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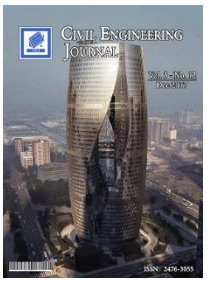

# A Cell Centered Finite Volume Formulation for the Calculation of Stress Intensity Factors in Mindlin-Reissner Cracked Plates

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**Abstract**

In fracture analysis, the stress intensity factor (SIF) is an important parameter which is needed for describing the stress state at crack tip. In this paper a finite volume formulation is developed for calculating the stress intensity factor (SIF) in Mindlin-Reissner plates with a through-the-thickness crack (through crack). For approximating the field variables and its derivatives the moving least square (MLS) technique is utilized. The problem domain is discretized into a mesh of elements where each element is considered as a control volume (CV). The center of CVs are considered as computational points where the unknown variables are associated with. The equilibrium equations of each CV are written based on the stress resultant forces acting on the boundaries of CV where the first order shear deformation theory (FSDT) is implemented in the formulation. Some benchmark problems of plate with through cracks are solved by the present method and the obtained results are compared with the results of analytical and XFEM numerical methods in order to demonstrate the accuracy of the present formulation. These comparisons illustrate the accuracy of predictions of the present solution method. Nevertheless, it is found that the formulation is free of shear locking property which greatly facilitates the cracked plates analysis due to its dual capabilities of analyzing both thin and moderately thick cracked plates.

*Keywords:* Mindlin-Reissner Plate Theory; Finite Volume Method; Moving Least Squares.

## 1. Introduction

Plate and shell elements are used in the construction of large number of structures such as airplane fuselages, storage tanks, and ship hulls. These structures are subjected to cyclic pressure which may develop defects inside the plate material and lead to arising cracks through the thickness of plate. Due to cyclic nature of applied pressure on these elements, evolving the through crack, results in the sudden failure; so-called as fatigue fracture. Investigation of this type of fracture is an important issue in the design of these structures. On the other hand, the plate element, due to its simplicity is used more than the shell element for modeling of the above mentioned structures. Thus there is a fracture problem that contains a plate element with through crack under the lateral loading in which internal moments and shear forces can be yielded. Similar to cracked plates under the in-plane loads, the main parameter which determines the crack tip field of the cracked plate under the edge moments, is the stress intensity factor. To study the cracked plate under the lateral loading, indeed three dimensional models represent the stress and displacement fields near the crack tip more accurate than the simplified two dimensional theories but accompanied with difficulties in approaching to solution. Therefore, two dimensional plate theories such as the Mindlin-Reissner plate theory -so called the Reissner plate theory- and Kirchhoff plate theory have been developed by researchers to simplify obtaining the

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