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Publication date
2017

Document Version
Accepted author manuscript

Published in
Proceedings of the 11th Coasts, Marine Structures and Breakwaters 2017 conference

An advanced design project on 'Port Engineering and Maritime Works' in teaching future engineers

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Abstract

This paper describes a unique design project devised to teach and apply technical skills in port design, but also in the practical cooperation between students in a realistic design project. The 4-week long project now involves students of up to 19 nationalities from 7-10 universities, and has been based each year on real design projects. Student teams of 8-10 per team have to deliver a realistic design to examiners from both academia and industry. The students select from a number of optional modules. No student can take all of them, so appreciation of the skills available within the team are important.

Introduction

Industry has a strong demand for staff, not only well trained in the fundamental science behind coastal and port engineering (like wave-mechanics), but also able to integrate this basic knowledge to design of a real port, including also constructability of the design. This demand has led to development of this advanced design project, conducted in close cooperation with industry. The project objectives are:

- Define and organize a port engineering or maritime works design project
- Identify design parameters and gather and analyze relevant informations
- Elaborate and evaluate conceptual designs using dedicated simulation softwares
- Present and justify choices of concept and design solutions
- Experimental experience in research lab
- Use of state-of-the-art softwares

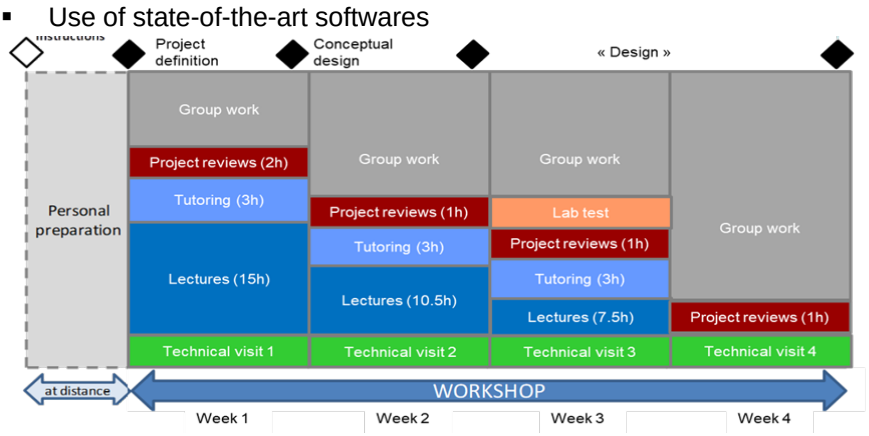

Figure 1 General Outline of the Workshop

The educational format selected is a combination of classic classroom teaching and a large group assignment. This industry-relevant training is dedicated to students that have completed most of their three – four years of higher education in Civil Engineering or a related field. The 4-week course held at ESITC in Caen (France) has run since June 2013. The target is to manage 4 teams of (say) 10 students, from different countries (initially Europe), with different skills and knowledges from their home university (Aalborg, Barcelona, Delft, Edinburgh, Genoa, Grenada, Plymouth, Sofia, La Republica de Uruguay, Trondheim……). Each student team works as virtual EPCI contractor (Engineering Construction Procurement Installation) with a team leader and have to deliver a completed conceptual design and accompanying technical justifications. All within 4 weeks. The working language is English.

Workshop PEMW	June 2013	June 2014	June 2015	June 2016	June 2017
TENDERS	Port of SAFI	Port of KRIBI	Port of NADOR	Port of THEMA	Port of NADOR
Number of students	11	30	30	24	40
Number of nationality	**6**	9	9	11	17
	Austrian British Bulgarian Dutch French Spanish	American British Bulgarian Chilean Chinese Dutch French Greek Spanish	Australian Belgium British Chinese Dutch French Irish Nigerian Spanish	British Chinese Dutch French Gabonese Greek Indonesian Irish Ivorian Panamanian Spanish	American British Bulgarian Chinese Danish Dutch French German Greek Italian Latvian Liberian Lithuanian Mauritian Polish Spanish Uruguayan

