Stress Analysis of Bulk Lever using FEA and Experimental Approach

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Abstract - Bulk lever is the main component of Dobby power loom. It is the most heavily stressed part of Dobby power loom. During its operation various stresses acts on Bulk lever. The effect of this stress is high due to continuous engagement and disengagement. For analysis purpose virtual model of Bulk lever is prepared by picking data from existing model of bulk lever made of ASTM A 48 C.I. This paper investigates the stresses acts on Bulk lever at different loading condition. Static structural analysis using ANSYS and experimental analysis was conducted on Bulk lever made up of ASTM A 48 C.I. The purpose of this study is to show the performance of Bulk lever under different loading condition. Experimental results will be verified with the FEA results. FEA and Experimental Analysis have been performed on both Notch 1 and Notch 2.

***Key Words*: Bulk lever, Dobby power loom, ANSYS, static structural analysis, Universal Testing Machine (UTM), finite element analysis (FEA)**

1 INTRODUCTION

Bulk lever is used to transfer a small effort continuously and it is used in the Dobby power loom by the application of a small effort. Dobby Power loom is device used to weave cloth. The basic function carry out is to hold the wrap threads under tension to facilitate the interweaving of weft threads. The most important task for bulk lever is to maintain the working stresses within predetermined specific limits, in order to avoid the failure of a bulk lever. The bulk lever is very important part in textile industries. Breakdown of bulk lever directly affects production & cost of the products. The lot of time is spent for replacing this bulk lever and whole unit is going to be stop. To improve productivity, it is necessary to determine the stresses in bulk lever at various areas especially in weak areas. Also there is necessary to know the stress distribution in order to predict the failure of component. Bulk lever failure occurs at an unexpected instant because of component is under subject of combined stresses created by fluctuating forces during continuous linkages. Hence to find out maximum stresses in weak areas where bulk lever can bear using FEM and experimentally are important steps during this work.

2. LITERATURE REVIEW

Study of stress pattern in bell crank lever analytically, numerically and photoelasticity method was used by author and found that increasing fillet radius at critical position and results of FEM and photoelasticity were in close harmony with each other [1]. Investigation of the compressive stress acting on connecting rod at different loading condition. Comparison between two samples of connecting rods is taken for experimental analysis. Static structural analysis using ANSYS and experimental analysis was conducted on connecting rod made up of forged steel [2]. Modified chassis for tractor trolley by keeping the material and dimension similar and using 'I' cross section area instead of 'C' resulted in more safer stresses than 'C' and the material used is mild steel [4]. Experimental and finite element approach for stress analysis is done. During this, to determining the strain gauge location points in the problems of stress concentration and it includes both experimental and numerical results. Strain gauges were proposed to be positioned to corresponding locations on beam and blocks to related node of elements of finite element models [10].

3. MODELLING AND FEA ANALYSIS:

The first step to start the analysis with the ANSYS programs is to select the type of analysis. The static structural analysis was selected for carrying out detail analysis of bulk lever. The geometry of bulk lever was created in ANSYS workbench by taking the parameter of bulk lever. After creating geometry material properties were applied to bulk lever. Material properties for bulk lever made of ASTM A 48 C.I. are:

Table -1: Material properties for bulk lever are:

Sr. No.	Material Properties	ASTM A 48 C.I.
1	Density in Kg/cm^3	7200
2	Young's modulus in GPa	97
3	Poisson's ratio	0.3
4	Ultimate tensile strength in N/mm^2	150
5	Yield strength in N/mm^2	98

3.1 Meshing:

After creating geometry and applying material properties is next step in ANSYS is to generate a meshing. The tetrahedron meshing is used for this analysis. The computation time required for meshing is less and the results obtained with the help of tetrahedron meshing are fast and accurate. Total number of elements and nodes are 3549 and 7408 respectively.

