SOME PROJECT/MASTER THESIS TASK SUGGESTIONS IN MARINE CIVIL ENGINEERING (Marin byggteknikk/IBM)

Information mainly in English as we like most of our students to write their theses in English.

Prerequisities:

Passed exam in TBA4265 Arctic and Marine Civil Engineering and

minimum 1 of the following NTNU courses or similar.

TBA4145 Port and Coastal Facilities

TBA4260 Ice Actions on Arctic Structures

TBA4270 Coastal Engineering

TBA4275 Dynamic Response to Irregular Loadings

If you find some topics of interest or have your own ideas in some of these areas, contact the person at NTNU listed. The group will not arrange a general information meeting.

- Port Infrastructure and Coastal Engineering: Raed Lubbad (raed.lubbad@ntnu.no); Hans Bihs (hans.bihs@ntnu.no); Øivind Arntsen (oivind.arntsen@ntnu.no); Jomar Tørset (jomar.torset@ntnu.no); Morten Bjerkås (morten.bjerkas@ntnu.no)
- Arctic Marine and Cold Climate Engineering: Knut V. Høyland (knut.hoyland@ntnu.no); Raed Lubbad (raed.lubbad@ntnu.no)
- Offshore Wind Turbines: Michael Muskulus (michael.muskulus@ntnu.no)

For practical issues contact: Øivind Arntsen (oivind.arntsen@ntnu.no)

NTNU, 02.05.2018

Øivind Arntsen

Course coordinator – TBA4920 Marine Civil Engineering Master Thesis

Contents

1 Port Infrastructure and Coastal Engineering

1.1 The Port of Fredrikstad

One of the largest ports in Norway – Fredrikstad havn – is a river harbour situated at the mouth of Glomma – the largest river in Norway. The harbour itself and nearby locations are steadily developing and several Civil Engineering challenges must be met by good technical solutions. Examples of such challenges are:

- Ships moving up in a river/channel whirls up sediments, with a consequence of changing the river bathymetry and thus the water speed distribution.
- Approach channel design for ship transport in Glomma.
- Removing 1 million m3 of sediments in the Røsvikrenna. What will be the consequences of water transport in the tributaries to Glomma as well in the environmental protected area «Ørareservatet” south of Fredrikstad port?
- How will the salt water wedge change due this vast dredging?
- Quantification of the physical environment related to future development of autonoumous vessels in the port and upstream Glomma.
- …

If some of these issues find your interest, contact us.

Our plan is to have a meeting with representatives from the Port of Fredrikstad before 15th of May, where those interested will be invited. The purpose of such meeting will be to clarify what topic could be of mutual interest to study.

Number of students: 1-4

Contact persons: Øivind Arntsen (oivind.arntsen@ntnu.no) or Raed Lubbad (raed.lubbad@ntnu.no).

Co-Supervisors: Tore Lundestad (tore.lundestad@borg-havn.no) , Roar Johansen (Roar.Johansen@borg-havn.no) .

1.2 Numerical modelling of wave interaction with a floating breakwater using REEF3D

Floating breakwaters have an advantage over conventional fixed-bottom breakwaters in areas with great depth and limited wave exposure. The cost of building a conventional breakwater increases significantly with water depth and for a number of marinas along the Norwegian coast, these solutions can be completely obsolete. The purpose of a wave absorber is to reduce the wave height on the leeward side relative to the incoming waves. Reduction in wave height inside occurs either because the waves lose energy by breaking and the energy passes into turbulence or due to reflection by the breakwater.

The objective of the Masters thesis is to simulate the interaction of waves with a floating breakwater using the open-source Computational Fluid Dynamics (CFD) model REEF3D and determine the wave reflection and transmission characteristics for various configurations of the floating breakwater. In addition, the mooring forces on the floating breakwaters can be calculated.

The floating breakwater is efficient against waves shorter than half of its width. In the case of longer waves, combination of a submerged breakwater in front the floating breakwater can be used to reduce the incident wavelength on the floating breakwater as shown in Figure 1.7.

Task type: Literature survey, numerical modelling, calculation.

Prerequisites:TBA4265 Marine Physical Environment.
Number of students: 1-2
Contact person at NTNU: Hans Bihs hans.bihs@ntnu.no

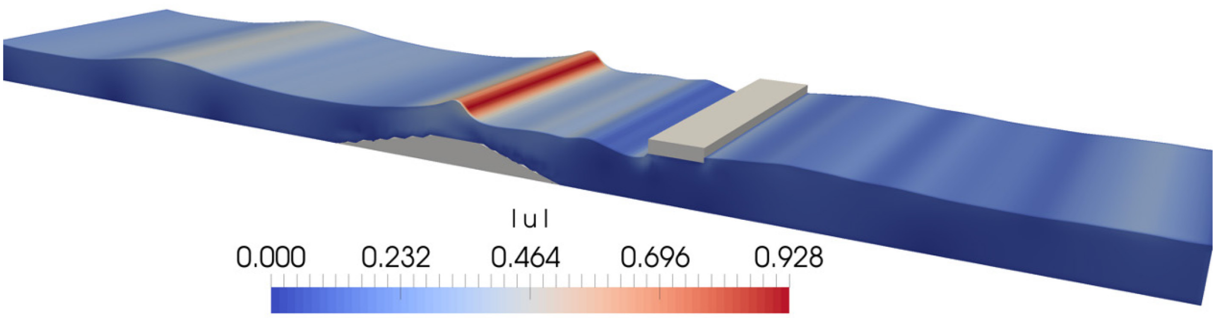


Figure 1.2 Incident wave with T= 2.02 s propagating over a submerged breakwater and incident on a floating breakwater.

1.3 Generation and propagation of extreme waves due to landslide events

Several regions in Norway such as around Åkneset in Møre and Romsdal, Stampa in Sogn and Fjordane susceptible to landslide events due to unstable mountain slopes along the fjords. Landslide events of large magnitude with impulsive impact of debris into the fjords can lead to the generation of extreme waves. The generation and propagation of these extreme waves has to be studied in detail to better understand the risk to the built-up areas around the fjords and reduce loss of life and property. Numerical modelling using Computational Fluid Dynamics (CFD) can provide a large amount of detail regarding the hydrodynamics involved in the process and several scenarios can be studied through a thorough parametric analysis.

The objective of this Masters thesis is to model the generation of extreme waves due to impact of a falling object into a water body and study the wave propagation characteristics. The effect of the volume and density of the falling body on the wave generation, wave kinematics of the extreme wave and the run-up on the coast will be studied. The study will be carried out using the open-source CFD model REEF3D. The six degrees-of-freedom (6DOF) algorithm in REEF3D will be used to model the falling object. The difference between a sub-aerial landslide and a submerged landslide and the characteristics of the consequent extreme waves generated will be studied.

Task type: Literature survey, numerical modelling, calculation.

Prerequisites:TBA4265 Marine Physical Environment.
Number of students: 1
Contact person at NTNU: Hans Bihs hans.bihs@ntnu.no

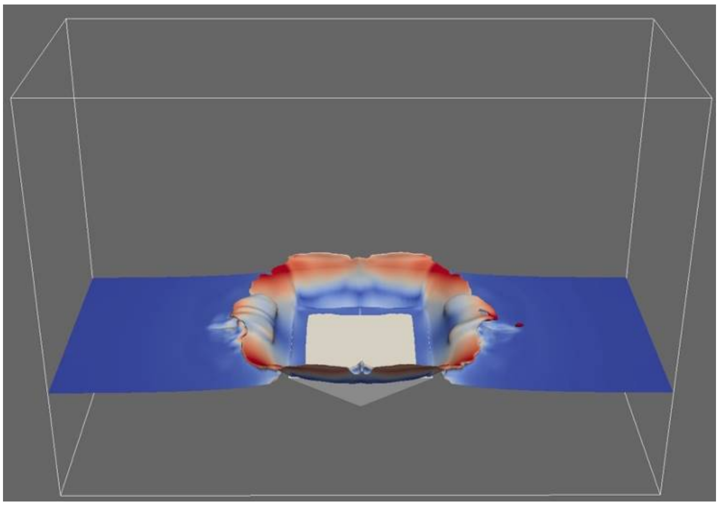


Figure 1.3: Impact of a freely falling wedge on water simulated using the 6DOF algorithm in REEF3D

1.4 Hydrodynamics of a floating bridge pontoon

The E39 project envisioned by the Norwegian Public Roads Administration involves replacing the ferry crossing along the highway with floating bridges and tunnels. The floating bridges and tunnels will be supported by moored floating pontoons. The wave and current interaction with such floating pontoons is to be studied in detail to obtain a better insight into the safety and stability of the floating bridges and tunnels. Conventional wave modelling techniques with potential flow and Boussinesq wave modelling can provide an overview on the wave and current propagation characteristics on a large scale. Whereas the near-field interaction with the floating pontoon has to be studied with a focus on detailed hydrodynamics around the structure. This includes diffraction around the pontoon, the mooring forces and the motion of the pontoon.

