

DETAILED BIOGRAPHICAL RESUME OF ZDENĚK P. BAŽANT

December 14, 2015

PERSONAL: Born Dec. 1937, Prague; U.S. citizen, naturalized 1976; married 1967; two children. Office tel.: (847)491-4025 (secretary 491-3351, dept. 491-3257, 491-3258). Fax: 491-4011. E-mail: z-bazant@northwestern.edu. www.civil.northwestern.edu/people/bazant.html

EDUCATION

C.E. (Civil Engineer), Czech Technical University in Prague (ČVUT) (with the highest distinction, straight A's all 5½ years, first in class), 1960.

Ph.D. in Engineering Mechanics, Czechoslovak Academy of Sciences (ČSAV), Prague, 1963.

Postgraduate Diploma in Theoretical Physics, Charles University, Prague, 1966.

Docent (habilitatis) in Concrete Structures, Czech Technical University in Prague (ČVUT), 1967.

REGISTRATION

Registered Structural Engineer, Illinois, 1971–.

PROFESSIONAL POSITIONS

Bridge Engineer, Dopravoprojekt (State Consulting Firm), Prague, Jan. 1961–Dec. 1963.

Scientific Worker and Adjunct Assistant Professor, Czech Technical University (ČVUT), Building Research Institute (now Klokner Institute), Prague, 1964–67.

Post-Doctoral Visiting Researcher, CEBTP Paris, 1966–67.

Research Fellow, University of Toronto, 1967–68.

Associate Research Engineer, University of California, Berkeley, 1968–69.

Associate Professor of Civil Engineering, Northwestern University, 1969–1973.

Professor of Civil Engineering, Northw. Univ., 1973–.

Staff Consultant (part-time), Argonne National Laboratory, 1974–94.

Walter P. Murphy Professor of Civil and Mechanical Engineering and Materials Science (a distinguished chair endowed in 1942 by W.P. Murphy), Northw. University, 1990–.

McCormick Institute Professor, Northwestern University, 2002– (held simultaneously with Murphy Chair).

MAIN ADMINISTRATIVE POSITIONS

Director, Center for Concrete and Geomaterials, Northwestern University, 1981–1987.

Program Coordinator, Structural Engrg. and Materials, Northwestern University, 1974–1978, 1992–96.

Secretary (elected), Class III of National Academy of Sciences (comprising sections Engrg. Science, Appl. Math., Appl. Phys. & Computer Sci.), 2009–2012.

HONORS

2002 elected **Member, National Academy of Sciences, Washington, D.C.**¹

1996 elected **Member, National Academy of Engineering, Washington, D.C.**²

2008 elected **Fellow, American Academy of Sciences and Arts**, Boston.

2015 elected *Foreign Member of Royal Society of London (ForMemRS)*.³

2000 elected *Corresponding Foreign Member, Austrian Academy of Sciences*, Vienna.

2006 elected *Foreign Member*, Italian National Academy (Accademia Nazionale dei Lincei), Rome.

2008 elected foreign *Corresponding Member*, Spanish Royal Academy of Engineering (Real Academia de Ingenieria).

1998 elected *Foreign Member, Academy of Engineering of Czech Republic*, Prague.

2002 elected *Foreign Member, Lombard Academy (Istituto Lombardo—Accademia di Scienze e Lettere, Milan, Italy)*.

2014 elected *Foreign Member, Academia Europaea*, London.

2008 elected *Member* European Academy of Sciences and Arts, Salzburg.

Honorary Doctorates

1991 **Honorary Doctorate (Dr. h.c.)**, Czech Technical University in Prague (ČVUT), Nov. 14⁴.

1997 **Honorary Doctorate (Dr.-Ing.E.h., Doktor-Ingenieurs Ehrenhalber)**, Universität Fridericiana (Technische Hochschule) Karlsruhe, Germany (conferred May 28, 1997, ceremony March 23, 1998)⁵.

2000 **Honorary Doctorate** (Doctor of Science h.c.), University of Colorado, Boulder.

2001 **Honorary Doctorate ('Laurea')**, Politecnico di Milano, Italy (conferred Oct. 25, 2001)⁶

¹Citation: "Bažant discovered the scaling law for the energetic size effect in quasibrittle structural failure bridging ductile and brittle behaviors, verified it experimentally for many important materials, showed its use for measuring fracture characteristics, and conceived nonlocal and crack-band models now widely used in numerical simulations of quasibrittle failure of structures."

²For "contributions to solid mechanics, particularly structural stability and size effects in fracture."

³citation Apr. 30: "Zdeněk Bažant discovered the scaling law for the energetic size effect in quasi-brittle structural failure, bridging ductility and brittleness. He verified the law experimentally for many important materials, showed its use for measuring fracture characteristics, and conceived the crack-band and non-local models now widely used in industry and commercial programmes to analyse quasi-brittle structural failure."

⁴cited for "important scientific contributions to mechanics"

⁵"In recognition of outstanding accomplishments in the field of building materials and structural engineering"

⁶Cited for "...novel approaches to inelastic and time-dependent behavior of concrete, lasting contributions to quasibrittle fracture, ... innovative techniques for material instability. Bažant's law for scale effects in fracture and microplane constitutive model represent fundamental contributions..."

- 2004 **Honorary Doctorate** (Docteur honoris causa), I.N.S.A. (Institut national des sciences appliquées de Lyon), Oct. 15, Villeurbanne, France.
- 2005 **Honorary Doctorate** (Dr.techn.h.c., Ehrendoktor der technischen Wissenschaften), Technical University Vienna (T.U. Wien), Oct. 28, Austria⁷.
- 2011 **Honorary Degree – Doctor of Engineering**, Ohio State University, Columbus (Dec. 11)⁸

Honorary Memberships:

- 2007 **Honorary Member, ASCE** (Am. Soc. of Civil Engrs.)
- 2012 **Honorary Member, ASME** (Am. Soc. of Mechanical Engrs.)
- 2011 **Honorary Member, ACI** (Am. Concrete Institute).
- 2015 **Honorary Member, RILEM** (Int. Union of Res. in Mat. & Str., Paris)
- 1991 **Honorary Member, CSC** Czech Society of Civil Engineers.
- 1991 **Honorary Member** Building Research Institute of Spain, Madrid.
- 2005 **Honorary Member, CCS** Czech Concrete Society, Prague (Česká betonářská společnost).
- 2009 **Honorary Member, CSM** Czech Society of Mechanics, Prague (Česká společnost pro mechaniku).

