Prepared for the future – WT Blade Test
Optimized fatigue test

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Abstract

Fatigue blade testing simulates the fatigue load on the Wind Turbine blade for the design life of the Wind Turbine. The challenge is to reach the bending load distribution along the blade without overloading the blade too much in several points. BLAEST has tools to simulate the bending moment distribution and methods to achieve the bending moment distribution in the laboratory. Instead of placing large masses on the blade and avoid unwanted effects, BLAEST has developed oscillation amplifiers mounted on the floor.

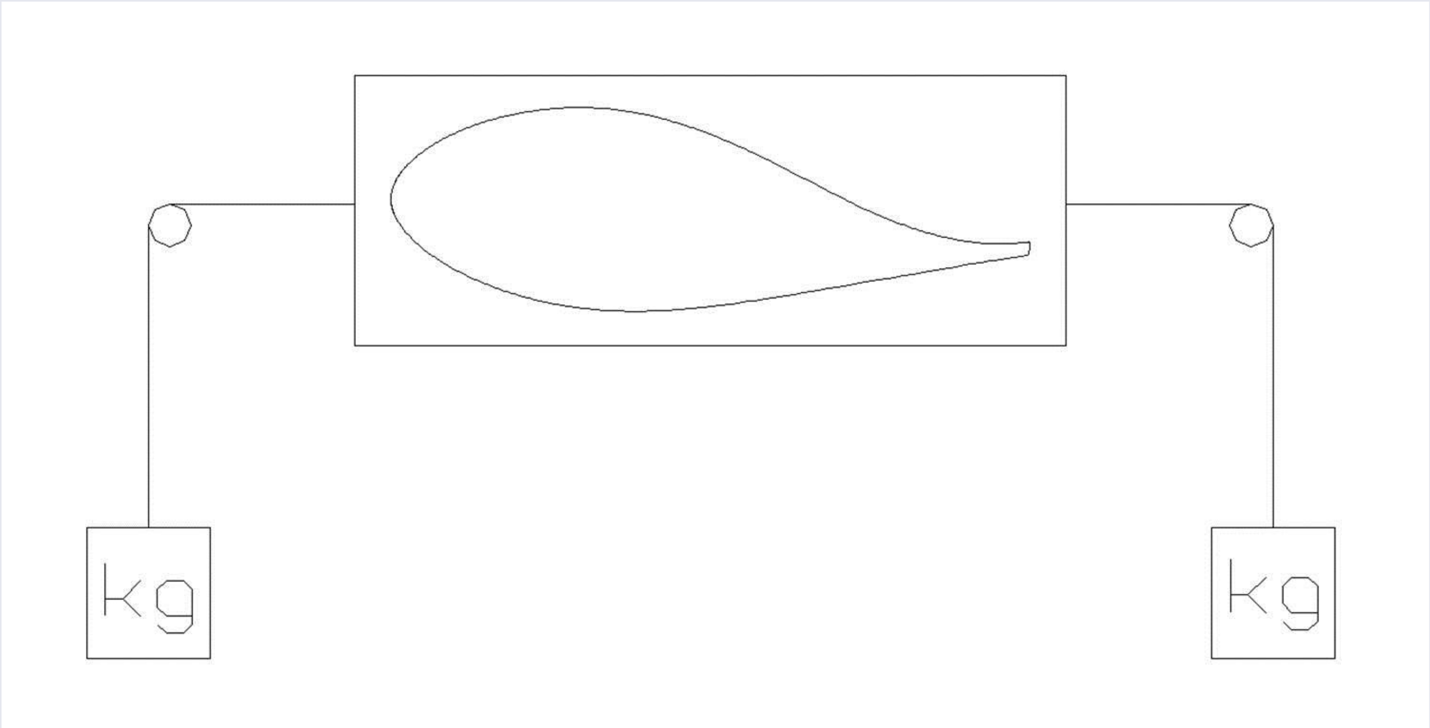
Objectives

It is crucial for the designer and manufacturer of a newly developed blade to have the blade strength verified without unnecessary delay. A fatigue test must reach the required bending moment from the root and until 70% of the blade length. It is often difficult to reach the target bending moment close to the root as the movements are minor close to the root. In order to increase the bending moment in the root it is necessary with very large masses. The large masses cannot just be added to the blade as they will increase local normal force on the web and the shear forces to an unacceptable level. Consequently, it is often seen that the number of cycles are increased in order to avoid too large unintended applied forces. The objective is therefore to apply large masses without adding unintended forces.

