SUMMER 2015

Center for Infrastructure Protection and Physical Security (CIPPS)

CIPPS Headquarters

CIPPS Activities

The primary mission of CIPPS is to establish comprehensive short- and long-term research and development activities in protective science and technology. Our goal is to ensure the safety of personnel and facilities under explosively induced hazards and evolving threats.

A special emphasis of CIPPS is in civil and structural engineering, computational mechanics and dynamics, and the behavior of structural systems under severe loading environments. These activities are handled by an experienced multidisciplinary technical and scientific staff. One of our key focus areas is to transfer technology through education, training, technical advising, and collaborative research and development.

The areas of technical expertise at CIPPS include:

- Antiterrorist, force protection, and physical security assessment
- Building enclosures under blast, shock and impact
- Blast, fragment, and ballistic resistant closures
- Blast resistant building systems
- Blast suppression
- Computer modeling, simulation, and validation
- Containment and storage facilities for hazardous materials, and energetic environments
- Evacuation, rescue, and recovery operations
- Explosive safety for industrial facilities
- External and internal explosive load definition
- Fortifications, and hardened facilities
- Ground shock, medium-structure interaction, and underwater explosions
- Materials and component behavior under blast and impact
- Multi-hazard threat assessment and mitigation
- Nuclear and conventional weapons effects
- Progressive collapse, and post-event damage assessment
- Precision impact testing
- Security barriers and gates
- Structural behavior, design, performance, and safety for blast, shock and impact mitigation
- Structural vibrations, damping, and shock isolation systems
- Survivability and fragility of land- and sea-based systems and facilities
- Threat, risk, and hazard assessment
- Technology transfer, education, and training
- Transportation infrastructure protection
- Ultra High Performance Concrete (UHPC) Structures

For more information about CIPPS visit our website at: www.cipps.eng.ufl.edu

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Examples of Research & Development

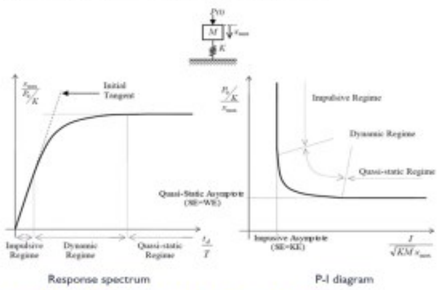
UF Center for Infrastructure Protection and Physical Security (CIPPS)
UNIVERSITY of FLORIDA

國防大學
National Defense University

Energy Based Load-Impulse Diagrams

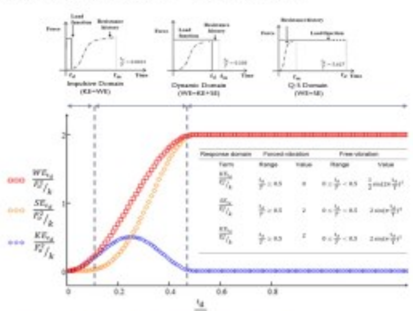
Introduction

- An energy-based approach for load-impulse diagrams for structural members under a wide range of dynamic loads will represent a fundamental improvement in the field of protective structures.
- This study proposed an energy based P-I diagrams (E-R diagrams) as a useful tool in preliminary strength design and damage assessment.



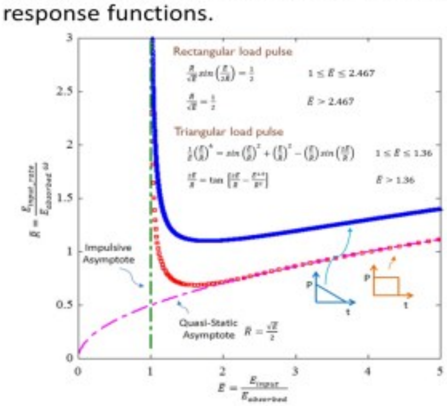
Energy Components Spectrum

- A comprehensive energy flow approach is proposed to define the entire P-I domain.



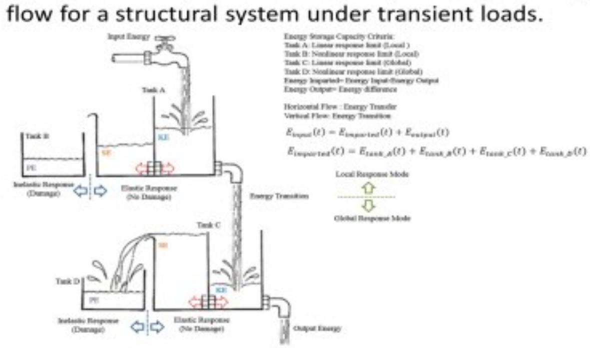
Analytical Solutions for E-R Diagrams

- Analytical solutions can be obtained for idealized load functions, which were accomplished based on the response functions.

