Approved in 45th BoA Meeting (18-02-22)

Course number : CE602
Course Name : Blast Engineering
Credit Distribution : *3-0-0-3*
Intended for : UG/PG elective
Prerequisite : Structural Dynamics (CE511) or Soil Dynamics (CE 560) or equivalent
Mutual Exclusion : None

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1. Preamble:

The critical infrastructure such as army facilities, key government buildings, nuclear power plants, and life-line bridges, tunnels, and hospitals must also be designed for abnormal loading such as blast and impact. The blast loads are short-duration high-magnitude impulsive loads and the structural response to such loads requires a proper understanding. Therefore, this course on 'Blast Engineering' is being proposed with the following objectives: (i) to understand the sources and characteristics of the blast loads, (ii) to apply the knowledge of structural dynamics in determining the structural response, (iii) to learn the different design aspects of the protective structures, and (iv) to get acquainted with different industrial practices. This course would be useful for those who wish to practice structural engineering or research in the field of protective structures.

2. Course Modules with quantitative lecture hours:

Module 1: Risks, Threat, and vulnerability Assessment, different scenarios: accidental or terrorism, chemical, or nuclear, sources of explosion and explosive devices, introduction to different types of problems through case-studies. **[5 hours]**

Module 2: Basic physics of shock/explosion phenomena, internal and external explosions, nuclear and chemical explosions, characteristics of blast loads, ideal and non-ideal blast waves, penetration (in concrete, rock, soil), fragmentation, ground shocks, shock wave propagation, cratering and ejecta phenomena. **[10 hours]**

Module 3: Blast load on buried structures, above ground structures, surface-flush and mounded structures, nuclear loads, soil arching, computing pressure-time curves for different structural components, dynamic behavior of materials (concrete, steel, rock, soil), dynamic response of idealized systems to blast loads (SDOF, MDOF, continuous systems, practices in design codes, equivalent SDOF approach, dynamic flexure and shear behavior), brief introduction to advanced computational tools (such as hydrocodes, LS-DYNA, AUTODYN, DYNA-2D) and methods. **[12hours]**

Module 4: Shock spectra, Pressure-impulse diagrams, their application in design, closed-form solution, energy balance approach, dynamic models (flexure, shear, resistance function, failure modes) and design/construction aspects for protective structures (connections, openings, site-selection, shock isolation, equipment protection, etc.),

progressive collapse under blast load. **[10 hours]**

Module 5: Current design practices, design and safety considerations as per national and international standards challenges, issues & prospects, industrial needs, interaction with industry/field experts. **[5 hours]**

3. Text book

1. Prasad, BK Raghu. *Structural Dynamics in Earthquake and Blast Resistant Design*. CRC Press, 2020.
2. Hetherington, John, and Peter Smith. *Blast and ballistic loading of structures*. CRC Press, 2014.

3. References:

- Ramamurthi, K. (2010). *Explosions and Explosion-Safety*. Tata McGraw-Hill Education.Dusenberry, Donald O., ed. *Handbook for blast resistant design of buildings*. John Wiley & Sons, 2010.
- Mays, Geoffrey, Peter Desmond Smith, and Peter David Smith, eds. *Blast effects on buildings: Design of buildings to optimize resistance to blast loading*. Thomas Telford, 1995.Baker, Wilfred Edmund, P. A. Cox, J. J. Kulesz, R. A. Strehlow, and P. S. Westine. *Explosion hazards and evaluation*. Elsevier, 2012.
- Krauthammer, T. Modern protective structures. CRC Press, Taylor & Francis, USA, 2008
- Bangash, Mohammad Yusaf Hassan. Shock, impact and explosion: Structural Analysis and Design. Springer Berlin Heidelberg, 2009.
- UFC (Unified Facilities Criteria). 2008. Structures to resist the effects of accidental explosions. Rep. No. UFC 3-340-02. Washington, DC: US Army Corps of Engineers, Naval Facilities Engineering Command, Air Force Civil Engineer Support Agency.
- ASCE. 1985. Design of structures to resist nuclear weapons effects. Manual of Practice 42. Reston, VA: ASCE
- IS 4991: 1968 (reaffirmed 2003): Criteria for Blast Resistant Design of Structures for Explosions Above Ground.

4. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content

6. Justification of new course proposal if cumulative similarity content is >30%: