Optimal Design of a Clutch Plate using Ansys

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ABSTRACT

The clutch is one of the main components in automobiles. The engine power transmitted to the system through the clutch. The failure of such a critical component during service can stall the whole application. The Finite Element Analysis providing a means for non-destructive analysis, which is used to analyze the clutch driven plate. The results from the FEA are accurate and hence being used worldwide for design and research engineers.

The driven plate used in Leyland Viking Vehicle is analyzed in this work. The driven main plate failed normally during its operation due to cyclic loading. This project explains the structural design analysis of the clutch plate and find out the failure region by doing static analysis in ANSYS software.

The 3D model of clutch plate was drafted using Solid works software and analysis of the plate was done for static loading condition. This project finds the maximum stress in failure region during operation. This project also suggests three design modifications to the company to improve the lifetime of the clutch plate.

Keywords: *Ansys, FEA, Single Plate Clutch, Solid works*

I. INTRODUCTION

The power developed inside the engine cylinder is ultimately aimed to turn the wheels so that the motor vehicle can move on the road. The reciprocating motion of the piston turns a crankshaft rotating the flywheel through the connecting rod. The circular motion of the crankshaft is now to be transmitted to the rear wheels. It is transmitted through the clutch, gearbox, universal joints, propeller shaft or drive shaft, differential and axles extending to the wheels. The application of engine power to the driving wheels through all these parts is called power transmission.

The power transmission system is usually the same on all modern passenger cars and trucks, but its arrangement may vary according to the method of drive and type of the transmission units. The power transmission of an automobile. The motion of the crankshaft is transmitted through the clutch to the gear box or transmission, which consists of a set of gears to change the speed. From gear box, the motion is transmitted to the propeller shaft through the universal joint and then to the differential through another universal joint. The differential provides the relative motion to the two rear wheels while the vehicle is taking a turn. Thus the power developed in the engine is transmitted to the rear wheels through a system of transmission. Clutch is a device used in the transmission system of a motor vehicle to engage and disengage the engine to the transmission. This device is used to transmit the power on user will.

II. Function of a clutch

Clutch is a device which is used to engage or disengage the power from the prime mover to the driven on users will. In automobiles clutch is located between the engine and the transmission. When the clutch is disengaged, the power is not transmitted to the rear wheel and the vehicle stops while the engine is still running. The clutch is disengaged when starting the engine, shifting the gears stopping the vehicle and during idle time. The clutch is engaged only when the vehicle is to move and is kept engaged when the vehicle is moving. When properly operates it prevents jerky motion of the vehicle. The main part of single plate clutch is shown in the fig 1.

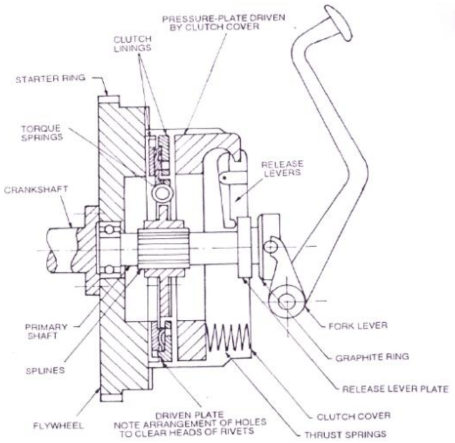

Fig.1 Main Parts of Single Plate Clutch

III. OPERATION OF THE CLUTCH

When the clutch pedal is depressed, through pedal movement, the clutch release bearing presses on the clutch release lever plate, which being connected to the clutch release levers, forces these levers forward. This causes the Pressure Plate to compress the Pressure Springs, thus allowing it to move away from the Clutch Driven Plate. This action releases the pressure on the Driven Plate and Flywheel, the flywheel is now free to turn independently, without turning the transmission. When the clutch pedal is released, reverse action takes place: the driven plate is again forced against the flywheel by the pressure plate- because of the force exerted by the pressure springs.

