International Journal of Offshore and Polar Engineering (ISSN 1053-5381)

Vol. 26, No. 3, September 2016, pp. 219–224; http://dx.doi.org/10.17736/ijope.2016.jcr31
http://www.isope.org/publications/publications.htm

Study of Stress-Monitoring Method in Supporting Structure of Floating Offshore Wind Turbine

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This paper presents a new stress-monitoring method in the supporting structure of a floating offshore wind turbine (FOWT). Though monitoring many points is preferable when making the maintenance plan and residual fatigue life prediction of the structure, measurement of these quantities is not realistic. Instead of direct measurement, the authors propose a method of estimation from motions that are easier to measure. The feasibility of the method was confirmed by a tank test with a spar-type FOWT.

INTRODUCTION

One of the problems with floating offshore wind turbines (FOWTs) is accessibility. To reduce the life cycle cost, maintenance work should be minimized. One solution for this problem is monitoring. As for structure, if load and stress are monitored with enough density in time and space, maintenance work can be conducted with a reasonable plan based on the residual fatigue life prediction. However, measurement of stress (strain) at many points of the floater, even if it is concentrated on the key points, is not so easy. This paper proposes a simple monitoring method using the motion data and the transfer function between motion and stress.

In this paper, the linearity among motion, load, stress, and strain is assumed. The relation between load and motion can be calculated by a hydrodynamic code or by tank tests. The relation between these two quantities and stress (strain) can be evaluated by structural analysis, e.g., the finite element method (FEM). Based on these assumptions and procedures, the authors propose a practical method of monitoring the internal forces of the structure from the motions of the floater.

MONITORING METHOD

Comparison between this monitoring method and others is necessary. There are two patterns of common monitoring methods with these kinds of measured items. Table 1 shows three monitoring methods and Fig. 1 shows the flow of monitoring.

There are two or more problems with method 1. It is difficult to measure stress with many strain gauges on many monitoring points, and the life of strain gauges is too short for the lifetime of the structure. The suggested method was developed to settle these problems. With the suggested method, it is possible to measure the stress on monitoring points with only the motion data of the floater. It is easy to measure the motion (e.g., by GPS and gyro) of the floater in the long term.

	Measured items	Method
Suggested method	Motion of floater	(1) Measurement of the motion of the floater (2) Estimation of the load from the motion (3) Estimation of the stress and the fatigue life from the load
Method 1	Stress	(1) Measurement of the stress at every point (2) Estimation of the fatigue life from the stress
Method 2	Metocean	(1) Measurement of the metocean at the site (2) Estimation of the motion and load from the metocean (3) Estimation of the stress and the fatigue life of the load

Table 1 Monitoring methods

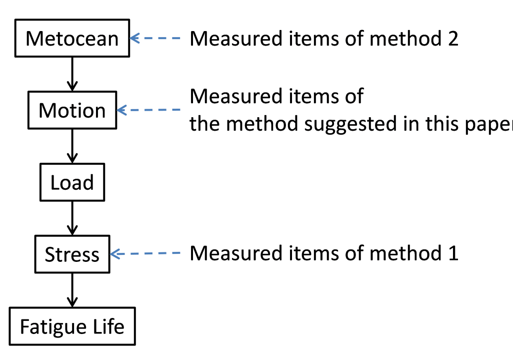

Fig. 1 Flow of monitoring

There are two or more problems with method 2. It is difficult to estimate stress from the metocean, and the measurement of the metocean has many costs. The suggested method was developed to settle these problems. It is possible to measure the motion of floater in real time with low costs.

Summary of the Monitoring Method

The monitoring method suggested in this paper is shown by algorithms in Fig. 2. There are three steps in this method. The

Received March 26, 2015; updated and further revised manuscript received by the editors June 8, 2016. The original version (prior to the final updated and revised manuscript) was presented at the Twenty-fifth International Ocean and Polar Engineering Conference (ISOPE-2015), Kona, Hawaii, June 21–26, 2015.
KEY WORDS: Monitoring, floating offshore wind turbine, stress, load, motion, supporting structure, fatigue life.