

QUESTIONS AND ANSWERS

27TH INTERNATIONAL WORKSHOP ON WATER WAVES AND FLOATING BODIES



EDITORS:
HARRY B. BINGHAM, ROBERT W. READ & TORBEN B. CHRISTIANSEN

APRIL 22-25, 2012
COPENHAGEN, DENMARK

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Approximations of wave propagation in one-dimensional multiple scattering problems with random characteristics

AUTHOR(S): Bennetts L. G. & Peter M. A.

QUESTIONER: Meylan M. H.

QUESTION(S)

1. What are your limitations on your parameter ϵ in both cases?
 2. Do you have a method to find the solution by Monte-Carlo for the ice case?
-

ANSWER(S)

1. For the embedded cell method, only that the scatterer cannot leave the cell i.e. cannot pass through an adjacent scatterer. For the multiscale method, ϵ must be 'small', but how small is not yet clear.
2. It's more complicated than we thought it would be. The attenuation is small and this makes it difficult to detect. I have some ideas to find a more reliable method but haven't had success yet.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Long duration experiments in irregular waves to determine 10,000-year wave loads on a 3.5 m diameter vertical cylinder

AUTHOR(S): Chaplin J. R. & Rainey R. C. T.

QUESTIONER: Bingham H.

QUESTION(S)

Your waves are generated using a transfer function based on linear theory (I assume). I would expect this to cause increasing levels of wave breaking close to the wave paddle as the steepness increases. Can you comment on how this might affect your results?

ANSWER(S)

Waves did break in the region close to the wave paddle, but breaking occurred also intermittently all the way along the length of the tank, about 18 m long, in the most severe sea states. The main consequence of wave breaking close to the wave paddle was that it made it rather difficult to achieve the target wave spectrum at the working section. Changes to the control signal sent to the wave paddle often had unpredictable effects there because of wave breaking. Many iterations were needed in most cases.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Long duration experiments in irregular waves to determine 10,000-year wave loads in a 3.5 m diameter vertical cylinder

AUTHOR(S): Chaplin J. R. & Rainey R. C. T.

QUESTIONER: Bredmose H.

QUESTION(S)

It was stated that F_{\max} is a unique function of η_{\max} independent of the wave period. Does this mean that F_{\max} is not a function of the KC-number?

ANSWER(S)

We were just referring to the well-known result that if you increase the wave frequency, ω as ω^2 (since acceleration is $a\omega^2$, where a is the wave amplitude), and the Morison drag force at $z = 0$ will too (since velocity² is $(a\omega)^2$). When we integrate over the water depth to obtain the total wave force, we introduce a factor $K^{-1} = g/\omega^2$ (in deep water). So overall the force is independent of ω .

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Simulation of free-surface viscous flows by a finite-element front-tracking approach

AUTHOR(S): Charlot L., Hay A., Etienne S. & Pelletier D.

QUESTIONER: Cooker M. J.

QUESTION(S)

On the wavemaker do you impose a slip or a no-slip boundary condition?

ANSWER(S)

We can have either slip or no-slip B.C.s depending on what we want to model. Note that no-slip B.C.s requires finer meshes.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Simulation of free-surface viscous flows by a finite-element front-tracking approach

AUTHOR(S): Charlot L., Hay A., Etienne S. & Pelletier D.

QUESTIONER: Kostikov V. K.

QUESTION(S)

1. Is the cylinder floating freely?
2. How do you define hydrodynamic loads on the cylinder?

ANSWER(S)

1. No, the cylinder is fixed in space. However, the computational framework allows for fluid-structure interactions so that our solver could easily perform such simulations.
- 2.

$$\bar{F} = \int_{\Gamma_{\text{cylinder}}} \bar{\sigma} \cdot \hat{n} d\Gamma, \quad (1)$$

where

$$\bar{\sigma} = -\rho \bar{I} + \bar{T}, \quad (2)$$

and

$$\bar{T} = \mu(\bar{D}\bar{u} + \bar{D}\bar{u}^T). \quad (3)$$

With u and ρ from the finite-element solver, we compute \bar{F} . In practice, we use the reaction methods from the F.E. theory.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: On application of multi-pole expansions to roll damping of a rectangular box

AUTHOR(S): Choi Y. M., Kwon S. H., Park J. H. & Lee S. B.

QUESTIONER: Evans D.

QUESTION(S)

Ursell found shapes which had zero roll damping. Have you confirmed this in your calculations? I have used Ursell's paper to capture solutions to sloshing problems inside Lewis-type shapes.

ANSWER(S)

Thank you for your comments. Let me take a close look at Ursell's paper.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: On application of multi-pole expansions to roll damping of a rectangular box

AUTHOR(S): Choi Y. M., Kwon S. H., Park J. H. & Lee S. B.

QUESTIONER: Noblesse, F.

QUESTION(S)

I agree with Prof. Korobkin's comment and wonder if it might not explain your student's finding with respect to the L_∞ norm, which essentially means that the velocity at the corner has a dominant effect that is largely independent of free-surface effects.

ANSWER(S)

I think it might be relevant to the L_∞ norm peak.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: On application of multi-pole expansions to roll damping of a rectangular box

AUTHOR(S): Choi Y. M., Kwon S. H., Park J. H. & Lee S. B.

QUESTIONER: Rainey R.

QUESTION(S)

All modern ships have bilge keels of course - as you, as a Korean, would know!
Can you handle these?

ANSWER(S)

Unfortunately, multipole expansion can not handle that kind of structure.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: On application of multi-pole expansions to roll damping of a rectangular box

AUTHOR(S): Choi Y. M., Kwon S. H., Park J. H. & Lee S. B.

QUESTIONER: Korobkin A.

QUESTION(S)

How much does the flow close to the corner point of the box depend on the presence of the free surface? It could be possible that the dependence is weak and the local flow is about that around the corner in unbounded fluid.

ANSWER(S)

Since multi-pole expansion formula includes free surface (illegible), the flow around the corner will be dependent on the presence of the free surface. However, it is not easy to tell the exact amount of influence at hands.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: On application of multi-pole expansions to roll damping of a rectangular box

AUTHOR(S): Choi Y. M., Kwon S. H., Park J. H. & Lee S. B.

QUESTIONER: Korobkin A. A.

QUESTION(S)

How much the flow close to the corner point of the box depends on the pressure of the free surface? It could be possible that the dependence is weak and the local flow is about that around the corner in unbounded fluid.

ANSWER(S)

Since multi-pole expansion formula includes free surface Green function, the flow around the corner will be depend on the presence of the free surface. However, it is not easy to tell the exact amount of influence at hands.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Two-component axisymmetric wave-energy absorber – analysis of dynamics and geometric proportions

AUTHOR(S): Cochet C. & Yeung R. W.

QUESTIONER: Eatock Taylor R.

QUESTION(S)

Can you not see an additional parameter to optimise this device, by incorporating a spring which constrains the relative (vertical) motion of the two cylinders?

ANSWER(S)

The additional parameters of spring constant is automatically contained in the coefficient c_{33} in equation 3. This can be additively modified from the water-plane area assumed in this study. It shifts the heave resonance to a higher frequency.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Two-component axisymmetric wave-energy absorber – analysis of dynamics and geometric proportions

AUTHOR(S): Cochet C. & Yeung R. W.

QUESTIONER: Rainey R. C. T.

QUESTION(S)

1. This is an axisymmetric device, so the capture width is limited to $\frac{\lambda}{2\pi}$, is it not?
2. There is a consensus (Phil. Trans. R. Soc. Lond. Vol. 370) that such devices must be small to be cost-effective. Do you agree?
3. Are you familiar with the ‘wave-bob’ device designed by William Dick in Dublin? It has many similarities to your device, does it not?

ANSWER(S)

1. Yes, we showed that $C_w = \frac{\lambda}{2\pi} \frac{1}{1+f_{vis}}$ which is in fact smaller than the inviscid case: Eq. 14.
2. The consensus depends on assumed capital layout cost of the grid, which depends on locality of deployment.
3. The ‘wave-bob’ indeed falls into a class of design that is covered by our generic study of two co-axial cylinders here. Methodology of Fig. 5 can be applied to all similar concepts.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: The new Bristol cylinder: a submerged cylinder wave energy converter

AUTHOR(S): Crowley S., Porter F. & Evans D.

QUESTIONER: Chaplin J.

QUESTION(S)

In the attached flow around a horizontal cylinder beneath waves there are some viscous effects that can have a surprising effects on the flow induced force. In some conditions this can have the effect of reducing the added mass almost to zero. It might be worth checking this effect out in the context of the Bristol cylinder. (I had 2 papers on this effect in JFM in about 1984.)

In response to the comment made by John Grue: I later carried out large scale experiments with a cylinder 0.5 m in diameter. The effect was still present, though a bit weaker. This was published (I think) in a BOSS conference a few years later.

ANSWER(S)

Ed. There was no recorded response to this comment.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: The new Bristol cylinder: a submerged cylinder wave energy converter

AUTHOR(S): Crowley S., Porter F. & Evans D.

QUESTIONER: Grue J.

QUESTION(S)

I want to make a comment on John Chaplin's comment to the presenter, where he correctly says that a secondary streaming in the cylinder's boundary layer, induced by the circular wave motion, may alter the wave induced wave forces significantly, and even cancel the added mass effect. We are doing LES simulations, in my laboratory, of the viscous effect on the added mass and damping on an oscillatory cylinder, and find, as the Reynolds number is increasing, disappointingly small effect of the KC-number, when this is even up to 3-4. Again, this was a comment to John Chaplin's comment.

