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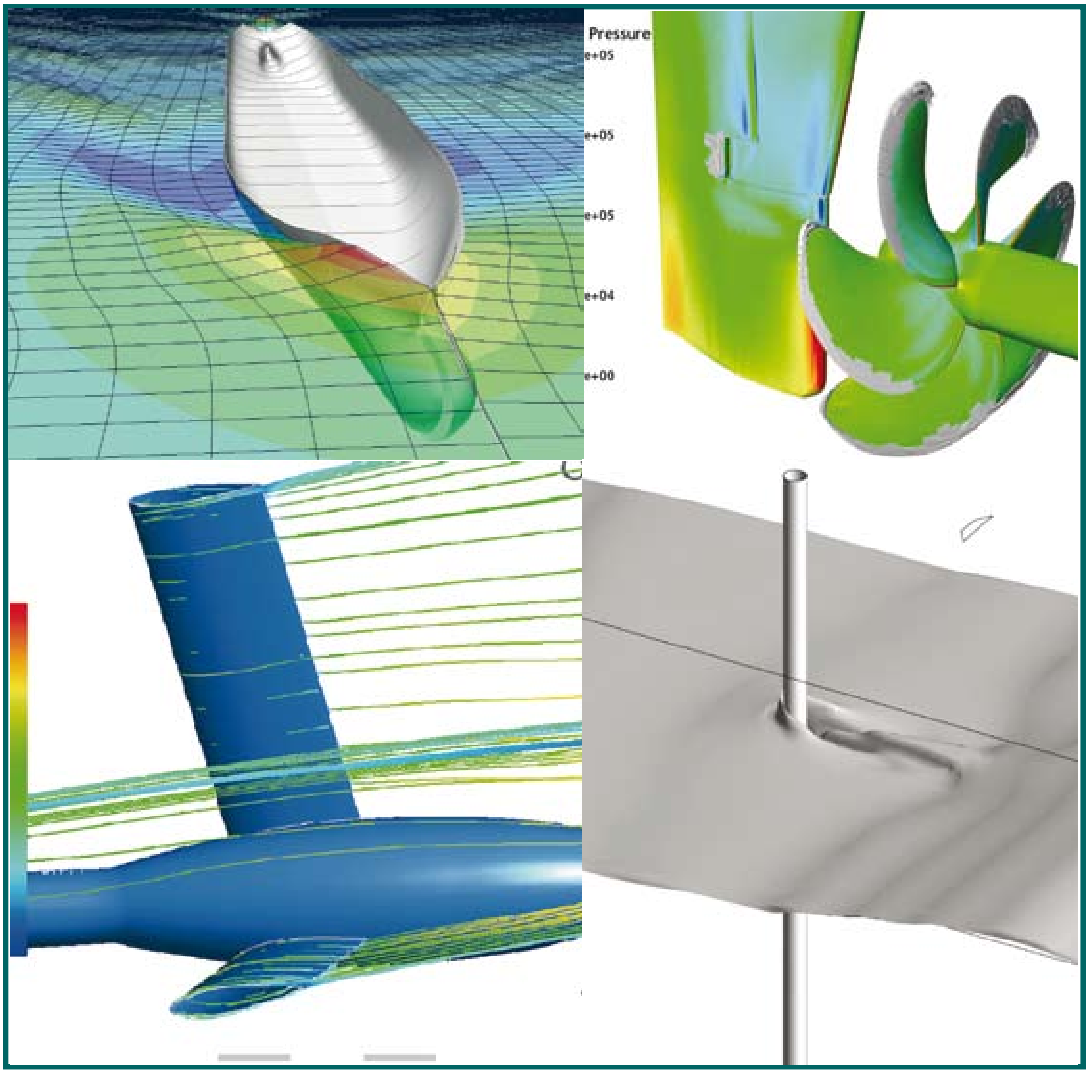

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International Conference

MARINE CFD

22 - 23 MARCH 2011
RINA HQ, LONDON, UK

day 1

08.30 – 09.00 COFFEE AND REGISTRATION

09.00 – 09.35 SIMULATION OF SHIP IN SELF PROPULSION WITH DIFFERENT CFD METHODS: FROM ACTUATOR DISK TO POTENTIAL FLOW COUPLED SOLVERS TO FULLY UNSTEADY RANS MODELS
D Villa , S Gaggero and S Brizzolara, University of Genova, Italy

The problem of self propulsion can be tackled from a numerical point of view with different theoretical models associated with different levels of accuracy. In this work different matching approaches are discussed. First a simple “unsteady” axial actuator disk, which strength is evaluated from the potential solution of the propeller inside the hull wake, will be employed in order to iteratively reach a balanced conditions between propeller thrust and ship drag. Moreover a more consistent model, based again on an iterative approach and on unsteady body forces, will be adopted to represent the three dimensional effects related to the effective blade geometry. Results will be compared in order to identify the capabilities of the coupling technique and the hypothesis of practical applicability of such kind of procedure.

