TẠP CHÍ KHOA HỌC
TRƯỜNG ĐẠI HỌC QUY NHƠN

Nghiên cứu về ảnh hưởng của hàm lượng xi măng đến khả năng chịu lực của cọc xi măng đất để xử lý đất sét yếu ở khu đô thị sông Hà Thanh, thành phố Quy Nhơn, tỉnh Bình Định, Việt Nam

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TÓM TẮT

Trong thực tiễn hiện tại của các tòa nhà xây dựng được đặt trên đất mềm ở Việt Nam, công nghệ cọc xi măng được sử dụng ngày càng rộng rãi vì những lợi thế nổi bật của nó. Cọc đất xi măng là cọc được làm từ đất địa phương trộn với một lượng xi măng và phụ gia nhất định tùy thuộc vào đặc tính địa kỹ thuật của đất trong khu vực dự án. Mục đích chính của nghiên cứu này là xác định hàm lượng xi măng tối ưu cho cọc xi măng - đất. Nhiều yếu tố ảnh hưởng đến cường độ của cọc đất xi măng, trong đó hàm lượng xi măng được sử dụng đóng một vai trò quan trọng và cần được nghiên cứu cẩn thận. Nghiên cứu này nhằm mục đích cung cấp thông số hàm lượng cấp phối xi măng phù hợp cho các cọc đất xi măng được áp dụng cho các dự án xây dựng ở khu vực đất yếu của sông Hà Thanh, thành phố Quy Nhơn. Các mẫu được tạo ra bằng cách trộn đất với hàm lượng xi măng thay đổi từ 5% đến 25%. Nhóm tác giả tiến hành xác định ứng suất dọc trục của các mẫu cọc đất xi măng ở thời điểm 7 ngày tuổi và 28 ngày tuổi bằng thí nghiệm nén một trục nở hông. Kết quả cho thấy hàm lượng xi măng tối ưu cho cọc đất xi măng đạt được từ 12% đến 15% đối với đất sét yếu khu đô thị Hà Thanh, thành phố Quy Nhơn, tỉnh Bình Định.

Từ khóa: *Cọc xi măng - đất, sức chịu tải của cọc, đất yếu, xử lý nền đất yếu.*

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Research on influence of cement content on bearing capacity of soil-cement piles to treat soft clay in Ha Thanh river urban area, Quy Nhon city, Binh Dinh province, Vietnam

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ABSTRACT

In the current practice of building foundations placed on soft soil in Vietnam, cement-soil pile technology is increasingly widely used because of its outstanding advantages. Cement-soil pile is made from local soil mixed with a certain amount of cement and additives decided by the geotechnical characterization of the soil in the project area. The main purpose of this study is to propose the optimal cement content for cement-soil piles. Many factors affect thecompressive strength of cement-soil piles, in which the cement content used holds an important role and needs to be calculated. This study aims to provide appropriate cement gradation content parameters for cement-soil piles applied to construction projects in the soft soil area of Ha Thanh River, Quy Nhon City. In the paper, the samples were created by mixing soil with cement content varying from 5% to 25%. The authors determined the axial stress of soil-cement pile samples at 7 days old and 28 days old using the unconfined compressive test. The results show that the optimal cement content for cement-soil piles ranges from 12% to 15% for soft clay in the Ha Thanh urban area, Quy Nhon City, Binh Dinh province.

Keywords: *Soil-cement pile, bearing capacity, soft soil, soft soil treatment method.*

1. INTRODUCTION

Due to constant development of the society, the need for land to build housing and infrastructure projects is essential, especially land in the coastal and lagoon areas of Quy Nhon City, Binh Dinh province, and the construction of high-rise apartment buildings, ports, and roads on soft foundations is extremely urgent. In this research article, the soft soil treatment method will encounter more and more complex problems, thus creating opportunities for developing new soft soil foundation treatment technologies. Therefore, effective treatment of soft soil has become an essential problem in construction designs. Among them, the cement-soil pile method is widely used for industrial and civil buildings, docks, and highways.

In this study, the survey location was located at the An Phu Thinh social housing apartment building project at land lot B1 - 32, An Phu Thinh new urban area, location: Dong Da ward, Quy Nhon City, Binh Dinh province as shown in Figure 1. Soil stratification of the survey location is illustrated in Figure 1.

