Discussions

16th International Workshop on Water Waves and Floating Bodies

22 – 25 April, 2001

Aki Grand Hotel, Hiroshima
JAPAN

Edited by

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Organization:
The 16th International Workshop on Water Waves and Floating Bodies was organized by the Department of Engineering Systems, Faculty of Engineering, Hiroshima University. The workshop was held at Aki Grand Hotel, Hiroshima, JAPAN from the 22nd to the 25th April, 2001.

Sponsors:
The 16th International Workshop on Water Waves and Floating Bodies was sponsored by The Office of Naval Research International Field Office and Electric Technology Research Foundation of Chugoku. The organizing committee cordially appreciate their financial supports.

ISBN 4-9900892-1-9

PREFACE

The 16th International Workshop on Water Waves and Floating Bodies (IWWWFB) was held at Aki Grand Hotel in Hiroshima, Japan from 22nd to 25th of April, 2001. The Workshop was organized by the Department of Engineering Systems, Faculty of Engineering, Hiroshima University.

Office of Naval Resaerch International Field Office, Electric Technology Research Foundation of Chugoku and Hiroshima University provided additional financial support for the workshop. We are most grateful for their support, without which the workshop would not have been possible.

As usual the papers were selected on the basis of extended abstracts. A total of 47 abstracts were selected to be presented at the workshop. The selection committee consisted of Professor Kazu-hiro Mori from Hiroshima University and the two previous organizers; Professor Robert Beck from the University of Michigan and Professor Touvia Miloh from University of Tel-Aviv.

The extended abstracts were published in the Proceedings distributed at the conference. This volume is the second volume of the wrokshop where all the written discussions to the technical presentations are given together with the replies by the authors. It is expected to have further understanding of the presented papers among those who are interested in. The discussions are listed in the alphabetical order of the first author so as the first volume.

In addition this volume also contains the final program of the workshop and the names and addresses of all the participants. Thank you for your participation.

Kazu-hiro Mori and Hidetsugu Iwashita
July 2001

CONTENTS

Wave-Drift Added Mass of Bodies with Slow Drift Motions

Bao, W. and Kinoshita, T.

Discuser: J. Grue

Questions/Comments:
A changed added mass due to the effect of incoming waves may be visible in experiments in the form of a changed resonance frequency of a moored system. In your case the added mass, and thereby the resonance frequency, changes according to the wave amplitude squared. Have this effect been observed in experiments?

Author's Reply:
We agree that a change in added mass will change the resonance frequency and it may be observed in the experiments. We are afraid that we did not make the measurement on the resonance frequency. Only the increase of added mass is observed in our previous experiments of forced oscillation. It is a good idea to include the observation on the resonance frequency in our future experiments.

Discusser: M. Kashiwagi

Questions/Comments:
How should we compute the motion by taking account of the wave-drift added mass? Because the wave-drift added mass is a function of the incident-wave frequency as well, the wave-drift added mass must be treated as a sort of the diffraction force to be considered as the right-hand side of the motion equations.

Author's Reply:
To compute the motion of floating body, the linear response and the slow drift motion are considered separately. In the linear case, we need not consider the wave-drift added mass since it is a quadratic term in wave amplitude. In the case of slow drift motion, the wave-drift added mass takes account of the component in the quadratic forces that is proportional to the acceleration of the motion. Although it is a function of the incident wave frequency, it can be moved to the left-hand side of the motion equation just like the way of wave-drift damping.

Discusser: B. Molin

Questions/Comments:
It seems to me that decay tests performed on semi-submersible platforms in waves yield a much larger change in added mass than what you obtain for a single cylinder. (I believe that you have reported such experiments in earlier papers). Is this due to interactions between the columns, as accounted for by potential flow theory, or are viscous effects at hand (flow separation around the columns)?

Author's Reply:

We agree that both interaction among cylinders and viscous effects may contribute to the significant increase of added mass when measured in waves. We are going to make another experiment in the near future to check their contributions.

An Enhanced Nonlinear Strip Method for Seakeeping Analysis

Bertram, V., Pereira, R. and Landrini, M.

Discusser: L. J. Doctors

Questions/Comments:

Could you please clarify the method of nondimensionalizing the results for the added mass and damping in the plots? For example,the sectional added mass has units of mass per unit length. Hence, the symbol ”m” cannot actually be the ship mass. Presumably, it is the sectional mass, instead.

Author's Reply:

The symbol m indeed is the ship mass. The added mass is that of the ship section, i.e. the integral of the sectional mass (per length) over one strip.

Discusser: M. Kashiwagi

Questions/Comments:

How are you treating the surge mode in the enhanced nonlinear strip method?

Author's Reply:

We use the hydrodynamic coefficients from the 3-d GFM and in addition have a correction considering the resistance characteristicsof the ship and the propeller characteristics. This correction is the same as previously described for my 3-d Rankine singularity method.

Unsteady Free Surface Waves by Domain Decomposition Approach

Campana, E. F., Iafrati, A.

Discusser: K. Mori

Questions/Comments:
The results you showed are very interesting. We are very much interested in the unsteadiess of the surface. May I ask about the unsteady phenomena of the free surface of the spilling case; was the surface fluctuating when the layer apperaed? How was the vertical velocity component?

Author's Reply:
The appearance of free surface instabilities in nearly breaking waves of the type you are mentioning should be probably related to flow transition to turbulence, when such experiments are conducted in water circulating channels.
Since in our numerical simulations the submerged hydrofoil is advancing in calm water, we do not observe any particular flow instability before the beginning of the breaking process. Furthermore, breaking waves simulations have been carried out at Reynolds = 1000 and this would probably prevent the presence of these instabilities in any case.

Discusser: Y. Xing

Questions/Comments:
As you've showed in your presentation the results from fine and coarse grids, they look rather different, have you ever tried a 3rd grid to estimate the errors?

Author's Reply:
The results you have seen are very recent. Of course, calculations on more refined grids have been planned aimed to verify the convergence of the solution.

The Bow Wave of a Vertical Surface-Piercing Circular Cylinder in a Steady Current

Chaplin, J.

Discusser: J. N. Newman

Questions/Comments:
You must have a vertical line of dipoles inside the cylinder to represent the flow past it, in addition to the images of the sources above the free surface?

Author's Reply:
Yes, I forgot to mention that. The total potential consists of the sum of components due to (a) the doublet on the axis of the cylinder, (b) a uniform stream, (c) sources distributed over the free surface, and (d) the image systems of these sources.

Discusser: J. Grue

Questions/Comments:
The results you show are most interesting. Will there be pronounced differences in experiments with small and large cylinder? Flow separation obviously has quite strong influence on the waves generated by the cylinder. Is is possible to estimate how much flow separation contributes to the wave making and wave resistance?

Author's Reply:
One has to think of this as a two-parameter problem: Reynolds number and Froude number. Choosing a cylinder diameter d, fixes the ratio $Re/Fr = \sqrt{gd^3}/\nu$, and the answer to your question at a given Froude number will depend on this value. For the conditions of my experiment, the total wave making resistance was roughly equivalent to the loading (at large submergence) of a length of cylinder of roughly one diameter.

Discusser: L. J. Doctors

Questions/Comments:
I am interested in your definition of the wave resistance. You indicate in the written paper that this was measured experimentally by numerically integrating the pressures recorded over the surface of the cylinder. I think that I would prefer to call this the pressure resistance. Because of the violent viscous effects in this problem, I would imagine that there would be a weaker correlation between pressure resistance and wave resistance than for, say, a thin ship.

Author's Reply:
I think that at these Reynolds numbers, shear resistance is very small, so all the loading can be considered as pressure resistance. Coming at this problem from bluff body flows, rather than ship hydrodynamics, I simply split the total force into that which would

occur if the loading per unit length at large submergence extended up to the still water level, and the rest. The latter I called wavemaking resistance, though I realise that other interpretations are possible.

Steady Free-Surface Flow in Water of Finite Depth

Chen, X.-B. and Zhao, R.

