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Design and Analysis of Clutch Plate Using Fiber Reinforcement Polymer

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Abstract

In a single plate clutch pressure plays very important role in transmitting torque from engine to transmission system. So the friction material property is very important in clutch mechanism. Generally clutch is in engaged position, when peddle is pressed clutch is disengaged and at that time there is sudden increase in temperature. Due to friction between mating part some part of material get worn out. Problem associated with clutch is when the force applied on the clutch; deformation will take place due to temperature variation and cyclic stresses. The object of the project is to change the material and observe the stress distribution and temperature distribution. Various test like tensile, flexural, SEM, water absorption is to be conducted to determine the properties of clutch plate. A comparison is done based on stress, temperature developed and vibration between the standard material and the developed material.

Introduction

The composite materials could be termed as those materials which are synthesized by two or more materials having diverse properties. Large composites materials have strong reinforcing material imbedded in weaker lattice materials. The combination of two or more materials is called matrix.Composite materials are characterized with high strength to weight ratio with easier methods of fabrication. The thermosetting polymers are those polymers, which during molding (by heating, etc.) get hardened once they have solidified, they cannot be softened, i.e., they are permanent setting polymers. Such polymers during molding acquire three-dimensional cross-linked structure, with predominantly strong covalent bonds. Thus, a thermosetting polymer once molded cannot be reprocessed. Thermoplastics possess comparatively weaker intermolecular forces and there is no cross-linking. Consequently, they are flexible and can be easily molded on heating. On the other hand, there is excessive cross-linking in thermosetting plastics and different polymer chains held through strong covalent bonds forming a three dimensional network.

Hence, these once set cannot be remolded. On heating, they first fuse to form hard mass and then burn. Generally, composite materials are arranged on the basis of matrix materials as:

- Ceramic Matrix Composites
- Polymer Matrix Composites
- Metal Matrix Composites

Bisphenol-A

Bisphenol-A, commonly abbreviated as BPA, is an organic compound with two phenol functional groups. It is used to make poly carbonate plastic and epoxy resins, along with other applications.

Glass Fiber Reinforced Plastics

Glass Fiber Reinforced Plastics, GFRP, like any other Reinforced Plastics is generally composed of two main constituents, which are the Matrix phase and the Reinforcing phase. The matrix phase may be of Polymeric, ceramic, metallic and the hybrid type. The hybrid may be of blends of any of the above phases. As a generalization polymers have low strengths and Young's modulus, ceramics are strong, stiff and brittle, and metals have intermediate strengths and modulus together with good ductility i.e. they are not brittle.

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Introduction of Clutch Plate

A Clutch is a mechanism designed to disconnect and reconnect the driving and driven members. It is a device, which enables one rotary drive shaft to be coupled to another shaft, either when both the shafts are stationary or when there is a relative motion between them.

Properties Of Clutch Friction Material

Clutch plate are subjected to severe rubbing so that generation of heat in relatively short period. Therefore, the lining material should have a combination of the following properties to withstand the severe operating conditions.

(a)Relatively high coefficient of friction under entire operating conditions.

(b)Maintenance of friction properties during entire working life.

(c)Relatively high energy absorption for short periods.

(d)Withstanding high pressure plate compressive loads.

(e)Withstanding high impacts of centrifugal force during gear changing.Adequate shear strength to transmit engine torque.

(g)High level of endurance in cyclic working without affecting friction properties.

(h)Good compatibility with cast iron facings over the entire range of operating temperature.

(i) A high degree of tolerance against interface contamination without affecting its friction take-up and grip characteristics.

Laminate Preparation Procedure

Fiber Sizing

The woven roving of glass fiber and chopped strand mat of glass fiber were marked with a marker pen for size of 300mm * 300mm.The fibers are cut to above mentioned dimensions. A special cutting scissors was used as a fiber is an abrasion resistant fiber. For2 layers of glass fiber laminate and 250 gram of ceramic were taken. The ceramic and epoxy resin were mixed and stir well. To apply the ceramic coating in glass fiber and apply fully and made another glass fiber on it. Thenumber of fiber layers is chosen such that the total thickness of laminate reaches a min. of 10mm.

