

ADVANCED PROPULSION SYSTEM – MID-TERM EXAM

21/11/2008 - 13:30-14:15

Asses the quality of the wake given below according to the BMT's wake non-uniformity criteria (w_Δ , σ_{nl}) given in figure 1. (15 Points)

Given:

$D = 4800$ mm (propeller diameter)

$N = 120$ (number of propeller revolution per minute - RPM)

$Z = 4$ (number of blades)

$Z_p = 2700$ mm (shaft height from the base line)

$T_a = 7.70$ m (Draft at the aft perpendicular)

$P_a = 100000$ Pa (Atmospheric Pressure)

$P_v = 1700$ Pa (Vapour Pressure)

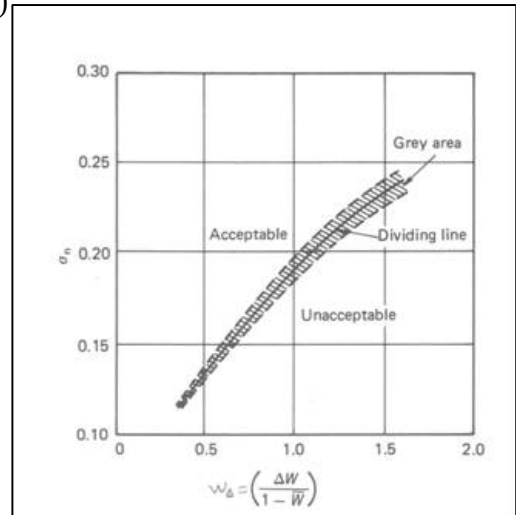
$\rho = 1025$ kg/m³. (Density of sea water)

$g = 9.80665$ m/sn². (Acceleration of gravity)

$$\sigma_{nl} = \frac{P_a - P_v + P_H}{\frac{1}{2}\rho(\pi nD)^2}$$

P_H = Hydrostatic pressure at the propeller tip

$$w_\Delta = \left(\frac{\Delta w}{1 - \bar{w}} \right)_{1.0R}$$



The wake is given in the following table.

ANGLE	Wake Velocity Ratios – V_x/V_s							
0	0.053	0.158	0.110	0.122	0.216	0.240	0.267	0.413
10	0.075	0.139	0.113	0.122	0.201	0.293	0.361	0.422
20	0.093	0.126	0.107	0.136	0.214	0.310	0.389	0.471
30	0.108	0.123	0.102	0.158	0.238	0.333	0.443	0.565
40	0.114	0.125	0.105	0.175	0.268	0.381	0.495	0.590
50	0.114	0.124	0.121	0.212	0.337	0.492	0.596	0.658
60	0.111	0.119	0.161	0.308	0.438	0.584	0.655	0.685
70	0.109	0.119	0.216	0.421	0.520	0.619	0.682	0.726
80	0.109	0.136	0.272	0.508	0.603	0.669	0.733	0.808
90	0.112	0.173	0.328	0.572	0.691	0.720	0.771	0.898
100	0.116	0.215	0.392	0.618	0.736	0.763	0.800	0.916
110	0.121	0.238	0.447	0.666	0.757	0.805	0.837	0.938
120	0.123	0.239	0.479	0.730	0.803	0.866	0.884	0.947
130	0.123	0.228	0.494	0.773	0.853	0.922	0.940	0.951
140	0.122	0.214	0.503	0.789	0.899	0.956	0.974	0.988
150	0.119	0.196	0.494	0.775	0.925	0.974	0.986	0.994
160	0.109	0.179	0.460	0.727	0.924	0.977	0.988	0.992
170	0.091	0.170	0.399	0.639	0.896	0.965	0.990	0.999
180	0.067	0.168	0.329	0.536	0.850	0.928	0.971	0.996
r/R	0.146	0.292	0.438	0.583	0.729	0.875	1.021	1.167

Here 0° – Top dead centre – 180° – bottom death centre

Good Luck!

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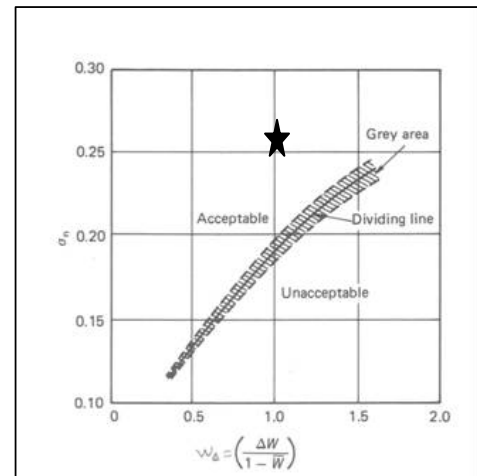
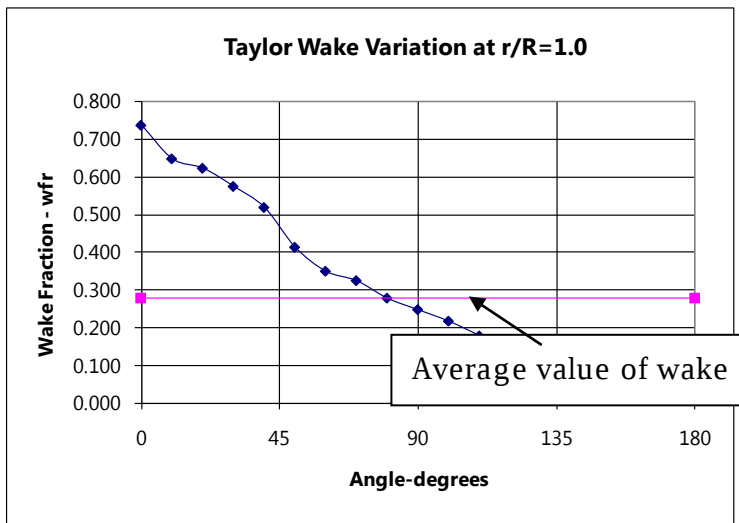
SOLUTION

First calculate the cavitation parameter σ_{NI} ,

$$\sigma_{nl} = \frac{100000 - 1700 + 9.80665 \times 1025 \times \left(7.70 - \frac{4.8}{2} - 2.7\right)}{\frac{1}{2} \times 1025 \times \left(\pi \times \frac{120}{60} \times 4.8\right)^2} = \frac{124434.7223}{466161.1551} = 0.267$$

Second calculate the wake parameter

$$w_{\Delta} = \left(\frac{\Delta w}{1 - \bar{w}} \right)_{1.0R} = \left(\frac{0.737 - 0.011}{1 - 0.277} \right)_{1.0R} = \frac{0.726}{0.723} = 1.004$$



ANGLE	w(1.0r)	SM	Mult.
0	0.737	1	0.737
10	0.648	4	2.591
20	0.623	2	1.246
30	0.575	4	2.298
40	0.519	2	1.037
50	0.413	4	1.652
60	0.349	2	0.699
70	0.324	4	1.297
80	0.278	2	0.556
90	0.247	4	0.989
100	0.217	2	0.433
110	0.178	4	0.710
120	0.125	2	0.250
130	0.062	4	0.246
140	0.028	2	0.056
150	0.015	4	0.061
160	0.013	2	0.025
170	0.011	4	0.045
180	0.033	1	0.033
Sum=			14.961
Area=			0.870
Mean =			0.277