Discusser: A. J. Hermans

Questions/Comments:
Is it possible to avoid the non-uniform limit by choosing a different form of the integral. You can do so by taking a different way of splitting up the potential. You took an infinite series of sources and image sources to start with. This is not the only way. Are you sure that every schoice leads to an integral contribution with a non-uniform limit ?

Author's Reply:
Unfornately non. Indeed, we may have different ways to split up the potential as a part composed of a finite or infinite series of source and image sources, and an associated part to satisfy the boundary condition at the free surface, such as in Chen & Ngyuen (2000) in which three decompostions were presented. However, the non-uniform behavior (singular for subcritical flow) is present in all three formulations.

Ship Entry into a Lock

Chen, X.-N., Sharma, S. D.

Discusser: L. J. Doctors

Questions/Comments:
I would like to thank the authors for a most interesting paper. One of the basic assumptions is that the thrust provided by the propeller is assumed to be constant. It would seem that the thrust might vary to some degree during the docking process, because the ship undergoes a substantial variation in speed. Would it be possible to utilize the steady-state propeller thrustcurve, together with the instantantaneous vaue of the average speed of the water past the stern of the vessel, to estimate the thrust; thus, one would be modeling the propeller by a simple quasi-steady process.

Author's Reply:
Author did not respond.

On a Fast Method for Simulations of Steep Water Waves

Clamond, D., Grue, J.

Discusser: M. Dingemans

Questions/Comments:

I notice that the behaviour of your computed results shows recurrent behaviour of the wave groups. nothing

Author's Reply:

Author did not respond.

Numerical Measurements of the Index of Wave Refraction through a Group of Vertical Cylinders

Clément, A. H. and Pianet, G.

Discusser: D. Evans

Questions/Comments:
Have you looked at the scattering problem such as the reflection from the front face of the prism?

Author's Reply:
As you might have seen on my first slide, the interaction of the incident wave train with such a triangular group of cylinders produces a lot of rays all around the group. Some of them are due, indeed, to reflection phenomena on the first interface but also, probably at the second one. Because we where only concern, in this study, by the refraction pnenomenon, we have focus our attention on the angular sector from which refracted waves, and only them, were supposed to emerge, and we disregarded the other propagation directions. We fully agree that reflection phenomena deserves at least the same interest as refraction, but it was left for a future work.

Discusser: L. J. Doctors

Questions/Comments:
What is the definition of the homogeneity factor h?

Author's Reply:
The homogeneity factor denotes the number of cylinders per unit sea surface.

The Generation and Decay of Waves behind High-Speed Vessels

Doctors, L. J. and Day, A. H.

Discusser: V. Bertram

Questions/Comments:
For the wash study in the Seattle region, an interdisciplinary team of coastalengineers, marine biologists and naval architects came up with two criteria to be fulfilled. One simply limited the wave height, one was misleadingly described as energy density, but is the energy of one wave length over a width of 1 meter. I myself am not too happy about this criterion. It could be a case of dumb naval architects vs even dumber civil engineers. Or vice versa.

Author's Reply:
Author did not respond.

Discusser: R. Beck

Questions/Comments:
An important reason to study wake wash is to determine the damage to a river bank due to the wave propagation along it. Do you know of any research into the characteristics of ship wave wakes that cause bank erosion?

Author's Reply:
Author did not respond.

Simulation of Sloshing Waves in a 3D Tank Based on a Psedo-Spectral Method

Ferrant, P. and Touze, D. L.

Discusser: M. Ohkusu

Questions/Comments:
Is your spectral method able to describe accurately the singular flow behavior at the intersection of the free surface and the wall? I suspect the convergence of the expansion is a problem there.

Author's Reply:
Since the solution is expanded using regular basis functions, I agree that we may observe a local non-spectral convergence if the solution is singular, as it is the case at the intersection of the free surface and a horizontally moving wall. This has not been checked in the present calculations, in which convergence was verified on *global* volume and energy.

Discusser: R. Eatock Taylor

Questions/Comments:
Following Faltinsen's question, asking about use of the eigenfunctions over the mean water depth, I wondered if you had considered use of the sigma transform to map the varying fluid region onto a fixed domain (e.g. a rectangle in 2D). Chern et al. (1999) found that this was quite successful for the fully non-linear problem (albeit using a different choice of spectral functions).

Author's Reply:
The only problem with the use of the linear problem eigenfunctions is that care must be taken with possible overflow when these functions are evaluated at a large distance above z=0. This is not a major concern. The sigma-transform used by Chern *et al* (1999) is another elegant way of solving non linear free surface flows in fixed domains. A major difference is that the sigma transform alters the field equation, which becomes time depending. Consequently, nodes must be distributed in each dimension of the fluid domain, in order to satisfy the boundary conditions and the field equation at each time step. In our method, the field equation (Laplace) is satisfied by each of the basis functions, and the distribution of nodes is restricted to the free surface. Without comparison on a common test case, it is however difficult to determine which of the two methods is the most effective.

Green Water Loading on a Deck Structure

Greco, M., Faltinsen, O. M. and Landrini, M.

Discusser: K. Takagi

Questions/Comments:
The three dimenional effect and forward speed effect play very important roll on the green water problem in the case of general ship. In this aspect, the two dimensional problem may be a special case. Do you have any comment about this?

Author's Reply:
Present study is for a ship with zero forward motion. The forward speed is surely an important factor but has not been studied, so far. The effect of three-dimensional flow is preliminary discussed in [1], where comparison of two-dimensional simulation with FPSO model tests have been presented. It appeared that three-dimensional effects in the water level become important as the flow propagates along the deck. Less sensitivity to the flow three-dimensionality was shown by the water front velocity.

Discusser: Y. Kim

Questions/Comments:
There will be some vertical velocity component of green water flow when the ship bow is in the motion. Do you think that the same model, especially dam-breaking model, can be applied when we include the ship motion ?

Author's Reply:
The equivalent dam-breaking model has been used only to study in a simplified way the role of hydroelasticity during the water impact with a deck house in the bow area. The other computations, in particular comparing with experimental data, are based on the "exact" simulation of the incoming flow and water shipping. The effects of ship motions have been discussed in [1]. The possibility to use the equivalent dam-breaking model is addressed to [2]. In particular, it is shown that errors with respect to the "exact" simulation can arise because of the approximation in the inflow conditions. The same limit applies in case of a moving deck.

[1] "Basic Studies of Water on Deck", Proc. 23^{rd} Symp. on Naval Hydrod., Val de Reuil, National Academy Press, Washington D.C., 2000.

[2] Greco, M., Faltinsen, O.M. & Landrini, M., "A Parametric Study of Water on Deck Phenomena", Proc. NAV 2000, Int. Conf. on Ship and Shipping Research, 2000.

Air Cushion under Floating Offshore Structure

Gueret, R. and Hermans, A. J.

Discusser: Y. Kim

Questions/Comments:
I think that there are a few resonance modes of sloshing, air cushion and the body motion. Can you point out each resonance modes in the figures of computational results ?

Author's Reply:
Author did not respond.

Influence of Canal Topography on Ship Waves in Shallow Water

Henn, R., Sharma, S. D. and Jiang, T.

Discusser: J. N. Newman

Questions/Comments:
Have you considered making full-scale measurements of waves in rivers or canals?

Author's Reply:
Yes! Right now we are discussing with the Federal Waterways Engineering and Research Institute Coastal Division Hamburg about a co-operation concerning the validation by full-scale measurements. We hope to present the relevant results at the next workshop.

Discusser: E. Baba

Questions/Comments:
Do you have a plan to measure pressure forces over the bank? The measurement is important to understand bank erosion problem.

Author's Reply:
Yes! In a research proposal of the VBD - European Development Centre for Inland and Coastal Navigation a comprehensive measurement program is planned, including pressure and shear stress on the bank. Currently, we are focusing on the wave generation by the ship moving over a topography having a rigid bottom-surface. Although our method yields a reasonable pressure distribution on the bottom and bank, we have not attacked the complex problem of the bank erosion in which viscous effects cannot be neglected.

Discusser: L. J. Doctors

Questions/Comments:
For the sample vessel, the beam is large compared to the draft (over seven times larger). Therefore, would it not have been more suitable to use a flat-ship theory to model the vessel, instead of the slender- body theory?

Author's Reply:
In the theoretical analysis by Jiang (2000) it has been shown that as the beam-draft ratio becomes large, the slender-body approximation becomes less accurate and, therefore, a flat-ship theory based on the hydrostatic pressure-assumption can be used. However, our systematic computations show that even for this exemplary vessel, both the flat- ship and slender-ship theory lead to a practically equivalent agreement of the wave profiles with the measurements. Moreover, for predicting the sinkage and trim we prefer the slender-body approximation.

Jiang, T.: Ship Wave in Shallow Water. Habilitation Thesis, Mercator University Duisburg, 2000, Germany.

Geometrical-Optics for the Deflection of a Very Large Floating Flexible Platform

Hermans, A. J.

Discusser: L. J. Doctors

Questions/Comments:
What is the definition of the homogeneity factor h?

Author's Reply:
In my presentation I have not used the notion *homogeneity factor h*. Maybe this question relates to an other presentation.

Discusser: D. Evans

Questions/Comments:
Many years ago I considered the problem of the reflection and transmission of waves by a large ice-field modelled by the bending of a semi-inifinite half-plane. The method used was the Wiener-Hopf Technique with produced an exact but complicated solution. The limiting case of shallow-water theory enabled results to be found. The report (R1313 D. V. Evans and T. V. Davies, Stevens Institute of Technology, Noboken, New Jersey 1968) was never published.

Author's Reply:
Unfortunately this work is not known. I know of at least two recent successful attempts to apply the Wiener-Hopf technique to the semi-infinite platform. As mentioned my geometrical-optics analysis neglects, in the deep water case, the influence of the discrete spectrum. A comparison with the W-H results of Tkacheva and of my student Alex Andrianov shows that the deep water results are very close to each other. In the case of finite water depth my approach is exact, a comparison of the methods is expected to lead to the same result, because both take the complete discrete spectrum into account.

Starting Flow Generated by a Floating Wedge Impact

Iafrati, A. and Korobkin, A. A.

Discusser: D. Evans

Questions/Comments:

Why do eigenvalues occur for values of the deadrise angle less than or equal to 45 degrees?

Author's Reply:

The Poisson equation I showed for $\overline{S}_1$ bar admits eigensolutions whatever is the deadrise angle. However, for deadrise angles larger than 45 degrees, eigensolutions are of higher order with respect to the terms retained in the expansion. As a consequence, for deadrise angle smalleer than 45 degrees, the eigensolutions may give an important contribution to the far field asymptotics.

Discusser: R. W. Yeung

Questions/Comments:

For the case of dead-rise angle less than $\pi/4$, you showed an equation for determining one of the constants of the homogeneous solution. What physical meaning is associated with that condition. This condition is not given in your paper.

Author's Reply:

The additional condition is not given in the paper since we introduced this case in the numerical procedure only after the paper was submitted. As I told in the presentation, for deadrise angles smaller than 45 degrees, we introduce the eigensolution part in the expression of the velocity potential at the far field boundary. Since the constant of the eigensolution is not known, it will appear on the right hand side part of the boundary integral representation. In order to solve the discrete problem we have to add an additional constraint. In order to understand the physical meaning of this additional condition, it must be noted that we apply a Dirichlet boundary condition at the far field boundary, so that the flow incoming from the far field boundary is unknown. On the other hand, if we differentiate the asymptotic expansion of the velocity potential in the direction normal to the far field boundary, we obtain that the normal derivative of phi can be expressed as the sum of a known term plus the contribution of the eigensolution multiplied by the corresponding constant. So, the additional condition we enforce require that the total flux incoming from the far field boundary must be equal to the sum of the incoming flow provided by the know term of the expansion plus the incoming flow provided by the eigensolution part.

Discusser: R. Rainey

Questions/Comments:

In my paper with Retzler and Chaplin at the last workshop, we showed that the small-time expansion scheme predicts infinite vertical velocity in front of a vertical cylinder, even if the motion starts arbitrarily smoothly (discontinuity in Nth derivative only). We concluded that "something was rotten in the State of Denmark". Are you likewise predicting jets even if your motion starts arbitrarily smoothly?

Author's Reply:
This is a very important point about defects of the small-time expansion procedure (STEP) being applied to the problems of water flow in the presence of a rigid body piercing the liquid free surface. Nothing is wrong with the STEP if to understand it correctly. This is, we must remember that the STEP is a way to obtain initial asymptotics of the solution in the main flow region, which is not necessary valid everywhere. It is quite obvious that the flow patterns in the main region and close to the intersection line are different and must be described by different equations. In the presented paper we described the flow pattern close to the intersection line in the case of impulsive start of the floating wedge. If the wedge motion starts smoothly, the inner solution will be different from that obtained for the impulsive start case. It is possible that in the case of smooth start the inner solution does not predict jets even if the outer solution given by the STEP is obviously singular. This problem requires a special study which was not carried out yet.

Side Wall Effects of a Towing Tank on Measured Unsteady Waves in Low Frequency Ranges

Iwashita, H.

Discusser: J. N. Newman

Questions/Comments:
Why did you include the wall surfaces (S_W) in your computational domain, instead of using images of the Green function?

Author's Reply:
My final interest of this study is to apply the method to wash problem in a harbor. Considering the flexibility of the method, I chose this method rather than the Green function method which includes the side-wall effect by mirror image.

Discusser: M. Kashiwagi

Questions/Comments:
When I worked on the side-wall effects on hydrodynamic forces more than 10 years ago, I found that the forces changed (fluctuated) rapidly in the frequency range around $\tau = 0.28$, a little greater than 0.25. Do you think this finding is related to the drastic change in the wave characteristics you pointed out in your presentation?

Author's Reply:
I think so, since hydrodynamic forces are physically related to wave fields.

Discusser: K. Mori

Questions/Comments:
Can you eliminate the reflected wave components by making use of your computed results?

Author's Reply:
This method is only to simulate the side-wall effect simply by representing ship hull form and its motions by a pulsating point source. In order to eliminate the side-wall effect from the measured data, the method should be more exact method which can capture the ship hull form and its motions. Then the purpose of the study becomes the development of the computational code of restricted water, and it's different from my interest in this study.

Water Wave Scattering by Inclined Barrier Submerged in Finite Depth Water

Kanoria, M. and Mandal, B. N.

Discuser: R. W. Yeung

Questions/Comments:
I enjoy your paper. In previous experiences that I have with boundary integral methods, I did find that thin plates can be very effectively represented by a finite thickness rectangle, either with a square tip or a rounded tip. Typically, I hardly run into an difficulty with an aspect ratio of plate thickness to breadth larger than O(100) using only single-precision floating-point calculations. Thus, unless there are some unusual physical hydrodynamic properties that one can find from the hyper-singular integral-equation treatment, most boundary-integral equation method for arbitrary body shapes can produce solutions of the type of thin plate problems you are examining. It seems a much bigger issue is the shedding of vortices from the sharp edges, especially for long waves. Of course, that cannot be modeled by purely potential method. Perhaps you would you agree?
Regarding Figure 2, there seems to be a secondary inflexion point in your solution at Ka slightly above 1.0. Is that some physical phenomena happening there? Your calculations appear not too susceptible to inaccuracies.

Author's Reply:
As far as I knew, it is very difficult to get exactly the thin plate results from the thick rectangular block results. For thin body we have square root singularities at the corner points but for thick rectancular body we have cube root singularities at the corner points. No, it is not so.I think the curve will be smooth if more steps will be taken in my numerical calculation.

Discusser: D. Evans

Questions/Comments:
For what depths of submersion and angles of incidence do you get zeroes of transmission?

Author's Reply:
When the angle of inclination is 89 with the vertical(as in fig2), this means that when it is nearly horizontal and the plate is very near to the surface of water then the zeroes in the transmission occurs. But I have to check exactly at what angle the zeros in the transmission begins to occur and at what depth.

Discusser: M. Takaki

Questions/Comments:
Thank your for your good presentation. I have the experience to perform the experiments

estinmating the hydrodynamic properties on a horizontal submerged plate in waves. According to my experimental results, violent breaking waves have occured on the submerged plate. Therefore, it seems to me that your theory cannot estimate accurately such a nonlinear phenomena because you have applied a linear free surface condition to your theory. I strongly recommend you to compare your estimated results with the experimental ones to validate your estimated results.

Author's Reply:
Thank you for your suggestion, I will try for this but I have considered here only the linearised theory of water waves.

Discusser: T. Khabakhpasheva

Questions/Comments:
As far as I know from experiments, if the free submerged plate is situated near free surface, the vibration of the body increases. Did you observe this effect?

Author's Reply:
Perhaps not. We are considering the body to be fixed in water.

Discusser: J. Grue

Questions/Comments:
The effect of the thickness of the geometry may be investigated considering e.g. an elliptic cylinder which can degenerate to a flat plate. In the case of the ellipse, if using a vertex distribution, one has the luxury of getting two integral equations, one due the boundary condition along the normal direction, and one due to the condition along the tangential direction. One of the integral equations are singular,while the other is regular. One may then investigate what happensin the limite when then thickness goes to zero. In the case of water waves this was investigated in J. Grue and E. Palm, Appl. Ocean Res. 1984.

Author's Reply:
Thank you for your comments.

Second-Order Steady Forces on Multiple Cylinders in a Rectangular Periodic Array

Kashiwagi, M.

Discusser: J. N. Newman

Questions/Comments:
It must be quite difficult to capture the near-trapped wave phenomenon in your experiments, due to the narrow bandwidth and slow convergence to a steady state, as well as the concern about tank wall effects when a very long time is required to reach the steady state. Can you comment on these problems?

Author's Reply:
It is true that there is a limitation in the measurement time due to tank-wall effects. Furthermore, it is difficult in experiments to generate a pure sinusoidal wave with designated single frequency. As the measurement time increases, the noise contained in the incident wave also increases. These might be a source of discrepancies around the near-trapped mode frequency. Even if we could generate an ideal sinusoidal wave, highly-tuned near-trapped wave would break in reality because of excessive steepness of the wave.

Discusser: R. Eatock Taylor

Questions/Comments:
Another possible source of discrepancy between the linear theory and the experiments, close to the near-trapped mode frequency, is the effect of non-linearity. At third order this changes the frequency of the incident waves, which may have some noticeable effect even at low amplitudes, given the highly localised behaviour of the trapping phenomenon seen here.

Author's Reply:
Since the near-trapped wave phenomenon occurs at a very particular frequency, that frequency might be different in the experiments due to higher-order effects, as you pointed out. However, the experiments have been conducted using incident waves of steepness equal approximately to 1/50, which is believed to be in the linear regime. We will work on the second-order effects in the wave interactions among many cylinders in the near future.

Reduction of Hydroelastic Response of Floating Platform in Waves

Khabakhpasheva, T. I. and Korobkin, A. A.

Discusser: M. McIver

Questions/Comments:
Why is the agreement between experiment and theory better in case 2 than in case 1?

Author's Reply:
All obtained numerical results are in good agreement for low frequencies of incident waves but differ each other for high frequencies. It is possible that the Euler beam model is not good enough to describe the high-frequency vibrations of VLFS.

Discusser: M. Kashiwagi

Questions/Comments:
In your method, the pressure and deflection are expressed with different basic functions. I agree that this scheme will work, but if you use the same orthogonal function system for both the pressure and deflection, you can use effectively the orthogonality relations. What is the main reason to use different basic functions in your method?

Author's Reply:
If we use trigonometric functions as basic ones, we cannot satisfy accurately the boundary conditions at the end points of the beam and at the point of the beams connection. On the other hand, the eigenfunctions of the compound beam are rather complicated and, moreover, they didn't correspond to the features of the hydrodynamic pressure distribution along the beam. If we use eigenfunctions of the compound beam as basic functions, we must solve eigenfunctions problem for each considered task. Presented method makes it possible to simplify the treatment of the hydrodynamic part of the problem and at the same time to satisfy accurately the beam boundary conditions.

Discusser: L. J. Doctors

Questions/Comments:
Could you kindly clarify the figure on Page 76 for me? Presumably, the oscillations in the deflection curves correspond to the undistorted form of the incoming sea waves. Secondly, why do the responses at the right-hand end become so large?

Author's Reply:
The oscillations of the plate didn't correspond to the undistorted form of the free surface with incoming waves. Figure on Page 76 shows that the amplitude of the plate deflections at the central part of the plate less than amplitude of the incoming wave in any case (either with the spring or without that). Length of the waves in plate also differs than length of

incoming water wave. As to the second question, I believe that spring with special rigidity takes main part of the energy of incoming waves and main part of the plate didn't obtain energy for the vibrations.

Hydroelastic Analysis of a Floating Runway with Inhomogeneous Structural Properties

Kim, J. W., Ma, J. and Webster, W. C.

Discusser: D. Evans

Questions/Comments:
Why does the Green-Naghdi dispersion relation given by equation 6 differ from the usual shallow-water dispersion relation?

Author's Reply:
Author did not respond.

Discusser: K. Takagi

Questions/Comments:
According to the geometric wave theory, it is expected that the wave trapping happens in the edge stiffen case. Did you observe this in your calculation?

Author's Reply:
Author did not respond.

Discusser: M. W. Dingemans

Questions/Comments:
The repeating of the wave group-forms seems to be due to the ordinary recurrence phenomenon which is obtained for NLS as it is obtained for Boussinesq-like equations.
What happens if you increase the stiffness everywhere instead of only in the middle or at the sides?

Author's Reply:
Author did not respond.

Coupled Analysis of Ship Motions and Sloshing Flows

Kim, Yonghwan

Discusser: B. Molin

Questions/Comments:
In Figure 9, we see that the heave motion is significantly affected by the sloshing motion in the tanks. What is the physical interpretation?

Author's Reply:
It is hard to make any conclusion from only Figure 9. Similar to the effect on roll motion, the slosh-induced moment will affect pitch motion. Since heave and pitch are strongly coupled, any change of pitch motion affects directly on heave motion. Figure 9 may show such case.

Wave Interactions in the Coastal Zone

Klopman, G. and Dingemans, M. W.

Discusser: B. Molin

Questions/Comments:

I do not know the work by Laing which you quote. How different is it from regular Stokes second-order theory applied to bichromatic seas?

Author's Reply:

Author did not respond.

Breaking Bow and Stern Waves: Numerical Simulations

Landrini, M., Colagrossi, A. and Tulin, M. P.

Discusser: K. Takagi

Questions/Comments:

I have two quetions. The first quetion is how do you treat the bottom boundary in your SPH code? The second one is have you check the difference between BEM and SPH about the velocity distribution or the pressure distribution?

Author's Reply:

For deep-water computations, we assumed a large but finite depth, and a no-penetration boundary condition has been imposed along the bottom. In this case and, generally, on solid boundaries, the no-penetration boundary condition is enforced by using "ghost particles". As shown in figure 1, a layer of fictitious particles is inserted inside the body, along the body contour. At any instant of time, appropriate values for position, density, velocity and pressure are obtained by mirroring those of the physical particles close to the boundary, within a layer with thickness equal to the radius of interaction (*cf.* right plot in figure 1).

We compared extensively BEM and SPH results, with good agreement. In particular, the verification study included free-surface profiles and free-surface velocities for several problems (sloshing flows, shallow-water flows before wave breaking occurs, 2D+t bow flows before breaking) and integrated loads on walls in case of fluid sloshing in a tank, (see the figure 2). The latter comparison implies that the pressure distribution along the solid boundary is correct, at least in a global sense. So far, a pointwise comparison for pressure field has not been performed.

