

Canoes F17 and C18 V3 comparison

Canoe F17 is a free interpretation inspired by Freedom 17, according to data as given at @4,25" waterline from :

<https://www.bearmountainboats.com/products/freedom-17>

Canoe C18 V3 is a free interpretation inspired by Cirrus 18, according to data (given at @4" waterline ?), from :

<http://www.greenval.com/cirrus.html>

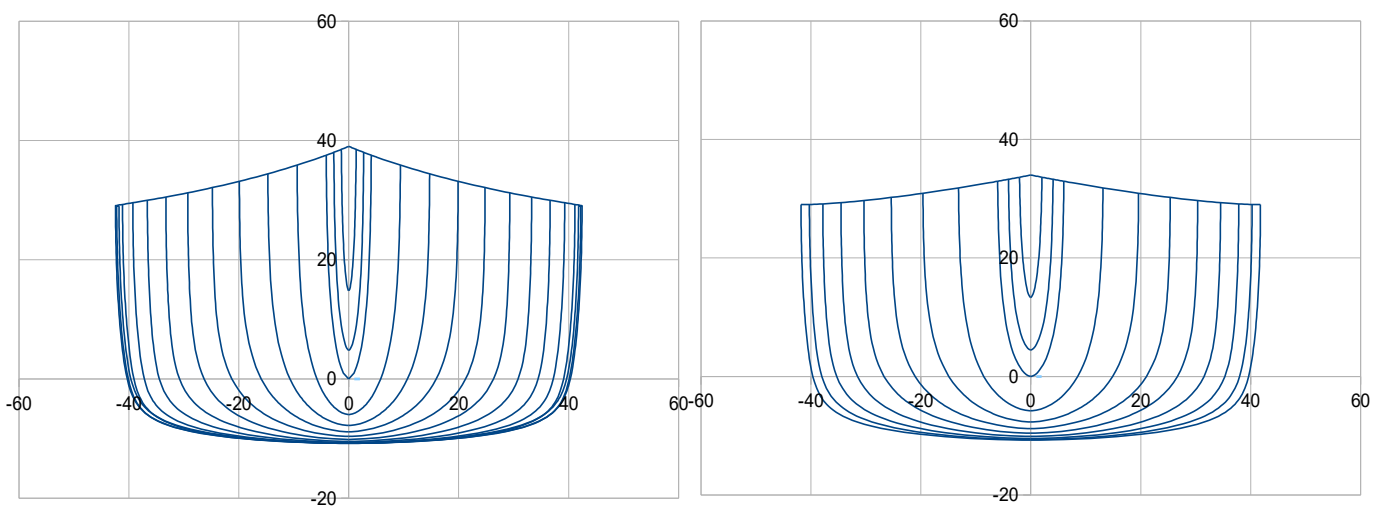
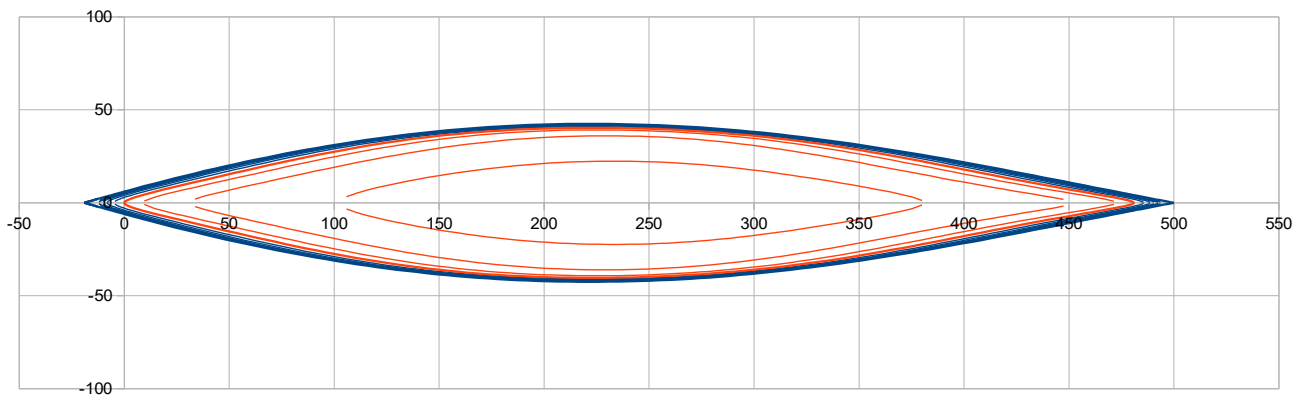
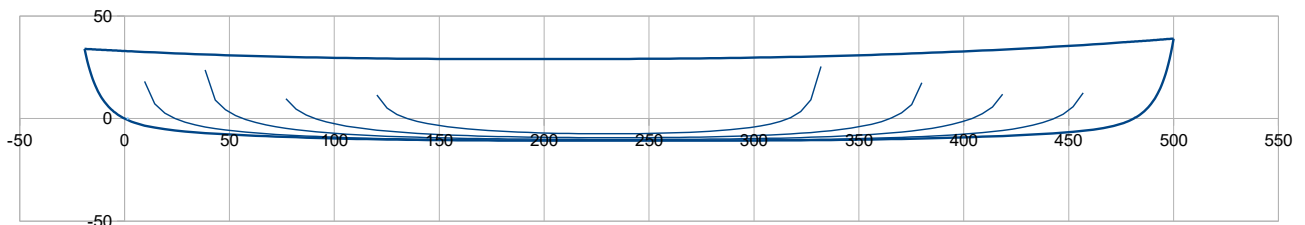
Canoe F17 :