Details of the meshed model of bulk lever shown in Fig -1,

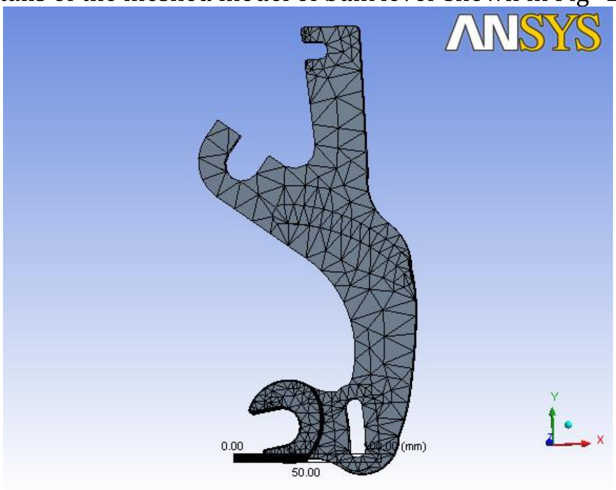

Fig -1: Meshed model of bulk lever

3.2 Loading and Boundary Condition:

After meshing the model, the boundary condition such as loads and constrains are imposed. One of the important factors to get accurate result is to apply correct the loads and the Boundary conditions. There are many ways to apply different loads and constraints to them model for example on nodes, on edges, on surfaces or elements. Final stage of analysis is running a solver to get the desired results.

3.3 Results of FEA:

In this study of finite element method, the force is applied at Notch 1 and Notch 2. The force applied at individual Notch is ranging from 3000 N to 7000 N. The tensile stress is calculated for each different force. The figure 2 to 7 represents the strain and stress generated in bulk lever.

Details when load of 3000 N, 5000 N and 7000 N is applied at Notch 1and Notch 2 shown in Fig-2 to 7.

