STUDY PROGRAMME GUIDE

FOR THE

MASTER PROGRAMME IN
STRUCTURAL AND CIVIL ENGINEERING
3RD SEMESTER 2009

THEME:

DESIGN AND ANALYSIS OF
ADVANCED/SPECIAL STRUCTURES

THE SCHOOL OF CIVIL ENGINEERING
AALBORG UNIVERSITY – AUGUST 2009
STUDY PROGRAMME GUIDE FOR THE MASTER PROGRAMME IN
STRUCTURAL AND CIVIL ENGINEERING – 3RD SEMESTER 2009

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DESIGN AND ANALYSIS OF ADVANCED/SPECIAL STRUCTURES

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0. INTRODUCTION

This study programme guide applies to the 3rd semester of the Master Programme in Structural and Civil Engineering under the School of Civil Engineering at Aalborg University 2009. The guide is an extension of the project unit description in the curriculum.

The guide is meant as a help for students and lecturers in connection to the planning and execution of the project work. The guide presents the limits within which the students may freely and independently formulate problems and come up with ideas for solutions.

Following the guidelines outlined in this document, the students will complete a project in accordance with the recommendations of the Study Committee of Civil Engineering. This ensures project of adequate scientific and technical quality and enables the student to meet the requirements of the project unit.

Hence, it is recommended to follow the guidelines systematically in the initial phase, where project ideas are discussed and the further course of the project is planned by problem delimitation and choice of methods and by setting up time and work schedules.

Later in the process, when the students have a better overview of the technical aspects of the project, the study guide should be utilised as a tool for structuring the thesis and the project work. In order to establish an overview, it is recommended that each project group arranges one or more status seminars in the course of the project. In this regard, appointments can be made with the supervisors.

1. GENERAL INFORMATION ABOUT THE SEMESTER

1.1. PLACEMENT OF THE PROJECT UNIT IN THE STUDY PROGRAMME

The Master Programme in Structural and Civil Engineering is a two-year full-time study programme leading to a Master of Science degree. It is a natural extension of the BSc education in Structural and Civil Engineering at Aalborg University, but students from other engineering schools in Denmark and abroad may be enrolled as candidate or visiting students. The MSc study programme is finished at the end of the 4th semester.

The specialisation in structural civil engineering is built on a number of technical and theoretical qualifications corresponding to the study graduation recommended by the Study Committee on Civil Engineering. In particular, the project on the 3rd semester has focus on the design and analysis of advanced and/or special structures.
1.2 Requirements According to the Curriculum

The following description of the semester can be found in the curriculum:

Theme: Design and Analysis of Advanced/Special Structures.

Purpose: The project unit has the purpose of enabling the student to apply and evaluate methods of analysis and design for advanced and/or technically complicated structures or materials within the field of civil engineering.

Motivation: The analysis and design of new and existing buildings and other civil engineering structures often rely on the application of advanced analytical, numerical and/or experimental methods. This requires an in-depth knowledge and understanding of existing methods or the development of novel methods and theories, including a critical evaluation of the assumptions, results and uncertainties. Such methods are treated in this project unit with focus on civil engineering structures and materials or sustainably energy plants.

Aim: The student is able to:

- Understand central problems and methods for their solution within the fields of design and analysis of complex load-bearing structures, loads, materials and/or geotechnical engineering,

- Analyse selected problems within the fields of design and analysis of complex load-bearing structures, loads, materials and/or geotechnical engineering,

- Describe and use advanced analytical, numerical and/or experimental methods for design and analysis related to complex load-bearing structures, loads, construction materials, and/or geotechnical engineering,

- Contribute to the development of new methods or an improved understanding of existing methods for the design and analysis of selected problems regarding complex load-bearing structures, loads, construction materials, and/or geotechnical engineering, and

- Compare and evaluate different methods for the design and analysis of selected problems regarding complex load-bearing structures, loads, construction materials, and/or geotechnical engineering.

