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Simulation Analysis of Automobile Disc Brake

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Abstract

The braking system is very important in nowadays moving vehicle. .In this paper aim to analysis the different cuts pattern of disc using the static structural analysis and the fluent analysis and find out the which types of cuts pattern is best according to heat dissipation and strength. For finding these objectives we use Ansys workbench 14.5 software. In this paper finding the air flow rate, velocity distribution and temperature counter using the fluent analysis in ansys workbench 14.5 which gives the results the elliptical cuts have better heat dissipation. In static structural analysis finding the total deformation, equivalent von misses stress and deformation using the ansys workbench software 14.5 which gives the results circular cuts has good strength. In steady state thermal analysis it is found that with the increase of braking time the temperature increases. Modeling of disc was done in ansys workbench.14.5.

Keywords

Elliptical cuts, circular cuts, von misses stress, deformation

Introduction

The main purpose of the friction brakes is to decelerate a vehicle by transforming the kinetic energy of the vehicle to heat energy by the cause of friction and after that dissipating heat to the surroundings. As before we saw a commercial truck or sometimes in automobiles, for both we have need of brake materials additional requirements like resistance to corrosion and light weight & long life, low noise, stable friction , and low wear rate & acceptable cost performance. There are two types of friction brakes that are commonly used drum shoe brakes and disc pad brakes. The heat flow, reliability and noise characteristics depend upon the designing of brake shoes. In case of braking system heat dissipation is caused by passing air over them. In this case heat dissipation is caused by conduction and convection and somewhat by radiation also. The cuts are given to the discs to improve the dissipation because large area imposed in the air. But increase in number and size of discs decrease the strength of discs.

Methodology

Mechanical modeling is done on Ansys workbench software. With these modeling shown in figure below these two cuts is used. Shows the circular cuts patterns having the inner diameter are 150 mm and the outer diameter is 250 mm respectively and the elliptical cuts

section with same dimensions. After making the geometry we have to import these models into ansys fluent models.

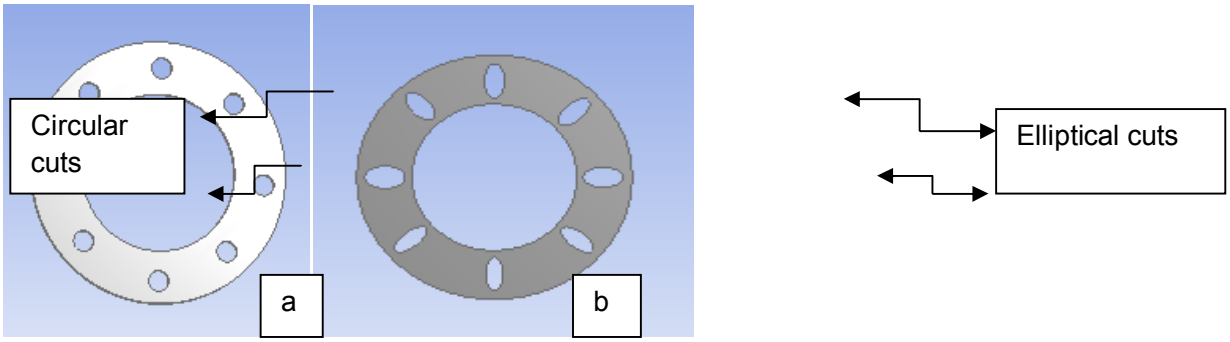


Fig: 1(a) Model with circular cuts (b) Model with elliptical cuts

ANSYS –Fluent 14.5 analysis:
Following steps followed in ansys fluent analysis:

1. Geometry
2. Meshing
3. CFD problem and solution

Geometry: Geometry fluid enclosure is created around the disc with length is equal to two times from the rear edge of the disc. Main proposes of enclosure to simulate the flow around disc.

Meshing: Basically mesh size influencing parameters for the numerical convergence of the solution. For accurate results considered the fine mesh. If the mesh size is poor then it will not give proper. In this fine mesh are generated below figures shows that the circular and elliptical fine meshes in ansys workbench software using fluent analysis.

