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FAILURE MECHANICS ANALYSIS OF COMPOSITE LAMINATE

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Delamination, which will initiate from matrix cracks or from manufacturing defects, is one of the most common failure modes of fibre reinforced composite laminates due to the low strength in the through-the-thickness direction. In laminated materials, repeated cyclic stresses, low velocity impacts, etc. can cause layers to separate and give rise to a delamination. The delamination may be difficult to detect and can reduce the bending stiffness, enough to cause local buckling when compressive loads are present. It can significantly influence the structural integrity and, for this reason, it has been the subject of past and on-going research.

The AP-PLY architecture[1] as shown in Figure 1, made possible through the use of the Advanced Fibre/Tow Placement technology, shows promise of improved damage tolerance. The simplified model we are going to use is shown in Figure 2. However, the specifics of where and when a delamination will start and how it will grow are not well understood. In the present contribution, the interlaminar stresses, which are crucial to the initiation of delamination, are evaluated based on the interlaminar stress recovery technology created by C. Fagiano[2] that showed accurate out-of-plane stresses can be obtained with relatively coarse mesh.

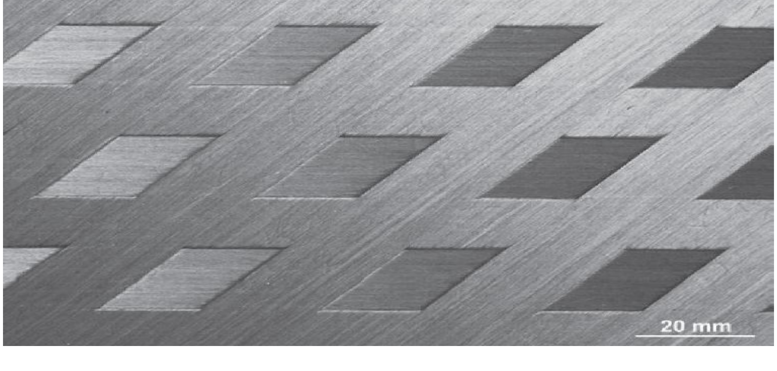

Figure 1 Example of one pattern of AP-PLY plate

Through the recovered stress, the critical location where delamination initiation is most probable is located. This is done with the use of a simple out-of-plane failure criterion[3]. After that, the energy release rate is used to predict the most probable direction of crack propagation. Then, cohesive elements are used to simulate the crack propagation. The load magnitude of which a crack initiates and the rate of crack propagation are monitored during the simulation. Representative results are shown in Figure 3.

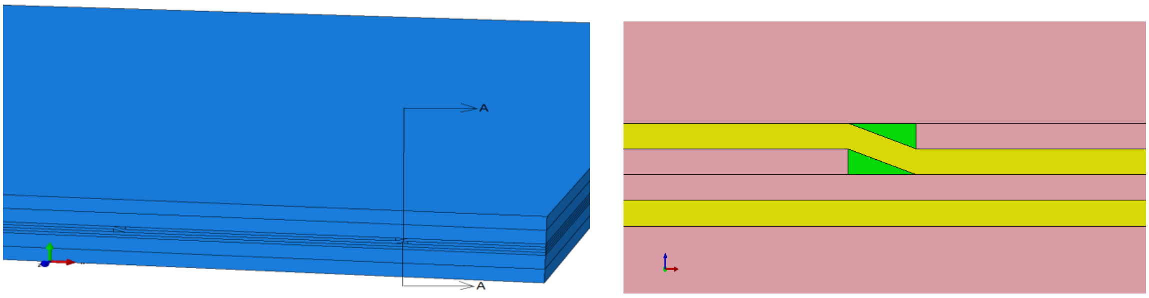

Figure 2: part of the simplified model and A-A section

In order to gain insight of how different AP-PLY configurations perform after damage, the effect of different parameters such as pattern used, thickness and inclination of crossing tows will be presented. Results of the simulation will be compared with test results.

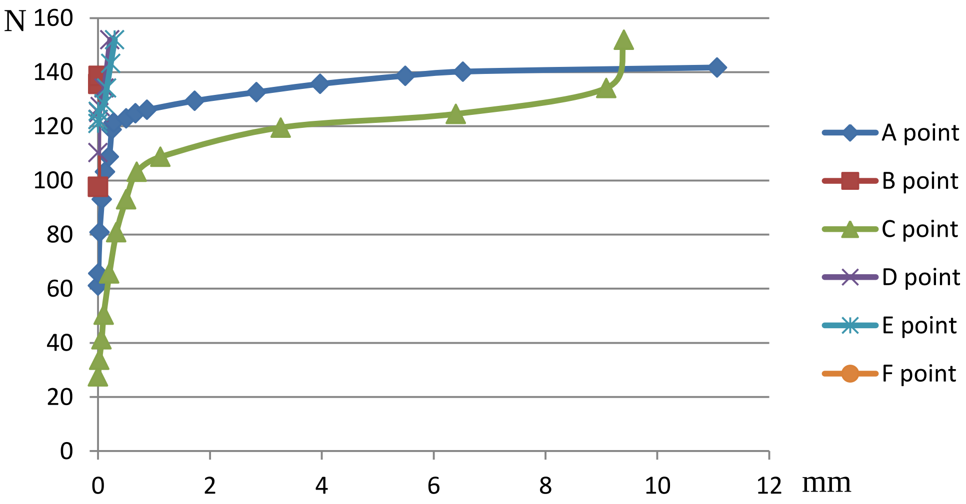

Figure 3: Crack propagation under loading

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