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GEOTECHNICAL CAPACITY OF FOUNDATIONS FOR SOME THILAWA AREA PHASE 1, YANGON, MYANMAR

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Abstract: *Thilawa Special Economic Zone-A is located in Thanlyin Township, Yangon Division, Myanmar. In this paper, Bearing Capacity of shallow foundations and pile capacity are described. In soil design parameter, cohesion C_u values are got from correlated SPT(N). According to the soil type, Modulus of Elasticity and Poisson's ratio are obtained. Foundation depth(D_f) is measured from the top soil layer. Bearing capacity of isolated spread footing (D_f =1m, B= 1m) is 63 kN/m^2 to 138.7 kN/m^2 for all bored holes. (D_f =1m, B= 2m) is 86 kN/m^2 to 140.5 kN/m^2, and (D_f =2 m, B= 2m) 86 kN/m^2 to 140.5 kN/m^2. For rigid raft –mat foundation (D_f =1m, B= 10m) is 137.83 kN/m^2 to 263.89 kN/m^2, (D_f =1m, B= 15m) is 126.08 kN/m^2 to 272.96 kN/m^2 , (D_f =1m, B= 20m) is 94.55kN/m^2 to 231.64kN/m^2 respectively. Average Settlements of isolated spread footings are 6.4 mm. Average Settlements for rigid raft –mat foundation are 43 mm. According to the soil classification results, driven piles are suitable for this project area. In this paper, RC pile capacities are described. Penetration Pile depths are about 15 m for Light structures, settlements are 5.85 to 6.4 mm respectively. Penetration Pile depths are about 20 to 24 m for heavy structures. Related settlements are 10.31to11.23mm respectively. PHC Pile is more suitable for this project.*

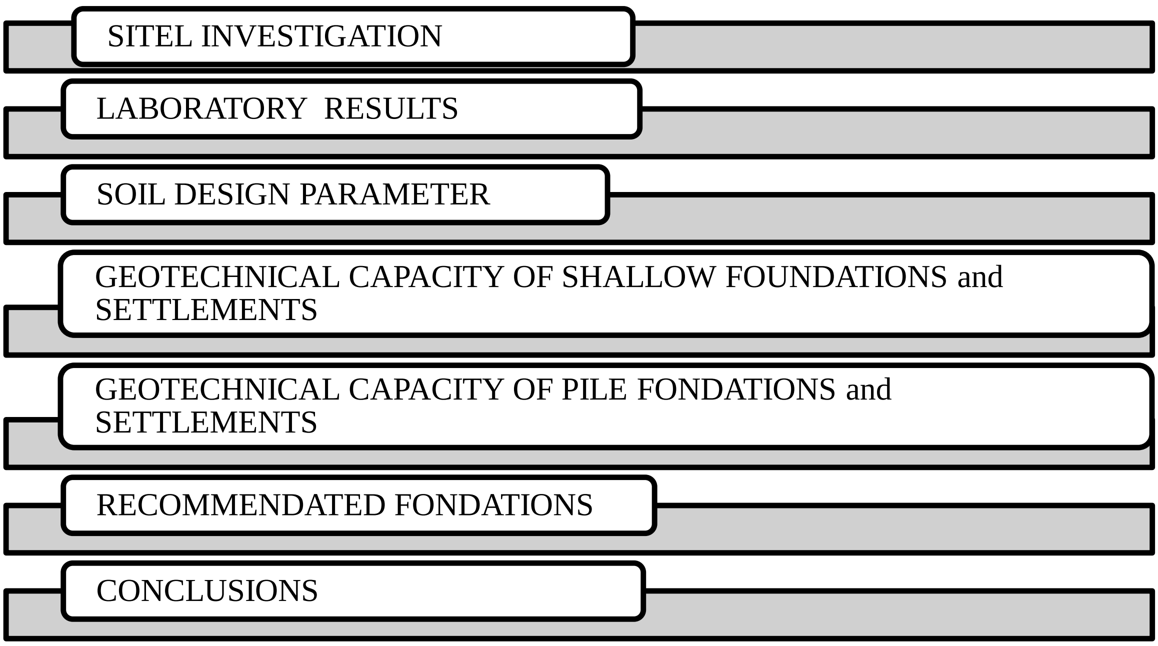
Key Words: *soil design parameters, soil classification, bearing capacity, pile capacities, settlement.*

1. INTRODUCTION:

Thilawa area is located Thanlyin Township, Yangon Division, Myanmar. In this paper includes Geotechnical Capacity of shallow foundations and Pile foundations for Thilawa area phrase 1. Meyerhof -general bearing capacity equation are used for bearing capacity of shallow foundations such as spread footing and mat (rigid raft) foundations and related settlements are computed based on the theory of elasticity. Pile capacity is calculated by the standard penetration test and related settlements are developed by the semi-empirical method (Vesic, 1977).

2. METHODOLOGY:

FLOW CHART FOR METHODOLOGY



3. SOIL DESIGN PARAMETERS: All Boreholes have topsoil condition up to 1.5 m depth below the existing grade. All boreholes have soft soil layers at below topsoil layers until up to 3 m. All boreholes depths are variable from 24.00 m to 35 m. The groundwater level was measured with respect to ground level, the average measurement of groundwater levels are 1.6 m to 2.4 m. Some parameters are needed to correlate SPT numbers. Cohesion C_u values are got from correlated SPT N. According to the soil type, Modulus of Elasticity and Poisson's ratio are obtained. Unit weight and other engineering properties are described in laboratory results. Figure 1 to Figure 3 show SPT versus Depth for all bored holes.