Methods

BLAEST has developed simulation tools that can be used in connection with setup for fatigue test of a wind turbine blade. This tool is used in order to find the best possible distribution of dead weight and exciter position. The exciter itself has a large influence on the need for other load applications from dead masses. It is therefore important to introduce the oscillating load with a minimum dead mass. Therefore, BLAEST has developed two different floor based exciters, mainly used for larger blades. One is an electrically driven exciter with rotating masses, mounted on a seesaw and the other is a newly developed lightweight electrically driven exciter with a pushrod connection to the blade.

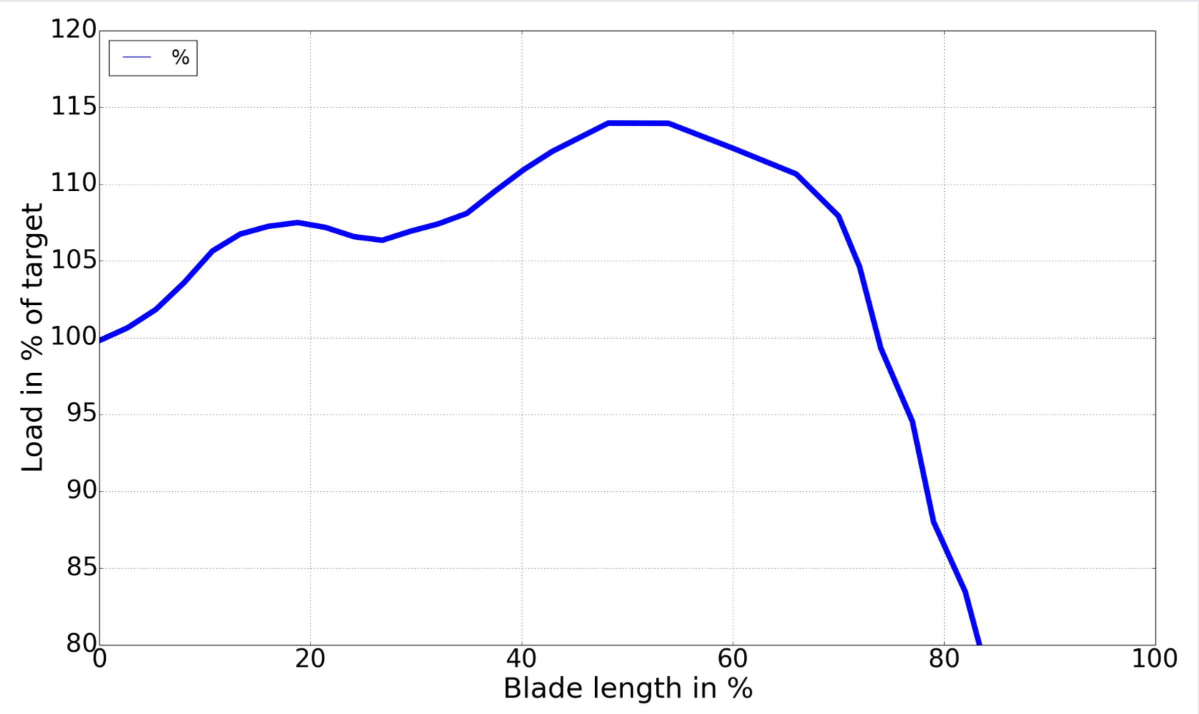
Furthermore, BLAEST has developed different oscillation amplifiers for both edgewise and flapwise directions which do not affect the blade unintendedly. Below figure shows an example for an edgewise horizontal test direction.



