Vibration Characteristics of Beam Structures Resting on Elastic Foundations using Finite Element Analysis

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Abstract:

Beams are one of the common elements used in engineering applications such as aerospace, marine, civil, and automotive structures. They resist applied transverse loads and bending moments. Beams are usually characterised based on their profile (shape of cross-section), length, equilibrium conditions, manner of support, and material. Loads from the external sources, such as wind and earthquake, may cause the vibration of beam structures, which should be controlled to prevent catastrophic failures of the structures. Hence, determining vibration characteristics of beam structures and knowing their natural frequencies can be helpful to prevent structural failures when the resonance phenomenon occurs. One method to control vibration and prevent failure of beam structures under external excitations is to use elastic foundations. To understand the vibration behaviour of beam structures, a finite element (FE) model of the beam is developed to simulate the beam geometry with assigned material properties, a generated FE mesh, elastic foundations, and applied loading and boundary conditions. Vibration modal analysis of the FE beam model is done to determine natural frequencies, and then harmonic responses are obtained to calculate the vibration displacement and phase angle for different natural frequencies. The effects of boundary conditions, beam material, elastic foundations, and excitation forces on the natural frequencies and harmonic responses are investigated.

Keywords:

Beams, Elastic foundations, Finite element analysis, Structural dynamics, Vibration.