Use of lengthy piles (more than 20 m) as component parts of a pile foundation (friction piles) is usually associated with complex geologic-engineering conditions at the construction site, i.e., where a large stratum of weak soils exists. Interaction between the piles and surrounding soil is complex space-time in nature, and depends on numerous factors, including the following ratios: the diameter and length of the pile \(d/l\), the diameter and distance between piles \(d/c\), the distance between the piles and their length \(c/l\), the width of the grillage and the length of the pile \(b/l\), and the height of the grillage and the length of the pile \(h/l\geq 0\).

When the distance between piles is no less than \(6d\), displacement of a pile and the soil in the interpile space occurs simultaneously, and the pile foundation and soil are displaced as a single mass [1-3].

It is precisely this mechanism on which the design scheme of pile foundations is based [3]. Here, the friction between the foundation and surrounding soil mass is disregarded. Moreover, the entire pile-soil mass is considered an additional load at the level of the lower ends of the piles. Based on this computational scheme, the settlement of the foundation is defined as the sum of the settlements of the soil layers beneath the lower end of the piles (Fig. 1, a). The shear settlement of the surrounding soil mass is neglected; this can be justified only in rare cases. The pattern of interaction between a pile and the surrounding soil vary considerably with increasing length of the piles, and distance between them. The role of lateral friction between a pile and the surrounding soil, and a group of piles with the surrounding mass is magnified. In that case, settlement of the pile foundation is dictated by the shear deformation of the soil surrounding a pile, and the settlement of the soil layers beneath the lower end of the piles (Fig. 1, b).

A new geomechanical model of a soil mass of limited dimensions is proposed in this study on the basis of analysis of results of numerical modeling of the interaction between long piles and the soil mass (Fig. 2).

The dimensions (boundaries) of the soil mass can be determined, proceeding from various criteria, and primarily from results of numerous field observations and large-scale laboratory experiments [1-2].
Fig. 1. Geomechanical computational model of soil mass based on [3] (a), and on our proposal (b) for determination of settlement of pile foundation.

Fig. 2. Isolines of vertical displacements of soil around pile (a) and group of nine piles (b).