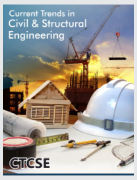

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Mini Review

Drilled Piles Ert as Reinforcement of Bases of Increased Bearing Capacity

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Abstract

The construction of foundations with increased bearing capacity values is an urgent task of modern geotechnical construction. As a rule, deep drill piles with large diameters are used as a basis for such foundations. There are many technologies for their manufacture. Increasing their bearing capacity is possible only by changing their length and diameter. The use of drill-injection piles manufactured by electric discharge technology (piles-ERT) with multi-seat widenings solves the problem of creating foundations of increased bearing capacity.

Keywords: Brown-injection piles; ERT piles; Multi-seat widening; Bored piles; Bearing capacity; Engineering and geological conditions

Introduction

Drill piles in modern geotechnical construction are the main buried structures. They are in demand both in pile fields and in strengthening the foundations of foundations and are also used as sheet walls of pit fences. The problem of increasing the bearing capacity of these piles remains very urgent. For this, two approaches are possible. In the first way, increased values are increased F_d can only be achieved by increasing the diameter and length of the drill piles. Particular attention should be paid to the fact that an excessive increase in drilling diameters will lead to the restructuring and compaction of the soil of the walls of wells, which will attract a change in the stress-strain state (VAT) of the base that has developed over a long geological period. At the same time, the return of the decompacted state to the original only due to the own weight of the concrete laid in the well is not possible. The second way to increase the F_d drill piles is by extending under the heel and along the shaft of the piles. According to this method, there are large reserves in terms of a significant increase in their bearing capacity. When creating widenings of the trunk and heel of the pile, there is a multiple increase in its bearing capacity on the ground. The practice of designing, manufacturing, and operating such piles has shown their high efficiency. Including very serious laboratory and field research in this regard were carried out by specialists of the laboratory of foundations and foundations of the Ural Institute "Promstroyinvestrproekt" under the leadership of A.N. Tetiora [6]. According to the results of field tests with static loads, the bearing capacity of a pile with one and with two widenings was greater than the bearing capacity of the same pile without widenings by 1.5-2.0 and 3.0-4.0 times, respectively. At the same time, there are disadvantages of mechanical widening. This is, firstly, as in bored piles, the decompaction of the soil, both the walls and in the area of the widening device. Secondly, in sandy soils it is almost impossible to arrange widenings due to their crumbling on the bearing layer of the sole. In particular, it is not possible to accurately determine the marks of the widening device due to the complexity of the engineering and geological conditions (ISU) of the construction site.

The most acceptable geotechnical technology for increasing F_d by the second method is the device of widening by electric discharge technology.

The author of this article (LLC NPF "FORST")) for a long time is engaged in the design and installation of ERT piles. They showed that ERT piles with multi-seat widenings (SMEs) have an increased bearing capacity compared to piles without widenings. Pressure testing of the walls of the well using ERT technology is carried out using camouflage extensions [5-10, 13]. These are drill injection piles arranged using discharge-pulse technology (piles-ERT). These piles have increased values Y_{CR}и Y_{CF}, namely Y_{CR} = 1.3, and Y_{CF} = 1.1÷1.3 due to the restoration of the soil structure of the walls of the wells, and in most cases - its compaction beyond natural values. Thus, the increase in bearing capacity under the lower end of the pile-ERT is 1.3 times, and on the lateral surface – B 1.1/0.5 ÷ 1.3/0.5 = 2.2÷2.6 times. When determining the bearing capacity of F_d according to the formula (7.11) [11], the values of the calculated resistances R and f are determined from Tables 7.3 and 7.8. [11]. In Table. 7.3 [11] shows the values f for different values of I_L and f, and in Table 7.8 [11] - the same for R. For clarity of the value R/ f = f (h) for different values of I_L is listed below in Table 1 and figure 1 (Table 1, Figure 1).