Elected Fellow:

American Academy of Mechanics (1978), Society of Engineering Science⁹ (1979), RILEM (Paris, 1977), ASME (1989), ASCE (1983), ACI (1979); U.S. Assoc. for Computational Mechanics (USACM, 2009), Czecho-Slovak Society of Arts and Sciences (Washington, D.C., 2003), Engineering Mechanics Institute of ASCE (2013).

Medal and Prize Named after Bažant:

1) **Zdeněk P. Bažant Medal for Damage Prevention**, established in 2015 by the Am. Soc. of Civil Eng. as an overall society medal administered by ASCE Eng. Mech. Institute in consultation with USNC-TAM; <http://www.asce.org/templates/award-detail.aspx?id=11613>

2) **Z. P. Bažant's Prize in Engineering Mechanics**, given annually since 2012 by the Czech Society of Mechanics, Prague; selection comm. joint with Czech Techn. Univ. Prague and Czech Academy of Sciences (see <http://www.csm.cz/en/z-p-bazant-prize-for-engineering-mechanics/>)

Medals, Prizes & Awards Received:

- 2009 *Timoshenko Medal*, ASME (Am. Soc. of Mechanical Engrs.).¹⁰
- 2005 *Theodore von Karman Medal*, ASCE (Am. Soc. of Civil Engrs.).¹¹

⁷“For accomplishments in the field of stability of structures and size effects in fracture mechanics”

⁸Cited for “distinguished career as a foremost civil and mechanical engineer” and for “significant contributions to the advancement of engineering research and education”.

⁹cited for ‘many important and lasting contributions in the mechanics of solids and structures, including the theory of scaling of quasibrittle materials, constitutive equations, and stability problems of fracture, damage and inelastic behavior’

¹⁰“For fundamental contributions to scaling research in solid mechanics, particularly to the effect of the size of a structure on its strength and failure behavior; and for outstanding advances in structural stability, fracture mechanics, the micromechanics of damage, concrete creep and probabilistic mechanics”

¹¹The Medal is given “in recognition of distinguished achievement in engineering mechanics”; cited “for extensive and substantive contributions to the understanding and solution of multitude of problems in engineering mechanics involving structural stability, behavior of con-

- crete, and uncertainty and scale effects in materials and structures”
- 1996 *W. Prager Medal*, Soc. of Engng. Science (SES).¹²
- 1996 *Newmark Medal*, ASCE.¹³
- 2015 *Raymond Mindlin Medal*, ASCE.¹⁴
- 1997 *W.R. Warner Medal*, ASME (Am. Soc. of Mechanical Engrs.).¹⁵
- 2008 *Nadai Medal*, ASME (Am. Soc. of Mech. Eng.)¹⁶
- 2011 *Maurice Biot Medal*, ASCE.¹⁷
- 2008 *Wilhelm Exner Medal*, Austrian Trade Association (Gewerbeverein), Vienna.
- 1997 *J.J.R. Croes Medal*, ASCE.¹⁸
- 2003 *Lifetime Achievement Award*, from ASCE Illinois Structural Engineering Section.
- 1993 *Medal of Czech Society for Mechanics*¹⁹ (čestná medaile České společnosti pro mechaniku), Prague.
- 1990 *Torroja Gold Medal* from Building Research Institute of Spain.²⁰
- 1975 *L’Hermite Medal* from RILEM²¹ (in 1975 called RILEM Medal).
- 2007 *Zdeněk Bažant (Sr.) Medal* (1st recipient of), Czech Techn. University, Prague (ČVUT) (medal named after late grandfather, professor of structural mechanics and rector (i.e. president) of ČVUT)²².
- 1998 *Šolín Medal*, Czech Technical University, Prague (ČVUT)²³
- 1999 *Stodola Gold Medal*, Slovak Academy of Sciences, Bratislava.
- 2008 *Outstanding Contributions Award*, IACMAG (International Association for Computer Methods and Advances in Geomechanics).
- 2001 *ICOSSAR Lecture Award*, Int. Assoc. for Structural Safety and Reliability (Int. Conf., Newport Beach, CA, June 20, 2001).
- 2001 *D.M. Roy Lecture Award*, Am. Ceramic Society (2nd Roy Lecture, Annual Meeting, Indianapolis,

crete, and uncertainty and scale effects in materials and structures”

¹²Given once every two years “for contributions to solid mechanics”.

¹³The Medal is given to “a member who, through contributions to structural mechanics, has helped substantially to strengthen the scientific base of structural engineering”; cited for “fundamental contributions to the understanding of constitutive behavior of structural materials, nonlinear fracture mechanics and stability of structures.”

¹⁴Citation: For outstanding contributions to mechanics and for important extensions of Mindlin’s results to nonlocal softening damage and size effect in quasibrittle materials.

¹⁵The Medal “honors outstanding contributions to the permanent literature of engineering”; cited for “important contributions to solid mechanics, focusing on the size-effect law for failure of brittle structures, modeling of material damage from softening, local and nonlocal concepts, stability and propagation of fracture and damage in material and thermodynamic concepts associated with stability of non-elastic structures.”

¹⁶Cited “for demonstrating spurious localization instability in strain-softening models of quasibrittle materials, devising a remedy by crack-band and nonlocal damage formulations, discovering and experimentally validating the energetic size effect law for such materials, and showing applications to particulate and fiber composites.

¹⁷Cited “for groundbreaking contributions to the mechanics of concrete as a nano-porous material, particularly the creep and diffusion processes, thermodynamics of nano-pore water and high temperature effects, with numerical algorithms and consequences for structural design”.

¹⁸For paper “Is No-Tension Design of Concrete and Rock Structures Always Safe?—Fracture Analysis,” by Bažant, J. Struct. Eng. 122, Jan. 1996, 2–10.

¹⁹“For advances in mechanics.”

²⁰Cited for “outstanding achievements in the fields of structural engineering and mechanics of concrete”

²¹Cited for “brilliant developments in mechanics of materials, thermodynamics of creep and stability theory, bridging experimental and theoretical research”.

²²“In recognition of lifelong successful scientific research”

²³Cited for “fundamental research contributions”.

April 24, 2001).

