

<b>Antonio Salguero</b>	<b>Sound Boats</b>
P.O. Box 633	Tel (360) 385-7077
Port Townsend, WA 98368	Fax (360) 385-4157
<a href="mailto:salguero@olypen.com">salguero@olypen.com</a>	Cell (360) 301-4714

Schooner JUNO  
January 15, 2002

Robert and Melissa Soros: Owners  
Nat Benjamin: Designer

Lead Ballast Calcs

Volume Determined using Simpson's Rule					
Ballast Station Spacing		1.83			
Scale of Ballast DWG		1"=1'0"			
Scale Factor (1/scale^2)		1			
Planimeter used to determine area					
Station	Half Area	S. Mult.	S. Func.	Station	S.Moments
0	0.07	1	0.07	0	0
1	0.65	4	2.60	1	3
2	0.90	2	1.80	2	4
3	1.16	4	4.64	3	14
4	1.35	2	2.70	4	11
5	1.50	4	6.00	5	30
6	1.65	2	3.30	6	20
7	1.70	4	6.80	7	48
8	1.67	2	3.34	8	27
9	0.80	4	3.20	9	29
10	0.20	1	0.20	10	2
<b>Column Totals</b>			<b>34.65</b>	<b>186</b>	
Volume (ft^3)	=	(sum of S. Func. x S. S. x 2)/3			
	=	42.27 ft^3			
Density of Virgin Lead	=	710 lbs/ft^3			
Weight in Lbs.	=	<b>30,014</b> lbs			
LCG	=	0.54			

**Volume by Summation of Individual Station Spaces**

Station	C.S. Area	Ave. C. S. Area	Volume	Weight
0	0.14			
1	1.10	0.62	1.13	806
1B	1.30		No Volume	
2	1.80	1.55	2.84	2,014
3	2.32	2.06	3.77	2,677
4	2.70	2.51	4.59	3,261
5	3.00	2.85	5.22	3,703
6	3.30	3.15	5.76	4,093
7	3.40	3.35	6.13	4,353
8	3.34	3.37	6.17	4,379
8B	3.00		No Volume	
9	1.60	2.30	4.21	2,988
10	0.40	1.00	1.83	1,299
<b>Column Totals</b>			41.65	29,572 lbs

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Schooner JUNO  
February 5, 2002

Robert and Melissa Soros: Owners  
Nat Benjamin: Designer

### Ballast Keel Bolt Sizes - Bolts In Frame Bays only

\* as per Nevins rule: 1" CS area of bolt for each 1500 lbs ballast  
CS= cross section

Bolts to be Silicon Bronze (60,000 psi tensile strength) and cut with coarse thread  
1 cu. ft. lead (10% antimony)=710lbs

Location	Weight of the Lead						Bolt Calcs.						
Frame Bay	Fwd CS Half Area	Aft CS Half Area	verage CS Area	Length	Volume	Weight	CS needed *	# of Bolts	CS each bolt	Diameter	Use bolt(s)	Fractions	Torque
	sq. ft	sq. ft	sq. ft	ft.	cu. ft.	lbs.	sq. in.		sq. in.	in.	in.	in.	ft-lbs.
Nib-3C	0.06	0.40	0.46	1.58	0.73	516	0.34	1	0.34	0.44	0.75	3/4	118
3C-4	0.40	0.85	1.25	1.29	1.61	1,145	0.76	1	0.76	0.97	1.00	1	265
4-4A	0.85	1.00	1.85	1.29	2.39	1,694	1.13	2	0.56	0.72	1.00	1	265
4A-4B	1.00	1.20	2.20	1.29	2.84	2,015	1.34	2	0.67	0.86	1.00	1	265
4B-4C	1.20	1.32	2.52	1.29	3.25	2,308	1.54	2	0.77	0.98	1.00	1	265
4C-5	1.32	1.45	2.77	1.29	3.57	2,537	1.69	2	0.85	1.08	1.125	1 1/8	383
5-5A	1.45	1.55	3.00	1.29	3.87	2,748	1.83	2	0.92	1.17	1.25	1 1/4	485
5A-5B	1.55	1.69	3.24	1.29	4.18	2,968	1.98	2	0.99	1.26	1.25	1 1/4	485
5B-5C	1.69	1.75	3.44	1.50	5.16	3,664	2.44	2	1.22	1.56	1.625	1 5/8	650
5C-6	1.75	1.80	3.55	1.50	5.33	3,781	2.52	2	1.26	1.61	1.625	1 5/8	650
6-6A	1.80	1.35	3.15	1.29	4.06	3,051	2.03	2	1.02	1.30	1.375	1 3/8	577
6A-6B	1.35	0.95	2.30	1.29	2.97	2,107	1.40	2	0.70	0.89	1.00	1	265
6B-Nib	0.95	0.20	1.15	1.92	2.21	1,568	1.05	1	1.05	1.33	1.375	1 3/8	577
Total Lead Ballast						<b>30,100</b>	Total Bolts	<b>23</b>					

