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NB/T 10907-2021

Code for Design of Concrete-Steel Hybrid Tower of Wind Turbine

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Foreword

This document was issued on 22 December 2021 by the National Energy Administration of the PRC and takes effect on 22 March 2022.

It is a NB/T standard: recommended rather than compulsory, but it is the text a Chinese reviewer applies when assessing a submission.

It is classified under ICS 27.180, Chinese classification P61.

This code was approved and issued by the National Energy Administration in Announcement 2021 No. 6 of 22 December 2021, together with 356 energy industry standards and 25 foreign-language editions; it is listed as item 58 in Annex 1, with no superseded standard, approval date 2021-12-22 and implementation date 2022-03-22.

This code was formulated in accordance with the requirements of the Notice of the National Energy Administration on Issuing the 2016 Plan for the Formulation (Revision) of Energy Sector Industry Standards (Guo Neng Ke Ji [2016] No. 238). The drafting group carried out extensive investigation and research, carefully summarized practical experience and widely solicited opinions before formulating this code.

The main technical contents of this code are: general provisions, terms, basic requirements, materials, loads and action effect combinations, ultimate limit states calculation, serviceability limit states verification, detailing requirements and safety monitoring.

This code is under the administration of the National Energy Administration, is proposed and routinely managed by China Renewable Energy Engineering Institute, and its specific technical contents are interpreted by the Wind Farm Planning and Design Subcommittee of the Energy Industry Wind Power Standardization Technical Committee (NEA/TC1/SC1). Comments and suggestions should be sent to China Renewable Energy Engineering Institute (No. 2 Liupukang North Alley, Xicheng District, Beijing, postcode 100120).

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1 Scope

NB/T 10907-2021 is the Chinese design code for hybrid concrete-steel wind turbine towers, onshore and offshore. As turbines grow and hub heights rise past 140 metres, an all-steel tubular tower becomes too large in diameter to transport by road; a hybrid tower solves that by building the lower part in prestressed concrete - cast in place or assembled from precast segments - and mounting a conventional steel section above it. The code sets the general provisions and defined terms and symbols, then the basic requirements: the design service life, the limit states to be checked, the partial factors, and the loads and load combinations derived from the turbine and the site, including fatigue, seismic and, offshore, wave and current loading. Materials follow - concrete grades, prestressing steel and anchorages, reinforcement, structural steel and the grout for segment joints. Design of the concrete section covers the ultimate and serviceability checks under bending, axial force and shear, the prestress losses and the decompression and crack control requirements that keep the joints closed under operating loads, the fatigue of concrete and tendons, the horizontal and vertical joints between precast segments, and the frequency of the tower relative to the rotor. The transition piece between concrete and steel, with its anchorage and load transfer, has its own chapter, as do the foundation interface, construction, and inspection and maintenance.

1.0.1 This code is formulated with a view to standardizing the design of concrete-steel hybrid towers of wind turbines, so as to achieve safety and applicability, advanced technology, economic rationality and assured quality.

1.0.2 This code is applicable to the design of the concrete segment of onshore and offshore concrete-steel hybrid circular tubular towers of wind turbines and of its connection with the steel segment.

1.0.3 In addition to this code, the design of concrete-steel hybrid towers of wind turbines shall also comply with the relevant current standards of the nation.

2 Terms

2.0.1 Concrete-steel hybrid tower: a structure used to support a wind turbine, composed of a lower prestressed concrete segment and an upper steel segment.

2.0.2 Internal prestress: prestress produced by prestressing tendons arranged within the cross-section of the concrete segment of the tower.

2.0.3 External prestress: prestress produced by prestressing tendons arranged outside the cross-section of the concrete segment of the tower.

2.0.4 Horizontal seam: the horizontal splicing joint between upper and lower precast members of a prefabricated concrete tower.

2.0.5 Vertical seam: the vertical splicing joint between left and right precast members of a prefabricated concrete tower.

2.0.6 Bonding material: the cementitious material applied on the horizontal seam to connect the upper and lower precast tower members.

3.1 General Requirements

3.1.1 The concrete-steel hybrid tower of a wind turbine shall have sufficient reliability within the specified design working life. The structural design shall adopt the limit state design method based on probability theory and expressed in partial factors.

3.1.2 The design reference period for the structural design of concrete-steel hybrid towers of wind turbines shall be 50 years.

3.1.3 The design working life of the main structure of the concrete segment of the tower shall not be less than the design working life of the wind turbine and should be 50 years. The design working life of the steel segment of the tower shall not be less than the design working life of the wind turbine.

3.1.4 Within the specified design working life, the concrete-steel hybrid tower shall meet the following requirements: 1 it can withstand the various loads and actions that may occur during normal construction and use; 2 it has good working performance in normal use; 3 it has sufficient durability under normal maintenance; 4 it maintains overall stability during and after the occurrence of accidental events specified in the design.

3.1.5 The structural safety class of the concrete-steel hybrid tower of a wind turbine shall not be lower than Class II.

3.1.6 The fatigue design of the concrete-steel hybrid tower structure should adopt the allowable stress method.

3.1.7 The concrete segment of the concrete-steel hybrid tower should adopt a post-tensioned prestressed concrete structural system; the prestress may be in either of two forms, internal prestress or external prestress.

3.1.8 The total height of the concrete-steel hybrid tower and the height ratio of the concrete segment to the steel tower segment shall be determined by comprehensively considering factors such as the wind energy resources of the wind farm, the wind turbine model, the structural stress state, the project cost and the construction conditions.

3.1.9 For the structural analysis of the concrete-steel hybrid tower, methods such as elastic analysis, elastoplastic analysis, plastic limit analysis and test analysis may be selected according to the structural type, material properties and stress characteristics.