SIMONIS VOOGD
YACHT DESIGN

LEOPARD
CATAMARANS

LEOPARD 43 PC

"POWER CATAMARANS DON'T LIKE TO GO UPHILL"

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POWER CATAMARANS DON'T LIKE TO GO UPHILL.

I have been asked on a number of occasions what it is that sets the Leopard 51 and 43 Power-cats apart from others and why it is that we believe their efficiency and ride is better than those they are in competition with.

For any motor yacht, be it a mono- or multi-hull, there are many considerations affecting performance. In this article I will just concentrate on some and make some simple assumptions for the purpose of explaining the workings on the Leopard power catamarans.

If the yacht is a slow one (staying in displacement mode) weight, wetted surface and wave resistance remain the key players. Irrespective how may hulls you consider; their performance will be pretty identical.

However if it is a fast craft (not operating in the classic displacement mode), then other factors come into play and it is there that you will see a distinct difference in behavior between fast mono-hulls and fast multi-hulls.

A mono-hull will move over its bow wave and start planing, thereby significantly reducing wetted surface and wave resistance. It can do this because it has sufficient planing area (as a single hull, it is sufficiently wide). Power catamarans haven't got anywhere close to sufficient planing area and remain in what you could call a "forced" displacement mode. To have a low enough resistance they have to solely rely on very slender hulls so that the wave resistance at higher speeds remains small.

An important design consideration to look at for catamarans is the largest cross sectional area you are trying to push forward through the water. Basically this is the area of the underwater body you would see if you stand exactly in front of the yacht.

The bigger it is, the more resistance it will generate, the more power you need or the slower your yacht will go if you only have a set amount of horsepower available.

This brings us to the point of the trim of a power yacht. With a zero trim angle this area is the smallest and as such it stands to reason that it would have the least resistance and give you the most speed. However, all yachts under power tend to trim by the stern (backwards). This happens because the bow wave lifts the front and the propeller tends to pull the stern down. On a mono-hull this is often only momentary when the yacht gets on the plane (jumps over the bow wave) after which it then levels out. A mono-hull can also make use of trim tabs as they have a wide stern, they can fit large trim-tabs or put them far apart to make them more effective. By means of using these trim-tabs the skipper can make sure that the boat goes at the best running trim giving the least resistance for different load conditions.

On a power catamaran none of these options are available. It doesn't plane and it hasn't got a wide enough transom for trim-tabs to make any worthwhile difference.

To make matters worse, because we are trying to make the hulls as slender as possible to reduce the wave resistance, the direct side effect of that is that those same hulls are now also becoming far more sensitive to trim.

So how do you solve this, especially when there are conflicting requirements to deal with? You need to control the trim of the yacht, but you can't use trim tabs and you can't make the hulls wider as that will give you too much wave resistance.

The solution we looked to for this problem was to design a hull shape, which is less sensitive to trim over a range of loading conditions at different speeds. The way we wanted to make it less sensitive to trim was by finding a perfect balance between the trim generated by the bow wave and the downward force of the propellers to be counteracted by a dynamic lifting force in the stern generated out of a specific tunnel design to partly house the propeller in. On the Leopard catamarans the tunnel design in way of the propeller is such that there is such a force, trying to keep the boat level over a range of speeds and conditions.

The idea itself sounds simple enough, and propellers in tunnels are also nothing new as it is used for decades to improve propeller efficiency. But the idea to use the tunnels not only to improve propeller efficiency, but also to reduce the trim of the yacht is far less common and may even be unique.

To get this right we started an extensive CFD (Computational Fluid Dynamics) program with NUMECA in Germany. We would supply the initial Hull shapes and NUMECA would model and run the CFD study and report back to us for further evaluation. The CFD study allowed us to carefully look at the resulting trim angles (Figure 1) and associated power requirements to drive the yacht.