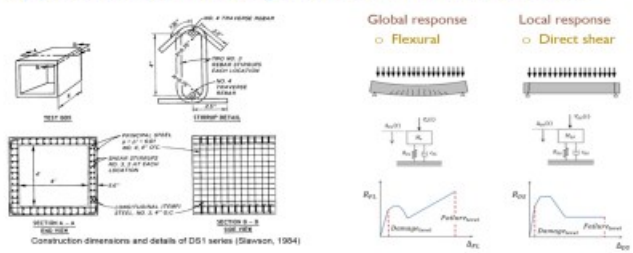


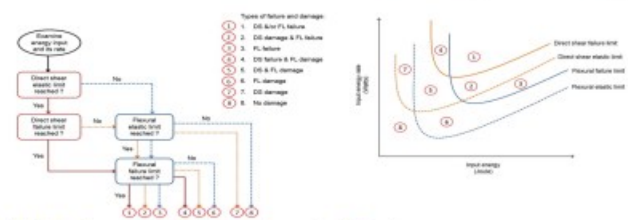
Energy Tank Analogy

- It provides a simple and clear description of the energy flow for a structural system under transient loads.

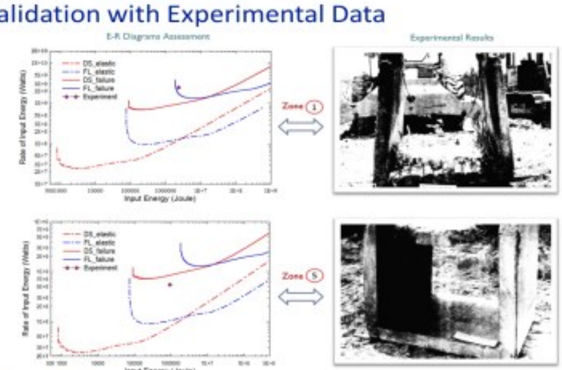


Application of E-R Diagrams on Buried Structures





Validation with Experimental Data



Conclusions

- One can determine if the threat or hazard will cause a specific damage level by examining the input energy flow conditions.

Examples of Research & Development

UF | Center for Infrastructure Protection and Physical Security (CIPPS)
UNIVERSITY of FLORIDA

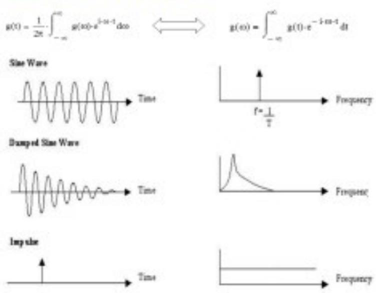
ERDC
US Army Engineer Research and Development Center

Experimental Frequency Analysis of Direct Shear in NSC and UHPC

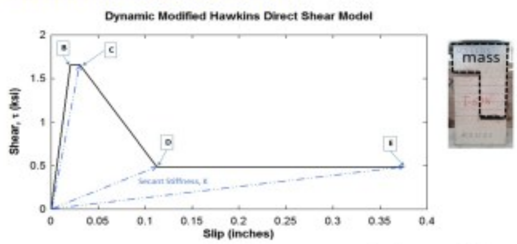
Objectives

The focus of this study was to characterize the direct shear behavior of NSC and UHPC by comparing impact test response data in the time and frequency domains in order to identify and validate shear model parameters.

Fourier Transform



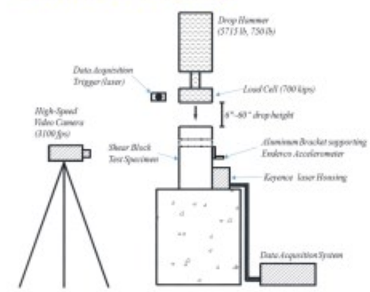
Research Methodology



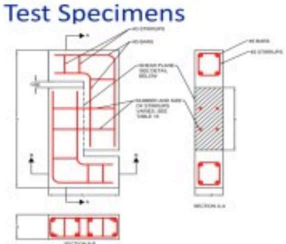
The secant frequencies were computed using the relations, $f = \frac{1}{2\pi}\sqrt{\frac{K}{m}}$ and $K = \frac{\tau A_c}{slip}$

A_c is the area of the shear plane, m is the moving mass of the shear block, and K represents the slope of the secant line

Impact Test Setup



Test Specimens



Test specimens modeled after Valle and Buyukozturk (1993)

Push-off specimen reinforcement and compressive strengths

Specimen Type	f_c' (ksi)	Reinforcement Ratio, ρ	Number of Shear Bars	Stirrup Size
NC-1A-0-D-4	5	0.0%	0	NA
NCS-1-1-D-4-3	5	0.8%	4	#3
NCS-1-1-D-5	5	0.8%	4	#3
NCS-1-1-D-6	5	0.8%	4	#3
NCS-1-1-D-7-6	5	0.8%	4	#3
NCS-2-2-D-1	5	1.6%	8	#3
CT1-1-1-D-3	29	0.8%	4	#3
CT1-1-1-D-4	29	0.8%	4	#3

Push-off specimen geometry

Specimen Size	L (in)	h (in)	d (in)	b (in)	Gap (in)	Shear Plane (in^2)
1	11.5	25	5.5	10	1	55
1A	11.5	27	5.5	11	1.5	60.5
2	14.5	31	5.5	13.5	2	74.25

Typical Test Results

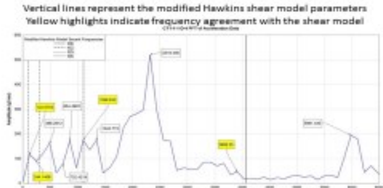
NSC with 0.8% shear reinforcement | CORTUF-1 with 0.8% reinforcement | NSC with 1.6% reinforcement

