Stability analysis of smoothed finite element method with explicit method for transient heat transfer

***†X. Rong ¦, M.Li[1], and R.P.Niu[1]**

[1] College of Mathematics, Taiyuan University of Technology, China.

*Presenting author: rongxin6328@163.com
†Corresponding author: rongxin6328@163.com

Abstract

In this paper, the transient heat transfer problems are analyzed using the smoothed finite element method (S-FEM) with explicit time integration. It has been well known that the computational cost per time step in the explicit method is less than that in the implicit method, but the time step is always much smaller in explicit analysis than that in implicit analysis when the same size mesh is used. The stability applied to S-FEM is researched and the relationship between the critical time step used in S-FEM and the maximum eigenvalues of stiffness matrix and mass matrix is analyzed. In addition, it is found that the relationship exists between the critical time step and the soft degree of a model. For example, node-based smoothed finite element method (NS-FEM) is softer than edge-based smoothed finite element method (ES-FEM) so that the maximum time step of NS-FEM is longer than that of ES-FEM. Further, it is known that computing the eigenvalues is very costly, especially for higher order matrix. Therefore, we proposed a simple algorithm to estimate the maximum time step, which presents the relationship between the maximum eigenvalues and minimal mesh size. Intensive numerical examples show that our scheme can work accurately and stably for explicit method in S-FEM.

Keywords: Transient heat transfer problems, Smoothed finite element method, Explicit method, Critical time step