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ANALYSIS OF THE EXPERIMENTAL RESEARCH OF THE FOOTING OPERATION FROM THE GROUP OF THE INTERRELATED PILES WITH DIFFERENT LENGTHS

There had been analyzed the experimental research of the operation of footing from the group of interrelated piles with different lengths, on the base of which there had been determined that the order of short and long piles influence the loading-carrying ability of the footing. It had been proved that the loading-carrying ability of the group of piles with different length is approximately equal to the loading-carrying ability of the group of piles with equal length.

Key words: *pile, loading-carrying ability, group of piles with different length, efficiency factor, ultimate loading on the group.*

Introduction

Using piles as footing for industrial and civil buildings helps eliminate ground works and mechanize the process of footing. Piled footing in civil engineering requires sufficient costs which cause the increase in expenses for building.

The existing methods for calculation of piled footing are pretty conventional and are poorly based on analysis of mechanical processes, which appear in basement under loading. Due to this reasons the sizes of piled footings are determined by calculation following the principle of simple addition of loading-carrying abilities on single piles, though the ultimate loading on the group of piles is not the simple addition of ultimate loading-carrying abilities of single piles. Many experiments state that the functional dependence “loading -subsidence” of the single pile in the majority of ground conditions does not correspond to the analogical dependence for the group of piles [1 - 3]. These circumstances stipulate for the expediency in further improvement of piled footings and reduce their costs by using piles with different lengths.

The task of the paper is to conduct the model test for group of piles with different lengths as well as to plot a chart of dependence of force distribution between the piles on group loading following the results of experimental researches.

The main part

Testing the group of piles with equal length showed the efficiency of those with distance between piles equaling 3d [4], therefore during the test of groups of piles with different length the distance did not very and was assumed as 3d for all cases.

There had been tested the groups of 9 piles in two variants:

– the longest (700 mm) are the corner piles (К-3);

– the longest (700 mm) are the intermediate and central piles (К-4);

– the longest (700 mm) corner, middle (600 mm) – intermediate, short (500 мм) – central (К-5).

Testing had been carried out in sands with average density. Each experiment was repeated 3-6 times. The average testing results are presented in table 1.

Comparison of loading-carrying ability of groups of piles with different lengths with that of group of piles with equal length [4] allowed to reveal that decreasing the length of both, corner and central piles somewhat decrease their loading carrying ability. Whereas the efficiency factor for the set ground conditions does not change in value.

Testing results, received during the experiment, did not prove the test results of Berman V. I. [5], according with whom the loading-carrying ability of the group with shortened piles did not decrease in comparison with the loading-carrying ability of the logest group of though the same

sequence of pile driving had been used. This may be explained by the fact that in Berman's tests the groups of piles did not reduce to the loss of loading-carrying ability, more then that it might have been influenced by redistributing influence of the grill with the tight coupling with piles (in the author's tests the coupling of grill with piles was swing joint).

The use of group of interrelated piles with different length may be recommended for sands with average dencity since even since even with the absence of the effect of the increase in the loading-carrying ability there remained the effect of decrease in energy and material losses. Since more short piles, which are driven as the last, do not enter the overcompacted zone, created due to the driving of previous piles, may easily be driven up to the designing mark.

The results of the experiments showed that the order of short and long piles in the group influence the loading- carrying ability of the footing in general. Pile groups with short central piles and long corner piles (К-3, К-5) have larger loading- carrying ability in comparison with groups which have long middle piles and short corner piles (К-4). This may be explained by the change in the form of the bottom part of pile group, which ensures the transfer of big loading on the surface with compacted base due to formation of zones with concentrated strain (Fig. 1).

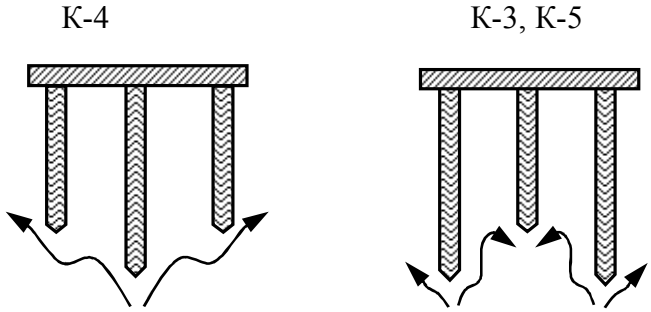

Fig. 1. Operation direction of the strains in the basis of the groups of piles with different length

In case of using the groups of piles with different length in the process of footing, the redistribution of strain between the separate piles in the groups K-3 and K-5 the strain is distributed approximately equally in the final phase of the group loading. Since the function between the pile and the grill was joint coupling, this unequity is determined by the stress state of the ground around piles.

