Centrifugal Model Tests on a Micropile Foundation

Part 2 : Outline of the Experiment Results and Conclusions

Masahiro Moriwaki *
Takeshi Oshita **
Yasumitsu Ichimura ***
Masashi Itani ***
Masao Sagara ****

* Affiliated Researcher, Construction Method Division, Material and Construction Method Department, Public Works Research Institute, Ministry of Construction
**Director, the same as the above, PWRI, Ministry of Construction
*** Researcher, the same as the above, PWRI, Ministry of Construction
****Former Affiliated Researcher, the same as the above, PWRI, Ministry of Construction

1. Introduction

This report describes the clarification of the bearing capacity properties of micropiles (referred to as MP in the report) made with steel pipe. This was done by performing bearing capacity experiments on a model of a spread foundation reinforced with MP in a centrifugal force field to study the effects of the angles and installation patterns of the MP on their bearing capacity. This report presents part of the findings obtained from the experiment.

See Centrifugal Model Tests on a Micropile Foundation - Part 1: Outline of the Large Centrifugal Force Loading Test Apparatus and Model Experiment Apparatus for the experiment apparatus and experimental method.

2. Experimental Results and Conclusions

Figure 1 and Figure 2 show the relationship between load strength and the quantity of settlement. The vertical axis in the figure is the load strength obtained from the (loading weight / surface area of the bottom of the MP foundation bottom), and the horizontal axis presents the dimensionless quantity of settlement (S/B) obtained from the (measured quantity of settlement (S) / diameter of the cylindrical foundation (B)).

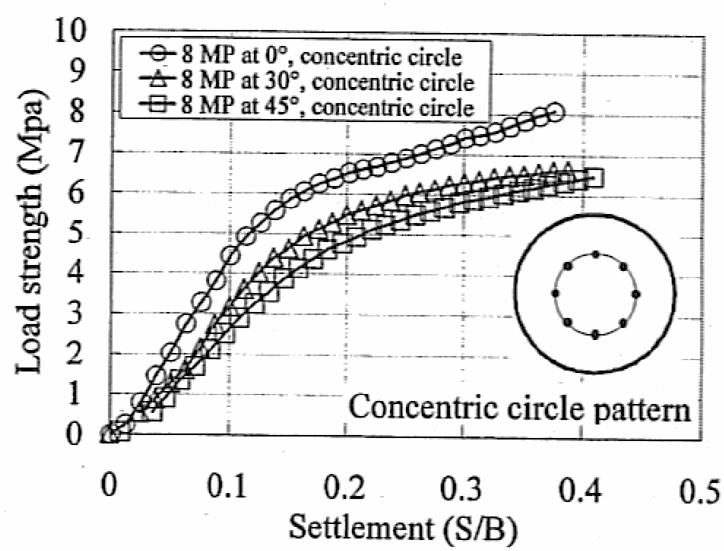
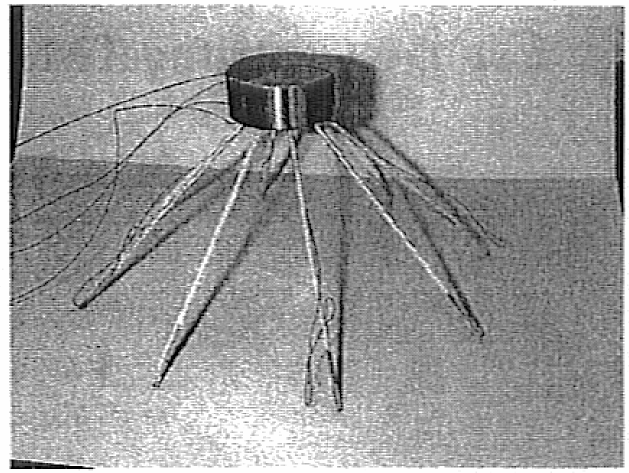


Fig.1 Load Strength – Quantity of Settlement (Concentric Circle)

(1) Effects of pile angle

Figure 1 shows results of arranging the MP on concentric circles. Picture 1 shows models of the MP and the foundation (8 MP at 45°, concentric circle). Table 1 shows the load strength when the quantity of settlement is 0.05 and when it is 0.1 that is near the yield time. It also shows this ratio for pile angles of 30° and 45° when the load strength at a vertical pile angle (0°) is assumed to equal 1.