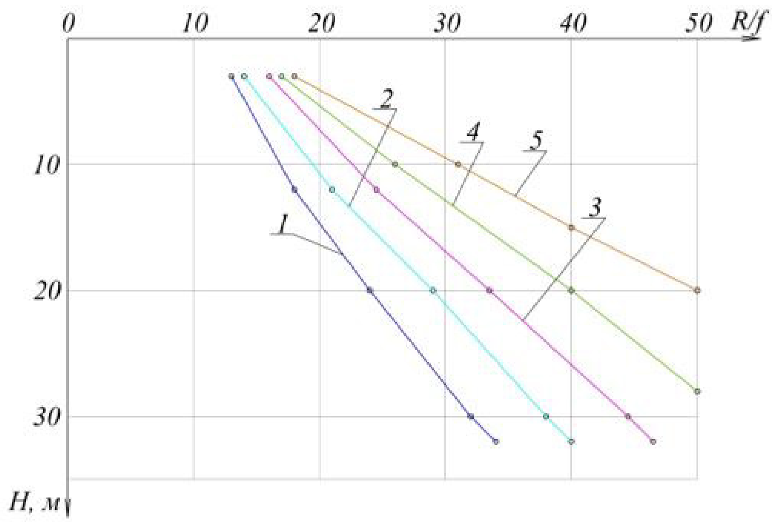


Figure 1: Plots of R/f =f(h) for different values of the flow index IL
1 – for IL=0.2; 2 – for IL==0.3; 3 – for IL==0.4; 4 – for IL==0.5; 5 – for IL==0.6.

Table 1: Resource requirements by component Dependencies R/f =f(h) for different values of I_L.

	I_L=0.2			I_L =0.3			I_L =0.4			I_L =0.5			I_L =0.6		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
h,м	R, КПа	f, КПа	R/f	R, КПа	f, КПа	R/f	R, КПа	f, КПа	R/f	R, КПа	f, КПа	R/f	R, КПа	f, КПа	R/f
3	650	48	13,5	500	35	14,2	400	25	16,0	300	20	15,0	250	14	17,9
5	750	56	13,7	650	40	16,3	500	29	17,2	400	24	16,7	350	17	20,6
7	850	60	14,2	750	43	17,4	600	32	18,8	500	25	20,0	450	19	23,7
10	1050	65	16,2	950	46	20,7	800	34	23,5	700	27	25,9	600	19	31,6
12	1250	68	18,4	1100	48	22,9	950	36	26,4	800	28	28,6	700	19	36,5
15	1500	72	20,8	1300	51	25,5	1100	38	28,9	1000	28	35,7	800	20	40
18	1700	76	22,4	1500	53	28,3	1300	40	32,5	1150	29	39,7	950	20	47,5
20	1900	79	24,1	1650	56	29,5	1450	41	25,4	1250	30	41,7	1050	20	52,5
30	2600	81	32,0	2300	61	37,7	2000	44	44,0	-	-	-	-	-	-
≥40	3500	93	37,6	3000	66	45,4	2500	47	53,2	-	-	-	-	-	-

Unlike bored piles, unlike bored piles, have the main advantage. This is the ability to seal the compacted walls of boreholes by means of electrohydraulic treatment in an environment of fine-grained concrete in excess of natural. As a result of this process, in the cross-section of piles-ERT, in addition to the reinforced concrete section of piles (Figure 1), the following are created: 1) cementation zone; 2) sealing zone (see Figure 2). In this case, the cementation zone tends to increase over time (Figure 2).

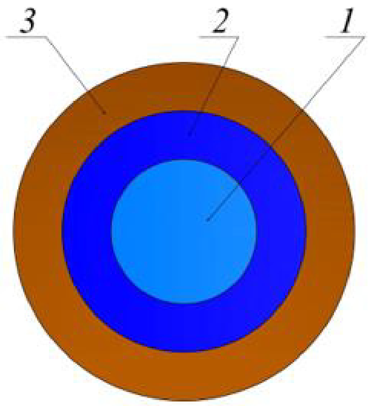


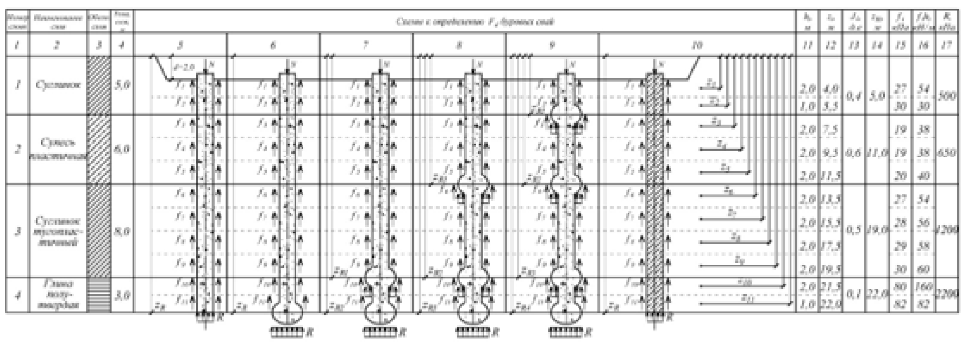
Figure 2: Cross-section of the drill injection pile-ERT. 1 – reinforced concrete section of pile-ERT; 2 - cementation zone; 3 – sealing zone.

