Stabilization of Ariake clay treated by cement and slag

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I INTRODUCTION

Chemical stabilization is one of the soft ground improvement methods that are successfully applied to soft clay. Lime and cement are effective admixtures that are normally applied to improve engineering properties of soft clay. In some cases the lime fails to stabilize soft clay and the application of cement is also uneconomic to achieve the strength requirement (Thompson, 1966). The applications of waste material as fly ash and foaming glass mixed with lime are more suitable for stabilization because of economical and environmental considerations (Onitsuka and Shen, 2000). From this concept it merits applying cement or lime with waste material, called the replacement concept. The content of waste material must be investigated to obtain the content that can replace the cement or lime content. The application of cement or lime with waste materials is not a new area. But in the case of the non-active clay (the clay is unsuccessfully stabilized by lime and cement), it is very interesting to investigate that it is possible or not to stabilize this clay by cement or lime with waste materials. Then this study focuses on investigating the strength development of cement with slag stabilized non-active clay.

II EXPERIMENTAL INVESTIGATION

Ariake clay used in this study was obtained from Ashikari, Saga prefecture. The clay was sampled from 1.0 m depth from the bottom of the creek. Properties of the soft clay sample were showed in Table 1. Blast furnace slag was obtained from Arita. Density and specific area are 2.91 g/cm^3 and 4350 cm^2/g, respectively. Cement and slag was applied for stabilization. To investigate the strength development of cement and cement-slag stabilized clay, the soft clay at the initial water content of about 185% was mixed with 10% cement and slag contents of 5, 10, 15 and 20% by weight of dry soil. And cement content of 15% plus slag contents of 5, 10 and 15% were applied. The specimens are 50 mm diameter and 100 mm height. They were cured at temperature about 20 ^{o}C and humidity 90%. The unconfined compression tests were carried out after the curing periods of 7, 14 and 28 days.

Table 1. Properties of soil

Water content, %	Liquid limit, %	Plasticity index	pH	Organic matter, %	Particle size distribution, %		
					Sand	Silt	Clay
185	143	89	6	1	3	52	45

III RESULTS AND DISCUSSIONS

From the previous work this clay fails to be stabilized by lime. The strength of 20% lime stabilized clay is 5 kPa at curing time 28 days because the sulphide in the clay sample obstructs the pozzolanic reaction that was reported by Onitsuka and Chirdchanin, 2001. And the strength of cement stabilized is also low. Thus the clay is called "non-active clay." Fig. 1 shows that unconfined compressive strength, q_u of cement stabilized soft clay increases with the cement contents and curing time. The strength development of cement-stabilized clay at 7 to 14 days is faster than 14 to 28 days because the strength of cement stabilized clay mainly is achieved by forming of cemented materials that is induced at initial stage. It is quite different from lime-stabilized clay because it derives from pozzolanic reaction that is a kind of slow reaction. Fig.2 and 3 show the strength development of stabilized clays that were mixed with 10 and 15 % cements, respectively and then were mixed with various slag contents to investigate the influence of slag. The results show that the strengths of stabilized clay increase with slag contents. Because the addition of slag increases Calcium (Ca), Alumina (Al) and Silica (Si) that induced to increase the pozzolanic reaction in stabilized clay.