Time Domain Response

Secant stiffness to point B not observed
Slope corresponding to 2075 Hz on FFT plot not observed

Frequency Domain Response

Vertical lines represent the modified Hawkins shear model parameters
Yellow highlights indicate frequency agreement with the shear model



Fourier Analysis Results

Frequency comparison between modified Hawkins, FFT and resistance function parameters

Specimen	Modified Hawkins Parameters (Secant Slopes)	Modified Hawkins Secant Frequency (Hz)	FFT Frequency Spike (Hz)	Resistance Function Secant Frequency (Hz)
NCS-1-1-D-5	B	2828	2686	slope undefined
	C	1015	1099	979
	D	261	244	248
	E	107	122	131
CT1-1-1-D-4	B	4070	3906	3672
	C	1109	1099	1017
	D	303	244	284
	E	98	122	127

Only one specimen each of NSC and UHPC shown
All specimens have similar agreement

Conclusions

- Frequencies for the entire response behavior for each specimen were captured by the accelerometers
- FFT frequencies showed close correlation to the frequencies determined from the modified Hawkins shear model and from resistance functions
- In several cases, early response modes could not be determined from the resistance function but could be identified in the corresponding FFT plot
- Recent and current shear models provide an overall response envelope for tests so far

Approved for public release; distribution is unlimited

Examples of Research & Development

UF | Center for Infrastructure Protection and Physical Security (CIPPS) UNIVERSITY of FLORIDA

國防大學 National Defense University

ERDC US Army Engineer Research and Development Center

Predicting Combined Blast - Fragment Effects

Introduction

Blast and fragmentation effects are treated separately in current protective design approaches. Although the synergetic effects of blast and fragmentation loadings are acknowledged, the combined effects are difficult to properly define, model, and implement.

Objectives

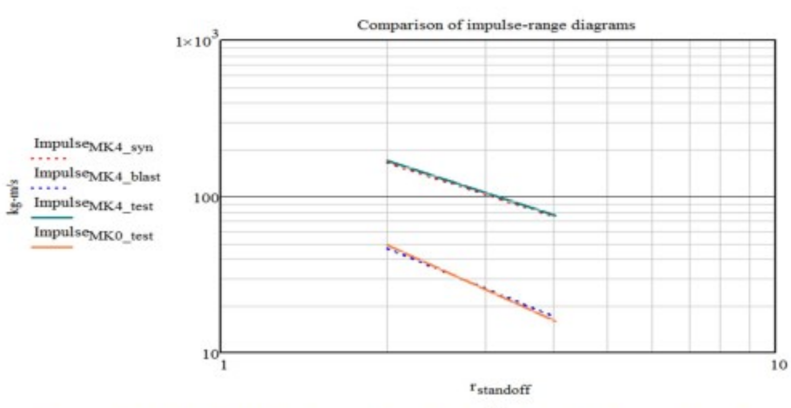
- To investigate, through computer modeling and analysis, the combined effects of blast and fragment loading from previous experimental results.
- To produce a rational combined load function methodology.

Research Approach

- Address several load cases that were investigated by Mehlin and Parr (1983).
- Perform blast simulations with ConWep and Air3D to extract pressure time histories.
- Perform fragmentation calculations with ConWep, and extract a force-time history.
- Combine blast and fragmentation loads-time histories.

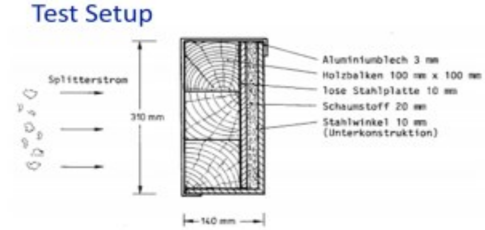
Results

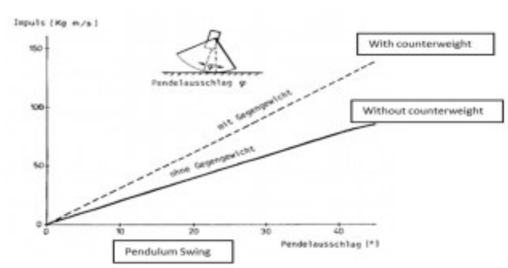
Charge Type	Standoff	Recorded Impulse (m*kg/s)	Proposed Impulse (m*kg/s)	Difference (%)
Mk0	2m	49	46.88	-4.33%
	4m	16	17.1	6.88%
Mk1	2m	90	96.51	7.23%
	4m	Unavailable test data		
Mk2	2m	120	130.76	8.97%
	4m	62	57.1	-7.90%
Mk4	2m	170	164.14	-3.45%
	4m	75	74.14	-1.15%

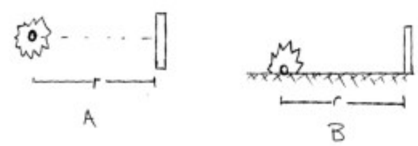


Example for Mk 4 (1kg Comp B and 4 kg cylindrical steel case)

Test Setup







Conclusions

- Load sequencing must be taken into account as it varies with the distance of separation from target and explosive charge. In this study, the fragments reach the target prior to the blast wave.
- The combined effects total impulse was obtained by summing the areas under the load-time history curves.
- The combined effects highlight the significant increase in delivered impulse by fragments to the target.
- Rigorous experimental testing is required to achieve better results.
- Future precision tests are needed to characterize these coupled phenomena more accurately.
- This effort continues, and further refinements of the approach are expected.

