26th International Workshop on Water Waves and Floating Bodies

April 17~20, 2011
Athens, Greece

Q/A Sheet

Title of Abstract: Linear wave-structure interaction using overset grids
Author(s): Read R.W. & Bingham H.B.

Question(s)

Name: J. N. Newman

Question(s):
Your conclusion that a small bottom slope does not affect the linear force coefficients is consistent with our experience with 3d computations for ships, at least for heave. For an elongated vessel there is more effect on the pitch moment, which is not surprising. More interestingly, there is a stronger effect on the mean drift force, perhaps because the bow and stern are in substantially different depths, so this may not be the case for a circular cylinder.

Answer(s)

Thank you for your comments.

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Q/A Sheet

Title of Abstract: Investigation on the diffraction and radiation forces of a bulging tube.
Author(s): A. Babarit & P. Ferrant

Question(s)

Name: Harry Bingham

Question(s):
A comment and a question:

- I don't think it is surprising that wave radiation is important to the power absorption of this device, indeed to absorb wave power a device must scatter waves.
- How are you modelling the PTO?

Answer(s)

- We fully agree with your comment. However, there is no previous indicating that this particular wave energy device would scatter a lot of waves. By verifying it, then it indicates that it could be a good wave energy absorber.
- The PTO is modelled by a pressure drop at both ends of the tube. We assume that the flow velocity at the ends of the tube is proportional to the inner pressure. Then it corresponds with damping of energy.

Question(s)

Name: David Evans

Question(s):

I did not understand how you compared the power absorbed with the incoming power. For example what is the capture width ratio once diffraction effect is included?

Answer(s)

We did not provide such comparison yet. We only showed results of energy absorption for a range of wave frequencies, but we did not calculate the corresponding capture width ratio. We promise to do it for the next workshop.
However, we showed that preliminary results indicate that this device has a good energy absorption ability for long waves. Although it is very beneficial for a wave energy device, it is also very unusual. That is why we concluded that it is a promising way for wave energy conversion.

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Q/A Sheet

Title of Abstract: Wave forcing of submerged elastic plates
Author(s): Williams T.D., Meylan M.H. & Peter M.

Question(s)

Name: A. Korobkin

Question(s):
Could current effects be considered with this model?

Answer(s)

Possibly would need to check what eqn's for a perturbation analysis looked like. (There would be no disturbance to a current at the moment as the plate is infinitesimally thin in our model)

Question(s)

Name: David Evans

Question(s):
1. You have shown the equivalence of the Wiener-Hopf method and the Residue Calculus Method, but I wonder if there are any problems which can be done by one method and not by the other.
2. You have two transmission coefficients here, or two reflection coefficients if the waves approach from the opposite side. Have you worked out the reciprocal relation which must exist as they would provide a check on your numerical results?

Answer(s)

1. In infinite depth, when the dispersion relations have branch cuts, then RC cannot be used. However, that problem might turn into a singular integral equation in infinite depth (such as De & Mandal described yesterday).

2. Hassan et al. presented us energy conservation laws of the form

$$1 - |a_0|^2 = a_1|b_1|^2 + a_2|b_2|^2 \quad ,$$

which we satisfied, but we didn't look for reciprocity relations.

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Q/A Sheet

Title of Abstract: Wave-drift force on a rectangular barge by a vertical wall
Author(s): Kimmoun O., Molin B. & Oikonomidou H.

Question(s)

Name: J. N. Newman

Question(s):

1) In the 1976 BOSS conference Ohkusu showed a nice movie of oscillatory drift of a small 2D barge up wave of a large fixed structure. This showed quite dramatically the negative drift associated with a nearly-resonant standing wave between the two bodies.
2) When the reflection coefficient is much less than one, how do you account for the energy loss?

Answer(s)

When we add only roll damping, the reflection coefficient still equal to one. But when we add heave damping we obtained a reflection coefficient less than one. For particular values of the distance wall-barge and for particular values of the period this reflection coefficient could be equal to zero.
Therefore, in this case, the heave damping is responsible of this absorption of energy.

Question(s)

Name: T. P. Mazarakos

Question(s):

3) Did you make any calculations for the drift forces with the direct integration method (near field)?

Answer(s)

No, due to singularities on the corner of the body, this method gives systematic errors.