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Schooner JUNO  
February 13, 2002

Robert and Melissa Soros: Owners  
Nat Benjamin: Designer

**Ballast Keel Bolt Sizes - Bolts In Bronze Floors and Frame Bays**

\* as per Nevins rule: 1" CS area of bolt for each 1500 lbs ballast  
CS= cross section

Bolts to be Silicon Bronze (60,000 psi tensile strength) and cut with coarse thread  
1 cu. ft. lead (10% antimony)=710lbs

Location Frame/ Bay	Weight of the Lead				Bolt Calcs.						
	Average CS Area sq. ft	Length ft.	Volume cu. ft.	Weight lbs.	CS needed sq. in.	# of Bolts	CS each bolt sq. in.	Diameter in.	Use bolt(s) in.	Fractions in.	Torque ft-lbs.
3C	0.72	2.25	1.63	1,154	0.77	1	0.77	0.98	1.00	1	265
4	1.70	1.29	2.19	1,557	1.04	1	1.04	1.32	1.00	1	485
4A	2.00	1.29	2.58	1,832	1.22	2	0.61	0.78	1.00	1	265
4B	2.40	1.29	3.10	2,198	1.47	2	0.73	0.93	1.00	1	265
4C	2.64	1.29	3.41	2,418	1.61	2	0.81	1.03	1.00	1	265
5	2.90	1.29	3.74	2,656	1.77	2	0.89	1.13	1.25	1 1/4	485
5A	3.10	1.29	4.00	2,839	1.89	2	0.95	1.21	1.25	1 1/4	485
5B	3.38	1.21	4.09	2,904	1.94	2	0.97	1.23	1.25	1 1/4	485
5B-5C	3.48	1.13	3.93	2,792	1.86	2	0.93	1.19	1.25	1 1/4	485
5C-6	3.55	1.29	4.58	3,251	2.17	2	1.08	1.38	1.25	1 1/4	485
6-6A	3.15	1.29	4.06	3,051	2.03	2	1.02	1.30	1.25	1 1/4	485
6A-6B	2.30	1.29	2.97	2,107	1.40	2	0.70	0.89	1.00	1	265
6B-Nib	1.15	1.92	2.21	1,568	1.05	1	1.05	1.33	1.25	1	485
Total Lead Ballast				<b>30,327</b>	Total Bolts		<b>23</b>				

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Schooner JUNO  
February 7, 2002

Robert and Melissa Soros: Owners  
Nat Benjamin: Designer

### Ballast Keel Bolt Sizes - Bolts In Bronze Floors and Frame Bays

As Determined using Lloyd's Rules Part 2, Chapter 6, Section 4.2.2

**Minimum Bolt Diameter at bottom of threads in mm = .704 WDcg/B**

W = portion of the weight of ballast support by the bolt in kg  
Dcg = vertical distance of the cg of weight, W, below the top of the ballast in mm.  
B = breadth of top of ballast keel in mm.

