

Project : B20-R
Designer : Sea Tech
Created by : NA Razmik Baharyan
Filename : B20-R-Hull-v3_50 FS.fbm

Design length : 20.000 m
Design beam : 5.580 m
Design draft : 1.190 m
Midship location : 10.000 m
Water density : 1.000 t/m³
Appendage coefficient : 1.0000

Date : 12.3.2019 r.
Time : 11:08:39

Input variables

General

Start speed : 9.60 kn
End speed : 16.00 kn
Water density : 1.000 t/m³
Water viscosity : $1.1390 \cdot 10^{-6}$ m²/s

Hull

Length on waterline : 19.632 m
Beam on waterline : 5.028 m
Draft on midship : 1.191 m
Wetted surface area : 92.41 m²
Waterplane area : 69.81 m²
Displacement : 54.990 m³
Longitudinal center of buoyancy : -6.487 %
Prismatic coefficient : 0.6135

Data for Sea margin coefficient:

Time of ship hull is in water, month : 0.0
Height of 3% wave, m : 3.500
Course angle of moving wave, degree : 0.00
Wind speed, m/s : 13.40
Course wind angle, degree : 0.00
Height of a board above DWL, m : 1.525
Air density, kg/m³ : 1.226
Middle height of superstructure above DWL, m : 4.220
Depth of water, m : 10.00
Wetted area of midsection, m² : 4.57
Absolute roughness, mkm : 150
The Ship types (1-11): : 1

Calculated variables

Cp = 0.6135
Cb = 0.4679
Cwp = 0.7072
Cm = 0.7626
Am = 4.57 m²
Tc = 1.191 m
Lwl/Bwl = 3.905
Bwl/T = 4.223
Lwl/T = 16.488

Psi = 5.163
 ie = 10.480 degr.
 LCB = -1.297 m
 LCB/Lpp = -0.0649
 Ca*10^3 = 0.450
 Capp*10^3 = 0.050
 Caero*10^3 = 0.050
 Nser = 10

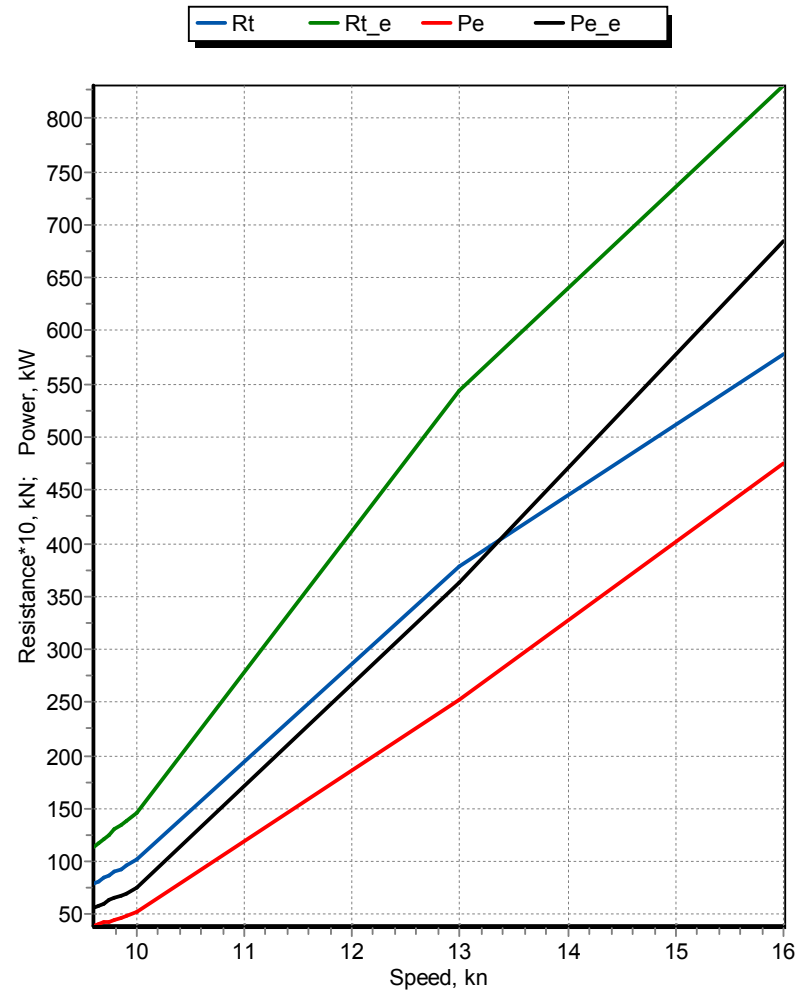
Final calculations of resistance and power prediction by a diagram of de Groot