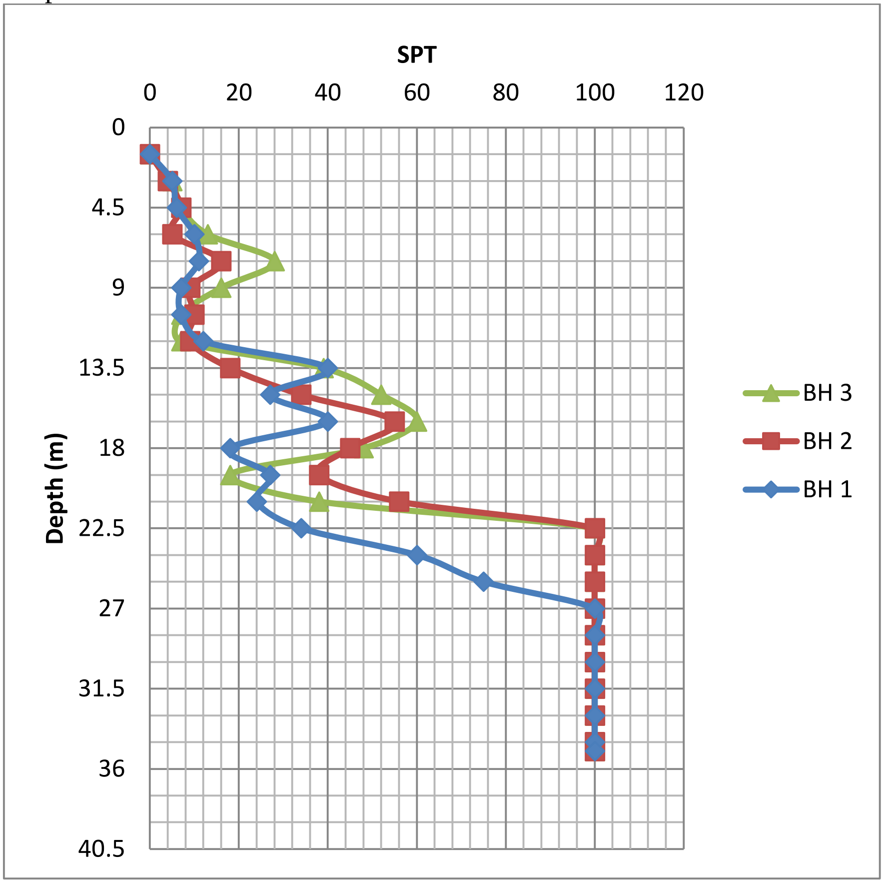


Figure (1) SPT versus Depth for BH 1,2,3

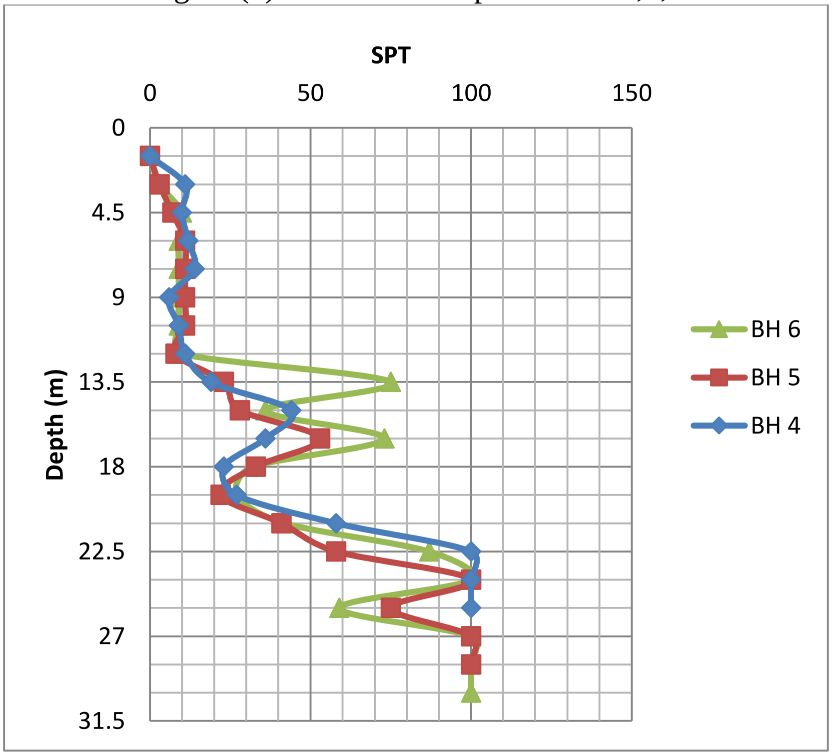


Figure (2) SPT versus Depth for BH 4,5,6

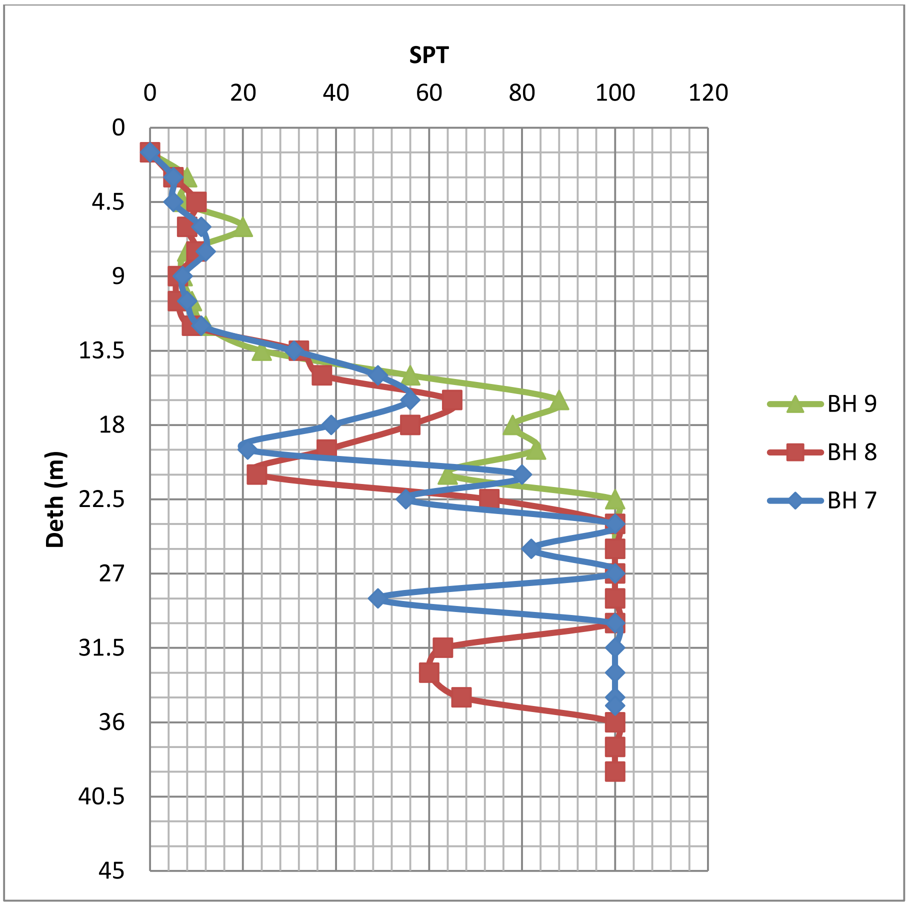


Figure (3) SPT versus Depths for BH 7,8,9

4. SOIL CLASSFICAIONS:

<table>
<tr><th colspan="3">BH 1</th><th colspan="3">BH 2</th><th colspan="3">BH 3</th></tr>
<tr><th>Layer</th><th>Depth(m)</th><th>Subsoil Type</th><th>Layer</th><th>Depth(m)</th><th>Subsoil Type</th><th>Layer</th><th>Depth(m)</th><th>Subsoil Type</th></tr>
<tr><td>I</td><td>0-1.5</td><td></td><td>I</td><td>0-1.5</td><td></td><td>I</td><td>0-1.5</td><td></td></tr>
<tr><td>II</td><td>1.5-3.00</td><td>ML</td><td>II</td><td>1.5-3.00</td><td>CL</td><td>II</td><td>1.5-3.00</td><td>ML</td></tr>
<tr><td>III</td><td>3.00-6.00</td><td>ML</td><td>III</td><td>3.00-4.5</td><td>ML</td><td>III</td><td>3.00-4.5</td><td>CL,CH</td></tr>
<tr><td>IV</td><td>6.00-7.50</td><td>ML</td><td rowspan="2">IV</td><td rowspan="2">4.50-7.50</td><td rowspan="2">ML</td><td>IV</td><td>4.5-6.0</td><td>CL</td></tr>
<tr><td rowspan="3">V</td><td rowspan="3">7.50-12.0</td><td rowspan="3">ML</td><td>V</td><td>6.0-7.5</td><td>ML</td></tr>
<tr><td rowspan="4">V</td><td rowspan="4">7.50-13.5</td><td rowspan="4">CL,SP-SM</td><td>VI</td><td>7.5-9.0</td><td>ML</td></tr>
<tr><td>VII</td><td>9.0-12.0</td><td>CL</td></tr>
<tr><td rowspan="2">VI</td><td rowspan="2">12.0-15.0</td><td rowspan="2">ML</td><td>VIII</td><td>12.0-13.5</td><td>ML</td></tr>
<tr><td>IX</td><td>13.5-16.5</td><td>ML</td></tr>
<tr><td>VII</td><td>15.0-16.50</td><td>SM</td><td rowspan="2">VI</td><td rowspan="2">13.5-18.0</td><td rowspan="2">CL</td><td rowspan="3">X</td><td rowspan="3">16.5-21.0</td><td rowspan="3">CL/ML</td></tr>
<tr><td rowspan="3">VIII</td><td rowspan="3">16.5-22.50</td><td rowspan="3">CL,ML,SM</td></tr>
<tr><td>VII</td><td>18.0-19.5</td><td>SM</td></tr>
<tr><td rowspan="2">VIII</td><td rowspan="2">19.5-24.0</td><td rowspan="2">CL,SP-SM</td><td rowspan="2">XI</td><td rowspan="2">21.0-24.0</td><td rowspan="2">SM,</td></tr>
<tr><td rowspan="5">IX</td><td rowspan="5">22.5-35.00</td><td rowspan="5">SP-SM</td></tr>
<tr><td rowspan="4">IX</td><td rowspan="4">24.0-35.0</td><td rowspan="4">SP-SM</td><td>XI</td><td>24.0-25.5</td><td>ML</td></tr>
<tr><td>XII</td><td>25.5-28.5</td><td>SM</td></tr>
<tr><td>XIII</td><td>28.5-30.0</td><td>ML</td></tr>
<tr><td>XIV</td><td>30.0-35.0</td><td>SM</td></tr>
</table>

