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OPTIMIZATION OF A COMPOSITE PANEL REPAIRED BY BONDED SCARF PATCH

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Summary: In the last 50 years the use, development and understanding of adhesive joints has been continually growing thanks to the many advantages that adhesives offer compared with other more traditional techniques for fastening materials, such as welding, riveting and bolting. The adhesive joints offer improved stress distribution in the joint, superior corrosion resistance, ability to join dissimilar materials and thin sheets, lower assembly weight, etc.
Because of the advantages mentioned above, adhesives are used to repair CFRP panels that have undergone damage in the aircraft industry. The purpose of the repair is to restore the damaged component to a usable condition. As the use of advanced composite materials increases, there is a growing need for studying the consequences of the repair methods on structural performance.
After many years of study, various repair techniques have been successfully applied. Among them, adhesively bonded structural repair has gained more favor than mechanically fastened structural repair for the reason that fiber reinforced composites are essentially bonded in nature. Therefore, in recent years, considerable experimental and numerical studies have been conducted to investigate the influence of different repair parameters on the stress distribution, ultimate strength, and stress intensity factor of the bonded repaired structures. However, relatively little research work has been carried out to analyze the failure mechanism of these repaired structures, a good knowledge of which is essential for the repair design and certification.
In this work, the structural response of a bonded scarf joint has been investigated by means of finite element analyses. The study aims to investigate the major parameters which influence the behavior of composite panels repaired by means of bonded scarf patch. Starting from a test case available in literature, a 2D model was defined using plane strain elements. Thanks to the reducing of the degree of freedom of the 2D problem, it was possible to simulate in a relatively short time, by means of non-linear analyses and a quite fine mesh, the real plasticization process of the adhesive with its final failure. Therefore the experimental elasto-plastic curve was considered for the adhesive material while the composite was considered linear-elastic up to failure.
Another reason which push to a computational cost saving was the optimization process planned. The software ModeFrontier was used to perform the optimization and in particular a genetic algorithm was used.
The design variables taken into account were the scarf angle and the staking sequence of the bonded patch, while the objective function consisted into maximize the residual strength of the repaired item. Constrain functions were defined to overcome physical requirements. The obtained results would give useful information about the best layout of a composite panel repaired by bonded scarf patch.