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THERMO-MECHANICAL ANALYSIS OF DISK BRAKE'S ROTOR PLATE FOR DIFFERENT MATERIALS

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ABSTRACT

This paper present the study of thermal and mechanical effects induced in a disk break during a working process using ansys. The performance and service life of rotor disk mainly depend on the material which used in the manufacturing of disk. For the better performance and to increase the service life of rotor disk of disk break various materials can be used. In this study the analysis is done on various material used for disk brake. The aim of this analysis is to evaluate the dependence of rotor disk on material properties. The transient structure and thermal analysis have been done using ansys.

Keywords:*Ansys analysis, Disk Break, materials analysis for disk rotor.*

I. INTRODUCTION

Breaking is process of slowing down the speed of a vehicle by means of break. Every component is developed to make human life more secure and safe [1]. It is essential to have proper breaking system to make a wheel safe [1]. Disk brakes are now widely used in automobile industries. It retards the speed by means of brake pads which is forced against a rotor. The pads can be pushed hydraulically, mechanically or by other way. When two surface of disk break forcedagainst each other the rotation of wheel retard automatically. Disk brakes mainly consists brake pads, brake pedal, rotor, master cylinder and caliper. This study is about the thermal and structural effects induced in various materials that used for disk brake rotor disk.

II. MATERIALS AND PROPERTIES

Analysis is done by taking four materials. The properties of materials are as follow:

Table 1. Materials properties

Property	Cast iron	Aluminum	Alsic-10	Stainless steel
Density (kg/m^3)	7300	2700	2960	7100
Young's modulus (pa)	200e9	69e9	167e9	210e9
Poisons ration	0.30	0.33	0.251	0.3
Thermal conductivity (W/m °c)	16	155	190	110
Specific heat	460	960	786	320

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III. MODELING OF ROTOR DISK

The thermo-mechanical analysis of rotor disk is carried by using FEM code ansys. First of all modeling is done in ansys workbench as shown in fig.

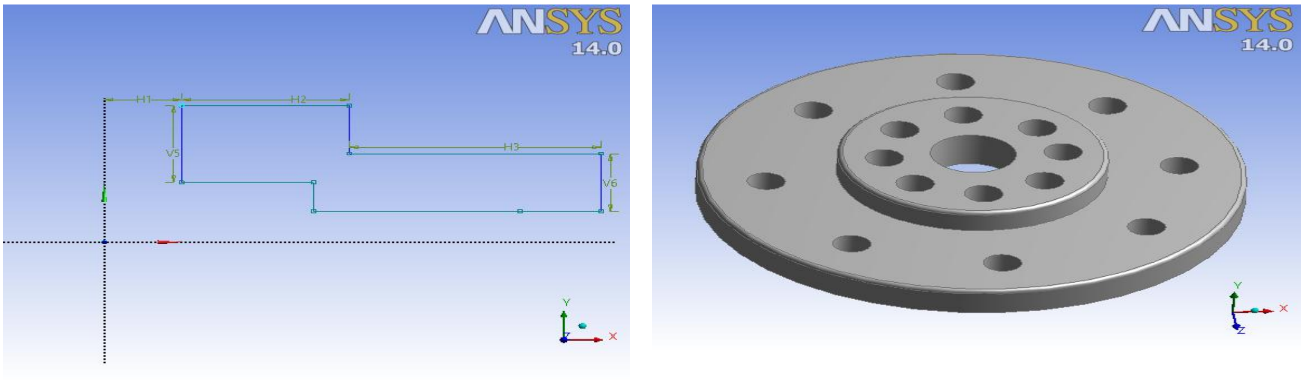

Fig. 1(a) Dimension for rotor disk, (b) Modal of rotor disk

Table 2. Specifications of rotor disk

H1	24mm
H2	52mm
H3	78mm
V5	32mm
V6	2mm

IV. MESHING

After the modeling the meshing of modalhas been done:

Table 3. Meshing Properties

Sizing	
Use Advanced Size Function	Off
Relevance Center	Fine
Element Size	Default
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Fast
Span Angle Center	Coarse
Minimum Edge Length	6.7274e-002 m
Statistics	
Nodes	24872
Elements	13769
Mesh Metric	None

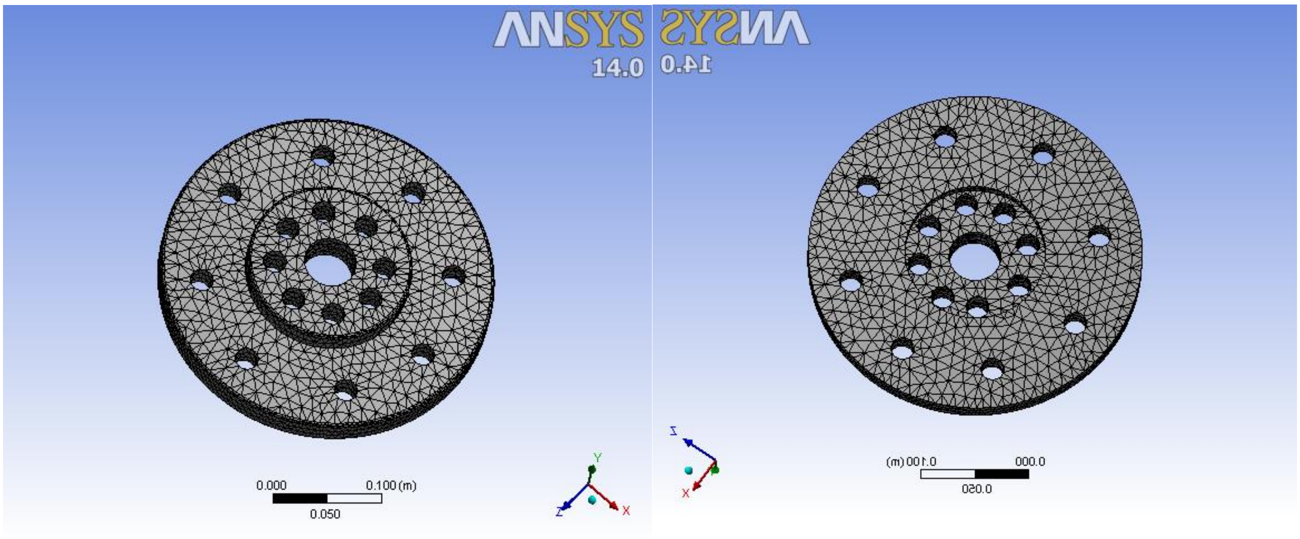

Fig. 2. Meshing of modal

Fine meshing of modal is created to get much accurate results. Total number of elements is 13769 and number of nodes is 24872. After meshing, boundary condition is applied.

V. BOUNDARY CONDITION

After the meshing of modal structure and thermal boundary conditions were applied to the modal. The fixed boundary condition applied to the hub and the rotational velocity of rotor is given 30 rad/s. the convection boundary condition is also applied as shown in figure.

