SAVIAC
Shock and Vibration Information Analysis Center
Current Awareness
May 2005

ERDC GEODYNAMICS AND PROJECTILE PENETRATION RESEARCH FACILITIES

by Dr. Stephen Akers and Dr. J. Donald Cargile, Research Civil Engineers, US Army Engineer Reseach and Development Center

The Geotechnical and Structures Laboratory (GSL), one of seven laboratories within the US Army Engineer Research and Development Center (ERDC), has complementary research facilities expressly developed to support the Corps of Engineers' mission in Survivability and Protective Structures. Two of these facilities are the Geodynamics Research Facility and the Projectile Penetration Research Facility. The Geodynamics Research Facility has evolved over the last four decades and provides researchers with unique capabilities to investigate the mechanical response of geologic and man-made materials at loading rates and pressures associated with nuclear and conventional explosions and projectile impact and penetration. The facility houses many unique and specialized high-pressure test devices permitting the application of both static and dynamic states of stress and strain.

The Projectile Penetration Research Facility was developed to specifically investigate the response of target materials and target configurations to the penetration of a wide range of projectiles. This facility permits research into the behavior of target materials, such as soil backfills, rock, concrete, etc., and target configurations, such as antipenetration shields and structural sections, to projectile impact. The major components of the facility consist of an 83-mm smoothbore solid-propellant launcher, a target room, and the supporting instrumentation and diagnostic devices. The 83-mm "gun" has the capability of launching projectiles with masses up to 2.8 kg at velocities in excess of 1 km/s and launching projectiles with masses of 12 kg or more at veloc-

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Sea Systems Live Fire Test and Evaluation Call for Papers

US Navy policies and programs to design, build and certify shock hardened surface ships and submarines were developed and implemented in the 1940s. With the enactment of the Live Fire Test and Evaluation (LFT&E) legislation in 1986, the Navy's shock testing was incorporated as a component of the LFT&E program for new ships - an independent assessment of the survivability of the ship and crew to realistic threats.

Similar to all weapon system acquisition programs, the Navy is concerned about the cost effectiveness of the testing necessary to assess ship survivability. With respect to realistic undersea threats, the fundamental question to be answered is, "What are the susceptibility, vulnerability, and recoverability of the ship to underwater explosions?" The vulnerability component of that question will likely be addressed through an appropriate mix of testing and simulation, focusing on the integrated full-ship system, as determined mainly by the Navy's technical community and ship program managers. The centerpiece of the vulnerability testing has been the Full-Ship Shock Trial (FSST), which is the only test of the integrated full-up ship system to underwater explosions. However, questionable representation of realistic threats, diminishing return-on-investment, and increasing environmental restrictions and associated costs are threatening the future of the FSST.

The Office of Secretary of Defense, Director of Operational Test and Evaluation (DOT&E), and the Navy (Office of Naval Research and Program Executive Office (Ships)) are interested in reviewing new and emerging technologies that could improve the technical adequacy and cost effectiveness of sea systems (both system and component-level) survivability simulation and testing. The 76th Shock and Vibration Symposium is a forum for the presentation and discussion of simulation and testing innovations that may have practical application for more cost-effective ship survivability testing; papers and sessions that would stimulate discussion in these areas are invited. Presenters are urged to respond to the call for papers with a notification to SAVIAC that the presentation/paper has sea systems LFT&E applicability. The Navy, and the DOT&E LFT&E Office, will help to organize classified and/or unclassified sessions for these discussions depending on the level of community interest.

Modern Protective Structures Training
July 18-22, 2005

"Today the issue of abnormal loading on a building during a terrorist attack is part of everyday life. This issue directly impacts public safety. The key is knowledge--what exists and what can be done regarding simple to complex threats."
--Dr. Theodor Krauthammer, Director, Penn State's Protective Technology Center

Building and retrofitting structures to withstand a terrorist attack is a relatively new problem in the United States. The Modern Protective Structures short course will present the entire problem--from understanding the nature of threats to analysis and design--and will provide engineers and architects with practical information on performance and design requirements for hardened facilities. In addition, a review of blast damage assessment issues will provide forensic and rescue personnel with information that is vital to rescue and investigative efforts after a catastrophic structure failure.