The objective of this Masters thesis is to simulate the wave and current interaction with a floating pontoon using the open-source Computational Fluid Dynamics (CFD) model REEF3D which provides detailed information of the flow features around the pontoon. The interaction of the pontoon with waves of different heights and wavelengths and currents will be studied. The mooring forces on the the pontoon and the motion of the pontoon under the action of waves and currents will be calculated. The six degrees-of-freedom (6DOF) equations implemented in REEF3D will be used to model the motion of the pontoon and calculate the forces and moments.

Task type: Literature survey, numerical modelling, calculation.

Prerequisites:TBA4265 Marine Physical Environment.
Number of students: 1
Contact person at NTNU: Hans Bihs hans.bihs@ntnu.no

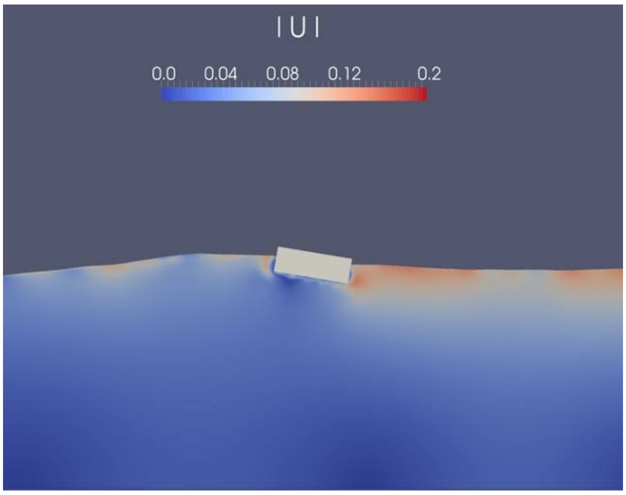


Figure 1.4: Roll motion of a rectangular barge under wave action modelled using 6DOF algorithm in REEF3D

1.5 Modelling of wave interaction with a breakwater using REEF3D

Breakwaters are the most common coastal constructions used to control wave action in a near-coastal region and protect the coastline form erosion or provide harbour tranquillity. The rubble mound breakwater is a type of commonly used breakwaters. Here, the breakwater is made of several layers and the porosity of the layers reduces towards the core of the structure. In order to model such structures, the numerical modelling of porous objects should be studied in detail, including the pore pressure and the velocity of the water through the porous layer. A computational fluid dynamics (CFD) model can calculate the wave hydrodynamics accurately and further research research is required to include the hydrodynamics of a porous breakwater.

The objective of this Masters thesis is to model wave interaction with a breakwater including the porosity of the layers using the open-source CFD model REEF3D. Different approaches for the inclusion of the porosity will be explored. The results for the pressure, the free surface and velocities will be compared to experimental data. Simulations in three-dimensions will be carried out to study wave interaction including diffraction around the breakwater, erosion at the toe due to the action of waves and breakwater toe stability.

Task type: Literature survey, numerical modelling, calculation.

Prerequisites:TBA4265 Marine Physical Environment.
Number of students: 1
Contact person at NTNU: Hans Bihs hans.bihs@ntnu.no

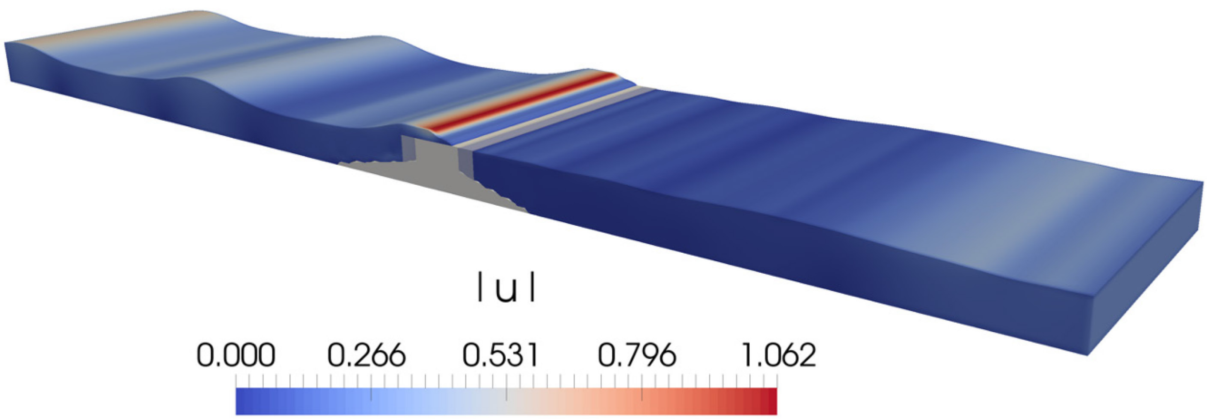


Figure 1.5 Wave interaction with a breakwater modelled with a porous layer around the crest.

1.6 Application of REEF3D to the study of wave overtopping

Wave overtopping is an important physical process on coastal structures such as sea walls and breakwaters. Excess overtopping volumes over coastal structures leads to flooding of the area behind the structure leading to loss of property or maintenance and operational problems. In current practice, overtopping is calculated using empirical formulae and further research can provide deeper insight into the overtopping process and the contribute to the design process.

The objective of this Masters thesis is to model wave overtopping using the open-source CFD model REEF3D. The water free surface undergoes complex deformations including wave breaking as it approaches the overtopping structure and further parts of the water volume propagate over the structure. The numerical model will be used to evaluate the free surface deformations on approach, over the structure and the overtopping water volume. The numerical results will be compared to experimental data. The effect of different slopes and crest crest heights of the overtopping structure on the free surface, the overtopping distance and the overtopping volume will be investigated in the thesis work.

Task type: Literature survey, numerical modelling, calculation.

Prerequisites:TBA4265 Marine Physical Environment.
Number of students: 1
Contact person at NTNU: Hans Bihs hans.bihs@ntnu.no

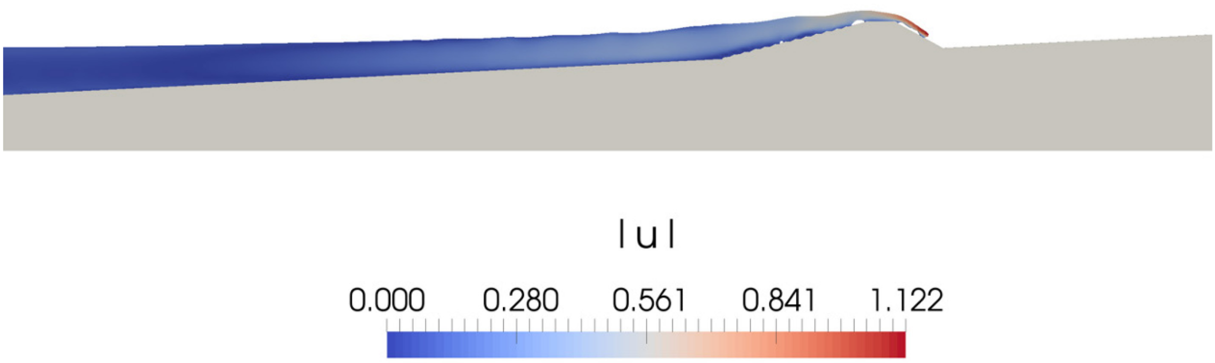
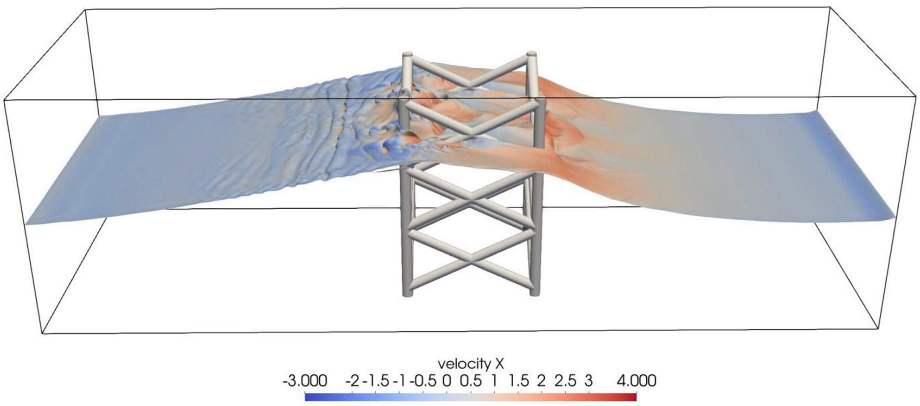


Figure 1.6 Solitary wave overtopping modelled using REEF3D

1.7 Numerical study of the irregular wave forces on a truss structure

Substructures of the offshore wind turbines are exposed to the irregular sea states. Interaction of the waves with the offshore structures is a vital factor in the safety and design of the offshore structures. The substructure can be a monopile or a truss structure. The waves undergo transformations due to non-linear, wave-wave interactions and due to interaction with the structures they are incident on. The wave forces on structures placed in such a wave field are influenced by the stochastic nature of the incident waves.



