TO FRAC OR NOT TO FRAC?--HOW MECHANICS OF QUASIBRITTLE HYDRAULIC FRACTURE COULD SWAY THE ANSWER

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The proponents of hydraulic fracturing (aka fracking) of gas shale have potent arguments—a drastic increase of national energy supply, a huge drop in gas price with major geopolitical consequences, and a significant reduction of CO_2 release compared to coal technology. But so do the opponents—the risk of leaks of contaminated water and methane, and of induced seismicity with geological fault activation. After a brief overview of the technology, the seminar focusses on only one facet of this multifaceted problem, the mechanics of fracking. While all the recent and current studies deal with the propagation of one or (exceptionally) a few parallel hydraulic cracks, it is argued that the key is to induce and control a stable formation of a system of cca 10^6 vertical intersecting bi-directional hydraulic cracks per fracking stage, with the spacing of about 10 cm. The lecture discusses: 1) the stability of hydraulic crack system, 2) its dependence on fluid pressure distribution along the cracks, 3) the branching of secondary quasibrittle hydraulic cracks from primary crack walls, 4) the viscous flow of compressive fracking fluid with propants through a growing crack system, 5) the diffusion of water through shale pores (which is the key to branching), 6) the orthotropy of shale, and 7) the numerical simulation of 3D propagation of numerous fractures caused by pore pressure in a three-phase medium. Taking advantage of such modeling capabilities should help to increase the percentage of gas extracted from the shale stratum, which currently stands at only 5—15%. This will not only improve the economy of fracking but also reduce the amount of contaminated water per unit of energy extracted from gas. Furthermore, producing more cracks of smaller spacing would mitigate seismicity-generating crack jumps. The answer to the paramount question of our time—to frac of not to frac—may thus be nudged toward the affirmative.

Biosketch: Born and educated in Prague (PhD 1963), Bažant joined NU in 1969, served as Director of Center for Concrete and Geomaterials (1981-87), and holds simultaneously the Murphy and Mc Cormick endowed chairs. He is a member of NAE, NAS, AAAS, Royal Soc. of London, the Austrian, Czech, Italian and Spanish national academies and Academia Europaea. He received seven honorary doctorates (Prague, Karlsruhe, Boulder, Milano, Vienna and Ohio State), published six books and many papers (48,500 citations, H-index: 107, i10-index: 526, on Google), and received ASME Timoshenko, Nadai and Warner medals, ASCE von Karman, Newmark, Biot, Mindlin and Croes Medals, RILEM L'Hermite Medal, and more from nine societies. In 2015, ASCE established Zdeněk P Bažant Medal for Failure and Damage Prevention.

Reference: ZP Bažant, M Salviato, VT Chau, H Viswanathan, H. and A Zubelewicz (2014). "Why fracking works." *J. of Applied Mechanics* 81 (Oct.), 101010-1---101010-10