Use of Modal Flexibility Method to Detect Damage in Suspended Cables and the Effects of Cable Parameters

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ABSTRACT: Modal flexibility is a widely accepted technique to detect structural damage using vibration characteristics. Its application to detect damage in long span large diameter cables such as those used in suspension bridge main cables has not received much attention. This paper uses the modal flexibility method incorporating two damage indices (DIs) based on lateral and vertical modes to localize damage in such cables. The competency of those DIs in damage detection is tested by the numerically obtained vibration characteristics of a suspended cable in both intact and damaged states. Three single damage cases and one multiple damage case are considered. The impact of random measurement noise in the modal data on the damage localization capability of these two DIs is next examined. Long span large diameter cables are characterized by the two critical cable parameters named bending stiffness and sag-extensibility. The influence of these parameters in the damage localization capability of the two DIs is evaluated by a parametric study with two single damage cases. Results confirm that the damage index based on lateral vibration modes has the ability to successfully detect and locate damage in suspended cables with 5% noise in modal data for a range of cable parameters. This simple approach therefore can be extended for timely damage detection in cables of suspension bridges and thereby enhance their service during their life spans.

Keywords: Modal flexibility, damage detection, lateral modes, vertical modes, damage indices, noise, bending stiffness, sag-extensibility