Report No: 1029

Annual Report 1994

June 1995

TU Delft

Delft University of Technology

Department of Mechanical Engineering and Marine Technology
Ship Hydromechanics Laboratory

ANNUAL REPORT 1994

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Delft University of Technology
Dep. of Mechanical Engineering
and Marine Technology
Mekelweg 2, 2628 CD Delft
The Netherlands

Ship Hydromechanics Laboratory

INTRODUCTION

In 1994 the department of Ship Hydromechanics merged with the departments of Ship Construction and Ship Design to form the department of Maritime Technology. The merger reflects the growing need to increase the efficiency of the organisation. This has already resulted in increasing co-operation in the field of research and formed a good basis for carrying out projects with industry requiring input from all sections of the new department. The head of the department of Maritime Technology is elected every two years. The present head of department is Prof.dr.ir. J.A.Pinkster.

This report covers the activities of the Ship Hydromechanics Lab. for 1994. In this year two staff members obtained their doctorate. Dr.ir. J.A. Keuning, a well known member of the staff, obtained his doctorate on the subject of 'Dynamic Behaviour of Fast Ships'. His promotor was Prof.ir. J. Gerritsma. Dr.ir. J.H. de Koning Gans obtained his doctorate on the subject of 'Instationary Cavitation on a 3-dimensional Foil'. Promotor was Prof.dr.ir. G. Kuiper.

This year ir. A.P. van't Veer started his 4 year Ph.d. study in the Laboratory. The subject of his work is wave loads and motions of fast catamarans.

The department was fortunate to have as visiting research fellow, Dr. Irina Dmitrieve from the Ship Hydrodynamics department of the Marine Technical University of St.Petersburg. Her work was mainly concerned with 3-dimensional diffraction theory computations in connection with offshore structures.

Within Delft University of Technology co-operation with the faculty of Civil Engineering has been increasing. Assistance has been given with respect to a number of final year student projects involving floating offshore structures. This has involved both model tests in our facilities and the use of specialised software developed by the department. We look forward to strengthening of these ties in the future.

Prof.dr.ir. J.A. Pinkster

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1. ORGANIZATION OF THE SHIP HYDROMECHANICS LABORATORY

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Ir. J.M.J Journée	(member)	783881
Ing. A. Goeman	(member)	781893

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Prof.dr.ir. J.A. Pinkster	783598
Prof.dr.ir. G. Kuiper	786860
Ir. J.M.J. Journée	783881
Ir. J.A. Keuning	781897
Ir. J. Ooms	783876
Ir. P.F. van Terwisga	781570
Ing. A.A.M. van Gulik	784684
Ing. A. Versluis	783871

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Ing. A. Goeman	781893
P.W. de Heer	786873
R. Onnink	786872

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Ph.D. Students:

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Arun Kr. Dev, BScEngg. MSc. CEng.	781570
Ir. H.J. de Koning Gans	781852
Ir. A.P. van't Veer	781859

During this year the following persons left the Ship Hydromechanics Laboratory:

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2. DOCTOR'S THESES

At the Ship Hydromechanics Laboratory the following persons were working on their doctor's thesis:

- Doctor's Thesis, March 15, 1994 at the Delft University of Technology
  Ir. J.H. de Koning Gans on the theme:
  'Instationary Cavitation on a 3-Dimensional Foil'
  Supervisor: Prof.dr.ir. G. Kuiper

- Doctor's Thesis, September 14, 1994 at the Delft University of Technology
  Ir. J.A. Keuning on the theme:
  'Dynamic Behaviour of Fast Ships'
  Supervisor: Prof.ir. J. Gerritsma

- **Ir. J.L.M. Adegeest** on the theme:
  'Short and Long Term Wave Loads'
  Supervisor: Prof.dr.ir. J.A. Pinkster

- **Arun Kr. Dev, BScEngg. MSc. CEng.** on the theme:
  'Hydrodynamic Aspects of Moored Semi-Submersibles in Extreme Seas'
  Supervisor: Prof.dr.ir. J.A. Pinkster

3. EDUCATIONAL PROGRAM (in Dutch)

Prof.dr.ir. J.A. Pinkster

MT513, 'Ship Motions and Steering I'
Part 1: Ship Motions
Part 2: Steering and manoeuvring
Part 3: Waves

MT514, 'Ship Motions and Steering II'
Part 1: Steering
Part 2: Ship Motions

Prof.dr.ir. G. Kuiper

MT512, 'Resistance and Propulsion' (in English)

Ir. J.M.J. Journée

X2MT1, 'Offshore Hydromechanics'

X1, 'Offshore Technology'

Ir. J.A. Keuning

Wbm107, 'Technical Systems'

MT510, 'Geometric and Stability'

4. STUDENT THESIS

05-07-1994 **Moulijn, J.C.**
'De invloed van Skew en Rake op Cavitatie-Inceptie'.

19-08-1994 **Marburg, C.G.A.**
'Energiewinning uit golven'.

