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Experimental Investigations of the Characteristics of Pressure Sensors for 2D Wedge Drop

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There are many experimental studies of the measurement of the water impact load. Pressure sensors are widely used to measure the water impact load, but there are few papers handling the characteristics of the pressure sensor thoroughly. The present study investigates the characteristics of the pressure sensor for the measurement of the water impact load. For this purpose, seven pressure sensors are attached to a 2D wedge surface, and the water impact pressure is measured during the free falling of the wedge. Those pressure sensors have different types, sensing areas, and sensitivities. The peak pressures, rise times, and pressure impulses measured by the different types of pressure sensors are compared with one another. On the basis of these results, the characteristics and reliability of the pressure sensor for the measurement of the water impact load are discussed.

INTRODUCTION

The measurement of pressure is a major concern in water impact problems, e.g., water-entry, ship-slamming, green water, and sloshing problems. A pressure sensor, a so-called pressure transducer, was widely used to measure the water impact load in previous experimental studies. The measured pressure was compared with that of the analytic and numerical solutions, and reasonable agreements were reported in the previous studies. However, it is not easy to find research cases that consider the reliability and accuracy of the pressure sensor itself.

WILS JIP-III (Wave Induced Loads on Ships Joint Industry Project-III) was carried out to investigate the hydroelastic behaviors and ship-slamming phenomena of an ultra-large containership (Hong et al., 2014). In the WILS JIP-III, drop tests of the 2D wedge and various ship sections were carried out. In the ship section drop test, two different types of pressure sensors were used (piezoelectric with 9.5 mm diameter and piezoresistive with 5.5 mm diameter), and a discrepancy of the measured peak pressure was observed. Figure 1 shows the measured pressure signals during the ship section drop test of WILS JIP-III. The piezoelectric and piezoresistive pressure sensors show the different peak pressure and decaying pressure. A similar tendency is also observed in the previous study (Kim et al., 2015). Kim et al. (2015) presented that the sloshing impact pressure can be different depending on the pressure sensor (see Fig. 2). The measured pressures of the Integrated Circuit Piezoelectric (ICP) sensors show a large difference in the magnitude although the pressure sensors are the same type and have the same sensing area.

In terms of the accuracy of the pressure sensor, a few papers were recently published. Van Nuffel et al. (2013) presented that the pressure sensor is weak from the thermal shock due to the different temperatures between the pressure sensor and the material.

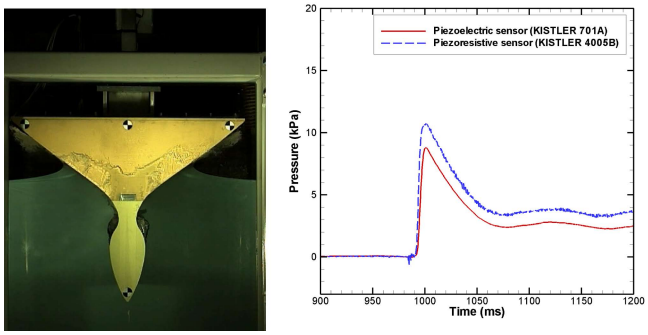

Fig. 1 Pressure difference in ship section drop test

They also presented that the measured impact pressure is reduced by the wrong mounting and water droplet on the diaphragm of the pressure sensor during the water-entry test. Kim et al. (2015) also showed that the measured impact pressure is different depending on the sensor type and its performance in sloshing tests.

The objective of this study is to compare the measured impact pressures through the use of various pressure sensors and to minimize the error source due to an inappropriate selection of the sensor type in the measurement of the impact pressure. For this purpose, pressure sensors used in the water-impact problem are compared. Seven pressure sensors with piezoresistive, piezoelectric, and ICP types, widely used in the water-impact problem, are applied to the water drop test. Those sensors are attached to

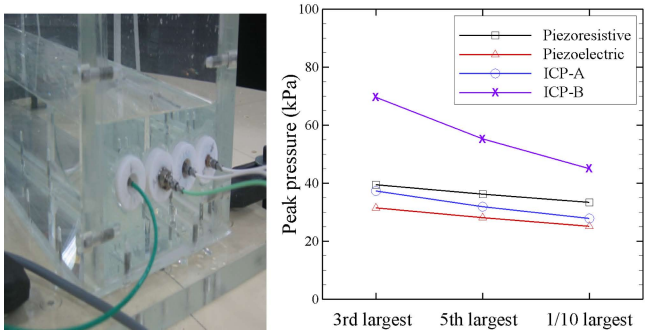

Fig. 2 Pressure difference in sloshing test (Kim et al., 2015)

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