ABSTRACT

The objective of this investigation was to establish the sensitivity of damage detection techniques based on frequency and mode shape, when different boundary conditions were applied. Modal testing was conducted on a steel beam with varying crack depths by introducing a saw cut at the quarter span point. The steel beam was subjected to three different support conditions by suspending it at the ends with elastic tubing, simply supported on springs or rollers. The first eleven natural frequencies and mode shapes were extracted and compared with the readings from the datum state. Changes in natural frequencies, curvature mode shape, modal assurance criterion (MAC) and coordinate modal assurance criterion (COMAC) were used as damage identification techniques to evaluate and identify the state of the structure.

It was observed that the frequencies for all the modes reduced with the occurrence of damage and for the flexural modes the magnitude of reduction was smaller with increase in support stiffness. It was also possible to use the percentage change in natural frequencies to detect the damage location in the structure. By applying an algorithm using changes in the mode shape curvature, the damage location can be located for the free-free beam, but not sufficiently sensitive for the other support conditions. A new algorithm was developed to identify the damage location for the other support conditions. The dual cracks condition was also considered in order to verify the applicability of the algorithm. Finally, by combining the results from experimental modal analysis and a finite element model, a new damage identification technique was proposed.