

The Fundamental Study of the Dynamic Properties of Simply-Supported Beams with Damage

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Summary

Damage detection methods based on vibration tests have obtained much attention over the past 30 years, because dynamic properties can be conveniently obtained in engineering [1, 2]. However, from practical experience, many researchers in this field argue the suitability of these methods, especially when measurements are taken in a noisy environment [3, 4]. One possible support of these arguments is the intuition that damage is a local phenomenon, while modal data are global properties of a system. However, these arguments are still lack of fundamental explanations.

In this paper, an analytical solution of natural frequencies and modes of simply-supported beams with a single damage is presented. With this solution, detail studies have been carried out about the sensitivities of natural frequencies, mode shapes, the mode of rotation angle and the curvature mode to damage. Solid proofs are presented to give a fundamental explanation why natural frequencies and mode shapes are insensitive to local damage. Moreover, it finds out that the mode of rotation angle and the curvature mode are sensitive to damage. However, it is very difficult to measure curvature modes precisely in real engineering project. Therefore, the damage detection method based on the mode of rotation angle is most promising, if the measurement noises are well controlled.

keywords: damage detection, dynamic properties, analytical solution, beam, structural health monitoring

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