Numerical Study on the Dynamic Characteristics of a Fixed Horizontal Cylindrical Fish Cage under Earthquake Load

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ABSTRACT

A finite element model of a fixed horizontal cylindrical fish cage is established to calculate the dynamic characteristics based on the ABAQUS platform. The natural frequency and vibration mode of the fish cage are obtained by modal analysis. Through the time-history analysis of the dynamic characteristics under seismic load, the responses of strain, acceleration and displacement of the fish cage are obtained. Compared at various positions, the maximum acceleration response of the structure is determined. It is expected to provide a reference for the optimization design and engineering safety of the new type of fixed horizontal cylindrical fish cage.

KEY WORDS: fish cage; seismic; dynamic characteristics; finite element model.

INTRODUCTION

Aquaculture is a globally important industry that provides essential food for a growing world population and plays an important role in providing protein to countries with inadequate food supplies. Fish cage is currently the main facility for marine aquaculture all over the world. Especially in recent years, a variety of different types of fish cage emerge.

A large number of studies have been carried out to investigate the hydrodynamic characteristics of the net structure and the net cage (Klebert et al., 2013). The structural safety of the fish cage is the basis for ensuring the normal operation of a fish farm. For example, Fu and Moan (2012) conducted dynamic analyses of 5 by 2 floating fish cage collars in waves using hydroelasticity theory in the frequency domain. Similar to other marine structures, mariculture facilities are vulnerable to severe biofouling. The biofouling on the netting will directly affect the quality of fish and the safety of aquaculture structures (Fitridge et al., 2012). Many scholars have studied the effects of biofouling on the hydrodynamic characteristics of the netting (Bi et al., 2017; Bi et al., 2018; Gansel et al., 2015; Lader et al., 2015; Swift et al., 2006).

Although much progress has been made, to our knowledge, the negative effects of biofouling on the hydrodynamic characteristics of a fish cage cannot be completely avoided.

Hence this study aims to develop a fixed horizontal cylindrical fish cage which can rotate around the central axis. In this way, the biofouling on the main structure could be easy to be cleaned. For offshore engineering structures, the strong earthquake is one of the main loads leading to structural failure. Especially, some offshore fish farms may be located on the edge of the continental plate where may has strong seismic activity. Therefore, it is necessary to study the dynamic characteristics of the fixed fish cage under earthquake load.

NUMERICAL METHOD

In this study, a finite element model of an offshore fixed horizontal cylindrical fish cage (see Fig. 1) was established with commercial software ABAQUS to analyze the dynamic characteristics of the structure.

![Fig. 1 The finite element model of the fixed horizontal cylindrical fish cage structure](image)

Governing equation

The dynamic response of the structure is described by a second-order