Loa : 5,19 m (17') ; Boa : 0,849 m (33,43")

At 4,25" waterline (as drawn here below) :

Lwl : 4,81 m (15,78') ; Bwl : 0,8065 m (31,75") ; Cp : 0,567 ; LCB : 48,5 %Lwl

Sw : 2,79 m² (30,04 sq.ft.) ; Displacement : 200,1 kg (441 lbs)



Hydrostatics data at waterline H0 = 4,25" :

2. Data sum-up and results of hydrostatic and surfaces calculations

Hull										
Loa (m)	5,190	Lwl (m)	4,81	> Lwl/D^(1/3)	8,22	Fn at 5 mph	0,325			
>> ft	17,03	>> ft	15,78	DLR	50	M(lbs/2240)/(Lwl(ft)/100)^3				
B (m)	0,849	at X (% Lwl)	46,2							
>> inch	33,43									
Bwl (m)	0,8065	at X (% Lwl)	46,0	> Bwl / B	0,950					
>> inch	31,75			Freeboards (m) >		Aft	Midship	Fore		
Tc (m)	0,108	at X (%Lwl)	50			0,34	0,29	0,39		
>> inch	4,25					>> inch	13,39	11,42	15,35	
Displacement at H0 (m3)	0,20009	at Xc (m)	2,332	Xc (%Lwl)	48,48	Zc (m)				
(kg)	200,09	>> ft	7,65			>> inch				-0,044
>> lbs	441,0	with water mass / vol. of		1000		kg/m3				-1,75
Cp (%)	56,71									
Sf (m2)	2,50	at Xf (m)	2,316	Xf (%Lwl)	48,15	>>> Xc - Xf (%Lwl)				0,32
>> ft2	26,89	>> ft	7,60							
Angle immersed sheer li (°)		34,8	at section C4 (40% Lwl)							
Sw (m2)	2,79	>Sw/D^(2/3)	8,16							
>> ft2	30,06									
Shull (m2)	5,97	at X (m)	239,49	Z (m)	0,05					
>> ft2	64,31	>> ft	785,71	>> ft	0,15					

Simplified mass spreadsheet with the payload 170,15 kg (375 lbs) :

Assuming an average weight unit of 4,18 kg/m2 of hull surface (0,856 lbs/sq.ft.)

Simplified Mass spreadsheet

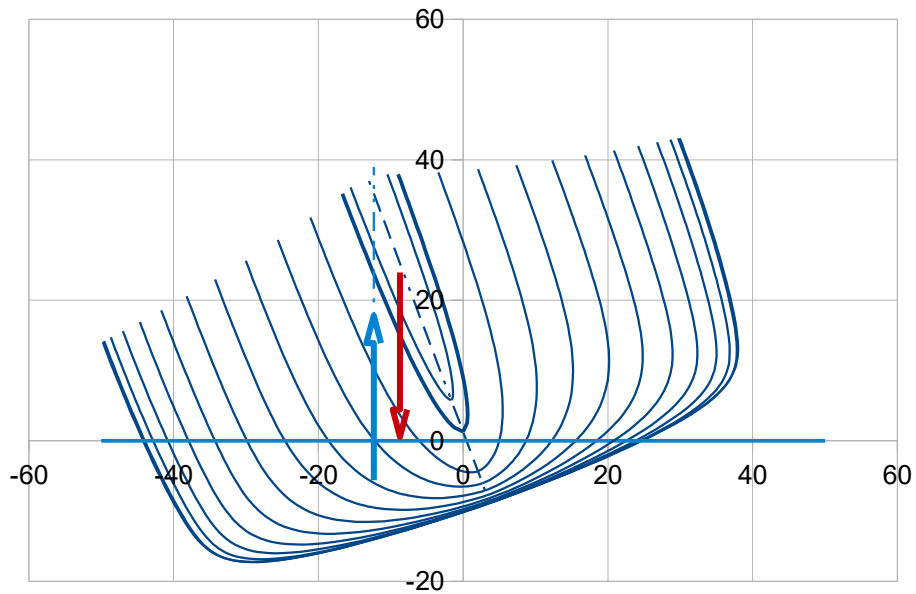
	Hull weight unit (kg/m2)	Mass (kg)	Zg (/H0) (m)	Zg (m)
Canoe (kg)	4,18	24,97	0,05	0,048
Load (kg)		170,15	0,27	0,272
M tot (kg)		195,1		
Zg tot (m)				0,243

>>> canoe weight : 24,97 kg (55 lbs) and total displacement with load : 195,1 kg (430 lbs)

GM at total displacement, at Heel 0,1° (initial stability) et 20° :

Data to enter		Results					
Heel (°)	0,1	Disp. Heel 0°	0,20009	Disp tot(m3)	0,19512		
Height (cm)	0,2013	> Disp. (m3)	0,19512	>> Lwl (m)	4,802	>> Bwl (m)	0,802
		Xc (m)	2,33	/ Xc Heel 0°	2,33	>> Draft (m)	0,106
		Yc (m)	0,00	/ Yc Heel 0°	0,00	Ym (m)	0,00
		Zc (m)	-0,04	/ Zc Heel 0°	-0,04	>> GZ (m)	0,0003
		>> Sw (m2)	2,79	/ Sw Heel 0°	2,79	GM (cm)	16,6
						(inch)	6,54

Data to enter		Results					
Heel (°)	20,0	Disp. Heel 0°	0,20009	Disp tot(m3)	0,19512		
Height (cm)	1,3635	> Disp. (m3)	0,19512	>> Lwl (m)	4,759	>> Bwl (m)	0,796
		Xc (m)	2,32	/ Xc Heel 0°	2,33	>> Draft (m)	0,094
		Yc (m)	-0,12	/ Yc Heel 0°	0,00	Ym (m)	-0,09
		Zc (m)	-0,06	/ Zc Heel 0°	-0,04	>> GZ (m)	0,0364
		>> Sw (m2)	2,58	/ Sw Heel 0°	2,79	GM (cm)	10,6
						(inch)	4,19



Canoe C18 V3 :

As there was no indication on the C_p , I take the opportunity to investigate on this value, and the lowest drag at around 5 mph is obtained with a C_p of 0,52 (below this value, we are outside the limit of validity of the residuary drag computation from Delft series). A slight reduction of the Lwl (at @ 4" waterline) also contributes to a drag reduction of the loaded canoe. I also pay attention to put the free boards and the Bwl/Lwl ratio in agreement with the Yukon 1000 rules. This version is named **C18 V3** :