The objective of this study is to investigate irregular wave interaction with a truss structure. Numerical simulations will be carried out using the open-source CFD model REEF3D (www.reef3d.com),   to simulate the irregular waves with the different peak periods and the different significant wave heights and their interaction with a truss structure. The numerical model will be validated by comparing the numerical results with the experimental results. The wave forces and the free surface features during wave-structure interaction for every member of the truss will be analysed in detail.

Task type: Literature survey, numerical modelling, calculation.

Prerequisites:TBA4265 Marine Physical Environment.
Number of students: 1
Contact person at NTNU: Hans Bihs hans.bihs@ntnu.no

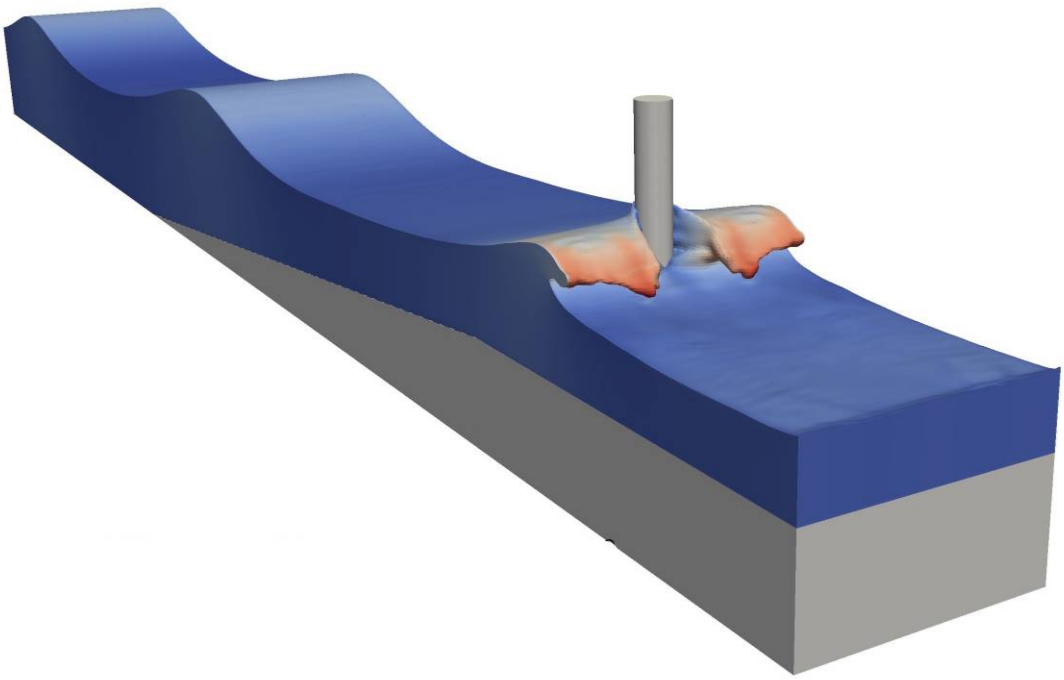
1.8 Breaking Wave Forces on Offshore Wind Substructures

Breaking wave forces a highly non-linear and very difficult to estimate with simplified approaches. For offshore wind substructures, such as monopoles, tripods or truss structures, the breaking wave impact forces are design critical. With computational fluid dynamics (CFD), the wave hydrodynamics can be resolved with a large degree of accuracy and detail. Also, the extremely complex wave breaking process can be simulated in a very realistic manner.

In the current project, the in-house open-source CFD code REEF3D (www.reef3d.com) will be used to calculate breaking wave forces on different types of offshore wind structures. The model calculates the flow for water and air and has advanced methods for capturing the interface between the two phases. The model is fully parallelized and runs on NTNU's supercomputer facilities. In this project, the breaking wave kinematics and the hydrodynamic loads will be analysed for different wave, structure and sea bed properties.

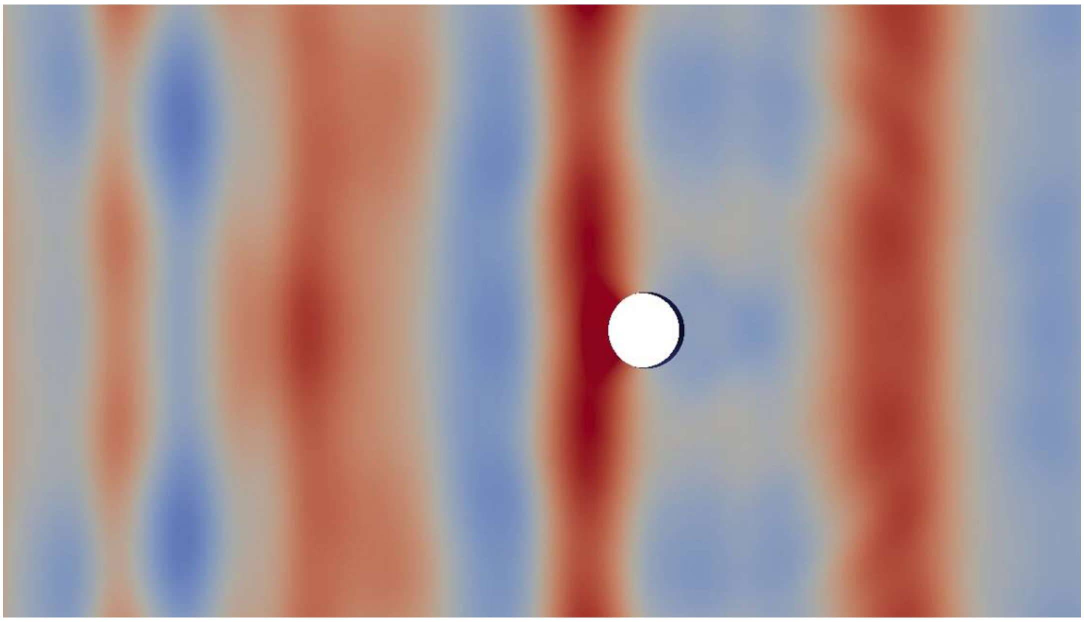
Task type: Literature survey, numerical modelling, calculation.

Prerequisites:TBA4265 Marine Physical Environment.
Number of students: 1
Contact person at NTNU: Hans Bihs hans.bihs@ntnu.no



1.9 Investigation of the wave-structure interaction under irregular waves for a single cylinder and multiple cylinders using CFD

The sea state in reality is highly irregular. It is composed of the waves with the different wave heights and wave periods. A complete three-dimensional representation of the sea state requires the consideration of the sea surface as an irregular wave train. The offshore structures like wind turbines or oil platforms experience the irregular wave forces on the substructures perpetually. Thus, the study of the irregular wave force on the offshore structures is very important in the design of the structure. The structure is usually located in the relatively shallow depth. Thus, the breaking of the waves might be a vital phenomenon to be considered. CFD simulations can be used as a good tool to simulate and analyze the irregular wave kinematics and the wave forces on a single cylinder and multiple cylinders.



The main objective of this study is to simulate and study the behavior of irregular waves during the wave-cylinder interaction. In this study, the numerical tests will be carried out in a three-dimensional numerical wave tank using an open-source CFD model REEF3D (www.reef3d.com), developed at the Department of Civil and Transport Engineering. A detail analysis of the kinematics of the irregular wave during the wave-cylinder interaction with a single cylinder will be carried out in this study as an initial step. Next section of the study will deal with the investigation of the wave-cylinder interaction with an arrangement of multiple cylinders.

Task type: Literature survey, numerical modelling, calculation.

Prerequisites:TBA4265 Marine Physical Environment.
Number of students: 1
Contact person at NTNU: Hans Bihs hans.bihs@ntnu.no

1.10 CFD simulations to analyse wave impact and uplift forces on a horizontal platform

The phenomenon of wave impact on structures is important from the point of view of design, stability and safety of a marine structure. Understanding the action of extreme waves under a horizontal structure located close the free surface can help in better design for these conditions. Decks of coastal and marine structures are built of many independent units placed together. The failure of these decks could be either due to the global failure of the whole platform or due to the local failures of the individual members. Wave impact can cause high local forces, which can cause failure of the individual members. Wave slamming involves a rapidly varying peak uplift pressure and a slowly varying uplift pressure. The forces resulting from the rapidly varying peak pressure have can cause local failure of the members of a platform.

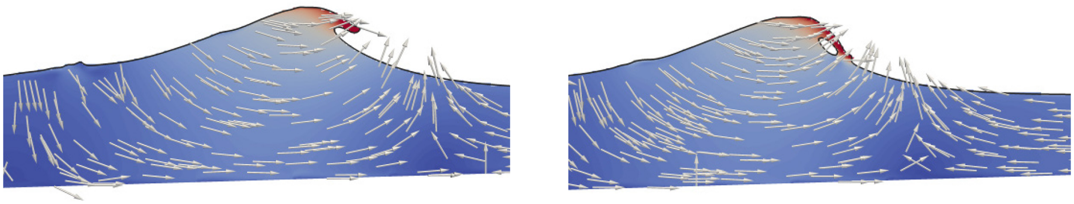
This project aims at simulating wave-structure interaction with a focus on uplift forces on a thin plate under the action of a solitary wave. The study will be carried out using a CFD model adapted to be a numerical wave tank, developed at the Department of Civil and Transport Engineering. The relation between the freeboard and the maximum uplift force is to be explored. The results obtained from the numerical simulations are to be compared with the experimental data.