The course will examine these topics:

* fortification science and technology
* analysis, design, assessment, and retrofitting
* industrial explosive safety
* antiterrorist design
* hazard sources
* physical security
* blast damage assessment

The course will feature hands-on, guided analysis and design activities, including case studies and simulations. Participants will be given computer programs to assist in the analysis and design of protective structures, as well as a design manual and reference materials.

About the Instructor:
Dr. Theodor Krauthammer, professor of civil engineering and director of the Protective Technology Center at Penn State, is an internationally renowned expert on enhanced structural performance and safety. In 2002 Dr. Krauthammer was recognized by the U.S. Army Engineer Research and Development Center--the research branch of the U.S. Army Corps of Engineers--for his outstanding contributions to the plan to rebuild the Pentagon following the September 11, 2001, terrorist attack. He is currently the chairman of a task committee on structural design for physical security, working for the American Society of Civil Engineers' Structural Engineering Institute.

Continuing Education
Continuing Education Units (CEUs) are based on a standard of 1 unit per ten hours of classroom instruction. Upon completion of this course, each participant will be awarded a certificate for the CEUs earned. In addition, Penn State is a Registered Provider with the AIA Continuing Education System. This program qualifies for 32 hours of Health, Safety, Welfare (HSW).

Fee and Registration
$1,295--on or before May 18
$1,195--two or more people on or before May 18
$1,395--after May 18

The fee covers all instruction, program materials, refreshment breaks, and lunches. Registrants are responsible for all other meals and lodging.

You can register by phone with your credit card by calling 800-PSU-TODAY (778-8632). To register on-line go to http://www.outreach.psu.edu/C&I/ProtectiveStructures/onlinereg.htm

For More Information
go to http://www.outreach.psu.edu/C&I/ProtectiveStructures/default.asp or contact:

About registration

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Make sure your events get into the 2006 SAVIAC Calendar!

The 2006 SAVIAC Calendar is being compiled for distribution among the 76th Shock & Vibration Symposium attendees, as well as hundreds of other SAVIAC community members around the globe! Don't miss your opportunity to have your event placed in our calendar. Contact Joel Leifer with your event dates and details at *joel.leifer@saviac.org*.

FREE

Summer Shock & Vibration Seminar

SAVIAC invites you to attend a FREE seminar on Shock & Vibration. The course will be held on June 29, 2005 at the Royal Sonesta in New Orleans, LA in conjunction with the 76th Shock & Vibration Program Committee Meeting. SAVIAC and the featured experts in their disciplines have organized this seminar to introduce you to the SAVIAC community, while providing a valuable educational experience.

Agenda

7:30 - 8:00	Registration & Continental Breakfast	
8:00 - 8:15	Introduction to SAVIAC	Joel Leifer, SAVIAC
8:15 - 9:15	A Primer On Explosion Effects In the Air, Water, and Soil	Dr. Charles Robert Welch, US Army Engineer Research and Development Center
9:15 - 10:15	Oklahoma City Bombing - Lessons Learned	Dr. Paul Mlakar, US Army Engineer Research and Development Center
10:15 - 10:30	Break	
10:30 - 11:00	Shock Propagation in Water	Margaret Tang, Weidlinger Associates
11:00 - 11:30	TBD	
11:30 - 12:00	Earthquake vs Blast Design	Prof Sam Kiger, University of Missouri
12:00 - 1:15	Lunch	(no host)
1:15 - 1:45	An Innovative Approach For The Derivation Of Pressure-Impulse Relationships	Prof. Ted Krauthammer Protective Technology Center
1:45 - 2:15	Introduction to Robust Design Techniques	Bart Mcpheeters, MSC.Software
2:15 - 2:45	TBD	
2:45 - 3:00	Break	
3:00 - 3:30	New Desktop Tools for Blast Assessment of Structures	Dr. Ray Daddazio, Weidlinger Associates
3:30 - 4:00	Shock Design for the Medium Weight Shock Machine	Dr. Rudy Scavuzzo, University of Akron
4:00 - 4:30	Simulating Blast Loadings on Responding Structures; How to Work Less and Get More Out of Simulations	Bence I. Gerber, Century Dynamics, Inc.
4:30 - 4:45	Wrap-up & Questions	All

