COMPARATIVE ANALYSIS OF TWO CYLINDRICAL ROLLER BEARINGS DESIGN USING FINITE ELEMENT METHOD (FEM)

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Abstract: Cylindrical roller bearings are manufactured in a wide variety of types and sizes especially with a single row of rollers, but and on two rows of rollers or more, with cages or roller beside roller. Researches carried out by authors in this paper, have followed a comparative analysis of two cylindrical roller bearings design using finite element method (FEM). The finite element method is commonly used and enjoyed by an extended use in the structural areas, for analysis. FEM it consists of three main phases: Pre-processing, conducting or importing of the solid model system that are to be analysed, solid meshing design in finite elements, implementation of conditions and loads at the limit, Processing, numeric solving of the characteristic equations behaviour of the system and getting the solution, Post-processing, viewing the results in order to analyse system reaction and identification of areas with critical applications. After been designed the cylindrical roller bearing and all proposed changes, it was then executed a mechanical and with vibration analysis of the bearing. Using the finite element method in this purpose it was able to analyse the design of the structure of the cylindrical roller bearing in detail.

Key words: cylindrical roller bearing, finite element method, cages, comparative analysis.

1. INTRODUCTION

The enterprises of building bearings brought remarkable technological advancement, a result of the lasting researches and widely undertaken jointly by research specialists.

Optimization of standard construction, improving the calculation methods and testing have provided high quality guarantees steadily increasing.

Bearings are composed, in the general case of two rings or washers, a number of rolling elements and a cage. The inner and outer rings are meet at radial bearings, while the washers (thrust and housing) are meet at thrust bearings. Both on the rings as well on washers, toward the inside bearing, raceways.

The rolling elements (balls or roller) are in direct contact with those two rings through the raceways. Through means of rings or washers is performed the direct connection of the bearing with the assembly in which it is mounted; the inner ring it is mounted on the shaft, and the outer one in the housing. the cage have the role to maintain fixed distances between rolling elements. There are bearing construction at which the might be missing one or more components. Thus there is bearings without the one ring or both rings; in this case the raceways are made directly on the shaft or/and on the housing. Also there are bearings that may be without cage, [1].

2. METHOD

To optimize cylindrical bearings was an analysis of static structural benchmarks. Analysis was prepared using the finite element method. This method consists of a continuous body mesh and finished in several finite element (FEM - Finite element method).

By subdividing the mesh structure is meant in sub mathematical model with simple geometric form, which do not overlap, called finite elements.

If the simulation, finite element each response is expressed on a finite number of degrees of freedom that represent the values of unknown function (movement function) in a number of crucial points. Thus the answer to the mathematical model will result as an approximation of the meshed model response obtained by assembling all elements of the model answers.

This method has a wide application and enjoys widespread use in areas of structural, thermal analysis, mechanical and vibration.

FEA programs in our case CREO Parametric 3.0 software and ANSYS holding a library of hundreds of types of finite elements. It has achieved a landmark 3D software using CREO Parametric 3.0, then was analysed using Ansys software

ANSYS simulation software allows the designer to predict how the product will work under real conditions. Simulation is a powerful modular system.

Simulation-Driven Product Development Product, brings simulation to another level. ANSYS adds

value by providing the design process efficiency, encouraging innovation and reducing physical constraints, allowing simulated tests that might not be possible otherwise. It is unmatched in functionality and power needed to optimize components and systems.
Incorporating world leading software capabilities of PTC Creo product design, S.C. Bearing S.A. Barlad ANSYS extends the functionality even further to ensure and to obtain the fairest solution in the shortest time.
ANSYS Mechanical is a comprehensive tool for analysis FEA structural type analysis, including linear and nonlinear dynamic studies. The product offers a complete set of elements, material models and equation solving a wide range of mechanical design problems, [2].
ANSYS Mechanical includes expanded capabilities for solving dynamic, including modal analysis for calculating the natural frequencies and mode shapes, harmonic analysis to determine its harmony which varies over time depending on load transient nonlinear dynamic analysis and random vibration spectrum analysis. Behavioural characterization of the material is intuitive mathematical models using library materials, regardless of their structure, [3,4].
Because complex systems are made of several parts, ANSYS tools enable to be captured critical interactions between them. Whether using contacts, special connections or joints that define the relationship between bodies cinematic solutions lead to insight into the complex interactions. Its parametric capabilities to help you effectively perform sensitivity studies or optimization.
By selecting ANSYS Mechanical simulation as a tool, S.C. Bearing S.A. Barlad has a high gain due to high computing power and how the response of its products. It covers a wide range of properties such as stress, deformation, vibration characteristics, thermal characteristics, and durability.