Task type: Literature survey, numerical modelling, calculation.

Prerequisites:TBA4265 Marine Physical Environment.
Number of students: 1
Contact person at NTNU: Hans Bihs hans.bihs@ntnu.no

1.11 Numerical investigation of shoaling and breaking characteristics of waves on beaches

The breaking process involves many complex parameters and breaking waves may occur at the site depending on the water depth, wave height, seabed slope, wave period and steepness. An exact numerical modeling of wave breaking process is still highly challenging due to the strong non-linear air-sea interaction at the free surface, air entrainment, and strong turbulent production by breaking is highly dissipative. Accurate assessment of wave shoaling and breaking wave characteristics is essential for an accurate prediction of wave forces on coastal structures.



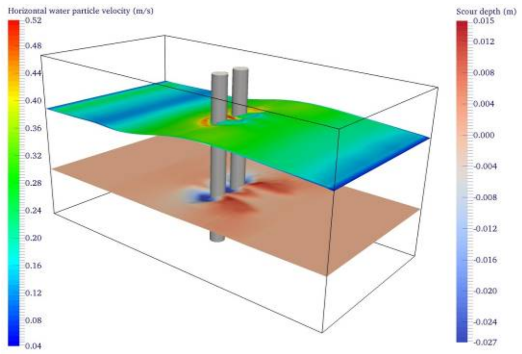
The main objective of the study is to investigate the shoaling and breaking characteristics of waves on plane beaches numerically. In the present study, the numerical experiments will be performed in a three-dimensional wave tank based on a two-phase flow CFD model REEF3D (www.reef3d.com), developed at the Department of Civil and Transport Engineering. The study investigates the features of the shoaling and the breaking process of waves over plane beaches in detail to gain more insight into the physical phenomenon. The outcomes of the project determine the key parameters of many field problems in nearshore coastal processes such as wave forces on coastal structures due to steep waves, non-breaking and breaking waves, surf-zone dynamics, sediment transport, run-up and scour around coastal structures etc.

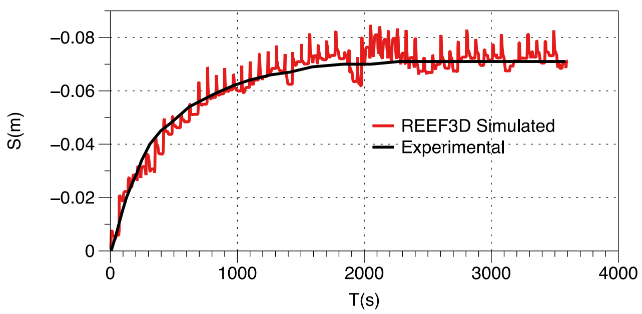
Task type: Literature survey, numerical modelling, calculation.

Prerequisites:TBA4265 Marine Physical Environment.
Number of students: 1
Contact person at NTNU: Hans Bihs hans.bihs@ntnu.no

1.12 3D Numerical modelling of local scour processes in coastal environment

Sediment transport plays an important role in many aspects of coastal and marine engineering such as local scour, beach erosion, scour below coastal pipelines and harbor accretion. Sediments are transported by waves or currents or sometimes through a combined action of both. An accurate prediction of sediment transport rates becomes an important element for the safety of hydraulic structures in coastal environments.





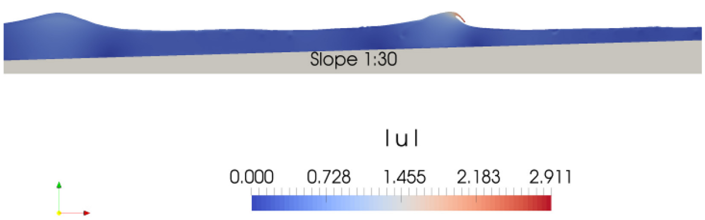
The main objective of the study is to investigate the local scour process in coastal environment using the open-source CFD model REEF3D. The task will focus on detailed analysis of the waves and current flow hydrodynamics, the resulting scour/deposition and the subsequent changes in the bed elevation using different sediment transport formulations available in the code. The numerical results will be compared with experimental data. The results shall be discussed in forms of time evolution of scour processes, the free surface profile and maximum scour/deposition contours.

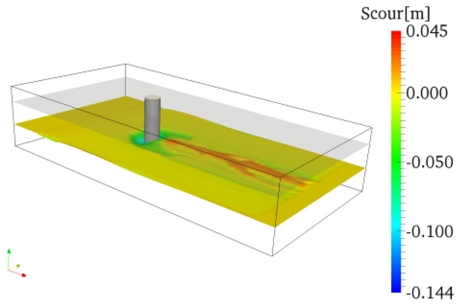
Task type: Literature survey, numerical modelling, calculation.

Prerequisites:TBA4265 Marine Physical Environment.
Number of students: 1
Contact person at NTNU: Hans Bihs hans.bihs@ntnu.no

1.13 3D Numerical modelling of cohesive sediment transport under wave and current action

Generally, cliffed-shorelines and foundations of coastal structures are composed of cohesive soils which consist of very fine grained silt and clay particles in a well bounded form. Continuous exposure of the cohesive sediment bed to waves or current causes horizontal and vertical erosion that can be a serious concern for the stability of structures on horizontal and sloping beds respectively. Further, suspended load due to higher fine particle concentration can also lead to other problems such high turbidity, live bed scour and beach accretion. The numerical modeling of cohesive sediment transport process is a challenging task, since unlike non-cohesive soils, there is a lack of practical measurements, numerical models and accepted guidelines on scour processes.



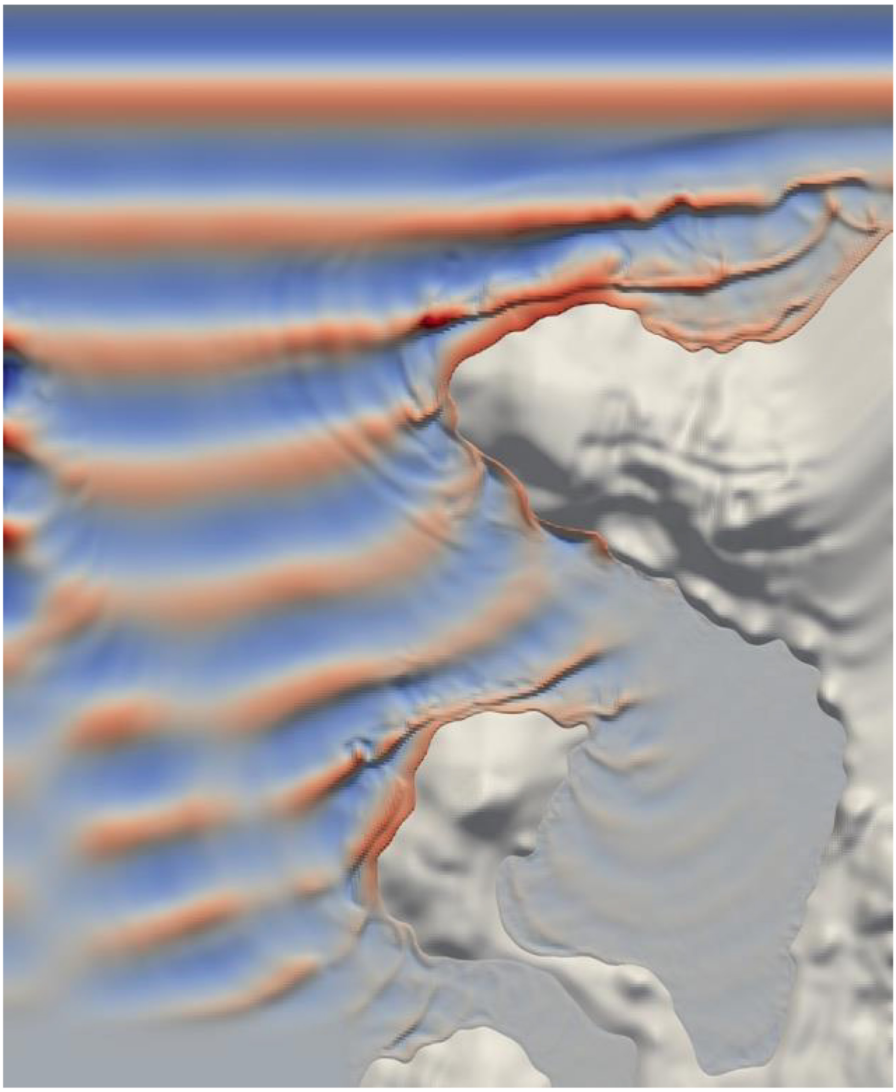


The study shall investigate cohesive sediment transport under waves and currents. The open-source CFD model REEF3D (www.reef3d.com) will be used. Emphasis shall be placed on analysis of hydrodynamics, resulting scour/deposition and subsequent change in bed elevation using different sediment formulations available in the code. The numerical results shall be compared with experimental observations. The expected results are an improved understanding of spatial and temporal distribution of suspended load concentrations, time evolution of scour processes, changes to the free surface profile and maximum scour/deposition contours.