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In the survey area, the soft clay layer has a relatively large thickness. The foundation of the construction is placed on this ground which is required to treat the soft clays or choose the deep foundation. However, choosing a deep foundation for low-rise buildings is not reasonable. Therefore, the authors recommend that the soft soil treatment method is the cement-soil pile, which increases the bearing capacity of the ground and solves the cost of the foundation for the project.

Thus, we conducted experiments to determine the cement content to optimize the grade for soil cement piles. Based on the results of this research, construction engineers can choose the optimal cement content as recommended by the study to manufacture soil-cement piles. Then, the soil-cement piles are statically compressed at the building site to determine the load capacity that is applied in the design ground consolidation.

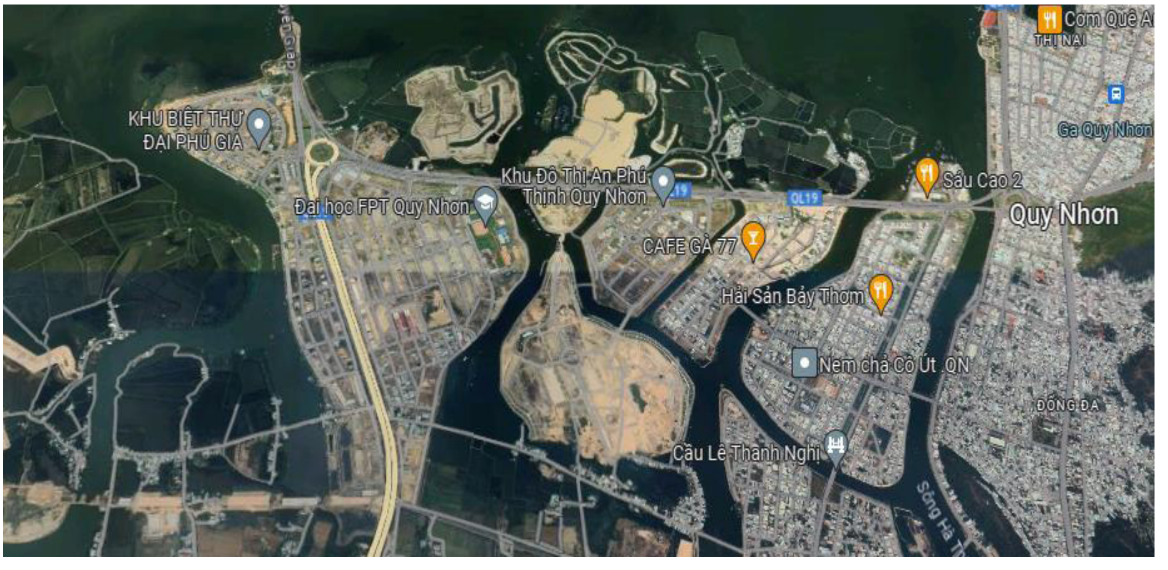

Figure 1. Location of the An Phu Thinh social housing apartment building project.

2. METHODOLOGY

2.1. Geological structural conditions in the survey area

The survey area has relatively flat terrain because it has been partially leveled with river bottom materials. Regarding geomorphology, the area belongs to agglomeration morphology, the geological formations are river and lake sediments with many types of heterogeneous materials. The soil and water samples were brought in the laboratory to determine physical and mechanical criteria.[1] The geotechnical characteristics of the soft clays are shown in Table 1.

Table 1. Geotechnical parameters of soft clays in the survey area.

Depth(m)	**Sample test**	**Description**							**SPT (N-Value)**
10-52m	Soft clay	Soft, blue-gray, dark gray, organic content of 13.1%, low plasticity							<3
Mechanical consistency of soft clay									
γ	c	ϕ	G_s	W	W_L	W_P	I_P	I_L	e_0
kN/m^3	kN/m^2	^{0}		%	%	%			
16.3	27.01	7	2.72	69.9	40.9	22.4	63.3	1.28	1.843

2.2. Stabilization of soft soil - The soil cement column method (TCVN 9403:2012)

In this study, the group of authors used the dry mixing method to cast sample tests. The process includes mechanically loosening the soil in the field and mixing dry cement powder with soil with or without additives. The method of creating soil-cement samples conducted following TCVN 9403:2012. Water and cement in the required amount were mixed manually until there was obtained homogeneous state of "laitance". The amount of cement is determined by the weight ratio of dry soil. After that, the cement mortar was mixed with soil which is specific humidity. The obtained mixture was mixed to a homogeneous mass over 5 minutes in cylinders with dimensions h = 100 mm and d = 50 mm. The samples were pulled from the blocks on the second day and they were retained period till the test when 7 days and 28 days.[2,3] The parameters of test samples are presented in Table 2.

