Structural Optimization of Tubular Steel Wind Turbine Towers with Respect to Buckling

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Abstract

As attention on wind energy is progressively increased, wind turbine towers grow in height and the blades become longer in order to better exploit the available wind potential. As a result, actions on the towers are also increased and their safe and cost-effective design is important for the further development of the wind energy sector. A commonly used type of wind turbine tower is the tubular steel tower which offers several structural advantages and has dominated the market over other alternatives, such as truss-type towers. The tubular wind turbine tower is composed of a number of cylindrical and/or conical shells, manufactured in the factory and erected on site by means of bolted ring flange connections.

In the present article, the buckling design of an actual 120m tall wind turbine tower is described, aiming towards optimizing the tower with respect to weight, hence also cost, and taking properly into account restrictions pertaining to fabrication, transportation and erection. Among several constraints that the tower design has to satisfy, in the present paper only buckling is addressed, based on Eurocode 3 recommendations for steel shells, as well as on nonlinear finite element analyses, and taking into account realistic action effects in normal and extreme conditions. Namely, initial results obtained by verifications according to EN1993-1-6 are then compared to numerical results from non-linear finite element analysis accounting for geometrical and material nonlinearity and imperfections (GNMNIA). Thus, areas where the tower wall thickness has margins for reduction are identified, so that in future work an optimized tower design can be achieved.

References

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