Abstract. The crack problems are important not only in macromechanics but also in micromechanics. Because of its importance a lot of analytical, numerical and experimental studies have been published in journals and books. Among them, the study of Green’s function attracts many researchers’ attention because analytically it may provide solutions for arbitrary loading through superposition and numerically it can be employed as the fundamental solutions for boundary element method and as the kernel functions of integral equations to consider crack interaction problems. Although a lot of Green’s functions have been presented in the literature, due to mathematical infeasibility most of them are restricted to two-dimensional problems and very few of them consider possible coupled stretching-bending analysis which may occur for general unsymmetric composite laminates subjected inplane and/or out-of-plane forces and moments. In this paper we consider an infinite composite laminate containing a traction-free crack subjected to concentrated forces and moments at an arbitrary point of the laminate. By employing Stroh-like formalism for the coupled stretching-bending analysis, recently the Green’s functions for the infinite laminates (without holes) were obtained in closed-form. Based upon the non-hole Green’s functions, through the use of analytical continuation method the Green’s functions for cracks are now obtained in explicit closed-form and are valid for the full fields. By proper differentiation, the associated stress intensity factors are also solved explicitly.

Introduction

Although there are several papers published in the literature discussing cracks in laminates subjected to concentrated forces and moments, most of them dealing with two-dimensional or pure bending problems such as those presented in [1,2]. However, pure two-dimensional or pure bending formulation is not enough to describe the mechanical behavior of general unsymmetric composite laminates because even under inplane or pure bending loading condition coupled stretching-bending deformation may occur due to anisotropy and asymmetry layup of the laminates. To deal with the laminates with stretching-bending coupling, recently Stroh-like complex variable formalism was developed [3]. By this formalism, the analytical solution for a perfect infinite composite laminate subjected to concentrated forces and moments was obtained explicitly [4]. Employing the solution for the perfect laminates the Green’s function for a laminate containing an elliptical hole is obtained through the use of analytical continuation method [5]. In this paper, we will discuss more detailedly about the cracks in laminates subjected to concentrated forces and moments when possible stretching-bending coupling occurs.

Cracks in Laminates

Consider an infinite composite laminate containing a straight through-thickness crack subjected to concentrated forces $\hat{f} = (\hat{f}_1, \hat{f}_2, \hat{f}_3)$ and moments $\hat{m} = (\hat{m}_1, \hat{m}_2, \hat{m}_3)$ at point $\hat{x} = (\hat{x}_1, \hat{x}_2)$ (Fig. 1). The crack is located on

$$-a \leq x_1 \leq a,$$  \hspace{1cm} (1)