CRUISING PROA CONCEPTS II

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After noticed (by messages) some inaccuracy at the original cruising proa concepts, I decided to make this new memo. It should be study with the original one. I use terms as follows:

ama is the windward hull
vaka is the leeward hull
aka is the bridge structure.

Assumptions

The new idea here is to estimate better the weight (mass) and length of proa hulls. Keeping the structures comparative I calculated length-displacement ratios of EQL-7 proa to get some real numbers. The ama is hull with accommodation, LWL = 7.0 m and m = 200 kg empty. The vaka has only the structure needed, LWL = 7.0 m and m = 100 kg. The bridge structure has mass of 20 kg.

Length displacement ratios assumed (LDR) are:

For accommodation hull LDR = LWL/D^0.333 = 7.0 / 0.2^0.333 = 12

For structure only hull LDR = LWL/D^0.333 = 7.0 / 0.1^0.333 = 15

For akas, the mass is estimated to 20 % of ama's mass.

For every type of proa, the structure mass (ama + vaka + aka) is 1000 kg. Using above, the pacific proa has length of ama 8.0 m (approx. 70 % of vaka) and vaka 11.2 m. Atlantic proa has similar lengths, but accommodation hull weight double the structure hull. See the table on next page.

The crew and equipment are 200 kg and are placed on the ama. The rigging and mass of sails is different because of different sail area. These are added to total masses.

Cruising proa is not a flying proa.

Calculations

The righting moment is calculated as follows:

$RM = (m_{ama} * B_c + m_{aka} * B_c / 2) * g$, where

m_{ama} is the total mass of ama (kg)
m_{aka} is the total mass of aka (kg)
B_c is the distance between hull centers (m)
g = 9.81 m/s

"One-tonne" Cruising Proas

Pacific proa	Ama	Vaka	Aka	Proa	Calculated comparision	
m (kg)	150	820	30	1000	RM (Nm)	18 250
LDR	15	12			Luff (m)	8,2
LWL (m)	8,0	11,2			SA (m^2)	22,2
Crew (kg)	200	0			W (knots)	20,0
Rigging (kg)	0	50			SDR	19,1
Total m (kg)	350	870	30	1250	MR	0,89

Atlantic proa	Ama	Vaka	Aka	Proa	Calculated comparision	
m (kg)	588	294	118	1000	RM (Nm)	47 340
LDR	12	15			Luff (m)	11,7
LWL (m)	10,0	10,0			SA (m^2)	45,4
Crew (kg)	200	0			W (knots)	20,0
Rigging (kg)	100	0			SDR	38,1
Total m (kg)	888	294	118	1300	MR	1,18

Harry proa	Ama	Vaka	Aka	Proa	Calculated comparision	
m (kg)	420	496	84	1000	RM (Nm)	33 100
LDR	12	15			Luff (m)	10,5
LWL (m)	9,0	11,8			SA (m^2)	37,1
Crew (kg)	200	0			W (knots)	20,0
Rigging (kg)	0	70			SDR	31,6
Total m (kg)	620	566	84	1270	MR	1,18

EQL proa	Ama	Vaka	Aka	Proa	Calculated comparision	
m (kg)	588	294	118	1000	RM (Nm)	42 340
LDR	12	15			Luff (m)	11,5
LWL (m)	10,0	10,0			SA (m^2)	44,3
Crew (kg)	200	0			W (knots)	20,0
Rigging (kg)	0	80			SDR	37,6
Total m (kg)	788	374	118	1280	MR	1,17

Distance between centres of ama and vaka (m)	5,0
Allowed wind speed (knots)	20

Having similar sail shapes the sail area is calculated:

SA = 0.333 * h^2 , where

h is the height of luff in m
0.333 is from lemma: base of sail area is 2/3 of luff height.

Allowed wind speed is set to 20 knots varying luff height and calculated as follows (applied from ISO standard):

$W = 1.6 * (RM / (SA * (h_{CE} + h_B))^{0.5}$, where

SA is the sail area in m^2
h_{CE} is the centre of effort in sail (m), $h_{CE} = 0.4 * h$
h_B is the height from water line to base of sail (m)

Sail area - displacement ratio is a “power number”, < 20 for cruising monos, > 25 for racing monos. SDR is calculated as follows:

SDR = SA / D^0.667 , where

D is total displacement mass, D = (Total m) /1000

Measured rating (MR) tells the proportional speed of multihull (Harvey, Multihulls for cruising and racing, 1990).

MR = 2 * (SA * LWL / m)^0.5 , where

LWL is the waterline length of vaka (m)
m is the total mass of proa (kg)

Conclusions

Cause of small righting moment, the pacific proa can carry only the half of the sail area compared to other types. Also sail area – displacement ratio is low and leads to slow proa, very near cruising monos.

Measured ratings show the same thing. If pacific proa sails at 9 knots, the others will do 12 knots.