SA-VPP Power Catamaran 1.0_User Guide

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SA-VPP Power Catamaran (Velocity Prediction Program) makes possible the prediction of the catamaran drag and power to install for speeds in the Froude range 0,3 to 1,0. Conditions of validity are :

- Length Beam ratio Lw/Bw > 7
- Length Displacement ratio Lw/Dc^(1/3) > 6,5
  (Length, Beam, Displacement here considered for one hull)
- Space Length S/Lw ratio 0,3 to 0,5

It is a free and open source speadsheet application, developed on a support itself free and widespread (Open Office Calc 4.0.1) : to open and use an ods file, you have to download Open Office or Libre office according to : http://www.openthefile.net/extension/ods

User guide

The spreasheet application includes 2 sheets :

- SA-VPP
- Data storage , where can be stored the various set of input data

SA-VPP : includes an User space (input & outputs) followed by an Administrator space (from line 74) where all the computations are carried out. The User space includes :

The data to input

Example 3	Lwl (m)	Bwl (m)	Sw (m2)	Disp. (m3)	
Each Hull >>	14,75	1,70	28,58	8,42930	
	Hulls axis space S (m)		Saero (m2)	Cx aero	Propulsion efficiency
Cata >>	5,20		23	0,40	0,54

First line, for each hull :

Lwl (m) : lenght of waterline

Bwl (m) : beam of waterline

Sw (m2) : wetted area of one hull

Disp. (m3) : displacement of one hull (i.e. half displacement of the catamaran)

Second line, for the catamaran as a whole :

S (m) : transversal space between the 2 hulls axis

Saero (m2) : the frontal section

Cx aero : The Cx to take into account for the wind drag comptutation (to estimate due to the overall shape of the superstructure)

Propulsion efficviency : to estimate with the one for the propeller and the one of the mechanical transmission. Example : 0,54 = 0,6 (propeller) x 0,9 (mechaniccal transmission)

On the right side of the input data is a check of the ratios / necessary conditions :

Conditions :

>>> Lw/Bw	
8,68	> 7
>>>Lw/Dc^(1/3)	
7,25	> 6,5

Output data

, include the main figures and 3 curves :

Ship			Hulls frictional drag Df			Hull residuary drag Dr							Aero drag	D total	> Power net		Power
Vb (Knots)	Vb (m/s)	½ Rho Vb^2	Re hull	Cf hull	Df (kN)	Fn	Formule 1 Fn < 0,4	Formule 2 0,4< Fn< 0,6	Formule 3 Fn > 0,6	> Dr/mg (%)	K interhull	Dr (kN)	Daero (kN)	Dtot (kN)	EHP (kW)	EHP (hp)	to install (hp)
7,0	3,609	6674,2	3,73E+007	0,0024	**0,922**	**0,300**	0,735	-0,782	2,685	**0,735**	0,29	**1,601**	**0,073**	**2,597**	**9,37**	12,57	**23,3**
8,0	4,135	8762,7	4,27E+007	0,0024	**1,185**	0,344	1,146	0,498	2,912	**1,146**	0,33	**2,592**	**0,096**	**3,873**	**16,02**	21,48	**39,8**
9,1	4,661	11135,2	4,81E+007	0,0023	**1,478**	0,388	1,693	1,591	3,139	**1,693**	0,38	**3,958**	**0,122**	**5,559**	**25,91**	34,75	**64,3**
10,1	5,188	13791,6	5,36E+007	0,0023	**1,801**	0,431	2,400	2,498	3,367	**2,498**	0,40	**5,927**	**0,152**	**7,880**	**40,88**	54,82	**101,5**
11,1	5,714	16731,8	5,90E+007	0,0023	**2,154**	0,475	3,289	3,217	3,594	**3,217**	0,39	**7,566**	**0,184**	**9,904**	**56,59**	75,88	**140,5**
12,1	6,240	19955,9	6,44E+007	0,0022	**2,535**	0,519	4,384	3,750	3,821	**3,750**	0,35	**8,565**	**0,219**	**11,319**	**70,63**	94,72	**175,4**
13,2	6,766	23463,9	6,99E+007	0,0022	**2,945**	0,563	5,709	4,096	4,049	**4,096**	0,30	**9,009**	**0,258**	**12,212**	**82,63**	110,81	**205,2**
14,2	7,293	27255,8	7,53E+007	0,0022	**3,383**	0,606	7,288	4,255	4,276	**4,276**	0,25	**9,094**	**0,300**	**12,776**	**93,17**	124,95	**231,4**
15,2	7,819	31331,5	8,07E+007	0,0021	**3,849**	0,650	9,147	4,227	4,503	**4,503**	0,23	**9,360**	**0,344**	**13,554**	**105,97**	142,11	**263,2**
16,2	8,345	35691,2	8,62E+007	0,0021	**4,343**	0,694	11,312	4,012	4,731	**4,731**	0,21	**9,712**	**0,392**	**14,448**	**120,57**	161,68	**299,4**
17,2	8,871	40334,7	9,16E+007	0,0021	**4,865**	0,738	13,809	3,611	4,958	**4,958**	0,20	**10,125**	**0,443**	**15,433**	**136,91**	183,60	**340,0**
18,3	9,398	45262,1	9,70E+007	0,0021	**5,414**	0,781	16,664	3,022	5,186	**5,186**	0,20	**10,569**	**0,498**	**16,481**	**154,88**	207,69	**384,6**
19,3	9,924	50473,4	1,02E+008	0,0021	**5,989**	0,825	19,905	2,247	5,413	**5,413**	0,20	**11,027**	**0,555**	**17,571**	**174,38**	233,84	**433,0**
20,3	10,450	55968,6	1,08E+008	0,0021	**6,592**	0,869	23,558	1,285	5,640	**5,640**	0,20	**11,489**	**0,615**	**18,696**	**195,38**	262,00	**485,2**
21,3	10,976	61747,7	1,13E+008	0,0020	**7,222**	0,913	27,652	0,136	5,868	**5,868**	0,20	**11,951**	**0,679**	**19,852**	**217,91**	292,21	**541,1**
22,4	11,503	67810,6	1,19E+008	0,0020	**7,878**	0,956	32,214	-1,200	6,095	**6,095**	0,20	**12,414**	**0,746**	**21,038**	**241,99**	324,51	**600,9**
23,4	12,029	74157,5	1,24E+008	0,0020	**8,560**	**1,000**	37,274	-2,723	6,322	**6,322**	0,20	**12,877**	**0,815**	**22,253**	**267,68**	358,96	**664,7**

Df is the frictional drag

Dr is the residuary drag

, where K is the amplification factor due to hulls interference :

