

Moment Study for the Glen-L Crackerbox

Enter input values into Blue cells.
Enter values for a boat as per plans in (Case 1) column.
Enter values for proposed modifications in (Case 2) column.

Stock boat built to Plans :

Overall Length (feet) = 15 feet
Hull weight = 600.00 lbs.
Hull CB @ 58.39" from transom, computed by DelftShip.
Engine weight = 700 lbs @ 70" from transom. Assuming a flywheel-forward V8 with Velvet Drive C71 transmission.
Battery weight = 43 lbs. @ 12" from transom
Passenger weight Front = Variable (1 to 2) @ 36" from transom
Fuel tank capacity = 25 gallon aluminum fuel tank @ 15" from transom
Fuel tank & fittings weight = 8 lbs.

Modified boat :

Overall Length (feet) = 16.6 feet
Hull weight = 650.00 lbs.
Hull CB @ 67.20" from transom, computed by DelftShip.
Engine weight = 700 lbs @ 70" from transom. Assuming a flywheel-forward V8 with Velvet Drive C71 transmission.

Enter input values into BLUE cells. LIGHT YELLOW are computed values.

Distances from Transom (inches)		Case 1	Case 2
Hull	Overall Length (feet)	15.00	16.60
	Hull weight (lbs)	600.00	650.00
	Hull CB from transom	58.39	67.20
Engine	Weight of engine	700.00	700.00
	Distance of Engine CG from transom	70.00	70.00
Transmission	Weight of transmission, cooler and brackets & hoses	0.00	0.00
	Distance of Transmission CG from transom	0.00	0.00
V-Drive	Weight of v-drive	0.00	0.00
	Distance of v-drive CG from transom	0.00	0.00
Battery	Battery weight	43.00	43.00
	Distance of battery from transom	12.00	12.00
Passengers	Average Passenger weight	175	
	Number of Passenger (1)	1	1
	Distance of Passenger CG (1) from transom	36.00	36.00
	Number of Passengers (2)	0	0
	Distance of Passenger CG (2) from transom	0.00	0.00
	Number of Passengers (3)	0	0
Fuel	Fuel Tank Capacity (gallons)	25.00	25.00
	Fuel Tank and related fittings weight	8.00	8.00
	Distance of Fuel Tank CG from transom	15.00	15.00
	Total Fuel Tank Weight	154.04	154.04
Summary	Hull CB	58.39	67.20
	CG	67 "	71 3/8"
	CG to CB	-8 5/8"	-4 1/8"

Notes

- (1) Hull stretched to 16' 6"
- (2) Stretched hull adds 50 lbs.
- (3) Hull CB's From HullForm software. Corrected waterline length error.
- (4) Flywheel Forward V8 and C71 transmission
- (5) Stock engine location from plans.
- (6) Transmission weight included in Case 2 Engine weight.
- (7) Battery relocated to rear

1kg =	2.205	lb
L Gas @ STP	0.711	kg/L
1 US gallon =	541178	L
US Gal Gas in KG	2.6498	
US Gal Gas in LB	5.842	

- http://www.simetric.co.uk/si_liquids.htm
<http://www.essochad.com/Chad-English/PA/Files/SectH.pdf>
 (8) Total weight = (Capacity * 5.84178311 lbs.) + tank and related fittings

Calculate Variable Passenger Loads

Distance Engine to Transom		Passenger Load	Front	Rear	Passenger Weight	Passenger Moments	Total Moments	Total Weight	CG		CB	CG to CB		Balance Weight @ 16.10'	Balance Weight Stock Hull
									Feet	Inches		Feet	Inches		
70 (Stock)		1 Front	1	0	175.00	525.00	9343.89	1672.04	5.59	67 "	58.39	-0.72	-8 5/8"	262	261
		2 Front	2	0	350.00	1050.00	9868.89	1847.04	5.34	64 1/8"	58.39	-0.48	-5 6/8"	225	225
68		1 Front	1	0	175.00	525.00	10238.89	1722.04	5.95	71 3/8"	67.20	-0.35	-4 1/8"	236	261
		2 Front	2	0	350.00	1050.00	10763.89	1897.04	5.67	68 1/8"	67.20	-0.07	-7/8"	203	225
69		1 Front	1	0	175.00	525.00	10180.56	1722.04	5.91	71 "	67.20	-0.31	-3 6/8"	232	261
		2 Front	2	0	350.00	1050.00	10705.56	1897.04	5.64	67 6/8"	67.20	-0.04	-4/8"	199	261
70		1 Front	1	0	175.00	525.00	10238.89	1722.04	5.95	71 3/8"	67.20	-0.35	-4 1/8"	236	261
		2 Front	2	0	350.00	1050.00	10763.89	1897.04	5.67	68 1/8"	67.20	-0.07	-7/8"	203	225
71		1 Front	1	0	175.00	525.00	10297.22	1722.04	5.98	71 6/8"	67.20	-0.38	-4 4/8"	239	261
		2 Front	2	0	350.00	1050.00	10822.22	1897.04	5.70	68 4/8"	67.20	-0.10	-1 2/8"	207	225
72		1 Front	1	0	175.00	525.00	10355.56	1722.04	6.01	72 1/8"	67.20	-0.41	-5 "	275	261
		2 Front	2	0	350.00	1050.00	10880.56	1897.04	5.74	68 7/8"	67.20	-0.14	-1 5/8"	243	225

