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K-28 Mast and Rigging Calculation Notes

1. Two methods were used to calculate loads and stresses on spars and rigging, the traditional method as described on page 2 and the Nordic Boat Standard method from Principles of Yacht Design. The more conservative results from either method were used for mast, boom, and rigging.
2. This document is for reference and study purposes only and may not represent the final calculations used for the vessel.

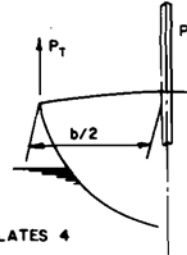
FOR REFERENCE ONLY



RIGGING & MAST DESIGN FACTORS

MAIN MAST & RIGGING - DESIGN LOADS

$P_T = \frac{RM_{30}}{b/2} \times 1.5$ WHERE P_T = VERT. LOAD ON MAST & CHAINPLATE DUE TO TRANSVERSE RIGGING
 RM_{30} = RIGHTING MOMENT AT 30° HEEL
 $b/2$ = ONE HALF BEAM AT CHAINPLATES
 1.5 = FACTOR FOR ADDITIONAL HEEL



MAST COMPRESSION $P = 1.85 P_T$
 WHERE 1.85 = FACTOR FOR FORE & AFT STAYING

RIGGING FACTORS OF SAFETY
 UPPER SHROUDS 2.5-3, ALL OTHER SHROUDS & STAYS 3, CHAINPLATES 4

MIZZEN MAST & RIGGING - DESIGN LOADS

$P_T = \frac{RM_{30}}{b/2} \times 1.5 = P$

RIGGING FACTORS OF SAFETY SHROUDS 1.5, CHAINPLATES 2

MAST SIZE

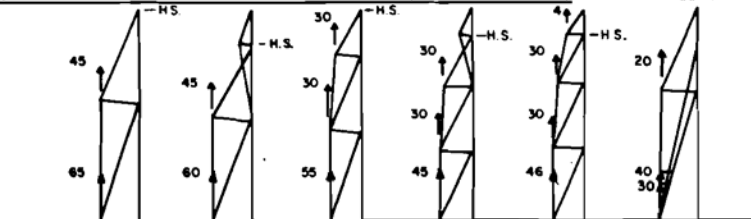
$I = \frac{F.S. \times PL^2}{K \times E} = \frac{CPL^2}{10^8}$ WHERE P = MAST COMPRESSION
 L = UNSUPPORTED PANEL LENGTH, INCHES
 C = CONSTANT - SEE TABLE BELOW

FOR SINGLE LOWER SHROUDS - ADD 10% TO CALCULATED FORE AND AFT I
 FOR MASTS STEPPED ON DECK - C VALUES ASSUME 80% FIXITY

VALUES OF C FOR VARIOUS RIG TYPES

	TYPE OF MAST STEP	ALCOA COL FACTOR $K_A = 1/\sqrt{K}$	EULER COL FACTOR K	TRANSVERSE PANELS		FORE & AFT PANELS			MATERIAL
				MULTIPLE SPREADERS	SINGLE SPREADERS	L TO JIBSTAY OR FIXED FORESTAY		L TO JIBSTAY WITH REMOVABLE FORESTAY	
						TALL MASTHEAD "REVONOC"	7/8 FORE TRIANGLE "NY 32"		
				F.S.=2.5	F.S.=2.1	F.S.=1.20	F.S.=1.15	F.S.=0.8	
ALL LOWER PANELS	MAST THRU DECK	.67	2.25	8.11	6.78	3.95	3.74	2.62	SPRUCE
				1.13	.94	.54	.52	.36	ALUM.
	MAST STEPPED ON DECK	.734	1.8	10.20	8.56	4.94	4.70	3.28	SPRUCE
				1.41	1.18	.68	.65	.45	ALUM.
ALL UPPER TRANSVERSE PANELS	.82	1.5	12.20	10.92				SPRUCE	
				1.69	1.52				ALUM.

LOAD DISTRIBUTION ON SHROUDS (FROM TESTS)



VALUES ARE VERTICAL COMPONENTS IN PERCENT OF CHAINPLATE LOAD (P_T).

Project:	K-28			Date:	09/01/10			
Nordic Boat Standard Mast Design from Principles of Yacht Design				Single Spreader Fractional				
INPUT:				OUTPUT:				
RM @ 1	150	N*m	mldc	delta RM	753	N*m		
RM @ 30	3200	N*m	mldc	RM min =	4350	N*m		
				RM =	4803	N*m		
I =	6.750	m						
P =	7.400	m		a1 =	7.337	m		
Fs =	0.587	m		a2 =	3.031	m		
BD =	0.964	m		l1 =	3.375	m		
1/2 beam	0.891	m at shroud base		l2 =	3.375	m		
alpha =	29.0	deg backstay angle		d1 =	2.029	m		
B =	1.830	m		d2 =	1.346	m		
n =	3							
m =	1.00	aluminum		T1 =	655	N		
k3 =	1.35	deck stepped		T2 =	1585	N		
Ox =	1.790	m		Thead =	634	N		
Oy =	1.841	m		Tboom =	523	N		
Yield Strength	138	MPa aluminum		Thu =	381	N		
Spreader Length	941	mm		Th1 =	253	N		
Spreader Angle	23	deg		Tbu =	149	N		
E =	69000	MPa aluminum						
				F1 =	402	N		
SHROUD TENSION AND LOAD:				F2 =	655	N		
beta 1 =	14.8	deg						
beta 2 =	14.8	deg						
gamma =	0.5	deg						
D2 =	2564	N						
V1 =	2480	N						
C1 =	633	N						
D1 =	4055	N						
PD1 =	11354	N	1158	kg				
PD2 =	7693	N	784	kg				
PV1 =	7439	N	759	kg				
Pfo =	9819	N	1001	kg				
Pa =	3099	N	316	kg				
MAST:				SPREADERS:				
PT =	8085	N		I =	0.73	cm ⁴		
k1 =	3.24	Panel 1		SM =	2.49	cm ³		
k1 =	3.35	Panel 2		Moment =	344	kN*mm		
Ix =	29.8	cm ⁴	Panel 1	0.72	in ⁴			
Ix =	15.9	cm ⁴	Panel 2	0.38	in ⁴			
k2 =	1.00	swept spreaders						
Iy =	49.7	cm ⁴	1.19	in ⁴				
SMx =	9.3	cm ³	0.22	in ³				
SMy =	15.7	cm ³	0.38	in ³				