

## **Concept of Ice-resistant Production Platform on Gravity Base Substructure for 70 – 80 m Water Depth**

*A.A. Malyutin, S.L. Karlinsky*

*SOE «RUBIN Central Design Bureau for Marine Engineering»*

*St. Petersburg, Russia*

### **ABSTRACT**

Research design analysis of a substructure for the production platform for the Russian Far East shelf for a medium sea depth from 70 m to 80 m ("Sakhalin-5" for example) is presented. The specified facility shall be operated under the most severe conditions wherever on shelf, which include seasonal ice and severe storm as well as earthquake. The base task is how to provide the platform stability under wave loads as well, as under ice, also seismic loads. As a rule fixed substructures of GBS type are used under such conditions. For example PA-A (33 m water depth), PA-B (32 m) and LUN-A (48 m) platforms have been installed for Sakhalin-II field. However, it is known that for the Sakhalin seismic conditions provision of stability for the gravity based platform for a sea depth more than 60 m requires a huge amount of solid ballast and a very high pressure on the ground. Also the pile foundation requires accordingly an unattainable number of piles. In this paper a new concept of the GBS-type platform concrete substructure for a medium sea depth (from 70 to 80 m) is presented.

Such substructure using precast concrete becomes an acceptable structure provided that some innovations are applied – and this is the matter of this article.

**KEY WORDS:** Platform substructure, GBS-type, ice force, wave forces and moments, seismic accelerations, movement parameters, assembling, towing, substructure installation, afloat stability, computer simulation.

### **INTRODUCTION**

Development of platforms for oil and gas production on the shelf of the Barents and Kara seas and offshore Sakhalin raises a necessity to overcome an extremely severe combination of environmental conditions. The platforms must withstand ice and storm waves and in addition to it sustain seismic conditions of magnitude 9 (Sakhalin, Sea of Okhotsk). These severe conditions make platforms on the gravity base substructures (GBS) a preferable type. An experience has been gained in the design and installation of such ice-resistant platforms on the Russian shelf, for example, steel GBS (with a soil core) of «Vityaz» platform (PA-A of Sakhalin-II) deployed at a water depth of 32 m. Steel GBS of «Prirazlomnoye» platform for the Pechora sea will be installed at a depth of 19 m for operation in heavy ice conditions. Reinforced concrete 4-legged gravity base substructures of Piltun-Astokhskoye (PA-B) and Lunskeye (Lun-A) were installed offshore Sakhalin in 2006 at a water depth of 33 and 49 m respectively. Thus,

platforms on both steel and reinforced concrete gravity base substructures are installed on the Russian shelf at water depths to 50 m. However, a number of fields (offshore Sakhalin-5, for example) are in 70 – 80 m or deeper waters. There is an experience in installation of platforms on GBS, including reinforced concrete type (Condeep, for example), at significantly deeper waters (to 300 m) but in ice-free and non-seismic areas. Ice action and/or seismic load considerably restricts acceptable depth for this type of platforms due to a greater overturning moment.

This paper proposes a GBS concept for such a platform suitable for depths of 70 – 80 m. The paper gives a comparative overview of reinforced concrete and steel GBS (or a combined structure). Also the experience gained in the construction of the PA-A platform, where the spacer has been used to cover the greater water depth of the substructure installation site, is reviewed. Environmental loads upon the facilities have been determined using DNV rules, codes and recommendations, those of the Russian Registry of Shipping and Russian building codes SNiP. The paper demonstrates relative effect of the various loads and their contribution to the values of the structural design criteria. The wave and ice loads are significant ones for all platform cases, while seismic load is governing for Sakhalin platforms on the gravity base substructure. The design criteria applied are: weight of the substructure (with a breakdown to weights of the reinforced concrete, steel and concrete ballast), constructability and feasibility of the assembly marine operations with account for the Russian content. The paper reviews practicability of a dry dock similar to that used to construct Piltun-Astokhskoye-B (PA-B) and Lunskeye-A (LUN-A) platforms (port Vostochny).

Stability of the proposed substructure affected by ice/wave and earthquake has been verified using computer time simulation of stresses.

Environmental conditions were assumed as mean conditions for the as yet poorly studied Sakhalin-IV, V, VI fields (for regions with water depth from 70 to 100 m). Computer simulation showed satisfactory behaviour of platforms under 100-year recurrence period loads.

### **BASIC IDEA FOR SUBSTRUCTURE CONCEPT**

#### **The platform specified characteristics for the field concept and comparison with the prototype**

The designed platform shall meet the following requirements:

- the topsides mass: 60000 t;
- total area of substructure: ca. 22000 m<sup>2</sup>;