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BEARING CAPACITY AND SOIL SETTLEMENT ANALYSIS BASED ON CONE PENETRATION TEST (CPT)

[1]Annisa, [2]Yulian Firmana Arifin, [3]Muhammad Afief Ma'ruf
Program Studi Teknik Sipil, Fakultas Teknik, Universitas Lambung Mangkurat
Jl. Jenderal Achmad Yani Km 35,5 Banjarbaru, Kalimantan Selatan – 70714
Email: ansbdmn@gmail.com

ABSTRACT

Soft clay soil has a low bearing capacity so it can cause large settlements. This study calculated soil settlement from the Cone Penetration Test (CPT) data because it is the most widely available data for the City of Banjarmasin. 98 CPT points are used to analyze the bearing capacity and soil settlement. Both are calculated for two-story shophouse and three-story shophouse models with the dimensions commonly used in Banjarmasin City. Foundation design calculations based on CPT soil data points using the largest load distribution in building structure modeling. The bearing capacity obtained ranges from 1.63–59.13 kN. The amount of consolidation settlement is 0–2.3 meters for the two-story shophouse model and 0–2.5 meters for the three-story shophouse model. The greater the value of the soil-bearing capacity the smaller the settlement that occurs.

Keywords: Consolidation Settlement, Bearing Capacity, CPT

1. INTRODUCTION

The city of Banjarmasin is an area of swamp land which is often or always inundated with water, so most of the soil formed is soft clay. In general, soft clay soils have a low bearing capacity which can result in large settlements. Safe civil buildings start from planning a good foundation design with a safe soil-bearing capacity and the settlement does not exceed the provisions.

2. THEORETICAL STUDY

2.1 Soil Tests

2.1.1 Cone Penetration Test (CPT)

Cone Penetration Test (CPT) is very suitable for layers of clay with low strength because it is not difficult to penetrate with low strength. In the design of the foundation, it can calculate the value of bearing capacity and soil settlement with soil classification. The graph used to determine the type of soil using the value of the cone resistance (QC) and friction ratio (FR) published by Robertson et al. (1986), which can be seen in Figure 1, is used more often than other charts [1].

Based on SNI 2827:2008, the value of the friction ratio (FR) with the equation:

$$FR = \frac{fs}{QC} \times 100$$

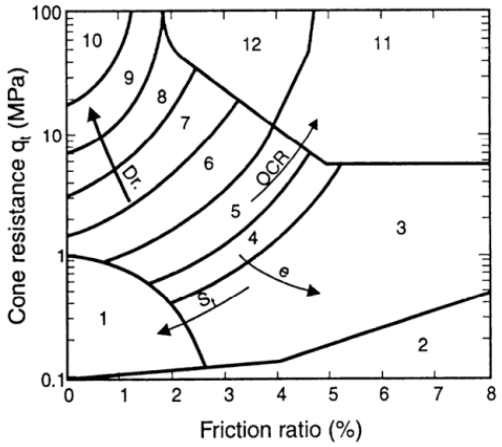

Figure 1. Soil Type Zone with QC–FR Value

Table 1. Soil Type Zone with QC–FR Value

Zone	*Soil Behaviour Type*
1	*Sensitive fine grained*
2	*Organic material*
3	*Clay*
4	*Silty Clay to clay*
5	*Clayey silt to silty clay*
6	*Sandy silt to clayey silt*
7	*Silty sand to sandy silt*
8	*Sand to silty sand*
9	*Sand*
10	*Gravelly sand to sand*
11	*Very Stiff fine grained**
12	*Sand to clayey sand**

**Overconsolidated or cemented*

"USCS" soil classification according to Bowles (1991) in Table 2.

Table 2. "USCS" Soil Classification [2]

Soil Type	Prefix	Sub Group	Surfix
		Well-graded	W
Gravel	G	Poor-graded	P
Sand	S	Silty	M
		Clayey	C
Silt	M		
Clay	C	wL < 50%	L
Organic	O	wL < 50%	H
Peat	Pt		

Soil consistency categories can be seen in Table 3 for cohesive soils and Table 4 for granular soils.

Table 3. Soil Consistency (Cohesive Soils) [3]

Soil Consistency	NSPT Value	QC Value (kg/cm^2)
Very soft	0–2	0–2,5
Soft	2–4	2,5–5
Medium	4–8	5–10
Stiff	8–15	10–20
Very stiff	15–30	20–40
Hard	>30	>40

Table 4. Soil Consistency (Granular Soils) [4]

Soil Consistency	NSPT Value	QC Value (kg/cm^2)
Very loose	<4	<20
Loose	4–10	20–40
Medium dense	10–30	40–120
Dense	30–50	120–200
Very dense	>50	>200

2.2 Foundation Design

Pile foundations are used when foundation soils at normal depths are unable to support the load, and hard soil is located at very deep depths [4].

The ultimate bearing capacity of the pile foundation is expressed as:

$$Q_p = \frac{q_{c1} + q_{c2}}{2} . A_p$$

Where:

A_p = The cross-sectional area of the pile

QC_1 = QC average at 0,7D–4D

QC_2 = QC average at 8D

The blanket resistance for a single pile can be taken directly from the cumulative friction (Tf) multiplied by the perimeter of the pile (p), so:

$$Q_s = Tf . p$$

Allowable bearing capacity is expressed as:

$$Q_{all} = Q_p + Q_s = \frac{qc . Ap}{FS1} + \frac{Tf . p}{FS2}$$

Where:

FS1 = 3 and FS2 = 5

The number of piles required (N):

$$N = \frac{Pu}{Q_{all}}$$

The optimal distance between piles (S) is either: S ≥ 2.5 D or S ≤ 3 D

Pile Group Efficiency (E_g) is expressed in several equations.

Simple equation: $E_g = \frac{2(m+n-2)s+4D}{p . m . n}$

Converse-Labarre equation: $E_g = 1 - \theta \frac{m . (n-1)+(m-1) . (n-1)}{90 m n}$

Los Angeles Group equation: $E_g = 1 - \frac{D}{\pi s m n}\left[m(n-1) + n(m-1) + (m-1)(n-1)\sqrt{2}\right]$

The ultimate bearing capacity of group piles is expressed as:

$$Qg = Eg . N . Q_{all}$$

Total Capacity of Pile Groups:

$$\Sigma Qu = N . Q_{all}$$

The ultimate capacity by assuming that the piles in the group act as a block in dimension (L_g, B_g, Ld):

$$\Sigma Qu = L_g . B_g . QC + \Sigma\, 2\,(L_g + B_g)\, fs . L$$

Where:

Pu	= Working load (kN)	L_g	= Length of group piles section (m)
n	= Number of columns in a row	B_g	= Width of group piles section (m)
m	= Number of column rows	H	= Length of piles (m) [5]

2.3 Settlement

Consolidation is the process of releasing water from the pores of the soil which causes changes in soil volume (compression) [6]. The coefficient of volume compressibility (mv) is used to calculate settlement in clay soils. Fugro (1996) and Meigh (1987) stated that the coefficient of volume compressibility is [7]:

$$m_v = \frac{1}{\alpha \times qc}$$

Deformation parameters (α) are from CPT results as follows:

Table 5. Deformation Parameters (α)

	Soil Classification
α = 5	CH, MH, ML
α = 6	CL, OL
α = 1,5	OH, with moisture >100% for overconsolidated soils
α = 4	CH, MH, CL, ML
α = 6	ML, CL with QC > 2 Mpa

Calculate the additional load (dq) using the following equation, with the initial soil thickness (H) before consolidation [8]:

$$d_q = \frac{Pu}{(L_g + H) \times (B_g + H)}$$

So the consolidation settlement (S_c) is:

$$S_c = m_v \,.dq.H$$

In the consolidation settlement of pile groups on clay soils, the working load on the foundation plate is transferred at a depth of 2/3 H below the foundation plate. Land subsidence above this depth is very small and can be neglected [4].

3. METHOD

The diagram of the design is in Figure 2.