Question(s)

Name: M. Maylan

Question(s):

4) What is the long term behaviour of the system near the resonant frequencies? When the wall is far away $|T|=1$ for body in isolation is condition for no net force. Does this generalise to the presence of the wall?

Answer(s)

For the long term behaviour there are 2 answers. First it is difficult in a wave channel to perform long time simulation due to the multiple reflections (wall-barge-wavemaker). Second, for the period, where normally we expect a stable state we observed oscillations around the equilibrium position. We have mentioned that the adding of a heave damping leads to an absorption of the energy at resonant periods. For the zero case, where there is cancellation of sway and roll, the transmission coefficient is no longer equal to one. For the drift case where there is cancellation of the heave, the transmission coefficient could be equal to one, but this case is unstable case. So is not possible to obtain it experimentally.

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Q/A Sheet

Title of Abstract: On the modelling of passing ship effects
Author(s): Bunnik T. & Toxopeus S.

Question(s)

Name: J. N. Newman

Question(s):

How do you represent the unsteady effects in the frequency-domain diffraction analysis?

Answer(s)

In the frequency domain a pulsating, frequency-dependent Green function is used satisfying $-\omega^2\phi + g\frac{\partial\phi}{\partial z} = 0$ on the free surface.

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Q/A Sheet

Title of Abstract: Deformation of free surface due to a water droplet impact
Author(s): Kwon S.H., Park C.W., Lee S.H., Shin J.Y., Choi Y.M., Chung J.Y. & Isshiki H.

Question(s)

Name: Malte PETER

Question(s):

The little extra drops you observe have been intensively investigated in the context of liquid jet breakdown. There are known as "satellite drops"

Answer(s)

I see. Thank you for pointing that out.

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Q/A Sheet

Title of Abstract: Nonlinear coupled dynamic analysis for waves and a moored platform in time domain

Author(s): Teng B. & Yang M.D.

Question(s)

Name: T. P. Mazarakos

Question(s):

Is it possible to explain if the damping is constant at your approximation? Is the damping first or second order?

Answer(s)

The scattering potential in this model includes the diffraction and the radiation potentials, and are accurate to the second order. Therefore, the first order and the second order radiation damping are considered in this model.

Question(s)

Name: T. Bunnick

Question(s):

What is the advantage of your method compared to the indirect time domain method?

Answer(s)

The indirect method is based on the Taylor expansion about mean body surface. For slow drift motion with large amplitudes, it is not strictly. The present method can overcomes this weakness by Taylor expansion about its position of low frequency oscillation. Another advantage of the method is that it can give the fluid pressure on the body surface directly, and be coupled with structure models. By the indirect method, we have to keep the impulsive functions of all potentials over the body surface, and to compute by convolution integration.

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Q/A Sheet

Title of Abstract: Transmission of water waves through apertures in a pair of thin vertical barriers
Author(s): De Soumen & Mandal B.N.

Question(s)

Name: Timothy Williams

Question(s):

How much does the symmetry help you to get the analytical solution?

Answer(s)

Symmetry helped us to get analytic result. It will be very interesting to consider the problem of unsymmetrical barriers. At present we can not say whether the analytical solution for unsymmetric barriers exist or not.

Question(s)

Name: David Evans

Question(s):

The key to the solution is the generalisation of the Abel integral equation, the proof of which you did not show. I am surprised that the solutions of the integral equations for such a difficult problem turn out to be so simple. It would be desirable to present a full proof of the new Abel integral equation solution so that it can be seen clearly that it can be applied to this problem.

Answer(s)

A proof of this theorem for b=0 is given in De et al. (2009). For b>0 a similar proof with appropriate modification is given. Although the proof of this theorem given in De et al.(2009) is not convincing. We try to proof this theorem using another method.

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Q/A Sheet

Title of Abstract: The interaction factor for wave power in arrays
Author(s): Wolgamot H., Eatock Taylor R., Taylor P.H. & Fitzgerald C.J.

Question(s)

Name: Michael Meylan

Question(s):
What are the difficulties of extending this work to bodies of more general geometry?

Answer(s)

To answer this question, reference must be made to David Evans' comment on this work, which shows that the maximum power absorbed by an array can be dealt with in a general fashion.
The interaction factor result cannot be generalised so easily, because there are difficulties in the definition of the interaction factor for non-axisymmetric bodies- however, considering the above point, this is perhaps not too important.

