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THERMAL AND STRUCTURAL ANALYSIS OF DISC BRAKE USING MODELLING ANALYSIS BY CATIA & ANSYS SOFTWARES

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Abstract

The disc brake is a device for slowing or stopping the rotation of a wheel. Repetitive braking of the vehicle leads to heat generation during each braking event. Transient Thermal and Structural Analysis of the Rotor Disc of Disk Brake is aimed at evaluating the performance of disc brake rotor of a two wheeler under severe braking conditions and there by assist in dis,c rotor design and analysis. Disc brake model analysis is done using CATIA and ANSYS.

Keywords: Disc brake, FEM, CATIA,ANSYS

I. INTRODUCTION

The very basic concept of FEM is a system-a-body of a structure can be divided into elements of finite dimensions, called "finite elements". The fundamental concept of the finite element method is that any continuous quantity, such as temperature, pressure or displacements can be approximated by a discrete model composed of a set of piece wise continuous functions defined over a finite number of sub domains. These series of functions are piece wise continuous and should approach the exact solution as the number of sub domains approaches infinity. FEM is more appealing to the engineer as it can be explained through the physical concept and also for heat transfer and fluid mechanics. It is amenable for programming on a digital computer in a systematic way. The scope of application is practically very much large covering wide range of analysis problems. The finite element method has become a powerful tool for the numerical solution of a wide range of engineering problems. Applications range from deformation and stress analysis of automotive, aircraft, building, and bridge structures to field analysis of heat flux, fluid flow, magnetic flux, seepage, and other flow problems. With the advances in computer technology and CAD systems, complex problems can be modeled with relative ease. Several alternative configurations can be tried out on a computer before the first prototype is built. All of this suggests that we need to keep pace with these developments by understanding the basic theory, modeling techniques, and computational aspects of the finite element method. In this method of analysis, a complex region defining a continuum is discretized into simple geometric shapes called finite elements. The material properties and the governing relationships are considered over these elements and expressed in terms of unknown values at element corners. An assembly process, duly considering the loading and constraints, results in a set of equations. Solution of these equations gives us the approximate behavior of the continuum.

II. BACKGROUND INFORMATION

Advantages of Finite Element Method:

The present day application of finite element method is very extensive and it involves physical problems that are governed by differential equations. Some of the several advantageous, properties of the finite element method that have contributed to its extensive use are:

1. The material properties in adjacent elements do not have to be the same. This method can be applied to bodies composed of several materials.

2. Irregularly shaped boundaries can be approximated using elements with straight sides or can be matched exactly using elements with curved boundaries. The method is therefore not limited to regular shapes with easily defined boundaries.

3. The size of elements can be varied. This property allows the element grid to be expanded or refined as the need exists.

4. Boundary conditions such as discontinuous surface, loadings, present no difficulties

   for the method. Mixed boundary conditions can also be easily handled.

5. The above properties can be incorporated into one general computer program for a subject matter area.

Introduction to Ansys:

The ANSYS Workbench platform is the framework upon which the industry‟s broadest and deepest suite of advanced engineering simulation technology is built.

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An innovative project schematic view ties together the entire simulation process, guiding the user through even complex multi physics analyses with drag-and-drop simplicity. With bi-directional CAD connectivity, powerful highly-automated meshing, a project-level update mechanism, pervasive parameter management and integrated optimization tools, the ANSYS Workbench platform delivers unprecedented productivity, enabling Simulation Driven Product Development.

Source: http://www.ansys.com/Products/Workflow+Technology/ANSYS+Workbench+Platform
ANSYS works on three principles; those are Penalty method, Lagrange method and augmented Lagrange method. These principles used in the process of contact analysis and non – linear analysis. Source: http://www.cadfamily.com all are coming into the following main three methods.

a) STRUCTURAL ANALYSIS:

b) THERMAL ANALYSIS

c) FLUID ANALYSIS

In this project ANSYS 14.0 played a major role, all the analysis was done with the ansys software. Mainly Modal ANSYS and Transient Thermal Analysis were done in this Project. These two analysis come into the structural (Model Analysis) and Thermal.

In this Modal Analysis the deformations will be calculated at different natural frequencies and it was mentioned as different mode shapes. In the Transient Thermal Analysis initial temperature is applied and cooling time will be calculated.

Open Ansys Workbench14.0, It opens a project Schematic window with tool box, graphical User Interface with some other important tools.

Use import tool to import the geometry with IGES file format.

After importing the geometry file we do the required Analysis. Now on our disk brake transient thermal analysis is required. From the tool box select Transient Thermal analysis tab and drop on GUI.

Now link the imported geometry to the Transient Thermal analysis tab as shown below in the

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Project Schematic window:

Double click on the Model it opens Ansys Mechanical Window. This window contains many tools to do the analysis.

