Plate Formulation based on the strong discontinuity method for reinforced concrete components subjected to seismic loadings

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ABSTRACT

Recent damage models, based on a continuum description of the media, succeed in representing the main features related to the complex behavior of quasi-brittle materials such as cracking, crack closure effect and permanent strains [1]. Nevertheless, cracking is described in a diffuse way and it is always difficult to quantify the cracking features such as openings and spacing. Post-processing methodologies are necessary to estimate the aforementioned quantities [2]. Recently, a new concept of displacement discontinuities embedded into a standard finite element has come up in the continuity of the smeared crack approach. The kinematics of a traditional finite element is enhanced by a displacement jump which represents the crack opening. In our study, the Embedded Finite Element Method (E-FEM) is used [3]. Numerically, the enhancement related to the displacement jump takes places locally in the finite element. The non-linear behavior is handled by the tension/separation law characterizing the energy dissipation on the discontinuity. The objective of our study is the development of a kinematic enhanced damage model to represent cracking patterns of reinforced concrete components subjected to seismic loadings. Within the framework of earthquake engineering in which time-consuming non-linear dynamic analyses have to be carried out to make seismic assessments, the use of reduced kinematic-based elements such as plates and shells is relevant to model reinforced concrete components such as slabs or shearwalls. An anisotropic damage model, based on micromechanical assumptions, is used [4]. This model allows accounting, in a natural manner, for particular crack orientations in reinforced concrete membrane elements. A "discrete" damage formulation is considered by introducing *p* couples of microcrack densities and directional tensors, denoted by $\rho_p\mathbf{N}_p$. Microcrack densities ρ_p are considered as internal variables and the directional tensors $\mathbf{N}_p$ constructed as the tensor product of the normal to the crack. The model can represent either mode-I and mode-II cracking mechanisms which can be handled independently. This model is then enhanced with the strong discontinuity kinematics. Regularization of the Dirac distribution [3] provides a consistent discrete constitutive model expressed in terms of traction/separation law. Some numerical simulations will be shown to illustrate the performances of this model.

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