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Associated elements for assessment the deviation of cylindrical surfaces form

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Abstract

For cylindrical surfaces requirements for roundness deviation, deviation the straightness of the generatrix of the cylindrical surface and straightness of the axis can be determined. In this paper the existing associated reference elements are analyzed, and the influence of selected associated reference elements on assessment of cylindricity deviation and mutual location of their axes are discussed. Experimental studies were conducted in order to determine the level of these deviations due to the associated reference element used. Further, the location of axes was observed after application of various associated reference elements.

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Keywords: Shape deviation; cylindricity; roundness; straightness; associated refeferences elements.

1. Introduction

Product quality can be defined as “ability to fulfill customer's needs and expectations” [1,2,3]. Quality is determined in terms of performance requirements which vary among different products. For discrete workpieces, the primary performance requirements, commonly referred to as characteristics refer to dimension (e.g. length, diameter, thickness, or area), geometry (e.g. flatness, cylindricity, etc.), and appearance (e.g. surface finish, color, or texture). To ensure overall quality delivered workpieces must meet the required quality characteristics. Thus, workpiece quality is measured by its conformance to performance requirements.

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Real surfaces of workpieces obtained by various technological processes are characterized by deviation of the nominal (geometric) shape. In order to fulfill the intended function of finished product, deviations of geometric elements must be within certain limits. The deviations of shape and layout of surfaces and axis of workpieces are major factors for determining their performance. These deviations occur and change as a result of technological impacts, assembly deformations, power and temperature loads, etc. In mechanical engineering 70% of the details are cylindrical. Due to increased requirements for shape accuracy of workpieces the measurement of cylindricity deviation gets more important. Cylindricity deviation is a complex indicator for assessing deviation of shape of cylindrical surfaces and depends on roundness deviation, straightness of the generatrix of the cylindrical surface and straightness of the axis. The assessment of this deviation indicates how high is the difference between the measured cylindrical surface and an ideal cylinder specified as an associated element. Currently, all methods for measuring the cylindricity deviation are approximate, and the accuracy of measurements depends on the number of measured profiles or points and the method for determining the associated elements for assessment the cylindricity deviation [4,5,6].

Table 1. Association symbols.

Symbol	Association
C	Minimax (Chebyshev)
G	Least squares (Gaussian)
X	Maximum inscribed[a]
N	Minimum circumscribed[a]
E	Constrained external to the material
I	Constrained internal to the material

[a] Only applies to spherical and cylindrical features for form and features of size for data.

2. Normative documents' requirements for setting and measuring the cylindricity deviation

The cylindrical deviation is described in [7] and three associated elements for the cylindricity deviation are defined. The last revision of the standard introduced symbols for their marking (Table 1 and Table 2).

Table 2. Specification elements in tolerance zone, feature and characteristic section of tolerance indicator

Toleranced feature				Characteristic			
Filter		Ass. tol. feature	Derived feature	Association	Parameter	Material condition	State
Type	Indices						
G S etc.	0,8 -250 0,8-250 500 -15 500-15 etc.	Ⓒ Ⓖ Ⓝ Ⓧ	Ⓐ	C CE CI G GE GI X N	P V T Q	Ⓜ Ⓛ Ⓡ	Ⓕ

The standard also provides instructions for designating the filters used to measure cylindricity deviation. All terms associated with filtering are defined in [8]. The specificity of filters is defined in other parts of ISO 16610.