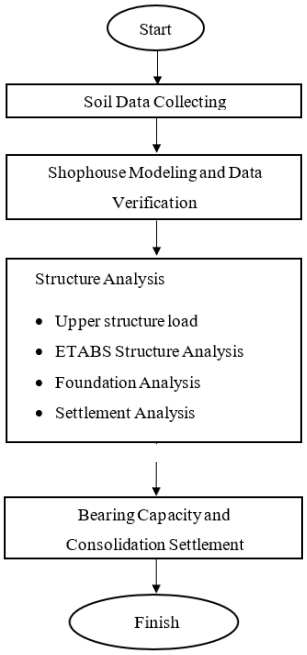

Figure 2. Design Diagram

3.1 Data Collecting

Soil data collected from the CPT test were 98 test points.

3.2 Structure Modelling

The building models are a two-door, three-story shophouse (9 m x 22 m x 11.5 m) and two doors two-story (8 m x 22 m x 8 m) based on the most common building models from the survey data, which can be seen in Figure 3.

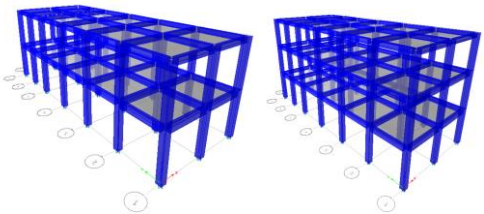

Figure 3. 3D Model of a Two-Story Shophouse (Left) and a Three-Story Shophouse (Right)

The structure modeling only calculates the structure of the building itself so that the influence of conditions around the building is not calculated. So the load distribution used is only based on the results of the largest lateral force resulting from structural analysis using ETABS in Table 6.

Table 6. Distribution of Structural Analysis Largest Lateral Forces

	FZ (kN)
Two-story Shophouse	463,0665
Three-story Shophouse	854,5278

4. RESULT AND DISCUSSION

4.1 Bearing Capacity

Fondation Design Data:

Diameter of piles (D) = 10 cm Cross-sectional area of the pile (A_p) = 37,68 cm^2

Length of piles (H) = 900 cm Perimeter of the pile (p) = 113,04 cm^2

The results of the calculation of the allowable bearing capacity (Q_{all}):

