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Stress Analysis and Optimization of a Piaggio Ape Clutch Plate with different Friction Materials

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Abstract—
clutch plate is one of the important part in the power transmission systems. Good design of clutch provides better engine performance. Clutch is device which is used to engage or disengage of gears and it transfers the rotary motion of one shaft to the other shaft when desired. In automobiles friction clutches are widely used in power transmission applications. To transmit maximum torque in friction clutches selection of the friction material is one of the important tasks.

In this thesis a model of Piaggio Ape clutch plate has been generated in Pro-E Cre0-5 and then imported in ANSYS for power transmission applications. We have conducted structural analysis by varying the friction surfaces material and keeping base material aluminium same. By seeing the results, Comparison is done for both materials to validate better lining material for Piaggio Ape clutch plate by doing analysis on clutch with help of ANSYS software for find out which material is best for the lining of friction surfaces.

Keywords— cork, cr2m, cre0-5 , Kevlar, Piaggio ape , sa80, sa92…..

I. INTRODUCTION

Clutches are designed to transfer maximum torque with minimum heat generation. During engagement and disengagement the two clutch discs has the sliding motion between them. Due to rubbing of the two discs the large amount heat is generated during engagement and disengagement. The default state of the clutch is engaged that is the connection between engine and gearbox is always "on" unless the driver presses the pedal and disengages it. If the engine is running with clutch engaged and the transmission in neutral, the engine spins the input shaft of the transmission, but no power is transmitted to the wheels. There are two types of clutch positive contact clutch and friction clutch. Positive clutch transmits large amount of torque without slip but they have certain disadvantages such asthey cannot be engaged at high speeds, max 60 rpm for jaw clutches, and 300 rpm for toothed clutches. Shock develops during engagement at any speed. Require some relative motion in order to engage when both driving and driven shafts are at rest. These drawbacks are overcome in friction clutch hence friction clutch is most widely used in automotive applications.

Generally there are two types of clutches based on the type of contact:

- Positive clutch
- Friction clutch

Fig.1 Piaggio Ape Clutch Plate

II. MAIN PARTS OF CLUTCH

The main part of clutch are divided into three groups.
1. Driving member
2. Driven member
3. Operating member

Fig.2 Parts of Piaggio Ape Clutch

III. USED MATERIAL PROPERTIES

USED MATERIAL PROPERTIES		
MATERIALS/PROPERTIES	**MODULUS OF ELSTICITY**	**POSSIONS RATIO**
CORK	0.032E9	0.25
CR2M	7000	0.28
KEVLAR	5381	0.24
SA80	2413	0.23
SA92	3896	0.27

TABLE.1 MATERIAL PROPERTIES

IV. MODELING USING PRO-E CREO-5

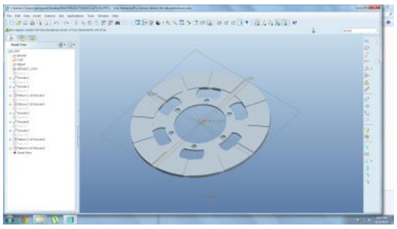
Fig.3 original model

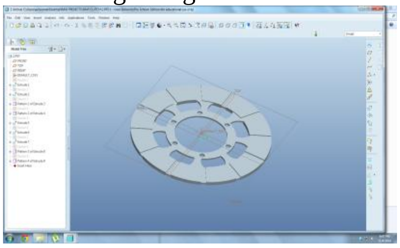
Fig.4 optimized model-1

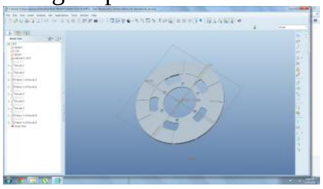
Fig.5 optimized model-2

V. ANALYSIS BY USING ANSYS

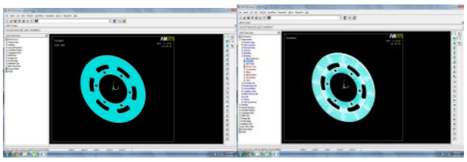
Fig.6&7 imported & meshed original modal

