The Ocean Engineering Committee

Committee Chairman: Dr. Pierre Ferrant

Session Chairman: Prof. Atilla Incecik

1. DISCUSSIONS

1.1 Discussion (1) to the 25th ITTC Ocean Engineering Committee by Yanying WANG, Dalian University of Technology, Dalian, China

Comments on Extreme High Waves. It is indicated in the report of the Ocean Engineering Committee that reproduction and identification of extremely high waves in model basins will become very important as requirements for the safety assurance of floating structures become more stringent under severe design conditions. In fact the design wave has been applied to be designing condition for floating structures in the engineering practice. Based on the database of the North Sea and on the analysis procedure[1] the calculating result in Tab. 1 can be obtained[2], in which we can point the following comments on extreme waves:

1. For 100-year sea state with significant wave height $H_S = 31.6m$ the appearance probability is about 10^{-9}, but the encounter probability equals 18% for floating structures with 20-year of service life.
2. For 500-year sea state with significant wave height $H_S = 32.9m$ the appearance probability is about 10^{-10}, but the encounter probability equals 4% for floating structures with 20-year of service life.
3. For 100-year sea state with the tenth maximum wave height $H_{1/10} = 33.9m$ the joint probability between the encounter probability and the exceed probability is about 1.8%.
4. For 500-year sea state with the tenth maximum wave height $H_{1/10} = 35.1m$ the joint probability between the encounter probability and the exceed probability is about 0.4%.

Specially the perils of the sea at the Gulf of Mexico in 2005 due to the hurricane Katrina brings on query that the significant wave height with 100-year of return period is used to be the standard of ocean environment condition.

Tab.1 The Comparison of extreme sea state with different return periods

Item	Return period (*year*)	
	100	500
Encounter probability for special sea state (%)	18	4
Significant wave height (*m*)	31.6	32.9
Lower limit maximum wave height (*m*) with exceed probability of 10^{-1}	33.9	35.1
Joint probability of maximum height (%)	1.8	0.4

Reasonably increasing the return period can decrease the risk both for design and operation. The recommendation is as that

1. The maximum wave height with 1/10 of exceed probability and corresponding up-zero period is to be design wave parameters instead of the signification wave for the 100-year sea state, or
2. The signification wave height and corresponding up-zero period is to be design wave parameters for the 500-year sea state instead of the 100-year sea state.

References.

Yanying WANG: Waves and wave loads on offshore structures, Dalian Marine University Press, 2003.

Yanying WANG: Discussion on the parameters of design waves, J. Marine. Sci. Appl. (2008) 7:1-10.

1.2 Discussion (2) to the 25th ITTC Ocean Engineering Committee by Yanying WANG, Dalian University of Technology, Dalian, China

Comments on the Local Pressure Coefficient for Slamming Loads. A wave impact analysis to determine the design slamming loads starts with a seakeeping analysis to calculate the maximum relative velocity v of the ship hull relative to waves. And then the slamming loads can be expressed as $p = 0.5\rho k v^2$ approximately[1], in which k is the local pressure coefficient. Generally the value of k is determined according to experiential and/or experimental data. In fact CFD approach such as 2D water entry and exit numerical simulation can be used to predict the local pressure coefficient. The pressure coefficient C_p is a function of time and location and the local pressure coefficient is the maximum one in the non-dimensional time domain for each cross section, i.e. $k = \max(C_p)$.

In fig. 1 the pressure coefficient C_p versus non-dimensional time vt/D (D is character size of cross section) for cross sections of 18-19th respectively with the same velocity v. For a FPSO hull the variety of local pressure coefficient k at bottom of bow is shown in Fig. 2 with different relative breadth b/B (b is breadth of local section and B is mould breadth of hull) under given velocity v. For the above computation a BEM software and FLUENT software are used to calculate the motion of hull in waves and the hydrodynamic pressure distribution on hull surface for enter water case.