Please forward this invitation to anyone you know who may be interested in attending this program.

The seminar is free, but you must register to attend and **space is limited**. You may register online at **www.saviac.org/76th_Symposium/seminar_registration_form.htm**, or RSVP to Darnise Johnson, (301) 596-0100 or **darnise.johnson@saviac.org** to assure your space and note packet. SAVIAC reserves the right to substitute topics and/or instructors when necessary. This schedule is subject to change. For more information about SAVIAC please visit our website at http://www.saviac.org/s&v_seminar.htm. For directions to the Royal Sonesta Hotel or to make reservations please visit http://www.sonesta.com/neworleans_royal/. SAVIAC has NOT made any arrangements with the Royal Sonesta Hotel for special rates to attend this seminar.

Don't Forget to Submit Your Abstract for the 76th Shock & Vibration Symposium

Go to
http://www.saviac.org/76th_Symposium/76th_symposium.htm
and follow the instructions

INDUSTRY NEWS

Explosion, Blast, and Shock Wave Pressure Sensors

High-frequency pressure sensors from the Pressure Division of PCB Piezotronics, Inc. are designed for a broad range of explosion, blast, and shock wave testing. Applications include free-field and underwater blast testing, shock wave and time-of-arrival measurements, shock tube research, closed bomb testing, and squib lot acceptance testing. General purpose ICP® and charge output blast sensors feature extremely fast response, with resonant frequencies to 500k Hz. ICP® microsensors provide rapid rise times of <= 0.5 microseconds for projectile detection and time of arrival measurements. Free-field blast pressure ICP® pencil probes measure blast effects on structures, vehicles, and humans, and feature integral microelectronics for long cable driving. Underwater blast pressure probes measure shock wave pressures associated with underwater explosion testing, and are available in ICP® and charge output versions. For additional information, contact the Pressure Division of PCB Piezotronics, Inc. toll-free at 888-684-0011 (in the U.S. and Canada) or 716-684-0001; fax 716-686-9129; email: pressure@pcb.com, or visit PCB's web site at www.pcb.com.

Small Capacity Reaction Torque Sensors

The Force/Torque Division of PCB Piezotronics, Inc. offers a series of small capacity, strain-gage reaction torque sensors for torque measurements in applications such as lubricant studies, torsion testing, bearing friction, small motor dynamometers, stepping switch torque, and starter testing. Series 2308, 2309, and 2508 reaction torque sensors feature high torsional stiffness, flange mounting, and 2 mV/V output sensitivity, and are available in capacities from 5 to 1000 in-lb FS (0.56 to 115 N-m FS). Units are supplied with a shunt calibration resistor. Calibration is traceable to NIST and is performed in PCB's laboratory, which is ISO 17025 accredited by A2LA for most services. For additional information, contact the Force/Torque Division of PCB Piezotronics, Inc. toll-free at 888-684-0004 (in the U.S. and Canada) or 716-684-0001; e-mail: force@pcb.com; fax 716-684-8877; or visit PCB's web site at www.pcb.com.

DC Powered Signal Conditioners

New Series 485M DC Powered Signal Conditioners from the Electronics Division of PCB Piezotronics, Inc. provide constant current excitation for ICP® sensors from 18-30 VDC battery or lab power supply. Unit includes a variety of options for connecting directly to readout devices and data acquisition systems. A variety of power connections allow for flexibility in connecting directly into various power supplies. Compact, lightweight signal conditioners feature low noise operation and x1 gain circuitry. Custom 1 to 3 channel configurations are available. For additional information, contact the Electronics Division of PCB Piezotronics, Inc. toll-free at 888-684-0015 (in the U.S. and Canada) or 716-684-0001; E-mail: electronics@pcb.com; fax: 716-684-0987, or visit our web site at www.pcb.com.

