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INVESTIGATION OF CALCINATION EFFECT WITH USING WHITE BAYBURT STONE IN SOIL STABILIZATION

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Abstract: *A significant component that makes up civil engineering is structural safety. The safety of the structure depends on the bearing capacity of the soil. The soil may lose its bearing capacity for various reasons. Great numbers of methods have been developed to improve the bearing capacity of the soil. One of these is chemical stabilization by adding different additives to the soil. In this study, the effect of calcination in soil improvement was investigated. White Bayburt Stone, reserved in the Bayburt province of Turkey, was used in its natural state and as white Bayburt Stone calcined at 800 degrees. At rates of 5%, 10%, 15%, and 20%, all kinds of additives were added to the soil, and their influence on the unconfined compressive strength was examined. Curing time of the samples was 7 days. The calcined additive material increased the compressive strength significantly at all ratios. While samples containing 20% White Bayburt Stone showed a 262% increase in strength compared to the natural soil, a 458% increase was detected in samples containing 15% calcined White Bayburt Stone compared to the untreated soil.*

Keywords: *Soil stabilization, calsination, unconfined compressive strength, white Bayburt Stone*

1. INTRODUCTION

Soil is a material of different sizes formed as a result of mechanical or chemical weathering of rocks. Soil deforms due to both natural causes and loads applied on it. Stabilisation techniques have been developed to improve the deformed properties of the soil. There are many studies on soil stabilisation in the literature. When these studies are examined, [1] classifies soil stabilisation into two groups as mechanical and chemical improvement in general, while [2] classifies soil stabilisation as deep stabilisation types and superficial stabilisation types. Figure 1. shows the soil stabilisation methods.

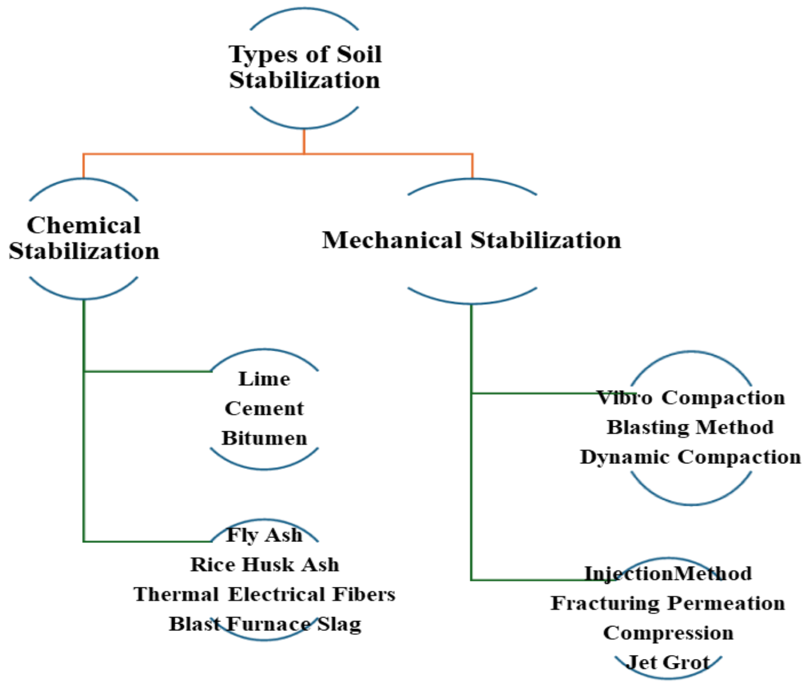

Figure 1. Types of Soil Stabilization Lambe (1979)

Calcination process; It is the process of activating the materials by subjecting them to heat treatment at temperatures of 800 °C -1200 °C. In the studies carried out, it has been determined that the temperature at which the reaction will be carried out in the calcination process is an important parameter. [3] examined the effect of calcination on phosphate material. As a result of the study, it was determined that the chemical structure of phosphate deteriorated when the calcination temperature was increased to 700°C-710°C.[4] In this study, in order to investigate the usability of volcanic tuff, he produced light geopolymer by using two different tuffs and calcined types of these tuffs from waste in the production of geopolymer composites.

