

# A short course on Modern Protective Structures

17. - 21. June 2013, Trondheim, Norway

**Lecturer: PROF. TED KRAUTHAMMER, Center for Infrastructure Protection and Physical Security (CIPPS), University of Florida**

## BACKGROUND

Structures can suffer from unintentional external loads and it is thus an increasing need to protect critical infrastructure facilities and systems against terrorist acts, industrial accidents onshore and offshore as well as from natural hazards such as floods, wind (storms, tornados, and hurricanes) and rock fall on roads. Addressing such challenges, may in fact, explain the reason for having structures or systems which are able to withstand the defined threats, accidents and hazards in order to ensure the probability of survival of people and other contents as well as reducing the economic losses and the impact on the environment.

The Modern Protective Structures short course will present the latest research on designing buildings to save lives-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 following topics will be addressed:

- Fortification science and technology
- Analysis, design, assessment, and retrofitting
- Industrial explosive safety
- Antiterrorist design
- Hazard sources
- Physical security
- Blast damage assessment

Besides comprehensive lectures and discussions, the course will feature hands-on, guided analysis and design activities, including case studies and simulations. Participants will be given the course book, as well as a CD with computer programs to assist in the analysis and design of protective structures, design manuals, and extensive reference materials.

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## COURSE OUTLINE

### Introduction

- General Background
- Protective Planning and Design Philosophy
- Protection Methodology, Threat, and Risk Assessment
- From Threat and Hazard Environments to Load Definition
- Technical Resources and Blast Mitigation Capabilities
- Analysis Requirements and Capabilities
- Protective Technology - Current State and Future Needs

### Explosive Devices and Explosions

- Characteristics of Explosive Processes, Devices and Environments
- Explosives, Explosions, Effects and their Mitigation
- Examples and Applications

### Conventional and Nuclear Environments

- Air Blast
- Penetration
- HE-Induced Ground shock, Cratering and Ejecta
- Cratering, Ejecta, and Ground Shock from Nuclear Devices
- Fragmentation
- Fire, Chemical, Bacteriological Radiological Environments
- Examples and Applications

### Conventional and Nuclear Loads on Structures

- Conventional Loads on Structures
- Nuclear Loads on Structures

- Step-by-step Procedures
- Examples and Applications

### Behavior of Structural Elements

- Distance from Explosion and Dynamic Loads
- Material Properties of Steel and Concrete
- Flexural Resistance
- Shear Resistance
- Tensile and Compressive Members
- Principal Reinforcement
- Cylinders, Arches, and Domes
- Shear Walls
- Frames
- Natural Periods of Vibrations
- Advanced Considerations
- Application to Structural Design
- Practical Damage and Response Limits
- Examples and Applications

### Dynamic Response and Analysis

- Single-Degree-of-Freedom (SDOF) Analysis
- Multi-Degree-of-Freedom (MDOF) Systems
- Continuous Systems
- Intermediate and Advanced Computational Approaches
- Validation Requirements for Computational Capabilities
- Practical Computational Support for Protective Analysis and Design
- Examples and Applications

### Connections, Openings, Interfaces and Internal Shock

- Connections
- Openings and Interfaces
- Internal Shock and its Isolation
- Internal Pressure
- Examples and Applications

### Load-Impulse Diagrams and their Applications

- Background
- Characteristic of P-I Diagrams
- Analytical Solutions of P-I Diagrams
- Numerical Approaches to P-I Curve
- Dynamic Structural Model
- Application Examples for SDOF and P-I Computational Approaches
- Examples and Applications

### Progressive Collapse and its Mitigation

- Introduction and Background

- Progressive Collapse of Different Types of Structures
- DoD and GSA Guidelines
- Foreign Guidelines
- Advanced Frame Structure Analysis
- Examples and Case Studies

### Critical Infrastructure Protection

- Introduction and Background
- Critical Infrastructure Systems and their Assessment
- Protection Methodologies for Critical Infrastructure Systems
- Applications and Examples

### A Comprehensive Protective Design Approach

- Introduction and Background
- Protection Approaches and Measures
- Planning and Design Assumptions
- Siting, Architectural, and Functional Considerations
- Load Considerations
- Structural Behavior and Performance
- Structural System Behavior
- Structural System and Components Selection
- Multi-Hazard Protective Design
- Other Safety Considerations
- Development and Implementation of Effective Protective Technology
- Summary

### Presentation of Krauthammer

Dr. Krauthammer is currently Goldsby Professor of Civil Engineering at the University of Florida, and Director of the Center for Infrastructure Protection and Physical Security (CIPPS). His main research and technical activities are directed at structural behavior under severe dynamic loads, including considerations of both survivability and fragility aspects of facilities subjected to blast, shock, and impact effects. He has specialized in the nonlinear behavior of structures (including medium-structure interaction) under impulsive loads, and the development of numerical simulations and testing techniques for structural assessment. His work has included the development of design recommendations for enhancing structural performance, physical security and safety of buildings, facilities and systems.

Dr. Krauthammer's teaching background includes courses on structural design and behavior, structural analysis, advanced dynamics, protective structures, and numerical methods. He has been invited to lecture in the USA and abroad, and he has been a consultant to industry and governments in the USA and abroad.

## COURSE FEE AND REGISTRATION

Included in the fee:

- Five day course with Prof. T. Krauthammer as the lecturer
- Course material: CD with software and publications and the course textbook T. Krauthammer: Modern Protective Structures. CRC Press, 2008.
- Lunch and coffee breaks
- One dinner

Course fee NOK 16 000,-

Registration deadline:  
**May 15th 2013**

**ACCOMMODATION** Accommodation is not included in the course fee.

**LOCATION** NTNU campus in Trondheim, Norway

**OTHER** The participants can bring their own laptops but this is not required.

## CONTACT

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