Table 2. Parameters of test samples in the axial load test.

Number	Sample group	Number of samples	Weight of samples		Size of samples	
			Cement Phuc Son PCB40(g)	Soil (g)	Height (mm)	Diameter (mm)
1	5%	6	74.23	1814.27	100	50
2	8%	6	118.77			
3	10%	6	148.47			
4	12%	6	178.16			
5	15%	6	222.70			
6	18%	6	267.24			
7	20%	6	296.93			
8	25%	6	371.17			

2.3. Axial load test

This test method is used to determine the unconfined compressive strength of cohesive soil in the undisturbed, remolded, or compacted condition by using strain-controlled application of the axial load based on ASTM D2166 standards. The equipment used in the unconfined compressive test is the Triplex II advanced as shown in Figure 2. In this standard, the unconfined compressive strength (q_u) is extracted as the maximum load attained per unit area or the load per unit area at 20% axial strain.[1]

$$q_u = \sigma_1 - \sigma_3 \quad (1)$$

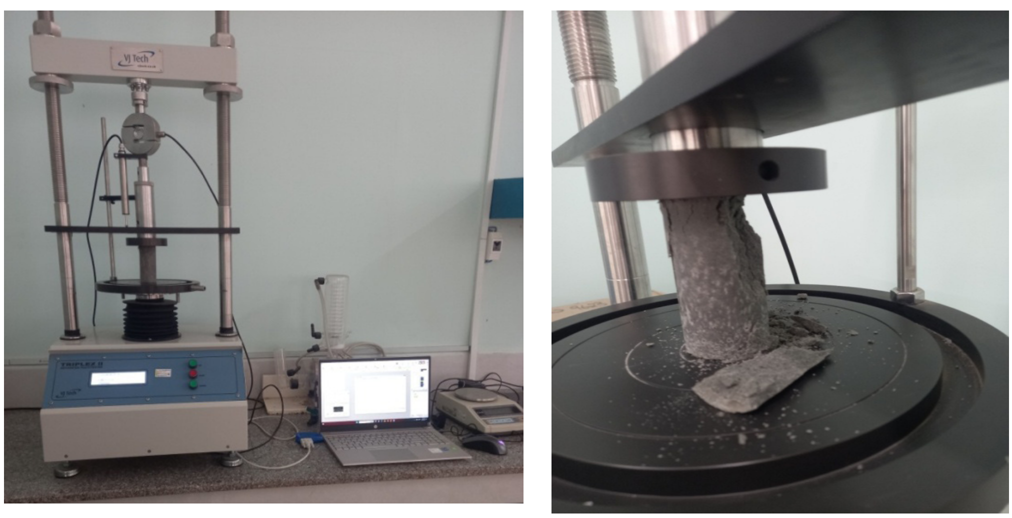

Figure 2. The Triplex II advanced and form of cement-soil piles damage.

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3. RESULTS AND DISCUSSION

The cement-soil strength is increasing over time. As the cement content of the cement-soil pile increases, the unconfined compressive strength increases as shown in Figure 3.[3-5]

When the cement content increased from 5% to 8%, the compressive strength of samples at 28 days increased from 249.5 Mpa to 842.3 Mpa. The percentage increase of the compressive strength is 238% as shown in Figure 4.

When the cement content increased from 8% to 10%, the compressive strength of samples at 28 days increased from 842.3 Mpa to 961.3 Mpa. The percentage increase of the compressive strength is 14% as shown in Figure 4.

When the cement content increased from 10% to 12%, the compressive strength of samples at 28 days jumped from 961.3 Mpa to 1632.4 Mpa. The percentage increase of the compressive strength is 14%. Similarly, the percentage increase of the compressive strength is 99% when the cement content increased from 12% to 15%as shown in Figure 4.[6]

When the cement content of the samples increases from 12% to 15%, the compressive strength of cement-soil plies increases from 70% to 99%. However, when the cement content is greater than 15% the compressive strength of samples at 28 days decreased significantly, as presented in Figure 4.

