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Investigation of structural and thermal analysis of clutch facings with different friction materials

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Abstract

Almost every part of an automobile has been upgraded due to technological progress over the previous century. The automobile industry is a significant contributor to environmental degradation. Automobile engineers have a responsibility to develop innovative approaches to safety and environmental protection. The importance of determining the influence of stress and heat wear on transmitted torque has grown as interest in studying clutches has grown. Composite materials that are safer for the environment make it easier for vehicle developers to provide greater alternatives. This article investigates the potential for replacing conventional clutch facing materials with composites and other suitable materials like sintered metal, Kevlar, and hard steel. Clutch facings composed of base material have been modelled and analysed in Solid Works and ANSYS Workbench, respectively, to achieve this goal. The mechanical characteristics of clutch facings made of three materials have been compared.

Introduction

The friction clutch's primary components are the pressure plate, the clutch disc that has been lined with friction material, and the flywheel. When the clutch first begins to engage, there will be slipping between the contact surfaces because of the difference in the velocities between them. After this period, all of the contact parts are rotating at the same velocity without slipping because they are rotating at the same speed [1]. The amount of torque that is sent begins at zero at the beginning of the first period and grows until it reaches its maximum value at the conclusion of this period. During the second period, the amount of torque that is transmitted will remain constant. In the scenario described above, the ultimate engagement and disengagement are handled by the friction lining that is present in the clutch plate. This lining is put under extreme amounts of pressure and heat, in addition to having its rotational velocity increased [2].

Two or more bodies are squeezed together and slide against one another to form a sliding system, such as those found in vehicle brakes and clutches. For efficient heat dissipation, one of the contact bodies must be a conductive material with high wear resistance. A high coefficient of friction and an insulating material are desirable for the other body. The contact pressure distribution will change as a result of the interplay between thermal deformation brought on by the elastic contact and the heat generated between the contact surfaces due to their relative velocity. This will take place as a result of the contact between the two surfaces. Because of this interaction, the sliding system's state might change from stable to unstable under certain conditions. In order to keep the friction system in its stable zone, it is important to eliminate the potential for thermal failure brought on by variables like high sliding speeds and improper friction material choices [3].

The purpose of a clutch is to transmit as much torque as possible while generating as little heat as possible. It is necessary to disengage the wheels from the engine in order to bring the car to a stop without first turning off the engine. This may be accomplished by using the clutch. A device for conveying rotation has the ability to be engaged and withdrawn at will. Not only does it take up the drive smoothly, but it also absorbs significant engine power pulsations so that they are not transferred through the driveline. These jobs are accomplished by careful design and the use of both static and sliding or kinetic friction. Gray cast iron, cork, Kevlar49, sintered iron, aluminum 6061, steel, pressed asbestos, bronze, and other materials may be used for friction clutch plates. Other friction materials include asbestos and bronze. One type of clutch is called a single plate clutch, and it is the type of clutch that is used on light-duty vehicles. The other type of clutch is called a multi-plate

clutch, and it is the type of clutch that is used on heavy-duty vehicles. It has a number of friction plates and an assembly of steel plates [4], [5].

The restricted component technique is a numerical inquiry system for estimating outcomes for several design challenges. Since it can be used in so many different ways, it is gaining traction as a research tool across many sectors. The need for approximate solutions to problems, rather than precise shut-discovery arrangements, is becoming more apparent in today's rapidly evolving design contexts. Investigational numerical solutions to certain construction difficulties are just unthinkable [3], [6].

In recent years, there has been a rise in the application of automatic transmissions in the drivetrains of agricultural and construction machinery, as well as in the gearboxes of automobiles. This has led to an increased interest in assembly on the part of both industrial companies and academic researchers. The wet clutch is one of the most significant subassemblies in the gearbox, despite the fact that the gearbox has a wide variety of components. Studies on its design as well as the effects it has on those clutches are frequently conducted. The purpose of these investigations is to gather knowledge about their influence on the performance of a clutch, the durability of a clutch, and the overall efficiency of a gearbox [7].

One of the most fundamental elements of any motor vehicle is the clutch. The power from the engine is transferred to the system by means of the clutch. In the event that this vital component fails while in service, the application as a whole may be rendered inoperable. Because of cyclic loads, the driven main plate failed in a typical manner while it was being operated. Therefore, in order to solve this issue, the clutch must be constructed to have the highest possible level of performance [8]. In this research, three different kinds of friction materials are used in order to explain the static structural analysis and thermal analysis of the clutch plate friction material. The purpose of this research is to determine the distribution of stress, deformations, and temperature in the failure zone during operation. The design process was done with the software Solid Works 2020, and both the static structural analysis and the thermal analysis were done with the software ANSYS.

Section snippets

Materials and methods

The work that is going to be done to implement the suggested changes will principally take place in two stages. The first step in the design process is to perform the calculations necessary to determine the amount of torque that is being transmitted, the total operating force that is being exerted on the contact surface of the clutch facing, and the average pressure that is being applied to the contact surface. After that, the job of material selection includes determining the composition and

Experimental details

When it comes to finding approximations of solutions for a wide variety of engineering issues, Finite element analysis (FEA) continues to be the technique of choice. The discretization is achieved by specifying a mesh size along a line, surface, or solid, and the FEA program then automatically fills the continuum with elements [12], [13]. In this case, the purpose of the FEA is to determine the equivalent stress, strain, and total deformations at a variety of contact pressure magnitudes. In

Structural analysis

The purpose of structural analysis is to predict how a structure will react in response to a set of arbitrary external loads that have been stated in advance. This may be done by looking at how the structure behaves in isolation. During the early phase of the structural design process, estimates of the external loads that will be placed on a structure are created, and the sizes of the connected sections of the structure are determined on the basis of these estimates. A structural analysis will

Conclusion

In this work, a friction plate has been developed with the help of the program Solid-works 2020, and both structural and thermal analysis have been carried out with the assistance of ANSYS Workbench 18. Hard steel, Kevlar, and sintered metal were chosen as the materials for the friction surface. Structural and thermal analyses were performed in order to determine the total deformation, equivalent von mises stress, temperature distribution, and total heat flux. It is evident, on the basis of the

CRediT authorship contribution statement

S. Padmanabhan: Conceptualization, Writing – original draft. **T. Vinod Kumar:** Resources, Writing – review & editing. **D. Sendil Kumar:** Project administration, Supervision. **Gowsikan Velmurugan:** Data curation, Formal analysis. **B. Akshay Kumar:** Investigation, Methodology. **K. Hitesh Sri Subramanyam:** Software, Validation, Visualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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