Iterative strategies based on constitutive dissipation

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ABSTRACT

Most nonlinear systems are solved by iterative strategies such as the Newton-Raphson method, the Quasi-Newton method, the Constant Stiffness method and the Arc-length method. The last one was developed by [1-2] and alternative formulations were widely used such as [3-5], even in commercial codes. These methods use the norm of displacements constraint to obtain the load factor increment making it possible to describe snap-back and snap-through behaviour. Cylindrical Arc-length [6] is probably the most popular of these methods. Because the constraint is quadratic, it can lead to potential spurious unloading and, besides, in the context of crack propagation the norm of displacements may be small and cause problems to establish the tolerance. To overcome these shortcomings, a new alternative method based on an energy dissipation constraint has been developed to control the loading process. Constitutive dissipation may be considered as an always-increasing "time" parameter with the advantage that constrain is always linear (thus avoiding the possibility of spurious unloading). Iterative methods based on a dissipation constraint can be found in the literature. Gutiérrez [7] introduced the energy release parameter as a constraint, other subsequent articles following the same concept are in the literature [8-9]. But most of those formulations are based on specific constitutive models. In contrast, the present formulation is general in the sense that it is valid for any constitutive model, as long as the model subroutine provides, additional to the standard output, also the appropriate values of dissipation and dissipation derivatives. Some application examples in concrete structures with progressive fractures are also provided to illustrate the performance of the model proposed.

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