Experimental Validation of an original 3-D Finite Volume Method Model Applied to Wind Turbines Design under Vibration and Shock Constraints. TRÉVISE Platform.

As wind turbines are dynamically complex structures operating under complex conditions due to the non-stationary and turbulent speed of the wind, the dynamic response of their components subjected to vibration (the blades, the nacelle and the tower) are analytically, numerically and experimentally investigated in this paper. Thus, a three-dimensional (3-D) numerical model of a wind turbine created by the finite volume method (FEM) is set up using the academic finite element analysis software ANSYS. To check the validity of this created model, experimental vibration tests are carried out using a high-force electro-dynamic shaker in ECAM-EPMI Trevise-laoratory. The tests are based on the modal analysis (MA) technique, which is one of the finest techniques allowing confidentially the identification of structures dynamic response. MA requires multi-point excitations in order to maximize the energy inputs. Thus, several dynamic random, swept sine and shock-forces are applied in the frequency range of interest, to excite a six blades Rutland 504 micro-wind turbine. The responses are recorded at different positions by measuring vibrations levels using accelerometers connected to a dynamic data acquisition system. Accordingly, frequency response functions (FRF), between input and output spectrums, are calculated to extract the mode shapes and natural frequencies of the structure. Based on the obtained modal parameters, the designed finite volume model under vibration constraints is up-dated.

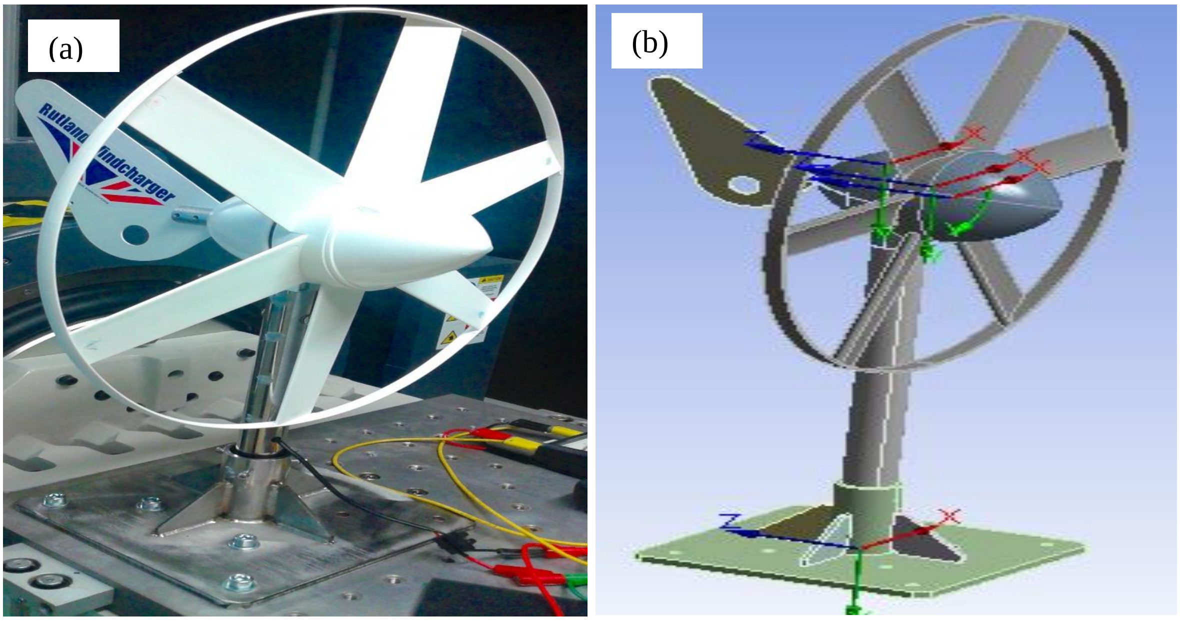

Fig. 1 Rutland 504 micro-wind turbine; *(a)* real one and *(b)* numerical model designed by ANSYS