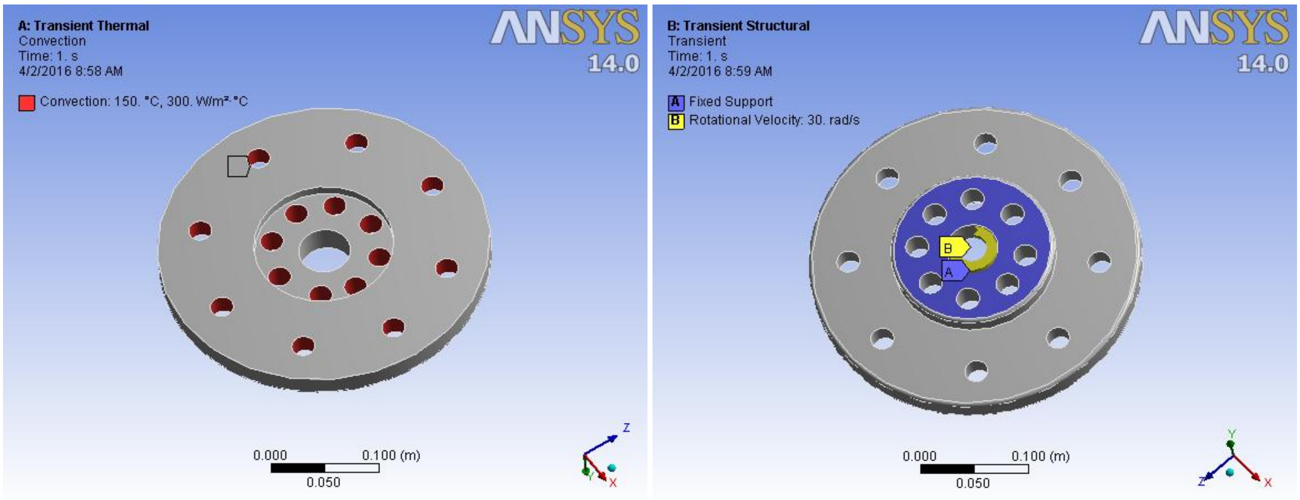

Fig. 3. Thermal and structural boundary condition

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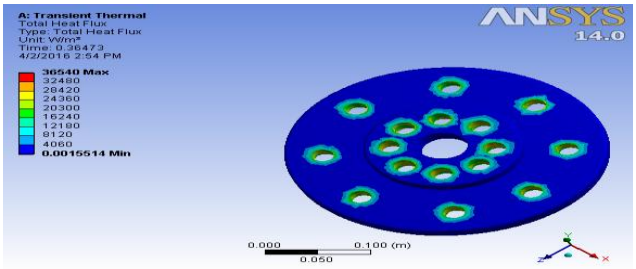
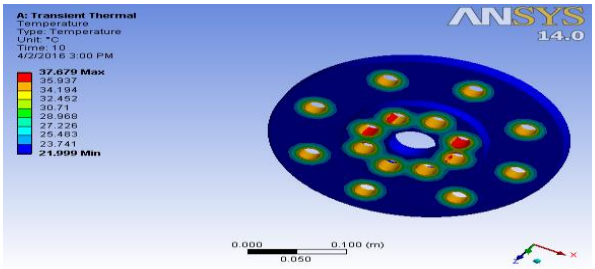
VI. RESULTS

6.1 Results of cast iron rotor

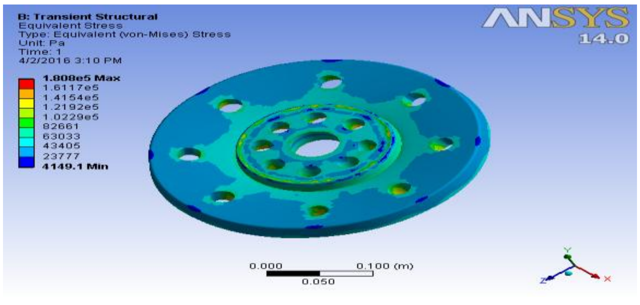


(a)

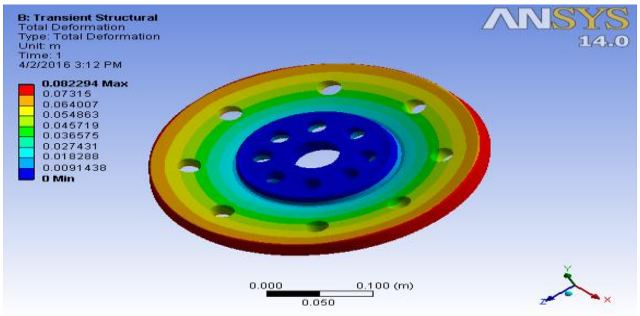


(b)

