

ADVANCED PROPULSION SYSTEM – MID-TERM EXAM

05/11/2010 - 13:30-14:15

1. 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.

Given:

D = 4.8 m (propeller diameter)

N = 125 (number of propeller revolution per minute - RPM)

Z = 4 (number of blades)

Z_p = 2.6 m. (shaft height from the base line)

T_a = 7.98 m (Draft at the aft perpendicular)

P_a = 100000 Pa (Atmospheric Pressure)

P_v = 1700 Pa (Vapour Pressure)

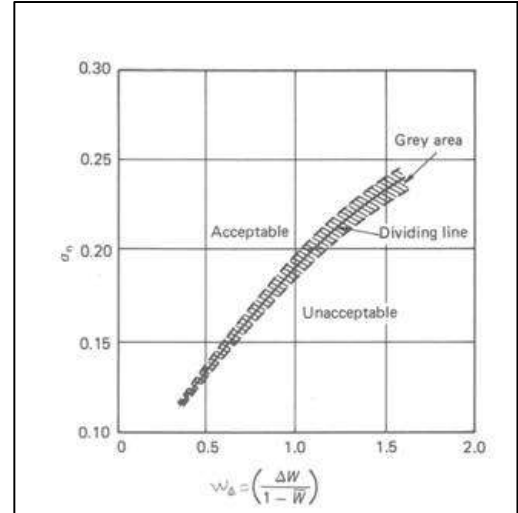
ρ = 1025 kg/m³. (Density of sea water)

g = 9.80665 m/s². (Acceleration of gravity)

$$\sigma_{nl} = \frac{P_a - P_v + P_H}{\frac{1}{2} \rho \pi n D^2}$$

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 Fraction - w							
0	0.986	0.908	0.863	0.860	0.880	0.920	0.964	0.990
10	0.978	0.860	0.851	0.860	0.946	0.933	0.949	0.950
20	0.976	0.860	0.860	0.871	0.958	0.920	0.923	0.913
30	0.986	0.934	0.876	0.876	0.888	0.893	0.855	0.802
40	0.990	0.944	0.794	0.753	0.770	0.795	0.737	0.660
50	0.988	0.907	0.764	0.691	0.650	0.636	0.585	0.523
60	0.962	0.815	0.689	0.596	0.530	0.468	0.431	0.404
70	0.954	0.746	0.617	0.513	0.422	0.333	0.305	0.308
80	0.950	0.689	0.556	0.445	0.336	0.243	0.219	0.238
90	0.951	0.626	0.495	0.380	0.271	0.189	0.168	0.191
100	0.954	0.576	0.426	0.310	0.218	0.154	0.140	0.160
110	0.963	0.542	0.360	0.244	0.172	0.132	0.123	0.140
120	0.980	0.531	0.321	0.205	0.138	0.120	0.111	0.123
130	0.986	0.535	0.326	0.204	0.127	0.118	0.103	0.110
140	0.988	0.546	0.352	0.222	0.139	0.116	0.097	0.101
150	0.985	0.570	0.354	0.224	0.158	0.112	0.093	0.096
160	0.985	0.615	0.344	0.221	0.174	0.120	0.097	0.092
170	0.984	0.648	0.438	0.316	0.239	0.188	0.137	0.091
180	0.990	0.733	0.567	0.471	0.409	0.364	0.232	0.076
r/R	0.305	0.407	0.508	0.610	0.712	0.813	0.915	1.017

Here 0 – Top dead center – 180 – bottom death center

Good Luck!

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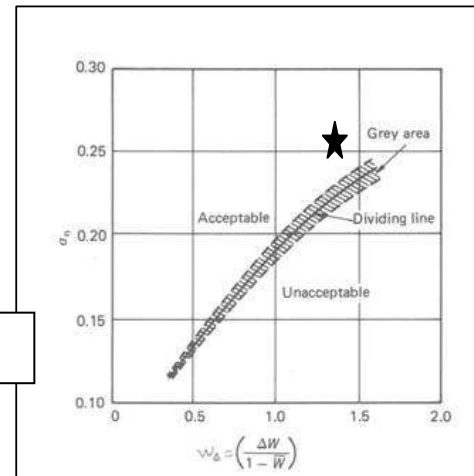
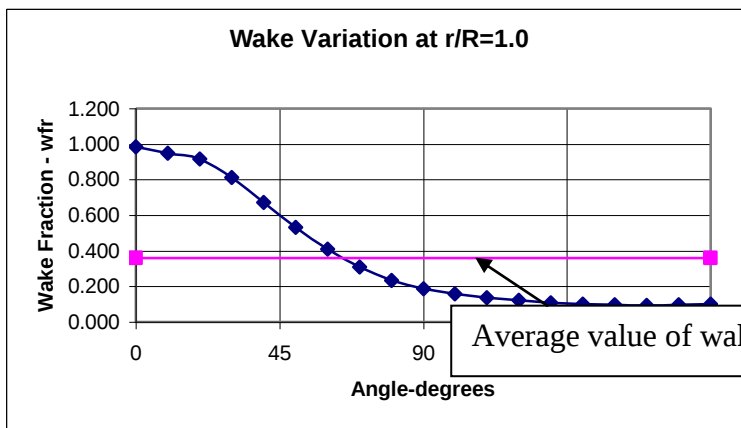
SOLUTION

1. a) First calculate the parameter σ_{NI} ,

$$\sigma_{NI} = \frac{100000 - 1700 + 9.80665 \times 1025 \times \left(7.98 - \frac{4.8}{2} - 2.6\right)}{\frac{1}{2} \times 1025 \times \left(\pi \times \frac{125}{60} \times 4.8\right)^2} = \frac{128254.4124}{505817.2256} = 0.2535$$

Second calculate the wake parameter

$$w_{\Delta} = \left(\frac{\Delta w}{1 - \bar{w}} \right)_{1.0R} = \left(\frac{0.986 - 0.093}{1 - 0.359} \right)_{1.0R} = \frac{0.893}{0.641} = 1.393$$



w	SM	Mult
0.986	1	0.986
0.950	4	3.799
0.915	2	1.829
0.811	4	3.243
0.673	2	1.346
0.533	4	2.133
0.409	2	0.817
0.308	4	1.230
0.235	2	0.470
0.187	4	0.749
0.157	2	0.313
0.137	4	0.549
0.121	2	0.242
0.109	4	0.435
0.100	2	0.201
0.096	4	0.382
0.093	2	0.186
0.099	4	0.395
0.102	1	0.102

Sum= 19.406

Area= 1.129

Mean = 0.359