The local pressure coefficient k should be a function of multi-variable, which includes v (depending on the hull motion under specifically sea states), D (cross section form and size of hull), L (local position of cross section), and so on. All of numerical results can make up of a database which is composed of independent variable k and dependent variables $v, D, L, \cdots$.

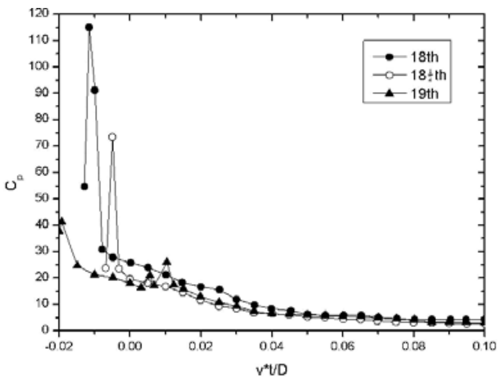

Figure.1 The pressure coefficient distribution with $\bar{t}$

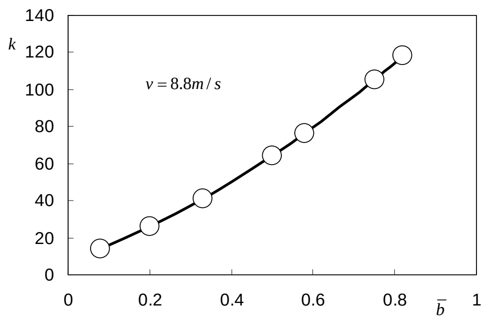

Figure. 2 The k coefficient distribution with $\bar{b}$

Suggestion to the Ocean Engineering Committee is the following:

1. To recommend feasible numerical software of water entry and exit calculation;
2. To promote developing numerical simulation in order to extend data base of local pressure coefficient;
3. To organize validation test to numerical results from ITTC institutions.

Reference.

Ge Wang, Shaojie Tang, Yung Shin: Proceedings of 12th ISOPE, Kitakyushu, Japan, May 26–31, 2002.

1.3 Discussion (3) to the 25th ITTC Ocean Engineering Committee by Yanying WANG, Dalian University of Technology, Dalian, China

Comments on Suppressing Marine Riser's VIV. In order to realize the mechanism and to actualize the optimization for suppressing marine riser's VIV by use of the helical strakes the characteristics of flow field around the marine riser should be shown and discussed. The vorticity contours, total pressure contours, and time history of drag and lift coefficients in each spanwise cross-section can be calculated by using CFD software FLUENT for bare riser or riser outfitted with different forms and size of the helical strakes respectively. In the following figures the simulative results for total pressure contours and mean drag and lift coefficients are given to be an example. Some of comments may be useful to the engineering design.

1. The CFD software FLUENT can be applied to simulate the flow field around the marine riser numerically. The characteristics of flow field at different cross-sections are different and this phenomenon will be more obvious with the increasing of Reynolds number.
2. The helical strakes are very effective in suppressing the VIV response. Both the vibration magnitude and the frequency in two directions will decrease when the marine riser is outfitted with helical strakes.
3. This numerical approach can be used to make optimization for form and size of helical strakes, including helical strake number, helical pitch ratio, strake width, and so on.

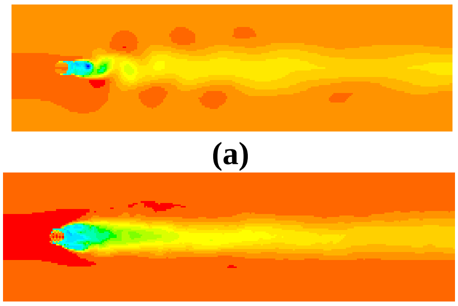

Figure.3 Instantaneous total pressure contours for the flow past (a) for a bare riser and (b) for a fixed riser outfitted with three helical strakes at Re=800 respectively.

