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Comparative Analysis of the Support Capacity and Settlement of Bored Pile Foundations Using Manual Methods and Allpile Software: Case Study

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Abstract

Foundations are structural elements that function to bear the load of a building and transfer it to the ground to a certain depth. Foundations must be designed so that the transferred load does not exceed the bearing capacity of the soil, as this can cause excessive settlement and lead to structural collapse. The purpose of this study is to determine the comparison of bearing capacity and settlement of bored pile foundations in the Poltekkes Kemenkes Mataram building using two approaches: the manual method and the Allpile software. The analysis was conducted based on secondary data obtained from the Detailed Engineering Design (DED), results of the Standard Penetration Test (SPT), and laboratory soil test results. The results of the manual Meyerhof method yielded an ultimate bearing capacity of 13,127.79 kN and a single pile settlement of 0.0455 m. The manual Reese and Wright method yielded an ultimate bearing capacity of 2,697.3453 kN and a single pile settlement of 0.0241 m. Meanwhile, the Allpile software calculation yielded an ultimate bearing capacity of 14,391.891 kN and a single pile settlement of 0.0027 m. All settlement values, both for single piles and groups, remain below the maximum permitted limit.

Introduction

Civil engineering is a branch of engineering that focuses on the planning, design, and maintenance of infrastructure and building structures (Zhang et al., 2021; Wang et al., 2022; Manzoor et al., 2021). A construction project is a series of related activities designed to achieve a specific construction goal, taking into account key parameters such as time constraints, costs, and quality (Prima et al., 2024). In line with government programs and as part of efforts to support development, Mataram City has also experienced growth in various sectors, such as drainage, highways, shopping centers, campuses, schools, housing, offices, and hotels (Munaroh et al., 2025; Widayanti & Witasari, 2024; Krisnanta et al., 2025).

In designing a building, the foundation is one of the elements that plays a vital role in ensuring the stability of the structure (Hu et al., 2024; Zhao et al., 2025; Hassan, 2025). The foundation is a structural element that functions to bear the load of the building and transfer it to the ground to a certain depth. The foundation must be designed so that the transferred load does not exceed the soil's bearing capacity, as this could cause excessive settlement or even structural collapse. Therefore, soil investigation is a critical stage, particularly to determine the depth of the hard soil layer. Bored pile foundations are one type of deep foundation

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commonly used, especially considering the project's environmental conditions and the presence of surrounding buildings (Pribadi et al., 2023; Sushma et al., 2025; Shan et al., 2024).

With advances in technology and the emergence of new analysis methods, there are great opportunities to improve the accuracy and efficiency of foundation bearing capacity evaluations. In increasingly complex modern construction projects, in-depth knowledge of soil and foundation behavior is crucial to ensuring project success (Tan & Tiorivaldi, 2024; Alselami et al., 2025; Abualghethe et al., 2025).

This study aims to analyze the comparison of bearing capacity and foundation settlement of bored piles in the Mataram Ministry of Health Polytechnic building using two approaches, namely the manual method and Allpile software (Widiarso et al., 2025; Nurjanah, 2024; Wang et al., 2022). The analysis was carried out using the manual method, namely the Meyerhof and Reese and Wright methods, and compared with the results from Allpile software to determine the effectiveness and suitability of the calculation results from each method.

Methods

The approach applied in this study is a descriptive analysis that begins with a literature review on bored pile foundation theory, bearing capacity, and foundation settlement. Next is the collection of secondary data, which includes Detailed Engineering Design (DED) data, Standard Penetration Test (SPT) results, and soil laboratory test results. This data is used as the basis for performing calculations on the bearing capacity and settlement of bored pile foundations.

The analysis was conducted using two approaches, namely the manual approach using the Meyerhof (1976) method and the Reese and Wright (1977) method, as well as the approach using Allpile software. The calculations included pile tip bearing capacity, blanket bearing capacity, ultimate bearing capacity, allowable bearing capacity, and foundation settlement for both single and group piles.

