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Reducing resonances of beams using antiresonance technique

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The suppression of structural resonances has been an important subject in the engineering field for decades. Several researchers have presented that the addition of single or multiple damped absorbers can be used as a practical solution for reducing beam resonances [1-5]. The determination of the optimal parameters of damped absorbers became the main focus on their studies. Recently, Chen and Sun presented a new alternative for reducing the resonant vibration of simply supported structures [6]. Their analytical and numerical results showed that with appropriate resonators, a significant reduction in structural vibration can be achieved. This novel idea arises from a two-degree-of freedom system which is composed of an absorber mass connected by linear springs to a drive mass subjected to a harmonic exciting force [7]. If the driving frequency is close to the antiresonance frequency of the whole system, the absorber mass will generate an equal force but opposite to the external force. As the result, the original oscillating system remains stationary since the absorber mass exactly cancels the effects of the input force. In this study, the experimental verification of the antiresonance effect on vibration suppression of beam structures was performed. Results showed that the resonances of the beam can be effectively suppressed by using resonators with proper frequencies.

An aluminium beam structure with periodically attached resonators as shown in Fig. 1 was constructed and used in vibration experiment. For comparison, the responses of the beams with and without the resonators were acquired using a white-nose signal with bandwidth from 0 to 500 Hz. The resonant frequency of the resonators is designed as the same as the first resonant frequency (106Hz) of the beam structure. Fig. 2 shows the power spectruma of two beams, which are directly acquired from LabView. A clear peak indicating the first resonant frequency of the beam is found in Fig. 2(a). The results of Fig. 2(b) showed that when the forcing frequency is close to the antiresonant frequency of the whole structure, the intensity of the wave with frequency 106 Hz almost goes to zero and two other peaks with smaller intensity are found. Fig. 2(c) and Fig. 2(d) exhibit the acceleration response spectruma of the beams without and with resoantors, respectively.

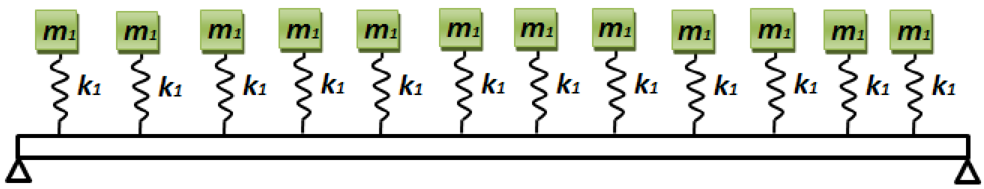

Fig. 1 A simply-supported beam with periodically attached resonators

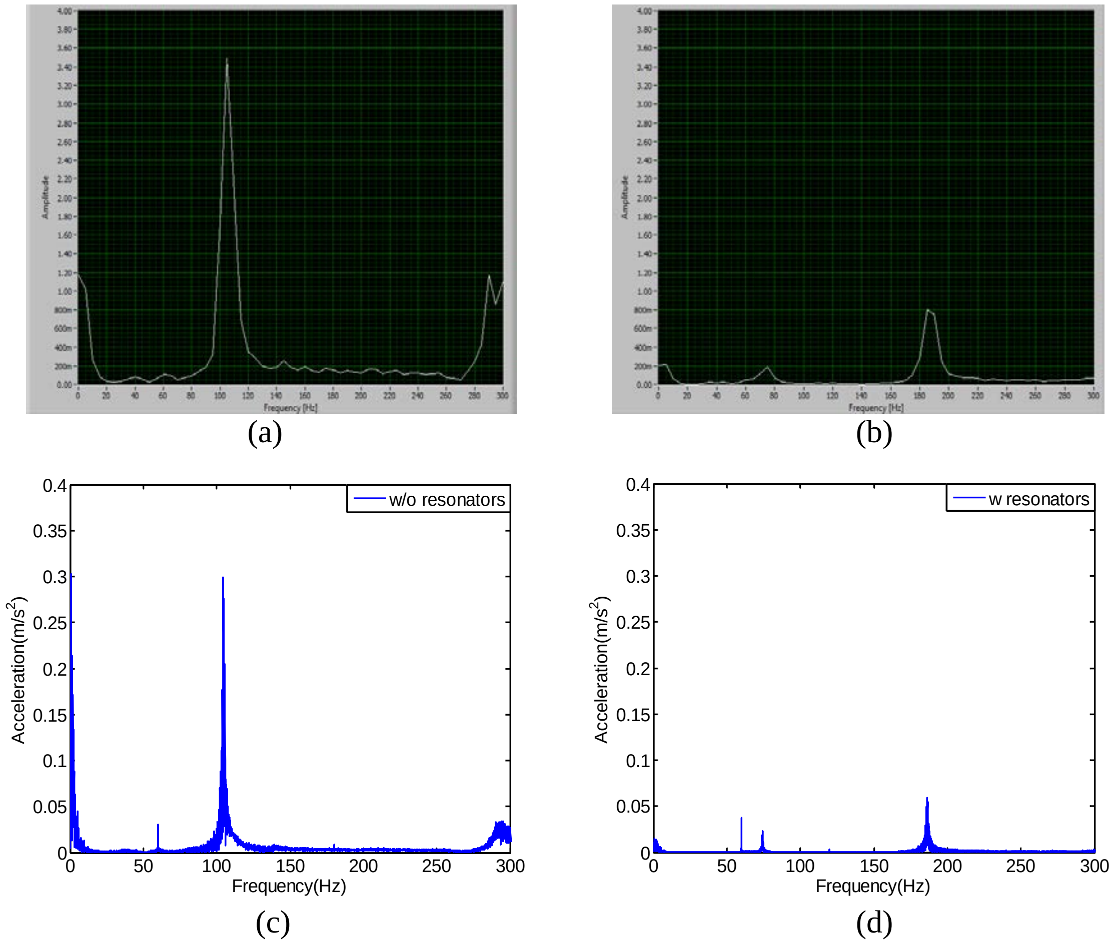

Fig. 2 (a) Power spectrum of the beam without resonators (b) power spectrum of the beam with resonators. (c) acceleration response spectrum of the beam without resoantors (d) acceleration response spectrum of the beam with resoantors.

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