1. Fig 4(a) Heat flux distribution, (b) Temperature distribution

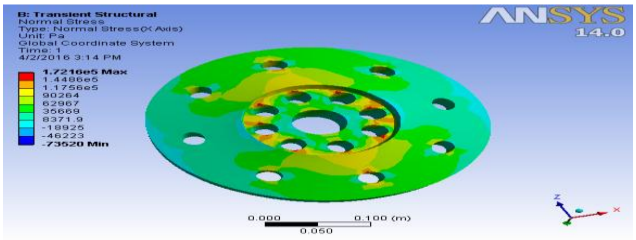


(c)

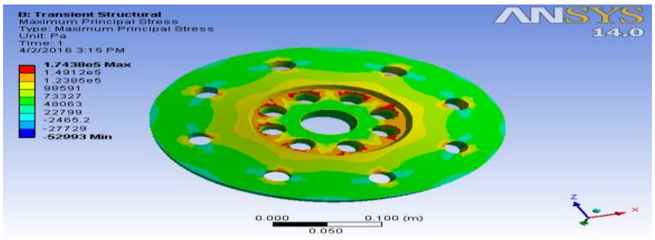


(d)

Fig. 4(c) Von-mises stress, (d) Total deformation



(e)



(F)

Fig. 4(e) Normal stress distribution, (f) Maximum principal stress

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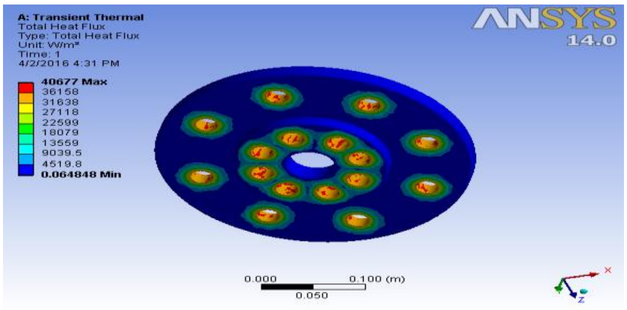
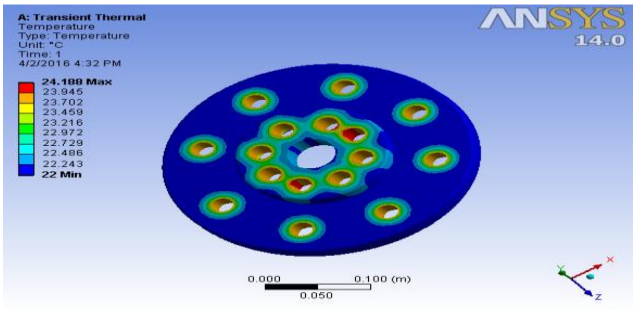
6.2. Results of stainless steel rotor

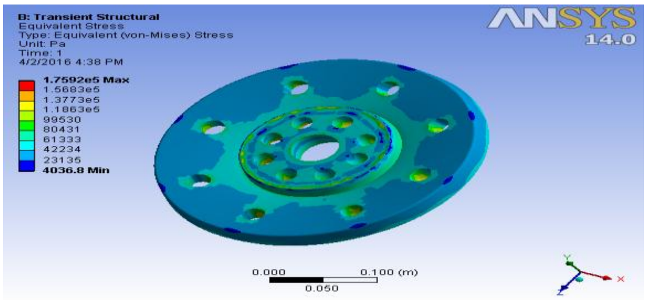


(a)

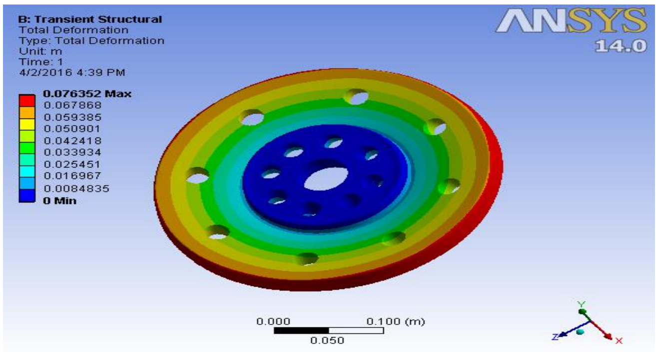


(b)

