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Alternative Method of Calculation of Pile Bearing Capacity Using Graphical Correction N-SPT

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ABSTRACT

Field N-SPT, used as the primary data in calculating pile bearing capacity, must be corrected by analytical methods to become N-SPT analytical correction. The analytical process requires unit weight, groundwater level, soil classification, and drilling equipment specifications to calculate field N-SPT to become analytical correction of N-SPT. A graphical approach is proposed to simplify the analytical method and to accelerate calculating the estimated pile-bearing capacity, which can be directly obtained from the relationship between the field N-SPT and the graphical correction N-SPT. The calculation results of analytically corrected N-SPT and graphical corrected N-SPT based on the field N-SPT show that the graphic of N-SPT increases linearly acording value of the field N-SPT. From all the calculations of the corrected N-SPT and pile bearing capacity obtained the ratio of pile capacity (RQ) of the graphical corrected N-SPT to the analytically corrected N-SPT are RQu = 0.93, RQp = 0.94, and RQs = 0,94. This shows that the N-SPT Graphical Correction chart can be used to simplify and accelerate the prediction of pile-bearing capacity based on field N-SPT

INTRODUCTION

The distribution of soft soils in Banjarmasin, South Kalimantan, Indonesia, has created problems in infrastructure development, resulting in low pile-bearing capacity. The pile bearing capacity is obtained from the soil bearing parameters by conducting soil sample investigations in the laboratory and the Standard Penetration Test (SPT) in the field. So far, the field N-SPT values have been corrected to analytical N-SPT, which are determined based on the results of N-SPT investigations in the field and the physical and mechanical properties of the soil using the analytical method Terzaghi-Peck (1960) & Bazaraa (1967). To simplify and accelerate the determination of pile bearing capacity, an alternative graphical method is needed to determine the corrected N-SPT without analytical correction or called the graphical correction N-SPT which is obtained directly from the field N-SPT graphic correlation.

METHODS

The research phase began with the collection of field N-SPT data and the physical mechanical properties of the soil, especially the saturated soil unit weight (□ sat) from 17 (Seventeen) deep drill points in Banjarmasin. Saturated soil unit weight (□ sat) that produces the minimum and maximum effective stress per soil layer representing all locations was processed and analyzed using the Terzaghi-Peck (1960) & Bazaraa (1967) analytical method to correct field N-SPT to N-SPT analytical correction for each location. Then the field N-SPT values for all locations were arrayed from field N-SPT values = 1 to 40 and correlated with analytical correction N-SPT in the range of minimum and maximum values. These results are analyzed into a graph of the relationship between the field N-SPT and analytical correction N-SPT which is called a correction graph or graphical correction of N-SPT. The N-SPT correction graph is used to calculate the bearing capacity of piles by directly inputting or plotting field N-SPT values according to the N-SPT correction graph curve or the equation of graphical correction of N-SPT without analytical correction N-SPT calculations. The calculation of the pile bearing capacity using Meyerhoff (1956) and Luciano Decourt (1982) methods consist of the ultimate pile bearing capacity (Qu), the end bearing capacity (Qp), and the skin bearing capacity (Qs) for each location until the final pile depth of 40 m. The calculation results of the pile bearing capacity using the graphical correction N-SPT are compared with the pile bearing capacity calculated based on the analytical correction N-SPT which is expressed in the form of pile bearing capacity ratio RQp, RQs and RQu. The results of this ratio indicate the validation of the accuracy of the graphic correction N-SPT method against the analytical correction N-SPT method.

Table 1. Deep Bore Hole Location

No. Location	Street	Coordinate	Kecamatan
1	Lambung Mangkurat	-3.325760, 114.590169	Central Banjarmasin
2	Mesjid Jami	-3.307709, 114.593566	Central Banjarmasin
3	Cempaka 1	-3.322635, 114.585916	Central Banjarmasin
4	Brigjen Hasan Basri	-3.298922, 114.585107	North Banjarmasin
5	Bumi Mas Raya	-3.338746, 114.615123	South Banjarmasin
6	Pramuka	-3.337554, 114.631270	East Banjarmasin
7	Veteran	-3.320114, 114.599599	East Banjarmasin
8	Kelayan	-3.332884, 114.585092	South Banjarmasin
9	Rawa Sari	-3.314419, 114.578835	Central Banjarmasin
10	Veteran	-3.320692, 114.602792	East Banjarmasin
11	Trisakti-1	-3.326518, 114.559363	West Banjarmasin
12	Trisakti-2	-3.326746, 114.559247	West Banjarmasin
13	Trisakti-3	-3.326525, 114.558733	West Banjarmasin
14	Trisakti-4	-3.326258, 114.558822	West Banjarmasin
15	Trisakti-5	-3.326491, 114.559015	West Banjarmasin
16	A. Yani Km. 4,5 -1	-3.333444, 114.614984	East Banjarmasin
17	A. Yani Km. 4,5 -2	-3.331562, 114.617847	East Banjarmasin

RESULTS AND DISCUSSION

The results of soil investigations using deep borehole and field N-SPT at 17 (seventeen) locations are shown in Table 2.