12-bit Digitizer with 400 MS/s Sampling

Gage Applied Technologies has introduced a new high-performance 12-bit digitizer. The CompuScope 12400 (CS12400) can reach sampling speeds up to 400 MS/s and features the deepest on-board memory available on the market today of up to 4 Gigabytes (2 Gigasamples). The fast sampling rate enables the capture of high-speed signals with ultra-high timing precision and the high resolution allows signals with very high dynamic range to be captured. This combination of speed and resolution are ideal for implementation in a wide range of applications such as radar/lidar system design and test, spectroscopy, communications, ultrasonic non-destructive testing, manufacturing test, as well as signal intelligence and high-performance imaging. Gage's new Finite Impulse Response (FIR) Filtering and Signal Averaging Field-Programmable Gate Array (FPGA) technologies are also optionally available for the new CS12400 digitizer. The FIR Filtering Technology allows users to filter digitized data in real-time with a completely flexible and user customizable FIR filter. Filtering of analog voltage signals is a powerful method for removing unwanted signal features (like noise) and emphasizing signal features of interest. Data is transparently filtered with no processing required by the host PC's CPU. Signal Averaging is a powerful method of improving the fidelity of noisy repetitive signals. Using Signal Averaging, small signals can be extracted from a background of high amplitude noise, which may even be larger than the actual signal itself. The CS12400 is available with up to 2 Billion samples of on-board acquisition memory. Deep acquisition memory is useful for applications that require sampling of a long record at a high sampling rate. Gage also offers Software Development Kits (SDKs) in C/C++, MATLAB(r) and LabVIEW(r) for users that want to create their own custom applications. For Further Information contact: Nicole Faubert, (514) 633-7007 ext. 3034 or nfaubert@gage-applied.com

Got News?

Send your organization's press releases to:

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5136 Celestial Way
Columbia, MD 21044
301 596-0100 fax

or to really make friends, e-mail it to

darnise.johnson@saviac.org

People in the News

Our "Get Well Wishes" go out to Bill Yancey's wife Carolyn, who underwent surgery on Wednesday, April 27th at Johns Hopkins University Hospital in Baltimore, Maryland. The surgery was a big success and Carolyn is resting and recooperating comfortably.

Jeffery Cipolla, from ABAQUS is marrying Cindy Sebrell on June 25. Cindy is the Communications Director for the Pomfret School, a college preparatory boarding and day school for boys and girls in grades 9-12.

Conference & Short Course Announcements

Practical Shock Analysis & Design Course
MFPT Society
July 25-18, 2005
Portland, Maine
Sept. 19-23, 2005
Virginia Beach, VA

Participants in this course will have an opportunity to increase their knowledge and understanding of the analytical and experimental tools that are available for shock design and qualification particularly with respect to requirements that are imposed for shipboard equipment. The lectures will provide a basic review of vibration and shock theory and will present the analytical and experimental methodology in the context of particular design applications. Analytical lectures will emphasize the physical significance of the results. Examples and case histories will be used as illustrations of design approaches; workshop problems that involve class participation will be used to advantage throughout the course. Class members will be encouraged to propose real design problems. The instructors will provide guidance for solutions or the problems may be used as class exercises. Although this course is aimed primarily at shock design applications on ships, the analysis and design techniques presented are equally applicable to problems related to design for seismic loads or blast induced ground shock. Thus, engineers in these related areas may find the course to be useful. For all who participate, the course will provide a comprehensive coverage of shock design practice and a solid basis for further exploration of shock technology. Please visit http://www.saviac.org/Courses/Shock%20Course.htm for a more comprehensive overview of the course, and for a list of instructor bios.