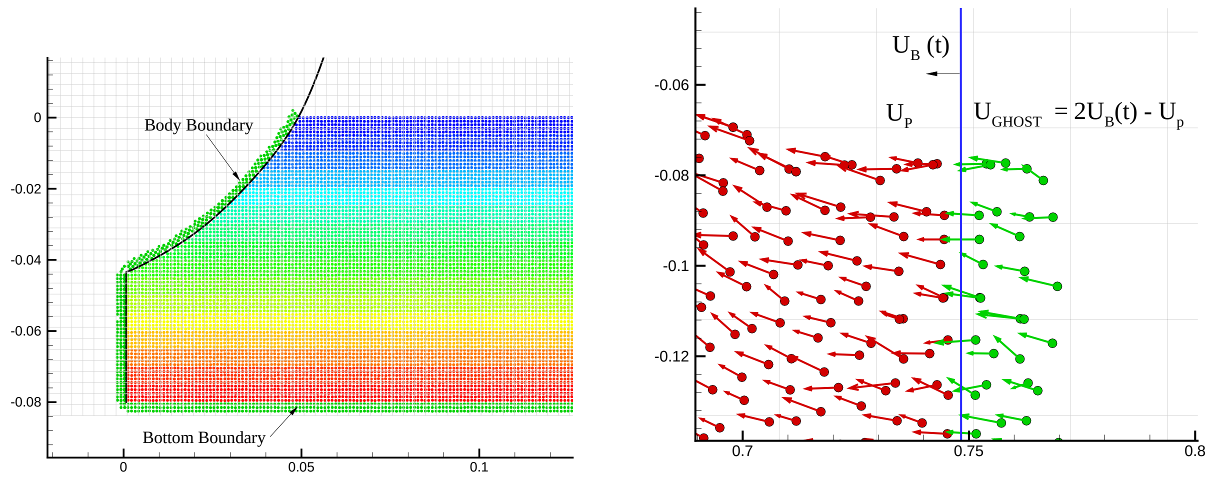

Fig. 1 Ghost-particle technique to enforce the no-penetration boundary condition. Left: 2D+t computation (for graphical reasons a shallow-water case is shown). The black line is the physical body boundary, green particles are the ghost particles. Right: example of application of ghost particles when the physical solid boundary (blue line) is moving with velocity $U_B(t)$. U_P is the velocity of a physical particle. The grid gives the radius of interaction of particles.

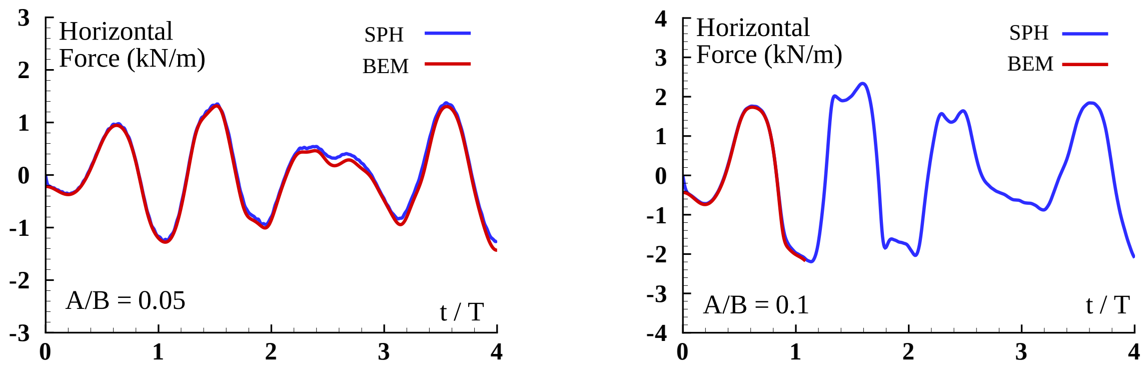

Fig. 2 Sloshing flow in a rectangular tank, ($h/B = 0.4$, without roof, $h=$ filling height, $B=$ tank beam) for forced sway oscillations (period $T = 2$ s). The horizontal force computed by BEM (red lines) and by SPH (blue lines) are compared for two different oscillation amplitudes. Left: oscillation amplitude $A/B = 0.05$. Right: oscillation amplitude $A/B = 0.1$, BEM computation is stopped because of free-surface breaking.

Solution of Radiation Problems with Exact Geometry

Lee, C.-H. and Newman, J. N.

Discusser: A. Ballast

Questions/Comments:
It's quite common to represent (or even define) a ship by means of a NURBS formulation. (In design and production, I think MARIN does for example). The described method is therefore not limited to simple geometric forms with an analytical representation. It's biggest promise seems to be the easy inclusion of any shape available in a NURBS formulation, including a lot of "real" ships.

Author's Reply:
Thank you for pointing this out. It is certainly correct that if a structure's submerged surface is described in a CAD program by NURBS or other mathematical expressions, our method can be used to adapt this description to the panel code so that geometry inputs are automated and more accurate.

Discusser: M. McIver

Questions/Comments:
Is a patch defined to be a portion of the surface which is smooth?

Author's Reply:
Yes. Any portion of the surface which is smooth, and which can be mapped to a square domain in parametric space, can be considered as a patch. For computational efficiency it is desirable to minimize the total number of patches. Thus optimum patches are, in some sense, the largest portions of the surface with these necessary properties. For a body which has lines of discontinuous slope, such as the circular cylinder or the torus shown in the abstract by P. McIver and J. N. Newman (Figure 2), these lines are the natural boundaries between patches, together with the free surface and planes of symmetry. In more complicated cases additional subdivisions with extra patches may be desirable for computational purposes; for example to simplify the representation of the cylindrical middle body of a ship hull which is connected (smoothly) to the non-cylindrical forebody and afterbody.

Trapping of Waves by a Submerged Elliptical Torus

McIver, M., Porter, R.

Discusser: J. N. Newman

Questions/Comments:
Perhaps it is possible to use an inverse procedure for similar submerged bodies, where the flow is induced by a submerged ring of singularities such as vertical dipoles?

Author's Reply:
Yes, I used this inverse procedure to show that there were trapped modes for a pair of submerged two-dimensional bodies (Proc Roy Soc Lond A 2000, Vol.456, pp 1851 - 1860). The flow field was generated by a combinationn of horizontal and vertical dipoles. However it is necessary to prove that there is a pair of closed streamlines in the flow and this is a nontrivial task.

Discusser: L. J. Doctors

Questions/Comments:
Since you are using potential-flow theory, together with a linearized free-surface condition, I assume that the extremely high responses at the singular frequencies would not actually occur in reality, because of viscous and nonlinear effects. Can you please comment.

Author's Reply:
I agree. If the body is oscillated in heave the linear theory predicts that the fluid oscillations will become unbounded. In practice these will be damped by viscosity. It is also possible that energy will be transferred away from the neighbourhood of the body in the form of second harmonic waves.

Discusser: D. Evans

Questions/Comments:
This would appear to be the first example of constructing trapped modes for a given choice of body, in this case an elliptical torus. Do you think it is possible to construct 2-D surface trapped modes using a pair of surface ellipses?

Author's Reply:
I think that it is quite likely provided that the ellipses are immersed to more than half their depth. If they aren't I would not expect their to be a zero of transmission associated with one of the ellipses, although this is not proved.

Non-Axisymmetric Trapping Structures in the Three-Dimensional Water-Wave Problem

McIver, P. and Newman, J. N.

Discusser: D. Evans

Questions/Comments:
Can you do the converse problem of constructing a non-axisymmetric trapped mode in the presence of an axisymmetric body? I mean a solution which does not have the periodicity properties of choosing a higher-order ring singularity which radiates no waves.