New Development at the Powell Lab

Boundary Layer Wind Tunnel Development

Project Objective

- To develop an automated control instrument capable of simulating complex flows for implementation in a shared-use boundary layer wind tunnel (BLWT) facility

Location

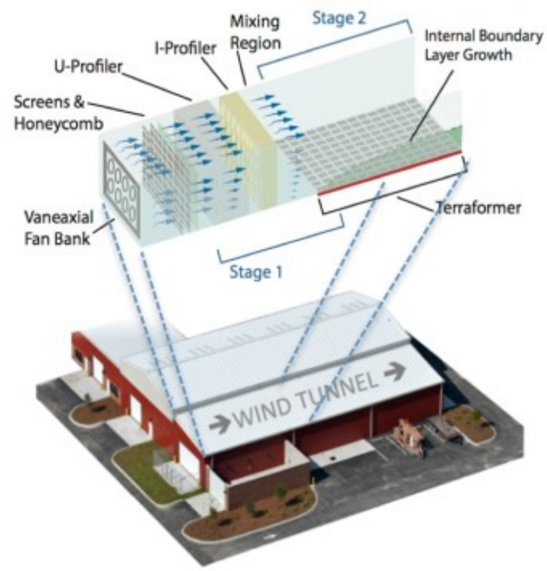
- Powell Family Structures and Materials Laboratory Annex
- University of Florida - East Campus

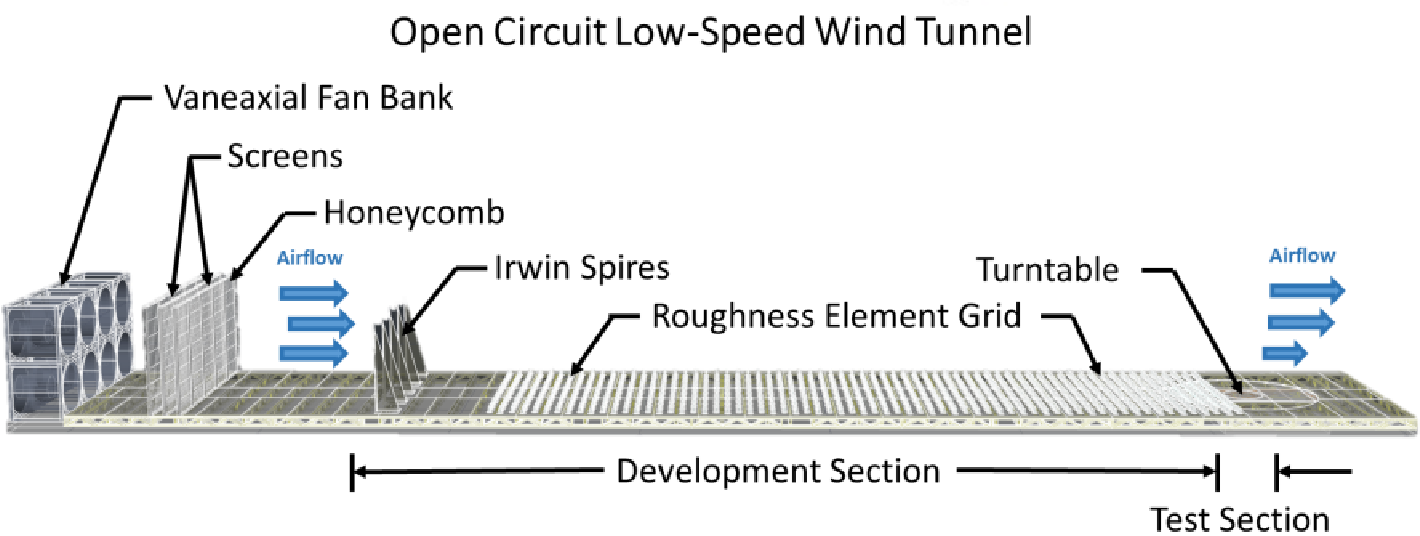
Existing Wind Tunnel Infrastructure

- Wind Tunnel
- Control Room
- 2 MW Power Delivery System
- 8 Vanexial Fans

Novel Features (Subsystems)

- U-Profiler (Wind Velocity Gradient)
- I-Profiler (Turbulence Intensity)
- Terraformer – Current Focus of Work
- Wind-Driven Rain Simulator (WDRS)





Approach to Modeling

Wooding and Bradley (1973)

- Analyzed the individual contributions (i.e., partitioning) of floor drag and pressure drag on elements
- Produced early concept for roughness element grid spacing
- Proposed that roughness element grid may be described by universal laws involving its geometry and associated boundary layer

Raupach (1992)

