58th ICMD 2017
6 - 8 September 2017, Prague, Czech Republic

THE OPTIMIZATION PROCEDURE OF THE INNER GEOMETRY IN THE SPHERICAL ROLLER BEARINGS WITH REGARD TO THEIR DURABILITY

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Abstract
This article deals with the optimization procedure of the inner geometry in the spherical roller bearings. The term optimization is in this case understood as the selection process of the most appropriate solution to the spherical roller bearing durability increase. It analyses the issue of current state of the spherical roller bearings, two-body line contact and the bearings durability. It describes the contact strain along the spherical roller in the spherical roller bearing using curves. It subsequently shows the optimization procedure of the contact strain curves and so the bearing itself. The article also describes the creation procedure of the 3D parametric model and the contact strain analysis using the finite element method.

Key words: *Spherical roller bearing; optimization; contact strain*

INTRODUCTION

Rolling bearings are an inseparable part of most machines and devices in which rotation movement and linear motion are performed. There are different requirements on rolling bearings. Production machines need bearings which are able to work in high revolution, in power engineering bearings have to carry heavy load, trains require bearings with high speed performance, etc.
Development or rather rolling bearing optimization is conditioned by the technical parameters increase in machines and devices. This fact refers especially to input parameters increase such as power and revolution, weight and volume reduction, noise level reduction, etc. However, the most important parameters requiring optimization are bearing lifetime and reliability. New technologies development introduces also new construction materials, new production techniques of semi-finished products and bearing components or new installation methods. It is important not to overlook the bearing construction. Here it is possible to perform geometry adjustment optimization. This adjustment applies especially to geometry adjustment of runways and rolling elements in the spherical roller bearings. (Kohár et al., 2016)

MATERIALS AND METHODS

The double row angular spherical roller bearing has a runway spherically ground on the outer ring. The bearing is able to accommodate very high radial loads, as well as heavy axial loads in both directions. High radial load capacity is caused by the great number of rolling elements, so-called spherical rollers and their close contact on the inner ring runways.
Rolling bearings durability depends on revolution number which the bearing is able to perform. Peeled material is a sign of a component fatigue. The fatigue is crucial and natural way of bearing damage. It is demonstrated by the presence of small cracks under the bearing runway surface. The depth of these cracks is usually about 0,05 – 0,3 millimetres depending on the surface curve radiuses of rolling elements and the bearing rings runways. The crack depth allows the material changes which are caused by slide pulsing strain. This process leads to the gradual crack formation under the surface. It can take quite a long time until it is visible on the surface in form of the material peeling off, so-called pitting.

It is possible to calculate the intensity of the contact pressure and the size of the contact surface - effective length l_{ef} and width 2b from the contact pressure distribution on the most strained point in the bearing inner ring. The picture (Fig. 1) shows the course projection (the curve) of the contact pressure along the contact surface l_{ef} of the contact ellipse on the bearing inner ring. The contact strain curve has been calculated using the finite element method. (Kohár et al., 2016)

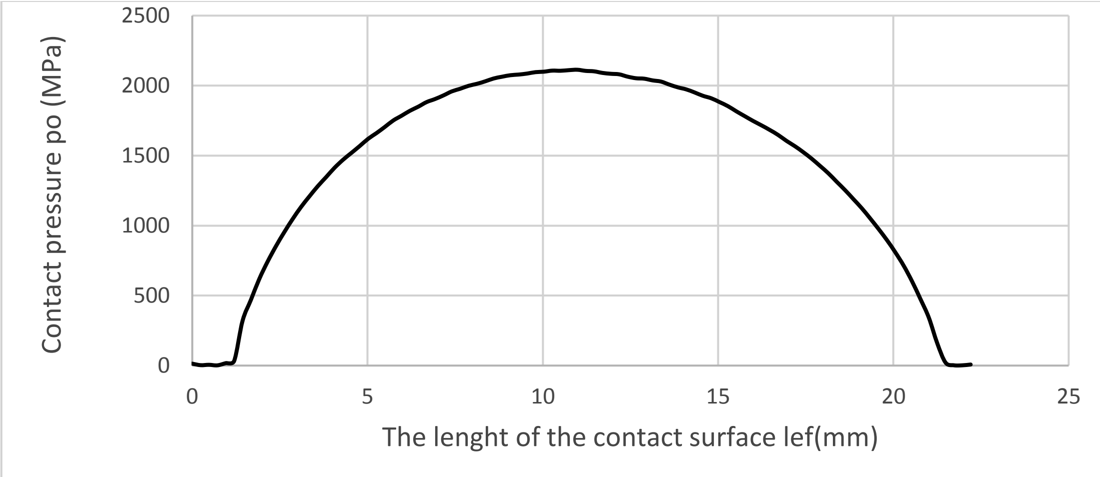

Fig. 1 The contact pressure course on the inner bearing ring runway

For under surface strain evaluation it is necessary to define a plane which crosses the maximum contact pressure point and it is orthogonal to the inner ring runway. It is possible to define the size of maximum orthogonal slide strain τ_{yz} in the defined plane for under surface strain evaluation. The coordinate system, in which the above mentioned slide strain will be evaluated, is oriented in the way that the axis x is in the tangent´s direction to the inner ring runway in the spherical roller bearing. This operation will be located in the maximum contact pressure point. (Lukáč, et al., 2016)

