Stochastic Dynamics Modeling for Uncertainty Quantification in Composite Structure in Wind Turbine

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Abstract

Wind turbines are among the most important sources of renewable energy that are used to generate electric power, and this clean energy has many uses in industry, agriculture and other uses. The rapid development of renewable energy gave us a new technology to solve the main problem in the sea and land, the problem of vibration and instability offshore, which has a defect in the wind turbine system, the system has an impact force from the water, the marine foundation has many challenges in design, rigidity and mass are the most important characters, Which comes to the natural frequency, this paper deals with the foundation and support of offshore and onshore wind turbines through the use of composite materials of glass fibers saturated with an epoxy binder, and thus a structure with strength, durability, light-weight and good resistance to vibrations.

Keywords: *Offshores, wind turbine, review, design.*

Introduction

1. Development of offshore wind energy

The renewable energy is increasing rapidly in which come for wind turbine, the Nano technology has become one of the important field in material development, which the structure of the wind turbine has high strength to weight ratio, which mean that the structure has more strength to act against external forces with low weight [1].

Last decade the emission of gas has been decreasing with improving the renewable energy [2].

Various sources that used form like geothermal, solar energy,.etc, about 60 % of the wind power capacity are found in Europe and north America [3,4,5,6], the wind energy estimated to supply about 20 % of the world electricity in 2050 [7].

With two different design of wind turbine is onshore and offshore [8].

Onshore wind energy is extremely successful technological since it can used for over 2000 years [9,10].

Onshore has been developed and revolution in recent years [11].

The bar chart in figure 1 can explain the offshore and onshore energy that has been installation over ten year’s form 2011 to 2020 [12].

The energy of wind turbine with offshore has been developed and accelerate with later years as shown in Fig 1 [13].

In 2030, the Europe country will invest about 20 billion euro in the wind turbine energy and wind energy that which 60 % of this market will be offshore design [14, 15].

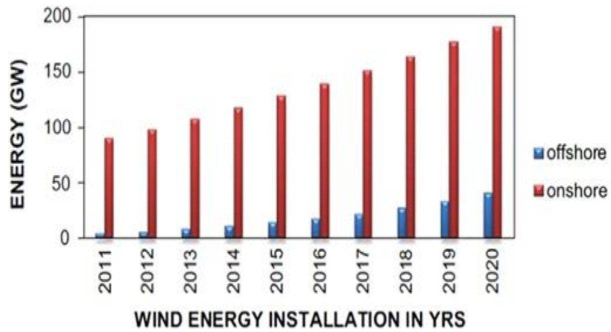
The market and industry in Asia will also will expand with offshore wind farms like in China and India. The onshore farms will be located in the main cities [16].

The offshore wind power will have capacity to estimate about 200 GW form electricity to china [17].

This energy will come from farms that are foundation at location far from the main city [18].

This huge industry is one of the main reason that research is investing in wind turbine industry [19].

Fig.1. Onshore and offshore wind energy installation: from 2011 to 2020 [13].



2. Rationale

As wind energy has been gathered in farm, exploration over water and lately deeper water, the support of the wind turbine for fixed and floatation offshore is important to consider [20].

The foundations of offshores is the base consider.

The boundary condition of the wind turbine and stiffness affect by offshore support [21,22].

2.1. Offshore wind foundations

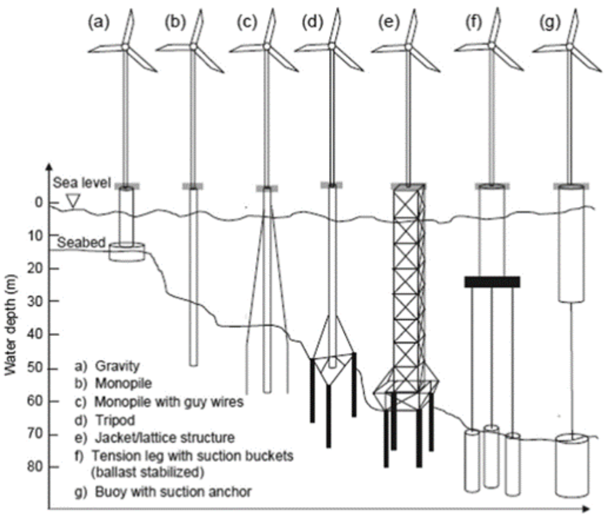
1. Offshore wind turbine structures

Most of offshore wind farms is consider far away from the city, the main reason is to found land that have wind speed fit the design and power generation of the wind turbine [23].

The structure of wind turbine in water may go to 10 m in depth and 10 km from the coast, which is consider challenge in design of the wind turbine foundation [24].

The Fig 2 show different support of wind turbine.

Fig. 2. Typical support structure options applicable at different water depths [13].



2. Types of offshore wind turbine FOUNDATION

About 20 to 30 percentage of total cost of wind turbine goes to offshore that because difficulty of constructing as well as material, technology and maintaince parameter [25].

Different types of offshore to meet the propose of the construction [26].

1. Gravity Base Foundations (The weight of the wind turbine is the support.as it design of gravity base foundations).

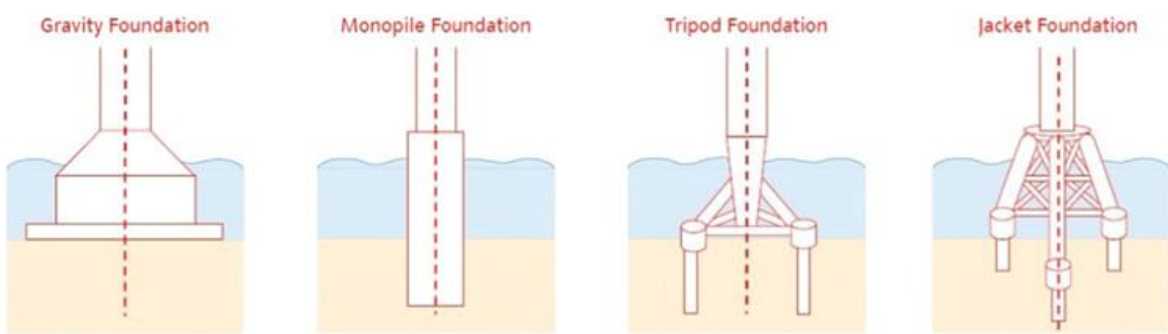
2. Monopile Foundations (As single steel with diameter about three to eight meter that has shape of tube is foundation of monpile).

3. Tripod Foundations (Three steel pipe piles that shape as piles with equilateral triangle is the foundations of tripod).

4. Jacket (Lattice Structure) Foundations (The jacket foundation comprises a space frame structure assembled from steel tubular members).

5. Tension Leg With Suction Buckets (Suction bucket foundations, otherwise known as suction caisson or suction pile foundations).

Fig. 4. Schematic diagram illustrating bottom-fixed offshore wind turbine foundations [26].



a. Gravity b. Monopile c. Tripod d. Jacket

Summary

This paper presents an overview of offshore wind turbines of various types that will be designed in the future. Despite the difficulty in designing and transferring energy, green energy is very important, especially in Europe as well as in the Middle East, and it will be implemented if good results are achieved in the designs.

The design of offshore and onshore wind turbine structures using composite materials with epoxy binders and wind turbine foundations will be considered according to water depth and for different surfaces.

This paper discusses the different types of offshore and onshore wind turbines in terms of anti-vibration foundations.

The future recommendation to work in light structures with strength and efficiency to resist earthquakes and all external obstacles.

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