- Formalized theory of drag partitioning producing a simple analytical solution for total drag (τ)

$$\tau = \tau_r + \tau_s$$

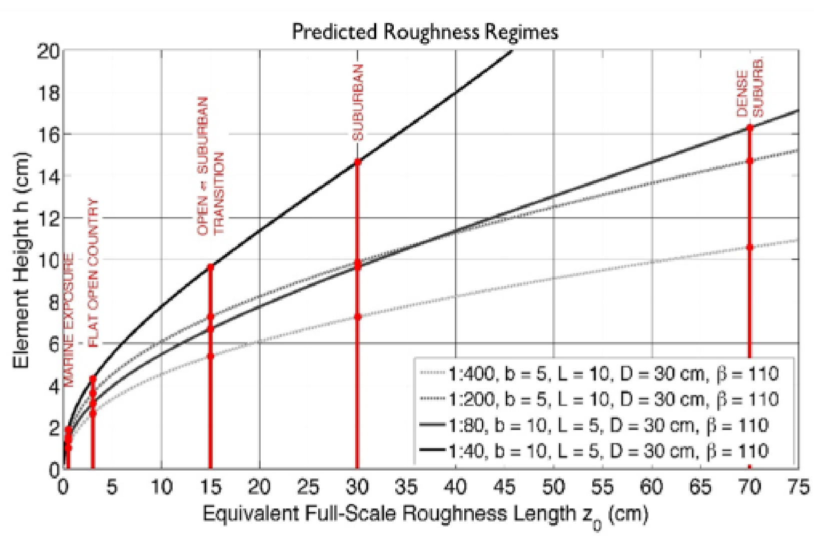
τ_r = *element pressure drag*
τ_s = *ground surface drag*

Shao and Yang (2008)

- Produced most accurate prediction for drag partitioning

$$\tau = \tau_r + \tau_s + \tau_c$$

τ_c = *roughness-element-surface skin drag*



Presentations at DAPS 2015

The following presentations were made at the 5th International Symposium on Design and Analysis of Protective Structures (DAPS) that was held in Singapore on 19-21 May 2015:

Energy Based Load-Impulse Diagrams

Ying-kuan Tsai and Ted Krauthammer

Center for Infrastructure Protection and Physical Security, University of Florida, USA(1* tsai0406@ufl.edu; 1 tedk@ufl.edu)

A load-impulse (P-I) diagram is a useful tool in preliminary strength design and damage assessment. Current approaches to derive P-I diagrams are primarily based on numerical dynamic analyses of the structural system. Further, there are no general energy based solutions that define P-I relationships, and very little has been done to address energy flow as a basis for P-I diagrams. Since the behavior of a structural member is governed by the amount and rate of external energy input and its ability to dissipate energy, defining energy flow relationships will characterize the entire domain of structural responses and corresponding damage. This paper presents a comprehensive energy flow approach to enable one to define the entire P-I domain, and illustrates the application of an energy-based P-I diagram. The results are validated using test data and numerical tools, such as DSAS and ABAQUS/Explicit.

Experimental Frequency Domain Assessment of Direct Shear in NSC and UHPC

Earl Maher[1], Ted Krauthammer[1], Michael Stone[1], Robin French[2], and Jaeyoon Kim[3]

[1] Center for Infrastructure Protection and Physical Security, University of Florida, PO Box 116580, Gainesville, FL 32609, USA

[2] 1 Engineer Support Unit, Canadian Army, Kingston, Canada

[3] Civil and Environmental Engineering, University of West Virginia, Morgantown, West Virginia 26506, USA

Direct shear is recognized as a possible response mechanism in structural concrete systems subjected to severe dynamic loads, and it can lead to catastrophic failure. Behavioral models for direct shear in normal strength concrete (NSC) were introduced in the 1970s and their adaptation for the analysis of structural response under blast and ground shock effects was presented in the 1980s. The introduction of ultra-high performance concrete (UHPC) for protected facilities has created the need to reevaluate direct shear in both NSC and UHPC, and to characterize this response mechanism more accurately. Therefore, direct shear impact tests were conducted on NSC and UHPC specimens with three varying reinforcement ratios and the results were analyzed in both the time and frequency domains. This paper is focused on the assessment of direct shear in the frequency domain to identify the relationships between parameters of the direct shear resistance functions for NSC and UHPC, and the power spectral density of the captured data from impact tests.

Boundary Condition Effects on Ultra High Performance Concrete (UHPC) Slab Performance

Bradley Foust[1], Will McMahon[1], Ted Krauthammer[2]

[1] U.S. Army Engineer Research and Development Center, Vicksburg, MS

[2] Center for Infrastructure Protection and Physical Security, University of Florida, Gainesville, FL, USA

Reinforced concrete slabs are found in common structural systems for both civilian and military applications. The boundary conditions that support the slabs, specifically the amount of lateral and rotational restraint, dictate how it responds to a particular load. Compressive membrane (in-plane) forces are present in slabs when their boundaries are sufficiently stiff, therefore restricting the slabs from both lateral translations and rotations. Advancements have been made to account for the additional capacity due to compressive membrane forces in Normal-Strength Concrete (NSC) slabs. The effects of compressive membrane forces in UHPC have not been adequately studied. Increases in compressive strength and ductility in UHPC introduce additional strength enhancement not present in NSC. This introduces significant unaccounted strength for UHPC slabs with certain boundary conditions. Fourteen NSC slabs and 13 UHPC slabs were tested both statically and dynamically to better understand the behaviors of each material set and the effects that boundary conditions have on slab responses. The results of these experiments were then compared to the results of response calculations based on existing theory. Existing theory should be used with caution to calculate the ultimate resistance of UHPC slabs. The experimental and numerical results showed that UHPC slabs with sufficiently rigid boundary conditions have a resistance two-and-a-half-times greater than the traditional yield-line theory resistance for UHPC slabs due to compressive membrane effects.