Author's Reply:
Axisymmetric trapping structures for azimuthal variations in a ring-source potential of the form $\cos m\beta$, m an integer, were constructed by Kuznetsov and McIver (1997); as noted in the abstract this was done by identifying stream surfaces of the flow. If the ring has radius c, then for each value of m the frequencies of trapped modes are given by $Kc = j_{m,n}$, the nth zero of the Bessel function J_m. Each choice of m and n produces different sets of trapping structures.
For a fluid motion in the presence of an axisymmetric structure the potential may be expanded as a Fourier series in the azimuthal angle β, so that Prof Evans' question may be equivalent to asking whether two or more variations in the ring-source potential of the form $\cos m\beta$ may be combined to obtain a trapping structure. For simplicity consider the combination of two such solutions. The frequencies of the two solutions can be matched by choosing the ring-source radii appropriately, but the sets of stream surfaces will,in general, have no common member. However, it may be possible to distort a member of one set of stream surfaces into a member of the second set by addition of further non-radiating ring singularities, and hence obtain a trapping structure of the type required.

Spectral Solution of Time-Dependent Shallow Water Hydroelasticity

Meylan, M. H.

Discusser: T. Khabakhpasheva

Questions/Comments:
Do you have any comparison of your results with some experimental results?

Author's Reply:
No we do not. Furthermore, it would actually be difficult to make an experimental comparison because of the shallow water assumption.

Waves Generated by Ship Motions

Ohkusu, M.

Discusser: K. Takagi

Questions/Comments:
Which did you get as experimental data 2 omega component or the second order component?

Author's Reply:
I mean the second order is the second harmonics of the wave elevation in this paper. Of course we have the steady component of the second order which is the difference in the steady wave elevation with and without the ship motion. I know it is not negligibly small in experiment but in this paper I am not concerned with it.

Discusser: J. Grue

Questions/Comments:
Are radiated waves with harmonics higher than twice the leading mode observed in the experiments? Does the amplitudes of the second harmonic wave systems reach a saturation when the forcing is increased?

Author's Reply:
We need more than five wave probes to find higher harmonics than the second. The result presented here is by five probes. On other experiment where I used more than five probes, though it was to determine still the terms to the second harmonics, I did not find any significant appearance of the existence of the third or higher terms in the curves as far as the amplitude of motion is within the limit of our experiment. Certainly the second harmonics component becomes smaller than distingushable as we decrease the amplitude of motion or incident waves.

A Panel-Free Method for the Time-Domain Radiation Problem

Qiu, W. and Hsiung, C. C.

Discusser: M. Kashiwagi

Questions/Comments:
Your scheme needs to represent the source distribution with some mathematical functions over the whole submerged area of a body, such as orthogonal function system of Legendre functions. Increasing the number of Gaussian points is equivalent to increasing the number of functions in the orthogonal system used for representing the source distribution. Is this understanding correct?

Author's Reply:
After the integral equation was desingularized and the body geometry was mathematically represented by NURBS surfaces, the Gaussian quadrature could be applied directly. Theoretically, there is no assumption for the representation of the source distribution. Increasing the number of Gaussian points is to increase the accuracy of integration.

Discusser: R. Eatock Taylor

Questions/Comments:
Can you comment on the influence of the irregular frequency phenomenon on your results?

Author's Reply:
The irregular frequencies were shown in the computed added mass and damping coefficients in the frequency domain for the Wigley hull. The added mass and damping coefficients were obtained by Fourier transform of the response function computed in the time domain. This was due to the oscillation of the response function in the time domain, particularly at the large time. In the panel method, this could be mitigated by improving the discretization of the body surface. In our panel-free method, it could be improved by increasing the number of Gaussian points and/or changing the arrangement of Gaussian points. The effect of irregular frequencies could also be mitigated by using other integration schemes. We are in process of investigating it.

The Pelamis Wave Energy Converter: It May be Jolly Good in Practice, But Will It Work in Theory?

Rainey, R. C. T.

Discusser: J. N. Newman

Questions/Comments:
Why is coupling forced between sway and heave, when the resonant behavior could be imposed directly by mechanical constraints of the vertical modes?

Author's Reply:
Author did not respond.

Discusser: L. J. Doctors

Questions/Comments:
Thank you for a very interesting presentation. An important question related to all devices for converting renewable sources of energy, such as light, wind, and waves, is how does one define the efficiency. The problem relates to specifying the effective capture area. Do you have any suggestions for defining the efficiency of the Pelamis Converter?

Author's Reply:
Author did not respond.

Effect of Sloshing on Ship Motions

Rognebakke, O. F. and Faltinsen, O. M.

Discusser: Y. Kim

Questions/Comments:
The sway motion is somewhat tricky to simulate in the time domain. I assume that you applied the same restoring coefficient in numerical computation with the experimental data. I am curious if the same quantity can be applied to both cases,because there are some more mechanical and viscous-related restoring components in the experiment. How about adding a little more restoring in the numerical computation ? Then, I guess that the numerical results will be better, although your results are already excellent.

Author's Reply:
We do not think that additional mechanical and viscous related restoring components lead to the observed difference between the experimental results and the computations. This effect is more related to unwanted nonlinearities of the experimental wave excitation load at high frequencies. An indirect way of seeing this is that the linear theoretical results should approach the experimental results when we are far away from the first linear eigenfrequency of the fluid motion in the tanks.

Discusser: B. Molin

Questions/Comments:
In your equation (1), the term Fslosh has a component linearly related to the acceleration. How do you treat this term when integrating equation (1) in time?

Author's Reply:
In order to describe our method we have to examine the expression for the horizontal force. In [2] Eq. (8.7) we find that

$$F_x/m_l = \left(H\sigma^2 \cos\sigma t + \frac{l}{\pi^2 h} \sum_{i=1}^{N} \ddot{\beta}_i(t) \frac{1}{i^2}(1 + (-1)^{i+1}) \right)$$

where m_l is the mass of the water in the tank, σ is the sway excitation frequency, H is the sway amplitude, h is the water depth in the tank, l is the breadth of the tank and β_i is the amplitude of the free surface modes. The first term on the right hand side represents the rigid body acceleration force of the fluid in the tank. This is an important term, although the relative importance decreases when σ approaches the first natural frequency of the fluid flow in the tank. We move this term to the left hand side of the equation of motion when integrating in time.

Extension of the Havelock / Dawson Method to Include Nonlinear Free-Surface Boundary Conditions

Scragg, C. A.

Discusser: M. Kashiwagi

Questions/Comments:
I applied the idea similar to yours to the unsteady problem in 1994 (9th IWWWFB), using the frequency-domain Green function to satisfy complicated free-surface conditions on z=0. At that time I utilized the Gauss theorem to convert the 2nd derivatives of the velocity potential appearing in the free surface condition into the velocity potential itself as the unknown. In that scheme, as a trade-off, the 2nd derivative of the Green function had to be evaluated, which was extremely difficult. How are you treating the 2nd derivatives of the velocity potential in the free-surface condition when solving the boundary-value problem by the direct formulation of BEM?

Author's Reply:
Thank you. I was unaware of your efforts in the unsteady problem and I look forward to reading the reference. In the steady problem we employ a spectral description of the wave terms and this approach is well suited to the calculation of higher order derivatives since differentiation in physical space is accomplished by simple multiplication by the appropriate wave number in k-space.

Discusser: L. J. Doctors

Questions/Comments:
The work covered in this paper represents a novel approach to solving the problem of the steady-state flow past a surface ship. The advantage of the Havelock source, of course, is that the far-field condition (the radiation condition) is satisfied automatically. I understand that you are satisfying the Neumann boundary condition on the surface of the hull by means of the collocation approach. Have you tried using the Galerkin technique, in which the Neumann condition is satisfied in an integrated sense on the field panel? This should lead to better-behaved convergence.

Author's Reply:
We use a method that is equivalent to the Galerkin technique. Since integration over the panel in physical space is the same as filtering the spectrum in k-space, we can develop spectral filters corresponding to the physical dimensions of the panels. These filters remove subresolution wavelengths from the spectra, leaving a wave field that is consistent with the grid resolution of the hull and the free surface.

Discusser: Y. Kim

Questions/Comments:
Your study concentrates on the nonlinearity on free surface. Some other existing results show that wetted-surface correction provides somewhat significant correction of the wave resistance. Could you make any comment about the body nonlinearity in the wave resistance problem ? How much do you think that the body nonlinearity is important ?