Analysis

With 1 passenger in the front seat, it would take a 236 pound weight at the bow to balance the boat. CG is 4 1/8" forward of CB. Trim angle is bow down
 With 2 passengers in the front seat, it would take a 203 pound weight at the bow to balance the boat. CG is 7/8" forward of CB. Trim angle is bow down

"The CB can be considered the fulcrum point, while the CG can be considered the combined weights acting on either end of the boat to affect its balance. In many cases the designer will note the location of the CB on his plans. From this reference point, known weights on either side of the CB can be multiplied times their distance fore or aft of the CB in order to find moments. This is what the designer does in his weight study ; he literally figures each and every weight of EVERYTHING in or aboard the boat as it will be normally equipped so that the moments will balance. It is easy to see that if the weights are shifted from what is known, the hull could be thrown out of balance. " ⁽¹⁾

Methodology

- 1) Calculate the weights. In the example, engine, passengers and fuel.
- 2) Choose a starting point. This is called the datum. This point is arbitrarily placed at the CB.
- 3) Measure the distances from the datum to the center of each object. In the example, you must find the distances to the center of the see-saw and each of the two kids. The see-saw is 16ft long, so the center is 8ft from the datum. The kids are sitting exactly one foot from the end on either side, so their distances from the datum are 1ft and 15ft. respectively.
- 4) Multiply each distance by the respective weight. This gives you the moment for each object. First, the see-saw: 30lb * 8ft = 240ft*lb. The first kid: 40lb * 1ft = 40ft*lb. And the second kid: 60lb * 15ft = 900ft*lb. Add the moments to get 1180ft*lb for the total moment.
- 5) Add the weights of all the objects. The sum of the weights are 30lbs + 40lbs + 60lbs = 130lbs.
- 6) Divide the total moment by the total weight. 1180ft*lb / 130lb = 9.08ft. This is the distance from the datum to the center of gravity.

References

⁽¹⁾ **Inboard Motor Installations** by Glen L. Witt and Ken Hankinson, Chapter 2, Motor Location and Hull Balance, page 13

Overall Length (feet)	15.00		16.60
Hull CB from transom	58.39		67.20

Moments = (weight X distance from Transom)

		Case 1 - CB @ 58.39"			
		Weight	Distance Transom	Distance CB	Moment ft*lb
Passengers	Hull	600.00	90.00	-31.61	4500.00
	Engine	700.00	70.00	-11.61	4083.33
	Transmission	0.00	0.00	0.00	0.00
	V-Drive	0.00	0.00	0.00	0.00
	Battery	43.00	12.00	46.39	43.00
	Passengers (1)	175.00	36.00	22.39	525.00
	Passengers (2)	0.00	0.00	58.39	0.00
	Passengers (3)	0.00	0.00	58.39	0.00
	Fuel	154.04	15.00	43.39	192.56
Engine + Trans + V-Drive + Battery + Fuel moments					4318.89
Moments listed above - passenger moments					3793.89
Total Moments		9343.89			9343.89
Weight of all objects		1672.04			
Distance to CG = Total Moment / Total Weight (feet)		5.588	67 "		
Distance CG to CB (feet)		-0.72	-8 5/8"		

		Case 2 - CB @ 67.2"			
		Weight	Distance Transom	Distance CB	Moment ft*lb
		650.00	99.60	-32.40	5395.00
		700.00	70.00	-2.80	4083.33
		0.00	0.00	0.00	0.00
		0.00	0.00	16.60	0.00
		43.00	12.00	55.20	43.00
		175.00	36.00	31.20	525.00
		0.00	0.00	67.20	0.00
		0.00	0.00	67.20	0.00
		154.04	15.00	52.20	192.56
					4318.89
					3793.89
		10238.89			10238.89
		1722.04			
		5.946	71 3/8"		
		-0.35	-4 1/8"		

Spreadsheet prepared by Paul Kane, Kane Custom Boats Ltd, Chelsea Quebec 21 Feb 2015 11:44:26

Building the Glen-L Hot Rod : <http://www.kanecustomboats.com>