Presentations at DAPS 2015 (Cont.)

Recent Observations on Design and Analysis of Protective Structures (Key Note Paper)

Ted Krauthammer

Center for Infrastructure Protection and Physical Security (CIPPS), University of Florida, 365 Weil Hall, Gainesville, FL, USA

Recent studies have focused on both active and passive protection, the definition and characterization of combined blast and fragment loads on structural elements, and the influence of Ultra High Performance Concrete (UHPC) on the behavior of structural elements. These studies have highlighted important issues that have not been addressed in various design guidelines. This paper is aimed at describing several such issues, and propose approaches that could be used to address them.

Design of Wireless System for the Detection of Accidental and Terrorist Explosions and Fires in Manufacturing Sites

Edgar Mataradze[1], Mikheil Chikhradze[1], Ted Krauthammer[2], Shalva Marjanishvili[3]

[1] G.Tsulukidze Mining Institute, Tbilisi, Georgia
[2] Center for Infrastructure Protection and Physical Security (CIPPS), University of Florida, USA
[3] Hinman Consulting engineers, inc., San Francisco, CA, USA

The development of contemporary detection devices is oriented to the creation of integrated systems ensuring monitoring of all possible threats as well as respective measures for threat prevention. A comprehensive security system enables identification of emergency and pre-emergency conditions and have WiFi modes of operation. The system shall be quick-acting and reliable, and not impede the normal functioning of the manufacturing sites and/or underground facility. In order to achieve relibility, the system should not depend on the external power.Detection system have to meet the requirements of the Directive 94/9/EC on equipment and protective systems intended for use in potentially explosive atmospheres (ATEX). This paper describes results of experimental investigations to identify and process signals from various sources. The described works are necessary for designing the integrated module of identification which is based on the constant monitoring on potential threat that may take place in manufacturing sites and tunnels. The potential threats discussed in the paper are: The blast, which is based on the monitoring of overpressure and methane concentration control in the media, and the fire, which identification is based on the monitoring of flame and smoke parameters. Besides the reliable identification and generation of the emergency signal, proposed multifunctional device will ensure also the activation of the protective systems to reduce the damage and fatal consequences. Results of tests of system show that potentially it can be used for identification of danger in 2.4 ms after excitation of a sensor of the detector and activation of protection device in 11 ms after the time of explosion.

Sponsored Research

- Coupled Size and Rate Effects in Ultra-High-Performance Concrete, Ministry of Defense, Israel, 2012—present.
- Thermodynamic Blast Suppression in Underground Structures, NATO, Collaborative study with Institute of Mining Mechanics, Georgian Academy of Sciences, 2014—present.
- Physics-Based Prediction of Unexploded Ordnance Penetration into Granular Materials, 2015—present.
- Other collaborative R&D agreements are under development with defense organizations in Canada, Germany, Japan, Singapore, South Korea, and the United Kingdom.

Technical Visits

- 13 January 2015: Visit by Smart Defense to UF, and meetings to explore collaborative R&D for various DOD agencies.
- 22-23 January 2015: Dr. David Ornai of the Ben Gurion University, Israel, visited to finalize an MOU with UF/CIPPS, and to discuss collaborative R&D.
- 18-19 March 2015: Technical data exchange meeting at CIPPS between a delegation from Gramat, France, US Air Force, AFRL, and US Army, ERDC.
- 7 April 2015: ERDC delegation visited CIPPS to explore PhD studies for ERDC personnel.
- 19-24 April 2015: Prof. Krauthammer visited the Mining Institute of the Republic of Georgia in Tbilisi, as part of the collaborative activities on the NATO-sponsored project *Thermodynamic Blast Suppression in Underground Structures.*

Academic Courses and Training

CIPPS staff are involved in the following five graduate-level courses on protective structures have been developed:

Protective Structures

This course is aimed at understanding the loading phenomena associated with the effects of conventional and nuclear explosive devices, and the structural response to such loads. Dynamic analysis and design approaches for a wide range of structural systems and materials to mitigate such effects are addressed, as are the behavior and design of structural connections, non-structural systems, and progressive collapse. Load-impulse (P-I) diagrams for structural behavior and damage assessment are discussed to address a wide range of applications.

Advanced Protective Structures

This course addresses the planning, security assessment, and technical issues involved with mitigating the severe effects associated with explosive incidents (e.g., blast, shock, impact, etc.). It is focused on the advanced treatment of threat and hazard assessment, as well as mitigation approaches when considering conventional, nuclear, industrial, and terrorism hazards. Some of the addressed topics include characteristics of explosive devices and environments, including improvised explosive devices (IED); combined effects (e.g., blast-fragment and medium-structure interaction effects); advanced treatment and derivation of P-I diagrams; and damage assessment.