Author's Reply:
Of course the body nonlinearities can be even more important in certain situations. In this study, we have attempted to model them simply by extending the hull panelization above the position of the mean free surface. At every iteration, we compare the dynamic waterline with the depth of each panel and then set the source strength of any unwetted panel to zero. For the examples discussed here, we have held sinkage and trim fixed. To properly account for the geometric nonlinearities, the hull would have to be free in pitch and heave.

Discusser: A. J. Hermans

Questions/Comments:
I wonder whether using Haskind sources at the free surface is applicable in the case of very blunt ships. I expect serious problems near the bow in this case. Is it possible to introduce a transom stern? How do the values of the wave resistance compare with measured data especially in the slow speed case for non-slender ships?

Author's Reply:
Unfortunately this study is far from complete and we have demonstrated convergence only for two ship hulls, both of which have a fine entry. It would not be surprising to encounter numerical difficulties if we were to examine hull geometries that are significantly dissimilar to those studied to date. We have also not yet performed what could be considered a rigorous validation of the accuracy of this method, although early comparisons with a well-validated nonlinear method look encouraging.

A New Type of Trapped Mode and Its Relevance to the Forces on Parallel Arrays of Breakwaters

Shipway, B. J. and Evans, D. V.

Discusser: J. N. Newman

Questions/Comments:
Presumably the case you consider with a Neumann condition on the centerplane is equivalent to a series of half-obstacles protruding from one tank wall? If so, this is an example of trapping with a non-symmetric structure.

Author's Reply:
Author did not respond.

Discusser: C. Linton

Questions/Comments:
1. I find the accuracy of the wide-spacing approximation for your problem to be surprising. In other similar problems that I know of, the wide-spacing approximation serves only as a guide to the numerical values.
2. In the pressure formulation you seem to have sums of products of eigenfunctions which are divergent. Is this true?

Author's Reply:
1. I was also surprised at the accuracy of the wide-spacing approximation.
2. I have interchanged (illegally) the order of integration and summation, purely for ease of notation, but in computing the numerics the order is left unchanged.

Discusser: M. McIver

Questions/Comments:
Can you prove that zeros of transmission exist for a pair of barriers?

Author's Reply:
Evans and Morris usecertain bounds to prove the existence of zeros of transmission. Similar bounds can be obtained for this problem and I would expect a similar proof to exist.

Parabolic Approximation of the Hydro-Elastic Behavior of a Very Large Floating Structure in Oblique Waves

Takagi, K.

Discuser: A. J. Hermans

Questions/Comments:
Your theory is developed for shallow water. It seems that some practical applications are in deep water. In that case the application of ray theory is not as simple as in the shallow water case. Do you have any ideas how to extend your method to the case of deep water?

Author's Reply:
Honestly speaking, I have no idea to extend my theory to deep water case. But, there is no essential problem to extend my theory to the finite depth case.

Discusser: M. Ohkusu

Questions/Comments:
I am pleased to learn my idea was extended for the more difficult case of oblique wave incidence. Yet the accurate prediction of the deflection at the corner will be a problem. I recall you presented fine result on the corner problem at the 14th IWWWFB. Do you have any idea of matching or connecting your oblique sea solution with your corner solution?

Author's Reply:
It is possible to connect my corner solution to the present theory. But, the problem is that the corner solution is not "simple", since it contains a boundary integral equation. Yet, I would like to make a further investigation on the corner problem to justify the ray approach.

Development of a 3D-NWT for Simulation of Running Ship Motions in Waves

Tanizawa, K. and Minami, M.

Discusser: M. Kashiwagi

Questions/Comments:

In order to be fair, let me make a comment on the results of EUT.

1. In the results of EUT shown in your paper, the experimental values of A35 and A53 (cross added-mass terms between heave and pitch) are used instead of computed values, because near the heave and pitch resonance the cross terms are important but computed values of A35 and A53 by EUT are not so good.

2. The asymptotic value of the pitch amplitude with increasing the wavelength seems to be smaller than the expected value. This is due to the underestimation of the pitch exciting moment, but at present that shortcoming is resolved and thus we can expect better results by EUT.

Author's Reply:

Thank you for your comments.

Discusser: Y. Kim

Questions/Comments:

1. (comment) You mentioned about the saw-tooth waves near the body. These can be numerically removed using pseudo-panels inside of the body and apply the typical filtering scheme suggested by Shapiro or Longuet-Higgins and Cokelete. Also we can find the exmplicit expressions of 5- and 7-point filters on the collocation points at the boundary edge. We need a careful application since the local component near the body can be damped too much due to filtering.

2. (Q) Do you have any comparison of hydrodynamic coefficients with other data ? You showed the comparison of motion RAOs, but it is hard to tell the accuracy of the ship motion program from the comparison of the linear RAOs. This is because that the motion is sort of secondary output after getting the velocity potential and pressure. I believe that checking the added mass and damping coefficient has more meaning to observe the accuracy of the program.

Author's Reply:

1. Thank you for your comment. I have tried five points smoothing along the water line. However, the simulation was still not stable. I have also tried smoothing spline technique which is very effective for my 2D-NWT. However, for 3D-NWT, simulation of waterline is unstable and too much smoothing affects to the result. Stability analysis might be needed to stabilize the simulation. If ship is not running, there is no instability and the converged result is easily obtained.

2. I intend to check the accuracy of the simulation systematically after I tamed the instability.

Discusser: H. Yasukawa

Questions/Comments:
How did you deal with the surge motion in your computation? If the surge is free, I guess you added the restoring term to the surge force component.

Author's Reply:
Yes, I added weak restoring and dumping terms to the surge force component.

Fast Multipole Method for Hydrodynamic Analysis of Very Large Floating Structures

Utsunomiya, T., Watanabe, E. and Nishimura, N

Discusser: M. Kashiwagi

Questions/Comments:

In my experience from the study of hierarchical interaction theory a couple of years ago, the convergence rate of Bessel (more exactly Hankel) functions used in Graf's addition-theorem is slow, and thus when increasing the number of hierarchical levels we had to increase greatly the number of terms of Bessel functions. I guess the same problem happens in your scheme, and there must be a trade-off between accuracy and computation time in deciding where the far-field and near-field points are in setting up the matrix. Could you comment on this point?

Author's Reply:

There exist two major truncation parameters in the multipole expansions. In Eq. (3) of the Proceedings, the infinite series in terms of m are truncated at $m_{max} = [6h/R]$ (ref. 1); and the series of n are truncated at $n_max = 20$ when $ka < 5$ and $n_{max} = [1.2ka + 15]$ when $ka > 5$, where a designates the maximum cell size used in the calculations (ref. 2). Obviously, as the wave number becomes higher, the number of series terms becomes larger in proportional to the wave number. However, still the efficiency of the method is exellent, as we see in the numerical examples.

[1] Newman, J.N. (1985) Algorithms for the free-surface Green function, J. Eng. Maths. 19, 57-67.

[2] Fukui, T. & Katsumoto, J. (1998) Fast multipole boundary element method accelerated by FFT in two dimensional scattering problems, Proc. 15th Japan National Symp. on Boundary Element Methods, 93-98 (in Japanese).

The Coupled Finite Element and Boundary Element Analysis of Nonlinear Interactions between Waves and Bodies

Wu, G. X. and Eatock Taylor, R

Discusser: M. McIver

Questions/Comments:
Have you done any calculations for the untethered elliptical cylinder? The circular cylinder has special properties (zero of reflection) so how would you expect the results to differ when the cylinder is not circular?

Author's Reply:
We have not so far considered an untethered elliptical cylinder. For the reason you mention, this case seems of less interest than the circular cylinder. We have however computed results for the elliptical cylinder which is free only to rotate. These illustrate the interesting phenomenon of progressively increasing angular motion as a result of non-linear effects. The time history of the rotation looks very similar to that for the horizontal drift of the untethered circular cylinder.

