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В сборник вошли доклады студентов, магистрантов, докторантов и молодых ученых по актуальным вопросам естественно-технических и гуманитарных наук.

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FEATURES OF DESIGN AND CALCULATION OF FOUNDATIONS OF WIND POWER PLANTS

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In the Programm "Strategy "Kazakhstan – 2050" [1]: a new political course of an established state," energy security was named one of the ten main problems of this century. The relevance of this problem is justified by the holding of the international exhibition EXPO-2017 in Astana, which is dedicated to green, renewable and safe energy. Analyzing the energy infrastructure of the Republic of Kazakhstan, a regional shortage of energy capacity is revealed. In this regard, the question arises: the construction of wind power plants that will provide the necessary energy to the population of the Republic of Kazakhstan.

Wind power plants are a device for converting the kinetic energy of an air stream into electricity.

Foundations of wind power plants are a structure that transmits vibrational, static, dynamic and vibrational loads to the ground.

Work will be carried out on the study of regulatory documents related to the topic of the master's thesis. Within the framework of this issue, there are tasks for calculating and analyzing the operation of the foundations of wind power structures, for ensuring the reliability and optimization of foundations and foundations. An analysis of the literature data on this topic allows us to conclude that the study of this topic has not been fully completed.

As shown by numerous studies, the collection of loads and the analysis of the state of the soil state are the main criteria in the calculation of the structure. Some sources [2] offer a calculation method and a method for evaluating the safety for crack resistance using the double K crack propagation criterion, which differs from. The FoundDyn module [3] created in OpenFAST to account for fundamental dynamics, which is an important addition to the OpenFAST version view. The impact models turn out to be non-linear tunings and hysteresis, which assume the expected dependence of the application of three-dimensional parameters of the hyperbolic function and linear function using a genetic algorithm (GA) and manual tuning, as well as the assumed damping curve using Ishihara Yoshida's rules. Researches [4] have shown that the collection of observations and the analysis of the state of the soil are serious criteria when designing a structure for seismic. Under seismic loads, the foundation may remain elevated, but lose lightness or tip over.e. which iteratively manages load-reload curves with three parameters. The source [5] pays special attention to the combined stochastic wind and wave loads. In addition, study parameters of foundation modeling approaches were carried out, with an emphasis on their sensitivity to foundation stiffness, pile diameter, fit and degree of pile placement to the size of design solutions.The methods of calculation of these structures by the finite element method are given. The problem from here is the lack of an analogue in Kazakhstan.

Here it is necessary to determine what calculations will be made in different directions. The first is the strongest in terms of strength, hard and tough. And the second is the calculation of the soil for strength and settlement. However, this calculation says that with regard to the fundamental work and the prediction of the prediction, the expected score is predicted.

In this literature (Evans Amponsah, Zhiquan Wu) [2] , the calculation methods for the second limit states, for the disclosure of cracks in the foundation, are reviewed.

The load-bearing mechanism of the embedded steel ring to foundation connection used for onshore wind turbines causes high stress concentrations in the concrete around the base flange. Cracks initiate and propagate through the foundation from the base flange. The crack growth under normal operating and extreme loading conditions reduces the stiffness and load-bearing capacity of the tower to foundation connection. This in turn affects power production and could lead to economic losses if failure of the foundation occurs. This paper investigated the stability of a horizontal crack propagation in a typical onshore wind turbine foundation using the double-K fracture propagation criterion. The study involved experiments on two sub-part models and numerical simulation of a large-diameter onshore wind turbine foundation. Using the numerical results, the stress intensity factors at the tip of a horizontal crack emanating from the outer edge of the base flange were calculated at different stages of loading. The stress intensity factors were compared with the initial and unstable fracture toughness of concrete to assess the stability of the crack propagation. It was found that for vertical displacements of the embedded steel ring exceeding 9 mm, the crack propagation became unstable. Based on the crack propagation behaviour, a method was proposed to assess the safety of onshore wind turbine foundations using the vertical displacements of the embedded steel ring.

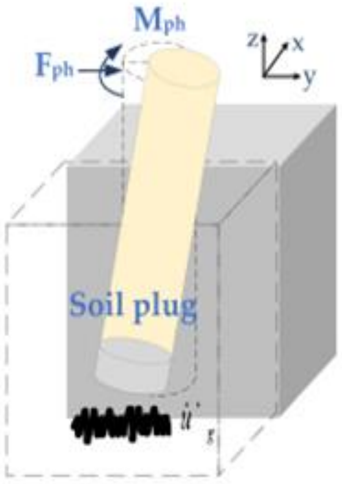
And scientists Lilin Wang and Takashi Ishihara propose a rule that controls the unloading-reloading curves iteratively using three parameters in the article "A new FounDyn module in OpenFAST to consider foundation dynamics of monopile supported wind turbines using a site-specific soil reaction framework” [3].

