MECHANICAL ENGINEERING

The Department of Mechanical Engineering presents:

The Ph.D. Dissertation Defense of

Gongbo Long

Wednesday, November 13, 2013
9:00AM
Bourns Hall A277

A Combined Boundary Integral Method for Crack Problems in Multilayered Elastic Media under the Plane Strain Condition

Doctor of Philosophy, Graduate Program in Mechanical Engineering
University of California, Riverside, December 2013
Professor Guanshui Xu, Chairperson

The crack problems in multilayered elastic media are of considerable interest in many engineering applications, particularly in hydraulic fracturing treatments for increasing hydrocarbon production. Various computational methods have been developed for the analysis of crack problems, and boundary integral methods stand out for their broad applicability and accuracy. Among various boundary integral methods the standard boundary integral method, such as the direct method, can be used for general elastic analysis of multilayered media, while the displacement discontinuity method based on fundamental dislocation solution is more suitable for the analysis of crack problems. The displacement discontinuity method, however, cannot be applied directly to the general crack problems in multilayered media due to the lack of fundamental dislocation solutions. In this dissertation study, we therefore address this issue by developing a new approach that combines the displacement discontinuity method and the direct method. The combined method shares both the efficiency of the displacement discontinuity method and the applicability of the direct method. In this combined method, the displacement discontinuity method is implemented to construct the fracture matrix in each layer, while the direct method is used to characterize the effects of the interfaces. As a consequence, all variables on the interfaces can be eliminated through continuity conditions, leading to the final equation which only consists of variables on crack surfaces. The concept of the crack tip element is also adopted and extended for better treatment of the crack tip singularity. The example studies have demonstrated that the combined method has comparable accuracy but far more efficiency for practical applications as compared to the traditional direct method.