3. RESULTS

For performing experimental researches was used cylindrical roller bearings type NJ2317 EMA prototype. Was performed a mechanical analysis on bearing.
Boundary conditions were established that the bearing is subjected respectively declared as moving from fixed and limiting axial displacements.
It was designed bearing and all proposed changes and then was awarded a mechanical vibration analysis (fiure 1).
It was subject to the following conditions simulation:
a) The boundary conditions are identical to those of the static structural analysis;
b) The outer ring is constrained in all degrees of freedom;
c) Load bearing is applied through the shaft;
d) Load levels are: 1200 rpm rotational speed respectively 80 Kn radial load.

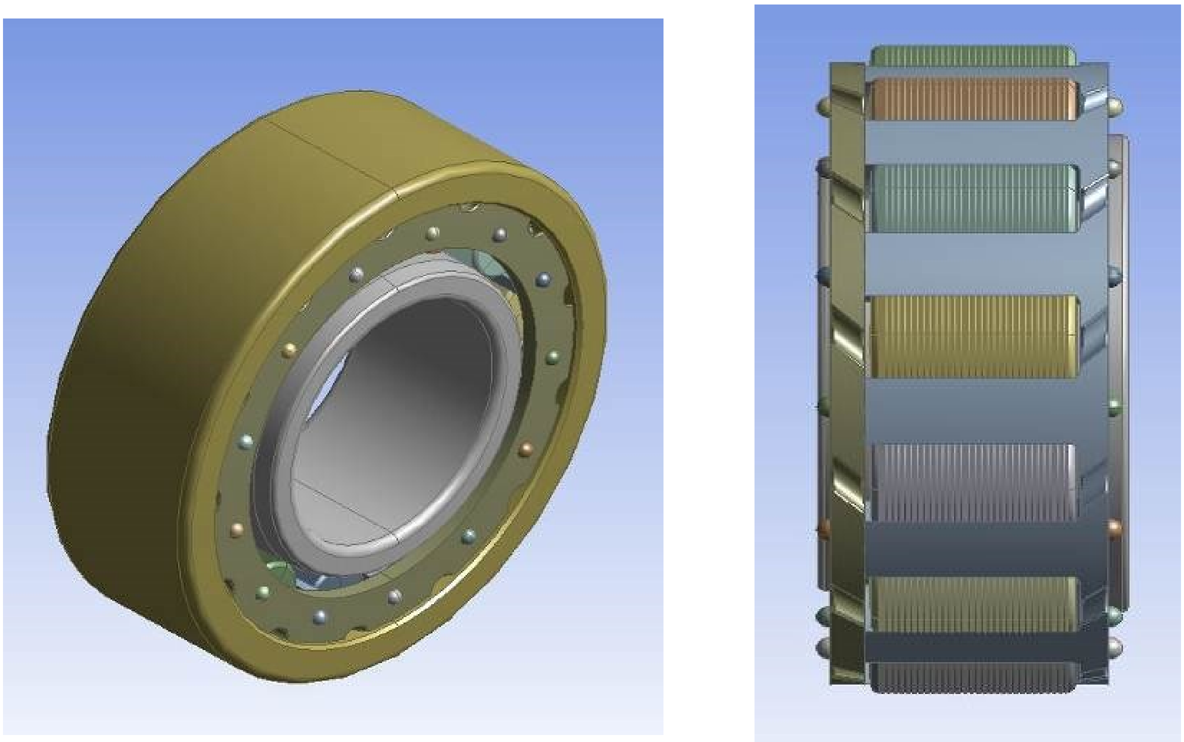
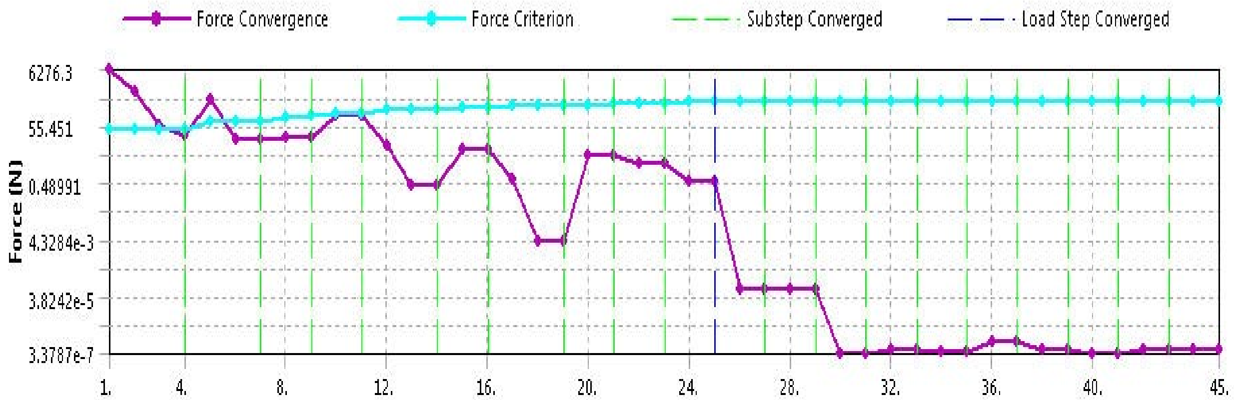
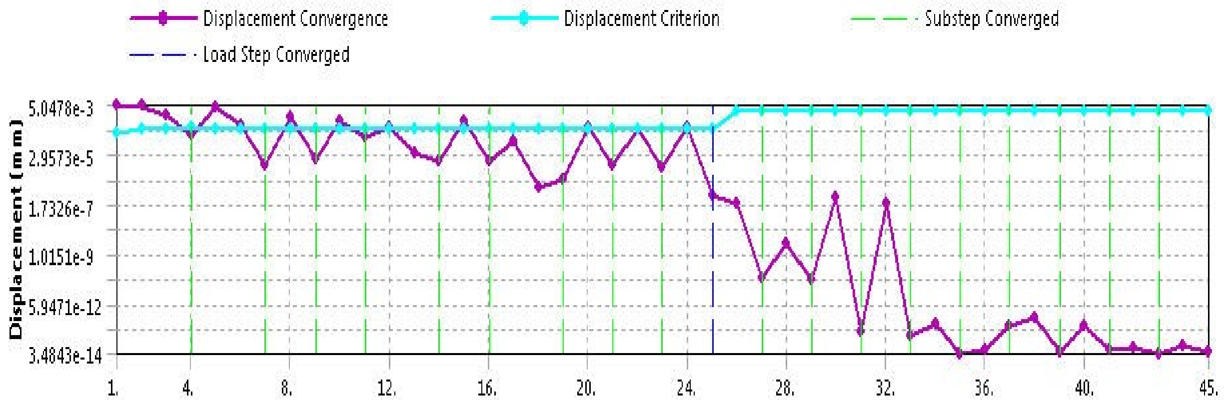


Fig.1. Bearing Nj2317 EMA (Cage prototype)