ANSWER(S)

Ed. There was no recorded response to this comment.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: The new Bristol cylinder: a submerged cylinder wave energy converter

AUTHOR(S): Crowley S., Porter F. & Evans D.

QUESTIONER: Rainey R.

QUESTION(S)

It is wonderful to see Bristol University back in the wave energy business. The non-linear feature (pendulum without end-stop) is very important I believe. There is an consensus that good wave energy devices are nonlinear, see Phil.Trans. R. soc. vol. 370. You have not begun to analyse the nonlinear properties (ability to shed power survivability), and I encourage you to do so. You mention Pelamis at the end of the paper. Pelamis has a displacement of 1,000 tonnes, compared 4,500 tonnes for your 28 m long 7 m radius cylinder.

ANSWER(S)

Ed. There was no recorded response to this comment.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Experimental and numerical analysis of the wave propagation through a narrow channel in a wave flume

AUTHOR(S): Fitzgerald C., Grice J., Taylor P. H., Eatock Taylor R. & Zang J.

QUESTIONER: Chaplin J.

QUESTION(S)

1. In the experiment, did your control signal for the wave board contain discrete changes in frequency or continuous play out of a large number of constant frequency components, or as a continuous modulation of frequency?
2. Did you have to make empirical corrections to the control signal to achieve what looks like a very nice focus?

ANSWER(S)

1. The control signal for the wave number was obtained by summing over $N=1000$ frequency components at each time-step. That is, the paddle signal comprised the discretised form of a continuous time-domain signal defined as $\Sigma(a_n \cos(k_n x - \omega_n t))$, $n = 1, 1000$, with each discrete time interval 0.1 s apart. The signal was computed using a Matlab script and then formatted for use with the wavemaker controller.
2. To achieve the maximum force at the focus it was necessary to alter the phase of the control signal which is based on linear theory. The focus location of the actual wave generated by the linear wavemaker signal was altered because of nonlinear wave-wave interactions (third order and higher). Therefore, the free-surface elevation was measured at locations around the focus (in the absence of the cylinder) and the position of maximum elevation was noted. The control signal phase was altered so as to 'correct' the focusing and another wave was generated and the free-surface elevation measured at the gauges around the location of the focus. The focus location of this wave was not exactly as desired also (a

APRIL 22-25, 2012 — COPENHAGEN, DENMARK

linear correction is implemented) and so the process is iterated until a satisfactory focus location is obtained. The success of the focusing was estimated by comparing the depths of the troughs immediately before and after the main crest – a higher degree of symmetry in these troughs implies better focusing. The effect of non-linearity on focusing is analysed in detail in the paper 'Free-surface evolution and wave kinematics for nonlinear uni-directional focused wave groups' by Ning et al.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Experimental and numerical analysis of the wave propagation through a narrow channel in a wave flume

AUTHOR(S): Fitzgerald C., Grice J., Taylor P. H., Eatock Taylor R. & Zang J.

QUESTIONER: Schäffer H.

QUESTION(S)

How do nonlinear interaction terms, e.g. of frequencies $f_1 + f_2 - f_3$, fit into your analysis framework?

ANSWER(S)

For an irregular wave, the higher order non-linear interactions terms will feature terms with frequency content $(f_i - f_j)$ and $(f_i + f_j)$ at second order and $[(f_i + f_j + f_k), (f_k + f_i - f_j), (f_k - (f_j + f_i)), (f_k + f_j - f_i)]$ at third order. In the case of a regular wave train $f_i = f_j = f_k = f$ these terms have the frequencies $(2f, 0)$ at second order and at third order $(3f, f)$ (sum and difference terms respectively). For the focused wave group, we assume the force (and also free-surface elevation) has a Stokes-type expansion of a similar form to the regular wave at the focus. In attempting to eliminate the first order force sum term $aF_{11} \cos(\theta)$, it is impossible to eliminate the third order difference contribution by phase manipulation because the phase content of the linear sum term corresponds to $\cos(\theta)$ and the phase content of the third order difference term $\cos(\theta + \theta - \theta)$. However, for weakly nonlinear waves it can be assumed that $a^3 \ll a$ so that the contamination of the first order sum term by the third order difference contribution is negligibly small. The same reasoning also applies for the second harmonic and third harmonic forces where phase manipulation yields $a^2 F_{22} \cos(2\theta) + a^4 F_{42} \cos(2\theta)$ and $a^3 F_{33} \cos(3\theta) + a^5 F_{53} \cos(3\theta)$ respectively. Only in the case of the fourth order sum harmonic term is the order of magnitude of a difference term ($a^2 F_{20}$) greater than or equal to the sum term ($a^4 F_{44} \cos(4\theta)$) and in the case we are interested in both contributions can be separated by filtering.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Experimental and numerical analysis of the wave propagation through a narrow channel in a wave flume

AUTHOR(S): Fitzgerald C., Grice J., Taylor P. H., Eatock Taylor R. & Zang J.

QUESTIONER: Rainey R.

QUESTION(S)

Your results are for 0.61 Hz (1.5 s period approximately), so approximately 100:1 model of 15 s North Sea survival waves. So your 5 cm wave elevation corresponds to a 5 m full scale wave. So quite modest compared with approx 20 m elevation of survival waves. Yes?

ANSWER(S)

This is correct – we choose a wave of relatively modest wave steepness so that it lies in a regime where we are confident that the solver (in its current version) gives robust solutions. The main priority was to use the results of the numerical simulation to demonstrate how the higher order force harmonics could be separated using phase manipulation and also to validate the numerical solver in weakly nonlinear waves. Simulating strongly nonlinear interactions was not critical to the investigation and given that for waves of higher steepness the solver tends to encounter difficulties it was considered sufficient to simulate the wave of lowest steepness from the set investigated in the experiment. However, the experimental work motivating the numerical analysis did consider strongly nonlinear waves including waves breaking on to the cylinder. The other waves generated in the experimental study were of height 11.5 cm and bi-directional waves, each of amplitude 11.5 cm, meeting at the focus. So, the experimental study involved waves much closer to survival waves.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Experimental and numerical analysis of the wave propagation through a narrow channel in a wave flume

AUTHOR(S): Fitzgerald C., Grice J., Taylor P. H., Eatock Taylor R. & Zang J.

QUESTIONER: Grue J.

QUESTION(S)

Let me comment on the third harmonic force that originates by drag in your formulation. The magnitude is governed by the drag coefficient C_d . With reference to ongoing LES-computations of an oscillatory cylinder in unbounded fluid in my group, we find, for $KC < 2$: C_d behaves according to the Stokes-Wang solution and goes to 0 when the Reynolds number goes to infinity. For the range $KC = (2, 4)$ C_d is in the range 0.2-0.4, for $\beta = 11000$. However, C_d is approximately equal to 1.5 for β approximately equal to 1000. It is an important scale effect, which is very small at high Reynolds numbers. See Rashid, Vartdal, Grue J. Eng. Math. (2011). When it comes to the free-surface effects there is a high-order contribution that is not yet well explained. It is an abrupt high order load measured in experiments with β around 50000. See Grue (2011) Theoretical and Applied Mechanics Letters 1, 0602001 (2011) and Grue and Huseby (2002) Applied Ocean Research. This abrupt appearance of the high order loads cannot be explained by drag effects, since C_d is very small when the Reynolds number goes to infinity. I have suggested that this force appears when the Froude number exceeds 0.4 based on the local wave kinematics and the cylinder diameter.

ANSWER(S)

Thanks for the comment; it is clear from the papers you refer to that it is difficult to determine the mechanism that causes third order excitation. From our results, we argue that in a Morison formulation the drag force on our cylinder would be around 5% of the inertia force at the crest. But once we look at triple frequency components, the drag component is larger than the (small) third order diffraction component coming from our nonlinear computation in this wave (KC

APRIL 22-25, 2012 — COPENHAGEN, DENMARK

is about 1.25). We have also done some preliminary investigations on the nature of the drag force using Morison's equation and it has been observed that the time scale of the third order drag force (with an amplitude term a^2) is much closer to the experimental measurements than the potential flow contributions extracted from the fully nonlinear potential flow solvers. In particular, the triple frequency component of the drag force has a broader time-envelope and significant contributions to the force can occur a couple of seconds before the potential flow contributions in agreement with the experimental result. Thus, we speculate that the drag force plays an important role in the discrepancy between the measured and numerically simulated third order excitation force although other mechanisms may well contribute also.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Investigation of gap resonance in moonpools at forward speed using a non-linear domain-decomposition method

AUTHOR(S): Fredriksen A. G., Kristiansen T. & Faltinsen O. M.

QUESTIONER: Molin B.

QUESTION(S)

I wonder how the flow would look like if you do computations with no heave motion and only forward speed. Presumably in the experiments a recirculation flow would appear behind the twin boxes. Can it be correctly captured by numerical model that assumes viscous (rotational) flow in the lower part of the fluid domain and non-viscous (irrotational) flow in the upper layer?

ANSWER(S)

Our experience from experiment shows that the vorticity will as you say appear behind the twin boxes in the free surface. And we have not been able to get stable solutions with current only. But with heave motion and forward it appears that the vorticity is less concentrated at the free surface.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Investigation of gap resonance in moonpools at forward speed using a non-linear domain-decomposition method

AUTHOR(S): Fredriksen A. G., Kristiansen T. & Faltinsen O. M.

QUESTIONER: Chen X. B.

QUESTION(S)

Have you made convergence tests in your numerical computations? It seems that your numerical results are much more damped than experimental measurement.

