

动态断裂力学的无限相似边界元法

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摘要 对弹性动力学的相似边界元法进行了进一步研究, 推导了相应的计算公式, 并在此基础上提出了动态断裂力学的无限相似边界元法. 与传统的边界元法相比, 相似边界元法由于只需在少数单元上进行数值积分, 大大减少了计算量. 对动态断裂力学问题, 无限相似边界元法由于在裂纹尖端的边界上设置了逼近于裂纹尖端的无限个相似边界单元, 可直接得到裂纹尖端具有奇异性的应力, 而不需要设置奇异单元, 从而突破了奇异单元对应力奇异性阶次的局限. 另外, 还讨论了无限相似边界元法得到的无限阶的线性代数方程组的求解方法.

关键词 [无限相似边界元法, 弹性动力学, 动态应力强度因子](#)

分类号

INFINITE SIMILAR BOUNDARY ELEMENT METHOD FOR DYNAMIC FRACTURE MECHANICS

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Abstract

In the conventional boundary element method, in order to obtain the last algebraic equation system a large number of integrals must be calculated numerically on all boundary elements and internal cells so that a large amount of computing time is needed. If we can form similar boundary elements on the boundary and obtain the relation of the matrices on the similar boundary elements, it is not needed to obtain the matrices on all elements by numerical integrals, then a great amount of numerical integrals will be decreased. In this paper, similar boundary element method (SBEM) for elastodynamic problems is discussed in detail. Similar boundary elements are classified and their properties are discussed. The interpolation method to obtain the matrices on the similar boundary elements is presented and the formulae of the method are obtained. In similar boundary element method, the boundary is represented with some sub-domains on which the boundary elements are similar. Then on a sub-domain of the boundary we only need to compute the matrices on a few boundary elements by numerical integrals, and the ones on all other boundary elements can be obtained by the interpolation method. Then superimposing the matrices on all boundary elements the coefficient matrix of the last algebraic equation system can be obtained. Comparing with the conventional boundary element method that the matrices on all boundary elements are obtained independently by numerical integrals, similar boundary element method can decrease the computing time to a great extent, and the solution is in total agreement with the one from the conventional boundary element method. To obtain the singular stress at the tip of a dynamic crack, infinite similar boundary element method (ISBEM) is presented. In the method the similar boundary element sub-domain at the tip of the crack contains infinite similar boundary elements. From infinite similar boundary element method, the singular stress at the tip of a crack can be obtained directly, but the singular boundary element is not needed and the degree of singular stress is not assumed. For some materials that we do not know the degree of singular stress at the tip of a crack, infinite similar boundary element method can be applied better than the conventional boundary element method does. In this method the numbers of boundary elements and nodes are infinite, so an infinite order linear algebraic equation system is formed, and then the numerical method for this infinite order system is discussed. For a problem with an irregular domain, we can use the curvilinear coordinate system on the boundary of the domain, and then similar boundary element method and infinite similar boundary element method presented in this paper can be applied too. Similar boundary element method can be applied to other problems which can be solved with the conventional boundary element method, and infinite similar boundary element method can be applied to other crack problems.

Key words [infinite similar boundary element method](#) [infinite similar boundary element method](#) [elastodynamics](#) [dynamic stress intensity factor](#)

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