New Damage Model Benefits Assessment of Existing, Future Airfield Pavements

A University of California (Los Angeles) professor has developed an advanced, thermomechanical damage model to assess the quality of both existing and new types of airfield pavements. Prof. Jiann-Wen Woody Ju's new analytical and numerical method provides a predictive capability:

- to evaluate potential alternative materials without large-scale field experiments, and
- to determine the remaining useful life of concrete airfield pavements.

Many modern aircraft subject airfield pavements to combined stresses caused by high-temperature exhaust gasses from vectored-thrust engines and auxiliary power units (APUs), JP-8 jet fuel, and high-pressure wheel loadings. These factors cause the pavement to undergo very rapid, intense heating and cooling cycles combined with chemical and wheel-stress loads. The B-1, A-10, AV-8B, F/A-18, the proposed F-22, and the future Joint Strike Fighter typify aircraft that can or could produce these thermo-mechanical loads. The resulting concrete pavement damage is severe and appears as large spalls, cracking, and weakened areas.

With this new understanding, the Air Force could potentially save hundreds of millions of dollars in the beddown of the new aircraft and prevent engine damage caused by foreign object debris.

For a technical description:
http://www.cee.ucla.edu/faculty/woody.htm

Major Michael Chipley, Ph.D
Directorate of Aerospace and Materials Sciences
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AFOSR INVESTIGATOR RECEIVES HUBER AWARD, TOP CIVIL ENGINEERING ACCOLADE

Dr. Jiann-Wen Woody Ju has received the 1997 American Society of Civil Engineers (ASCE) Walter L. Huber Award, considered the mid-career achievement award for academic professors who have made notable achievements in civil engineering and research applications. ASCE's Mechanics Division nominated Dr. Ju as one of 20 ASCE division finalists. The ASCE singled out Dr. Ju and his research on the elasto-plastic continuum and micromechanical damage models.

In addition, in February 1998, the American Society of Mechanical Engineers (ASME) elected Professor Ju as an ASME Fellow, becoming one of the youngest members of the society. Professor Ju is recognized for his contributions in damage mechanics, plasticity, and mechanics of composites.

For more information, ASCE maintains a website at:
http://www.asce.org/aboutasce/allabout.html

The ASME website is located at:
http://www.asme.org

Photo courtesy of:
Naval Facilities Engineering Service Center
University of Arizona researchers have discovered that a simple mammalian protein — called Substance P (SP) — may protect humans from lung damage caused by JP-8 jet fuel aerosol. The protective benefit also occurs even if SP is administered after exposure. This simple protein — a neuropeptide — shows promise for developing protective agents for warfighters. The discovery has also triggered studies on SP's anti-AIDS and anticancer potential.

Using a synthetic analog of SP, Dr. Mark Witten observed that an aerosol application of the substance offered complete protection for mice against JP-8-induced injury. SP protected the mice even if it was administered after they were exposed to the fuel aerosol. In another experiment, set up to confirm SP's role in protecting the lung, the researchers exposed mice to the same fuel aerosol but then chemically blocked SP activity in the lung. This action exacerbated the tissue damage — leaky lungs and impaired breathing function — and thus confirmed SP's protective role.

In a similar experimental approach, Dr. David Harris studied SP's affect on JP-8-induced changes to the immune system in mice. JP-8 can reduce organ weights and the number of immune cells, can alter immune cell populations, and can cause functional changes in the immune system.

Dr. Harris found that SP treatment shielded immune cells from jet fuel-induced reductions in both their number and function. This, in turn, triggered trial studies to examine the potential anti-AIDS and anticancer effects of SP. In these studies, SP actually delayed the onset of viral effects and reduced the spread and growth of cancer cells in mice.

Drs. Witten and Harris have patented the use of SP as an inhalation aerosol therapy. For health risk assessment purposes, study results were transitioned to the Air Force Surgeon General and to the

Toxicology studies reveal:
- effective treatment of tissue injury due to JP-8 jet fuel exposure
- potential treatments for warfighters exposed to biological and chemical stressors
- potential anti-AIDS and anticancer treatments
Researchers at the University of Arizona have discovered that a simple mammalian protein, Substance P, may protect humans from lung damage caused by JP-8 jet fuel aerosol. Results were also transitioned to several pharmaceutical companies interested in this technology for its potential to stimulate the immune system and enhance the effectiveness of vaccines. They are currently negotiating rights for its further development.

The Substance P research will also help explain how chemicals and mixtures of chemicals can damage human tissue. Understanding this mechanism may be of value in identifying specific, tissue-damaging chemicals within JP-8 which could aid in designing safer new fuels.

The Navy's jet fuel, JP-5, is also very similar to JP-8.

Dr. Walter Kozumbo
Directorate of Chemistry and Life Sciences
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Dr. Jerry Franck, an Air Force optical physicist and manager of AFOSR's international programs, and patented a new type of powerful, compact, powerful laser's inherent simplicity makes it robust in design and use, making it very suitable to withstand the rigors of hard field use. Because the laser is less complex and less costly than other military lasers of similar power, it is a strong candidate for use in target designators, illuminators, and range finders. Medical laser applications could also benefit.