When the cement content of the sample increases from 15% to 20%, the increase in axial compressive strength of the cement-soil pile decreases from 99% to 15% as presented in Figure 4.[7,8]

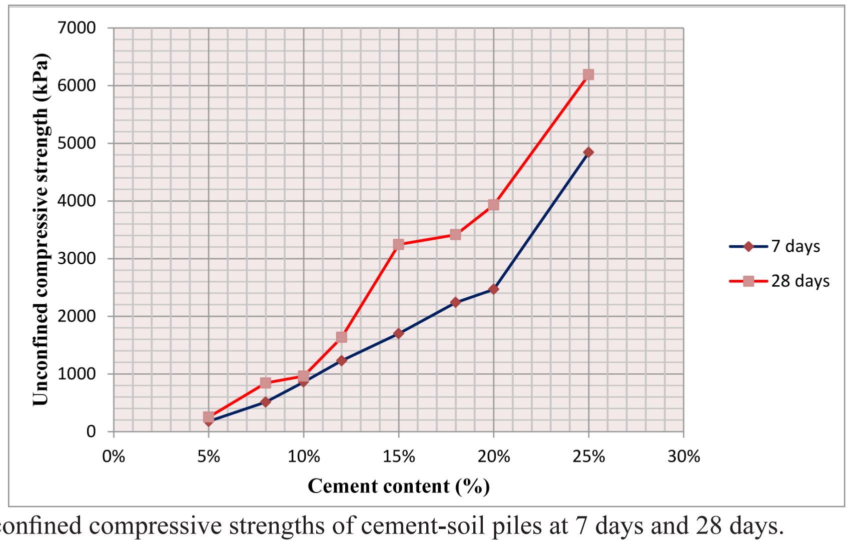

Figure 3. The unconfined compressive strengths of cement-soil piles at 7 days and 28 days.

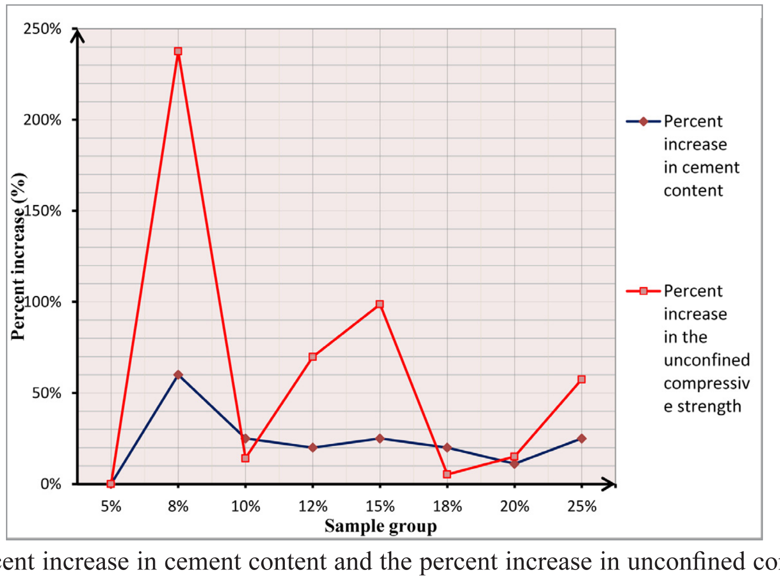

Figure 4. The percent increase in cement content and the percent increase in unconfined compressive strength of the sample groups.

4. CONCLUSIONS

The unconfined compressive strengths of cement-soil piles increase rapidly when cement content increases from 12% to 15% as presented in Figure 4.

The cement content increases or decreases depending on the moisture content of the soil. The authors also proposed the optimal cement content percentages of 10% and 18% for cement-soil piles in the Mekong delta area.

Therefore, the authors suggested reasonable cement content for soft clay in the Ha Thanh River urban area, Quy Nhon City is from 12% to 15%. So the content of cement has a great influence on the unconfined compressive strength of cement-soil piles.

In the geographical area of the study, based on the experimental results regarding the cement content for soil-cement pile specimens as mentioned above, the group of authors proposes an optimal cement content ratio for soil-cement piles ranging from 12% to 15%. The research recommends that design engineers may use a cement content for soil-cement piles from 12% to 15% to manufacture soil-cement piles and conduct static compression tests on-site in the research area for application in design problems.

The cement-soil pile method is proposed to treat soft clay for 4 to 8-storey buildings, located in the Ha Thanh River urban area, Quy Nhon City.

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