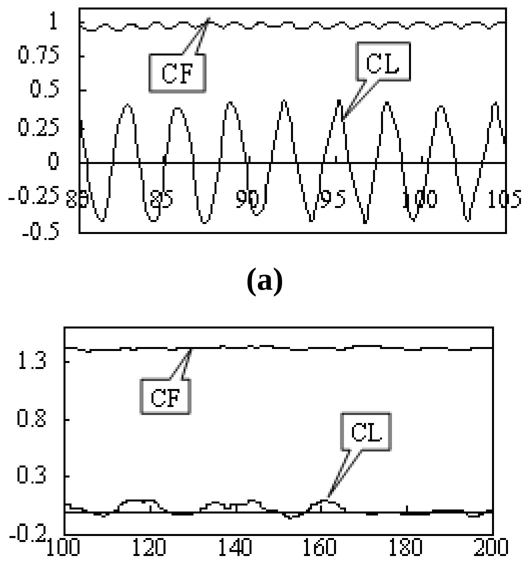

Figure.4 Time history of mean drag and lift coefficients for (a) for a bare riser and (b) for a fixed riser outfitted with three helical strakes at Re=800 respectively.

Reference.

Haihua LIN and Yanying WANG: Discussion of Mechanism and Optimization for Restraining Marine Riser's VIV by use of

Helical Strakes, Proceedings of APHydro2008, Vol.1, 153-160. June 16-18 2008, Taipei.

1.4 Discussion to the 25th ITTC Ocean Engineering Committee by Woo-seung Sim, Hyundai Heavy Industries Co., Ltd.

Congratulate the Ocean Engineering Committee for the well-organized and comprehensive report. Recently, many attempts are performed to calibrate the roll calculation to model test result for FPSO design. Most of those recommend that the engineers calibrate woll motion using linear and quadratic roll damping values from roll decay test.

However, many engineers only find that this theory and related numerical tools in industry are not proper for the roll calibration.

This kind of difficulty in roll calibration is especially occurred:

- when waves are coming from near the bow or stern direction for turret moored system as well as spread-mooring system in directional swell environment.
- when roll motion is relatively small up to 4 degrees approximately.
- when roll motion shows the asymmetrical behavior for the quartering waves from port and starboard direction due to off-diagonal mass inertia terms or asymmetrical appendages in FPSO.
- when wave peak period are part from roll natural period and roll-damping adjustment is not effectively in calibrating roll motion.

It results that engineers calibrates the roll motion by means of pragmatic approach without theoretical consistency. Consequently, the difference in roll RAO between model test and numerical calculation is observed as shown in Figure 5. (FPSO Roll RAO for 30 degrees wave incidence. Marked difference may look smaller, but it always makes an argument due to its sensitive effect in FPSO design.)

Considering that the roll motion is the most important design parameter in most of floating offshore structures, I hope to discuss whether ITTC need to review and develop the systematic roll calibration procedure for ship-shaped vessel including FPSO.

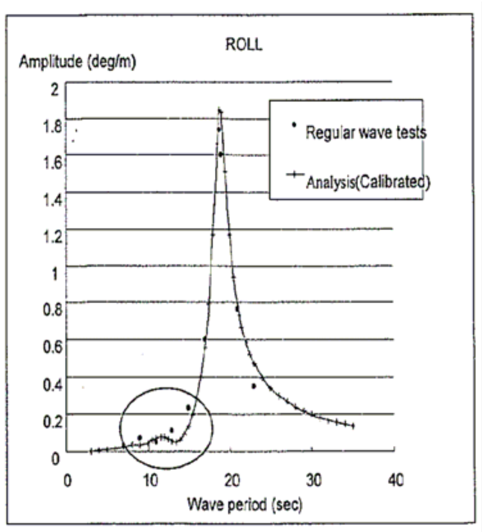

Figure 5 The difference in roll RAO

1.5 Discussion to the 25th ITTC Ocean Engineering Committee by Carl Trygve Stansberg, MARINTEK, Trondheim, Norway

I congratulate the Committee for their large amount of work within the very wide range of topics that is covered within this field. In the further work of this committee, I would suggest that in order to avoid too high workloads, overlaps with other Technical Committees should be looked into and possibly reduced. Within such a wide field there is always a chance that overlap may occur, and communications with several committees would be quite helpful, e.g. with the Seakeeping, VIV, Uncertainty Analysis, CFD, Detailed Flow Measurements, Propulsion committees and even possibly others.

