Chapter 6

Conclusions and future work

6.1 Conclusions

In this section, the entire research work has been summarized. The thesis focuses on five problems related to crack propagation in single or double-layered media resting over half spaces, under various theoretical mechanical loading conditions, which are distributed over four main chapters. Stratified engineering structures can be made from a variety of materials, such as viscoelastic, anisotropic, transversely isotropic, heterogeneous, composites, and more, and this diversity is an important factor to consider in understanding crack propagation behavior.

The main goal of this thesis is to use specific mathematical techniques to investigate some crack propagation problems across the aforementioned multilayer engineered structures. Furthermore, the results of each problem of this work have shown the numerical simulation for different combinations of orthotropic composite materials. The software used to generate graphs for each study conducted during the whole research work are MATHEMATICA and MATLAB.

The fracture parameters to study crack propagation, such as SIF, SMF, and COD, have been studied theoretically and shown graphically for various crack and material-related parameters. Lastly, the summary of some of the most important findings and conclusions from the whole thesis is given below.

- **Chapter 1** introduced the thesis with the literature survey and the methods used.

- **Chapter 2** investigates the first crack problem of the thesis. In this chapter, the problem of three collinear cracks has been studied in a sandwiched medium under normal loading conditions. The approximate analytical expressions of SIF derived at tips of the cracks and SMF obtained for the central crack. The effect of wave number and depth of the strip on SIF and SMF have been shown graphically.

- **Chapter 3** is designed to incorporate two different problems of an edge crack. In the first problem, the edge crack is situated in a vertical orthotropic strip bonded by a half-plane, and the second problem consists of the problem without the half-plane. The expressions of SIFs for both problems have been derived using Schmidt Method. It is observed that the SIF is much higher for the second problem than for the first problem through the numerical simulation and graphical representation of the SIF.

- **Chapter 4** deals with the interfacial semi-infinite crack for antiplane shear loading conditions. The crack problem in this chapter was solved by using the Wiener-Hopf technique along with Fourier transformation. The asymptotic analytical expressions for SIF and COD have been derived. The effect of the depth of the strip and the material parameters have been shown graphically. The semi-infinite interfacial crack problem in this chapter using Wiener-Hopf technique was studied very first time.

- **Chapter 5** investigates a new crack model consisting of a system of four semi-infinite orthotropic strips weakened by two interfacial semi-infinite cracks under normal loading. The asymptotic analytical expressions of SIF and COD have been obtained for both cracks by using Wiener-Hopf technique. The effect of the depth of the strips and material constants have been shown through graphical presentation.

This thesis aims to contribute to ongoing research efforts in the field of crack propagation by studying the behavior of the cracks in a specific material or structure under various loading conditions. The ultimate goal is to gain a better understanding of the underlying mechanisms that control crack growth and also to develop predictive models those can be used to inform design and maintenance strategies.

6.2 Scope for future study

Crack propagation is an interesting and important area of research, and looking into its future, the following insights are the motivation to continue the research work in this field.

- Advances in material science: The field of material science is constantly evolving, and new materials are being developed to address various engineering problems, including crack propagation. The identification of the next generation of materials with improved crack resistance, strength, and toughness, can be used in existing systems. For example, crack propagation and arrest in smart materials, nanomaterials and FGM, etc., can be the part of future research work.

- Computational modeling: Advances in computational modeling have changed the way to approach crack propagation problems. With the development of new algorithms and software, it is now possible to simulate crack propagation in complex systems with high accuracy. Investigating the future of computational modeling in this area, using new techniques and tools for solving crack propagation problems will be the future direction of research.

- Use of AI-ML in crack modelling: In recent years, there has been an increasing interest in using machine learning techniques to predict stress intensity factors. These methods involve training a model on a dataset of known stress intensity factors and using the model to predict ()K) for new geometries and loading conditions. While these methods are still in the early stages of development. There are scopes to improve the accuracy and efficiency of the calculations of stress intensity factor. As machine learning and artificial intelligence are the depend of the future, so using the AI-ML models in the composite structures, one can predict the failure and maintenance of the system more effectively.

- Sustainability and environmental considerations: Sustainability and environmental concerns are becoming increasingly important in engineering research. Researchers are exploring how to crack propagation problems can be addressed in a sustainable and environmentally friendly way. This could involve exploring new recyclable materials or repair methods that minimize waste.

- Industry applications: Crack propagation problems are relevant to many industries, including aerospace, automotive, and manufacturing. Investigating the future of these industries can provide valuable insights into the challenges and opportunities for addressing crack propagation problems. This can involve exploring new technologies, processes, or materials being developed to address these challenges.

Overall, the future of crack propagation problems is an exciting area of research with many potential avenues for exploration. By investigating the latest developments in material science, computational modeling, sustainability, and industrial applications, identifying new approaches and solutions to this critical problem will be the focus of future work.