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A Review on Stress Analysis of Friction Clutch Using FEA

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Abstract: *Clutch is one of the most essential component used in automobiles. Its main function is to initiate the motion or increase the velocity of the vehicle by transferring kinetic energy from flywheel. This operation of clutch involves heavy and sudden forces, which results in generation of stresses. Analysis of generated stress is an important step to be followed in order to reduce the risk of failing of the system. Finite Element Analysis (FEA) is one such computational numerical method used for solving such problems. The current paper reviews stress analysis performed on friction clutch, for different friction materials, using ANSYS software. Further, the results are compared and discussed.*

Keywords: *Friction Clutch, Finite Element Analysis, Friction lining, Stress.*

I. Introduction

A Clutch is machine member used to connect the driving shaft to a driven shaft, so that the driven shaft may be started or stopped at will, without stopping the driving shaft. A clutch thus provides an interruptible connection between two rotating shafts

Clutches allow a high inertia load to be stated with a small power. A popularly known application of clutch is in automotive vehicles where it is used to connect the engine and the gear box. Here the clutch enables to crank and start the engine disengaging the transmission and change the gear to alter the torque on the wheels. Clutches are also used extensively in production machinery of all types, to connect or disconnect the source of power to the other transmitting parts.

This operation involves heavy and sudden forces which results in formation of stresses. As shown in the figures, clutch contains fixed and movable disk. Movable disk is connected to gear box and fixed disk always runs at engine speed, which should be disengaged with movable disk while changing the gear.The clutch connects the two shafts so that they can either be locked together and spin at the same speed (engaged), or be disengaged for changing gears.

Static Analysis plays a very important role when it comes to the safety of the system as it is used to determine displacements, stresses, etc. under static loading conditions. ANSYS can compute both linear and nonlinear static analyses. Nonlinearities can include plasticity, stress stiffening, large deflection, large strain, hyper elasticity, contact surfaces, and creep.

The Finite Element Analysis (FEA) is a numerical method for solving problems of engineering and mathematical physics. It is useful for solving problems with complicated geometries, loadings, and material properties where analytical solutions cannot be obtained. Alternatively finite element analysis (FEA), can be defined as a computational problem solving technique used to obtain approximate solutions of boundary value problems in engineering. Boundary value problems are also called field problems. The field is the domain of interest and most often represents a physical structure.

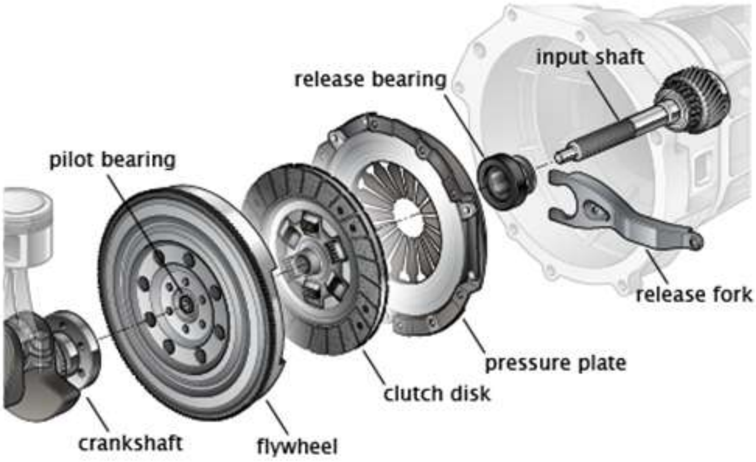

Fig.1: Clutch Parts[1]

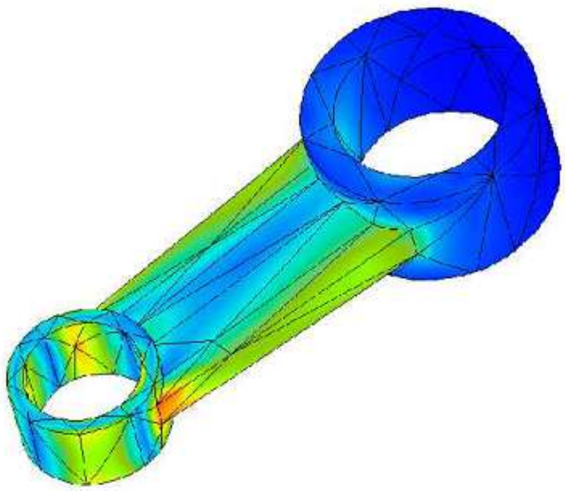

Fig. 2: Example of FEA (3D)[2]