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BH 4			***BH 5***			***BH 6***		
Layer	***Depth(m)***	***Subsoil Type***	***Layer***	***Depth(m)***	***Subsoil Type***	***Layer***	***Depth(m)***	***Subsoil Type***
I	0-1.5		I	0-1.5		I	0-1.5	
II	1.5-6.0	CL	II	1.5-3.0	CL	II	1.5-4.50	ML
III	6.0-7.5	ML	III	3.0-6.0	CL	III	4.5-7.5	ML
IV	7.5-9.0	CH	IV	6.0-7.5	ML	IV	7.5-10.5	ML,CL
V	9.0-12.00	CL,	V	7.5-12.0	CL	V	10.5-13.5	CL,ML
VI	12.0-16.5	SM	VI	12.0-13.5	SM	VI	13.5-15.0	ML
VII	16.5-19.5	CL	VII	13.5-15.0	SM	VII	15.0-16.5	ML
VIII	19.5-24.5	CL,SM	VIII	15.0-16.5	SM	VIII	16.5-19.5	ML
			IX	16.5-18.0	CL	IX	19.5-28.5	SM,CL
			X	18.5-19.5	CL	X	28.5-29.0	SM
			XI	19.5-29.0	ML,SM			
BH 7			***BH 8***			***BH 9***		
Layer	***Depth(m)***	***Subsoil Type***	***Layer***	***Depth(m)***	***Subsoil Type***	***Layer***	***Depth(m)***	***Subsoil Type***
I	0-1.5		I	0-1.5		I	0-1.5	
II	1.5-3.0	CL	II	1.5-3.0	CH	II	1.5-4.5	CL
III	3.00-7.5	CL,ML	III	3.0-6.00	CH	III	4.5-6.0	SM
IV	7.5-12.0	ML	IV	6.0-7.50	CL,CH	IV	6.0-13.5	CL
V	12.0-15.0	ML	V	7.5-12.00	CH	V	13.5-22.50	SM
VI	15.0-16.5	ML	VI	12.0-15.00	CL	VI	22.5-24.50	SM
VII	16.5-21.0	ML	VII	15.0-16.5	CL-ML			
VIII	21.00-30.0	SM	VIII	16.5-18.0	CL			
IX	30.0-34.5	SM	IX	18.0-19.5	ML			
X	34.5-35.0	SM	X	19.5-21.0	CL			
			XI	21.0-27.0	SP-SM			
			XII	27.0-34.50	SP-SM			
			XIII	34.5-36.0	SP-SM			
			XIV	36.0-37.5	SP-SM			
			XV	37.5-38.0	SP-SM			

5. GEOTECHNICAL CAPACITY OF SHALLOW FOUNDATIONS and SETTLEMENTS:

Bearing Capacity for Shallow Foundation

$q_u = c' N_c F_{cs} F_{cd} F_{ci} + q\, N_q F_{qs} F_{qd} F_{qi} + \frac{1}{2} \gamma\, B N_\gamma F_{\gamma s} F_{\gamma d} F_{\gamma i}$

In this equation:

c' = cohesion

q = effective stress at the level of the bottom of the foundation

γ = unit weight of soil

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B = width of foundation
F_{cs} ,F_{qs} , $F_{\gamma s}$ = shape factors

F_{cd} ,F_{qd} , $F_{\gamma d}$ = depth factors
F_{ci} ,F_{qi} , $F_{\gamma i}$ = load inclination factors
N_c , N_q , N_γ = bearing capacity factors

$$q_{net(u)} = q_u - q$$

where
$q_{net(u)}$ = net ultimate bearing capacity

$$q = \gamma D_f$$

$$q_{all(net)} = \frac{q_u - q}{FS}$$

- **Immediate settlement for shallow foundation**

$$\Delta H = q_o B' \frac{1-\mu^2}{E_s}\left(I_1 + \frac{1-2\mu}{1-\mu} I_2\right) I_F$$

Where
q_o = intensity of contact pressure in units of E_s
B' = least lateral dimension of contributing base area in units of ΔH
I_F = influence factors, which depend on L'/B', thickness of stratum H, Poission's ratio μ and base embedment depth D
E_s ,μ = elastic soil parameters

$$\Delta H = q_o B' \frac{1-\mu^2}{E_s} m I_s I_F$$

Figure (4) to Figure (12) are bearing capacity of isolated spread and mat (rigid raft) with settlements.