It is clearly seen in the studies that the engineering properties of the soil can be improved by adding additives. It has been determined that the use of perlite and lime, which are pozzolanic additives in clay soil stabilisation, improves soil properties.[5]

In this study, the effect of different ratios of lime and pozzolan on soil stabilisation was investigated. As a result of the study, it was observed that the PI value decreased and the strength increased as the pozzolan ratio increased in the use of lime and natural pozzolan together.[6] He tested the specimens formed with the combination of different proportions of cement (2.5%, 5%, 10%) and different proportions of basalt fibres (1%, 2%, 3%, 4%) in the stabilisation of sand soil and the maximum compressive strength was reached in the specimens formed with 10% cement and 4% basalt fibre combination.[7]

One of the materials used in soil improvement is Bayburt stone, which is a natural pozzolan. Bayburt stone is the main underground source of Bayburt province of Turkey. Bayburt stone is found in three types: yellow, green and white. When the studies in literature on the effect of Bayburt stone on soil stabilisation are examined, it is determined that the use of Bayburt stone improves the durability properties of the soil [8]. He examined the effect of grain size of green Bayburt stone on low plasticity soil and concluded that it increased the compressive strength. [9].

2. METHODOLOGY

The soil sample used in the experimental study was obtained from the province of Erzurum, Turkey. The natural soil brought to the laboratory environment was kept in an oven at 104±5°C (ASTM D 422) for 24 hours before being used in experimental studies. To determine the engineering properties of the natural soil, Atterberg's consistency limits (ASTM D 4318), standard compaction test (ASTM D698), and specific gravity (ASTM D 854) tests were conducted. The data obtained from the experiment are shown in Table 1. According to the combined soil classification, the soil class has been determined as highly plastic clay soil.The engineering parameters of the natural soil are shown in Table 1.

Engineering Property	***Value***
Liquid limit	*65,9 (%)*
Plastic limit	*41,63 (%)*
Plasticity index	*24,2*
Dry unit volume weight	*11,87 (kN/m³)*
Optimum water content	*23,75 (%)*
Specific gravity	*2,75*
Soil class	*CH*

Table 1 Clay soil characteristics

The white Bayburt stone is sourced from the Bayburt province of Turkey. Bayburt stone is found in three colors: white, green, and yellow. The differences observed in Bayburt stones are clearly visible not only physically but also mineralogically and chemically. Table 2 shows the chemical components of the white Bayburt stone.

The calcination process was carried out in the experimental equipment in the laboratory of the engineering faculty of Bayburt University. The white Bayburt stone waste was obtained by holding it at 800 °C for 3 hours and cooling it suddenly.

According to the determined optimum water content additives were added to the natural soil in proportions of 5%, 10%, 15%, and 20% to produce samples (Figure 1). Table 3 shows the optimum water contents for the additive ratios. The samples were produced using the Harvard sample preparation device. The sample dimensions are 36x72 mm. A total of 27 samples were produced, with 3 samples for each mixture ratio. The samples were covered with stretch film and left for 7 days. At the end of the 7-day curing period, a free pressure test (ASTM D 2160) was conducted. As a result of the experiment, the effect of the additives on the compressive strength of the soil was examined.

Property	***Value (%)***
Total SiO_2	*69,96*
Al_2O_3	*12,25*
Fe2O3	*0,33*
CaO	*2,52*
MgO	*1,2*
SO_3	*0,05*
K2O	*2,43*
Na2O	*0,57*
Glow Loss	*10,08*
Cl	*0,0280*

Table 2 Chemical Properties of White Bayburt Stone

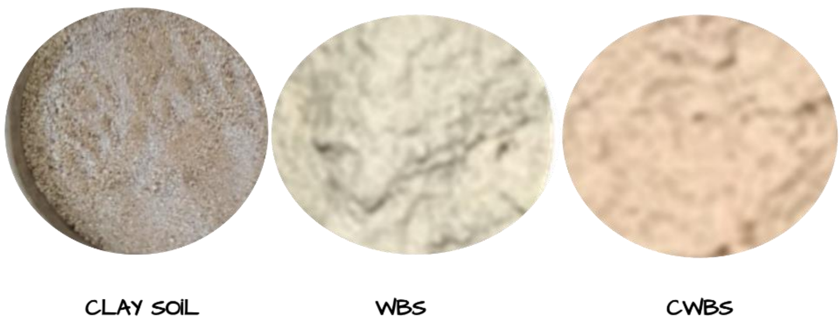

Figure 1 Types of natural soil and additive

Additive Type	***Optimum Water Content (%)***
Clay soil	*23,8*
WBS 5	*23,3*
WBS 10	*23*
WBS 15	*22,5*
WBS 20	*22,5*
CWBS 5	*23,3*
CWBS 10	*23*
CWBS 15	*22,5*
CWBS 20	*22,5*

Table 3 Types of additives optimum water content

3. CONCLUSIONS AND SUGGESTIONS

At the end of the 7-day curing period, when the effect of white and calcined white Bayburt stones on compressive strength was examined, both additives increased the compressive strength compared to the natural soil (Figure 2). Compared to the natural soil, white Bayburt stone showed increases of 2.17, 2.06, 2.16, and 2.67 times at 5%, 10%, 15%, and 20% addition rates, respectively, while calcined white Bayburt stone showed increases of 4.41, 4.45, 4.58, and 4.22 times, respectively. The calcined material showed increases of 2.03, 2.16, 2.11, and 1.61 times, respectively, compared to the non-calcined material at the same additive ratios. As a result of the study, the effect of the calcinated additive material on the compressive strength in soil stabilization was clearly observed.

Addıtıve Type	**Value (kPa)**
Clay	124,8
WBS 5	271,72
WBS 10	256,58
WBS 15	270,62
WBS 20	327,36
CWBS 5	554,26
CWBS 10	556,18
CWBS 15	572,66
CWBS 20	527,376

Table 4 UCS Results at the of WBS and CWBS 7-Day Cure Period (kPa)

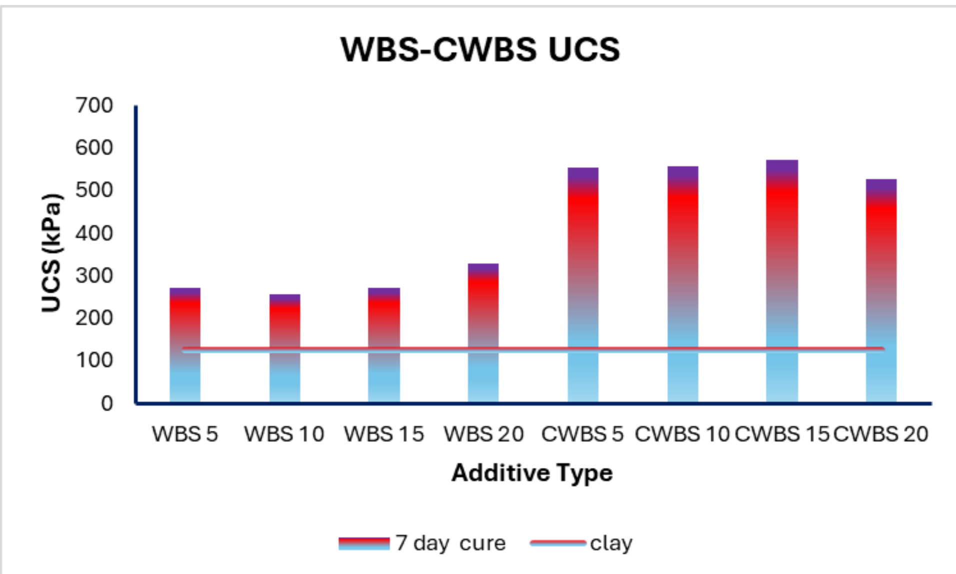

Figure 2. UCS Results at the of WBS and CWBS 7-Day Cure Period (kPa)

In addition to these results, the behavior of different additive materials after calcination should be examined to clearly investigate the effect of calcination. Experimental studies should be conducted at different curing durations and additive ratios.To determine the effect of calcination on soil improvement, a free compressive strength test was conducted in the study. The number of tests should be increased to investigate its impact on strength and durability. The cost and environmental impact of the calcination process have not been examined in this study; research should be conducted on this topic.

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