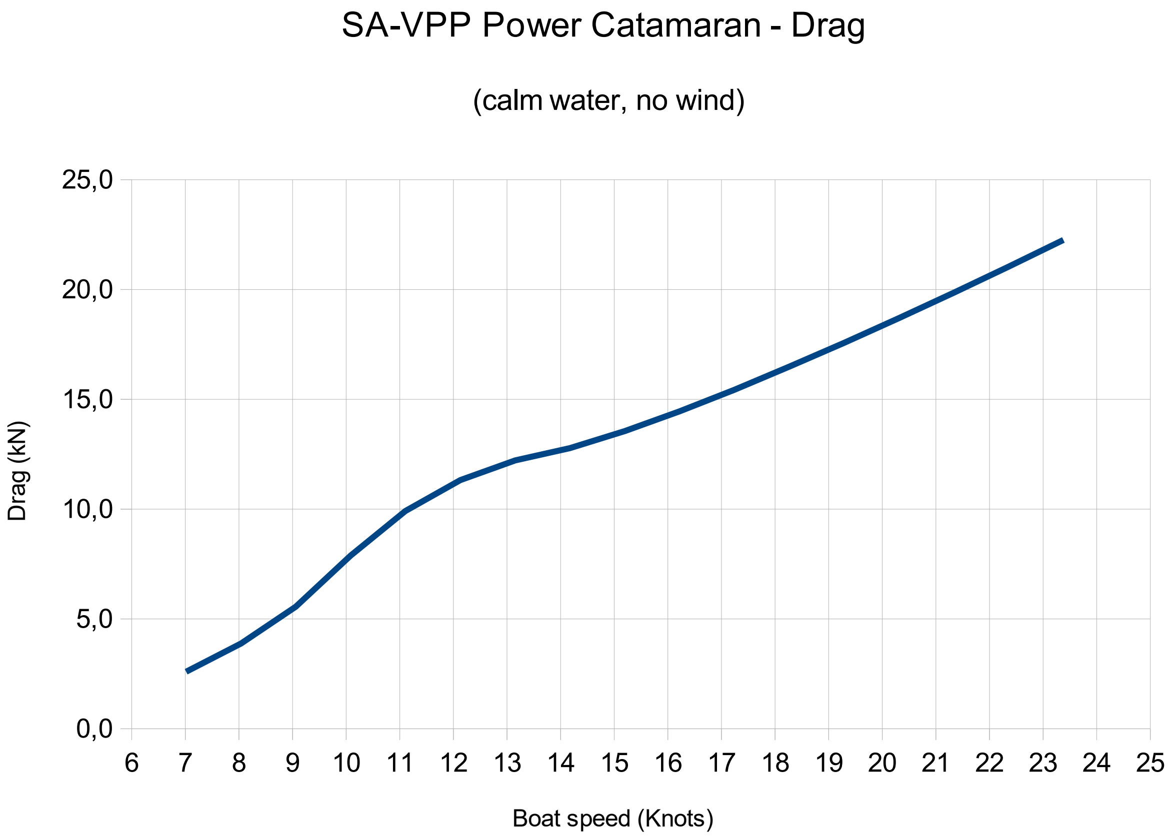
Dr cata = (1+K) (Dr of the 2 hulls)