Retrofit Methods for Protective Structures

This course addresses the threat and risk assessments of existing structural facilities under explosive loading effects. Topics include damage prediction of various structural elements under explosive loads, applications of P-I approaches for accurate and expedient assessments of retrofit options, and the development of retrofit strategies to mitigate anticipated damage.

Applied Protective Technology

This course discusses sound protective technology approaches and procedures under emergency conditions, when expedient action is required in urban and field settings. The topics include application assessment of procedures for threat and hazard definition, load definition, facility response and consequence assessment, expedient remediation procedures and their assessment, and expeditionary and modular force protection approaches.

Impact Engineering

This course is aimed at understanding elastic and plastic behavior of beams and plates under concentrated and distributed impact loads. Some of the topics addressed include limit states, plastic hinge and/or yield line formation, and comparisons of closed-form solutions with fast-running approximate solutions and advanced numerical solutions for cases tested under precision impact conditions.

Critical Infrastructure Protection Certificate (CIPC)

The Civil and Coastal Engineering (CCE) Department, an academic unit of the Engineering School of Sustainable Infrastructure and Environment (ESSIE), has established a nine-credit *Critical Infrastructure Protection Certificate (CIPC)* program that for graduate students with interests in the area of protecting the Nation's critical infrastructure systems against blast, shock, and impact incidents. The CIPC program will create new research and development funding opportunities and enhanced job placement for both graduate and undergraduate students. The Certificate is awarded to participants upon the completion of their graduate degree studies. Details are available upon request: cipps@ce.ufl.edu

MOU with the Ben-Gurion University, Israel

CIPPS has initiated in 2014 the development of a Minutes of Understanding (MOU) with the Ben-Gurion University in Israel. The MOU became effective on 28 January 2015, and it will enable both universities to embark on a wide range of collaborative activities. Initially, the emphasis will be in various engineering areas. Accordingly, CIPPS has entered into advanced communications with the Protective Technology Research and development Center (PTRDC) in December 2014, followed by a visit to CIPPS by Dr. David Ornai of the PTRDC. Several collaborative R&D programs are planned to start by Summer 2015.

Short Course

MODERN PROTECTIVE STRUCTURES

Short Course

Arlington, Virginia, July 2016

The dates will be announced soon

Sponsored by the University of Florida and the Center for Infrastructure Protection and Physical Security (CIPPS), and endorsed by the Society of American Military Engineers (SAME) and The Infrastructure Security Partnership (TISP)

Terrorism and various other forms of armed conflicts are not new phenomena, and one can find historic references that such activities existed for more than two thousand years. Societies in many regions around the world have been increasingly burdened by various types of warfare during the last quarter century (e.g., Afghanistan, Columbia, Egypt, France, Germany, Greece, India, Iraq, Israel, Italy, Japan, Lebanon, Libya, Mexico, North Africa, Russia, Syria, Spain, Sri Lanka, United Kingdom, USA, and many more). Historically, the data about such incidents indicates that more than 90% of recorded incidents involved explosive devices or ballistic attacks. Vehicle bombs and other types of improvised explosive devices (IED) have become the preferred mechanism for terrorist attacks, followed by the use of homicide bombers. Furthermore, the proliferation of nuclear, radiological, chemical, and bacteriological weapons poses a persistent threat of weapons of mass destruction (WMD) in several geographic areas. Defending society against such rapidly evolving threats will remain a challenge throughout the 21st century. Any successful response to protect society from such incidents will require a well-planned, multilayered approach that strikes a fine balance between assuring a nation's security and maintaining the freedoms that modern societies enjoy. Technology has and will continue to play a major role in these efforts, and innovative and comprehensive protective technologies must be developed to achieve this objective.

Do you have the required training in designing buildings or other critical facilities that can protect people and/or assets from different types of explosions and or ballistic attack? Are you familiar with the regulations and guidelines that need to be followed for protection from such incidents?

The key to achieving these objectives is knowledge—what exists and what can be done regarding various evolving threats. Modern Protective Structures (MPS) is a short course based on a graduate-level, semester-long course at the University of Florida. It is one of five graduate-level courses that have been developed by Prof. Ted Krauthammer to educate and train the next generation of scientists and engineers to work in this vital and challenging field. It is aimed at addressing a broad range of scientific and technical issues involved in mitigating the severe loading effects associated with blast, shock, and impact. MPS has been modified every year since it was first introduced in 1988 to include new material, and to address the latest developments in this challenging field. Past participants, who represent an international cross-section of public and private organizations, have told us that the lectures on a broad range of relevant advanced topics, combined with a hands-on and problem-based approach have provided them with valuable and practical knowledge they could incorporate effectively and immediately into their work. Architects, Engineers, and Safety and Security Managers will have the opportunity to:

- Learn how to assess the risk associated with threats, hazards, and various explosive incidents
- Have access to knowledge on how such facilities (e.g., office buildings, schools, airports, hospitals, power stations, and industrial and transportation infrastructure facilities and systems) behave under blast, shock, and impact loads
- Learn how to analyze and design various facilities to protect lives and property, using software that you can take with you for later use
- Study and practice how to implement such knowledge for conducting effective pre- and post-event facility assessments, rescue and recovery operations, and forensic investigations
- Receive an extensive of books, manuals, software, reports, and technical articles to form your state-of-the-art electronic library in this field

Prof. Ted Krauthammer has been teaching the Modern Protective Structures short course internationally since 1988, and hundreds of former participants have benefitted from it. He will be instructing this course in Arlington, Virginia, from July 13th through July 17th 2014. We invite you and your colleagues to register for this course. Please visit the link: http://reg.conferences.dce.ufl.edu/MPS to view information on the course location, accommodations, and registration. Also, please visit the CIPPS website at www.cipps.eng.ufl.edu for related updates.

