate value of outer or inner radius. Versatile and accurate methods allow to measure not only the diameter/radius, but also form deviations. It is possible to apply the coordinate measuring machines or formtester [7, 8, 9, 10, 11, 12].

3. Preliminary measurements of the master ring

The master ring with diameter of 100 mm and undefined type of roundness deviation with the value of 0.9 μm and the ring with defined type of roundness deviation – 3-lobbing, with the value of 0.037 mm and diameter of 101.6 mm were measured during the investigations [13, 14].

Each element was measured in a scanning mode with CMM and form measuring machine (FMM). Full contour of the ring – 360° was measured and it was taken as a reference value. Next, incomplete contours were measured for the following sectors: 180°, 90° and 45°. Reduction of measuring length causes that obtained information is only referred to a part of the contour. In order to verify the possibilities of detection of form deviation in relation to the position of measuring length and contour extremum, the following measurements were performed:

- contour of 180° which was measured 4-times – arranged at every 90°,
- contour of 90° which was measured 8-times – arranged at every 45°,
- contour of 45° which was measured 16-times – arranged at every 22.5°.

Figure 1 presents the measurement results of the master ring with the use of CMM. Each line in this figure denotes the different angular range of the measurement. Axis of abscissae shows the angular scale which allows to present the values of roundness deviation in relation to angular position of the starting point of contour measurement. Figure 2 presents the measurement results of the master ring with the use of FMM.