The boomerang consists of two crossed slender rods at right angles, forming four arms each of length L. We designed the airfoil shape of the boomerang such that the lift forces are in the \( \hat{i} \) direction. So,

\[
\vec{F}_{\text{Total}} = \rho C_L L \left( \frac{2}{3} \omega^2 L^2 + V_G^2 \right) \hat{i}
\]

\[
\vec{M}_{\text{Total}} = \frac{2}{3} C_L \omega \rho V_G \hat{j}
\]

Then, by neglecting the gravity force – which does not create any moment on the center– and the drag forces acting mainly at the tips of each wing, we used the famous Euler equations of rigid body dynamics which are simplified by the symmetric shape. This allowed us to conclude that the boomerang is following a circular path of radius \( R \) and at constant precessional angular velocity. The equation for the radius of the orbit is

\[
R = \frac{3 I_{xx}}{2 C_L L^3 \rho_{\text{air}}}
\]

This equation is the basis of our design process. In order to satisfy it, we had to choose appropriate geometrical dimensions by paying attention that

- the boomerang should not break if it hits the ground
- it should be heavy enough for stability

**Airfoil profile**

The choice of the airfoil profile depends mainly on his convenience of manufacturing. We used a slightly revised Tsagi R3-A profile by smoothing the trailing edge on a matter of impact resistance. The lift coefficient \( C_L \), which is linear to the angle of attack, is estimated by a logiciel.

**Design**

The left boomerang is a simple and easy to build design, without regard to the tip effects. The one on the right is more complicated. We need to modify the equation of the lift forces by varying the chord and obtain a different equation for the radius. By the way, both designs fulfil the radius equation.