A coupled stress and energy criterion to assess the strength of pull-pull bonded joints

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ABSTRACT

Finite Fracture Mechanics makes use of a coupled stress and energy fracture criterion resting on the assumption of a discrete crack growth. It was first proposed by Leguillon [1]. Afterwards, Finite Fracture Mechanics has been applied successfully to a wide class of materials and geometries, including bonded joints [2-3]. While for the pull-push direct shear test [3] delamination always occurs at one edge, for the pull-pull test (or the double lap joint) both the bonded region extremes are prone to debonding. Aim of the present work is to provide a failure load estimate for this latter geometry according to the Finite Fracture Mechanics approach.

Depending on the ratio among the axial stiffness of the adherents, on the bond length and on the brittleness of the interface, the discrete crack growth leading to debonding failure of the joint can occur only at one side or at both sides, either symmetrically or asymmetrically. The estimate of the failure load is given by developing a suitable numerical procedure: the actual crack growth is found by solving a minimization problem.

After a parametric analysis, the predictions obtained by the present approach are compared with the ones recently provided by Liu et al [4] exploiting the widely-used and well-established Cohesive Crack Model. Excellent agreement is obtained both in terms of failure load estimates and in terms of finite crack growth/process zone size. The agreement corroborates the use of the Finite Fracture Mechanic as an effective tool for strength assessments. The solution provided herein can be of interest both for civil engineering applications, e.g. to assess the mechanical performance of FRP-to-concrete interface, and for mechanical engineering purposes, e.g. to estimate the strength of double lap joints (provided the adhesive behaviour is sufficiently brittle).

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