5. MEMBERSHIPS OF INTERNATIONAL ORGANIZATIONS

- Member Advisory board Institute for Marine Dynamics (IMD), St John's, New Foundland.
- Member Advisory board Offshore MARIN.
- KIVI/MarTec, Chairman.
- Ocean Engineering: International editor.
- International Shipbuilding Progress (ISP): Senior editor.
- International Towing Tank Conference (ITTC): Ocean Engineering Committee (chairman).
- Membership of CMO advisory panels and committees: General Hydrodynamics.
- SNAME
- Int. Techn. committee of Offshore Racing Council, London
- High Speed Marine Vehicles Committee of the International Towing Tank Conference
- Chairman of the Organisation Committee of International Symposium on Yacht Design and Yacht Construction

6. CONTRIBUTIONS TO SYMPOSIA, CONGRESSES etc.

1. **'Probability distributions for wave loading on single point mooring systems', by Dr.ir. A.E. Mynett, Ir. H. Boonstra and Ir. J.A. Keuning**

   BOSS'94 Symposium, 7th International Conference Behaviour of Offshore Structures, Massachusetts Institute of Technology, USA, 12-15 July 1994

2. **'Experimental Evaluation of the Viscous Contribution to mean Drift Forces on Vertical Cylinder', by Arun K. Dev, BScEnng.MSc.CEng and Prof.dr.ir. J.A. Pinkster**

   BOSS'94 Symposium, 7th International Conference Behaviour of Offshore Structures, Massachusetts Institute of Technology, USA, 12-15 July 1994

3. **'Shipmotion Calculations in Ship Design Process', by Ir. J.M.J. Journée and Ing. A. Versluis**

   Advances in computer auded engineering, CAD/CAM-research at Delft University of Technology, VF-project CAD/CAM 1989-1994, Delft University of Technology, the Netherlands

4. **'Hydrodynamic Loading on Semi-Submersibles and Tension Leg Platforms in Steady Currents' by Arun K. Dev, BScEnng.MSc.CEng**

   Offshore South East Asia, 10th Conference and Exhibition, World Trade Centre, Singapore, 6-9 December 1994

5. **'Mathematical modelling of motions and damaged stability of Ro-Ro ships in the intermediate satges of flooding' by Ir. H. Vermeer, Ir. A.W. Vredeveldt and Ir. J.M.J. Journée**

STAB'94 Conference, Melbourne, USA

7. PUBLIC ASSISTANCE

During this period considered the Laboratory, besides its normal research, provided (payed) services for Industry and Government. This included model tests, full scale trials studies etc. In 1994 the next projects have been carried out:

- 'FIFE FPSO: Motions, relative motions and pressures', Bluewater Engineering BV, Marsstraat 33, Hoofddorp, the Netherlands.

- 'Passeerkrachten afgemeerde schepen', Marine Safety Rotterdam BV, Wilhelminakade 701, Rotterdam, Nederland.

- 'Metingen aan een zeiljacht model met Rotary Wing', Lumiflex Precision Engineering, Nijverheidsweg-N. 60, Amersfoort, Nederland.

- 'Loodstender VOYAGER, deel IIa: Hydromechanisch gedrag', Loodswezen BV, Kanaaldijk 242, IJmuiden, Nederland.

- 'Loodstender VOYAGER, deel IIb: "Langeduur" metingen', Loodswezen BV, Kanaaldijk 242, IJmuiden, Nederland.

- 'Loodstender VOYAGER, deel IV: Comfortmetingen', Loodswezen BV, Kanaaldijk 242, IJmuiden, Nederland.

- 'Motions and Loads on a LPC-Vessel', GEFONZO BV, Veere, the Netherlands.

- 'Experiments on the dynamic behaviour of Ferry-62 during a sudden ingress of water due to a collision amidships', TNO-CMC, Leeghwaterstraat 5, Delft, the Netherlands.

- 'Simulations of the motions and loads for the M-frigate MF19',
  Royal Dutch Navy, P.O.Box 20702, The Hague, the Netherlands.

- 'Development of a 3-D computational Method for a SES at Zero Forward Speed',
  MARIN, P.O.Box 28, Wageningen, the Netherlands

8. RESEARCH

Dynamics behaviour of high-speed vessels in waves.
Dr.ir. J.A. Keuning.

The final set of experiments with fast monohulls in head waves have been carried out in the towingtank of the Laboratory. The results of these experiments have been analysed and used for validation of the code FASTSHIP. In the framework of the doctors thesis a sensitivity analysis of some of the nonlinear components in the computational model underlying FASTSHIP has been performed and their influence on the validity of the predicted motions and accelerations checked. All results obtained in the framework of this project are incorporated in the doctor's thesis " The nonlinear behaviour of fast monohulls in head waves", which was succesfully defended in september 1994. This part of the project is closed.

For an extension of the work on planing hulls four additional models have been prepared and constructed for the Delft Systematic Deadrise Series. These models have a deadrise at ordinate 10 of 19 degrees and are intended to fill up the "gap" in the Series. A measurement scheme in accordance with the Series has been made and testing is foreseen in 1995. The results of these tests will be used to improve the polynomials used for the prediction of the trim, sinkage and resistance of planing hulls, which is operational at the Laboratory.

To investigate whether it is possible to fulfil the present, needs for another kind of oscillation experiments in order to be able to investigate nonlinear behaviour of ships. Hereto a new kind of oscillator is necessarry capable of performing non-harmonic motions in more than three degrees of freedom. A part of the project has been carried out by a student of the Technische Hogeschool Brabant as his final thesis-work. A preliminary report has been written. The proposed instrument offers very promising new possibilities which will be investigated further.

