 Proceedings of ICCES'08, pp.167-168

Recent Advances in Dynamics of Trusses with the Method of Reverberation Ray Matrix

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Summary

Recently, Pao, Keh and Howard [1] proposed a novel matrix method, i. e. the method of reverberation ray matrix (MRRM). Based on Timoshenko beam theory the method investigates the dynamic response of the planar trusses in terms of axial and flexural waves propagating along structural members and scattering at the joints. Comparison to experimental data of the model truss under a step load shows good agreement for the early as well as considerably long time responses. Afterwards, Pao and Sun [2] applies MRRM to analyze the dynamic behavior of pin-jointed trusses subjected to suddenly applied force. It is found that the amplitude of dynamic bending strains in the members of pin-jointed trusses, as in the rigid jointed trusses, are comparable with the dynamic axial strains in the same member.

The investigations of dynamic response of truss type structures with MRRM are still limited in the literature. Nothing else than the responses of bending and axial strains of trusses subjected to Heaviside step force have been reported. However, some of the engineering problems, such as sudden subsidence of foundation of engineering structures, can be categorized as suddenly applied displacement at support or joint of the structure. The present work develops formulation of MRRM in terms of Euler-Bernoulli beam theory and analyzes the transient response of the structure subjected to step or impulse displacement load. The efficiency and accuracy of MRRM is verified by comparison of results of MRRM and Mindlin's solution for a single beam, and that of FEM for the transient response of axial and shear forces, bending moment, displacement, velocity and acceleration of a 17-bar rigidly jointed truss.

In modal analysis, the modal vectors are often obtained as eigenvectors of a set of homogeneous differential or algebraic equations. However, in the present study the modal functions of frames are retrieved from the frequency response function (FRF) of displacement of the structure under the action of an impulse load. Nevertheless, solutions of MRRM in frequency domain here are employed to obtain FRF of displacement of frame. Three example problems are analyzed: (1) a simply supported beam; (2) a Γ shape frame and (3) a 17-bars planar frame. The vibration modes as well as natural frequencies obtained from MRRM coincide well with those obtained from FEM of ANSYS.

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References

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