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ON THE USE OF A COMPONENT-WISE APPROACH FOR THE ANALYSIS OF DAMAGED STRUCTURES

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The computational analysis of damaged structures requires the proper detection of very accurate displacement, strain and stress fields. Moreover, the effects due to the presence of multi-scale components (e.g. layers and fibers) or multi-dimension components (e.g. 1D and 2D) has to be taken into account to obtain reliable results. Currently, most of the techniques that have been developed for these tasks are based on the 3D solid finite elements with very high computational cots. This means that the accurate structural analysis of complex structures is almost impossible due to the enormous number of degrees of freedom that is required.
This paper proposes an innovative approach that is based on 1D (beam) advanced models for the damage analysis of structures. The present 1D formulation stems from the Carrera Unified Formulation (CUF)[1][2] and it leads to a Component-Wise (CW) modeling [3, 4]. The CUF represents an innovative tool to develop theories of structures. Any-order 2D and 1D structural models can be developed in a unified and hierarchically manner and they provide extremely accurate results with very low computational costs. The 1D CUF formulation, which is based on the use of Lagrange polynomials to describe the cross-section displacement field of the structure, is exploited in this paper and leads to a Component-Wise approach (CW). In a CW model, each component of a complex structure can be modeled through a refined 1D model based on Lagrange expansions. The adoption of only 1D models to model complex structures improves the multi-dimension coupling capabilities and reduces the computational costs to a great extent. The CW can lead to a multi-scale approach for composites since each typical component of a composite structure can be modeled through the 1D CUF models and, moreover, different scale components can coexist in the same model with no need of further modeling tools. A detailed physical description of a real structure can be obtained since

- Each component can be modeled with its own material characteristics, that is, no homogenization techniques are required.

- Although 1D models are exploited, the problem unknown variables can be placed on the physical surfaces of the real 3D model, that is, no artificial surfaces or lines have to be defined to build the structural model.

In this paper, damages are introduced in structures and their effects are evaluated in terms of static and dynamic responses. Comparisons against classical approaches are provided to show the enhanced capabilities of the present approach in obtaining 3D-like accuracy with very low computational costs.

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