II. Literature Review

Sagar Olekar, Kiran Chaudhary, Anil Jadhav, P. Baskar [3]. analyzed a multi plate clutch which was designed using uniform wear theory and the 3D model of multi plate clutch was prepared using modeling software Pro/E. Structural analysis was carried out for friction plate by using analysis software ANSYS Workbench 14.0.with material as cork and SF001(fiber) and results for stress, strain, total deformation and for strain energy were compared . It was observed that the total deformation, strain energy, shear elastic strain for clutch plate with SF001 as a friction material is less than that of Cork and for same input torque stress developed in clutch plate with friction material SF001 is less compared to cork which led to the conclusion that the clutch plate with friction material SF001 gives better performance than cork.

Anil Jadhav, Gauri Salvi, Santosh Ukamnal, Prof.P.Baskar [4].carried out solid modeling of multi plate clutch using PRO-E CAD and followed by structural analysis of clutch plate was done using ANSYS workbench to get appropriate results. Analysis was carried out on cork, copper and SA92 as friction lining materials. Further the results were analyzed for stress, strain and total deformation, and compared for all the three materials and the best one out of the three was to be found out. Ultimately, from this analysis it was seen that, on the strength basis, SA92 is more suitable and is a quite better friction material than copper and cork for same rated torque.

P.Viswabharathy G.Vigneshwar M.Pragadhishwaran M.Gopalakrishnan [5]. designed and modeled a single plate clutch using CREO 2.0 software. Static analysis and Dynamic analysis was carried out using ANSYS 15.0. Analysis was done using uniform wear theory. Present used material for clutch, Alloy steel, was replaced with Gray cast iron, En-Gjs-400 – 15Steel, E Glass Epoxy, Aluminium Alloy A360, Silicon

Carbide and Kevlar 49. Furthermore, plots for equivalent stress, strains and total deformation were obtained for different friction materials for friction clutch plate. Results were compared to define the best material for friction plate and it was clear that Aluminium Alloy A360 has less deformation than other materials and it is more advantageous to use Aluminium Alloy A360 than other materials due to its less weight and high strength.

B.Sreevani, M.Murali Mohan [5] .studied a single plate clutch which was model using Creo 2.0 software and the present used material, Cast Iron on clutch plate was replaced with Aluminium alloy 7075, Aluminium metal matrix composite and composite material E – Glass Epoxy. Static analysis is carried out using ANSYS and it is observed that the analyzed stress values are less than the respective yield stress values hence using these materials is safe. Comparing the results between materials showed that E – Glass Epoxy is more advantageous than other materials due to its low weight and high strength.

E Glass Epoxy
Material Properties:-
Young's modulus - 27600Mpa
Poisson ratio - 0.34
Density - 0.0000019kg

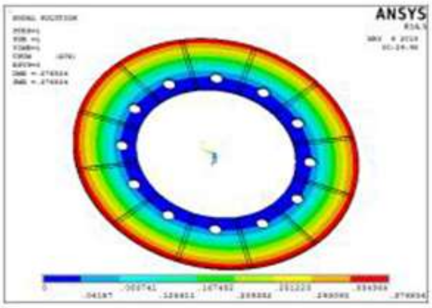

Figure 3: Displacement

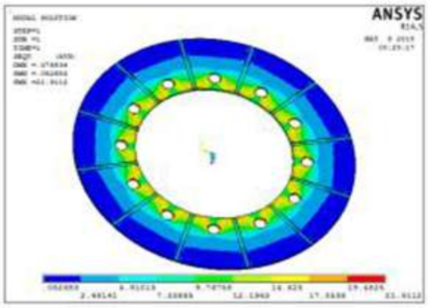

Figure 4: Stress

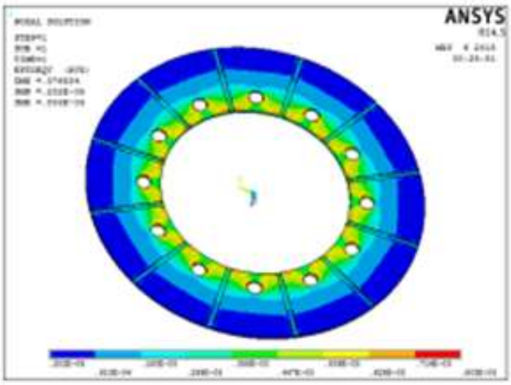

Figure 5: Strain

GRAY CASTIRON
Material Properties
Young's modulus - 120000Mpa
Poisson ratio - 0.29
Density – 0.0000072kg/m3

