

To Vee or Not to Vee ...

A Designer's Perspective

by
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Seems like a simple question, to Vee or Not to Vee. The answer depends on a number of factors related to just how and where you intended to use the boat. Boat speed and wave conditions are primary considerations in this trade-off between flat bottom and Vee hull forms. Wide flat bottom skiffs with a high powered outboard will plane easily but will be a very rough ride in any waves over more than a few inches high. Unfortunately, use of flat bottom boats at planing speeds in waves has caused much of the misunderstanding on ride comfort of flat bottom boats.

Let's look at the phenomena of pounding or slamming to understand what causes the impact forces that are associated uncomfortable ride characteristics of boats in a seaway.

First, the bow must immerse from the water and reenter at a speed high enough to cause an impact force. The emergence of the bow is caused by pitching motion at lower displacement speeds and a combination of waves induced motions and bow up trim at planing speeds. On flat bottom boats, having the stem heel in the water helps keep the forward part of the hull deeper and is less likely to immerse and pound. Boats with the bow out of the water at rest have a head start presenting the flat surface for pounding at almost any forward speed in waves even at anchor.

Second, there must be a vertical impact velocity. The impact velocity is produced by motions from waves, forward speed or a combination of both. Boats with flat or Vee bottoms will have similar motions in a seaway if they have similar vertical centers of gravity. Generally, flat bottom boats have increased added mass and damping in a seaway, and slightly less motion as a result. Less motion helps reduce impact velocities. Impact pressure is proportional to velocity squared; therefore, impact pressure builds very quickly as speed increases. For the most part, going slower has the greatest influence on ride comfort from bottom slamming induced impacts.

Third, there must be flat, or nearly flat bottom area to pound. Flat surfaces will produce impact pressures at relatively low reentry velocities. Shallow Vee sections will still slam if the reentry velocity is high enough. Even a round bottom will pound if presenting a flat area upon reentry at the right speed. Planing boats must have Vee or near Vee shaped sections to cut through the water and reduce impact pressure at high speeds in a seaway. Slamming typically occurs at about 15% of LWL aft of the bow on a flat or nearly flat surface. Even boats traveling at lower speeds require good hull design characteristics so they do not pound in waves. On flat bottom or nearly flat bottom boats, narrow bottom waterlines forward minimizes the exposed area and pressure build up. Similarly built up keels and rounded chines help reduce flat bottom area available to impact a wave upon reentry.

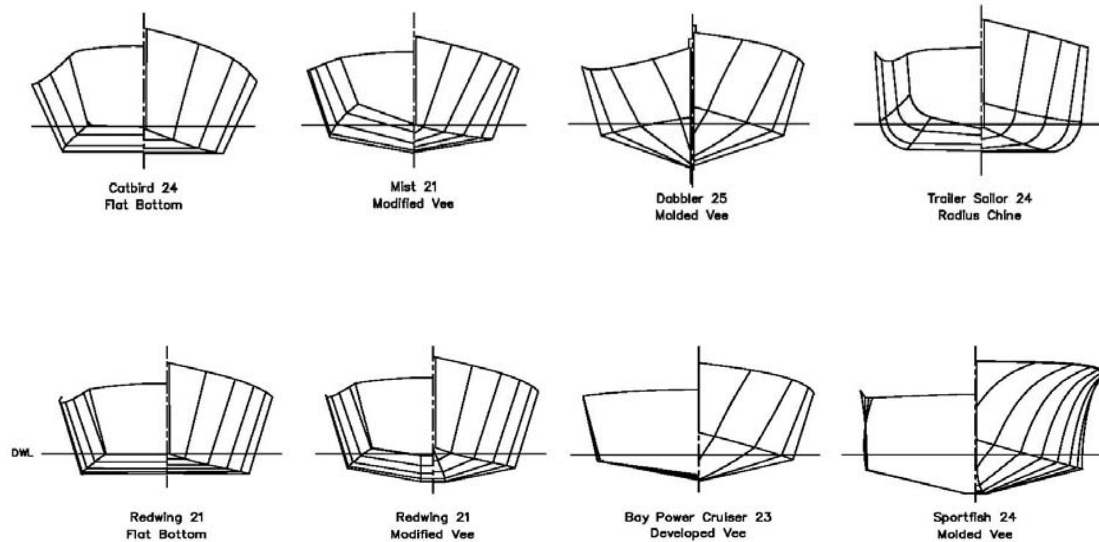
Flat bottom boats similar to the Redwing (power) and Catbird (sail) are designed for moderate to low speeds in protected water. They are able boats in good hands when the seas kick up. Although flat bottom hulls, these boats have features that help to minimize pounding, like narrow bottom forward, rounded chines and keels all help minimize or break up the bottom area needed to pound upon re entry. Also, the bottom at the bow should be designed to be in the water or level trim in calm water. The immersed bow helps help the forward sections from emerging to slam upon reentry. There is a limit to how much the bow can be submerged so as not to cause bow rooting or boaching in a following sea. The depth of bow must be a good compromise between slamming and bow rooting. Boats with hulls designed for lower speeds must be trimmed correctly so the bow is not out of the water. Generally, flat bottom boats are able to carry a good deal of weight for their size and like to be loaded down to help push through the chop rather than pounding on to the seaway in a bow up attitude.

