World Academy of Science, Engineering and Technology
International Journal of Civil and Architectural Engineering
Vol:11, No:05, 2017

Application of Continuum Damage Concept to Simulation of the Interaction between Hydraulic Fractures and Natural Fractures

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Abstract : The continuum damage concept is used to study the interaction between hydraulic fractures and natural fractures, the objective is representing the path and relation among this two fractures types and predict its complex behavior without the need to pre-define their direction as occurs in other finite element applications, providing results more consistent with the physical behavior of the phenomenon. The approach uses finite element simulations through Abaqus software to model damage fracturing, the fracturing process by damage propagation in a rock. The modeling the phenomenon develops in two dimensional (2D) so that the fracture will be represented by a line and the crack front by a point. It considers nonlinear constitutive behavior, finite strain, time-dependent deformation, complex boundary conditions, strain hardening and softening, and strain based damage evolution in compression and tension. The complete governing equations are provided and the method is described in detail to permit readers to replicate all results. The model is compared to models that are published and available. Comparisons are focused in five interactions between natural fractures (NF) and hydraulic fractures: Fractured arrested at NF, crossing NF with or without offset, branching at intersecting NFs, branching at end of NF and NF dilation due to shear slippage. The most significant new finding is, that is not necessary to use pre-defined addresses propagation and stress condition can be evaluated as a dominant factor in the process. This is important because it can model in a more real way the generated complex hydraulic fractures, and be a valuable tool to predict potential problems and different geometries of the fracture network in the process of fracturing due to fluid injection.

Keywords : continuum damage, hydraulic fractures, natural fractures, complex fracture network, stiffness
Conference Title : ICGATA 2017 : International Conference on Geomechanical Analysis Techniques and Applications
Conference Location : Barcelona, Spain
Conference Dates : May 26-27, 2017