Fig. 5(a) Total heat flux, (b) Temperature distribution

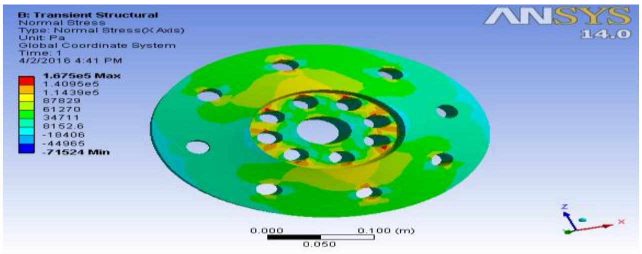


(c)

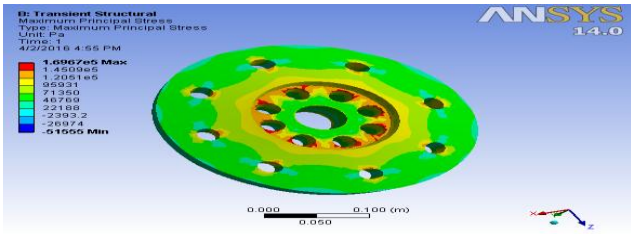


(d)

Fig. 5(c) Von-mises stress, (d) Total deformation



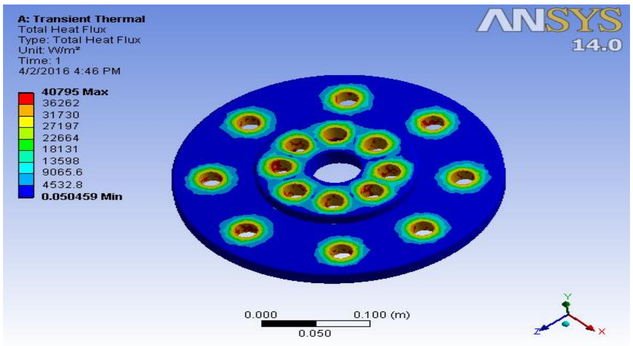
(e)



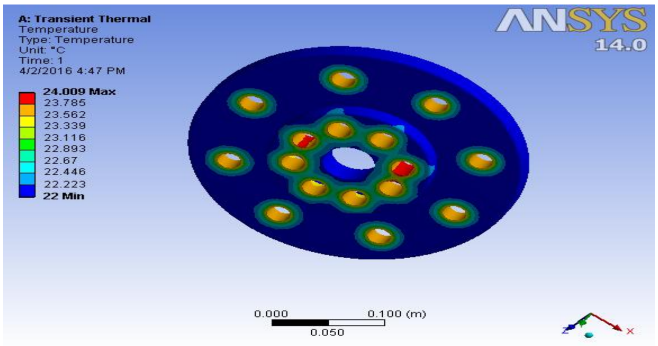
(f)

Fig. 5(e) Normal stress distribution, (f) Maximum principal stress

6.3. Result of aluminum rotor disk

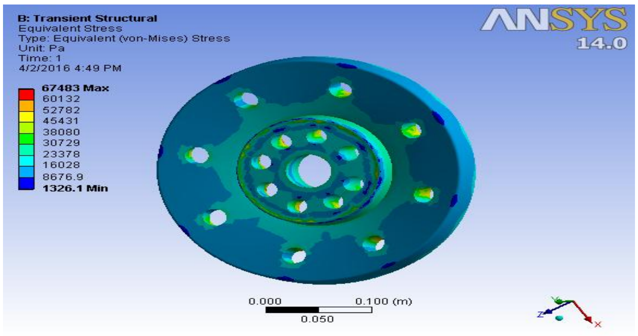


(a)