Flat bottom boats gain form stability from the bottom width. Vee bottom boats gain hydrodynamic lift and dynamic stability at semi-displacement and planning speeds. There are additional advantages and considerations for Vee bottom hulls at higher planing speeds; however, this could easily be the subject of another article by itself. Flat bottom boats 18 to 30 feet in length are suitable for protected water generally 1 to 2 foot waves with occasional use in 3 to 4 foot waves. Vee bottom boats are suitable for higher waves. Deep Vee fishing boats are known to make frequent trips off shore, but have the speed to return quickly if the weather deteriorates. Cruising in a small boat in waves of 4 feet or more for long periods of time require a design more like the Redwing 26 with box keel. Similarly, lobster boat style hulls have Vee shaped sections with rounded bilges forward provide a hull form with renowned seakeeping abilities.

There are differences in construction between flat bottom hull and Vee bottom hulls. A few words about the construction differences may dispel undeserved biases in this area as well.

Generally, the more pieces to assemble, the more time is required to measure, layout, cut, fit, trim, fit etc..., sand, and paint, sand and paint etc... well you get the idea. While not significantly more, a Vee bottom hull does have more pieces to deal with. The number of pieces can be significantly more if of a compound shape, especially in the bow area. If not developable of sheet ply material, the compound curvature must be cold molded of many pieces of thinner, narrow strips and then faired, sanded, faired some more...etc again. All this is worth while for finer deep Vee bow shapes needed for higher speed boats. Developable surfaces generally have fuller bow Vee shapes in shorter wider hull forms. So if you are heading out into a steep chop for most of the time on the water, a Vee shape is worth the extra construction time. Vee bottom hulls can be lighter because they do not have to absorb the bottom impacts of a flat bottom. On the Redwing designs, bottoms are two layers of 1/2" plywood, where as a deeper Vee hull might have cold molded layers of plywood for a total thickness of 3/4" as is typical for the Bay Power Cruiser 23. Not much difference in the scheme of things, but the number of pieces does

