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Experimental Vibration Analysis of Brake Rotor of a Bike

[#1]Mr. Akshay A. Pophale ,[#2] Prof.R.A.Marne

[1]pophale1992@gmail.com

[2]rahulashokmarne@gmail.com

[#1] PG Student -Mechanical Design Engineering, AISSMS College of Engineering, Pune-01.

[#2] Assistant Professor -Mechanical Engineering Department, AISSMS College of Engineering, Pune-01.

ABSTRACT

Noise and vibration associated with the braking process in passenger automobiles has become an important economic and technological problem in the industry. The knowledge of natural frequencies of components is of great interest in the study of response of structures to various excitations. Hence a brake disc plate with central hole, fixed at inner edge and free at outer edge is chosen and its dynamic response is investigated. The objective of current dissertation work is to analyze the vibration characteristics as natural frequency, mode shapes of brake disc with drilled holes of different diameter & of wear discs at outer end due to braking but with same ratios of inner to outer radius for inner edge clamped and outer edge free boundary condition. Clamped disc will be mounted on exciter and different resonance's was detected by varying the exciting frequency. As before response will be measured by an accelerometer. Also FEM software package is used for vibration analysis of brake discs with drilled holes with same boundary condition but having different dia. of holes for determining different parameters like Natural frequency, Mode shapes. Thus, theoretical and experimental results obtained are to be compared. This thesis deals experiences on finding natural frequency and the mode shape of disc brake. The test is done in both simulation and also experimental using a simple test. The disc brake is modeled using commercial computer aided design (CAD) software, Ansys. Experimental is done by using impact hammer to excite the disc brake and data recorded using data acquisition system (DAS) connected to sensor located on the disc brake. The results for both simulation and experimental is compared. The discrepancy errors recorded between simulation and experimental. Both mode shape of the natural frequency are discussed and analyzed.

Keywords— **Natural frequency, mode shape, vibration analysis, impact hammer, disc brake**

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I. INTRODUCTION

Disc brake noise and vibration are known to involve structural coupling between such components as the rotor, pads, caliper, and knuckle. Depending on the frequency range of interest, the hydraulic system, body panels, steering column, and other vehicle components can also become active. In an aggregate sense, the disc brakes of only a few percent of new vehicles exhibit sufficient noise and vibration to generate significant customer complaints, but the volume and expense of remediation efforts, in

addition to the perception of reduced product-line quality, place pressure on brake noise and vibration.
An acute problem is called as “squeal" noise, which is typically defined as that occurring within the range 1.5 to 20 kHz at one or more of the rotor's natural frequencies and its harmonics. For ventilated and solid core designs, rotors have the distinction of being structural elements, members of the disc-pad friction pair, and efficient radiators of sound because of their large surface area. The study of the dynamic behavior of brake disc is important, as several machine components. It can be considered as annular plates with radial holes for the purpose of analysis.

II.EXPERIMENTATION

Experimentation and analysis done by four methods as below:

- To find natural frequency by theoretical calculation.
- To find natural frequency & modes by FEM (Ansys software)
- To find natural frequency by FFT(Impact hammer test)
- To find modes by exciter

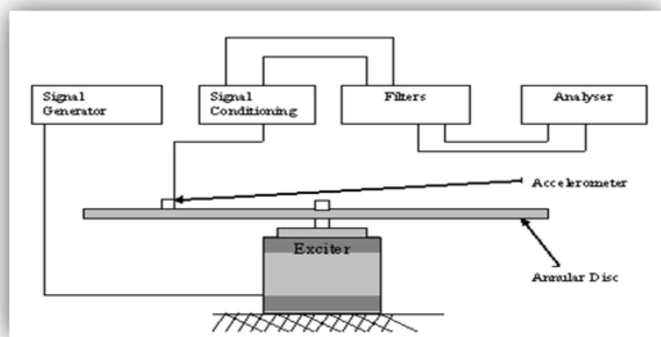

Fig.1. Experimental set up

TABLE 1

TEST SPECIMEN DIMENSIONS TYPE I (HERO HONDA CBZ).ASPECT RATIO B/A=0.5416, INNER DIAMETER =130 MM , OUTER DIAMETER = 240MM
.

