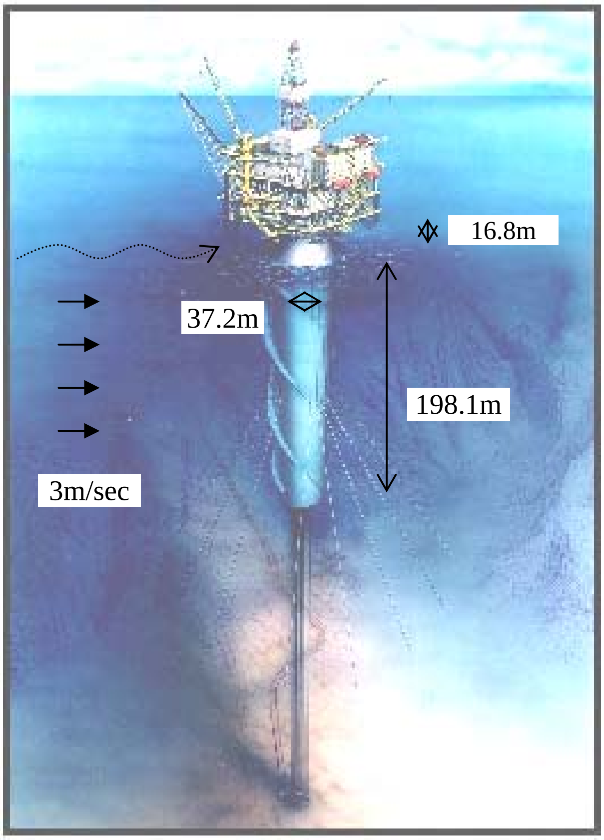
Final-Term Exam

Dec. 17, 2007
15:00~17:00

1. (40%) In 1998, Chevron's Genesis Spar was installed in the Gulf of Mexico at the location of 790-m depth. It is the second-built spar platform which has a hull of 37.2-m diameter and 214.9-m length. The draft of the hull is 198.1-m and a topside deck has the freeboard of 16.8-m.



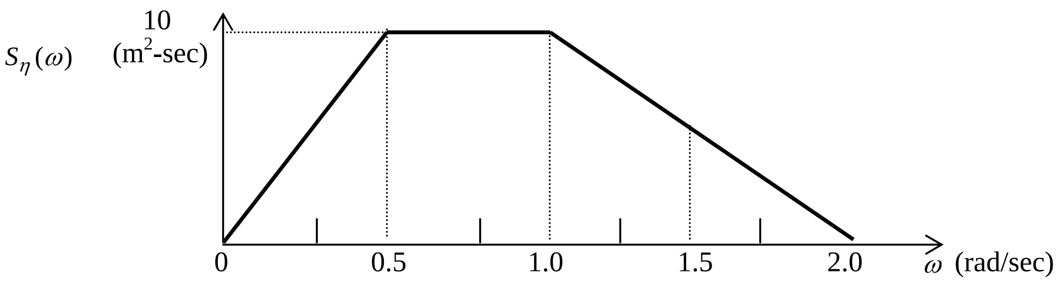
(1) For the following condition of long-crested wave spectrum, obtain the wave height of 100-year return period. Is the freeboard of this spar will be enough for this wave condition? Assume Rayleigh distribution for wave peaks. (15%)
- Modal wave period: 14.08sec
- Significant wave height: 6.93m

(2) If the incident waves are not long-crested and short-crested, do you think that the wave height of 100-year return period will be larger or smaller? (5%)

(3) If there is uniform current of 3m/sec in this region, obtain approximately the drag force on the hull. Choose a proper drag coefficient, and justify your choice. (15%)

(4) If VIV (vortex-induced vibration) is observed in the presence of current, what is the period of the vortex shedding if the Strouhal number is 0.28? (5%)

2. (30%) Let's assume that you have a wave spectrum as shown below:

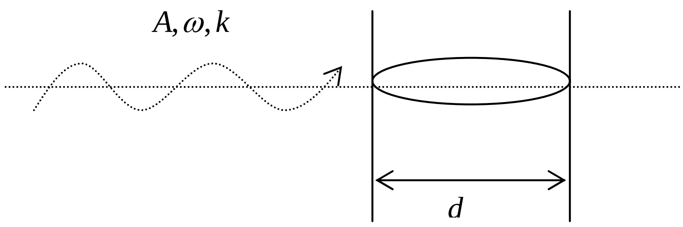


(1) Describe this wave spectrum with four components. Obtain the amplitudes and frequencies of the four wave components. (15%)
(2) What are the significant wave height and mean energy density if wave elevations and wave peaks can be described with Gaussian and Rayleigh distribution. (5%)
(3) If this spectrum is observed during the development of a hurricane, sketch roughly how the spectra will be look like (i) after the fully development of hurricane and (ii) during calm-down of hurricane. (10%)

3. (30%) Let's consider a vertical cylinder of diameter *d* in regular waves. As you learned in class, we can approximate the sectional force using Morrison's equation as follows:

$$dF \equiv dF_I + dF_D = C_I \rho \frac{\pi d^2}{4} \frac{du}{dt} + \frac{1}{2} C_D d \rho u |u|$$

where all the notations are the same introduced in the class. When the wave flows can be described by potential theory, answer the following questions:



(1) Write the maximums of horizontal velocity u and du/dt using linear waves at the center of the body., i.e. x=0, z=0. (5%)
(2) Write $|dF_D|/|dF_I|$ as a function of maximum horizontal particle velocity at z=0. Here, | | indicates the maximum value. In other words, you need to write as below: (15%)

$$\frac{|dF_D|}{|dF_I|} = Function\left(C_D, C_M, \frac{Tu_{\max}}{d} \right)$$ where T means wave period.

The last term $\frac{TU_{\max}}{d}$ is called Keulegan-Carpenter number (K.C. number)
(3) Show that the viscous drag becomes relatively larger when K.C. number becomes large. (5%)
(4) The period of drag force is a half of that of inertia force. Explain why. (5%)

Extra Point (5%, Total will not exceed 100%.): Write any suggestion to improve this class.

Very Merry Christmas and Happiest New Year!