"EMSHIP"
Erasmus Mundus Master Course
in "Integrated Advanced Ship Design"

Ref. 159652-1-2009-1-BE-ERA MUNDUS-EMMC

ABSTRACTS OF MASTER THESIS

8th Cohort - 2017-2019

Master Thesis presented in February 2019

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Feb 2019 – 8th Cohort

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Control of welding deformation in thin plate

ALI Muhammad Taha

Master Thesis

ABSTRACT

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8th Cohort – 2017-2019

Supervisor : *Associate Professor Renardo–Florin Teodor, "Dunarea de Jos" University of Galati*

December 2018

ABSTRACT

Control of welding deformation in thin plate

By **ALI Muhammad Taha**

Welding is the production process to join metals. Shipbuilding industry trying to improve the welding process from last seven decades but welding in thin plate brings more nonlinear problems. Welding deformation in the thin plate is one of the critical issues in the shipbuilding especially in ferry boats and yachts for good outlook.

Welding deformation decreases the productivity and increases the production cost for treating the welding distortion. That is why shipyards more concern in this issue because they want to deliver the ship to the client on time with minimum cost. For this reason, this thesis is focused on the different welding techniques, clamping and additional heating to control welding distortion.

In shipbuilding two types of analysis are commonly used, experimental and computational analysis. Both the methods of analysis for 5mm to 8mm plates of steel and aluminium materials are used.

For experimental analysis, MAG and MIG welding process is used while compiling with IACS rules and DAMEN standards.

For computational analysis, 3D model in FEM is developed to validate the analysis by temperature and residual stress measurements. Computational results and experimental measurements are validated. These measurements and modification are used to optimize the methodology to curtail the welding deformation.

Keywords
Welding deformation, Welding distortion, Analysis, FEM.

Velocity Prediction Program Development for Hydrofoil-Assisted Sailing Monohulls

BORBA LABI Gaetan

Master thesis

ABSTRACT

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8th Cohort – 2017-2019

Supervisor: Prof. Nikolai Kornev, University of Rostock

Rostock, November 2018

Velocity Prediction Program Development for Hydrofoil-Assisted Sailing Monohulls

BORBA LABI Gaetan

ABSTRACT

In the last decade the popularity of hydrofoil-assisted monohulled yachts has increased, especially for high performance racing crafts, as the ones used in the Vendée Globe. In the academic environment some research has been done to follow the industry evolution to better understand the behaviour of such vessels, yielding to the need of developing a tool able to predict the performance of such boats. For this reason, the present document aims to propose a simplified model that forecasts the velocity of hydrofoil-assisted monohulled sailing yachts through the development of velocity prediction program (VPP).

Due to the complexity of describing the behaviour of a complete sailing yacht, the developed tool uses empirical and analytical equations only, being a useful solution for a preliminary design stage. The aerodynamic model is based in the Offshore Racing Congress (ORC) documentation, the hydrodynamic model uses the Delft Systematic Yacht Hull Series (DSYHS) method, and the foil model is based in the Glauert's biplane theory, corrected and adapted for particular hydrofoil with towing tank tests. The combination of the three models allowed the development of a VPP that balances forces and moments in three degrees of freedom: surge, sway and roll.

The VPP includes three different hydrofoils designs: Dali Moustache, developed for the IMOCA 60 class by VPLP and used in the 2016-17 Vendée Globe regatta; Chistera, also developed by VPLP but now for the new Beneteau Figaro 3; Dynamic Stability System, patented by Hugh Burkewood Welbourn and largely used in several different vessels for racing and cruising.

Finally, the present thesis: compares the performance of different foils, pointing its advantages and drawbacks; discuss possible optimizations for the foils design and the precautions that should be taken; presents the limitations of the used models, which yields to the VPP limitations and suggests future works that should be done to better predict the performance of such yachts.

Keywords: velocity prediction program, sailing yacht, hydrofoil, fluid dynamics, preliminary design.

Structural Optimisation of Midship Region for RoPax Vessel in Early Design Stage using FEA

CHAKKALAKKAL JOSEPH Jose Mishael

Master Thesis

ABSTRACT

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8th Cohort – 2017-2019

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December 2018

ABSTRACT

Structural Optimisation of Midship Region for Ro-Pax Vessel in Early Design Stage using FEA

By CHAKKALAKKAL JOSEPH Jose Mishael

The international shipping industry covers around 90% of the world trade. The bulk transport of raw materials, affordable import and export of food and manufactured goods between inter continents won't be possible without the maritime transport. The requirements from the maritime industry and the classification societies related with safety, energy efficiency, environmental protection, etc. force us to look for more efficient and cost effective technologies. This calls for the development of an integrated multi-disciplinary and -objective design optimisation platform to be used in early design stage of traditional ship design process.

The thesis focuses on demonstrating the application of an automated platform for the structural optimisation of the midship of a typical Ro-Pax vessel in the early stage of ship design process. It is based on the undergoing researches on the framework of European Research Council funded project, HOLISHIP (Holistic Optimisation of Ship Design and Operation for Life Cycle), which focuses on developing innovative holistic design optimisation methods for European maritime industry. The thesis covers the development of a parametric model of the midship using commercial finite element software ANSYS® and which will eventually be used for optimisation using modeFRONTIER® with an aim to reduce the total weight of the structure. A number of in-house tools/ modules are also developed and integrated in the automated platform. The study also extended to implement surrogate models to replace the finite element analysis which allow the customer to reduce the calculation time.