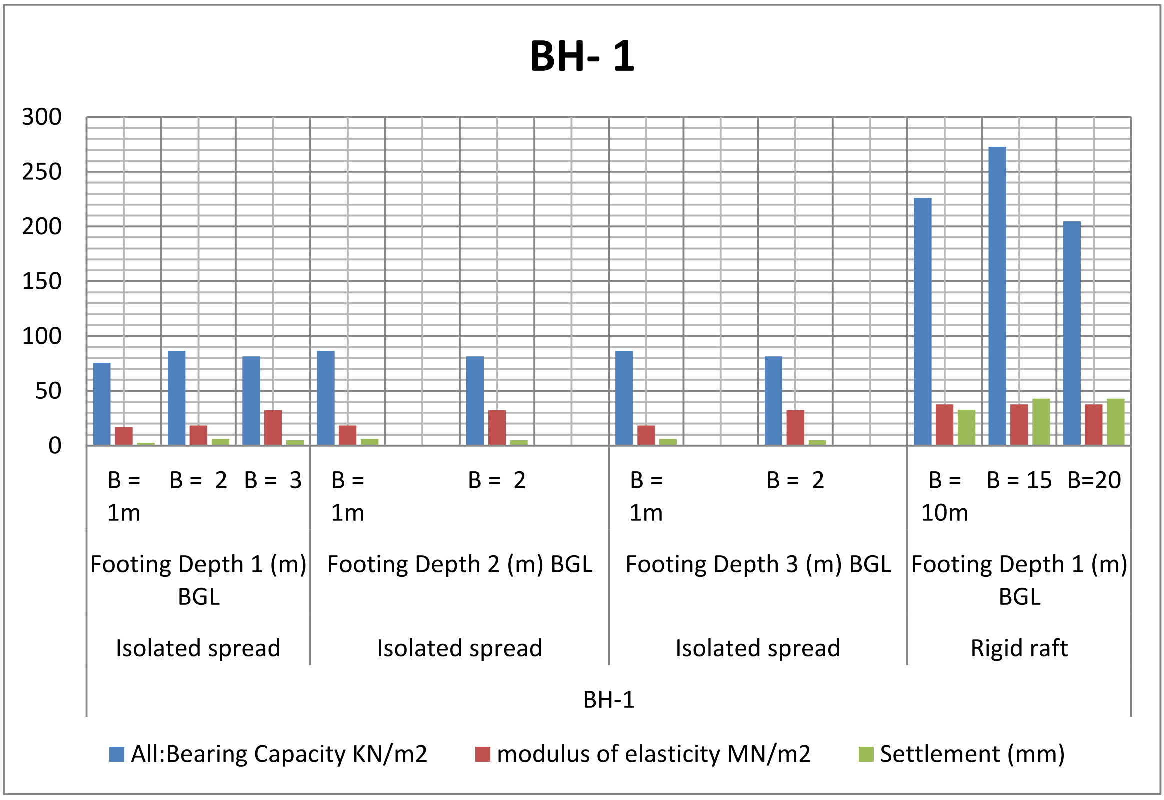

Figure (4) Bearing Capacity of Isolated Spread and Mat (rigid raft) with Settlements BH 1

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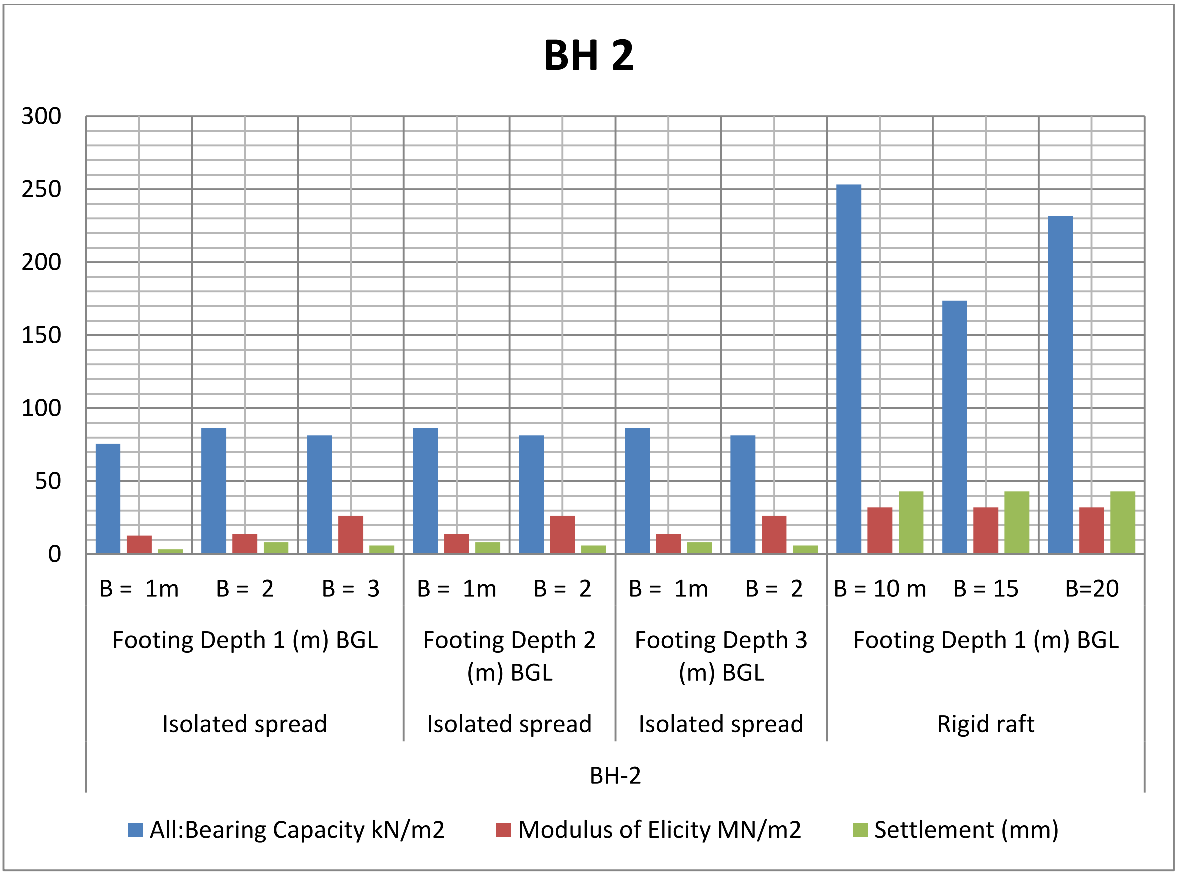

Figure (5) Bearing Capacity of Isolated Spread and Mat (rigid raft) with Settlements BH 2

