

MODULE I : SEAKEEPING

Topic: Irregular Waves and 2DSpectrum

Question 1

From an irregular wave record, the following statistical information could be found:

wave-height intervals (m)	average wave height (m)	Number of occurrences
0.25-0.75	0.5	15
0.75-1.25	1.0	30
1.25-1.75	1.5	54
1.75-2.25	2.0	22
2.25-2.75	2.5	15
2.75-3.25	3.0	9
3.25-3.75	3.5	4
3.74-4.25	4.0	1

Find the 1/3rd and 1/10th significant wave heights.

Answer:

The total number of occurrences $N=15+30+54+22+15+9+4+1=150$.

By definition, 1/3rd significant wave height is the average of the highest 1/3rd number of waves. Thus here it is the average of the highest $150/3 = 50$ occurrences of waves. Counting from top, it is seen that $1+4+9+15+21 = 50$ (note here that for the wave ht. 2.0 for which there are 22 occurrences, we taken 21 occurrences since this results in total 50 occurrences).

Thus, $H_{1/3} = [(4.0)(1)+(3.5)(4)+(3)(9)+(2.5)(15)+(2)(21)]/50 = 2.49\text{m}$

Similarly, 1/10th significant wave height is the average of the highest 1/10th number of waves, or average of the top $150/10=15$ waves.

Thus, $H_{1/10} = [(4.0)(1)+(3.5)(4)+(3)(9)+(2.5)(1)]/15 = 3.17\text{m}$

Question 2

From analyzing an irregular wave record, the following data is obtained.

$T(s)$	1-4	4-6	6-8	8-10	10-12	12-15	15-20	20-25	25-30	30-40
$H(m)$	0.2	1.01	2.20	6.0	15.5	11.8	8.0	4.0	1.8	0.01

Determine the ordinates of the wave-energy spectrum, and plot the spectrum.

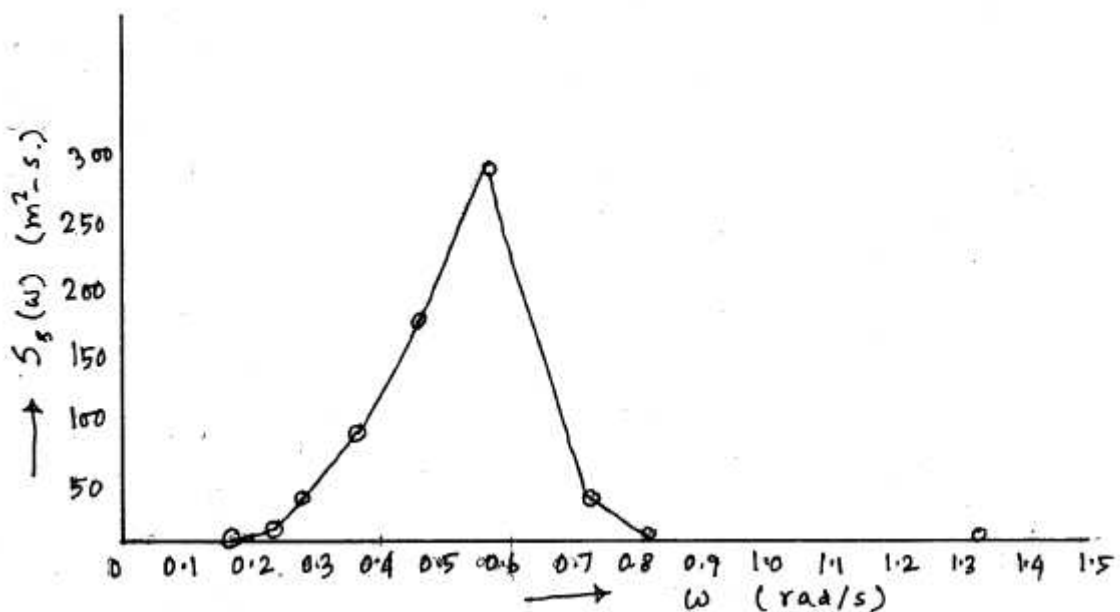
Answer:

The long-crested (2D) wave-spectrum ordinate are given by

$$S_{\zeta}(\omega) = \frac{1}{2} A^2 / d\omega = \frac{1}{8} H^2 / d\omega.$$

Thus the spectral ordinates $S_{\zeta}(\omega)$ against ω can be calculated as below. Since period and frequency are inversely related, the table is arranged in descending order of period, which gives an ascending order of frequency.

T range (s)	H (m)	ω range (rad/s)	$d\omega$ (rad/s)	ω_{mean} (rad/s)	$S_{\zeta}(\omega) = \frac{1}{8} \frac{H^2}{d\omega}$ (m ² -s)
30-40	0.1	0.157-0.209	0.052	0.183	0.024
25-30	1.8	0.209-0.251	0.042	0.23	9.643
20-25	4.0	0.251-0.314	0.063	0.283	31.75
15-20	8.0	0.314-0.419	0.105	0.367	76.190
12-15	11.8	0.419-0.523	0.104	0.471	167.356
10-12	15.5	0.523-0.628	0.105	0.576	286.012
8-10	6.0	0.628-0.785	0.157	0.707	28.662
6-8	2.20	0.785-1.047	0.262	0.916	2.309
4-6	1.01	1.047-1.571	0.524	1.309	0.243
1-4	0.2	1.571-6.283	4.712	3.927	0.0011



Plot of the wave spectrum