Keywords: Maritime transport, Ro-Pax vessel, Structural Optimisation, HOLISHIP, Surrogate models

Identification of Uncertainties in Geometrical and Strength Properties of Steel Plates for Shipbuilding

DAL-COL DOS SANTOS Marco Túlio

Master Thesis

ABSTRACT

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8th Cohort – 2017-2019

Supervisor: Prof. Zbigniew Sekulski, West Pomeranian University of Technology

December 2018

ABSTRACT

Identification of Uncertainties in Geometrical and Strength Properties of Steel Plates for Shipbuilding

By **DAL-COL DOS SANTOS Marco Túlio**

Uncertainty in the basic geometrical and strength properties of steel plates that are used in marine structures can significantly affect its structural performance and safety, thus affecting the reliability of the structural system.

The design strength of a marine structure is based on nominal values of both material and geometric properties, such as yield strength of the material, plate thickness, modulus of elasticity, etc. The actual values of these variables are often different from the nominal value and tend to have a random manner, therefore the actual strength of the structural system tends to have a random behaviour, which might vary the strength of the structure beyond acceptable levels.

Quantifying the uncertainty, or randomness, of these properties allows the designer to take into account this variability as a safe margin in the design strength of the structure, giving to it some reliability level. The basic strength variables may be grouped into two classes, material variables (such as yield strength) and geometric variables (such as plate thickness). The objective of the research is to find the probabilistic characteristics of both yield strength and plate thickness in order to be used in reliability analysis and design of marine structures.

The data source were provided by CRIST Shipyard, and the data related to material variable is based on certificates of steel plates from Classification Societies, and the data related to geometric variables is based on measurements made on field with the use of a Vernier caliper. The pursuit of random variables are made manly in terms of their means, standard deviations or COV's, and probability distributions, and that can be achieved in two steps: (1) data collection and (2) data analysis. The first step concerns to the collection of as many samples of data deemed to be appropriate for representing the random variables under investigation. The second is concerned with the statistical analysis of the collected data, in order to determine the probabilistic characteristics of these variables. The main goal of the investigation is therefore to present statistical estimation of the uncertainty associated with both yield strength and thickness of a hull structural steel plates used in the analysis and design of marine structures.

Keywords: Structural reliability, structural steel, steel plates, geometrical properties, strength properties, statistical analysis, probability distributions.

Comparative Study of Requirements for High Speed Crafts

HLAING Nandar

Master Thesis

ABSTRACT

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Ref. 159652-1-2009-1-BE-ERA MUNDUS-EMMC

8th Cohort – 2017-2019

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December 2018

ABSTRACT

Comparative Study of Requirements for High Speed Crafts

By **HLAING Nandar**

High speed craft represents a growing segment of the maritime industry, most especially in ferry market and military purposes. Along with the rapid pace of high speed crafts in the market, classification societies' rules and guidelines for the design of different hull forms for these crafts have emerged and developed. IMO adopted International Code of Safety for High Speed Craft (HSC Code) in 1994 which entered into force in 1st January 1996. Later, the amendments were made in 2000 and the last edition was dated in 2013. The present 2000 HSC Code applies to all high speed crafts ($V \geq 7.16\ \Delta^{0.1667}$ knots) in international voyages. Many reports and conference papers were also done on the structural design of high speed crafts.

This work is firstly focused on the comparison of rule methods for design loads of high speed crafts proposed by DNV and DNVGL. Design loads and structural requirements for a specific high speed craft are recalculated using DNVGL HSLC Rules, followed by the verification of results which are described in Ship Structure Committee Report SSC-439.

Afterwards, using DNVGL HSLC rules and DNVGL Naval rules, design loads and structural analyses are carried out for three existing high speed monohull crafts of different lengths between 30m and 80m. Analysing the background of the rule formulations and referencing the results obtained, the limits of rule application range are to be identified with respect to speed-length ratio V/sqrt(L). Possibility of merger of HSLC rules and Naval rules are to be evaluated, shortcomings in the current applying rules, if any, are to be pointed out and proposals for further improvements are expected from the work.

Keywords: High Speed Crafts, Rules, Design Loads, Scantling, Structural Analyses.

Grid Refinement Study of Unstructured Meshes for Marine CFD Cases

LACERDA GIRO Felipe

Master Thesis

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8th Cohort – 2017-2019

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December 2018

ABSTRACT

Grid Refinement Study of Unstructured Meshes for Marine CFD Cases

By **LACERDA GIRO Felipe**

Every computational fluid dynamic simulation has its credibility compromised by the different types of errors, especially on unstructured grids. Among the acknowledged errors, there is one regarding the representation of the governing flow equations as algebraic expressions in a discrete domain of space. This is the spatial discretization error (or numerical error). The discrete domain can be named as grid or mesh. This type of error is linked to how the grid (or mesh) parameters were setup by the grid generator.

The aim of this present work is to analyse how the parameters of a specific unstructured grid generator (HEXPRESS™/Marine, Numeca) influence the reliability of the results of the solver (ISIS, EMN/ECN). By reliability means the magnitude of the errors and uncertainties on the results of a determined model.

To evaluate these errors and uncertainties, some Grid Convergence Studies were performed for different models with different refinement approaches. The models are: a two-dimensional Magnus Rotor, a mono-fluid model of KVLCC, and a multi-fluid model of DTMB. The first one was carried out using Adaptive Grid Refinement (AGR), while the other two used conventional unstructured grids. The parameters considered on the grid generator for the convergence study were the refinement threshold for the AGR and a combination of the initial mesh size, diffusion, and target mesh size on the conventional unstructured grids. The estimation of the uncertainty and errors was performed by a python script developed by the author, which uses the Grid Coefficient Index (GCI) proposed by Roache, and a procedure using Least-Squares sense for data fitting, proposed by Eça and Hoekstra.