- 1977 *T.Y. Lin Prestressed Concrete Award* from ASCE (for the paper “Creep and Shrinkage in Reactor Containment Shells”, with D. Carreira and A. Walsler, J. Struct. Div. 101, 1975, 2117–2131).
- 1976 *Walter L. Huber Civil Engineering Research Prize* from ASCE²⁴
- 2001– *ISI Award of “Highly Cited Scientist in Engineering”*²⁵
- 1992 *Best Engineering Book of the Year*—Award for Excellence from Assoc. of Am. Publishers (Professional & Scholarly Publ. Div.), for “Stability of Structures” (with L. Cedolin).
- 1992 *Meritorious Publication Award*—Structural Engineers Assoc. of Ill.; for the paper “Size effect on diagonal shear failure”, with M.T. Kazemi, ACI Struct. J.
- 2008 *Publication Merit Award*—Structural Engineers Assoc. of Ill.; for the paper “Justification of ACI-446 code provisions for shear design of reinforced concrete beams”, with Q. Yu et al., ACI Struct. J.
- 2015 *RILEM Outstanding Paper Award* (Extrapolation of short-time drying shrinkage tests based on measured diffusion size effect: concept and reality, by ZP Bazant and A Donmez, in Materials and Structures).
- 1990 *Alexander von Humboldt Award of Senior U.S. Scientist*, from Federal Republic of Germany.
- 2006 *Mindlin Centennial Lecture*, US National Congress of Theoretical and Applied Mechanics, Boulder, CO, June 26, 2006.
- 1984 *Scientific and Technical Prize*, shared with Tong-Sheng Wang, from Ministry of Water Resources and Electric Power, Beijing, for paper “Random Temperature and Shrinkage Stresses in Aging Concrete”.
- 1982 *IR-100 Award* (with S. Meiri), from Industrial Research and Development, for developing a new triaxial-torsional high-temperature testing machine.
- 1955 *National Winner, Mathematical Olympics* (for high school students), Czechoslovakia.
- Honorary Professor*: 2007 National Taiwan University of Science & Technology, 2012 Southeast University, Nanjing, China, 2012 Xi’Yan Jiaotong University, Xi’Yan, China.

Other Honors:

- 1976 *Outstanding New Citizen*, from Metropolitan Chicago Citizenship Council.
- 2004 elected *Honorary President*, IA-FRAMCOS (Int. Assoc. of Fracture Mech. of Concr. Str.)
- 1997 elected Professor Emeritus (by courtesy), Czech Technical University, Prague.
- 1998 *Special Issue in Honor of Prof. Z.P. Bazant*, Int. J. of Solids & Structures, “Special Topics in Structural Mechanics and Materials”, Vol. 35, Numbers 31–32, pp. 4019–4350, John P. Dempsey and Gilles Pijaudier-Cabot, guest editors (20 papers).
- 2006 *Special Issue in Honor of Professor Zdeněk P. Bazant*, Int. J. of Fracture, Vol. 137, Numbers 1–4, pp. 1–294, G.J. Dvorak, guest editor (13 papers).
- 1998 *honored by a Workshop* (dedicated to Bazant’s 60th birthday) on Mechanics of Quasibrittle Materials sponsored by Electricité de France at Czech Techn. University, Prague, chaired by Z. Bittnar, G. Pijaudier-Cabot and B. Gérard (with dedicated Proc. volume).

- 2007 *honored by a Symposium* on Microplane and Multiscale Models at ECCOMAS Thematic Conference on Mechanics of Brittle Heterogeneous Materials in Prague, and pre-conference *ZPB70 Workshop* (at 70th birthday).
- 2007 *Asian Workshop in Honor of Bazant’s 70th Birthday*, 1st Annual Meeting of Taiwan Concrete Institute, National Taiwan University, Taipei.
- 2012 *Symposium in Honor of Bazant’s 75th Birthday*, at ASCE Annual Engineering Mechanics Institute Conference, University of Notre Dame, South Bend, IN
- 2012 *Symposium in Honor of Bazant’s 75th Birthday*, “From Nanopores to Large Structures: A Life Journey across Length Scales”, Society of Engineering Science Annual Meeting, Georgia Institute of Technology, Atlanta, Oct. 10, 2012.
- 2013 *Symposium in Honor of Bazant’s 75th Birthday*, 3rd Int. Conf. on Computational Fracture Mechanics (CFRAC-3), Prague, June 6–7.
- 2013 *ConCreep-9* (Int. Conf. on Creep, Shrinkage and Durability of Concrete Structures), named “Tribute to Prof. Bazant”
- 1991 *Government Lectureship Award*, National Science Council, Republic of China (Taiwan).
- 1978–79 *Guggenheim Fellowship*.
- 1996 *JSPS Fellowship*, Japan Soc. for Promotion of Science.
- 1988 *NATO Senior Guest Scientist Fellowship*, France.
- 1987 *Kajima Foundation Fellowship*, University of Tokyo.
- 2014 *Elected Council Member*, Czech Society of Sciences and Arts (Česká společnost pro vědu and umění, SVU), Washington, D.C.

Endowed, Distinguished and Named Lectures:

- 1982 *11th Arthur J. Boase Lecture*, Univ. of Colorado, Boulder
- 1982 *Special University Lecture* of University of London in Civil and Mechanical Engineering, Imperial College, London.
- 1987 *Kajima Foundation Lecture*, University of Tokyo.
- 1990 *Inaugural Lecture* of Walter P. Murphy Professorship, Northwestern University.
- 1991 *2nd International Torroja Lecture*, National Council for Scientific Research, Madrid.
- 1994 *Lecturer, Southwest Mechanics Lecture Series*.
- 2001 *D.M. Roy Lecture*, Am. Ceramic Society Annual Meeting, Indianapolis.
- 2002 *Gurley Lecture*, Rensselaer Polytechnic Institute, Troy, N.Y.
- 2005 *Beyer Distinguished Lecture*, University of Houston.
- 2005 *Carroll Memorial Lecture*, Engineering Society of Baltimore.
- 2005 *Professor C.S. Krishnamoorthy Memorial Lecture*, Indian Institute of Technology Madras, Chennai.
- 2006 *Mindlin Centennial Lecture*, US National Congr. of Theor. & Appl. Mech., Boulder, CO.
- 2008 *Nadai Lecture*, ASME Annual Meeting, Boston.
- 2009 *Biot Lecture*, 4th Biot Conf. on Poromechanics, Columbia University, New York.
- 2009 *Distinguished Lecture*, Civil Eng. Dept., UCLA.
- 2009 *Inaugural Lecture*, Spanish Royal Academy of Engng., Madrid.
- 2009 *Patterson Lecture*, Civil Eng. Dept., University of Colorado, Boulder.
- 2009 *Richardson Lecture*, Univ. of Colorado, Boulder
- 2009 *Annual Distinguished Lecture*, University of California, Los Angeles.
- 2009 *Elisabeth Rockwell Lecture*, Dept. of Mechanical Engng., University of Houston, Oct. 13.
- 2009 *William Gurley Lecture*, Dept. of Mechanical, Aerospace & Nuclear Engng., Rensselaer Polytechnic Institute (RPI), Troy, NY, Dec. 2.

²⁴Cited for “research on creep, inelasticity and moisture effects in concrete, nonlinear and time-dependent structural behavior, stability and fracture”.