Random Vibration and Shock Testing Training
Equipment Reliability Institute (ERI).
August 24-26, 2005
Santa Barbara, CA

A short course on practical vibration and shock testing, measurement, analysis and calibration, also HALT, ESS and HASS. The course will be taught by Wayne Tustin, internationally recognized vibration and shock educator and also president of ERI. This course material is too practical for university engineering departments. This course is needed by engineers and technicians who conduct developmental and production vibration and shock tests. Also by designers of products that must survive tests AND rigorous service conditions. Also by metrologists who measure vibration and shock on automobiles, aircraft,etc. Also by sales/applications engineers involved in the sales of equipment used in test (shakers, shock test machines, etc.) and measurement (transducers, data acquisition etc.). Registration and course details can be found at http://www.equipment.reliability. com/sb1.htm. To register, visit http://www. equipmentreliability.com/regist_form.htm. Instructor Tustin welcomes questions about the course.

Structural Design of Buildings and Industrial Facilities for Bomb Blasts and Accidental Chemical Explosions
ASCE
August 4-5, 2005
New York City, NY

This course teaches how to analyze and design steel/concrete buildings and indusrial facilities subjected to bomb blasts or accidental chemical explosions. Learn how to compute loads generated by bomb blasts and accidental chemical explosions, how to determine structural response to blast and explosion loads. Understand structural material behavior under intense short duration dynamic loads, design steel and concrete members, receive a completely worked out design example of a steel and concrete building, including step-by-step calculations, receive a comprehensive set of notes and books containing tables, charts and graphs necessary for the analysis and design. Registration and course details can be accessed at http://www.asce.org/conted.

Explosion Effects and Structural Design for Blast
September 27 and 28, 2005
Huntsville, AL.

Engineers have an opportunity to improve their skills in understanding explosion effects and designing facilities that are safer to occupants by understanding and minimizing the effects of explosive detonations on structures. Architects and builders will also benefit by appreciating the impact of explosive design decisions early in the process. All new government buildings now require some level of blast resistant design and this training will specifically address those requirements. The course will focus on the fundamentals of explosion effects, determining blast loads on structures, computing structural response to blast loads, and the design and retrofit of structures to resist blast effects. The emphasis will be on terrorist threats from vehicle bombs, but the fundamental concepts can be applied to other explosive scenarios. Currently available software and publications for blast effects and design guidance will be demonstrated and discussed. Much of the design guidance is restricted distribution to government agencies and their contractors, however specific information on how qualified users may obtain the software will be provided. The participant will gain an understanding of how to compute blast loads on a structure, how a structure responds to blast loading, and practical methods for designing and retrofitting structures to resist blast effects. Participants will be provided with a complete set of class notes. More information about the instructors, the course, and accommodations can be found at http://www.blastdesigntraining.com/ or http://www.uah.edu/BevillCenter/. This is the fourth offering of this popular course and previous offerings have been full to capacity; so register early to ensure your place is reserved. Secure on-line registration is available. Questions should be directed to Dr. Sam Kiger at 573-882-3285, KigerS@missouri.edu or Dr. Stan Woodson at 601-636- 4429, woodsoneng@netzero.net.

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GEODYNAMICS RESEARCH FACILITY

The Geodynamics Research Facility contains a wide assortment of unique test devices that have been specially designed to investigate the behavior of undisturbed soil, soil backfills, rock, grout, concrete, and other construction materials. The devices in this facility have the capability to measure the response of these materials under a variety of different loading conditions such as uniaxial strain, isotropic compression, and triaxial compression and extension, and other complex stress or strain paths. Static and dynamic mechanical properties developed from the results of laboratory experiments provide input to numerical computer codes designed to predict ground shock propagation, dynamic soil-structure interaction, and projectile penetration. A dynamic test is defined as a test that reaches peak load or pressure in several milliseconds. Static tests are generally conducted for several seconds to several minutes.