09.35 – 10.10 USING CFD CALCULATIONS TO IMPROVE PREDICTIONS OF SHIP MANOEUVRES
Serge Toxopeus, MARIN, The Netherlands

This paper presents the necessary steps required to predict ship manoeuvres using CFD tools as a Virtual Manoeuvring Basin. The test subject is the Hamburg Test Case (HTC). Based on a series of CFD calculations (including extensive verification and validation of the results) in which captive model tests on the bare hull are mimicked, hydrodynamic coefficients are derived. Comparison between the original (fully empirics-based) predictions, the predictions improved by using CFD results and free sailing manoeuvring test results are made.

10.10 – 10.45 APPLICATION OF OPEN FOAM TO HULL FORM OPTIMISATION AT STX FRANCE
S Cordier, L Morand and J Roux, STX France SA, France
E Cortey, CFD Numerics, Lyon, France

The approach developed at STX France SA with CFD Numerics is presented along with the calculated resistance of 3 very close hull forms, each optimised for a different speed (16, 18 and 21 knots). These results compared with model test resistance data for the 3 forms as well as potential flow results will be the highlight of the paper since they show that both the relative ranking of the 3 forms at the 3 speeds is predicted but the absolute value of resistance at model scale is also well predicted.

10.45 – 11.15 COFFEE

11.15 – 11.50 PREDICTIONS OF RESISTANCE AND PROPULSION PERFORMANCE PARAMETERS FOR SURFACE SHIPS USING COMPUTATIONAL FLUID DYNAMICS
P W Bull, QinetiQ Haslar

Numerical computations of the viscous and free surface flow around representative ship hulls and propellers are compared with the equivalent measurements obtained for the resistance, sink, trim and wake parameters for the ship and thrust and torque characteristics of the propellers. The objectives of the predictions were to examine the numerical and modelling parameters required for reliable comparison with the measured data for the complex three-dimensional, turbulent wake and wave flows. The two ship hulls are the KCS container ship hull and the fully appended Alliance survey vessel and the propeller blades were the standard DTRC 4119 and a more advanced, skewed blade, designated C670, which is one of a systematic series of propeller blades designed at QinetiQ Haslar.

11.50 – 12.25 VISCOUS FLOW COMPUTATIONS ON PROPULSORS - VERIFICATION, VALIDATION AND SCALE EFFECTS
D Rijpkema, G Vaz, M Hoekstra, C Klaij, J Windt and J Bosschers, MARIN, Wageningen, The Netherlands

In this paper, viscous flow results for three propulsors in open-water configuration are shown: 1) the well-known E779A propeller normally used as benchmark test-case; 2) a modern highly-skewed propeller; 3) a ducted propeller. Numerical sensitivities are checked, verification is performed and the open-water characteristics for the three test-cases are validated against experimental data. The computations are performed for a broad range of advance-coefficients from J=0.1 up to J=1.2, using structured and/or unstructured grids. Viscous flow related features (blade-hub flow, tip flow, tip-vortex, limiting-streamlines, separation areas, slip-strea) are studied.

12.25 – 13.30 LUNCH

13.30 – 14.05 A REDUCED ORDER MODEL OF PROPELLER UNSTEADY FORCES FOR COMPUTATIONAL FLUID DYNAMICS SIMULATIONS
J Koncoski, E Paterson and W Zierke, Applied Research Laboratory, The Pennsylvania State University

This work calibrates an unsteady, gust-response model for low-aspect ratio blades in sheared flow, typical of turbomachinery applications. The gust-response model is integrated with an existing, steady, bodyforce representation of a propeller in a viscous flow solver. The resulting unsteady-body-force model is validated against geometrically-resolved, unsteady simulations of a propeller in spatially-varying flow. The unsteady-body-force model predicts directionality of propeller unsteady forces and moments based on inflow harmonic content. The magnitude and phase of forces and moments generated by the model compare well with geometrically-resolved simulations, and match published results from unsteady liftingsurface codes.

14.05 – 14.40 STERN CHALLENGE – GETTING IT RIGHT
D.Radosavljevic, S.Whitworth and C.Zegos, Lloyd’s Register

Minimising the drag force and ensuring a good quality propeller inflow, so as to maximise propeller thrust and minimise cavitation, are two of the most important factors in hull design and optimisation. An essential part of this process is a good prediction of the wake field. However, this prediction can become a very complex task in the presence of various appendages or flow altering conditions, such as condenser outflows or multi-body interactions as in a tug-barge combination.

