ABSTRACT

In this study, an analysis method to analyze problems involving cracking localization is proposed. The proposed analysis method employs the well-know smeared crack model. Nevertheless, in the finite element formulation, a mixed formulation that discretizes not only displacements but also crack strains is used. The reason why the smeared crack finite element analysis with the mixed formulation is selected is that the smeared crack approach is suitable for problems with many cracks, compared with the discrete crack approach. However, the stability analysis of crack patterns cannot be performed easily with the conventional smeared crack finite element analysis since the irreversible parameter in the model—the crack strain—is not discrete. Discretizing the crack strain field therefore allows stability consideration of crack patterns to be done efficiently even when the smeared crack finite element analysis is used. Stability analysis of crack patterns is done by performing eigenvalue analysis of Hessian matrices obtained from the mixed finite element formulation. At each bifurcation point identified by the stability analysis, the actual equilibrium path is incrementally traced by searching for a crack pattern with the minimum total potential energy increment. Search algorithms employed in this study include an exhaustive search algorithm and a genetic algorithm. For small problems, the exhaustive search is applied because the number of possible crack patterns is small and it is still possible to investigate all available crack patterns. Nevertheless, for larger problems where too many crack patterns are possible, the exhaustive search is not appropriate, and the genetic algorithm is used instead. Finally, the proposed analysis method is used to analyze some localization problems of plain concrete and steel-fiber-reinforced concrete and the results are discussed.