Boat dual chines and a narrow planing bottom with low deadrise

Long and flat or beamy and deep V-bottom
An effective alternative to deep V-bottom

Here is a *ground-breaking* powerboat concept with high efficiency and excellent seaworthiness over the whole speed range. It is a combination of all the good qualities which are usually held by a deep-V bottom and a traditional round bottom.

Behind the final form is a multi-annual development work with theoretical and computational models and many model tests. Finally, there was a comparative study as a candidate in-depth studies course at the Department of Marine systems at KTH in Stockholm. *Extract from the statement from the Royal Institute in italics in this presentation.*

Overall, the new boat requires 15-25% less power. The new boat is much smoother and steadier at all speeds. During the same sea conditions, the new boat runs in 29 knots with the same comfort as similar boat with deep V-bottom running in 20 knots.

Is it time to abandon the idea of the deep V-bottom boat's excellence?

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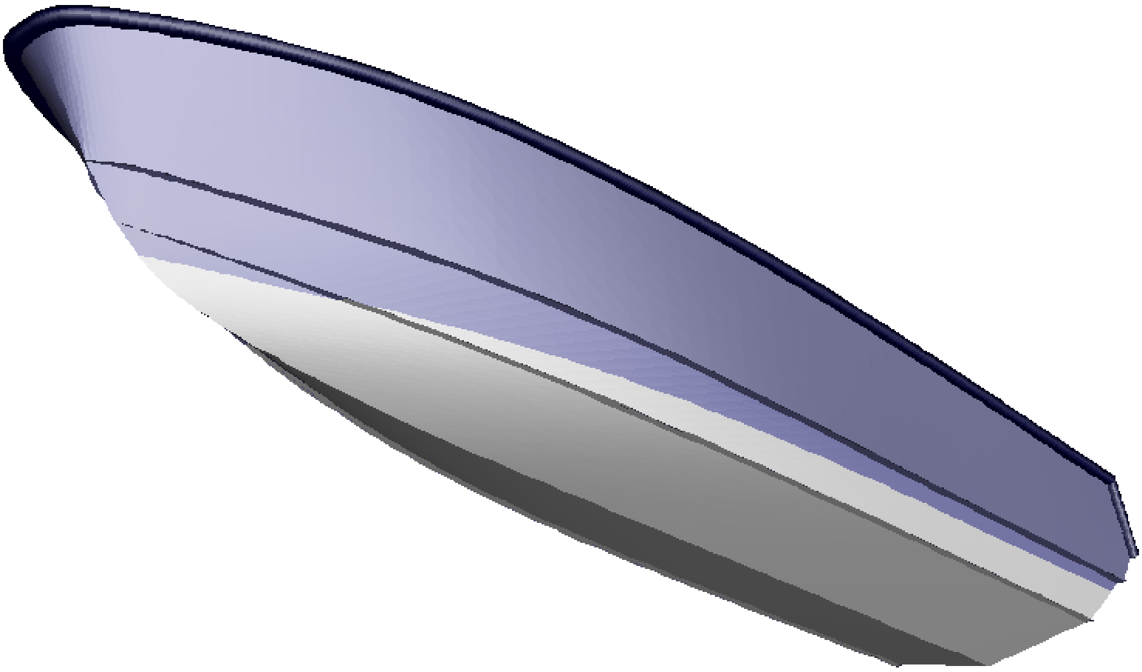

A feature of the new boat is that it has a narrow planing bottom with low deadrise and bottom with double chines. Above the waterline it is beamier to get interior space and good sea keeping ability. This also creates higher static and dynamic stability.

The shape and size of the bottom is carefully adapted to the load at both minimum and maximum total weight. Similarly, the longitudinal center of pressure of the planing bottom surface and the water surface line is optimized for the actual need

The static stability is somewhat better than might be expected from a similar round-bottom boat because the spray strips appear as bilge keels. In seaway the stability is much higher thanks to the carefully designed spray strips and the top chine just above the waterline. Subsequently, the boat is surprisingly little affected of the other boats waves, even when they come in from an unfavourable direction.

The tested boat is designed and equipped to have the lowest fuel consumption at speeds between 20 and 25 knots.