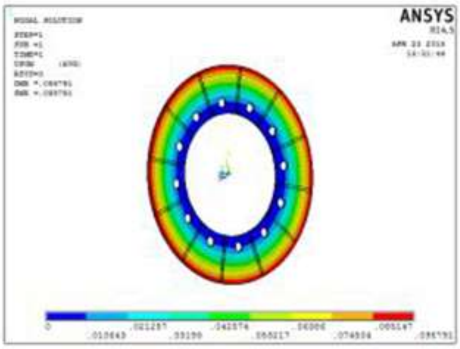

Figure 6: Displacement

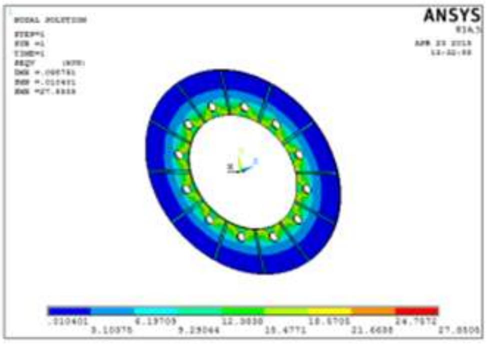

Figure 7: Stress

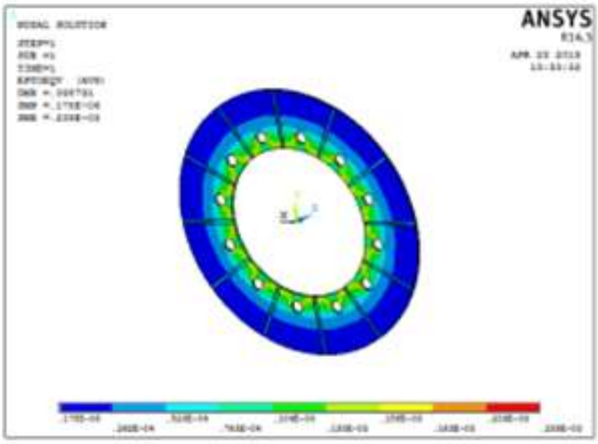

Figure 8: Strain

ALUMINIUM MMC
Material Properties
Young's modulus:-115000Mpa
Poisson ratio:-.0.30
Density :-0.00000288 kg/m3

