Selection of the Optimal Structural Solutions of Reinforced Concrete Gravity Base Substructures for Platforms on Sakhalin Shelf

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ABSTRACT

The main purpose of this work is to develop approaches and conduct analyses necessary for the validation of the structural solutions at Sakhalin shelf. The geological engineering conditions at the sites, nature of loads, impacts and their combinations acting on the facilities are analyzed, analyses and estimations of the stability (bearing capacity) of the platform – foundation system necessary for validation of structural solutions from the point of view of Russian and foreign standards and Russian practice of designing hydro-technical facilities are made.

KEY WORDS: Platform; foundation; stability; stress; load; impact; soil.

INTRODUCTION

Five large fields are currently explored at Sakhalin shelf. Works under Sakhalin I and Sakhalin II projects are being made, other projects are started. The works are impeded by the complicated natural conditions in the region, including high seismic activity.

There are a lot of issues in designing fixed oil and gas production platforms in offshore areas due to unique nature of the project, complicated climatic conditions in the construction area, partial insufficiency of the current standards, and methodically different approaches and even some discrepancies in numerical provisions of different standards (both Russian and foreign).

During the design of support facilities of gravity platforms at Sakhalin shelf, it was necessary to conduct the following scientific and research work:
- analysis of geological engineering conditions of the construction sites, schematization of the foundations, content of necessary design parameters and their values;
- determination of the design values of seismic, ice and wave loads on the platforms;
- assessment of the stability of platforms under static and dynamic loadings.

In addition, in order to ensure reliability of the facilities at all stages of their construction, installation and operation, it was necessary to do the following calculations and assessments in the project:
- analyses of the bearing capacity of the foundation and the stability of the platform – soil foundation system under different combinations of loads with account for actual properties of foundation soils;
- analyses of foundation soil compaction including determination of excess pore pressure;
- analyses of vertical and horizontal displacements and tilts of the platform;
- analyses of the stresses delivered from foundation soils to the skirts and footprint of the base platform slab; development of measures eliminating tensile stresses at the contact of the substructure with soil;
- analyses of the possibility of scour and liquefaction of soils near the platform base, development of necessary structural measures to eliminate it;
- analyses of the conditions of platform installation with embedding skirts in foundation soils;
- analyses of the conditions of platform lifting.

The following tasks were solved:
- current Russian and foreign standards on the determination of the content of the newest requirements on loads and impacts were reviewed;
- the most adequate and validated approaches to the selection of standard values of loads were chosen;
- possible design combinations of loads and combination factors were determined;
- the necessary level of safety and reliability of the platforms was ensured.

The listed above allowed to optimize the selection of structural solutions of the reinforced concrete gravity base substructures for each platform on Sakhalin shelf, that is, select the dimensions of the substructures, number and shape of shafts, necessity for skirts, etc.

The experience of designing reinforced concrete substructures shows that, even for the same region (Sakhalin shelf in this case), the facilities may be significantly different structurally due to geotechnical details.