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REVIEW OF TRANSIENT THERMAL ANALYSIS OF DOUBLE DISC ROTOR FOR DIFFERENT MATERIALS WITH HYBRID MECHANISM

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ABSTRACT

This paper is presented review of disc brake rotor of different materials with hybrid mechanism, which is showing about on disc brake rotor by analysis of different shapes of slot of various vehicles. Optimization of shapes and slotsare use to estimate good thermal conductivity of the disc brake rotor. In this paper, review about challenges and problems associated with disk brake and characteristics of Thermal analysis on real model of disc brake rotor. It deals with literature survey of transient, thermal analysis of composite disc brake. Various disk brake as well as its materials is also discussed in this paper for review.

KEYWORDS: Thermal Analysis, Disc Brake Rotor,CATIA V5R21 and ANSYS 19R1.

1. INTRODUCTION

In ancient disc brakes began in England in the 1890s.Fredrick William Lanchester, a Birmingham car maker, designed the first Disc brakes in 1902[1]. The first time disc brakes are used in racing was in 1950. In 1965, Ford Thunderbird came with front disc brakes asstandard equipment. In 2005China was manufacturing of brakediscs is migrating predominantly.Typically, there are two types of brake that were implement in today's car, drum brakes and disc brakes. Drum brakes are used on the rear of many rears-wheel- drive, front-wheel-drive, and four-wheel-drive vehicles.Drum brakes were the first types of brakes used on motor vehicles [2].A drum brake is a brake that uses friction caused by a set of shoes or pads that press against a rotating drum shaped part called a brake drum [3].Disc brakes are used due to their optimal heat dissipation features, as recent research has proved that this type of brake disc has elevated heat transference rates.

2. DISK BRAKE: REVIEW

Frictional brakes: Friction brakes are the most commonly employed braking system in special purpose vehicles or commercial. The kinetic energy of the moving vehicle is utilized to stop the vehicle by conversion of this kinetic energy into heat energy/frictional energy. Figure1 (a) is showing more detail.

Disc brakes: Pads or Shoes 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. The design of Disc brakes is varied depending on the amount of exposure, application. It contains the design of a Disc brake rotor, and analyzes results of Structural and Thermal Analysis at a later stage. Figure1 (b) is showing more detail.

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 its 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. Figure1 (c) is showing more detail.

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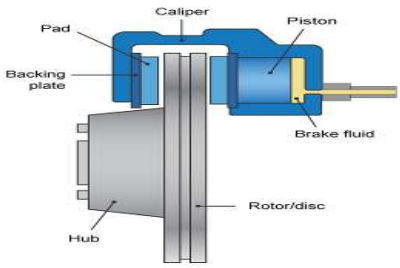

Figure: 1(a) Frictional brake

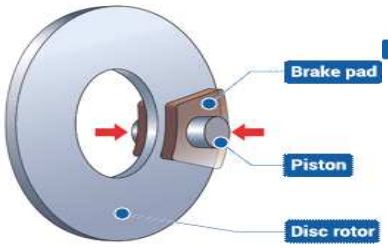

Figure: 1(b) Disc brake

Figure1(c)Drum brake

3. DOUBLE DISK BRAKE ROTOR

Before proceeding with the design of the double disc brake rotor, it is of utmost importance to understand the requirements of brake, following mentioned are a few of them [4]:

• Double disc Brakes must be strong enough to stop the four wheeler vehicle with minimum distance in an emergency or at accident.

• Double disc Brakes must have good characteristics i.e., their effectiveness should not decrease with constant prolonged application.

• They should not have wear properties of vehicle.

• The material should be selected such that it is able to withstand high temperatures and heat.

Materials for Double Disk Brake Rotor

In addition, the lower density of aluminum MMCs gives them an economic advantage over cast iron with respect to efficient use of fuel and fabrication expenses. Based on the properties, potential candidate materials for automotive brake disc were selected as:

- Gray cast iron (GCI)
- Ti-alloy (Ti-6Al-4V)
- 7.5 wt% WC and 7.5 wt% TiC reinforced Ti-composite (TMC)
- 20% SiC reinforced Al-composite (AMC 1)
- 20% SiC reinforced Al-Cu alloy (AMC 2)

CAD Modelling for Double Disk Brake Rotor and Its Consideration

Inoue [7] wrote that, providing a heat input is applied that is identical at all angular positions on the braking face then no distortion or thermal phenomenon occurs that varies around the disc. Coning and radial expansion could be examined this way, even though it may not be strictly correct in practice, because the existence of these phenomena is not dependent on or affected by circumferential variation.