In all the construction, all input parameters must be monitored very carefully. Otherwise the risk is that you get a "normal" boat to "normal" characteristics such as high power demand, hard and wet run, poor visibility ahead in some low speeds and low stability

This bottom form is a protected by trademark, nr 2009/0573 nr 80977

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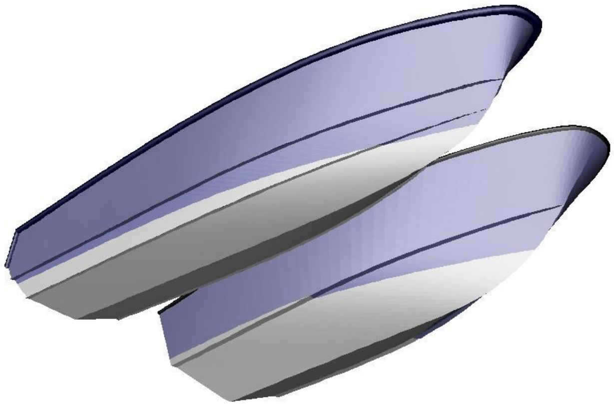

The boat with deep V-bottom

To verify the calculations two comparable boats was tested alongside. One was a boat with a common hull form with deep V-bottom. The second was a new designed boat with the optimized shape of the bottom double chines. Both boats are built of aluminum. The boats have the same interior volume and total weight.

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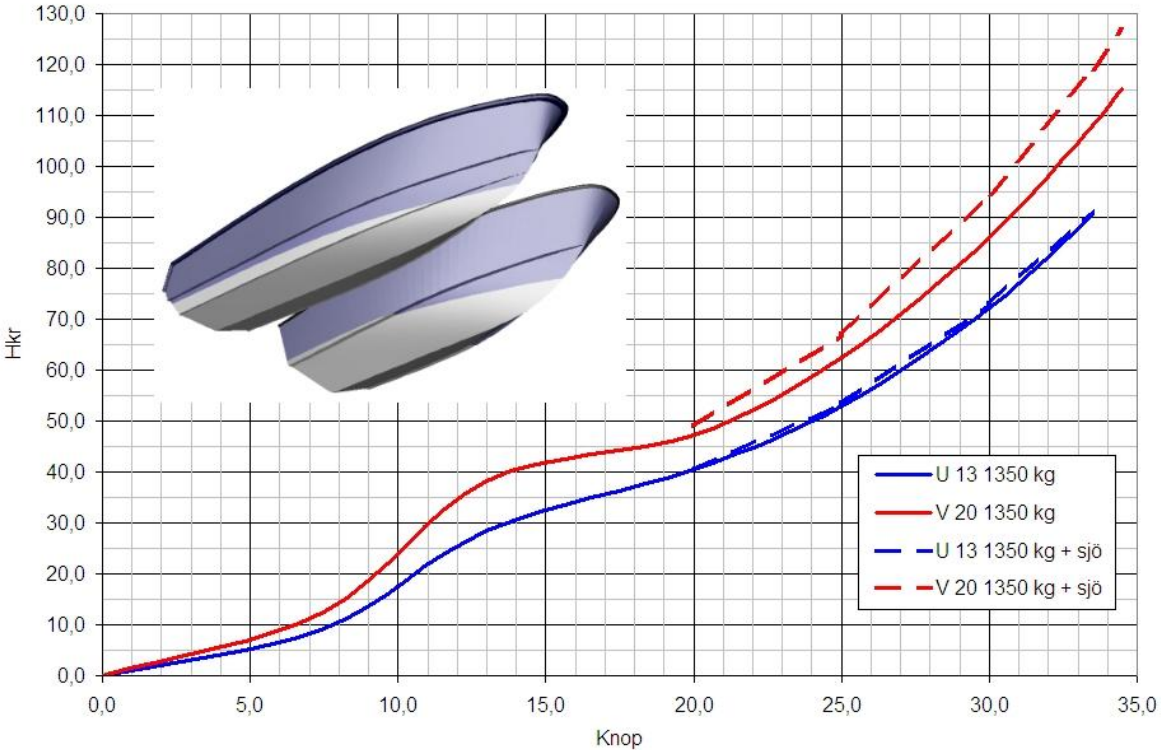
		V20	**U13**
Length overall, hull	m	6.2	6.6
Length of chine Lp	m	5.4	6.1
Length of waterline	m	5.1	6.0
Beam overall, hull	m	2.2	2.0
Beam in the waterline	m	1.9	1.6
Beam over chine Bpx	m	1.66	1.33
Depth	m	0.40	0.33
Bottom deadrise	dgr	20	13
Total test weight	kg	1350	1350
CG fr transom	m	1.9	2.3
Prismatic coefficient		0.72	0.76
Wet surface area	m^2	8.0,	8.8
Waterline Area	m^2	7.1	7.6
Engine power	hp	140	90
Maximum speed	knots	34.5	33.5

