Vibration characteristics measurement of beam-like structures using infrared thermography

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PII: S1350-4495(16)30232-8
DOI: http://dx.doi.org/10.1016/j.infrared.2016.09.003
Reference: INFPHY 2133

To appear in: *Infrared Physics & Technology*

Received Date: 18 May 2016
Revised Date: 31 August 2016
Accepted Date: 9 September 2016

Please cite this article as: S.M. Talai, D.A. Desai, P.S. Heyns, Vibration characteristics measurement of beam-like structures using infrared thermography, *Infrared Physics & Technology* (2016), doi: http://dx.doi.org/10.1016/j.infrared.2016.09.003

Vibration characteristics measurement of beam-like structures using infrared thermography

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HIGHLIGHTS

- A new IRT technique developed for structural vibration measurement in terms of frequency and displacement
- Frictional temperature evolution obeys coulomb law of friction
- Frictional heat generation increases with structural excitation frequency
- FFT checks the spectral peak in the noisy DFT temperature signature
- Heat transfer in the beam through conduction is non-linear, thus, finite temperature equation is used for computation of structural displacement

Keywords:

Vibration behaviour

Infrared thermography
Frictional heat generation

Condition monitoring

ABSTRACT

Infrared thermography (IRT) has matured and is now widely accepted as a condition monitoring tool where temperature is measured in a non-contact way. Since the late 1970s, it has been extensively used in vibrothermography (Sonic IR) non-destructive technique for the evaluation of surface cracks through the observation of thermal imaging of the vibration-induced crack heat generation. However, it has not received research attention on prediction of structural vibration behaviour, hence; the concept to date is not understood. Therefore, this paper explores its ability to fill the existing knowledge gap. To achieve this, two cantilever beam-like structures couple with a friction rod subjected to a forced excitations while infrared cameras capturing the thermal images on the friction interfaces. The analysed frictional temperature evolution using the Matlab Fast Fourier Transform (FFT) algorithm and the use of the heat conduction equation in conjunction with a finite difference approach successfully identifies the structural vibration characteristics; with maximum error of 0.28 % and 20.71 % for frequencies and displacements, respectively. These findings are particularly useful in overcoming many limitations inherent in some of the current vibration measuring techniques applied in structural integrity management such as strain gauge failures due to fatigue.

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