Table 2. Field N-SPT Values at Each Location

Depth (m)	Location and Field N-SPT																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Min	Max	Avg
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	3	1
4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	2	1
10	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	1	1	1	2	1
12	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	1	1	1	2	1
14	1	1	1	1	1	1	1	1	1	1	2	2	2	1	2	1	1	1	2	1
16	1	1	1	1	1	1	1	1	1	1	2	2	2	1	2	1	2	1	2	1
18	1	1	1	3	10	9	1	1	2	1	2	2	2	1	2	1	2	1	10	2
20	1	1	1	4	8	9	1	1	1	1	2	4	3	1	4	4	5	1	9	3
22	1	1	1	3	10	11	12	1	1	10	3	5	7	2	7	7	11	1	12	5
24	2	13	3	5	9	6	7	9	1	10	5	5	10	5	6	10	10	1	13	7
26	3	17	4	8	9	9	11	8	4	5	7	6	19	6	14	10	10	3	19	9
28	12	10	8	7	7	13	9	7	3	7	15	7	40	7	36	13	14	3	40	13
30	9	22	12	7	16	13	39	6	6	7	35	7	46	24	37	15	15	6	46	19
32	13	9	28	8	20	9	8	10	7	7	48	12	50	38	47	19	21	7	50	21
34	13	10	31	37	19	60	11	18	8	11	60	14	56	41	60	24	29	8	60	30
36	32	16	30	50	22	50	13	46	21	11	60	40	60	43	60	24	34	11	60	36
38	51	17	35	60	17	47	50	30	41	32	60	60	60	46	60	35	43	17	60	44
40	33	18	37	57	34	38	50	35	50	31	60	60	60	48	60	45	52	18	60	45

(Source: Soil Investigation Results)

Table. 2 and Figure. 1 show the field N-SPT values at 17 (seventeen) soil investigation locations in Banjarmasin. Field N-SPT values and soil classification (Terzaghi & Peck, 1973) at a depth of 1 m to 20 m are clay very soft to soft shows N-SPT is 2 to 3, at 20 m to 24 m are clay mild to medium shows N -SPT is 3 to 7, at 24 m to 28 m are clay medium to stiff shows N-SPT is 7 to 13, at 28 m to 34 m are clay stiff to very stiff shows N-SPT are 13 to 30 and 34 m to 40 m are sand dense to very dense shows N-SPT are 30 to 45. The soil investigation results show that the distribution of field N-SPT values is a more bigger to the increasing depth of the soil layer as shown in Figure 1.

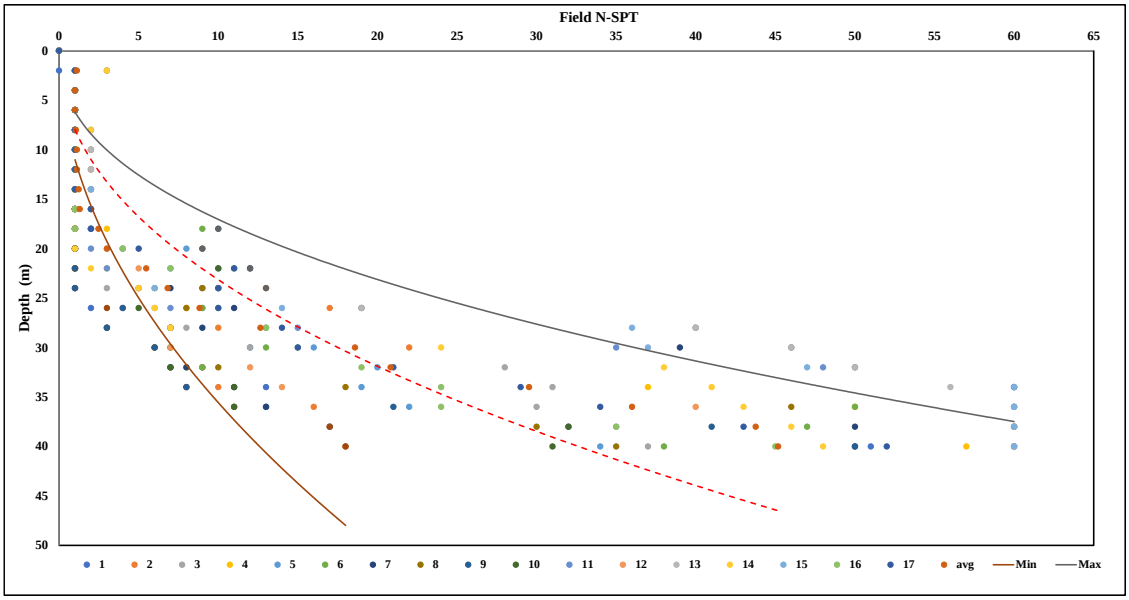

Figure 1. The Field of N-SPT Againts to Depth (m)
(Source: Field Investigation Results)

Saturated soil of unit weight (γsat) was obtained from the laboratory test of the UDS for each location with variations in sampling depth. From several variations in sample depth for each of these locations, the minimum and maximum limits are shown in Table 3. In general, the classification of soil layers according to the distribution of field N-SPT values to depth, γsat at depths of 0 to 20 m is 1.420. gr/cm^3 up to 1.881 gr/cm^3 , γsat at depths of 20 m up to 24 m is 1.42 gr/cm3 up to 2.002 gr/cm^3 , γsat at depths of 24 m up to 28 m is 1.501 gr/cm^3 up to 2,050 gr/cm^3, γsat at depths of 28 m up to 34 m is 1,600 gr/cm^3 up to 2,268 gr/cm^3 and at depths of 34 m up to 40 m, γsat is 1,762 gr/cm^3 cm^3 up to 2.381 gr/cm^3.