Task type: Literature survey, numerical modelling, calculation.

Prerequisites:TBA4265 Marine Physical Environment.
Number of students: 1
Contact person at NTNU: Hans Bihs hans.bihs@ntnu.no

1.14 Large Wave Modeling of Norwegian Harbors with REEF3D::SFLOW
For harbors, diffraction effects are very important, prohibiting the use of phase-averaged spectral wave models. For large scale wave phase-resolved wave modelling, Boussinesq models are often used. Their drawback is a severe lack of robustness for real-world applications. A new and more robust class of phase-resolved large scale wave models are models that solve the shallow water equations and take dispersion into account through solving for the non-hydrostatic pressure.



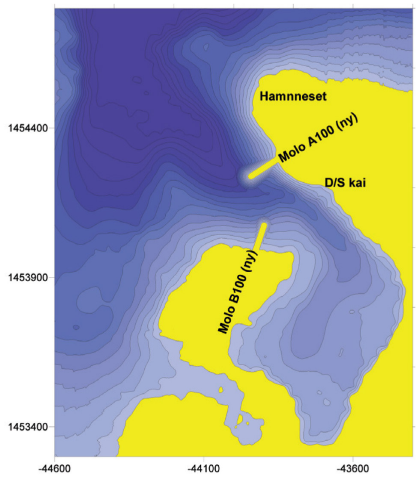
The study shall investigate waves and currents in the vicinity of the coast, especially outside and inside harbors. The open-source hydrodynamics model REEF3D (www.reef3d.com) will be used with the wave model module REEF3D::SFLOW. Emphasis shall be placed on analysis of wave propagation and resulting wave conditions for ships berthing in the harbor. The numerical results shall be compared with experimental and field observations.

Task type: Literature survey, numerical modelling, calculation.

Prerequisites: TBA4265 Marine Physical Environment.
Number of students: 1
Contact person at NTNU: Hans Bihs hans.bihs@ntnu.no

1.15 Wave propagation over rough topography

Numerical wave transformation models (e.g. Spectral and Boussinesq models) are implemented in software packages such as MIKE21, Delft3D/SWAN, etc. These software packages are developed mainly for gentle variable bottom topography. The question becomes how well they can predict wave transformation on a rugged coast like the Norwegian coast.



In the project work the student shall familiarize himself/herself with the use of MIKE21. In addition, the student shall develop routines to analyse wind and wave data provided by the Norwegian meteorological institute in order to establish the deep water sea state.

The project work is assumed to be continued in a thesis where the task is to use MIKE21 to transfer the deep water waves to a specific location on the Norwegian coast. The student will compare the results from the spectral wave models with those from the Boussinesq models and if possible with field data.

Type: Numerical modelling using commercial software
Prerequisites: TBA4265 Marine Physical Environment ,
Contact person at NTNU: Raed Lubbad, raed.lubbad@ntnu.no
Supervisor: Raed Lubbad.

1.16 Numerical modelling of sediment transport and coastline evolution

The coastal zone is an extensively used area for many activities and industries. Around half of the world's population live or work within one or two hundred kilometres of the coastline. Because of the high population density and the extensive development in these areas, it is very important to know the dynamics of the forcing and response of the coastal system involved and how to model them for an appropriate choice and design of measures.

There is a number of numerical models present that are available for predicting coastline evolution using different formulations. Some software packages such as Delft3D, TELEMAC etc. are available through open source whereas some packages such as MIKE21 are available commercially. The available models are also classified based on their temporal and spatial scale of application. Delft3D and MIKE21are applicable over a period of months to decades and can be applied to coastlines of kilometres whereas models such as XBeach are applied over a period of days to months and a cross a distance of several hundred meters only.

In the project work the student shall familiarize himself/herself with the use of MIKE21 or Delft3D. In addition, the student shall develop routines to analyse wind and wave data provided by the Norwegian meteorological institute in order to establish the deep water sea state

The project work is assumed to be continued in a thesis where the task is to use MIKE21or Delft3D to study the sediment transport and the coastline evolution at a specific location on the Norwegian coast. If possible, the student will compare the simulation results with field data.

Type: Numerical modelling using commercial software
Prerequisites: TBA4265 Marine Physical Environment ,
Contact person at NTNU: Raed Lubbad , raed.lubbad@nrnu.no

1.17 Tømmerkaier. (Timber quays.)

Tømmerkaier.

Det skal bygges en del tømmerkaier langs kysten I tiden som kommer.
Oppgaven vil bestå av:

- Kostnadsoptimalisering av tømmerkaier
- Logistikkplanlegging

Hvilken konstruktiv struktur behøves?
Hvordan kan man lage en kaifront med tilstrekkelig lengde til å lagre nok tømmer til å fylle et skip uten mellomlagring?
Prosjektoppgaven går ut på å dimensjonere en kai ut fra gitte kravspesifikasjoner og I følge gjeldende retningslinjer. Masteroppgaven vil omfatte kostnadsoptimalisering og logistikkplanlegging av kaier for forskjellige kravspesifikasjoner, miljøforhold (bølger, vind og strøm), egenlast og nyttelast. Anbefalinger vil bli et viktig tema. Oppgaven antas å være av spesiell interesse for Innovasjon Norge og for Kystverket.

Forutsetter: TBA4265 Arktisk og marin byggteknikk
Antall studenter: 1
Kontaktperson ved NTNU: Raed Lubbad (raed.lubbad@ntnu.no)
Ekstern veileder: Svein Ove Nyvoll, Nyvoll-consult.
Kommentar: Dersom aktuell vil Svein Ove også kontakte Nils Aakre i AT Skog, daglig leder for 3 terminalen som vil være en ressurs på denne oppgaven.

English version:

1.17 Timber quays.

It will be built some timber quays along the coasts in the coming years.
The task will mainly consist of:

- Cost Optimization
- Logistics Planning

What constructive structure will be optimal?
How can one make a quay with sufficient length to store enough timber to fill a ship without any intermediate storage?
The Project task is to design a quay from given requirement specifications and in according to current guidelines. The Master's thesis will include cost optimization and logistics planning of quays for different specifications, environmental conditions (waves, wind and currents), dead and live load.

Recommendations will be an important topic. The work is believed to be of particular interest for Innovation Norway and the Norwegian Coastal Administration.

Prerequisites: TBA4265 Arctic and marine civil engineering
Number of students: 1
Contact at NTNU: Raed Lubbad (raed.lubbad@ntnu.no)
External supervisor: Svein Ove Nyvoll, Nyvoll-Consult
Comment: If of interest, Svein Ove will also contact Nils Aakre in AT Skog, general manager of the 3 terminal who will be a resource on this assignment.

1.18 Kaikonstruksjon oppbygget i stål

Norskspråklig kandidat er ønsket. (The student should be fluent in Norwegian)

Kaikonstruksjoner ivaretar grensesnittet mellom skip og land og ligger i kystsonen. Dette er et av de hardest miljøbelastede stedene hvor konstruksjoner bygges med påfølgende skader og redusert levetid. Tradisjonelt bygges kaikonstruksjoner i betong og materialutvikling med forståelse av nedbrytningsmekanismer har i de senere årene forbedret seg kraftig med påfølgende øket levetid og forbedret konstruksjonskvalitet.

Bygge-kostnader har også øket kraftig i de senere årene og i den forbindelse er det naturlig å undersøke mulighet for bruk av alternative byggematerialer som stål og trevirke. En kombinasjon av trevirke og limtre benyttes i dag til bygging av mindre kaikonstruksjoner og strandpromenader. Kreosotimpregnering klasse marin viser seg å motstå pelemark og gi trevirket god beskyttelse, samt sikre konstruksjonens levetid. Trevirke som materiale er godt egnet til bygging av lettere kaikonstruksjoner for passasjertrafikk med mindre båter men begrensning i styrke reduserer muligheten for bruk i industrikaier og kaier hvor større skip anløper. Stål derimot er et materiale som kan være godt egnet for tyngre kaikonstruksjoner så fremt at bestandighet håndteres på en riktig måte og at materialforbruk optimaliseres. I dag benyttes stål til kystnære konstruksjonsdeler, men ikke til komplette kaikonstruksjoner.

Prosjektoppgaven består i å designe en mindre kaikonstruksjon bygget i stål etter gjeldende regelverk i Norge. Konstruksjonen designes med basis i Norsk Standard NS-EN 1990 til NS-EN1999 og det tas utgangspunkt i forskjellige prosjekterte levetider. Forskjellige byggemetoder som stedlig montering og modulbygging vurderes. Avvik i byggeperioden spesielt med posisjonering av peler er vanlig ved kaibygging og håndtering av avvik opp mot 0,50m i horisontal peleplassering inngår i oppgaven.

Stabilitet av kaikonstruksjonen med opptak av støtlaster fra skipsanløp og fortøyningslaster fra skipet inngår i prosjektoppgaven. Det skal utføres en global stabilitetsanalyse av hele konstruksjonen hvor horisontale laster følges helt inn i fundamenter.

