



REVIEW ON FRICTION CLUTCH PLATE OF AN ATV

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Abstract— Clutch is a mechanical device located between a vehicle engine and its transmission and provides mechanical coupling between the engine and transmission input shaft. Multi plate clutch is one of the important part in the **power** transmission systems. Good design of clutch provides better engine performance. Multi plate clutch is most widely used in ATV's, racing cars and heavy duty vehicle where high torque transmission required and limited space is available. The multi plate clutch has modelled in NX 9 software and imported in ANSYS Workbench 15. The structural analysis has been carried out for friction material clutch plate. The result of friction materials is based on the static and dynamic analysis, stress and total deformation and temperature variation and heat flux of the friction plate. Uniform wear theory were used for the analysis. The Grey Cast Iron and Kevlar 49 friction material are compared based on the total deformation of the clutch plate to find the better lining material. The Von Mises stress has been determined by varying the friction surfaces material-Grey Cast Iron and Kevlar 49. After that the FEM analysis is done for Kevlar friction material. The stresses & deformation obtained for this friction material is then compared to analysis software result. The analysis is done for worn out friction disc. By extracting the result we found that Kevlar49 as friction material solve this difficulty.

Key words: ANSYS, Clutch, friction plate, Grey Cast Iron, Kevlar49, Stress, Strain, VonMises stress, Deformation.

1. INTRODUCTION

The clutch is a mechanical device, which is used to connect or disconnects the source of power from the remaining parts of the power transmission system at the will of operator. The friction clutch is an important component of any automotive machine. It is a link between engine and transmission system which conducts power, in form of torque, from engine to the gear assembly. Mainly there are two types of clutches, one is single plate clutch which is used for small duty vehicles and the other is multi plate clutch, which has number of friction plates and steel plate's assembly used for heavy duty vehicles. The clutch principle is based on friction. When two friction surfaces are brought in contact with each other and pressed they are united due to friction between them. If one is revolved the other will also revolve. The friction between the two surfaces depends upon. Area of the friction, Pressure applied on them. Generally there are two types of clutches based on type of contact: 1.Positive clutch, 2.Friction clutch. Desirable Properties for Clutch Plate Lining: (a) the materials in contact must have a high coefficient of friction. (b) The materials in contact must high resistance to wear effects, such as scoring, galling, and ablation. (c) The coefficient of friction should be constant over a specified range of temperatures and pressures. The material must be resistant to environmental conditions such as moisture, dust and pressure. (d) The material should possess good thermal properties, high specific heat capacity, good thermal conductivity and capable of withstanding high temperatures and contact pressures. (e) The material should possess high shear strength to transfer torque.

1.1 Working principle of clutch system

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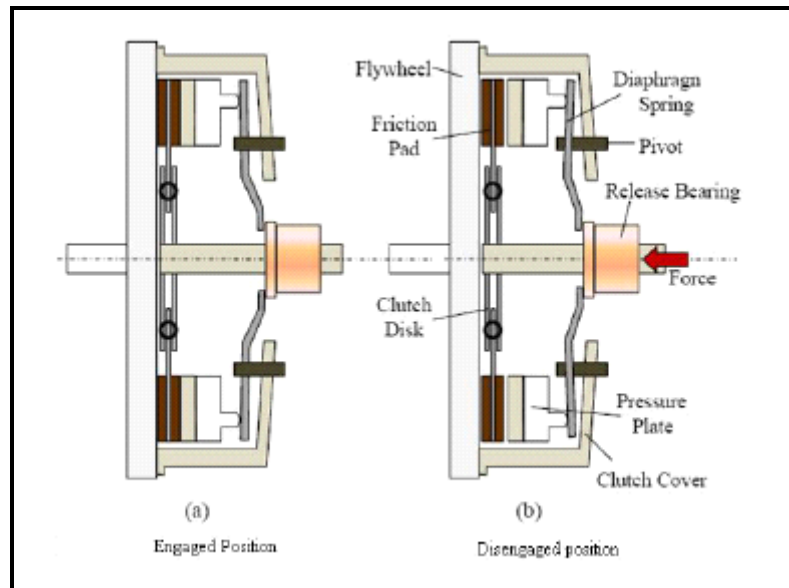


Figure 1 Engagement and disengagement of clutch plate

Fig 1(a) shows the engagement position of clutch plates, during this the clutch pedal is engaged with flywheel which transmit power from the engine to the clutch and it is transmitted towards the transmission .Fig(b) shows the disengagement of clutch plates, which does not transmit power towards the transmission.

