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SPECIAL ISSUE

DAMAGE AND FAILURE ANALYSIS OF MATERIALS

Guest Editors: **Zdeněk P. Bažant, Ignacio Carol and Paul Steinmann**

PERGAMON

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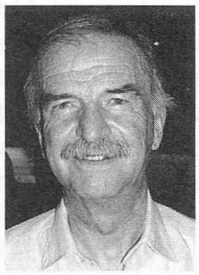
Preface



Kaspar Willam

This special issue contains most of the papers which were presented at the workshop "Deterioration Analysis of Materials at Various Scales of Observation", which was held in honor of Kaspar Willam on the occasion of his 60th birthday at the Soellerhouse in Hirschegg, Austria, March 25–28, 2001. The workshop was organized by his co-workers at Northwestern University (Evanston, Illinois, USA), Universität Kaiserslautern (Germany) and Technical University of Catalonia (UPC, Barcelona, Spain), with partial financial support from Electricité de France and the School of Civil Engineering (ETSECCPB) in Barcelona, Spain. The Soellerhouse facility was made available by the University of Stuttgart, thanks to Ekkehard Ramm and his co-workers.

Born in Vienna, Austria, on December 20, 1940, Kaspar Willam graduated in civil engineering at Vienna University of Technology in 1964. He continued his studies at the University of California, Berkeley, where he received his Ph.D. degree in 1969 with a dissertation on Finite Element Analysis of Box Girder Bridges under the advisorship of Alex Scordelis.

After a brief postdoctoral term at the University of California Berkeley, he joined the Institute for Statics and Dynamics of the University of Stuttgart in 1970, which was at that time directed by John H. Argyris. He worked there as a Group Leader on prestressed concrete reactor pressure vessels and on computational aspects of elastic and inelastic materials in general. In 1980 he became "Universitätsdozent" for Structural Mechanics in Aeronautical and Aerospace Engineering.

In 1981 he joined the University of Colorado, Boulder, where he spent most of his academic and scientific career, except for the two-year period 1988–1990, when he was Professor and Head of th

he taught a great variety of undergraduate and graduate courses in structural mechanics and

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materials. He directed a number of major research projects which were funded among others by NSF, AFOSR, WES, DFG, FHWA, CASI and the European Commission. The projects covered a wide range of topics related to constitutive modeling of engineering materials and localized failure analysis in static and dynamic environments using finite elements.

He has been active as a Member and Fellow of a number of professional societies organizations, including ASCE, ACI, ASME and USACM. He chaired for many years ASCE-ACI Joint Committee 447 on "Finite Element Analysis of Reinforced Concrete Structures". He is a member of the editorial board of several international journals. He has authored over 150 refereed publications, and delivered over 100 invited lectures and presentations at scientific and technical meetings. Over the last 25 years he organized and chaired a great number of sessions at international symposia and annual conventions of ACI, ASCE, ASME, and USACM. He co-chaired the fifth US National Congress for Computational Mechanics which took place in Boulder in 1999. He received the prestigious Alexander von Humboldt Award (Bonn-Bad Godesberg).

Kaspar Willam has made significant contributions to mechanics of materials which have become mandatory reference to many of us. Since the early times of multiaxial modeling of concrete for nuclear reactors, he and his co-workers have proposed a number of constitutive formulations of the elasto-plastic type. Widely known is the "Willam-Warnke" five-parameter model of a three invariant failure envelope (1975) [1], the fracture-energy based "Pramono-Willam" model (1989) [2], the "Extended Leon Model" with Etse (1990) [3], (1994) [4], and the "Three-Parameter Concrete Model" with Menétrey (1995) [5], as well as the most recent extension by a cap with Kang (1999) [6]. In the last decade, his contributions moved from plasticity towards isotropic and anisotropic damage formulations, which included a general framework for elastic degradation (1994) [7], consideration of spurious dissipation in stiffness recovery (1996) [8], stability of multiple dissipation processes (1996) [9], and the recent "Pseudo-Rankine" model developed in collaboration with Carol and Rizzi (2001) [10]. The current state-of-the art in constitutive modeling of engineering materials was summarized in the encyclopedic review article published by Academic Press in (2002) [11].

