



How Hydraulic Fracture is paying back to Fracture Mechanics

Prof. Gennady Mishuris

Mathematical Modelling of Structures, Solids and Fluids Group
Department of Mathematics at Aberystwyth University

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This talk aims to provide an overview of key results by the Aberystwyth group in the mathematical and numerical modelling of hydraulic fracture that we have been privileged to work with over the last decade. Revisiting the approach to a basic (BEM) algorithm for the classic HF models (PKN, KGD, Radial), has eventually allowed us to construct an extremely accurate and effective time-space adaptive algorithm for the models. Utilizing this, and adjusting where necessary, we have been continuing our endeavour to analyse some of the more delicate pieces of this extremely rich physical process. First, we considered the effect of the shear traction induced by the fluid on the crack surface and discover another, fourth, stress intensity factor, which to our best knowledge was not previously known in the classical Fracture Mechanics. This required us to compute Rice's Energy Release Rate taking the effect into account. Furthermore, discussing the results, we have extended the classic Irwin's crack closure integral representation to the ERR computation. Interestingly, this leads to a complete LEFM theory with six SIFs with applications to, among others, hydraulic fracturing, soft materials containing stiff inclusions, rigid inclusions, shear bands and cracks characterized by the Gurtin-Murdoch surface stress elasticity. It also resolves an ambiguity in using the same SIF's terminology in the cases of open cracks and rigid inclusions. Finally, if time permits, we will discuss whether an averaging-based approach to the material toughness can be introduced and justified (we remind that, generally speaking, a toughness homogenisation was proven to be the wrong conception in the framework of LEFM).