Table 7. Results of the Bearing Capacity Calculation of the Banjarmasin City

NO	SUB DISTRICT NAME	PROJECT NAME	NO. POINTS	Tf (kg/cm2)	qc1 (kg/cm2)	qc2 (kg/cm2)	qca (kg/cm2)	Qall kg	Qall kN
1	BANJARMASIN BARAT		001	108,6	2	2,00	1,93	732,63	7,33
2	BANJARMASIN BARAT	PEMBANGUNAN TURAP PT. DOK	002	131,1	3	0,83	2,13	878,91	8,79
3	BANJARMASIN BARAT		003	153,6	6	2,67	4,32	1077,69	10,78
4	BANJARMASIN BARAT	WORKSHOP 2 LANTAI JL. AMPERA GG. 20 KEL. TELAGA BIRU	001	266,82	3	5,00	4,24	1786,53	17,87
5	BANJARMASIN TENGAH	JEMBATAN SUNGAI SULAWESI/MASJID JAMI	001	90	1	1,00	1,01	591,68	5,92
6			002	100	1	1,00	1,11	656,97	6,57
7			001	116	4	2,67	3,37	816,64	8,17
8	BANJARMASIN TENGAH	LPH BANGUNAN GEDUNG UJUNG MURUNG	002	140	3	3,67	3,52	971,41	9,71
9			003	182	6	7,33	6,44	1311,49	13,11
10			004	194	6	18,33	12,37	1541,98	15,42
11	BANJARMASIN TENGAH	PEMBANGUNAN SIRING TEPI JALAN JENDRAL SUDIRMAN	001	115,69	3	1,00	1,87	775,44	7,75
12	BANJARMASIN TENGAH	RSUD ULIN	001	236	4	5,00	4,64	1603,57	16,04
13			001	55,37	1	1,17	0,88	370,78	3,71
14			002	62,81	1	1,67	1,43	431,83	4,32
15	BANJARMASIN TENGAH	GEDUNG KANTOR WILAYAH DJBC KALBAGSEL	003	531,37	2	3,33	2,68	3407,09	34,07
16			004	154,53	1	0,67	0,83	992,25	9,92
17			005	42,97	1	0,50	0,60	285,58	2,86
18			006	111,56	1	1,17	1,17	731,12	7,31
19	BANJARMASIN TENGAH	PERENCANAAN DED MONUMEN PAL NOL KALSEL	001	84,67	3	2,83	2,87	606,80	6,07
20			002	95,33	3	3,00	2,89	674,37	6,74
21			003	139,33	9	3,50	6,02	1032,62	10,33
22	BANJARMASIN TENGAH	PENANGANAN GEDUNG MIRING BANK BRI JL. PANGERAN SAMUDRA	001	212	11	1,67	6,20	1493,66	14,94
23	BANJARMASIN TENGAH	PENYELIDIKAN TANAH INDOMARET SUTOYO 13	001	342,7	10	16,00	13,20	2497,62	24,98
24			002	482,7	14	20,00	16,89	3473,39	34,73
25	BANJARMASIN TENGAH	PERENCANAAN RUMAH TOKO PT. KUMALA CENTRAL PARTINDO	001	96	5	7,00	5,88	756,76	7,57
26			002	91	2	3,67	2,71	642,35	6,42
27			003	85	2	4,67	3,51	625,54	6,26
28	BANJARMASIN TENGAH	PEMBANGUNAN RUKO 1 PINTU 3 LANTAI JL. PANGERAN ANTASARI	001	152,68	5	2,50	3,65	1054,31	10,54
29	BANJARMASIN TIMUR	HOTEL GLOBAL	001	154,55	3	2,00	2,45	1034,74	10,35
30			002	145,45	2	2,33	2,29	973,24	9,73
31			003	149,09	3	3,00	2,88	1011,67	10,12
32			004	134,55	2	3,67	3,04	924,41	9,24
33	BANJARMASIN TIMUR	PERENCANAAN PAMBANGUNAN GEDUNG LABORATORIUM DOSEN TERPADU UIN ANTASARI	001	116,5	1	2,67	1,97	783,17	7,83
34			002	96,6	1	2,67	1,85	655,09	6,55
35			003	108,5	2	2,67	2,54	747,73	7,48
36			004	128,6	6	1,33	3,50	899,19	8,99
37	BANJARMASIN TIMUR	TOWER SITE ID KAL-BAN-51-T-0835	001	112,4	2	16,33	9,06	942,93	9,43
38			002	107,9	1	14,67	7,92	884,76	8,85
39	BANJARMASIN TIMUR	PEMBANGUNAN RUKO 4 PINTU 3 LANTAI BANUA ANYAR	001	148,21	3	6,00	4,42	1046,33	10,46
40			002	137,5	4	6,33	5,01	994,49	9,94
41	BANJARMASIN TIMUR	PEMBANGUNAN PERUMAHAN ASMAN BANUA ANYAR	001	129,6	1	5,00	3,20	897,68	8,98
42	BANJARMASIN TIMUR	PERENCANAAN DESAIN ARSITEKTURAL RUKO 1 LANTAI ALFAMART JL. PRAMUKA	001	437,3	11	11,67	11,52	3047,78	30,48
43	BANJARMASIN TIMUR	P. ARSITEKTURAL DAN P. HUNIAN RUMAH TINGGAL JL. MERPATI GATOT DUBROTO IV	001	136	2	5,00	3,62	948,78	9,49