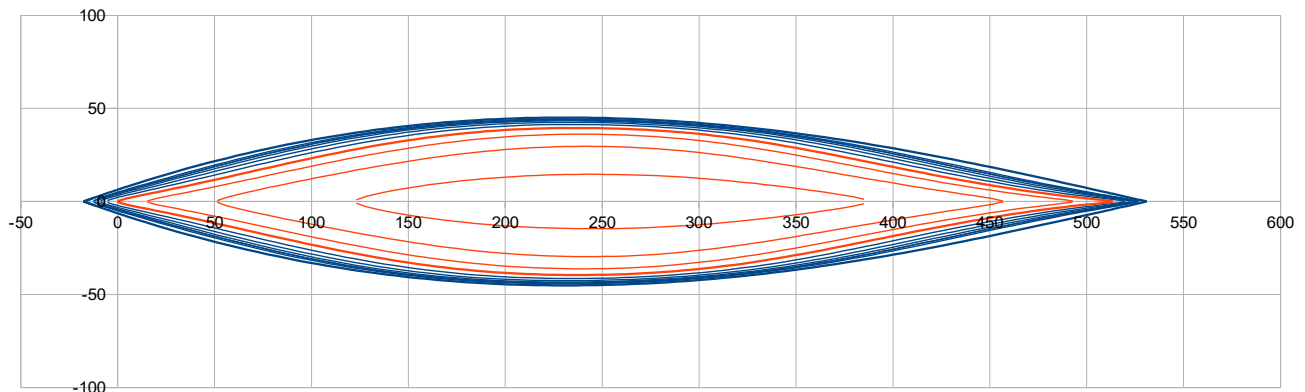
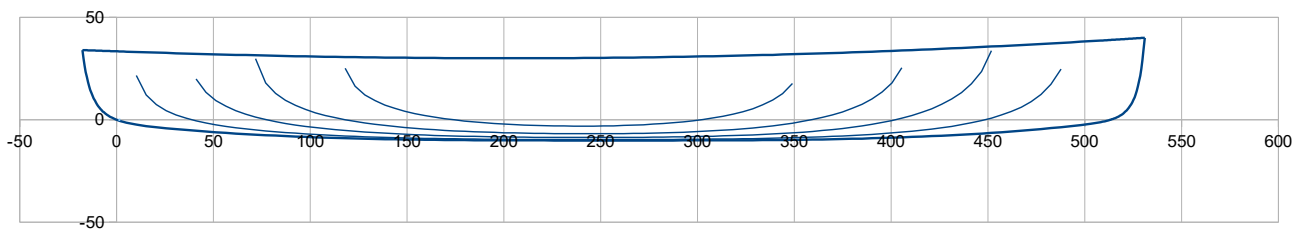
Loa : 5,486 m (18') ; Boa : 0,902 m (35,50")

At 4" waterline (as drawn here below) :

Lwl : 5,13 m (16,84') ; Bwl : 0,7903 m (30,75") >>> Bwl/Loa = 0,14406

C_p : 0,52 ; LCB : 47,65 %Lwl

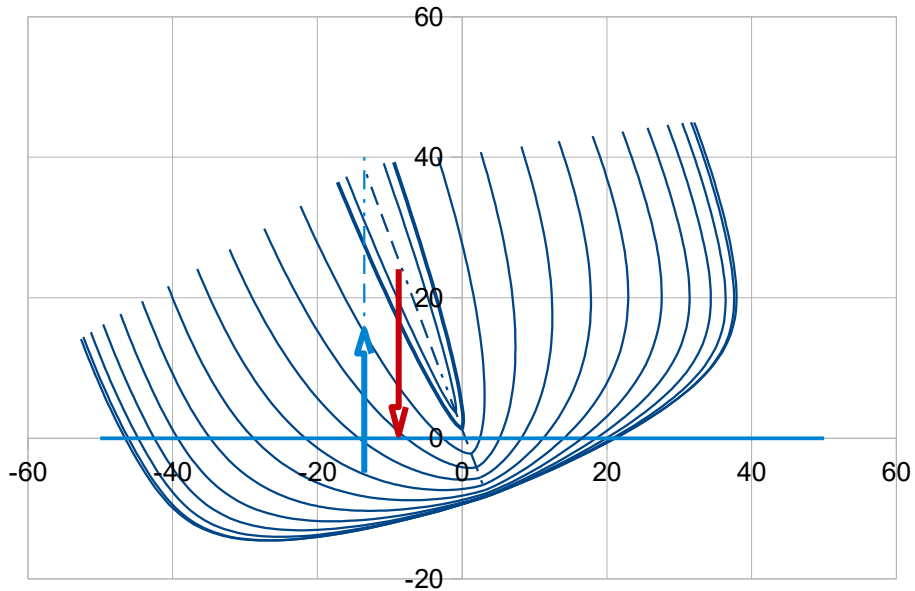
Sw : 2,61 m² (28,07 sq.ft.) ; Displacement : 158,51 kg (349,5 lbs)



GM at total displacement, at Heel 0,1° et 20° :

Data to enter		Results					
Heel (°)	0,1	Disp. Heel 0°	0,15851	Disp tot(m3)	0,19631	>> Bwl (m)	0,808
Height (cm)	-1,5277	> Disp. (m3)	0,19631	>> Lwl (m)	5,225	>> Draft (m)	0,117
		Xc (m)	2,44	/ Xc Heel 0°	2,45	Ym (m)	0,00
		Yc (m)	0,00	/ Yc Heel 0°	0,00	>> GZ (m)	0,0004
		Zc (m)	-0,04	/ Zc Heel 0°	-0,04	GM (cm)	20,3
		>> Sw (m2)	2,83	/ Sw Heel 0°	2,61	(inch)	8,01

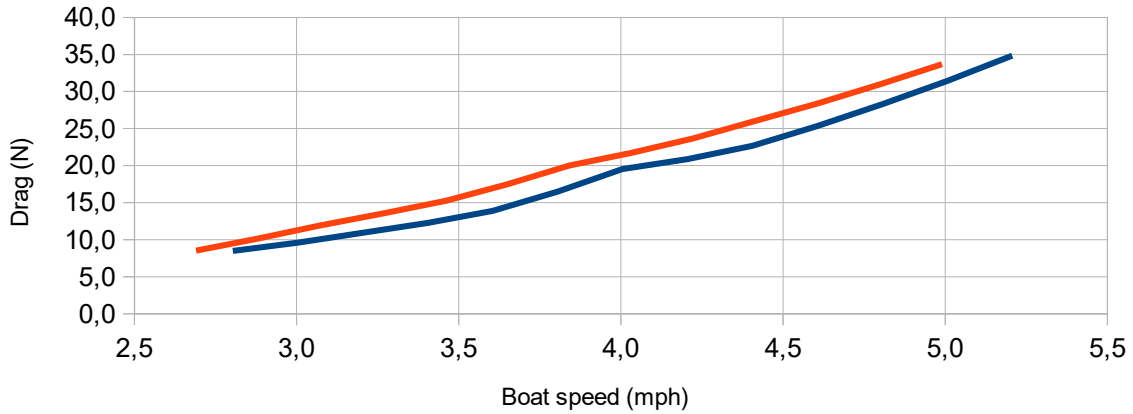
Data to enter		Results					
Heel (°)	20,0	Disp. Heel 0°	0,15851	Disp tot(m3)	0,19631	>> Bwl (m)	0,762
Height (cm)	1,3635	> Disp. (m3)	0,16971	>> Lwl (m)	5,051	>> Draft (m)	0,088
		Xc (m)	2,43	/ Xc Heel 0°	2,45	Ym (m)	-0,09
		Yc (m)	-0,14	/ Yc Heel 0°	0,00	>> GZ (m)	0,0477
		Zc (m)	-0,05	/ Zc Heel 0°	-0,04	GM (cm)	13,9
		>> Sw (m2)	2,46	/ Sw Heel 0°	2,61	(inch)	5,49



Drag and propulsion net power comparison :

