MODULE I : SEAKEEPING

Topic: Ship in Wave: Encounter Frequency

Question 1

A ship is advancing at a speed of 16 knots in a regular wave-field of wave-length 200m. For heading angles 180,135,90,45 and 0 deg., determine the encounter periods.

Answer:

Encounter frequency is given by: $\omega_e = \omega - \frac{\omega^2 V \cos\beta}{g}$ where β is the heading angle, defined here as the angle between the direction of ship's forward velocity and wave velocity.

Here V =16knots=(0.5144)(16)m/s = 8.23 m/s

Assuming deep water, from dispersion relation the absolute wave frequency is $\omega = \sqrt{gk} = \sqrt{2\pi g / \lambda} = \sqrt{(2)(3.141592)(9.8)/200} = 0.555\,\text{rad/s}$

Thus we have $\omega_e = \omega(1 - 0.84\cos\beta\ \omega) = 0.555 - 0.259\cos\beta$

$\beta =$ 0 deg.	$\Rightarrow\ \omega_e = 0.296$ rad/s,	$T_e = 2\pi / \omega_e = 21.22$ s.
$\beta = 45$ deg.	$\Rightarrow\ \omega_e = 0.372$ rad/s	$T_e = 2\pi / \omega_e = 16.89$ s
$\beta = 90$ deg.	$\Rightarrow\ \omega_e = 0.555$ rad/s	$T_e = 2\pi / \omega_e = 11.32$ s
$\beta = 135$ deg.	$\Rightarrow\ \omega_e = 0.738$ rad/s	$T_e = 2\pi / \omega_e = 8.51$ s
$\beta = 180$ deg.	$\Rightarrow\ \omega_e = 0.814$ rad/s	$T_e = 2\pi / \omega_e = 7.72$ s

Question 2

A person on board a ship traveling at 20 knots in a regular wave field in head wave condition observes that the successive crests are passing the ship at an interval of 8 sec. What is length of the wave?

Answer:

For this problem, β is 180 deg.

Here, encounter period is given as 8 sec. Thus, $\omega_e = 2\pi / 8 = 0.7854$ rad/s

For β=180 deg.,

$$0.7854 = \omega + \frac{\omega^2 (20)(0.5144)}{9.8} = \omega + 1.05\omega^2$$

This gives $\omega = \frac{-1 \pm \sqrt{1 - 4(1.05)(-0.7854)}}{(2)(1.05)} = 0.511, -1.463$ rad/s

Since ω cannot be –ve, the admissible answer is $\omega = 0.511$ rad/s.

From deep-water dispersion relation, wave length is $\lambda = 2\pi g / \omega^2 = 236$ m.