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J Aeronaut Aerospace Eng 2017, 6:3 (Suppl)
DOI: 10.4172/2168-9792-C1-020

5th International Conference and Exhibition on

MECHANICAL & AEROSPACE ENGINEERING

October 02-04, 2017 Las Vegas, USA

Instability analysis of brake disc with lattice structure with transient complex eigenvalue method and excitation applied to the pad

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Automotive disc brake squeal has been investigated as the constant source of worry in warranty and assurance issues in many years. Despite the fact that the brake works completely safe and reliable, it may cause the car manufacturer considerable profits loss from warranty claims depended to the characteristic of noise produced by the brake. Many researches have recorded that overheating of brake system and deterioration of friction coefficient can cause dynamic instabilities. Therefore, performance of braking mechanism obtains by adequate cooling properties of braking components and especially for high performance passenger vehicles is critical. Periodic cellular metals (PCMs) are effective heat exchange media with open cell topologies, which has high potential heat dissipation with small spaces and light weight relatively. PCMs are frequently used to design light weight sandwich panel structures, which create unilateral fluid flows and also are capable for absorbing the energy of contacts by thermal transport across the faces of sandwich structures. By recent advances in manufacturing technologies the evolution of PCMs has been encouraged. Thus, presentation of a new concept of bidirectional ventilated brake disc with more effective thermal capabilities for passenger vehicles is possible. The lattice brake disc is more capable for heat transferring which caused by the lattice core area at the pumping capacity, Nusselt number and circumferentially non-uniform heat transferring. But still yet there are no instability studies about the lattice brake disc structure. On this point of view, in this paper we model a rotationally periodic lattice structure consists of a finite number of identical substructures forming a closed structure as a brake disc, present equations of motion in principal coordinates with respect to the periodicity cell of lattice plate, the lattice stiffness and consequently define the response of the modes of a rotating disc excited by distributed axial load. The experimental modal analysis (EMA) with impact hammer test is used to obtain the brake rotor modal properties. Also, finite element Free-Free State and stability analysis with using the complex eigenvalue method is applied to define instability of lattice brake design.

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