Axial loads are applied through several unique loading devices. Dynamic loading is produced by ram loaders, which use compressed nitrogen to produce controlled impulse loads of up to 8.9 MN in five to seven milliseconds (ms). The static loaders use pressurized fluid or mechanical screws to produce controlled loads. The facility has the capability to produce static loads up to 8.9 MN. Pressures may be generated from several different sources depending upon the desired pressurizing rate and the peak stress level. Mechanical intensifiers are commonly used for either static or dynamic tests by applying an air or nitrogen input pressure against the large surface area of a sliding intensifier piston. Our largest system can apply static fluid pressures of 1 GPa.

Two basic types of test devices are used in the Geodynamics Research Facility. Uniaxial strain devices, which measure the compressibility of laterally-constrained, wafer-shaped specimens under loading, unloading, and reloading conditions. Lateral strains are prevented by physically constraining the sides of the specimen within the test device. The devices are primarily used to test soils, grouts, and soft rocks. Measurements are made of the applied axial stress and the specimen's axial deflection with time. Fluid pressures of up to 400 MPa are applied statically or dynamically.

Because of their versatile loading systems, triaxial test devices are used to apply a variety of stress and strain states. Triaxial test specimens are cylindrical in shape and typically have a length-to-diameter ratio greater than two. Specimens with diameters as large as 150 mm can be tested to pressures of 150 MPa, while specimens with 50 mm diameters or smaller can be tested to pressures of 1 GPa. Uniaxial strain with lateral stress measurements, isotropic compression, triaxial compression, triaxial extension and specialized stress or strain path tests can be conducted in the TX test device. The devices are coupled to the axial loaders and pressurization systems previously described.

PROJECTILE PENETRATION RESEARCH FACILITY

The 83-mm ballistic range was developed to investigate the response of target materials and target configurations to penetration of a wide variety of projectiles. An experiment typically involves the launch of a projectile into a target consisting of geologic and/or man-made materials. Complexity of the target can range from a simulated half-space of concrete contained within a steel culvert, to a layered system of concrete and soil, to a subscale model of an actual structure component. Targets can be fabricated from special concrete mixtures developed by ERDC personnel or by conventional concrete mixed at a local batch plant under the supervision of ERDC personnel. ERDC personnel can place soil backfills to desired specifications. Subscale structural components, such as sections of aircraft shelters, can also be fabricated at ERDC. To facilitate large targets up to 2.1-m in diameter, targets are placed in a target room, a 5.6-m-long by 4.6-m-wide by 3.0-m-high reinforced-concrete structure. Viewing ports on the side and in the ceiling of the room permit high-speed digital photography of projectile/target interaction. Flash x-ray heads and breakscreens can be located freely within the room for additional experiment diagnostics.

Basic information obtained during projectile penetration experiments includes impact velocity and projectile orientation, depth of penetration, and target damage such as crater profile, crack patterns and photographs. Additional diagnostics are available such as high-speed digital imagery of the projectile impact with a target and flash x-rays to obtain the time-displacement of the projectile during target penetration. Instrumentation within the projectile, using an accelerometer and a miniature hardened data acquisition package, can be used to determine the loading history and velocity-displacement during penetration. Characterization tests to determine the mechanical properties of the target materials are conducted in the Geodynamics Research Facility.

SUMMARY

These two complementary facilities support the Army's and the Department of Defense's Survivability and Protective Structures Research Program and weapons effects research. The two facilities provide researchers with unique capabilities to investigate the response of geologic and man-made materials to the transient loadings associated with weapon detonations and projectile penetration. Together, these two facilities provide ERDC, the Army, and the Department of Defense with unique capabilities to develop design criteria for hardened structures to withstand the threat of tomorrow's weapons systems, and to better understand the interaction of weapons with structures.

ACKNOWLEDGEMENT

Approval to publish this document was granted by the Director, Geotechnical and Structures Laboratory.

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In the May 2005 Current Awareness Newsletter

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