Resin and Hardener Quantities

For glass fiber and ceramic the quantity of resin was taken in the ratio 1:1 as both the fibers where of woven roving type i.e., 1g resin for 1g fiber. For E glass fiber the quantity of resin to fiber was in the ratio 2:1 as the ceramic was of chopped mat strand. Hence 2g resin for every 1g fiber.10% extra resin was added along with above quantity to aid for wastage. Wastage occurs because of deposition of resin on the sides of the mug and on the hand brush. After adding extra resin the total amount of it is obtained. Now, 10% of hardener with respect to the resin's amount is added and stirred thoroughly. Hence for every gram of resin 0.1g of hardener is added. For glass-ceramic laminate, the weight of 2layers of glass and 250 gram of ceramic.Hence the resin quantity 250g.

Materials used

Various materials being used in the fabrication process are as follows

- Epoxy resin (LY556)
- Glass fiber
- Ceramic
- Mica sheet

Laminate Making

The laminate preparation is started as soon as the resin and hardener are mixed as the curing process gets started. A thin plastic sheet of400mm * 400mm is placed on a clean and flat wooden surface. Now the resin-hardener mixture is applied on the plastic film and spread properly on all sides using hand roller. Now the base fiber is placed on the resin, after which resin is poured on the fiber layer and using hand brush it is spread all over the fiber layer equally. The same process is repeated for all the fiber layers and after applying final layer of resin the laminate is covered with a plastic film.

Hand Lay-up Process

Resin is mixed with a catalyst or hardener if working with epoxy, otherwise it will not cure (harden) for days/ weeks. Next, the mold is wetted out with the mixture. The sheets of fibers are placed over the mold and rolled

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down into the mold using steel rollers. The material must be securely attached to the mold, air must not be trapped in between the fibers and the mold. Additional resin is applied and possibly additional sheets of fibers. Rollers are used to make sure the resin is between all the layers, the fiber is wetted throughout the entire thickness of the laminate, and any air pockets are removed. The work must be done quickly enough to complete the job before the resin starts to cure. Various curing times can be achieved by altering the amount of catalyst employed.

Glass and Ceramic laminate

Hand Lay Up Process

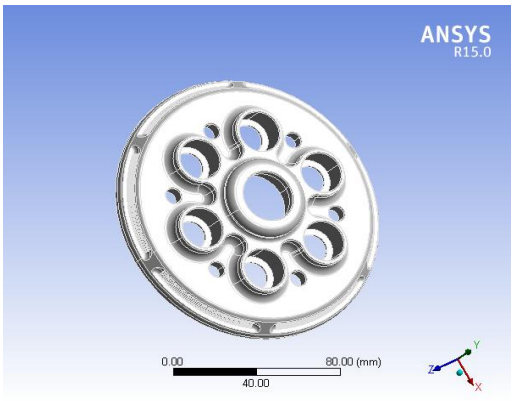
Clutch Plate Analysis

Clutch plate is designed using solid works software and the analysis is performed using ansys analysis software. By graphical comparison of pressure plate of existing material (mild steel) with glass ceramic laminates by comparing various analyses like stress, total deformation, Temperature and total heat flux

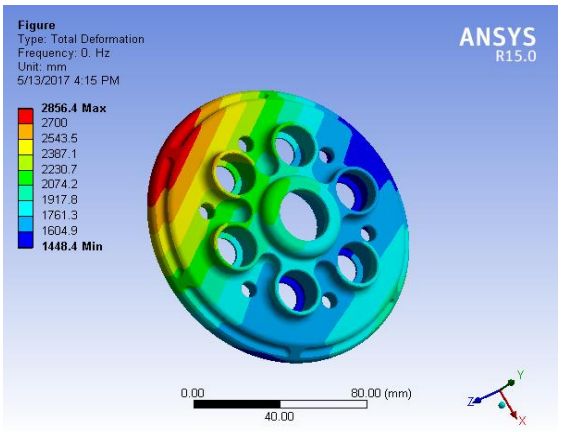
When compared to existing material with the ceramic material, the ceramic materials gives a less vibration and it gains a more strength compared to mild steel.

Result comparison

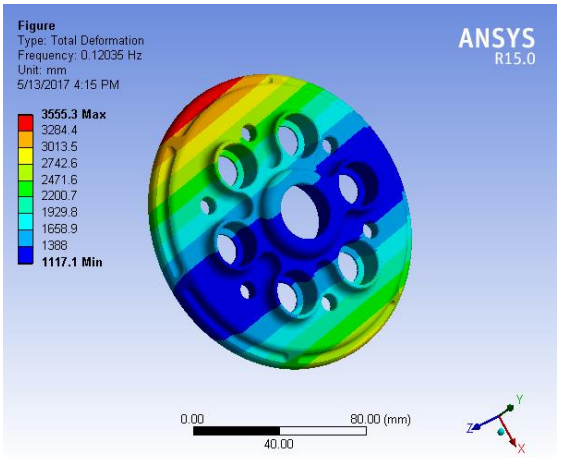
Material	Stress N/mm²	Vibration Hz
Mild steel	7.12e⁷	3100
Glass ceramic	7.035e⁷	2875