Contents: The starting point for the project is a complex load-bearing structure, a structural member or detail, and/or the applied load thereon. Alternatively, the focus of the project may be a construction material or geotechnical engineering. For example, the project may concern the
analysis and assessment of structures subject to stochastic loads, using non-linear computational models. The applied methods may be theoretical, numerical and/or experimental. The project may be a part of a research programme, or it may concern a complicated practical problem, e.g. initiated by an engineering consultant.

The project will typically deal with one of the following topics which are all related to the current research at the Department of Civil Engineering:

- Advanced hardening technology,
- concrete technology,
- safety and reliability assessment of load-bearing structures,
- structural dynamics,
- aerodynamics and aeroelasticity (e.g. wind turbines, high-rise buildings and long-span bridges),
- optimal design/structural optimisation,
- robustness of structures,
- application of alternative materials, e.g. glass and fibre-reinforced laminates,
- geotechnical engineering (e.g. soil dynamics, constitutive modelling and design of foundations),
- harbour engineering and coastal protection,
- offshore structures, including wind turbines and wave power plants,
- fatigue and failure,
- design of complex structures (e.g. bridges and wind turbines),
- material modelling.

**Organisation:**

The main part of the project unit consists of problem-based, project-organised group work that may be carried out in Danish or English. The project unit is supported by laboratory and/or field work and computer-based modelling. Further, a number of project-unit courses are given. The medium of teaching is English.

The project may be carried out in conjunction with a 4th-semester project, i.e. as the first part of an extended candidate project.

Alternatively, all of the semester, or some part thereof, may be organised as training in a consulting company, an entrepreneur company, within the
building-construction or wind-turbine industry, or in another civil-engineering company. Prior to the visit, the student must prepare a detailed study plan defining the goals of the training. This is done in collaboration with a supervisor at Aalborg University and the host company.

**Prerequisites:** The student must document qualifications corresponding to one full year of study at the M.Sc. programme in Civil and Structural Engineering.

**Scope in ECTS:** 30 ECTS.

**Placing:** Master programme in Civil Engineering; 3rd semester; fall.

**Examination form:** External individual oral test.

**Assessment:** Individual marks according to the Danish 7-step scale.

**Assessment criteria:** Please, confer the master curriculum.

1.3 **Contents of the Project Unit**
The project unit consists of 24 ECTS project work and 6 ECTS project unit courses, in total 30 ECTS. This corresponds to half a year of full-time study. No courses are given beyond the project unit. A further discussion of the courses may be found in Section 3.3.
2. PROJECT DESCRIPTION

The general theme of the project unit is the Design and Analysis of Advanced/Special Structures. This should be interpreted in a fairly broad sense. Thus, as an alternative to an engineering structure, the focus of the project may be a structural element, e.g. a joint, a construction material, e.g. concrete, or any aspect of geotechnical engineering. Furthermore, the project may concern the evaluation of loads on a structure rather than the structure itself. A typical project will, to some extent, include all the above aspects.

In any case, the project must be carried out at a scientific level that surpasses the level achieved at the preceding semesters. Hence, a project should include the analysis of highly complex problems, research and/or novel design within the field of civil and structural engineering. After the first month of the project, a final study plan must be prepared, providing a description of the project, including

- a short description of the problem and the intended methods of design/analysis,
- a description of any demands on laboratory facilities, field test etc.,
- a specification of the aim of the particular project, conforming to the requirements of the curriculum given in Section 1.2,
- a short time schedule (optional),
- the date for delivery of the project thesis (binding),
- the signatures of each student and the primary supervisor,
- the signature of a representative of the host company or institution, if appropriate.

The study plan should be delivered to the Director of the School of Civil Engineering no later than the date listed in Section 4.

3. TECHNICAL ASPECTS

3.1 CONTENTS OF THE PROJECT

The contents of the project are highly dependent on the problem being analysed or the actual structure being designed. Hence, no general information can be provided. Instead, each project group must prepare a final study plan in collaboration with their supervisor(s). An outline of the study plan was given in Section 2.
3.2 Course of the Project

Typically, the project on the 3rd semester of the M.Sc. programme includes the following:

- Choice of project after an evaluation of the different possibilities.
- Planning of a time schedule for the project.
- Preparation of the final study plan.
- Review of scientific methods based on a literature study.
- Preparations for laboratory tests if appropriate. This may include the design of test models.
- Preparation of numerical models, including programming, if appropriate.
- Model tests:
  - Experimentally in the field and/or in the laboratory,
  - Numerically, e.g. by means of the non-linear finite-element method.
- Evaluation of results including, for example,
  - Comparison of measured and computed results,
  - Comparison with other results, e.g. from the literature,
  - Analysis of the applied methods.
- Identification of related problems.
- Preparation of the project thesis or another medium of dissemination.