Seakeeping Behaviour of Ships.
Ir. J.M.J. Journée.

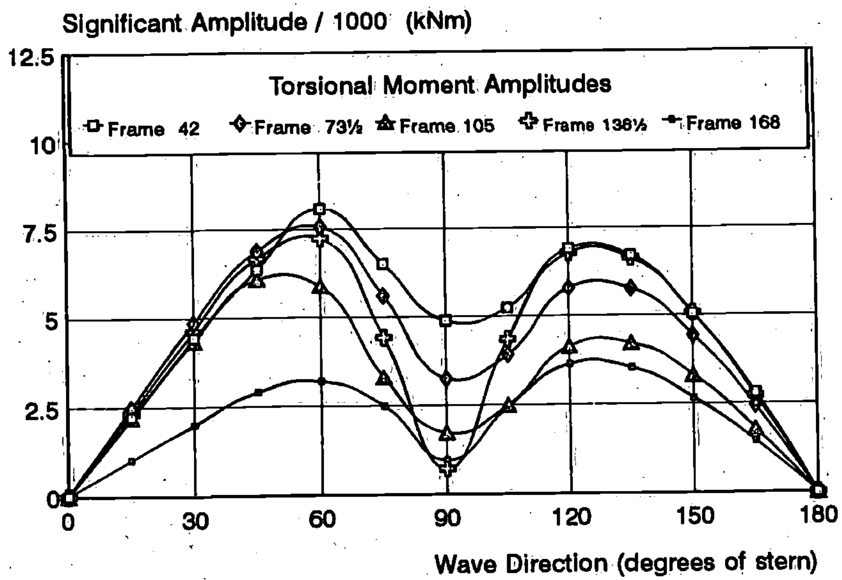
Using Lewis and close-fit conformal mapping of cross sections to the unit circle, a method has been developed to determine the wave loads on a ship in beam waves from the results of potential coefficient calculations only. The results will be presented at the ISOPE-1995 Conference.

The time-domain shipmotions program SEATIME, which calculates the (non-)linear motions of floating structures, has been extended with the forward ship speed. To obtain the linear and quadratic roll damping of a vessel a semi-empiric method, which determines the linearised roll damping only, has been modified. The results will be used in a study to the behaviour of the nets of a sailing fishing vessel in waves and its effect on the environment of the seabottom.

The shipmotions program SEAQUICK, which delivers the ship-designer information on the seakeeping qualities of his design in an early designstage, has been adapted to the last modifications and improvements of the program SEAWAY. Detailed updated reports are in preparation.

In behalf of "Loodswezen BV", full scale experiments were conducted with the high speed pilotvessel "Voyager". During an intensive one-week measuring program, full scale acceleration, stopping, manoeuvring and seakeeping tests were carried out in- and outside the jetties of IJmuiden. During one month, long term ship motion data have been collected by an automatic recording equipment on the ship. All data have been translated to statistics for judging the behaviour of this type of a ship. Measured motions have been compared with predictions made by program SEAWAY.

Also this program has been used to examine the design of a new type containervessel of GEFONZO BV at Veere, suitable for inland waterways and North Sea areas. Special attention has been paid to acceleration, shipping green water, slamming and the bending and torsional moment aspects.



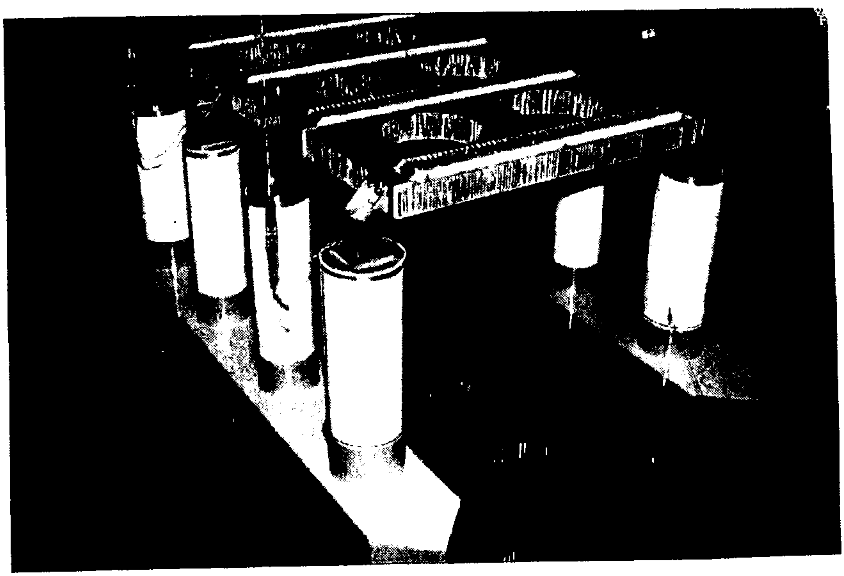
Short and long term behaviour of (non-)linear wave loads on ships.
Ir. L.J.M. Adegeest.