ANSWER(S)

Not at this stage in the development. Note that the results will also depend on the size of the potential domain inside the gap. This study will also be included in future publications.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Investigation of gap resonance in moonpools at forward speed using a non-linear domain-decomposition method

AUTHOR(S): Fredriksen A. G., Kristiansen T. & Faltinsen O. M.

QUESTIONER: Bredmose H.

QUESTION(S)

I am impressed by this extensive work – numerical development and extensive experimental program. Two questions/comments:

1. For non-overturning flows, the free surface can be expected to be a single valued function $\eta(x, t)$ which can be time stepped for Euler (Navier-Stokes) equations similarly to potential flow solvers. It seems some of the coupling effort and development could have been saved by doing so. See e.g. Mayer, Sørensen and Madsen (1998).
2. How fine a grid is needed to resolve the flow separation at the corners?

ANSWER(S)

Thank you for the first comment. I will have a look at that. Regarding the second comment, we have not studied that in detail, since the main focus so far has been on the method and its implementation. But see convergence test done (Kristiansen and Faltinsen 2012) for a similar method. Gap response analysed by a new domain-decomposition method combining potential and viscous flow.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Investigation of gap resonance in moonpools at forward speed using a non-linear domain-decomposition method

AUTHOR(S): Fredriksen A. G., Kristiansen T. & Faltinsen O. M.

QUESTIONER: Maki K. J.

QUESTION(S)

1. What is the cost to solve the Laplace equation versus the Poisson equation?
 2. Why don't you solve the Navier-Stokes in the entire field?
-

ANSWER(S)

1. There is a marginal increase in computation time, since you have to set up the right hand side of the Poisson equation. But this is negligible from our experience.
2. We use higher order method (HPC, Harmonic potential cell method) in the potential domain to achieve high accuracy in wave propagation.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Assessment study of a domain-decomposition strategy for marine applications

AUTHOR(S): Greco M., Colicchio G. & Lugni C.

QUESTIONER: Yeung R.

QUESTION(S)

This is interesting work on domain decomposition method. On roll damping roll and added moment of inertia, I have forwarded to you the findings of the IJOPE 1998 (Yeung, Roddier, Liao) which showed both experimental and theoretical computations of rectangular cylinders. The ONR paper in 2008 (Seah and Yeung) also has quite a few references that can be useful, with and without bilge keels.

ANSWER(S)

Thanks for the useful comment. We plan to use your data to check our model and to understand the differences with Vugts' roll added moment of inertia and damping.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Assessment study of a domain-decomposition strategy for marine applications

AUTHOR(S): Greco M., Colicchio G. & Lugni C.

QUESTIONER: Grue J.

QUESTION(S)

Please comment on the practice/experience with your Level Set method.
Another question: how do you handle the intersection between the free surface and the geometry?

ANSWER(S)

The Level Set method is useful and practical for large deformations of the free surface and to handle topological changes of the water domain. In several works presented at the IWWF, we have shown its reliability in those cases. However it can be affected by large numerical errors when the motion of the free surface is very small. There is no special handling of the intersection between the free surface and the geometry but for the mirroring the Level-Set function inside the body. This allows the contact point to move with a velocity extrapolated from the surrounding water region.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Nonlinear Forces on a submerged, horizontal plate: the G-N theory

AUTHOR(S): Hayatdavoodi M. & Ertekin R. C.

QUESTIONER: Evans D. V.

QUESTION(S)

The flow around the sharp edges of the plate is large. On linear perturbation theory the velocity has a square-root singularity. What does G-N theory say about the behaviour of the flow near the edges?

ANSWER(S)

We thank Professor Evens for bringing this issue up. We used the Level I GN theory which requires that the horizontal velocity component is independent of the vertical coordinate and the vertical velocity component is a linear function of the vertical coordinate. Clearly, these cause problems at the leading and trailing edges of the plate. To overcome this we had to use the jump condition so as not to violate the conservation laws (mass, linear momentum and energy), and a number of matching conditions to ensure the continuity of various physical quantities. Unlike in the perturbation theory, we are unable to detect such singularities here as the theory does not depend on any perturbation parameter. At the second or higher levels of the theory it may be possible to determine the type of singularity and this needs to be looked into.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Nonlinear Forces on a submerged, horizontal plate: the G-N theory

AUTHOR(S): Hayatdavoodi M. & Ertekin R. C.

QUESTIONER: Bredmose H.

QUESTION(S)

The horizontal force is based on the pressure difference between the leading edge and trailing edge of the plate. In the limit of a thin plate, the force however, will be purely viscous. Have you assessed the magnitude of this viscous force contribution relative to the force you find?

ANSWER(S)

We thank Dr. Bredmose for this discussion. The plate, in our current approach, is considered to be thin and we are assuming inviscid fluid. This means that we do not consider the viscous forces, even at the limit of a thin plate. Initial comparisons of the horizontal forces calculated by the G-N model shows a very good agreement with laboratory experiments. Comparisons between the G-N results and a N-S solver (viscous fluid) is undergoing by our research group, and will be reported soon.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Nonlinear Forces on a submerged, horizontal plate: the G-N theory

AUTHOR(S): Hayatdavoodi M. & Ertekin R. C.

QUESTIONER: Grue J.

QUESTION(S)

In the case where loads due to (periodic) conoidal waves are investigated, you have the chance to make a bridge between your nonlinear modeling and classical linear analyses, by letting your amplitude go to zero (or be small), in the long wave range ($k \rightarrow 0$). There are many recent works on the flat horizontal plate, in Applied Ocean Research, that provides this literature/references. One such reference is Grue and Palm, Appl. Ocean Res. (1984).

ANSWER(S)

We thank Professor Grue for this discussion. In the absence of appropriate laboratory experiments for the wave-induced forces or pressures, a comparison with linear theory for periodic waves would provide us with an idea of accuracy of the GN Level 1 theory for small wave amplitudes. Such a comparison is undergoing by the authors, using a linear solution that has been validated for other problems. Theoretically, the nonlinear GN results should agree with the linear results provided that any non-linearity is negligible. Possible discrepancies, however, could be due to the difference in the fundamental assumptions behind each of the approaches: The GN equations are derived for a fluid sheet of very small thickness while linear theory assumption breaks down in such a limit. Ideally both linear and nonlinear models should be validated by appropriate laboratory experiments. The above mentioned paper gives an expression for the second-order horizontal forces. Initial investigations of the horizontal forces predicted by GN equations show a very good agreement with the available laboratory experiments, while the vertical force comparisons show a slight difference. It would be interesting to compare Grue and Palm's expression with the experimental data.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Wave Pattern Analysis by a Higher-order Boundary Element Method

AUTHOR(S): He G. & Kashiwagi M.

QUESTIONER: Shao Y. -L.

QUESTION(S)

1. Is the QHOBEM based on quadratic shape function or spline?
2. Comment: The QBEM is similar to the cubic BEM that we have used in our time-domain code. There may be some experiences I would like to share. Using 3-point upwind scheme for the Φ_x terms in the free surface conditions will enable us to use the higher order explicit time-integration, e.g. Runge-Kutta 4th order.

ANSWER(S)

Thanks for your comment and nice information of keeping numerical simulation stable even by using the explicit time integration method. My answer to the question is that our HOBEM is based on shape function with q-mode in the element.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Computational evaluation of the added resistance in oblique seas

AUTHOR(S): Joncquez S., Simonsen C. & Otzen J. F.

QUESTIONER: Sportelli M.

QUESTION(S)

The sea spectrum might play an important role when comparing added resistance methods for a certain ship/route combination. Do you include, or plan to include, this effect in your analysis?

ANSWER(S)

Yes, I plan to include this effect but as the ship travelling on a route it will meet waves which are considered short waves, long waves etc. So all frequencies will have an influence.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Wave-energy absorption efficiency by a rotating pendulum-type electric-power generator installed inside a floating body
AUTHOR(S): Kashiwagi M., Nishimatsu S. & Sakai K.

QUESTIONER: Kim Y.

QUESTION(S)

You showed two experimental cases which were the roll and sway coupled problems. We know that the roll and sway are weakly nonlinear, but the coupling effects may be slightly more important in your problem, since the internal pendulum experiences sway as well as roll. Do you have any comments on such coupling effects?

ANSWER(S)

Exactly speaking, the sway motion must be coupled with the roll motion in general. However, since both are antisymmetric motion modes, the results shown in this paper are essentially the same even if the sway coupling is taken into account, although the motion equations become more complicated. It is known for small wavenumbers that the coupling terms of sway into roll are cancelled by the scattering term in the wave-exciting roll moment and thus the single-mode motion equation is justified for that special case. Anyhow, taking care of the roll-sway coupling is one of the future work to be done.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Wave-energy absorption efficiency by a rotating pendulum-type electric-power generator installed inside a floating body

AUTHOR(S): Kashiwagi M., Nishimatsu S. & Sakai K.

QUESTIONER: Li Y.

QUESTION(S)

What is the survivability condition?

ANSWER(S)

In the present analytical model, the linear assumption is adopted. However, even if the roll angle of a floating body and thus the rotation angle of an interior smaller circular cylinder becomes large including capsizing of the floating body, there is no essential problem in the mechanism for extracting the wave energy by an electric-power generator installed at the centre of the smaller circular cylinder. The floating body can be water-tight and thus can be survival even in the severe-wave conditions.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Inclined impact of a smooth body on thin liquid layer
AUTHOR(S): Khabakhpasheva T. I. & Korobkin A. A.

QUESTIONER: Grue J.