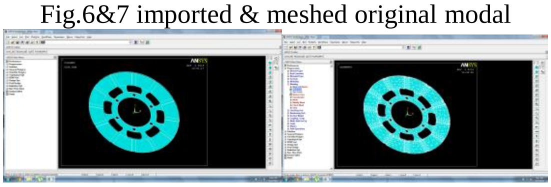
Fig.8&9 imported & meshed optimized model-1

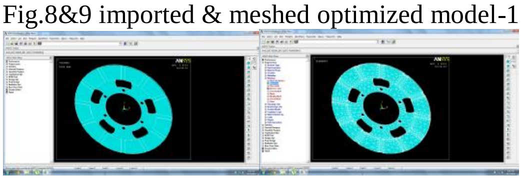
Fig.10&11 imported & meshed optimized model-2

VI. RESULTS & DICUSSION

Original model results:

- **CORK**

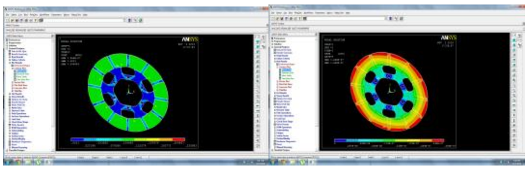
Fig.12&13 Stress &Displacement

- **KEVLER**

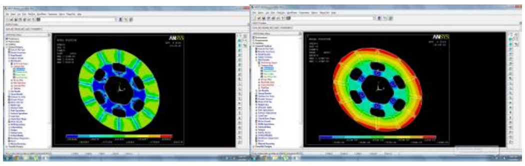
Fig.14&15 Stress &Displacement

- **CR2M**

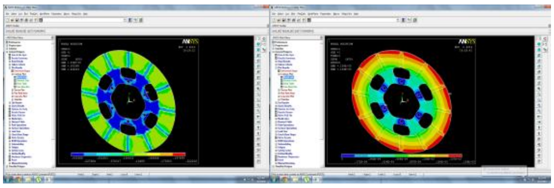
Fig.16&17 Stress &Displacement

- **SA80**

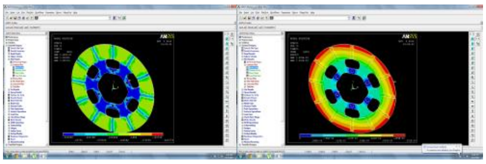
Fig.18&19 Stress &Displacement

- **SA92**

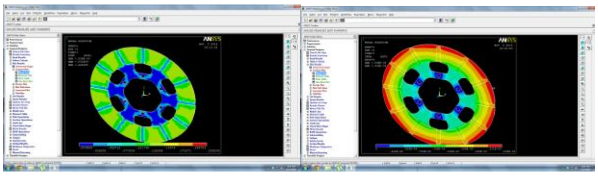
Fig.20&21 Stress &Displacement

Optimized model-1 results:

- **CORK**

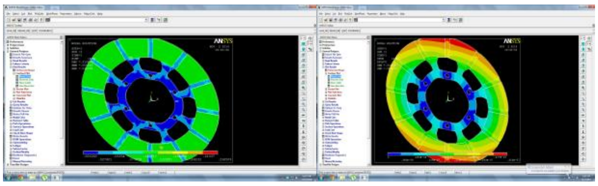
Fig.22&23 Stress &Displacement

- **KEVLAR**

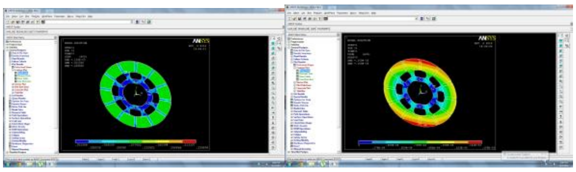
Fig.24&25 Stress &Displacement

- **CR2M**

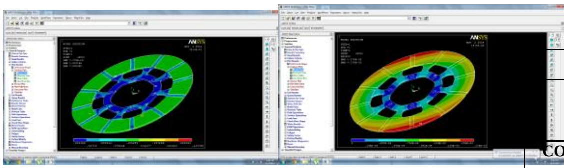

Fig.26&27 Stress &Displacement

- **SA80**

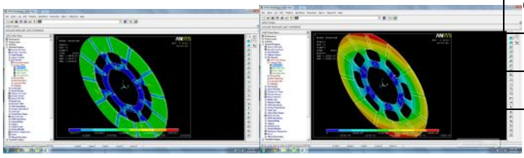

Fig.28&29 Stress &Displacement

- **SA92**

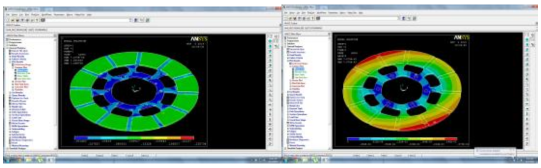

Fig.30&31 Stress &Displacement

Optimized model-2 results:

- **CORK**

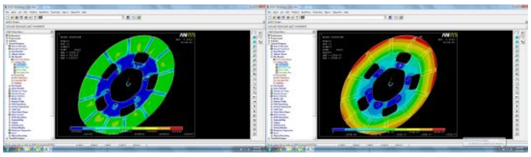

Fig.32&33 Stress &Displacement

- **KEVLAR**

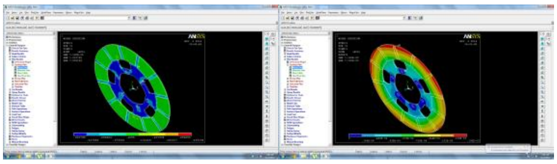

Fig.34&35 Stress &Displacement

- **CR2M**

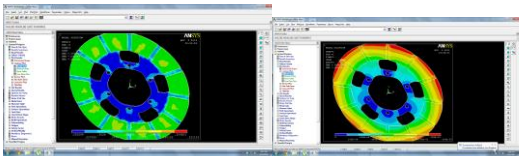

Fig.36&37 Stress &Displacement

- **SA80**

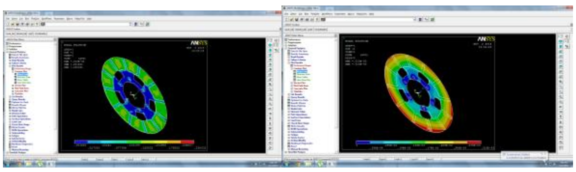

Fig.38&39 Stress &Displacement

- **SA92**

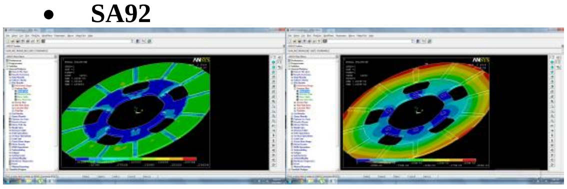

Fig.40&41 Stress &Displacement

VII. TABULATION OF RESULTS

	ORIGINAL MODEL		OPTIMIZED MODEL-1		OPTIMIZED MODEL-2	
	STRESS	DISPLACEMENT	STRESS	DISPLACEMENT	STRESS	DISPLACEMENT
CORK	235963	268E7	236509	312E7	232157	255E7
KEVLER	225178	136E3	239808	159E3	235194	130E3
CR2M	222216	154E3	235365	178E3	231103	146E3
SA80	221574	331E3	234204	382E3	230031	313E3
SA92	224295	238E3	238724	275E3	234204	255E3

VIII. CONCLUSION

In our project we have designed a Piaggio Ape clutch plate using theoretical calculations. 2-D drawings are drafted from the calculations. 3-D model of the Piaggio Ape clutch plate are done in Pro-E Creo-5 software. Structural analysis is done on the friction plates to verify the strength. Friction materials used are **CORK, KEVLER, CR2M**, **SA80** and **SA92**. By observing the analysis results, the maximum stress and total deformation values for hybrid **SA80** are less than All other materials respective values. So we expected that for Piaggio Ape clutch plate using as hybrid **SA80** friction material is advantageous than using cork or other friction materials. And if we compare the results of the model reference optimized model-2 have nearest values than the optimized model-1 so optimized model-2 advantageous than using optimized model-1 & original model.

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