ANALYSIS OF VENTILATED DISC BRAKE THROUGH SOFTWARE

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***ABSTRACT*:**In today's developing automobile sector, there is drastic change in the technology from transmission system to braking system. The braking system is considered as one of the most important system from performance as well as safety point of view. When the brakes are applied to the moving vehicle, all the kinetic energy of the vehicle gets converted into equivalent amount of heat generation. The brake disc has an inherent ability that there is no change of co-efficient of friction on the disc so there is no problem of brake fading phenomenon. Disc brake is the recent trend in automobile vehicles which dissipates the heat faster than the conventional drum brakes. but if hard braking is done, there is induction of thermal stresses in the brake disc which leads to generation of excessive temperature .If this heat is not dissipated properly, then distortion will be get produced in the disc which leads to thermal cracking of the disc leading to disc failure. The main advantage of disc brake is that only a small portion of the disc is in contact with the friction material i.e. the caliper. Hence there is large surface area of the disc which can dissipate the heat to the atmosphere. Specifically the heat dissipated to the atmosphere is the forced convection mode. The aim of this research work is to choose best profile and best material which can dissipate maximum amount of heat to the surrounding. The models of disc are created in Creo parametric 2.0 while the analysis is conducted in ANSYS 15.0.the analysis performed in ANSYS is steady state thermal.

Keywords: Disc brake, Stainless steel, Cast iron, Profile, Heat Flux

I. INTRODUCTION

Braking is a process of converting kinetic Energy of the moving object into heat energy. It is done by the producing friction to stop or slow down the moving object in case of automobiles. The heat produced is stored and later conduct into the air. But during hard braking and routine braking increase its thermal stress, hence this frictional heat stored in the disc would cause excessive amount temperature. lead to most undesirable effects such as premature wear, elastic instability and brake vibrations. In order to minimize this ventilated disc is used to maximize the heat dissipation. [5]

It is obliged to stop or ease off the vehicle in the briefest conceivable separation when needed to do so. Braking of a vehicle relies on the static function that demonstration in the middle of tires and street surface. Brakes take a shot at the following standard to stop the vehicle: "The kinetic energy because of movement of the vehicle is scattered as heat energy because of contact between moving parts (wheel or wheel drum) and stationary parts of the vehicle (brake shoes)". The heat energy so produced because of use of the brakes is dispersed into the air. Brakes work most successfully when they are connected in a way so the wheels don't bolt totally, yet keep on moving without slipping on the surface of the street. The whole time, the brakes take in either kinetic energy of the moving part or the potential energy surrendered by articles being brought down by lifts, and so on. The energy absorbed by the brakes is scattered as heat. This heat is dispersed into the encompassing air to stop the vehicle, so the slowing mechanism ought to have the following prerequisites:

The brakes are solid enough to stop the vehicle inside a base Distance.

1. The driver brought to have fitting control over the vehicle amid braking, not to slip.
2. The brakes must have great against blur aspects.

The brakes brought to have great against wear properties. In light of mode of operation brakes are named after: Hydraulic brakes, Electric brakes Mechanical brakes. The mechanical brakes are subdivided as per the bearing of acting energy may be the following two assemblies: Radial brakes: The force on the brake drum is in the outspread heading. The outspread brake may be subdivided into outer brakes and inside brakes. [6] The disc brake is a wheel brake which slows rotation of the wheel by the friction caused by pushing brake pads against a brake disc with a set of calipers. The brake disc (or rotor in American English) is usually made of cast iron, but may in some cases be made of composites such as reinforced carbon–carbon or ceramic matrix composites. This is connected to the wheel and/or the axle. To stop the wheel, friction material in the form of brake pads, mounted on a device called a brake caliper, is forced mechanically, hydraulically, pneumatically or electromagnetically against both sides of the disc. Friction causes the disc and attached wheel to slow or stop. Brakes convert motion to heat, and if the brakes get too hot, they become less effective, a phenomenon known as brake fade. Disc-style brakes development and use began in England in the 1890s. The first caliper-type automobile disc brake was patented by Frederick William Lanchester in his Birmingham, UK factory in 1902 and used successfully on Lanchester cars. Compared to drum brakes, disc brakes offer better stopping performance, because the disc is more readily cooled. As a consequence discs are less prone to the "brake fade"; and disc brakes recover more quickly from immersion (wet brakes are less effective). Most drum brake designs have at least one leading shoe, which gives a servo-effect. By contrast, a disc brake has no self-servo effect and its braking force is always proportional to the pressure placed on the brake pad by the braking system via any brake servo, braking pedal or lever, this tends to give the driver better "feel" to avoid impending lockup. To achieve proper cooling of the disc and the pad by convection, study of the heat transport phenomenon between disc, pad and the air medium is necessary. Then it is important to analyze the thermal performance of the disc brake system to predict the increase in temperature during braking. Convective heat transfer model has been developed to analyze the cooling performance. Brake discs are provided with cuts to increase the area coming in contact with air and improve heat transfer from disc. This is because large area is exposed to air which makes more heat transfer through conduction and convection. But increase in number and size of cuts decreases the strength of disc.