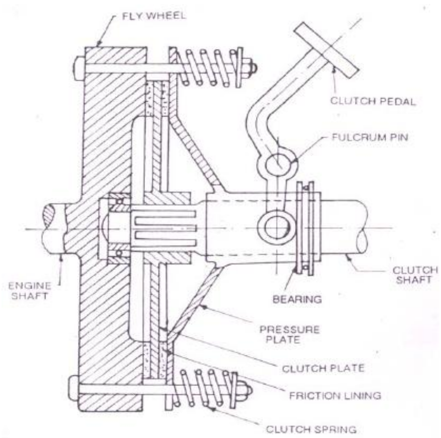

Fig.2 Single Plate Clutch

The pressure plate will keep on compressing the facings of the driven plate until the friction be created becomes equal to the resistance of the vehicle. Any further increase in pressure will cause the clutch plate and the transmission shaft to turn along with the flywheel; thus achieving vehicle movement.

IV. DRIVEN PLATE

Every time the clutch is engaged, the entire power delivered by the engine is transmitted from the flywheel to the transmission, through the splines in the hub of the clutch driven plate. When new, the clearance between the splines of the clutch plate hub and transmission shaft is kept as small as possible but at the same time allowing the clutch plate free movement along the transmission shaft.

If, at the time of transmitting the engine torque, the driving face of the driven plate hub spline is in contact with the transmission shaft spline face, the transfer of energy will be like a smooth push-there will be no shock or jolt. The driven plate under analysis is a fan type clutch. The shape of the clutch is like a fan . The conventional spring centered driven plate is shown in the fig 3.

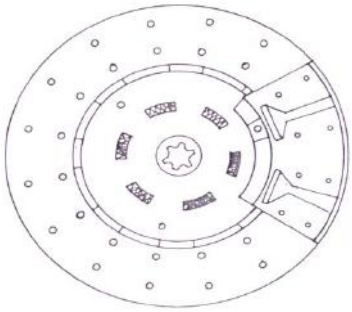

Fig.3 Driven Plate

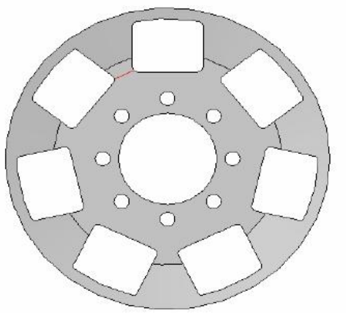

Fig.4 Crack Formation Area

V. CRACK FORMATION AREAS

Crack is formed on the side plate of the clutch. Side plate consist of various slots in which the damper springs are engaged. And these slots are called as windows. These damper springs is used to absorb the torque during the engagement of the clutch. The crack is formed between these two windows. The crack is shown as red mark in the fig 4.

VI. MODELING AND ANALYSIS OF ACTUAL DRIVEN PLATE OF A CLUTCH

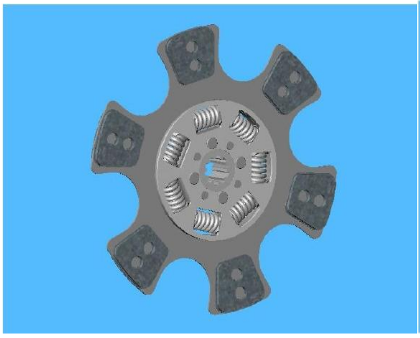

Fig.5 Assembled View of the Side Plate

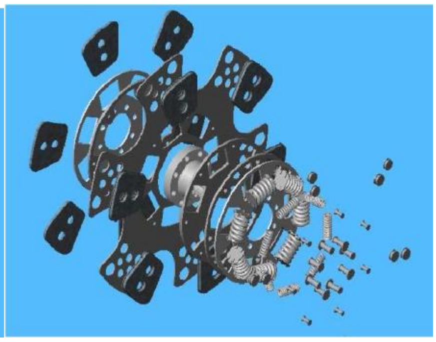

Fig.6 Exploded View

The exploded view can be created by using following commands. Insert -Exploded view- new-direction to explode- pick entities to be exploded the exploded view is shown in the fig 6.