²⁵One of the original top 100 in engrg.; www.ISIhighlycited.com.

- 2010 *Frank L. Parker Lecture*, Dept. of Civil & Env. Engrg., Vanderbilt University, Nashville, Kentucky, Feb. 1.
- 2010 *Fazlur Rahman Khan Lecture*, Rossin College of Engrg. & Appl. Sci., Lehigh University, Bethlehem, PA, Feb. 26.
- 2010 *Samuel J. Mathis Memorial Lecture*, Dept. of Civil & Environmental Engineering, M.I.T., Cambridge, MA, Dec. 13.
- 2011 *CEAS Distinguished Lectures*, College of Engrg. and Appl. Sci., University of Wisconsin, Milwaukee, Oct. 28.
- 2011 *College of Engrg. Distinguished Lecture*, University of Miami, Corral Gables, FL, Nov. 7.
- 2012 *Fowler Distinguished Lecture*, Texas A & M University, College Station, TX, Oct. 24, 2012.
- 2012 *Distinguished Lecture in Mechanical Engrg.*, Carnegie-Mellon University, Pittsburgh, PA, Nov. 16, 2012.
- 2013 *Distinguished Lecture in Mechanical Engrg.* Arizona State University, Tempe, AZ, Oct. 18, 2013.
- 2014 *Distinguished Lecture in Mechanical Engrg.*, Northeastern University, Boston, Nov. 14, 2014.
- 2014 *Why Fracking Works and How to Optimize It*, Warren Lecture, University of Minnesota, Minneapolis, Dec. 5, 2014.
- 2015 *Why Fracking Works and Why Not Well Enough*, Distinguished Lecture of Faculty of Engineering, Chongqing University, Chongqing, China, January 12, 2015.
- 2015 *Why Fracking Works and Why Not Well Enough*, Tsinghua Global Vision Lecture, Tsinghua University, Beijing, China, Jan. 13, 2015.
- 2015 *Why Fracking Works and Why Not Well Enough*, Presidents' Distinguished Lecture Series in Engineering, Science and Medicine, Texas Tech University, Lubbock, TX, February 9, 2015.
- 2015 *Why Fracking Works and Why Not Well Enough*, Edison Lecture, Aerospace and Mech. Engrg. Dept., University of Notre Dame, South Bend, IN, March 31, 2015.
- 2015 *Why Fracking Works and Why Not Well Enough*, IMNI Distinguished Lecture, Institute for Molecular and Nanoscale Innovation, Brown University, Providence, RI, April 29, 2015.
- 2015 *To frac or not to frac? How quasibrittle fracture mechanics can sway the answer*, Inaugural Lecture, Royal Society of London, July 10, 2015.

Plenary Lectures at Major Conferences: 89 (since 1982).

Other:

- 1976 *Outstanding New Citizen*, from Metropolitan Chicago Citizenship Council.
- 1967-68 *Ford Science Foundation Fellowship*.
- 1966-67 *French Government ASTEF Fellowship*.
- 1964 *Second Prize in Public Anonymous Competition on Danube Bridge Design*, Czechoslovakia.
- 1958 & 1960 *National Winner* (twice), Student Research Competition in Civil Engineering, Czechoslovakia.

Listed: Who's Who in America (since 1977), etc.

EDITORIAL BOARDS

Editor (in-Chief):

1. *Journal of Engineering Mechanics*, ASCE, 1988-94.

Board Member Handling and Accepting Papers:

2. *Regional Editor (U.S.)*, Intern. Jour. of Fracture (Kluwer Academic Publ.), 1991-.
3. *Editor*, Cement and Concrete Research (Pergamon Press, later Elsevier), 1970-2006.
4. *Editor*, Materials and Structures (RILEM, Paris), 1981-93; *Board Member*, 1993-2003.
5. *Associate Editor*, Jour. of the Engrg. Mechanics Div., ASCE, 1973-77 and 1981-83.
6. *Associate Editor*, Applied Mechanics Reviews (ASME), 1987-95, 2007-.

Editorial Board Member:

7. Intern. J. of Numerical Methods in Engineering (J. Wiley), 1990-.
8. Archive of Appl. Mech. (Ingenieur-Archiv) (Springer, Berlin), 1990-.
9. Intern. J. of Numerical and Analytical Methods in Geomechanics (J. Wiley), 1979-.
10. Probabilistic Engineering Mechanics (Elsevier), 1986-.
11. Engineering Computations (Pineyrd Press), 1987-.
12. Intern. J. of Damage Mechanics (Technomic Publ. Co.), 1992-.
13. Acta Mechanica (Springer), 1995-.
14. ASCE J. of Aerospace Engrg., 2002-.
15. Journal of Geomechanics ASCE, 2003- (formerly Intern. J. of Geomechanics, CRC Press, 2001-2003).
16. Journal of Nanomechanics and Micromechanics ASCE, 2015-.
17. Acta Mechanica Sinica, 2001-.

Other: 17. Advances in Structural Engineering—An Intern. J. (Multi-Science Publishing, Ltd., U.K.), 1996-2000. • 18. Int. J. of Computational Civil and Structural Engineering (Begell House, N.Y.), 1999-. • 19. Computer Modeling in Engineering Sciences (Sage Science Press), 1999-. • 20. International Journal of Structural Stability and Dynamics (Elsevier), 2001-. • 21. Dam Engineering (Wilmington Publishing, UK), 1992-. • 22. Mechanics of Advanced Materials and Structures (Taylor & Francis), 2002-. • 23. Interaction and Multiscale Mechanics: An International Journal (IMMIJ). 2008-. • 24. Multiscale Computational Modeling (Begell House, New York), 2003-. • 25. International Journal of Materials and Structural Reliability (Rangsit University, Thailand, publ.), 2003-. • 26. Computers, Materials & Continua (Tech Science Press, Encino, CA), 2004-. • 27. J. of Zhejiang Univ. SCIENCE, 2004-. • 28. Journal of Nuclear Energy & Power Generation Technologies, OMICS Publishing Group, 2010-. • 29. J. of Structural Fire Engrg., Multi-Science Publishing, 2010-. • 30. Acta Poytechnica (CVUT Prague), 2015-.

Formerly: 31. Nuclear Engrg. and Design (North Holland), 1990-2001. • 32. Int. J. of Cohesive-Frictional Materials and Structures (J. Wiley) 1995-2000. • 33. J. of Advanced Cement-Based Materials, 1993-98 • 34. Archives of Mechanics (Sijthoff & Noordhoff), 1980-1990. • 35. FRAGBLAST—The Intern. Quarterly J. for Blasting and Fragmentation (Balkema), 1996-2004.

