Failure Analysis of Excavator Bushes and Induction Hardening With Different Case Depth Using FEA Approach

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***Abstract* - Wear of a pins and bushes is normal, but the rate of wear can be unnecessarily increased by factors such as inadequate and improper lubrication, overloading, misalignment of parts or failure of adjacent parts. Uneven loading on pins and bearings may also cause the failure. In our project, we are going to apply induction hardening process on pins and bushes and its comparison will be done with existing pins and bushes .Different hardening thickness or case depth will be applied and analysis will be done to interpret the results. Existing bush will be replaced with steel, brass and bronze alloy. The main objective in this project is to determine the appropriate induction hardening case depth to be used in fabricating pins and bushes. Three-dimension models of bushes used in excavator were created using CatiaV5 software, meshing will be done using Hypermesh and Ansys will be used to analyze the stress status on the pins and bushes. The maximum deformation and maximum stress point found by the stress analysis.**

I. INTRODUCTION

A bush is a mechanical fixing component between two possibly moving parts or a strengthened fixing point where one mechanical assembly is attached to the other assembly.

Bushes are used to wear inside a hole and reduce friction of moving parts. They are also called as plain bearings and are either long thin cylinder or a sleeve-shaped linings. The purpose of bush is to assist in the process of spreading the friction on a particular spot to cover its surface, therefore, friction is minimized. In bushing mechanism, there is a rotating shaft in a hole, which is lined with mechanical bushing. This shaft rotates inside the bush with the bushing decreasing its friction. Bushes fit into the bore of a moving parts to provide wear resistance, lubrication, strength for the components, which are assembled by bolts or by pins[1].

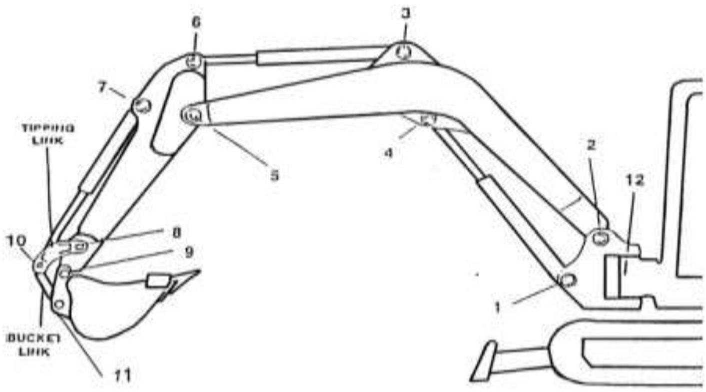

Figure 1 Position of Bushes in excavators

Problem statement:

Wear of a pins and bushes is normal, but the rate of wear can be unnecessarily increase by factors such as inadequate and improper lubrication, overloading, misalignment of parts, or failure of adjacent parts.

Objective:

To carry out FEA analysis using three different materials with different case hardening thickness and proposing the best material. Also analyze the bushes with the help of ANSYS and to find out the experimental results on Universal Testing Machine.

II. WORK METHODOLOGY

Finite Element analysis:

The software used for the Analysis of the study is ANSYS 15.0 APDL. For modeling purpose CATVIAV5 is used and the pre-processing is done through the Hypermesh 12.5 interface. The boundary conditions used for particular study are fixing outer part of the bush and applied forces to the internal surface of the bush under study. Basic three bushes having maximum loading conditions are Boom arm bush, Bvek-bush, Cabin bush.

In the first case the study is performed on the above three bushes without Induction hardening (Existing Application) for stresses and deformation with maximum loading conditions. Material used is EN8 Steel; The stresses found in this case are around 138 MPa, 94 MPa and 207 MPa for Boom arm, Bvek and Cabin bush respectively. he deformation observed as 0.0018 mm for Boom arm, 0.0013 mm for Bvek and 0.0023mm for cabin bush.

The next step in analysis study is to observe the changes in above deformation after Induction hardening with varying case depth from 1mm to 2 mm. From the study for different case depth it is found that case depth of 2 mm yields minimum deformation as compared to others. Similarly, it decreases deformation considerably as compared to the existing bushes without Induction hardening [2].