Congratulations, Welcome & Farewell

- Maj. Earl Maher of the Canadian Forces who completed his MS degree, and will return to Canada to resume his duties.
- Ying-Kuan (Jeremy) Tsai who completed defended successfully his PhD dissertation. He also received the Best Paper Award for his paper "Energy Based Load-Impulse Diagrams" presented at the 5th International Symposium on Design and Analysis of Protective Structures (DAPS) that was held in Singapore on 19-21 May 2015. Dr. Tsai plans to return to Taiwan to teach at the Chung Cheng Institute of Technology, National Defense University.

Conferences & Events

- **The 11th International Conference on Mechanical and Physical Behaviour of Materials under Dynamic Loading (DYMAT2015)** - Lugano, Switzerland, 07 - 11 September 2015: http://www.dymat2015.org/
- **16th International Symposium for the Interaction of Munitions with Structures (16th ISIEMS),** 9 - 13 November 2015, Sandestin, Florida, USA: **http://reg.conferences.dce.ufl.edu/isiems**
- **24th International Symposium on Military Aspects of Blast and Shock (MABS 24),** 18- 23 September 2016 , Westin Nova Scotian Hotel in Halifax. Canada: **http://www.mabs2016halifax.com/**

The 16th International Symposium on the Interaction of the Effects on Munitions with Structures will be held at the Hilton Sandestin in Sandestin, Florida on November 9-13, 2015. It follows the tradition of previous meetings held in the United States of America and Germany. It will address all aspects of the response of civil engineering structures and materials to explosive loading. Scientists, engineers and other experts or personnel working in the technical areas of interest are invited to participate in and contribute to the symposium.

ABSTRACTS AND PAPERS:
Abstract submission guidelines and topics can be found on the ISIEMS registration website. Please review the guidelines before submitting your abstract online.

Abstract Topics:
- Environments from weapon effects
- Impact and penetration
- Techniques for mitigating weapons effects
- Materials response to short duration loading
- Structural response to explosion effects
- Structure contents subjected to weapons effects
- Progressive collapse considerations
- Modeling of innovative payload effects
- Experimental approaches for any of the above-noted topics
- Computational approaches for any of the above-noted topics
- Analytical or experimental techniques that did not work
- Research in progress

Timeline:

March 1, 2015	Deadline for Abstracts
April 30, 2015	Presenter Notification
August 1, 2015	Papers Due

REGISTRATION:
The symposium will be open to the general public. Some sessions may be restricted to NATO-members only. Security clearance is not required.
- The symposium is limited to 300 attendees on a first come-first serve basis.
- Lodging information is provided on the ISIEMS registration website
- The registration fee covers the symposium materials, symposium sessions, special events, morning & afternoon coffee breaks, and lunch Tuesday-Thursday.

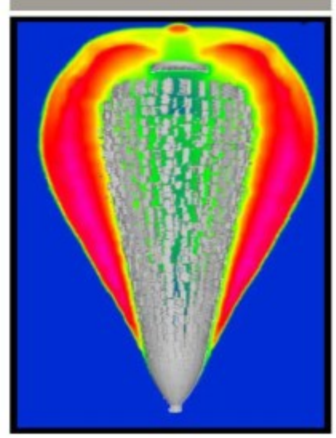
ISIEMS 2015
Announcement and Call for Papers

November 9-13, 2015
Hilton Sandestin
Florida's Emerald Coast

REGISTRATION NOW OPEN!

Special Events:

- Welcome Reception
- Banquet
- Air Force Armament Musuem Tour
- Eglin Air Force Base Tour



Center for Infrastructure Protection and Physical Security (CIPPS)

The University of Florida
2100 NE Waldo Road
PO Box 116580
Gainesville, FL 32609

Phone: 352-273-0691
Fax: 352-273-0186
E-mail: cipps@ce.ufl.edu

Visit us at:
www.cipps.eng.ufl.edu

Our Sponsors and Partners

CIPPS is recognized internationally and its collaborative activities have been supported by organizations and government agencies in the U.S. and abroad.

New Activity

Multi-Hazard Mitigation

After a very successful NATO-sponsored workshop on Urban Structures Resilience under Multi-Hazard Threat, Moscow, Russia, July 16–18, 2007, CIPPS continues to work with colleagues from the hurricane research facility at UF, and from the University of the Armed Forces in Germany, on developing our innovative multi-hazard mitigation approach.

Available Positions

CIPPS is currently seeking high-quality candidates for Post-Doc and Research Assistant positions with documented experience in impact testing of structural concrete elements. Interested individuals should contact us for further information (U.S. citizens preferred).