The problems of cracking, localization, finite element objectivity and regularization procedures have been a fundamental component of Willam's work since the emergence of these issues in the early 1980s. Among his original contributions along this line, one should mention his "Composite Fracture Model" (1984) [12], (1984) [13], (1986) [14], his assessment of the fundamental concepts underlying the fixed and rotating crack models (1989) [15], and several studies of localization indicators at material, element and structural levels (1987) [16], (1991) [17], (1996) [18], and (2000) 19]. One particular proposal, that has become well known, is the fixed vs rotating smeared crack st of isotropic and anisotropic softening models (1989) [15], which consists of a load stage of ect tension up to peak strength, which is followed by a second load stage of increasing tension- r strain with proportions $(\epsilon_{xx}, \epsilon_{yy}, \epsilon_{xy}) = (1 : 1.5 : 1)$. This non-proportional load history re- s n a gradual increase of the principal tensile strains in which the principal axes first rotate fast ar en slowdown progressively until an angle of 52° is reached asymptotically. This test, col- loq v known as the "Willam Test", has become one of the standard benchmarks for aniso- trop. ftening models of quasi-brittle materials proposed in the literature.

Ot heoretical and numerical research topics in which Willam made significant contributions include ropolar continua, finite deformation elasto-plasticity and integration algorithms for multiple ace plasticity models. In micropolar continua, the work with his former students Paul Steinman ndreas Dietsche and Maria-Magdalena Iordache includes an extension of von Mises and Drucker-Prager plasticity to Cosserat continua (1995) [20], an extension of the traditional localization analysis based on the acoustic tensor by a second localization condition (1991) [21], and a novel proposal (1998) [22] of a Mohr circle for non-symmetric stress when the origin of Mohr's circle is no longer positioned on the horizontal σ-axis (unlike the case of Boltzmann continua).

Micromechanical simulations of material specimens, which are nowadays emerging as a powerful tool for material analysis and design, were early on pioneered by Kaspar Willam (1989) [23], and led to the prominent doctoral thesis of Thomas Stankowski at the University of Colorado Boulder [1991]. In this study, concrete was idealized by an arrangement of numerically generated particles representing coarse aggregates, embedded in a contiguous matrix representing the mortar and fine aggregates. The particles were assumed to behave as linearly elastic, while the matrix was elasto-plastic, and the interface between them was modeled via elasto-plastic zero-thickness interfaces. The plastic zones in the matrix would lead to specimen failure with mode I patterns in tension, and shear band patterns in compression. These pioneering results were confirmed by later experimental work, and by other numerical results using similar geometries but alternative models for crack formation and development.

Although not central to Willam's work, experimental studies have also been germane to his contributions, including concrete testing in direct tension and triaxial compression (1986) [24], (1989) [25], and ultrasound measurements of progressive damage in concrete specimens (1995) [26], (1996) [27].

Finally, but not of lesser importance to all those who have interacted with Kaspar, is his personal and human side. Always friendly and smiling, never one single word too sharp, Kaspar can make those around him feel better and encourage hard work. Perhaps one of his main non-technical interests are mountains and skiing. Mountains and snow have been always present in his life—in his native country of Austria, when his family moved during World War II from Vienna to Bezau in the high mountains of Vorarlberg, and in his subsequent move to beautiful Colorado, where the snow compares with dry champaign and the skies are blue. In connection with technical events, many of us have shared great ski outings with him, hiking Breckenridge's Peaks 7 and 8, going down the untouched snows of British Columbia or Utah after ACI Conventions, or participating in the 'social' ski races of the EURO-C's in Austria. No doubt, these great times when skiing was often combined with technical exchanges on the chairlift or in the mountain cafe, have been the motivation for organizing this workshop in honor of his 60th birthday anniversary in the mountains of his beloved Austria.

The workshop has been a success as demonstrated by this special issue of IJES. The group who participated and many others who could not do so are all grateful of having had the opportunity to interact with Kaspar during all these years. We all look forward to many more such meetings of productive technical and non-technical exchange in the future.

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