EXPERTS IN FOUNDATION DESIGN FOR WIND TURBINES
Reliable – Efficient – Responsive – Worldwide
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Dear editor,

Thank you for your interest in CTE Wind Civil Engineering SAS. The Experts in Foundation Design for Wind Turbines

Below you will find two articles:

The first one is a technical article about resource-saving foundation solutions. The Article has 937 words and has never been printed. Pictures available upon request. The second article is about CTE Wind Stand in Bilbao (124 words).

On the last page you will find the boiler plate (68 words).

More information and pictures on our website or upon request.

Kind Regards

Sergio CARÈ LUCAS

PS: WE SPEAK GERMAN, FRENCH, ITALIAN, SPANISH AND ENGLISH.

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La Richardais, 22 March 2022

Engineering of Wind Turbine Foundations

With the increase in average turbine size witnessed by the global wind industry over the years, foundations have also become enormous. Therefore, innovation and expertise are crucial to remain competitive in an industry where optimisation is essential in order to reduce the costs associated with foundations.

The engineering approach of designing foundations has evolved since the industrial take-off of the sector. In 20 years, the foundation diameters have increased from 10 to 27 metres. The latest wind turbines transfer colossal loads to the tower, which are then transmitted through the foundation into the ground. The international guidelines and regulations have also progressed, becoming more complex. Foundations are not designed in the same way as 10 years ago.

Several criteria influence the choice of foundation to be used. The geotechnical investigations reveal the nature of the soil, providing a first set of foundation solutions that can adapt to the site. But the type of wind turbine also has a decisive influence. Firstly, the loads specific to each machine will have an impact on the sizing of the foundation and the type of connection (i.e. anchor cage) between the tower and the foundation. Other aspects include seismic requirements or liquefaction, to name a few.

Foundation Solutions

CTE Wind is constantly developing new solutions to reduce the concrete volume required – Star Foundation and Soft-Spot® designs for instance. Both are particularly useful in soils with buoyancy (water pressure), where the foundations are heavier in order to withstand the upward forces and to ensure stability. Star-shape foundations appeared in the market a while ago with little success. The star shape allows a saving of concrete of up to 40% per foundation. This type of solution consists of a thin concrete base with star-shaped elevation on top, and backfill is compacted between the ribs. However, the formwork to form the ribs of the star is more complicated than that of a conventional shallow foundation. Savings are due to concrete volume reductions but expenditures increase on formwork. It is therefore necessary to perform a comparative analysis at the predesign stage, but this is not always easy in countries where concrete is affordable. In Europe, it is on a case-by-case basis. In Latin America, on the other hand, the calculation is quite different since concrete is usually twice as expensive as in Europe and the cost of labor is lower.

Soft-Spot® Foundation

This foundation design optimizes the use of resources through placing a layer of soft material below the central part of the foundation and helps to save concrete and reinforcement, compared to a traditional shallow foundation. The slab will effectively act as a ring foundation with respect to the soil-structure interaction. The bearing pressure of the WTG is concentrated at the annular contact surface closer to the edge of the slab. This increases the lever arm of the stabilizing moment. Therefore, the foundation diameter can be reduced in

comparison to a standard foundation solution. One of the requirements for this kind of solution is to have relatively good soil because the foundation will behave in a ring shape. This means that stresses will be higher in the outer area and the stresses in the middle section covered by the Soft-Spot are reduced to zero.

Thanks to Soft-Spot® design less excavation work is needed. This reduces the machine costs. A major point is that no additional training of site workers is required for the construction of the soft layer. The construction is very easy and the material for the soft layer can be purchased cheaply all over the world.

This solution has been developed by CTE Wind's engineering team (patent application FR1902552 and WO 2020/182957) and implemented in more than 100 projects for nearly 1.500 turbines across 20 countries, such as France, Spain, Finland, Mexico, Chile, USA, to name a few.