The different approaches of grid setups performed indicate some clues of how and what parameters on grid generator should be modified. The grid refinement ratio should be constant. The parameter of diffusion is fundamental for the grid similitude of different degrees of refinements. Initial cell size on initial mesh and target cell size on every element of geometry should be refined/coarse equally. Besides, not only the similitude of the topology of the grids guarantees the quality of the Grid Refinement Study, but also the constant grid refinement ratio between the grids.

Keywords: Grid Convergence Study; Grid Refinement Study; CFD; Grid Similitude; Unstructured Grid; Richardson Extrapolation; Least Squares Method; Grid Coefficient Index; Uncertainty, HEXPRESS.

Implementation of the Arbitrary Lagrangian Eulerian Method in Soft Body Projectile Impacts Against Composite Plates

MARQUEZ DUQUE Lucas

Master Thesis

ABSTRACT

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8th Cohort – 2017-2019

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December 2018

ABSTRACT

Implementation of The Arbitrary Lagrangian Eulerian Method in Soft Body Projectile Impacts Against Composite Plates

By **MARQUEZ DUQUE Lucas**

Underwater Explosions (UNDEX) have been a subject of high interest not only for military organisms but also for commercial industry. The analytical and numerical tools that have been developed until these days have allowed to study the energy transport mechanisms occured in UNDEX and its interaction with man crafted structures, allowing also to improve the structural scantlings and defense systems against these kind of treats. Similiar approaches can be used as well to study the instantaneous high pressure impact loads such as slamming, which is one of the most important design loads in a vast majority applications in naval engineering. However, performing experimental tests of these mechanisms is not only a costly but a complicated process, due to the hazards involved in handling explosives and the limited organisms which have licenses to develop such tests.

Under the framework of Project SUCCESS, one of the main objectives is to study the response of Fiber Reinforced Polymers (FRP) structures subjected to slamming and UNDEX, therefore developing accurate calculation tools which allows the designers to take into account these loads in the design of different naval components. One of the main challenges of the project is to include adequately the intra-laminar and inter-laminar damage mechanisms during these events, which is far more complex to the ones suffered by metallic materials. For these reasons, a series of experimental tests will be performed in order to understand the dynamic behaviour of FRP square plates subjected to soft body projectile impacts and validate some of the models that will be developed.

The research performed in this Master thesis will be focussed in the use of Arbitrary Lagrangian Eulerian (ALE) methods for solving Fluid Structure Interaction (FSI) problems involving Soft Body Impacts on composite laminates, focusing mainly in the structural behavior of the plates during the impact whereas studying the intralaminar damage mechanisms and its evolution. Simplified models of composite damage will be used to predict the different phases of the plate response: elastic response, initiation of matrix craking due to tension loads and finally fiber rupture. These initial results will be used then as an initial reference for the first gas canon tests that will be performed during the project campaign.

Keywords: Fluid Structure Interaction, Arbitrary-Lagrangian-Eulerian, Intralaminar damage, Composites Modelling , Soft Body Impact.

Development of intact stability weather criterion applicable to river-sea vessels

MARUTHERI PARAMBATH Jaizel Ibrahim

Master Thesis

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8th Cohort – 2017-2019

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December 2018

ABSTRACT

Development of intact stability weather criterion applicable to river-sea vessels

By **MARUTHERI PARAMBATH Jaizel Ibrahim**

Inland vessels, in general are not allowed to navigate in seas and thus there is a need to solve the missing link between minor inland ports to major ports. River-sea vessels are proven models now in many countries to move cargoes in order to solve this missing links in waterway systems. These vessels are intended for inland navigation waterways and suitable for restricted navigation at sea, with significant wave height limited to 2m. For these vessels suitability for restricted navigation at sea should be proven by the compliance with appropriate Rules of a recognized classification society as well as with applicable local/national statutory Regulations. For stability assessment, these Regulations refer to the IMO code for intact stability, difficult to meet for inland vessels. Also as statutory regulations may not always available, classification rules are expected to include those vessel designs generally prescribed by administrations. The research follows on to define appropriate requirements related to intact stability weather criterion from the study of local meteorological data and the results of the seakeeping analysis. Simulating navigation condition is done using accepted time-series analysis and spectral analysis techniques. The nonlinear relationship between excitation and response of structures is to be done and in this context, wave conditions that produce rare events are to be defined. Through this paper validation of requirements developed is done for roll amplitude and relative wave elevation along with design criteria regarding the evaluation of vessel intact stability.

Keywords: Stability, Weather Criterion, River-sea vessels, Navigation condition, Seakeeping analysis

Orthotropic Elements for an Idealized Representation of Complex Structures in Ship Global Strength Analysis

Min Htin Kyaw

Master Thesis

ABSTRACT

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8th Cohort – 2017-2019

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December 2018

ABSTRACT

Orthotropic Elements for an Idealized Representation of Complex Structures in Ship Global Strength Analysis

By **Min Htin Kyaw**

The preliminary design stage is very important in the process of shipbuilding. Most of the major decisions are to be made during the preliminary design stage. From the structural design point of view, the global strength of the ship needs to be assessed as quickly and accurately as possible. For passenger ships, global finite element analysis is the most recognized way to evaluate the global strength. Fine mesh finite element analysis of the complete ship is too time-consuming for the purpose of preliminary design stage. Therefore, during the preliminary design stage, complex structural parts of the ship need to be idealized in the global finite element model. The creation of global finite element models using idealized components should not be very complicated and the analysis of such models should be also relatively fast.