In 1994, a four-years project focussed on the nonlinear behaviour of hull girder loads in ships was finished by compilation of all the results into a dissertation, titled 'Nonlinear Hull Girder Loads in Ships'.
The vertical hull girder loads in a ship in head waves are studied. Fourier analysis of new regular wave towing tank results indicated clear second and third harmonic responses. The severest nonlinear behaviour occurs around the resonance peak of the relative motions at the bow. An increase of the bow flare and of the forward speed both increase the nonlinear response components significantly. In irregular waves, large skew and kurtosis are measured.

These nonlinear characteristics of the hull girder loads have an important impact on the strategy to be followed to determine statistical properties in arbitrary waves. A straightforward solution in the time domain is not acceptable due to the huge required computation time. Applying a *third* order Volterra modelling, nonlinear responses in irregular waves are calculated very efficiently using Fast Fourier Transformation techniques. The first order and the required approximations of the second and third order frequency response functions are derived from regular wave results only. A comparison of the power spectra and the probability density functions of fifty towing tank recordings for two models with those of the reconstructed signals shows a good agreement. The same degree of correspondence is not found using a linear or second order modelling.
A complete numerical analysis of the statistical properties of the hull girder loads requires the calculation of the response functions in regular waves for a limited number of frequencies. Encouraging results are obtained using a nonlinear time domain program in which variations of the wetted geometry are taken into account.
A complication in applying the third order Volterra modelling is the unique determination of the nonlinear frequency response functions. Amplitude dependent trends in the normalised second harmonic responses show that higher than third order effects are present. As the statistical properties are predicted well by the third order Volterra modelling, it follows that a reasonable estimate of the nonlinear frequency response functions already satisfies. The Volterra modelling in combination with the known frequency response functions can also be used to calculate directly the spectral and statistical response moments in arbitrary waves without performing simulations. Knowledge of these moments offers the opportunity to apply approximate statistical models for the calculation of lifetime statistics.

The behaviour of moored semisubmersibles in extreme sea-conditions.
A.K. Dev, MSc.

Experiments have been conducted for a ITTC semi-submersible model in Towing Tank No. I of Ship Hydromechanics Laboratory. Tests have been done for a wide range of parameters in regular waves for head seas and beam seas condition for a captive model with zero speed and with forward velocity to simulate currents.
Following the above experiments, the model construction was changed for conducting experiments in a free floating condition (soft moored) condition. Tests have been conducted in head seas condition both in regular and irregular waves with zero speed and with forward velocity.



Data analysis for regular waves show encouraging results for the second order mean drift forces when viscous effects are taken into account when compared to experimental results. Further, excellent comparisons are noticed for first order forces and motions as well. Detailed results are being produced in internal reports. Partial results have been disclosed in a technical paper (BOSS-1994 Conference) and a further publication would be available in a technical paper (ISOPE-1995 Conference).

Test results for the interference effects between columns of a semi-submersible in currents (in a uniform flow field) with respect to viscous drag forces are well predicted by a earlier developed Computer Program when experimentally obtained values of the drag coefficients are used. In this connection, a technical paper has been published in OSEA-1994 Conference.

Development of a radiation/diffraction model for floating structures in waves.
Prof.dr.ir. J.A. Pinkster.

The 3-dimensional computation method has been validated by Dr. Irina Dmitrieva Research Fellow from the Marine Technical University of St. Petersburg by comparing results of computations with analytical results for simple shapes of floating bodies and with experimental results for more practical shapes. The numerical model is being extended to take into account interaction effects between multiple indepently floating or fixed stuctures in waves. Numerical solutions for the unknown source strengths, which determine the ensuing wave pressures, are obtained using a direct solution technique, a conjugate gradient squared iterative solver and a method based on successive approximation of the interaction between the various floating structures. This allows a larger number of bodies to be included in the computations.

Manoeuvring of ships.
Prof.dr.ir. J.A. Pinkster / Ing. W. Beukelman.

A simplified model of the manoeuvring behaviour of fast planing craft has been selected as the basis for a set of experiments which will be carried out in 1995. This investigation will be carried out in co-operation with MARIN. A mathematical model based on 3-dimensional inviscid flow has been developed with the purpose of predicting the interaction effects of passing ships on each other or on moored vessels. The interaction effects in terms of time dependent forces and moments on the ships can be used to evaluate the dynamic loading in mooring lines of the moored vessels or the behaviour of the sailing vessels. The results of computations have been compared with published experimental results of the loads on large moored tankers in shallow water due to the passing of tankers. The computation method has been applied to practical cases relating to the harbour of Rotterdam.

The study on the lift production of a low aspect-ratio surface piercing wing-model in deep and shallow water has been continued.
Now, as starting point served the same static measurements as used for the first part. Now however, the manoeuvring aspects only are considered. Moreover, use has been made of the results of forced horizontal motion tests with a Planar Motion Mechanism (PMM) to obtain the hydrodynamic manoeuvring derivatives for deep and shallow water.
Calculations based on the potential theory and on the variation of the added mass impulse were carried out to determine the manoeuvring derivatives. Comparison with the measurements shows encouraging results to determine manoeuvring coefficients, also for the velocity derivatives. Both, experiments and calculations demonstrate a strong increase of the derivatives with draught and reduction of waterdepth. The report of this second part of the research related to manoeuvring is in print now.

