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RANSE Simulations of a Naval Combatant in Head Waves

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ABSTRACT

The paper presents a set of viscous computations for a fixed or free pitch and heave surface combatant David-Taylor model basin (DTMB 5512) advancing in head waves. A detailed comparison on the forces coefficients, the phase-averaged free-surface elevations when available, between simulation and experiments will be shown for the fixed ship at moderate (Fr=0.28) and high (Fr=0.41) Froude number, demonstrating an excellent agreement. With a unique viscous computational tool, it will be proved that it is possible to compute implicitly radiated and diffracted waves. Even for the medium speed test case (Fr=0.28), the computational results demonstrate that the radiated bow and stern waves associated with the heave and pitch of the ship can not be neglected.

Keywords: numerical simulation, RANSE, turbulence, fixed and free ship in waves

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Adaptive Grid Refinement for ISIS-CFD

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ABSTRACT

An adaptive grid refinement method for a parallelised unstructured finite-volume code is described in the present paper. The method currently provides directional refinement for unstructured hexahedral meshes. To get a flexible and general method, the refinement criterion, the decision whether or not to refine each cell, and the actual refinement are strictly separated. Also, the refinement of cells and faces is decoupled. Results for a free-surface refinement criterion on two steady ship test cases show significant increases in accuracy and efficiency, compared to non-refined grids.

Keywords: Numerical simulation, adaptive grids, grid refinement

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Numerical Flow Investigation around a Ship with Propeller and Rudder

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ABSTRACT

A simplified infinite-bladed propeller model is coupled with the Reynolds averaged Navier-Stokes (RANS) to give a model that interactively determines hull-propeller-rudder interaction without requiring detailed modeling of the propeller geometry. Computations are performed for the single-screw container vessel Hamburg Test Case (HTC), in different maneuvering conditions. The results are further used to study the interaction between the hull, propeller, and rudder. For the ship, the flow study reveals a rather complex flow field in the stern region, where the velocity distribution and propeller loading reflect the flow changes caused by the different maneuvering conditions. Summarizing the results, the method shows encouraging results, so taking into account the effort related to modeling the ensemble, the method appears to be useful in connection with studies of hull-propeller-rudder related flow problems, where the real propeller geometry cannot be modeled properly by the existent geometric methods.

Keywords: HTC hull, propeller, rudder, interaction.

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A Comparative Study of DDES and URANS by an Unstructured Grid Based NS Solver

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ABSTRACT

Numerical studies of DES, DDES and URANS for a simple geometry are carried out in this paper. Flows around a circular cylinder of DES, DDES and URANS are shown, and the pressure distributions on the cylinder are compared with measurement result. Both of DES and DDES results show the improvement of prediction of drag coefficient and Strouhal number. Aside of that, the DES and DDES solutions show the complex flow structure behind the cylinder. Thus, the present results demonstrate the effectiveness of DES and DDES for the particular case of highly separated flow.

Keywords: numerical simulation, DES, DDES, SURF

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Experimental Methodologies to Investigate Transverse Stability of Ships on Regular Waves

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ABSTRACT

The hydrodynamic safety of ships represents a major requirement from the operational point of view. Statistics on marine accident prove that the capsizing of ships due to critical environmental conditions represents a fundamental and, still, unsolved problem in marine engineering. The severe criteria on transverse stability given by the Classification Societies didn't prove their effectiveness in evaluating the capsizing risk. Taking into account the above mentioned aspects, the authors are investigating different experimental methodologies developed in towing tanks in order to evaluate the transverse stability of ships on waves. The application is based on the results of the towing tank tests carried out for a 2700 dwt multipurpose cargo ship model. The experimental methodologies are used to provide a better understanding of physical mechanisms which lead to transverse stability for different heeling angles and to validate theoretical approaches in this respect.

Keywords: transverse stability, restoring moment on waves, experimental tests.

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Wall Pressure Fluctuations on Lifting Bodies in Transient Regimes

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ABSTRACT

The primary aim of this study is to provide a better understanding of the hydrodynamic loading responses on flow phenomena like transition and of laminar separation induced transition. Aside of that, the research focus on the verification of the accuracy for the RANS simulation to predict them, and to evaluate their limitations. The flow is first studied in the case of a slow rotation velocity based on wall pressure near the leading edge and the trailing edge and numerical separation and transition localization on the hydrofoil. Then the influence of the four rotation velocities on the boundary layer events is analyzed with CFD results. Then Local wall pressures are integrated in order to define a suction side loading which will allow to compare measurement and calculation on the basis of a reconstructed hydrodynamic loading.