A FounDyn module is created in OpenFAST to consider foundation dynamics, which is an appealing supplement to the current version of OpenFAST. The FounDyn module receives the motions from the SubDyn module and sends the forces back to the SubDyn module. In FounDyn, the soil-monopile interaction is captured using a sitespecific soil reaction framework. The soil reaction framework possesses the same configuration of the semianalytical 1D model to consider effects of the large plie diameter and the small pile aspect ratio but uses new site-specific soil reaction models. The soil reaction models are nonlinear and hysteretic, which match the desired modulus reduction curve by identifying three parameters in a hyperbolic function and a linear function using genetic algorithm (GA) and manual parameter tuning, and the desired damping curve by applying the IshiharaYoshida rule that controls the unloading-reloading curves iteratively through three parameters (Figure 1). The FounDyn module is verified by the well-confined OC3 project in terms of modal frequencies, tower top displacement and shear force and moment at the mudline, and reasonable agreements are achieved between them. A series of emergency shutdown analyses of the NREL 5 MW wind turbine are performed using OpenFAST plus FounDyn. The results show that the misalignment of wind and earthquake affects the tower bending moments largely. The earthquake excitation is found to be the design driving load, prevailing over the wind excitation for the design of wind turbine supporting structures.

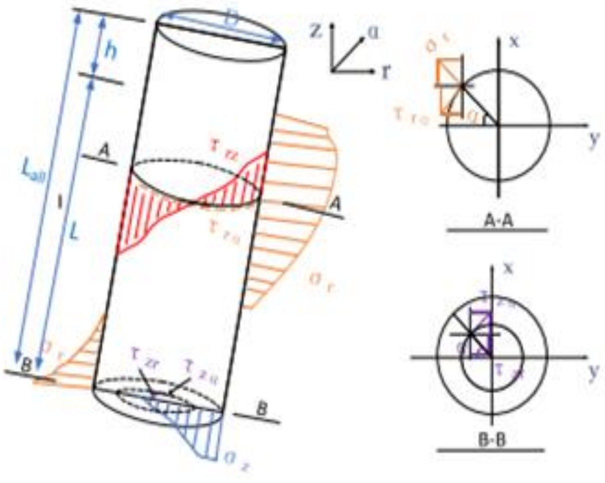
Authors J. Son a, S.K. High, S.P.G. Madabhushi, R. Srivastava, R.Veluvolu, P. Padhy studied the effects of seismic loads on foundations by empirical methods and obtained data on the study [4].

Wind turbine structures can be susceptible to damage from earthquake loading due to large overturning moments at the foundation level (Figure 2). As the wind energy market expands to seismically active parts of the world, it becomes important to evaluate the seismic behaviour of these structures. Especially, earthquake-induced liquefaction can be important when wind farms are located on sites with marginal soil conditions such as loose, saturated sands or non-plastic silts. Reduction of stiffness during liquefaction can cause excessive foundation settlement and/or rotation. Thus, suitable mitigation methods should be investigated. This paper discusses the seismic behaviour of the wind turbine on liquefiable soil and the effectiveness of the stone column-based liquefaction mitigation method. Two geotechnical centrifuge tests were conducted with and without stone columns for a model wind turbine on a circular raft foundation (Figure 1-3). The results show that stone columns can significantly reduce both the settlement and rotation of the raft.

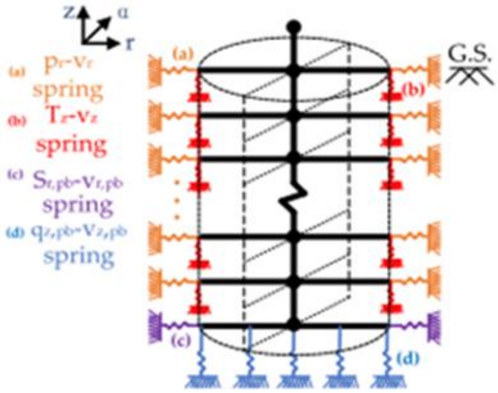
The authors Shanghai Yang, Xiaowei Ding, Jun Yang compared three approaches to



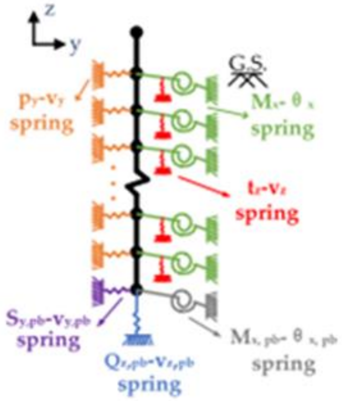
a) Monopile with seismic excitation



b) Indication of stress on monopole from soil



c) Fishone frame model (4 types of springs)



d) Semi-analytical 1D model

Figure 1. Monopile foundation and its dynamic semi-analytical model

Figure 2. Wind turbine foundation failure

foundation modeling [5] with special attention to their displacement, acceleration and response to internal force under combined stochastic wind and wave loads.