QUESTION(S)

Please comment on how you model the separation point, and similarities and differences from how Semenov et al. model this, and also Reinhard et al.

ANSWER(S)

To determine the position of the separation point we use the same Brillouin-Villat criteria as Semenov used and as one of the model by Reinhard. et al. I am sure that to decide which model of separation is correct we definitely need to have comparison with experiments.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Unsteady motion of elliptic cylinder under ice cover

AUTHOR(S): Kostikov V. K., Makarenko N. I. & Korobkin A. A.

QUESTIONER: Bennetts L. G.

QUESTION(S)

It appears that the authors include a non-linear curvature term in the fluid inter-facial condition. Is it possible to incorporate more complicated (non-linear) plate models in the solution method?

ANSWER(S)

To solve the problem we use the fully nonlinear equation of motion of the fluid, but the dynamic condition on the ice-water interface used is linear. Actually we start from the problem of motion under the free surface without ice. Knowing the free-surface elevation it appears possible, to calculate the new dynamic condition with the help of the linear equation of pressure. In other words, an iteration process is used. Answering on your question I think it is possible to use the non-linear equation for the pressure in another statement of the same problem.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Unsteady motion of elliptic cylinder under ice cover

AUTHOR(S): Kostikov V. K., Makarenko N. I., Korobkin A. A.

QUESTIONER: Meylan M. H.

QUESTION(S)

Could you have variable ice cover, finite length floes or other non homogeneity in your method?

ANSWER(S)

No, I can't. That is out of the scope of this problem.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Unsteady motion of elliptic cylinder under ice cover

AUTHOR(S): Kostikov V. K., Makarenko N. I., Korobkin A. A.

QUESTIONER: Cooker M. J.

QUESTION(S)

Can you allow the body size to grow or shrink while keeping the same shape?
(This might be done by including a source term inside the body?)

ANSWER(S)

We consider in our statement only rigid bodies, so they cannot vary their shape during the motion. However, our method allows one to consider elliptical cylinders with different shapes.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Multi-objective optimization of a wave energy absorber geometry

AUTHOR(S): Kurniawan A. & Moan T.

QUESTIONER: Rainey R.

QUESTION(S)

Your suggestion of a variable geometry bottom-fixed flap is interesting. The conventional view is that a flap does not need variable geometry, because it can shed power easily by limiting the hydraulic pressure in the power-take-off rams.

ANSWER(S)

Changing the flap angle relative to the arm has the added benefit of broadening the power absorption bandwidth when we do not have any other means for phase control. This is because changing the flap angle also changes the resonant characteristics of the device.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Multi-objective optimization of a wave energy absorber geometry

AUTHOR(S): Kurniawan A. & Moan T.

QUESTIONER: Newman, J.N.

QUESTION(S)

It is nice to see the combination of WAMIT with a multidimensional optimiser, especially since my own abstract does a similar optimization for a very different problem. But we need to be cautious since the optimizer is not aware of some practical restrictions. It looks like some of your structures are very close to having zero submergence above the inner cylinder, where the linear theory may be invalid. Have you considered this issue?

ANSWER(S)

In the study we set the maximum radius in the inner cylinder to be 0.95 the submergence of the cylinder axis. We do not know how valid linear theory is in this case.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Multi-objective optimization of a wave energy absorber geometry

AUTHOR(S): Kurniawan A. & Moan T.

QUESTIONER: Li Y.

QUESTION(S)

Have you considered other optimization methods?

ANSWER(S)

We have not considered other optimization methods.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Time-harmonic water waves trapped by surface-piercing motionless bodies floating freely

AUTHOR(S): Kuznetsov N. G. & Motygin O. V.

QUESTIONER: Kostikov V.

QUESTION(S)

You consider floating bodies with complex geometry. How does the geometry of the body influence the boundary condition?

ANSWER(S)

According to the inverse procedure the geometry is constructed so that the homogeneous Newman condition is fulfilled on it, but there is an infinite family of such geometries.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Towards real time simulation of ship-ship interaction
AUTHOR(S): Lindberg O., Bingham H. B., Engsig-Karup A. P. & Madsen P. A.

QUESTIONER: Newman J. N.

QUESTION(S)

I think it is wonderful that you are working towards the goal of real-time solutions to use with simulators. This should facilitate more realistic simulations for training and research, without the limitations inherent in semi-empirical manoeuvring coefficients.

ANSWER(S)

Ed. There was no recorded response to this comment.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Experimental investigation on the power generation performance of floating point absorber wave energy systems

AUTHOR(S): Li Y., Yu Y. -H., Epler J. & Previsic M.

QUESTIONER: Rainey R. C. T.

QUESTION(S)

This is a very interesting paper. However both Johannes Falnes and I disagree with your conclusion that for a point absorber 'big is beautiful'. We argue that because of the ' $\lambda/2\pi$ ' capture width limit 'small is beautiful'. See Phil Trans R. Soc. Lond. Vol 370.

ANSWER(S)

Thanks for the comment. I believe that we are both on the same page. The statement, or more precisely, the speculation I made is, under the capture width, ' $\lambda/2\pi$ ' or be adjust with viscous effect the bigger device could be better. This includes the mooring line cost and other costs. When it become an array the optimal solution would be different again.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Experimental investigation on the power generation performance of floating point absorber wave energy systems

AUTHOR(S): Li Y., Yu Y. -H., Epler J. & Previsic M.

QUESTIONER: Maki K. J.

QUESTION(S)

How suitable are the RANS equations for predicting the effect of viscosity on the power prediction of the wave energy device?

ANSWER(S)

RANS has its limitations especially when the viscous force dominates the motion and significant separation is observed at the bottom plate of the WED. However due to the time and funding restriction, we work on more advance methods such as LES in other applications, e.g. boundary layer's input to ocean energy device.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Hydrodynamic exciting forces on immersed prolate spheroids

AUTHOR(S): Mavrakos S. A. & Chatjigeorgiou I. K.

QUESTIONER: Evans D.

QUESTION(S)

Can you comment on how many modes you need to attain accuracy of the method?

ANSWER(S)

The number of modes strongly depend on immersion. For $f/a \geq 1.5$ (where f is the immersion and a is the semi-major axis of the spheroid), 10 modes appear to be sufficient. For smaller immersion more modes are needed e.g. for a spheroid that nearly touches the FS, $f/a = 1.01$ the method converged using approximately 35 modes.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: The time dependent motion of a floating cylinder
AUTHOR(S): Meylan M. H. & Ralph T.

QUESTIONER: Evans D.

QUESTION(S)

The problem in finite depth was considered by Gordon Crapper who confirmed that the long-time behaviour is exponential damping due to the singularity (pole) in the complex ω -plane closest to the real axis. In infinite depth the force coefficient has a logarithmic branch-cut at the origin which gives rise to the algebraic behaviour in inverse time.

ANSWER(S)

Yes, the finite depth case is different.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: The time dependent motion of a floating cylinder
AUTHOR(S): Meylan M. H. & Ralph T.

QUESTIONER: Bingham H.

QUESTION(S)

You showed a figure with the decay at the body's heave response after an initial (unit) velocity which appears to tend asymptotically to a non-zero value. Can you explain this?

ANSWER(S)

The initial velocity case decays at t^{-1} and you are seeing this very slow decay.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: The time-dependent motion of a floating cylinder

AUTHOR(S): Meylan M. H. & Ralph T.

QUESTIONER: Williams T. D.

QUESTION(S)

How does the complex pole, which causes exponential decay, approximate the algebraic decay that you showed?

ANSWER(S)

The exponential decay is only for medium time. For long times the decay is algebraic.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Experimental and numerical study of the sloshing motion in a rectangular tank with a perforated screen

AUTHOR(S): Molin B. & Remy F.

QUESTIONER: Chen X. B.

QUESTION(S)

To capture further the dissipation due to wave breaking, you may consider to include an additional dissipation term in the linear boundary condition at the free surface (see Chen X. B. and Dias F., 24th IWWWFB). In this case the wavenumber associated with the modified dispersion relation contains an imaginary component so that the sloshing waves decay due to the dissipation effect at the free-surface (breaking).

ANSWER(S)

Thank you for your suggestion. The extra dissipation term introduced in the free surface equations would have to be non linear in order to come into play only when the wave steepness exceeds some threshold value.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Experimental and numerical study of the sloshing motion in a rectangular tank with a perforated screen

AUTHOR(S): Molin B. & Remy F.

QUESTIONER: Bredmose H.

QUESTION(S)

The potential flow model seems to work very well despite the creation of vorticity from the perforated screen. Do you have an explanation as to why it works well?

ANSWER(S)

Vorticity is shed from the openings but quickly gets dissipated under the condition that the size of the openings is small as compared to the flow scale (see Molin, Hydrodynamic modeling of perforated structures, Applied Ocean Research, 2011).

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Scattering by a cylinder with variable bathymetry

AUTHOR(S): Newman J. N.

QUESTIONER: Bingham H.

QUESTION(S)

Some of your bathymetries seem to be axi-symmetric, or nearly so. Could you find an axi-symmetric cloaking solution which would then cloak a cylinder for all wave heading angles?