II. OBJECTIVE

1) To suggest best material which can give more life & more heat dissipation
2) To suggest best profile which dissipate more amount of heat to the atmosphere
3) To analyze the thermal behavior of the material using Ansys 15.0.
4) To compare the material for disc brake and checking for low thermal gradient.
5) To analyze the temperature distribution of rotor disc during the operation using Ansys 15.0.

III. RESULT & DISCUSSION

3.1. Contour Diagrams for Profile I:

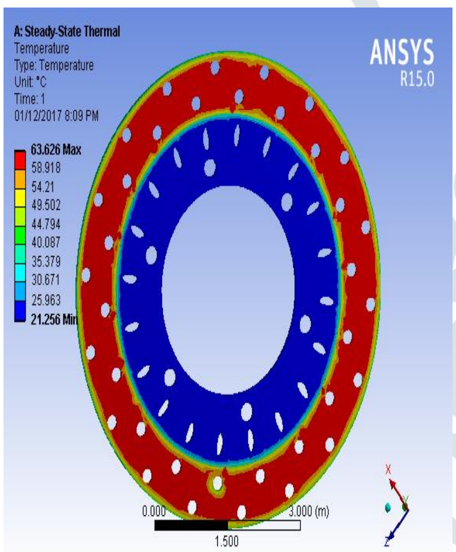


Figure 1 temperature for profile i stainless steel

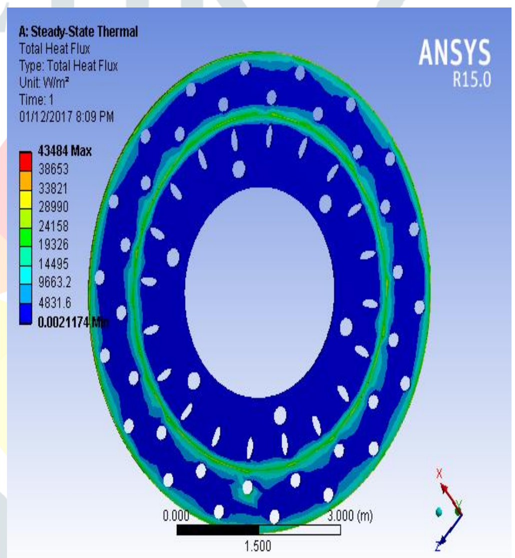


Figure 2 total heat flux for profile i stainless steel.

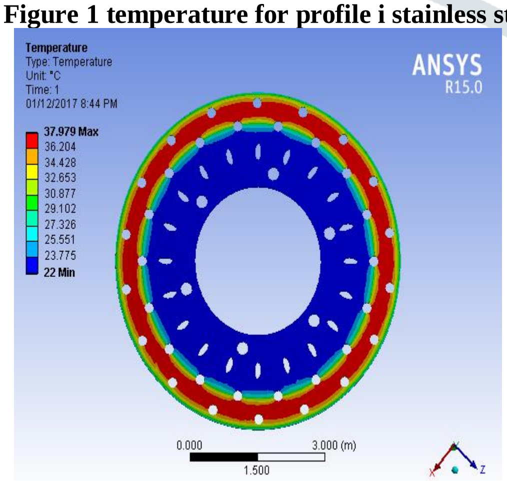


Figure 3 temperature for profile i cast iron.

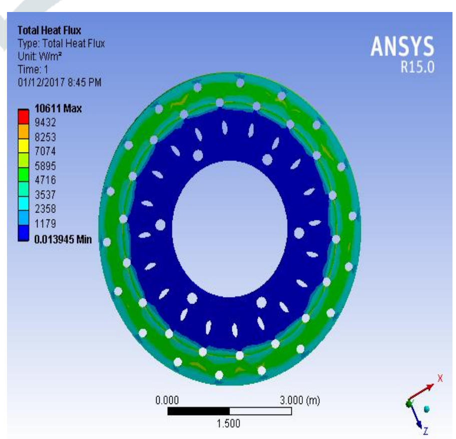
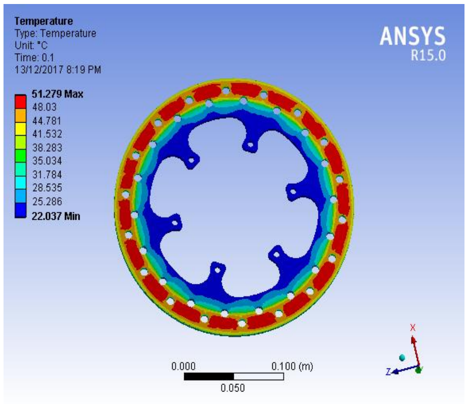


Figure 4 total heat flux for profile i cast iron.