In this thesis, various approaches to idealize two common structural components are investigated: stiffened panels and side openings. They can be idealized by using orthotropic shell elements depicting different stress-strain relationships in the orthogonal directions. The applicability of different idealization approaches is reviewed and arrangements for an easier implementation are made. The proposed methods are employed in a complex submodel of a global finite element model of a cruise vessel. The results delivered by the idealized finite element model are validated against those of the standard, non-idealized finite element model.

Keywords: Cruise Ships, Global Strength Analysis, FEM, Idealization, Orthotropic shell.

Influence of the statistical properties of parameters of steel products on the ultimate strength of ship hull

Nyan Zaw Htet

Master Thesis

ABSTRACT

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8th Cohort – 2017-2019

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December 2018

ABSTRACT

Influence of the statistical properties of parameters of steel products on the ultimate strength of ship hull

By **Nyan Zaw Htet**

The design of a ship structural component is based on nominal values of both material and geometric properties such as yield strength of the material, plate thickness, modulus of elasticity etc. However, in reality, the actual values of these properties are different from nominal ones. Suppose a simple stiffened panel of a ship which consists of a plate, stiffeners and girders of normal strength steel. The nominal value for yield strength of each component of the panel would be 235MPa. However, the actual yield strength of each component is randomly varying from the nominal value, which will have an impact on the structural strength prediction of the panel. Ultimately, it will affect the ultimate strength of a ship hull. Therefore, prediction of the strength of a structural component needs to consider for the variability of the properties of steel components.

This thesis will focus on the random behaviour of the material and geometric properties of steel products and their influence on the ultimate strength of ship hull. There are two main objectives in this thesis. The first is to compile the statistical data for material and geometric properties of steel products from previously published sources and the new data collected in shipyards, Classifications and manufacturers. Statistical distributions (probability density functions) for these properties will be calculated in a statistic software called Dell™ Statistica™ 13.1.

Secondly, based on these statistical distributions, random values for material and geometric properties of steel members will be generated by using Monte-Carlo simulation and assign these values to each component of a randomly selected ship structure and assess the ultimate bending capacity of ship hull. The purpose is the compare the ultimate strength of ship hull by using random values for the material and geometric properties of strength members with the one by using nominal values. It is expected that the actual ultimate strength of the ship hull will be increased. The goal is to find how much is increased.

Keywords: ship structure, strength properties, material properties, statistical analysis, Monte-Carlo simulation, ultimate bending strength

Automated Modelling of Ship Structures in Early Ship Design Phase

PERUMANA THOMAS Hans

Master Thesis

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8th Cohort – 2017-2019

Supervisor : Dr.-Ing. Robert Bronsart, University of Rostock

December 2018

ABSTRACT

Automated Modelling of Ship Structures in Early Ship Design Phase

By **PERUMANA THOMAS Hans**

3D modelling is a process which takes several months of man-hours during the initial design phase. In addition to the initial time period taken to generate the model, every small individual change in design or calculation brings up changes which will ask for a modification in the 3D model. These problems seek for automation in such model generation which can bring a significant impact in those early design phases regarding man-hours saved.

New NAPA Designer recently implements the possibility to access and edit the 3D model with the help of integrated scripting platform by C#. This upgrade gives the user a wide range of opportunity to customise the 3D model as per user requirements and imaginations.

The objective of this thesis is to automate 3D modelling of ship steel structures like plates and structural elements, using the scripting language platform offered in new NAPA Designer. The execution of those scripts can automatically generate vertical walls based on imported GAP drawing in dxf format. It is also equipped to create primary and secondary elements on to those generated surfaces based on very few manual inputs. For accurate model generation considerations has been taken to ignore the overlapping of stiffeners with girders or any walls. It is also taken care to make modelling automated locally where class/client seeks for small modifications. The codes have been experimented so to ensure functionality and diversity with various structural elements and types.

With the implementation of this code, the steel structural model is generated at early stage of basic design which can help the user to have a more accurate global strength analysis of the vessel by exporting the meshed structural model from NAPA for finite element analysis. This model can also be used to generate CAD structural drawings with precision and quality so to submit to class.

Keywords: Structural Modelling, Early Design Stage, Automation, NAPA

Structural Design of Sea Gates against Tsunami Loads considering Ultimate Strength

POOKOTT ALANCHERY Amith Prasad

Master Thesis

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Supervisor: Prof. Maciej Taczala, West Pomeranian University of Technology

December 2018

ABSTRACT

Structural Design of Sea Gates against Tsunami Loads considering Ultimate Strength

By POOKOTT ALANCHERY Amith Prasad

The aftermath of Tohoku Tsunami (Japan, 2011), cost the country some major destruction to both life and property. In this context, the concept to deploy a steel water gate around the metropolitan areas that would protect the land against any future Tsunami that may occur was developed. The principle behind the action of the gate is the automatic erection of the structure that normally lies on seabed upon the action of Tsunami hydrodynamic lift force. Hence the gate has to have sufficient strength against the Tsunami loads that occurs once in tens of thousands years.

The Sea gate is already being designed and the functionality of the structure is been proved by performing a series of hydraulic tests on small scale models. Since the tsunami event is very rare and extreme, the design is made by using the so-called Level II methodology for reasonability (allows plastic deformation while keeping functionality), instead of Level I methodology (allows only elastic deformation).