As a participant in the Air Force Engineer and Scientist Exchange Program (ESEP), Dr. Franck was assigned to the Institut für Technische Physik within the Deutsche Forschungsanstalt für Raumfahrt (DLR) in Stuttgart, a German institution similar to NASA. Dr. Franck was assigned research in the area of phase conjugate optics, a research area of interest for anti-aircraft and tracking applications, and coherent for building high-power laser systems. At DLR, Dr. Franck observed that a small, piggyback laser suddenly delivered an unexpected power of more than 1 gigawatt, a phenomenon not previously observed.

Below: Two pulses from a standard solid-state laser. The pulse on the left is the beginning pulse. On the right is the amplified pulse compressed using stimulated Brillouin scattering (SBS) and bulk plasma switching. The peak power of the compressed pulse can be up to six times higher than the starting pulse.


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New U.S. Air Force, European Patents

Air Force Engineer and Scientist Exchange Program Leads to Compact, Powerful Laser

Dr. Jerry Franck, an Air Force optical physicist and now manager of AFOSR's international programs, has developed and patented a new type of powerful, compact laser with Mr. Wolfgang Riede, a German physicist and colleague. The laser's inherent simplicity makes it robust and more rugged in design and use, making it very suitable to withstand the rigors of hard field use. Because the laser is less complex and less costly than other military lasers of similar power, it is a strong candidate for use in target designators, illuminators, and range finders. Medical laser applications could also benefit.

As a participant in the Air Force Engineer and Scientist Exchange Program (ESEP), Dr. Franck was assigned to the Institut für Technische Physik, a division within the Deutsche Forschungsanstalt für Luft- und Raumfahrt (DLR) in Stuttgart, a German research organization similar to NASA. Dr. Franck was asked to perform research in the area of phase conjugation work in nonlinear optics, a research area of interest for automatic focusing and tracking applications, and coherent beam combining for building high-power laser systems. During an experiment, Dr. Franck observed that a small, 4-megawatt laboratory laser suddenly delivered an unexpected increase in power of more than 1 gigawatt, (a thousand-fold increase.)

Dr. Franck and Mr. Riede discovered that focusing laser energy into a test cell containing nonlinear optical materials produces a dynamic mirror. Through a process termed stimulated Brillouin scattering, or SBS, the dynamic mirror returns energy back continued on back page...
Technology Transition Spotlight

(Each issue, RH will highlight a recent technology transition that benefits Air Force operations.)

Customer .......... Air Combat Command (ACC) adopted a research simulator in January to support training for operators of Predator Uninhabited Air Vehicles (UAVs).

Benefit ............ The research simulator provides ACC with its first dedicated training capability for both individuals and teams controlling UAV assets.

Basic Research .... Research simulators were used to conduct university, industry, and government laboratory research on human performance. Research simulators and embedded task scenarios provided researchers with new capabilities for multi-disciplinary research that combines disciplines of cognitive process modeling, human interface, training, team communication, and physiology.

Performer .......... A research team led by Dr. Elizabeth Martin, of the Warfighter Training Research Division, in Mesa, Ariz., assembled the apparatus for research simulation of UAV tasks. The Division is part of AFRL's Human Effectiveness Directorate. AFOSR program manager: Dr. John Tangney, Directorate of Chemistry and Life Sciences, (202) 767-8075, DSN 297-8075.

New U.S. Air Force, European Patents (continued)

to the source. This in combination with bulk plasma switching — a term the researchers coined to describe laser-induced breakdown within the cell — compresses and truncates the resulting return pulse by as much as a factor of ten. The return pulse re-enters the laser, is amplified, and then sent back to the cell. This begins the process again, producing increasingly shortened pulses.

The U.S. Air Force has received its patent. The DLR's patent is pending with the European Community (Germany, France, United Kingdom.) The laser's U.S. patent Serial Number is 5,648,976. For more information on licencing the patent, contact Dr. Franck. For more technical information, see our website at: http://www.afosr.af.mil

Research Highlights

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Research Highlights is published every two months by the Air Force Office of Scientific Research. This newsletter provides brief descriptions of AFOSR basic research activities including topics such as research accomplishments, examples of technology transitions and technology transfer, notable peer recognition awards and honors, and other research program achievements. The purpose is to provide Air Force, DoD, government, industry and university communities with brief accounts to illustrate AFOSR support of the Air Force mission. Research Highlights is available on-line at:
http://www.afosr.af.mil

To access our web-site, click on the Research Products and Publications icon, then on Research Highlights.

Engineer Scientist and Exchange Program (ESEP)

The DoD Engineer and Scientist Exchange Program (ESEP) supports science and technology through international cooperation in military research, development, and acquisition through the exchange of defense scientists and engineers. ESEP provides on-site assignments for U.S. military and civilian scientists and engineers (S&Es) in foreign government organizations and reciprocal assignments of foreign S&Es in U.S. government organizations. ESEP supports current USAF S&T requirements by targeting specific foreign technologies. It provides insight into the technology and project management techniques of foreign laboratories and centers, opens new areas of possible technical cooperation, and attempts to eliminate duplication of technical efforts among allied and friendly nations.

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