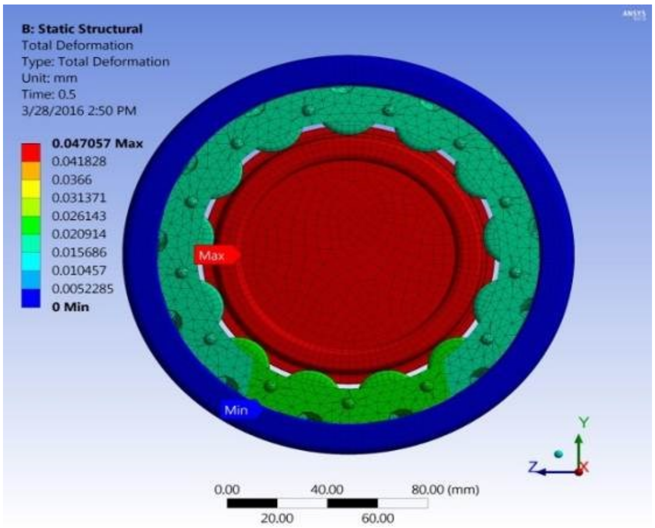
a) Convergence of the force



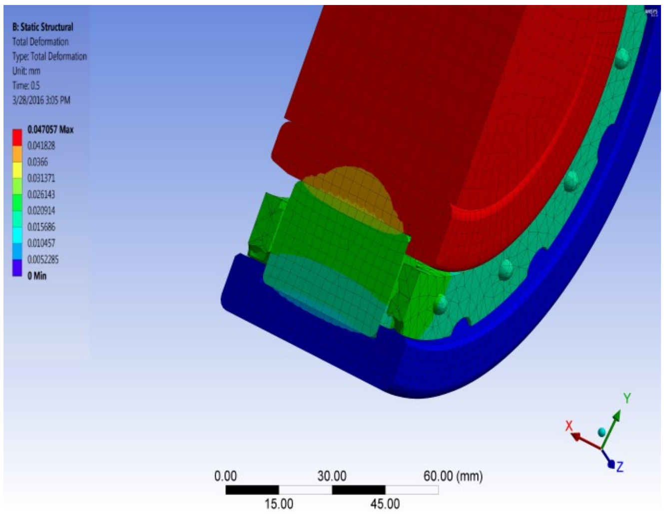
b) Displacements

Fig. 2. Graphical results

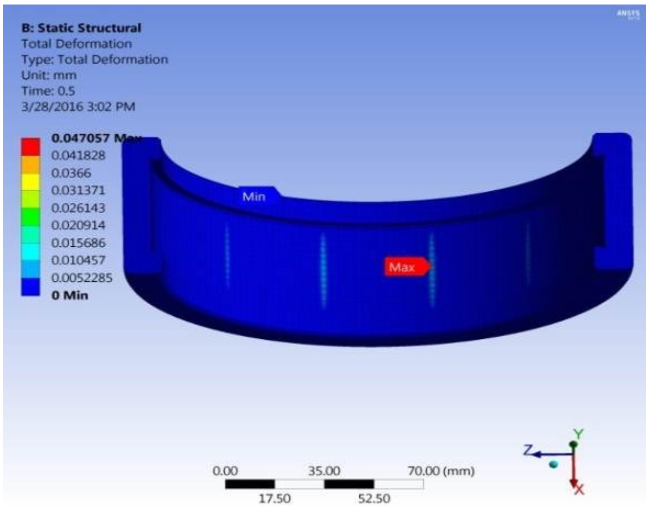
Figure 2 presents the results of the analysis of the contact pressure on the bearing, and Figure 3 presents the total deformation results.