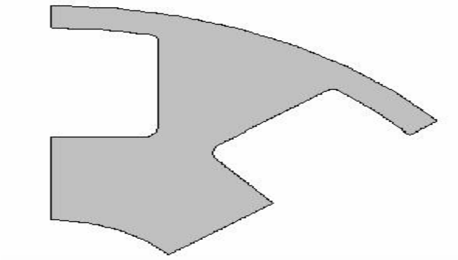

Fig.7 Part under Analysis

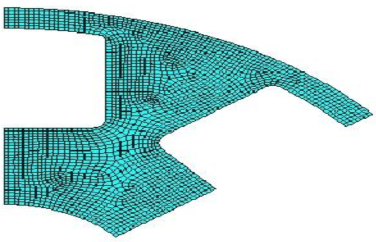

Fig.8 Meshed Model

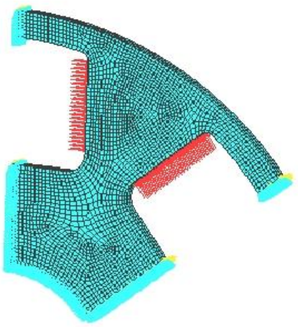

Fig.9 Boundary and Load Condition

VII. RESULTS FOR ACTUAL DRIVEN PLATE

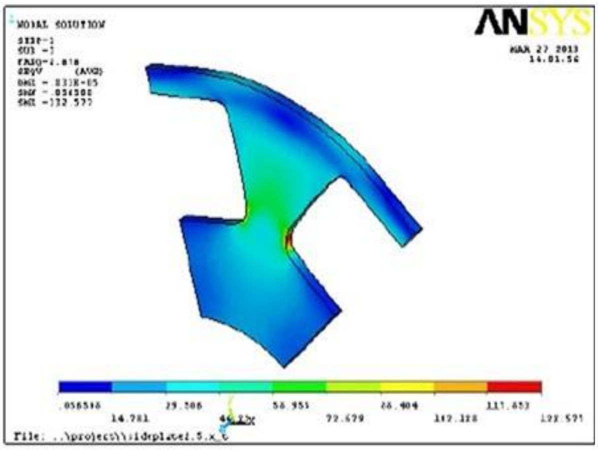

Fig.10 Stress Intensity

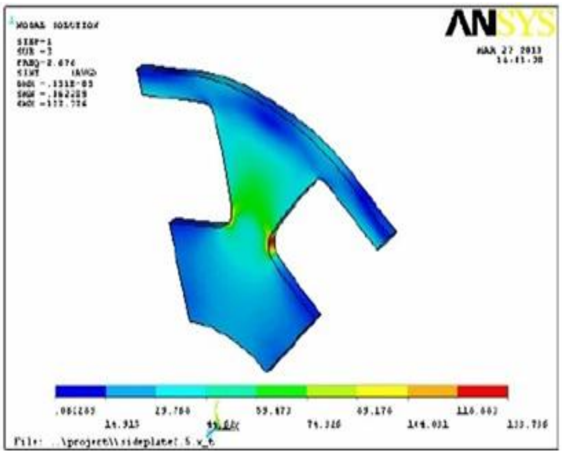

Fig.11 Von Mises Stress

VIII. MODELING AND ANALYSIS OF MODIFIED DRIVEN PLATE OF A CLUTCH

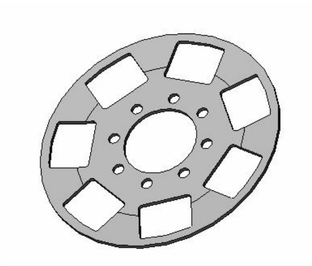
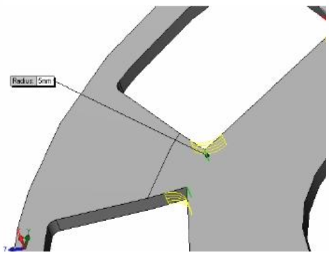
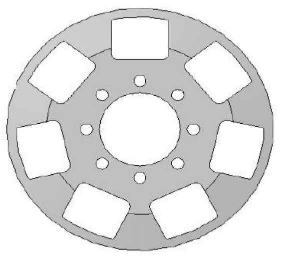