Keywords: numerical simulation, lifting bodies, transient regimes

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Unconventional Propulsors and Devices for Improved Propulsive Efficiency

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ABSTRACT

As part of the continuing effort to increase ship propulsion performances and to reduce fuel consumption, various energy saving devices have been put into practice on the shipbuilding market. The present paper provides a state-of-the-art report on the subject, an examination of various types of energy saving devices that are already commercially available. Each type of energy saving device has a wide field of application, depending on ship type, size, engine, type of fuel, etc. Some of them can be used for both new buildings and retrofit situations. Many of these devices can improve the propulsive performance in case the original design is not competitive enough.

Keywords: energy saving devices, unconventional propulsors.

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Numerical Analysis of Ship-Ship Interaction by a High-Order Potential Flow Code with Ship Motions

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ABSTRACT

A high-order boundary-element model has been used to consider the interaction effects between a sailing tanker and a nearby tug-boat for a range of speeds and relative positions. Although the absolute magnitude of the tug-boat resistance predicted by the numerical model is often quite different form the experimental measurements, the change in resistance with relative position as well as the transverse repulsive force are both reasonably well captured with typical discrepancies of around 10%. A similar correspondence is obtained even using a very coarse discretization which leads to calculation times which are only about 2.5 times larger than the real-time simulation at full-scale. This shows that with some further optimization of the numerical solution (and/or somewhat faster computers), the model can be used for real-time inclusion in a training simulator.

Keywords: Boundary element method, ship-ship interaction

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The Use of CFD in Modelling Blanketing Effects for Yacht Race Simulations

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ABSTRACT

A detailed examination of the performance of a typical upwind sail rig arrangement was carried out for different heel and yaw angles using a commercial Computational Fluid Dynamics (CFD) solver. Experimental wind tunnel data provided by the Wolfson Unit for Marine Technology and Industrial Aerodynamics were used to validate the calculated CFD results. The computed results demonstrate good agreement and the effect of mesh density on the flow solution is presented. The purpose of this work is to identify the downwind position and track of the resultant sail vortex system. The ability to model correctly this behaviour within a yacht race simulation is critical to identifying the blanketing effect between two yachts.

Keywords: ship resistance, numerical simulation, potential flow theory.

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Prognosis of Rudder Cavitation Risk in Ship Operation

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ABSTRACT

A route based rudder design procedure has been developed. Therefore a criterion for benchmarking different rudders for a set of operation conditions has been introduced. Based on measured data three different rudder designs have been compared. For optimizing the profiles a new method allows the determining of the occurring inflow conditions based on equivalent pressure distributions.

Keywords: numerical simulation, rudder, cavitation

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A Numerical Study of Incompressible Juncture Flow

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ABSTRACT

Steady high-Reynolds-number flowfields about a hydrofoil mounted upright on a flat plate were numerically simulated by solving three-dimensional incompressible RANS equations with finite volume method. The flow is assumed to be fully turbulent so that the transition on the strut is not considered. Effects of turbulence were represented by an explicit algebraic model.

Keywords: juncture flow, numerical simulation, horseshoe vortex

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Wake Field Analysis of a Drifting Ship with RANS-CFD-Methods

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ABSTRACT

The present work describes a methodology for defining the nominal wake field of a Series60 hull form is investigated in drift motion. The wake is analyzed with two different RANS-CFDcodes (FreSCo and COMET). The computational results are compared to each other and to the measurements for validation purposes.

Keywords: ship resistance, numerical simulation, wake field, experimental tests.

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RANS Simulation of the Flow around a Ship Appended with Rudder, Ice Fins and Rotating Propeller

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ABSTRACT

In the present work RANS simulations are conducted for a propeller in open water, an appended ship in a resistance test setup and a combined ship-propeller configuration in a cavitation tunnel setup at atmospheric pressure. The open water and resistance calculations are steady state computations, while the combined case is run time accurate. Grid studies will be performed for the open water propeller and the appended hull calculation. A formal verification was not conducted, so the grid uncertainty was not estimated. Only changes in solutions between grids are considered. For the medium and fine grid solutions the two studies show changes in integral quantities between grids of 1.6% and 0.6%, respectively. Concerning the results of the calculation all the three considered configurations proves promising results.