Table 3. Unit Weight of Saturated Soil (γSat) at Each Location

Depth (m)	Location and Saturated Unit Weight (γsat, gr/cm3)																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Min	Max	Avg
0	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000
2	1.44	1.44	1.39	1.43	1.39	1.46	1.47	1.58	1.58	1.58	1.51	1.51	1.49	2.26	1.52	1.58	1.58	1.388	2.261	1.541
4	1.44	1.44	1.39	1.43	1.39	1.46	1.47	1.58	1.58	1.58	1.52	1.52	1.51	1.55	1.51	1.58	1.58	1.388	1.580	1.502
6	1.44	1.44	1.39	1.43	1.39	1.46	1.47	1.58	1.58	1.58	1.52	1.52	1.51	1.55	1.51	1.58	1.58	1.388	1.580	1.502
8	1.44	1.44	1.39	1.43	1.39	1.46	1.47	1.58	1.58	1.58	1.52	1.55	1.49	1.56	1.52	1.58	1.58	1.388	1.580	1.504
10	1.44	1.44	1.39	1.43	1.39	1.46	1.47	1.58	1.51	1.58	1.52	1.51	1.51	1.48	1.52	1.58	1.58	1.388	1.578	1.493
12	1.44	1.44	1.39	1.43	1.39	1.46	1.47	1.58	1.51	1.58	1.52	1.51	1.51	1.48	1.52	1.58	1.58	1.388	1.578	1.493
14	1.44	1.44	1.39	1.43	1.43	1.46	1.47	1.58	1.51	1.58	1.75	1.51	1.62	1.50	1.67	1.58	1.58	1.388	1.749	1.526
16	1.44	1.44	1.39	1.43	1.43	1.46	1.47	1.58	1.50	1.58	1.82	1.50	1.49	1.49	1.52	1.58	1.59	1.388	1.817	1.513
18	1.42	1.44	1.43	1.43	1.81	1.88	1.48	1.58	1.47	1.58	1.82	1.50	1.49	1.49	1.52	1.58	1.59	1.420	1.881	1.560
20	1.42	1.44	1.43	1.43	1.81	1.88	1.48	1.58	1.50	1.58	1.52	1.63	1.54	1.69	1.52	1.59	1.52	1.420	1.881	1.562
22	1.42	1.44	1.43	1.43	1.81	1.88	1.60	1.58	1.50	2.00	1.52	1.51	1.53	1.50	1.53	1.71	1.76	1.420	2.002	1.598
24	1.42	1.88	1.43	1.43	1.81	1.88	1.91	1.84	1.50	2.00	1.52	1.51	1.53	1.50	1.53	2.00	2.00	1.420	2.002	1.689
26	1.42	1.88	1.43	1.80	1.81	1.88	1.91	2.00	1.93	1.52	1.52	1.51	1.52	1.50	1.57	2.00	2.00	1.420	2.002	1.718
28	1.81	1.88	1.81	1.80	1.81	1.88	1.91	1.71	1.60	1.92	1.98	1.50	2.05	1.52	2.00	1.79	1.81	1.501	2.050	1.811
30	1.81	1.88	1.81	1.80	1.88	1.88	1.76	1.62	1.84	1.92	1.98	1.50	2.05	1.52	2.00	1.83	1.83	1.501	2.050	1.818
32	1.81	1.88	1.81	1.80	1.88	1.88	1.91	1.88	1.92	1.92	2.07	1.58	2.12	2.09	2.02	1.90	1.93	1.583	2.121	1.905
34	1.81	1.88	1.81	1.83	1.88	1.88	1.60	1.96	2.00	1.91	2.27	2.03	2.08	1.99	2.13	1.98	2.07	1.600	2.268	1.948
36	1.83	1.83	1.81	1.83	1.88	1.88	1.91	2.08	1.93	1.76	2.27	2.03	2.08	1.99	2.13	1.98	1.95	1.762	2.268	1.952
38	1.83	1.83	1.81	1.83	1.88	1.88	1.91	2.08	2.02	1.79	2.42	2.07	2.13	2.09	2.29	1.86	1.89	1.787	2.425	1.976
40	1.83	1.83	1.81	1.83	1.88	1.88	1.91	1.86	2.24	1.76	2.38	2.26	2.15	2.26	2.34	2.12	2.08	1.762	2.381	2.025

(Source: Field Investigation Results)

Several location points and variations of saturated soil unit weight show that the saturated soil unit weight value increases according to the depth of the soil layers as shown in Figure 2.