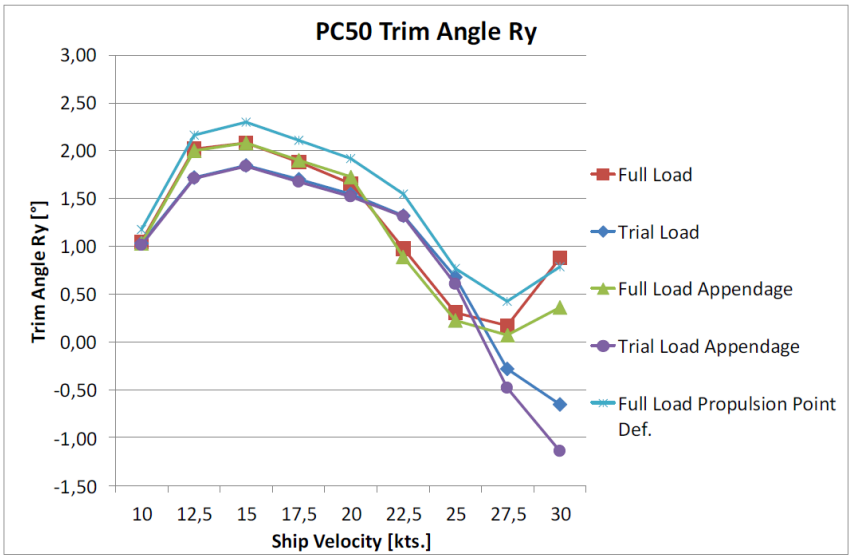

Figure 1: Early results out of a CFD Trim Study

The result of the program which ran over a period of 6 months was the Leopard 51PC which proved that the concept worked. The 51 PC has a low running trim in all conditions and excels in speed and fuel efficiency compared to some vessels with similar Power to Weight ratio's by as much as 22%, primarily because the running trim is kept under control at all times.

With the success of the 51, the demand grew for a smaller power cat with similar offerings in terms of performance, but in a smaller and more economical package.

So the challenge was on to see if the research done on the 51 could be continued for the 43 and improved upon.

To do this on a smaller vessel successfully we needed to work to an even lower running trim. To do this at a lower speed (compared to that of the 51) the upward force generated in the stern had to become bigger. This was done by moving the volume distribution further aft than on the 51 and making it wider in the aft sections. The danger here is that if we would become too wide, the wave resistance would go up too much and the result would be a significant drop in speed.

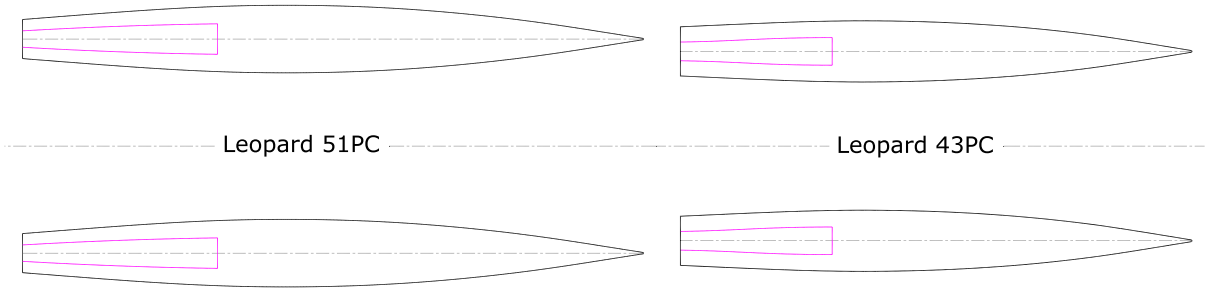

Figure 2: Waterlines profiles of Leopard Catamarans.

Figure 2 shows a comparison between the waterline and tunnel profiles of the Leopard 51 and 43. One can clearly see that the 43 has relatively wider hulls and more volume at the back in order to create a bigger lift in the stern sections. That is hasn't been too much can probably best be seen in Figure 3.

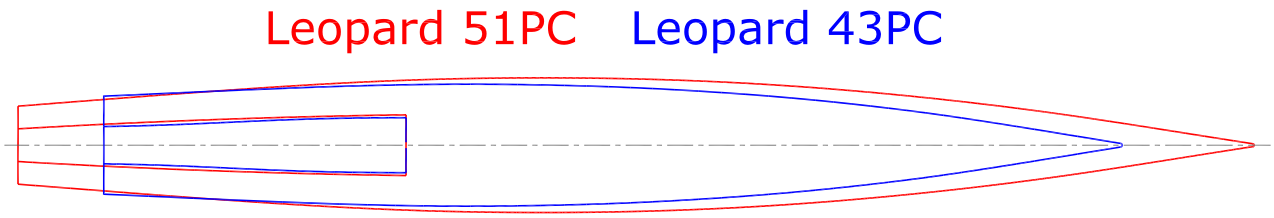

Figure 3: Overlay of Waterline profiles Leopard Catamarans.

Here you can see that the tunnel width and transom width are much closer if we line the hulls up on the point where the propeller tunnel starts. The amount of area lost in the front exceeds that which is lost at the back while the overall beam hasn't increased. As such this picture probably best depicts the changes in design between the two yachts and can serve as an illustration why the 43 manages to operate at an even lower running trim than the 51.

On a power catamaran at high speed everything is about the trim angle, if it is too much, all you will do is burn fuel as the resistance becomes excessive for the speed. As explained, power catamarans don't plane and don't respond to trim tabs so your only option is to get it right from the start in the hull design. Which brings me to the title of the article: Power cats don't like trim. (Or in other words, going uphill).

Alexander Simonis, June 2016