The performance of sailing yachts.
Dr.ir. J.A. Keuning / R. Onnink.

The systematic calculations on the surfing behaviour of yacht hulls in large following waves have been delayed due to some shortcomings found in the computer code SIMULO. These have been investigated but have not yet been solved.

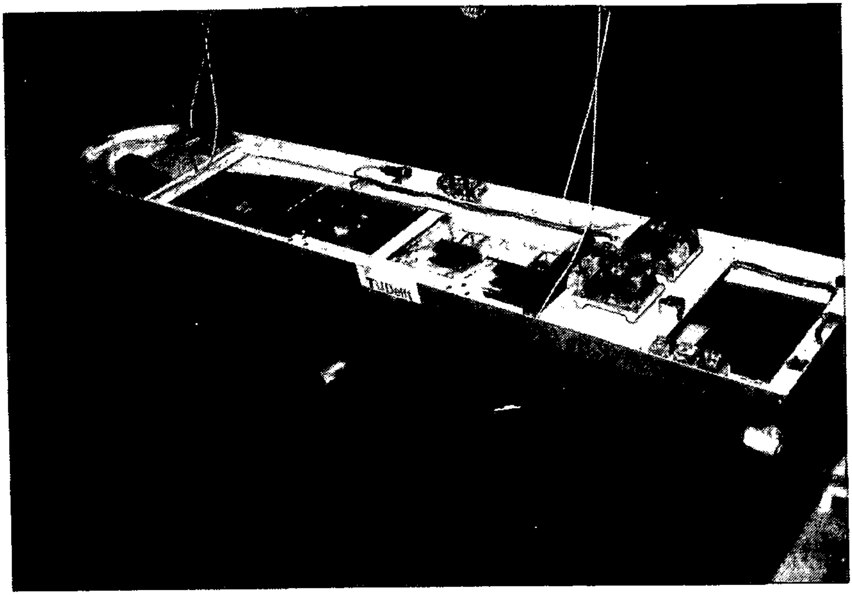
An extensive research has been carried out into the behaviour of a systematic family of yacht hulls in head waves. The lines of these hulls are derived from the results presented by Sclavounos from MIT. He calculated the motions and added resistance in waves of these yachts with the 3-D code SWAN from MIT. These results are presently being used in the Velocity Predictions of IMS for assessing the speedloss due to waves. The experiments in the towing tank have been set-up to validatie these results. In addition the results will be compared with those obtained with the 2-D strip theory code SEAWAY from the Laboratory.

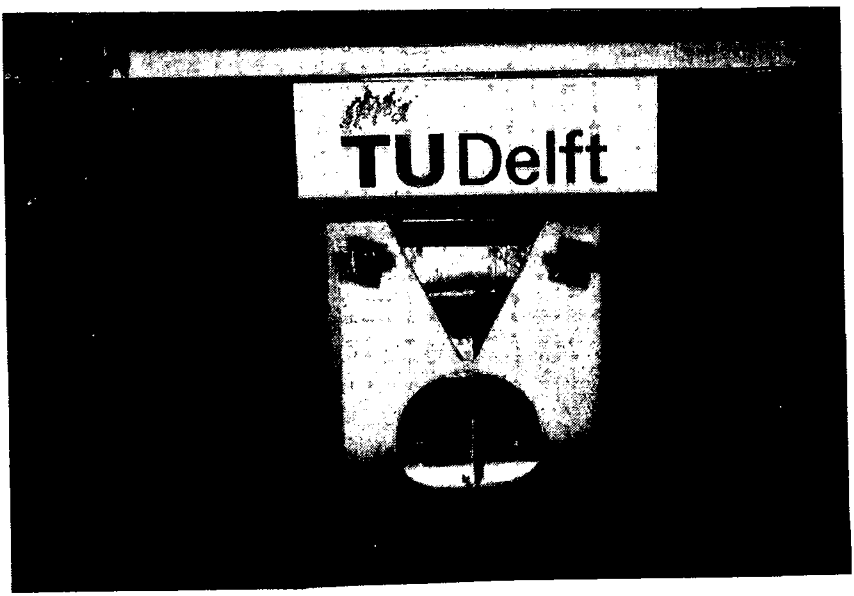
Extensive experiments have been carried out with the model of a sailing yacht to investigate the wing-body interaction. The hull used was a hull with great similarity to the 1992 America's Cup yachts. The keel and rudder were connected to the model by means of dynamometers to measure the lift and the drag of the appendages separately. This model has been tested in four different configurations, i.e.: the bare hull, the hull with keel, the hull with rudder and the hull with keel and rudder. The results of the experiments have been analysed. The results are compared with the results obtained with the CFD codes DAWSON and RAPID from MARIN. The first results will be presented at the Chesapeake Sailing Yacht Symposium of the SNAME in 1995. Further experiments are presently under way with additional models.

Safety at sea.
Ir. J.M.J. Journée.

In cooperation with TNO-CMC and DGSM, the dynamic behaviour of a ship after a sudden ingress of water due to a midship collision by an other ship has been investigated. The first results of this study were presented at the STAB-1994 Conf. in Melbourne, USA.