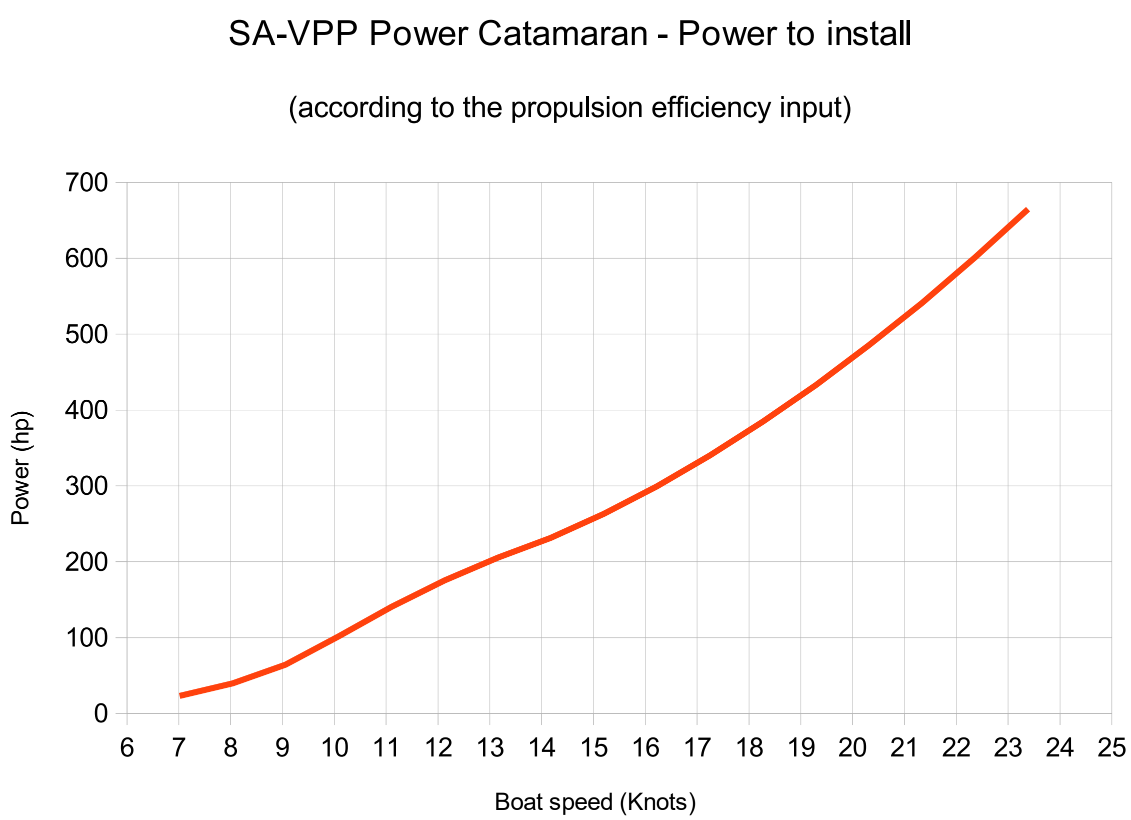
Daero is the aerodynamical drag

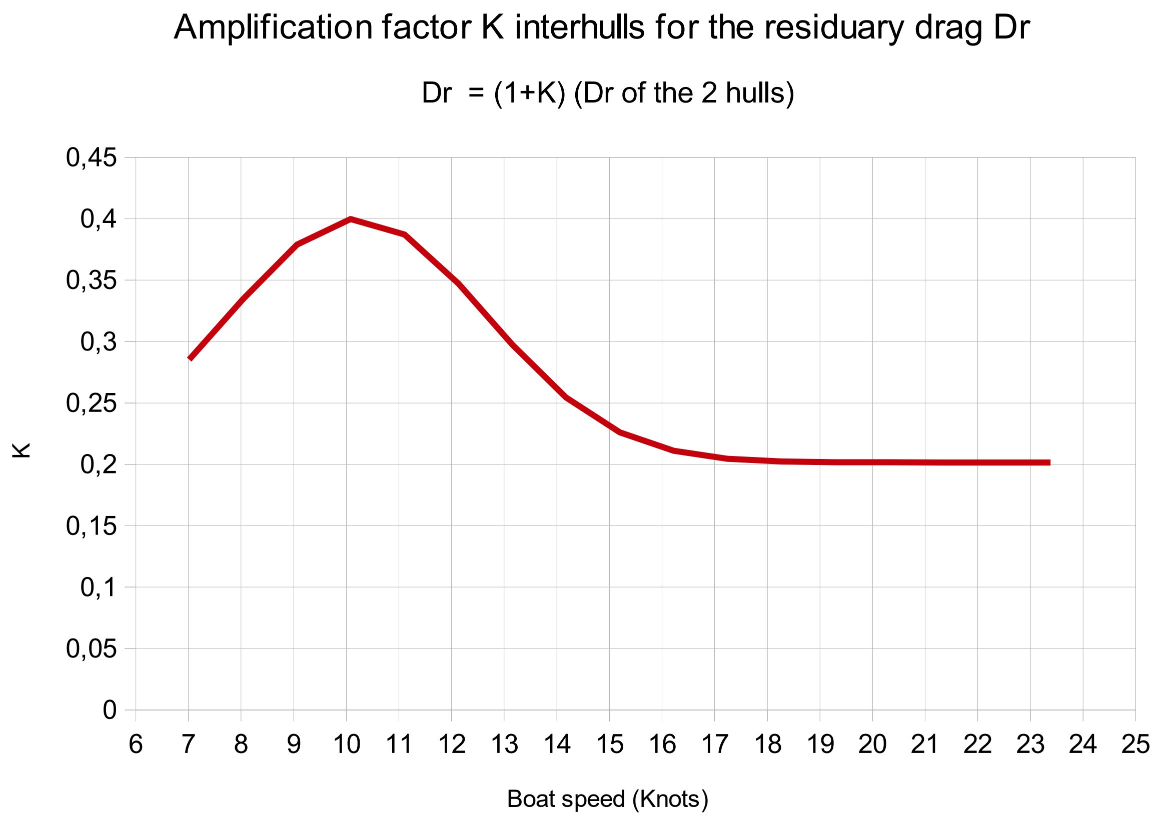
Dtot is the total drag

EHP : net propulsion power (= drag x speed)

Power to install : taken into account the propulsion efficiency


SA-VPP Power Catamaran - Drag
(calm water, no wind)
Drag (kN)
25,0
20,0
15,0
10,0
5,0
0,0
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Boat speed (Knots)


SA-VPP Power Catamaran - Power to install
(according to the propulsion efficiency input)
Power (hp)
700
600
500
400
300
200
100
0
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Boat speed (Knots)



Annex

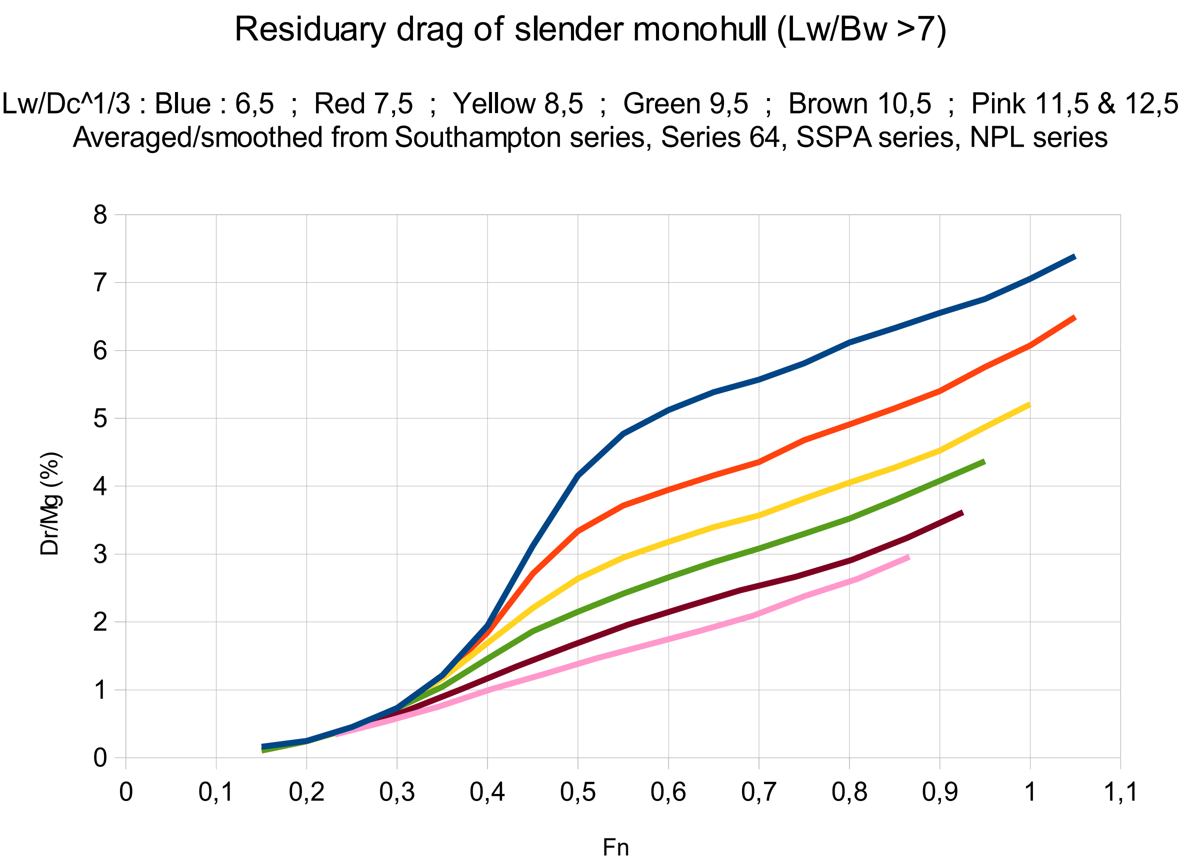
Information about the sources of the computation :

For the friction drag and the aero drag :
State of the art formulations as for any boat project, for friction it is the ITTC57 formula for Cf with the Reynolds based on 0,7 Lw as recommended by Larsson & Eliasson in « Principles of Yacht design ». The key points being of course to have a right value of the wetted surface for the design displacement (for friction drag), of the frontal area and its global Cx (for the aero drag).