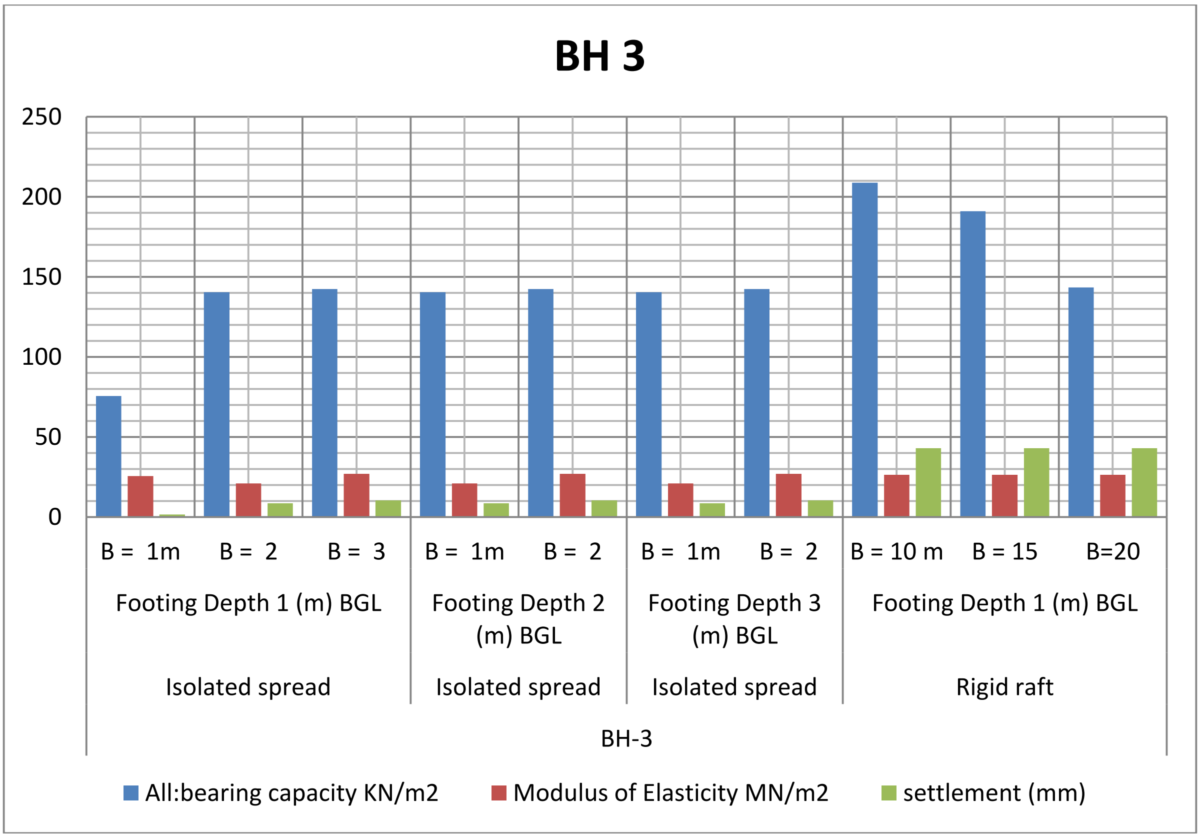

Figure (6) Bearing Capacity of Isolated Spread and Mat (rigid raft) with Settlements BH 3

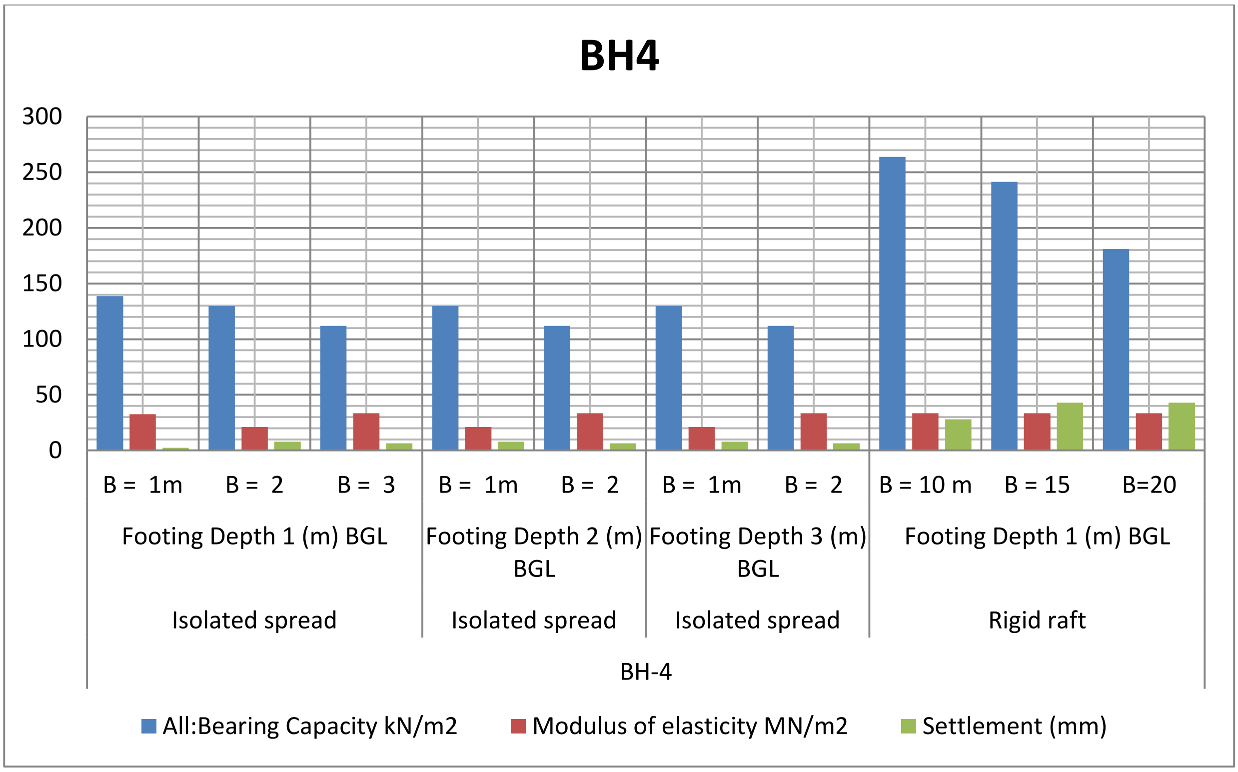

Figure (7) Bearing Capacity of Isolated Spread and Mat (rigid raft) with Settlements BH 4

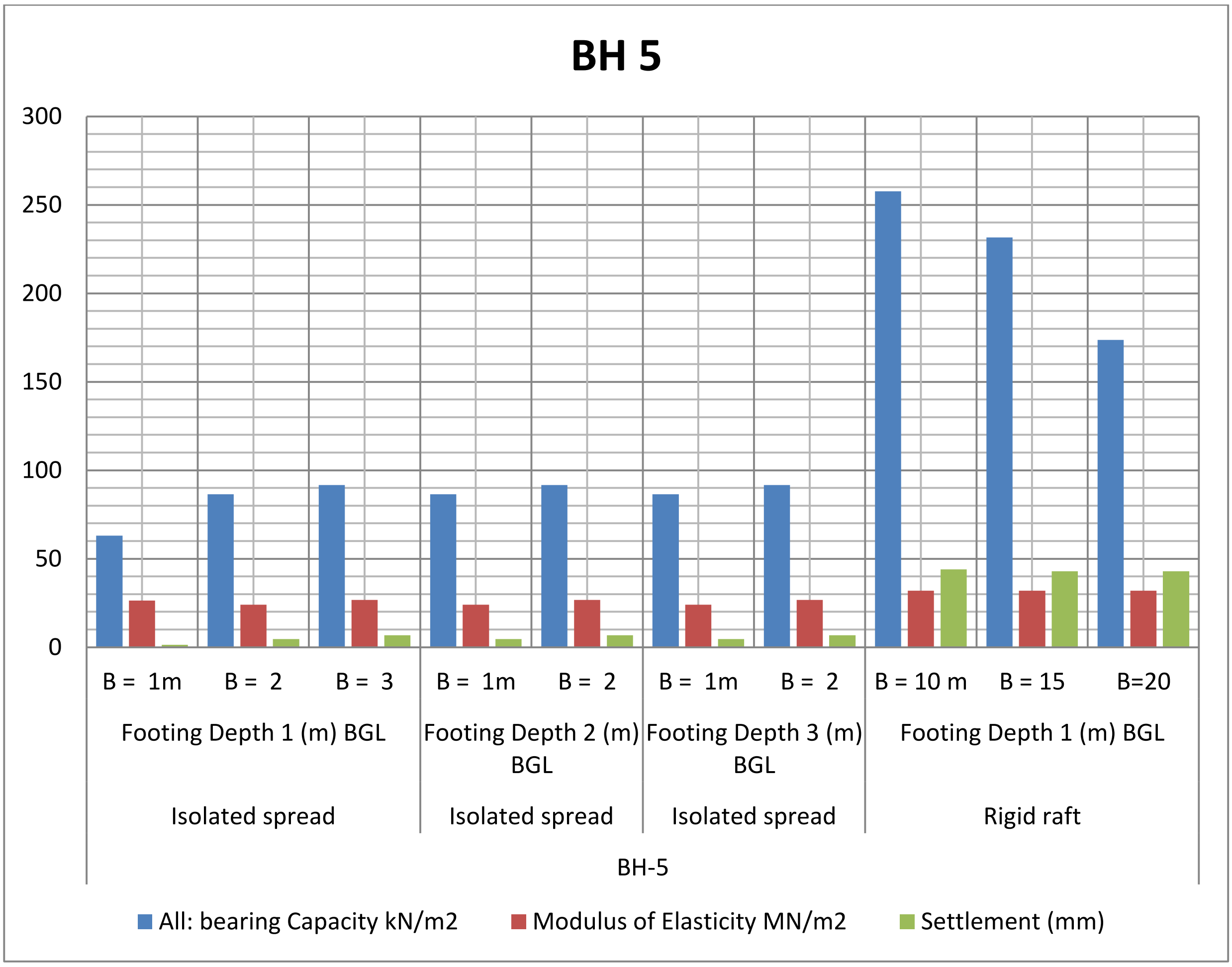

Figure (8) Bearing Capacity of Isolated Spread and Mat (rigid raft) with Settlements BH 5