ANSWER(S)

It may be difficult to judge the angular variation of the optimised beds from the perspective figures, but they are not axi-symmetric or nearly so. For example, in the case of the structure (2,4) in Figure 3, the depth of the intersection between the bed and cylinder varies between a minimum of 0.86 on the sides and a maximum of 1.34 on the ends, relative to the unit depth at infinity. For the structure (4,8) the corresponding values are 0.49 and 1.59. I cannot answer your question with certainty, but it seems most unlikely in my view that cloaking is possible if the structure and bed are axisymmetric. If the boundary surface was axisymmetric one could separate the infinite set of Fourier modes which are present in the incident wave. Zero scattering of the complete solution would require that the same profile in the (r, z) plane has zero scattering in the far field for each of these modes.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Scattering by a cylinder with variable bathymetry

AUTHOR(S): Newman J. N.

QUESTIONER: Rainey R. C. T.

QUESTION(S)

You can reverse time in this problem, can you not? The normal objection (that the diffracted wave is then propagating inwards in the far field) does not apply. So your 'cloaked' cylinder is equally 'cloaked' for waves travelling in the opposite direction, yes? This explains why your bathymetry is up/down wave symmetric, does it not?

ANSWER(S)

I agree completely. Thanks for your contribution.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Scattering by a cylinder with variable bathymetry

AUTHOR(S): Newman J. N.

QUESTIONER: Li Y.

QUESTION(S)

Very interesting and nice paper. Just a quick comment. There are many applications in the applied technology area. The limitation is how to systematically conduct the optimisation. My experience from optimising tidal current turbines suggest that one must build a link between the optimisation method and the core hydrodynamic calculation so as to reach a better optimisation process. Therefore, perhaps a door can be opened from WAMIT to allow external access.

ANSWER(S)

It is not difficult to call WAMIT from an optimiser such as Matlab as described in the abstract by Adi Kurniawan and Torgeir Moan. Thus it is not necessary to modify WAMIT for this purpose.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: The Neumann-Mitchell theory of ship waves

AUTHOR(S): Noblesse F., Huang F. & Yang C.

QUESTIONER: Chen X.

QUESTION(S)

It is interesting to see your Neumann-Michell integral formulation involving the Neumann-Kelvin Green function. We know the short waves are deformed naturally by surface tension effects and damped out by viscous effects. Is it fully reasonable or satisfied by just filtering them comparing ship length (instead of using formulations including surface tension and viscous effects)? In the waterline integral, the two terms in the classical NK formulation are equivalently troublesome, does removal of the first term change indeed the difficulty?

ANSWER(S)

I certainly agree that a physics-based approach that properly takes into account surface tension and viscosity is inherently more satisfactory than filtering; nevertheless filtering is a satisfactory pragmatic approach in my opinion. The line integral around the ship waterline is entirely (both terms) eliminated in the NM theory, as is explained in the abstract. Thus, the NM theory does not involve a line integral.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: The Neumann-Mitchell theory of ship waves

AUTHOR(S): Noblesse F., Huang F. & Yang C.

QUESTIONER: Bingham H.

QUESTION(S)

Does your argument for removing one of the waterline terms also apply to other Neumann-Kelvin problems, for example the unsteady time- and/or frequency-domain problems?

ANSWER(S)

I have not considered the waterline integral for unsteady time- and/or frequency-domain problems in any depth, but my feeling is that the two arguments used to remove the waterline integral for steady ship waves should carry over to the more general case.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: The Neumann-Michell theory of ship waves

AUTHOR(S): Noblesse F., Huang F. & Yang C.

QUESTIONER: Kashiwagi M.

QUESTION(S)

The far-field wave drag looks larger than the near-field one. What is a possible reason for that?

ANSWER(S)

Ideally one would hope that the near-field and far-field wave drag are identical; in reality, they usually differ for various reasons including numerical inaccuracies and flaws in the theory.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Accurate computation of wave loads on a bottom fixed circular cylinder

AUTHOR(S): Paulsen B. T., Bredmose H. & Bingham H. B.

QUESTIONER: Grue J.

QUESTION(S)

If you redo your simulation in figures 3 and 4, with a cylinder radius of 2 m, you should obtain a very strong, high harmonic oscillation in the force, obtained by the integrated pressure, but not in the Morison force. The point is that the Froude number based on the wave induced velocity and the cylinder diameter exceeds 0.4 (when R is reduced from 3 m to 2 m). For reference see illustration of these forces in Grue (2011), *Theor. Appl. Mech. Lett.* 1, 062001 (2011).

ANSWER(S)

The high harmonic oscillation in the integrated pressure has been observed with the numerical model - results are presented and discussed in Paulsen et. al (2011) proceeding EWEA offshore 2011.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Accurate computation of wave loads on a bottom fixed circular cylinder

AUTHOR(S): Paulsen B. T., Bredmose H. & Bingham H. B.

QUESTIONER: Li Y.

QUESTION(S)

Have you compared your result with SPH?

ANSWER(S)

No, I have compared against analytical solutions, experiments, computations made by an Eulerian-Lagrangian code and alternative VOF formulation. I have not come across relevant SPH results, but if you are aware of any please let me know.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Water exit of a wedge-shaped body

AUTHOR(S): Piro D. J. & Maki K. J.

QUESTIONER: Li Y.

QUESTION(S)

Have you experienced any instability when the body motion is not prescribed?

ANSWER(S)

Yes, it is very important to chose a time-integration scheme for the body motion that works together with that for the fluid equations. Due to the large added mass relative to the body mass, some sort of implicitness in the time integration with iteration at the new time level is useful.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Water exit of a wedge-shaped body

AUTHOR(S): Piro D. J. & Maki K. J.

QUESTIONER: Cooker M.

QUESTION(S)

To help interpret the positive upward force during exit, consider (compute) the gravity-driven free-surface force in the absence of the body and the fluid starting from rest. A wedge-shaped depression in a free surface generates an upward jet. I have published a solution to this simple problem for a semi-circular depression – your wedge shape will make a more violent flow.

ANSWER(S)

We appreciate the suggestion and will consider the problem and solution for our future work.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Water exit of a wedge-shaped body

AUTHOR(S): Piro D. J. & Maki K. J.

QUESTIONER: Rainey R.

QUESTION(S)

Your observation that the hydrodynamic force is out of the water on exit, just as it is on entry, is familiar in another context. This is the problem of an oblique cylinder (axis inclined to the horizontal) moving vertically in/out of the water at constant velocity. There we argue either

1. that the sign of the force must correspond to the rate of increase/decrease of kinetic energy, which gives us a force of the same sign on entry and exit.
2. that if we adopt a frame of reference moving with the water surface intersection, the flow is steady. So the only hydrodynamic pressure is $0.5\rho V^2$, which is the same sign if we change the sign of V .

In both cases we rely on treating the water surface simply, as a "rigid lid". See references [6] and [7] in my paper with John Chaplin.

ANSWER(S)

We appreciate the comments and references which will surely be useful as we continue to study this problem.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Investigating interaction effects in an array of multi-mode wave energy converters

AUTHOR(S): Ransley E. & Greaves D.

QUESTIONER: Newman J.N.

QUESTION(S)

How large an array are you envisioning to analyse? These days it is practical to use direct radiation/diffraction codes for $O(100)$ interacting bodies, but $O(100)$ may require high computational cost.

ANSWER(S)

I envisage this concept to be applicable for any size array offering potential to design arrays of WECs with alternative objective functions very rapidly to assess the improvement multi-mode devices may be able to make. When considering a specific project a more rigorous method may be more applicable once the initial design concept has been considered.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Investigating interaction effects in an array of multi-mode wave energy converters

AUTHOR(S): Ransley E. & Greaves D.

QUESTIONER: Evans D.

QUESTION(S)

Your definition of q relates the local wave height H_{local} to the incident wave height. Does this take into account the radiated wave out to infinity in the power budget?

ANSWER(S)

Here the local q factor is defined as the local wave height at each position (which is the sum of the incident waves, the scattered waves and the radiated waves at that position) over the incident waves height in the absence of any devices. This is used as an indicator of the wave energy available to a potential device position at that location.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Solving the linear radiation problem using a volume method on an overset grid

AUTHOR(S): Read R. W. & Bingham H. B.

QUESTIONER: Grue J.

QUESTION(S)

Please comment on the combination of: finite body excursion, locally very strong non-linearity, finite grid resolution, potential (or real) local breaking, generated wave energy at very high wavenumber and your model. How would you tackle local effects of breaking, seen from your experience?

ANSWER(S)

The work described in this paper is based on a linear potential theory analysis to validate the overset grid methodology that we are implementing for the first time. We are therefore assuming that the excursion of the body is small in comparison to its characteristic length, and that there is a complete absence of non-linearity and local wave breaking. Regarding grid resolution, we have taken careful steps to ensure that the waves which we generate with lengths shorter than the typical grid spacing contain negligible energy, thus avoiding aliasing. In a more advanced simulation, local effects of breaking might be modelled by introducing a surface-forcing term on an otherwise potential flow.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Solving the linear radiation problem using a volume method on an overset grid

AUTHOR(S): Read R. W. & Bingham H. B.

QUESTIONER: Kashiwagi M.

QUESTION(S)

You have explained that the accuracy in computed results for the cross-coupling terms is not so good as compared to other terms. What is the reason for that inaccuracy? I think the numerical accuracy can be self-checked through the symmetric relation or the energy-conservation relation in the radiation problem.

ANSWER(S)

The reason for this inaccuracy remains unclear. However, we suspect that it may be related to slight geometry differences between our simulation and the analytical reference, particularly close to the corners. We are in the process of further investigating this possibility. We agree that the symmetry of the results for different cross-coupled modes is an important check that the simulation is behaving correctly. Indeed, we have confirmed this for all of our simulations.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: The bounce of a blunt body from a water surface at high horizontal speed

AUTHOR(S): Reinhard M., Korobkin A. A. & Cooker M. J.

