

DISPUTATION



ONSHORE WINDMILL FOUNDATIONS Evaluation of new proposals

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Abstract <p>Windmill structures must withstand very high horizontal loading giving an extremely large overturning moment on the foundation. These structures have very low stability loads in comparison to the overturning loads. The traditional way to solve the construction problem uses a shallow foundation with a massive concrete volume or a piled foundation to resist the extreme overturning moment. This work aims towards finding new and reusable cost effective onshore foundation solutions. The new solutions include a conical raft and rafts with active stabilization systems. A number of case studies have been done in order to illustrate the behaviour of the new foundation solutions and compare them with the behaviour of the traditional solutions. A comparative study between a proposed raft of conical shape and the traditional raft foundation is done, and the results show that a conical raft can be a good choice if the location of the groundwater is at or near the ground surface. Also, a conical raft requires a smaller diameter than a flat raft to pass the requirements of the geotechnical design. This may decrease the concrete volume used, shorten the construction time, and save money. It can be a good economical and environmental alternative to a flat raft, especially in countries where labour to material cost ratio is low. For soils containing deep soft layers of clay, using a piled raft with deep friction piles is the traditional solution. In this work two solutions using an active stabilization system, are proposed. They both use movable loads to counteract the overturning moment, using the control system of the rotor hub to move the loads to the best position. The foundation solutions use water and stone material, respectively, to facilitate the counteraction of the overturning moment. It is shown that a raft using an active stabilization system overcomes the tilting problem giving a tilting lower than a piled raft in many existing soil profiles. Although, using a piled raft gives the lowest magnitude of total settlement. In the case of using water, a cost comparison is done looking at costs for a raft surrounded by a water tank compared to a piled raft with long friction piles. It is shown that the active system decreases the foundation costs compared to traditional piling. As the foundation life time is significantly longer than the rest of the structure, the possibility to reuse foundations is also investigated. It has the advantage of speeding up the repowering process, reduce the environmental impact and it could also save money. Reusing foundations when tower and turbine need upgrading can be done both for the new solutions discussed and in some cases also for existing foundations. A study of 60 geotechnical reports for windmill sites in Sweden show that it is possible to increase the load capacity of the foundations, by doing some adjustments. Increasing the stability loads of the windmill structure by using natural materials is a good solution to increase the load capacity of the foundation and make it able to support extra overturning loads. Concerning the environmental impact, reusing the foundations can save a significant amount of CO₂ compared to the complete dismantling of an existing raft foundation and replacing it with a larger one. Reuse of windmill foundations can also reduce the repowering construction time and make the process less expensive.</p>		
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