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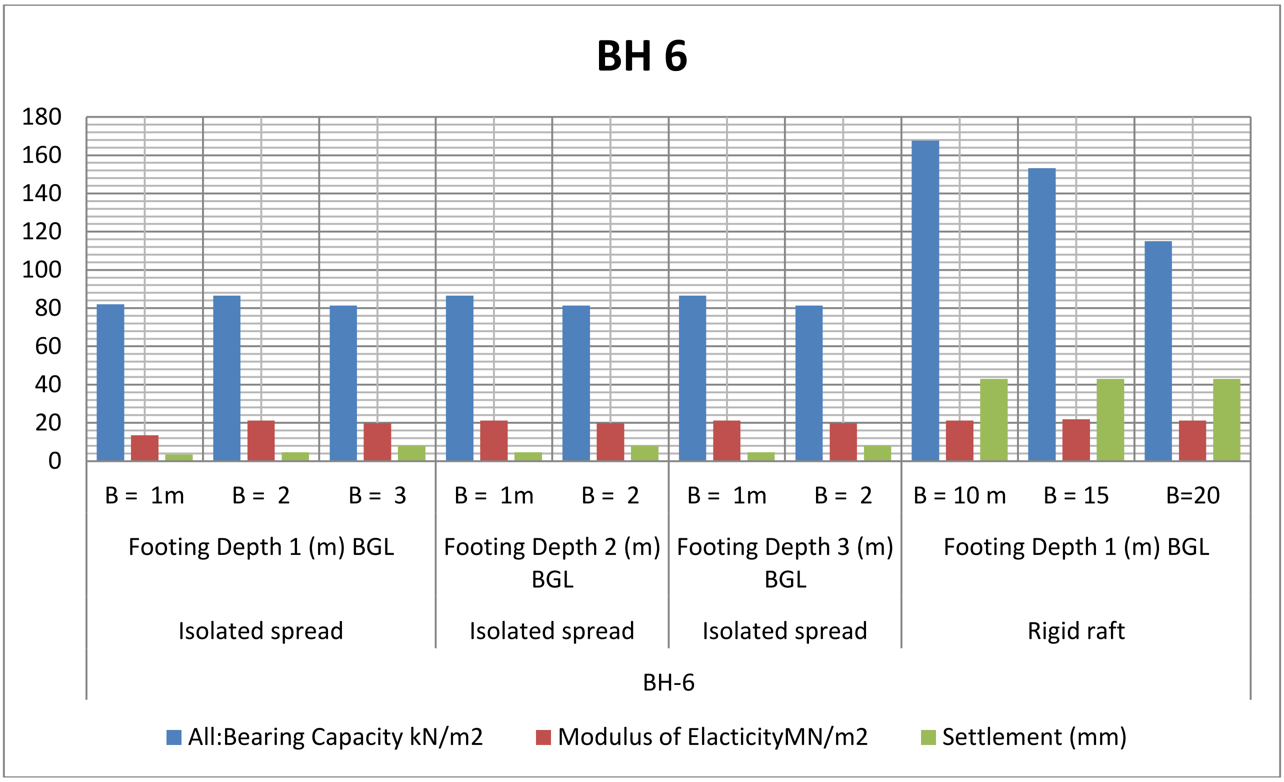

Figure (9) Bearing Capacity of Isolated Spread and Mat (rigid raft) with Settlements BH 6

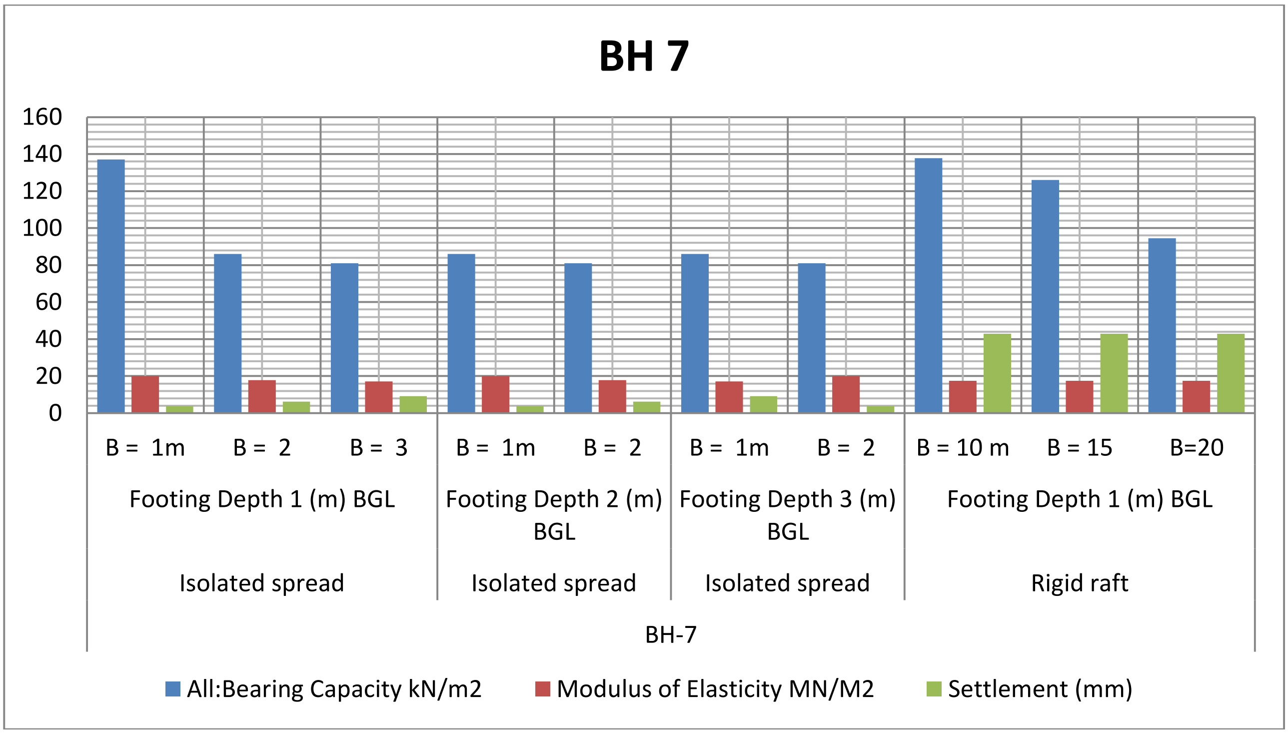

Figure (10) Bearing Capacity of Isolated Spread and Mat (rigid raft) with Settlements BH 7

6. GEOTECHNICAL CAPACITY OF PILE FONDATIONS and SETTLEMENTS:

According to soil classification results, driven piles are suitable for this project area. In this paper, RC pile capacities are described. Penetration Pile depths are about 15 m for Light structures, settlements are 5.85 to 6.4 mm respectively. Penetration Pile depths are about 20 to 24 m for heavy structures. Related settlements are 10.31to11.23mm respectively. There are results of pile capacity in Figure 13, 14.