Discusser: R. W. Yeung

Questions/Comments:
I noticed that there is a signficant negative drift for the steeper wave case you showed. We have also similar experience in recent computations but think that it was a strong coupling of motion that causes it. Do you have an view of what caused the negative drift? Previous works that found similar behavior did not address this physical origin of such behavior very clearly.

Author's Reply:
The circular cylinder is here free to respond both horizontally and vertically, but it is not clear that the upwave drift is associated with coupling effects. As indicated in our response to Maureen McIver, the case of the elliptical cylinder which is only allowed angular motion shows analogous rotational behaviour in the steeper wave conditions.

CFD Simulation of Flow-Induced Floating-Body Motions

Xing, Y., Hadzic, I., Muzaferija, S. and Peric, M.

Discuser: J. Grue

Questions/Comments:
Methods like the one you describe seem to develop rather rapidly, and seem to be rather promising. Visualizations using the method seem convincing. Have you also performed comparisons with published results produced by e.g. boundary element methods, or other methods, where convergence is documented?

Author's Reply:
No, not really. One of the co-authors did compare one case like a 2D Cylinder initially submerged in the still water with some experimental data at the beginning, and it seemed to show good agreements, but no comparisons were done with other methods. So far it has been just the first stage of the development of our method and our effort has therefore been focused on developing and testing it. But validation is certainly a very important issue and should be one of our further steps, it is a running project, and I hope the further development including validation will be presented in near future.

Discusser: R. Eatock Taylor

Questions/Comments:
You have mentioned mesh refinement and mesh independence. Would you like also to comment on your choice of time step?

Author's Reply:
Time is considered as the fourth dimension in this problem, which is chosen and monitored by the Courant number. When we did grid refinement and mesh independent analysis, time step size was also reduced in a similar manner.

Discusser: R. W. Yeung

Questions/Comments:
Thank you for a very nice presentation. You claimed in your presentation that there was no existing numerical works on the subject of nonlinear motion in waves. I would not agree with you at all. The subject has a long history and I myself and my students have contributed to this problem by including viscous effects in a series of publications on the 3 degrees of freedom solution of floating bodies, published over a period of about 3 years. These include careful comparisons of our time-domain solution with our own and other know results from experiments. You may want to compare your results with some of our published data. There were 3 papers in the IJOPE journal and ISOPE Conferences (1998, 2000), two papers in the 21st and 23rd ONR Symposia. Each somewhat forms the

foundation of one for the following papers. There have also been a few other papers along a similar line since our studies.
The methods you pursue have condsiderable promise in three dimensions. Validations and comparison with existing literature is the normal way for scientific advances.

Author's Reply:
Thank you for your comment and information and sorry for the ignorance. As I mentioned for the first question, verification and validation of our method would be our next steps. Hopefully I can work more on the validation of our method in near future.

Unsteady Wash Generated by a High Speed Vessel

Yasukawa, H.

Discuser: V. Bertram

Questions/Comments:
Are the artificial panels for the transom stern considered in the computation of trim and sinkage or dummy panels for that purpose?

Author's Reply:
The dummy panels were put for smoothing the flow at the stern end to avoid the unexpected large stern waves and are excluded in integration of the hull surface pressure for the hydrodynamic force computation, which is based on the computation of the trim and sinkage.

Discusser: R. Henn

Questions/Comments:
How can you explain that, in the supercritical simulation, the first diverging wave, generated at the stern, has a negative wave elavation? (Suggestion: Please include the plot from your presentation, showing the wave pattern at supercritical speed, in your answer)

Author's Reply:
Attached 2 figures show wave pattern around a vessel, and wave elevation along the profile and on the center line of the channel respectively. In the high speed range such as F_n=0.693, independently of the water depth, it becomes difficult to specify the only diverging waves come from ship stern in the numerical results since there exists remarkable interaction between 2 wave components from the fore and the stern. We think that the diverging waves with negative elevation near the stern part mostly come from the fore disturbance.

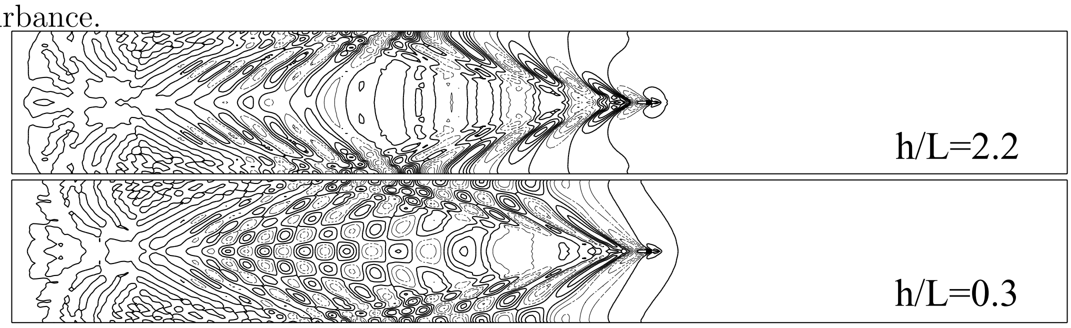

Fig. 1 Wave pattern around a vessel at $F_n = 0.693$. Water depths of $h/L = 2.2$ and 0.3 are corresponding to depth Froude number F_h =0.467 and 1.265 respectively.

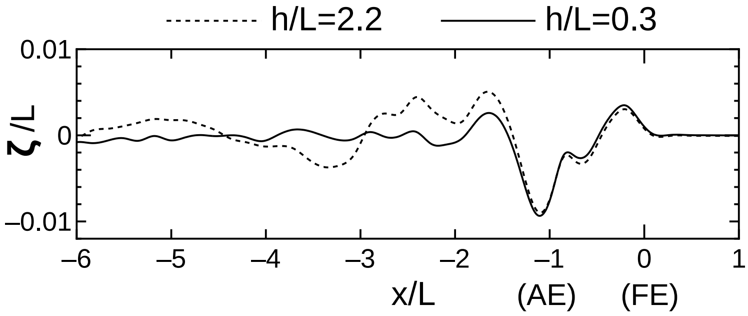

Fig. 2 Wave elevation along the profile and on the center line of the channel. The $x/L = 0$ means the position of fore end(FE) of the vessel.

Computation of Waves Generated by a Ship Using an NS Solver Based on B-Spline Solid

Zhao, C. and Zou, Z.

Discusser: G. Klopman

Questions/Comments:
The results on the Wigley hull you showed are for a very high Reynolds number. What kind of turbulence model did you use to compute the eddy viscosity?

Author's Reply:
Author did not respond.

Fluid Motions in a Tank with Internal Structure

Zhu, R. and Saito, K.

Discusser: M. Kashiwagi

Questions/Comments:

1. You mentioned that the analytical integration is possible for the surface integral of the normal derivative of 1/r. Why don't you use analytical results?
2. An artificial damping term is included in the dynamic free-surface condition. How much value did you use for the coefficient of the artificial damping?

Author's Reply:

1.We used the numerical integration in this paper since our final goal is to deal with the integration on a curved panel, in which the analytical integration will be difficult.
2.We assumed that the value of the artificial damping coefficient is zero and as is shown in Fig.5, some differences are recognized between our results and MAC's ones in the free surface elevations .

Discusser: R. Eatock Taylor

Questions/Comments:

I would be interested to know the sensitivity of the time step required to the degree of non-linearity in your problem.

Author's Reply:

We used the center difference method and 2% of the period of forced oscillation as the time step. The computer program will stop for a bigger time step.

Discusser: Y. Kim

Questions/Comments:

1. The equivalent damping coefficients for partially-filled tanks with internal members can be found in the recent research results by Issacson. A systematic experiment has been carried, and some results are presented in ISOPE conference, 2000.
2. You intended to solve the vibration problem on plate. Can you give some quantative description about how much the potential component is important to induce vibration of the accelerating plate ? And also how much vortex-induced component ?

Author's Reply:

1.We would like to improve our results in the future by considering an appropriate damping coefficients which can be found in the literature you showed us.
2.We applied the present calculation to the plate vibration problem just as an example and we do not analyze the components of the velocity potential in detail.