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A New Concept for Tower Structures of Wind Turbines

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The increase of worldwide wind energy delivery output led to the design of wind turbines with big hub heights using tower structures made of concrete or the combined use of concrete and steel (hybrid tower structures). A new approach to constructing towers out of double walls (two thin concrete slabs connected by steel bars) is presented in the current work. In order to show the feasibility of the proposed construction method a prototype was erected. The experiences and results gained from the prototype erection are promising and indicate that the new construction method is likely to establish itself on the market.

I. Tower Construction Method

The proposed building method is based on simple double wall elements. These light-weight double wall elements can easily be transported to the construction site by standard construction vehicles. There a preassembly field is used to position, angle and temporarily fix the single elements by skew bracings, so that the loose elements can be connected to form polygonal ring segments. After each ring segment is assembled it can be placed on top of the preceding segment. In order to create a monolithic structure the separate segments are then filled with in-situ concrete. The continuous filling of the segments with in-situ concrete allows the structure to rise without any joints in the core of the hollow elements. As a final optional step of the tower erection, all segments can be, if needed, post-tensioned vertically against the foundation.

II. Prototype

A prototype tower was built to test the previous proposed construction method. This prototype consists of six segments with different heights result in a tower with a total height of 16.15 m and an outer diameter of 4.15 m at the bottom, whereby the cross section of the structure is chosen as a regular nonagon, see Fig. 1. A method using semi-precast elements to erect a concrete structure is confronted with various challenges during the erection, which is further discussed in a master thesis [2]. One of these challenges is the connection of the double walls which should resist all erection load cases so that the set up segment geometry is secured. Another one is the segment joint sealing construction enabling the concreting of the tower.

III. Comparison of Concrete Tower Structures

The relevance of the new building method can be shown by comparing the different erection methods of concrete towers for wind turbines. In-situ concrete towers erected with slip- or climbing formworks show the best load bearing and fatigue resistance but there erection is too time-consuming and therefore expensive because only approx. 4 m high segments per day can be produced. At present the most common concrete tower for wind turbines made of fully bodied precast elements can be erected very fast and is therefore a cheaper variant but the elements have to be kept in place by post-tensioning. Thus, the new construction method using double walls should combine the advantages of the in-situ and the precast towers allowing for producing a tower which can be erected fast but can still be designed without post-tensioning.

Fig. 1 Erected Prototype with an outer diameter of 4.15 m at the bottom and a total high amounting to 16,15 m

IV. Conclusion

It can be stated that the present results gained from the prototype erection and the structural analysis show that the proposed construction method is promising and is likely to establish itself on the market.

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