QUESTIONER: Tyvand P.

QUESTION(S)

You are very close to solving the classical problem of skipping a spinning stone. Just make the body symmetric around a vertical axis and include body rotation. You will need to include the pitch degree of freedom. The impact torque must be allowed to modify slightly the spin and the pitch angle, in order to solve the stone skipping problem as such.

ANSWER(S)

In this presentation we rather focused on the effects of different separation criteria on the body-water interaction and, hence, wanted to keep the body shape and dynamics as simple as possible. We already have considered to introduce a pitch degree of freedom as it was done for the oblique plate impact in Reinhard et al. (2011). If the body's surface shape is an ellipsoid, the rotation of the body influences the hydrodynamic loads significantly as it was illustrated by Khabakpasheva and Korobkin (IWWF 2012). The spin is important for the body dynamics and can be taken into account by a restoring force for the pitch motion. However, in our inviscid model the spin itself has only negligible influence on the water flow.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: The bounce of a blunt body from a water surface at high horizontal speed

AUTHOR(S): Reinhard M., Korobkin A. A. & Cooker M. J.

QUESTIONER: Chatjigeorgiou I.

QUESTION(S)

Which one from the three separation criteria you investigate is more reliable as the results you have shown are significantly different?

ANSWER(S)

It is common to use Brillouin-Villat condition for laminar separation in high Reynolds-number flow. However, we believe that for our body impact problem the fluid flow along the body is turbulent, so that the fluid may detach far behind the separation point given by Brillouin-Villat condition. For turbulent flow practical separation criteria do not exist. We doubt for impact of large bodies that viscosity plays a significant part on the position of the separation point which motivated us to introduce two further inviscid criteria. Experiments will be very helpful to choose the right condition.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: The bounce of a blunt body from a water surface at high horizontal speed

AUTHOR(S): Reinhard M., Korobkin A. A. & Cooker M. J.

QUESTIONER: Hayatdavoodi M.

QUESTION(S)

Is it possible for air pockets to form between water surface and the body? If so, and assuming the air pockets would change the impact process, how do you take this into consideration?

ANSWER(S)

We distinguish three means that air pockets can emerge in the region where the body is in contact with fluid. The first type arises when the free surface deforms to a pocket before air is trapped between the body and the fluid at the initial touch down (see Wilson 1991). Another form of air pocket can enter the fluid bulk during impact at high horizontal speed or planing stage when air comes between the forward spray root region and the body due to a tilt upstream of the body or due to waves coming up front. As the body's horizontal speed is high, air pockets of these two types move along the underside of the body and leave the body quickly at the rear contact point. A third type of air-pocket can arise in the area where the hydrodynamic pressure is below atmospheric pressure. Air from outside could be ventilated into this zone. But it may be possible that air bubbles, coming from air pockets of the previous two types, accumulate on the low pressure zone on the rear part of the body. Air pockets of all three types may have a significant influence on the hydrodynamic loads acting on the body and also the position of the separation point. It is possible to incorporate air pockets in the present model by introducing dry areas in the original wetted interval $(d1, d2), y = 0$. However, the mathematics is more complicated.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Resonant scattering by an array of thin plates for wave energy extraction

AUTHOR(S): Renzi E. & Dias F.

QUESTIONER: Evans D.

QUESTION(S)

You seek to maximise the excitation force in the fixed plate in order, you say, to maximise the power when it is hinged and absorbing power. But the power is given by $P = |X_s|^2/8B$ where X_s is the exciting force and B is the radiation damping and the two are related in two dimensions. In fact the maximum power available for a symmetric device in a tank - even when not spanning the tank, is 0.5.

ANSWER(S)

As a preliminary analysis for our work, we studied the flap in the 2D geometry and got a maximum efficiency of 0.5. For the 3D model this figure still holds when the gap between the device and the channel is small. (i.e. the device shows a 'quasi-2D' behaviour). However, when the gap is large, resonance of the transverse short-crested modes of the channel can increase the efficiency of the device over the 2D theoretical value. We compared our analytical results against data obtained with a finite-element numerical code, which as well predicts values larger than 0.5 for the efficiency in the 3D geometry. Comparison shows good agreement between analytical and numerical models.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Resonant scattering by an array of thin plates for wave energy extraction

AUTHOR(S): Renzi E. & Dias F.

QUESTIONER: Porter R.

QUESTION(S)

1. In your formulation you use a system of infinite images in terms of Hankel functions. There are other representations for the channel Green's function which have better convergence such as 'Ewald methods' (see paper by Linton ~1999). Are you aware of such methods? Can you comment on your convergence with m ?
2. You have a $\cosh(k(z + h))$ depth dependence in your formulation. How can you produce wave power results for a flap which does not move with the same dependence in z ?

ANSWER(S)

1. I am not aware of the cited method, and will look at it in detail. Nevertheless, we are aware of the existence of alternative forms for the Green function, but we are more familiar with that presented in our paper. Furthermore, Hankel functions enjoy many properties for which we preferred them to other known representations. Convergence is with $m^{-3/2}$, which is good for our purposes.
2. The formulation with $\cosh(k(z + h))$ refers to the scattering potential, which, does not contain parasite modes varying with z . Of course, the radiation potential (not shown in the presentation) features a sum of vertical eigenmodes, so that the overall dependence with z is more complicated. More details in the mathematical computations can be seen in Renzi & Dias, "Resonant behaviour of an oscillating wave energy converter in a channel", J. Fluid Mech., in press. 2012.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: A non-reciprocal Green's function providing an exact, explicit Dirichlet-Neumann operator: an example for linear waves on a sloping beach in 1DH

AUTHOR(S): Schäffer H.

QUESTIONER: Grue J.

QUESTION(S)

Please comment on the behaviour of the formulation at the end of the beach, and also the limitation, if any, by the assumption that the domain is not infinite.

ANSWER(S)

The impulse response function is characterised by geometric similarity, so the picture looks the same no matter how much we zoom in on the shoreline vicinity. To have any significance, the zoom must thus be related to the horizontal length scale of the flow. If, for analysis purposes, we assume that the flow field is band limited, then the zoom can make the impulse response function sufficiently narrow for the gradient of the flux (where flux is horizontal velocity times depth) to be constant within its footprint. Using integration by parts the convolution may be recast in terms of the flux and an impulse response function that approaches the Dirac Delta distribution. The sifting property of the Dirac Delta distribution then eliminates the convolution and results in an expression that is equivalent to the shallow water continuity equation. The limitation of the domain follows from the limited support of the impulse response function. This naturally terminates the domain at the beach.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: A non-reciprocal Green's function providing an exact, explicit Dirichlet-Neumann operator: an example for linear waves on a sloping beach in 1DH

AUTHOR(S): Schäffer H.

QUESTIONER: Porter R.

QUESTION(S)

You use the mild-slope equations but what is your small parameter that defines 'mildness'?

ANSWER(S)

The significance of my expansion today is that it makes no mild-slope assumption. In the previous work as used for reference, 'mildness' means smallness of water-depth-gradient magnitude. The convolution approach gives a flow model rather than a wave model and the mildness measure is thus related to the bathymetry alone and does not involve the wavelength scale.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Hydrodynamic impact (Wagner) problem and Galin's theorem

AUTHOR(S): Scolan Y. -M. & Korobkin A. A.

QUESTIONER: Chatjigeorgiou I.

QUESTION(S)

1. You solved the boundary value problem in terms of Cartesian coordinates. Have you, tried to solve the same problem using a different coordinate system?
2. What do you mean saying that forces do not depend on horizontal kinematics but only on vertical?

ANSWER(S)

1. Wagner's problem for an elliptic paraboloid has been solved by Korobkin (1982) by using coordinates adopted to the body shape.
2. Horizontal velocity does not contribute to the force at leading order, only to pressure distribution.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: A surface-piercing body moving along the free surface
AUTHOR(S): Semenov Y.A., Wu G.X. & Yoon B.S.

QUESTIONER: Grue J.

QUESTION(S)

What is the condition at the point where the flow detaches from the geometry?
Are there numerical difficulties experienced with the condition?

ANSWER(S)

The Brillouin-Villat condition is applied to determine the point of the flow separation. This condition provides an additional nonlinear equation with respect to the wetted length of the body at which the curvature of the free surface is equal to the curvature of the body. For other wetted lengths the curvature of the free surface is infinite at the point of the flow separation. From a numerical point of view it is necessary to solve 5-10 times the system of the integral equations to satisfy the additional nonlinear equation with respect to the wetted length of the body.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: A surface-piercing body moving along the free surface

AUTHOR(S): Semenov Y. A., Wu G.X. & Yoon B. S.

QUESTIONER: Korobkin A. A.

QUESTION(S)

Is it correct that the flow is calculated first without separation of the jet in front of the mooring body and then the flow in the jet is corrected to find the separation point and the jet shape? Is there a coupling between the flow in the main region and the flow in the jet?

ANSWER(S)

Yes, the iteration procedure is organised in such a manner that the pressure coefficient is calculated first, and then the shape of flow boundaries. If the pressure coefficient becomes zero at some distance from the trailing edge, then we apply Bernoulli's equation to determine the velocity magnitude on the unknown boundary of the splash jet. Repeating the iterations we finally determine both the shape of the free surface and the location of the point (separation point) where the pressure coefficient becomes zero, that indicates the separation of the splash jet.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Solution of nonlinear free surface-body interaction with a harmonic polynomial cell method

AUTHOR(S): Shao Y. -L. & Faltinsen O. M.