44	BANJARMASIN TIMUR	PEMBANGUNAN KAPITA PSIKOTEST JL. PRAMUKA	001	169,43	4	3,67	4,01	1169,00	11,69
45	BANJARMASIN TIMUR	PERENCANAAN PEMBANGUNAN CAFÉ EXCELSO KM 5,5 A. YANI	001	156	4	2,67	3,27	1065,34	10,65
46			002	134,7	3	4,33	3,71	943,11	9,43
47	BANJARMASIN UTARA	DERMAGA MESJID DAN MAKAM SULTAN SURIANSYAH	001	27,27	0	2,00	1,24	203,65	2,04
48	BANJARMASIN UTARA	GEDUNG AUDITORIUM BJM	001	88,18	1	2,00	1,68	597,69	5,98
49			002	80,91	1	2,33	1,71	552,97	5,53
50			003	77,27	1	2,00	1,55	525,75	5,26
51	BANJARMASIN UTARA	PELEBARAN BAHU JALAN	001	748	10	10,00	10,07	4960,98	49,61
52			002	590	8	5,00	6,67	3879,64	38,80
53			003	890	10	15,00	12,38	5913,17	59,13
54			004	132	2	3,00	2,73	900,30	9,00
55			005	110	2	3,00	2,55	757,46	7,57
56			006	180	3	3,00	2,96	1207,97	12,08
57	BANJARMASIN UTARA	ULM PIU UDB	001	48	1	2,33	1,52	341,31	3,41
58			002	52	1	1,67	1,19	357,71	3,58
59			003	34,67	0	1,33	0,89	241,09	2,41
60			004	22,67	0	1,33	0,79	162,93	1,63
61			005	52	1	3,67	2,14	382,63	3,83
62			006	158,67	3	7,33	5,20	1132,58	11,33
63			007	72	1	5,33	3,18	535,33	5,35
64			008	52	1	5,33	3,02	405,68	4,06
65			009	80	1	10,00	5,58	648,50	6,48
66			010	81,33	1	6,67	3,95	614,17	6,14
67			011	125,33	2	9,33	5,75	937,53	9,38
68			012	198,67	3	15,67	9,38	1493,12	14,93
69			013	58,67	1	3,33	2,05	422,03	4,22
70			014	82,67	1	2,00	1,71	564,02	5,64
71			015	52	1	1,67	1,19	357,71	3,58
72			016	49,33	1	4,00	2,32	370,54	3,71
73			017	44	1	2,67	1,64	319,31	3,19
74			018	44	1	2,00	1,29	309,96	3,10
75			019	48	1	3,33	1,98	353,15	3,53
76			020	89,33	1	6,00	3,70	657,87	6,58
77	BANJARMASIN UTARA	PEMBANGUNAN RUKO 3 LANTAI KAYU TANGI	001	197,32	6	2,00	3,83	1339,32	13,39
78			002	125	2	2,00	1,83	832,97	8,33
79	BANJARMASIN UTARA	PERENCANAAN PERUMAHAN KOMP. TAMAN PESONA SUNGAI ANDAI	001	55	1	1,67	1,37	381,22	3,81
80			002	92	2	3,00	2,65	647,23	6,47
81	BANJARMASIN UTARA	PEMBANGUNAN PERUMAHAN GRIYA PELANGI SEI JINGAH	001	216	4	6,00	5,10	1489,81	14,90
82			002	209,3	4	6,00	5,04	1446,17	14,46
83	BANJARMASIN SELATAN	RUKO GRILYA JL. LINGKAR DALAM SELATAN	001	84	1	2,00	1,44	565,21	5,65
84			002	88	1	3,00	2,08	607,15	6,07
85			003	98	1	2,00	1,74	660,92	6,61
86	BANJARMASIN SELATAN	PERENCANAAN PERUMAHAN KOMP. GREEN SUNNY ESTATE TATAH BANGKAL	001	138	3	1,00	1,86	915,24	9,15
87			002	119	2	1,17	1,64	790,15	7,90
88	BANJARMASIN SELATAN	PEMBANGUNAN SPBE 3 KG JL. LINGKAR DALAM SELATAN	001	95,5	1	1,00	1,20	631,20	6,31
89			002	75	1	1,00	1,00	497,17	4,97
90	BANJARMASIN SELATAN	KAWASAN PERUMAHAN JL. A. YANI KM. 5 KOMPLEK KENCANA	001	176,1	2	2,67	2,38	1168,21	11,68
91	BANJARMASIN SELATAN	PEMBANGUNAN RUKO 2 LANTAI BANJAR INDAH PERMAI	001	336,19	7	18,00	12,54	2439,29	24,39
92	BANJARMASIN SELATAN	PERENCANAAN RENOVASI BANGUNAN MITSUBISHI KM. 5,7 BANJARMASIN	001	130,7	4	2,00	2,83	894,93	8,95
93			002	89,3	3	2,67	2,61	629,02	6,29
94			001	358,7	7	7,00	7,02	2436,43	24,36
95	BANJARMASIN SELATAN	PEMBANGUNAN PERUMAHAN AR-RAUDAH KOMP. GRAND AR-RAUDAH 12	002	336	7	8,00	7,54	2307,26	23,07
96			003	101,3	2	5,00	3,43	725,88	7,26
97			004	110,7	2	5,33	3,75	793,32	7,93
98			005	118,7	2	5,33	3,69	842,00	8,42