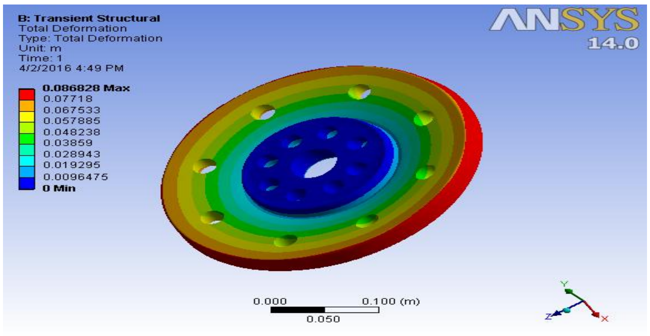


(b)

Fig. 6(a) Heat flux, (b) Temperature distribution

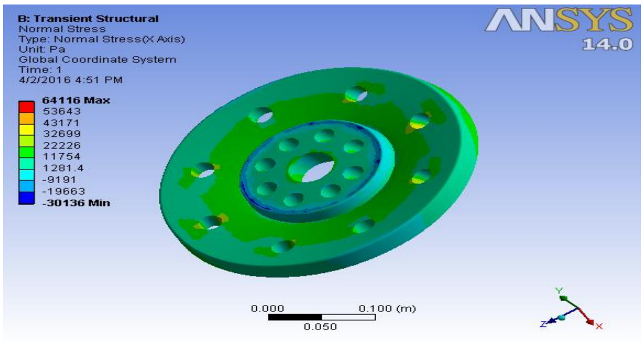


(c)

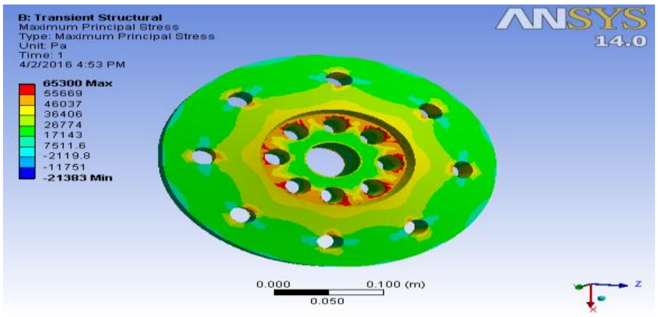


(d)

Fig. 6(c) Von-mises stress distribution, (d) Total deformation



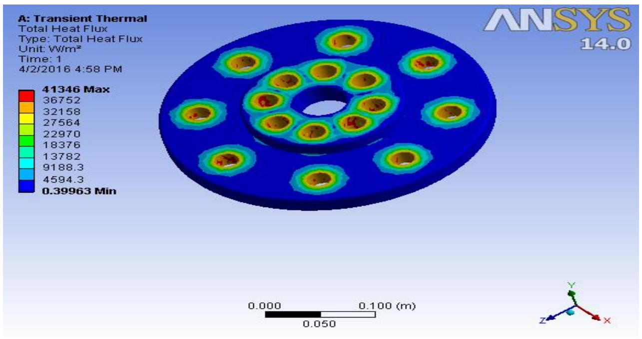
(e)



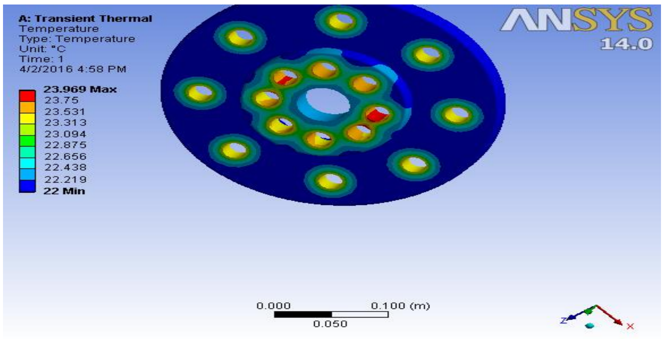
(f)