1.6 Discussion to the 25th ITTC Ocean Engineering Committee by Kourosh Koushan, MARINTEK, Norway

I would like to congratulate the committee for the comprehensive work performed on wide range of topics. In the report the committee has paid some attention to dynamic positioning and different interaction effects on thrusters in calm waters.

However dynamic positioning system and thrusters have also inevitably to operate in waves and in fact their operators in severe conditions are critical from safety point of view. There have been significant research on the effect of waves and ventilation on dynamic positioning and thrusters. MARINTEK and NTNU have been performing considerable research and testing in this field, which can be a good contribution to the community. A good starting point would be the "dynamic positioning conference" held annually in Houston. I would appreciate committee's comments on this issue.

Reference:

Koushan, K. 2004 "Environmental and interaction effects on propulsion systems used in dynamic positioning, an overview" PRADS symp. Germany

Koushan,K.2007 "Dynamics of Propeller blade and duct leading on ventilated thrusters in dynamic positioning mode" Dynamic Positioning Conference; Houston, USA, 2007

1.7 Discussion to the 25th ITTC Ocean Engineering Committee by Marcelo A. S. Neves, LabOceano, COPPE/UFRJ, Brazil

First of all I would like to congratulate the Committee members for the interesting and well-organized report.

With regard to the hydrodynamic performance of Spar platforms, my question is: considering that vertical floating cylinders may be in some circumstances subjected to Mathieu instabilities, has the Committee given any consideration to the possible occurrence of parametric instabilities in such type of floating platforms?

In more general terms, what would be the Committee's views on this particular design area: is parametric rolling a possible source of engineering problem in the design of Spar platforms?

1.8 Discussion to the 25th ITTC Ocean Engineering Committee by Mehmet Atlar, Dazheng Wang and Roderick Sampson, University of Newcastle, UK

We would like to acknowledge the committee's consideration of the review on the marine renewable and call for the development for appropriate experimental techniques and procedures. This is rather appropriate and timely.

Within this context, we would like to report our recent experimental research work conducted in the Emerson Cavitation Tunnel of Newcastle University, UK, on the efficiency, cavitation, noise and slipstream wash of a 3 bladed horizontal marine current turbine published in Wang & Atlar (2006) and Wang et al (2007)

This study discusses the possibility of adopting standard propeller model test procedures for horizontal tidal turbines and explores the possible undesirable effects of cavitation, noise and slipstream wash on the blade and environment using conventional cavitation tunnel facility and associated equipment including an open water dynamometer, hydrophone system and 2D LDA facility as discussed in the following papers and to be presented by the discusser.

References.

Wang, D.; Atlar, M.; Sampson, R. An experimental investigation on cavitation, noise, and slipstream characteristics of ocean stream turbines. Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy 2007, 221(2), 219-231.

Wang, D. and Atlar, M. Experimental Investigation on Cavitation Performance, Noise Characteristics and Slipstream Wash of an Ocean Stream Turbine. In: 4th International Marine Renewable Energy Conference (MAREC 2006) at World Maritime Technology Conference 2006, London, UK: IMarEST

1.9 Discussion to the 25th ITTC Ocean Engineering Committee by Sandy Day, University of Glasgow, UK

Marine renewable energy is well-funded and fast moving market. In UK the Government + industry have committed £ 100M (i.e. one hundred million pounds sterling) over next five years. A significant proportion will be spent on testing at various scales (including full scale), including performance and loading and survivability.

