World Academy of Science, Engineering and Technology
International Journal of Geotechnical and Geological Engineering
Vol:11, No:07, 2017

A Reusable Foundation Solution for Onshore Windmills

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Abstract : Wind farms repowering is a significant topic nowadays. Wind farms repowering means the complete dismantling of the existing turbine, tower and foundation at an existing site and replacing these units with taller and larger units. Modern wind turbines are designed to withstand approximately for 20~25 years. However, a very long design life of 100 years or more can be expected for high-quality concrete foundations. Based on that there are significant economic and environmental benefits of replacing the out-of-date wind turbine with a new turbine of better power generation capacity and reuse the foundation. The big difference in lifetime shows a potential for new foundation solution to allow wind farms to be updated with taller and larger units in order to increase the energy production. This also means a significant change in the design loads on the foundations. Therefore, the new foundation solution should be able to handle the additional overturning loads. A raft surrounded by an active stabilisation system is proposed in this study. The concept of an active stabilisation system is a novel idea using a movable load to stabilise against the overturning moment. The active stabilisation system consists of a water tank being divided into eight compartments. The system uses the water as a movable load by pumping it into two compartments to stabilise against the overturning moment. The position of the water will rely on the wind direction and a water movement system depending on a number of electric motors and pipes with electric valves is used. One of the advantages of this active foundation solution is that some cost-efficient adjustment could be done to make this foundation able to support larger and taller units. After the end of the first turbine lifetime, an option is presented here to reuse this foundation and make it able to support taller and larger units. This option is considered using extra water volume to fill four compartments instead of two compartments. This extra water volume will increase the stability moment by 41% compared to using water in two compartments. The geotechnical performance of the new foundation solution is investigated using two existing weak soil profiles in Egypt and Sweden. A comparative study of the new solution and a piled raft with long friction piles is performed using finite element simulations. The results show that using a raft surrounded by an active stabilisation system decreases the tilting compared to a piled raft with friction piles. Moreover, it is found that using a raft surrounded by an active stabilisation system decreases the foundation costs compared to a piled raft with friction piles. In term of the environmental impact, it is found that the new foundation has a beneficial impact on the CO2 emissions. It saves roughly from 296.1 tonnes-CO2 to 518.21 tonnes-CO2 from the manufacture of concrete if the new foundation solution is used for another turbine-lifetime.

Keywords : active stabilisation system, CO2 emissions, FE analysis, reusable, weak soils
Conference Title : ICGGE 2017 : International Conference on Geomechanics and Geotechnical Engineering
Conference Location : Zurich, Switzerland
Conference Dates : July 27-28, 2017