DESIGN AND ANALYSIS OF DISC BRAKE ROTOR OF CAR

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Abstract:The disc brake uses callipers to squeeze pairs of pads against a disc or "rotor" to create friction. A brake disc usually made of cast iron or ceramic composites(as well as Kevlar, carbon and silica), is coupled to the wheel or the axle. To stop the wheel, resistance material in the form of brake pads is forced hydraulically, pneumatically, mechanically or electromagneticallyagainst both sides of the disc. Repetitive braking of the vehicle leads to heat generation during each braking event. Transient Thermal Analysis of the Rotor Disc of Disk Brake is aimed at evaluating the performance of disc brake rotor of a car under braking conditions and there by assist in disc rotor design and analysis.

Index Terms-Braking system, design of disc brake, Thermal analysis.

I. Introduction:

In the present developing car advertise the opposition for better execution vehicle is developing massively. The circle brake is a gadget utilized for abating or ceasing the pivot of the wheel. A brake is generally made of solid metal or artistic composites incorporate carbon, aluminum, Kevlar and silica which is associated with the haggle, to stop the vehicle. A grating material delivered as brake cushions is constrained mechanically, using pressurized water, pneumatically and electromagnetically against the both side of the circle. This contact makes the plate and connected wheel ease back or to stop the vehicle. The strategies utilized as a part of the vehicle are regenerative stopping mechanism and grinding slowing mechanism. A rubbing brake creates the frictional power in at least two surfaces rub against to each other, to lessen the development. In view of the outline arrangements vehicle rubbing brakes are assembled into circle brakes and drum brakes. Our venture is about circle brakes demonstrating and investigation. Dreary braking of a vehicle creates expansive measure of warmth. This warmth must be scattered for better execution of brake. High temperature may cause warm splits, brake blur, wear and diminishment in coefficient of grating. Amid braking, the dynamic and potential energies of a moving vehicle get changed over into warm vitality through grating in the brakes. The warmth created between the brake cushion and circle must be scattered by disregarding air them. This warmth exchange happens by conduction, convection and fairly by radiation. To accomplish appropriate cooling of the circle and the cushion by convection, investigation of the warmth transport wonder between plate, cushion and the air medium is important. At that point it is imperative to dissect the warm execution of the circle stopping mechanism to anticipate the expansion in temperature amid braking. Convective warmth exchange show has been created to investigate the cooling execution. Brake plates are given slices to expand the region interacting with air and enhance warm exchange from circle. Warmth exchange rate increments with number of cuts in the plate.

II. Braking system:

A brake is a gadget by methods for which counterfeit frictional protection is connected to moving machine part, with a specific end goal to stop the movement of a machine. During the time spent playing out this capacity, the brakes retain either active vitality of the moving part or the potential vitality surrendered by objects being brought down by lifts, lifts and so forth. The vitality consumed by brakes is scattered as warmth. This warmth is scattered in to the encompassing climate to stop the vehicle.

2.1 Classification of brakes:

- Radial Brake
- Axial Brake

i Disc brake
iiCone brake

III. Materials used and its properties:

- **Titanium**

  Titanium is recognised for its high strength to weight ratio. It is a strong metal with low density that is quite ductile lustrous and metallic white in colour. The relatively high melting point makes it useful as a refractory material. It is paramagnetic and has fairly low electrical and thermal conductivity.

- **Cast Iron**

  Cast iron is very cheap to produce and produces very good friction coefficients but it is also fragile, it is not compatible with many modern pad materials, particularly sintered pads, it is heavy and of course it rusts. Grey cast iron discs can shatter and ductile cast iron is fragile, very fickle with pads and in our experience can warp very easily.

- **AlSiC-9**

  AlSiC-9, containing 37 vol.% of A 356.2 aluminium alloy and 63 vol.% silicon carbide. Its thermal conductivity is 190–200 W/m K. Its thermal expansion roughly matches gallium arsenide, silicon, indium phosphide, alumina, aluminium nitride, silicon nitride, and Direct Bonded Copper aluminium nitride. It is also compatible with some low temperature co-fired ceramics, e.g. Ferro A6M and A6S, Heraeus CT 2000, and Kyocera GL560. Its density at 25 °C is 3.01 g/cm^3.

