SPECIAL TOPICS IN STRUCTURAL MECHANICS AND MATERIALS
A VOLUME IN HONOUR OF PROFESSOR ZDENĚK P. BAŽANT

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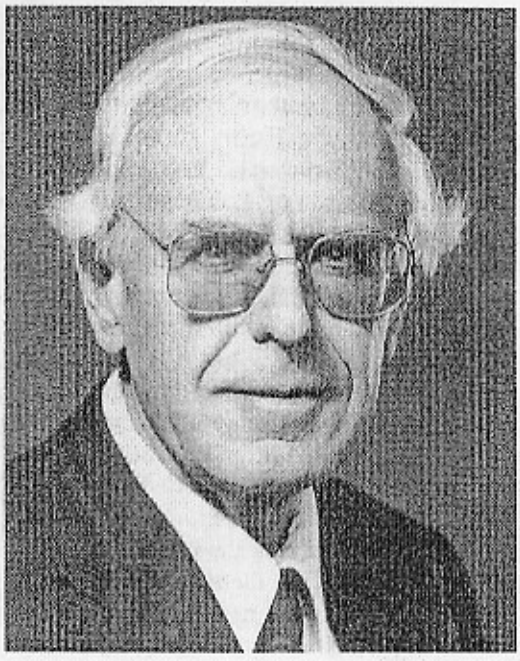
PREFACE



ZDENĚK P. BAŽANT—The 1996 SES Prager Medalist

This special issue of the *International Journal of Solids and Structures* has been prepared in honor of Professor Zdeněk P. Bažant, the 1996 recipient of the Prager Medal, awarded by the Society of Engineering Science (SES) for "outstanding contributions in solid mechanics". This special issue is comprised of a selection of invited papers, most of which were presented at the Prager Symposium held during the 35th Annual Meeting of the Society of Engineering Science at the Arizona State University, Tempe, Arizona in October 1996.

A native of Prague, Zdeněk P. Bažant received his engineering education from the Czech Technical University (ČVUT) and obtained a Ph.D. in engineering mechanics from the Czechoslovak Academy of Sciences in 1963. For six years he worked in Prague as an engineer, a research scientist, and an adjunct assistant professor to ČVUT. The year 1967 marked a turning point in his career: he left Czechoslovakia and began a series of visiting appointments which led him to the University of California, Berkeley in the United States, via the CEBTP in Paris and the University of Toronto in Canada. The journey ended in 1969 with an appointment to the faculty of the Civil Engineering Department at Northwestern University. He became a full professor in 1973 and was named a W. P. Murphy distinguished professor in 1990. Since his arrival in the United States, Zdeněk Bažant has never really stopped traveling, accepting visiting appointments from major universities in five continents. The United States of America became his country of citizenship and Evanston his home town. He lives there with his wife Iva, a staff physician in a state hospital, whom he met in Prague as a student and married in 1967, only two days before leaving his native country forever. Their son, Martin, recently finished his Ph.D. in physics at Harvard and daughter, Eva, is pursuing graduate study in public health at Columbia University.

While Zdeněk P. Bažant is a well-established figure in the mechanics and civil engineering communities, he has many other "Bažant" qualities which are appreciated by all of his collaborators and colleagues, especially his students. While working with him is typically like being caught in the turmoil of a tornado; he discusses both politics and the arts with the same zeal. Even though Zdeněk reached his 60th birthday in December 1997, he approaches sport with the characteristic "Bažant" intensity and never hesitates to challenge his colleagues on the tennis court or on the ski slopes.

Zdeněk P. Bažant is a person with many qualities who cannot leave his colleagues indifferent. His enthusiasm and dynamism in research has led to a prodigious output. Over the past thirty years he has written over 350 scientific papers in refereed journals, which amounts to an average of one paper per month approximately, not counting proceedings papers! His work deals essentially with structural materials and structural analysis—particularly computer modeling, fracture mechanics, stability, size effect, creep, thermal and moisture effects, probabilistic aspects, etc. He has authored or co-authored four books, the best known being the *Stability of Structures: Elastic, Inelastic, Fracture and Damage Theories* prepared with Luigi Cedolin from Politecnico di Milano (Italy), and the latest being *Fracture and Size Effects* written with Jaime Planas of Universidad Politecnica de Madrid. This momentum and enthusiasm has by now become a recognised "Bažant-ism". Everyone in a conference room knows when he is attending the session. He will always try to invigorate the discussion with constructive comments regarding the subject matter being presented.