Regarding the final item of the list, it is encouraged to prepare appendices in electronic form and keep the main thesis at approximately 100 pages. The main thesis should contain the introduction and definition of the problem, a clear description of all assumptions made in the mathematical and physical models and, finally, the conclusions. Any lengthy derivations, numerical or experimental results and auxiliary material can be put in the appendices on a DVD. However, students are allowed to hand in a written thesis including all appendices.

The actual course of each individual project depends on the topic, the number of students in the project group and so forth.
3.3 PROJECT UNIT COURSES
As part of the project unit, the following project unit courses are scheduled:

- Ocean Energy Structures 1 ECTS
- Elastodynamics 1 ECTS
- Stochastic Structural Dynamics 2 ECTS
- Fracture Mechanics and Fatigue 1 ECTS
- Wind Load 1 ECTS

In total 6 ECTS

OCEAN ENERGY STRUCTURES

Placing: Master programme in Civil Engineering; 3rd semester; fall

Scope in ECTS: 1 ECTS

Purpose: To provide an introduction to various technologies presently being developed for utilization of the abundant amounts of energy available in the ocean. A wide variety of technologies will be touched upon – however, the main focus will be on wave energy converters (WECs).

Contents: The following topics are covered: Overview of the ocean energy sector: Reasons to work with ocean energy utilization, ocean energy potential, technical sector status, involved technical disciplines. Overview of existing ocean energy converter technologies: Categorization of WECs, the way they work, pros and cons of various WEC types. Hydraulic and structural evaluation and development of WECs: Energy production, definition of efficiencies, the conversion of energy through the device, from wave to wire, survivability, optimization (geometrical, structural, PTO), modelling (hydrodynamical, power simulation), scaling, certification and standardisation. Case studies: detailed presentation of selected projects. Site visit: Visit to prototype WECs being tested at Nissum Bredning and Hanstholm.
ELASTODYNAMICS

Placing: 3rd semester

Scope in ECTS: 1 ECTS

Purpose: To provide an understanding of waves propagating in elastic and viscoelastic materials and computational methods for their analysis.

Contents: Body waves in elastic material: P- and S-waves, reflection and refraction at interfaces; Rayleigh waves; dissipation: geometrical and material damping; dispersive and non-dispersive waves; finite-element formulation: wave propagation in a continuum, wave propagation in rods, time and frequency-domain solution, wave propagation in infinite domains; other relevant topics.

STOCHASTIC STRUCTURAL DYNAMICS

Placing: 3rd semester

Scope in ECTS: 2 ECTS

Purpose: To provide the theoretical background for analysing the dynamic response of structures subject to random excitation.

FRACTURE MECHANICS AND FATIGUE

Placing: Master programme in Civil Engineering; 3rd semester; fall

Scope in ECTS: 1 ECTS

Purpose: To provide an understanding of modern fracture mechanics and how the methods and concepts from fracture mechanics can be used for analysis of fatigue problems.


WIND LOAD

Placing: Master programme in Civil Engineering; 3rd semester; fall

Scope in ECTS: 1 ECTS

Purpose: To provide an understanding for modelling and calculation of wind loads on civil engineering structures, especially buildings.

4. **IMPORTANT DATES**

The following dates are milestones or deadlines on the 3rd semester of the Master Programme in Structural and Civil Engineering.

**2 September 2009:** Semester start

**30 September 2009:** Delivery of final study plan

**8 January 2010:** Delivery of project theses (this is a recommended date. Final date is to be agreed upon with the supervisor(s))

**Week 3/4, 2010:** Examination of the project unit