Question(s)

Name: David Evans

Question(s):
This is a very nice result which was not noticed by workers in the field 30 years ago! It is tempting to suggest that a simpler proof might be possible but your proof is already very neat.
In fact your method can be generalised to include any number of arbitrary bodies having N absorbing modes. Thus

$$P_{\max}(\beta) = \frac{1}{8} F_e^* B^{-1} F_e = \frac{1}{8} \sum_{i=1}^{N} \sum_{j=1}^{N} F_i^*(\beta)(-i)^{i+j} M_{ij} F_j(\beta) / \det B$$

So

$$\frac{1}{J}\frac{1}{2\pi}\int_0^{2\pi} P_{\max}(\beta)d\beta = \frac{1}{16\pi \det B}\sum_{i=1}^{N}\sum_{j=1}^{N}(-i)^{i+j} M_{ij}\int_0^{2\pi} F_i^*(\beta)F_j(\beta)d\beta$$

But

$$\mathrm{B}_{ij} = \frac{1}{16\pi J}\int_0^{2\pi} F_i^*(\beta)F_j(\beta)d\beta$$

So

$$\frac{1}{J}\frac{1}{2\pi}\int_0^{2\pi} P_{\max}(\beta)d\beta = \frac{1}{R}\sum_{i=1}^{N}\sum_{j=1}^{N}(-i)^{i+j} M_{ij} / \det B = \frac{N}{R}$$

Answer(s)

Indeed, "normalising" the power absorbed by the array by J rather than the power from a single device does generalise the result –thank you for this insight. There is more to do in this direction.

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Q/A Sheet

Title of Abstract: Tank Green function with partial reflections from side walls
Author(s): Shen J. & Qin H.D.

Question(s)

Name: J. N. Newman

Question(s):
The Green function for the infinite domain based on (lb) may be similar to the so-called Rayleish Viscosity solution where $G_z - k'G = 0$ and $k' = k(1+ie)$. Is there a practical advantage to using (lb) instead of this somewhat simpler solution?

Answer(s)

I adopt free surface condition (lb) mainly due to the theoretical consistence that this conditions shows clear the relationship between artificial viscosity and real fluid viscosity. I will try in future job to do a lot of numerical calculations to check the pros and cons of different free surface conditions.

Question(s)

Name: David Evans

Question(s):
The problem of using truncated images is that the plane wave behavior expected at large distances can never be accurately modeled. An alternative approach is to modify the open sea Green function by adding integral terms so that the conditions on the walls are satisfied exactly including all the images. This has been done for line-courses solution in 2-D and I believe Linton has extended the idea to this case also.

Answer(s)

It is definitely right that in the 2-D case. I will check again for the 3D case and try to make clear what Linton expressed in his paper.

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Q/A Sheet

Title of Abstract: Hydrodynamic forces and wave run-up on concentric vertical cylinders forming piston like arrangements

Author(s): Mavrakos S.A., Chatjigeorgiou I.K., Mazarakos T.P., Konispoliatis D. & Maron A.

Question(s)

Name: Trygve Kristiansen

Question(s):

1. Did you have sharp corners/edges at the lower part of the devices in your experiments?
2. I then believe that the reason for the discrepancies between the linear theory and experiments is due to flow separation from these edges at the "moonpool" inlet. If you make them rounded, I think that you could reach close to the theory in new experiments.

Answer(s)

1. Yes
2. That may be so, but we have not investigated this. It would be nice if we could achieve the theoretical values by rounding the corners.

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Q/A Sheet

Title of Abstract: Experimental validation of a linear numerical model for the water wave scattering by a compliant floating disk

Author(s): Montiel F., Bonnefoy F., Bennetts L.G., Squire V.A., Ferrant P. & Marsault P.

Question(s)

Name: David Evans

Question(s):

You have made considerable efforts to match the mathematical model to the experiments but isn't the real challenge to module what happens in the field, for example is green water a problem?

Answer(s)

In order to check the validity of mathematical models looking at the ocean wave scattering by vast field of ice floes, it is crucial to validate the underlying theory in some simple configurations, such as the single floe case. Many physical processes may affect the dynamics of these regions, such as green water effects or floe collision, in addition to scattering effects. We try in this work to identify the regimes at which the scattering is well predicted by the current numerical models that only consider scattering processes. Further research may be needed to include other physical processes in numerical models.