http://www.youtube.com:80/watch?v=cXDfQqxJ_pM



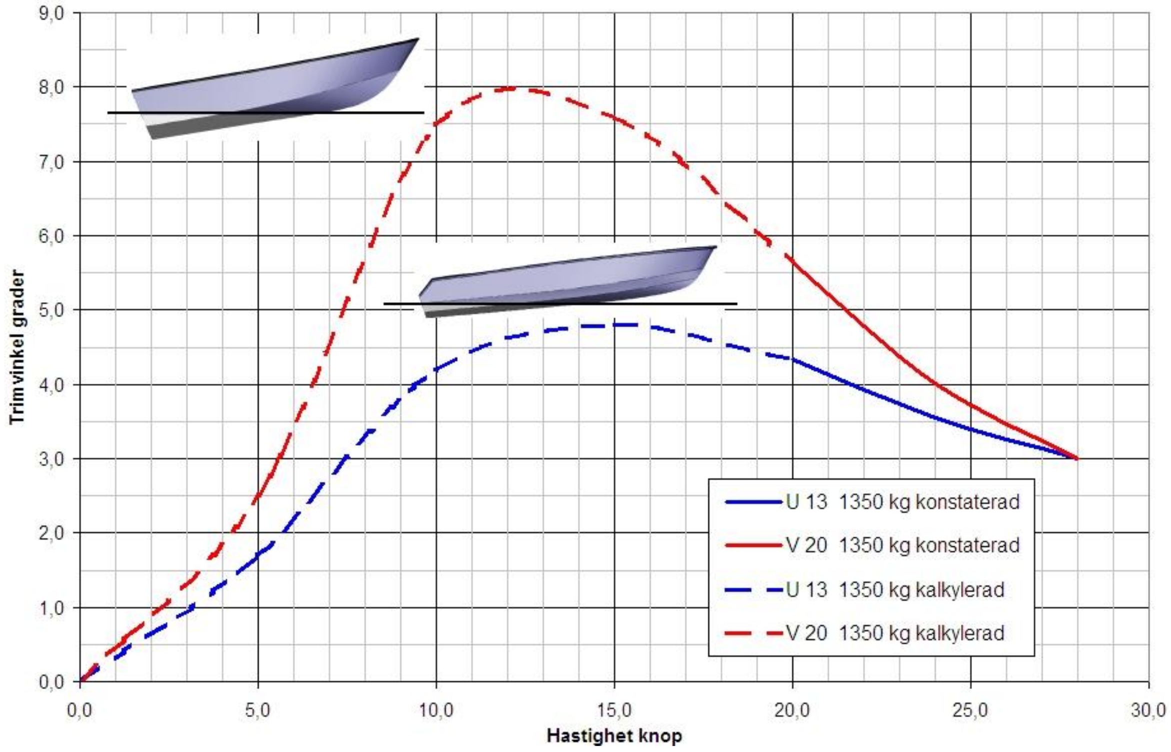
The optimized bottom shape is found to have slightly better properties than calculated in flat water. In the seaway are all values much better than what the calculations show. Resistance increase in the seaway is barely detectable. This is something totally new. The deep V-bottom, however totally responds to what can be expected under the well-proven methods of calculation..