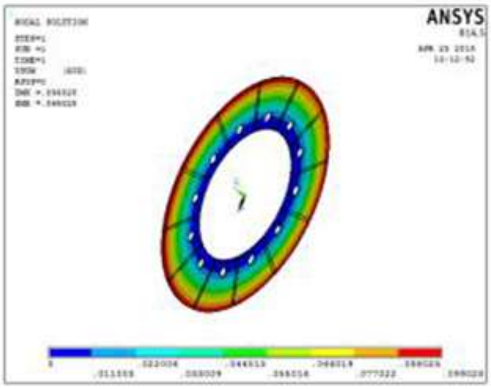

Figure 9: Displacement

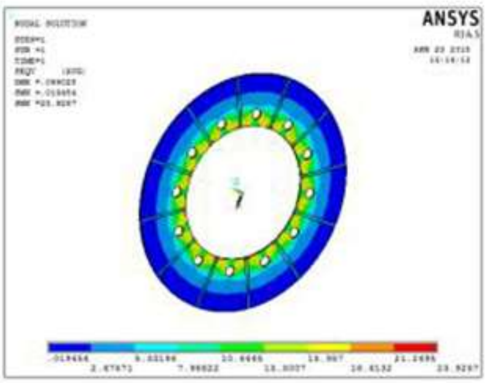

Figure 10: Stress

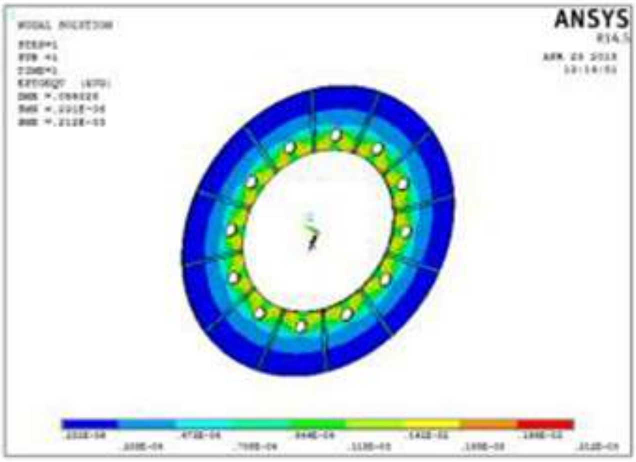

Figure 11: Strain

Structural Analysis Result Table

Sr.No	Material	Displacement	Stress	Strain
1.	E-Glass Epoxy	0.376834	21.9122	0.803e03
2.	Gray Cast Iron	0.095791	27.8505	0.235e-03
3.	Aluminium MMC	0.099208	23.9257	0.212e-03

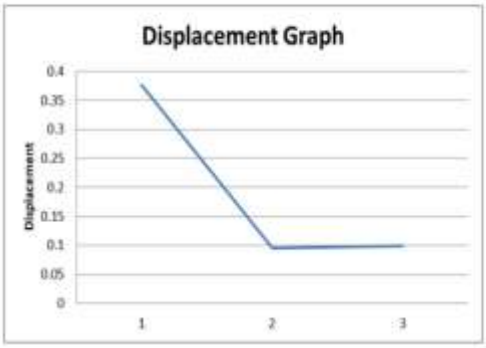

Chart 1: Variation of displacement wrt material

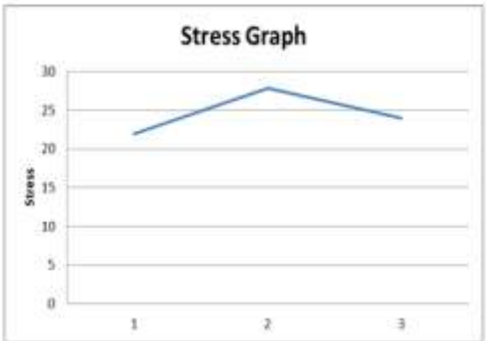

Chart 2: Variation of stress wrt aterial

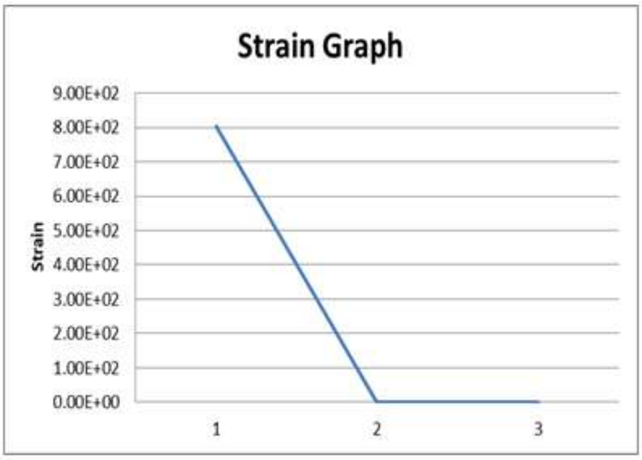

Chart 3: Variation of strain wrt material

III. Conclusion

Finite Element Analysis being a modern day technique, gives appropriate and more accurate results. Different analysis software help visualize and understand the stress distribution over the friction clutch plate. It becomes easier to select a proper material available and if it is a better option as a friction material compared to other materials available and will it sustain that amount of stress. Stress and deformation being one of the vital parameter which may lead to failure of system, its analysis also plays important role and FEA with its accurate results and plots and illustrations and animations enables better performance for analysis.

Refernces

[1]. *Google Images*
[2]. *Google Images*
[3]. Sagar Olekar, Kiran Chaudhary, Anil Jadhav, P. Baskar "Structural analysis of multiplate clutch IOSR *Journal of Mechanical and Civil Engineering (IOSR-JMCE), Volume 10, Issue 1 (Nov. - Dec. 2013)*
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