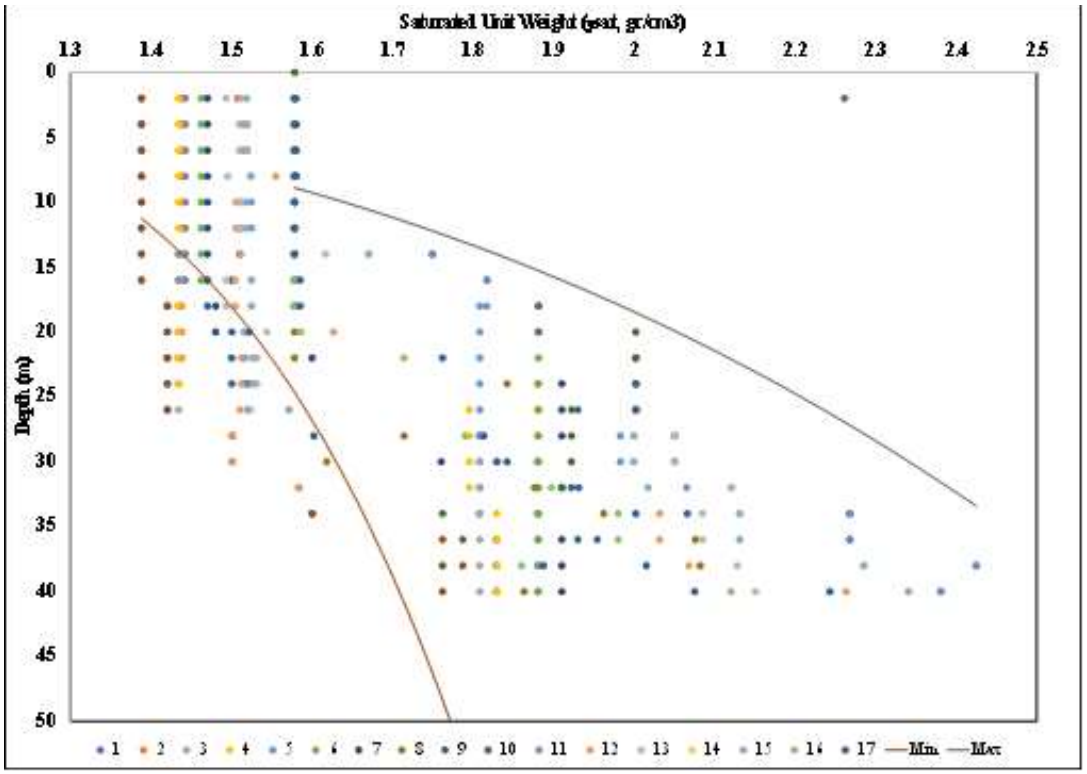

Figure 2. Saturated Soil Unit Weight to Depth

(Source: Field Investigation Results)

The N-SPT analytical correction was obtained from the field N-SPT data (Table 2) which was corrected for the groundwater level and the minimum and maximum effective soil stress at each location using the analytical correction method from Terzaghi-Peck (1960) & Bazaraa (1967) as presented in Table 4. The results show that the analytical correction values of N-SPT increas as the field N-SPT value increases.

Table 4. Average N-SPT Analytical Correction Values

Depth (m)	Location and N-SPT Analytic Correction																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	3.60	1.20	1.20	1.20
4	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
6	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07
8	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	1.82	0.91	0.91	0.91
10	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	1.58	1.58	0.79	0.79	0.79	0.79
12	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	1.40	1.40	0.70	0.70	0.70	0.70
14	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	1.25	1.25	1.25	0.62	1.25	0.62	0.62
16	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	1.18	1.18	1.18	0.59	1.18	0.59	1.18
18	0.57	0.57	0.57	1.72	5.75	5.17	0.57	0.57	1.15	0.57	1.15	1.15	1.15	0.57	1.15	0.57	1.15
20	0.56	0.56	0.56	2.24	4.48	5.04	0.56	0.56	0.56	0.56	1.12	2.24	1.68	0.56	2.24	2.24	2.80
22	0.54	0.54	0.54	1.63	5.44	5.99	6.53	0.54	0.54	5.44	1.63	2.72	3.81	1.09	3.81	3.81	5.99
24	1.06	6.86	1.58	2.64	4.75	3.17	3.70	4.75	0.53	5.28	2.64	2.64	5.28	2.64	3.17	5.28	5.28
26	1.54	8.70	2.05	4.09	4.61	4.61	5.63	4.09	2.05	2.56	3.58	3.07	9.72	3.07	7.16	5.12	5.12
28	5.94	4.95	3.96	3.46	3.46	6.43	4.45	3.46	1.48	3.46	7.42	3.46	19.78	3.46	17.81	6.43	6.92
30	4.31	10.53	5.74	3.35	7.66	6.22	18.66	2.87	2.87	3.35	16.75	3.35	22.01	11.48	17.70	7.18	7.18
32	6.00	4.16	12.93	3.69	9.24	4.16	3.69	4.62	3.23	3.23	22.17	5.54	23.09	17.55	21.71	8.77	9.70
34	5.79	4.46	13.81	16.49	8.47	29.85	4.90	8.02	3.56	4.90	26.73	6.24	24.95	18.27	26.73	10.69	12.92
36	13.77	6.89	12.91	21.52	9.47	21.52	5.59	19.80	9.04	4.73	25.82	17.21	30.13	18.51	25.82	10.33	14.63
38	21.21	7.07	14.55	24.95	7.07	19.54	20.79	12.47	17.05	13.31	24.95	26.61	24.95	19.13	24.95	14.55	17.88
40	13.25	7.23	14.86	22.89	13.65	15.26	20.08	14.05	20.08	12.45	24.09	24.09	24.09	19.27	24.09	18.07	20.88

(Source: Land Investigation Results)

The average analytical correction N-SPT value (table.4) for all locations was grouped according to each field's N-SPT value from 1 to 40 and then graphed to form a graphical equation N-SPT graphic = 0.8004 x(N-SPT field $^{0.7914}$) as presented in Table 5, Table 6 and Figure 3.