2. BACKGROUND

Design and Analysis of Friction Clutch Plate using Ansys By S.Gouse seema begum, and A. Balaraju

investigated experimentally and numerically friction plate using CATIA V5 R20 software and theoretical calculations and also structural analysis has done by using ANSYS Workbench 14.5. In the study the materials gray cast iron and Kevlar 49 has been selected for friction plate and structural analysis has been done to find the total deformation, equivalent (von mises) stress and equivalent elastic strain and concludes that the material Kevlar 49 is more advantageous than Gray cast iron.

Static And Dynamic Analysis of Clutch Plate With Crack By N.V.Narasimharao,

has Done Research Work On Investigate How A Crack Propagates And Grows In A Clutch. A Clutch Plate Is Analyzed For Crack Propagation For Different Materials Aluminum Alloy 6061, Aluminum Alloy 7475, Composite Materials S2 Glass And Kevlar. Theoretical Calculations Are Done To Determine Stress Intensity Factor, Crack Extension Force, Crack Opening Displacement. . From Dynamics And Fracture Mechanics, It Is Well Known That Accelerated Crack Nucleation And Micro-Crack Formation In Components Can Occur Due To Various Reasons, Such As Transient Load Swings, Higher Than Expected Intermittent Loads, Or Defective Component Materials. Normal Wear Causes Configuration Changes That Contribute To Dynamic Loading Conditions That Can Cause Micro Crack Formation At Material Grain Boundaries In Stress Concentrated Regions (Acute Changes In Material Geometry). So, Finally They Conclude That If The Crack Propagates In The Composite Materials, They Tend To Fail Faster Than Aluminum Alloys Thereby Reducing Their Life. So Care Should Be Taken For Composite Materials Not To Get The Crack

Static and Dynamic Analysis of Single Plate Clutch By B.Sreevani ,and M.Murali Mohan

explained that present used material for friction disc is Cast Iron and aluminum alloys. In this thesis analysis is performed using composite materials and concluded that by analytical and theoretical results, E Glass Epoxy is better.

Design Modification & Failure Analysis of a Driven Plate/Friction Plate of a Clutch using FEA By Marella. Veerendra, Gowthamtham Reddy, Vudumula, and K. N. D. Malleswara Rao[4]

investigated on a Friction plate of a clutch using FEA and from the analysis result it was found that in the actual side plate the maximum value of stress is very near to the theoretical endurance limit. It was proofed experimentally.

A Literature Review on Failure in Single Plate Clutch System By K.C.Lathiya,N.P.Badola2,C.L.Undhad,and B.D.Dhamecha[5] ,

studied on failure of single plate clutch system and from results obtained it was concluded that failure of clutch and its damage due to excessive frictional heat and heat fluctuations in the clutch counter-mate disc usually occurs in all type of automotive clutches.

DESIGN FAILURE MODES AND EFFECTS ANALYSIS (DFMEA) OF AN ALL-TERRAIN VEHICLE By Sidhartha Pattnaik[6],

explained about DFMEA (Design Failure Modes and Effects Analysis), technique which is used to list out all modes of failure for various components of the ATV, its causes, effects and ways of preventing it.

Effect of Band Contact on the Temperature Distribution for Dry Friction By Oday I. Abdullah, and J. Schlattmann[7],

Investigated Heat Generation Due To Friction Using Finite Element Method to avoid the failures due to the high thermal stresses. Analysis has been completed using a three dimensional model to simulate the thermo-structural coupling in automotive clutches using Ansys.

Static/kinetic Friction behaviour of a Clutch Facing Material: Effects of Temperature and Pressure By A.Chaikittiratana, S. Koetnuyom,and S. Lakkam[8]

Investigated The feasibility of applying a simple and cost effective sliding friction testing apparatus to study the friction behaviour of a clutch facing material, effected by the variation of temperature and contact pressure.. It was found that the method used in this work was able to give a convenient and cost effective measurement of friction coefficients and their transitions of a clutch facing material. The obtained results will be useful for the development process of new facing materials

Flowpath Optimization of Wet Multi-plate Friction Clutch By Qing Wang, Tengjiao Lin , Li Pan and Quancheng Peng [9]

explained that by optimizing internal flow path of wet friction clutch heat generated can be reduced significantly. The optimized structure of flow path is obtained, and the rationality of optimization result is verified.

