Experimental Studies on Ice Flaking Characteristics of Compliant Indentors

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ABSTRACT

This paper describes the relation between ice flaking characteristics and the modes of structure vibration due to ice-structure interaction. We have attempted to analyze the ice crushing damage length in terms of indentation velocity and stiffness of the indentor using results of a series of indentation test. In the analysis the spring back length of a compliant indentor was regarded as the average size of damage zone. The spring back length increases as the stress rate decreases. Based on this result, we discussed the mechanism of simultaneous failure of ice.

KEY WORD: flaking, spring back length, indentation, ice-structure interaction, simultaneous failure, stress rate, strain rate

INTRODUCTION

It has been reported that the Gulf Molikpaq experienced significant interactions with moving ice during the winter 1985-86 (Jefferies and Wright, 1988; Wright et al., 1992). Many of these interaction caused a dynamic response of the platform near its limiting stability. Since then it has been recognized that a suitable evaluation of ice-structure interaction and its influence to the base ground are necessary to the design of offshore structures in ice-infested sea area. However the mechanism of this dynamic response is still not fully understood.

As a part of the research work on the mechanism of ice-structure interaction, Kamesaki et al. (1996) have conducted a series of small-scale indentation tests in an ice tank and showed that lower stiffness of indentor and lower indentation velocity cause simultaneous failure of ice sheet with quasi-static vibration of the indentor. Furthermore Kamsaki et al. (1997) have conducted another series of indentation tests using vertically placed ice sheets so as to measure the flaking length by video equipment and observed that lower stiffness of indentor and lower indentation velocity cause larger size of flaking fragment. These results are suggesting that ice flaking characteristics have considerable influence on the response of structure.

To clarify these ice flaking characteristics in detail, we have analyzed the relation between ice flaking length and the response of indentors, and as a result we address a mechanisms of simultaneous failure. The tests were carried out at the Ice and Snow Engineering Laboratory of NKK Corporation.

TEST ARRANGEMENT

Model and Test Arrangement

Figure 1 shows the side view of the model which was used for indentation tests and Figure 2 shows its arrangement in the ice tank. For the measurement of local ice load, we used ten segmented local pressure panels (88mm wide) as depicted in Figure 1. Disk springs (Fig. 1) provided compliance between the model and towing carriage. We had three specified levels of structure stiffness Ks, labelled them as LS model, MS model and HS model in order of the stiffness. In total, we performed 74 tests.

The physical characteristics of the models are as follows;