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Vibration Analysis of Circular Tile Cutter

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ABSTRACT

Circular annular cutters with uniform radial cracks are extensively used in the cutting processes. Unwanted noise, vibration & accidental failure associated with the cutting process have 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, it is important to study a circular plate cutter with central hole, which fixed at inner edge and free at outer edge with its dynamic response. In this study some efforts are taken for analyzing vibration characteristics of annular disk cutter used in tile cutting industries with free boundary condition but having different (numbers of cutting teeth's, aspect ratio, effect of different slots, variable radial slit, circular concentric slit). From the FFT experimentation and FEM validation results, it is found that this study is needful for design data preparation. Secondarily, modal analysis is one of the better tools for finding vibration characteristics for such components. Thus theoretical and experimental results obtained are to be compared.

Keywords- Circular tile Cutter, aspect ratio, teeth's, radial slit, circular concentric slit ,diff.slots, vibration,FFT,FEM

I. INTRODUCTION

The study of the dynamic behavior of circular tile cutters with free boundary condition but having different (numbers of cutting teeths,aspect ratio,effect of radial slots,enlargement of stress concentration holes) is important, as used in several machine components, such as flywheels circular saw plates etc. The knowledge of natural frequencies of component is of great interest in the analysis of response of structures to various excitations. This study is fundamental for high-risk plants. Unwanted noise,vibration & accidental failure associated with the cutting process has become an important economic and technological problem in the industry that can be solved by this dissertation work.

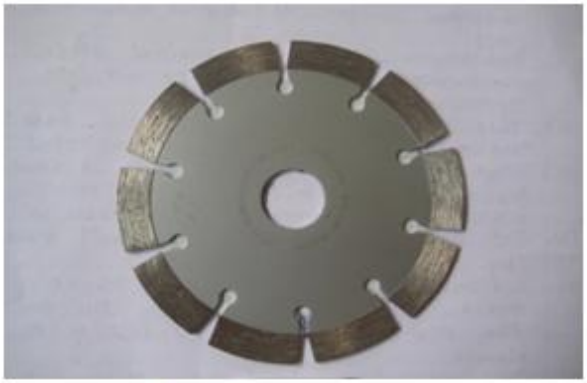


Fig. 1 Circular tile cutter

II. PHASES OF THE PAPER WORK

The paper work has divided by different phases such as literature survey, theoretical investigation, experimental procedure and validation of results,

Phase I -Review of literature regarding the work done. Extensive research review of the literature on this proposed topic of analysis of vibration of tile cutters; implemented by different researchers at present and their comparison with the proposed conceptual method of analysis.

Phase II -Theoretical investigation contain analysis of vibration characteristics of circular tile cutters with free boundary condition but having different (numbers of cutting teeth, aspect ratio, effect of radial slots, enlargement of stress concentration holes) is done with the FEM analysis.By purchasing such tile cutters in fig 1.from market, drawing & meshing.FEM software package is used for vibration analysis of tile cutters with same boundary condition for determining different parameters like natural frequency and mode shapes. Software analysis of different types of tile cutters done by using ANSYS.This will be needful in FEA for determining natural frequencies & mode shapes.

Phase III - Experimental work is done by two types. Using FFT analyzer, natural frequencies are detected by hitting the plates with impact hammer shows in fig 2.a. the response at a point of a plate is measured by using an accelerometer.FFT analyzer analyzed the output of

accelerometer.Analysis is done experimentally with the help of FFT analyzer, accelerometer, impact hammer.

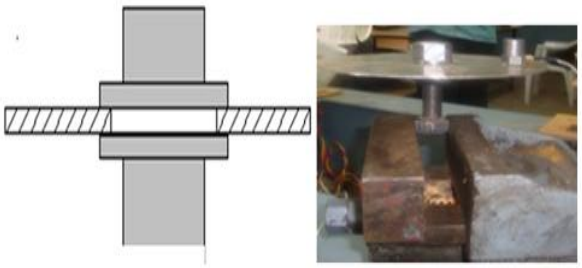


Fig. 2.a. Natural frequencies are detected by hitting the plates

Phase IV – Using exciter. Fig 2.b..shows that The clamped tile cutter will be mounted on exciter and different resonance's was detected by varying the exciting frequency. Mode shapes are investigated using sea shore sand, coal dust or salt to compare with FEM mode shapes of same test specimens.