Clutch Plate Model



Total Deformation at 0 Hz



Total Deformation at 0.12035 HZ

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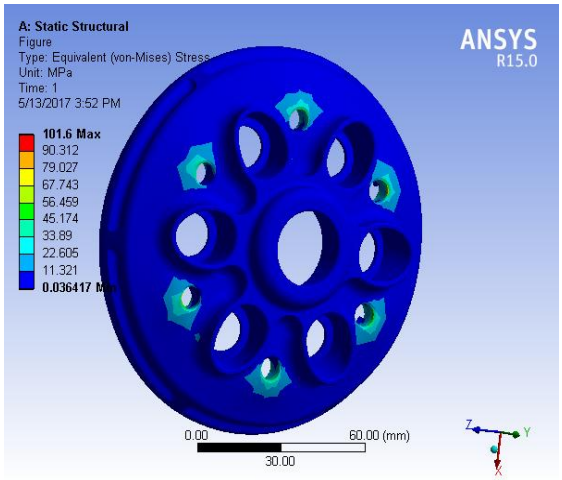
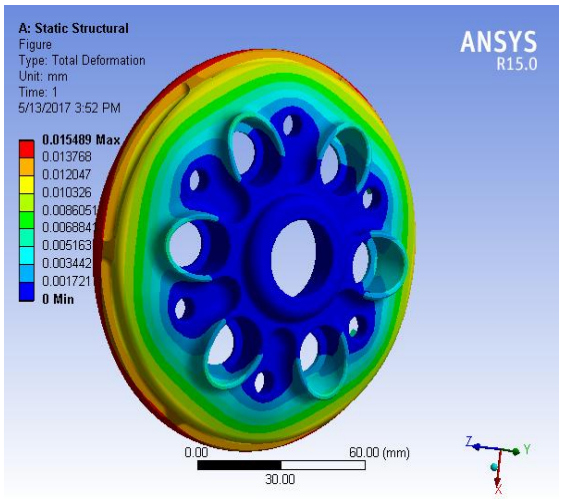
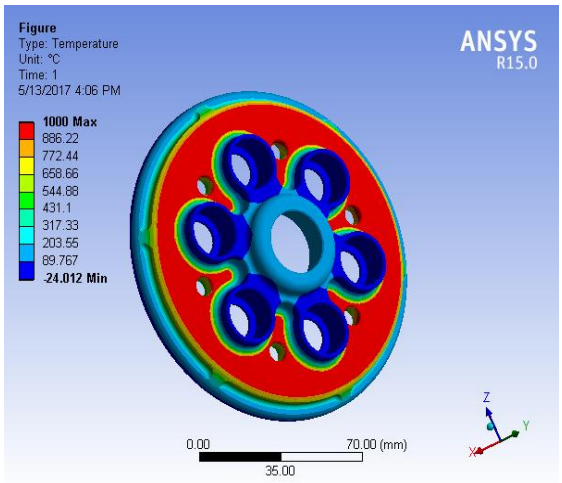


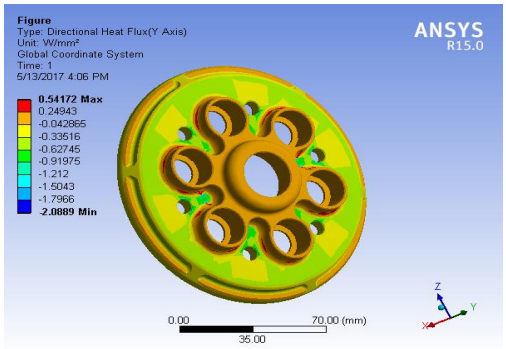
Von Mises Stress



Static Structure



Temperature Deformation



Y-axis Heat Flux Deformation

CONCLUSION

This paper explains the design of single plate using theoretical calculations and analysis. The design of clutch plate is designed by using Solid Works. Friction materials used are glass fiber reinforced polymer. The analysis of results of stress, strain and displacement values with standard materials is performed. The result of this paper, using glass fiber using glass fiber reinforcement polymer as friction material is advantageous than using alloy steel and copper as friction material. The glass fiber reinforcement polymer can be an alternative for single plate clutch.

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