The research location is at the Mataram Ministry of Health Polytechnic Building, located on Jalan Prabu Rangkasari, Dasan Cermen, Sandubaya District, Mataram City, West Nusa Tenggara, with geographical coordinates -8.6065360 LS and 116.1300787 BT. The location of the building can be seen in Figure 1 below:

Figure 1. Research location

Source : Google earth, 2025

Foundation bearing capacity

According to (Hardiyatmo, 2015), based on the mechanism of load transfer to the ground, poles can be divided into two types, namely: 1) End bearing piles obtain their main bearing capacity from resistance at the end of the pile. Generally, end pile resistance is located in soft

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soil layers or other hard layers that have undergone consolidation and are capable of withstanding loads without causing excessive settlement. Pile capacity is determined entirely by the bearing resistance of the hard layer beneath the end of the pile; 2) A friction pile is a pile whose load-bearing capacity is determined by the frictional force between the side surface of the pile and the surrounding soil. In calculating the load-bearing capacity of a pile, it is necessary to consider the contribution of frictional resistance and the impact of soil consolidation processes beneath the pile (Cheng et al., 2024; Lu et al., 2025; Yao et al., 2023).

Soil is a natural material composed of solid mineral particles that are not chemically bound to each other, as well as organic particles that have undergone weathering (Regassa et al., 2023; Rani, 2021; Mansab et al., 2025). In addition, soil also contains liquids and gases that fill the spaces between particles (Kurniawan & Siregar, 2023). The soil must have sufficient bearing capacity to support the load transferred by the foundation, while the foundation must be strong enough to prevent excessive settlement (Azizi et al., 2020; Bouassida et al., 2022; Malviya et al., 2023). Base on (National Standardization Agency Indonesian National Standards Geotechnical Design Requirements, 2017), the bearing capacity of the foundation is obtained by dividing the ultimate bearing capacity of the foundation by the safety factor. The safety factor used is a minimum of 3 for shallow foundations or a minimum of 2.5 for deep foundations

To determine the soil elasticity modulus (Es), Poisson's ratio (μs), and Cp coefficient values, refer to Tables 1 to 3 below:

Table 1. Soil elasticity values

Soil type	**Es(kN/m^2)**
Clay	
Very soft	300-3000
Soft	3000-4000
Currently	4500-9000
Keras	7000-20000
Hard	30000-42500
Sand	
silty	5000-20000
Not dense	10000-25000
Dense	50000-100000
Sand and gravel	
Dense	80000-200000
Not dense	50000-140000
silt	2000-20000
Loess	15000-60000
Flakes	140000-1400000

Source : Bowles, 1997

Table 2. Poisson ratio values

Soil type	**Poisson number**
Saturated clay	0,4 – 0,5
Unsaturated clay	0,1 – 0,3
Sandy clay	0,2 – 0,3
Silt	0,3 – 0,35
Compacted sand	0,3 – 0,4
Coarse sand (pore count e,= 0,40-0,70)	0,15

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Fine sand (pose count e,=0,40-0,70)	0,25
Stone	0,1 – 0,4
Loose	0,1 – 0,3

Source: Hardiyatmo, 2002

Table 3. Cp coefficient values

Soil type	Pile	Drill pole
Sand	0,02 – 0,04	0,09 – 0,18
Clay	0,02 – 0,03	0,03 – 0,06
Silt	0,03 – 0,05	0,09 – 0,12

Source: Das, 2004

Based on SPT data at the Poltekkes Kemenkes Mataram building site, the soil at the research site consists of a layer of clayey silt to a depth of ± 2.5 m with an NSPT value of 3-5, and a layer of sandy clay at a depth of 2.5-8 m with an NSPT value of 5-39. At a depth of 8–10 meters, there is sandy clay with an NSPT value >50. At a depth >10 meters, there is sandy silt with an NSPT value >50, which has very high density and serves as the supporting layer for the pile tip. Therefore, the soil at the research site is non-cohesive soil. The foundation tip is located at a depth of 23.65 meters with an NSPT value of 50.42. The soil elasticity value used is 30,000 kN, the Poisson's ratio is 0.3, and the Cp coefficient is 0.03. These values are adjusted to the field soil conditions, which are dominated by sandy clay soil.

