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Short Communication

Some comments on use of antiresonance for crack identification in beams

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1. Introduction

Identification of crack in a structure is an active area of research since decades. Several vibration based methods have been suggested in the literature to identify the crack size and location in a structure. Doebling et al. [1] gave the review of identification methods. Sinha et al. [2] have discussed several methods and have suggested the model updating-based identification of crack size and location. In recent years, the use of antiresonance of structure has received great attention in system identification and diagnosis [3]. Bamnios et al. [4] has used first antiresonance to identify the crack in a beam. They have shown that the driving point impedance changes substantially due to the presence of the crack and the changes depend on the location and the size of the crack and on the force location. Monitoring the change in the first antiresonance frequency as a function of the measuring location along the beam, a sharp change in the slope of the plot in the vicinity of the crack occurs. The magnitude of the change in the slope depends on the size of the crack. Bamnios et al. [4] has demonstrated this concept through few experimental results. However experiments conducted on a free–free beam with open cracks could not show such a distinct feature to identify the crack location. The observations are presented here.

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2. Modal experiments

An aluminum beam of 1.95 m long and 20 mm diameter is used in the experiment. A small instrumented hammer (Kristler 9722A2000) and a tiny accelerometer (B&K4500 A) weigh 4.1 g has been used for the modal experiments. Fig. 1 shows the schematic of modal testing on a free–free beam hung on a very flexible rubber band on either sides of the beam. Total 14 locations in steps of 150 mm shown in Fig. 1 were used for response measurements. LMS CADA-X system was used for data accusation, frequency response functions (FRFs) computation, and modal analysis using multi-degrees of curve fitting on the measured FRFs to extract modal parameters—natural frequencies, modal damping and mode shapes. Initially the complete dynamic characterization of the free–free beam without crack was carried out. The frequency band up to 512 Hz with a small frequency resolution of 0.0625 Hz was used to measure the first few beam modes. The identified first five bending modes are 32.25, 85.75, 167.9, 277.5 and 413.2 Hz. Then the point frequency response function (FRF) tests were conducted on the same beam using same frequency band and resolution to pick-up the small changes in anti-resonance along the beam length. The driving point FRF tests were conducted at 14 locations in steps of 150 mm on the beam without crack, with one saw cut open crack (crack size 50% of the beam diameter) at center (between locations 7 and 8), and with two 50% saw cut cracks (one at center, other at 450 mm from one end). Fig. 2 compares the variation in four anti-resonances along the length of the beam for all three cases (no crack, one crack, and two cracks).

3. Comments

Although the tests in the laboratory were conducted in a very controlled manner, it can be seen from the figures that it is difficult to locate the actual crack locations for a simple example chosen. Theoretically the sharp change in the slope of antiresonance plot at crack location may be observed but realization in the measurements is difficult. It is shown through a simple example of a free–free beam. In fact, such tests in the field—e.g., on rotor of a turbo-generator set, would impose even more difficulty to locate the crack location, as there could be more noise in the

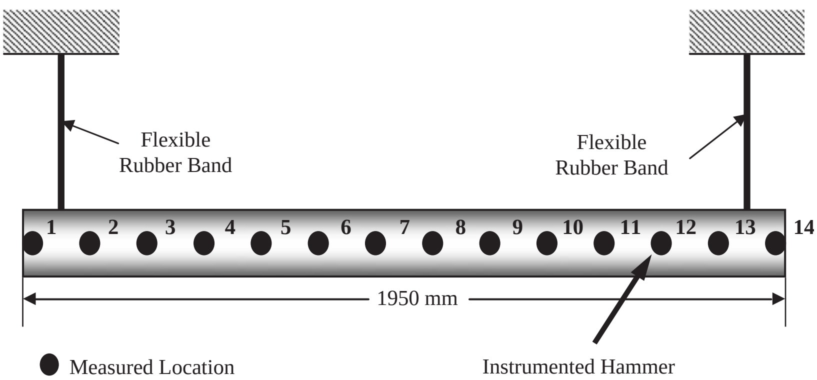

Fig. 1. Setup for modal tests.

