3-Day Short Course on

Analysis and Design for Robustness of Offshore Structures Subjected to Accidental Loads

By

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&

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- *PDUs pending approval by PEB, Singapore*



Date:	30th November – 2nd December 2010
Time:	9.00 am – 5.00 pm daily
Venue:	National University of Singapore

Organized by:

- **Professional Activities Centre, Faculty of Engineering**
- **Centre for Offshore Research & Engineering**

NUS National University of Singapore

Topics to be Covered

The course will be given by a combination of lectures based on power-point and flip-over board and exercises on realistic problems. The solution will be compared with results from advanced nonlinear finite element analysis using the computer codes USFOS. The course attendants may, if so desired, have the opportunity get hands-on experience with USFOS. Lectures notes and copies of power-point presentations will be distributed.

Introduction

Course outline/objectives
Determination of characteristic actions
Design principles -Accidental limit state
Design for direct actions
Residual strength

Elastic-plastic methods of analysis

Plastic hinge concept – the plastic section modulus.
Stepwise elastic –plastic analysis of beams under transverse loading (concentrated load or distributed load). Stress/Force redistribution cross-section and beam length
Elastic plastic analysis of beams with axially fixed and partially fixed beam ends
Compactness requirements – the effect of local buckling
Plastic analysis of unstiffened and stiffened plates
Simplified analysis of plates with partially fixed ends.
Calculation of strain in plastic hinges – deformation limits in beams and plates
Exercises:
Calculation of elastic plastic resistance versus deformations of beams, unstiffened and stiffened plates with varying axial boundary conditions.
Critical deformation wrt to fracture

Strength of tubular joints

Elasto-plastic behaviour of tubular joints
Joint classification
Strength of simple and reinforced tubular joints
Strength of thick-walled and grouted tubular joints
Effect of chord stresses on joint strength
Exercises
Calculation of strength for different joint types

Strength of tubular frames

Elasto-plastic behaviour of tubular frames
Results of large-scale tests of 2D and 3D frames
Role of redundancy in ultimate and reserve strengths
Nonlinear finite element analyses and comparisons of results
Exercises
Nonlinear finite element analysis of 2D and 3D frames

Ship collision with jackets and jack-ups

Characteristic collision actions
Design principles – strength design versus ductile design
Simple impact theory - External collision mechanics
Energy dissipation in local denting and global beam bending
Joint strength versus beam resistance
Energy dissipation in supply vessel bow and side
Designing for optimum collision protection
Static versus dynamic analysis
Exercises:
External collision mechanics – demand for strain energy dissipation
Estimation of energy dissipation up to rupture in jacket legs and braces

Ship collision with floating structures

Maximum force and intensity for bow and stern collision – supply vessels
Energy dissipation in ship bow crushing
Exercises:
Calculation of energy dissipation in bulbous ship bow
Strength and ductile design of stiffened column.

Explosions – assessment of structural resistance

Characteristic accidental explosion actions
Single Degree of Freedom Models (SDOF) for explosion action effect analysis
Maximum response charts for SDOF- models
Pressure - impulse diagram
Resistance versus deformation relationships for beams, unstiffened and stiffened plates
Asymptotic deformation assessment in the impulsive, dynamic and quasi-static range - approximate response charts for worksheet implementation
Exercises:
Estimation of maximum response of beams and plates using response charts for SDOF analysis and asymptotic solutions
Generation of pressure-impulse diagram for an acceptable deformation level.

Resistance of structures to accidental fires

Characteristic accidental fire actions
Transient heat transfer analysis: Conduction, convection and radiation
Simplified analysis of temperature evolution in plates, stiffeners and girders
Passive fire protection – protection properties and modeling for temperature analysis
Mechanical properties for steel at elevated temperatures
Fundamental behavior of columns and beams subjected to fires
Redundancy consideration of major load-carrying structure
Exercises:
Estimation of temperature evolution in unprotected and protected member subjected to fire.
Designing for passive fire protection a major load-carrying framework.

Modelling for nonlinear finite element analysis with USFOS

Foundation models – pile/soil – spudcan/soil
Grouted members
Grouted joints
Simulation of earthquakes

Course Lecturers' Profile

Prof. Jørgen Amdahl is Professor of Marine Technology in Norwegian University of Science & Technology (NTNU). His research interests include: Response of ships and offshore structures to extreme environmental loads and accidental actions like fires and blasts, dropped objects, ship collision and grounding.

He has been instrumental in the development of the nonlinear finite element program, USFOS, which is widely used by the offshore industry to design for extreme and accidental loads. He has carried out laboratory tests with models of double bottoms subjected to lateral penetration, simulating the effects of grounding, and axial crushing of aluminium and steel structures to determine the energy absorption of high-speed vessels and ordinary ship bows in collision. He has considerable experience in the use of nonlinear finite element programs (LS-DYNA, ABAQUS) through comparative analysis of experiments to analysis of the behaviour of actual ship structures.

J. Amdahl is the major responsible for the development of the NORSOK STANDARD N-004 and on Accidental Actions on Offshore Structures and Det norske Veritas' Recommended Practice for Design against Accidental Actions, DNV-RP-C204, and has contributed actively on the development of of ISO Standard for offshore topside structures subjected to accidental actions and Eurocode 1 Part 1-7: Accidental actions (prEN 1991-1-7). He is co-author of the book: Nonlinear Analysis of Offshore Structures, Research studies Press Ltd (2002).

Prof. Choo Yoo Sang is The Lloyd's Register Educational Trust Chair Professor, and Director (Research), Centre for Offshore Research & Engineering (CORE) in NUS.

Professor Choo is Past President of The Institute of Marine Engineering Science & Technology (IMarEST), and was its first President from Asia. He served in many international scientific/technical committees and organized conferences and workshops. He is a Past President of Singapore Structural Steel Society (SSSS). He is member of International Institute of Welding (IIW) Sub-commission XV-E: Tubular Structures, International Ships & Offshore Structures (ISSC) Steering Committee and Chairman of Singapore Mirror Committee for ISO TC67 SC7 for offshore structures.

Professor Choo has received various recognitions, including Lifetime Achievement Award – Maritime Academics, ISOPE Awards, Stanley Gray Award, IES Prestigious Engineering Achievement Award, James Watt Medal and Stanley Gray Medal. He is Honorary Fellow of SSSS, Fellow of IMarEST and The Royal Institution of Naval Architects, Chartered Engineer (in UK) and Professional Engineer (in Singapore). He has served as technical consultant in major offshore projects, and led or participated in international joint industry projects.

2 Easy Ways to Register!

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Please contact Mr Gabriel ONG for more information at
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Email: engokhg@nus.edu.sg

REGISTRATION FEE*

Local Participants: SGD950.00 + SGD66.50 (GST)
Overseas participants: SGD950.00 (GST Exempted)

** Course registration fees include course materials, refreshments and lunches*

DISCOUNT

10% (max.) discount is applicable to:

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A 50% refund will be made for withdrawals (**received in writings**) **ten working days** before the commencement of the course. No refunds will be made thereafter. However, a replacement will be accepted upon prior arrangement at no extra cost. Please inform us of the changes, if any, by fax. **The Professional Activities Centre reserves the right to cancel the course and fully refund the participants, should unforeseen circumstances warrant it**. Every effort will be made to inform participants of any changes.

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Registration Fees:

Participants from Singapore: **SGD950.00 + SGD66.50 (GST)**
Overseas participants: **SGD950.00 (GST Exempted)**

Participant's details

Name: Dr/Mr/Ms: _____ Designation: _____
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