Determination of bearing capacity F_d is made according to the formula (7.11) [11]

$$F_d = \gamma_c(\gamma_{cR} \cdot R \cdot A + u\sum(\gamma_{cf} f_i h_i)), \qquad (1)$$

where γ_c is the coefficient of the working conditions of the pile in the ground, taken to be equal to 1; R is the calculated resistance of the soil under the lower end of the pile, kPa (Tc/m^2), taken according to Table. 7.2 [11]; A - area of support of the pile on the ground, m; u - the outer perimeter of the cross-section of the pile, m; fi is the calculated resistance of the i-th layer of the base soil on the side surface of the pile, kPa (tf/m^2), taken according to Table. 7.3 [11]; hi is the thickness of the i-th layer of soil in contact with the side surface of the pile, m; γ_{cf} is the coefficient of working conditions of the soil, respectively, by the lower end and on the side surface of the pile, taking into account the influence of the method of immersion of the pile on the values of the calculated resistance of the soil and taken according to Table. 7.6 [11]; γ_{cR} is the coefficient of working conditions under the lower end of the pile according to clause 7.26 [11].

According to the formula (1), calculations of the bearing capacity of F_d on the soil of various types of drill piles cutting through tight-plastic loam with I_L = 0 are made. 4, plastic loam with I_L = 0.6, tight loam with I_L = 0. 5, and semi-solid clay with I_L = 0. 1. The heel of the piles is sealed in semi-hard clay. As types of drill piles, the following are used: 1) brown injection piles-ERT without widenings and with widenings under the heel and along the shaft; 2) bored piles Ø 600, 800, 1000 mm, recyclable in casing pipes, under the protection of thixotron clay, as well as laid by deep vibration. Schemes for the calculation of F_d are given in Figure 3, and the results of calculations are summarized in Table 2 (Table 2, Figure 3).



Notes by column: 5÷9 brown-injection piles-ERT respectively without widenings and widenings along the heel and along the trunk; 10 – bored pile.

Figure 3: Schemes for determining the bearing capacity of Fd drilling piles.

Table 2:

No. p.p.	Pile Type	Position	Bearing Capacity, kN	Design Load	Notes	Pile Volume, m³	Specific Load Capacity, kN/ m³	Specific Design Load, kN/ m³
1	2	3	4	5	6	7	8	9
1	Bored pile Ø600 A=0,2826 m²	1	1500,0	1070,0	Bored pile in casing pipes	5,4	277,0	198,0
		2	1380,0	985,0		5,4	256,0	182,0
		3	1630,0	1165,0		5,4	302,0	216,0
2	Bored pile Ø800 A=0,50 m²	1	2280,0	1630,0		9,5	220,0	160,0
		2	2110,0	1510,0		9,5	210,0	150,0
		3	2450,0	1750,0		9,5	240,0	171,0
3	Bored pile Ø1000 A=0,785 m²	1	3200,0	2290,0		15,0	215,0	153,0
		2	2990,0	2140,0		15,0	200,0	143,0
		3	3150,0	2510,0		15,0	210,0	167,0
4	Bored pile Ø2000 A=6,28 m²	1	9860,0	7040,0		119	83,0	59,1
		2	9430,0	6740,0		119	79,2	56,6
		3	10280,0	7340,0		119	86,3	61,7
5	Brown injection piles-ERT Ø350 A=0,10 m²	4	830,0	593,0	brown injection pile-ERT without extensions	1,9	437,0	312,0
		5	890,0	635,7	brown injection pile-ERT with extensions under the heel	1,9	468,4	334,6
		6	940,0	671,4	brown injection pile-ERT with widenings under the heel and along the trunk	1,9	494,7	353,4
		7	980,0	700,0	brown injection pile-ERT with widenings under the heel and two widenings along the pile shaft	1,9	515,8	368,4

For a comparative assessment of the values of the bearing capacity of piles and the design loads on them in Table 1 there are values of their specific values, this is the specific bearing capacity of the corresponding and specific design load corresponding to, where is the volume of the pile under consideration.

