Global Journal of Engineering Design & Technology

Extended Abstract

Computer Aided Design and Analysis of Disc Brake Rotors

Pandya Nakul Amrish

Abstract

The purpose of this research is to analyze different types of disc brake rotors, which are commonly used in automobile industry and to propose a new design of brake rotor. Analysis of brake rotor includes Structural analysis and Steady state Thermal analysis for each design. A comparison between the existing brake rotors and proposed new design is carried out and based on the results the best design is found out byANSYS software.

Keywords:

Mechanical device; Electrical devices; Disc brake rotors; Heat energy

Introduction

Brakes are mechanical or sometimes electrical devices or components that help to decelerate the vehicle and eventually stop the vehicle in a certain time and certain distance called the stopping distance or the braking distance. The automotive brake is basically a mechanical device which inhibits motion, slowing or stopping a moving object, here, the automobile, and thereby preventing its motion [1]. Brakes are one of the most significant safety systems in any automobile. Functioning of brakes is based on the conservation of energy. Most commonly used brakes are frictional brakes, where the friction produced between two objects convert the kinetic energy of the moving vehicle into heat energy.

Theory of brakes

Frictional brakes: Friction brakes are the most commonly employed braking system in commercial or special purpose vehicles. They generally are rotating devices with a rotating wear surface like Disc or drum and a stationary pad or a shoe. Here, the kinetic energy of the moving vehicle is utilized to stop the vehicle by conversion of this kinetic energy into heat energy/frictional energy. A few common configurations of this type of braking are disc brakes, drum brakes and hydrodynamic brakes

Disc brakes: Shoes or pads contract and provide compressive frictional force on the outer surface of a rotating Disc. It is a circular metal Disc on which the pads are mounted. Usually it is made up of cast iron material. The design of Disc brakes is varied depending on the application, amount of exposure, thermal properties of the material and the amount of heat dissipation required when brakes are applied and the total mass to be stopped.

Drum brakes: Shoes or lining expand and rub against the inside surface of a rotating drum. Drum is again made up of cast iron material and mounted in the wheel hub in such a manner that the liner pads attach themselves to the inner surface of the drum and during the braking process, the shoe or brake lining expand or move outwards, due to the cam and spring action, to attach themselves to the brake drum which provides friction and causes the drum to retard or stop it's rotating motion. Drums are usually heavier than Disc brakes and occupy significantly more space due the lining and drum it and hence its application in commercial vehicles is somewhat restricted

Pumping brakes: As the name suggests, pumping brakes are used where a pump is already one of the components of equipment or the machinery system. For example, an internal-combustion piston motor can have the fuel supply stopped, and then internal pumping losses of the engine create some braking. Pumping brakes dump energy losses into heat energy. At times, some pumping brakes can act as regenerative brakes that can recharge a pressure reservoir called the hydraulic accumulator.

Electromagnetic brakes: Here, again, as the name goes, Electromagnetic brakes are equipped in systems in which an electric motor is pre-installed. For instance, hybrid gasoline and electrical automobiles use an electrical motor for the purpose of battery charging. This motor is in turn used as a regenerative brake. Electromagnetic brakes or Electro-mechanical brakes, as formerly referred, retard or stop the

Pandya Nakul Amrish
BITS Pilani, UAE, nakul292@gmail.com

motion using electromagnetic force which applies a mechanical resistance or friction.

Material selection

Brakes are of utmost importance in an automobile and safety of the operator and passengers depend directly on the braking system the material for the disc rotors must be chosen appropriately Many materials are widely available in the market like ceramic components, carbon-carbon composites, stainless steels and cast iron components; gray cast iron is apt for rotors because of its strength and thermal properties, high temperature resistance and availability.

Design calculations for disc brake rotor

The brake pedal: The brake pedal exists to multiply the force exerted by the driver's foot. From elementary statics, the force increase will be equal to the driver's applied force multiplied by the lever ratio of the brake pedal assembly:

$$F_{bp} = F_d \times \{L_1 \div L_2\}$$

where,

F_{bp} = the force output of the brake pedal assembly

F_d = the force applied to the pedal pad by the driver = 370 N

L_1 = the distance from the brake pedal arm pivot to the output rod clevis attachment

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Pandya Nakul Amrish
BITS Pilani, UAE, nakul292@gmail.com