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COMPONENT-WISE MODELS FOR THE ANALYSIS OF COMPOSITE STRUCTURES EXPOSED TO AGING PHENOMENA

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Composite materials are progressively replacing the conventional metallic materials, especially in aeronautical applications, by contributing to significant weight and cost savings. The benefit of these kinds of materials lies in their enhanced specific strength and stiffness, design flexibility, long life. The presence of the polymeric matrix makes fiber-reinforced composite materials liable to absorb moisture in a humid environment, eventually at elevated temperatures and, in general, to undergo detrimental aging phenomena if exposed to atmospheric condition. The phenomenon of aging can be depicted as a gradual process in which the properties of a material, structure, or system, change (for better or worse) over time or with use, due to biological, chemical, or physical agents; corrosion, obsolescence, and weathering are examples of aging. The prediction of the mechanical response of composite structures exposed to aging phenomena is crucial to avoid the structural failure, that is, appropriate numerical tools must be adopted. Since the aging acts differently on the polymeric matrix and the carbon fiber the classical models may lead to inaccurate results when homogenized materials are considered.

The present paper aims to extend the use of refined one-dimensional models to the analysis of aged composite structures. The use of the component-wise approach allows the matrix and the fibers to be considered as independent entities. The introduction of refined kinematic approximations leads to a three-dimensional solution. The Carrera Unified Formulation has been used to derive the formulation in a compact and general form. The effect of the aging phenomena, in particular, due to the UV light exposition, has been introduced with a reduction of the material properties following the results presented in the literature. The present models have been used to investigate the effects of the aging phenomena on the structural response and the distribution of the internal stress field. The results show that the aging can generally affect the structural response. The more dramatic effects can be seen at the local level where the reduction of the matrix performances leads to a substantial variation in the stress field.