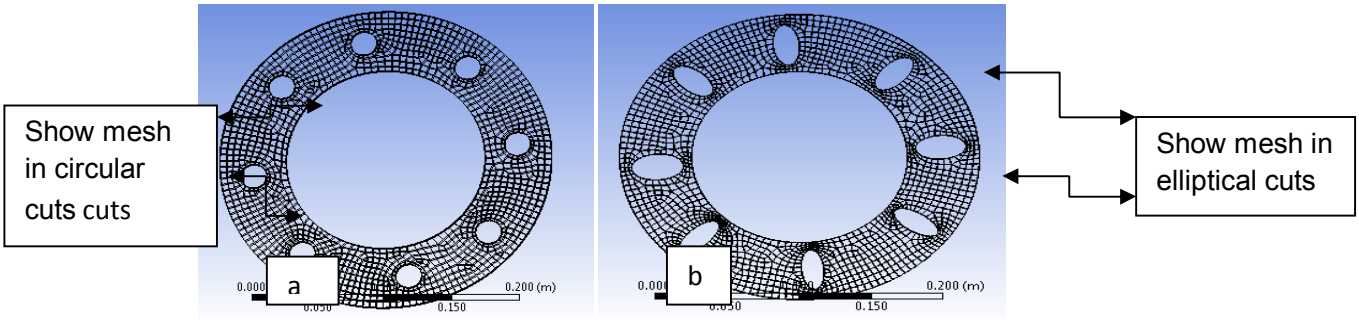


Fig: 2(a) Fine mesh for circular cuts (b) Fine mesh for elliptical cuts

CFD problem set up and solution: This problem we considered the fluid entering with the velocity 30 m/s and temperature around the disc is consider 500 k. problem is solved using 500 iteration pressure based solution method is followed by K-epsilon model is followed by turbulence flow.

Results and Discussion

From below figures it is concluded that how temperature counter vary from circular to elliptical cross section. In figure 3(a) shows dense dots near cuts. This shows that air enters into the cuts but not leave easily. In figure 3(b) shows that less dots near the cuts this is due to the air circulation through the cuts is better.

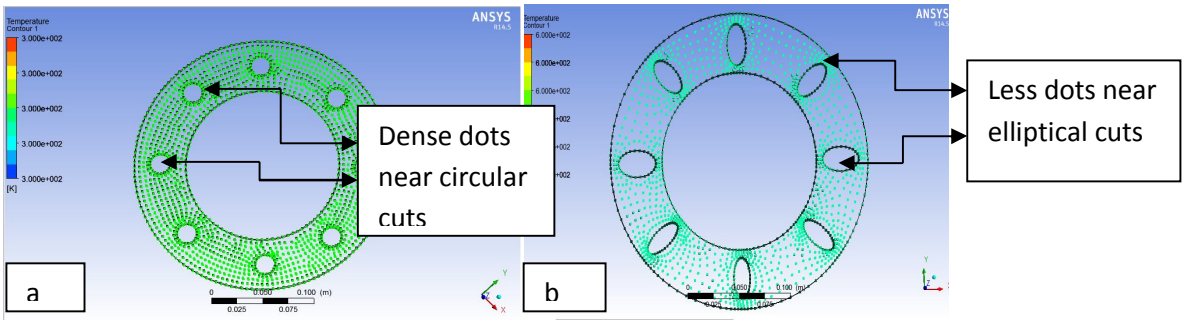


Fig: 3 (a) Temperature contour for the circular cuts (b) Temperature contour for elliptical cuts

