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High-Precision Isoparametric Hole, Ring, Tube, Disk, Sphere Boundary Element and Their Applications in Mechanics Analysis

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ABSTRACT

Recently, a series of isoparametric boundary elements have been constructed to simulate the shape of holes, tubes, disks, rings and spheres based on the Lagrange interpolation formulation and the closure condition at two ends of an arc. These elements can simulate the models which contain the shapes mentioned above with less nodes and less elements than the conventional boundary elements. However, the basis of those elements, i.e., hole elements, have the poor accuracy when the number of nodes is less than 6. To improve these elements, two kinds of improvements are proposed in this study. The first one let more nodes be auxiliary nodes repeatedly, based on a higher order one dimensional Lagrange element. The second one let trigonometric functions be the basis of shape function to substitute the basis of Lagrange interpolation. Two kinds of hole elements and their derived tube, disk, ring and sphere element are used to simulate the structures containing holes, cylinders, and spheres, such as fiber reinforced composites and particle reinforced composites etc. Through those simulation, it can be found that two kinds of newly proposed hole elements and their derived elements both perform very well in the discretization of the geometry and the interpolation of physical quantities. When simulating the circle or sphere, the second method is better. When simulating the ellipsoids, the first method is better.

KEYWORDS

Boundary element method; isoparametric element; fiber reinforced composites; particle reinforced composites

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