COMMITTEES AND SOCIETIES

- *President*, Society of Engineering Science, 1993 (*Board of Directors*, 1988-94).
- *President and Founder*, Intern. Assoc. for Fracture Mechanics of Concrete Structures (IA-FraMCoS, headquarters in Evanston, IL), 1991-93 (Board of Directors, 1991-2004).
- *President and Founder*, Intern. Assoc. for Concrete Creep and Durability (IA-ConCreep), 2001 (Board of Directors, 2001-08).
- *Chairman and Founder*, ACI Comm. 446, Fracture Mechanics, 1985-92.
- *Member*, U.S. National Committee on Theoretical and Applied Mechanics, 2000-2003.
- *Chairman*, Division H, Concrete Structures, Intern. Assoc. for Structural Mechanics in Reactor Technology (SMiRT), 1981-87, 1989-94 (and *Division Advisor*, 1994-96).
- *Chairman*, Division Q, Concrete and Nonmetallic Materials, *ibid.*, 1987-89.
- *Chairman*, ASCE Engrg. Mech. Div. Programs Committee, 1989-91.
- *Chairman*, ASCE Committee on Properties of Materials (Eng. Mech. Div.), 1975-77, 1981-83.
- *Chairman*, RILEM Comm. TC107, Prediction of Creep & Shrinkage of Concrete, 1988-2000.
- *Chairman*, RILEM Comm. TC69, Math. Models for Creep & Shrinkage of Concrete, 1981-88.
- *Chairman*, RILEM Comm. TC-QFS, Size effect and scaling of quasibrittle fracture, 1994-2000.
- *Chairman*, RILEM Comm. TC-MDC, Multi-Decade Creep; 2010-
- *Member of Council*, Czechoslovak Society for Arts and Sciences (SVU, Společnost pro vědy a umění), Inc., Maryland, 2002-05.
- *Member*, Dept. of Homeland Security (DHS) Committee on Aircraft Impact Effects on Dams, 2007-09.

- *ACI Representative* at European Concrete Institute (CEB) Comm. on “Time-Dependent Deformations of Concrete”, 1971–80.
- *Member*, Task Committee of National Academy of Engineering on Status of Cement & Concrete R & D in the U.S., 1977–80.
- *Member*, Advisory Committee of National Academy of Engineering on Reinforced Concrete Floating Marine Structures, 1979–83.
- *Member* ACI Committee 209, Creep and Shrinkage in Concrete, 1970–. *Chairman*, Subcommittee 1 on Creep Mechanisms, 1970–75; *Chairman*, Subcommittee 2 on Creep Prediction, 1988–.
- *Member* Joint ASCE-ACI Comm. on Finite Element Analysis of R.C. Structures, 1979–84 (*Chairman*, Subcom. 5 on Time-Dependent Effects, 1979–85; *Chairman*, Subcom. on Fracture Mechanics, 1989–).
- *Member* of the NAS Committee on Human Rights, 1996–.
- *Member* of the Science Council, Czech Techn. Univ. Prague, 2005–. National Taiwan University of Science and Technology, 2007–.
- *Member* International Code Council (ICC), 2007–2012.
- *MTS Visiting Professor in Geomechanics* (chair endowed by Materials Service Corporation), Nov.-Dec. 2104.
- *OTHER: NSF Charter Panelist*, 1990–. ASCE-EMD Committee on Probabilistic Methods, 1984–88; ASCE-EMD Comm. on Structural Stability, 1989–; Joint ASCE-ACI Comm. 334 on Shell Design, 1977–1986; ACI Comm. 348 on Struct. Safety, 1985–93; ACI Comm. 231 on Concrete at Early Ages, 1994–; ACI Comm. 445 on Shear & Torsion, 1994–; ASME-AMD (Applied Mechanics Div.), Comm. on Fundamental Research, 1975–78; ASME-AMD Comm. on Constitutive Relations 1984–; ASME Materials Div. Ceramics Comm., 1994–; Composites Comm., 1998–; Probabilistic Methods Comm. 2002–. SEM (Society for Experimental Mechanics) Committee on Fracture Mechanics, 1986–; RILEM Committee TC50 on Fracture Mechanics of Concrete, 1979–85; RILEM Committee on Rheology of Young Concrete, 1976–82; RILEM Comm. TC89 on Applications of Fracture Mechanics, 1987–91; RILEM Comm. TC90 on Fracture of Concr. 1987–93; RILEM Comm. TC148-SSC on Strain-Softening 1992–; RILEM Comm. TC114 on Computer Models for Creep & Shr., 1988–; RILEM Comm. TC123 MMC, 1993–; RILEM Comm. on Creep Data Bank, 1994–; RILEM Comm. TC-SOC 2001–; SES (Soc. of Engrg. Science) Awards Committee, 1989–83; SEAIO (Struct. Engrs. Assoc. of Illinois) Awards Committee, 1988–90, & judge on Best Design Award Panel, 1992; ASTM Subcomm. on Fracture Testing of Rock, 1979–82; ASTM Committee C-09 on Concrete, 1981–89, 1994–; Am. Soc. of Composites 2002–; US Nat. Assoc. of Computational Mech., 1993–; SSRC (Struct. Stability Res. Council) Comm. on Nonl. Frame Analysis; Council for High Rise Buildings and Urban Habitat: *Chairman* of Creep Committee, 1992–94. Czech Techn. Univ. Prague, member of Scientific Council, 2006–. ASTM Committee F-17 on Skiing, 1984–. Nat. Acad. of Sci. Committee on Human Rights, 1997–. ASCE-SEI Comm. on Progressive Collapse, 2006–.

PUBLICATIONS

> 550 research papers in refereed journals (since 1958), plus 52 state-of-art review papers, 230 proceedings papers, 2 published course texts, 6 authored books, 20 edited books

1. Bažant: *Creep of Concrete in Structural Analysis* (in Czech). SNTL, Prague 1966 (186 pp.).
2. Bažant and L. Cedolin: *Stability of Structures: Elastic, Inelastic, Fracture and Damage Theories*, Oxford Univ. Press, New York 1991, 2nd ed. Dover Publ., N.Y. 2002; 3rd ed. World Scientific Publ. 2010 (1009 pp.).
3. Bažant and M.F. Kaplan: *Concrete at High Temperatures*, Longman (Addison-Wesley), London 1996 (424 pp.).
4. Bažant and J. Planas: *Fracture and Size Effect in Concrete and Other Quasibrittle Materials*, CRC Press, Boca Raton and London 1998 (638 pp.).
5. M. Jirásek and Bažant: *Inelastic Analysis of Structures*, J. Wiley & Sons, London and New York 2002 (753 pp.).

