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# PROGRESSIVE INTERFACIAL FAILURE OF ADHESIVE JOINTS BASED ON A 1D MODEL OF DECOHESION

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## ABSTRACT

A notorious issue in the study of the mechanical behavior and failure of composites materials and structures is still a good knowledge of the interactions between the constituents and the constitutive response of the interfacial regions. In fact, in case of initiation and subsequent propagation of decohesion zones at these regions a severe degradation of both stiffness and strength can compromise the integrity of a structure. As an example, decohesion processes arisen at the joint between a structural element (steel, concrete or wood beams; masonry arches and vaults) and its reinforcement system (steel plates or fiber reinforced textile composites strips attached by welding or adhesive bonding) can vanish all strenghtening effects of the retrofit method for repairing a damaged structures.

With reference to adhesive joints in particular, a great deal of work has been done. The earliest investigations on this subject were focused on the interfacial stress distributions in the elastic regime [1-3]. More recently, on the one hand many experimental and numerical studies have dealt with the strength and failure mode of single bonded joints (see, e.g., [4-5]), on the other the behavior and efficiency of specific strengthening systems bonded to structural elements has been analysed (see, e.g., [6-9]). On the contrary, a little attention has been payed to the analysis of as simple as possible systems, but representative of the essential mechanical aspects of the adhesion/decohesion problem, to investigate the influence of the adherend geometry and elasticity as well as of the interface stiffness and toughness on the mechanical response and strength of an adhesive joint (see, e.g., [10] for an exhaustive study on fiber pullout).

In this context, this paper deals with the analysis of the interfacial stresses as well as of the initiation and propagation of decohesion zones in multilayered one-dimensional adhesively bonded structures. In particular, an attempt at semi-analytically and numerically modeling of the damage process is made through a complete simulation from damage initiation to ultimate failure of the adhesive bond. Within classical linearly elastic beam theory and according to a bilinear damaging interface model, the analysis builds on that proposed in [11-12]. The simplified 1D structural model previously developed considering only shear interfacial stresses is here extended to investigate also

the effects of the transverse (peeling) stresses on the damage evolution and failure of the bond. The results so obtained are then used to characterize the interface strength and behavior also in the post-critical regime, as well as to draw interesting conclusions and suggestions on suitably planning strength tests for adhesive bonds in order to optimize the accuracy of experimental results.

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