Regularization and differential quadrature procedures for dynamic analysis of beams with arbitrary discontinuities

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Abstract

Many physical and mechanical phenomena that can be well described by means of the Dirac-delta function and its derivatives. For instance, the dynamics of beams with an arbitrary number of Kelvin-Voigt viscoelastic rotational joints, translational supports, and attached lumped masses under heat source points can be mathematically modeled by means of the Dirac-delta function and its derivatives. The resulting partial differential equation has to be handled by means of well adapted numerical procedures. In this work, the differential quadrature method (DQM) is adapted for space an implicit scheme for time discretisation. The DQM is a straightforward method that can be implemented with few grid points and resulting with a reasonably good accuracy. However, the DQM is well-known to have some difficulty when applied to partial differential equations involving singular functions like the Dirac-delta function. This is caused by the fact that the Dirac-delta function and its derivatives cannot be directly discretized by the DQM. To overcome this difficulty, this work presents a combination of the DQM with a regularization procedure. Thanks to this regularization of the Dirac-delta and its used derivatives, the resulting differential equations can be directly discretized using the DQM. To validate the applicability of the proposed formulation and its implementation, computational examples of beams with arbitrary discontinuities are considered. The obtained results are well compared with the analytical and numerical results available in the literature.

References

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