Geometry: To check the imported geometry and also to apply the required material.

Mesh: To generate the meshing, there are two methods one is automatic mesh generation and the other is with required size meshing. In this we used size meshing with 6mm.

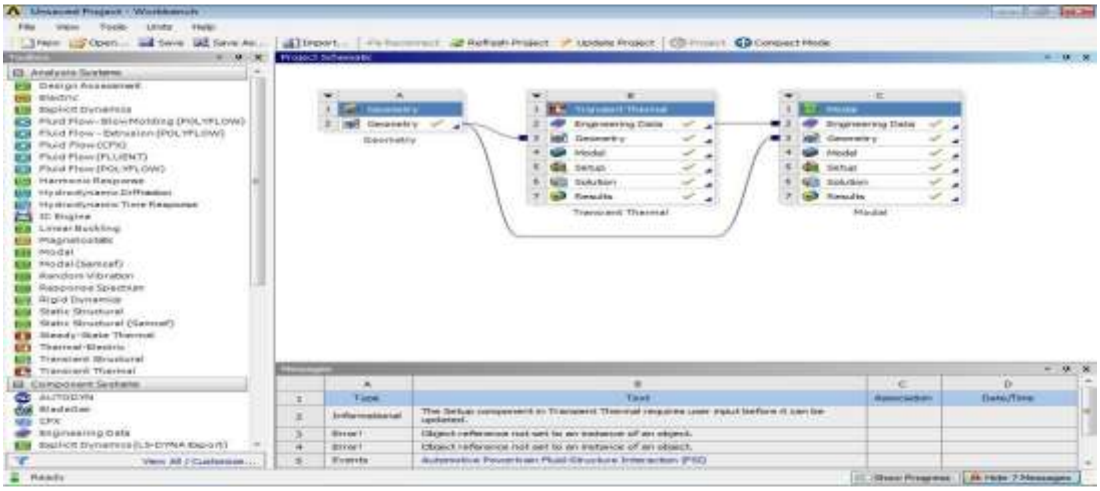


Fig 1

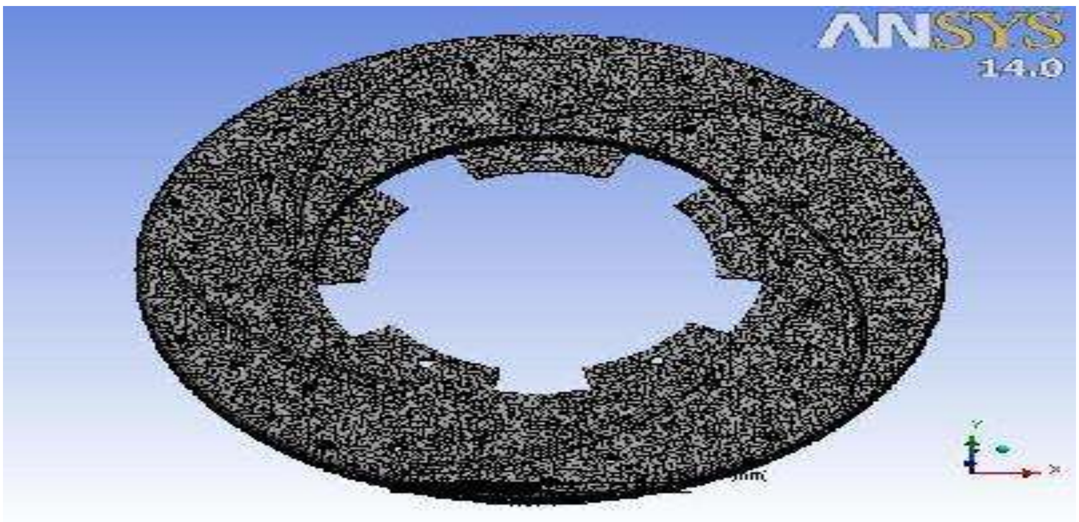


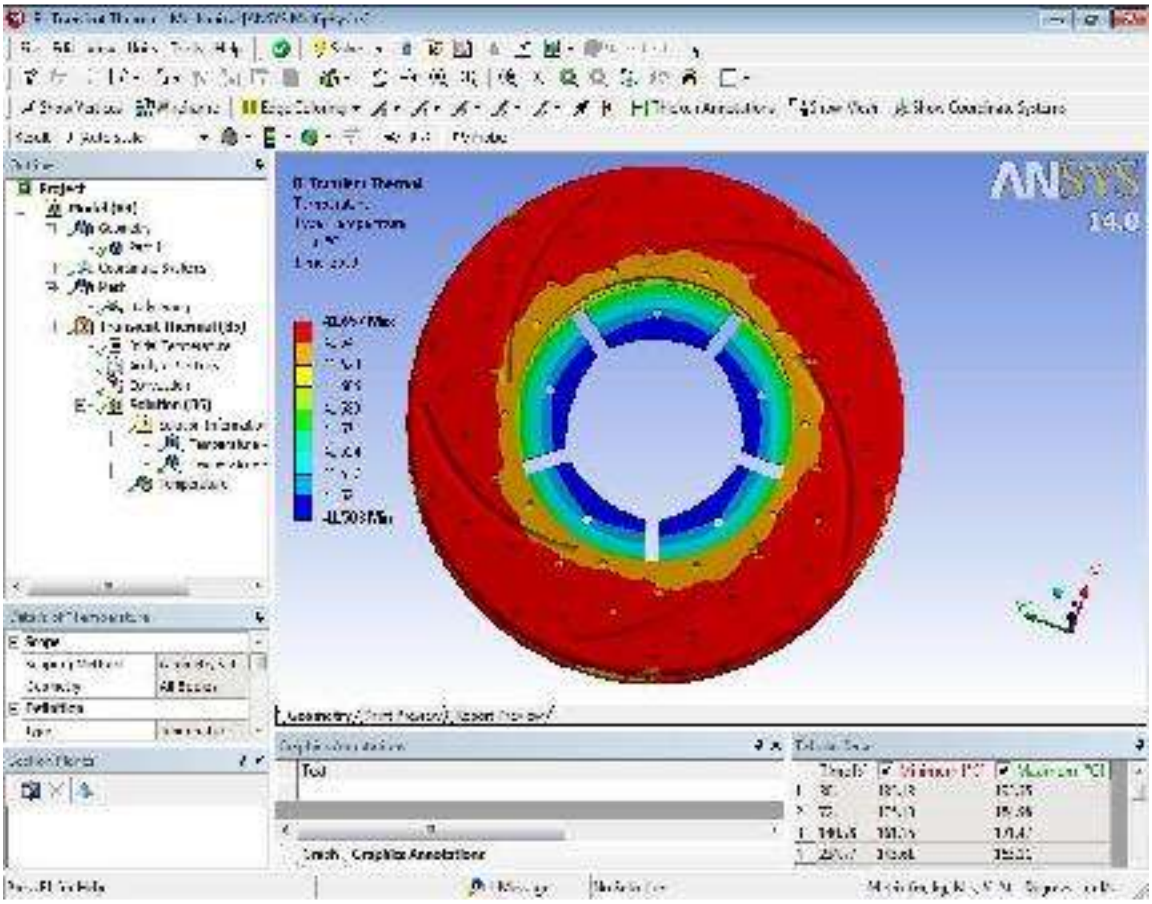
Fig 2. Meshed Geometry

In transient Thermal:
Set the initial temperature as 200^0C
Analysis Settings: step end time 3600 Sec
Right click on Analysis settings – Insert – Convection – enter the film coefficient is different for different materials and bulk (final Temp) as 40^0C.

III. MAIN RESULT

Transient Thermal Analysis

Structural Steel:



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Transient Thermal Analysis

Structural Steel:

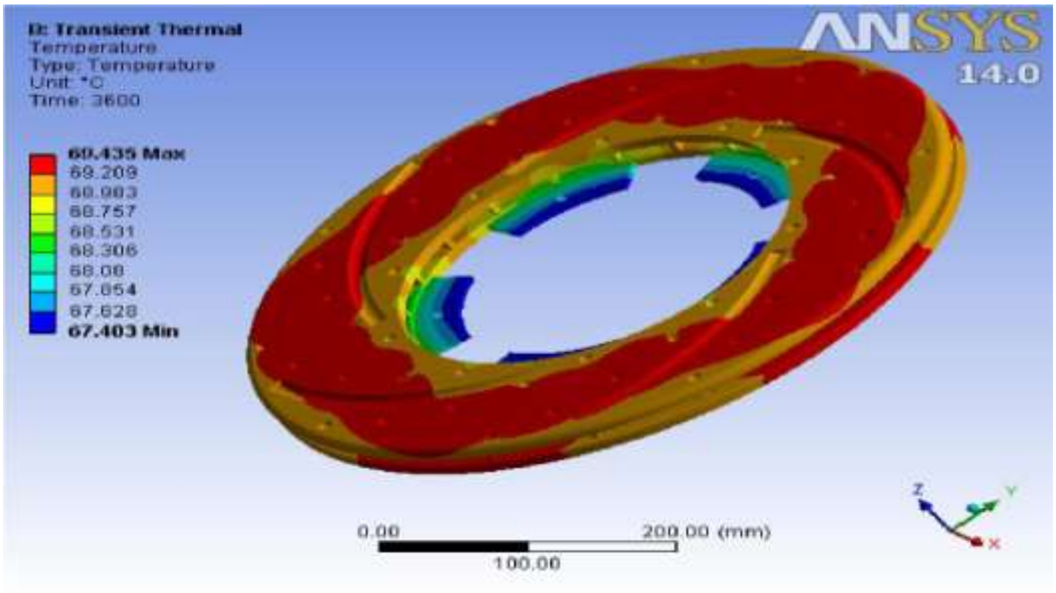

Fig 5. Temperature distribution

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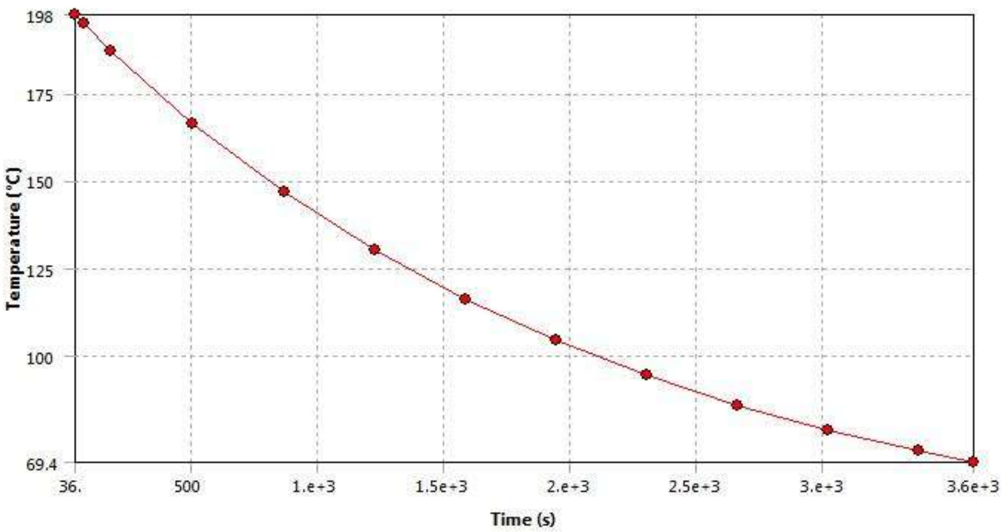