The preparation of the parametric 3d model and the contact analysis.
Double row spherical roller bearing model (Fig. 2) has been simplified to the maximum extent thanks to the even load distribution on both rows and individual roller elements. The model consists of the rolling element, the outer ring, the inner ring and the contact surfaces. These surfaces are important for more precise model meshing in FEM system ANSYS. The contact pressure will be measured in the above mentioned parts. (Tropp, et al., 2016)

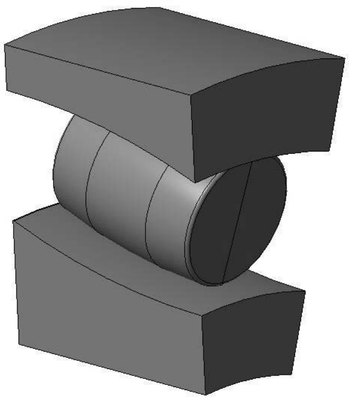

Fig. 2 The simplified model of the double row spherical roller bearing

RESULTS AND DISCUSSION
Spherical roller bearing will be optimized on the basis of the contact pressure decrease. This pressure exerts in the contact place of the rolling element and the outer and inner ring. The optimization relates

to the rolling element profile. However, the calculation relates to the contact strain between rolling elements and bearing rings. The pictures Fig. 3 and Fig. 4 show the curve shape of the contact pressure in the spherical rollers depending on the length of the contact surface. The shape of this original curve is derived from the finite element analysis. The aim of optimization lies in the maximum contact pressure decrease in the contact place of the rolling element with the bearing rings runways. This is shown in the picture Fig. 3 (the inner ring), Fig. 4 (the outer ring) – so-called four-point contact. (Kohár 2016)

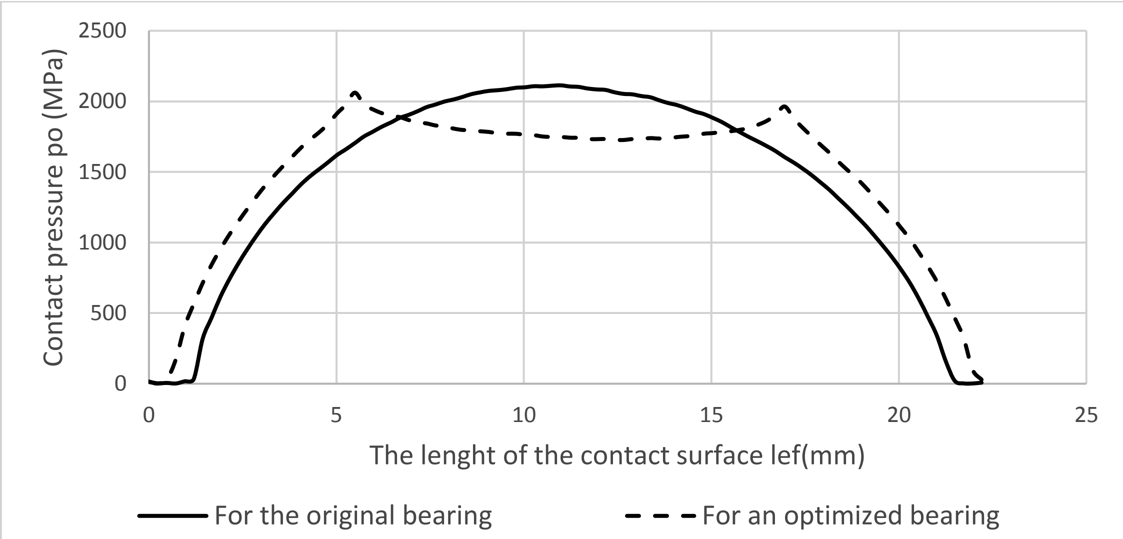

Fig. 3 The original and optimized contact pressure course projection on the inner bearing ring runway