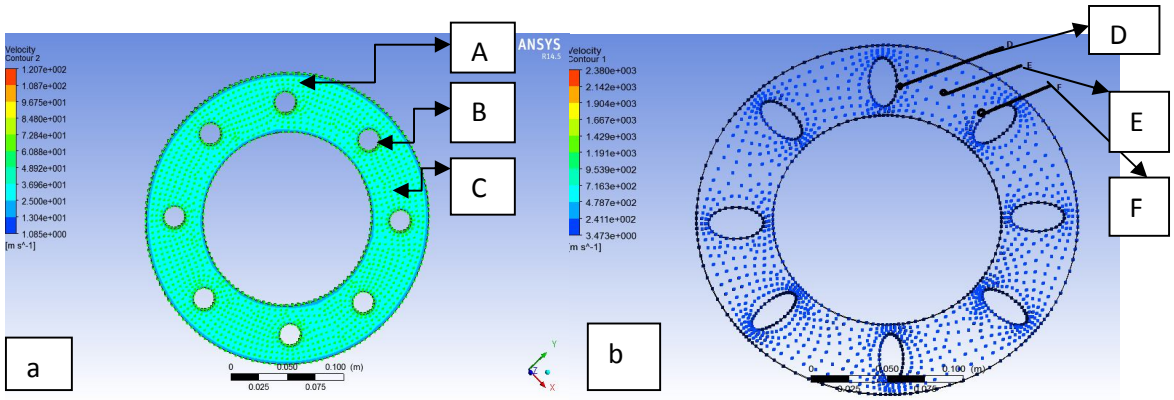


Fig: 4 (a) Velocity counter for elliptical cuts (b) Velocity counter for circular cuts

Fig.4 (a) & (b) shows that air movement around the disc and cuts. From the below we see that the layer of circular disc is large as compared to the elliptical disc. The point A and B and C shows the more layer instead of point D, E and F. This means that heated in elliptical cuts leaves the space and allows fresh air to come contact with cut surfaces of disc and carry the heat from disc. This phenomenon for circular cuts take place on lower scale which shows there is better heat transfer for elliptical type of cuts than circular type of cuts. Now we imported the same material into the static structural. For better results considered the fine mesh. In this model take the inner surface of the disc is fixed and after that apply load on it and after that analysis for the total deformation and equivalent von misses stress ,directional deformation and elastic strains following are the result of the analysis.

Materials properties	Value
Thermal conductivity	52Kg/m2c
Density	7200Kg/m3
Elastic Modulus	110Gpa
Poisson's ratio	0.28

Table1. Material properties for grey cast iron

With considering the same dimensions as earlier considered in fluent analysis. This geometry is imported in static structural analysis. Take the disc inner surface is fix and gives the anticlockwise moment, analysis is done for total deformation and equivalent von misses stress.

Total Deformation

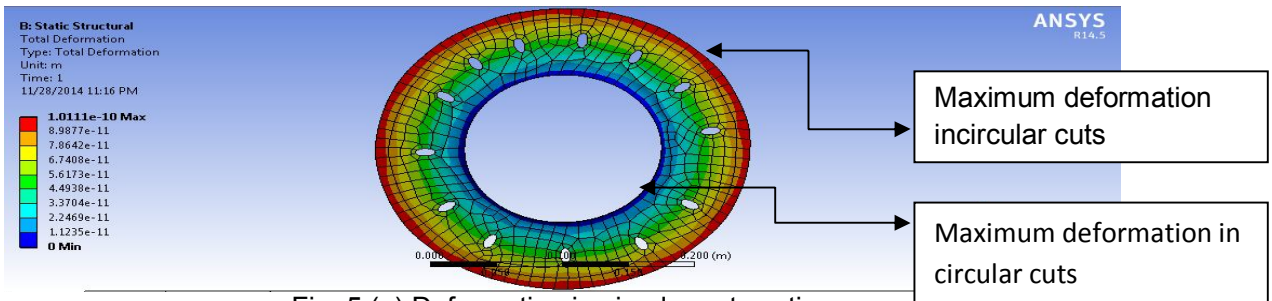
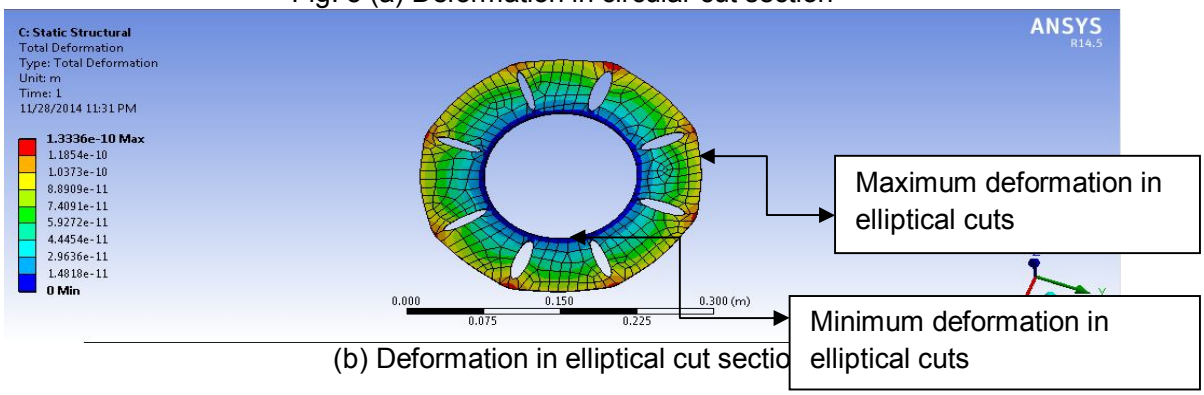


