Non-Linear data-driven model for a solar tracker aeroelastic simulation

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Abstract

The solar tracker industry has evolved dramatically in recent years with huge PV-farm demanding for challenging structural design. In such framework it is essential to consider aeroelastic wind loads due to flow unsteadiness and vortex shedding. Dynamic loads estimation is therefore not easy: this is due to the fact that, being the tracking systems equipped with a torsional flexible constraints, complex fluid-structure interaction phenomena, briefly called flutter, can be triggered. The latter modify the load scenario and the structural damping in an apparently unpredictable way, generating a dangerous self-excited load on the system, that can be unhealthy for the structure integrity. The aeroelastic behaviour of the panel could be described through dimensionless parameters (the so-called "Scanlan Derivatives"), that usually are function of the reduced wind speed and that can be estimated starting from damping and frequency under freely excited oscillation, basing on the classic vibration's theory. Several experiments have been performed in the "R. Balli" Wind Tunnel at the University of Perugia to estimate such parameters in different wind condition using a scaled model of the solar tracker. Results demonstrate how these aeroelastic parameters are function of wind speed and of the angle of attack; this behavior affect dramatically the final critical wind speed (the speed at which flutter occurs). Basing on the experimental campaign a numerical model has been developed in order to reproduce the non-linear aeroelastic behavior of the structure. A comparison of the results of the linear and the data-driven non-linear model were discovered to be a very useful tool in order to understand the complex dynamic behavior of the structure: it has been found that under certain operating conditions the non-linear model provides an average amplitude error five times lower than the value obtained from the linear model.Only this type of analysis can give useful insight to improve the challenging design of huge solar tracker structures.

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