The bearing capacity value for West Banjarmasin (BB) ranges from 7.33–17.87 kN, Central Banjarmasin (BH) ranges from 2.85–34.73 kN, East Banjarmasin (BT) ranges from 6.55–11.69 kN, North Banjarmasin (BU) ranges from 1.63–59.13 kN, and South

Banjarmasin (BS) ranges from 4.97–24.39 kN. Determination of the number of piles in the pile's group used is determined based on the value of the highest dimension of group piles in each sub-district in the city of Banjarmasin in the calculation. Pile spacing is taken as 2.5D. Thus, the foundation design dimensions are in Table 7 and Table 8.

Table 8. Foundation Design Dimensions of Two-story Shophouses

Code	Configu-ration	N	Dimension	
			L_g	B_g
BU	12 x 12	144	3	3
BS	9 x 9	81	2,25	2,25
BB	8 x 8	64	2	2
BT	8 x 8	64	2	2
BH	9 x 9	81	2,25	2,25

Table 9. Foundation Design Dimensions of Three-story Shophouses

Code	Configu-ration	N	Dimension	
			L_g	B_g
BU	16 x 16	256	4	4
BS	12 x 12	144	3	3
BB	10 x 10	100	2,5	2,5
BT	10 x 10	100	2,5	2,5
BH	12 x 12	144	3	3

Based on the calculation of the efficiency of the pile group, the simple formula of Eg ranges from 0.6–0.7, the Converse-Lebarre formula, Eg ranges from 0.99, and the Los Angeles Group formula, Eg ranges from 0.001–0.002. Determined the value of the bearing capacity of the pile group using the efficiency of the Converse-Lebarre formula so that the bearing capacity exceeds the working load (Qg > Pu).

Group pile bearing capacity (Qg) ranges from 467.112–940.107 kN for two-story shophouses and 854.126–1468.292 kN for three-story shophouses (>Pu). In calculating the total pile capacity (∑Qu) ranges from 470.859–946.107 kN for two-story shophouses and 860.921–1478.292 kN for three-story shophouses (>Pu and >Qg). The value of the bearing capacity of the pile group is taken to be the smallest (Qg < (∑Qu). The ultimate block bearing capacity (∑Qu) ranges from 195.261–912 kN for two-story shophouses and 322.515–1332 kN for three-story shophouses (<Pu), so does not meet safety requirements.

4.2 Consolidation Settlement

After classifying the soil, the settlement calculation uses the volume change coefficient (mv) multiplied by α, and the additional load (dq) on each soil layer is then added up to the depth of soil that can be compressed to obtain the consolidation settlement value.

QC = 5 kg/cm^2

H = 0,2 m

FR = 3,31 → From Robertson's chart (1986) and the Soil Consistency Table for Classification of Silt and Clay Soil, the value considered as Clayey Silt Medium (CL), then:

α = 6

Foundation design for a two-story shophouse in North Banjarmasin (12x12 configuration):