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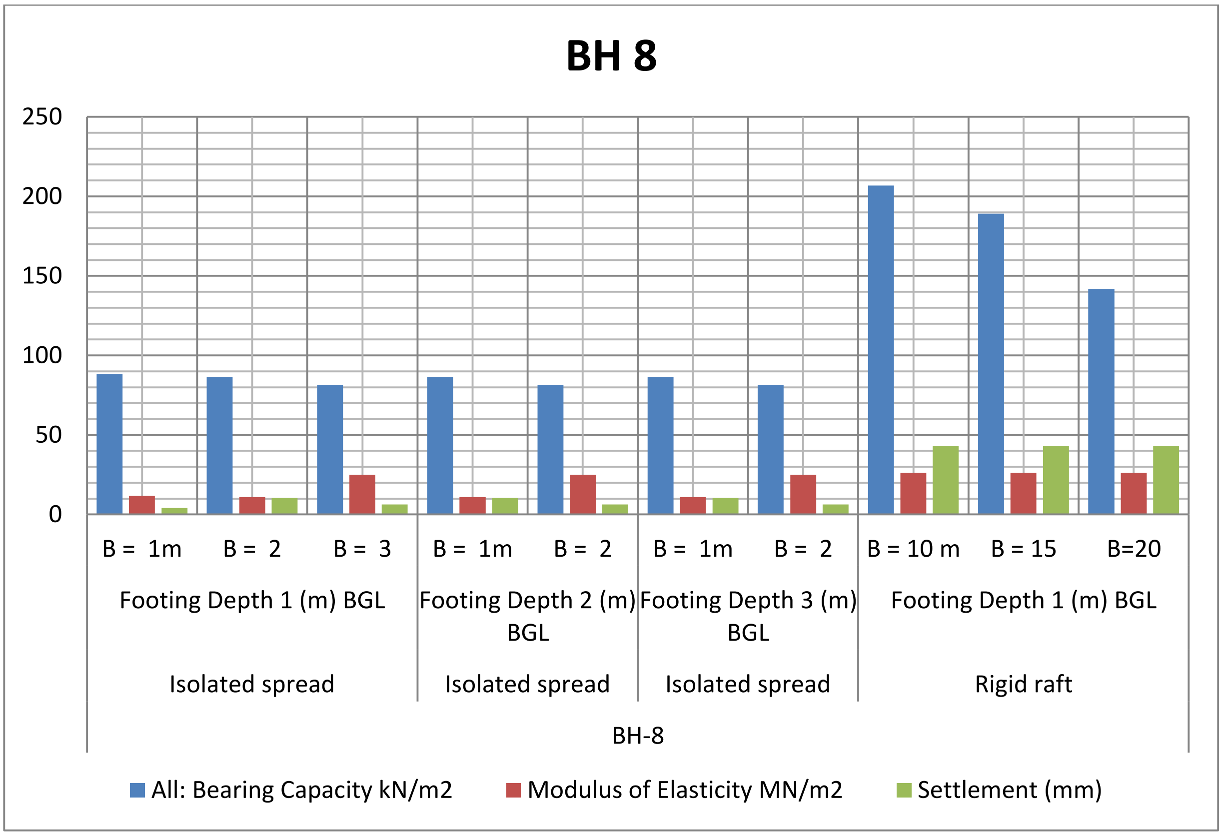

Figure (11) Bearing Capacity of Isolated Spread and Mat (rigid raft) with Settlements BH 8

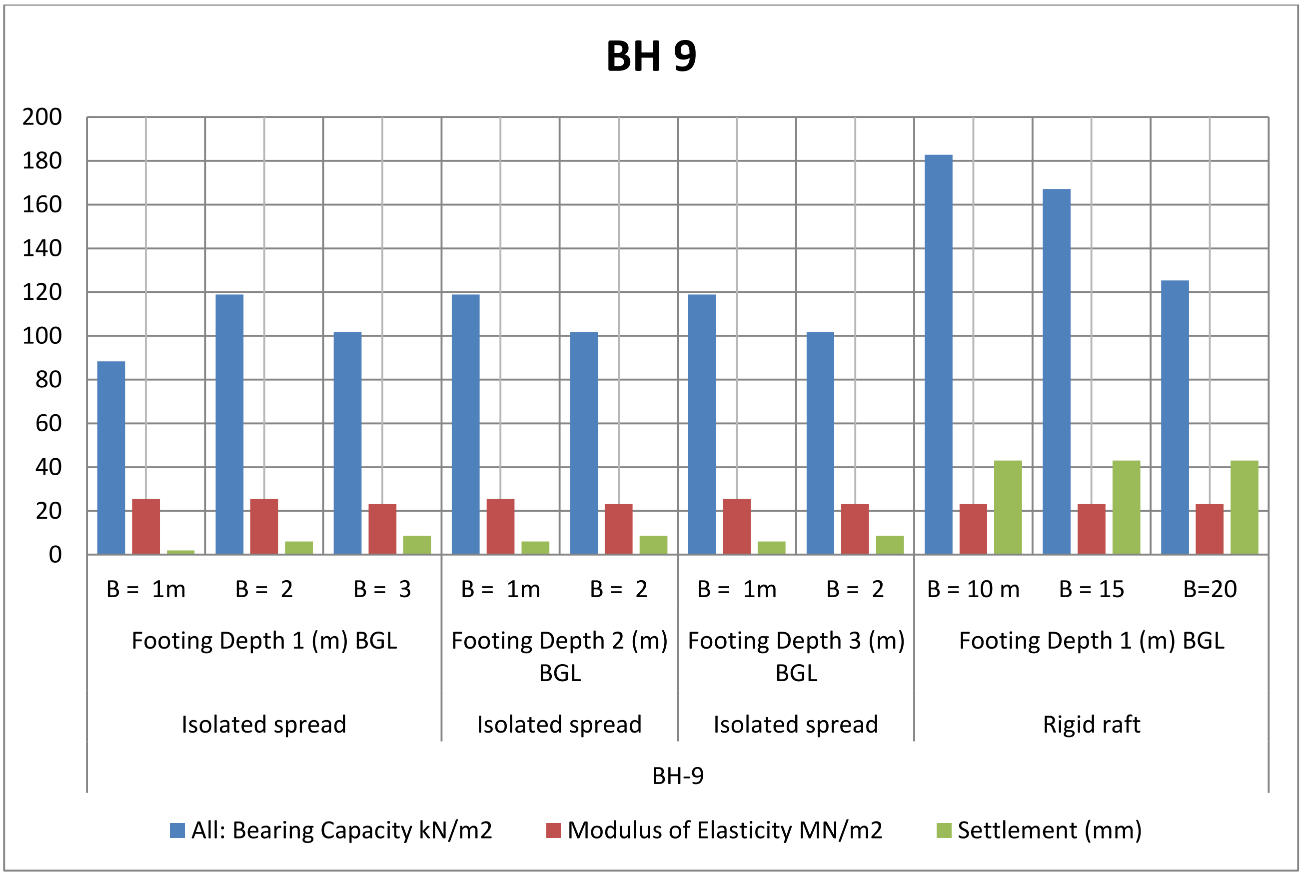

Figure (12) Bearing Capacity of Isolated Spread and Mat (rigid raft) with Settlements BH 9