Fig: 5 (a) Deformation in circular cut section



(b) Deformation in elliptical cut sectio

Fig.5 (a) & (b) shows that the deformation is highest at the outer edge and lower at the inner edge .We can see that the maximum value of deformation for circular type cut is 1.0111e-10 m whereas in case of elliptical type cut is 1.3336e-10 m. this shows that the value of deformation is more in case of elliptical section as compared to circular disc when apply same load.

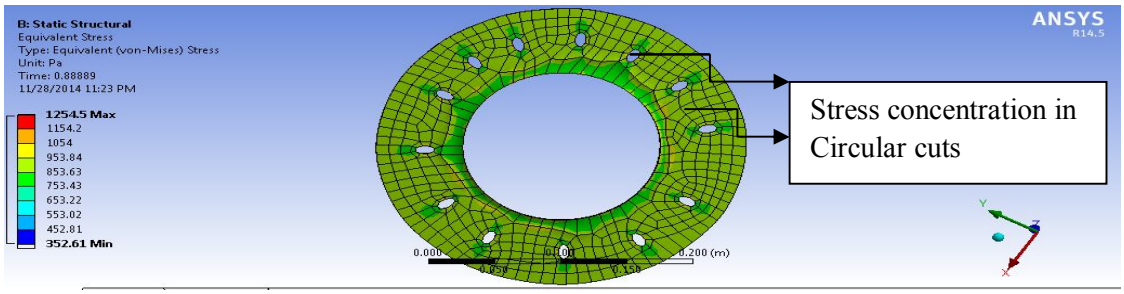
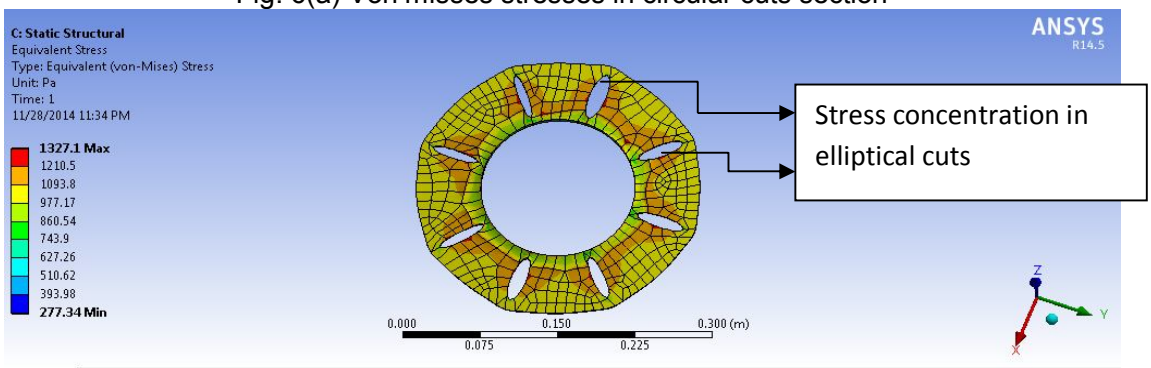


