The Effect of harmonic moving load on the stress intensity factor of cracked beam

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Abstract

Beam type structures are one of the most important elements which have been studied intensively. Many researches have been devoted to the study of the effects of moving loads on the dynamic behavior of beams. On the other hand, the effect of cracks on the dynamic behavior of beams has received much attention because of its importance in both mechanical and civil engineering applications.

Stress intensity factor (SIF) is a parameter of the crack which denotes the intense of stress at the cracked zone. The effect of the SIF is more intense when the beam is subjected to a moving load. Moving loads cause larger displacements and higher stresses than static loads in structures. The presence of cracks affects the mechanical properties and also the strength of beams especially in cases in which beams are subjected to a moving load. One kind of the moving loads which is more important in the engineering applications is harmonic moving load. In this work the effect of a harmonic moving load on the stress intensity factor (SIF) for the single edge crack in a simply supported undamped Euler-Bernoulli beam is investigated. Also the effects of the loading duration, frequency and the speed of the moving load and also the location and size of the crack on the SIF are studied.

Keywords: stress intensity factor (SIF), cracked beam, harmonic moving load, vibration

1. INTRODUCTION

In many engineering applications, fatigue crack propagation and/or Brittle fracture are of important concerns. One of the main parameters of crack behavior is stress intensity factor (SIF). Structures, in the linear elastic regime, should be checked using the SIF for existing cracks. One important problem both in the field of transportation and in the design of structures is the effect of moving loads.

The SIF depends, in addition to crack size and its location, on the loading conditions of the structure. In this study the concentration is on the harmonic moving load as one of fundamental important problems. Moving loads cause larger displacements and higher stresses than static loads in structures. The effect of time, speed and frequency of harmonic moving load, crack size and location is assessed on the SIF. This problem has received considerable attention in the

literature for uncracked structures, there has been growing interest in studying the vibration of cracked components and structures. In one estimate, over 500 papers on the subject were published in two decades (Dimarogonas, 1996, Mahmoud, 2001). One of the methods of acquiring the frequencies of cracked beam is using rotational spring model. Another method developed a continuous cracked beam theory to rigorously include singularities at the crack tip into the equations of motion by Chondros, Dimarogonas (1998) and M.A.Mahmoud(2001).Their results were verified experimentally and confirm that the rotational spring model is a good approximation.

To the best of the author's knowledge, the effect of cracks on the strength of beams subjected to harmonic moving loads was not reported in the literature before. In this study, a procedure for determining stress intensity factors (SIF) for single edge cracks in beams subjected to a harmonic moving load is presented. Attention is focused on the fundamental problem of simply supported Bernoulli–Euler undamped beams subjected to a single concentrated harmonic load of constant magnitude moving at constant speed along the beam span. The analysis does not include longitudinal motion or coupling between bending and torsional motion. Numerical results are presented to show how the SIF is influenced by crack size, load speed, and crack location and frequency of harmonic load along the beam.