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Title of the thesis: A Study of Some Multiple Crack Problems

Abstract

The primary objective of the thesis is to study multiple crack problems under different mechanical loading conditions. The problem of multiple cracks is a highly complex phenomenon. The main complication is the interaction between closely located cracks, the formation of the coalesced yield zones, and the effect on the residual strength of the material. Therefore, this thesis is an attempt to study some multiple crack problems when yield zones coalesce between closely located cracks. The effect on the residual strength of the plate is evaluated when the yield zones are subjected to constant, linear, and nonlinear stress distributions. Mathematical expressions of some fracture parameters are obtained using the well-known complex variable method. This thesis is prepared in seven chapters and a chapter-wise summary is given below.

Chapter-1 (Introduction to Fracture Mechanics) is devoted to the brief idea of some basic concepts of fracture mechanics. An effort has been made to study the brief history, origin, introduction, application, and scope of the field of fracture mechanics. The basic idea of brittle materials, ductile materials and the concept of ductile to brittle transition is given. A brief literature review is also presented in this chapter.

Chapter-2 (Mathematical formulation for the crack problems) consists of basic terminologies and fundamentals of the theory of elasticity. Complete mathematical methodology solves the problem of multiple cracks in an infinite isotropic plate under given boundary conditions and is discussed in detail. Relations between stress components and complex potential functions are given in this chapter.

Chapter-3 (A study on four straight cracks with coalesced yield zones in an infinite elastic perfectly plastic plate) presents the theoretical work for a multi-site damage problem in which an infinite isotropic plate is weakened by four cracks with coalesced yield zones. The approach is based on the Dugdale's strip yield model, the analytical solution of the problem is obtained by using the complex variable approach. Closed-form expressions for some fracture parameters like applied load ratio and yield zone length are obtained in terms of elliptical integrals for different kinds of stress profiles constant, linearly, and quadratically varying. Moreover, a numerical study was also carried out in the chapter to validate the analytical findings. Results are also compared with the solution of some equivalent configuration of previously published work.

In **Chapter-4 (Mathematical model for five collinear straight cracks with coalesced yield zones)** Dugdale's model has been modified to investigate the behaviour of load bearing capacity of an infinite plate containing five collinear straight cracks with coalesced yield zones. Yield zone lengths near each crack tip for mode-I type deformation are analysed under small scale yielding conditions. The effect of coalesced yield zones under different types of mechanical loading conditions is studied in this chapter. Numerical results are obtained for yield zone length and applied load ratio. Obtained analytical results are also validated with the available results for some limiting cases.

An effort has been made in **Chapter 5 (Strip yield zone model for six straight cracks with coalesced yield zones)** to study the problem of six collinear straight cracks with coalesced yield zones. The infinite boundary of the plate is under the application of uniform stress distribution, and as a result, cracks open in mode-I type deformation. Mathematical expressions to evaluate the length of yield zones are derived and the results represented graphically in the chapter.

Chapter-6 (Three unequal and asymmetric cracks with coalesced yield zones) is devoted to the strip yield model solution for the problem of three unequal straight cracks with coalesced yield zones. The effect of parabolic stress distribution is considered on the rims of yield zones is studied. Analytical results for various fracture parameter are obtained in terms of elliptic integrals. A numerical study is carried out to study the yield zone length at each crack tip.

Chapter-7 (Conclusion) contains brief and condensed representations of results obtained for different stress profiles in chapter 3, 4 and 5. The reason for including these results in this chapter is just for the sake of completeness.