

Ice Model Tests of Caisson Platform in Shallow Water

E. B. Karulin and M. M. Karulina
Krylov Shipbuilding Research Institute, St. Petersburg, Russia

L. B. Blagovidov*
OJSC Central Design Bureau Corall, Sevastopol, Ukraine

The purpose of the model tests performed in the Ice Tank of the Krylov Institute, St. Petersburg, Russia, was to study the effect of the closeness of the sea bottom on the ice pile-up in front of a caisson-type platform and on the ice loads acting onto the platform. Grounding of the ice rubble can lead to both a reduction and increase of the ice load. Both these phenomena were noted during the model tests in different stages of platform/ice interaction. The load increase was observed in the initial stage of the underwater pile-up formation, when its draft approached the water depth. In the later stage, when the stationary grounded pile-up against the platform was formed, ice load reduction was observed. The paper provides quantitative and qualitative analysis of the model test data.

INTRODUCTION

The Northern Caspian Sea has promising hydrocarbon fields, whose development either has started or is about to. The Korchagin Field is one of such deposits. Offshore structures intended for use during the development of this field should, among other things, be designed with consideration of natural features characteristic of the region, such as stable ice coverage in winter, relatively small water depths and significant water-level fluctuations.

One of the structures planned for installation on the Korchagin Field is the ice-resistant platform (IRP-1) being built based on the Shelf-7 semisubmersible. It consists of a caisson-type rectangle in-plane view, with sloping sides where the platform interacts with ice (Fig. 1).

Operating experience of caisson installations and artificial islands for well drilling in shallow water conditions—in particular, the Molikpaq platform in the Beaufort Sea and artificial island on the Kashagan Field in the Caspian Sea—indicates that in winter large rubble accumulations formed near these structures are in rather firm contact with the seafloor (Neth, 1991; Wright and Timco, 1994; Croasdale et al., 2004; Evers et al., 2001). If the above formations are not taken away in the event of ice drift changing, the structures turn out to be fully surrounded by ice piles. As theoretical studies and full-sized measurement records showed, the steady seabed-supported ice accumulations in front of the structures contribute to reducing the ice loads transferred to these structures by drift ice (Marshall et al., 1989, 1991). According to Marshall et al. (1991), the level of ice loads transferred to the installation through the ice formations can be diminished to zero depending on the extent of formed piles, consolidated layer thickness, physical and mechanical properties of their non-adfrozen part, and roughness of the seabed. This effect is used to construct artificial ice barriers near structures in shallow waters as was done at the time of the Sunkar drilling platform operation in the Caspian Sea (Croasdale et al., 2004).

Practically all the above parameters influencing the level of ice loads depend on the age of the accumulation. As the age increases, one can expect that the formation extent and consolidated layer thickness will go up. These 2 factors contribute to decreasing the ice loads acting on the structure. However, when predicting global ice loads, one should consider all probable scenarios of ice effects to select the one resulting in the greatest ice loads. Such scenarios are not always known in advance.

Model investigations were carried out in the Krylov ice basin to study how the IRP-1 platform interacts with surrounding ice under shallow water conditions. With the view of tracing the processes and measuring the levels of expected ice loads at the initial stage of ice formation generation, the scope of experimental modeling included some cases where ice and installation interacted without steady ice accumulations in front of the structure. At this stage it was found that the proximity of seabed and lack of stiff contact between ice formation and seafloor can bring greater ice loads onto the structure. This paper investigates the reasons for such an effect as recorded during the experiments.

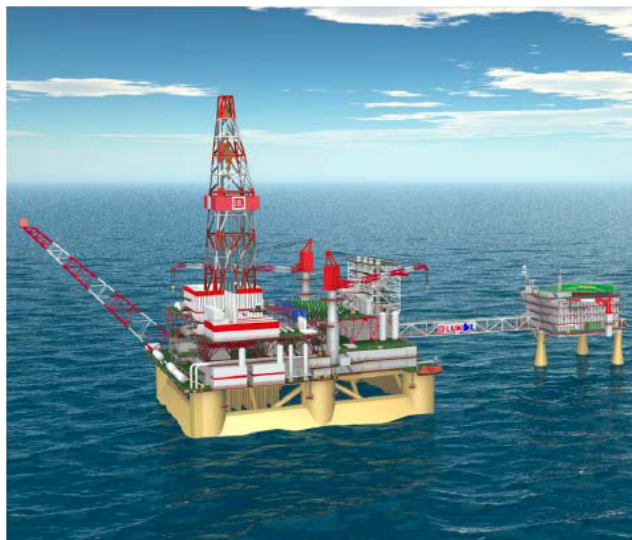


Fig. 1 Complex of offshore facilities for Korchagin Field

*ISOPE Member.

Received March 25, 2007; revised manuscript received by the editors September 9, 2007. The original version (prior to the final revised manuscript) was presented at the 17th International Offshore and Polar Engineering Conference (ISOPE-2007), Lisbon, July 1–6, 2007.

KEY WORDS: Caisson platform, ice load, ice rubble, grounded rubble, shallow water.