Table 5. Average Graphical Correction N-SPT Value

Depth (m)	Location and N-SPT Graphic Correction																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	1.909	0.800	0.800	0.800
4	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800
6	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800
8	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	1.385	0.800	0.800	0.800
10	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	1.385	1.385	0.800	0.800	0.800	0.800
12	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	1.385	1.385	0.800	0.800	0.800	0.800
14	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	1.385	1.385	1.385	0.800	1.385	0.800	0.800
16	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	1.385	1.385	1.385	0.800	1.385	0.800	0.800
18	0.800	0.800	0.800	1.909	4.951	4.555	0.800	0.800	1.385	0.800	1.385	1.385	1.385	0.800	1.385	0.800	0.800
20	0.800	0.800	0.800	2.398	4.150	4.555	0.800	0.800	0.800	0.800	1.385	2.398	1.909	0.800	2.398	2.398	0.800
22	0.800	0.800	0.800	1.909	4.951	5.339	5.720	0.800	0.800	4.951	1.909	2.861	3.734	1.385	3.734	3.734	5.720
24	1.385	6.094	1.909	2.861	4.555	3.305	3.734	4.555	0.800	4.951	2.861	2.861	4.951	2.861	3.305	4.951	3.734
26	1.909	7.535	2.398	4.150	4.555	4.555	5.339	4.150	2.398	2.861	3.734	3.305	8.228	3.305	6.462	4.951	5.339
28	5.720	4.951	4.150	3.734	3.734	6.094	4.555	3.734	1.909	3.734	6.824	3.734	14.831	3.734	13.645	6.094	4.555
30	4.555	9.241	5.720	3.734	7.182	6.094	14.537	3.305	3.305	3.734	13.344	3.734	16.566	9.899	13.944	6.824	14.537
32	6.094	4.555	11.184	4.150	8.569	4.555	4.150	4.951	3.734	3.734	17.133	5.720	17.696	14.241	16.850	8.228	4.150
34	6.094	4.951	12.122	13.944	8.228	22.308	5.339	7.884	4.150	5.339	25.669	6.462	19.356	15.124	25.669	9.899	5.339
36	12.430	7.182	11.811	17.696	9.241	17.696	6.094	16.566	8.907	5.339	25.669	14.831	23.095	15.705	25.669	9.899	6.094
38	17.975	7.535	13.344	20.443	7.535	16.850	17.696	11.811	15.124	12.430	25.669	21.514	25.669	16.566	25.669	13.344	17.696
40	12.737	7.884	13.944	19.629	13.041	14.241	17.696	13.344	17.696	12.122	25.669	25.669	25.669	17.133	25.669	16.280	17.696

(Source: Field Investigation Results)

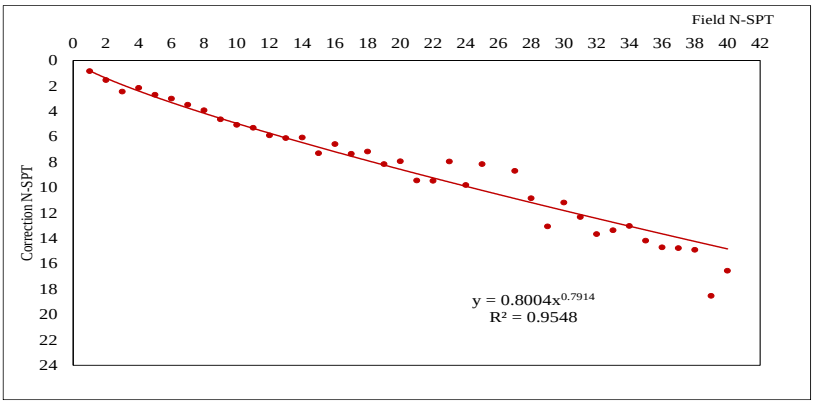

Figure 3. N-SPT Correction Graphic
(Source: Field Investigation Results)

Table 6. Correlation of N-SPT Graphic Correction to Field N-SPT

Field N-SPT	Graphical N-SPT
1 - 5	1 - 3
6 - 10	3 - 5
11 - 15	5 - 7
16 - 20	7 - 9
21 - 25	9 - 10
26 - 30	11 - 12
31 - 35	12 - 13
36 - 40	14 - 15
41 - 45	15 - 16
46 - 51	17 - 18

(Source: Calculation Results)

Figure 3, Table 5 and Table 6 show the relationship between field N-SPT and graphically corrected N-SPT, which is almost linear. The graphical N-SPT value increases with increasing field N-SPT values. The graph (Fig.3) or the equation of the correction of N-SPT = 0.8004 x (Field N-SPT $^{0.7914}$) is used to validate the pile bearing capacity (Q) directly from the field N-SPT value without N-SPT analytical correction. The results are used to know the ratio (R) of the pile bearing capacity based on graphical N-SPT value to pile bearing capacity based on analytical correction N-SPT data.

The pile used in this pile bearing capacity simulation is a square prestressed pile 40cmx40cm with a length of 40m. The pile bearing capacity is calculated using from the analytically corrected N-SPT value and graphical corrected N-SPT value. The calculation results of the pile bearing capacity using Meyerhoff (1956) and Luciano Decourt (1982) methods consist of the ultimate pile bearing capacity (Qu), the end bearing capacity (Qp), and the skin bearing capacity (Qs) for each location until the final pile depth of 40 m is presented in Table 7 and Table 8.

