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Load capacity and the stress-stain state of the poly eccentric connections with interference

Evgeny Chukhlantsev[a], Alexey Schenyatskiy[a,*]

[a]*Izhevsk state technical university of the name M.T. Kalashnikov, Department of Mechatronic Systems, 7 Studencheskaya street, 426069 Izhevsk, Russia*

Abstract

The article provides an overview of the poly contact connections with a tightness. The range of their application, considered the advantages and disadvantages. The methods of calculating the load capacity and the stress - strain state under different conditions of contact interaction. Numerical simulations of the poly contact connection with interference for different relative positions of the three mating parts. The analysis of the load-bearing capacity and stress - strain state to the extreme positions of the connection details. Obtained geometric load capacity depending on the angles of rotation of mating parts which can significantly speed up the calculations. Spend a full-scale experiment, whose results confirm the adequacy of the mathematical model. At the end of the article presents the findings.

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Keywords: stress-stain state; mathematical model; interference; quality of the products.

1. Introduction

In modern mechanical engineering the creation of assemblies and mechanisms, which do not require repair for long, is priority. The various mechanisms, which are responsible for the change in the relative position of mating part, hold special place in this sphere. One of such mechanisms is eccentric mechanism of skewness, which used not only in the light and heavy mechanical engineering, but also in the oil and gas industry (directional drilling column of oil and gas) [1]. Cam mechanisms are generally composed of two or more mating parts. Contact details can occur on cylindrical or conical surfaces. In some cases, to increase the rigidity between the product parts is mated with an interference fit. To their mutual movement between the mating parts oil is supplied under high pressure. Parts relative rotation mechanism by using different types of actuators, such as ratchet mechanisms, worm gears, etc. The drive mechanism may be a hydraulic or electrical, depending on the performance of the mechanism. Analysis of calculation methods used for compounds with an interference fit, showed that they do not fully satisfy the numerous conditions that occur in these compounds.

The analysis of this problem showed that modern machine-building enterprises still use outdated methods based on the Lagrange equations of the first and the second kind when they design unequal hard connections with a interference. That, in turn, has a significant influence on strength characteristics and, as a consequence, the quality of the products.

2. Formulation of research problem

Therefore, now the most urgent task is to improve the existing theory calculation poly eccentric connections with a interference. For example, see Fig. 1.

* Corresponding author. Tel.: +79 (3412) 77-60-55
E-mail address: fmim@istu.ru

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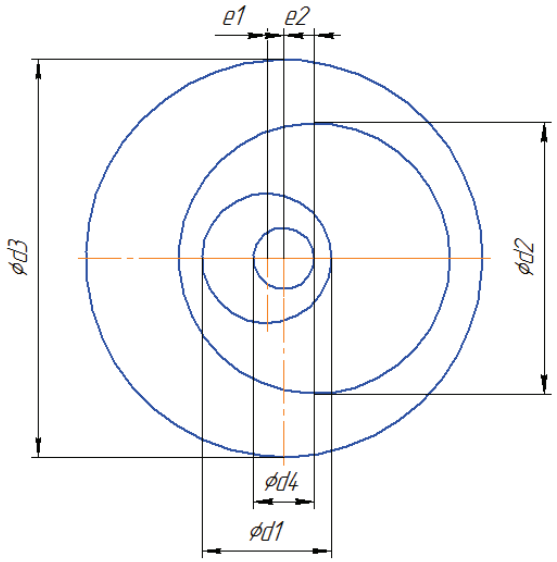

Fig. 1. Poly eccentric connection with an interference.

where:
d1 – the diameter of the inner cam (shaft);
d2 – the diameter of the intermediate eccentric (intermediate sleeve);
d3 – the diameter of the outer eccentric (sleeve);
d4 – the diameter of hole of the inner eccentric (sleeve);
e1≠e2 – the magnitude of the eccentricity of the inner and intermediate eccentrics.

Depending upon the design scheme, poly eccentric connection with interference (PECwI) can be assembled with interference or transition fit, wherein interference will change from Nmin=0 (transitional planting) to Nmax (limit value, bounded physical and mechanical properties of the material parts σi=σT.

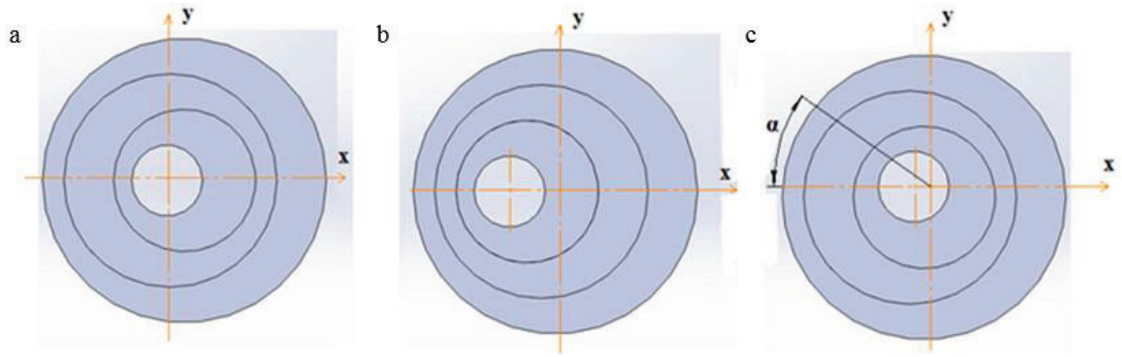

Fig. 2. Different versions of assembly of parts PKNS after pre-pressing:
a) rotation parts relative to each other at an angle α =0˚, ey=ex=0; b) rotation parts relative to each other at an angle α =180˚, ey=0, ex=max; c) rotation parts relative to each other at an angle α =45˚, ey=ex≠0.

For relative rotation of the parts, their separation is performed. This process can be of the following types:
- hydro pressing method (by introducing oil into the coupling zone under high pressure);