m = 12 L_g = 300 cm = 3 m Pult = 463,0665 kN

n = 12 B_g = 300 cm = 3 m

$m_v = \frac{1}{6\,.5.100} = 0{,}000333$ kN/m^2

$d_q = \frac{604{,}729}{(3+0{,}2)\times(3+0{,}2)} = 45{,}221$ kN/m^2

$Sc = 0{,}000333\,.\,45{,}221\,.\,0{,}2 = 0{,}030148\,m$

Table 10. Calculation results of Sub-District Consolidation Settlement

NO	SUB DISTRICT NAME	CODE	PROJECT NAME	NO POINTS	ΔSc (Two-story) (m)	ΔSc (Three-story) (m)
1				001	1,446	1,772
2	BANJARMASIN BARAT	BB_01	PEMBANGUNAN TURAP PT. DOK	002	1,604	1,965
3				003	0,981	1,201
4	BANJARMASIN BARAT	BB_02	WORKSHOP 2 LANTAI JL. AMPERA GG. 20 KEL. TELAGA BIRU	001	0,319	0,391
5				001	0,682	0,836
6	BANJARMASIN TIMUR	BT_01	HOTEL GLOBAL	002	0,619	0,758
7				003	0,525	0,643
8				004	0,578	0,709
9				001	0,968	1,186
10	BANJARMASIN TIMUR	BT_02	PERENCANAAN PAMBANGUNAN GEDUNG LABORATORIUM DOSEN TERPADU UIN ANTASARI	002	1,022	1,253
11				003	0,989	1,212
12				004	0,987	1,209
13	BANJARMASIN TIMUR	BT_03	OWER SITE ID KAL-BAN-51-T-083	001	0,805	0,987
14				002	0,845	1,035
15	BANJARMASIN TIMUR	BT_04	PEMBANGUNAN RUKO 4 PINTU	001	0,225	0,275
16			3 LANTAI BANUA ANYAR	002	0,104	0,127
17	BANJARMASIN TIMUR	BT_05	PEMBANGUNAN PERUMAHAN ASMAN BANUA ANYAR	001	0,277	0,340
18	BANJARMASIN TIMUR	BT_06	PERENCANAAN DESAIN ARSITEKTURAL RUKO 1 LANTAI ALFAMART JL. PRAMUKA	001	0,029	0,035
19	BANJARMASIN TIMUR	BT_07	P. ARSITEKTURAL DAN P. HUNIAN RUMAH TINGGAL JL. MERPATI GATOT DUBROTO IV	001	0,146	0,179
20	BANJARMASIN TIMUR	BT_08	PEMBANGUNAN KAPITA PSIKOTEST JL. PRAMUKA	001	0,537	0,658
21	BANJARMASIN TIMUR	BT_09	PERENCANAAN PEMBANGUNAN CAFÉ EXCELSO KM 5,5 A. YANI	001	0,330	0,405
22				002	0,293	0,359
23	BANJARMASIN TENGAH	BH_01	JEMBATAN SUNGAI SULAWESI/MASJID JAMI	001	2,378	2,572
24				002	2,278	2,465
25				001	0,625	0,676
26	BANJARMASIN TENGAH	BH_02	LPH BANGUNAN GEDUNG UJUNG MURUNG	002	0,342	0,370
27				003	0,175	0,189
28				004	0,144	0,156
29	BANJARMASIN TENGAH	BH_03	PEMBANGUNAN SIRING TEPI JALAN JENDRAL SUDIRMAN	001	0,625	0,676
30	BANJARMASIN TENGAH	BH_04	RSUD ULIN	001	0,141	0,153
31				001	2,270	2,455
32				002	1,025	1,109
33	BANJARMASIN TENGAH	BH_05	GEDUNG KANTOR WILAYAH DJBC KALBAGSEL	003	0,510	0,552
34				004	1,963	2,124
35				005	2,252	2,437
36				006	1,746	1,888
37	BANJARMASIN TENGAH	BH_06	PERENCANAAN DED MONUMEN PAL NOL KALSEL	001	0,528	0,571
38				002	0,569	0,615
39				003	0,140	0,152
40	BANJARMASIN TENGAH	BH_07	PENANGANAN GEDUNG MIRING BANK BRI JL. PANGERAN SAMUDRA	001	1,148	1,242