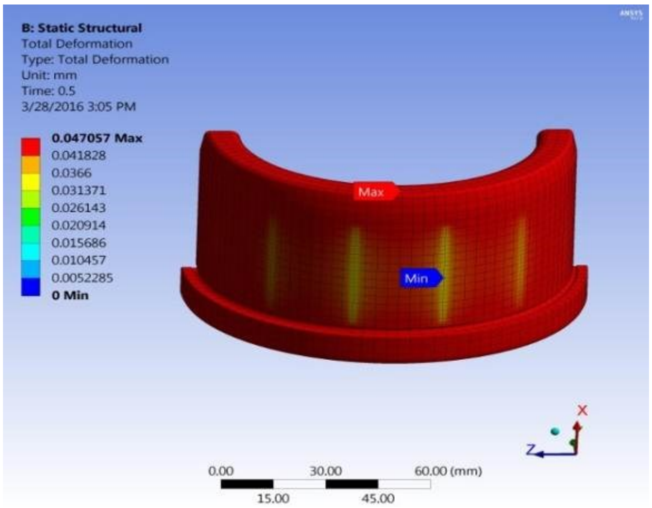
a) Frontal view



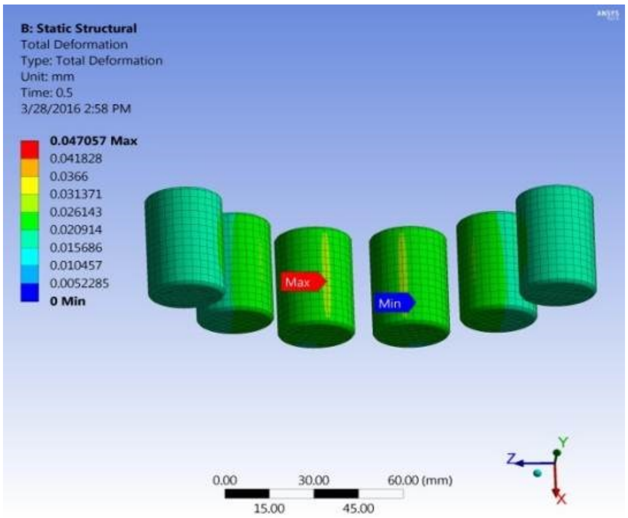
b) Cross section



c) Deformation on the outer ring



d) Deformation on the inner ring



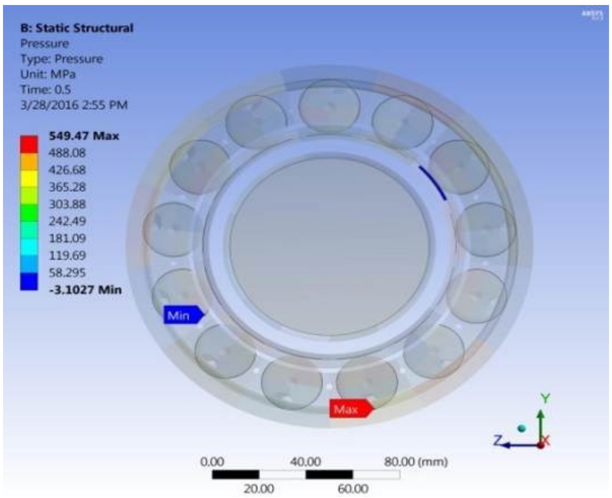
e) Deformation of the rollers

Identifier	
Suppressed	No
Results	
Minimum	0. mm
Maximum	4.7057e-002 mm
Minimum Occurs On	Outer ring
Maximum Occurs On	Solid
Minimum Value Over Time	
Minimum	0. mm
Maximum	0. mm
Maximum Value Over Time	
Minimum	8.5238e-003 mm
Maximum	4.7057e-002 mm
Information	

