Condition evaluation of offshore wind structures by statistical inference

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ABSTRACT

Here we proposed a condition evaluation method for offshore wind turbines by statistical inference using strain data. To determine the unknown statistical parameters of the data and its confidence level, we first assume the data obey the normal distribution or Weibull distribution, and the unknown parameters are solved by maximum likelihood estimation. Then statistical inference of the distribution with unknown parameters is performed using the Chi-square tests. We find that the monitoring data obey the Weibull distribution at a significance level of 0.05. A method based on statistics for qualitative evaluation of the operation condition of offshore wind structures is proposed at last.

KEYWORDS: statistics, inference, maximum likelihood estimation, normal distribution, Weibull distribution

INTRODUCTION

In recent years, the renewable energy industry has developed rapidly, and offshore wind power has made an irreplaceable contribution to the use of renewable energy worldwide. However, the high cost of offshore wind structure design and construction, coupled with the extremely harsh marine environment, results in the high cost of offshore wind power development, which is the biggest defect of the offshore wind power industry. The objective of this paper is to reduce the operation and maintenance cost of offshore wind power through condition monitoring information mining.

In China, the service life of offshore wind turbines is 25 years. During its entire life, the offshore wind turbine condition monitoring system usually generates huge amounts of data, which may be structured or unstructured and may include or lack time information. There are different methods used worldwide to deal with these data. Such as Bayesian methods (Li and Shi, 2012), statistical pattern recognition paradigm (Martinez et al., 2016), component reliability estimations (Scheu et al., 2017), probabilistic surrogate modeling (Singh et al., 2022), etc.

In the field of civil engineering (bridge structure), many scholars have already done some work in structural condition evaluation based on monitoring data. Abdullah et al. (Abdullah et al., 2021) used the Gumbel distribution model combined with strain data to evaluate the reliability of fatigue life of automotive leaf springs under variable amplitude road load strain data; Lei et al. (Lei et al., 2022) used empirical mode decomposition (EMD) algorithm and rain flow counting method for signal preprocessing and statistical analysis of on-site monitoring data, and proposed a method based on strain monitoring data to evaluate the