The foundation used has a diameter of 0.8 m and a length of 23.65 m. The concrete used has a strength of f'c 28 MPa with a modulus of elasticity of the pile material (Ep) of 24870.06232 MPa. This data was obtained from the technical specifications of the Detailed Engineering Design (DED) and was used consistently throughout this calculation method.

Method Meyerhof (1976)

End bearing capacity (Qp)

The bearing capacity at the end of the pile can be determined using Meyerhof's equation (1976) as follows (Putri, 2025). The bearing capacity of the pile tip using the Meyerhof method can be calculated using equations 1 to 3.

$$Qp = Ap \text{ x } qp \quad (1)$$

$$Ap = \frac{1}{4}\pi \text{ x } D^2 \quad (2)$$

$$qp = 0{,}4\ x\ N60x\ (L/D)\ x\ \sigma r \leq 4\ x\ N60x\ \sigma r \quad (3)$$

With:

Qp = End support capacity (kN)

qp = Wide end restraint (kN/m^2)

Ap = Cross-sectional area of pole tip (m^2)

N60 = Value N-SPT

D = pole diameter (m)

L = pole length (m)

σr = reference voltage = 100 Kpa

Blanket carrying capacity (Qs)

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The carrying capacity of the Meyerhof method blanket can be calculated using equations 4 to 6.

$$Qs = As \times fs \quad (4)$$

$$As = \pi \ x \ D \ x \ L \quad (5)$$

$$fs = 1/100 \times \sigma r \ x \ N60 \quad (6)$$

With:

Qs = blanket support (KN)

As = Area of pole cover (m^2)

fs = friction from the blanket layer of the union pole area (KN)

D = Pole diameter (m)

L = Pole length (m)

N60 = value N-SPT

σr = reference voltage = 100 Kpa

Metode Reese dan Wright (1977)

End bearing capacity (Qp)

Daya dukung ujung tiang berdasarkan metode Resse and Wright dapat dihitung dengan persamaan 7 sampai dengan persamaan 9.

$$Qp = Ap \times qp \quad (7)$$

$$Ap = \frac{1}{4}\pi \times D^2 \quad (8)$$

For cohesive soil

$$qp = 9 \times Cu$$

$$Cu = 2/3 \times NSPT \times 10$$

For non-cohesive soil

$$qp = 7N \text{ kN} \leq 4000 \text{ kN, if } N < 60 \quad (9)$$

$$= 4000 \text{ kN, if } > 60$$

With:

Qp = end support (kN)

Ap = cross-sectional area of bored pile (m^2)

qp = end resistance per unit area (ton/m^2)

Cu = soil cohesion

Blanket carrying capacity (Qs)

The carrying capacity of the Reese and Wright method can be calculated using equations 10 to 13.

$$Qs = fs \times As \quad (10)$$

$$fs = 0{,}32N, \text{ if } N < 53 \quad (11)$$

$$= 1/34N, \text{ if } 53 < N \leq 100$$

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$As \quad = L \times p$ (12)

$p \quad = \pi D$ (13)

With:

Qs = support capacity of pole covers (kN)

fs = friction from the friction layer of the wide union pole (kN)

As = Area of pole cover (m^2)

L = drill rod length (m)

p = circumference of the pole cross section (m)

D = Pole diameter (m)

Ultimate bearing capacity

Ultimate bearing capacity can be calculated using equation 14.

$Qu \quad = Qp + Qs$ (14)

With:

Qu = ultimate bearing capacity (kN)

Qp = ultimate bearing capacity (kN)

Qs = support capacity of pole cover (kN)

Permit carrying capacity

Permit carrying capacity can be calculated using equation 15.

$Qall \quad = \frac{Qu}{Sf}$ (15)

With:

Qall = permit capacity

Qu = ultimate bearing capacity

Sf = security factor

Foundation settlement

Foundation settlement occurs due to the load above the foundation, which causes stress on the soil layer beneath the load. Elastic settlement of pile foundations is the vertical displacement of piles due to elastic deformation of the surrounding soil when receiving loads (Khairunnisa, 2025). When soil receives a load, it will experience deformation or settlement. Settlement is caused by changes in the soil structure, either due to shifts in particle arrangement or a reduction in pore space or water content within the soil (Fadilah & Tunafiah, 2018). The settlement of a single pile foundation can be calculated using equations 16 to 20.

$S \quad = Ss + Sp + Sps$ (16)

$Ss \quad = \frac{(Qp+(\alpha\ Qs))L}{Ap\ x\ Ep}$ (17)

$Sp \quad = \frac{Cp\ x\ Qp}{D\ x\ qp}$ (18)

$Sps \quad = (\frac{Qp}{p\ x\ L}) x \frac{D}{Es} x (1- \mu_s^2)\ I_{ws}$ (19)

$I_{ws} \quad = 2 + 0{,}35 \sqrt{\frac{L}{D}}$ (20)

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$S_{total} \leq S_{permission}$

$S_{total} \leq$ 10%D

With:

S = Settlement of single pile foundations

Ss = Settlement due to axial deformation of a single column (m)

Sp = Decrease due to load at the end of the pole (m)

Sps = Decrease due to load along the pole (m)

Qp = End bearing capacity (kN)

Qs = Support capacity of pole covers (kN)

L = Pole length (m)

Ap = Area of the pole tip (m^2)

Ep = Elastic modulus of pile material

α = 0,5 (for uniform friction distribution)

Cp = empirical coefficient (Cp coefficient can be seen in Table 3)

D = Pole diameter (m)

Qp = End post restraint (kN)

P = Circumference of pole cross section (m)

Es = Soil elasticity modulus (soil elasticity modulus can be seen in Table 1)

μ = Poisson number (Poisson numbers can be seen in Table 2)

I_{ws} = Influencing factors

Settlement of pile group foundations

To determine the simplest reduction in pile group allowances, Vesic (1969) proposed Sg ≤ 10%D (Yelvi et al., 2022). The settlement of pile group foundations can be calculated using equation 21.

$$Sg = S\sqrt{\frac{B}{L}} \tag{21}$$

With:

Sg = Settlement of pile group foundations (m)

S = Settlement of single pile foundations (m)

B = Width of the ballot paper (m)

L = Pole length (m)

Software Allpile

AllPile software is a program that efficiently and accurately analyzes pile load capacity. This software can analyze various types of foundations such as bored piles, auger piles, driven piles, H-piles, steel pipe piles, tapered piles, wooden piles, bell piles, shallow foundations, etc (Rahmat Waluyo & Triarso, 2023). In the Allpile program, calculations are performed through six stages of data entry, namely: pile type, pile profile, pile properties, load and group configuration, soil properties, and advanced settings (Fabian et al., 2019). Program ini mampu This program is capable of performing the following calculations: 1) Capacity and lateral

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deflection; 2) Capacity and vertical drop; 3) Vertical and lateral analysis of groups; 4) Static and cyclic conditions; 5) Negative and zero friction; 6) Shallow footing; 7) FHWA SHAFT Program; 8) Tower Foundation.

The initial menu screen of the Allpile software can be seen in Figure 2 below:

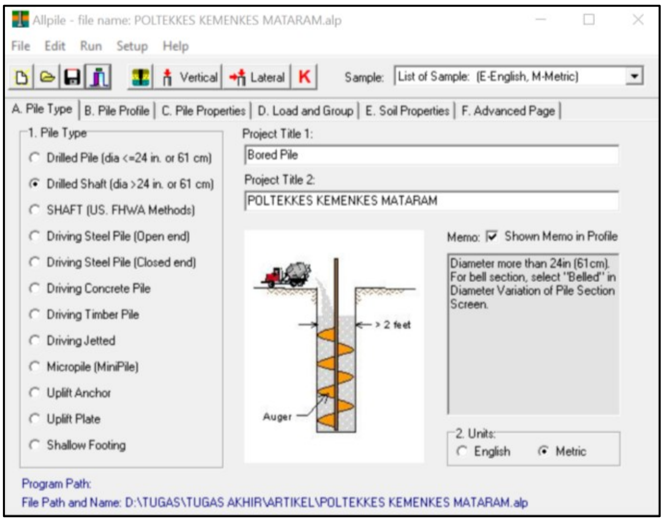

Figure 2. Allpile software start menu

Source : *Allpile software,* 2025

Results and Discussion

Calculation of bored pile foundation bearing capacity

Calculating the bearing capacity of the pile tip (Qp) Meyerhof (1976)

Ap $= \frac{1}{4} \times 3{,}14 \times 0{,}8^2$

$= 0{,}5024\ m^2$

qp $= 0{,}4 \times 50{,}42\ (23{,}65/0{,}8) \times 100 \leq 4 \times 50{,}42 \times 100$

$= 59621\ kN/m^2 \leq 20168\ kN$ (Use the smallest value)

qp $= 20168$ KN

Qp $= 0{,}5024\ m^2 \times 20168\ kN$

$=10132{,}40\ kN$

Calculating the carrying capacity of blankets (Qs) Meyerhof (1976)

As $= 3{,}14 \times 0{,}8 \times 23{,}65$

$= 59{,}4088\ m^2$

fs $= 1/100 \times 100 \times 50{,}42$

$= 50{,}42\ kN/m^2$

Qs $= 59{,}4088 \times 50{,}42$

$= 2995{,}39\ kN$

Calculating ultimate bearing capacity

Qu $= 10132{,}40 + 2995{,}39$

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$= 13127,79$ kN

Calculating permit carrying capacity

Qall $= \frac{13127,79}{2,5}$

$= 5251,116$ kN

Calculating the bearing capacity of the pile tip (Qp) Reese and Wright (1977)

Ap $= \frac{1}{4} \times 3,14 \times 0,8^2$

$= 0,5024\ m^2$

qp $= 7N\ kN \leq 4000\ kN$

$= 3529,4\ kN \leq 4000\ kN$

Qp $= 0,5024\ m^2 \times 3529,4\ kN$

$= 1773,17$ kN

Calculating blanket carrying capacity (Qs) Reese and Wright (1977)

fs $= 0,32$ N

$= 0,32 \times 50,42$

$=16,1344$ kN

p $= 3,14 \times 0,8$

$= 2,512$ m

As $= 23,65 \times 2,512$

$= 59,4088$

Qs $= 16,1344 \times 59,4088$

$= 958,5253$ kN

Calculating ultimate bearing capacity

Qu $= 1738,82 + 958,5253$

$= 2697,3453$ kN

Calculating permit carrying capacity

Qall $= \frac{2697,3453}{2,5}$

$= 1078,9381$ kN

Allpile software

Data processing in Allpile software is carried out by inputting field data from Standard Penetration Test (SPT) and Detailed Engineering Design (DED) data. The data is inputted into six stages in Allpile software. The stages and data inputted are as follows:

1. Pile type

Drilled shaft (diameter > 24 inc or 61 cm)

2. Pile profil

Pile length (L) = 23,65m

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3. Pile properties

a) select shape (circle)

b) outside (concrete)

c) inside (steel)

d) diameter variation (straight)

e) crack deduction % (0)

f) bar size = (22mm),bar number = (20)

g) width = (80cm)

4. Load and group

a) single pile (fixed head)

b) group piles (fixed head)