Preliminary model experiments with a RO-RO vessel, Ferry-62, have been carried out. The results have been compared with theoretical data, obtained by using Cummins equations to describe the motions of the vessel in the time domain and a theoretical description of the fluid-flow of the ingressed water in the ship. The results have been published. These first experimental results indicate that extra attention has to be paid to the theoretical description of the fluid-flow in the vessel.





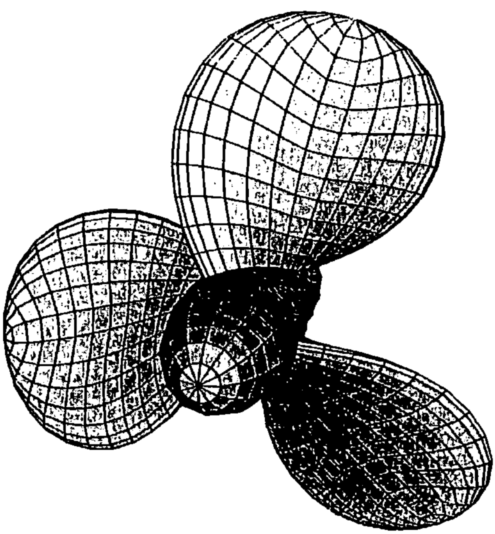
As a result of these first experiments, the measuring equipment has been improved and the experimental program for this model has been adapted. Additional experiments will be carried out for a range of collision gaps and metacentric heights.

Experiments with a model of a second ferry, Ferry-72 with other watertight bulkhead configurations, are in preparation.

Design of Profiles with a Prescribed Cavitation Behaviour.
Ir. H.J. de Koning Gans.

A calculation method has been developed for the determination of the hydrodynamic potential effects of a sailing vessel. This calculation routine is suitable for carrying out double-body flow calculations. The routine is suitable for flow calculations around rudders and propellers too.

Besides this, the development of a grid-generation program has been started. This program will generate numerical surfaces, to be used for flow calculations. An interface has been created to visualize the velocities and pressures.



The nonlinear behaviour of fast monohulls in head waves.
Dr.ir. J.A. Keuning

This study on the nonlinear behaviour of fast monohulls in head waves has been carried out at the Delft Shiphydromechanics Laboratory. Research on the dynamic behaviour of fast planing boats at the Laboratory started as early as 1970 with the work of J J van den Bosch and J Gerritsma.

The occurrence of high peaks in the vertical accelerations experienced by fast ships whilst sailing in head seas is the limiting factor for the safe operation. However the methods most commonly used for the calculation of the motions and accelerations of ships in waves are based on linear mathemathical models and these appeared not to be capable of predicting these peak values in the vertical accelerations with great accurracy.
Therefore in the frame work of this study an adapted computational model has been sought for the prediction of the motions and vertical accelerations of these ships. The aim was to use this model to be able to predict the operability of these fast monohulls in an early design stage. To do this the new computational model would have to incorporate a number of phenomena which are considered to be of importance for the nonlinear behaviour of these fast monohulls and which were presently not accounted for by using linear computational models.

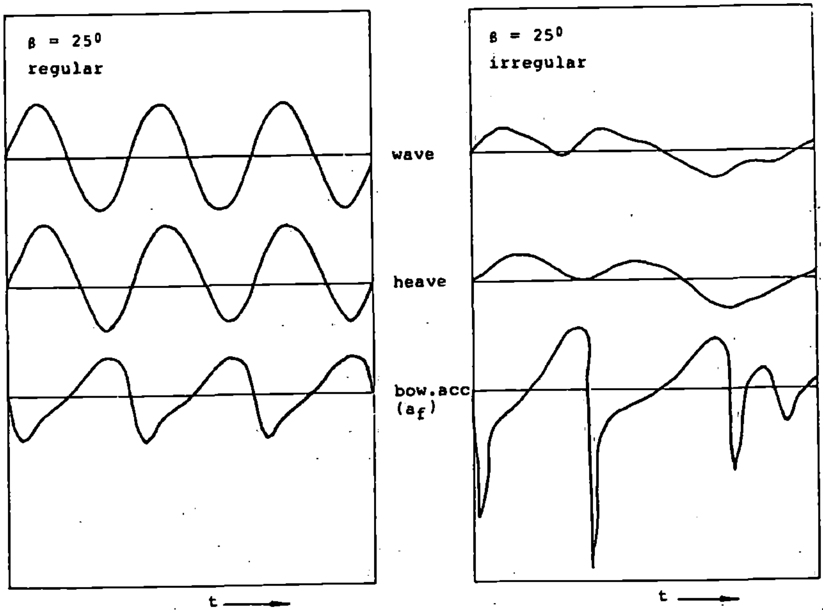
Most methods to predict ship motions in waves are based on linear models. This implies that the ship is considered to perform small amplitude motions around its "calm water zero speed" reference position. It is known however that fast ships may develop a considerable hydrodynamic lift. This hydrodynamic lift results among other things in a change of the reference position of the ship with respect to this "calm water zero speed" position: i.e. the sinkage (stationairy heave) and the trim (stationairy pitch). In addition to this the continous change of this hydrodynamic liftforce on the ships hull whilst performing its motions in the waves appeared to be a major contribution in the forces. The wave exciting and hydrodynamic reaction forces also have a considerable nonlinear character due to the change in instantenous submerged hull geometry of the ship while performing large relative motions with respect to the incomming waves.