Bolts to have ultimate tensile strength of 400 N/mm<sup>2</sup>  
1 cu. ft. lead (10% antimony)=710lbs  
Refer to Table A for minimum bolt diameters

Location	Weight of the Lead				Bolt Calcs.								
Frame/ Frame Bay	Average CS Area sq. ft	Length ft.	Volume cu. ft.	Weight lbs.	Weight kg	Dcg in	Dcg mm	B in	B mm	Diameter mm	Diameter in.	Use bolt(s) in.	Fractions in.
3C	0.72	2.25	1.63	1,154	523	8.50	216	15	381.00	12.12	0.48	0.625	5/8
4	1.70	1.29	2.19	1,557	706	7	178	15	381.00	12.78	0.50	0.625	5/8
4A	2.00	1.29	2.58	1,832	831	7	178	18	457.20	12.65	0.50	0.625	5/8
4B	2.40	1.29	3.10	2,198	997	9	229	19.00	482.60	15.30	0.60	0.750	3/4
4C	2.64	1.29	3.41	2,418	1097	10	254	20.00	508.00	16.49	0.65	0.875	7/8
5	2.90	1.29	3.74	2,656	1205	11	279	20.00	508.00	18.12	0.71	0.875	7/8
5A	3.10	1.29	4.00	2,839	1288	12	305	20.50	520.70	19.33	0.76	0.875	7/8
5B	3.38	1.21	4.09	2,904	1317	13	330	20.50	520.70	20.35	0.80	1.000	1
5B-5C	3.48	1.13	3.93	2,792	1266	14	356	20.00	508.00	20.96	0.83	1.000	1
5C-6	3.55	1.29	4.58	3,251	1475	14	356	19.00	482.60	23.21	0.91	1.125	1 1/8
6-6A	3.15	1.29	4.06	3,051	1384	14	356	19.00	482.60	22.48	0.89	1.125	1 1/8
6A-6B	2.30	1.29	2.97	2,107	956	20	508	18.00	457.20	22.94	0.90	1.125	1 1/8
6B-Nib	1.15	1.92	2.21	1,568	711	22	559	17.25	438.15	21.20	0.83	1.000	1
Total Lead Ballast				<b>30,327</b>	<b>13,756</b>								

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Schooner JUNO  
February 7, 2002

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Nat Benjamin: Designer

**Ballast Keel Bolt Sizes - Bolts In Bronze Floors and Frame Bays**

As Determined using ABS Rules

**Minimum Bolt Diameter at the bottom of the threads in in. =  $2.55WY/\sum liS$**

W = total weight of the ballast keel in lbs.

Y = vertical distance of the cg of the keel from top of the keel in in.

$\sum li$  = sum of distances from the center of the bolts on one side of the keel to the edge of the keel on the other side in in.

Sy = minimum yield strength of the bolt material in psi

W =	30,000	lbs.	
Y =	13	in.	
$\sum li$ =	178	in.	
Sy =	30,000	psi	
<b>bolt diameter =</b>	<b>0.43</b>	in.	
<b>use 1/2" bolts (.45" root diameter)</b>			
			<u>7.75 in.</u>
			8.50 in.
			13.25 in.
			14.50 in.
			15.00 in.
			15.75 in.
			16.25 in.
			16.25 in.
			16.25 in.
			15.75 in.
			15.25 in.
			14.63 in.
			<u>8.50 in.</u>
			177.63 in.



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February 7, 2002

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### Ballast Keel Bolt Sizes - Bolts In Bronze Floors and Frame Bays

**As Determined using David Gerr's formula\***

Formula determines the average load on all the bolts then a bolt size is selected from bolt strength chart in appendix 3

$$\text{Bolt Load in lbs.} = \frac{8(\text{ballast depth in in.})(\text{total weight of ballast in lbs.})}{2(\text{bolt bearing width in in.})(\text{number of bolts not on CL})}$$

bolt bearing width = average distance of one row of bolts to the opposite side of the top edge of the ballast keel

<p>Total Weight = 30,000 lbs.  Ballast Depth = 29 in.  Average bolt bearing width = 15.29 in.  Number of bolts not on CL = 10</p> <p style="margin-left: 40px;"><b>bolt load = 22,371 lbs.</b></p> <p style="margin-left: 40px;"><b>use 7/8" Silicon Bronze bolts, Breaking Strength 27,704 lbs. each</b></p>	<p>Bolt bearing widths (bolts on CL are ignored)</p> <p>13.25 in.  14.50 in.  15.00 in.  15.75 in.  16.25 in.  16.25 in.  16.25 in.  15.75 in.  15.25 in.  14.63 in.</p> <hr style="width: 10%; margin-left: auto; margin-right: 0;"/> <p style="text-align: right;">Average = 15.29 in.</p>
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\*published in "The Elements of Boat Strength" p.56-57