Fig: 6(a) Von misses stresses in circular cuts section



(b) Von misses stress in elliptical cuts section

In this case Fig. 6(a) & (b) shows that the stress value of circular cuts is 1254.5 Pa whereas In case of elliptical cuts is 1327.1 Pa. So in this case the maximum value for elliptical type cuts pattern is more as compared to the circular cuts. It means that the elliptical types of cut pattern are weaker than the circular type cuts pattern.

Steady State Thermal Analysis

Now after that the disc is imported into steady state thermal analysis for the temperature distribution. Now analysis the variation of temperature distribution along the length of the disc. In this analysis considered the depth of disc is 5 mm.

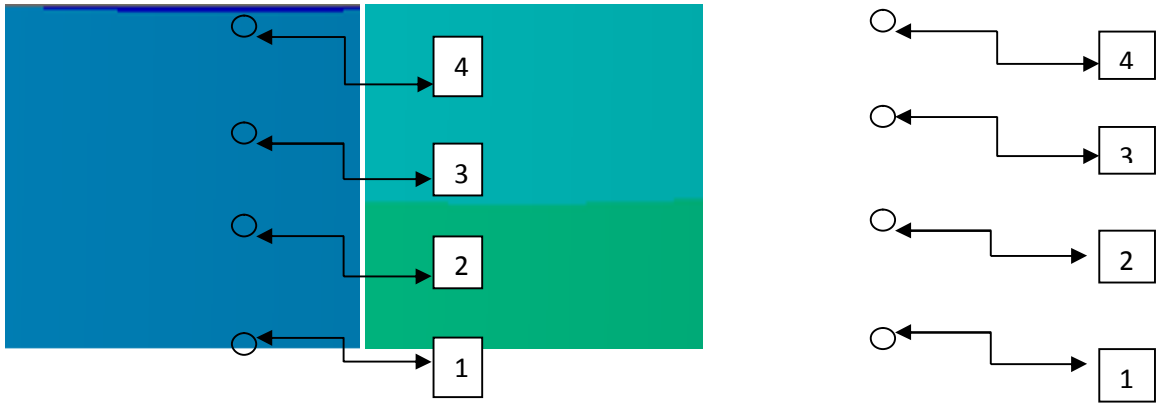
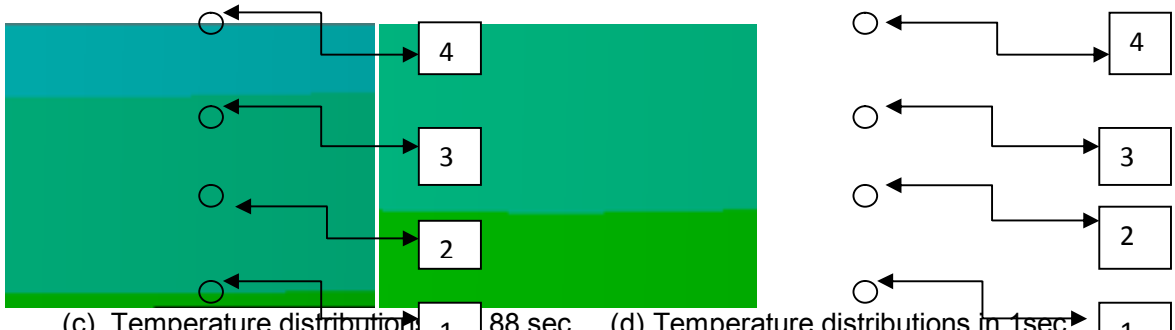
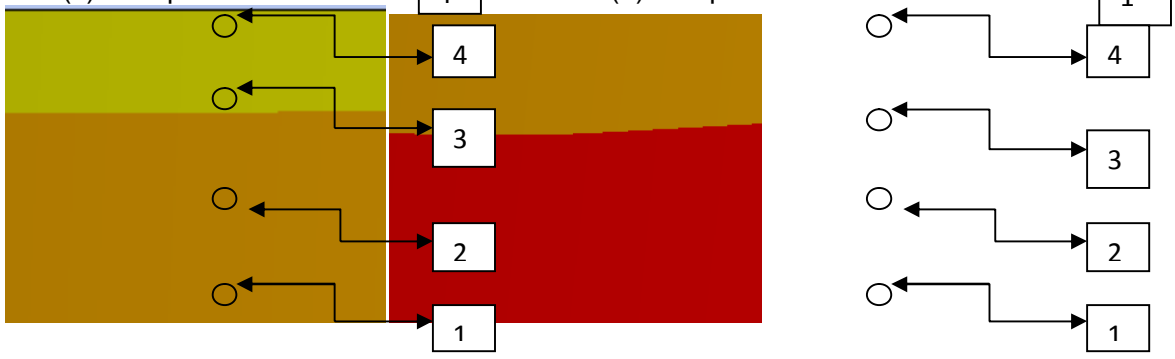