In the new computational model special attention has been given to:

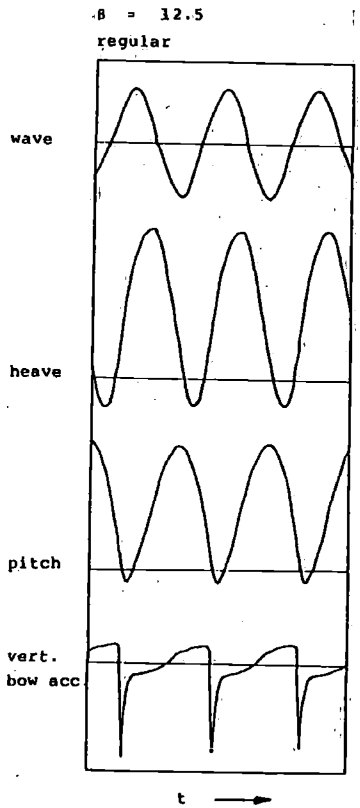
- the computation of the sinkage and the trim of the ship due to the high forward speed. A method to predict sinkage and trim of an arbitrairy monohull at speed based on results of extensive experiments has been developped.
- the computation of the hydrodynamic lift force distribution along the length of the ship using the known result for sinkage and trim at speed.
- the influence of the large relative motions of the ship and the bow flare of these ships
- the vertical added mass and its distribution along the length of the ship at high forward speed. In the model the added mass has been evaluated as time dependend.
- the wave exciting forces computed over the actual submerged volume of the hull in its relative motion with respect to the wave.

The first aim of the development of the new computational model in this study was to check whether the implementation of these effects was important for a more accurate prediction of the motions and accelerations of these fast monohulls in head waves. Hereto the emphasis has been placed on a proper but often more emperical discription of the effects mentioned rather than on an exact mathematical formulation hereof (if at all possible at the time).

As an example some sample results of the computer code FASTSHIP based on the nonlinear computational model are shown in the Figure. The results refer to two hard chined planing boat hulls with 12.5 and 25 degrees deadrise at midship respectively. These are two of the models of the Delft Systematic Deadrise Series consisting of some 15 different models all tested extensively in 80 different design conditions in calm water and a limited number in both regular and irregular waves in the frame work of this project. The forward speed for which the results are shown corresponds to approximatly 25 knots for a 15 meter boat. Shown are the heave- and pitchmotion and the vertical acceleration at the bow in both regular and irregular waves. The nonlinear respons of the boats is obvious and matches the results obtained from model experiments with identical models in the towing tank of the Delft Shiphydromechanics Laboratory. In addition the dependency of the nonlinear behaviour on the deadrise angle may be observed from these results.

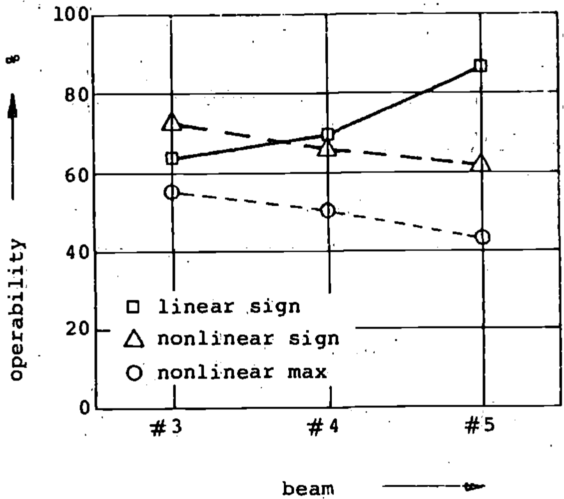


The results of this computational model have been validated using the results obtained from model experiments. The improvement in particular for the vertical accellerations over the linear computational models has been shown. It was shown that the implementation of the discribed effects into the nonlinear computational model improved the predictions considerably. In particular the high peaks in the vertical



accellerations were much better predicted. From full scale experiments aboard actual fast ships at sea carried out in the framework of this project this proved to be of importance. From these tests it was found that the occurrence of these peaks was the limiting factor for the save and comfortable operation of fast ships at sea. So the capability to predict these is of considerable importance.

The impact of these nonlinearities on the operability calculations for fast monohulls in head waves, as commonly carried out in the design process, have been demonstrated by using both linear and nonlinear computational models for these calculations. From this comparison it was shown that the use of linear models may lead to opposite trends of operability with respect to the change of certain design parameters.



Operability comparison as function of the beam using both linear and nonlinear computational models.

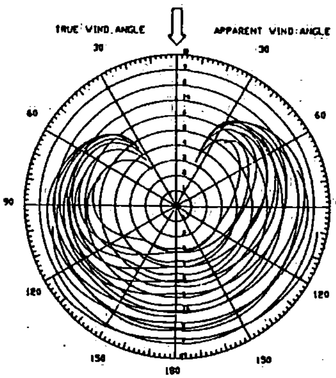
Behaviour of multi-hull vessels in waves.
Ir A.P. van 't Veer.

