Report B: Experimental setup

B01 Previous setup & problems

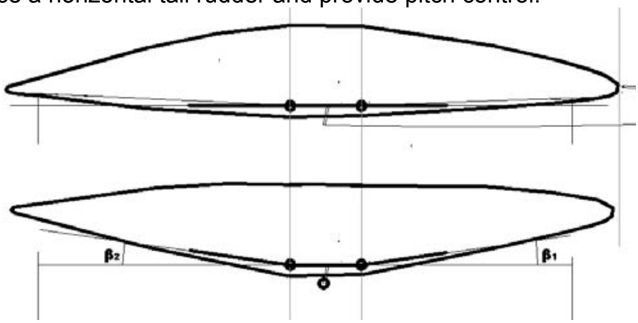
The model is suspended on 2 dynamometers while being towed along a rail. This gave a very clean setup, with minimal air disturbance in front of the model. It also had the advantage of being able to test the model ‘heavy’, saving on helium.

This setup confronted us with a number of problems. It turned out to be very difficult to build a rail sufficiently straight to get a smooth run. The model tends to start oscillating on the dynamometers. The measuring instruments then operate as shock absorbers, and no significant values can be read.

Test setup with sled

B02 Goal

The model can be deformed vertically with 2 motorized hinges. This can potentially:
-provide a way to trim the aerodynamics of the ship to a stable position in forward flight
-replace a horizontal tail rudder and provide pitch control.

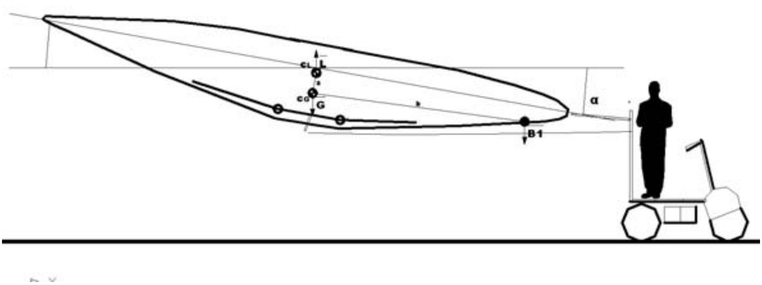


Different vertical trim settings and placement of hinges

The goal of these experiments is to measure the aerodynamic forces on the model for different vertical position and evaluate the feasibility of this control mechanism

B03 Setup

The model is trimmed to be weightless and is pulled along by an electric cart.



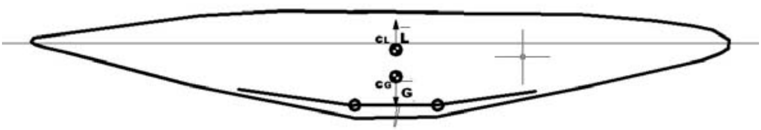
Ropes are attached from a frame on the rear of the car to the mounting points of the engines. The model is pulled along by these ropes.
A sliding rod connecting the nose to the frame restricts the movement of the model in the Y-as and limits movement in the Z-axis (pitch) to +/- 80 cm.

The model is tested for different fixed settings for the vertical trim.

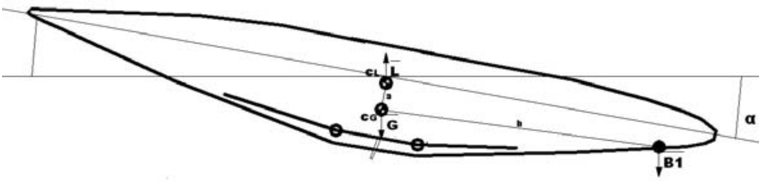
Testing with cart tow

B04 Measurement method and calibration

In rest the model is suspended by its own lift. Ballast is distributed so the model floats parallel to ground level.



At this point, pushing down the nose of the ship to a pitch angle α, results in a self-righting momentum M=G.a.sin α . This momentum increases with the angle α.



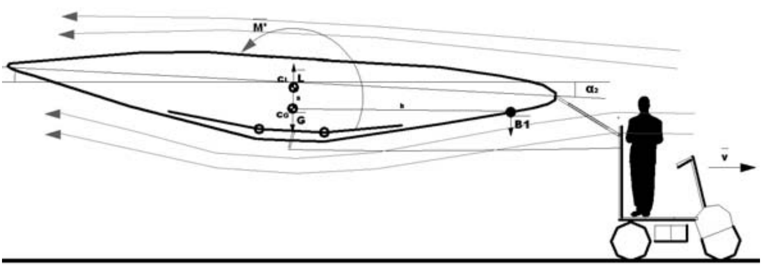
Downward pitch angle caused by nose ballast B1 α

We can determine the size of M by measuring the rotation around the Y-axis of the model by adding a known mass B1 as ballast in the nose.

This gives us a relation between a rotational momentum working on the model and the angle of rotation.

It now suffices to measure α during a test to calculate the resulting rotational momentum M' working on the model.

If, for example, the tail of the ship is trimmed 'up' this will cause the model in-flight to assume a positive pitch angle α. The size of this angle allows to determine the size of the rotational momentum M'



For a number of fixed settings of the model shape, the model is towed at a constant speed v.
These runs are photographed with time interval cameras, and the pitch angle α is determined by analysing these images.

B05 Problems and disadvantages

-using the cart , with 2 people on it, will disturb the air flow in front of the model. It should be possible to adapt a smaller electric carts for RC.
However, the second person on the car now provides a very good way to control the model and stop the test if anything goes wrong.