Keywords: RANS, motion modeling, velocities distribution.

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Influence of the Near Wall Treatment on the Flow Features around a Two-Dimensional Hydrofoil close to the Free Surface

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ABSTRACT

A two-dimensional hydrofoil close to the free surface has been simulated using the commercial RANS code Fluent. Two submergences were considered, corresponding to a breaking and non-breaking condition of the wave behind the hydrofoil. The obtained results were compared with experiments by Duncan (1983) and with three different numerical solvers. The converged viscous analysis of the non-breaking wave case shows a satisfactory agreement with the experimental results and the potential flow solution, both in terms of free surface deformation and lift coefficient. A sensitivity analysis is performed in terms of (i) turbulence modeling, (ii) near wall grid size and (iii) boundary condition on the foil (free- and no-slip).

Keywords: submerged hydrofoil, viscous flow, numerical simulation, experimental tests.

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Validation and Verification of Hull Resistance Components Using a Commercial CFD Code

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ABSTRACT

A mathematically defined Wigley hull form is used to investigate the application of a commercial CFD code in prediction of the total resistance and its components from tangential and normal forces on the hull wetted surface. The computed resistance and wave profiles alongside the hull were compared with experimental observations for six different Froude numbers to validate the simulations. The effects of grids, domain size and turbulence models were studied. A statistical hypothesis test was carried on these resistance data in order to determine the most suitable turbulence model for the lowest and highest Froude numbers.

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Preliminary LBM Study of Hydrodynamic Problems

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ABSTRACT

The present work presents a L.B.M. study aimed at solving the flow around different geometries. A popularly adopted kinetic model for the solution of the Lattice Boltzmann equation is the single-relaxation-time (SRT) approximation, the so called Bhatnagar-Gross-Krook (BGK), which is employed in here as well. In the discrete form of the LBM method, the distribution function is represented on a lattice unit, that is a cell with a number of nodes on which f is distributed.

Keywords: ship resistance, numerical simulation, experimental tests.

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Numerical Strength Analysis in Head Waves, for a Large Liquefied Natural Gas Carrier

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ABSTRACT

The main topic of this paper is the global strength analysis for a large LNG carrier ship, with double hull structure and membrane type cargo-tanks. The following loads are considered: eigen ship and cargo weight, still water and equivalent quasi-static head wave pressure. Two types of analysis models are employed: the classical 1D-girder equivalent ship and the 3D-FEM-hull model, extended over the whole ship length. In order to obtain the floating and trim equilibrium condition, in vertical plane, eigen iterative numerical procedures were used. Two main loading cases are considered: full cargo and ballast. The numerical results point out the advantages of using 3D-FEM models instead of the 1D-girder models, for the global ship strength analysis. For the numerical analyses the LNG model provided by the ICEPRONAV Galati is used, within the frame of the MARGAS CEEX X2C16/2006-2008 Project.

Keywords: ship structure, global strength analysis, finite element method.

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Numerical Simulations of the Flow Around a 6:1 Prolate Spheriod

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ABSTRACT

This paper aims at comparing RANS, DES and LES predictions of the flow about a prolate spheroid, with a 6:1 major–minor semi-axis ratio, at α=10 and 20 degrees angles of attack. The simulations are compared with experimental data from previous experimental investigations, and also with the experimentally-based visualization studies providing a detailed understanding of the surface flow pattern.

Keywords: prolate spheroid**,** large eddy simulation, detached eddy simulation.

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Wave Excitation on a Ship Bow in Short Waves

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ABSTRACT

The aim of the study was to find out whether this kind of numerical method could be applied to get further knowledge on the non-linear springing loads. The results show that it could and that the strong non-linearity of the excitation is revealed. Based on these results it was possible to determine the accuracy of the obtained non-linear terms. The grid dependency of the wave field was first analysed in 2D. The increase of the wave force with grid refinement seems to be contradictory to the decrease of the wave height with grid refinement. This may indicate that the coarser grids do not capture accurately enough the interaction of the waves and the hull.

Keywords: ship resistance, short waves, numerical simulation, potential flow theory

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Hull Forms Improvement

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ABSTRACT

A numerical method is proposed to simulate the free motion of a submerged body. The method involves a Navier-Stokes or a potential solver coupled with a routine solving the equations of motions. The model has been verified and the simulations performed so far indicate that the numerical scheme is stable and produces realistic results. The design of the experimental device to validate the Navier-Stokes model is in progress. The coupling with the potential flow solver provides a motion with a Strouhal number similar to those of cetacean.