Table 7. Pile Bearing Capacity of Meyerhoff Method (1956)

Location	Qp (ton)		Qs (ton)		Qu (ton)	
	Analytical	Graphical	Analytical	Graphical	Analytical	Graphical
1	97.53	89.90	83.43	64.03	165.60	138.57
2	47.66	49.90	50.93	57.19	83.24	91.73
3	96.64	88.28	71.86	74.74	153.14	147.66
4	149.78	126.93	88.92	91.39	223.34	202.96
5	79.01	74.65	92.47	83.28	156.12	142.57
6	101.54	95.32	115.74	116.03	201.92	195.98
7	127.36	113.25	84.31	77.73	196.31	175.63
8	87.42	82.95	101.11	95.66	173.16	163.25
9	123.65	109.14	64.49	65.50	172.77	159.28
10	81.04	78.07	65.08	76.07	130.76	138.79
11	155.56	130.83	121.82	103.70	262.03	219.17
12	158.22	132.55	96.48	90.57	239.35	207.76
13	155.56	130.83	158.46	131.08	298.66	246.55
14	123.12	108.75	98.24	86.74	206.00	180.12
15	155.56	130.83	142.97	120.54	283.17	236.02
16	115.64	99.50	71.44	66.95	171.73	151.09
17	128.83	112.75	84.07	76.63	197.55	174.01
Min	47.66	49.90	50.93	57.19	83.24	91.73
Max	158.22	132.55	158.46	131.08	298.66	246.55
Avg	116.71	103.20	93.64	86.93	194.99	174.77

(Source: Calculation Results)

Table 8. Pile Bearing Capacity of Luciano Decourt Method (1982)

Location	Qp (ton)		Qs (ton)		Qu (ton)	
	Analytical	Graphical	Analytical	Graphical	Analytical	Graphical
1	96.25	89.90	78.21	74.93	178.51	164.44
2	38.99	49.90	69.76	69.49	115.38	119.01
3	80.18	88.28	82.28	79.18	176.49	167.08
4	126.96	126.93	96.47	89.31	245.87	215.86
5	65.10	74.65	82.10	79.98	158.56	154.25
6	88.60	95.32	105.20	95.85	209.33	190.78
7	109.88	113.25	88.89	83.67	218.14	196.54
8	74.09	82.95	77.77	75.75	164.80	158.32
9	104.79	109.14	71.28	70.10	194.54	178.85
10	68.69	78.07	69.04	69.24	149.69	146.93
11	131.86	130.83	123.62	108.07	278.79	238.52
12	134.12	132.55	92.56	86.77	250.40	218.94
13	131.86	130.83	141.79	120.58	296.97	251.03
14	104.35	108.75	100.81	92.26	223.54	200.62
15	131.86	130.83	133.37	115.08	288.55	245.53
16	93.23	99.50	87.49	83.99	197.13	183.10
17	109.18	112.75	97.46	91.38	225.91	203.74
Min	38.99	49.90	69.04	69.24	115.38	119.01
Max	134.12	132.55	141.79	120.58	296.97	251.03
Avg	99.41	103.20	94.01	87.39	210.15	190.21

(Source: Calculation Results)

The pile-bearing capacity obtained from the analytical correction N-SPT is compared with that obtained from the graphical correction N-SPT for each method presented in Figure 4, Figure 5, and Figure 6.

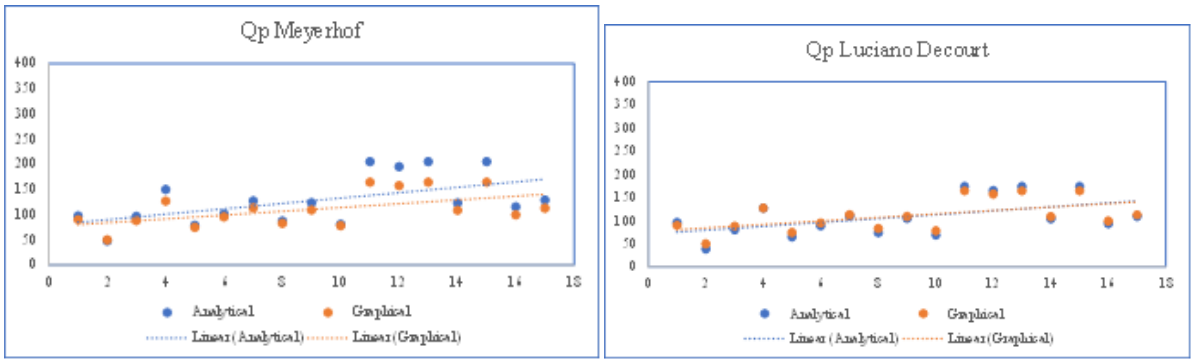

Figure 4. Analytical Qp Against Graphical Qp
(Source: Calculation Results)

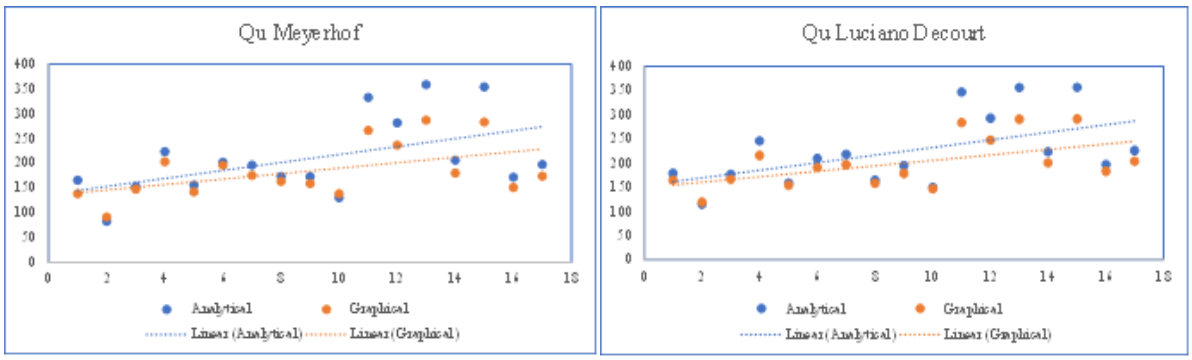

Figure 5. Analytical Qs Against Graphical Qs
(Source: Calculation Results)