As it is seen form table 1, in the moment when the pile group losses its load-carrying ability in the character if redistribution of loads between the piles in the groups of piles with different length, has its peculiarities. The majority of loading is accepted by long pile groups, dispite the short pile, if it is in the center, rests on the ground, compressed by previously driven long piles.

Assumption [5] that the strains between piles in this case shall be redistributed equally, is not proved experimentally in this paper. The results state that for most of the groups with long piles, placed in the corners, the most part of loading on the first stages of driving is transferred to the corner piles.

Fig. 2 presents the dependence of strain redistribution between the piles of under research group К3, which consists of corner piles with big length (700 mm), intermediate and central, more short (500 mm). The specific feature of our test is the increase in loading on corner piles (700 mm) and approaching to load, which is accepted by the central pile (500 mm) though in the group from long piles with equal length the difference in strains was significant.

Fig. 3 presents data on redistribution of strains on piles of the К4 group, when the corner piles – short (500 mm) and intermediate and central - long (700 mm). Big loading is accepted by long piles, that is, by intermediate. But comparing data from fig. 3 and 4 allows to determine that the short corner piles o the initial driving stage accept more loading then the central pile . It testifies for more acceptable operating conditions of the short corner pile with main one, in comparison with the short central in initial driving phase.

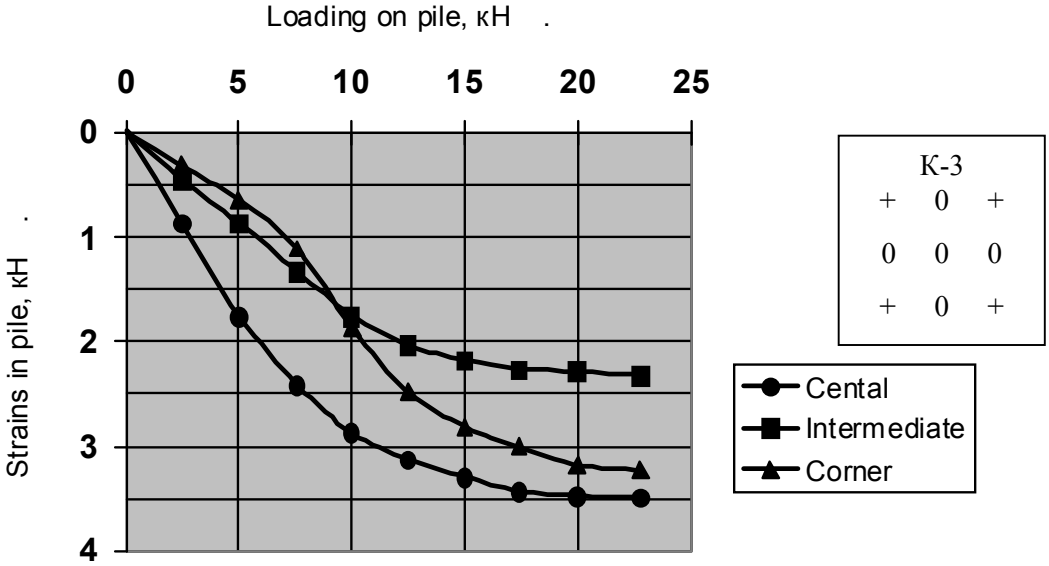

Fig. 2. Dependence of strain redistribution between piles on loading on loading of the group:
+ – the pile with length 700 mm; 0 – the pile with length of 500 mm