The objective of this research is to check the structural behaviour of the sea gate against extreme hydrodynamic Tsunami loads and to evaluate the ultimate strength of the structure. For this purpose, the finite element mesh model of the innovative steel made gate structure has to be prepared based on the drawings using the pre/post FE processor MSC PATRAN. The meshed model will then be exported to the FE software MSC MARC for nonlinear finite element analysis. This time only static analysis will be performed and the reason for the non-necessity of the dynamic analysis will be proved during the course of the research.

Finally, the research objective has to be fulfilled, by showing the structural safety of the Sea Gate under the Tsunami loads with the return period of over thousand years.

Development of an Alternative Approach for Determination of Propeller Stresses

PRESEETHA ANIL Arjun

Master Thesis

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Supervisor : Prof. Dr.-Ing. habil Nikolai Kornev, University of Rostock

December 2018

ABSTRACT

Development of an Alternative Approach for Determination of Propeller Stresses

By **PRESEETHA ANIL Arjun**

The design of a propeller as a turbo machine is based mainly on its hydrodynamic boundary conditions. However, it also has to comply with classification rules and stress and fatigue requirements in order to guarantee a safe ship operation even in rough environmental conditions. Failure of the propulsion system is to be avoided during the ship lifetime. The stress and fatigue analysis play an important role on the propeller characteristics with respect to mass and blade profiles, which of course influence the overall propulsion efficiency. To reach mass and blade thickness reduction, the stress is to be analysed within a realistic manner.

The objective of this thesis is to develop an alternative approach for the determination of the propeller stresses, by taking the hydrodynamic pressure field into account. Special attention is given to the time required for the analysis to complete in order to implement the methodology in professional environment. The hydrodynamic loads are calculated using potential flow solver and the obtained hydrodynamic pressure field is used as loads in structural analysis of propeller blade. Furthermore, a bridge programme is developed to couple the potential flow solver for hydrodynamic analysis and finite element solvers for structural analysis, so that the hydrodynamic results is studied and required details for the structural analysis can automatically exported to finite element solver, with the goal of reducing overall analysis time. Finally, the resultant pressure for different meshes in hydrodynamic and structural analysis is compared on the aspects of accuracy and efficiency. The calculated final stress value is checked with the classification society requirements.

Keywords: CFD, Potential flow, Structural analysis, FEM, Stress

Initial design of Rivera 780 Kabe motor yacht hull structure

PURWAR Tumul

Master Thesis

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8th Cohort – 2017-2019

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December 2018

ABSTRACT

Initial design of Rivera 780 Kabe motor yacht hull structure

By **Purwar Tumul**

The description of this topic involves structural arrangement and scantling of Rivera motor yacht in Aluminum Hull in Conceptual design phase by classification rules and Direct method calculation of Engine girder to understand the stresses magnitude developed and their critical location in Girders by doing local and global load analysis.

The objective of this thesis is to complete successfully hull scantling of Rivera Motor yacht 780 in Aluminum Hull by classification rules and estimating the total weight of hull structure, as well as optimizing total weight of structure by altering frame and stiffener spacing for various different cases, other objective includes to investigate the magnitude of maximum stresses developed and the critical area location of development by direct method calculation in engine girder.

The method used to do hull scantling for Aluminum hull of Rivera motor yacht is by following rules guided by classification society and direct method calculation for investigating the maximum magnitude stresses developed and its critical areas.

The result expected by this work involves successful completion of hull scanting of Rivera motor yacht by following classification rules, estimating overall weight of structure of this yacht, optimizing weight of structure of hull by altering frame spacing and stiffener spacing by investigating various cases for both. Other result includes, investigating the critical areas in engine girder where maximum stresses develops and the maximum stress value magnitude.

Investigation of Hull Strength of River Sea Container Vessel

RAHMAN Sohanur

Master Thesis

ABSTRACT

"EMSHIP"
Erasmus Mundus Master Course
in "Integrated Advanced Ship Design"

Ref. 159652-1-2009-1-BE-ERA MUNDUS-EMMC
8th Cohort 2017-2019

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February 2019

ABSTRACT

Investigation of Hull Strength of River Sea Container Vessel

By **RAHMAN Sohanur**

River sea vessels are vessels intended for inland navigation waterways and suitable for restricted navigation at sea, significant wave height not exceeding 2m, according to Bureau Veritas Rules for the classification of inland vessels – NR217. Suitability for restricted navigation at sea should be proven by the compliance with appropriate rules of a recognized classification society as well as with applicable regulatory requirements. As statutory regulations are not always available, classification rules are expected to include those vessel design and equipment topics generally prescribed by administrations. The aim of the thesis is to investigate the hull strength of a river sea container vessel. In a container vessel structure, almost the entire deck space is occupied by hatches, usually only one in the breadth of the vessel, leaving a narrow strip of deck plating outboard. This necessitates a topside structure of heavy plating or a double hull to provide material in tension, stiffness against lateral and torsional loads, and resistance to buckling in compression when the vessel is in sagging condition. The containers may be stacked as many as six high and weigh around 30 tons each, with resulting loads on the bottom or double bottom structure applied entirely through the four corner posts of the containers. The strength analysis includes:

- Analysis and calculation of design loads, using direct analysis for still water and wave loads
- Scantling of structural elements
- Hull girder strength analysis under bending and torsion, taken alone or combined
- Cargo hold structural analysis
- Hull girder deflection analysis.

