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FINITE ELEMENT ANALYSIS OF DISC BRAKE

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ABSTRACT

The aim of my paper is to disc brake squeal has been examined by developing a finite element model of the coupled pad-disc system , conducting complex eigenvalue analysis and associating unstable modes with potential squeal problem areas. A key issue in this process is the representation of the contact pressure distribution at the frictional interface between the disc and the pad. Non-linear contact analysis using the finite element model of the pad revealed that contact is only partial at the pad-disc interface and that the contact pressure distribution depends on the friction coefficient, Young's modulus of the friction material and the way the applied pressure is distributed on the pad backplate. A new method is proposed in which interface contact stiffness is related to brake line pressure using a statistical approach based on the measured surface properties of the interface. Complex eigenvalue analysis of the coupled pad-disc system has shown that unstable modes exist within different ranges of contact stiffness thereby providing an explanation of the effect of varying line pressure on squeal. The two most unstable modes from the analysis show good correlation with experimental squeal results. The objective of current work is to analyze the vibration parameters as natural frequency, mode shapes of brake disc with drilled holes of different diameter & of worn discs at outer end. Redesigning of the braking system by substitution of lighter material like aluminum and carbon composite brakes primarily have been responsible for this state of the art technology, which is being used in aircrafts and formula one racing cars .The requirement is of the materials that have light weight, are strong, abrasion resistant and are not corroded easily. Composite materials provide such unique combination of properties.

KEYWORD: FEA, Ansys, Solid works, Disc Brake

INTRODUCTION

A disc brake is a type of brake that uses calipers to squeeze pairs of pads against a disc in order to create friction that retards the rotation of a shaft, such as a vehicle axle, either to reduce its rotational speed or to hold it stationary. The energy of motion is converted into waste heat which must be dispersed. Hydraulic disc brakes are the most commonly used form of brake for motor vehicles but the principles of a disc brake are applicable to almost any rotating shaft

DESIGN PARAMETER

In this type of brake two friction pads are pressed axially against a rotating disc to dissipate kinetic energy. The working principle is very similar to friction clutch. When the pads are new the pressure distribution at pad-disc interface is uniform, i.e.,

$$p = \text{constant} .$$

If F is the total axial force applied then $F = p A$, where A is the area of the pad. The frictional torque is given by

where μ = coefficient of kinetic friction and r is the radial distance of an infinitesimal element of pad. After some time the pad gradually wears away. The wear becomes uniform after sufficiently long time, when $pr = \text{constant} = c$ (say)

It is clear that the total braking torque depends on the geometry of the pad. If the annular pad is used then

where R_1 and R_2 are the inner and outer radius of the pad.

The most important member in a mechanical brake is the friction material. A good friction material is required to possess the following properties:

- High and reproducible coefficient of friction.
- Imperviousness to environmental conditions.
- Ability to withstand high temperature (thermal stability)
- High wear resistance.
- Flexibility and conformability to any surface.

METHODOLOGY

1. GEOMETRY

2. Material Properties

Al6061-SiC

Density 9.7544e-002 lbm in⁻³

Coefficient of Thermal Expansion 6.6667e-006 F⁻¹

Specific Heat 0.10366 BTU lbm⁻¹ F⁻¹

Thermal Conductivity 8.0917e-004 BTU s⁻¹ in⁻¹ F⁻¹

Resistivity 8.5235 ohm cmil in⁻¹

Compressive Yield Strength psi 36259

Tensile Ultimate Strength psi 66717

3. Meshing

Mesh Detail

Sizing

Use Advanced Size Function Off

Relevance Center Coarse

Element Size Default

Initial Size Seed Active Assembly

Smoothing Medium

Transition Fast

Span Angle Center Coarse

Minimum Edge Length 4.6012e-003 in

Inflation

Use Automatic Inflation None

Inflation Option Smooth Transition

Transition Ratio 0.272

Maximum Layers 5

Growth Rate 1.2

Statistics

Nodes 11014

Elements 5118

Mesh Metric None

4. BOUNDARY CONDITION

In analysis setting put the value maximum modes to find 10

5. Result

The analysis was done by applying the maximum mode shape 10 the following result obtained

CONCLUSION

In this analysis we find the at frequency at 468 the design is safe at mode shape 7. Natural frequencies of disc brake of bike increases as the disc thickness decreases till first six natural frequencies but reverse effect after 7th natural freq but seventh frequency is changed very less. Natural frequencies of disc brake of bike decreases as the air ventilation hole diameter increases. Although the aim of this dissertation is fulfill by finding natural frequency, mode shapes of annular brake disc with different holes & patterns with same ratios of inner to outer radius for inner edge clamped in shaft and outer edge kept free still further investigation can be carried out on dynamic behavior of disc brake such as rotor caliper.

REFERENCES

1. B. sing, V. Saxena (1997) studied, "Transverse Vibration of Skew Plates with Variable Thickness" [Academic Press Limited Received 19 March 1997], PP 1-3.
2. Mehdi Hamadan, Kristina M. Jeric, Daniel J. Inman (2001) studied "An Experimental Evaluation of Smart Damping Materials for Reducing Structural Noise and Vibrations", Advanced Vehicle Dynamics Laboratory, Department of Mechanical Engineering, Virginia Tech, Blacksburg, PP 533-536.
3. H. Ouyan, J. E. Motters head (2001) studied, "A Bounded Region of Disc brake Vibration Instability", Department of Engineering, University of Liverpool, Liverpool L693 GH, England, PP 543-54. [4] Tsuyoshi Inoue, Yukio Ishida, (2006) studied, " Chaotic Vibration and Internal Resonance Phenomena in Rotor Systems" Department of Mechanical Science and Engineering, School of Engineering, Nagoya University, Nagoya, Aichi,464-8603, Japan, pp 157-158.
4. F. Talati and S. Jalalifar, Analysis of heat conduction in a disc brake system, Heat Mass Transfer, 45 (2009) 1047-1059.
5. J. T. Kim and B. J. Baek, A numerical study of thermal performace in ventilated disk brake, Journal of the Korean Society of Tribologists & Lubrication Engineers, 17 (5) (2001) 358-364.
6. Y. Choi, J. W. Choi, H. M. Kim and Y. W. Seo, Thermal dissipation performance of the ventilated brake disc having helical grooved vent, Journal of the Korean Society of Precision Engineering, 21 (3) (2004) 117-123.
7. S. M. Kim, A study on thermal analysis in ventilated brake by FEM, Journal of the Korean Society of Machine Tool.
8. International Journal of Scientific & Engineering Research Volume 2 , Issue 8, August-2011.