For the residuary drag :
Use of the available output data of model tests as reported by :
•P. van Oossanen in « Resistance prediction of small high-speed displacement vessels » where I picked up the ones for slender hulls (i.e. Lw/Bw > 7) in Series 64, SSPA series and NPL series.
•Molland & al. in « Resistance experiments on a systematic series of high speed catamaran forms – Variation on length-displacement ratio and breadth-draught ratio », the Southampton series.

All the data from these papers were put in same units and presented in the form of adimensional data and curves ready to use.

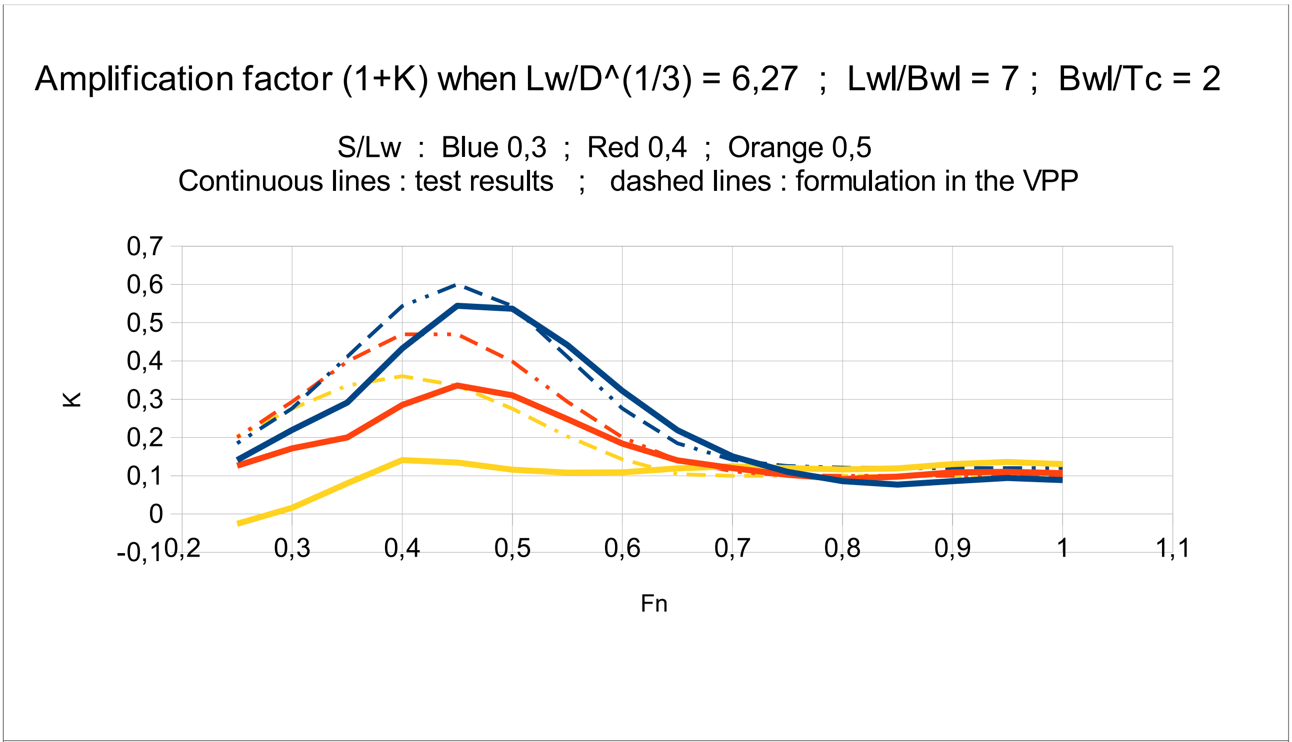
The key point for narrow monohulls of Lw/Bw > 7, highlighted by P. Oossanen in his paper and confirmed later on by Molland results was that, quoting P. Oossanen (page 219), «Up to Fn-value of about 0,9, the results for the 3 B/T values are almost identical, again leading to the observation that in the speed range of Fn 0,4 – 0,9 the length-displacement ratio is the only significant parameter », the LD ratio being Lw/Dc^1/3 (Lw waterline length, Dc displacement of the canoe body hull). The resulting curves are :