6. Bažant: *Scaling of Structural Strength*. Hermes Penton Science, London 2002 (293 pp.) (French transl. 2004); 2nd updated ed. Elsevier 2005.

PATENTS: 4 (in 1959: one of the earliest release ski bindings, mass-produced in Czechoslovakia, exhibited in New England Ski Museum, Franconia, NH).

CITATIONS

H-index: 104, citations: 46,500, i10 index: 496 (on Google, Nov. 2015, incl. self-citations). Citations during the last 5 years: 17,500. Top cited paper: 2300 citations. Total number of refereed journal articles (incl. a dozen of invited book chapters): 607 (in Nov. 2015) Bažant is one of the original top 100 ISI Highly Cited Scientists in Engineering (all fields); www.ISIhighlycited.com.

SOCIETY MEMBERSHIPS

- American Society of Civil Engineers, Hon. Member and Fellow
- American Concrete Institute, Hon. Member and Fellow
- American Society of Mechanical Engineers, Hon. Member and Fellow
- Society of Engrg. Science, Fellow
- American Academy of Mechanics, Fellow
- International Association of Computational Mechanics, Fellow
- RILEM (International Union of Research Laboratories in Materials and Structures, Paris), Fellow
- IA-FraMCoS (Int. Assoc. of Fracture Mech. of Concr. Str.), First President and Founder, Fellow, Honorary President
- IA-ConCreep (Int. Assoc. of Concrete Creep and Durability), First President and Founder
- American Institute of Aeronautics and Astronautics (AIAA)
- American Society of Composites (ASC)
- American Rock Mechanics Society (ARMA)

Also *Member*: NAS, NAE, Austrian, Italian, Spanish, Czech, Lombard, and European Academies, American Ceramic Society, American Society for Testing Materials, IABSE (International Association for Bridge & Structural Engineering), Society for Experimental Mechanics, Amer. Soc. of Rock Mechanics Composites, International Association for Structural Mechanics in Reactor Technology, Int. Soc. for Computational Mechanics, International Society of Soil Mechanics & Foundation Engineering, Structural Engineers Association of Illinois, Earthquake Engineering Research Institute, Materials Research Society, U.S. Committee on Large Dams, Structural Stability Research Council, Prestressed Concrete Institute, Intern. Soc. for Computational Engineering Science (founding member), Int. Assoc. for Bridge Maintenance and Safety, IALCEE Int. Assoc. Lifetime Cycle Eng.), ARMA (Am. Rock Mech. Assoc.). (Previously also: National Ski Association, Centennial Tennis Club, Kenilworth Sailing Club, Evanston Running Club, U.S. Olympic Society.)

GRADUATE STUDENT ADVISING

- At Northwestern: advisor of 57 Ph.D.’s, 15 M.S. theses; also advised 12 Ph.D. theses defended at other universities.

LECTURES AND SEMINARS

- 89 plenary conference lectures, and 35 endowed, named or distinguished university lectures
- 139 invited and sectional ‘keynote’ conference lectures
- 473 guest seminars at universities and institutes
- 426 other conference papers presented
- 18 intensive short courses at other universities & abroad

CONFERENCE CHAIRMAN/ORGANIZER

1. NSF Symposium on “Creep and Shrinkage in Concrete”, Lausanne, 1980 (co-chairman with F.H. Wittmann).
2. NSF Workshop on “High Strength Concrete”, Chicago, 1979 (co-chairman with S.P. Shah).
3. IUTAM Prager Symposium on “Mechanics of Geomaterials: Rocks, Concrete, Soils”, Northwestern University, 1983 (chairman).

4. 4th RILEM International Conference on “Creep and Shrinkage of Concrete: Mathematical Modeling (CONCREEP-4)”, Northwestern University, 1986 (chairman).
5. AFOSR Workshop on “Constitutive Relations and Modeling of Distribution Cracking, Strain-Softening and Localization”, Institute for Mathematics, University of Minnesota, Minneapolis, 1987 (co-chairman with T. Beltychko).
6. France-U.S. Workshop on “Strain Localization and Size Effect Due to Cracking Damage”, sponsored by NATO, Paris-Cachan, 1988 (co-chairman).
7. First International Symposium on “Fracture Mechanics of Concrete Structures” (FramCoS1), Breckenridge, Colorado, 1992 (chairman).
8. CONCREEP-5—5-th RILEM Int. Conf. on Creep & Shrinkage of Concrete, Barcelona, 1993 (co-chairman with I. Carol).
9. Co-chairman (as ASCE-EMD Representative) of Joint ASME-ASCE-SES Mechanics Conference, Charlottesville, VA 1993 (chair: C.T. Herakovitch).
10. Europe-U.S. Workshop on Damage and Fracture in Quasibrittle Structures: Experiment, Modeling and Computer Analysis, sponsored by U.S. National Science Foundation and European Union, Prague, Sept. 1994 (co-chairman).
11. Co-Organizer and SES Representative, McNU’97—Joint ASCE-ASME-SES Mechanics Conference, Northwestern University, 1997.
12. Chairman, ONR Workshop on Fracture Scaling (sponsor: Office of Naval Research), University of Maryland, College Park, 1999.
13. CONCREEP-6 (co-chairman with F.J. Ulm and F.H. Wittmann)—6th Int. Conf. on Concrete Creep and Durability, M.I.T., 2001.
14. NSF Workshop on Model-Based Simulation of Material Durability (co-chairman with Z. Bittnar, G. Pijaudier-Cabot and Y. Xi), Czech Techn. Univ. Prague, 2002.

RESEARCH GRANTS, CONTRACTS: 65 Grants and Contracts since 1970 from NSF, ONR, AFOSR, DoE, DoT, EPRI, ARO, DARPA, DNA, DTRA, FAA, Boeing Co., Chrysler Corp. (USCAR), Ford Motor Co., Oak Ridge National Laboratory, Los Alamos Nat. Laboratory, U.S. Army Corps of Engineers (WES), ERDC, Sandia Laboratories, ARPA, RCRC, Shimizu Corp. (Tokyo), Korea Electric Power Institute, ADD Korea, Cirrus Aircraft Corp.

CONSULTANT: – Argonne National Laboratory (staff consultant, 1974-94) – Oak Ridge National Laboratory – Sargent & Lundy, Chicago – ETA Corp., Chicago – Teng & Associates, Chicago – Ontario Hydro, Toronto – Swedish Cement & Concrete Institute (CBI) – WES (U.S. Army Corps of Eng.), Vicksburg – Sandia National Laboratory, Albuquerque – Portland Cement Association, Skokie – Babcock & Wilcox, Pittsburgh – Systems, Science & Software, La Jolla, CA – W.R. Grace, Columbia, MD – U.S. Forrest Products Laboratory, Madison – MGM Engineers, Pittsburgh – Euratom, Ispra, Italy – Quadrio, Milano – Institut für Werkstoffe im Bauwesen, Stuttgart University – Institut für Statik und Dynamik, Stuttgart University – Det Norske Veritas, Oslo – Analysis & Technology, Inc. – KAIST & Hyundai Corp., Korea – KEPRI (Korea El. Power Inst.), – Taisei Corp. (Tokyo) – Červenka Co. (Prague) – DTRA (Washington D.C.) – Boeing Co. – Los Alamos Nat. Lab. – ES3, San Diego, and other.