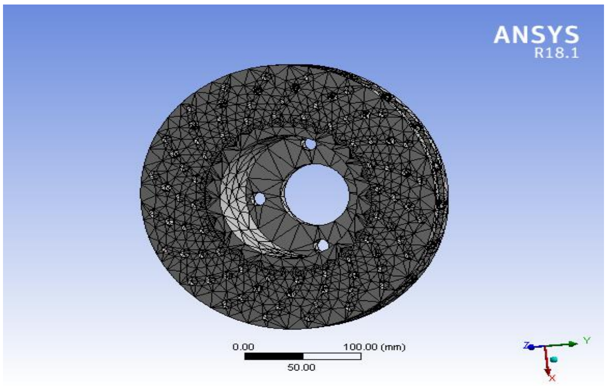
IV. Literature review:

Gao and Lin (2002) presented Transient temperature field analysis of a brake in a non-axisymmetric three-dimensional model [1]. The disk-pad brake used in an automobile is divided into two parts: the disk, geometrically axisymmetric; and the pad, of which the geometry is three-dimensional. Using a two-dimensional model for thermal analysis implies that the contact conditions and frictional heat flux transfer are independent of y. This may lead to false thermal elastic distortions and unrealistic contact conditions. An analytical model is presented in this paper for the determination of the contact temperature distribution on the working surface of a brake. To consider the effects of the moving heat source (the pad) with relative sliding speed variation, a transient finite element technique is used to characterize the temperature fields of the solid rotor with appropriate thermal boundary conditions. Numerical results shows that the operating characteristics of the brake exert an essentially influence on the surface temperature distribution and the maximal contact temperature.

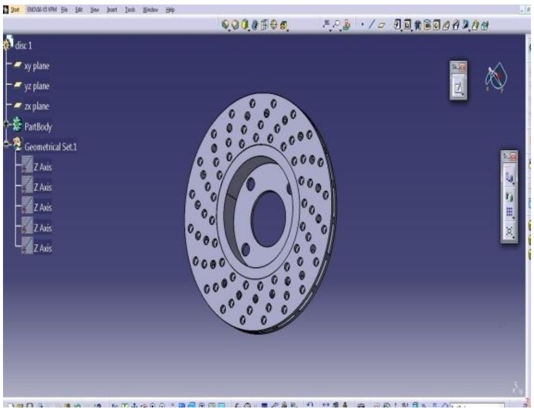
Voller, et al.(2003) perform an Analysis of automotive disc brake cooling characteristics [2]. The aim of this investigation was to study automotive disc brake cooling characteristics experimentally using a specially developed spin rig and Singh and Shergill 85 numerically using finite element (FE) and computational fluid dynamics (CFD) methods. All three modes of heat transfer (conduction, convection and radiation) have been analyzed along with the design features of the brake assembly and their interfaces. The influence of brake cooling parameters on the disc temperature has been investigated by FE modelling of a long drag brake application. The thermal power dissipated during the drag brake application has been analyzed to reveal the contribution of each mode of heat transfer.

Choi and Lee, (2004) presented a paper on Finite element analysis of transient thermo elasticbehaviours in disk brakes [3]. A transient analysis for thermo elastic contact problem of disk brakes with frictional heat generation is performed using the finite element method. To analyse the thermo elastic phenomenon occurring in disk brakes, the coupled heat conduction and elastic equations are solved with contact problems. The numerical simulation for the thermo elasticbehaviour of disk brake is obtained in the repeated brake condition. The computational results are presented for the distributions of pressure and temperature on each friction surface between the contacting bodies.

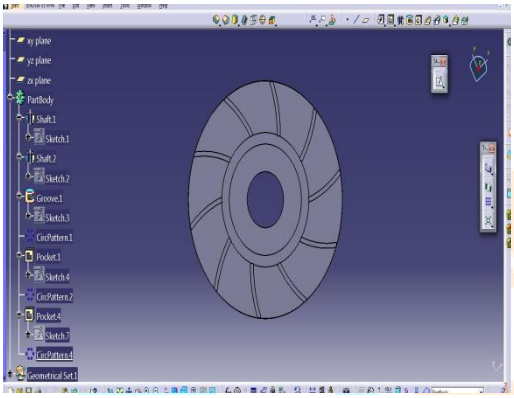
V.Design of disc brakes:



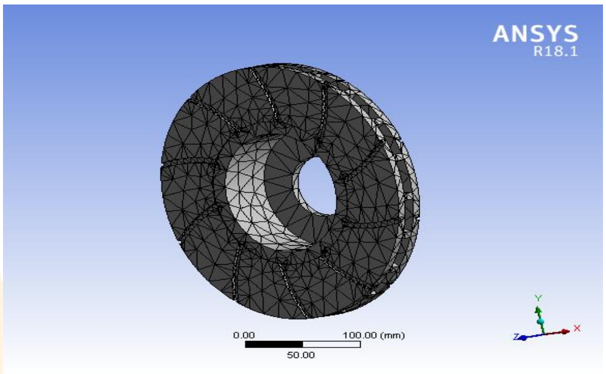
Profile(a)(i)



Profile(a)(ii)



Profile(b)(i)



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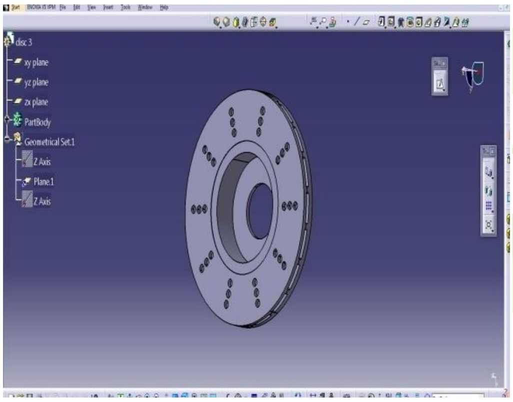
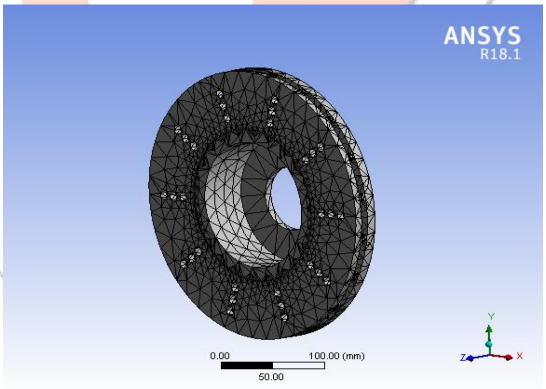


Profile(c)(i)



Profile(c)(ii)

VI.Thermal Analysis.

Warm examination is characterized as a gathering of techniques in light of the assurance of changes in concoction or physical properties of material as a component of temperature in a controlled air. Warm examination is a decent expository instrument to quantify.

VII. Finite Element Analysis:

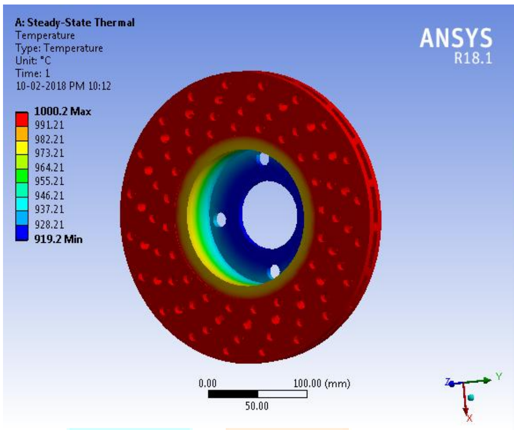
The limited component technique is an intense instrument to acquire the numerical arrangement of extensive variety of designing issue. The technique is sufficiently general to deal with any mind boggling shape or geometry, for any material under various limit and stacking conditions. The all inclusive statement of the limited component technique fits the investigation necessity of the present complex building frameworks and plans where shut shape arrangements of representing balance conditions are typically not accessible. What's more, it is an effective plan apparatus by which fashioners can perform parametric outline thinks about by considering different plan cases, (distinctive shapes, materials, loads, and so forth.) and investigate them to pick the ideal outline.

VII. Ansys:

It also supports a process-centric approach to design and manufacturing, enabling the clients to stay away from costly and tedious "fabricated and break" cycles. ANSYS examination and recreation apparatuses give clients usability, information similarity, multi-stage bolster and coupled field multi-material science abilities.