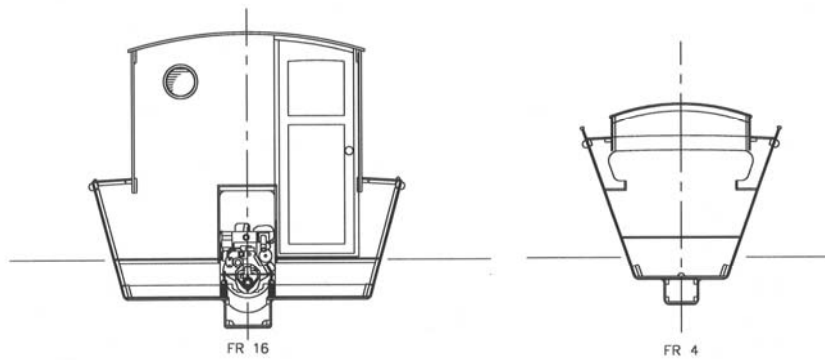
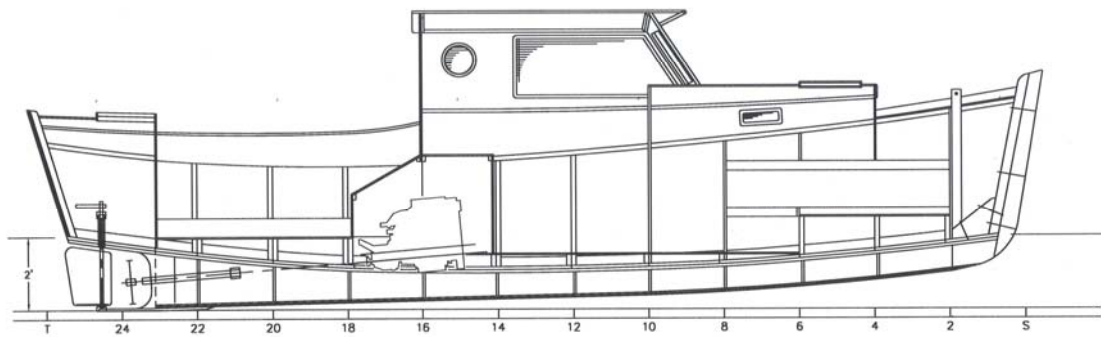
add up along with construction time. For higher speed planing boats, Vee bottom shapes are essential to minimize the wave impacts to reduce structure size and weight. Under these circumstances more internal framing is required in addition to developable or cold molded deep Vee hull and bow shapes. The construction time difference is smaller in stitch and glue boats than in more traditional glue and screw construction where keels and chines are fit and beveled to receive bottom shell planking or sheeting.



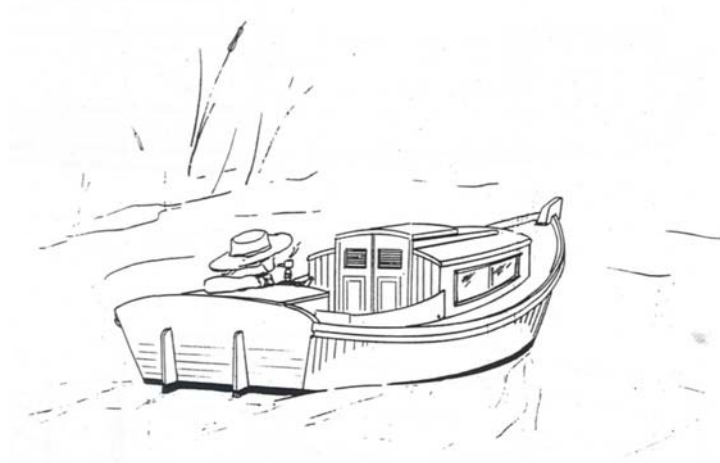
Another option is adding a box keel similar to the Redwing 26 shown here. This can be an easy add on to the flat bottom version, inboard or outboard. Box keels are very popular on serious long distance passage makers for a good reason. Benefits of the box keel include:

- Reduces bow slamming, better than a shallow Vee,
- Dampens roll motion for a more comfortable ride in a seaway,
- Tracks well for easy course keeping,
- Protects for the propeller on inboard or outboard installations,
- Protects against bottom damage. Can be filled with foam in its entirety or just in the bow,
- May be used for battery, ballast or other storage,
- Reduces shaft angle for inboard engine installations,
- Easy and inexpensive to build as an add-on option to the easily build flat bottom,
- No increase in draft for the inboard version and only slight increase for the outboard version when the motor is tilted up.

All of these great features provide more comfort, safety and fun at little added cost. You will find much more capability for the dollar.



The advantages of flat bottom boats include: greater stability, shallower draft, beachability, more room in the bilge for storage, more weight carrying ability, and less time consuming to build. Are they worth the trade off for comfort in open water? Those who built and fished from skiff and sharpie of the past used them in protected water. Today, flat bottom boats offer a unique opportunity for fun on the water in a simple easy to build shape. Flat bottom hulls are fine for protected waters at lower speeds and Vee hulls are best for use in a seaway or higher planing speeds. It all depends on the intended use.



Inspiration for a simple flat bottom boat starts by imagining the possibilities of cruising along the backwaters and barrier islands watching the shore go by and wildlife hidden there in at a leisurely pace. Larger flat bottom boats are capable of occasional open water use with a good hull design, moderate speed and an eye on the weather.

Acknowledgements: The author would like to thank contributors to a posting in WoodenBoat's Forum who raised many of these issues and offered their insights on this seemingly age old question.

For more information on the boats described in this article go to www.cmdboats.com