Speed	Speed	Fr_V	R_f	R_r	R_T	Power	R_T_e	Power_e
[kn]	[m/s]	[-]	[kN]	[kN]	[kN]	[kW]	[kN]	[kW]
9.60	4.94	0.809	2.5	5.5	7.9	39.2	11.4	56.5
9.65	4.96	0.813	2.5	5.7	8.2	40.7	11.8	58.6
9.70	4.99	0.817	2.5	6.0	8.5	42.2	12.2	60.8
9.75	5.02	0.821	2.5	6.2	8.7	43.8	12.6	63.1
9.80	5.04	0.825	2.6	6.5	9.0	45.5	13.0	65.5
9.85	5.07	0.830	2.6	6.7	9.3	47.1	13.4	67.8
9.90	5.09	0.834	2.6	7.0	9.6	48.8	13.8	70.3
10.00	5.14	0.842	2.6	7.5	10.2	52.4	14.7	75.4
13.00	6.69	1.095	4.3	33.4	37.8	252.5	54.4	363.7
16.00	8.23	1.348	6.3	51.4	57.7	475.2	83.1	684.3

Tb = 16.979 kN
 Kde = 1.091
 Kdt = 0.829
 Dp = 0.812 m
 Z = 4
 Ae/Ao = 0.711 - calculated
 Ae/Ao = 0.711 - for selection of propeller diagram
 P/Dp = 0.900 - by curve of propeller optimal frequency
 Ke = 1.440
 Wt = 0.1819 - by Papmehl's formula with addings of KSRI (Russia)
 t = 0.1365
 EtaR = 1.0000
 EtaH = 1.0555
 EtaH*EtaR = 1.0555

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Resistance and power are calculated by a diagram of de Groot



Program of resistance and power prediction for naval ships (NUoS,Ukraine,2010).

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Design length : 20.000 m
Design beam : 5.580 m
Design draft : 1.190 m
Midship location : 10.000 m
Water density : 1.000 t/m³
Appendage coefficient : 1.0000

Date : 12.3.2019 r.
Time : 13:24:53

Input variables

General

Start speed : 5.00 kn
End speed : 16.00 kn
Water density : 1.000 t/m³
Water viscosity : 1.1390*10⁽⁻⁶⁾ m²/s

Hull

Length on waterline : 19.632 m
Length over surface Los : 19.726 m
Beam on waterline : 5.028 m
Draft on midship : 1.191 m
Draft on F.P. : 1.191 m
Draft on A.P. : 1.191 m
Wetted surface area : 92.41 m²
Waterplane area : 69.81 m²
Displacement : 54.990 m³
Longitudinal center of buoyancy : -6.823 %
Prismatic coefficient : 0.6135

Data for Sea margin coefficient:

Time of ship hull is in water, month : 6.0
Height of 3% wave, m : 3.500
Course angle of moving wave, degree : 0.00
Wind speed, m/s : 13.40
Course wind angle, degree : 0.00
Height of a board above DWL, m : 1.525
Air density, kg/m³ : 1.226
Middle height of superstructure above DWL, m : 4.220
Depth of water, m : 10.00
Wetted area of midsection, m² : 4.57
The Ship types (1-11): : 1
Absolute roughness, mkm : 150

Calculated variables

Cp = 0.6135
Cb = 0.4679
Cwp = 0.7072
Cm = 0.7626
Am = 4.57 m²
L/B = 3.978
ie = 10.480 degr
Tc = 1.191 m
B/T = 4.223
Lwl/T = 16.488
DLR = 210.506

$T_a = 0.250$
 $T_w = 0.851$
 $N_p = 2$

 $C_v = 0.00361$
 $C_{p1} = 0.72809$
 $C_f = 0.00215$
 $Ca = 0.00074$
 $(1+k) = 1.33904$

Final calculations of resistance and power by method Fung-Leibman 1995

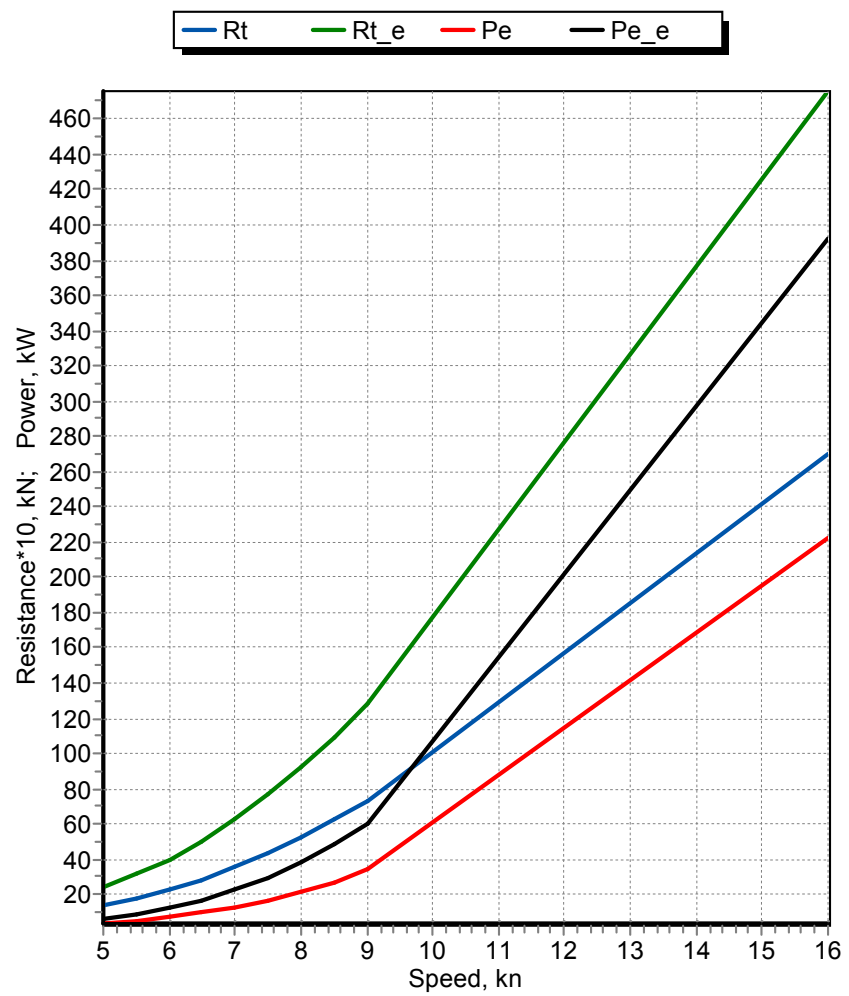
Vs	Vms	Fr	R_f	R_r	R_T	Pe	R_T_e	Pe_e
kn	m/s	-	kN	kN	kN	kW	kN	kW
5.500	2.829	0.204	0.931	0.849	1.781	5.038	3.138	8.877
6.000	3.087	0.222	1.095	1.177	2.272	7.012	4.003	12.36
6.500	3.344	0.241	1.271	1.586	2.857	9.552	5.034	16.83
7.000	3.601	0.259	1.459	2.085	3.544	12.76	6.245	22.48
7.500	3.858	0.278	1.659	2.678	4.337	16.73	7.642	29.48
8.000	4.116	0.297	1.871	3.362	5.233	21.54	9.221	37.95
8.500	4.373	0.315	2.095	4.130	6.225	27.22	10.97	47.96
9.000	4.630	0.334	2.331	4.972	7.303	33.81	12.87	59.57
16.00	8.231	0.593	6.830	20.18	27.01	222.3	47.59	391.7

$T_b = 7.220 \text{ kN}$
 $K_{dt} = 0.860$
 $D_p = 0.560 \text{ m}$
 $Z = 4$
 $A_e/A_o = 0.753$ - calculated
 $A_e/A_o = 0.753$ - for selection of propeller diagram
 $P/D_p = 0.900$ - by curve of propeller optimal frequency
 $K_e = 1.762$
 $W_t = 0.1091$
 $t = 0.1089$
 $\eta_{tR} = 1.0019$
 $\eta_{tH} = 1.0002$
 $\eta_{tH} \cdot \eta_{tR} = 1.0021$

NOTE: Coefficients W_t , t and η_{tR} were calculated by formulas of method Holtrop-1988

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Resistance and power are calculated by Fung-Leibman's method 1995



Resistance prediction for sea vessels, according to Associate Prof. Timoshenko.

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Design beam : 5.580 m
Design draft : 1.190 m
Midship location : 10.000 m
Water density : 1.000 t/m³
Appendage coefficient : 1.0000

Date : 12.3.2019 r.
Time : 13:02:57

Input variables

General

Start speed : 5.00 kn
End speed : 16.00 kn
Water density : 1.000 t/m³
Water viscosity : 1.1390*10⁻⁶ m²/s

Hull

Length on waterline : 19.632 m
Beam on waterline : 5.028 m
Draft on midship : 1.191 m
Draft on F.P. : 1.116 m
Draft on A.P. : 1.266 m
Wetted surface area : 92.41 m²
Waterplane area : 69.81 m²
Displacement : 54.990 m³
Longitudinal center of buoyancy : -6.823 %
Prismatic coefficient : 0.6135

Data for Sea margin coefficient:

Time of ship hull is in water, month : 0.0
Height of 3% wave, m : 3.500
Course angle of moving wave, degree : 0.00
Wind speed, m/s : 13.40
Course wind angle, degree : 0.00
Height of a board above DWL, m : 1.525
Air density, kg/m³ : 1.226
Middle height of superstructure above DWL, m : 4.220
Depth of water, m : 10.00
Wetted area of midsection, m² : 4.57
The Ship types (1-11): : 1
Absolute roughness, mkm : 150

Calculated variables

```

Cp          = 0.6135
Cb          = 0.4679
Cwp         = 0.7072
Cm          = 0.7626
Cbt         = 0.0000
Am          = 4.57 m^2
Lwl/Bwl     = 3.905
Tc          = 1.191 m
Bwl/T       = 4.223
Lwl/T       = 16.488
Cstrn       = -24
Np          = 2
ie          = 10.480 degr

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Bwl/T  is outside valid domain 2,10 ... 4,0
LCB    is outside valid domain -6 % ... 6 %

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Final calculations of resistance by a method Holtrop-1988

Speed	Speed	Fr	R _f	R _r	R _T	Power	R _{T_e}	Power _e
[kn]	[m/s]	[-]	[kN]	[kN]	[kN]	[kW]	[kN]	[kW]
5.00	2.57	0.185	0.9	0.8	1.6	4.2	2.2	5.6
5.57	2.87	0.207	1.1	0.9	2.0	5.7	2.6	7.6
6.14	3.16	0.228	1.3	1.1	2.4	7.7	3.2	10.2
6.71	3.45	0.249	1.5	1.4	2.9	10.2	3.9	13.4
7.29	3.75	0.270	1.8	1.8	3.6	13.4	4.7	17.7
7.86	4.04	0.291	2.0	2.4	4.4	17.9	5.8	23.6
8.43	4.34	0.312	2.3	3.0	5.3	23.1	7.0	30.5
9.00	4.63	0.334	2.6	3.6	6.2	28.7	8.2	37.9
12.50	6.43	0.463	4.8	18.0	22.8	146.5	30.1	193.4
16.00	8.23	0.593	7.6	36.6	44.2	363.6	58.3	479.9

```

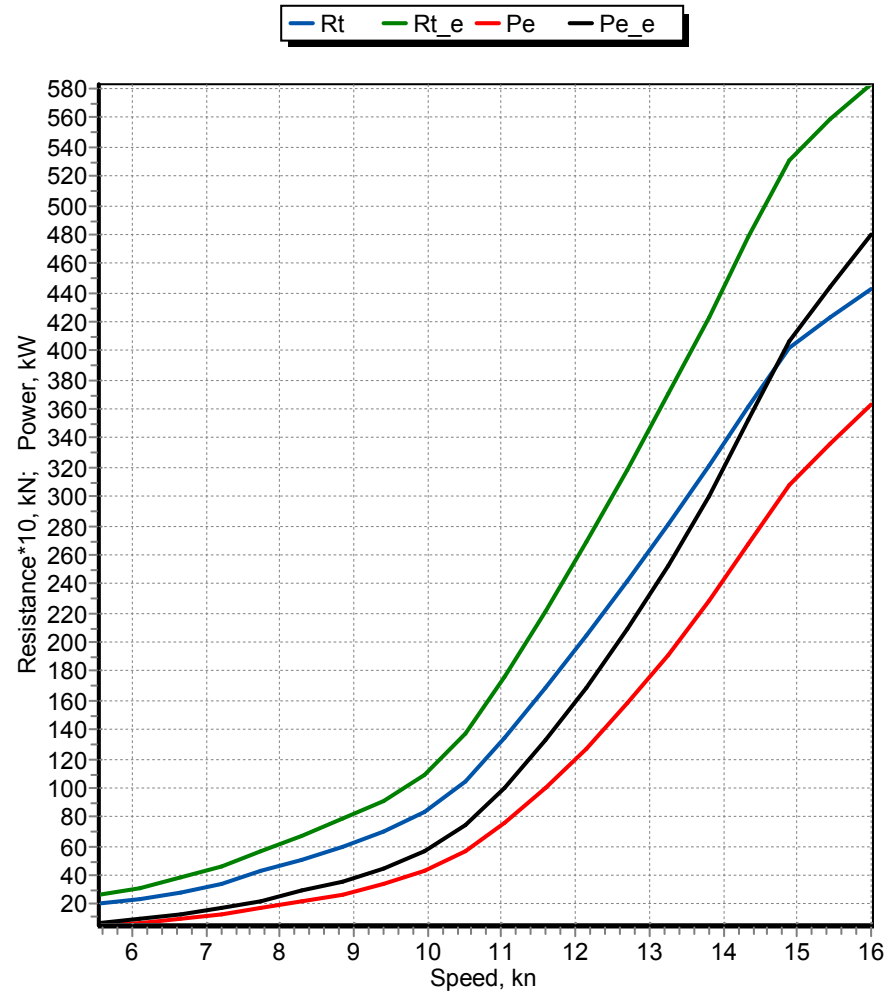
Tb          = 4.595 kN
Kdt         = 1.080
Dp          = 0.560 m
Z           = 4
Ae/Ao       = 0.551 - calculated
Ae/Ao       = 0.700 - for selection of propeller diagram
P/Dp        = 0.918 - by curve of propeller optimal frequency
Ke          = 1.320
Wt          = 0.1070
t           = 0.1089
EtaR        = 1.0008
EtaH        = 0.9979
EtaH*EtaR   = 0.9986

```

NOTE: Coefficients Wt, t and EtaR were calculated by formulas of method Holtrop-1988

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Resistance and power are calculated by a method Holtrop-1988



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Design draft : 1.190 m
Midship location : 10.000 m
Water density : 1.000 t/m³
Appendage coefficient : 1.0000

Date : 12.3.2019 r.
Time : 09:33:25

Input variables

General

Start speed : 5.00 kn
End speed : 16.00 kn
Water density : 1.000 t/m³
Water viscosity : $1.1390 \cdot 10^{-6}$ m²/s

Hull

Length on waterline : 19.632 m
Beam on waterline : 5.028 m
Draft on midship : 1.191 m
Wetted surface area : 92.41 m²
Waterplane area : 69.81 m²
Displacement : 54.990 m³
Longitudinal center of buoyancy : -6.487 %
Prismatic coefficient : 0.6135

Data for Sea margin coefficient:

Time of ship hull is in water, month : 0.0
Height of 3% wave, m : 3.500
Course angle of moving wave, degree : 0.00
Wind speed, m/s : 13.40
Course wind angle, degree : 0.00
Height of a board above DWL, m : 1.525
Air density, kg/m³ : 1.226
Middle height of superstructure above DWL, m : 4.220
Depth of water, m : 10.00
Wetted area of midsection, m² : 4.57
Absolute roughness, mkm : 150
The Ship types (1-11): : 1

Calculated variables

Cp = 0.6135
Cb = 0.4679
Cwp = 0.7072
Cm = 0.7626
Am = 4.57 m²
Tc = 1.191 m
Lwl/Bwl = 3.905
Bwl/T = 4.223
Lwl/T = 16.488

Psi = 5.163
 LCB = -1.297 m
 LCB/Lpp = -0.0649
 Ca*10^3 = 0.450
 Capp*10^3 = 0.050
 Caero*10^3 = 0.000
 Nser = 0
 Np = 2
 Fr_min = 0.185
 Fr_max = 0.593

Final calculations of resistance and power prediction by according to modeling experiment

Speed	Speed	Fr	R_f	R_r	R_T	Power	R_T_e	Power_e
[kn]	[m/s]	[-]	[kN]	[kN]	[kN]	[kW]	[kN]	[kW]
5.00	2.57	0.185	0.7	0.8	1.5	4.0	2.2	5.7
6.00	3.09	0.222	1.0	1.8	2.8	8.7	4.0	12.5
7.00	3.60	0.259	1.4	3.6	5.0	17.9	7.2	25.8
8.00	4.12	0.297	1.7	6.5	8.2	33.9	11.8	48.8
9.00	4.63	0.334	2.2	10.4	12.6	58.3	18.1	84.0
10.00	5.14	0.371	2.6	15.6	18.2	93.8	26.2	135.0
11.00	5.66	0.408	3.2	22.1	25.3	143.2	36.4	206.2
13.00	6.69	0.482	4.3	40.1	44.4	297.2	64.0	427.9
14.50	7.46	0.538	5.3	58.5	63.8	475.7	91.8	685.0
16.00	8.23	0.593	6.3	81.7	88.0	724.4	126.7	1043.2

Tb = 35.372 kN
 Ke = 1.440
 Wt = 0.1161 - by Papmehl's formula with addings of KSRI (Russia)
 t = 0.0955
 EtaR = 1.0000
 EtaH = 1.0232
 EtaH*EtaR = 1.0232

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Resistance and power are calculated according to modeling experiment