41	BANJARMASIN TENGAH	BH_08	PENYELIDIKAN TANAH	001	0,000	0,000
42			INDOMARET SUTOYO 13	002	0,000	0,000
43			PERENCANAAN RUMAH TOKO	001	0,088	0,096
44	BANJARMASIN TENGAH	BH_09	PT. KUMALA CENTRAL	002	0,285	0,309
45			PARTINDO	003	0,230	0,249
46	BANJARMASIN TENGAH	BH_10	PEMBANGUNAN RUKO 1 PINTU 3 LANTAI JL. PANGERAN ANTASARI	001	0,486	0,525
47	BANJARMASIN UTARA	BU_01	DERMAGA MESJID DAN MAKAM SULTAN SURIANSYAH	001	0,479	0,513
48				001	0,457	0,489
49	BANJARMASIN UTARA	BU_02	GEDUNG AUDITORIUM BJM	002	0,362	0,387
50				003	0,543	0,582
51				001	0,023	0,024
52				002	0,000	0,000
53	BANJARMASIN UTARA	BU_03	PELEBARAN BAHU JALAN	003	0,000	0,000
54				004	0,018	0,019
55				005	0,000	0,000
56				006	0,000	0,000
57				001	0,408	0,438
58				002	0,296	0,317
59				003	0,350	0,375
60				004	0,381	0,409
61				005	0,269	0,289
62				006	0,075	0,080
63				007	0,122	0,131
64				008	0,127	0,136
65				009	0,087	0,094
66	BANJARMASIN UTARA	BU_04	ULM PIU UDB	010	0,126	0,135
67				011	0,065	0,070
68				012	0,006	0,006
69				013	0,155	0,166
70				014	0,320	0,343
71				015	0,339	0,363
72				016	0,177	0,190
73				017	0,202	0,217
74				018	0,224	0,240
75				019	0,224	0,240
76				020	0,064	0,068
77	BANJARMASIN UTARA	BU_05	PEMBANGUNAN RUKO 3 LANTAI KAYU TANGI	001	0,398	0,426
78				002	0,445	0,476
79	BANJARMASIN UTARA	BU_06	PERENCANAAN PERUMAHAN KOMP. TAMAN PESONA SUNGAI ANDAI	001	0,355	0,381
80				002	0,118	0,127
81	BANJARMASIN UTARA	BU_07	PEMBANGUNAN PERUMAHAN GRIYA PELANGI SEI JINGAH	001	0,035	0,038
82				002	0,019	0,020
83				001	0,792	0,857
84	BANJARMASIN SELATAN	BS_01	RUKO GRILYA JL. LINGKAR DALAM SELATAN	002	0,424	0,459
85				003	0,334	0,362
86	BANJARMASIN SELATAN	BS_02	PERENCANAAN PERUMAHAN KOMP. GREEN SUNNY ESTATE	001	1,092	1,182
87				002	1,166	1,261
88	BANJARMASIN SELATAN	BS_03	PEMBANGUNAN SPBE 3 KG JL. LINGKAR DALAM SELATAN	001	1,652	1,787
89				002	1,489	1,611
90	BANJARMASIN SELATAN	BS_04	KAWASAN PERUMAHAN JL. A. YANI KM. 5 KOMPLEK KENCANA	001	0,684	0,740
91	BANJARMASIN SELATAN	BS_05	PEMBANGUNAN RUKO 2 LANTAI BANJAR INDAH PERMAI	001	0,000	0,000
92	BANJARMASIN SELATAN	BS_06	PERENCANAAN RENOVASI BANGUNAN MITSUBISHI KM. 5,7	001	0,534	0,578
93				002	0,662	0,716
94				001	0,020	0,039
95				002	0,036	0,072
96	BANJARMASIN SELATAN	BS_07	PEMBANGUNAN PERUMAHAN AR-RAUDAH KOMP. GRAND AR-RAUDAH 12	003	0,124	0,246
97				004	0,092	0,184
98				005	0,090	0,179

5. CONCLUSION

5.1 Conclusion

From the calculation results, the allowable bearing capacity values range from 1.63–59.13 kN and the value of consolidation settlement is 0–2.3 meters for two-story shophouses and 0–2.5 meters for three-story shophouses. The greater the value of the soil-bearing capacity the smaller the settlement that occurs.

5.2 Suggestion

CPT soil test data, SPT, and laboratory tests need to be reproduced. Buildings with deep foundations in the form of group piles need to be watched out for and buildings to be built are advised to use other types of foundations.

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