Fig 6 Time temperature Curve

ALLUMINUM ALLOY

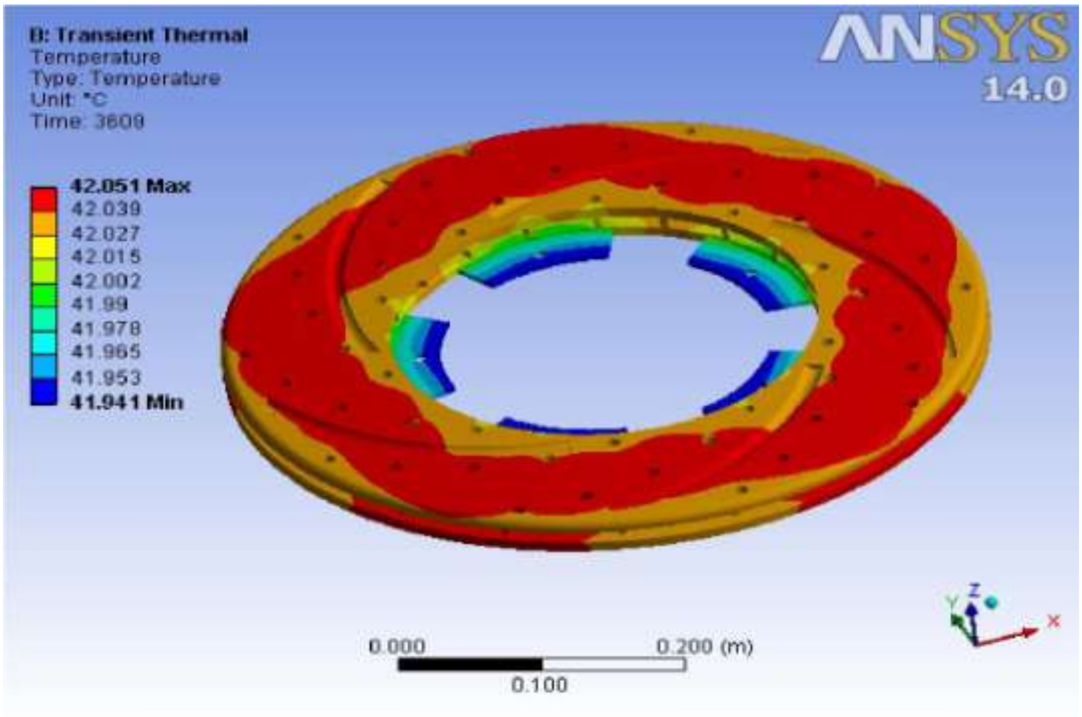

Fig 7. Temperature distribution

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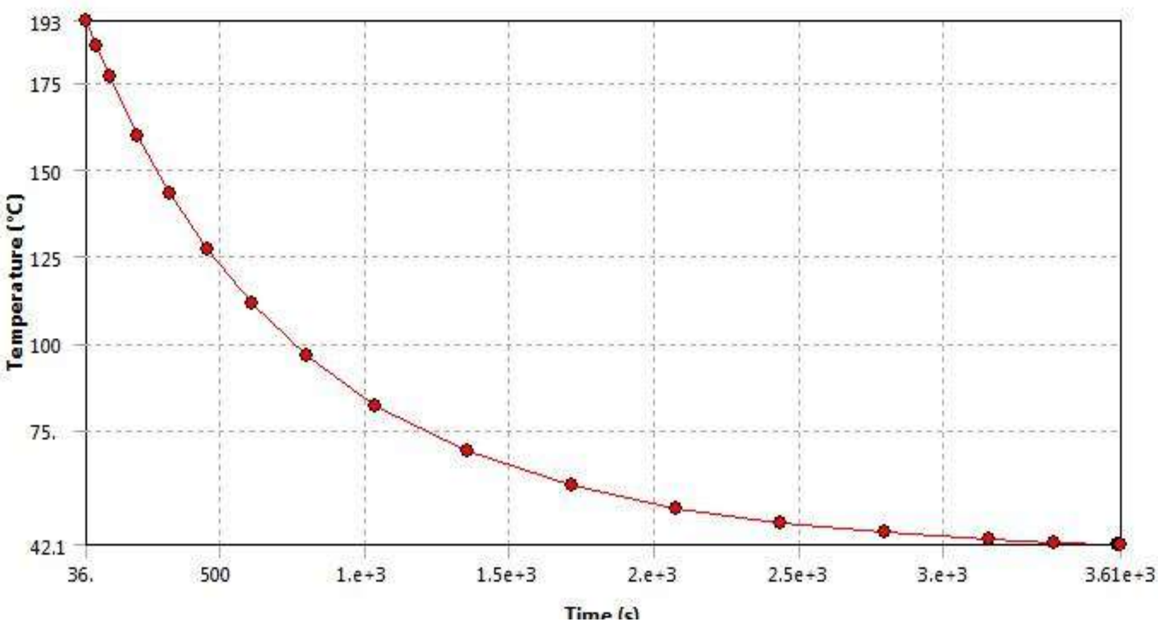

Fig 8. Time temperature Curve.