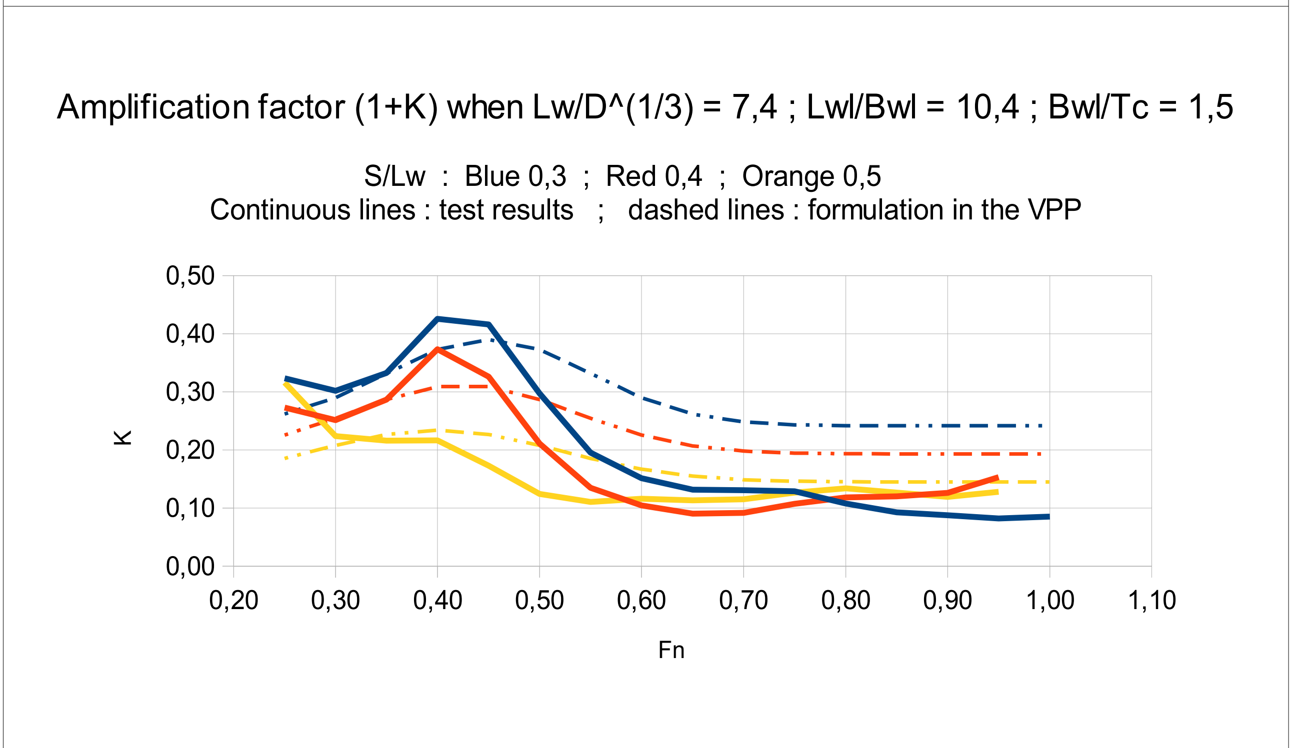


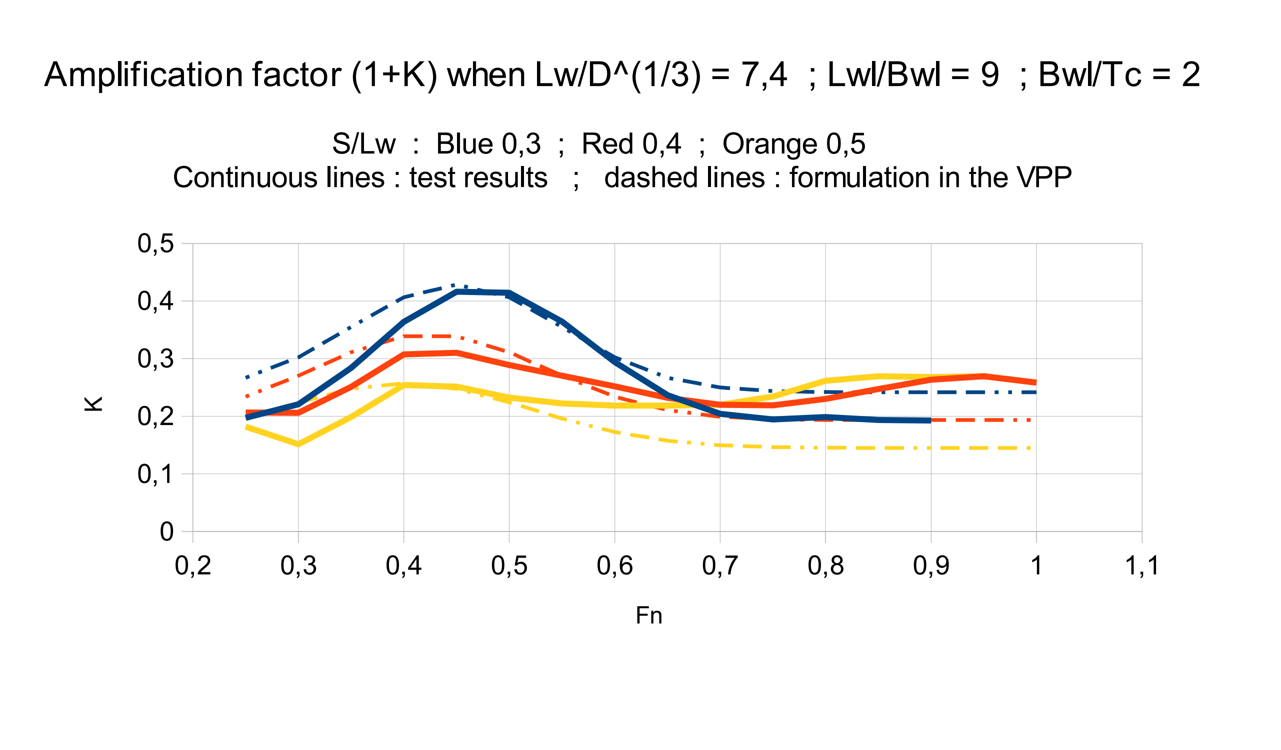
The other crucial point is the amplification factor 1+K due to interaction between the 2 hulls, fully adressed by Southampton series / Molland experiences in 1994 :

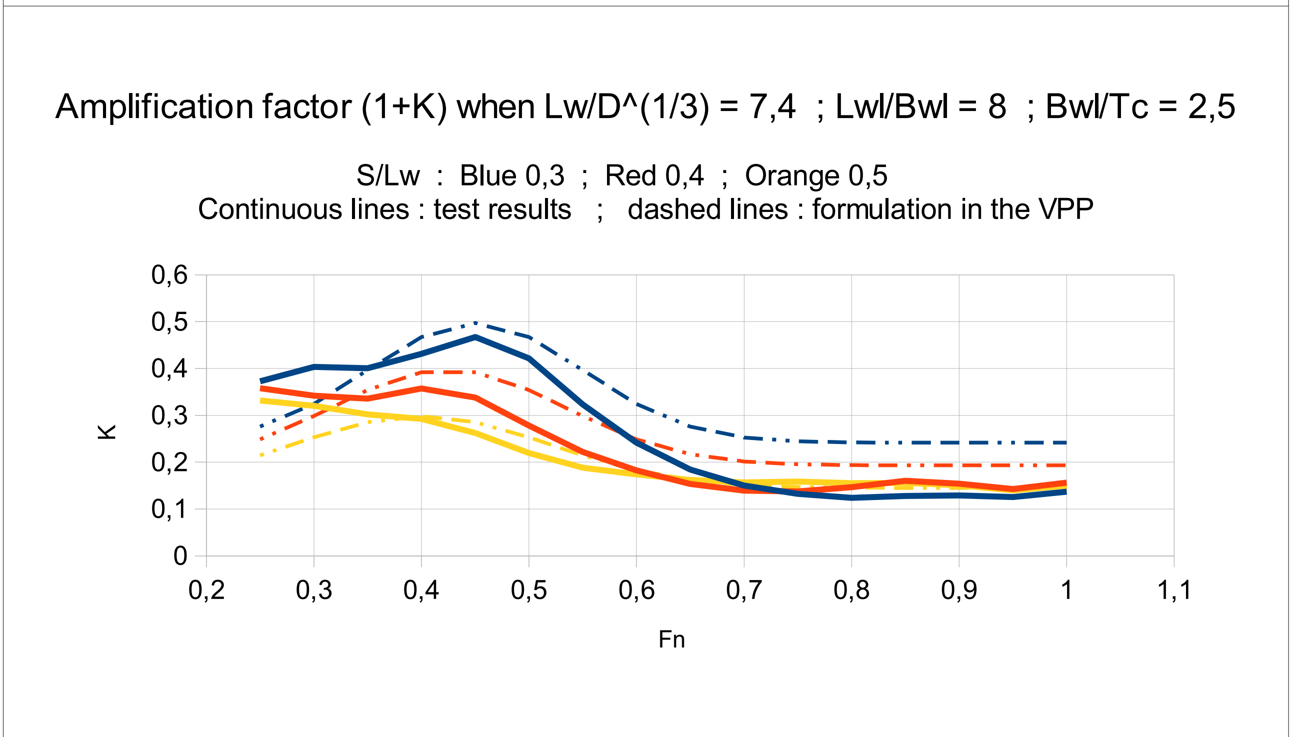
Residuary drag : Dr/Mg (%) Cata = (1+K) * Dr/Mg (%) Monohull