3.2. Contour Diagrams for Profile II:



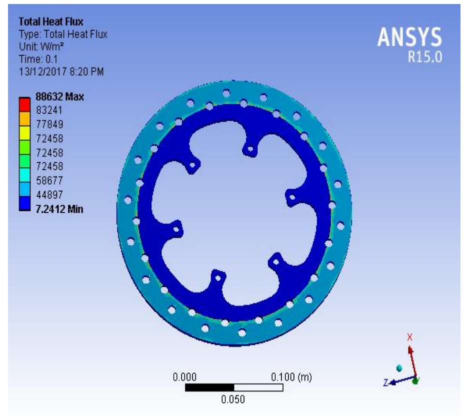
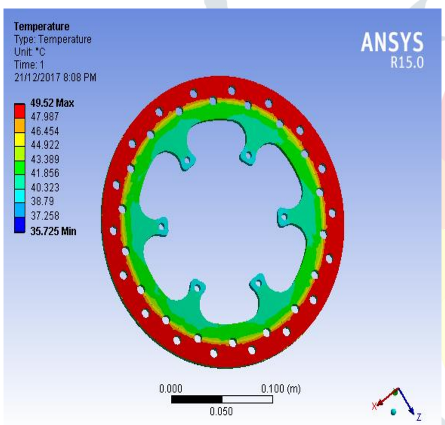


Figure 5 temperature distribution for profile ii stainless steel. **Figure 6 total heat flux for profile ii stainless steel.**



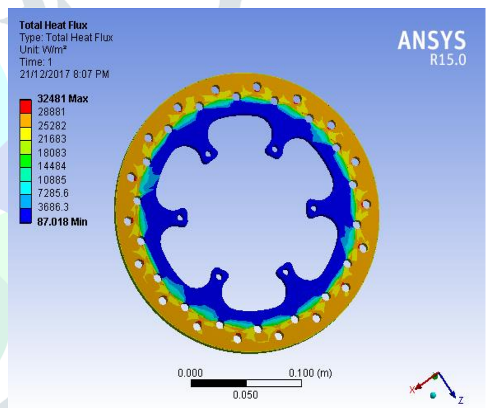


Figure7 temperature distribution for profile ii cast iron. **Figure 8 total heat flux for profile ii cast iron.**

Influence of Profile:

When disc has no. of holes i.e. Spacing between the holes is less, the air entrap between the disc & caliper occupied vented holes of disc. Thus reducing back pressure which in term of results into braking action effectively. If we observe that maximum values of total heat flux in tabular form, we can easily understand that the profile having maximum value is selected for further production. The value obtained from heat flux distribution diagram are tabulated as follows

Material	Profile	Total Heat Flux
Stainless steel	Profile I	43484
	Profile II	88632
Cast Iron	Profile I	10611
	Profile II	32481

From the data mentioned above, we can suggest two profiles i.e. Profile II made of stainless steel & profile II made up of cast iron.

If Cast iron is used for design purpose, we get less temperature difference but the drawback of cast iron is that it get corroded very easily when it comes in contact with water. Hence the profile will be best for summer & winter but will fail during rainy season.

The Second suggested profile is Profile II made up of stainless steel gives more value of total heat flux which is being dissipated to the atmosphere. Also the main advantage of the stainless steel is that there is no effect of atmospheric conditions on the material. In other words, the performance of the profile made up of stainless steel gives better performance irrespective of the climatic change.

The Mathematical is also done & the obtained values are tabulated as shown in table below.

Table 1.1 mathematical analysis of temperature

Profile	ANSYS Temp	Actual Temp during Mathematical	% error
SS Profile I	63.28	60.24	4.804
SS Profile II	51.23	47.68	6.9295
CI Profile I	37.97	35.8	5.715
CI Profile II	49.52	46.78	5.5331

IV. CONCLUSION

1] The material is compared & it is found that the stainless steel gives more life & has maximum heat dissipating capacity.

2] The the material as well as profile compare and maximum heat dissipating profile has been found as profile II made of stainless steel.

3] The thermal behavior of the material is analyzed by Ansys.

4] Cast iron may be suggested but it has tendency it get corroded in rainy season since this material cannot be used for disc manufacturing.

5] S.S. & C.I. temperature distribution has been analyzed.

6] Also the mathematical analysis ("Design and thermo-structural analysis of disc brake" by M. Sasikumar) has been performed to compare the temperature.

V. FUTURE SCOPE

Like Stainless steel used for disc manufacturing, the future scope for this dissertation work is that the use of fibers reinforced metal matrix composite can be tested for better performance & better Disc life with addition of additional materials as reinforcement.

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