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Experimental Investigation Of Windmills Aerodynamics, Torque Regulation By Use Of Elastic Bindings

Roberto Putzu*, Pierre-Louis Schmitt† and Anthony Haroutunian†
HES-SO - hepia Geneva, 4 Rue de la Prairie 1202 Geneva, Switzerland.

In the framework of the Patmos windmills Restoration, an experimental investigation of the rotor aerodynamics was considered necessary for the windmill regulation.

Historically, at high wind speed, the windmill's shaft torque was regulated by manually rolling the triangular sails around their own spoke to reduce the lifting surface and decrease the aerodynamic loads. Continuous changes in wind speed could demand frequent human interventions on the rolled surface. In order to reduce these interventions, a self regulation mechanism involving the use of an elastic binding instead of a classical rope to tighten the sail was investigated.

The analysis, performed in Reynolds similarity considering a constant real rotor speed of $\omega = 1.57$ rad/s and a maximum real wind speed of 15.4 m/s, was conducted on the statical model of a single windmill blade in reduced scale.

Tests were performed for several sail rolling conditions: with a rigid rope and with elastic stripes binding the sail to the blade frame. Results show that the increase in aerodynamic torque due to wind rise can be reduced by using elastic bindings.

Nomenclature

b	Sail width at the reference section, m
D	Sail length at the spoke, m
C_f	Force coefficient
C_m	Moment coefficient
e	Binding elongation, cm
F	Force at the binding, N
L	Spoke length, m
Re	Reynolds Number
T	Torque, Nm
u	Reference section's rotational speed, m/s
V	Wind velocity, m/s
w	Relative velocity, m/s
x	x coordinate
y	y coordinate
z	z coordinate

Subscript

mod	Model
wt	Wind tunnel
wm	Windmill

*HES Professor, CMEFE, 7 Rue du Pont Butin, 1213 Petit Lancy, GE, Switzerland.
†HES Research assistant, CMEFE, 7 Rue du Pont Butin, 1213 Petit Lancy, GE, Switzerland.