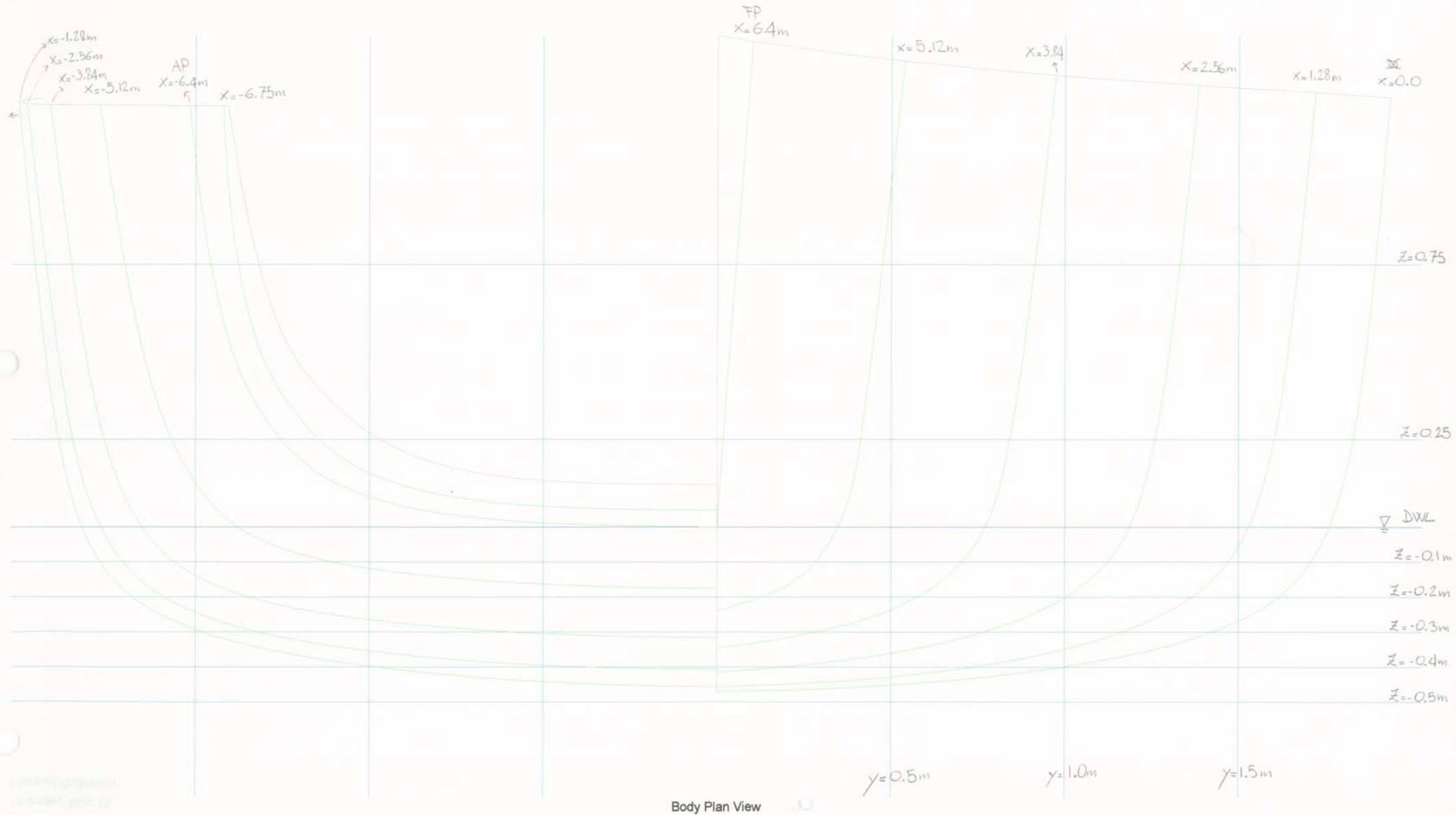


Appendix

The following pages contain drawings and calculations worksheets.
Here is the list:

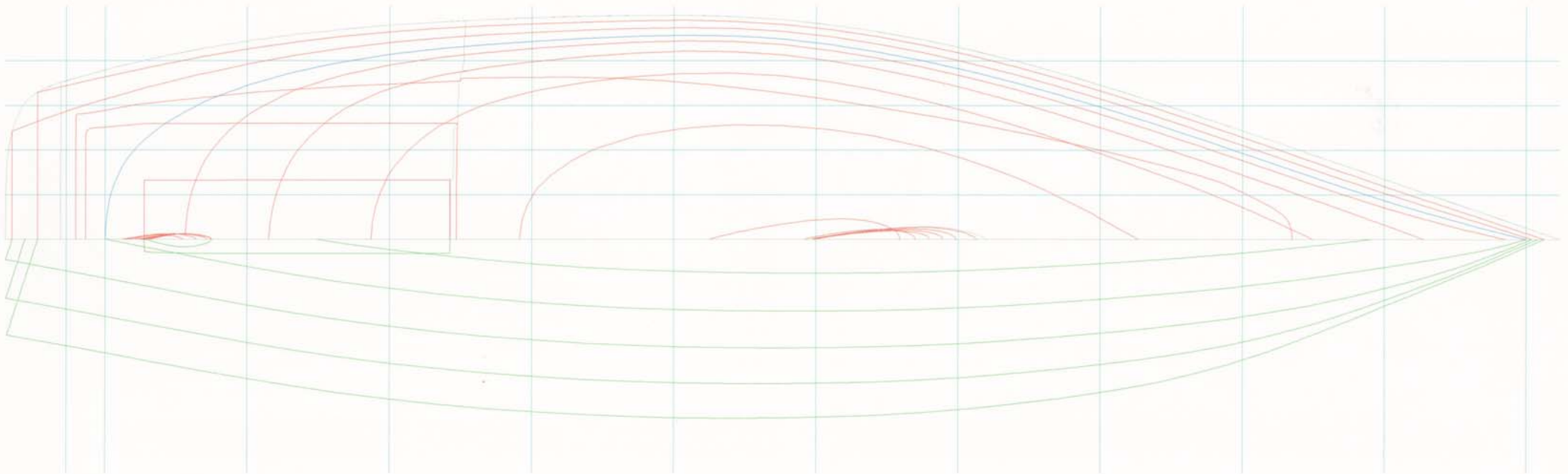
- a. Body Plan.
- b. Profile view.
- c. Plan view.
- d. Sailplan drawing of rig with 110% jib.
- e. Calculations for 110% jib rig.
- f. Mast and boom sections.
- g. Sailplan drawing of rig with 125% jib.
- h. Calculations for 125% jib rig.
- i. Hull structural calculations.
- j. Stiffeners arrangement.
- k. Interior arrangement plan.
- l. Deck and exterior layout.
- m. Winches information.
- n. Weight balance worksheet.
- o. Hydromax large angle stability analysis report.
- p. VPP results.