GRAY CAST IRON

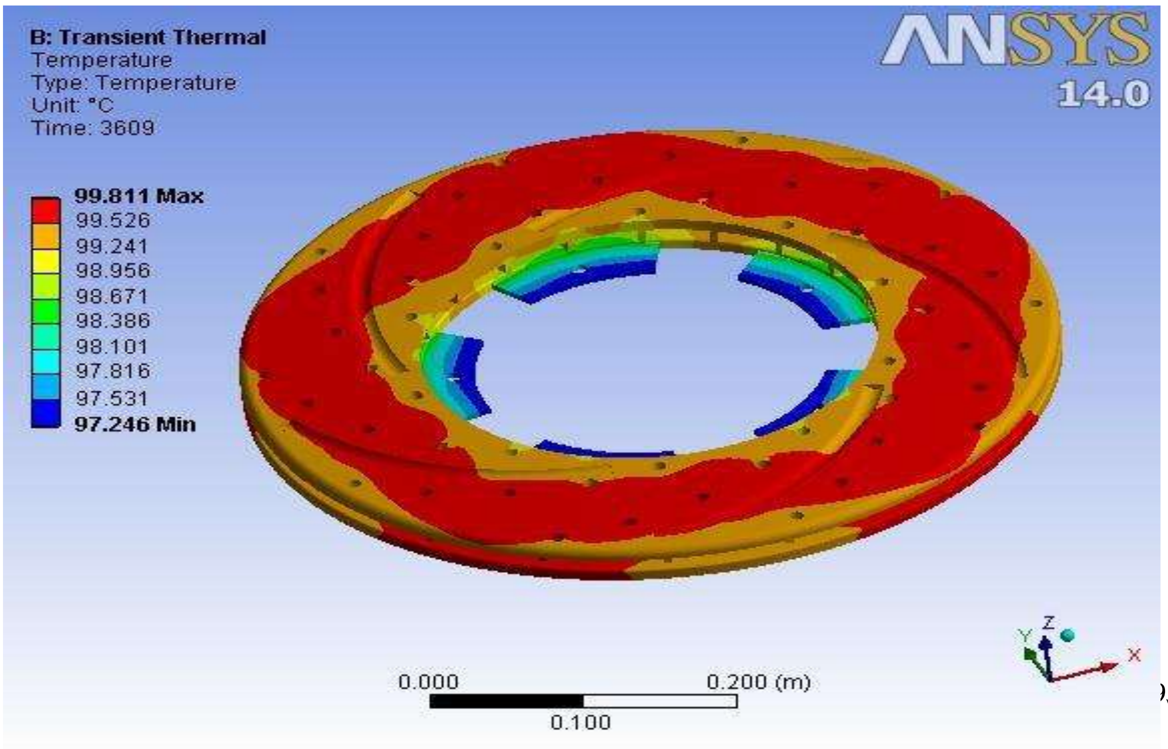

Fig 9. Temperature distribution

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IV. IMPLEMENTATION DETAILS OF THE PROPOSED METHOD

MODEL ANALYSIS AFTER MODIFICATION WITH ALLUMINUM ALLOY

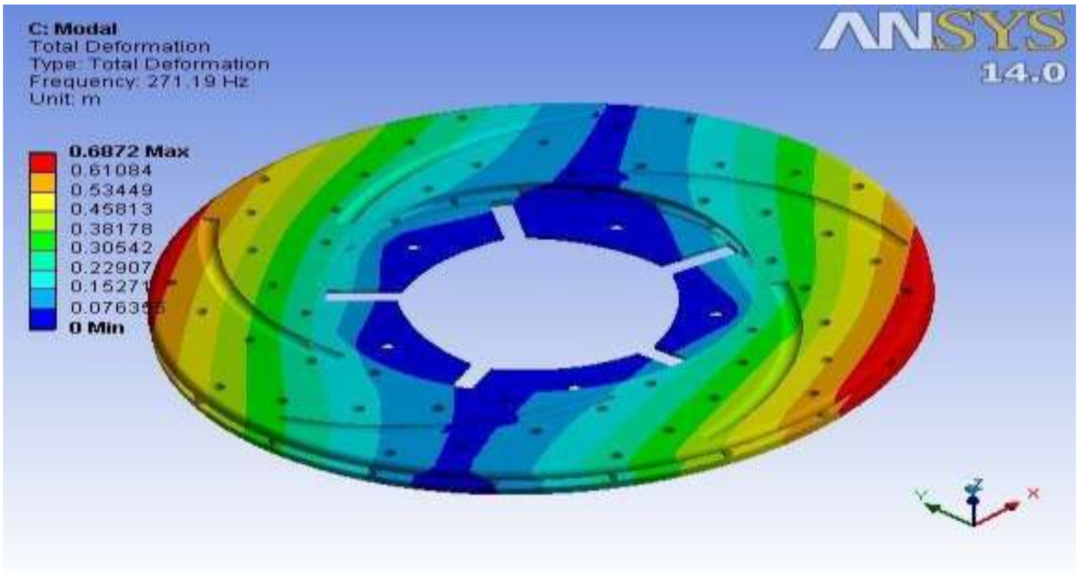

Fig 10. Total Deformation

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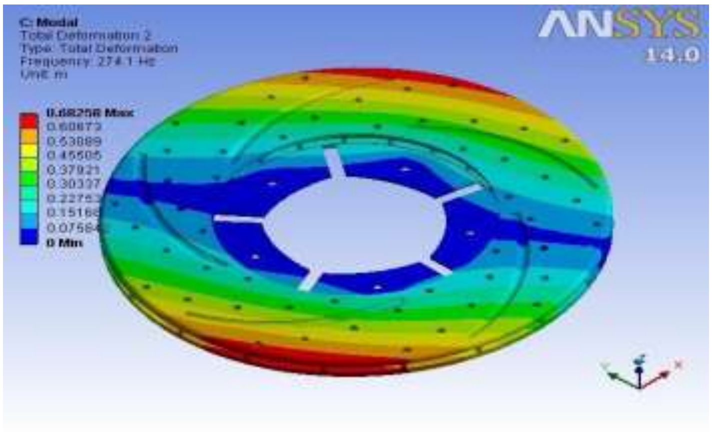

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V. RESULTS

Table -1. Temperature Vs Cooling time for different materials

Material	Time in min	Final Temp
Structural Steel	60	69.4
Alluminum Alloy	60	42.1
Gray Cast Iron	60	99.8
Alluminum Alloy(After Modification)	60	41.7