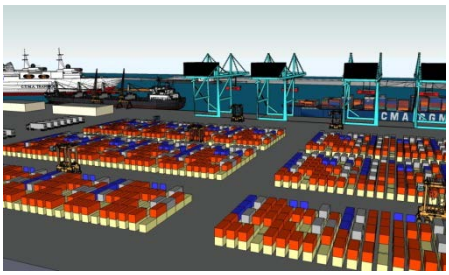

Figure 2 Chronology of the project (2013-2017)

Student experience

A real tender is adapted to the study case and the base requirements are given to all project teams who prepare an outline design on it and discuss with a "virtual client". But each team is given a set of slightly different requirements, so from that viewpoint each team's work is different.

During the project, 3 project reviews with the "virtual client" make conditions as close as possible to the experience of a coastal engineer within consulting companies. These review discussions with a client, are intended to refine technical solutions in accordance with rules for ‘Design & Construction’, a process between the client and the designer recorded via an excel sheet of ‘Q&A’ (Questions & Answers). Tutoring time allows the students to discuss with lecturers and professional in order to keep on improving their Design.

The students select from a number of optional modules, and no student can take all of them, so the team leader needs an appreciation of the skills available within the team. This matches the student’s expectations and allows for their different backgrounds because they come from different universities with different specialities (from Coastal Engineering to Port Engineering, or from Marine Civil Engineering to Hydraulic Engineering). More than half of the lectures are allocated in this way.

The main topics: (not always available)

- Wind and wave analysis (propagation and agitation)
- Determination of the design storm
- Use of artificial concrete armour units
- Port Planning / Terminal Typology / Site Selection
- Coastal structures
- Technics of dredging
- Ship Mooring Analysis (first editions)
- Mooring Dolphin Design
- Earth retaining structure Design
- Pile driving (first editions)
- Sediment transport
- Soil reinforcement technics and engineering
- Design of engineering structures
- Geotechnical analysis
- Use of wave flume

So students can make their own personal training programme adapted to their desire, in accordance with the needs of the project. For instance they have choice between : 'Wave Propagation ' or 'Wave Agitation' ; 'Sediment Transport' or 'Soil Reinforcement ', 'Stability of Marine Slope' or 'Mooring Dolphin Design' etc…This has also the advantage to keep student groups and higher quality of learning with easier exchange between lecturers and students. The whole training programme is awarded with 8 ECTS credit points.

To start this process, before the project, the students prepare a summary of their skills under 'Personal preparation' (Fig. 1), which is concluded before their arrival at ESITC CAEN by a video conference with the program manager of the Workshop. The discussion focusses on the reasons why the student applied, her/his main skills and obviously which skills they want to strengthen. Most of their main motivation is to carry out a practical case study and also to share experience with other international students. In these discussions, students have also the opportunity to choose their role within the group between project manager or design engineer.

The lectures are presented by a range of academic and industry teachers

Beyond the class room teaching, the project makes available a number of software tools common in consulting companies:

TOMAWAC – simulating wave conditions
ARTEMIS – detailed wave transformations
PLAXIS – ground and mound stability
KREA / TALREN – structural and global stability for retaining walls
ROBOT – structural design
SAP2000 – structural design

The designs

Previous sites have included ports of Safi, Kribi, Nador and Thema, These sites (modified a little to protect commercial sensitivities) have covered a wide range of wave exposures, coastal situations, and client requirements, so the relative importance of (say) coastal sedimentation, or ship down-time is different each year, just like real design projects!

In reality, new international projects show increasing complexity, so simplifications must be made. The students also need to learn to 'work with unknown colleagues', a frequent requirement of putting new project teams together. They must distill the key 'design parameters' from the client brief; and then they must 'gather, sift and analyse relevant information from a potentially huge volume of data'; 'Elaborate and evaluate conceptual designs using dedicated simulation software'; 'Present and justify

choices of concept and design solutions'; 'Define and organize a port engineering or maritime works design project using state of the Art within a limited time windows'.
But no design can be judged without the price, so typical cost rates are given for the student's calculation of tender prices for breakwater, quays, trestle, jetty head and dredging.

