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Hierarchical Legendre expansion for the dynamic response and wave propagation of metallic and composite beams

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An efficient tool for the analysis of the dynamic response and wave propagation of composite structures is presented. The Carrera's unified formulation (CUF) is used to generate higher-order beam theories that are able to deal with complex dynamic behaviors with a solid-like accuracy and reduced computational efforts. For this purpose, the Hierarchical Legendre Expansion (HLE) is employed to expand the displacement unknowns over the cross-section of the beam by means of locally defined domains which can represent arbitrary geometries of the structure. In this manner, any deformation state can be represented, e.g. shear and torsional warping, and the accuracy of the model is tuned by the polynomial order of the Legendre functions, which remains as a user-defined input of the analysis. The governing equations are obtained both in weak and strong form. For the former, the Finite Element Method (FEM) is recalled to discretize the longitudinal axis by means of 1D beam elements and, subsequently, the hp-convergence is studied. On the other hand, locally supported Radial Basis Functions (RBF) are employed to generate a class of meshless models based on Wendland's C^6 functions. The latter presents some interesting features for the dynamic analysis of beam-like structures, including high-fidelity of the solutions and computational advantages. The results from these two approaches are assessed and compared, and the coupling FEM-RBF is investigated.