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ON THE EFFECTIVENESS OF COMPONENT-WISE MODELS IN ANALYZING CIVIL ENGINEERING FRAMED STRUCTURES

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Numerous technologies have facilitated the advancement of civil engineering in the modern world, including complex analyses and computer aided techniques. The growth in the knowledge of structural engineering has mainly coincided with improvements in computational methods, notably the finite element method (FEM). In fact, the advancement of the complexity in structural design demands more refined analysis, which are usually accomplished by using complex 3D solid models. The main drawback of 3D FEM models is that the computational costs rapidly rise as problem complexity increases. In this work, a novel approach to the analysis of civil engineering structures is proposed. This approach is based on the Carrera Unified Formulation (CUF) [1], which allows for the straightforward implementation of refined beam models able to deal with solid-like analysis with very low computational costs. Particular attention is focussed on a class of CUF models that makes use of Lagrange polynomials to discretize cross-sectional displacement variables [2]. This class of models are referred to as Component-wise (CW) in recent works [3, 4]. According to the CW approach, each structural component (e.g. columns, walls, frame members, floors) can be modeled by means of the same 1D formulation [5]. A number of typical civil engineering framed structures (e.g. simple beams, arches, truss structures, complete industrial and civil buildings) are analyzed and CW results are compared to classical beam theories (Euler- Bernoulli and Timoshenko), refined beam models based on Taylor-like expansions of the displacements on the cross-section, and classical solid/shell FEM solutions from a commercial code. The results highlight the enhanced capabilities of the proposed formulation. It is in fact demonstrated that CW models are able to replicate 3D solid results with very low computational efforts.

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