5. Soil properties

a) Zs-m, (0), *soft clay,* NSPT = 1

b) Zs-m, (4), *soft clay,* NSPT = 6

c) Zs-m, (8), *stiff clay,* NSPT = 39

d) Zs-m, (12), *silt,* NSPT = 60

e) Zs-m, (16), *silt,* NSPT = 50

f) Zs-m, (20), *silt,* NSPT = 43

g) Zs-m, (23,65), *silt,* NSPT = 50

6. Advanced page

FS_side (2,5)

Based on the data entered into the Allpile software, the results obtained are as follows:

Qp = 10484,092 kN

Qs = 3907,891 kN

Qu = 14391,891 kN

Qall = 6147,536 kN

Foundation Settlement

Calculation of foundation settlement for single piles Meyerhof (1976)

$$Ss = \frac{(10132{,}40 + (0{,}5 \ x \ 2995{,}39))23{,}65}{0{,}5024 \ m2 \ x \ 24870062{,}32 \ KN}$$

$$= 0{,}0220 \text{ m}$$

$$Sp = \frac{0{,}03 \ x \ 10132{,}40}{0{,}8 \ x \ 20168}$$

$$= 0{,}0188 \text{ m}$$

$$I_{ws} = 2 + 0{,}35 \sqrt{\frac{23{,}65}{0{,}8}}$$

$$= 3{,}9029$$

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$$Sps = \left(\frac{2995,39}{2,512 \, x \, 23,65}\right) x \, \frac{0,8}{30000} \, x \, (1 - 0,3^2) \, x \, 3,9029$$

$= 0,0047$ m

S $= 0,0220 + 0,0188 + 0,0047$

$= 0,0455$ m

$S_{total} \leq 10\% \; 0,8$

$0,0455m \leq 0,08m$ OK

Calculation of single pile foundation settlement Reese and Wright (1977)

$$Ss = \frac{(1738,32 + (0,5 \, x \, 958,5253))23,65}{0,5024 \, m2 \, x \, 24870062,32 \, KN}$$

$=0,0042$ m

$$Sp = \frac{0,03 \, x \, 1738,32}{0,8 \, x \, 3529,4}$$

$= 0,0184$ m

$$I_{ws} = 2 + 0,35 \sqrt{\frac{23,65}{0,8}}$$

$= 3,9029$

$$Sps = \left(\frac{958,5253}{2,512 \, x \, 23,65}\right) x \, \frac{0,8}{30000} \, x \, (1 - 0,3^2) \, x \, 3,9029$$

$= 0,0015$ m

S $= 0,0042 + 0,0184 + 0,0015$

$= 0,0241$ m

$S_{total} \leq 10\% \; 0,8$

$0,0241m \leq 0,08m$ OK

Calculation of single pile foundation settlement Allpile Software

Based on the results of the analysis from the Allpile software with the data that has been input, the single pile settlement obtained is 0.0027 m. The allowable settlement in the Allpile software is 2.54 cm.

S ≤ 2,54 cm

0,0027 m ≤ 0,0254 m OK

Settlement of pile group foundations

Meyerhof (1976)

$$Sg = 0,0455 \sqrt{\frac{6,8}{23,65}}$$

$= 0,0243m$

Sg≤ 10% 0,8

0,0243m≤ 0,08m OK

Reese and Wright (1977)

$$Sg = 0,0241 \sqrt{\frac{6,8}{23,65}}$$

$= 0,0129m$

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Sg≤ 10% 0,8

0,0129m≤ 0,08m OK

Allpile software

Based on the results of the analysis from the Allpile software with the data that has been input, the group pile settlement was obtained at 0.0003 m. The permissible settlement in the Allpile software is 2.54 cm.