Question(s)

Name: Michael Meylan

Question(s):

Is it possible to include the surge motion in your experiments, as this motion is often neglected but may be significant?

Answer(s)

The surge motion could be included in the experiments although the experimental setting would have to be significantly modified. In particular, the tracking of the markers would be more difficult, as the disk would experience important lateral displacements and a progressive drift. The corresponding numerical model would have to include this feature as well.

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Q/A Sheet

Title of Abstract: Energy and damping analysis of the wet-modes of an elastic floating structure

Author(s): Dessi, D.

Question(s)

Name: Malte Peter

Question(s):

The approach is based on using well-adapted basis functions. Are there any estimates on how good this representation is, which accuracy is achieved with how many modes, e.g.?

Answer(s)

By definition, POD modes represent the best basis function choice -from the energy point of view- among all possible real valued orthogonal functions. In the case of a linear system that admits (almost real) linear normal modes (LNMS), POD modes capture more energy than LNMS. An empirical validation can be achieved, both for linear and nonlinear systems, by building a reduced order module of the system under consideration with POD modes and with an alternative basis function, and then comparing the solutions obtained (with the same number of basis function) with the direct integration of the system equations (if they are known).

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Q/A Sheet

Title of Abstract: A wave energy converter with an internal water tank
Author(s): Evans D.V. & Newman J.N.

Question(s)

Name: J. Grue

Question(s):
A good property of your submerged device is its submergence, which makes it less exposed to damages in strong sea states, which usually is a threat to WECs. I think linear analysis is very useful even with huge motions, which indeed are important in order to obtain a significant power conc=version. However, I wonder about the internal sloshing motion, if you have any thoughts about the resulting, wild internal motion?

Answer(s)

Yes it' s important the device remains submerged to avoid large forces in steep waves. Linear analysis can only give an indication of the efficiency as non-linear effects are clearly important near resonance. An alternative device we have considered which we call ROTA (Resonant overtopping absorber) allows the fluid to overtop into an internal reservoir so as to build up a low-head which drives a turbine before returning to the main chamber.

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Q/A Sheet

Title of Abstract: Damping of oscillatory body-motion at large forward speed
Author(s): Grue J.

Question(s)

Name: Torben Christiansen

Question(s):
1. (Non-scientific) Given the magnitude of the results and the excellence of the Norwegian canoeing team, have you considered to take your expertise into sports?
2. (Scientific) Have you considered the damping of other modes? Pitch and roll are often highly excited in canoeing (Sprint kayaks often have high directional stability- so yaw is certainly important, but maybe other modes contribute more)?

Answer(s)

This may be of interest to sports. We evaluate all modes of motion, including the heave and pitch added mass and damping coefficients, including also the cross coupling coefficients, and results for heave and pitch were shown in the presentation. Regarding roll damping, viscous effects may be important.

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Q/A Sheet

Title of Abstract: Asymmetric Impact of a two-dimensional liquid column
Author(s): Yoon B.S. & Semenov Y.A.

Question(s)

Name: J. Grue

Question(s):
My question relates to the educational dimension of this research, where all our fellow scientists, citing the literature of slamming, begin by citing the work by Dobrovol'skaya, Z. N., JFM (1969), Vol. 36. What was the particularly useful dimension of that analysis?

Answer(s)

Dobrovol'skaya' s solution is the first complete nonlinear solution to water entry problems. Although she studied the ease of symmetric entry, she was able to identify the basic features of water entry flows. They are: the coupled nonlinear and unsteady effects resulting in a pressure peak near the roof of the tip jet, a corner shaped tip jet, and a contact angle between the wedge side and the free surface, which takes its maximal value of 18 degrees when the wedge angle tends to zero. Yes it' s important the device remains submerged to avoid large forces in steep waves. Thus, Dobrovol'skaya's solution is very useful for a physical understanding of slamming and for validation purposes when solving various water entry problems and developing new analytical and numerical methods.

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Q/A Sheet

Title of Abstract: Band structures and band gaps in water-wave scattering by periodic lattices of arbitrary bodies
Author(s): Peter M.A. & Meylan M.H.

Question(s)

Name: Yaron Toledo

Question(s):
The same physical problem relates to Bragg resonance, which is a two way mechanism. This means that it can cause reflection. Did you see these effects in your model?

