


**Georgia
Tech**  **College of Engineering**
Structural Mechanics Seminar Series

**MECHANICS OF PROGRESSIVE COLLAPSE:
WHAT DOOMED WORLD TRADE CENTER AND WHAT CAN WE LEARN?**



Zdenek P. Bazant

W.P. Murphy Professor and McCormick Institute Professor, Northwestern University

Tuesday, April 3 at 3:00PM, MaRC Building, 1st Floor Auditorium

Host: George A. Kardomateas, AE

ABSTRACT

The collapse of World Trade Center (WTC) towers on 9/11/2001 was not only the biggest mass murder in the U.S. history but also the biggest surprise to structural engineers since the Tacoma Bridge collapse in 1940. After reviewing his original simple analysis submitted in September 2001 and the far more detailed analysis of the fire zone at the U.S. National Institute of Standards and Technology, released in 2005, Bazant will outline his theory of progressive collapse. After introducing proper distinction between the crush-down and crush-up phases of progressive collapse, he will show that the gravity alone suffices to explain the observations if the inelastic buckling of columns and the comminution of concrete floor slabs upon impact are properly taken into account, and in particular that: 1) there is no disagreement of the calculated total duration of collapse with observations; 2) the motion history identified from video records is in perfect agreement with the solution of the differential equation of progressive collapse; 3) the tilting of the falling part is easily explained and accounted for; 4) the particle sizes of pulverized concrete slabs agree with the energetic theory of comminution of brittle solids; and 5) only about 10% of the gravitational energy of tower (converted into kinetic energy) sufficed to create all of the pulverized concrete found on the ground. The results reconfirm Bazant's original conclusion (on 9/13/2001) that collapse driven solely by gravity was inevitable because the plastic-fracturing energy absorption capability of the steel frame was dwarfed by the initial kinetic energy of the upper part of tower set in motion by viscoplastic buckling of heated and damaged columns. The claims of conspiracy with planted explosives, recently advanced in laymen circles and promulgated in mass media, are thus proven to be false. Furthermore, Bazant will argue that, with a certain kind of precise remote monitoring of building demolitions, inverse analysis based on the proposed energetic theory of progressive collapse could be used to extract valuable information on the energy absorption capacity in various collapse modes. Finally, he will propose using such monitoring to rate the performance of various types of structural systems subjected to extreme fire, blast, impact, earthquake and terrorist attack.

BIO-SKETCH

Educated in Prague (Ph.D. 1963), Bazant joined Northwestern University in 1969, where he has been W.P. Murphy Professor since 1990, and simultaneously McCormick Institute Professor since 2002. He was inducted to US National Academy of Sciences, US National Academy of Engineering, Austrian Academy of Sciences, Italian National Academy (dei Lincei, Rome), Lombard Academy (Milan) and Czech Engrg. Academy; received six honorary doctorates (Prague, Karlsruhe, Colorado, Milan, Lyon, Vienna), ASCE von Karman and Newmark Medals, SES Prager Medal, ASME Warner Medal and many other honors, and authored six books (Scaling of Structural Strength, Inelastic Analysis, Fracture and Size Effect, Stability of Structures, Concrete at High Temperature, and Concrete Creep).