Keywords: River sea container vessel, Structural analysis, Simple beam theory, Thin wall girder theory, Finite element method.

NUMERICAL SIMULATION OF SIDE SHIP LAUNCHING

Mochammad Ramzi

Master Thesis

ABSTRACT

"EMSHIP"
Erasmus Mundus Master Course
in "Integrated Advanced Ship Design"

Ref. 159652-1-2009-1-BE-ERA MUNDUS-EMMC

8th Cohort – 2017-2019

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November 2018

ABSTRACT

NUMERICAL SIMULATION OF SIDE SHIP LAUNCHING

By **Mochammad Ramzi**

Side launching method has become a solution of transporting ship into water in restricted water/canal. Unfortunately, this method brings higher possibility of capsizing mainly occurred when the ship interacts to the water. Shipyards need detail calculations and procedures of predicting the outcome of ship in water, yet they are not able to perform due to its complexity of computation and time-consuming. Thus, this thesis proposes to study dynamic simulation of side ship launching.

Using the gravitational side launching theory a code have been developed to solve the 3D launching problem. Moreover, Computational Fluid Dynamics have been employed to simulate the hydrodynamics of side ship launching. In order to perform the CFD simulation, FINE™/Marine commercial software have been used. An Offshore Supply Vessel launching delivered by Damen Shipyard, Galati have been used as a test case but also for qualitative comparison.

Keywords
Side launching, CFD, RANS, VOF.

Modular design of cross flow channel through structural optimization

SAGAYA PUNITHASEGARAN Arrshan

Master thesis

ABSTRACT

"EMSHIP"
Erasmus Mundus Master Course
in "Integrated Advanced Ship Design"

Ref. 159652-1-2009-1-BE-ERA MUNDUS-EMMC

8th Cohort – 2017-2019

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Rostock, November 2018

ABSTRACT

Modular design of cross flow channel through structural optimization

By **SAGAYA PUNITHASEGARAN Arrshan**

The master thesis work involves in studying the modular design of complex double bottom structures in prefabrication as an alternative to working in section construction based on the geometry of a cross-flow channel through its structural optimization.

Presently, the complex double bottom structures such as cross flow channel and sea chests are built at the block assembly from separate single structural groups in most of the shipbuilding industries. The goal of this study will be to look into the modular design and construction of the cross flow channel. Which means that the entire construction is pre-fabricated and mounted as one module in the block assembly. The background to this is the theme of producing such built-in parts (e.g. double-hull or stainless steel tanks, shaft strut connection, etc.), together with the surrounding shipbuilding structure with simple interfaces for subsequent assembly in the section or on the ship as modules. This is to achieve a more favourable position & accessibility, shorter distances and relocation of work into the prefabrication to save costs in the preparation and construction time on the sectional building sites.

Taking advantage of the modular construction, there is a need of optimizing the cross flow channel in order to achieve certain functional and operational advantages such as to eliminate/reduce air bubbles & air cushions in flow, to have reduced flow resistance and avoiding mud/sludge formation or marine growth and most importantly to have better accessibility for inspection and maintenance. These requirements have to be studied and the cross-flow channel needs to be optimized accordingly. The optimized structure should be designed to be constructed as a module since the complexity of the structure might increase, where the importance of modular construction should play its role to overcome the issues related to construction that might arise.

Nevertheless, in this study, an optimized structure for the cross-flow channel shall be proposed and we will review the basic principles of modular design and construction of this particular structure, which will lead to better understanding of the method. In the company's point of view, the aim is to use recognized advantages of the optimized cross-flow channel and the modular design for the future implementation in the upcoming projects.

Structural Analysis & Design to mitigate lateral deflections of an offshore mining vessel's stern

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ABSTRACT

"EMSHIP"

Erasmus Mundus Master Course
in "Integrated Advanced Ship Design"

Ref. 159652-1-2009-1-BE-ERA MUNDUS-EMMC

8th Cohort – 2017-2019

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ABSTRACT

Structural Analysis & Design to mitigate lateral deflections of an offshore mining vessel's stern

By **Sandwipan Sarkar**

The behavior of ships in the sea is the sum of various criteria and situations, the ship hull, superstructures, onboard equipment and cargo create multiple set of challenging pressure and load combinations for design & analysis. The ship hull bending and deformation behavior is a result of global and local set of parameters that a structural designer has to carefully look into. This thesis is a study on one such typical behavior of the ship hull. Lateral deflections along with the vertical deformations have been identified in the hull of a modern offshore sea mining vessel (OSV) with a typical aft end.

The ship hull usually behaves like a symmetric open/closed thin walled beam which is stiffened to face various loading conditions, which results in global bending and twisting situations. Based on the continuity of the structure on decks, as in container ships, the global strength can be affected. There are several local stiffening methods to fix such lapse in structural strength.

In this thesis the main course of work was to study the behavior of an existing design, where the design is within global strength and hull deflection limits but the stern end had a distinct individual nature of lateral deflection which is different from the global deflection of the vessel. Due to no clear definition for deformation limits in this class of vessels, the owner had requested to minimize the effect.

The present thesis focuses on the internal mechanics of ships subjected to bending, torsional loads and warping stresses, generated due to shear loading in a thin walled section. Simplified methods for structural analysis have been used to understand and further develop the topic.

The problem addressed in this paper is answering a solution to the characteristic deformation at global level of the OSV using local scantling elements. The thesis works on an approach to solve a pure engineering problem in the ship.