Answer(s)

Indeed reflection is an important issue in this problem when thinking of practical applications such as wave focussing. We have not looked at this issue so far but it is planned to do this in further investigations.

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Q/A Sheet

Title of Abstract: Elastic plate impact onto water at high horizontal speed
Author(s): Reinhard M., Korobkin A.A. & Cooker M.J.

Question(s)

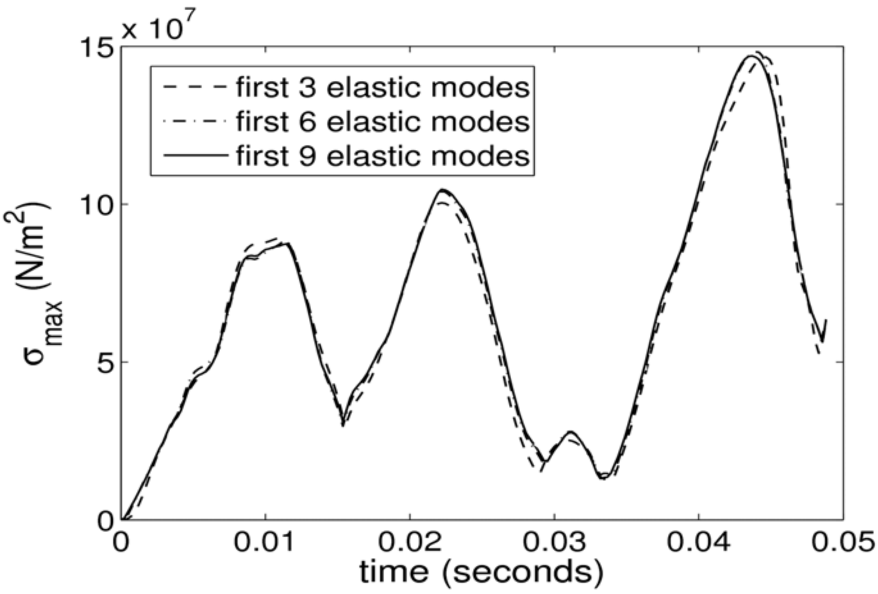
Name: R. Eatock Taylor

Question(s):

In your presentation you showed interesting results for the maximum bending stresses in the elastic plate. I am wondering how sensitive these are to the number of modes used in the modal superposition. Of course deflection converges much faster than the bending moments based on second derivative of deflections. What is your experience concerning the convergence of the plots you have shown involving bending stresses?

Answer(s)

Convergence of the normal-mode series for the stresses has not been studied yet. I checked the so-called "practical" convergence performing calculations with different number of modes up to 18. In the figure below the maximum bending stress as a function of time is shown for 3, 6 and 9 elastic modes retained in the calculations. The convergence is visible from this figure.



The convergence in a similar problem of wave impact onto a horizontal elastic plate was studied in the paper Korobkin A.A. (1998) Wave impact on the center of an Euler beam. Journal of Applied Mechanics and Technical Physics. Vol. 39. No. 5, pp. 770-781.

It was shown that the series for the bending stress (which is proportional to the curvature of the deflection) converges as O(n^{-2}), where n is the mode number. The principal coordinates of the modes also oscillate in time with frequencies increasing as O(n^2). The latter effect improves the convergence of the series. The rate of convergence is governed by the singularity of the pressure distribution on the wetted part of the plate. I expect that in my problem the convergence of the series is at the same rate, or even better, due to less singular pressure at the impact instant.

Question(s)

Name: J. N. Newman

Question(s):

You assume that both gL/U^2 and the vertical-horizontal velocity ratio are of the same order O(alpha)<<1. Does this restrict the results, or would you get the same results with two independent small parameters?

Answer(s)

The parameters gL/U^2 and V/U can be of order \alpha or smaller. My analysis does not assume any particular dependence of these two parameters on \alpha. This is because my approach is a leading order approach, valid for \alpha<<1.

Question(s)

Name: M. Makasyeyev

Question(s):

I have not seen the dynamical equation for the moment. How do you take the position of the center of mass into account in your model and can you perform your calculations for bodies which have a inhomogeneous mass distribution?