TEACHING AT NORTHWESTERN

49 PhDs, 17 MS graduated. Courses taught: 1. Stability of Structures 2. Inelastic Analysis of Structures 3. Fracture of Concrete 4. Cohesive Fracture and Scaling 5. Continuum mechanics 6. Structural Analysis 7. Advanced Structural Analysis 8. Design of Reinforced Concrete 9. Design of Prestressed Concrete 10. Concrete Inelasticity 11. Behavior of Reinforced Concrete 12. Concrete Shells 13. Inelastic Structural Stability 14. Material Modeling Principles 15. Mechanics (Statics and Dynamics) 16. Mechanics of Materials I and II 17. Selected Topics in Materials Science

VISITING PROFESSOR

• Swedish Cement and Concrete Institute (CBI), Royal Institute of Technology, Stockholm 1976–1977. • Chalmers University, Göteborg 1977. • Politecnico di Milano, 1982, 1993,

1996, 2000, 2002. • Swiss Federal Institute of Technology (EPFL), Lausanne 1983, 1997, 2001. • E.N.S. (Ecole Normale Supérieure), Paris-Cachan 1988, 1992, 2000. • Technische Universität München, Germany 1990, 1991. • Technische Universität Stuttgart, Germany 1991, 1992. • I.N.S.A. (Institut National des Sciences Appliquées), Lyon-Villeurbanne, France, 1993. • Lulea University, Sweden, 1994. • E.T.H. (Swiss Federal Institute of Technology), Zürich 1995. • National University of Singapore, 2001. Czech Techn. University,

Prague, intermittently 2000-2014. University of Minnesota, Minneapolis (MTS Vis. Prof.) 2014.

VISITING SCIENTIST

• CEBTP (Centre d’Etude du Bâtiment et des Travaux Publics), Paris, 1966-67; • University of California, Berkeley 1968-69; again 1978; • Stanford University, 1978; • E.T.H., Zürich 1979; • California Institute of Technology, 1979; • M.I.T., 1979; • Technische Universität, Wien, 1981; • University of Cape Town, 1984; • University of Adelaide, 1985; • University of Tokyo, 1987, 1996; • Universidad Politécnica de Madrid, Spain, 1992; • Universidad Politécnica de Catalunya, Barcelona, 1994, 1999. • Lulea University, Sweden, 1994. • Laboratoire central des ponts et chaussées (LCPC), Paris, 1998. • University of Palermo, 1998.

FOREIGN LANGUAGES

Foreign languages: Czech (native), French, German, Russian (lectured in all four).

Research Contributions and Impact

Bažant, with his disciples, has made groundbreaking contributions to four areas of solid and structural mechanics.

Size effect, fracture and distributed damage

Bažant is a world leader in scaling research in solid mechanics. He is best known for discovering the size effect law for quasibrittle failure and the related nonlocal and crack band models. With the advent of computers in 1970, analysis of structures with distributed softening damage became feasible. But the pitfalls were not recognized. Bažant showed in 1976 that the computed structure strength was spuriously dependent on the chosen finite element (or mesh) size and that a characteristic material length serving as a localization limiter had to exist. The size effect on structural strength was recognized but was incorrectly attributed to material randomness and fracture mechanics was thought to be inapplicable.

Bažant changed that. In a series of six landmark papers during 1976-1991, he revolutionized the theory of scaling of quasibrittle structure strength and demonstrated the applicability of quasibrittle fracture mechanics. In 1984, through asymptotic-matching arguments, he discovered the energetic (non-statistical) size effect law for quasibrittle failure – a deceptively simple law that bridges the small-size quasi-plastic behavior, exhibiting no size effect, to the large-size brittle behavior, exhibiting the maximum possible size effect. With his assistants, he amply verified his law experimentally. He showed that disregard of size effect was a major factor in the failures of Sleipner Oil Platform, viaducts in Kobe, Loma-Prieta and Norridge earthquakes, Schoharie Creek and Palau bridges, Shelby warehouse, St.-Francis and Malpasset dams, etc. Embodied in various standard recommendations, Bažant’s law is now widely used for sensitive large structures and was endorsed as a recommendation of ACI-446 committee. A standardized fracture energy test (RILEM-FMT/1990) for concrete is based on his law.

After demonstrating in 1976 the inobjectivity and spurious mesh sensitivity of the classical stress-strain-based models for softening material damage, Bažant pioneered fracture-mechanics-based remedies – the crack-band model (1983) and nonlocal (1984, 1987) damage models, which introduced a material characteristic length as the basic characteristic of distributed damage, and transformed computer analysis of concrete structures and geomaterials, as well as load-bearing fiber composites for large structures such as aircraft and ships. His simple crack-band model today dominates in civil engineering industry and is incorporated in commercial software (e.g., ATENA, SBETA, OOFEM, DIANA). His more fundamental nonlocal damage model and second-gradient model spurned an avalanche of follow-up studies and became a vital check for sensitive designs. His books *Fracture and Size Effect* (with Planas), *Inelastic Analysis* (with Jirásek) and *Scaling of Structural Strength* became classics.

For three-dimensional characterization of fracturing, Bažant conceived in 1983 the microplane model in which the constitutive law, formulated in terms of vectors rather than tensors, is based on the concepts of crack opening and frictional slip, with their orientation, and the stress tensor is obtained from stress vectors by a variational principle. With his assistants, he developed microplane models for concrete, rocks, fiber composite laminates, braided composites, rigid foam, clays, granular solids, shape memory alloys, fiber reinforced concrete and annulus fibrosus. He demonstrated the 'vertex' effect in concrete (e.g., stiffness drop in torsion after previous compression in softening range) and showed that the microplane model can capture it.

Bažant's microplane models M4 and M7 became favored tool for simulating the effects of terrorist explosions, missile impact and groundshock. Ramifications include the load-carrying capacity of sea ice, forces on oil platforms, snow-avalanche triggering, borehole breakout, size effect in metallic thin films, etc. He discovered experimentally and explained theoretically that material strain softening reverses to hardening when the loading rate suddenly increases, which is important for shock wave propagation.