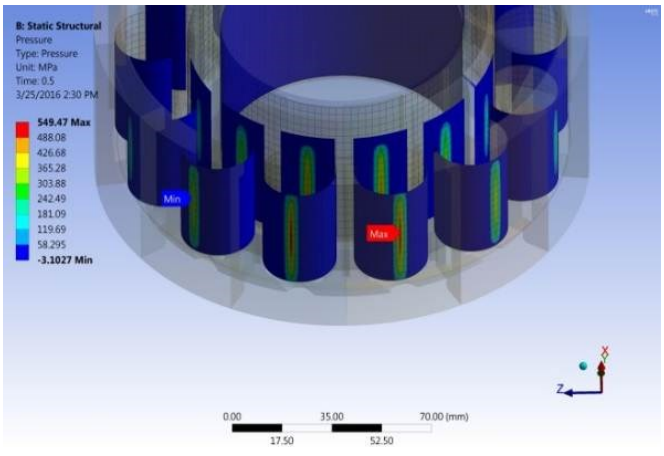
f) Analysis results

Fig. 3. Total deformation results

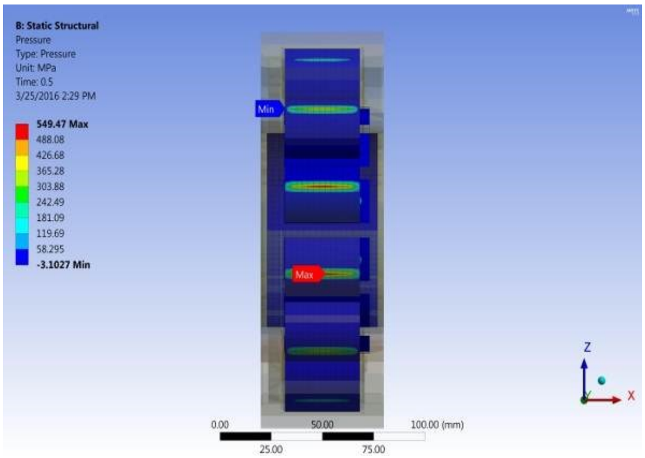
In figure 4 are presented the results of the analysis on the bearing contact pressure, and in figure 5 are presented the analysis results of bearing life.



a) Frontal view



b) Contact zone

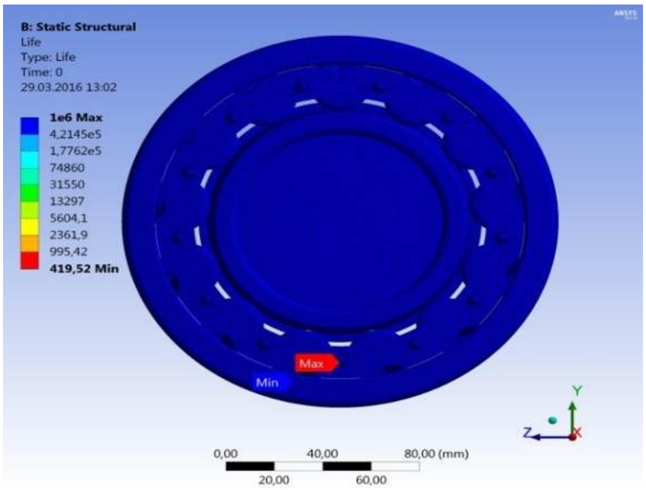


c) Side view

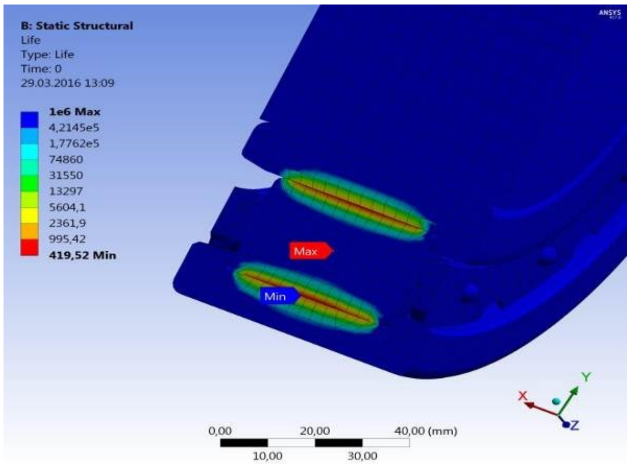
Integration Point Results	
Display Option	Averaged
Results	
Minimum	-3.1027 MPa
Maximum	549.47 MPa
Minimum Occurs On	RC-26X40-LN[555]
Maximum Occurs On	RC-26X40-LN[555]
Minimum Value Over Time	
Minimum	-3.1027 MPa
Maximum	-0.72682 MPa
Maximum Value Over Time	
Minimum	103.66 MPa
Maximum	549.47 MPa
Information	