The new hull shape shows no tendencies to any instability such as porpoising, or chine walking. It is stable in all situations, much depends on the shape and the optimized place of the various pressure points and the center of weight, CG. The relationship between the center of gravity distance from the stern and bottom width differs substantially from what is common

The low resistance due to greater part that the hull is long and narrow in relation to the total weight and the very moderate deadrise, the bottom is only thirteen degrees.

Low resistance requires little driving force and thus low power. Which in turn saves weight and therefore gives further lower resistance. It creates a spiral cycle to an environmentally friendly alternative by reducing fuel consumption.

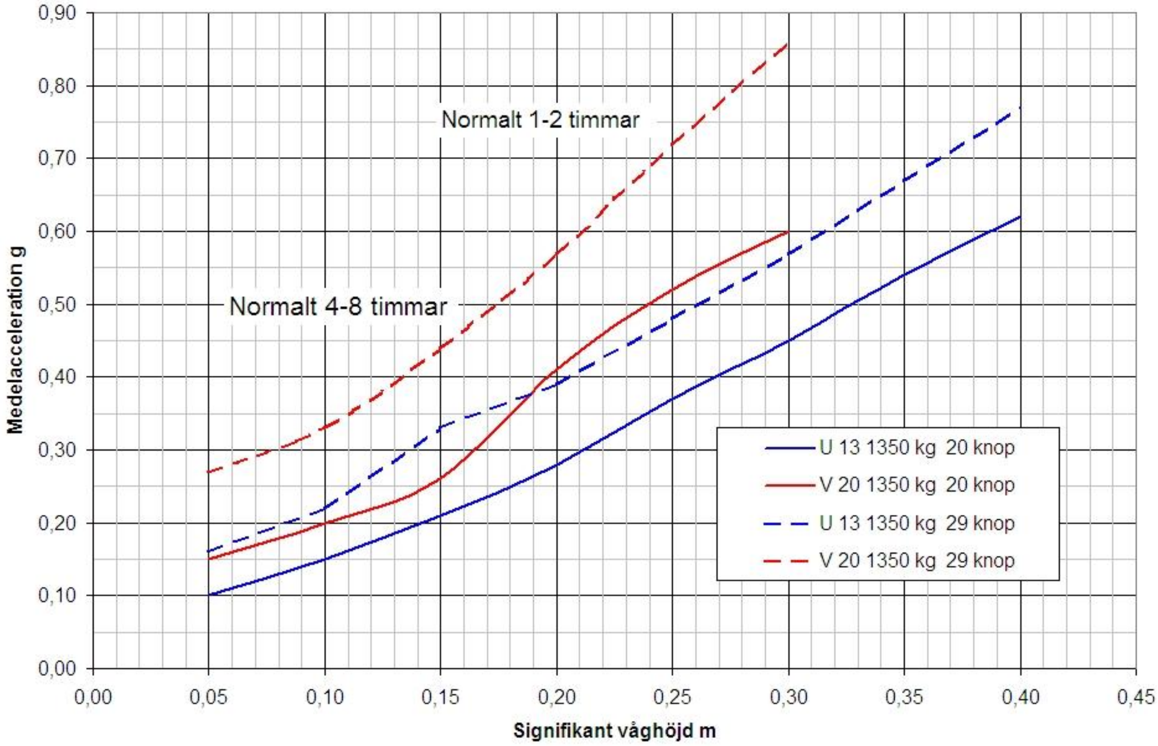
The V-20 boat had at a testing time a slightly too powerful engine that could not be fully exploited. The above resistance curve calibration is therefore more probable values for this type of boat.



The trim angles reported here relate to the keel. In fact, the boats are already in a tie-up trim angle about 1.5 degrees which can be subtracted in the above chart for the lowest speeds.

The chart above shows the trim angles of flat water. The trim in seaway is very violent at the V20-boat. between minus one degree and up to ten degrees. The new bottom shape have very calm movements between three and five degrees. This can be clearly seen in the movies.

Importantly, the new bottom shape always have such a small trim angle that it is always a clear view ahead. While the deep V-bottom always have a situation where visibility ahead is nonexistent in certain speeds. This allows the new boat can always run at any speed, while the deep V-bottom must be run at low or high speed, there is no appropriate intermediate position.