14.40 – 15.10 COFFEE

15.10 – 15.45 TRIMWEDGE OPTIMIZATION USING RANS/FS.
Starke, A.R., Ploeg, van der A. and Veldhuis, C.H.J., MARIN

In the present paper we will compare 3D RANS/FS computations including free trim and sinkage for a ship at a given draught and speed with available experimental data, showing the capabilities of our method. The comparison includes predicted resistance values, stern wave patterns and dynamical trim and sinkage values for various trimwedges. As the flow off the transom is dominated by viscous effects, it can be expected that the Reynolds scale effect can have a big influence on the flow off a transom, and possibly on the optimum trimwedge. This issue will be addressed as well.

15.45 – 16.20 CFD ANALYSIS OF THE HULL RESISTANCE OF SMALL CRAFTS
I Viola, Newcastle University, UK

In the present paper, the hull resistance of two hulls candidate to the 32nd America's Cup are computed with a Navier-Stokes code. The hulls are modelled with the appendages in a free to sink and trim condition. The experimental data of the first hull was known a priori, while the experimental data of the second hull was known only a posteriori. Froude numbers from 0.22 to 0.44 were investigated. The numerical/experimental comparison showed differences of the order of 1% for every Froude number. The relative difference between various speeds for the sink and the trim was of the order of 1 mm and 0.01 degree, respectively.

16.20 – 16.55 COUPLED CFD AND STRUCTURAL ANALYSIS FOR WORLD OUTRIGHT SAILING SPEED RECORD PREPARATIONS
T Clarke and S Howell, Verney Yachts Ltd

The brief for the boat, v-39 Albatross is to set a new world outright sailing speed record at Portland Harbour, UK by 2013. The boat is configured to add at least 10 knots to the current record by setting a speed above 60 knots (111 kph). The purpose of the analyses is to capture the above surface aerodynamics of the boat, and to establish overall aerodynamic forces and moments acting on the boat with different control inputs. This process allows us to tune the control system to minimise control cross coupling and to maximise forward thrust, whilst maintaining roll balance of the overall boat.

16.55 - EVENING DRINKS RECEPTION

day 2

08.30 - 09.00 COFFEE AND REGISTRATION

09.00 - 09.35 A CFD INVESTIGATION WITH HIGH-RESOLUTION GRIDS OF DOWNWIND SAIL AERODYNAMICS
I Viola, Newcastle University, UK

The aerodynamics of an America's Cup yacht - sailing downwind - is investigated with different grids. From 170,000 to more than one billion cells were used. Three numerical schemes of increasing accuracy were used for each tested grid. Being the first time that a grid of more than one billion cells is achieved on a complex three-dimensional geometry, the meshing procedure and the high performance computing (HPC) environment are described in details. The one-billion-cell simulations run on 512 CPUs for about 170 hours using 2 TB of RAM. The computed forces were compared with wind tunnel data. While the less accurate numerical scheme did not showed a consistent trend increasing the grid resolution, the most accurate numerical schemes showed asymptotic trends. Lift and drag were over-estimated of roughly 20%. Similar results were achieved in previous works. Differences and similarities are discussed.

09.35 - 10.10 CFD FOR EXHAUST GAS DISPERSION: RANS VERSUS LES SIMULATIONS
B Blocken, Eindhoven University of Technology (TU/e)

This paper attempts to demonstrate the differences in CFD results between steady RANS analysis and unsteady large eddy simulation (LES) for gas dispersion around navy ships. It indicates those situations in which steady RANS can be suitable, and those situations in which the more expensive LES approach is required to obtain accurate results. The study shows that RANS modeling alone is generally insufficient to deal with the complexity of gas dispersion dynamics over ship superstructures.

10.10 - 10.45 WIND ENVIRONMENTAL CONDITIONS IN THE CANAL RIA DE FERROL, GALICIA, SPAIN
B Blocken, Eindhoven University of Technology, The Netherlands
J Dekker, MARIN, The Netherlands
O Weiler, Deltares, The Netherlands

In this study, CFD has been used to analyse the wind conditions in the canal. Different CFD RANS turbulence models and near wall treatments have been employed. The CFD results have been compared with on-site measurements to validate the computational model. The study shows the unexpected but very large influence of the small-scale roughness of the terrain, as characterized by the aerodynamic roughness length or the equivalent sand-grain roughness height, on the wind conditions in the canal. It is shown that, when taking the actual roughness conditions into account, CFD predictions of about 10% accuracy are achieved.

10.45 - 11.15 COFFEE

11.15 - 11.50 NUMERICAL PREDICTION OF SQUAT OF LARGE CONTAINER CARRIERS ON WATERWAYS
C Böttner1, K Uliczka and M Kastens, Bundesanstalt für Wasserbau
J Heimann, FutureShip GmbH

Ship squat is regarded mainly a Bernoulli-Effect and should therefore be computable using potential flow approaches with reasonable accuracy. However, for extreme conditions at very low under keel clearance (h/T < 1.2) and/or tight side restrictions (banks, canal walls or similar), there are effects based on viscosity leading to severe deviations between squat prediction based on potential flow analysis and on RANS-E modelling, the latter accounting for viscosity and turbulence. Towing Tank test (scale 1:40) results as well as full scale measurements on the river Elbe offered a validation of the numerical results.