Specimen	Disc thickness at friction area	Dia. of hole of holding wheel hub	Dia. of 30 air cooling holes in mm
4th Disk	3.20	10.5	8
5th Disk	3.20	10.5	10
6th Disk	3.20	10.5	12

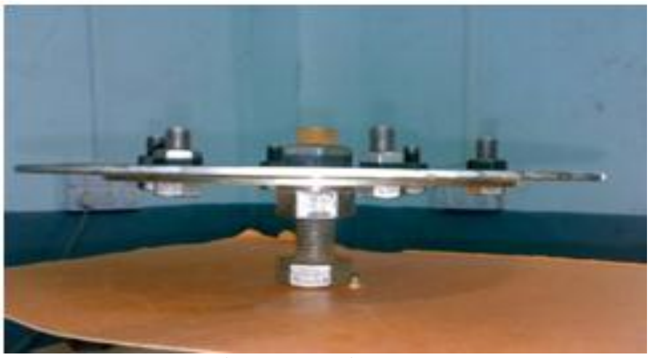

Fig 2. Test specimen and fixture in vice for impact hammer FFT test

Fig.3 Disc Brake Test Fixture In Vice.

In the second method, the clamped disk brake sample type II) (Hero Honda CBZ).was excited by electrodynamics exciter as Plate 4.4 Showing annular disk brake sample no.1 with seashore sand spread on disk brake before excitation starts.

1^{st} mode shape (0, 1) sample type I) (Hero Honda CBZ).
2^{nd} mode shape (1, 0) sample type I (Hero Honda CBZ).

Also, in second method of excitation, a sample type II) (Hero Honda Ambition).window having total 3 samples no. 5, 6, 7 were tested successfully to get two different mode shapes as shown in photographs below in plate 4.8 to 4.10


Mode shape (1, 0) of Sample No.4 type II (Hero Honda Ambition).
Mode shape (0, 1) of Sample No.4 type II (Hero Honda Ambition).

Mode shape (0, 2) of Sample No.4 type II (Hero Honda Ambition

III CONCLUSIONS

A. Specimen Type I:

- No. of nodal diameter decreases as natural frequencies increases all the six samples of disk brakes.
- Natural frequencies of disc brake of bike increases as the disc thickness decreases
- Natural frequencies of disc brake of bike decreases as the brake disc holder hole diameter increases

B. Specimen Type II:

- Natural frequencies of disc brake of bike decreases as the air ventilation hole diameter increases.

Some of the actual Mode shapes are found by spraying sea shore sand on disc while vibrated by Exciter.

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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.

[5.] Albert C. J. Luo, C. D. Mote, Jr. Glen L. Martin (2000), The Professor of Engineering, Honorary Mem. ASME, Office of the President, Main Administration Building, University of Maryland, College Park, MD 20742 studied, "Nonlinear Vibration of Rotating Thin Disks", PP 376-379.

[6.] D.V. Bambill, S. La. Malfa, C. A. Rossit, P. A. A. Laura, (2002),"Analytical and Experimental investigation on transverse vibration of solid, circular and Annular plates carrying a concentrated mass at an arbitrary position with Marine applications", Journal of ocean Engineering, vol31, pp127-138.

[7.] M. Ambali, G.frosali, M.K.Kwak(1996), "Free vibrations of annular plates coupled with fluids", Journal of sound and vibration, 1996 vol.191 (5), pp 825-846.

[8.] Wei-Ming Lee1 and Jeng-Tzong Chen(2009),"Free Vibration Analysis of a Circular Plate with Multiple 3 Circular Holes by Using the Multiple Trefftz Method", Tech science Press, PP 2-5.

[9.] W.M. Lee and J.T. ,Chen (2011),"Free Vibration Analysis of a Circular Plate with Multiple Circular Holes by Using Indirect BIEM and Addition Theorem", Journal of Applied Mechanics, PP011015-20 / Vol. 78, JANUARY 2011.

[10.] G.K. Grover, "Mechanical vibrations", Fifth edition, 1993, Nem Chand &
Bros., Roorkee, PP 295-305.

[11.] Larson Devis 2900B Company FFT analyzer Operating Guide, PP 219-225.

[12.] W.T. Norris and J.E.T Penny , **"**Revisitation of the computation of the resonant Frequencies of annular disc encastred at its inner edge and free at it's outer Edge", Dec 2002, AstonUniversity.