VIII. Analysed results of disc brake:

A)Thermal analysis of disc brake



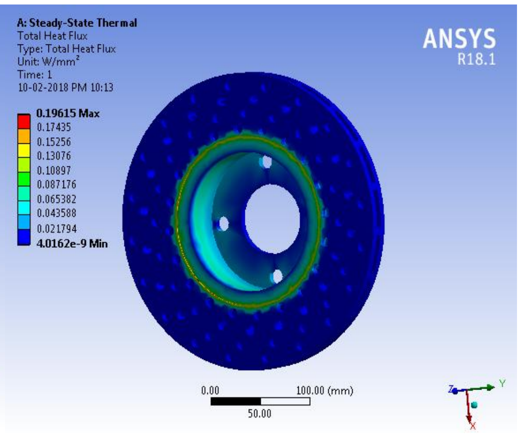
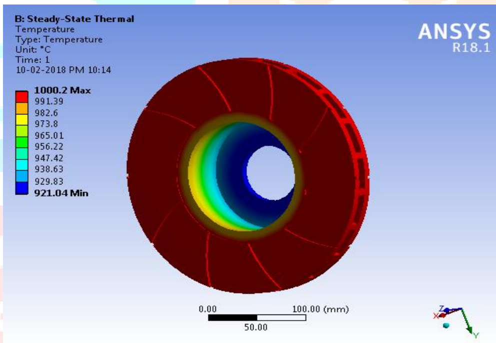


Fig1. Cast iron (Temperature) Fig2. Cast iron (Heat flux)



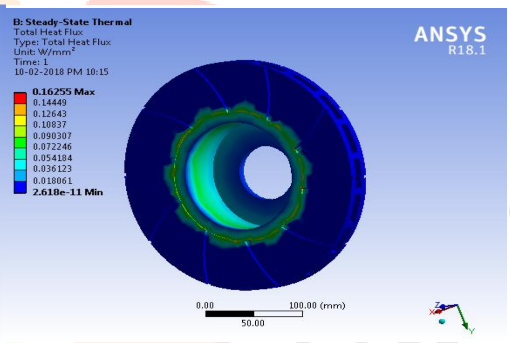
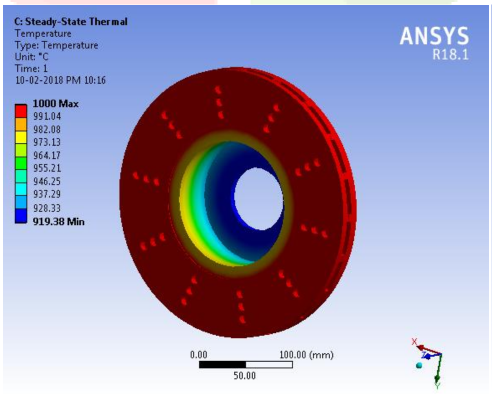


Fig3.Cast iron (Temperature) Fig4.Cast iron (Heat flux)



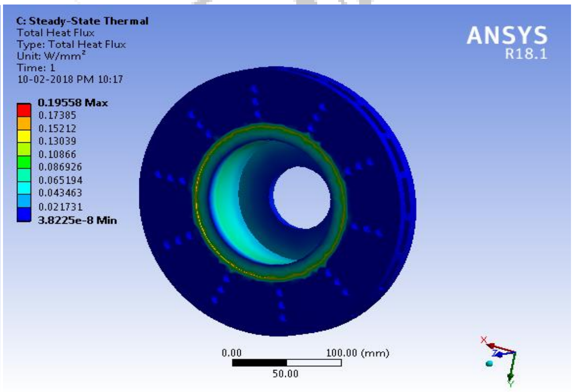


Fig5.Cast iron (Temperature) Fig6.Cast iron (Heat flux)

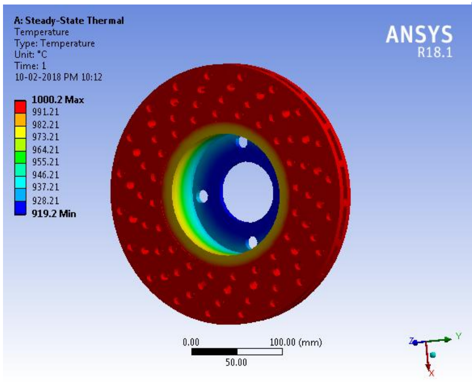


Fig7. AlSic-9(Temperature)

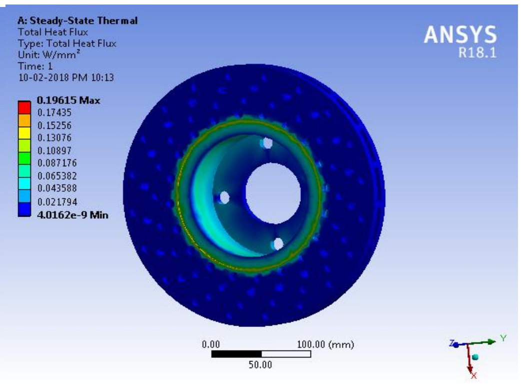


Fig8. AlSic-9(Heat flux)