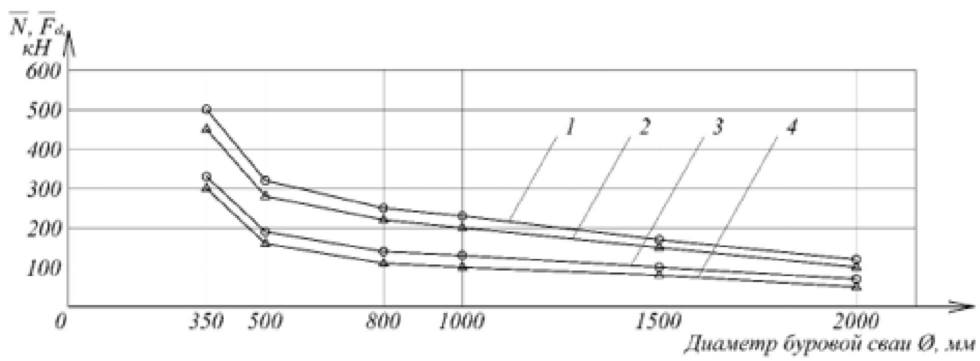


Figure 4: Dependency plots f(Ø,) и $\overline{N}$f(Ø,) $\overline{F}_d$.

Here is the specific load capacity [kN], is the specific design load [kN]; 1 and 2 – graphs f(Ø,); 3 and 4 – graphs f(Ø,), Ø – pile diameter.

The most characteristic graphs of dependence on the diameter and type of piles are shown in Figure 4. The predominance of piles-ERT reaching up to 5 times these values for bored piles is clearly traced. At the same time, with an increase in the diameter of the piles, the graphs acquire a linear falling character.

Acknowledgement

None.

Conflict of Interest

No conflict of interest.

References

1. Ilyichev VA, Mangushev RA, Nikiforova NS (2012) Experience in the development of the underground space of Russian megacities. Foundations, foundations and mechanics of soils, 2: 17-20.
2. Ulitskiy VM, Shashkin AG, Shashkin KG (2010) Geotechnical support of urban development. SPb.: Geo re-construction, p.551.
3. Ter-Martirosyan ZG (2009) Mechanics of soils. M.: ASV. P.550.
4. Ukhov SB (2007) Mechanics of soils, foundations, and foundations. M.: Vysshaya shkola, P.561.
5. Ulitskiy VM, Shashkin AG, Shashkin KG (2012) Geotechnics Guide (a guide to foundations, foundations, and underground structures). Second edition, additional. Saint Petersburg. P.284.
6. Sokolov NS, Sokolov SN (2005) The use of brown injection piles in the fixation of slopes. Materials of the Fifth All-Russian Conference "New in Architecture, Design of Building Structures and Reconstruction" (NASKR-2005), Cheboksary: Chuvash University Publishing House. pp.292-293.
7. Sokolov NS (2014) Method of calculating the bearing capacity of drill injection piles-RIT taking into account "podpyatnikov". Materials of the 8th All-Russian (2nd International) conference "New in architecture, design of building structures and reconstruction" (NASKR-2014). Cheboksary: Chuvash State University Publishing House. pp.407-411.
8. Sokolov NS, Ryabinov VM (2015) On one method of calculating the bearing capacity of brown injection piles-ERT. "OFiMG". 1: 10-13.
9. Sokolov NS, Ryabinov VM (2016) On the efficiency of the device of drill injection piles with multi-seat widenings using electric discharge technology. Geotechnics, 2: 28-34.
10. Sokolov NS, Ryabinov VM (2016) Features of the device and calculation of drilling piles with many-seated widening. Geotechnica, 3: 60-66.
11. Sokolov NS, Ryabinov VM (2016) Technology for the production of bored injection piles in an elevated quarry. Residential construction. 9: 11-14.
12. SP 24.13330. (2011) 2011 Updated edition of SNiP 2.02.03-85 Pile foundations. P.85.
13. TR 50-180-06 (2006) Technical recommendations for the design and installation of pile foundations performed using discharge-pulse technology for high-rise buildings (piles-RIT). Department of Urban Planning Policy, Development and Reconstruction of the City of Moscow. P.68.
14. Gorbushin AV, Ryabinov VM (2016) Possibility of using electro-discharge technology in construction in non-weak soils. OFiMG, p.10-13.