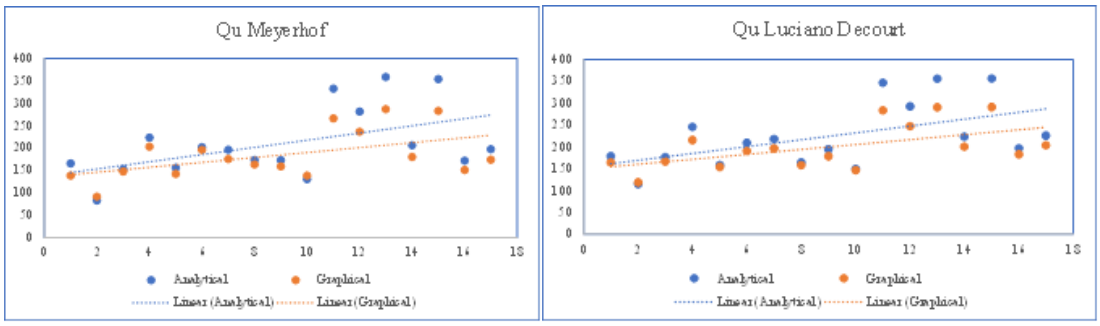

Figure 6. Analytical Qu Against Graphical Qu
(Source: Calculation Results)

Based on Figure 4, table 7 and table 8 show the value of the pile end bearing capacity (Qp) using the Meyerhof method (1956) and the Luciano Decourt method (1982). The average Qp of the Meyerhof method by analytical is 116.71 tonnes, and the graphical Qp is 103.20 tonnes. The average Qp of the Luciano Decourt method by analytical is 99.41 tonnes, and the graphical average Qp is 103.20 tonnes.

Based on Figure 5, table 7 and table 8 shows the value of the pile end bearing capacity Qs average from the Meyerhof method by analytical is 93.64 tonnes, and the graphical average Qs is 86.93 tonnes. The average Qs of the Luciano Decourt method by

the analytical method is 94.01 tonnes, and the graphical Qs are 87.39 tonnes.

Based on Figure 6, table 7 and table 8 shows the value of the pile ultimate bearing capacity Qu average from the Meyerhoff method by analytical is 194.99 tonnes, and the average Qu graphic is 174.77 tonnes. The average Qu of the Luciano Decourt method by analytical is 210.15 tonnes, and the average graphical Qu is 190.21 tonnes.

The pile bearing capacity values of these methods are compared to find out the ratio of pile bearing capacity (RQ) from the calculation of the graphically corrected N-SPT to the analytical corrected N-SPT presented in Table 9 and Table 10.

Table 9. Ratio of Pile Bearing Capacity Meyerhoff Method

Subdistrict	Location	RQp (ton)	RQs (ton)	RQu (ton)
Central Banjarmasin	1	0.92	0.77	0.84
	2	1.05	1.12	1.10
	3	0.91	1.04	0.96
North Banjarmasin	4	0.85	1.03	0.91
South Banjarmasin	5	0.94	0.90	0.91
East Banjarmasin	6	0.94	1.00	0.97
	7	0.89	0.92	0.89
South Banjarmasin	8	0.95	0.95	0.94
Central Banjarmasin	9	0.88	1.02	0.92
East Banjarmasin	10	0.96	1.17	1.06
West Banjarmasin	11	0.84	0.85	0.84
	12	0.84	0.94	0.87
	13	0.84	0.83	0.83
	14	0.88	0.88	0.87
	15	0.84	0.84	0.83
East Banjarmasin	16	0.86	0.94	0.88
	17	0.88	0.91	0.88
Average		**0.90**	**0.95**	**0.91**

(Source: Calculation Results)

Table 10. Ratio of Pile Bearing Capacity of Luciano Decourt Method

Subdistract	Location	RQp (ton)	RQs (ton)	RQu (ton)
Central Banjarmasin	1	0.93	0.96	0.92
	2	1.28	1.00	1.03
	3	1.10	0.96	0.95
North Banjarmasin	4	1.00	0.93	0.88
South Banjarmasin	5	1.15	0.97	0.97
East Banjarmasin	6	1.08	0.91	0.91
	7	1.03	0.94	0.90
South Banjarmasin	8	1.12	0.97	0.96
Central Banjarmasin	9	1.04	0.98	0.92
East Banjarmasin	10	1.14	1.00	0.98
West Banjarmasin	11	0.99	0.87	0.86
	12	0.99	0.94	0.87
	13	0.99	0.85	0.85
	14	1.04	0.92	0.90
	15	0.99	0.86	0.85
East Banjarmasin	16	1.07	0.96	0.93
	17	1.03	0.94	0.90
Average		**1.06**	**0.94**	**0.92**

(Source: Calculation Results)

Tables 9 and 10 show that the average pile bearing capacity ratio of the Meyerhof method (1956) for pile end bearing capacity (RQp) is 0.90, for pile skin bearing capacity (RQs) is 0.95, and pile ultimate bearing capacity (RQu) is 0.91. The ratio of the average pile bearing capacity of the Luciano Decourt method (1982) for pile end bearing capacity (RQp) is 1.06, pile skin bearing capacity (RQs) is 0.94, and pile ultimate bearing capacity (RQu) is 0.92. The value of the ratio pile bearing capacity of analytical to graphical for both Meyerhof and Luciano Decourt methods shows that the level of validity is 90% to 100% ; this indicates that graphical N-SPT can be directly used to estimate pile bearing capacity as an alternative method of calculating pile bearing capacity without processing N-SPT analytical correction.

