Experimental Study on Effects of Helical Strake on Vortex-Induced Vibration

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ABSTRACT
Helical strakes are widely used to suppress VIV of slender structures. In this study, the effects of the pitch and height of helical strakes on suppression of VIV were studied experimentally. Experimental results show that the ratio of strake pitch and height could be an indicator to discuss the suppressing efficiency of helical strakes.

KEYWORDS: vortex; vibration; strake; suppression; appendage; effects; cylinder.

INTRODUCTION
In the field of ocean industries, there are many cylindrical structures. Marine risers are one of them. These structures receive various external forces such as hydrodynamic force by waves and currents. Meanwhile, vortices shed from the structures by the current or the motion of structures. They cause a vibration of structures. This phenomenon is called Vortex-Induced Vibration (VIV). VIV is not only to the cross flow direction. It contains a high frequency component to the in-line direction. This in-line oscillation is also important as well as transvers one. These vibrations cause fatigue damage because VIV gives structures cyclic load. A response of a cylinder with two degrees of freedom had been reported (N. Jauvtis, 2003). It is also a problem that VIV causes an increase of drag force. Therefore, VIV of structures should be suppressed. Blevins and Coughran (2009) proposed a guide lines for avoidance of VIV using two parameters, which are mass and damping of bare cylinder.

There has been a great deal of work concerned with VIV suppressing device. It is revealed that the appendages such as splitter plates and fairings are effective to suppress VIV of the structures, riser pipes, and cables. If some appendages are attached to the structures, the frequency and amplitude of VIV will change. It is also noted that such appendages affect on the torsional force acting on the structures. For example, Chung and Whitney (1993) examined the effects of straight cables on VIV and the torsion of the pipes or cables under various flow angles of attack. The parameters in their study were the diameter and the number of straight and helical cables attached on the bare cylinder.

In late years, helical strakes are used widely because it is easy to handle. There are many researches to investigate the strake effect on suppressing VIV (Trim, 2005; Gao, 2015). Even though the effects of strake height to suppress VIV was also reported in the paper described above (Blevins and Coughran, 2009), there is some research on the effects of both the strake height and pitch to suppress VIV.

In this study, the effects of helical strake height and pitch on the suppression of VIV were studied experimentally. A bare cylinder and several straked models with different helical strake properties were studied. They are supposed to a uniform flow and the motion, flow field around models, and hydrodynamic force acting on the model were measured. From these data, suppressing effects on VIV were verified and discussed.

EXPERIMENTAL SET-UP

The outline of experiment
Experiments were carried out in a circulating water channel (Fig. 1) in Osaka University. It has an observation window with 1.0 m (Length) \times 0.3 m (Breadth) \times 0.3 m (Depth). Maximum uniform velocity is 1.0 m/s. A cylinder and six kinds of helical straked cylinder model were examined in this research. They were supported horizontally with a coil spring at both ends in this circulating water channel. These springs enabled the model to move inline (IL) and crossflow direction (CF) to the uniform flow. The motion of the model, the flow field, and hydrodynamic forces were measured. The details of measurement system were mentioned in the later section. Velocity of uniform flow is from 0.33 m/s to 0.74 m/s (Table 1). Corresponding Reynolds number is from 10000 to 22000.

Fig. 1 Circulating water channel