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STRESS AND SIF ASSESSMENTS ON A DAMAGED ADHESIVES JOINT FOR SPACE APPLICATIONS

Abstract

The emerging paradigm of new and reusable launch vehicles (e.g. SpaceX in the USA or MaiaSpace-Ariane Group in Europe) is requesting the use of more performant and reliable structures able to withstand the launch and re-entry loads for multiple missions. Within this field, the use of structural adhesive joints for bonding composite-composite, metal-metal or composite-metal parts is technologically essential to achieve lightweight structures with higher reliability levels. In working with adhesives, the Very High Cycle Fatigue (VHCF) range is of special interest. Particularly, it is necessary to evaluate the effects of manufacturing defects or damages that are ascribable to pre-existent microcracks, flaws or voids, which imply the failure onset. In addition, the available literature in this field highlights the failure onset from the free surface/edge also in the case of internal defects that could be driven by closure mechanics and plasticization. In this work, Stress Concentration Factor (SCF) - Stress Intensity Factor (SIF) assessments based on linear Frequency Response Analysis (FRA) are provided on a classical damaged/undamaged aerospace joint sample, within the framework of the Finite Elements Methods (FEM) along with theoretical considerations. The adopted methodology consists of a global-local analysis where the global results concern the full displacement of the overall mathematical model, while the local outcomes are deduced from a refined sub-region of the global one. Especially, the local region refers to the structure-adhesive section of a space launch vehicle in both the case of undamaged and damaged specimens. Moreover, the influence of the defect shape, dimension and position is also explored by means of stress analyses and a failure index evaluation. By means of this approach, rational and robust evaluations can be effectively performed regarding: *i*) singular/non-singular stress field, *ii*) SIF and SCF, *iii*) possible crack closure mechanisms, *iv*) failure conditions, *v*) influence of the shape and position of the defect.