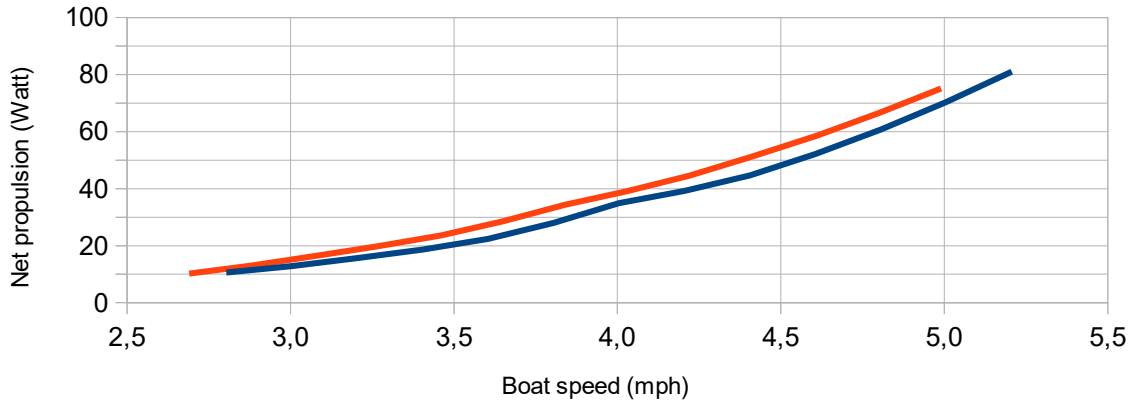
Total drag (N) versus speed (mph)

F17 : Red ; C18 V3 : Blue (Flat sea, no wind)



Propulsion power net (Watt) versus Speed (mph)

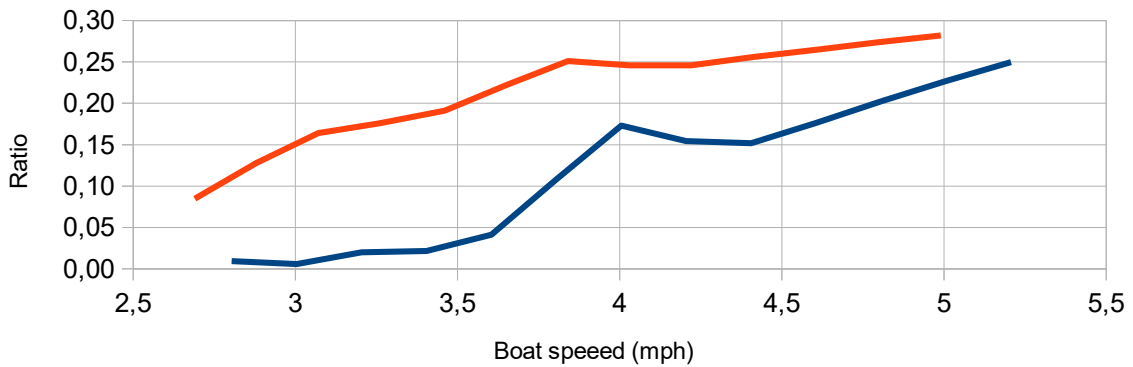
F17 : Red ; C18 V3 : Blue (Flat sea, no wind)



Residuary drag / Total drag ratio :

Residuary drag / total drag ratio

F17 : Red ; C18 V3 : Blue (Flat sea, no wind)

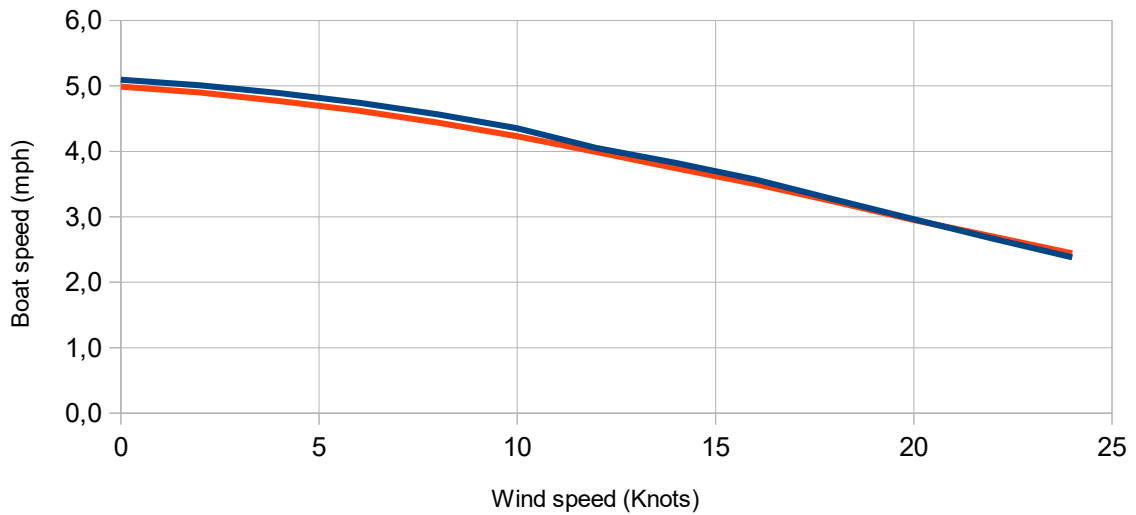


Boat speed comparison at constant propulsion net power and with head wind

For constant net power 75 W :

Boat speed with head wind

F17 : Red ; C18 V3 : Blue (At constant net power 75 W)

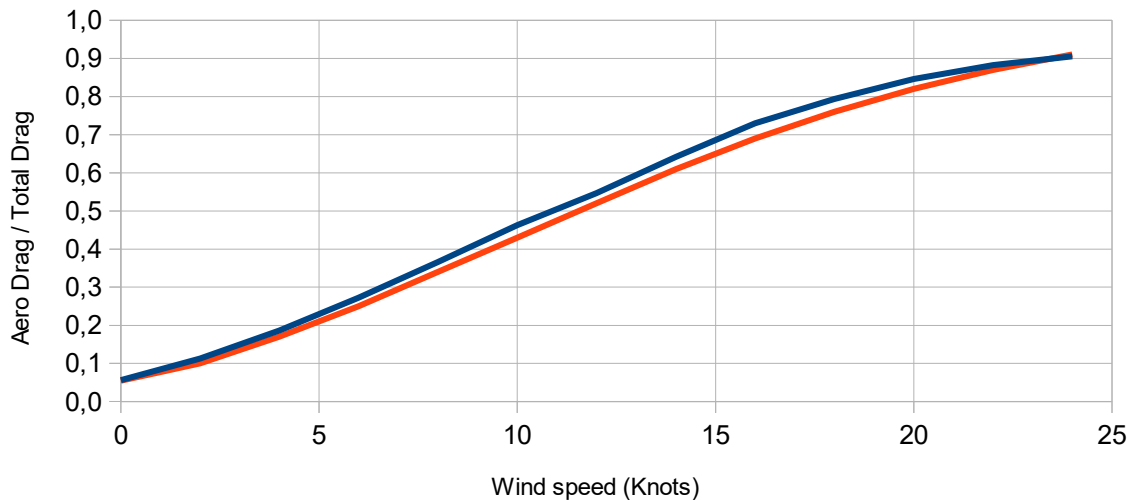


>>> with 12 knots of wind, the speed falls to 4 mph
>>> with 20 knots of wind, the speed falls to 3 mph

Aero drag / Total drag ratio at constant propulsion net power and with head wind :

Aero Drag / Total drag

F17 : Red ; C18 V3 : Blue (At constant net power 75 W)



>>> with head wind 24 knots, the aero drag is 90% of the total drag.