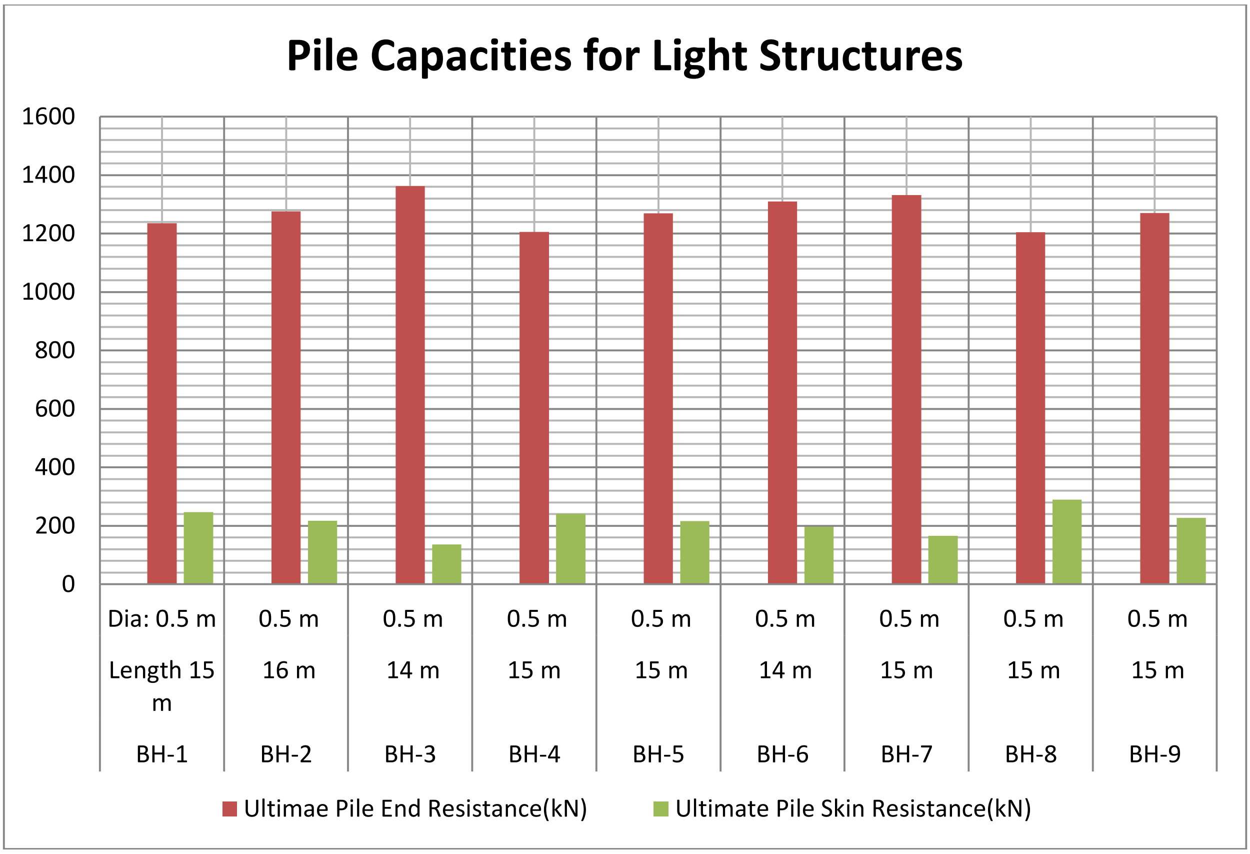

Figure 13 Pile Capacities for Light Structures

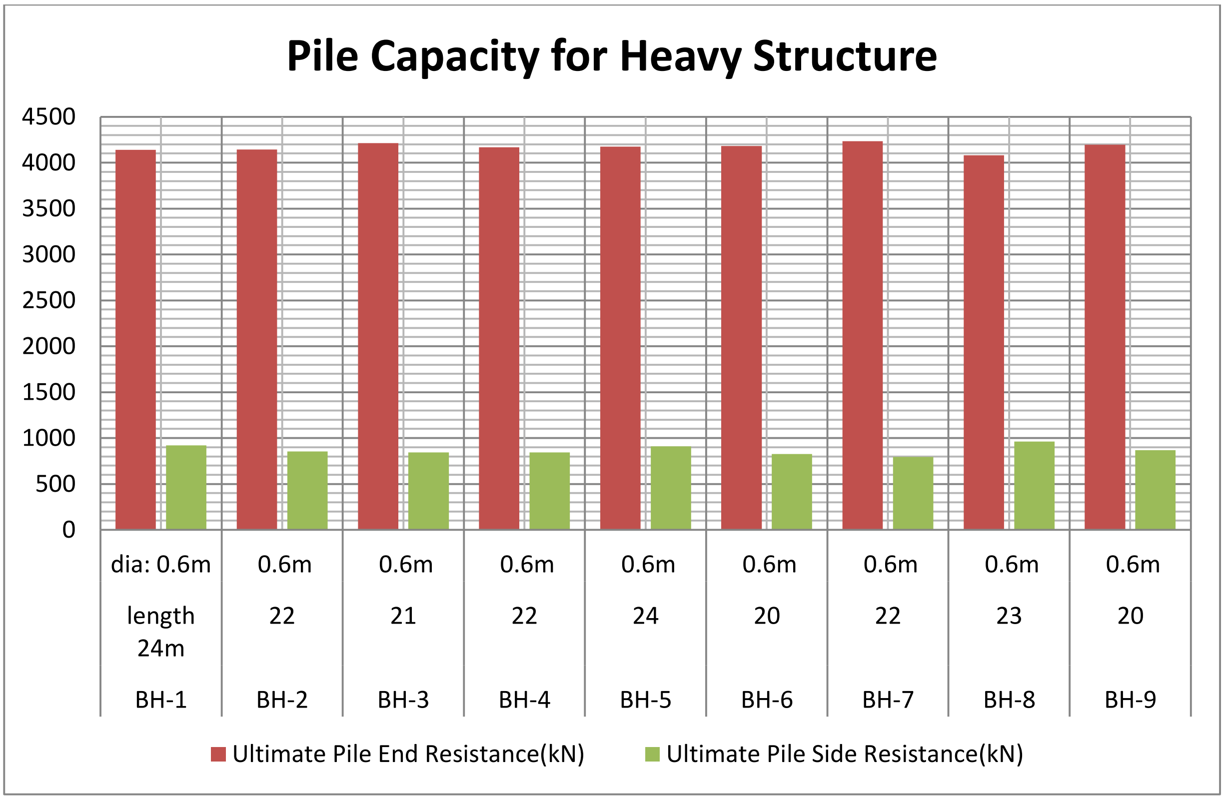

Figure13. Pile Capacities for Heavy Structures

7. RECOMMENDED FONDATIONS AND CONCLUSIONS:

According to soil condition, cement grouting will need at the tip of the bored pile if bored piles are used. PHC Piles are suitable due to heavy structure load with penetration depths are deep.

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