S ≤ 2,54 cm

0,0003 m ≤ 0,0254m OK

The recapitulation of the results of the bearing capacity calculation and bored pile foundation settlement using two approaches, namely the Meyerhof and Reese and Wright manual methods and the Allpile software approach, can be seen in Tables 4 and 5 below:

Table 4. Summary of foundation bearing capacity calculation results

Method	**Qp (kN)**	**Qs (kN)**	**Qu (kN)**	**Qall (kN)**
Meyerhof	10132,40	2995,39	13127,79	5251,116
Reese and Wright	1773,17	958,5253	2697,3453	1078,9381
Allpile software	10484,092	3907,891	14391,891	6147,536

Source: Author, 2025

Table 5. Recapitulation of the results of calculations for single and group foundation settlement

Method	**S (m)**	**Sg (m)**
Meyerhof	0,0455	0,0243
Reese and Wright	0,0241	0,0129
Allpile software	0,0027	0,0003

Source: Author, 2025

From the summary of the calculation results in Table 4, different ultimate bearing capacities were obtained for each method used. The Meyerhof method produced an ultimate bearing capacity of 13,127.78 kN, the Reese and Wright method produced 2,697.3453 kN, and the Allpile software showed an ultimate bearing capacity of 14,391.891 kN.

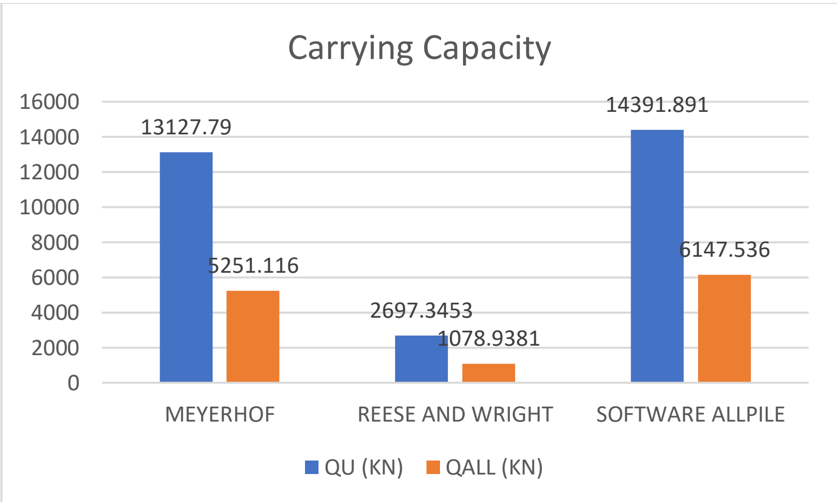

Figure 3. Carrying capacity

Source : Author, 2025

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The difference between the Meyerhof and Reese and Wright methods is 10,430.44 kN or 386.8%, while the difference between the Allpile software and the Meyerhof method is 1,264.10 kN or 9.63%, and the difference between the Allpile software and Reese and Wright is 11,694.54 kN or 433.3%. When compared to the existing bearing capacity data for the Poltekkes Kemenkes Mataram building, which is 5,297.7 kN, the Meyerhof method is higher by 7,830.09 kN or 147.8%, the Reese and Wright method is lower by 2,600.35 kN or 49.1%, and the Allpile software is higher by 9,094.19 kN or 171.7%. The ultimate carrying capacity and permit carrying capacity graphs can be seen in graph 3.

From the recapitulation of the calculation results in Table 5, the results of single and group foundation settlement were obtained. The Meyerhof method produced a single settlement of 0.0455 m, the Reese and Wright method produced 0.0241 m, and the Allpile software produced 0.0027 m. The difference in single foundation settlement between the Meyerhof and Reese and Wright methods is 0.0214 m or 47.03%, while the difference between the Allpile software and the Meyerhof method is 0.0428 m or 94.06%, and the difference between the Allpile software and the Reese and Wright method is 0.0214 m or 88.79%. For group pile settlement, the Meyerhof method is 0.0243 m, the Reese and Wright method is 0.0129 m, and the Allpile software is 0.0003 m. The difference in foundation settlement between the Meyerhof method and the Reese and Wright method is 0.0114 m or 46.91%, while the difference between the Allpile software and the Meyerhof method is 0.0240 m or 98.76%, and the difference between the Allpile software and the Reese and Wright method is 0.0126 m or 95.34%. The graphs showing the settlement of single pile foundations and group pile foundations can be seen in graph 4 below:

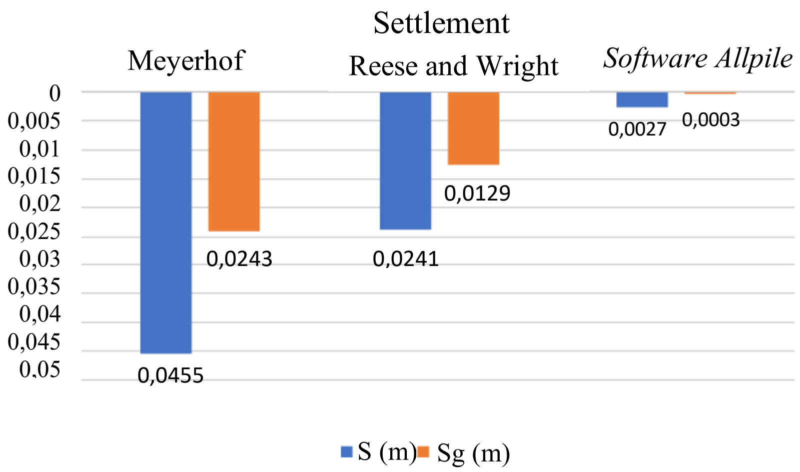

Figure 4. Settlement of single poles and group foundations

Source : Author, 2025

The differences in results between methods are due to differences in analytical approaches and parameters used. The Reese and Wright method shows the lowest bearing capacity results because it only uses an empirical correlation approach between NSPT values and soil bearing capacity without explicitly considering the characteristics of soil layers. The Meyerhof method yields higher results because it combines an empirical approach with pile geometry factors such as length and diameter, as well as soil reference stress. The results from the Allpile software show the highest values because it uses a discrete element-based approach and considers detailed geotechnical parameters such as soil specifications, soil elastic modulus, Poisson's ratio, and foundation material.

The foundation settlement produced by the Allpile software shows the smallest value even though the ultimate bearing capacity calculated is greater than that of the manual method.

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This occurs because the Allpile software's numerical analysis approach takes into account the detailed soil parameters of each layer and the characteristics of the pile material. In contrast, manual methods such as Meyerhof and Reese and Wright use a simple empirical approach. The Meyerhof method produces a load nearly four times larger than Reese and Wright, but the resulting settlement is only twice as large. This also indicates that an increase in load does not always correlate directly with settlement, so a load five times larger does not directly result in a fivefold increase in settlement. Settlement is significantly influenced by other parameters, such as the bearing capacity at the tip and the bearing capacity of the soil layer, which directly factor into the settlement calculations. The magnitude of settlement is also influenced by soil elasticity parameters, pile length, and load distribution along the pile.

Conclusion

Based on the results of the comparative analysis of bearing capacity and foundation settlement for the Poltekkes Kemenkes Mataram building using the manual Meyerhof and Reese and Wright methods, as well as the Allpile software, it can be concluded that the ultimate bearing capacity using the Meyerhof method is 13,127.79 kN and the allowable bearing capacity is 5,251.116 kN, while the Reese and Wright method yields an ultimate bearing capacity of 2,697.3454 kN and a allowable bearing capacity of 1,078.9381 kN. The results from the Allpile software show an ultimate bearing capacity of 14,391.891 kN and an allowable bearing capacity of 6,147.536 kN. The largest single pile settlement was obtained from the Meyerhof method calculation, which was 0.0487 m, while the smallest result was from the Allpile software, which was 0.0027 m. All settlement values, both for single piles and groups, remain below the maximum allowed limit. Calculations using the Allpile software show larger and more realistic results for field conditions because they consider more geotechnical parameters. Meanwhile, manual methods such as Meyerhof and Reese and Wright remain relevant for initial calculations or comparisons.

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