Recently, Bažant clarified: 1) the effect of comminution of solids under impact due to release of kinetic energy of high-rate shearing, in which he pointed out a new analogy with turbulence; 2) the consequences of crack localization instability for effectiveness and environmental impact of hydraulic fracturing (fracking) of gas shale; 3) the size effect on fatigue crack growth in quasibrittle materials; 4) energy absorption in composite crush cans for cars; 5) multi-decade prediction of concrete creep based on inverse analysis of excessive bridge deflections and on Bayesian extrapolation of test data; and 6) Bažant's new microplane material model for jointed rock was adopted for the commercial software ANSYS.

Uncertainty of structural strength

Important for structural safety is Bažant's nano-mechanics-based calculation of probability distribution of strength and lifetime of quasibrittle structures. Based on statistics of interatomic bond breaks he derived the distribution of strength and crack growth rate on the atomic scale and discovered a surprisingly simple multiscale transition to the representative volume element of material on the macro-scale. Thus he showed that, for quasibrittle materials, which are characterized by a fracture process zone whose size is not negligible compared to structural dimensions, the strength distribution is a combination of Weibull and Gaussian distributions varying with the structure size. This causes that the safety factors of quasibrittle structures must vary with structure size, too. Recently, he demonstrated a similar distribution for static and fatigue lifetimes of quasibrittle structures.

Concrete Creep, Durability and Sustainability

Bažant is also a leading world authority in creep and shrinkage of concrete. In 1972 he derived the age-adjusted effective modulus (AAEM) method which became the industry standard for simplified analysis of creep and shrinkage effects in concrete structures and has been a standard recommendation of ACI in America and *fib* Model Code in Europe. Motivated initially by problems of nuclear reactor containments, and later by large-span box-girder bridges and super-tall buildings, Bažant achieved fundamental advances in nano-poro-mechanics, and particularly the long-term creep and diffusion processes. By 1970, there was a host of unexplained conflicting observations-e.g., why concrete creep increases during drying whereas, at thermodynamic equilibrium, a lower pore water content gives lower creep; or why the decrease of creep with the age at load application continues for decades whereas chemical hydration terminates within a year. During 1970-1997, Bažant with his assistants answered these questions by formulating a consistent theory based on surface thermodynamics and disjoining pressure in adsorbed nano-pore water. He based on it his models B3 and B4 for practical prediction of concrete creep and shrinkage, which he calibrated by assembling, with his assistants, a vast world-wide database of laboratory tests.

Model B3 became an international standard (RILEM-CGS/1995, endorsed also in ACI-209/2008 Guide. In 2015, Bažant's improved model, B4, became a new international standard recommendation of RILEM. It is the first prediction model that covers autogenous shrinkage, explained by chemical self-desiccation. More recently, beginning with his analysis of the ill-fated record-span bridge in Palau, Bažant showed how the multi-decade concrete creep prediction can be updated by data on dozens of excessively deflecting

large-span prestressed bridges, which he compiled with his assistants.

Aging creep computations at transient environment were facilitated by Bažant's conversion of history integrals to a rate-type creep law, and by his 1971 invention of the unconditionally stable exponential algorithm for aging creep of concrete, now widely used in finite element programs. By discovering that a pore humidity decrease causes moisture diffusivity to drop by an order of magnitude, he formulated a nonlinear diffusion equation for concrete which has become the mainstay of computer programs and is part of the CEB-*fib* Model Code. Bažant's further work dealt with Bayesian updating and quantified the effects of randomness of creep and environment.

Creep, drying shrinkage, permeability and pore water pressure increase due to heating above 100 C, while strength, fracture energy and stiffness decrease. Concrete spalls and may explode. Temperatures up to 600 C are of major concern for the survival of tunnel linings and tall buildings in fire, and of containments in nuclear accidents. Studying these phenomena, Bažant documented a 100-fold increase of concrete permeability upon surpassing 100 C, and formulated a comprehensive theory used to evaluate the safety of nuclear concrete structures at Argonne NL and EDF in France, and to analyze the 'Chunnel' fire. With Kaplan, he published a widely read book on Concrete at High Temperatures. Bažant also pioneered chemo-mechanics of reinforcement corrosion, freeze-thaw, salt ingress and, especially, alkali-silica reaction, whose prediction is essential for sustainability of concrete structures.

Stability of Structures

Bažant was the first to resolve decades-long controversies about stability and critical loads of three-dimensional structures. Since 1910, there have been incessant polemics about the theories of Southwell, Hencky, Truesdell, Rivlin, Biot, Engesser, Haringx, etc., based on different choices of finite strain tensor and of objective stress rate, yielding critical load estimates differing even by $\pm 100\%$. These polemics were resolved in 1971 by Bažant's (1971) variational derivation of objective stress rates which led him to formulate the work conjugacy criteria of finite strain tensors and stress rates. He showed that different tensors are mutually equivalent, that a transition from one to another can be effected by a certain stress-dependent transformation of the tangential stiffness tensor, and that only one particular finite strain tensor is admissible when the material stiffness is considered constant. Recently he demonstrated that non-conjugate rates, which are used in many commercial programs, can lead to errors of $\pm 50\%$ in critical loads of highly compressible or highly orthotropic structures soft in shear (e.g., foam core sandwich shells, fiber composites, orthotropically cracked bodies). Also, he recently clarified weakness in wave propagation properties of peridynamics. Bažant wrote (with Cedolin) a lucid and the most comprehensive treatise on stability of structures, treating in a unified manner not only the stability problems of elasticity and plasticity, but also those of creep, fracture and material damage.

Forensic Engineering

Among bridge designers, Bažant is known for clarifying the grossly excessive deflections of the ill-fated record-span prestressed concrete bridge in Palau and showing that they were the consequence of incorrect standard recommendations for long-term creep rather than lapses of quality control.

Bažant explained scientifically what did, and what did not, cause the 9/11 collapse of WTC towers in New York in 2001. Further he explained what caused the enormous deflections with ensuing tragic collapse of the world-record prestressed box girder bridge in Palau.

He also calculated that the quasibrittle fracture (non-statistical) size effect caused a 50% reduction of the strength of the Malpasset Dam (failed in 1959) and further estimated that it was a significant factor in many failures, including Sleipner A Oil Platform (sank 1991), St. Francis Dam, L.A. (1928), Schoharie Creek Bridge, N.Y. Thruway (1987), Cypress Viaduct, Oakland, CA (in Loma Prieta Earthquake 1989), Hanshin Viaduct, Kobe (Hyogo-ken, earthquake 1995), Shelby Warehouse (Ohio), Bridge columns in LA (Norridge earthquake, 1994), Laval Overpass (Quebec 2006), etc.