A significant amount of time has been spent in understanding the nature of a ship and creating an economic design without affecting the structural stability of the hull. An improved model with minimized deflections and suitable stress ranges has been proposed within the class guidelines and requirements of the owner.

Keywords: Structural Analysis & Design, DNV GL Poseidon, Lateral Deformation, Thin walled Beam Theory, Shear Center, ANSYS APDL, Hypermesh, Robot Structural Analysis.

Automated Manufacture of a Shape-Adaptive Large Hydrofoil

SOTELO ZORRILLA Marco Salvador

Master thesis

ABSTRACT

"EMSHIP"
Erasmus Mundus Master Course
in "Integrated Advanced Ship Design"

Ref. 159652-1-2009-1-BE-ERA MUNDUS-EMMC

8th Cohort – 2017-2019

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December 2018

ABSTRACT

Automated manufacture of a shape-adaptive large hydrofoil

By **SOTELO ZORRILLA Marco Salvador**

In this work will be presented the design and manufacture of a shape-adaptive large hydrofoil of 1.5 m long using the automated fibre placement technique (AFP). The AFP technique is an advanced manufacture process for composite materials that is widely used for aeronautic and aerospace applications due to the high productivity and quality of lamination. The idea behind this work is to compare this state-of-the-art manufacture technique in terms of quality of the final product with other conventional techniques like resin transfer moulding (RTM). The material used to manufacture the large hydrofoil is carbon/epoxy prepreg with 35% of resin content.

The first part of the project is dedicated to designing the lamination of the shape-adaptive hydrofoil. The optimization phase is based on the idea proposed Herath et al. (2015) for flexible composite propellers. To determine the optimum layup a coupled FEM code with a Genetic Algorithm is used. With this methodology, the goal is to obtain the layup orientation to achieve the required bend/twist capability of the large hydrofoil. This work had been carried out in collaboration with the Defence Science and Technology Group (DST-G) of the Department of Defence of Australia. The objective function in this work is to achieve the same flexibility of a large hydrofoil built by DST-G a few years ago using RTM techniques (Phillips et al. 2014).

Once the optimization phase is complete, the resulting layup orientation is used in the development of the manufacturing tool. The large hydrofoil was manufactured by wrapping carbon fibre prepregs into a fibreglass core. The manufacturing tool began with the definition of the core geometry and boundaries of each individual layer. Each layer of the laminate followed the orientation obtained in the optimization phase. During the development of the manufacturing tool, the constraints and limitations of the robot head in terms of the collision were considered. Once the G-code was finished and tested, the production of the large hydrofoil was performed.

In this work, a brief study of the curing cycle and scale effects of the thick laminate was included. The goal of this study is to ensure that the hydrofoil achieve the expected mechanical properties. As monitoring control for future tests of the hydrofoil, embedded optic fibre was implanted in the lamination to measure the strain and deformation. The embedded optic fibre sensor was placed in one of the last layers of the lamination. Finally, a 3D scan image of the hydrofoil is presented and compared with the geometrical model. Also some experimental schemes for future studies were proposed, as well as the expected results based on the FEM simulations.

Keywords: Automated fibre placement (AFP), Genetic Algorithm, Embedded optic fibre

Blade Element Momentum Theory numerical model of a tidal turbine in a realistic time-dependent environment

TOMY Joseph Praful

Master Thesis

ABSTRACT

"EMSHIP"
Erasmus Mundus Master Course
in "Integrated Advanced Ship Design"

Ref. 159652-1-2009-1-BE-ERA MUNDUS-EMMC

8th Cohort – 2017-2019

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December 2018

ABSTRACT

Blade Element Momentum Theory numerical model of a tidal turbine in a realistic time-dependent environment
By **TOMY Joseph Praful**

Tidal turbines are mechanical devices that convert the energy inherent in the tidal currents to useful electrical energy. Tidal energy being governed primarily by the gravitational forces between the earth and the moon, this form of energy has a better predictability compared to the other forms of renewable energy. The time and duration of the tides can be predicted, and consequently the current flow due to the tides. However, the ocean (or sea) environment in which the tidal turbines are located, significantly affect the inflow into the turbine.

Even though the free stream velocity of the tidal current can be predicted, the actual inflow at the turbine in a realistic environment is dynamically varying with time as well as the depth of the ocean. Theoretical predictions of the performance of the tidal turbine using the free stream velocity may produce reasonably accurate results in terms of an average power that can be produced; but in a dynamic environment, the forces experienced by the blades and the electrical output from the power grid would be fluctuating. Local flow acceleration and enhanced lift due to dynamic stall effects may create unanticipated high structural loads on the turbine blades, which could cause structural damage and might also be important for fatigue considerations. The variation of power output in time is also a primary concern in the managing of the electrical grid, to ensure smooth supply of power by coupling with the batteries. The rotation rate of the turbine will not be constant due to these dynamic effects, and this in turn further affects the flow. These are few of the factors which call for the simulation of tidal turbines in a realistic environment, rather than in simplified free stream velocity environment and constant rpm operating condition.

During full scale trials after installation, it is possible to obtain on-site measurements to predict such dynamic behaviour of the turbine blades. But factors such as strength of the blades and maintaining an electrical load balance need to be analysed at the preliminary design phase itself. Simulations using Computational Fluid Dynamics, though reasonably accurate, are computationally expensive and time consuming at this phase due to the geometrical complexity of the blades and the unsteady, depth-wise varying inflow velocity profile.