QUESTIONER: Eatock Taylor R.

QUESTION(S)

As I am the co-author of the 1995 paper with Wu (your reference [3]) you may not be surprised by my question. Your method appears to be very effective and, like professor Kim I am interested in how your HPC compare with FEM in terms of accuracy and efficiency. Your method leads to a minimal bandwidth but requires overlapping cells. What are the implications of the trade-off between bandwidth and the number of cells required for a given accuracy? The test for comparison with the FEM would need to include geometries where the FEM would normally employ non-structured meshes.

ANSWER(S)

These are very interesting comments. We will look into the possibility of comparing our approach with FEM. The method uses overlapping cells. It is so designed that we always have at most 9 non-zeros and 27 non-zeros in 2D and 3D respectively in the sparse matrix. When one wants to increase the accuracy we increase the number of elements (decrease the cell size). The method has truncated error $O(\Delta h)$ if the grid is uniform as it is used in the presented results.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Solution of nonlinear free surface-body interaction with a harmonic polynomial cell method

AUTHOR(S): Shao Y. -L. & Faltinsen O. M.

QUESTIONER: Kim S.

QUESTION(S)

Thank you very much for this nice work. It is an excellent study in many aspects. I wonder if you have had a chance to compare with the finite element method for error and CPU time? You showed the comparison with BEM's. If your results are compared with those of FEM, it will be very useful to figure out the overall performance of your method.

ANSWER(S)

Nice comments. We will look into the possibility of comparing our HPC method with FEM.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Solution of nonlinear free surface-body interaction with a harmonic polynomial cell method

AUTHOR(S): Shao Y. -L. & Faltinsen O. M.

QUESTIONER: Bingham H.

QUESTION(S)

Your HPC method ends up looking very much like a finite difference method. I suggest that you consider the truncation error of this method and compare it to a finite difference method using some stencil size.

ANSWER(S)

Thank you for your suggestion. We are going to include that in our future studies.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Added resistance in short waves: a ray theory approach

AUTHOR(S): Sportelli M. & Huijsmans R. H. M.

QUESTIONER: Kashiwagi M.

QUESTION(S)

Is it correct that the present ray theory can also be applied for the motion-free case?

There are two terms in the equation for computing the added resistance: one is related to the relative wave height on the ship waterline and the other is the velocity-squared term over the wetted body surface. The latter term is also computed along the ship waterline, but how did you approximate in the computation of the latter term?

ANSWER(S)

The ray expansion is based on the large k hypothesis; thus the wave lengths considered correspond to the case of a motionless ship advancing in waves. The second term in the added resistance equation is reduced analytically to an integral over the waterline by assuming vertical side walls, details of the calculation can be found in Kalske (4), Appendix A.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Generation of unsteady waves by three-dimensional source in deep water with an elastic cover

AUTHOR(S): Sturova I. V.

QUESTIONER: Duan W.

QUESTION(S)

I am wondering if your coefficients of multiple expansion were obtained by satisfying not only the body boundary condition but also the boundary condition of the ice.

ANSWER(S)

In multipole expansion method (see, for example, WU F.X. Proc. R. Soc. Lond.A, 1995, 448 (1932)) the expression for the potential presents as the sum of singular multipoles and the regular terms, which are obtained by satisfying the boundary condition on the upper boundary of the fluid and in the far field. But these are unknown coefficients. By applying the conditions on the body surface and using orthogonality relations for associated Legendre functions, we obtain the infinite systems of linear algebraic equations for unknown coefficients. The truncation of the infinite series is used.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Generation of unsteady waves by three-dimensional source in deep water with an elastic cover

AUTHOR(S): Sturova I. V.

QUESTIONER: Meylan M.

QUESTION(S)

What are the numerical challenges of your method?

ANSWER(S)

There are not the numerical challenges. It is necessary to calculate many integrals in the sense of the principal value.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Generation of unsteady waves by three-dimensional source in deep water with an elastic cover

AUTHOR(S): Sturova I. V.

QUESTIONER: Williams T. D.

QUESTION(S)

Are there any interesting effects near or at the boundaries between regions where there are different numbers of roots?

ANSWER(S)

Yes. It is possible there is a sharp variation of the radiation load in the vicinity of these boundaries.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Development of a time domain strip theory approach for maneuvering in a seaway

AUTHOR(S): Subramanian R. & Beck R. F.

QUESTIONER: Cooker M.

QUESTION(S)

Please report on the position of the waterline at the body, because this is a sensitive measure of where the numerics starts to get difficult in your very interesting work.

ANSWER(S)

On the body-exact approach we keep track of the intersection of the incident waves and the body surfaces. Thus, if there is interest we can easily report the intersection position.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Modelling of the oblique impact of an elongated body by a 2D+t approach

AUTHOR(S): Tassin A., Korobkin A. A. & Cooker M. J.

QUESTIONER: Dessi D.

QUESTION(S)

Have you tried to calculate with your model the best combination of descent slope, velocity and trim of the aeroplane. If not yet, do you think that it will be possible to issue with your model analytical rules after the optimisation is carried out?

ANSWER(S)

This is a main purpose of our project to find optimal conditions of landing on the water to reduce hydrodynamic loads and accelerations of aircraft in ditching. Indeed, our model(s) are derived to be used for preliminary optimisation with more complete models to be used later for refined optimisation.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Modelling of the oblique impact of an elongated body by a 2D+t approach

AUTHOR(S): Tassin A., Korobkin A. A. & Cooker M.J.

QUESTIONER: Duan W.

QUESTION(S)

Could the model be extended directly to landing of slender body on the incoming waves, and separation treatment of jet through hard chine by 45° be unified for a different body shape?

ANSWER(S)

Yes, the model can be extended to include incoming waves for head and following seas. The 45° angle for separation treatment was used for wedge and ship section shapes with hard chine. However, more validation is needed to support and/or tailor this separation model.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Simulation of nonlinear wave elevation around a square array of truncated cylinders

AUTHOR(S): Teng B. & Cong P. W.

QUESTIONER: Chen X.

QUESTION(S)

Have you compared your numerical results with those of model tests? My feeling is that the theoretical prediction based on the potential theory is much exaggerated. The small dissipation in the real fluid should reduce the second-order free-surface elevation sensibly.

ANSWER(S)

Thanks for the suggestion. In the next step we will do the comparison with others' experimental results.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Simulation of nonlinear wave elevation around a square array of truncated cylinders

AUTHOR(S): Teng B. & Cong P. W.

QUESTIONER: Evans D.

QUESTION(S)

The phenomenon of near-trapping arises because of the symmetry of the 4 cylinders in a square. In a paper published in 1997 in Applied Ocean Research, Richard Porter and I showed that the first-order exciting force was 53 times that in a single cylinder provided the 4 cylinders were within 1/2 radius of each other. But if we changed the geometry of one of the cylinders by 10%, the large force was considerably reduced. It would be of interest to see what happens in your case at second order when the symmetry is broken.

ANSWER(S)

Thanks for the information. We will do the computation with our model later.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Effective treatment of Fourier integrals associated with a hemi-sphere advancing in waves

AUTHOR(S): Ten I. & Chen X. B.

QUESTIONER: Kashiwagi M.

QUESTION(S)

The present calculation method is what we call the hybrid method, in which the Rankine source method is used for the inner region and the Green function for the forward-speed and the harmonic-oscillation case is used for representing the velocity potential for the outer region. A difficulty in this method is the existence of the line-integral terms along the waterline of the matching boundary. This difficulty stems from the forward-speed advection term in the free-surface condition and can be removed by adopting the spaced-fixed coordinate system. In fact, that is the work done by Iwashita and Kataoka (JASNAOE, 2004). Although the semi-prolate spheroid is used in the present analysis, essentially the same problem exists as that faced by Iwashita and Kata and I would recommend you to refer to their work.

ANSWER(S)

We would like to thank Professor Kashiwagi for his comment and given reference: the paper "Estimations of Hydrodynamic Forces Acting on Ship Advancing in the Calm Water and Waves by a Time-Domain Hybrid Method" by S. Kataoka and H. Iwashita (The Journal of the Society of Naval Architects of Japan, Vol. 196, 123-138, 2004, in Japanese).

In the above work (time domain) in which an earth fixed reference system is used then the control surface is also fixed as described in the paper, the external domain problem will be simpler in terms of the absence of the waterline integrals, but the area for the internal domain will increase dramatically so that the computation time might be an issue.

Indeed, in our method (frequency domain) using the mobile reference system moving with the ship, there are several difficulties to compute waterline

APRIL 22-25, 2012 — COPENHAGEN, DENMARK

integrals. We believe, that the difficulties can be overcome even if it will take time to compute the DN matrix correctly (due to evaluating the line integrals properly). But, once it is computed for some parameters, it can be saved and used to calculate the hydrodynamic forces acting on the ship of different shapes in the internal domain using the Rankine source method.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Incompressible impulsive sloshing

AUTHOR(S): Tyvand P. A. & Miloh T.

QUESTIONER: Cooker M.

QUESTION(S)

In order to reach a constant velocity impulsive state there is an acceleration stage about which the late Andy C. King and D. J. Needham wrote a JFM paper. They showed the contact line has displacement proportional to $-t \ln t$ and a non-zero surface slope starts, at $t = 0+$, and grows in a self-similar manner. Professor John Billingham at Nottingham University is publishing more on this for inclined wave makers.