Technical visits

It is not all office work! The students make 4 visits to different sites:

- Walking tour of Caen – aimed at building the teams, as well as finding the best restaurants ! Oh and seeing the sights!
- Cherbourg harbour – visiting the 'enclosed' port, discussion on the varying uses and users of a commercial port, especially new marine renewable users. Those users have required construction of new heavy-duty quay walls.
- Honfleur – very pretty little harbour, fishing boats and great restaurants, but the largest import port for cat litter. technical discussion on rehabilitation of an historical quay wall in a high tidal range.
- Le Havre – huge multi-purpose port, major liquid import export terminals, recently expanded as Port 2000 for post-Panamax container ships.

Examination of the designs

So the student teams have submitted their designs, with their costings. What happens next apart from the celebrations?
First their report. Then presentations to the "client", and others, and their competitor teams. Every student has to present, no hiding behind the team leader!
The final stage requires that each team presents a summary of the key strengths of their design to an industrial audience, the project sponsors, local and national government representatives (perhaps future employers).

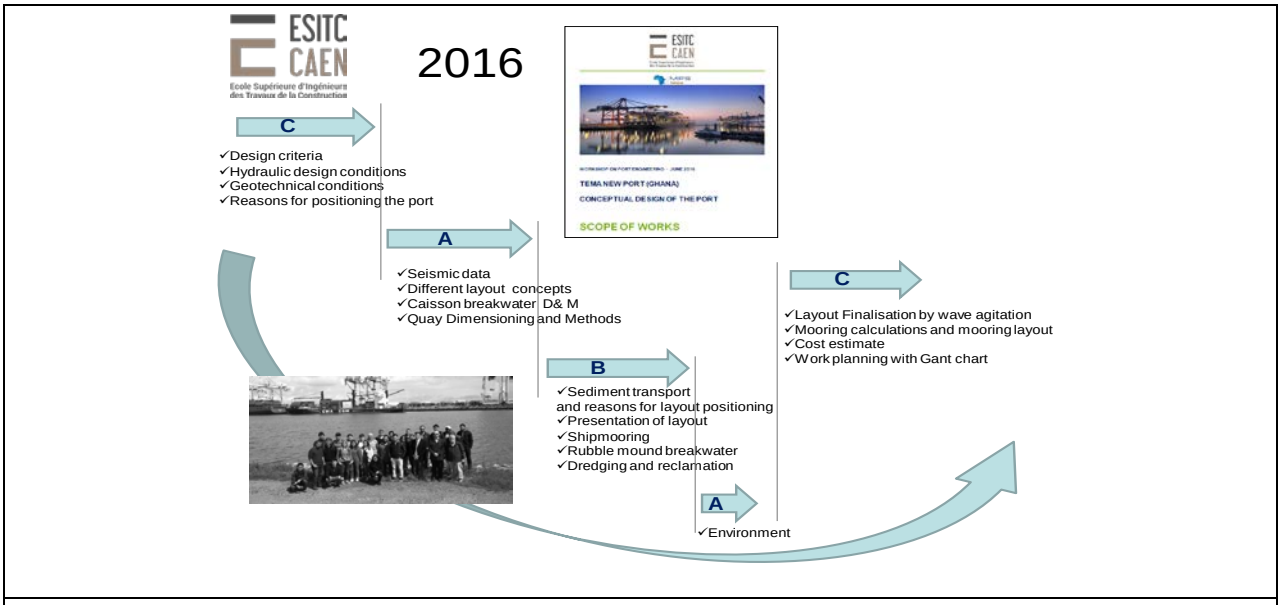

Figure 3 Example summary slide for project conclusion

Platinum partners : SYNTEC INGENIERIE ; ARTELIA ; BALINEAU ; DEME SDI ; VINCI MARITIME ET FLUVIAL; REGION NORMANDIE
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