

Course Type	Course Code	Name of the Course	L	T	P	Credit
DE	NCED509	Blast Protection of Structures	3	0	0	3

Course Objectives

- To develop knowledge and understanding on the overview of blast loading and its effect on structural components and systems.
- To appraise analysis methodology for prediction of blast loading and structural response.

Learning Outcomes

- Comprehend fundamental knowledge on origin, characteristics of blast loading and stress waves.
- Develop an in-depth knowledge on analysis and design of structures under blast loading.
- Identify key mechanisms involved in arresting a structural collapse and a comprehensive protective design approach.

Unit No.	Topic	Contact Hours	Learning outcomes
1.	Shock and Explosion: Blast Phenomena, Explosion Classifications, Types of Explosives, Unconfined and Confined explosion, Mechanism of Blast Loading, TNT-equivalence, Blast Wave Parameters, Blast Load on Structures, Blast Pressure-time Profile, Blast Wave-structure Interaction, Scaling Law, Reflection Coefficient, Mach Reflection, Blast Clearing, Industrial Explosion, Fragmentation, Stress Wave, Propagation and Particle velocity, Reflection and Transmission, Plastic Stress Wave, Ground Shock, Prediction of Blast Load	10L	Acquire knowledge regarding the origin, characteristics of blast loading and its effect on structures
2.	Material Response and Blast Analysis: Dynamic Material Behavior, High-Strain Rate Loading, Strain Rate Effects on Concrete and Steel, Dynamic Increase Factor, Constitutive Model, Building Types and Configurations, Structural Systems, Review of Fundamental Structural Dynamics, Impulsive Loading, Structural Analysis for Blast, Single-degree-of-freedom (SDOF) Approach, Multi-degree-of-freedom (MDOF) System, Continuous System, Finite Element Analysis, Pressure-Impulse Diagram, Shock Spectra, Numerical Analysis, Equivalent SDOF System Approach	11L	Understand the strain rate effects on structural materials and blast analysis techniques
3.	Structural Component Design: Blast-resistant Design Philosophy, Design Load and Strength, Safety Factor, Response Limit, Damage, Resistance-deflection Curve, Reinforced Concrete (RC) Component Design, Flexural and Shear Resistance, Spalling and Scabbing, Direct and Diagonal Shear, Dynamic Reaction, Design of Elements in Structural Steel, Plastic Behavior of Steel Structures, Ductility Ratio, Rebound, Member Detailing	11L	Comprehend the blast-resistant design of various structural elements
4.	System-Level Behavior and Building Envelope: Progressive Collapse, Code provisions, Structural Robustness, Alternate Path Method, Glazing and Glazing systems, Glazing Products and Constructions, Balanced Design, Mullions and Frames, Catch Systems	5L	Realize the whole-building response to blast damage and building envelopes and glazing
5.	Protective Measures and Recent Advances: Blast-retrofit Concept, Repairing Materials, Evaluation and Strengthening of Existing Structural Components, Sacrificial Cladding, Protection Approaches and Measures, Threat and Vulnerability Assessment, Effective Protective Technology, Case studies, Development of Computer Program	5L	Understand the structural resiliency and robustness and blast-hardening of existing structures
Total Contact Hours		42L	

Recommended Textbooks:

1. Krauthammer, T. (2008), “Modern Protective Structures”, CRC Press, Boca Raton, USA

Recommended References:

1. Smith, P. D. and Hetherington, J. G., (2011) “Blast and Ballistic Loading of Structures”, Routledge, New York, USA
2. Baker, W. E., *et al.*, (1983) “Explosion Hazards and Evaluation”, Elsevier, The Netherlands
3. IS 4991-Part 1 (2024) “Criteria for Blast Resistant Design of Structures: Above-ground Explosions”, New Delhi, India