In Importance of cooling: Although convection cooling has an important effect on disc behavior it has been shown that during a single stop, cooling by convection has a minimal effect on disc temperatures. This was extensively investigated by Newcomb [6], who concluded disc surface temperatures reached during a single brake application are little affected by air convection losses from the disc surface.

In Constant hub temperature: The disc is mounted to a large mass of metal initially at ambient temperature and so, assuming good conductive characteristics at the interface, the assumption that the hub of the disc where it contacts the axle remains at the same temperature throughout the test is valid.

In Constant heat input over each time step: It was assumed that because of the disc surface speed being high heat input could be considered even over small intervals of time. Therefore, for each of the time steps in the transient analysis, the heat input is assumed constant. Similarly, during these time steps the heat input around the face of the disc was considered constant.Segment pad loads[8] suggests that disc deflection due to mechanical loading alone is small compared to thermal loading'. Pad loads were not included in the segment model for this reason.

In Constant material properties: Virtually all material properties change with temperature variations. Incorporation of this fact into a finite element solution would require an iterative solution which greatly increases the time taken for the computations. The anisotropic nature of friction material properties has been well documented[9] but

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because thermal effects are not being considered in the pad, the inclusion of them is not necessary. The effect of material changes on the disc is also sufficiently small not to be a significant source of error.

In Friction film: As has already been extensively discussed the detailed heat transfer conditions are not being modelled and constant frictional properties are being assumed, although in practice friction coefficients and behavior varies with both temperature and pressure variations. In the case of this particular friction material values of between 0.35 and 0.55 are possible, depending on the age of the material and the temperature/pressure conditions.

In Constant deceleration: For this simulation a constant deceleration is assumed for two principle reasons. First, it is far simpler to produce a computer model based on constant deceleration and then it is simpler to do dynamometer tests using a constant resisting torque to simulate braking of a moving vehicle.

The friction film mentioned above might also affect the assumption that heat input is proportional to pad surface speed, and therefore vehicle speed, and decreases linearly with time during a constant deceleration.

4. REVIEW FOR MATERIALS

For Double Disk brake rotor, it can be seen that friction coefficient and wear resistance have the highest weighting factors followed by thermal capacity, whereas the least important properties are compressive strength and specific gravity hence, obtained lower weighting factor. It can be seen in figure: 2