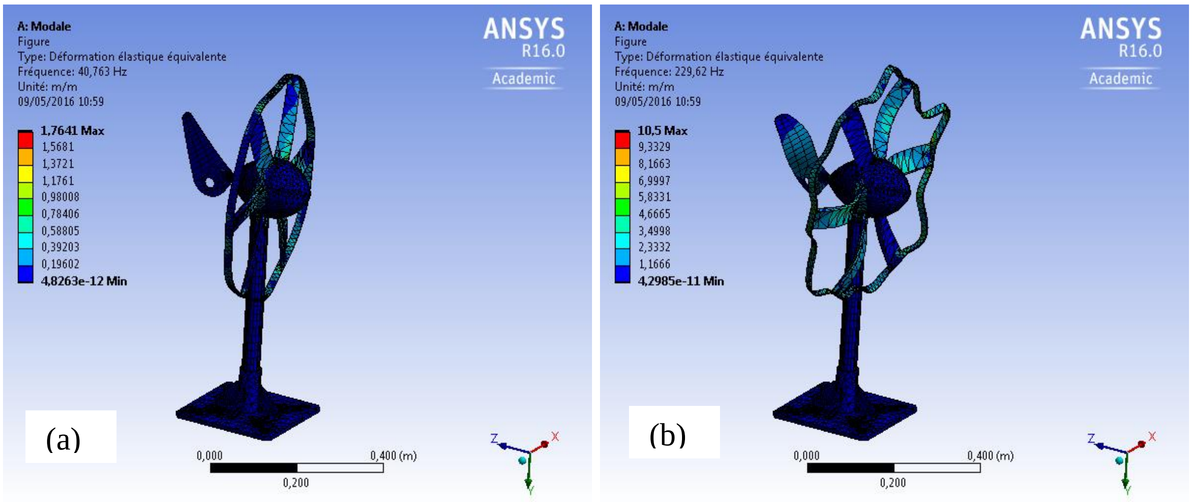

Fig .2 ANSYS-equivalent elastic deformation of the wind turbine at *(a)* the 5th mode shape and *(b)* the 12th mode shape

Fig. 3 Experimental Vibration-test platform of ECAM-EPMI Trevise-laoratory carrying the Rutland 504 wind turbine and the test instrumentations

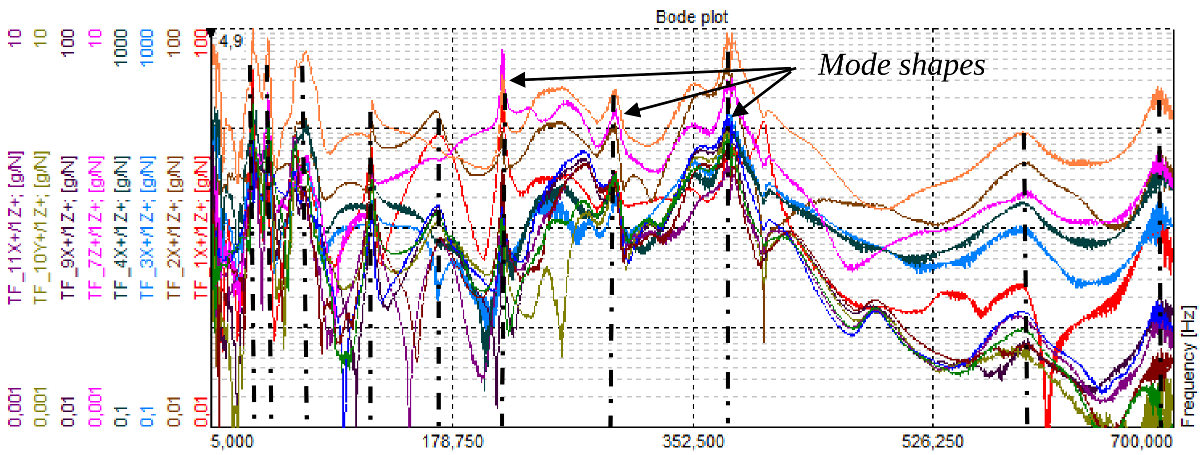

Fig. 4 FRF results of vibration tests of the wind turbine structure presenting some mode shapes