Recent advances in the Component-Wise modeling of structures for damage and wave propagation problems

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Abstract

This paper presented the latest developments related to the Component-Wise approach (CW). The CW is based on the use of Lagrange Expansion (LE) 1D CUF models. LE models have the following features [1]:

- The unknowns of the problem are pure displacements. In other words, no rotations or higher-order variables are needed.
- LE model variables and BCs can be located above the physical surfaces of the structure. No mathematical lines or surfaces are needed.
- Locally refined models can be easily built since Lagrange polynomial sets can be arbitrarily spread above the cross-section.

LE models are 1D models that lead to a high-fidelity physical, volume/surface-based geometrical modeling, as shown in Fig. 1. LE models are of particular interest for the analysis

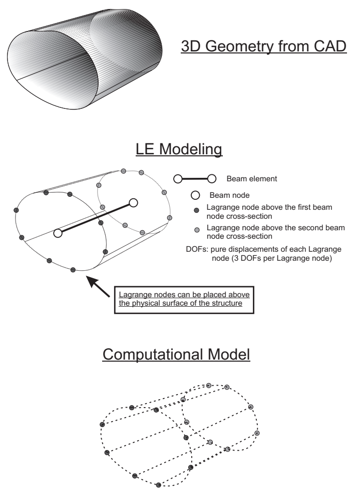

Figure 1: The physical volume/surface approach of LE.

of multi-component structures, such as reinforced shells for aeronautical applications or fibre reinforced composite plates. These structures have various components, which can have quite different geometrical and material characteristics. In an aircraft wing, for instance, ribs can be modelled as 2D structures, while stiffeners or spars can be modeled

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as 1D or 3D structures. An efficient FE modelling often requires the coupling of different elements beams/shells/solids to build sufficiently accurate models with a reasonable number of DOFs. LE models can be exploited to model each component of a structure separately. The resulting approach is denoted as component-wise (CW), since LE models are used to model the unknown variables of each structural component [2, 3]. The CW approach can also be considered as a multiscale approach. 1D LE models can be simultaneously adopted to model layers (macroscale), matrix and fibres (microscale)[4]. Figure 2 shows possible CW strategies. This paper presents an overview of the CW approach

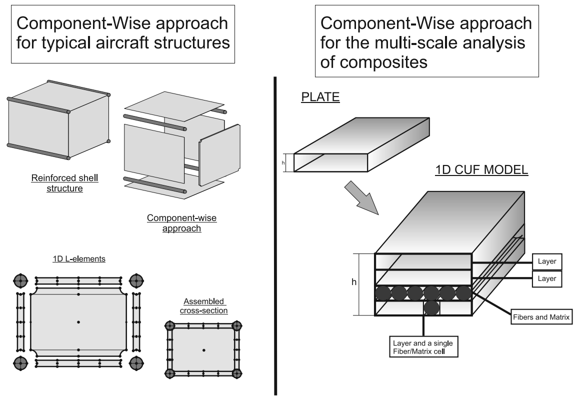

Figure 2: CW modeling strategies.

and numerical examples. Particular attention is paid to the damage analysis of structures [5] and wave propagation problems. The high-fidelity CW modeling of local damages and multiscale components is exploited to investigate dynamic responses. Comparisons with classical approaches are carried out.

References

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