Design of UHPC Wind Turbines

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Summary

Ultra-High Performance Concrete (UHPC) has impressive characteristics in terms of fatigue and durability which seem perfectly suited for the erection of wind turbine masts. A two-stage feasibility study is carried out to come up with an efficient design for the tower. First, an approach using linear finite elements based on the beam theory enables to define the global geometry. Then the latter is checked locally through shell elements in order to perform the necessary updates. Finally, a construction sequence shows the advantage of such a material when combined with prestressing for the erection process.

Keywords: Ultra-High Performance Concrete; wind turbines; fatigue; durability; prestressing; construction sequence.

1. Introduction

With a current worldwide capacity of 200 GW constantly increasing, wind energy is becoming one of tomorrow's main sources of energy [1]. To assure the competitiveness with regard to traditional energies, a race towards more productivity and efficiency has been launched. The current tendency consists of building offshore windfarms to benefit from the best wind conditions available. It requires massive structures designed for heavy loads in complex environments, making the design difficult when using traditional materials such as steel or concrete. Until now, the tower of the wind turbine, which represents by far the largest part of the structure, has been almost exclusively made of steel. The use of an Ultra-High Performance Concrete for the erection of the mast, revealing promising properties for fatigue and offshore conditions, could represent a breakthrough. It could be a more adapted material than steel or concrete and could push back the current limitations.

Fig. 1: View of a Typical Offshore Windfarm (Siemens Press Picture)

2. UHPC Characteristics in terms of Fatigue and Durability

2.1 Fatigue

The fatigue of UHPC has been investigated for many years, mostly on bridges and offshore

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