

DEPARTMENT OF CIVIL ENGINEERING
CASE SCHOOL OF ENGINEERING

Higley Lecture Series

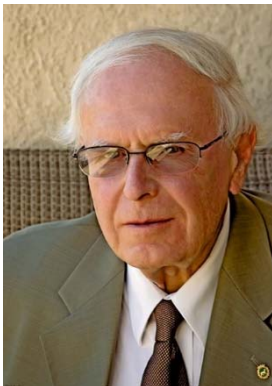
**Fishnet Statistics for Design of Quasibrittle and Biomimetic
Materials and Structures for Failure Probability $<10^{-6}$**

Zdeněk P. Bažant

3:30 pm, February 18th, 2019

Clapp Hall, Room 108

The failure probability of engineering structures such as bridges, airframes and MEMS ought to be $<10^{-6}$. This is a challenge. For perfectly brittle and ductile materials obeying the Weibull or Gaussian distributions with the same coefficient of variation, the distances from the mean strength to 10^{-6} differ by cca 2:1. For quasibrittle or architected materials such as concrete, composites, tough ceramics, rocks, ice, foams, bone or nacre, this distance can be anywhere in-between. This necessitates a new theory of strength probability distribution. The recent formulation of Gauss-Weibull statistics derived from analytical scale transitions and frequency of activation-energy controlled interatomic bond ruptures is reviewed. Then, motivated by imbricated lamellar architecture of nacre, a new probability model with alternating series and parallel links, resembling a diagonally-pulled fishnet, is developed. After the weakest-link and fiber-bundle models, it is the third model tractable analytically. It allows for a continuous transition between Gaussian and Weibull distributions, and is size-dependent. Comparisons with histograms and size-effect tests support the theory.



Bio-Sketch: Born and educated in Prague (Ph.D. 1963), Bažant joined Northwestern in 1969, where he has been W.P. Murphy Professor since 1990 and simultaneously McCormick Institute Professor since 2002, and Director of Center for Geomaterials (1981-87). He was inducted to NAS, NAE, Am. Acad. of Arts & Sci., and Royal Soc. London; to the academies of Italy (Lincei), Austria, Spain, Czech Rep., Greece, India and Lombardy, and Academia Europaea. Honorary Member of: ASCE, ASME, ACI, RILEM. Received: Austrian Cross of Honor for Science and Art I. Class; 7 honorary doctorates (Prague, Karlsruhe, Colorado, Milan, Lyon, Vienna, Ohio State); ASME Medal, ASME Timoshenko, Nadai and Warner Medals; ASCE von Karman, Freudenthal, Newmark, Biot, Mindlin and Croes Medals, and Lifetime Achievement Award; SES Prager Medal; RILEM L'Hermite Medal; Exner Medal (Austria); Torroja Medal (Madrid); Šolín Bažant, Sr., Medals (Prague), etc. He authored eight books: *Scaling of Struct. Strength, Creep Eff. In Concrete Str., Inelastic Analysis, Fracture and Size Effect, Stability of Structures, Concrete at High Temp., Creep & Hygrothermal Effects, Probab. Mech. of Quasibrittle Str.* H-index: 124, citations: 68,000 (Google, Dec. 2018, incl. self-cit.), i10 index: 616. In 2015, ASCE established ZP Bažant Medal for Failure and Damage Prevention. He is one of the original top 100 ISI Highly Cited Scientists in Engrg. (www.ISIhighlycited.com).

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