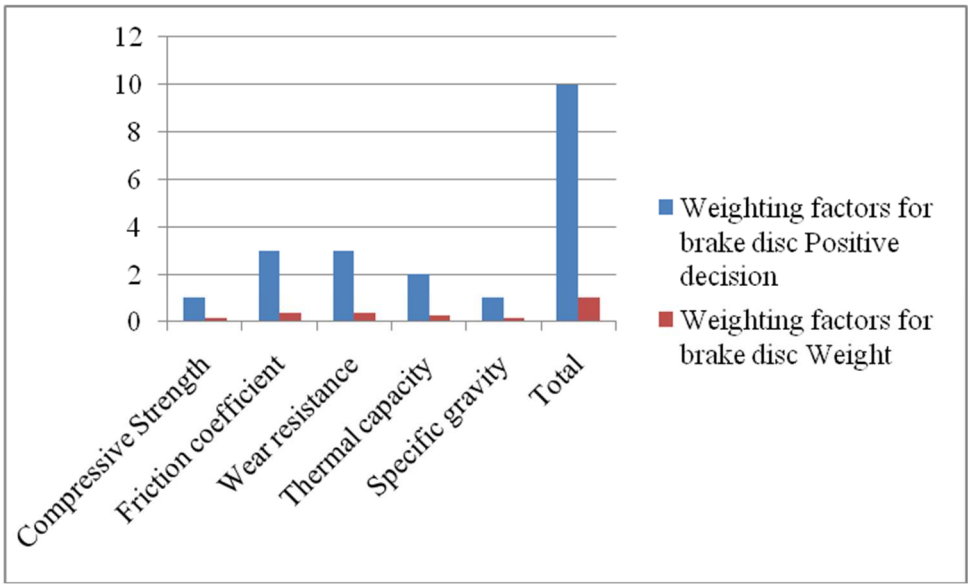

Figure :2 Weighting factors for brake disc

Cast iron is a group of iron-carbon alloys with carbon content greater than 2%.[1] Its usefulness derives from its relatively low melting temperature. Carbon fiber reinforced carbon; carbon–carbon or reinforced carbon–carbon (RCC) is a composite material consisting of carbon fiber reinforcement in a matrix of graphite. Ceramic matrix composites (CMCs) are a subgroup of composite materials as well as a subgroup of ceramics. They consist of ceramic fibers embedded in a ceramic matrix. The matrix and fibers can consist of any ceramic material, whereby carbon and carbon fibers can also be considered a ceramic material. It can be seen in figure: 3

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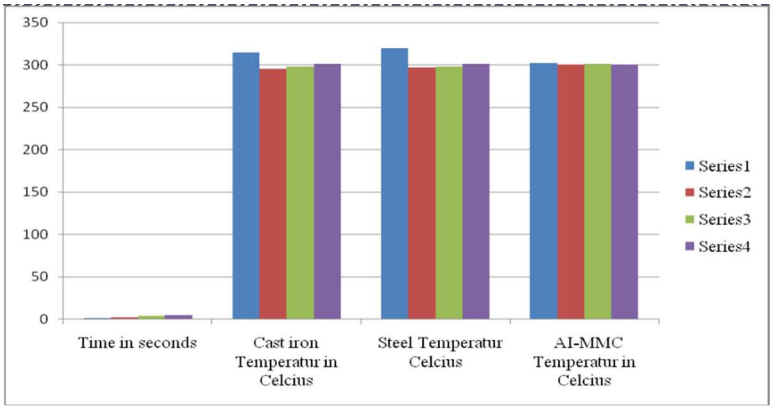

Figure :2 Transient state temperature distributions for materials

5. PROBLEM IDENTIFICATION AND CHALLENGES

The main problems and challenges for selection of materials for brake disc as well as thermal and design analysis to prepare best brake disc. In braking when temperature is increased therefore it become too high, deterioration in braking may result, and in utmostconditions complete failure of the braking system can exist. Brake fade is a temporary loss of braking that exists as a result of very high temperatures in the friction material. High temperatures in the braking system can form thermal deformation of the rotors leading to spotty braking, accelerated wear and premature replacement [10]. A vapor lock will then form in the hydraulic circuit, and as gas is more compressible than liquid the pedal stroke is used to compress this gas without actuating the brakes. The rise in temperature of the brake disc in any braking operation will depend on a number of factors including the mass of the vehicle, the rate of retardation, and the duration of the braking event. In this paper i try to overcome above problems and challenges as per review via literature.

6. CONCLUSION

The main problems and challenges for selection of materials for brake disc as well as thermal and design analysis to prepare best brake disc. Disc design will never be a rigidly defined procedure, the judgment and experience of the designer are naturally crucial but it is necessary to found judgments on sound bases In this case there appears to be a more favorable disc response with the proposed disc design as per literature survey and review about transient thermal analysis of double disk rotor for different materials with hybrid mechanism. The main advantages are for review to overcome challenges and problems which is associated with transient thermal analysis of double disk rotor for different materials with hybrid mechanism. Total twenty research papers are studied for review and write this paper and proposed for software simulation with CATIA V5R21 and ANSYS 19R1, so that the component having such a fundamental effect on the safety, performance and ride quality of the vehicle will improve by using double disk rotor for different materials with hybrid mechanism

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AUTHOR PROFILE: Mr .Krishnapal Singh is completed graduation from Mechanical Engineering and start working in area of vehicles and his interested area of research thermal engineering. He is pursing M.Tech in Thermal Engineering and as a research scholar he is doing his research work in area of Transient thermal analysis of double disk rotor brake for different materials with hybrid mechanism.