Bažant is perhaps best known for his size effect law and nonlocal concept of softening damage. Before 1984, the observed size effects on structural strength were explained via Weibull's statistical theory. This changed after Bažant showed theoretically and verified experimentally that for quasibrittle failures preceded by large stable crack growth (as observed in concrete, rock masses, tough composites, sea ice and other quasibrittle materials), the size effect is caused mainly by the release of energy stored in the structure. He contributed the size-effect method to identify nonlinear fracture characteristics (a RILEM recommendation). Bažant was the first to demonstrate, beginning in 1976, that strain-softening stress–strain relations for finite element modeling of cracking damage, which had become standard practice by that time, led to ill-posedness, spurious mesh sensitivity and localization, and lacked the ability to predict size effects. His simple remedy—the energy based crack band model—became widely used in industry and is now being incorporated in some commercial codes (e.g. DIANA, SBETA). As a more general remedy, he pioneered, beginning in 1983, the nonlocal continuum models and gradient models for damage localization, and later justified them physically by microcrack interactions. He showed that, for quasibrittle materials, Paris' law for fatigue crack growth requires a size effect correction. He extended the size effect law to rate dependence, to compression failures (columns, borehole breakout, fiber laminates) and to bending fractures of sea ice plates. He showed how the previously accepted Weibull-type statistical strength theory can be extended to nonlocality. Expanding G. I. Taylor's idea, Bažant developed the microplane constitutive model for softening damage in concrete.

In 1971, Bažant elucidated the correlation of three-dimensional continuum stability theories associated with different finite strain measures. He solved the three-dimensional stress singularity and edge angle for crack-surface intersections; derived conditions of localization into ellipsoidal domains and layers; clarified the thermodynamic basis of the criterion of stable post-bifurcation paths; demonstrated bifurcation and crack arrest occurring in systems of parallel cooling or shrinkage cracks; and derived a consistent micropolar continuum approximation for buckling of regular lattices; he found a new more efficient (21-point) Gaussian integration formula for spherical surfaces (used not only in constitutive modeling but also in computational chemistry and radiation problems); he demonstrated and quantified spurious wave reflection and diffraction phenomena due to changing finite element size (which found applications in geophysics and atomic lattice studies).

In 1972, Bažant came up with the idea of age-adjusted effective modulus, which allowed the system of integral equations for aging creep effects in concrete structures to be reduced

to a quasi-elastic analysis. This approach became standard, embodied in ACI Committee 209 and CEB recommendations and features in textbooks. As consultant to the Nuclear Reactor Safety Division of the Argonne National Laboratory, he developed thermodynamically based models for creep, hygrothermal effects, pore pressure, solidification, aging and stochastic behavior of concrete. Bažant's exponential algorithm for concrete creep (1971) has found use in various finite element codes. His Latin hypercube sampling models for statistics of creep effects and probabilistic extrapolation of short-time measurements have been applied in the design of special concrete structures. His model for coupled moisture and heat transport has been used in several laboratories for analyzing hypothetical nuclear reactor accidents. These contributions, many obtained with other co-workers, represent lasting contributions to the mechanics of solids and concrete design. They have impacted practice and influenced other researchers.

In addition to his ever intense research activities, Zdeněk is very much involved in the associated scientific community via the professional societies: ASCE, ASME, ACI, RILEM, IA-SMiRT and SES. He was elected to serve as President of SES in 1993. His involvement has led him to chair many technical committees and to serve as editor of the *ASCE Journal of Engineering Mechanics* and co-editor of several others. He was one of the principal originators of the International Association for Fracture Mechanics of Concrete Structure (IA-FraMCoS), and was IA-FraMCoS's first president. Zdeněk P. Bažant has at this time received two honorary doctorates (from ČVUT, his alma mater, and Karlsruhe University, Germany, the latter to be conferred about the time this is published), five medals, and over a dozen awards from societies and institutions in the United States, Europe and Japan. In 1996 he was elected to the U.S. National Academy of Engineering.

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