d) Analysis results

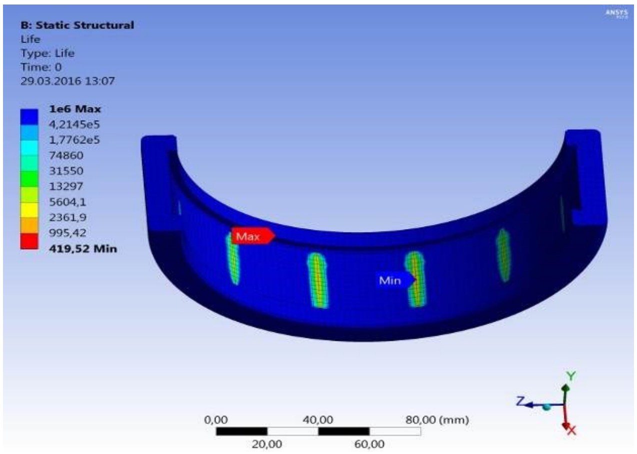
Fig.4. The analysis results on the bearing contact pressure



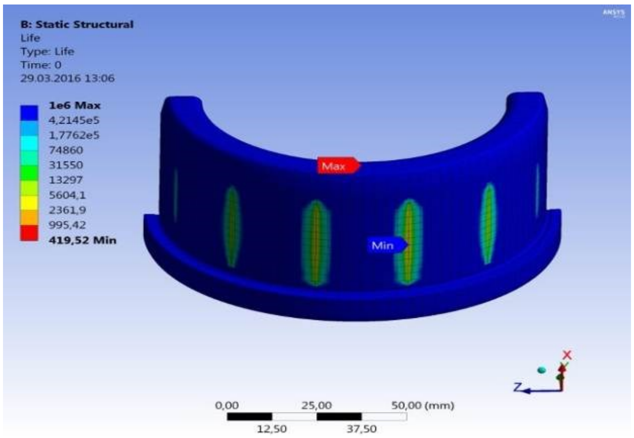
a) Frontal view



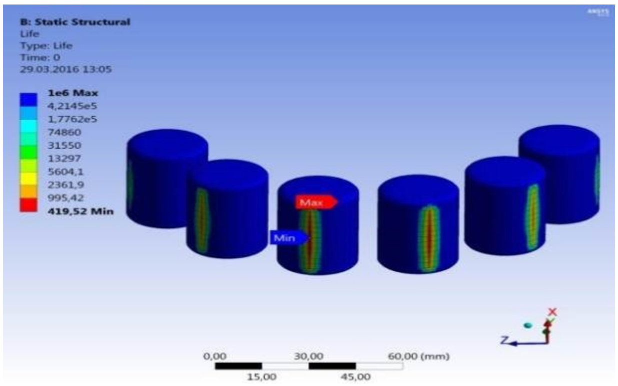
b) Contact zone



c) The life of the outer ring



d) The life of the inner ring



e) The life of the rollers

Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Life
Identifier	
Suppressed	No
Integration Point Results	
Average Across Bodies	No
Results	
Minimum	419,52 cycles
Minimum Occurs On	RC-26X40-LN[555]

f) Analysis results

Fig. 5. Results of the analysis bearing life

4. CONCLUSIONS

Analysis of the results led to the following conclusions: load distribution on the roller changed, disappeared Downloading the end rollers; the value of the safety factor increased the amount of 2.09 to 2.55; the life of the bearing was improved from 187-419 cycles value. The proposed amendments have made significant improvements in the life of the bearing. The safety factor is above the minimum framed. No abnormal distribution rezultrat areas where the thermal deformations to have values which may adversely affect the life of the bearing.

5. REFERENCES

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