HOW CAN SAIL BOATS MOVE FASTER THAN THE WIND?

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Abstract :

First of all, sailboats float on water due to archimedes' principle. But to make them move, several forces are necessary. The difference in flow of streams reveals the main force: lift. But the anti-drift force and wind power are necessary for the progression of these boats on water.
Now, how can sailboats move faster than the wind? Thanks to which mechanisms?
When we look at the America's cup, we can see flying boats! How is it possible?
Indeed, hydrofoils allow lifting the sailboat above water thanks to the same phenomenon that allows the boat to advance: the lift.
Water flows diverted on the immersed plan under water create a low pressure that lifts the boat. This phenomenon allows reducing forces of friction and thus the yacht to gain more speed. Lift and foils are in great part responsible of the high speed.
But to have a higher performance boat, it must be lightweight, rigid and sturdy. However, a material having these three properties is difficult to find. Indeed, when it is light, it is often fragile and when it's solid it's often heavy. Which one to use then? Thus, the most commonly used compromise is carbon because it's lightweight, stiff and strong.

Introduction :

On an island where water sports take a big place in the leisure of the inhabitants, as well as our common passion for sliding sports, we were then interested in sailboats and its functioning.
In addition to that, by looking via the media the America's cup, we notice that boats moved forward not only on the water but above also. This atypical mode of propulsion awakened our curiosity.
That's why we have decided to approach this theme of innovation and technical progress

Materials :

For the small-scale sailboat model :
- Carbon for the mast
- Spatula for the leeway
- Lead fishing
- Polystyrene+ fiber

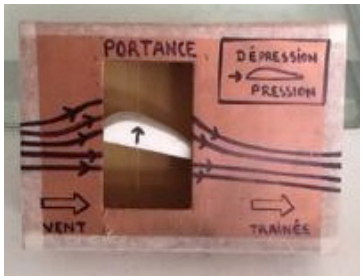
For the small-scale models of the experiments :
- Polystyrene
- Clean out tooth
- Flexible plastic for the sail

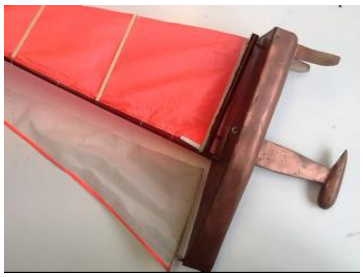
Experiments:
- Plasticine
- « lift box »
- Plastic ball
- Sinker

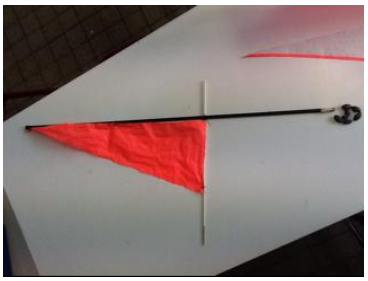
Method :

After studying the theory of sailboats: the wind and forces. We first of all built small-scale models to experiment the numerous forces such as the antidiverts force, resultant force as well as Archimedes' principle.
Afterward, we had begun to build the « big » small-scale model of the Pogo 40.
Once ended, we tested and filmed them to illustrate the various loads involvements.

Results :







Discussion and conclusion :

During our approach, we understood that only a tense sail could not take forward the sailboat, but that other parameters played an important role. What brought to us to interest us more particularly in the lewway, essential element for the boat's movement.
This phenomenon, the navigation, which seems simple results in fact from the complex combination of several particular loads that we succeeded to identify. Furthermore, these combinations allowed the boats to move forward faster than the wind, but especially outside the water, on top of it. Where from intervenes the hydrofoil.

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Works consulted :

"Voiles et voiliers" magazine
Press article : « About wings »