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ANALYSIS OF DAMAGE NUCLEATION AND GROWTH IN WOVEN COMPOSITE MATERIALS CONSIDERING LAYER SHIFTING EFFECTS

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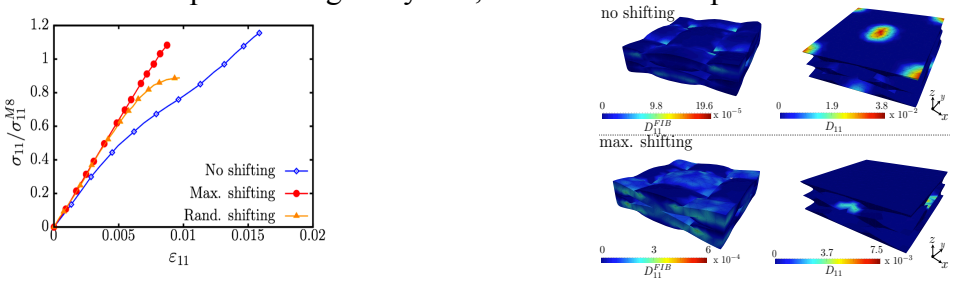
Woven composite materials have been used for decades in structural applications. However, there is still a lack of knowledge about their structural integrity, partially due to their complex microstructure introducing mesoscale effects in the manufacturing process such as the relative layer shifting between layers and local changes in volume fractions, adding additional challenges to the designer. This has led to different modeling approaches. One approach assumes that one-layered repeating unit cell represents the whole laminate [1,2] and another approach consists of several layers based on detailed imaging [3]. In this work, a step in-between these approaches is adopted by considering the effect of the layer shifting as an isolated mesostructural variation. First, the effects of layer shifting are analyzed focusing on the global elastic response using analytical, numerical and experimental results of [4] Fig. 1a.



a) b)

Figure 1. No shifting, random shifting and maximum shifting responses. a) Experimental global stress-strain curves [4], b) damage developed in the yarns (D_{11}^{FIB}) and matrix (D_{11}).

The nucleation and growth of damage is discussed, Fig. 1b, incorporating different non-linear constitutive relations in the matrix and yarns in finite element simulations. The magnitude and location of damage in the matrix and the yarns are highlighted, discussing their influence in the characteristic responses for each shifting configuration.

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