Fig: 7(a) when no brake is applied(b) Temperature distribution in 0.77 sec



(c) Temperature distribution .88 sec (d) Temperature distributions in 1sec



(e) Temperature distributions in 3 sec (f) Temperature distribution for 5 sec

Fig7. (a) Shows the point 1,2,3,4 which shows the point when there is no brake is applied and in case of (b) shows the temperature just going to start at point 1&2. In figure (e) at point 1, 2&3 shows the maximum temperature as compared to the figure (d) at point 1&2 which shows the with the increase of time in braking the temperature will increase and

when considering the case of depth as above figure the temperature is maximum at the upper braking surface of disc and after that the temperature is distributed through the whole depth of disc. Below graph represents the with increasing the braking time temperature increases.

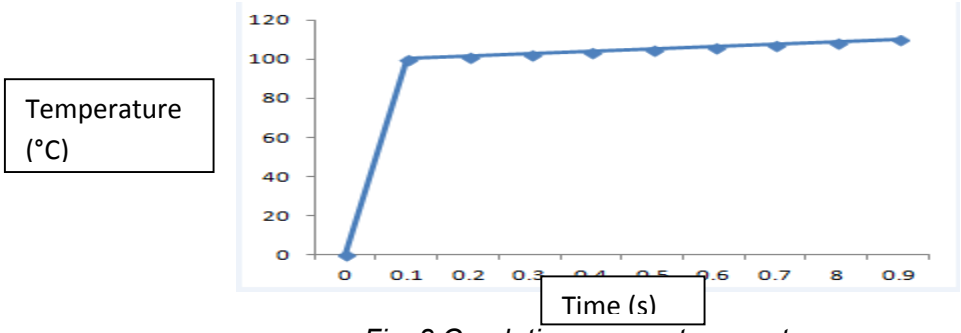


Fig: 8 Graph time verses temperature

Conclusion

From the studies conducted so far it is concluded for various geometry determining the heat transfer rate and strength. In case of elliptical types cut pattern has better heat transfer than the circular type of cut pattern. And after that in structural analysis shows that the elliptical types cut is weaker to withstand the braking force when we comparing it with circular types cut pattern. With the number of brake application temperature of disc also increases and this also affects the strength of the disc. So for better heat transfer rate and structural strength of materials and cuts pattern should be optimize properly along with consideration of temperature effect.

Acknowledgment

I take this opportunity to express my profound gratitude and deep regard to my mentor Mr. Ram Kumar, assistant professor lovely professional university for his guidance. The blessing, help and guidance given by him time to time shall carry me a long way in the journey of life on which I am about to embark.

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