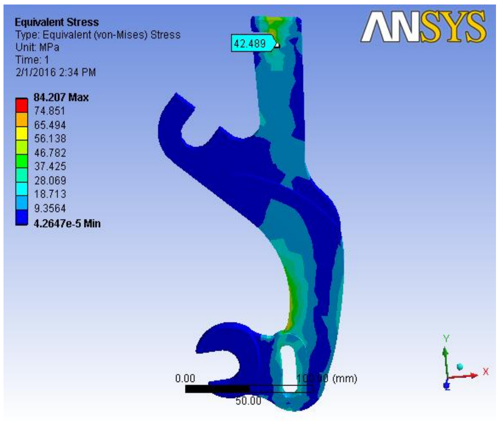

Fig -2: Stress at 3000 N on Notch 1

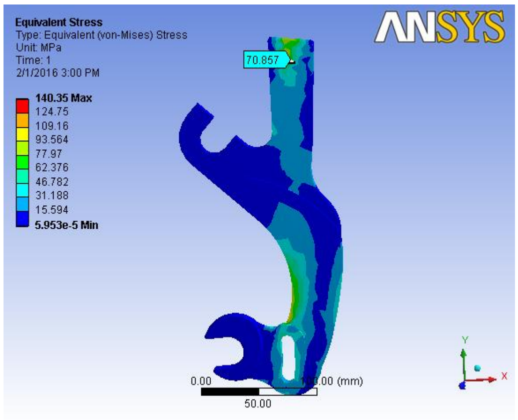

Fig -3: Stress at 5000 N on Notch 1

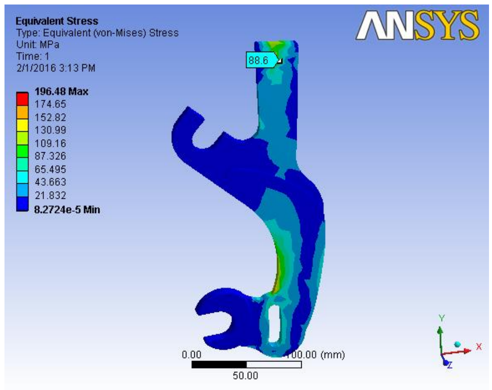

Fig -4: Stress at 7000 N on Notch 1

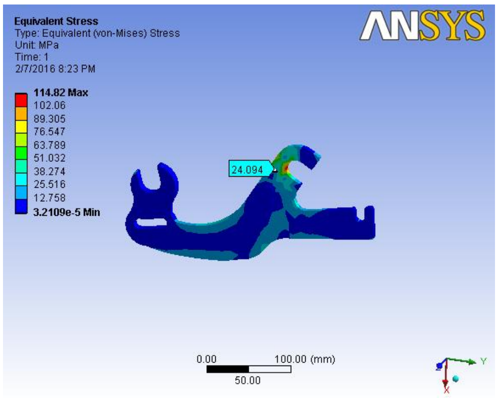

Fig -5: Stress at 3000 N on Notch 2

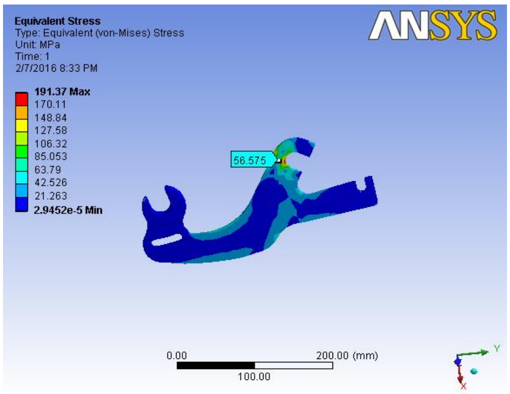

Fig -6: Stress at 5000 N on Notch 2

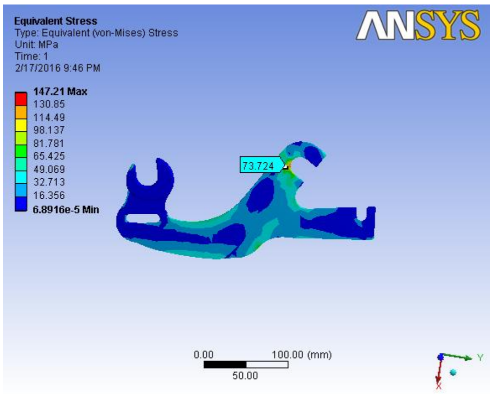

Fig -7: Stress at 6400N on Notch 2

Table -2: Details of FEA stress on ASTM A 48 C.I. at Notch 1,

Sr. No.	Load in N	Stress(σ) in N/mm²
1	3000	42.489
2	5000	70.85
3	7000	88.60

Table -3: Details of FEA stress on ASTM A 48 C.I. at Notch 2,

Sr. No.	Load in N	Stress(σ) in N/mm²
1	3000	24.094
2	5000	56.575
3	6400	73.72

4. EXPERIMENTAL ANALYSIS

During experimental analysis, tensile test is carried out with the help of Universal testing machine (UTM). Component is hold in jaws of UTM machine and tensile test has been carried out. Ultimate goal behind these tests is to find out stress on notch areas, where actually frequent failure occurs. Initially tests has been carried at notch 1 & 2 on ASTM A48 Grey cast iron component. The equipment required to calculate the stress in bulk lever is UTM, Samples of bulk lever (ASTM A 48 C.I.), Strain Gauge indicator, Load bridge circuit and digital multimeter. Since the strain gauge is an electrical transducer which translates changes in force (or weight) into change in voltage. Wire type strain gauge is mounted at Notch 1 and 2 of Bulk lever. The strain gauge is connected to load bridge circuit also called as Wheatstone bridge circuit. The readings are taken with the help of display on strain gauge indicator instrument.

Fig -8: Experimentation at Notch 1 on ASTM A 48 C.I.

Fig -9: Experimentation at Notch 2 on ASTM A 48 C.I.