Økonomi og byggetid er sentrale deler av oppgaven. Realistiske fremdriftsplaner med for de forskjellige byggekonseptene skal leveres som en del av rapporten. Videre skal økonomien i prosjektets undersøkes, både byggekostnader og levetidskostnader inkludert riving etter endt levetid. Prosjektkostnader angis i nåverdiberegninger med basis i gjennomsnittlige renter og prisstigning de seneste 5år gitt av SSB

Korrosjonshastigheter i Eurocode og NA (NS-EN1993-5:2007+NA:2010) angir store forskjeller i korrosjonshastigheter. Oppgaven skal også inneholde en sammenligning av levetidsforskjell og prosjektkostnader for begge korrosjonshastighetene. Arbeidet er en videreføring av en prosjektoppgave fra høsten 2012.

Aktuelle problemstillinger for en ny oppgave kan være.:

1. Konstruere et dekke som kan bære trafikklasten Det lages ikke store nok rister per i dag hos de leverandørene som ble sjekket. Det er derfor behov for å beregne og konstruere et dekke som er passende til dette formålet.

2. Design av knutepunkter Bæresystemet må settes sammen på en funksjonsmessig bra måte. Det er et helt symmetrisk bæresystem, derfor er det ikke nødvendig å designe alle knutepunktene for seg selv, men enkelte utvalgte avhengig av lastkombinasjonene.

3. Festeanordning for fendere. Hvordan man skal feste fenderene til kaifronten er en utfordring det må sees på, også i sammenheng med at man vurderer fendere som passer kaien godt.

4. Kaiens skjørt. Da dette er en stålkai må skjørtet konstrueres på en måte som ikke er gjort før, da vi ikke kan støpe ned et skjørt i betong. Her vil det være mulig å være kreativ og prøve seg frem med litt forskjellige løsninger.

Antall studenter: 1

Kontaktperson ved NTNU: Øivind Arntsen (oivind.arntsen@ntnu.no)
Ekstern veileder: Svein Ove Nyvoll, Nyvoll-Consult.

2 Arctic Technology (ice mechanics and ice actions on marine structures/vessels)

When designing coastal and marine structures (including vessels) the actions from floating ice covers often gives the most important environmental actions. There are mostly three scenarios that can be critical: icebergs, ice ridges and level ice. The suggestions below are offered within the SAMCoT project (http://www.ntnu.edu/samcot).

2.1 Level ice action, ice-induced vibrations and uncertainties.

It is possible to choose a topic with joint supervision from Veritas (DNV) or Reinertsen. Contact person at NTNU: Knut V. Høyland, knut.hoyland@ntnu.no or Sveinung Løset, Sveinung.loset@ntnu.no .

- Ice induced vibrations – a tool for prediction of cyclic loading due to ice crushing (with Morten Bjerkås from Reinertsen)
- Variability and uncertainty related to measured ice properties
- Analyse data about dynamic ice –structure interaction from laboratory tests (DNV/NTNU)
- Numerical model for ice-induced vibrations (DNV/NTNU)
- Velocity effects of high pressure zones in ice-structure interaction. (with Ole Øiseth K-Tek)
- Ice induced vibrations of offshore structures – development of experimental set-up (with Ole Øiseth K-Tek)
- Ice mechanical experiments in NTNU ice-lab, e.g. beam experiments or cyclic testing.

2.2 Ice ridges and ice ridge actions

Contact person at NTNU: Knut V. Høyland, knut.hoyland@ntnu.no.

- Ice ridge action on offshore structures - ice ridges as extreme ice features
- Ice ridge action on offshore structures – material modeling FEM (SAMCoT)
- Ice ridge action on offshore structures – experiments in NTNU ice-lab (SAMCoT)
- Ice ridge action on offshore structures – analysis of ice ridge geometry (how deep and how wide is the consolidated layer)
- Ice ridge action on offshore structures - How to produce sale-model ice ridges

2.3 Icebergs

It is possible to choose a topic with joint supervision from Veritas (DNV). Contact person at NTNU: Sveinung Løset, Sveinung.loset@ntnu.no .

- Drift of icebergs in the Barents Sea

2.4 Icing

It is possible to choose a topic with joint supervision from Veritas (DNV). Contact person at NTNU: Sveinung Løset, Sveinung.loset@ntnu.no.

- Marine icing

2.5 Development of laboratory or full-scale procedures and instrumentation.

Contact person at NTNU: Knut V. Høyland, knut.hoyland@ntnu.no or Sveinung Løset, Sveinung.loset@ntnu.no.

- Instrumentation of ice growth tank and characterization of ice
- Develop a practical and accurate method to determine the density of sea ice
- Study the reliability and accuracy of ice pressure sensors (tactile pressure sensors)

2.6 Ice thickness and level ice properties

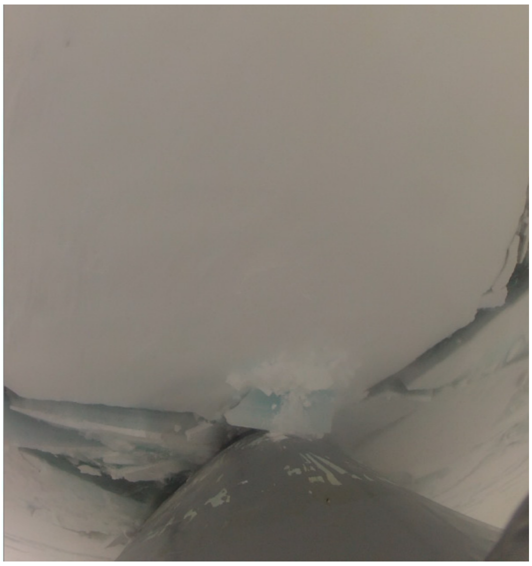
Contact person at NTNU: Knut V. Høyland, knut.hoyland@ntnu.no

- Level ice thickness in the Van Mijen fjord in Svalbard, analysis of existing data and / or perform new measurements on Svalbard / UNIS
- Ice texture and the brine and gas volume in first-year sea ice – seasonal development, measurements on Svalbard / UNIS

In most of these task it is possible to have a part-time stay at UNIS on Svalbard. Please get in touch with Sveinung Løset / Knut V. Høyland if you are interested in this.

2.7 Ship-ice interaction: Analysis of full-scale data

A better understanding of the interaction processes between ship and ice allow us to improve our models for ships operating in ice infested-waters, e.g. transporting, station keeping, performing ice management, etc.



Full-scale data from several surveys with the icebreaker KV-Svalbard will be available for this study. In additions to the ship measurements (movements, propulsion, etc.), video data from several cameras mounted on the ship are available. The video records capture the ice conditions in front of the ship and also the interaction processes between the incoming ice and the ship bow.

The student should analyse the video data and try to evaluate the icebreaking patterns, movement of the ice floes interacting with the ship, correlation between the ice conditions and ice resistance to the ship motion, etc.

During this project the student will acquire knowledge on the underlying processes of ship-ice interaction. The student shall familiarize himelf/herself with data analysis techniques and especially the image analysis.

Recommended subject: TBA4265 Marine Physical Environment; AT327 Arctic Offshore Engineering
Key words: Arctic offshore
Type of project: Data analysis (Image analysis)
Number of students: 1 to 2
Cooperation with: SAMCoT
Contact person at NTNU: Raed Lubbad, raed.lubbad@ntnu.no
Continuation of project: Can be extended into a Master Thesis

2.8 Transport of ice along a structure

Numerical simulations of a floater (ship or buoy) in ice involve modelling a wide range of physical processes related to the dynamical coupled floater-ice-fluid interaction, such as impacts, friction, buoyancy, hydrodynamics, fracture and fragmentation of ice. The task should focus on how fluid flow models, e.g. FLUENT, can be used to model the transport of broken ice pieces along the hull of a floater. The numerical results should be compared with model-ice test results from the Hamburg Ice Basin, Germany. This gives the student an excellent opportunity to validate his simulations. The student will be offered a summer job in 2012 to work on the data as well as a visit to the Hamburg Ice Basin.

Recommended subject: TBA4265 Marine Physical Environment; AT327 Arctic Offshore Engineering
Key words: Arctic offshore
Type of project: Numerical calculations
Number of students: 1 to 2
Cooperation with: SAMCoT
Contact person at NTNU: Sveinung Løset/Raed Lubbad
Continuation of project: Can be extended into a Master Thesis

2.9 Analysis of Model Ice Basin Tests of a ship in broken ice

A number of laboratory tests are performed with two vessels in broken ice in the Hamburg Ice Basin, Germany. The data from the tests will be made available for the student and he shall perform analysis of how the ice concentration, drift speed and floe size affect the load on the vessel. As an option the student may also study the effect of the characteristics (hull shape) of the two vessels on the loads. The student will be offered a summer job in 2012 to work on the data as well as a visit to the Hamburg Ice Basin.

