Determination of Loads on Mooring System During the Semisubmersible Interaction with Ice

Evgeny B. Karulin and Marina M. Karulina
Krylov State Research Centre
St. Petersburg, Russia

ABSTRACT

In the presented paper, some aspects of the moored multi-legged floater operation in ice cake and current conditions are studied. The investigations are based on numerical simulations of the semisubmersible/ice interaction using the discrete element method for the ice cake field modeling. The calculations were performed for the platform operation in current condition in open water without ice and in presence of ice. The kinematic parameters of the semisubmersible motion and the lines tensions in both cases were compared. The results have shown differences in the platform behavior, as well as in loads on the mooring system and in the tension distribution along the mooring lines due to the ice action.

KEY WORDS: Semisubmersible; ice action; mooring system; line tension; numerical model.

INTRODUCTION

The Arctic shelf areas where oil and gas fields are intensively developed differ by environmental conditions, and namely, sea depth, hydrometeorological and ice conditions. Selection of a type of facility to be used for field development depends on a number of factors, such as process challenges to be solved with the facility and operation conditions. Work in hard-to-access deep-water areas on the Arctic shelf can be carried out from floating drilling rigs retained with a mooring system or dynamic positioning system. One of such floating rigs is a semi-submersible drilling platform which can be used as a drilling rig or an interim helicopter pad, “Polyarnaya Zvezda” semi-submersible drilling rig (SSDR) is a good example. It has two pontoons connected with the topsides by six columns crossing the water free surface (Fig. 1).

Model tests completed in the ice basin of Krylov State Research Centre, Saint-Petersburg, Russia, revealed that the platform could be operated in winter only in light ice conditions, i.e. in thinned ice cake (Karulin et al., 2012). The model simulations of the platform/ice interaction were efficient means of studying the main issues related to the use of multi-leg facilities in ice conditions, including ice jamming of the space between the legs and blocked space between front columns, and determine ice loads on the platform and mooring system. The simulations with a rigid model did not allow studying dynamic behaviour of moored platform influenced by ice on the load level in mooring lines. This work provides theoretical basis for certain aspects of the movements of a multi-leg moored facility in broken ice drifting with the current. The surveys are based on numerical simulation of platform and ice interaction using the discrete element method.

Fig. 1. The semisubmersible “Polyarnaya Zvezda”

DESCRIPTION OF THE PLATFORM AND MOORING SYSTEM

The work gives an overview of a semi-submersible platform in the working condition when pontoons are fully submerged in water and free surface is crossed only by legs. Major dimensions of the platform are provided in Table 1.