CONCLUSION

Based on field N-SPT soil investigation data that has been processed analytically and graphically to simulate the estimated pile bearing capacity according to the relevant theory shows that the analytical method for correcting field N-SPT becomes an analytical correction N-SPT obtained from the effective stress analytical correction approach can be replaced by an alternative approach to graphical N-SPT which can be directly determined from field N-SPT values without processing an analytical correction. The graphic N-SPT value can be directly input into the pile bearing capacity equation with the explicit formula N-SPT = 0.8004 x (field N-SPT $^{0.7914}$) or by using the relationship graph of field N-SPT to graphical correction N-SPT as in Fig.3. The simulation results of calculating the bearing capacity of the pile using field N-SPT values corrected analytically and graphically show that the ratio of pile bearing capacity (RQ) is is 90% to 100%, which means that the graphical N-SPT correction method can be used as an alternative to estimate pile bearing capacity.

REFERENCES

Abd Elsamee, W. N. (2013). New method for prediction pile capacity executed by continuous flight auger (CFA).

Abd Elsamee, W. N. (2012). Evaluation of the ultimate capacity of friction piles.

Alternatif Perencanaan Perbaikan Struktur Fondassi pada Gedung No.3 PT. AKR Corporindo TBK di Margomulyo, 2018.https://repository.its.ac.id/53742/1/03111440000018_Undergraduate_Theses.pdf

Analisa Efisiensi Perbandingan Daya Dukung Pondasi Tiang Pancang Kelompok Menggunakan Metode Vesik Pada Proyek

Pembangunan Poltek Pariwisata Jakabaring Palembang, 2013–2015. http://repository.umpalembang.ac.id/id/eprint/5549/

Analisa Perbandingan Perencanaan Fondasi Tiang Pancang Menggunakan Berbagai Macam Metode pada Proyek Apartemen The Frontage Surabaya, 2017. https://repository.its.ac.id/1912/1/3114106013-Undergraduate_Theses.pdf

Anamali, E., Shkodrani, N., & Dhimitri, L. (2014). Axial Load Capacity of Cast in Place Piles from SPT and CPTU Data. World Journal of Engineering and Technology, 2(02), 100.

Badan Standar Nasional. (2008). *SNI 4153-2008 Cara Uji Penetrasi Lapangan Dengan SPT*. Jakarta.

Bazaraa, A. (1967). *Use of the Standard Penetration Test for Estimating Settlements of shallow foundations on sand,* Ph.D. Dissertation, Civil Engineering Department, University of Ilinois, Champaign Urbana, Ilinois.

Gouw Tjie-Liong. (1995). *Sudah Standarkah Standard Penetration Test Kita*. Jakarta.

Manurung, W, I., Mochtar, I, B., & Sari, P,T, K., *Perencanaan Pondasi Tiang Lekatan pada Gedung Tingkat 3 s/d 5 di Atas Tanah Lunak yang Tebal dengan Ketentuan Penurunan Merata dalam Jangka Panjang*. Jurnal Teknik ITS, 2021, 9.2: D271-D276.

Marzuki, A., Norhadi, A., & Eriza, M. (2022). RASIO DAYA DUKUNG TIANG RENCANA TERHADAP DAYA DUKUNG TIANG AKTUAL. Jurnal Gradasi Teknik Sipil, 6(1), 1-10.

Marzuki, A., Norhadi, A., & Surat, S. (2020). REDESAIN KAPASITAS DAN DISTRIBUSI BEBAN TIANG AKIBAT EKSENTRISITAS BERLEBIH. Jurnal INTEKNA: Informasi Teknik dan Niaga, 20(2), 59-69.

Meyerhof, G. G. (1956). *Penetration tests and bearing capacity of cohesionless soils.* ASCEJ Soil Mech Found Div 82:866-1019.

Padagi, E. A., Priadi, E., & Aprianto. (2015). *Korelasi nilai N-SPT terhadap sifat – sifat fisik dan mekanis tanah*.

Suryatmaja, R. (2019). *Analisa Efisiensi Perbandingan Daya Dukung Pondasi Tiang Pancang.*

Terzaghi, K. and Peck, R. B., 1967, *Soil Mechanics in Engineering Practice, John Wiley & Sons, Inc., New York*

Toha, F. X., 1989, *Karakteristik Konsolidasi Lempung Lunak Banjarmasin, National Symposium on Soft Soil and Landslides. HATTI. Bandung.*

Vidayanti, D., Simatupang, P,T., & Silalahi, S.(2013). *Sebaran Nilai N-SPT dengan Parameter Kuat Geser Tanah terhadap Grafik Korelasi yang Ada (Studi Kasus: Wilayah Jakarta dan Sekitarnya).*

Wardani, M,K., Riza, A., (2016). *Analisis Kapasitas Daya Dukung Tiang Pancang Berdasarkan Metode Statis Metode Dinamis Dan Kekuatan Bahan Berdasarkan Data NSPT (Studi Kasus Pembangunan Hotel Ayola Surabaya).*