Recommended subject: TBA4265 Marine Physical Environment; AT327 Arctic Offshore Engineering
Key words: Arctic offshore
Type of project: Numerical calculations
Number of students: 1 to 2
Cooperation with: Dynamic Positioning in Ice
Contact person at NTNU: Sveinung Løset
Continuation of project: Can be extended into a Master Thesis

3 Offshore Wind Turbines

3.1 Which loadcases contribute what to the fatigue damage of an offshore wind turbine?

A special feature of wind turbines is that a very large number of loadcases are required to estimate the fatigue damage during their 20 years of operation. Large tables of such loadcases exist, typically based on environmental conditions (seastate and wind speed), directionality and the operational conditions (normal operation, idling, parked, electrical failures, emergency stop). The goal of this project is to use numerical wind turbine simulations in order to understand how much these different loadcases contribute to the total fatigue damage. To be able to do this, the main task is to develop and verify a simulation event generator for FEDEM WindPower, that allows for setting up various operational states and fault cases for wind turbines as specified in the IEC 61400-3 standard, using FEDEMs application programming interface. The results can be presented at the DeepWind 2017 conference in Trondheim.

The project work is assumed to be continued in a thesis (e.g. "Efficient design of offshore wind turbine support structures").

Prerequisites:	Knowledge of programming (C# or Visual Basic) and structural analysis
Task type:	Simulation study, Programming
Number of students:	1-2
Contact person at NTNU:	Michael Muskulus, michael.muskulus@ntnu.no

3.2 Wind turbine jacket support structure with local joint flexibilities

In the standard hot spot stress approach to fatigue damage in offshore wind turbines, beam elements are used to model the structure and obtain the sectional stresses. The welded joints are thereby assumed to be rigid connections between elements. In reality, however, local joint flexibilities exist and play an important role in determining the fatigue damage. The goal of this project is to implement local joint flexibilities using springs for a jacket structure, to determine the fatigue damage for this structure with an offshore wind turbine on top, and to compare it to the structural model with rigid joints only. The results can be presented at the DeepWind 2017 conference in Trondheim.

The project work is assumed to be continued in a thesis ("Factors influencing fatigue damage estimates in offshore wind turbines").

Prerequisites:	Knowledge of structural analysis
Task type:	Modeling, Simulation study
Number of students:	1-2
Contact person at NTNU:	Michael Muskulus, michael.muskulus@ntnu.no

3.3 Stress concentration factors for untypical joints in offshore wind turbine jackets

Support structures for offshore wind turbines such as jackets consist of many members that are welded together. Due to the excitations from the rotor and the waves, the structure is constantly vibrating, and fatigue is an important issue. It is typically evaluated using a beam FE model and the hot-spot-stress approach. Stresses are calculated from the displacements of the nodes for each joint, and are multiplied by stress concentration factors (SCFs). The factors that are used (e.g. in the relevant DNV rules for wind turbines) are only valid for certain members dimensions (e.g. certain diameter / thickness ratios). The goal of this project is to use detailed FE simulations of joints (with shell elements) to find SCFs also for cases that are currently not covered by the rules, but which might be relevant and interesting for offshore wind turbine support structures. The results can be presented at the DeepWind 2017 conference in Trondheim.

The project work is assumed to be continued in a thesis ("Factors influencing fatigue damage estimates in offshore wind turbines").

Prerequisites:	Knowledge of structural analysis and the FE method
Task type:	Simulation study
Number of students:	1-2
Contact person at NTNU:	Michael Muskulus, michael.muskulus@ntnu.no

3.4 Markov approach to fatigue from rotor loads

Aerodynamic loads are a major cause of fatigue damage in wind turbines. The damage is normally evaluated by rainflow counting of stress time series. The rainflow count can be calculated from the statistical distribution of the minima and maxima of the stress time series, i.e., how probable it is to see a maximum of a certain size after a minimum of a certain size, etc. Discretizing the stress ranges and assuming that these distributions only depend on a very small number of previous extrema, one can calculate a Markov matrix from the time series that contains the complete information about the fatigue damage. This approach has been proposed by Frendahl & Rychlik. The aim of this project is to implement the method and test it with rotor loads and the resulting tower bottom moment time series, to understand if the assumptions of the Markov method can be made in this case, and how large the error is compared to the standard rainflow count in the time domain. The results can be presented at the DeepWind 2017 conference in Trondheim.

The project work is assumed to be continued in a thesis ("Markov approach to fatigue in offshore wind turbines").

Prerequisites:	Knowledge of programming (e.g. Matlab or Python)
Task type:	Programming
Number of students:	1-2
Contact person at NTNU:	Michael Muskulus, michael.muskulus@ntnu.no

3.5 Ultra-fast load simulations for offshore wind turbines

The blade element momentum theory (BEMT) is the standard engineering approach to calculate aerodynamic loads for wind turbines. The calculation is relatively straightforward, but as it is described by a self-consistent system of equations (two nonlinear equations for two variables that need to be determined) normally it is solved by iteration, which is time-consuming. The goal of this project is to try to speed up this calculation as much as possible, e.g. by implementing this method in parallel for a GPU co-processor card, or by implementing and testing various other ways of optimizing the speed of the calculations. The results can be presented at the DeepWind 2017 conference in Trondheim.

The project work is assumed to be continued in a thesis (e.g. "Parallel implementation of impulse-based substructuring techniques for offshore wind turbines") in cooperation with industry (Keppel Verolme, The Netherlands).

Prerequisites:	Experience with computer programming (e.g. Matlab)
Task type:	Programming
Number of students:	1-2
Contact person at NTNU:	Michael Muskulus, michael.muskulus@ntnu.no

3.6 Wind turbine builder – a game about wind turbine design

The design of wind turbines is not easy, since turbines are complex machinery and quite expensive. Many people have no idea what is involved, how wind turbines work (e.g. that electricity is produced with almost no thermal losses) and how they are designed. The goal of this project is to develop a concept for (the mechanics of) a pedagogical computer game that teaches users about the design of wind turbines in an enjoyable way, e.g. similar to the famous "bridge building" games that teach people some of the basics of structural design. The game should be based on a realistic physics simulation and the project will involve making sensible simplifications and thinking about strategies for (automatically) optimizing the simulation.

The project work is assumed to be continued in a thesis during which the game can be implemented and improved.

Prerequisites:	Knowledge of structural analysis and programming would be useful
Task type:	Modeling
Number of students:	1-2
Contact person at NTNU:	Michael Muskulus, michael.muskulus@ntnu.no

3.7 Design of a wind-turbine controller for an offshore wind turbine

A wind turbine controller tries to optimize power production. For smaller wind speeds it controls the power-take off in order to speed the rotor up or down. For each wind speed a different optimal rotor speed exists that maximizes power production, whereas for higher wind speeds the controller has to limit the power production. The goal of this project is to develop a simple, parametric controller (e.g. PID controller) that can be used with structural optimization studies (which so far only optimize the structure, but which ideally should also include the controller). The results can be presented at the DeepWind 2017 conference in Trondheim.

The project work is assumed to be continued in a thesis ("Wind turbine design optimization with a controller").

Prerequisites:	Some knowledge of control theory and programming
Task type:	Modeling, Simulation study
Number of students:	1-2
Contact person at NTNU:	Michael Muskulus, michael.muskulus@ntnu.no

3.8 Implementing a multi-rotor floater in Simis ASHES

There is currently some interest in multi-rotor solutions where more than one wind turbine is mounted on the same floating structure. Up to now it has not been possible to evaluate the vibrations in such a structure. However, this is now possible with the latest ASHES software by Simis AS. The goal of this project is to implement a multi-rotor floater and to compare vibrations and fatigue damage against a single-rotor floater, in close cooperation with the company Simis AS. The results can be presented at the DeepWind 2017 conference in Trondheim.

The project work is assumed to be continued in a thesis ("Structural aspects of multi-rotor floating wind turbines").

Prerequisites:	Structural analysis
Task type:	Modeling, Simulation study
Number of students:	1-2
Contact person at NTNU:	Michael Muskulus, michael.muskulus@ntnu.no

3.9 Conditional Langevin approach to fatigue

The Langevin approach assumes that the response of a system can be described as the sum of a deterministic response plus stochastic disturbances that can be modeled by uncorrelated white noise. The deterministic response depends on the state of the system, as well as on possible external loads, typically in a complex way. This method is very powerful and allows to analyze and understand nonlinear, stochastic systems, but at the same relatively easy to implement (e.g. in Matlab). Here we will apply it to fatigue estimation in an offshore wind turbine. Based on numerical wind turbine simulations, first the Langevin coefficients will be determined, conditional on the wind speed and the tower top motion. Then a second simulation with different wind speeds will be used to simulate the response directly from the one-dimensional Langevin equation. The fatigue damage will be estimated through rainflow counting. Will it be similar to what we get when doing a simulation of the complete wind turbine? The results can be presented at the DeepWind 2017 conference in Trondheim or at the ISOPE 2017 conference in San Francisco.

The project work is assumed to be continued in a thesis ("Conditional Langevin approach to fatigue damage and response dynamics of offshore wind turbines").

