Avoiding capsizing an offshore cruiser

Capsize ratio

With offshore cruisers in mind, I have tried to find some formula which cover the resistance against capsizing. Now I found this text on the web:

> **CAPSIZE RATIO:** Some years ago the technical committee of the Cruising Club of America came up with a simple formula to determine if a boat had blue water capability. The CR compares beam with displacement since excess beam contributes to capsize and heavy displacement reduces capsize vulnerability. The formula is the maximum beam divided by the cube root of the displacement in cubic feet:
>
> Capsize Ratio = Beam/Displacement$^{.333}$.
>
> The displacement in cubic feet can be found by dividing the displacement in pounds by 64.
>
> **The boat is acceptable if the result of the calculation is 2.0** or less but, of course, the lower the better. For example, a 12 meter yacht of 60,000 lbs displacement and 12 foot beam will have a CR Number of 1.23, so would be considered very safe from capsize. A contemporary light displacement yacht, such as a Beneteau 311 (7716 lbs, 10'7" beam) has a CR number of 2.14. Based on the formula, while a fine coastal cruiser, such a yacht may not be the best choice for ocean passages.

The formula works both when you use imperial or metric numbers. However, converting one metric ton to one cubic metre only works in fresh water. The formula in imperial numbers seems to be made for salt water (density 1.025 times fresh water), so to get the same result when working in metric as in Imperial numbers, this must be taken into the formula:

Metric formula: $$CR = {Beam[m]} \Big/ {(displacement[metric\ tons]/1.025)^{0.3333}}$$

Some examples:

- *Frøken Sørensen*, 15m^2 Jollenkreuzer, Disp= 740kg, Beam= 2.40m

$$CR_{FS} = \frac{2.40}{\left(\frac{0.74}{1.025}\right)^{0.3333}} = 2.68$$ *..only meant for sheltered waters…*

- *Malena*, Albin Viggen, Disp=1400kg, Beam = 2.24m

$$CR_{Malena} = \frac{2.24}{\left(\frac{1.4}{1.025}\right)^{0.3333}} = 2.02$$ *.. more a coastal than offshore cruiser…*

- *Johanna*, Alo28, Disp=3200kg, Beam= 2.55m

$$CR_{Johanna} = \frac{2.55}{\left(\frac{3.2}{1.025}\right)^{0.3333}} = 1.74$$ *..OK for offshore work...*

- *Tystie,* Disp =7tons, Beam= 10.44'/3.18m (..if I got the numbers right…)

$$CR_{Tystie} = \frac{3.18}{\left(\frac{7}{1.025}\right)^{0.3333}} = 1.68$$ *.. more than just OK for offshore work...*

As can be seen, this formula favours bigger boats, as their displacement generally grows faster than the beam. This makes sense to me - big is beautiful in this respect.

However, getting this CR-number below 2.0 is not all it takes to make a safe ocean cruiser. Besides demands on strength of hull, rudder, rig, superstructure, windows and hatches, there is also a need for something more: A *Balanced hull*, and in particular *directional stability.*

To save myself some work, I cut a bit from Chapter 2 in my "The Cambered panel Junk Rig":

- A *balanced hull* is a hull that does not alter helm balance (much) as the boat heels. To achieve this, the reserve volume (i.e. above the LWL.) in the fore sections must be similar to that in the aft sections. (A balanced hull makes life easier for the helmsman or the windvane self-steering gear).

- Directional Stability: The *Centre of Lateral Resistance*, CLR must be positioned aft of the boat's *Centre of Gravity*, CG. Then, like an arrow, the boat will want to go in a straight line. With the CG *aft* of the CLR the tiller can not be left for a second or the boat will throw itself into a sharp turn. Such a boat is simply directionally unstable.

Unfortunately, these days big boat factories are pouring out sailing cruisers that are neither directionally stable nor have balanced hulls. Still they are being sold as ocean cruisers since their static swimming-pool stability has been found (or calculated) to be good enough. You'll easily recognise these boats by their sharp, vertical bows, wide sterns and huge steering wheels to cope with the weather helm. In a pinch these floating caravans could be used for marina-hopping, mostly in sheltered waters - and always with an eye on the weather forecast. You have been warned.

As we can see, none of these two important factors has been incorporated when *the Cruising Club of America* developed its simple CR number. As for the STIX number, a product of an EU-committee, I do not know. However, when looking at the resulting boats that receive a CE "Ocean" certificate, I guess that these dynamic factors have been of little interest to the committee.

My worry about such boats, lacking both balanced hulls and directional stability, is that they can broach so easily. Their salesmen say that it is a part of the safety that the boat will run out of rudder and round up in a windgust. I don't buy it. The problem is that these hulls will also be prone to broaching when sailing downwind in a seaway. Such broaches can leave them in a vulnerable position and attitude to be knocked fully over by the next following sea. And yes, there has been a number of such accidents.

Conclusion:
The use of CR number makes sense to me as it favours some displacement and moderate beam. Combine this with strength, a decent ballast ratio and with balanced hull lines and directional stability, and the odds are good that the boat will cope well. Safety is all about improving the odds…

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PS: On the *coastal cruiser,* there is yet another demand: It must be powerful enough, either under sail or motor, to tack away from a lee shore, even in gale force conditions. Under sail, this favours long and slim hulls with plenty of ballast. The alternative is a powerful, reliable engine with a propeller that stays immersed even when the boat pitches badly.