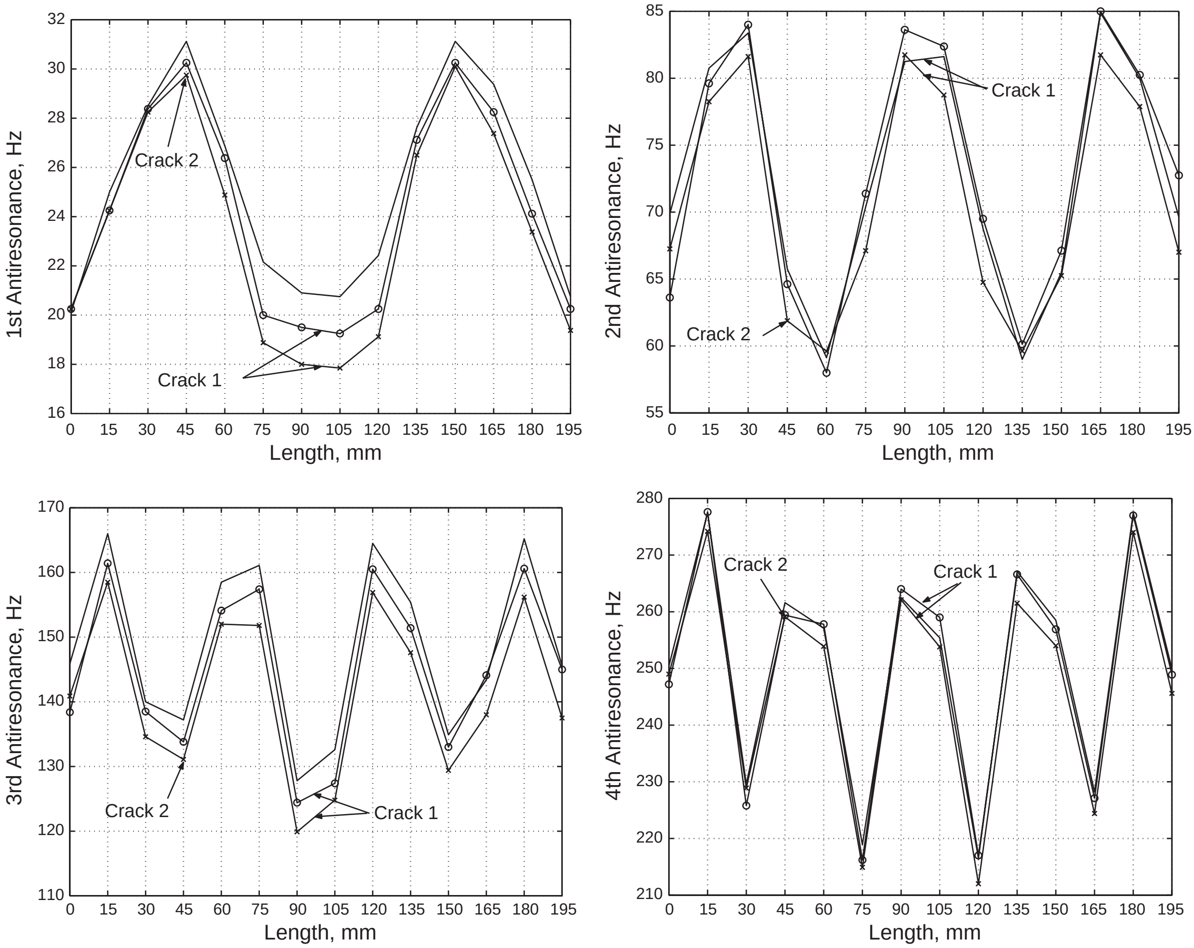

Fig. 2. Variation in antiresonances along the beam length (line—no crack, circle—one crack, ×—two cracks).

measurements. Hence a more robust method using antiresonances has to be evolved for practical applications.

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