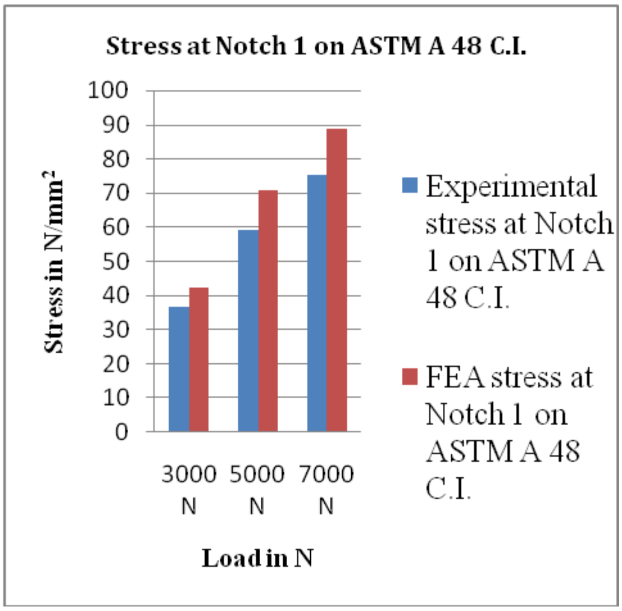

Chart -1: Load vs Stress at Notch 1 on ASTM A 48 C.I.

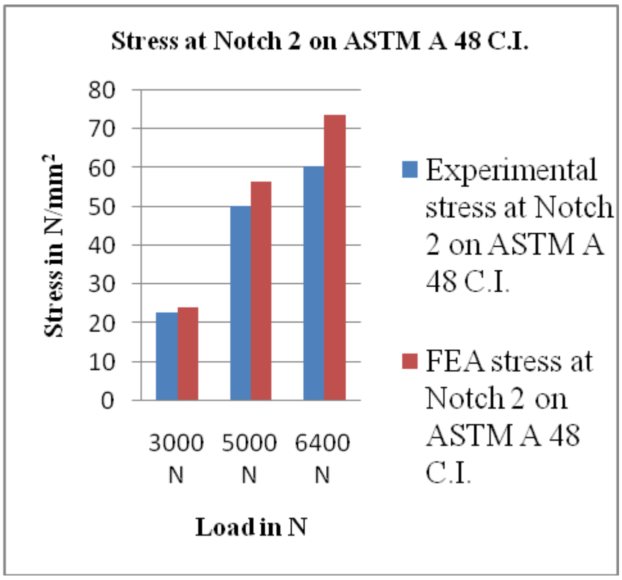

Chart -2: Load vs Stress at Notch 2 on ASTM A 48 C.I.

The Tensile stresses generated at the two Notches of Bulk lever are Represented by Table 3.1 and 3.2,

Table -4: Details of Experimental stress on ASTM A 48 C.I. at Notch 1,

Sr. No.	Load in N	Stress(σ) in N/mm²
1	3000	36.54
2	5000	59.06
3	7000	75.20

Table -5: Details of Experimental stress on ASTM A 48 C.I. at Notch 2,

Sr. No.	Load in N	Stress(σ) in N/mm²
1	3000	22.88
2	5000	50.19
3	6400	60.64

5. RESULTS AND DISCUSSIONS

By performing FEA and experimental analysis, results are obtained for stress generated at Notch 1 and 2 of Bulk lever. The results obtained from experimental analysis are compared with the results of FEA analysis and is plotted in the form of graph using table 2, 3, 4 and 5. The comparison of FEA results and experimental results on application of load from 3000 N to 7000 N is shown in chart 1 and 2.

6. CONCLUSION

By performing experimental and FEA analysis of Bulk lever, following conclusions are drawn:

1. It is observed from FEA and experimental analysis that maximum stress is obtained at Notch 1. The stress generated at Notch 2 is well below allowable limit. Based on experimental and FEA analysis it is also observed that maximum stress is generated at Notch 2. Hence, the chances of failure are more at the Notch 1.
2. On comparison of experimental results with FEA results it was found that both the results are closer to each other.
3. To improve the strength of bulk lever change in material is necessary.

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