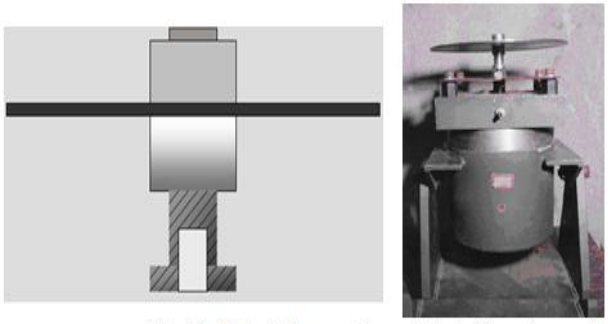
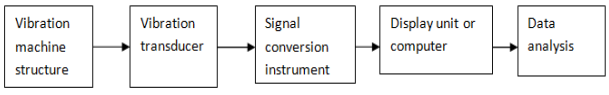


Fig. 2.b. Natural frequencies are detected by using exciter

Phase V – Validate the FEA result with available experimental (FFT) results

III. EXPERIMENT



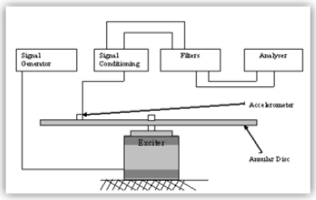


Fig. 3 Experimental set up

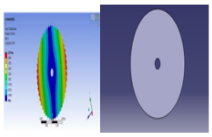
In analysis, fig. 3 gives overall flow dig and experimental set up of tile cutter is used for investigating the cutter bending modes. The structure is axi symmetric and formed of an isotropic homogeneous elastic material. Three dimensional parameters represents the disc's inner radius (*b),*outer radius (a) and thickness (h) respectively.

Test Specimens:- M.S. are chosen with same b/a ratio i.e. aspect ratio (Inner to outer radius ratio).Following are the material properties for the specimen tile cutter.
Young's modulus (E) = 2.1 X 10^{11} N/m^2
Poisson's ratio (γ) = 0 .3
Density of material (ρ) = 7850 N/m^3
Dia=100 mm, t=2 mm , N=14500 rpm
Different changes:-Specimens with variable thickness, different aspect ratios, different slot shape, variable no. of teeth of cutter, are chosen for test. These specimen sizes are chosen to facilitate the measurements by using the same fixture for all the specimens. As boundary conditions for cutter are inner edge fixed and outer edge free. The FEA analysis is done on the ANSYS software and following results was obtain which are tabulated as following

IV. RESULTS

By ANSYS Some of results are given below for circular TILE cutter.

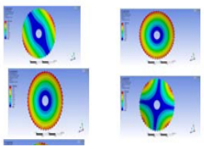
4.1. Following results were getting after variable teeth formation. Which is tabulated in bellow.



variable number of teeth	Mode1	Mode 1	Mode 2	Mode 2
For 9 teeth	80.14	80.34	100.34	100.84
For 10 teeth	82.64	82.75	102.51	102.67

4.1. Mode Shape & Natural Frequency for variable teeth

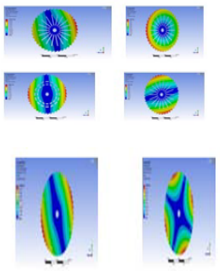
4.2. Following results were getting after variable aspect ratio . Which is tabulated in bellow



Variable Aspect Ratio	Mode1	Mode 2	Mode 3	Mode 4
For 9 teeth 20 mm inner dia.	82.64	82.75	102.51	102.67
For 9 teeth 25 mm inner	90.52	91.67	112.22	113.67

4.2. Mode Shape & Natural Frequency for Variable Aspect Ratio

4.3. Following results were getting after variable slits and slots.Which is tabulated in bellow



Natural Frequency	Mode1	Mode 2	Mode 3	Mode 4
a.Radial linear slit	65.25	65.36	90.45	91.68
b.Circular concentric slit	70.46	71.97	95.23	96.65
c.Different slots	82.74	82.87	102.75	102.88

4.3. Mode Shape & Natural Frequency for Variable a) Radial slit, b) Circular concentric slit and c) Different slots

V. COMPARISION OF RESULTS

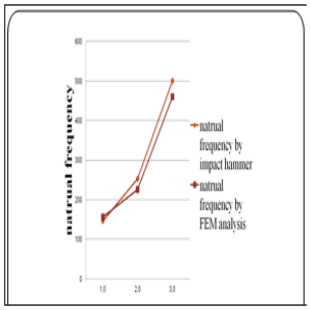


Fig 5.a.Impact hammer Verses FEM analysis

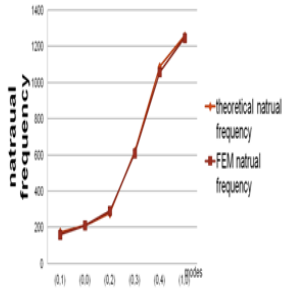


Fig 5.b.Theoretical Verses FEM

VI. CONCLUSION

Hence a circular saw cutter with variable central hole, inner edge is fixed and outer edge free with outer slots is chosen and its response is investigated, For increase in aspect ratio natural frequency also increase, for increase in number of Teeth natural frequency also increases, Natural frequency increases in case of circular slit & decreases in case of radial linear slit. Natural frequency decreases for change in shape of slot.

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