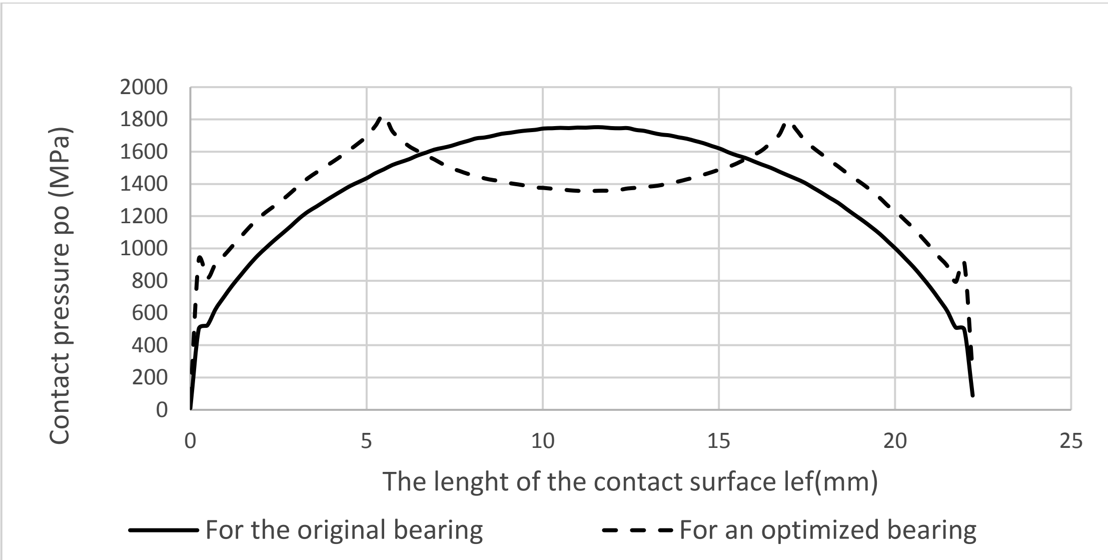

Fig. 4 The original and optimized contact pressure course projection on the outer bearing ring runway

CONCLUSIONS

Spherical roller bearings optimization can be performed using the geometry change in the rolling element – the spherical roller. The optimization involves the length change parameter of the adjusted spherical roller surface. Fig. 5 shows the contact pressure decrease of the inner and outer bearing ring using the lenght change parameter dsl increase.

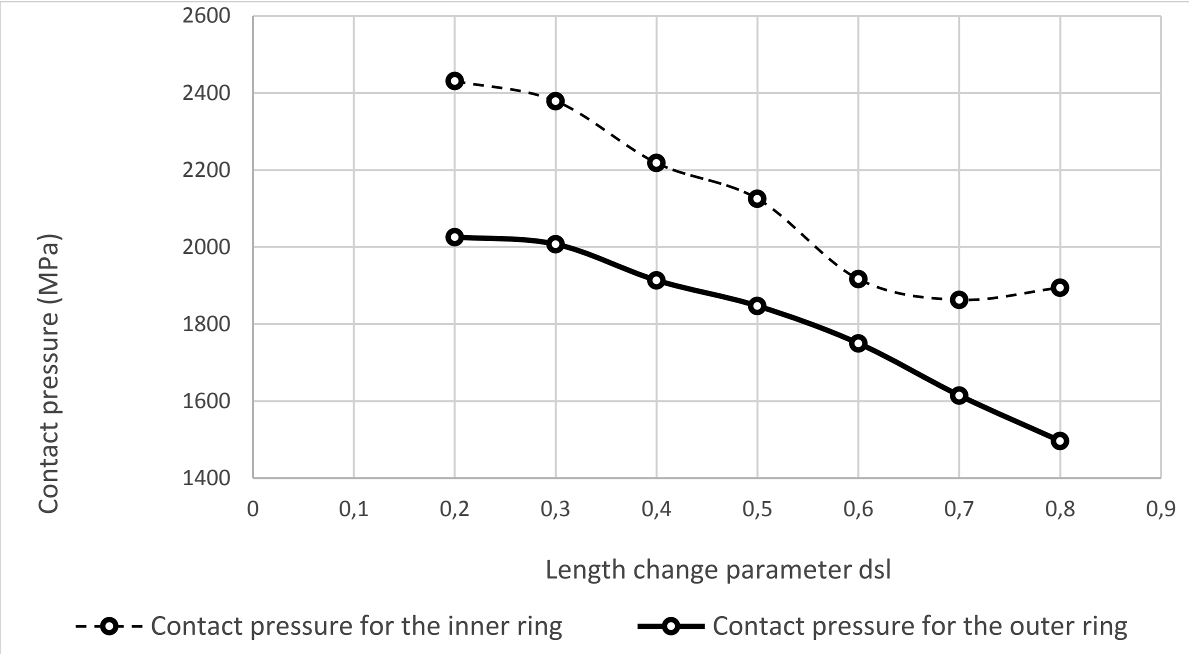

Fig. 5 The contact pressure decrease projection of the inner and the outer bearing ring using the length parameter dsl

ACKNOWLEDGMENT

This study was supported by Slovak Research and Development Agency under the contract no. APVV-14-0508 – Development of new methods for the design of special large-size slewing rings.

We support research activities in Slovakia / project financed from EU funds.
This article was created by the project "ProHiSpeB - prototype of telematics axle bearing for high speeds" on the basis Operational Programme Research and Development funded by the European Regional Development Fund.

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