Keywords: RANS equations**,** viscous flow, turbulence

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Experimental Evaluation of Dynamic Pressures on the Ship Hull

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ABSTRACT

The paper tackles the technology designed for measuring the dynamic pressures acting on a geo-symmetric ship hull model and its systematic wave testing in the ship hydrodynamics laboratory. The experimentally collected data are then compared to the results of numerical simulations.

Keywords: experimental tests.

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Contributions to Reducing Vibrations Onboard Ships through Additional Systems

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ABSTRACT

The vibrations measurements carried out onboard of a marine tanker powered by a slow diesel engine, in full load condition, revealed values of velocity vibration which exceeded the limits corresponding to the ACCEPTABLE domain imposed by ISO 6954 standard. After the first voyage of the vessel, in heavy ballast condition and rough sea, the ship’s crew complained about discomfort caused by vibrations. The situation required solutions to avoid the crew’s exposure to such vibrations. First of all, complete investigations were carried out during the next voyage of the vessel, between Genoa (Italy) – Taranto (Italy) – Odessa (Ukraine). The vibrations analysis of the data recorded during the voyage indicated that the main excitations were caused by the propeller. For the next marine tankers the wake field presumed to be the cause of these excitations was subjected to analysis; finally, it was decided to improve the propeller wake (the incoming propeller flow) using additional systems (hemi ducts) to reduce the excitations acting on the ship’s structure. To this purpose the size and location of these hemi ducts were decided on, by experimental research . With the new additional systems mounted on the next sister ships the vibrations were measured and the results displayed an improvement of the crew’s vibration comfort.

Keywords: ship vibration measurements, propeller wake improvement.

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The Kinetic and Dynamic Modeling of an ROV Robotic Arm

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ABSTRACT

The underwater wire-guided robots, known as well as Remotely Operated Vehicles represent increasingly utilized means of working undersea due to their growing versatility and more attractive effectiveness-cost ratio. Industrial and military ROV, beyond the mere sensor-based search of the aquatic environment, are capable of carrying more and more complex operations thanks to different robotic arms. The authors present in this paper the results obtained during designing a manipulator meant to equip an underwater remotely operated vehicle developed in the “Mircea cel Batran” Naval Academy of Constanta. The outcome of this research stands as a theoretical basis for the actual building of the robotic arm.

Keywords: ROV, robotic arm, modeling, numerical simulation

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On Diesel Engines Local Vibrations

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ABSTRACT

Diesel engines can affect the safety functionality and habitability of a naval vessel. Excessive vibration may result in fatigue cracking of local structural members, malfunction of machinery and equipment or adversely affecting crew performance. This paper presents the results of the vibration measurements effected on a Diesel engine, the apparatus and the methodology of vibrations analysis used. It presents the experimental and theoretical diagrams showing the vibrations distribution on the cylinder liner and the cylinder block.

Keywords: vibration, cylinder liner, cylinder block, acceleration, frequency

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Stresses and Deformations in a Submarine Vehicle Porthole

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ABSTRACT

This paper deals with a method of calculating the thickness of a porthole lens using a 2D FEM model. The FEM model was validated by experimental measurements on a design stand.

Keywords: static, porthole.

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Modeling of an Underwater Remotely Operated Vehicle's Motion through Water

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ABSTRACT

This paper presents the theoretical fundamentals for an underwater remotely operated vehicle (ROV) accompanied by the results of modeling its motion through the water in the proper domain of velocities.

Born from the ultimate requirements of good maneuverability and stability, the motion's study emerges from the actual set of the non-linear differential equations of motion. Taking in account the complex flow of the water around the ROV, the authors consider the influences of the laminar, turbulent and potential zones that surround the vehicle and eventually carry out a computer-aided simulation of the movement.

Keywords: ROV, motion modeling, velocities distribution.

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Stress Measurement for a 1000 m^3 Spherical Tank Using the Strain Gauge Method

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ABSTRACT

This paper is concerned with an assessment of the stress distribution over the cover of a spherical tank of 1000 m^3. Maximum strains are obtained by means of the strain gauge method. The measurements points are obtained from a FEM preliminary calculus, by using COSMOS/M program. The safety coefficients in respect of the yielding stress and the breaking stress were also evaluated.

Keywords: strain gauge method, stress distribution, safety coefficients.

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