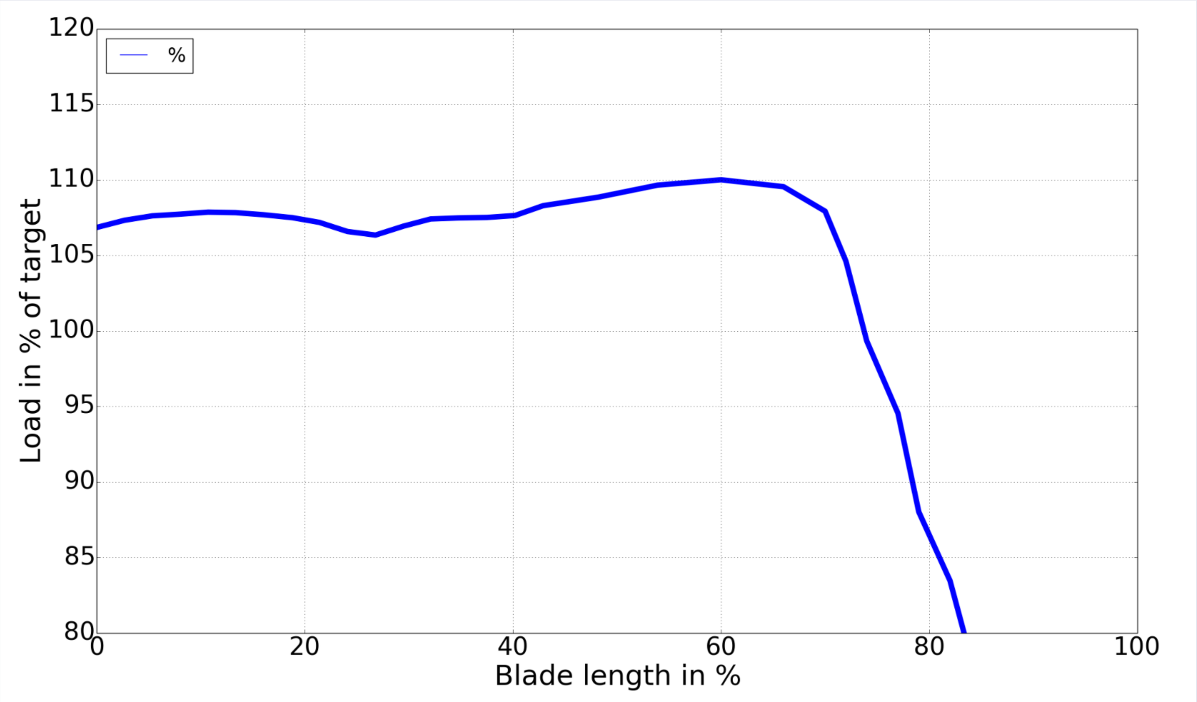
The introduction of masses acting in one direction can be done in several different ways. BLAEST has practical experience with several different methods used both in edgewise and flapwise directions. The above figure shows a method using a wire and a pulley which will add mass in the edgewise direction without affecting the flapwise direction.

Results

BLAEST has gained good results from the simulation of fatigue loads for both edgewise and flapwise tests. Below is shown a simulation of a flapwise test as it is often seen. Typically, the load level at the root gives the result for the rest of the blade. Here, the overload is not less than 14% at 50 % from the root.



Adding large masses relatively close to the root will increase the load in the root and thereby change the critical point to 70 % of the blade length. The maximum overload is now reduced to 3% at several points from the root to 70 % of the blade length. See also the diagram below:



Consequently, it is possible to decrease the overload on much of the blade and at the same time reach the required bending moment at the root. This method will also permit a small increase in the general load level, whereas the overload it kept at an acceptable level. This increase will also permit a reduced number of load cycles. Assuming that the blade is made of polyester, an increase of loads by 7 % will reduce the number of cycles to 50 %.

Conclusions

Using the oscillation amplifier permits a significantly shorter duration of a fatigue test and at the same time real loads are simulated more correctly.

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