GRAPH -I: Temperature Vs Cooling time for different materials

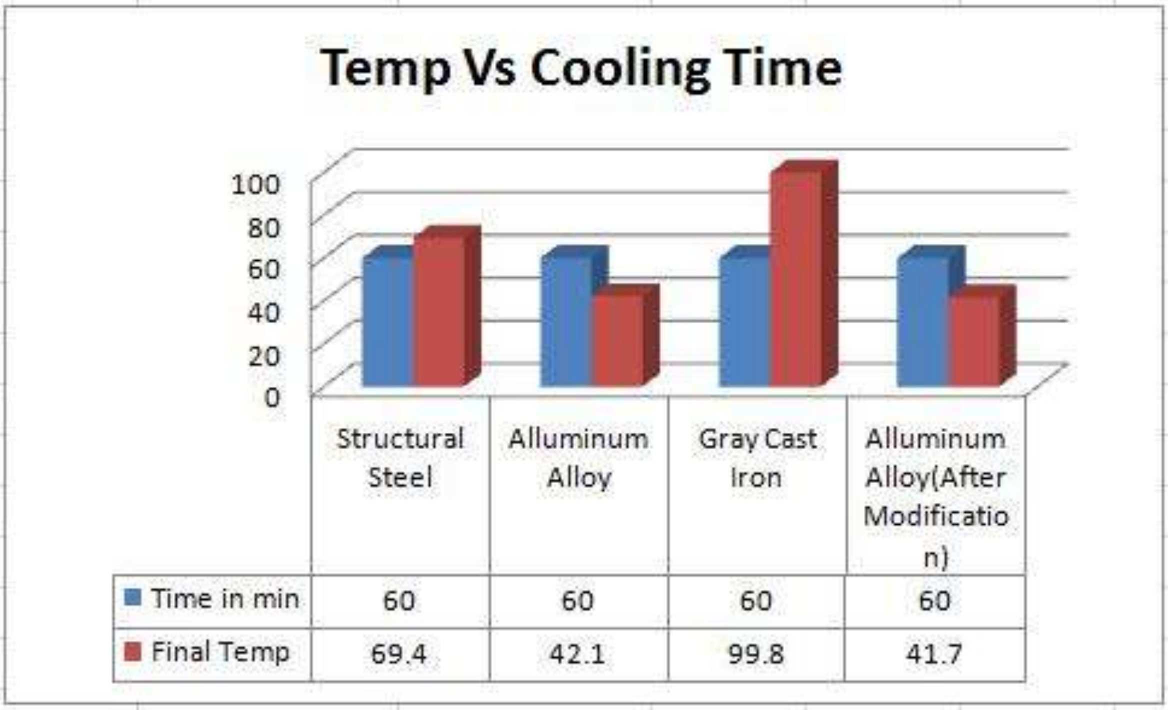

Fig 11.Schematic view of the temperature versus time.

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Table -2. Frequency Vs Deformations

Mode Shapes	Frequency in KHz	Deformation in mm
Total Deformation1	0.27119	0.6872
Total Deformation2	0.2741	0.68258
Total Deformation3	0.40223	0.50272
Total Deformation4	0.4369	0.72548
Total Deformation5	0.44018	0.71511
Total Deformation6	0.95826	0.7669