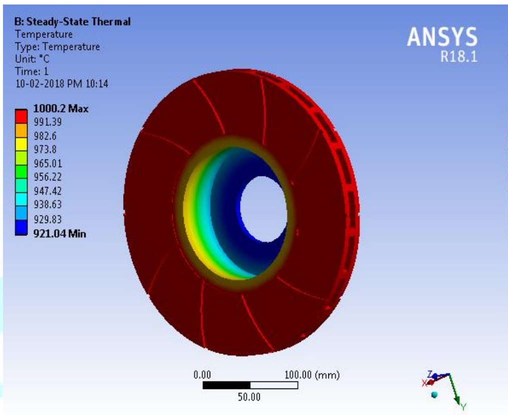


Fig9. AlSic-9(Temperature)

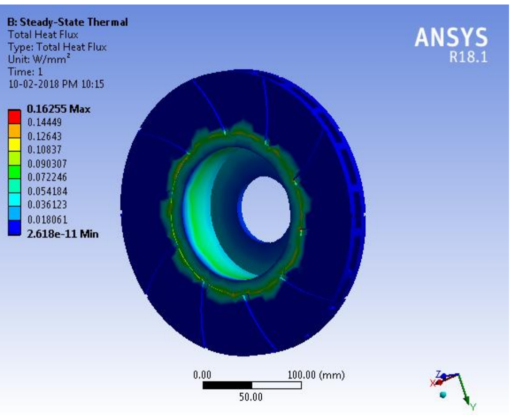


Fig10. AlSic-9(Heat flux)

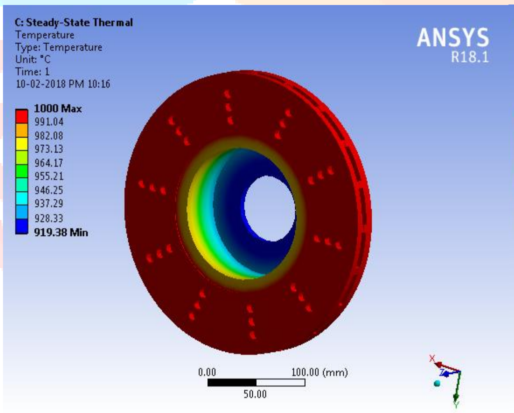


Fig11. AlSic-9(Temperature)

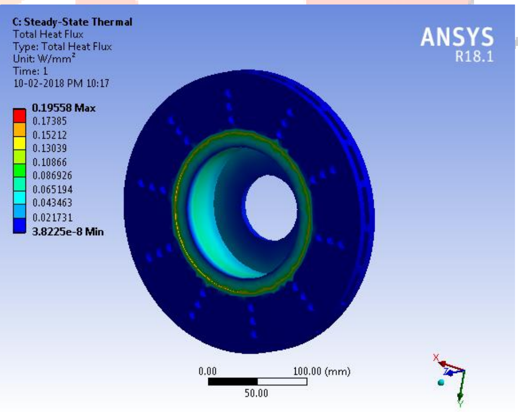


Fig12. AlSic-9(Heat flux)

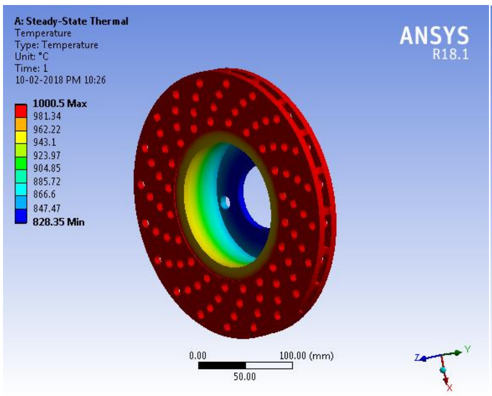


Fig13.Titanium (Temperature)