In order to function as a suitable alternative, numerical models based on elementary theories are used, with suitable improvements to account for the dynamic conditions. One such theory is the blade element momentum theory (BEMT), the basis of which is the conservation of linear and angular momentum. The blades are simplified to compose of multiple blade elements, which make independent revolutions around the hub centre. The momentum theory is then applied to each of these individual blade elements, and the results integrated to obtain the total performance of the turbine. Within the scope of this work, a numerical model based on BEMT is developed for prediction of the forces, torque and power output of the tidal turbine. The numerical model is developed using Python, and attempts to simulate the realistic working environment with a convenient user-friendly, multi-use implementation.

To cater for the dynamics of the working environment, the inflow velocity is taken as depth-wise varying and time dependent. Various modules to account for the imperfections of the BEMT are implemented. Unsteady flow effects, primarily in the form of dynamic stall, are accounted for by an extensive dynamic stall numerical module, similar to those implemented in aerodynamics. The numerical code is expected to produce accurate measurements of the forces, torque, power output, and the load on the blades. Future integration with an electrical power prediction module is envisaged in collaboration with University of Edinburgh, and the likelihood of such a feedback loop is also a consideration. Validation of the BEMT tool would also be done using experimental results and existing literature.

Analysis of added mass effect on surface ships subjected to underwater explosions

Trivedi Ruturaj Radhakrishna

Master Thesis

ABSTRACT

"EMSHIP"
Erasmus Mundus Master Course
in "Integrated Advanced Ship Design"

Ref. 159652-1-2009-1-BE-ERA MUNDUS-EMMC

8th Cohort – 2017-2019

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December 2018

ABSTRACT

Analysis of added mass effect on surface ships subjected to underwater explosions

By **Trivedi Ruturaj Radhakrishna**

This study presents a method to determine analytically the added masses used for analysis of surface ships subjected to underwater explosions. Regarding the action of the first shock wave generated by the explosion, Taylor's theory is used to calculate the acoustic pressure which applies on the ship hull. The main purpose of the present study is to investigate the effects of the water inertial forces on the response of the surface ships subjected to underwater explosions.

A macro is first developed in ANSYS APDL to calculate the added masses to be attached to the nodes of the wet hull, using strip theory and ellipsoid methods. The Lewis transformation mapping is used for simplifying the cross section of the ship. The results obtained from the developed macros are then compared to results from previous researches extracted from the literature. An implicit ANSYS model including added masses attached on wet hull nodes is built for modal analysis and then converted to be used for LS-DYNA explicit simulations.

Third, the model of a semi-cylindrical stiffened like-ship structure is considered and simulations with added masses calculated analytically are confronted to simulations based on a fully coupled finite element model where the water is represented by acoustic elements.

Then, above analyses are carried out considering the real surface ship the material and geometrical characteristics for which are provided by Chantiers de l'Atlantique.

Keywords: Underwater Explosion, Finite Element Method, Fluid Acoustic Elements, Added Mass, Strip Theory Method, Ellipsoid Method, Lewis transformation

Initial design of a 40 feet motorboat with experimental composite testing

Wiszniewski Jakub

Master Thesis

ABSTRACT

"EMSHIP"
Erasmus Mundus Master Course
in "Integrated Advanced Ship Design"

Ref. 159652-1-2009-1-BE-ERA MUNDUS-EMMC

8th Cohort – 2017-2019

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December 2018

ABSTRACT

Initial design of a 40 feet motorboat with experimental composite testing

By **Wiszniewski Jakub**

The objective of the thesis is focused on the practical aspects of design a 40 feet composite motor yacht among with the assessment of the effects of the production methods on the mechanical properties of the laminate. Composites are the modern day materials, with more strength and enhanced properties, yet lighter and more durable. With the advancement of technology, better methods are being developed by the industry and some of them are implement to yacht production.

The thesis consists of two parts - design and experimental. First part of the project was to design the 40 feet fibreglass composite pleasure motor yacht, with design category B assigned for navigation in the Mediterranean Sea. The boat complies with the ISO rules. The design was carried by using well recognized software in the industry, such as Maxsurf, Rhinoceros, HullScant and AutoCad.

The approach to the design started with comparison of the technical data of parent boats. Based on the principal dimension refined from those data, the hull shape was created. The general arrangement was designed according to the shape of the hull and the entry requirements. The structure of the boat was designed using empirical approach. The optimization of laminate strength and correctness of laminate layouts were assessed using HullScant software. The power of the engines was estimated in Maxurf Resistance. The weight estimation of the boat was done using empirical approach with necessary safety margins. Stability of the vessel was assessed in Maxsurf Stability software which comply with ISO rules.

The aim of the second part was to asses compliance of ISO 12215-5 rule with reality and to show influence of production method on mechanical properties of laminate. Destructive tests of fibreglass laminates were conducted with this purpose for various cases of flexure, tensile and compression. The tests were carried out using a universal testing machine. Laminate specimens were created according to ISO requirements and divided in two production methods: hand laminated and vacuum laminated. Common aspects for both specimen types were same material, laminate layout and fibres orientation.

The result of the study is an initial design of fibreglass composite pleasure motor yacht including parametric study based on technical data of parent boats present on the market, weight estimation, stability and resistance estimation using appropriate software. Compliance with ISO rules with emphasis on ISO 12217-1 and ISO 12215-5 was checked using Maxsurf Stability and HullScant software. In experimental part comparison of the results of the destructive tests with the results calculated according to the ISO 12215-5 rule using empirical formulas is presented and differences between production methods and their influence on the laminate strength are highlighted.