

## CENTRIFUGAL LOAD TEST

### VORPALINE PROPELLER

Centrifugal load tests are very important test in order to define the mechanical resistance. They are defined by EASA Certification Specifications for Propellers (CS-P).

EASA AMC P 350 Centrifugal Load Tests :

*It must be demonstrated that the Propeller complies with EASA CS-P 350 without evidence of failure, malfunction, or permanent deformation that would result in a Major or Hazardous Propeller Effect. When the Propeller could be sensitive to environmental degradation this must be taken into account. The hub, the blade retention system, and the counterweights must be tested for a period of one hour to a load equivalent to twice the maximum centrifugal load to which the Propeller would be subjected at the Maximum Permissible Rotational Speed or Maximum Governed Rotational Speed, as appropriate.*



#### 1. Calculation of the centrifugal load applied to a hub + blade

$$\|\vec{F}\| = m\|\vec{a}\| = m \cdot \omega^2 \cdot R$$

The maximum centrifugal load on the Vorpaline S propeller @ 3.400 tr/min has been calculated by the inhouse software LmPTR© : 15.000 N (1,5 tonnes).

In this case, the CS-P for certified propellers says that the propeller must be tested for a period of one hour to a load of 30.000 N.

## 2. Test of centrifugal load on a carbon hub + blade

The following tests have been made :

1/ Measurement of the instant torques at different RPM, including start and stop (confidential data), for engines :

- UL power 260i (direct drive)
- Rotax 912s reducer 1:2.43.
- Génésis 3 cylinders reducer 1:2.6

2/ After selection of a maximum instant torque value, a test of fatigue has been done to reproduce at 10 times the maximal conditions of a 100 hp 4-stroke 4-cylinders engine on a propeller VORPALINE S.

*1.000 hours of tests represent 180 millions of cycles*

At this end of this test, the hub and the blade have been disassembled and analysed. Nothing was to report.

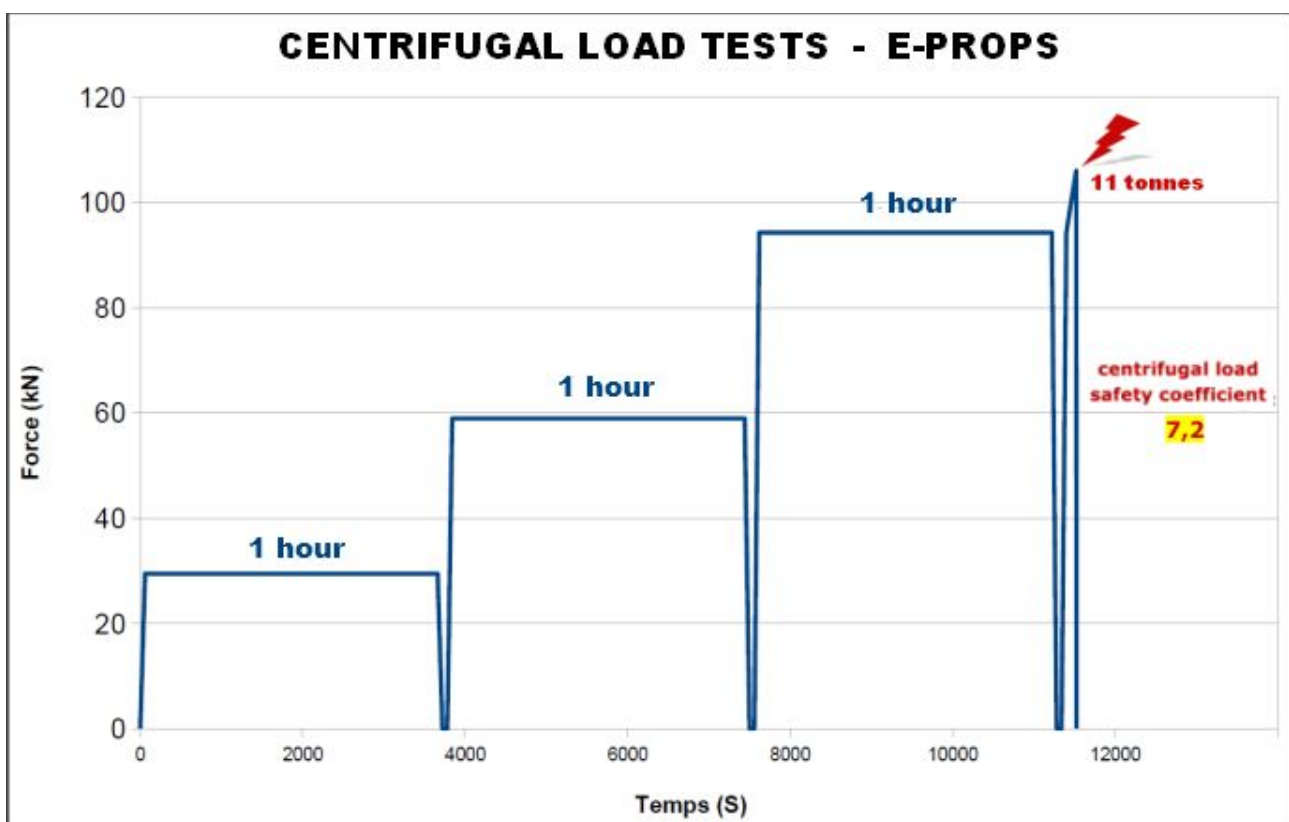
3/ The same hub + blade has been tested at centrifugal load.



*carbon hub + Vorpaline blade on a bench test with instruments*

This test has been made in 4 steps :

- 1st step : load 30.000 N (3 tonnes) during 1 hour. Then control : nothing to report
- 2nd step : load 60.000 N (6,1 tonnes) during 1 hour. Then control : nothing to report
- 3rd step : load 94.000 N (9.6 tonnes) during 1 hour. Then control : nothing to report
- 4th step : load up to 94.000 N (9,6 tonnes), then increase of the load at 4.000 N per minute  
=> **break of the carbon hub at load 108.000 N (11 tonnes)**



The maximum centrifugal load at 3400 RPM is 15.000 N, **the safety coefficient of centrifugal load is 7,2.**

The system hub + blade can hold **6 times the maximal load during 1 hour** without any damages.

Conclusion :

**The propellers made by Hélices E-Props are not only the lightest and the most efficient, but also the strongest of the market.**

Today, only the E-Props process allows to use the exceptional characteristics of the carbon, in order to obtain propellers 3 times lighter than the other propellers on the market, and 3 times stronger as asked by the EASA certifications specifications CS-P for certified propellers.

