NEW TECHNOLOGIES AND EQUIPMENT FOR CONSTRUCTING FOUNDATIONS

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This article discusses new technologies for constructing combined foundations under large loads, a waste-free technology with sinking of driven piles to a given level on the basis of static sounding, a jet technology for constructing supports, the use of piles with small cross sections, methods of constructing foundations on slopes and sites with mine workings, and construction of foundations in rammed pits.

The Ufa Scientific Research Institute of Industrial Construction (NIIpromstroi) has developed and introduced in the Urals, Siberia, and Bashkortostan new technologies for constructing foundations, which take into account the conditions of site development, geological conditions, and also the rate and cost of the work.

For separate support nodes of buildings with loads up to 3000 kN, a structure and technology were developed for construction of combined foundations that make it possible, in the presence of medium-power hammers, to obtain significant bearing capacity of the support.

The sequence for construction of the foundations is shown in Fig. 1. A bulky hollow unit (barrel) of pyramidal or conical shape is driven by a pile driver's hammer with the help of a stamp that is a cap closing the lower end of the unit (Fig. 2). After sinking the unit into its cavity, vertical or inclined piles are installed. The cavity of the barrel unit is used as the ready formwork for laying a column base under a reinforced-concrete or metal column.

The traditional technology for constructing pile foundations, which calls for dynamic monitoring of the piles' bearing capacity according to the amount of design resistance, often leads to the need to cut off or add onto the piles. This problem is especially aggravated in attempts to use pile foundations with precast foundation mats, foundations without mats, pile-columns, and pile supports of technological petrochemical pipelines, when sinking the piles to a given level is an obligatory condition.

A waste-free technology for constructing foundations with sinking of piles to the design level has been suggested by NIIpromstroi and is widely used. With the help of static sounding with an S-832M unit designed by NIIpromstroi, operating on a truck chassis, geotechnical cross sections are obtained through a computer, which reflect the variability of the piles’ resistance (Fig. 3), and also determine the necessary length of the piles according to the assigned bearing capacity, and the possibility of sinking them to that depth with the hammer used for the work.

The bearing capacity of the piles is monitored by an instrument that takes into account the number of hammer blows in driving the piles to their design level.

NIIpromstroi developed and introduced a set of pile-driving equipment based on tractors and trucks for sinking piles 4, 8, 10, 12, and 16 m long. The mobile pile drivers have a number of advantages: high productivity on account of the use of a hydraulic drive for all of the basic mechanisms, good maneuverability of the machine in tight conditions of the pile field as a result of an arrangement for side mounting of the pile-driving mast on caterpillar tractors, accuracy of driving the piles without additional maneuvering of the base machine thanks to the presence of auxiliary equipment. The pile drivers are equipped with a device for changing the slope of the mast in longitudinal and transverse directions, and also for extending it across the path of the pile driver.

We should especially dwell on a technology for sinking piles with small cross sections for buildings with only a few stories. For this purpose, NIIpromstroi developed equipment and process charts for sinking of piles with a small pile driver on the base of a KN-4 tractor (Fig. 4), and also with a KO-8 pile driver on the base of a truck. Piles 3, 4, or 6 m long with cross sections of 10 x 10, 12 x 12, and 15 x 15 cm, respectively, are recommended for sinking. The KN-4 pile driver sinks piles up to 4 m long; the KO-8, up to 6 m.

A unit has also been developed on the base of a T-40 tractor for stockpiling and laying out piles with a small cross section at the sinking sites. The mounted equipment, in the form of a forklift and guides, is fastened to the back part of the tractor frame. With the help of a hydraulic cylinder, the fork moves along the guide columns, with piles taken from the pile arranged in one row on it. The lifting capacity of the forklift is 7 kN. As the working members there are an auger for drilling holes in frozen ground and a hopper with capacity of 0.3 m³ for concreting a monolithic foundation mat. One of the advantages of piles with a small cross section is the possibility of working inside erected buildings with a height of more than 7 m under the intrashop partition and technological equipment. The equipment’s high mobility and the low weight of the piles make it possible to quickly construct foundations of dispersed small objects. Thus, construction of a single-story, two-apartment house requires one trip of a truck for hauling the piles. The KN-4 pile driver and the forklift move under their own power.

Compaction of the development of urban territory requires construction on previously unused territories (slopes of ravines, sites with shallow underground workings), construction of "inserts" between houses, and addition of sections onto existing buildings. In these complex conditions, builders and designers try to use driven piles.

Construction of foundations on the slopes of ravines already causes difficulties in conducting surveys. NIIpromstroi developed and manufactured a small sounding unit (Fig. 5) with output data analogous to the data from the S-832 unit, making it possible to obtain the necessary soil characteristics for calculating piles. It is made from separate portable parts: an