3. METHODOLOGY

3.1 Selection of materials

The following are the different types of materials used for clutch plate

3.1.1 Grey Cast Iron as Friction material

Many substances burn when they are heated. Others melt or evaporate. Some substances, such as asbestos, do not change when they are heated. This property can be very useful. For centuries, people have known that this fibrous mineral has many useful properties. It is fire resistant. It does not melt or react with air, at least not until it gets very hot. One form of the mineral withstands temperatures up to 2750 °C. It is a very good insulator. It is strong. It resists acid. It is chemically inactive. It can be woven into cloth. Asbestos has some very useful properties, and it is readily available at a low cost.

3.1.2 Kevlar 49 as friction material

Kevlar was introduced by DuPont in the 1970s. It was the first organic fiber with sufficient tensile strength and modulus to be used in advanced composites. Originally developed as a replacement for steel in radial tires, Kevlar is now used in a wide range of applications. Kevlar 49 is the registered trademark for pyramid synthetic fiber, comparable to other aramids such as Nomex and Technora. Developed by Stephanie K. Wolekat DuPont in 1965, this high strength material was used commercially for the first time in the early 70s as are placement for steel in racing tires. Typically spun into ropes or fabric sheets that could be used as such or as an ingredient in composite materials. Since it has a high strength-to-weight ratio Kevlar has found many applications, ranging from bicycle tires to body armor. By this measure it is about 5 times stronger than steel on an equivalent weight basis. As it can withstand high impact it is also used to make modern drum lining. It is

suitable for mooring lines when used as a woven material, for underwater applications and for possible replacement as lining material.

3.2 Method of analysis

The torque that can be transmitted by a clutch is a function of its geometry and the magnitude of the actuating force applied as well the condition of contact prevailing between the members. The applied force can keep the members together with a uniform pressure all over its contact area and the consequent analysis is based on uniform pressure condition may no longer prevail. Hence the analysis here is based on uniform wear condition.

3.2.1 Introduction to ANSYS

ANSYS is general-purpose finite element analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designated size) called elements. The software implements equations that govern the behavior of these elements and solves them all; creating a comprehensive explanation of how the system acts as a whole.

3.2.2 Static Analysis

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.

3.2.3 Transient Dynamic Analysis

Used to determine the response of a structure to arbitrarily time-varying loads. All nonlinearities mentioned under Static Analysis above are allowed.

3.3 Engineering Data

Type	Friction plate	Friction plate
Material Properties	Gray cast iron	Kevlar Aramide Fiber 49
Density	7200	1440
Young's Modulus	120 Pa	1.12×10^{11} Pa
Poisson's Ratio	0.29	0.36
Bulk Modulus	1.667×10^{11} Pa	1.333×10^{11} Pa
Shear Modulus	44-54 GPa	4.1176×10^{10} Pa
Specific heat Capacity	$450 \text{ J kg}^{-1} \text{ C}^{-1}$	$1420 \text{ J kg}^{-1} \text{ C}^{-1}$
Isotropic Thermal Conductivity	310 W/m.k	$0.04 \text{ W m}^{-1} \text{ C}^{-1}$

Figure 2 Material Properties for Grey Cast Iron and Kevlar 49

4 Problem Statement

Company has been receiving many complaints about clutch Burst Disc, Damaged Pressure Plate which resulted from an abnormal amount of clutch slippage/heat. The heat flow was so intense that the metal could not disperse the heat quickly enough these heat checks are actually small cracks with raised ridges that are capable of shaving off the facings of the driven disc. The typical evidence of such a failure was High and low spots on the plate Partial transfer of the facing material (ceramic or organic) from the driven disc onto the plate. A blue discoloration throughout the failed part was seen. Previous work has been done on the Grey Cast iron friction material clutch plate and dynamic analysis of cracks in composite

materials was carried out . Static and dynamic analysis of clutch plate had also been done to observe the clutch before crack and after crack but the crack propagation and growth were not observed.

5 CONCLUSION

In this thesis, a Multi friction plate clutch is modeled in 3D modeling software Unigraphics 9. Present used material for clutch is Gray cast iron. In this thesis static and thermal analysis is done to find the temperature variation and heat flux of the friction plate. Theoretical calculations are done to determine stress intensity factor, crack extension force, crack opening displacement. By observing the analysis results, the stress values are more for composite materials and when the crack is started the composite materials, stress values increases more than the condition of no crack so the composite materials fails faster once the crack propagates. And it is found that the temperature developed during the engagement and disengagement process is beyond the maximum temperature of the gray cast iron material, i.e. why there is crack and erosion of the friction material of the friction plate that the values of temperature increase linearly with disc radius and the maximum temperature. By changing the friction lining material of 125cc ATV life of the clutch plate can be increased.

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