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Analysis of Splicing Methods for High Speed Automated Fibre Placement Applications

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Abstract : The focus in the automotive industry is to reduce human operator and machine interaction, so manufacturing becomes more automated and safer. The aim is to lower part cost and construction time as well as defects in the parts, sometimes occurring due to the physical limitations of human operators. A move to automate the layup of reinforcement material in composites manufacturing has resulted in the use of tapes that are placed in position by a robotic deposition head, also described as Automated Fibre Placement (AFP). The process of AFP is limited with respect to the finite amount of material that can be loaded into the machine at any one time. Joining two batches of tape material together involves a splice to secure the ends of the finishing tape to the starting edge of the new tape. The splicing method of choice for the majority of prepreg applications is a hand stich method, and as the name suggests requires human input to achieve. This investigation explores three methods for automated splicing, namely, adhesive, binding and stitching. The adhesive technique uses an additional adhesive placed on the tape ends to be joined. Binding uses the binding agent that is already impregnated onto the tape through the application of heat. The stitching method is used as a baseline to compare the new splicing methods to the traditional technique currently in use. As the methods will be used within a High Speed Automated Fibre Placement (HSAFP) process, this meant the parameters of the splices have to meet certain specifications: (a) the splice must be able to endure a load of 50 N in tension applied at a rate of 1 mm/s; (b) the splice must be created in less than 6 seconds, dictated by the capacity of the tape accumulator within the system. The samples for experimentation were manufactured with controlled overlaps, alignment and splicing parameters, these were then tested in tension using a tensile testing machine. Initial analysis explored the use of the impregnated binding agent present on the tape, as in the binding splicing technique. It analysed the effect of temperature and overlap on the strength of the splice. It was found that the optimum splicing temperature was at the higher end of the activation range of the binding agent, 100 °C. The optimum overlap was found to be 25 mm; it was found that there was no improvement in bond strength from 25 mm to 30 mm overlap. The final analysis compared the different splicing methods to the baseline of a stitched bond. It was found that the addition of an adhesive was the best splicing method, achieving a maximum load of over 500 N compared to the 26 N load achieved by a stitching splice and 94 N by the binding method.

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