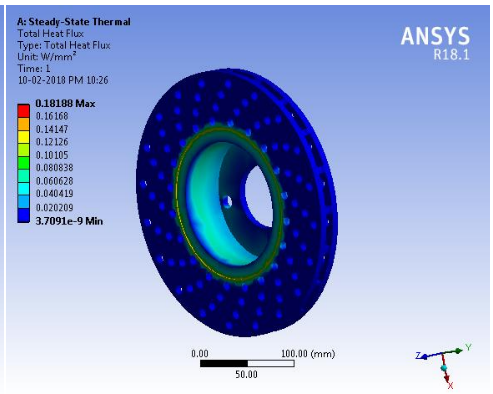


Fig14.Titanium (Heat flux)

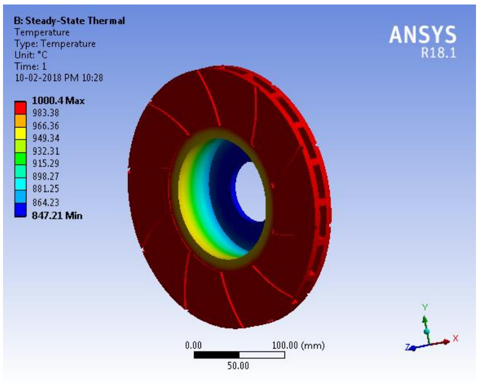


Fig15.Titanium (Temperature)

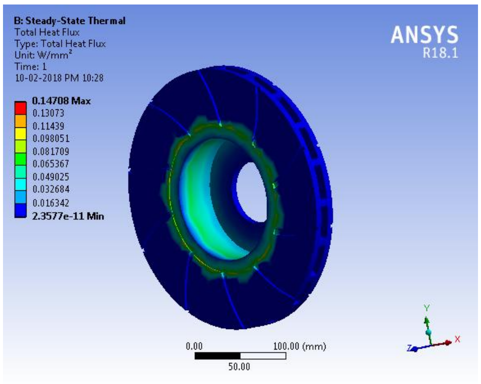


Fig16.Titanium (Heat flux)

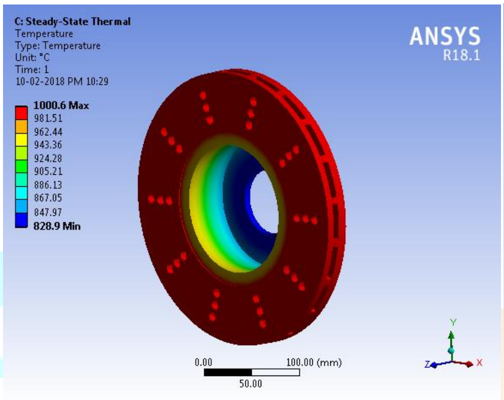


Fig17.Titanium (Temperature)

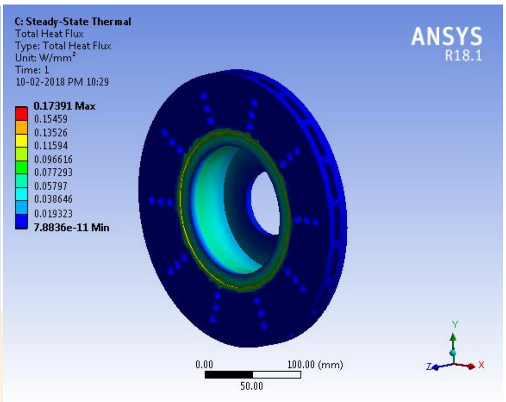


Fig18.Titanium (Heat flux)

RESULT:

TEMPERATURE

PROFILE	CAST IRON (c)	TITANIUM (c)	AlSic-9 (c)
1	919.2	828.33	**976.98**
2	921.04	847.21	977.53
3	919.38	828.9	977.01

TOTAL HEAT FLUX

PROFILE	CAST IRON (w/mm2)	TITANIUM (w/mm2)	AlSic-9 (w/mm2)
1	0.19615	0.18188	**0.20519**
2	0.16255	0.14708	0.16979
3	0.19558	0.17391	0.19666

CONCLUSION:

In this paper the circle brake and the outline has been done in the CATIA V20 and we have dissected the plate brake with different profiles and furthermore with various materials along these lines through the investigation made we found that titanium amalgam andAlSic-9are observed to be more appropriate with the end goal of warmth dissemination however titanium is observed to be costlier and henceforth it is troublesome for assembling in a mass and subsequently we recommend that the AlSic-9can be utilized as a reasonable material for the assembling of plate brakes later on as it lighter in weight,as well as have great warmth dispersal properties and furthermore cost productive when contrasted and titanium composite.

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