ANSWER(S)

We are aware of the three papers on inner expansions for the impulsive wavemaker (see reference list below). These papers resolve the waterline singularities and make the velocity (or acceleration) finite at the waterline. Our intention is to bring new attention to the almost forgotten topic of impulsive sloshing, and provide additional solutions for new geometries. Our 3D solutions are outer solutions with integrable waterline singularities. So far, no attempt has been made to resolve the waterline singularities for impulsive sloshing. The first thing to do will be to consider a very wide and shallow rectangular container, where one may combine two solutions of a piston wavemaker in positive surge motion and a piston wavemaker in negative surge motion.

References:

A.C. King and D.J. Needham (1994) *J. Fluid Mech.* 268, 89-101.

D. J. Needham, J. Billingham and A.C. King (2007) *J. Fluid Mech.* 578, 67-84.

D. J. Needham, P.G. Chamberlain and J. Billingham (2008) *Quart. J. Mech. Appl. Math.* 61, 581-614.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Incompressible impulsive sloshing

AUTHOR(S): Tyvand P. A. & Miloh T.

QUESTIONER: Bingham H.

QUESTION(S)

You claim that an impulsive start to the motion (or some derivative/integral of the motion) leads to a singularity at the free-surface/wall intersection point. In my mind this is at odds with the classical impulsive formulation of the ship motions problem (i.e. the method implemented in TiMIT). Here the problem is decomposed into an impulsive solution at $t = 0$ and a wave solution for $t > 0$. For example, an impulse in the body velocity at $t = 0$, leads to a smooth and finite initial free-surface elevation for the $t > 0$ problem which is straightforward to solve numerically and is by no means singular at the body/free-surface intersection. Can you resolve your claim with this fact?

ANSWER(S)

In our paper we want to bring attention to impulsive sloshing. More generally we focus on the general dilemma on how to develop a free-surface flow from rest. It is almost impossible to start an oscillatory free-surface flow by horizontal motion of a piston, because there are no initial forces that can bring the surface particles into horizontal motion. Since the potential flow model of water waves is reversible in time, you will not be able to stop something that you could not start. Given any state of wave motion, it is not possible to stop it abruptly, because all particles at surface slopes must have acceleration. We believe that this lack of continuous evolution from an initially undisturbed state through a rapid impulsive forcing to a developed oscillatory state of wave motion is common to all problems where a vertical wall put into motion is responsible for initiating the fluid flow. We therefore believe that the waterline singularity at a moving vertical wall will not just disappear but leave a signature on the following wave motion, also for ship motion if the ship walls are vertical at the waterline. It is possible that the transients due to the waterline singularities will

APRIL 22-25, 2012 — COPENHAGEN, DENMARK

be transported away in an infinite fluid domain, but for sloshing in open containers the waterline singularities will affect the flow for all times if there is no viscous damping. We do not believe that this singularity trouble for the outer solution is resolved by a simple separation of the impulsive solution from the wave solution, since the wave solution is generated by the impulsive flow. This is a complicated topic, and we need to discuss it more thoroughly. If we limit ourselves to linear theory and an impulsive velocity, it is true that both the potential itself and the time derivative of the potential are initially zero at the flat free surface. The only inhomogeneity in the problem comes from the Neumann condition at the vertical wall(s) that is forced into motion, and this inhomogeneity causes the waterline singularity.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Evolution of water waves generated by subaerial solid landslide

AUTHOR(S): Viroulet S., Cébron D., Kimmoun O. & Kharif C.

QUESTIONER: Renzi E.

QUESTION(S)

1. In your paper, you seem not to be aware of some papers with analytical, numerical and experimental studies available in the literature (e.g. Sammaco & Renci, *Journal of Fluid Mech.* 2008; Renzi & Sammarco, *NHESS*, 2012). I think they will provide you with a good benchmark for your analysis and results.
2. Your results are interesting, because the treatment of a thick slide is pretty novel in the literature. However, I am concerned with their application, since your layout looks very theoretical (2D, solid body...). Are you planning to extend your analysis to more realistic situations?

ANSWER(S)

1. I was aware of one of these two papers (Sammaco & Renci, *Journal of Fluid Mech.* 2008). This paper deals with subaerial solid landslide by an analytical, numerical and experimental treatment. The second is in press so I did not know it until now. From these papers I can say that the experiments are very different from our idealised case so I do not think it will provide a benchmark for our dimensional analysis. Anyway, these papers will be a great validation case for Gerris. I will look at this as soon as I get back!
2. To extend our analysis to more realistic situations, we immediately thought about a 3D development and/or using a deformable slide. In a tsunami generated by landslide, there are strong interactions between the slide and the waves, so we find that it was more challenging to study the influence of the rheology on the slide. We are conducting experiments with dry granular media falling into water which is still a totally unknown problem!

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: A waves-in-ice model with a floe-breaking parameterisation

AUTHOR(S): Williams T. D., Bennetts L. G. & Squire V. A.

QUESTIONER: Kwon S. H.

QUESTION(S)

I think you assumed that waves are independent. How good is the assumption?

ANSWER(S)

We do assume the waves are linear. Inside the ice the approximation is probably okay as the waves attenuate, particularly high frequencies. Propagating the waves from where the wave model stops into the ice, there may be some errors. We have suggested to the meteorological service of Norway to continue their wave model into the ice, but without any wind forcing where the ice is. This may give us an idea of the error, but their forecast could exaggerate the non-linear effects because they would not have attenuation due to broken ice.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Application of the high level GN theory to shallow-water wave problems

AUTHOR(S): Zhao B. B. & Duan W. Y.

QUESTIONER: Bingham H. B.

QUESTION(S)

Can you confirm that the bottom boundary condition is exactly satisfied (to some consistent numerical level) by this method? In particular it would be interesting to check this numerically on sections of the bottom with high gradients.

ANSWER(S)

In the GN theory, when we derive the GN equations nothing is thrown away. So all terms are kept. The GN theory is a fully nonlinear wave theory. And the free surface and bottom boundary condition are all met exactly. And thank you for your kind suggestion.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Application of the high level GN theory to shallow-water wave problems

AUTHOR(S): Zhao B. B. & Duan W. Y.

QUESTIONER: Grue J.

QUESTION(S)

Would you comment on the treatment at high wave numbers ($k \leftarrow \infty$). Particularly, the generation of the solitary wave has infinitely high k in the initial condition, and also substantial energy in this range.

ANSWER(S)

When we do the numerical calculation we smoothed the initial free surface ten times by using a five-point smoothing method. Maybe by doing this we removed the waves with high wave numbers.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Application of the high level GN theory to shallow-water wave problems

AUTHOR(S): Zhao B. B. & Duan W. Y.

QUESTIONER: Eatock Taylor R.

QUESTION(S)

What difficulties do you encounter in extending this approach to three dimensions?

ANSWER(S)

You can find our paper on 25th IWWF. We have applied the GN theory to 3-D. The difficulty is that I don't know how to deal with the case with an irregular boundary. What I have done till now are all cases with a regular boundary. That's the disadvantage of the finite difference method.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Application of the high level GN theory to shallow-water wave problems

AUTHOR(S): Zhao B. B. & Duan W. Y.

QUESTIONER: Taylor P. H.

QUESTION(S)

What happens in high-order GN theory when the water surface locally tends to the vertical? Does the finite difference spatial discretisation provide enough smoothing to remove this breaking problem?

ANSWER(S)

GN theory cannot deal with the breaking problem. But it can simulate a wave that is almost breaking. If the water surface locally tends to the vertical, you are right, we have to provide some smoothing to remove this breaking problem.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Numerical time integration methods for a point absorber wave energy converter

AUTHOR(S): Zurkinden A. S. & Kramer M. M.

QUESTIONER: Evans D.

QUESTION(S)

Back in the early 1980s E. R. Jefferies wrote a Ph.D. thesis based on modelling the convention integral by a state-space system of ordinary differential equations. I seem to remember he had problems modelling accurately the high-frequency part. Do you have any similar difficulties for large ω ?

ANSWER(S)

I have not experienced any problems, influenced by high-frequency effects. However, such problems, I assume, could occur when analysing impacts i.e. slamming or ship impacts on the structure. My study is more in the power absorption calculation and a subsequent structural analysis by means of fatigue damage calculation during the operation of the device.

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Numerical time integration methods for a point absorber wave energy converter

AUTHOR(S): Zurkinden A. S. & Kramer M. M.

QUESTIONER: Beck R.

QUESTION(S)

Do you have any comparisons between the full scale device that you showed pictures of and your model tests/numerical results?

ANSWER(S)

At this point we do not have such a comparison, meaning we do not have a quantitative comparison by means of graphs etc. However we have compared the capture width ratio (non-dimensional performance index) between the prototype and the laboratory device. It seems that they are in (relatively) good agreement, ($\Delta E=1-7\%$).

QUESTION & ANSWER SHEET

TITLE OF ABSTRACT: Numerical time integration methods for a point absorber wave energy converter

AUTHOR(S): Zurkinden A. S. & Kramer M. M.

QUESTIONER: Korobkin A.

QUESTION(S)

Your presentation is based on the linear FSI theory. Non-linear effects can be important and even dominant. If we make experiments with your design of the absorber for the same wave(s) but a different 'equilibrium' position of the absorber, we may expect to arrive at a curve showing dependence of the extracted energy on that position. It is possible that the energy is maximum for such a position that the absorber is completely above the water level without waves. It would be interesting to find such dependence by experiments.

ANSWER(S)

Thanks for this interesting comment, in fact the influence of the equilibrium position has not been investigated so far (to my knowledge) by our group. I agree that this could be an interesting study. Firstly, I would probably change the mass moment of inertia in order to change the draught of the hemisphere.