APCOM & ISCM
11-14th December, 2013, Singapore

Some Investigation on the Accuracy of BE and Fast BE Analyses

***Zhenhan Yao[1], Haitao Wang[2], and Xiaoping Zheng[1]**

[1] Department of Engineering Mechanics, Tsinghua University, Beijing, 10004 China.
[2] Institute of Nuclear and New Energy Technology, Tsinghua University, Beijing, 100084 China

*Corresponding author: demyzh@tsinghua.edu.cn

The boundary element method has been developed as one of the most important complement of the finite element method in the computation of solids and structures. Higher accuracy is one of the most important advantages of BEM over other numerical methods, especially in the stress analysis of solids and structures. In some cases the results of BE analysis is difficult to be verified, because without analytical solution, and the results of FE analysis are not as accurate as the BE results. Therefore, the accuracy of BE and Fast BE analysis should be further investigated.

The error of BE analysis include the discretization error and the calculation error, for the conventional BEM the calculation error is mainly the error of the integration of kernel function and shape function product on each element, provided the highly accurate Gauss elimination method is applied to solve the algebraic equations of BEM. For the fast BE analysis, the additional error will be caused by the fast algorithm and the related iteration algorithm of the BE algebraic equation system.

These errors have been investigated separately using a series of benchmark problems. Based on the benchmark problem of simple problem without discretization error, an improved adaptive Gaussian quadrature method is presented. By using this method the integration accuracy can be guaranteed, for the conventional BE analysis, the error will be mainly the discretization error. From the benchmark problem of pure bending, it is found that the constant element and linear element are not suitable for the bending problems. Furthermore, it can be found that the global equilibrium is not always satisfied in BE analysis due to considerable discretization error or integration error. To show the error of BE analysis clearly a kind of boundary equivalent stress plot is suggested. For the fast BE analysis using ACA and GMRES algorithms the additional errors have been investigated as well. It is found that too small leaf scale and too low tolerance of ACA and GMRES will result in additional errors.

Keywords: Boundary element method, Fast boundary element method, Calculation error, Discretization error, Additional error of fast algorithm