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Noise Analysis in Offshore Wind-Farm

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ABSTRACT

The purpose of this study is to investigate numerically the blade aerodynamic noise and to predict the noise map in offshore wind-farm. For the analysis of the flow field around wind turbine blade, the unsteady vortex lattice method is applied, the panel code X-FOIL is used for boundary layer properties of airfoil. The acoustic analogy and semi-empirical method is used for modeling of various aerodynamic noise sources and the ENPRO as a propagation model is applied for the simulation of noise map. The used methodology for noise prediction could be applied efficiently to blade design stage for development of low noise blade and to noise assessment of wind-farm.

KEY WORDS: Wind turbine noise; Blade aerodynamic noise; Mechanical noise; Noise map; Wind-farm; WINFAS; ENPRO

INTRODUCTION

Wind power is one of most cost effective, reliable renewable energy source. A lot of country have installed the wind turbine in onshore/offshore and investigated the wind power for more efficiency and reliability. However, there have been many adverse effects such as site pollution, TV interference and noise (unwanted sound) pollution when turbine is installed and operated.

In order to resolve these environment problems and to increase the efficiency of wind power, the wind-farm has been built up in offshore area or far region from residence area. Especially, it is predicted that offshore wind-farm would be promoted further due to the better wind properties suitable to high megawatt wind turbine. Among the environmental problems, the noise problem is still the major obstacle in the tremendous development of wind turbine over the last years. Noise gives an adverse effect to marine animal as well as human being. Fig. 1 shows the typical pile-fixed type offshore wind turbine and noise propagation mechanism from wind turbine to observer in air and underwater. When noise propagates through phase discontinuity surface (water to air, air to water), there is a transmission loss and refraction due to density difference. Therefore, the blade aerodynamic noise and auxiliary equipment noise in nacelle are higher than transmitted noise from underwater in upper sea surface (air region), while the structure-borne noise by pile & tower vibration is dominant in underwater region where the pile & tower vibration are transferred from the gearbox (gear transmission error) and generator vibrations. That is, the air-borne noise is predominant in air region and structure-borne noise is dominant in underwater region. From these characteristics, individual noise analysis methodology between air region and underwater region is required. In first stage of noise analysis for offshore wind turbine, we focused on the noise analysis above sea surface (air region). The noise analysis and simulation in underwater region will be carried out in future work.

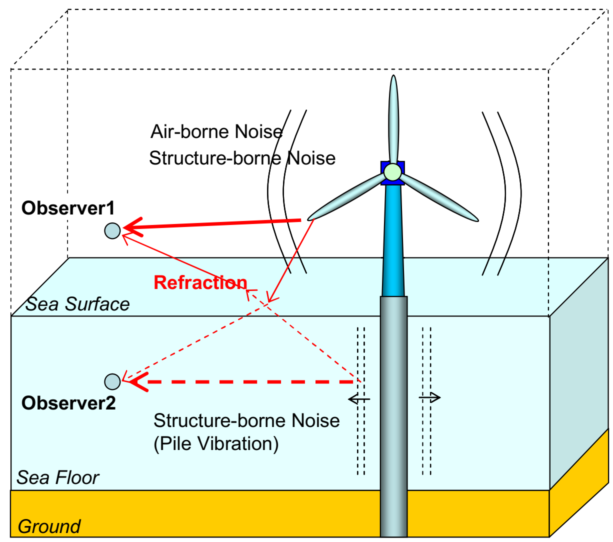

Fig. 1 Noise radiation characteristics in offshore wind turbine

Fig.2 shows the typical noise sources in wind turbine. Generally, wind turbine noises are classified into the aerodynamic noise (air-borne noise) and the mechanical noise (structure-borne noise) according to the generation mechanism. Mechanical noise is generated from mechanical impact & rotation such as gear meshing and friction phenomena. It tends to be tonal because of regular motion and rotation. However, the mechanical noise level has been decreased as the wind turbine technologies have been advanced (Pinder, 1992). For instance, gearboxes for wind turbine have been designed for quiet operation and wind turbine uses special gearboxes which the gear wheel are designed to flex slightly. In addition, the damping layer for reduction of mechanical vibration is applied in vibration area and the sound absorbing material for noise reduction in enclosed nacelle can be