Fig.12 Plate of Thickness 3mm - **Fig.13** Plate Of fillet radius 5mm - **Fig.14** Plate Of thickness 3mm and radius 5mm

IX. RESULTS FOR MODIFIED DRIVEN PLATE

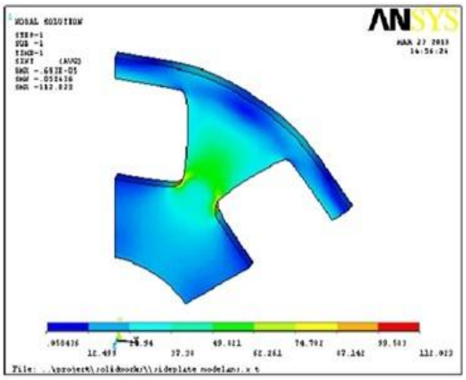

Fig.15 Plate of Thickness 3mm

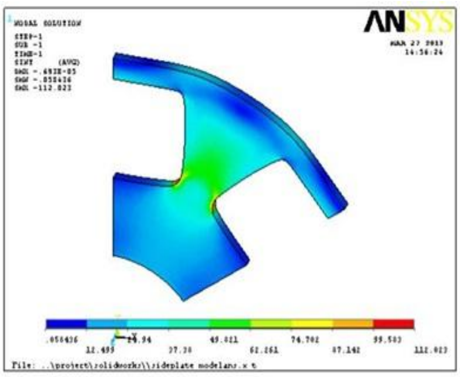

Fig.16 Plate Of fillet radius 5mm

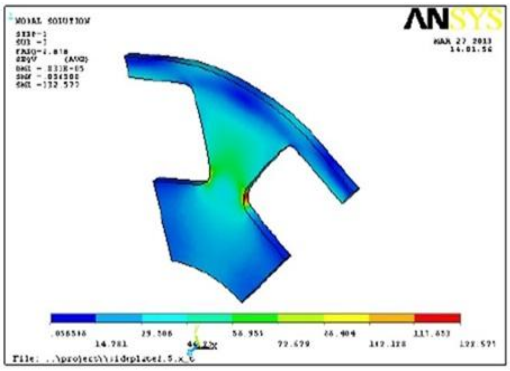

Fig.17 Plate Of thickness 3mm and radius 5mm

X. CONCLUSION

As from the analysis result of the actual side plate the maximum value of stress is very near to the theoretical endurance limit. Due to which the crack is formed on the side plate during the earlier period of the testing. In order to increase the life of the side plate of the driven plate. Some of the modifications are done on the side plate to reduce the maximum stress. Primarily the thickness of the plate is increased and this modification gives maximum stress lesser than the maximum stress of the actual side plate. Factor of safety is increased to 1.23. Alternative modification of the side plate is done by increasing the fillet radius. The maximum stress obtained by this modification is lesser when compared to the previous modification. Factor of safety is increased to 1.52.

In order to reduce the maximum stress further, both the above said modifications are combined. The maximum stress is reduced further. Factor of safety is increased to 1.7. This design has highest factor of safety than the other modifications. This ultimately increases the life of the driven plate. This design is also tested practically in the lab and it is confirmed that the life of the driven plate is increased.

The present design analysis was done to find the failure region and reasons for failure only by onsidering the structural analysis. In future this project can be extended to thermal analysis by considering frictional effects during the operation.

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