GRAPH -II: Frequency Vs Deformations

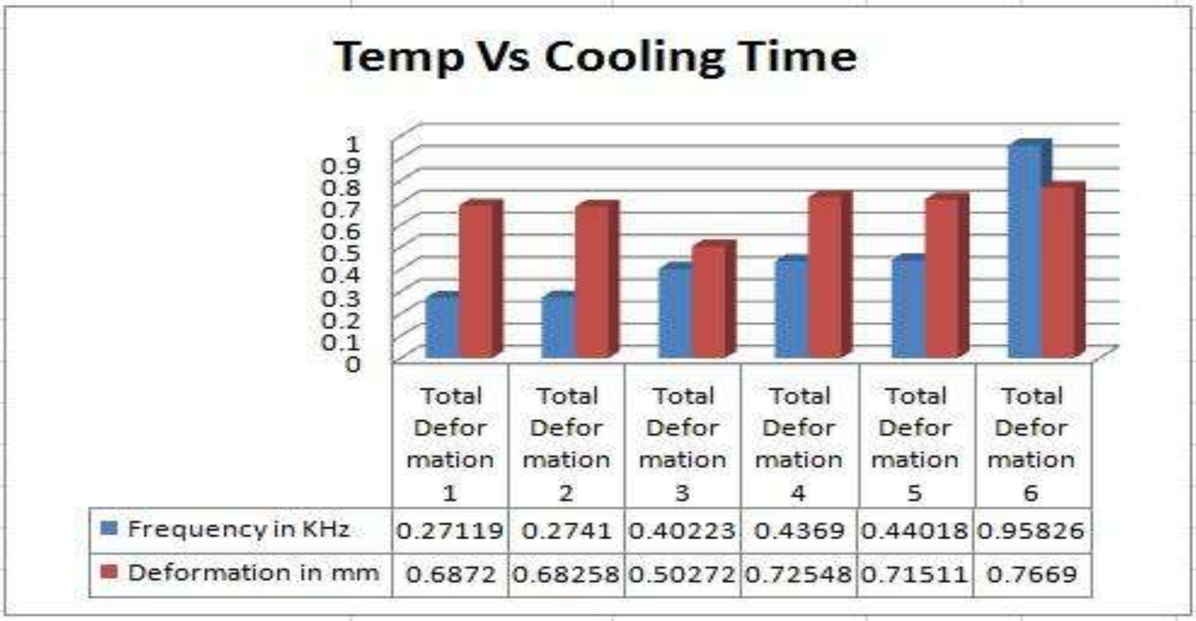

Fig 12 Schematic view of Temperature Versus Time

VI. CONCLUSION

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- From the above tabular values the cooling time is low for Alluminium Alloy.
- After modification we did the same analysis with Alluminium Alloy and we got the less time compared to before modification, so our modifications are better.
- In the model analysis the deformation is maximum at 6^{th} Mode shape.
- From the obtained results we can conclude that the Alluminium Alloy is better for disk brake.
- The design optimization also better as compared to before modification.

REFERENCES

[1] Dindayal Mahto, Danish Ali Khan and Dilip Kumar Yadav, "Security Analysis of Elliptic Curve Cryptography and RSA", Proceedings of the World Congress on Engineering 2016 Vol I, WCE 2016, June 29 - July 1, 2016.
[2] Geetha G and Padmaja Jain, "Implementation of Matrix based Mapping Method Using Elliptic Curve Cryptography", International Journal of Computer Applications Technology and Research Vol. 3, Issue 5, 312 - 317, 2014.
[3] Naresh S. Badve, "Cryptography using Elliptic Curve with Matrix Scrambling", Journal for Research, Vol. 01, Issue 01, March 2015.
[4] Fatima Amounas, "On enhancement of Elliptic Curve Encryption of Amazigh Text using Graph Theory", International journal of Computer Science & Network Solutions, Vol. 4, No.3, pp. 1-10, 2016.
[5] D. Sravana Kumar, Ch. Suneetha and A. Chandrasekhar, "Encryption of Data Using Elliptic Curve Over Finite Fields", International Journal of Distributed and Parallel Systems, vol. 3, no. 1, 2012.
[6] William Stallings, "Cryptography and network security principles and practice", Prentice Hall, 5th Edition, 2011.
[7] Padma Bh, D.Chandravathi, P.Prapoorna Roja, "Encoding And Decoding of a Message in the Implementation of Elliptic Curve Cryptography using Koblitz's Method", International Journal on Computer Science and Engineering, Vol. 02, No. 05, pp. 1904-1907, 2010.
[8] O.Srinivasa Rao and S. Pallam Setty, "Efficient Mapping methods for Elliptic Curve Cryptosystems", International Journal of Engineering Science and Technology, Vol. 2(8), pp.3651-3656, 2010.
[9] B. Ravikumar, G. Naga Lakshmi, T. Surendra, A. Chandra Sekhar. "A Study on group theoretic Elliptic curves - An m implementation to Cryptography", International Journal of Science and Advanced Technology, Vol 1, No 6, 2011.
[10] V.Kamalakannana and S.Tamilselvan, "Security Enhancement of Text Message Based on Matrix Approach Using Elliptical Curve Cryptosystem", 2nd International Conference on Nanomaterials and Technologies, Procedia Materials Science 10, pp. 489-496, 2015.

[11] Vishal Kumar, Ratnesh, Mashud A. And Monjul Saika, "Multiple Encryption using ECC and it's Time Complexity Analysis, International Journal of Computer Engineering In Research Trends, Vol. 3, Issue 11, pp. 568-572, 2016.
[12] Ameur M., Bouhjar A., Boukhris F., Boukous A., Boumalk A., Elmedlaoui M., Iazzi E., Souifi H. Initiation à la langue amazighe. IRCAM, Rabat, Maroc, 2004.
[13] Lazzi E., Outahajala M. Amazigh Data Base. In Proceedings of HLT & NLP Workshop within the Arabic world: Arabic language and local languages processing status updates and prospects, Marrakech, Morocco, pp. 36-39, 2008.
[14] Andries P. Unicode 5.0 en pratique, Codage des caractères et internationalisation des logiciels et des documents. Dunod, France, Collection InfoPro. 2008.
[15] Fatima Amounas and El Hassan El Kinani, "Fast Mapping Method based on Matrix Approach for Elliptic Curve Cryptography", International Journal of Information & Network Security , Vol.1, No.2, pp. 54-59, 2012.
[16] Geetha G, Padmaja Jain ,"Implementation of Matrix based Mapping Method Using Elliptic Curve Cryptography",International Journal of Computer Applications Technology and Research Volume 3– Issue 5, 312 - 317, 2014.
[17] R. Balamurugan, V. Kamalakannan, D. Rahul Ganth and S. Tamilselvan, "Enhancing Security in Text Messages Using Matrix based Mapping and ElGamal Method in Elliptic Curve Cryptography", International Conference on Contemporary Computing and Informatics, IEEE, pp.103-106, 2014.