Prerequisites:	Knowledge of programming; Knowledge of stochastic processes helpful
Task type:	Programming, Simulation study
Number of students:	1-2
Contact person at NTNU:	Michael Muskulus, michael.muskulus@ntnu.no

3.10 Stationary solutions in the probability density evolution method

The probability density evolution method (PDEM) is an alternative to time-domain or frequency-domain calculations. The state of the system is described by a number of variables. The joint probability density function of these variables develops in time, e.g. under the influence of a stationary load process. This probability density evolution is described by a simple partial differential equation that can be simulated and which thereby allows to obtain accurate solutions for the response of the system in question. If the load process is stationary, one expects the response process to be stationary, too, in general. The goal of this project is to implement a simple example of the PDEM for a one-dimensional mechanical system. The results can be presented at the DeepWind 2017 conference in Trondheim or at the ISOPE 2017 conference in San Francisco.

The project work is assumed to be continued in a thesis ("Stationary solutions in the probability density evolution method").

Prerequisites:	Knowledge of partial differential equations and probability theory
Task type:	Programming
Number of students:	1-2
Contact person at NTNU:	Michael Muskulus, michael.muskulus@ntnu.no

3.11 Integration of Fedem Windpower in FUSED-Wind

The Framework for Unified Systems Engineering and Design of Wind Plants (FUSED-Wind, see: http://fusedwind.org/) is a free open-source framework for multi-disciplinary optimisation and analysis (MDAO) of wind energy systems, developed jointly by the Wind Energy Department at the Technical University of Denmark (DTU Wind Energy) and the National Renewable Energy Laboratory (NREL). The framework is built as an extension to the NASA developed OpenMDAO, and defines key interfaces, methods and I/O variables necessary for wiring together different simulation codes in order to achieve a system level analysis capability of wind turbine plants with multiple levels of fidelity. The goal of this project is to integrate the Fedem Windpower wind turbine analysis software and some of our support structure models into this framework. The work can be done together with the company FEDEM AS, and results can be presented at the DeepWind 2017 conference in Trondheim.

The project work is assumed to be continued in a thesis ("Systems engineering analysis and optimization of offshore wind turbines").

Prerequisites:	Knowledge of programming (Python)
Task type:	Programming
Number of students:	1-2
Contact person at NTNU:	Michael Muskulus, michael.muskulus@ntnu.no

3.12 Code checks for FEDEM simulation software

In offshore steel structures such as jackets for offshore wind turbines, tubular joint connections are driving fatigue design of the structures, and fatigue calculations of these joints requires compliance with the relevant standards such as DNV-RP-C203.
The goal of the project is to implement and verify code checks for joint fatigue as a post-processing tool in the FEDEM simulation software, using the application programming interface. The work can be done together with the company FEDEM AS, and results can be presented at the DeepWind 2017 conference in Trondheim.

The project work is assumed to be continued in a thesis (e.g. "Reliability analysis of offshore wind turbine support structures").

Prerequisites:	Knowledge of programming (C# or Visual Basic) and structural analysis
Task type:	Programming, Stimulation study
Number of students:	1-2
Contact person at NTNU:	Michael Muskulus, michael.muskulus@ntnu.no

3.13 Hydrodynamic loads on big floating structures

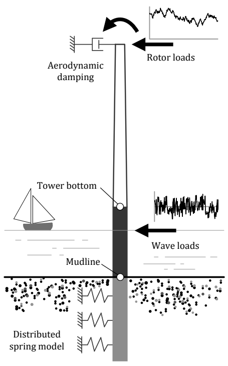
The goal of the project is to get familiar with the methods for calculation of hydrodynamic loads on big floating structures, based on the theory of diffraction implemented in the open source software Nemoh (http://lheea.ec-nantes.fr/doku.php/emo/nemoh/start), and to perform tests on relevant examples.
Nemoh is a Boundary Element Method (BEM) code developed over 30 years at Ecole Centrale de Nantes, and can calculate wave forces on offshore structures (added mass, radiation damping, and diffraction forces). Nemoh solves in the frequency-domain, so an important part of the assignment is to propose and test procedures for converting the results to time series for a given wave spectrum, in order to use them as load functions in a time-domain simulation of a floating structure.

The project work is assumed to be continued in a thesis (e.g. “Hydrodynamic loads on big floating structures”).

Prerequisites:	Knowledge of hydrodynamics, some programming
Task type:	Stimulation study
Number of students:	1-2
Contact person at NTNU:	Michael Muskulus, michael.muskulus@ntnu.no

3.14 Does fatigue crack growth retardation enable lifetime extension of offshore wind monopiles?

Offshore wind energy has developed rapidly in the past two decades - from small near shore wind farms in less than 10m water depth up to large turbines (>5 MW) in deeper water today. Monopiles are common support structures for offshore wind turbines installed in shallow to moderate water depth (<30 m). These support structures are exposed to complex environmental and operational loading from wind, waves, and the turbine rotor. Fatigue degradation is an important aspect for the service life of welded section on offshore wind support structures. Accurate lifetime predictions are in order to optimize operation and maintenance and to decide about lifetime extension of aging wind farms. Lifetime extension describes the continued operation of the asset beyond the end of their design lifetime (typically 20 years) and is an appealing option to increase the return on investment of the wind farm owner.



One important aspect, which is currently negelected in the offshore wind industry, is the effect of the load sequence on fatigue crack growth. Several experiments with materials exposed to variable amplitude loading have shown that large amplitude loads lead to a retardation of the crack growth rate. From these experiments, correction factors were derived for the commonly applied Paris law for crack propagation.

The goal of this project is to implement a fatigue crack growth retardation model for an offshore wind monopile using the programming environment Matlab. Existing stress simulations of a 5MW offshore wind turbine can be used as input to the crack growth analysis. The numerical analysis should answer the question if fatigue crack growth retardation leads to a longer fatigue lifetime of offshore wind monopiles. The work can be done in cooperation with industry partner RAMBOLL, and results can be presented at the DeepWind 2017 conference in Trondheim

The project work is assumed to be continued in a master thesis.

Prerequisites:	Fatigue analysis, Matlab
Task type:	Numerical analysis
Number of students:	1-2
Contact person at NTNU:	Michael Muskulus, michael.muskulus@ntnu.no

3.15 Simulating maintenance of an offshore wind farm under uncertainty

The goal of this project is to develop a simple simulation model for the maintenance of an offshore wind farm. This model should have the structure of a game simulating the challenges of the operational phase of an offshore wind farm. Multiple turbines shall be included in the wind farm. The power production will be calculated based on a simple power curve and occurrence of failures is based on annual failure rates. Both weather and repair times are subject to uncertainties. Repair costs depend on the number of failures, repair time and weather. Different maintenance strategies, including different vessel types and fleet sizes, can be studied and compared with the model and subsequently used in the game. The results can be presented at the DeepWind 2017 conference in Trondheim.

The project work is assumed to be continued in a thesis (e.g. "A simulation game for offshore wind farm maintenance").

Prerequisites:	Interest in the challenges of offshore wind energy, Basic programming knowledge (e.g. Python, R, or Matlab)
Task type:	Literature Research, Programming
Number of students:	1-2
Contact person at NTNU:	Michael Muskulus, michael.muskulus@ntnu.no

3.16 Slamming load considerations for the design practice of offshore wind turbines

Offshore wind turbines located at certain locations are exposed to plunging breaking waves, which leads to slamming loads featuring a high impact force during a short time. These loads cause special effects relevant for the dynamics of the wind turbines, and they are mentioned in various standards and guidelines for offshore wind turbine design. However, they are not described as any load cases in the documents and it is unclear how to implement these loads for the design of an offshore wind turbine and its foundation. It is important to know exactly how the breaking waves/slamming loads can be included in the design practice in an efficient and suitable way.

During this project, the student shall analyze the influence of slamming loads on the dynamics of a typical offshore wind turbine, and investigate how the slamming loads should be implemented in the design practice of offshore wind turbines. The basis for the study will be the use of a commercial wind turbine simulation software. The results can be presented at the DeepWind 2017 conference in Trondheim.

The project work can be continued in a thesis.

Prerequisites:	Structural analysis, statistics, hydrodynamics
Task type:	Literature study, Parameter study, Simulation
Number of students:	1
Contact person at NTNU:	Michael Muskulus, michael.muskulus@ntnu.no

3.17 Fatigue-equivalent lumping of loadcases

Offshore wind turbines are subject to fatigue damage. This needs to be assessed for the planned 20 years of operational lifetime. During this time many different wind speeds and sea states happen. It has become standard practice to simplify the fatigue assessment by using only one "fatigue-equivalent" loadcase for each wind speed. However, the lumping process is not well defined, as the damage at different locations in the structure will change differently with the seastate. The aim of this project is to learn more about fatigue damage calculations of offshore structures, and to evaluate the damage and the uncertainties in the fatigue assessment that occur when using such lumped loadcases. The results can be presented at the DeepWind 2017 conference in Trondheim.

The project work can be continued in a thesis (e.g., using parametric copulas to model the dependency between seastate and fatigue damage, or to better characterize also the extreme loads).

The project work can be continued in a thesis.

Prerequisites:	Structural analysis, statistics, hydrodynamics
Task type:	Literature study, Parameter study, Simulation
Number of students:	1
Contact person at NTNU:	Michael Muskulus, michael.muskulus@ntnu.no