OPTIMISATION OF LAYUP AND LAMINATE STACKING SEQUENCE TO MAXIMISE ENERGY ABSORPTION OF TENSION ABSORBING JOINTS

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Tension-absorbing composite joints are mechanically-fastened joints designed to absorb energy when loaded in tension in a crash scenario, by guiding the bolt to push through and crush the laminate over a long distance. They have been developed by Airbus and DLR [1]. Layup and laminate stacking sequence plays a significant role in the performance of a composite joint [2-6]. The situation is highly complex, due to the numerous possible stacking sequences, and the various possible failure modes. A two-fold optimisation algorithm is proposed, using a three-dimensional, finite element composite damage model. First, for each candidate lay-up (i.e. a given percentage of plies in each direction), the stacking sequence (exact sequence of ply directions) is optimised. Then optimisation is performed on the candidate lay-ups. Two objective criteria are used: offset bearing strength and energy absorption. Figure 1 shows the process. The laminate thickness is kept at 2 mm and only symmetric and balanced layups are considered to reduce the size of the optimisation problem. This work is a first attempt to incorporate a high-fidelity, three-dimensional model, in an optimisation framework for bolted joints.

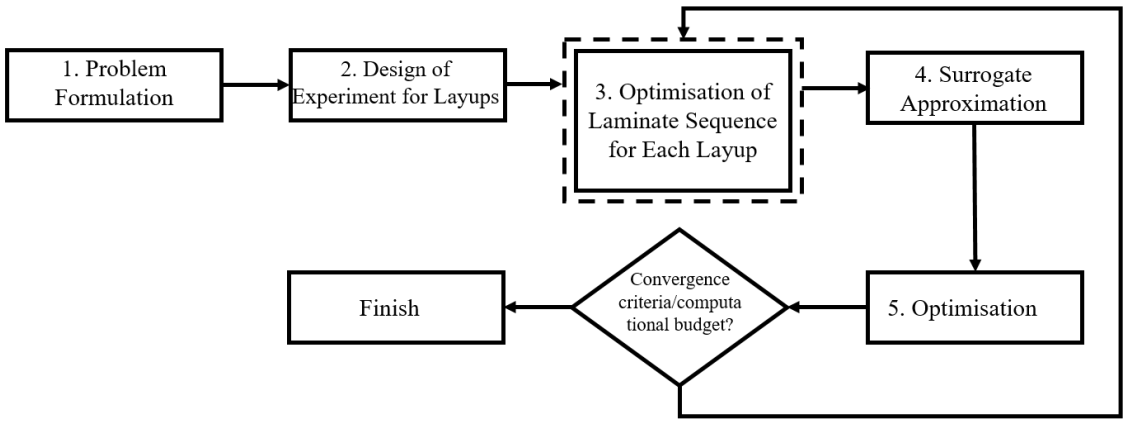

Figure 1. Optimisation algorithm for layup and laminate stacking sequence

[1] Waimer *et al.* (2018). *Int. J. Crashworthiness* **2**, 193-218 [2] Riccio *et al.* (2013). *App. Compos. Mats.* **20**, 249-273. [3] Aktas *et al.* (2003). *Compos. Struct.* **62**, 107-101. [4] Jiang *et al.* (2017). *Compos. Struct* **171**, 382-402. [5] Matthews & Tester (1985). *Int. J. Adhesion and Adhesives* **5**, 13-18. [6] Park (2001). *Compos. Struct* **53**, 213-221.