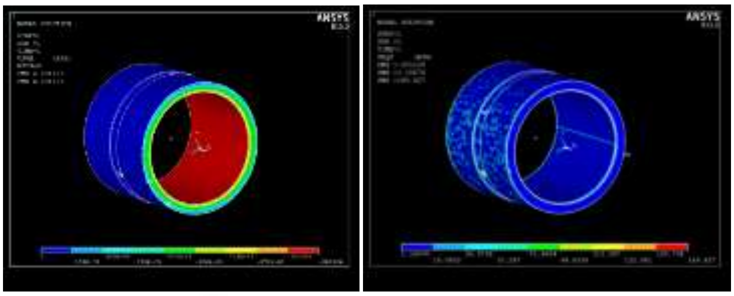

Figure 2 ANSYS Results for Boom-arm Bush (Case Depth 2 mm)

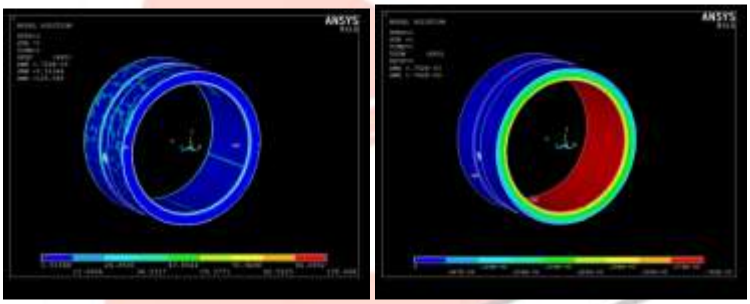

Figure 3 ANSYS Results for Bvek Bush (Case Depth 2 mm)

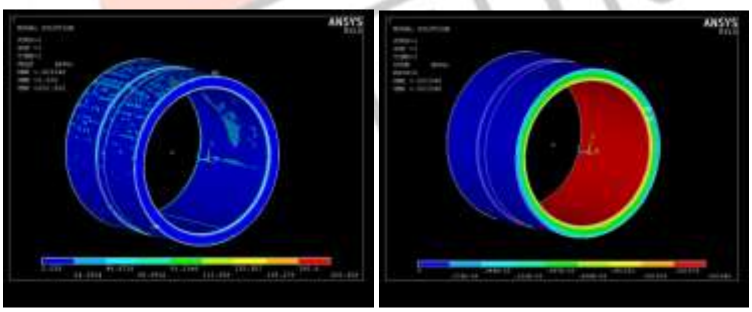

Figure 4 ANSYS Results for Cabin Bush (Case Depth 2 mm)

Experimental compression test:

The compression test on bushes is done on Universal Testing machine. Dimensions of the bushes under experimentation are: For Bvek bush OD 95 mm × ID 85 mm × L 50 mm, For Boom-arm bush OD 95 mm × ID 80 mm × L 800 mm and for Cabin bush OD 105 mm × ID 90 mm × L 80 mm respectively. The output obtained from the experimental compression test is used to validate the FEA results mainly deformation. Comparing the different case hardening depths on the basis of their deformation on maximum loading conditions.

In compression test the bushes are fixed or held in V-block attachment on the Universal testing machine, the load applied in the range of 100 KN to 450 KN according to the type of bushes and desired results.

The deformation is observed on the digital display of UTM Machine interface. Compression study on the bushes gives the idea about deformation in different bushes.

The conclusion of the deformation obtained from compression testing can be summarized as 0.0012 mm for Boom-arm, 0.0008 mm for Bvek bush and For cabin bush 0.0016 mm which are obtained for the condition of 2 mm depth of case hardening [3].-

III. VALIDATION OF EXPERIMENTATION AND FEA RESULTS

After the observations of experimental results and the FEA results, we compared both the results. There is matching between these results with minimum error below 15%.

IV. CONCLUSION:

The FEA analysis of Excavator bushes is carried out over conventional model. The bushes are analyzed for three different materials like EN8, Bronze and Brass. The results with different materials are studied and compared. The EN8 material shows better results than the other two. The analysis for hardening of Excavator bushes with deferent case depth like 1mm, 1.5mm, 2mm were carried out. The results were compared and the best results were of 2mm case depth. The Excavator bushes are fabricated and hardening of 2mm case depth are provided. Experimental testing of the model is performed and the results were interpreted with that of FEA results. A comparative study is made for FEA and Experimental values. The validation shows a close resemblance with acceptable 15 % error. Hence the objective is achieved.

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