Fig. 6(e) Normal stress, (f) Maximum principal stress

6.4. Results of AlSiC-10 rotor disk

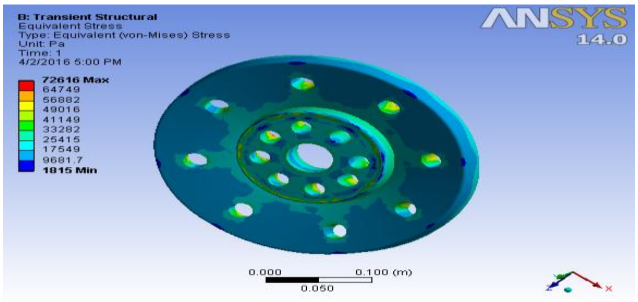


(a)

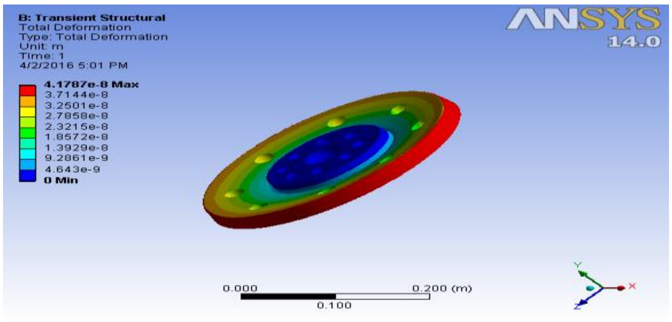


(b)

Fig. 7(a) Heat lux distribution, (b) Temperature distribution

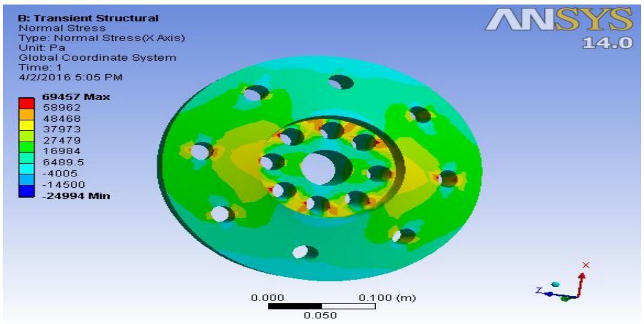


(c)

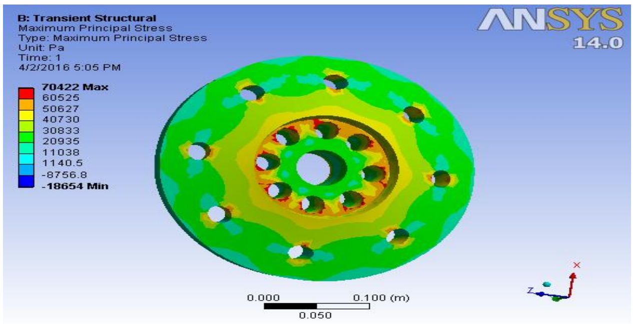


(d)

Fig. 7(c) Von-mises stress, (d) Total deformation



(e)



(f)

Fig. 7(e) Normal stress, (f) Maximum principal stress

The maximum values of above effects can be tabulate as follow:

Table 4. Maximum values of analysis

	Cast iron	Stainless steel	Aluminum	AlSiC-10
Heat flux (W/m^2)	37008	40677	40795	41346
Temperature (°c)	27.493	24	24.095	23.969
Von-mises stress (pa)	1.808e5	1.7592e5	67483	72616
Total deformation (m)	0.82294	0.076352	0.086828	4.1787e-8
Normal stress (pa)	1.7216e5	1.675e5	64116	69457
Maximum principal stress (pa)	1.7438e5	1.6967e5	65300	70422

VII. CONCLUSION

Thermo-mechanical analysis of machine component using ansys is very effective since it takes less time and gives much accurate results. In this, thermo-mechanical analysis is done using four materials which gives as an idea that which material is more suitable for disk rotor. This is essential to have knowledge about the effect of material while designing of component. Modeling of modal and various parameters like heat flux, temperature, normal stress, etc. are observed in ansys.This study is very useful to improve the quality of brakes in future and for new invention.

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