Annex : Drag components computation

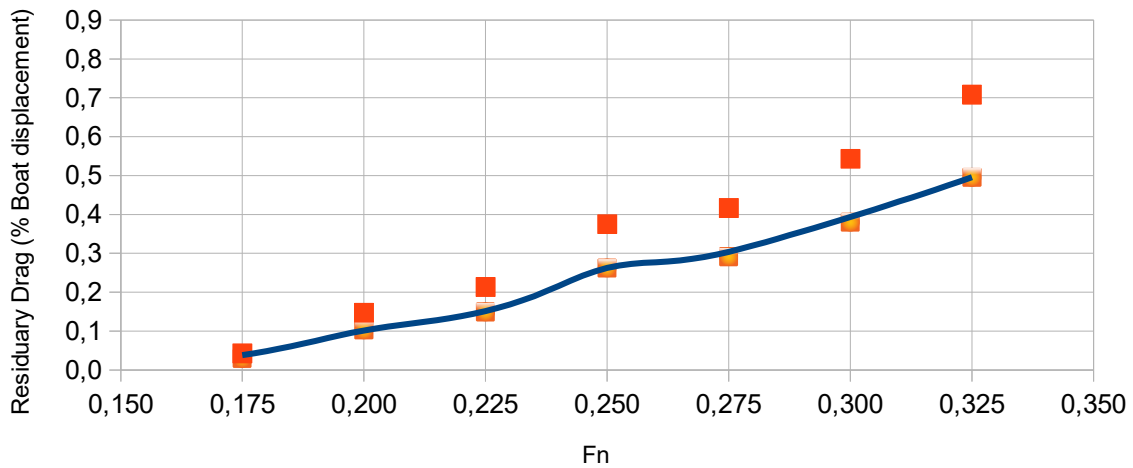
For the Residuary drag adimensional curve :

With reference to the Delft series (as given in book « Principle of Yachts Design » L. Larsson and R. Eliasson, 2nd edition 2000), we consider :

- the range of Froude F_n 0,175 to 0,325
- a mitigation factor of 0,7 : to take into account the higher Lwl/Bwl ratio of the canoes (usually > 6) compared to the limit of use of these Delft curves (Lwl/Bwl limited to 5), The user can choose another factor.
- and a smooth formulation.

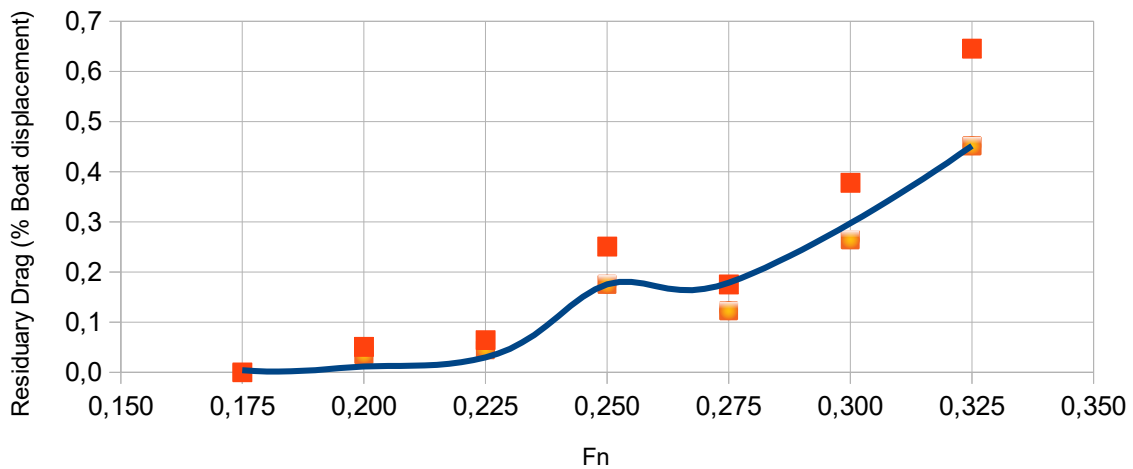
F17 residuary drag (% Boat displacement)

Red : Delft series ; Orange : Delft series x 0,7 ; Blue : programmed curve



Residuary drag (% Boat displacement)

Red : Delft series ; Orange : Delft series x 0,7 ; Blue : programmed curve



Other drag components are :

- frictional drag, based on the wetted surface of the canoe at their total displacement :
Canoe 18'6" : 2,88 m² ; Canoe 17' : 2,68 m²
Friction coefficient : ITTC 57 formula with Re based on 0,7 Lwl

- aerodynamic drag, based on :
 - canoe : surface = Beam oa x Bow height and Cx = 0,5
 - 2 persons in paddling mode : surface = 2 x 0,37 m² and Cx = 0,5