Body Plan View

1607 2107

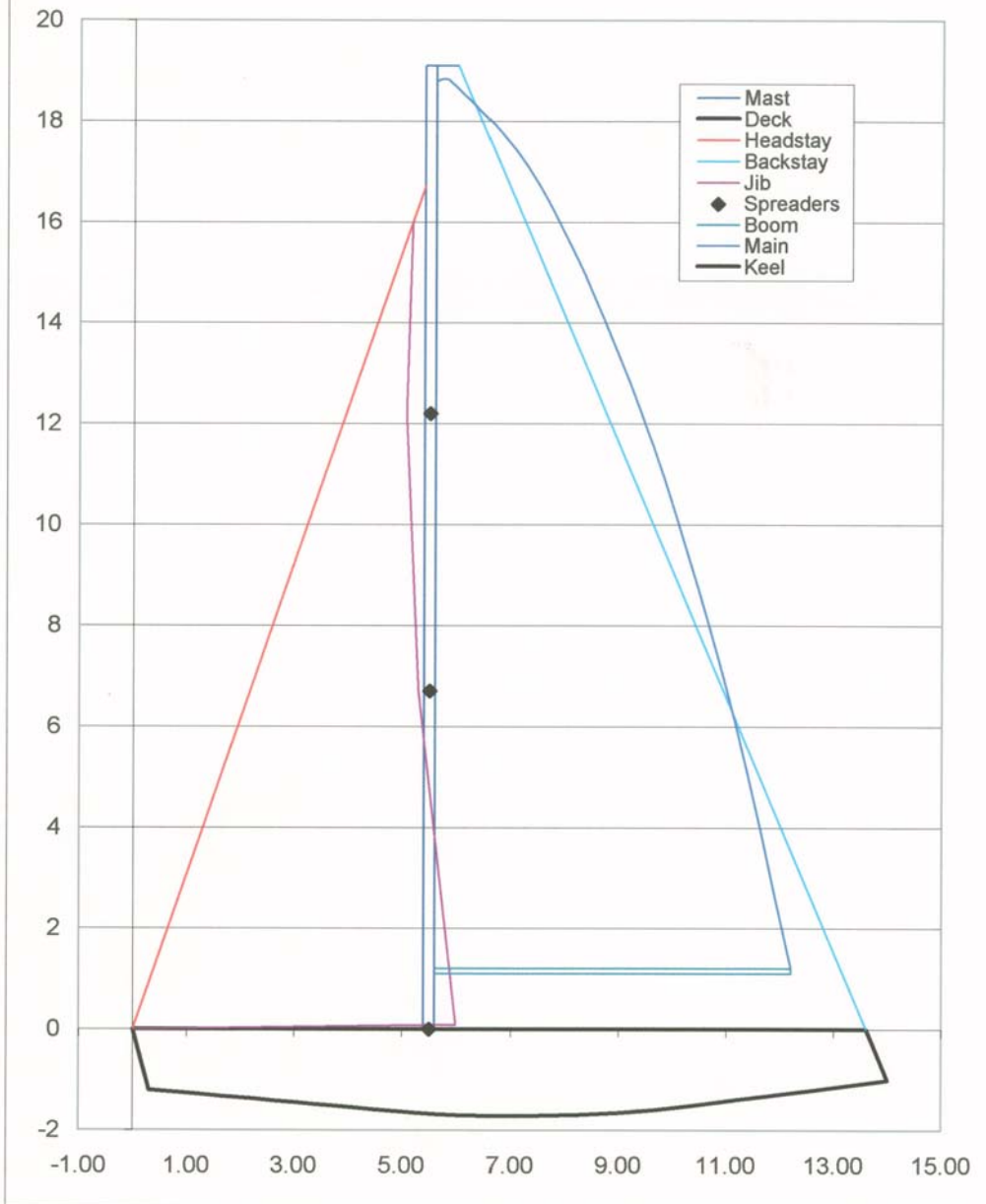
Waterlines @ 1.25 m, 0.75 m, 0.25 m, 0.0 m
-0.1 m, -0.2 m, -0.3 m, -0.4 m, -0.5 m
-1.0 m, -1.5 m, -2.0 m, -2.5 m, -2.25 m
Diagonal 45° @ -0.25, 0.0, 0.25, 0.5, 0.75 m at CL



Plan View

40

Non-overlapping Jib Sailplan



d

Rig Design - 110% Jib

Main Dimensions

First iteration

Mast height above the deck, I [m] =	19.10	19.1
Mast distance from stem, J [m] =	5.50	
Mast transverse dimension, MT [m] =	0.10	
Mast Longitudinal Dimension, ML [m] =	0.20	
Boom height above the deck BH [m] =	1.20	
Boom length, E [m] =	6.60	
Mainsail luff P [m] =	17.90	Main AR = 2.712121
Jib halyard height above deck IM [m] =	16.71	
Jib luff JL [m] =	16.00	Jib AR = 2.644435
Jib foot JF [m] =	6.05	
Height of lower spreader, HSL [m] =	6.70	
Height of upper spreader, HSU [m] =	12.20	
Freeboard at mast station, FR [m] =	1.35	

Sail area:

Mainsail SA _M [m ²] =	64.98
Jib area SA _J [m ²] =	48.40
Upwind sailarea SA _U =	113.37

Mainsail LCE from amidship [m] =	-0.476
Jib LCE from amidship [m] =	3.200628
Upwind LCE from amidship [m] =	1.093466
Mainsail VCE height above deck [m] =	7.89
Jib VCE height above deck [m] =	6.40
Upwind VCE height above deck [m] =	7.25

Balance Procedure

Heeling arm [m] = 9.749

Heeling moment HM:

Wind velocity [m/s] =	10.3
Air density [Kg/m ³] =	1.225
Average C _L =	1

HM [Nm] = 71820.27195

HM [KGm] = 7321.128639

Righting moment at 25 degrees of heel:

RM [kgm] = 7292.2

Error = 0.40%

Headstay angle from vertical, HA [deg] = 17.91

Backstay angle from vertical, BA [deg] = 23.74

The chainplate width is usually calculated imposing that the angle between the jib foot and the centerline is 12 degrees. But because there is no overlapping jib, it can go out to the edge of deck.
Chainplate width, b [m] = 1.800

Consider a true wind speed of 15 knots at 10 m above the water; the actual wind speed at a different height can be calculated using:

$$U(z) = U_{\text{star}} / k * \ln(z / z_0)$$

z₀ [m] = 0.004
k = 0.4
U₁₀ [kt] = 15
U₁₀ [m/s] = 7.725
U_{STAR} [m/s] = 0.909

So
U(Deck) [m/s] = 5.748
U(HSM) [m/s] = 7.511
U(HSU) [m/s] = 8.025

Now it is necessary to calculate the wind triangles to find the apparent wind speed and apparent wind angle at both heights:

Boat Speed, VB [kt] = 7
Boat Speed, VB [m/s] = 3.605
True wind angle, TWA [deg] = 42

At deck level:

Apparent Wind Speed, AWS [m/s] = 8.765
Apparent Wind Angle, AWA [deg] = 26.03
but this needs to be corrected for downwash, leeway and ideal angle of attack
Downwash, [deg] = 4
Leeway, [deg] = 2
Ideal AOA, [deg] = 1
Corrected AWA, [deg] = 19.03

At the lower spreader:

Apparent Wind Speed, AWS [m/s] = 10.471
Apparent Wind Angle, AWA [deg] = 28.68
but this needs to be corrected for downwash, leeway and ideal angle of attack
Downwash, [deg] = 3
Leeway, [deg] = 2
Ideal AOA, [deg] = 1
Corrected AWA, [deg] = 23.30 at the lower spreader

At the upper spreader:

Apparent Wind Speed, AWS [m/s] = 10.972
 Apparent Wind Angle, AWA [deg] = 29.30
 but this needs to be corrected for downwash, leeway and ideal angle of attack
 Downwash, [deg] = 2
 Leeway, [deg] = 2
 Ideal AOA, [deg] = 1
 Corrected AWA, [deg] = 24.30 at the upper spreader

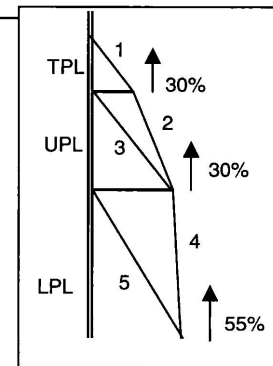
These angle allow us to calculate the ideal position of the jib leech at the mast
 On deck

Foretriangle dimension, [m] = 5.500
 Jib Chord, [m] = 6.050
 Jib distance from CL at mast, [m] = 1.897
 Jib distance from CL at leech, [m] = 1.972
 Long. position of jib leech, [m] = 5.719
 Average, [m] = 1.934

At lower spreader
 Foretriangle dimension, [m] = 3.295
 Jib Chord, [m] = 3.516
 Jib distance from CL at mast, [m] = 1.419
 Jib distance from CL at leech, [m] = 1.391
 Long. position of jib leech, [m] = 3.230
 Average, [m] = 1.405

At upper spreader
 Foretriangle dimension, [m] = 1.485
 Jib Chord, [m] = 1.437
 Jib distance from CL at mast, [m] = 0.671
 Jib distance from CL at leech, [m] = 0.591
 Long. position of jib leech, [m] = 1.309
 Average, [m] = 0.631

Final Geometry		
Chainplate width, b [m] =	1.800	b
Lower spreader length, [m] =	1.700	LSL
Upper spreader length, [m] =	0.850	LSU
Lower panel length, [m] =	6.700	LPL
Middle panel length, [m] =	5.500	MPL
Top panel length, [m] =	4.513	TPL
Angles from vertical [deg]:		
Shroud # 1 =	10.67	
Shroud # 2 =	8.79	
Shroud # 3 =	17.18	
Shroud # 4 =	0.86	
Shroud # 5 =	15.04	
Spreader Up-Angle from horizontal [deg]:		
Upper =	9.73	
Lower =	6.92	