Picture 1
Models of the MP and the foundation
(8 MP at 45°, concentric circle)

Figure 1 reveals that at all quantities of settlement from the initial quantity of settlement to that following yield, the load strength is greatest when the angle of the piles is vertical (0°). As the angle of the piles increases from vertical to 30° then to 45°, the load strength tends to decline and its percentage ranges from 45% to 72% of the load strength at the vertical (0°).

Figure 2 shows the results when the MP are arranged in a spiral pattern. The load strength when the angle of piles arranged in a spiral pattern is 0° and when it is 30° remains almost unchanged up to a quantity of settlement of 0.1.

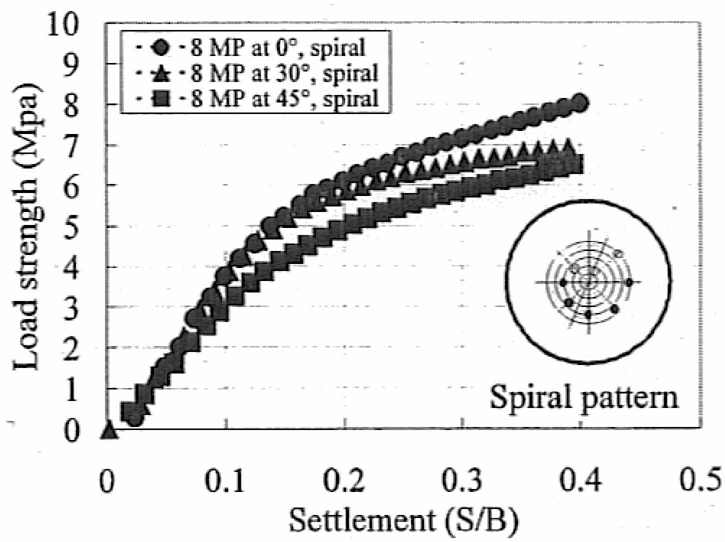


Fig.2 Load Strength – Quantity of Settlement (Spiral)

Table 1 Load Strength at Quantities of Settlement of 0.05 and 1.0

Pile Angle (°)	Load Strength [Mpa]							
	S/B=0.05				S/B=0.1			
	Concentric Circle	Ratio	Spiral	Ratio	Concentric Circle	Ratio	Spiral	Ratio
0	2.037	1.00	1.521	1.00	4.425	1.00	3.752	1.00
30	1.282	0.63	1.653	1.09	3.180	0.72	3.887	1.04
45	0.912	0.45	1.297	0.85	2.514	0.57	3.267	0.87

This is thought to occur because MP piles near the center of a round foundation act primarily to provide vertical support, but it will probably be necessary to perform further experiments to confirm this point. After a quantity of settlement of 0.1 that is assumed to be the yield time, as in the case of MP arranged in concentric circles, the greater the pile angle, the lower the load strength.

The above results indicate that regarding vertical bearing capacity, the closer the pile angle is to the vertical, the greater the load strength.

(2) Effects of the pile pattern

Table 1 compares the concentric circle MP pattern and the spiral MP pattern. In the vertical (0°) pile angle cases, the load strength of the concentric circle pattern is greater, but when the angle is 30° and 45°, inversely, the load strength of the spiral pattern is greater.

Figure 3 presents the coefficient of subgrade reaction – pile angle relationship. The vertical axis represents the value obtained by dividing the load strength by the quantity of settlement (= S/B), or in other words, the coefficient of subgrade reaction at the tangent, and the horizontal axis represents the pile angle. The figure plots the coefficient of subgrade reaction of quantities of settlement 0.05 and 0.1. This value is shown on Table 2.

Figure 3 and Table 2 show that a comparison of the coefficient of subgrade reaction of the concentric circle pattern with that of the spiral pattern. It reveals that the coefficient of subgrade reaction of the spiral pattern is greater for all pile angles and that the generation of strength during initial settlement is greater if the MP is arranged in a spiral pattern.

The above results reveal that excluding cases where the pile angle is vertical (0°), a spiral pattern provides greater vertical bearing capacity than a concentric circle pattern. This is so because in a spiral pattern, more MP are installed near the center of the cylindrical foundation than in a concentric circle pattern and this pattern provides greater vertical bearing capacity.

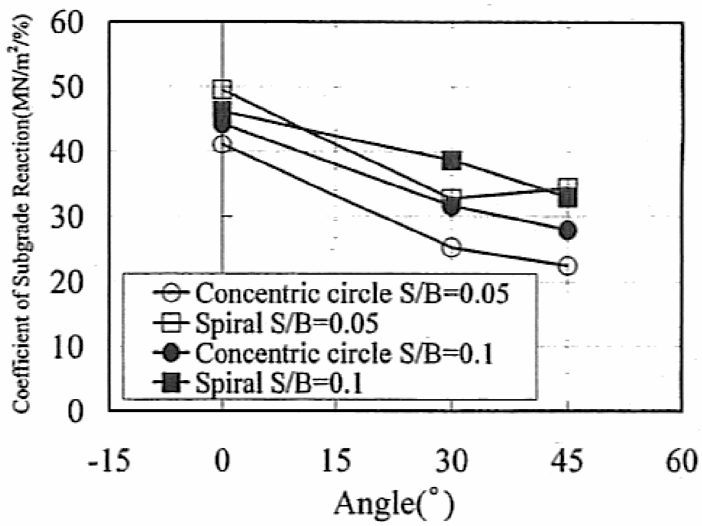


Fig.3 Coefficient of Subgrade Reaction - Angle

Table 2 Coefficient of Subgrade Reaction

Pile Angle (°)	Coefficient of Subgrade Reaction [MN/m²/%]			
	S/B=0.05		S/B=0.1	
	Concentric Circle	Spiral	Concentric Circle	Spiral
0	41.10	49.51	44.33	46.18
30	25.28	32.71	31.62	38.63
45	22.50	34.35	27.92	32.96

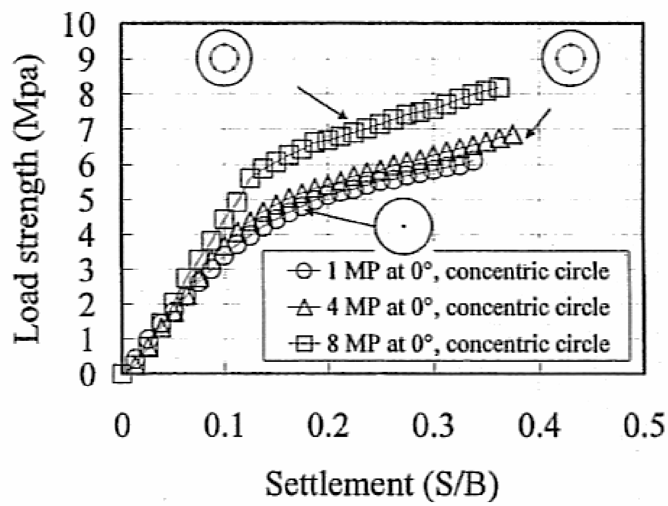


Fig.4 Coefficient of Subgrade Reaction - Angle

Table 3 Load Strength by Number of MP

Piles	Load Strength[Mpa]	
	S/B=0.05	S/B=0.1
1	0.000	0.000
4	0.000	0.000
8	2.037	4.425

(3) Comparison of the number of piles

Figure 4 shows the relationship of the load strength and quantity of settlement in cases where 1 MP, 4 MP, and 8 MP installed vertically (0°) in concentric circle patterns. Table 3 shows the load strengths at quantities of settlement of 0.05 and 0.1 by number of piles.

The figure and table reveal that the greater the number of piles, the greater the load strength. But at only 1 and at 4 piles, the difference is not particularly great.

3. Conclusions

This report presents the following findings obtained from this comparative study of the effects of the angle, arrangement, and numbers of MP.

[1] Regarding the installation angle of the MP, the closer the angle to vertical, the greater the load strength.

[2] Regarding the arrangement of the MP, when installed at an angle, they provide greater load strength in a spiral pattern. But the coefficient of subgrade reaction tends to be greater in a spiral pattern than a concentric circle pattern regardless of the angle of the piles.

[3] When the MP are vertical and arranged in a concentric circle pattern, the more piles installed, the greater the load strength.

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