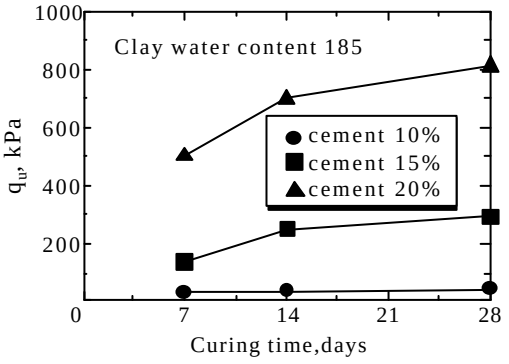

Fig.1 Strength of cement-stabilized clay

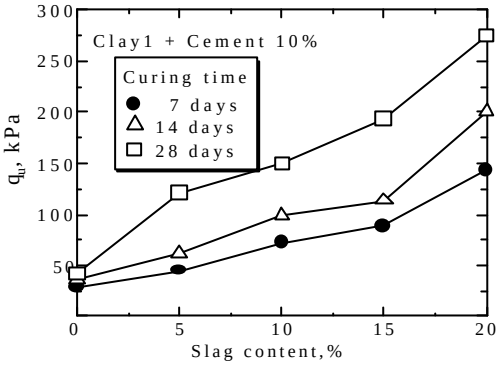

Fig.2 Strength of 10% cement and various slag contents stabilized clay

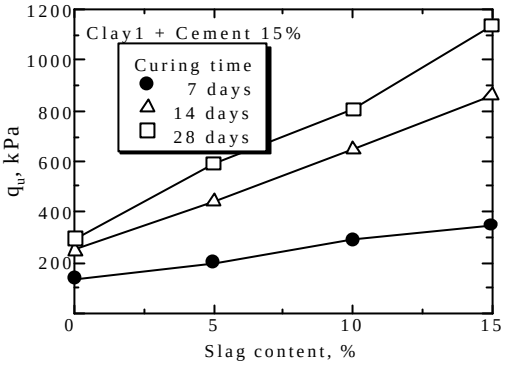

Fig.3 Strength of 15% cement and various slag contents stabilized clay

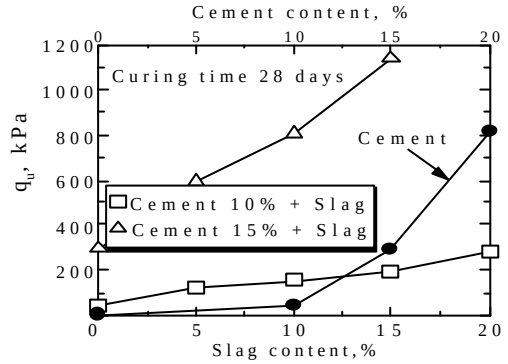

Fig.4 Strength of cement and cement-slag stabilized clay

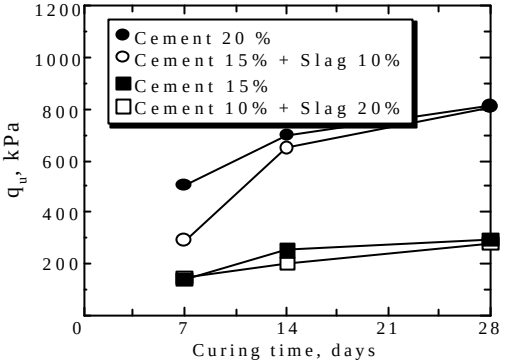

Fig.5 Strength of cement and cement-slag stabilized clay

Fig.4 plots the strengths of Ariake clay stabilized by cement alone, 10% cement plus various slag contents and 15% cement plus various slag contents at 28 days of curing time to investigate replacement characteristic of slag. The results show that the 15% cement content can be replaced by 10% cement with 20% slag and 20% cement can be replaced by 15% cement with 10% slag. These mean the 20% and 10% slags can replace 5% cement. The strength of cement-slag stabilized clay depends on cement content because cement contains the chemicals that induce cemented materials and Calcium reacts with the Al and Si in slag. Fig.5 shows that the strength of cement stabilized clay is higher than these of cement-slag stabilized clay at initial state as 7 to 14 days but at 28 days of curing, both strengths are the same. That shows the strength development of cement-slag stabilized clay is initially slower than cement stabilized clay because the strength of cement-slag stabilized clay is induced by pozzolanic reaction. It is clearly shown that cement-slag can replace cement to stabilize soft clay. The lime fails to stabilize non-active clay because the Al and Si in the clay cannot be dissolved and the pozzolanic reaction cannot occur then the cemented materials are not produced. In the case of cement stabilized non-active clay, the strength obtains from cemented material in cement and strength of stabilized clay still low because the pozzolanic reaction also cannot occur. The advantages of addition of slag in cement for stabilized clay are decrease water content in clay and increase Al, Si and Calcium in stabilized clay. Then the pozzolanic reaction can be formed.

IV CONCLUSIONS

From the study, it is possible to stabilize non-active clay by cement with slag. The test results clearly show that the slag is successful to replace cement for stabilized soft clay. The 20% cement can be replaced by 15% cement mixed with 10% slag. The strength development of cement-slag is slower than cement because the strength of cement-slag is induced by pozzolanic reaction. The addition of slag in clay decreases water content and increases Al, Si and Ca that are the main reasons of the strength increase.

V REFERENCES

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