Here it is less simple to resume the respective role of Lw, Bw, Tc and Dc combined with S the space between hull axis >>> the embedded formulation in the VPP try to cover all the cases in a conservative manner. You can see in the following figures the various test results compared with the programmed formulation, so that you can appreciate by yourself the approach :


Amplification factor (1+K) when Lw/D^(1/3) = 6,27 ; Lwl/Bwl = 7 ; Bwl/Tc = 2
S/Lw : Blue 0,3 ; Red 0,4 ; Orange 0,5
Continuous lines : test results ; dashed lines : formulation in the VPP
K
Fn
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
-0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1
1,1

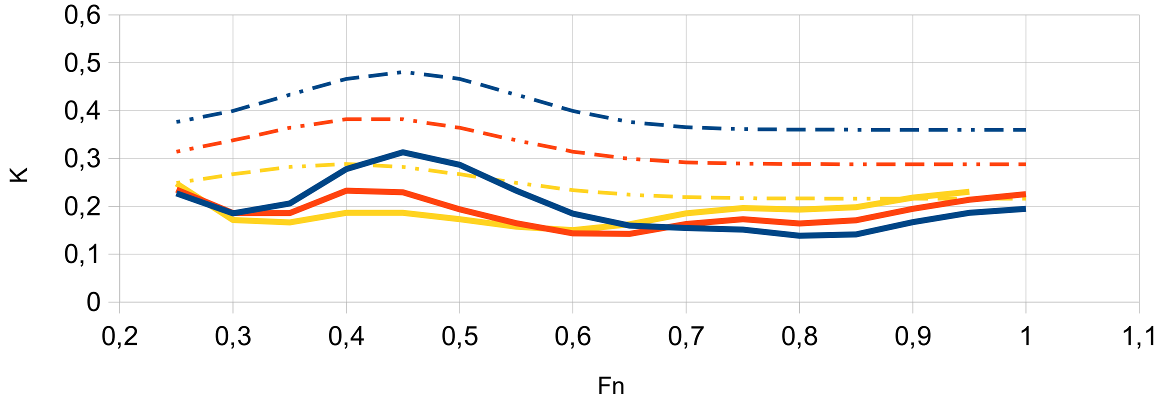

Amplification factor (1+K) when Lw/D^(1/3) = 7,4 ; Lwl/Bwl = 10,4 ; Bwl/Tc = 1,5
S/Lw : Blue 0,3 ; Red 0,4 ; Orange 0,5
Continuous lines : test results ; dashed lines : formulation in the VPP
K
Fn
0,50
0,40
0,30
0,20
0,10
0,00
0,20
0,30
0,40
0,50
0,60
0,70
0,80
0,90
1,00
1,10


Amplification factor (1+K) when Lw/D^(1/3) = 7,4 ; Lwl/Bwl = 9 ; Bwl/Tc = 2
S/Lw : Blue 0,3 ; Red 0,4 ; Orange 0,5
Continuous lines : test results ; dashed lines : formulation in the VPP
K
0,5
0,4
0,3
0,2
0,1
0
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1
1,1
Fn


Amplification factor (1+K) when Lw/D^(1/3) = 7,4 ; Lwl/Bwl = 8 ; Bwl/Tc = 2,5
S/Lw : Blue 0,3 ; Red 0,4 ; Orange 0,5
Continuous lines : test results ; dashed lines : formulation in the VPP
K
0,6
0,5
0,4
0,3
0,2
0,1
0
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1
1,1
Fn

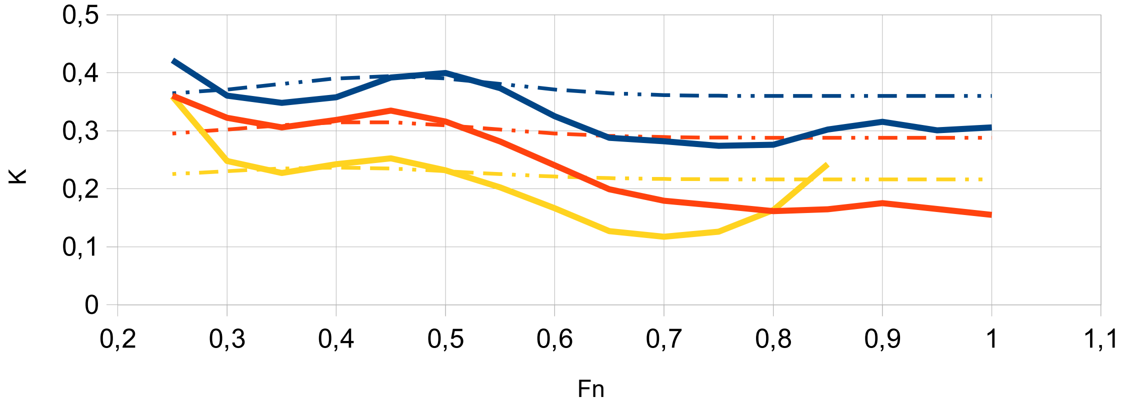
Amplification factor (1+K) when Lw/D^(1/3) = 8,5 ; Lwl/Bwl = 12,8 ; Bwl/Tc = 1,5