Three different characters on how a boat reacts to oncoming waves can be discerned. The boat can follow the wave, much like a sailboat normally do in a bit larger seaway, the boat responds to the wave very smooth. It can go through the wave like a normal planing boat makes in moderate waves, but not significant move up and down. And finally, the boat bouncing and flying from wave top to wave top, what planing boats do in rough seas or when a boat encountered strong waves..

Depending on the wave height in relation to boat speed, all three varieties occur at all speeds.

The above chart shows the measurements of how hard the boats goes in seaway. There are different computation and selection methods. All show the same relative performance. They show that the bottom width, the relative center of gravity and trim is much more decisive than the bottom deadrise. A deeper V-bottom has a marginal effect on the vertical **acceleration**. However, it is increasing the resistance and trim angle considerably

U13 is exposed to equal vertical accelerations at 29 knots as V20 at 20 knots.

Furthermore, U13 is not slowing down much as it meets the waves. This can be clearly seen in the movies where the boats had the same speed to begin with.

Normally we have managed to be exposed to 0.75 g in one to two hours or 0.5 g in four to eight hours. Paying guests should not be exposed to more than 0.3 g..

The fact that a light boat in relation to its length would give livelier movements is an idea which is hereby clearly disproven. In addition, it shows that a slightly slimmer boat is much more efficient and more comfortable in all situations.

Picture Study

During the experiments a lot of pictures and movies on the boats was recorded in order to get a picture of understanding how boats behave in seaway, especially in comparison with each other. Figures 42 to 46 shows a sequence where the boats running alongside the waves, that gave a slower process and could easier be observed and photographed.

Figure 42 Boats on the track to face a wave I

In Figure 42 we can see the two boats going in alongside in their normal trim and will soon meet their respective waves.

Figure 43. The boats have faced a wave. U13 left in image

Figure 43 shows how the boats have faced opposite wave and have accelerated upwards. Notably, the V20 has a higher trim angle than U13, which both may be due to the shorter length, but probably also because it has a higher acceleration upwards due the larger bottom width.

Figure 44 The boats are on the way down from his jump. U13 left in image.

In Figure 44, the boats turned and is heading downhill towards the water surface again. Here shows how the U13 has almost regained its normal trim angle while the V20 has characteristic set down the stern first and is still going down with the bow.

Figure 45. U13) already in the normal mode, while the V20 just struck down the bow..

It was first in Figure 45 one can see that the V20 came down firmly in the water again. U13 has long since stabilized in its attitude.

Figure 46. Both boats have regained their normal running positions. U13 in the foreground..

Figure 46 one can see the two boats have returned to their normal running positions. That there is such a difference in how long it takes for the boats to recover from a wave says much about their caracteristics. V20 exhibits a much longer recovery time than the V13 does. While V20 is jumping so much more than what U13 is doing. This can be attributed to the shorter length and larger bottom width aft of the V20, but the hull design was almost certainly also an impact on the outcome.

Figure 47 The water flow over the bottom. U13 in the foreground

If Figure 45 above is considered as zoomed in Figure 47 seen how easily water moves along the bottom. The circled areas in the picture shows the interesting area. In the case of the V-bottomed V20, aft, the water is following from the bottom up to the freeboard and leaves there. The greater part of the bottom is in the water and creates large wet surface. For the U13 is clearly visible how the water fed along the bottom up to the lower chine and leaves the bottom out to the side. This shows that the hull, from the drag point of view, is operating as intended to provide less resistance. This is also confirmed that the boats was almost equal fast, despite the substantial difference in engine power.

The results of the full-scale measurements confirm the results that semi empirical methods provide. U13 exhibits less vertical acceleration than the V20 in almost all measured speeds and wave heights. U13 is exposed to equally sized vertical accelerations at 29 knots as U20 at 20 knots, that means that other parameters than the bottom deadrise angle has a significant impact on comfort.

The drivers who drive the boats at the test agreed that they would prefer U13 on the priority smooth and comfortable ride in seaway. U13 is also preferable when driving in areas with speed limits, because its low trim at lower speeds.

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