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Formulation of the differential equations of motion for non-classically damped systems

Communication Info

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Abstract

Non-classically damped systems [1] have damping matrices that are not proportional to mass and stiffness, producing coupled modal equations and complex vibration behavior. This work presents a systematic formulation of the differential equations of motion for such systems, starting from the general multi-degree-of-freedom equilibrium in matrix form and retaining fully non-proportional damping [2][3][4]. The limitations of classical modal decoupling are highlighted, and the need for more general solution strategies is underlined. The governing equations are expressed in compact matrix notation and recast into an equivalent first-order state-space representation. This framework enables the computation of complex eigenvalues and bi-orthogonal mode shapes [5], which form the basis for modal decomposition and accurate prediction of dynamic response. The formulation provides a consistent foundation for numerical implementation and for the analysis of non-classically damped structural systems under dynamic loading.

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