MATHEMATICAL ASPECTS OF FRACTURE PROBLEMS IN FUNCTIONALLY GRADED MATERIALS

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by

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Chapter 6

Overall conclusion and scope for the future work

6.1 Overall conclusion

The increasing use of functionally graded materials necessitates a detailed study of this non-homogeneous composite under different loading conditions. The manufacturing process or service life of a mechanical component may be affected by the inherent flaws of functionally graded material, which could result in catastrophic failure. Beyond a certain size, the local increase of the stress in the vicinity of the provided fault might cause a fracture, which can significantly affect the system's load transmission behavior. As a result, a thorough understanding of fracture mechanics is required, as well as suitable insight into the different forms of fracture in functionally graded materials. Several factors, including the composition of materials, shape, applied external stress, temperature, time, number of cycles of load, environmental effects, SIF, SMF, SERR, etc., can affect the occurrence of a crack. As a result, the motivation behind this thesis was to employ mathematical tools and methodologies

to investigate the fracture problem in functionally graded composites under various loading conditions. For numerical computation and plotting graphs, the software MATHEMATICA is used. Some of the noteworthy findings drawn from the entire chapter are listed below.

- **Stress intensity factor:** The severity of stresses brought on by the remote load or residual stresses close to the crack or notch tip can be predicted with the help of SIF. From the different chapters of this thesis, it can be concluded that crack tip SIFs increase significantly when two or more cracks are in close proximity. Also, along with the applied loading, geometry, and non-homogeneity parameters, the impact of crack orientation angle and position of applied loading on SIF is non-negligible.

- **Stress magnification factor:** The crack's shielding and amplification tendencies are described by the SMF parameter that aids in finding the possibility of crack arrest. The chapters of this thesis reveal that even though the cracks are in close proximity under certain geometrical and loading conditions the possibility of crack arrest is there that leads to reduction in crack propagation.

- **Strain energy release rate:** The dissipation of energy while fracture per unit process of a newly created fracture surface area is measured by SERR. The effect of crack angle and behavior of SERR near the composite structure interface are the interesting findings of the chapters.

- **Heat flux intensity factor:** The HFIF is used to describe the singularity of heat flux near the crack tip. This driving force parameter is affected by the direction of heat flow in addition to the geometrical and thermal parameters.

6.2 Scope for future work

Despite ongoing research in the field of fracture mechanics in functionally graded materials, substantial challenges remain. The research of dynamic arbitrary-oriented crack propagation has always been a highly subjective topic. Researchers are working hard to find analytical solutions to various forms of boundary value problems by applying mathematical concepts to this type of crack problem. The numerical solutions to crack propagation problems in FGM are presented in this thesis. Future research will focus on analytical approaches for a variety of semi-infinite, arbitrary-oriented fracture models in the context of functionally graded composites. It will also be interesting to look into the fracture behavior of functionally graded orthotropic and functionally graded piezoelectric materials, where the study of crack propagation problems has a significant role.

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