In terms of the benefits, the traditional shallow foundation initially proposed in a recent project had a concrete volume of 1,192 cubic meters and a diameter of 27.4 meters. The Soft-Spot solution allowed a significant reduction, leading to a concrete volume of 980 cubic meters and a diameter of 24.5 meters. A central space in the lower area of the foundation is needed for a soft material such as EPS foam. This may have a variable diameter of 7 or 13 meters (depending on the project), but CTE Wind has demonstrated that the ring foundation, due to eccentricity determination, takes off from the ground at a later stage as opposed to a conventional foundation slab.

Other Aspects of the Soft-Spot®

Following OEM requirements, the Soft-Spot complies with the dynamic rotational stiffness stipulated in the specific technical specification according to the wind turbine chosen. In addition, the Soft-Spot® material (EPS foam for instance) is available worldwide, which makes it easier for contractors to purchase the material locally. The Soft-Spot® is a solution proposed on a case-by-case basis that must be compared with others at the predesign stage. The client will then have all available information to choose the best solution following the company's criteria. It is important to state that the construction sequence is very similar to that of a shallow foundation. Therefore, time delays in its construction remain the same. Some of the cost savings in choosing the Soft-Spot include the following: excavation, backfill, concrete and steel reductions.

Conclusion

As wind turbine technology advances steadily, constant innovation is required when dealing with foundations. The Soft-Spot® is a solution that fits well into this dilemma, with optimised materials and continued simple construction. Developing new foundation solutions is therefore necessary to keep up with the speed of the latest turbine models.

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Photo:

Ribbed / Star Foundation in Spain

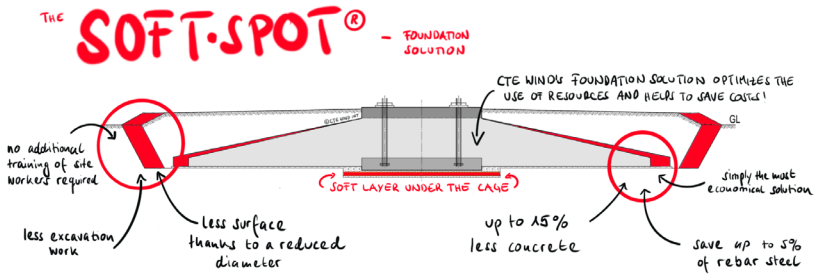

Photo:

Soft Layer under the anchor cage during the construction of the Soft-Spot® foundation in france.

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WindEurope 2022 in Bilbao on 5-7 April

WTG-Foundation experts back at WindEurope event

WindEurope Annual Event returns to Basque city Bilbao in 2022. CTE Wind will attend for the second time with an own booth. The opportunity for networking with the international wind turbine foundation experts.

CTE Wind is delighted that WindEurope has chosen to return to Bilbao for this event. Bilbao is known to be HQ of leading renewables company and also it is home town of CTE Wind Ibérica, CTE Wind's country office in Spain.

The event is a great opportunity for interested EPC/CBoP-experts to meet the dedicated engineering and sales team to learn more about CTE Wind's structural engineering and foundation expertise and to talk about future wind park projects. Meet the WTG-foundation experts at the Booth 3-B46.

Day 2 of the event a professional ham-cutter will perform at CTE Wind's stand.

About CTE WIND

CTE Wind Civil Engineering is an international engineering consulting firm specialized in the analysis and design of onshore wind turbine foundations. CTE Wind has been active in the wind energy sector since 2003. As of 2022, CTE Wind has designed, value-engineered or peer-reviewed foundations for over 23,500 turbines in 73 countries. CTE Wind is headquartered in France and has offices in Brazil, Poland, Portugal, Spain, USA and Vietnam.

Certified studies

CTE Wind designs for reinforced concrete, steel structures and geotechnics are approved by recognized certification and inspection bodies: Apave, DNV GL, Bureau Veritas, Seco, TÜV Nord, TÜV Süd, Socotec, Lahmeyer, Tractebel, etc.

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