Answer(s)

Euler's beam equation incorporates Newton's second law for the rigid modes of the plate motion. Rigid and elastic motions of the plate are computed all together. The presented model deals only with a uniform mass distribution along the plate. A similar analysis is possible for a non- homogeneous mass distribution. In this case the parameter \mu in Euler's beam equation is a function of the longitudinal coordinate. The modes of a plate with non-uniform characteristics can be computed by using the spectral problem similar to that in the present analysis, but with non-constant coefficients in the equation. In general, this can be done only numerically. Once the modes have been computed, the rest of the analysis is essentially the same as it was presented in my report.

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Q/A Sheet

Title of Abstract: Slack-chain mooring configuration analysis of a floating wave energy converter

Author(s): Vicente P. C. , Falcão A. F. e Justino P. J.

Question(s)

Name: Harry Bingham

Question(s):

You made calculations using an idealized PTO force. How do you propose to apply this force in reality?

Answer(s)

Most floating oscillating-body wave energy converters that have been proposed and developed so far are in fact two-body systems, in which the PTO is activated by the relative motion between bodies. If the submerged body is far from the free-surface and its mass (including the added mass) is substantially larger than the mass of the floater, such converters may be approximately modelled by a one-body device as done here. The assumption of a single body WEC whose PTO is activated by the heave motion was adopted here to limit the complexity of the theoretical and numerical modelling, while still providing a qualitative measure for comparison with and without mooring.

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Q/A Sheet

Title of Abstract: Response of a TLP floating wind turbine subjected to combined wind and wave loading
Author(s): Ramachandran G.K.V., Bredmose H., Sorensen J.N. & Jensen J.J.

Question(s)

Name:

Question(s):

Did you make any calculations for the current interaction too?

Answer(s)

No. At present we haven't included the current interaction since the influence of current is much less for the water depth under consideration (deep water). Inclusion of Doppler shift in wave length because of the presence of current and associated changes in the wave number, wave kinematics and kinetics can be done without difficulties, if found necessary.

Question(s)

Name:

Question(s):

How you are considering flexibility of tower?

Answer(s)

The tower flexibility has been considered through tower deflection, which is a result of bending for a cantilever beam. The beam bending deflection equation for cantilever is:

$$\delta = \frac{WL^3}{3EI}$$

From this relation, we can compute the stiffness of the tower as:

$$k_{tower} = \frac{W}{\delta} = \frac{3EI}{L^3}$$

Where:
E – Young's modulus
I – Area moment of inertia of the tower L – Tower height
W – Force

Corresponding tower frequency can be computed as:

$$\omega_t = \sqrt{\frac{k_{tower}}{m_{nacelle} + 0.5m_{tower}}}$$

Which is a lumped mass formulation. Half of the tower mass was lumped to the platform and the other half with the nacelle mass.

Question(s)

Name:

Question(s):
Diffraction phenomenon must be important? Have you included those into your model?

Answer(s)

Typical dimensional details of the system are:
Diameter of floater (platform), Df = 16 m
Diameter of tower, Dt = 6 m
Significant wave height, Hs = 7 m
Peak period, Tp = 10 s
Wave frequency, $f_p = \frac{1}{T_p}$ = 0.1 Hz
Circular wave frequency, $\omega = 2\pi f_p$ = 0.63 rad/s

By solving the dispersion relation, we get the wave number, k = 0.04
Wave length, $\lambda = \frac{2\pi}{k}$ = 156.1 m
In the case of floater, Df/λ = 0.1
In the case of tower, Dt/λ = 0.04

Since the ratios are less than 0.2, the effect of diffraction can be considered small and thereby we can use Morison's equation to compute the force with CM = 2. The results may also be validated through a model test.

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Q/A Sheet

Title of Abstract Gap resonances analyzed by a domain-decomposition method
Author(s): Kristiansen T. & Faltinsen O.M.

Question(s)

Name: A. Korobkin

Question(s):

Did you observe any cavitation near the square corners where the flow separation took place in your model tests?

Answer(s)

We observed some tiny air bubbles that was shed into the gap, but these were just air bubbles formed underneath the model during breaks.
The gap resonance problem is quite gentle, and not violent like slamming.

Question(s)

Name: Harry Bingham

Question(s):

Did you consider turbulence?

Answer(s)

In case of sharp corners, the separation point is fixed, and whether the boundary layers are turbulent or not will not, we believe, matter.
There will hence be no scaling effects in the gap resonance problem in case of sharp corners. In case of rounded edges, this is not so. But one should expect nearly no viscous damping in that case, at least if the KC number is smaller than 4-5.