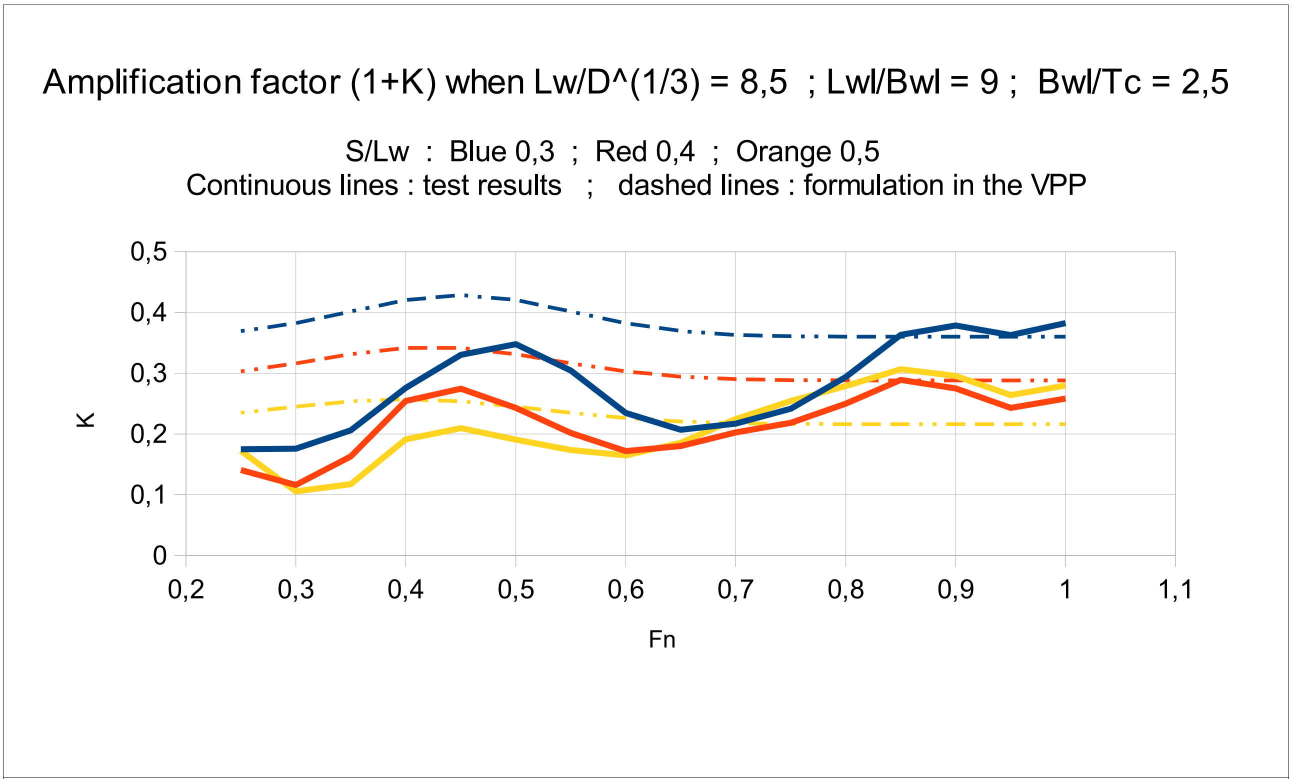
S/Lw : Blue 0,3 ; Red 0,4 ; Orange 0,5
Continuous lines : test results ; dashed lines : formulation in the VPP

