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ON THE THROUGH-THE-WIDTH PROPAGATION OF TRANSVERSE DAMAGE IN GLASS/EPOXY LAMINATES VERSUS PLY THICKNESS

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ABSTRACT

Cross-ply laminates fulfilling a low value of the 90º /0º ply block thickness ratio are particularly prone to suffering scale effect, Parvizi et al [1]. This effect has a well-known apparent consequence when subjecting a laminate to uniaxial tension, it consisting in a delay on the appearance of transverse damage in the 90º ply block as the thickness of this block decreases versus the 0º one.

More recently and motivated by the commercial appearance of ultra-thin plies, París et al [2] proposed a fully physically based explanation of the scale effect based on the experimentally observed actual mechanisms of damage of the laminates and, in particular, based on the initial stages of the damage mechanisms in the 90º ply block. The explanation provided was supported by a numerical study just based on energetic Fracture Mechanics concepts. The main conclusion derived from that study was that the first damage occurring in the 90º ply block was less detrimental as the thickness of this block was decreased, its growth being also delayed. Similar conclusions were obtained in the latter work of Sánchez-Carmona et al [3] but in the case of cyclic loads.

Those previous works were concentrated in the appearance of transverse cracks in the 90º ply block and the latter generation of delamination cracks between the 90 and 0º ply blocks; nevertheless, the propagation of these cracks along the axial direction of the fibres in the 90º ply block, i.e. the tunnelling, was not undertaken. The observation of the in-situ through-the width propagation of transverse cracks can be efficiently monitored when employing glass-epoxy laminates, Carraro et al [4].

In this work, an experimental programme is planned on different configurations of cross-ply laminates made of glass fibre and epoxy matrix, see Fig.1, in which the thickness ratio between the 90º and 0º ply blocks is varied. Specimens are tested under uniaxial tensile load. The main objective is to capture the beginning of the damage in the 90º ply block and its subsequent tunnelling along the specimens' width. The analysis of the results obtained will allow to elucidate whether any modification on this stage of damage arises as the 90º/0º thickness ratio changes, and, in particular, when ultra-thin thicknesses of the 90º layers are involved.

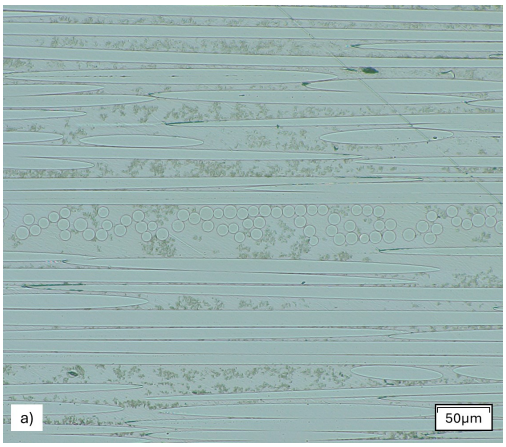

Figure 1: Pristine free-edge glass/epoxy specimen,

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