A literature research has been carried out to investigate the 3-D numerical methods being used to calculate the motions of a vessel sailing with forward speed in waves. The research has focussed on the frequency domain calculation methods. A report has been published on this topic. At the moment a detailed report is written on the numerical method, which will be used to calculate the motions of a multi-hull vessel. To investigate the ship motion problem a Rankine method will be used, including an implicit Kutta condition to model the interaction effects between the two hulls of the catamaran. The so-called double body potential will serve as the base flow of the ship motion problem.

Ship Design.
Ing. A. Versluis.

The "Velocity Prediction Program Delft" (VPP-Delft) has been extended to include the use of heeled resistance modeltest data as an input for the performance calculation of a sailing yacht. Also sailforce coefficients, measured on modelscale in a windtunnel, can be used as an input. The documentation of the "VPP"-Delft program is finished and will be reported soon.

In view of the continuous demand for new shipforms of varies types for student designwork and for the input in stability and shipmotion programs, such as PIAS, SEAWAY, DELFRAC and WAMIT, the database of basic shipforms has been extended with another three types. The programs to convert a general shipform to the required input for these programs have been completed. For all programs to calculate the resistance of the ship and determine the optimum propeller, usersfriendly shells have been made.



POLAR DIAGRAM

Low-Cost Motion Measurement Equipment.
Ir. J. Ooms.

Building on earlier research on low-cost sensors, 1994 saw their inclusion into a few instrumentation systems. Goal was to show that low-cost systems can be designed and built that can be used in applications where current systems are not cost-effective. One possible application is in disposable systems, like some wavebuoys. Another application is systems that monitor and display parameters, for example heave accelerations aboard fast vessels, and issue warnings when critical levels are approached. Still another application is long term unattended monitoring of ship motions for research applications. In all these applications cost is an important parameter. The systems implemented serve as demonstration projects and will be used by the Laboratory.

In 1994 the electronics of the Delft wavemeasuring buoy (WAVDEL-buoy) was redesigned using a new low-cost acceleration sensor. This made the electronics more stable, more rugged, easier to build, test and calibrate and shaved approximately DFl. 400,- of the parts cost of the buoy. Power consumption was reduced too. The roll-pitch measurement set, building of which started in 1993, was nearing completion in 1994. Calibration and writing technical documentation was almost finished by the end of the year.

Also at the end of the year, plans to develop a wavebuoy with built-in GPS receiver began to take shape. By now, prices have dropped so much that these too can be considered low-cost sensors. Using the Global Position System to determine the position and sending this information to the measurement site greatly facilitates the recovery of the buoy after use. Moreover, monitoring the buoy location also gives some clues about tide currents.
Also, attention has been paid to the presentation and the use of 3-D shipforms for analysing purposes. In cooperation with a master kayak builder from Texel a linesplan and a 3-D drawing of an original "Greenland" kayak have been made. In addition to this, an existing linesplan of a "Lely Schouw" has been converted to developable surfaces and plate expansions have been prepared.

For the optimalisation of 3-D floating wave breakers, DELFRAC computations have been carried out and the distorted wave surface in the shadow of the wave breakers has been analysed. The results have been used for an investigation of the efficiency of floating wave breakers, carried out by two civil engineering student

9. RESEARCH FACILITIES OF THE SHIP HYDRO-MECHANICS LABORATORY

For experimental research the Ship hydromechanics Laboratory has at its disposal of the following facilities:

TOWING TANK NO. 1

Length	: 142.00 m
Width	: 4.22 m
Water-depth	: 2.50 m
Carriage	: manned, motor driven
Carriage speed	: 7.00 m/s (maximum)
Capabilities	: Horizontal and Vertical PMM can be fitted
Wavemaker type	: flap type, electronic/hydraulic
Wavelength	: length 0.30 - 6.00 m, regular and irregular
Tests performed	: Resistance in calm water and waves. Open Water Propeller test. PMM-test on floating and submerged bodies, foils etc. Wave induced motions and loads on ships and floating and moored structures Slamming phenomena. Upright and heeled sailing yacht tests.

TOWING TANK NO. 2

Length	: 85.00 m
Width	: 2.75 m
Water-depth	: 1.25 m
Carriage	: manned, motor driven
Carriage speed	: 3.00 m/s (maximum)
Wavemaker type	: flap type, electronic/hydraulic
Wave length	: length 0.40 - 6.50 m, regular and irregular
Test performed	: Resistance and self-propulsion in calm water and waves. Open Water Propeller tests. Wave inducec motions and loads on ships and floating and moored structures upright and heeled sailing yacht tests.

CAVITATION TUNNEL

Facility tunnel.	: Kempf und Remmers, closed recirculation
Drive system	: 4-bladed axial flow propeller with Ward Leonard control.
Motor Power	: 15 Kw, (total) - 2920 rpm.
Pressures	: 102 kPa (max) - 11 kPa (min)
Instrumentation	: Propeller dynamometer, 5-hole pitot-tube, various pressure sensors, Laser Doppler Anemometry.
Type and location of torque and thrust dynamometer	: balance T- and Q dynamometer at the end of propeller shaft, Tmax 400 N, Q,max 10 Nm.
Propeller or model size range	: Propeller diameters from 50 - 160 mm.
Tets performed	: Propeller tests in uniform flows. Forces and pressure distributions on rudder, fins etc.

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