(8) Extensive Exploitation On 3-D Boundary Element Numerical System For HDR Geothermal Reservoir

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ABSTRACT

To extensively exploit the numerical system for comprehensively simulating HDR (Hot Dry Rock) geothermal reservoir on the basis of three-dimensional elastic analysis by DDM (Displacement Discontinuity Method) with analytical integrations over triangular leaf, the further work for High Order Displacement Discontinuity Distribution over Crack Tip Elements, in which the way of seeking analytical integration for Influence Coefficients of Target Element to itself forms the core work, has been fully prepared and started. This work will be combined with 3-D non-steady heat conduction analysis.

KEY WORDS : Fracture Extension, Acoustic Emission, Artificial Earthquake

Introduction

Due to environment protection and taking advantage of new energy instead of exhausting traditional ones, heat extraction from hot rocks becomes more and more attracting. A typical artificial system for the energy production contains two or more wells and a fractured reservoir between the wells at the depth, where heat can be extracted from the surrounding rock mass by circulating water flowing through fractures. Numerous numerical modeling methods with compromise have to be applying because of the contradiction between computer capability and problem complexity[1),2)]. Our 3-D boundary element system based on more accurate and faster analytical integration and more accurate shape approximation of triangular leaf elements should be more promising in the field[3),4)]. From the preliminary code of 3-D DDM on fracture mechanics, the way of seeking analytical integration for Influence Coefficients of Target Element itself is sought and the function for simulating fracture extension is being exploited.

Strategy

Shown as Fig. 1 is the flow for simulation of hot rock mass generating electricity. The portion of fracture extension as succeeds is to proceed, which definitely depends on a much more accurate computation at the elements close to the vicinity of fracture tip. To avoid the shortcoming that the constant elements can not provide accurate results for the above case, more accurate elements, i.e., tip elements, need considering. However, the solution of influence coefficients for the target elements to themselves has a singularity which makes numerical integration give unsatisfactory results and there is of course no usual way to get the corresponding analytical solution. Shown as Fig. 2, a novel idea appears here is that the integration throughout an infinite strip where contains the target element in the middle subtracts both integrations on the two half-infinite strips neighboring the target element should be an equivalent and alternative way to get the integration on the target element itself. However, it is interesting that the alternative way is able to give satisfactorily accurate result even by numerical integration in which certain finite strips with the length within the tolerance of approximation are substituted for infinite bands.

Progress

For the past four months, the corresponding practices on 2-D boundary element methods, 2 presentations[5),6)], 1paper[7)]and the code for 2D joint slip element TWOJE have been done. The existing work on 3D BEM with triangular leaf elements including the programs for heat conduction and isothermal elasticity and the preliminary code for 3-D crack tip element is being studied.

Future work

Based on the exploitation of 3-D triangular crack tip elements, accurate stress intensity factors at the fracture fonts can be sought. Fracture toughness is then used as the critical value to consider fracture extension. This step is extremely significant, for the further simulation is expected to apply to the research on artificial earthquake and hydraulic fracturing by the combination of acoustic emission and numerical modeling.

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SOME IMPRESSION

I've been deeply attracted by the significant work since I came here on Oct. 28th of last year. Especially, the numerical system, which is being constructed by our group and waiting for by researchers in this field around the whole world, is worth concentrated on with an effort.

I'd like to express my boundless gratitude to Yamaguchi University Venture Business Laboratory and Professor Yoshiaki Mizuta who offer me the precious research surroundings.

I will try my best to get most fruitful results during my staying.

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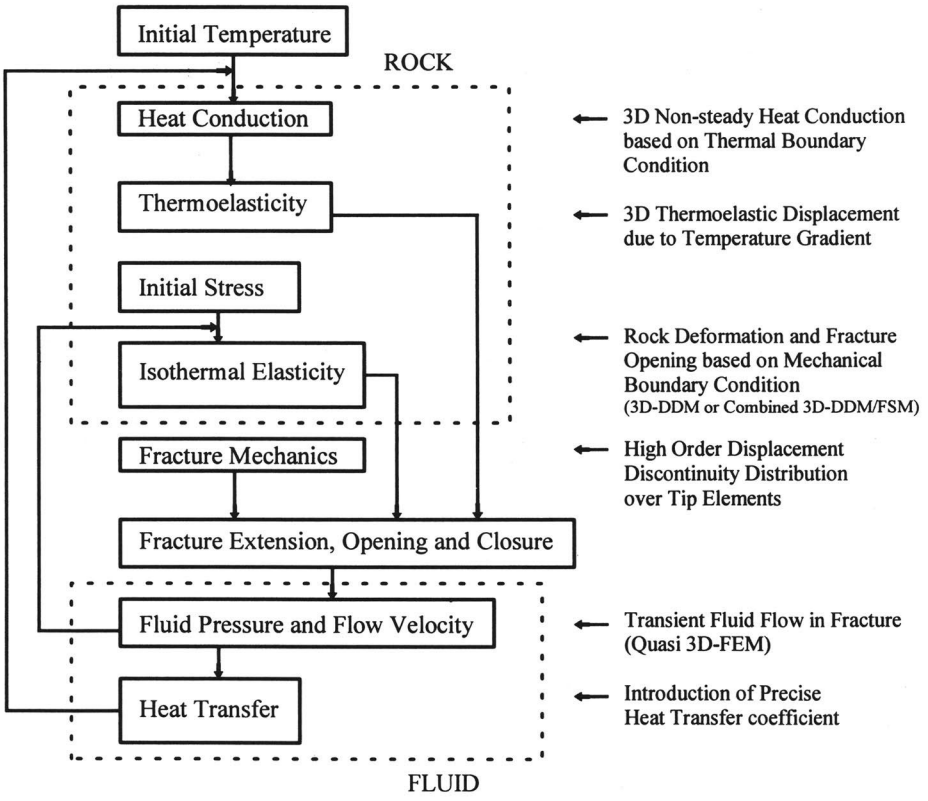

Fig. 1 The Flow for the Simulation Analysis of HDR Generating Electricity

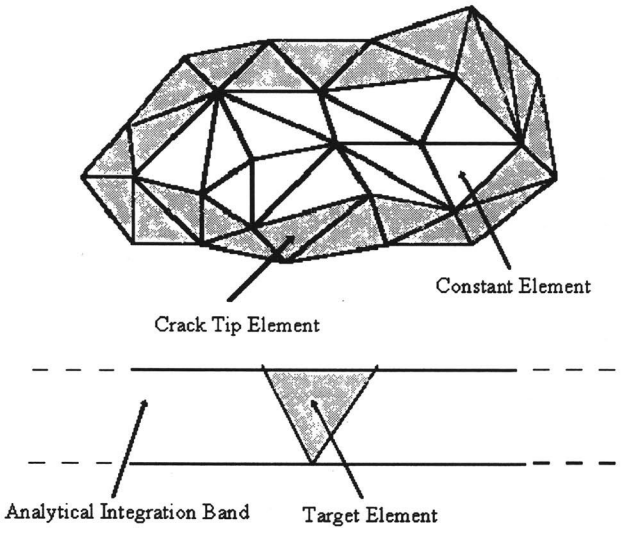

Fig. 2 The Novel Idea For the Integration On Target Element Itself