Structural Calculations

Righting Moment at 30 deg of heel, RM [Kg-m] = 7910.76
 RM [lb-ft] = 57218.52708

Chainplate tension, PT [lb] = 14533.683
 Mast Compression, PC [lb] = 26887.313

Moments of Inertia [in^4] = $C * P * L * 10^{-6}$

C_L = 0.52

C_T Upper = 1.69

C_T Lower = 1.13

L_L , [in] = 634.3

L_T Upper, [in] = 216.5

L_T Lower, [in] = 263.8

with split lower shrouds L_L , [in] = 571.3571

Forward lower shroud set at 2.2 m above deck, with a transverse angle of 10 deg and a forward angle of 10 deg.

I_L = 56.26 45.64 with split lower shrouds

I_T Upper = 21.31

I_T Lower = 21.14

Tension in the shrouds using the scheme in Henry and Miller paper.

Shr. # 1, [lb] = 4436.8	in [Kg] = 2012.5	
Shr. # 2, [lb] = 4411.9	in [Kg] = 2001.2	
Shr. # 3, [lb] = 3803.0	in [Kg] = 1725.1	
Shr. # 4, [lb] = 6540.9	in [Kg] = 2966.9	
Shr. # 5, [lb] = 8277.0	in [Kg] = 3754.4	

Sum of loads of shr. 2 and 3 is = 3726.275
 and is bigger than shr 4, so shr. 2 and 3 are brought down to the deck.

Compression in the spreaders:

Upper [Kg] = 66.9

Middle [Kg] = 1699.3

Weight Estimates

Mast section

Using the split lower shrouds I can use the section "5890" from SailNet Store, otherwise I need section "240".

These sections have the following characteristics:

Section	Chord [in]	Width [in]	C/W	I _L [in ⁴]	I _T [in ⁴]	Weight [lb/ft]
221	8.500	5.380	1.580	39.000	16.580	5.360
5890	9.000	5.750	1.565	45.700	21.500	5.300
240	9.910	6.200	1.598	68.440	27.230	6.250
255	10.000	5.375	1.860	98.470	26.450	9.130
205 Boom	8.000	4.880	1.639	32.200	12.000	4.560
061 Spreader	2.250	0.609	3.695	0.130	0.010	0.380
081 Spreader	3.250	0.880	3.693	0.540	0.060	0.790

Rigging

Type	Size	Break Str. [lb]	Weight [lb/100 ft]
1 x 19 302 SS	3/16"	4700.000	7.200
1 x 19 302 SS	1/4"	8200.000	12.560
1 x 19 Dryform	9/32"	10802.000	18.320
1 x 19 Dryform	1/4"	8844.000	15.000
1 x 19 Dryform	6 mm	7810.000	13.250
1 x 19 Dryform	5 mm	5368.000	9.100

Mast length for keel, ML [m] =	20.850 in [ft] =	68.40	Use section 5890
Boom length, BL [m] =	6.900 in [ft] =	22.64	Use section 205 boom
Top spreader length, LSU [m] :	0.850 in [ft] =	2.79	Use section 061 spreader
Low spreader length, LSL [m] :	1.700 in [ft] =	5.58	Use section 081 spreader
Length Shr. 1 + 2 + 3, [m] =	15.913887 in [ft] =	52.21	Use 1 x 19 Dryform 1/4"
Length Shr. 4 + 5, [m] =	27.27665 in [ft] =	89.49	Use 1 x 19 Dryform 9/32"
Headstay length, [m] =	17.594251 in [ft] =	57.72	Use 1 x 19 Dryform 9/32"
Backstay length, [m] =	21.444638 in [ft] =	70.36	Use 1 x 19 Dryform 9/32"

Item	Weight [Kg]	VCG [m]	LCG [m]
Mast, unfitted	164.45	10.025	1.200
Boom, unfitted	46.82	2.550	-2.350
Headstay	4.80	9.706	3.950
Backstay	5.85	10.900	-3.050
Shrouds 1, 2, 3	3.55	13.056	1.200
Shrouds 4, 5, 6,	7.44	7.450	1.200
Top spreader	0.48	13.550	1.200
Mid spreader	2.00	8.050	1.200
Mainsail	38.99	7.885	-0.476
Jib	29.04	6.400	3.201
Total =	235.39	8.508	0.444