Given that many problems in testing + scaling are quite different from traditional ship/ offshore engineering, do we need some guidelines + procedure? And if so, can the existing committee manage this, or should we have a dedicated committee? There’s a danger that if we don’t address this, and tests (EFD or CFD) are badly executed, this will reflect badly on ITTC community.

2. COMMITTEE REPLIES

2.1 Reply(1) of the 25th ITTC Ocean Engineering Committee to Yang WANG

Thank you for your comment on the very important issue of extreme waves and extreme response. I would, however, been useful for us if you could clarify some of the terms you are using.

The approach and the design wave to be used in either experiments or in computations will depend on both the type of structure and the response parameter. For a fixed structure the maximum responses will be associated with the highest wave the structure encounters. For a floating structure, however, the maximum response is not necessarily associated with the highest wave height. The response should be studied for several sea states along the e.g. 100-year or 10000 year (H_S, TP)-contour line. Moreover, when addressing extreme values several realizations of a critical sea state should be investigated.

Another important point is that regulations in different regions would dictate how to assess extreme responses. Practice in Northern European offshore industry, and adopted in the NORSOK standard on Norwegian sector, is to use 100-year (ULS) conditions for responses such as maximum line tensions and extreme off-sets, while 10000 year (ALS) conditions are used for air gap, wave-in-deck and line breakage.

Furthermore, both in the NORSOK standard for Norwegian sector and in other regions the industry and the regulations are pushing towards response based design. In this case, design values are often determined as the 95% fractal of the extreme value distribution in a 3 hours sea state both for ULS and ALS conditions. This appears to be almost in line with recommendation 1 in your comments.

Similarly in the USA, the new API rules made in the aftermath of the Katrina and Rita hurricanes also moves in the same direction by defining ULS and ALS conditions from 100 yr and 1000 yr sea states, respectively.

The industry and regulations set the requirements on how to carry out estimation of extreme responses, and it could be a good idea for the ITTC Ocean Engineering Committee to dig deeper into the subject of extreme waves and responses, thus following up a benchmark study carried up by the Ocean Engineering Committee of the 24th ITTC.

2.2 Reply(2) of the 25th ITTC Ocean Engineering Committee to Yang WANG

Thanks for your question and comment on the problem of determining local pressures during slamming events. It is not in the attributions of the Ocean Engineering Committee to recommend software for a particular application, including water entry and exit. However, your suggestion of organizing a benchmark test between ITTC institutions is welcome, and could possibly be part of the tasks of one of the future Ocean Engineering Committee.

2.3 Reply (3) of the 25th ITTC Ocean Engineering Committee to Yang WANG

Thanks you for your comment on the very important problem of the prevision and control of marine risers vortex induces vibrations (VIV). CFD will certainly become a very efficient way of assessing and optimizing the efficiency of VIV suppression systems. However, we refer to the Specialist Committee on VIV for a more comprehensive reply on this subject.

2.4 Reply of the 25th ITTC Ocean Engineering Committee to Woo –seung Sim

The Ocean Engineering Committee agrees that roll damping is still an open issue for stationary floater with a flat bottom such as a FPSO.

New papers are keeping coming about it (see for instance latest OMAE and ISOPE conferences).

As said in the Written Discussion (WD) the assessment of roll damping is usually made by calibration of linear and quadratic coefficients and of course, due to the nature of the decay test, this is made just for one frequency only. This could be just a polynomial adjustment not actually based on physics. For instance a purely cubic approximation could be better that the quadratic one.

For that matter, it has been recognized that the larger amplitude damping may be very different than the smaller amplitude damping as also commented in the WD. For a discussion about it see Oliveira and Fernandes (2006) in STAB2006.

The 24th ITTC Ocean Engineering Committee has reviewed this topic. However the Ocean Engineering Committee agrees that the subject should be studied more.

