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Solving Elasto-Static Bounded Problems with a Novel Arbitrary-Shaped Element

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Abstract

A simple method to analysis any arbitrary domain shapes with a single element which based on Decoupled Scaled Boundary Finite Element Method is presented in this paper. The introduced element is based on boundary finite element method which helps to modelling curve and sharp boundaries with acceptable accuracy. Shape functions and mapping functions are similar to Decoupled Scaled Boundary Finite Element Method but locating center origin (LCO) is relocated in this method from corners with direct view to whole domain into shape center and formulation and behavior of the method is developed for the element. The most important advantageous of this technique is ability of solving displacement in domain by solving differential equations which causes more accurate answers in domain. We also perform well-established numerical tests and show the performance of the new element. Results shown us the accuracy and reliable answers for the introduced element. Also some benchmark examples are solved by this method and answers are compared with correct answers and plotted. High accuracy of answers with low cost of calculations and ability of the method to analysis the curve and sharp boundaries are the most important advantageous of this new element.

Keywords: Decoupled Scaled Boundary Finite Element (DSBFEM); Arbitrary-shaped Element; 2D Analysis; Finite Element Method (FEM); Elastostatic; Bounded Domain.

1. Introduction

It is well known that 2D problems can be applied in engineering as well and the results can be reliable for engineering decision. Various types of numerical methods such as Finite Element Method (FEM), Boundary Element Method (BEM), Scaled Boundary Methods (SBFEM), and mesh-less methods are commonly used in order to solve elasto-static and elasto-dynamic problems in two-dimensional problems [1-3] and simulating cracks and fractures in domains [4-5]. All these methods have their own advantageous and disadvantageous. Many types of elements are used in FEM approach in order to solve general or conditional problems, Serendipity and Lagrange elements which belongs to classical FEM [6] and combined elements which developed to solve conditional problems such as, Arnold-Winther stress element, Crouziex-Raviart element, Pi element, Brezzi-Douglas-Marini element, Brezzi-Douglas-Fortin element, Virtual and polygonal elements which have their own conditions to be used [7-12].

One of the desirable methods for solving elastic problems is Boundary Element Method (BEM), in which requires reduced surface discretization and so fewer unknowns are needed to be stored. Moreover, BEM requires a fundamental solution for the governing differential equation in the domain in order to obtain boundary integral equation. In this condition, the coefficient matrices of BEM are much smaller than those of FEM, usually non positive, non-symmetric, and fully populated [13].

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