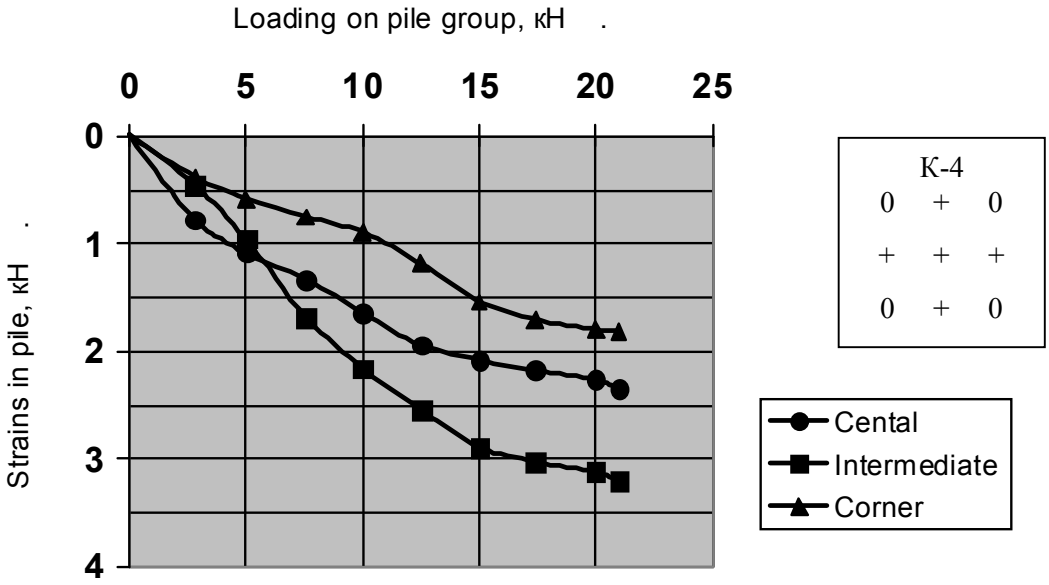

Fig. 3. Dependence of strain redistribution between piles on loading on loading of the group:
+ – the pile with length 700 mm; 0 – the pile with length of 500 mm

Table 1

Results of model testing of groups of intermediate piles with different length

Type of group	Position of the pile in the group	Length of pile, mm	Limiting load on the group, кН	Распределение усилий на сваи			Carrying ability of single pile, $F_{ОД}$ кН	Group settlement at the moment of loosing the carrying ability, мм	Theoretical carrying ability of group ($\Sigma F_{ОД}$), кН	Efficient factor , $К_{ЕФ}$
				central, кН	corner, кН	intermediate, кН				
К - 3	corner	700	22,7	3,42	3,21	2,38	2,87	10,5	23,27	0,89
	intermediate corner	500					2,23			
К - 4	corner	500	21,6	2,36	1,84	3,12	2,23	11,0	21,63	0,85
	intermediate central	700					2,87			
К - 5	corner	700	22,8	2,54	2,98	2,76	2,87	10,2	23,43	0,91
	intermediate	600					2,43			
	central	500					2,23			

Fig. 4 presents the dependence of the load distribution between the K5 pile group. Which consists of the combination of three piles with different length: corner – long (500 mm), intermediate – middle (600 mm), and central – short (500 mm). The redistribution of strains in the final phase of loading is approximately equal between all piles of the group, which influence the equal distribution of strains in grill. For the group K5 the driving of piles to the project mark was not difficult, and this is one of the factors of rationality and efficiency of this schema.

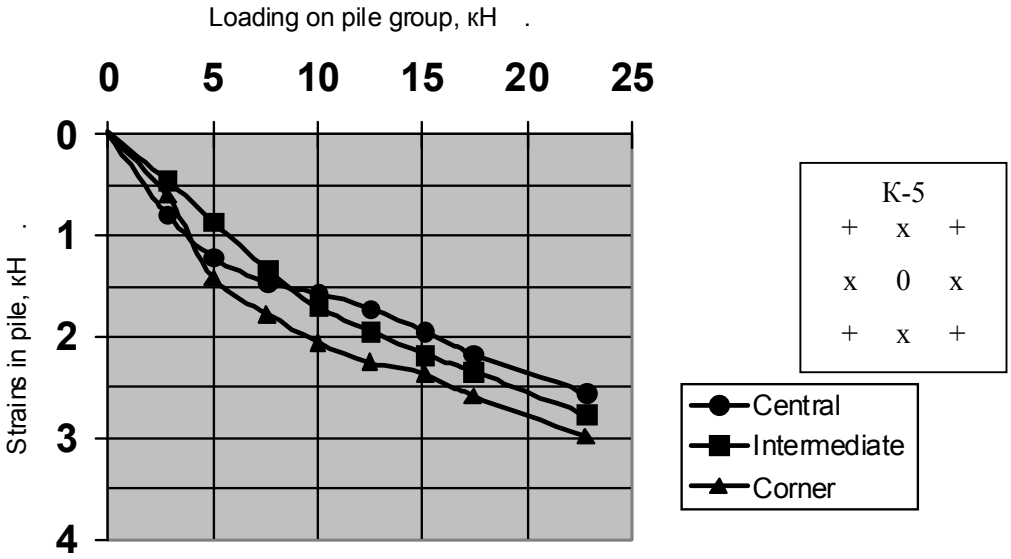

Fig. 4. Dependence of strain redistribution between piles on loading of the group:
+ – the pile with length 700 mm; x – the pile with length 600 mm;
0 – the pile with length 500 mm.

Conclusions

It had been proved experimentally that the carrying capacity of pile groups of different length is nearly equal with the carrying capacity of pile group of long piles of equal length. This may be explained by the change in the from of the bottom part of the group of piles of different length which ensures the transfer of bigger loading on the surface of the compressed base then in the group with equal length of piles, and factor the decrease in settlement under the same loadings.

Piled footing with piles of different length in the researched cases allows to decrease loss of material due to shortening the total length of piles by 13-16%, preserving the value of loading on the group which equals the resistance of the group of piles with equal length [4].

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