2.5 Reply of the 25th ITTC Ocean Engineering Committee to Carl Trygve Stansberg

We would like to thank Dr Stansberg for his nice comments on the Ocean Engineering Committee work. The domain potentially covered by the Ocean Engineering Committee is indeed very broad, and overlapping with other committees work has to be considered as almost inevitable. We agree that this has however to be as limited as possible, unless common tasks have explicitly be distributed to different committees. In this latter case, a coordination of different committees activities will be necessary, but probably not so easy to organize.

2.6 Reply of the 25th ITTC Ocean Engineering Committee to Kourosh Koushan

The committee has done an effort look into the development of dynamically positioned ships. The emphasis has been on control strategies and on thruster- thruster and thruster-hull interactions. We agree that the thruster-wave interactions are also critical and could have been addressed in a separate section. The committee appreciates the suggested references.

Otherwise the committee has noted that ITTC is lacking specific procedures for model testing of dynamically positions floaters and have taken initiative to develop a new procedure for this during the next term.

2.7 Reply of the 25th ITTC Ocean Engineering Committee to Marcelo A. S. Neves

Thanks for your fruitful comments on one very interesting topic related to spar design. Due to inherent geometrical characteristics of spar platform, typical ranges of natural periods of heave and pitch are 27~30 and 45~60 seconds in case of classical spar. In West Africa and North Sea, swell waves with 25 seconds peak period have been reported. Thus, spar platforms have a possibility of suffering from the so called Mathieu instability because heave natural period falls in half of pitch natural period which is a necessary condition of Mathieu instability. Mathieu instability, however, is not only a function of frequency but a function of damping. It has been reported that consideration of mooring line and risers also influences motion damping and stiffness. Model test results have illustrated that Mathieu instability occurs due to nonlinear coupling of heave and pitch (Roh et al., 2002), some numerical simulations considering realistic situations such as mooring lines and risers resulted in no Mathieu instability but higher heave motion under swell with 25 seconds peak period (Koo, Kim and Randall, 2004).

In engineering problem, it is very important to design a platform shape so as to avoid sub-harmonic resonance as well as linear resonance. Thus, numerical simulations with realistic damping coefficients are recommended to check Mathieu instability of spar platform in engineering procedure.

B.J. Kii, M.H. Kim, R.E. Randall, 2004, “Mathieu instability of a spar platform with mooring and risers”, Ocean Engineering, 31, pp 2175-2208

Rho, J.B., Choi, H.S., Lee, W.C., Shin, H.S., Park, I.K., 2002. Heave and pitch motion of a spar platform with damping plate. In: Proceedings of the 12th International Offshore and Polar Engineering Conference, Kitakyshu, vol. 1, pp. 198–201.

2.8 Reply of the 25th ITTC Ocean Engineering Committee to Mehmet Atlar, Dazheng Wang and Roderick Sampson

The Ocean Engineering Committee thanks Prof. Atlar, Dr.Dazheng Wang, Mr.Roderick Sampson for their very interesting presentation on the problem of testing horizontal tidal turbines by exploiting standard propeller model test procedures. This very interesting work will be most helpful to the next Ocean Engineering Committee while developing possible guidelines for testing marine renewable energy devices.

2.9 Reply of the 25th ITTC Ocean Engineering Committee to Sandy Day

The Ocean Engineering Committee is aware of the fast growth of the marine renewable energy (MRE) market. Indeed, the subject of MRE has been covered by dedicated chapters in 24th & 25th Ocean Engineering Committee’s reports.

We agree that there are a number of particular problems associated with testing MRE devices. Most ocean engineering facilities are nowadays building their own expertise in this domain from their experience on testing more conventional marine structures. We feel that it is probably too early to set up a dedicated committee, but that the Ocean Engineering Committee should increase the part of its activities dedicated to MRE systems.

In the short term, this implies drafting guidelines dedicated to MRE systems. Then probably more than one procedure will probably prove necessary, due to the variety of systems (Wave energy devices of different types, tidal turbines, offshore floating windmills, etc…)