CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: 2006 Society of Experimental Mechanics Annual Conference and Exposition on Experimental and Applied Mechanics
Project No. 20.06002.01.342
AI No. 20.06002.01.342.611

DATE/PLACE: June 4–7, 2006
St. Louis, Missouri

AUTHOR: R. Kazban
Center for Nuclear Waste Regulatory Analyses (CNWRA)

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PERSONS PRESENT:

Professionals from a large number of industries, universities, and government research facilities attended the conference. A total of 456 papers and posters were presented in 92 sessions. The conference also included a student paper competition and a student poster session. Society of Experimental Mechanics President, Eddie O'Brien, presented 10 awards to recognize outstanding achievements in experimental mechanics and service to the society. He also announced the first, second, and third place winners of the student paper.

BACKGROUND AND PURPOSE OF TRIP:

The conference featured technical symposiums on Experimental and Applied Mechanics, the 7th International Symposium on Microelectromechanical Systems and Nanotechnology, and vendor exhibitions. The purpose of attending this conference was to present the paper: "Effect of Tool Parameters on Temperature Fields in High-Speed Machining." This paper is based on work performed by the author at the University of Notre Dame for his doctoral thesis. The paper was published in the conference proceedings.

SUMMARY OF PERTINENT POINTS:

One of the main and extensively discussed topics at the conference was dynamic behavior of different materials. K. Tsembelis from Cambridge University discussed a series of impact experiments on the dynamical behavior of concrete in the longitudinal stress direction. The experiments were performed at different velocities up to 803 *m/s* for concrete composed of 50-percent coarse aggregate made of dolerite, 25-percent sand, and 25-percent cement paste by weight. The results of these experiments were compared to published data on cement paste, mortar, micro-concrete, and full-size concrete from the United Kingdom, Germany, and the United States. It was concluded that the differences in dynamic properties of examined materials are driven by the matrix material (cement paste) and initial density.

P. Ruggiero from the University of Rhode Island discussed the mechanical and physical characterization of lightweight shotcrete. Shotcrete is commonly used to rehabilitate a concrete structure deteriorating with age. Some causes of concrete deterioration include steel reinforcement corrosion, excessive deflections, and surface cracking. The compressive, indirect tensile, and flexural strength and fracture toughness of the cenosphere-modified shotcrete were obtained. Cenospheres are ceramic, hollow micro-balloons produced during coal-burning processes and have diameters ranging from 10–300 mm [0.0004–0.0118 in]. It was experimentally determined that the shotcrete sufficiently bonds to the concrete, and the weakest material in the shotcrete-concrete composite fails in tension before delamination occurs.

There appears to be an increasing interest in bulk metallic glasses, which is driven by the fact that these materials can provide desirable mechanical properties such as near theoretical strength, relatively larger elastic strain, and increased fracture toughness compared to ceramics, which are relatively brittle. Bulk metallic glasses can be used in high-intensity loading situations while used as a coating material to preserve structures with low specific strength.

Several presentations discussed the behavior of bulk metallic glasses under dynamic loading. G. Sunny from Case Western Reserve University discussed work on dynamic compression of amorphous and annealed bulk metallic glass. In particular, a performance of Liquidmetal-1 was examined in high strain-rate compression tests with strain rates varying from 500 to 2,000 s^{-1}. Liquidmetal-1 is a *Zr*-based bulk metallic glass that can be processed in a large sectional thickness {10 mm [0.4 in]} because of its low critical cooling rate (1 K/s). The main objective of this study was to better understand the effect of stress concentration on high strain-rate behavior of bulk metallic glasses.

G. Sunny also presented a paper on dynamic three-point bend testing of Liquidmetal-1 bulk metallic glass. Two main conclusions were made: (i) previous testing has not revealed that loading rate changes significantly affect the fracture toughness under quasistatic testing and (ii) there have been different observations of the effect of changes in strain-rates on the maximum stress attained prior to material failure.

G. Chen from Case Western Reserve University presented work on the effect of heat treatment on both dynamic deformation and failure of nickel-based super alloys. Thin plates of Inconel 718, in both annealed and precipitation hardening conditions were subjected to semi-quantitative high speed penetration, dynamic compression, and top-hat shear localization tests. It was concluded that annealed Inconel 718 absorbed more energy through multiple deformation modes and did not show any susceptibility to localization, which was in contrast to the precipitation hardened material.

At the session on residual stresses, A. Benamar from ENSET discussed strengthening of austenitic stainless steel by deep rolling, a method of cold working. This method can improve the mechanical properties and fatigue strength of a material. Generally, improvement of the fatigue strength is caused by a substantial plastic deformation and is due to generation of residual stresses. Optimum surface treatment depends on many parameters, including the type of the treated material, applied forces, duration of the procedure, shape of the treated part, and rollers used. The presentation was focused on both theoretical and experimental approaches. To optimize the surface treatment parameter, analytical prediction models were developed, and the results were experimentally validated by using X-ray diffraction methods.

A new hybrid monitoring technique for chloride stress corrosion cracking was discussed by A. Yonezu from Aoyama Gakuin University. This technique utilizes both the acoustic emission and corrosion potential fluctuation. Test results for aged austenitic steel Type 304 were presented, and conclusions were made that a simultaneous monitoring of acoustic emission and corrosion potential fluctuation can benefit not only the mechanistic study, but also help detect stress corrosion cracking initiation and propagation.

A keynote presentation was made on computational and experimental studies at Sandia National Laboratories in support of the Columbia accident investigation. This presentation provided background information associated with the orbiter break-up during re-entry and described the Sandia National Laboratories work in two major areas: aerothermodynamics and impact analysis. One of the most critical works performed on the full-scale impact testing of the wing leading edge was carried out at Southwest Research Institute®. The testing demonstrated that foam impact on different locations of the orbiter wing leading edge leads to damage in the reinforced carbon composite panels. Produced damage ranged from localized cracking to full breakage. The results of these tests were consistent with Sandia National Laboratories pre-test computational results. The most conclusive test at Southwest Research Institute resulted in a 40 cm [16 in]-diameter hole in the lower half of a leading edge panel of the orbiter. Such catastrophic damage would allow high-temperature gases to enter and melt the aluminum wing structure during re-entry. These studies supported the National Aeronautical Space Administration position that the most probable cause for the accident was foam debris damaging the orbiter wing leading edge during the launch phase.

CONCLUSIONS:

Participation in the 2006 Society of Experimental Mechanics Annual Conference and Exposition on Experimental and Applied Mechanics was beneficial. It provided (i) a source of information regarding the latest technical advances and (ii) leading edge research, development in experimental and applied mechanics, and material science. An electronic copy of the proceedings is available in the Geoscience and Engineering Division library.

PROBLEMS ENCOUNTERED:

None.

PENDING ACTIONS:

None.

RECOMMENDATIONS:

Future participation in Society of Experimental Mechanics Annual Conference and Exposition on Experimental and Applied Mechanics is recommended.

SIGNATURES:

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