The accurate prediction of the dynamic behavior of the offshore wind turbine plays a significant role in its safe and efficient operation, where special importance should be attached to the foundation modeling of soil-pile-structure interaction. The present study aims to compare the three foundation modeling approaches with special attention to their displacement, acceleration, and internal force response subject to the combined stochastic wind and wave loading. In addition, parametric studies have been conducted on the foundation modeling approaches with the focus on their sensitivity to the variation of the foundation stiffness, pile diameter, thickness, and pile embedded depth. Using the high-fidelity FE model of the soil-pile system as the benchmark, the apparent fixity model underestimates the foundation stiffness remarkably, while the distributed spring model can give a relatively accurate prediction of the foundation stiffness. Furthermore, the FE model of the soil-pile system is more sensitive to the soil densification and the pile embedded depth, while the apparent fixity model exhibits higher sensitivity to the pile diameter and thickness. Compared with the benchmark FE model (Figure 3), the study provides guidance for the applicability of the simplified foundation modeling approaches, the apparent fixity model and distributed spring model, to different foundation stiffness in engineering practice.

The article discusses the issue of energy security in Kazakhstan, which has been identified as one of the main problems of the 21st century. The country is facing a shortage of energy capacity, and there is a need to explore alternative energy sources such as wind power. The article discusses the foundations of wind power plants and the challenges associated with ensuring their reliability and optimization. The study of this topic is still ongoing, and the article highlights the importance of collecting loads and analyzing the state of the soil in calculating the structure [5].

In conclusion, the article underscores the importance of exploring alternative energy sources such as wind power to ensure energy security in Kazakhstan. The study of the foundations of wind power plants is ongoing, and there are various methods and tools available for their calculation and analysis. However, the lack of an analogue in Kazakhstan could pose challenges for the implementation of wind power projects. Further research and investment in this area could be necessary to overcome these challenges and achieve the goal of sustainable and secure energy in Kazakhstan.

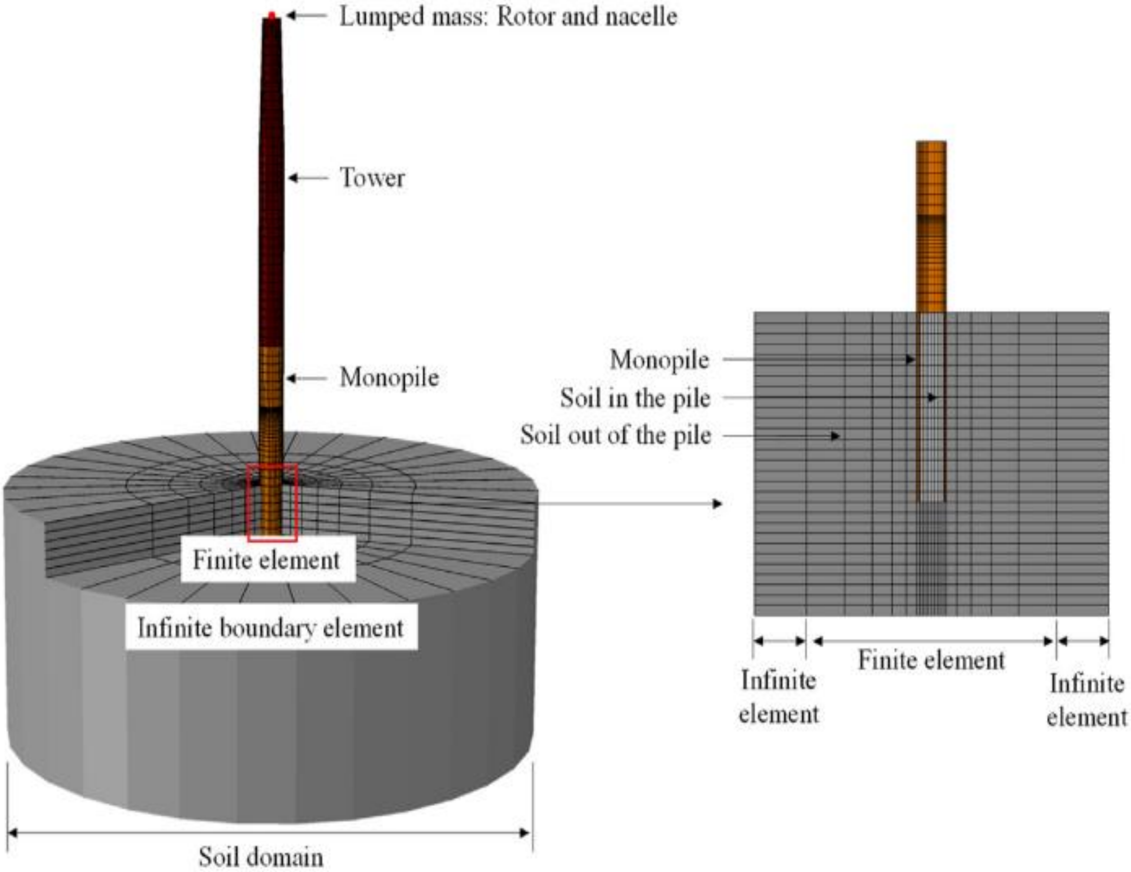


Figure 3. 3D FE model

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