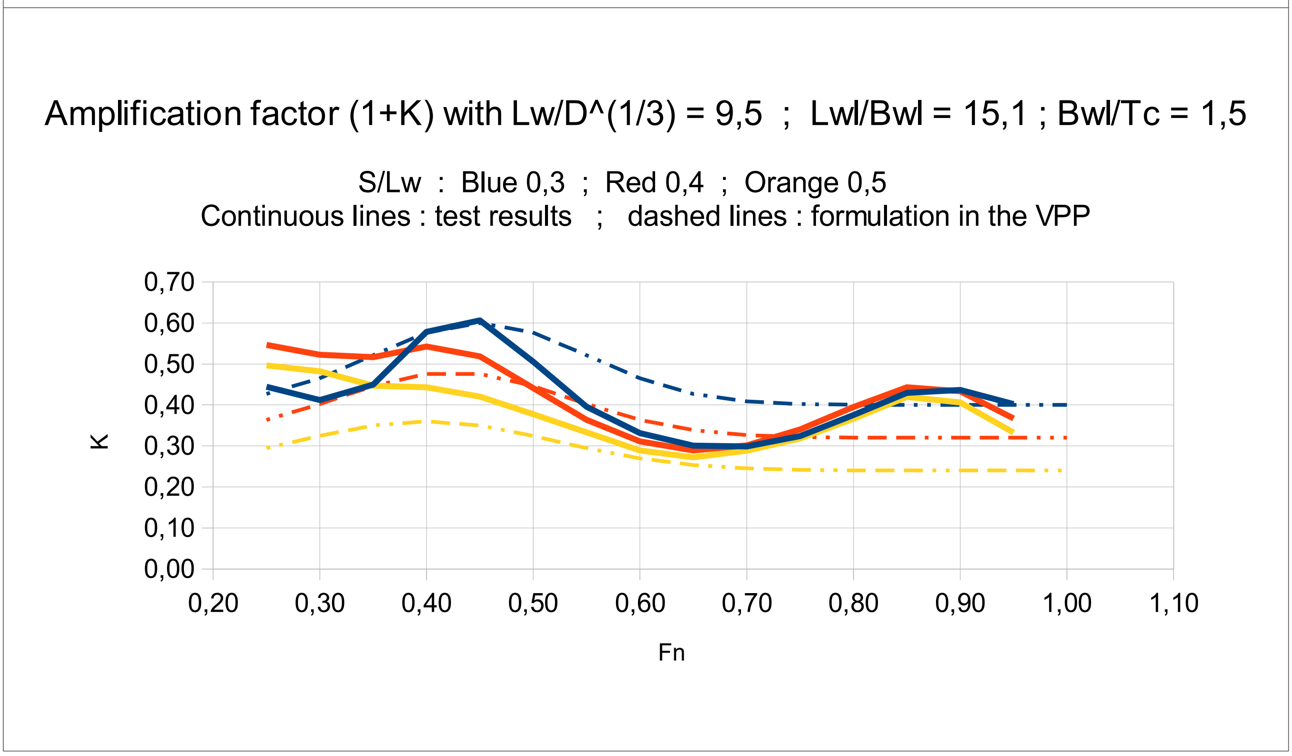


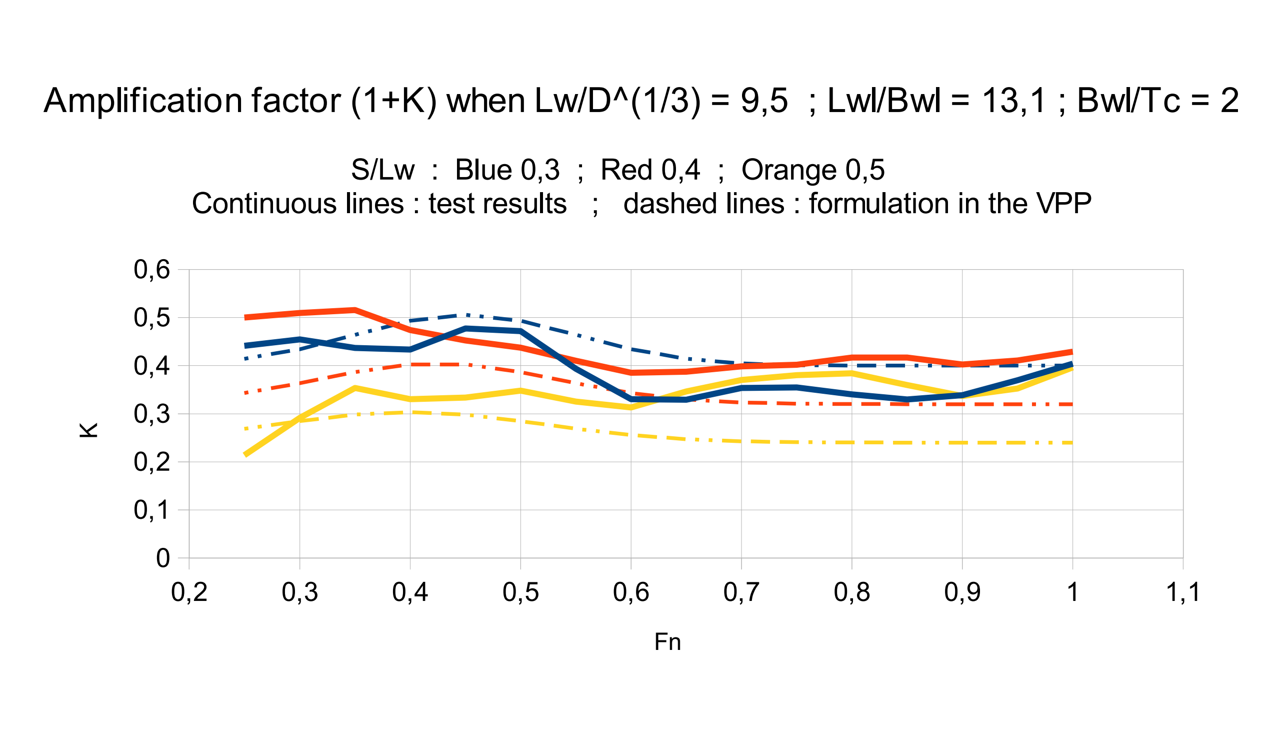
Amplification factor (1+K) when Lw/D^(1/3) = 8,5 ; Lwl/Bwl = 11 ; Bwl/Tc = 2

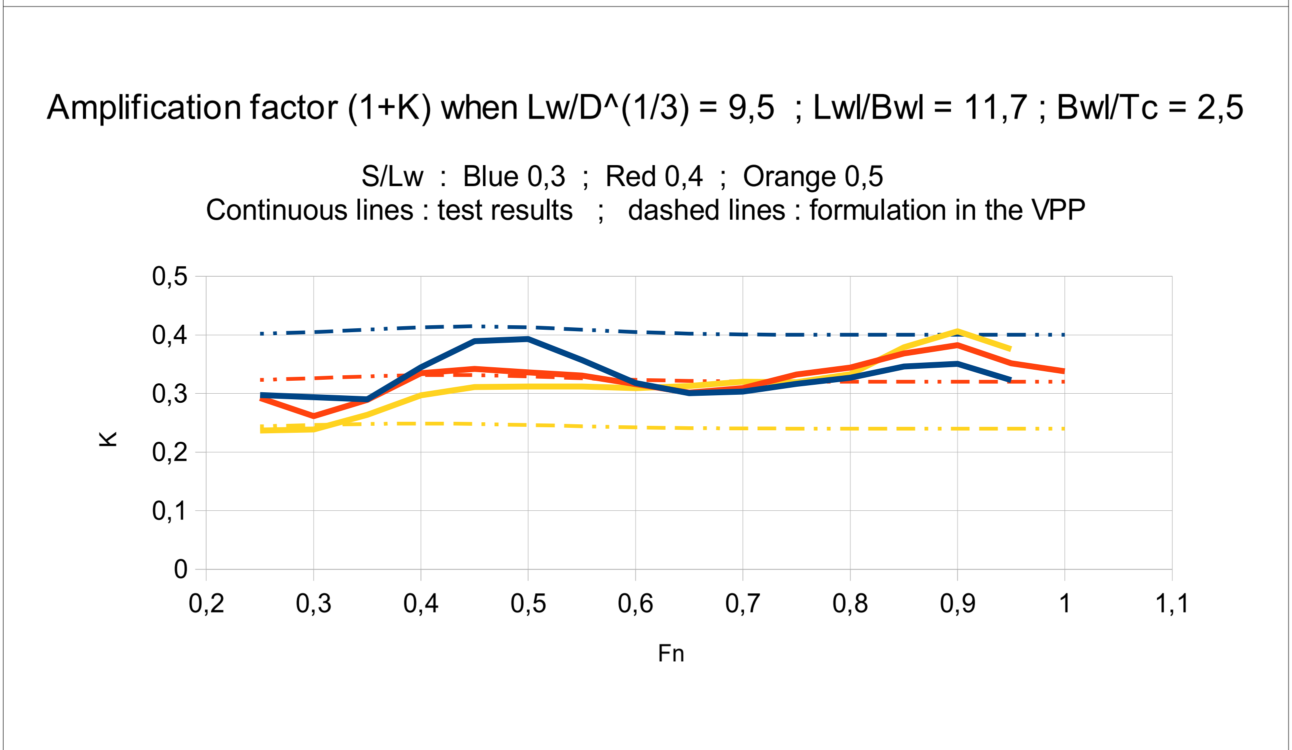
S/Lw : Blue 0,3 ; Red 0,4 ; Orange 0,5
Continuous lines : test results ; dashed lines : formulation in the VPP




Amplification factor (1+K) when Lw/D^(1/3) = 8,5 ; Lwl/Bwl = 9 ; Bwl/Tc = 2,5
S/Lw : Blue 0,3 ; Red 0,4 ; Orange 0,5
Continuous lines : test results ; dashed lines : formulation in the VPP
K
0
0,1
0,2
0,3
0,4
0,5
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1
1,1
Fn


Amplification factor (1+K) with Lw/D^(1/3) = 9,5 ; Lwl/Bwl = 15,1 ; Bwl/Tc = 1,5
S/Lw : Blue 0,3 ; Red 0,4 ; Orange 0,5
Continuous lines : test results ; dashed lines : formulation in the VPP
K
0,00
0,10
0,20
0,30
0,40
0,50
0,60
0,70
0,20
0,30
0,40
0,50
0,60
0,70
0,80
0,90
1,00
1,10
Fn





Why no longer reliable for Fn > 0,9 -1,0 ? : because then the hulls are no longer primarily in displacement mode, dynamic lift forces occur, and then a lot of parameters like sections shape (circular or in U), Bw/Tc, trim, … can change the resulting drag.

Why possibly inacurate for Fn < 0,3-0,4 ? : because the wave fields and their interaction are more complicated, but it should be noted that such speed is usually not a design objective except for slow by purpose catamaran.