11.50 - 12.25 CFD SIMULATION AND VALIDATION OF FREE SURFACE EFFECTS WITH APPLICATION TO MANOEUVRING IN SHALLOW WATER
S J P Watson, QinetiQ, UK

CFD prediction of turning circles in shallow water for a single hull and a catamaran is used to illustrate the changes in validation required by changes in environment and the associated changes in physics. As water depth decreases, there are systematic changes in both the wave and the viscous wake of a vessel which alters its resistance, propulsion and manoeuvring. When clearance becomes very limited, viscous secondary flows are induced in both wake and on the seabed. The influence of these interactions and the numerical formulation for the reliable prediction of component resistance and inertias is addressed.

12.25 - 13.30 LUNCH

13.30 - 14.05 NOZZLE DESIGN USING AUTOMATED OPTIMIZATION ROUTINES
T Huuva, Berg Propulsion

Here two methods for automated CFD-simulations are developed, one using a 2D axisymmetric simulation model, with a simplistic model of the propeller, and one with 3D geometry model including the propeller geometry. The simulation methods use design of experiments, optimization algorithms and statistical methods to evaluate the effect of geometrical changes to the efficiency of the propeller and nozzle. All nozzle geometries are analyzed using an automated CFD techniques, which handle meshing, solving and post processing of the results. The CFD results are used as input for the optimization algorithm and in order to understand the response of the geometrical shape in the thrust, data from the simulations were also investigated using statistical tools.

14.05 - 14.40 ANALYSIS OF CAVITATING FLOW IN TUNNEL THRUSTER
N Bulten and I Oprea, Wartsila Global

In this paper a numerical analysis of the flow through a tunnel thruster will be presented. The calculations are carried out based on the fully transient moving mesh approach. Since calculations have been made with and without the cavitation model activated, comparisons can be made between the results with and without cavitation. Interesting topics are among other the blade forces during a revolution and the pressure pulses. It is expected that the pressure pulse contributions of the wetted and cavitating flow in the confined space of a tunnel with extreme small tip clearance might act different compared to a standard open propeller behind a ship.

14.40 - 15.10 COFFEE

15.10 - 15.45 MULTI-OBJECTIVE OPTIMIZATION OF A HIGH-SPEED VESSEL WITH INTEGRATED BOW LIFTING BODY
B Rosenthal, Navatek Ltd. USA

To date, BLB's have been designed for a single operating condition: speed, sinkage, and trim. While this has proven to be effective, there may be further benefits to designing the BLB across the entire speed of operation of the target vessel. This paper examines the optimization of a high-speed, semi-planing hull with integrated bow lifting body. The optimization uses 26 objectives in finding a range of optimal designs. The objectives include the steady resistance at six speeds, the motions at six speeds, the accelerations at six speeds, added resistance at six speeds, the structural worth, and the presence of cavitation at max speed. All values are computed using the high-order potential flow code AEGIR.

15.45 - 16.20 COMPUTATION OF ADDED RESISTANCE ON HIGH-SPEED HULLS AND HULLS WITH LIFTING SURFACES
D Kring, Navatek Ltd. USA

A method for computing added resistance in a seaway was developed and implemented in the high-order potential flow code AEGIR. The method is solved directly on the underlying CAD geometry for a high degree of accuracy. This method was validated on a large, low-speed container vessel as well as a bulk carrier. For this paper, the code was tested on a high-speed, semi-planing vessel at several speeds and headings. The process was then expanded to examine the same vessel with integrated lifting surfaces. An intermediate step was done to examine the added resistance of a single lifting surface below a free surface. This paper examines the underlying equations for the barehull and how the solution needs to be expanded for lifting surfaces.

16.20 - 16.55 STABILIZING FINS: CFD SIMULATIONS TO OPTIMIZE LOCATION ON MOTORYACHTS
S Bartesaghi and S Della Rosa

CFD RANS code with multiphase Volume of Fluid model (VOF) makes possible to verify the fins' alignment with the fluid flow around the hull, for different design solutions. Moreover it has made possible to calculate added wave resistance increment and relative dynamic trim and sinkage, indicating the best design solution. 33m motoryacht has been tested with two different design solutions: 2 or 4 fins installation at the same total wet surface. The hydrodynamic features of the bare hull are known and numerically validate by a comparison between towing tank data scaled to real geometrical dimension and CFD simulations also in 1:1 scale.

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