Parametric study on the behavior of bagasse ash–calcium carbide residue stabilized soil

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PREVIOUS RESEARCH

- Soil stabilization with lime, cement, fly ash, bagasse ash, rice husk ash, and combination of fly ash-cement, bagasse ash–lime, rice husk ash-lime have been investigated .
- The effect of the combination of bagasse ash–calcium carbide residue on the shear strength of expansive soil has been performed
- Research concerning fly ash and lime for soil improvement has been conducted.
- The physical and chemical performance of both short term and long term reactions related in soil-lime-fly ash mixtures have been written on the literatures.

The previous studies have discussed the effects of temperature and curing period, proportion of lime and fly ash, on the behavior of stabilized soil. **However, they were performed without considering the effects of compaction parameters (on the shear behavior of stabilized soil. maximum dry density and optimum moisture content)**

PURPOSE OF STUDY

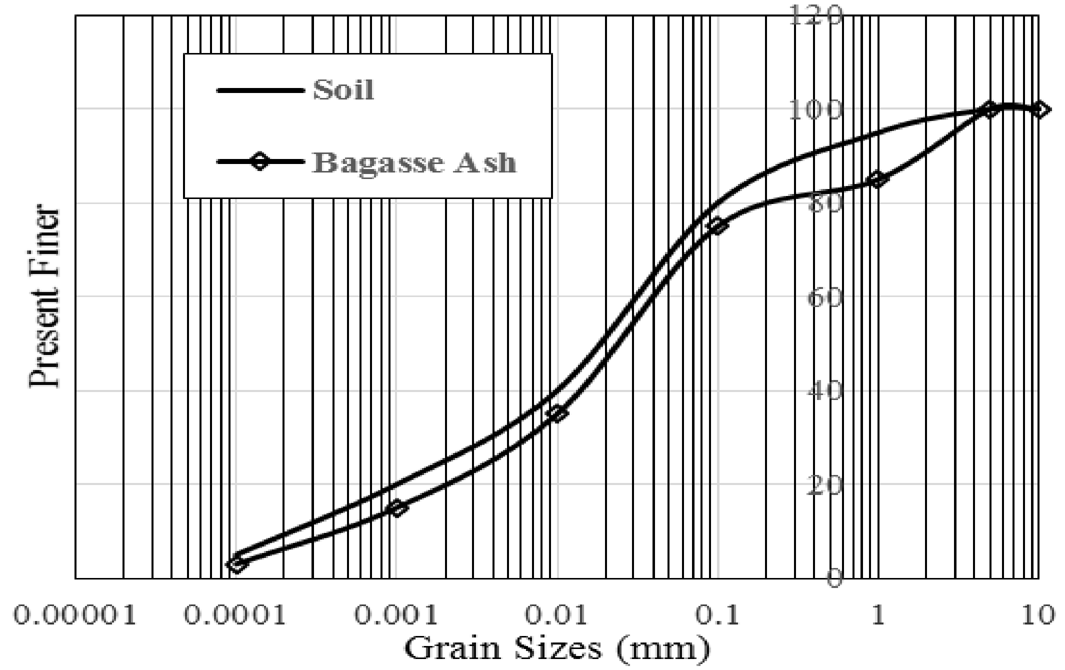
To investigate the effect of compaction parameters : maximum dry density(MDD), optimum water content (OMC), and curing period of Bagasse Ash-Calcium Carbide Residue Stabilized Soil

RESEARCH METHODS

Materials

The Soil sample is low cohesion-high plasticity red clay. According **to USCS**, the soil is classified **as high plasticity clay (CH).** The specific gravity :2.68. The gradation **>75% is silt and clay** (d < 0.075), 5% is fine sand (0.075 < d < 0.46 mm), 15% is medium sand (0.46 < d < 1.06 mm), is 10% coarse sand (1.06 < d < 4.75 mm), and less than 5% is gravel. The liquid limit and plastic limit of soil sample are **66.5%, and 32.3% .**

The bagasse ash is non-cohesive fine residue and classified as non-hazardous, non-plastic waste material. The specific gravity is 2.05 .The grain size distribution :1.5% is clay size, 72.9% is silt, 17.9% is fine sand and the rest is medium sand (Fig.1). The chemical content : **51% SiO_2, 17.4% Al_2O_3, 4.9% Fe_2O_3,** 6.3% CaO, 1.4% MgO, 0%, SO_3, 2.3% K_2O, 2.6% Na_2O, 2.1% H_2O, and 1.8% Lost of ignition (LI).



Calcium carbide residue : 0.34 % SiO_2, 2.21 % Al_2O_3, 0.97 % Fe_2O_3, **60.2 % CaO**, 0.15% MgO , 0.11% SO_3, 1.46% K_2O ,0.08% Na_2O , and 1.4% H_2O.

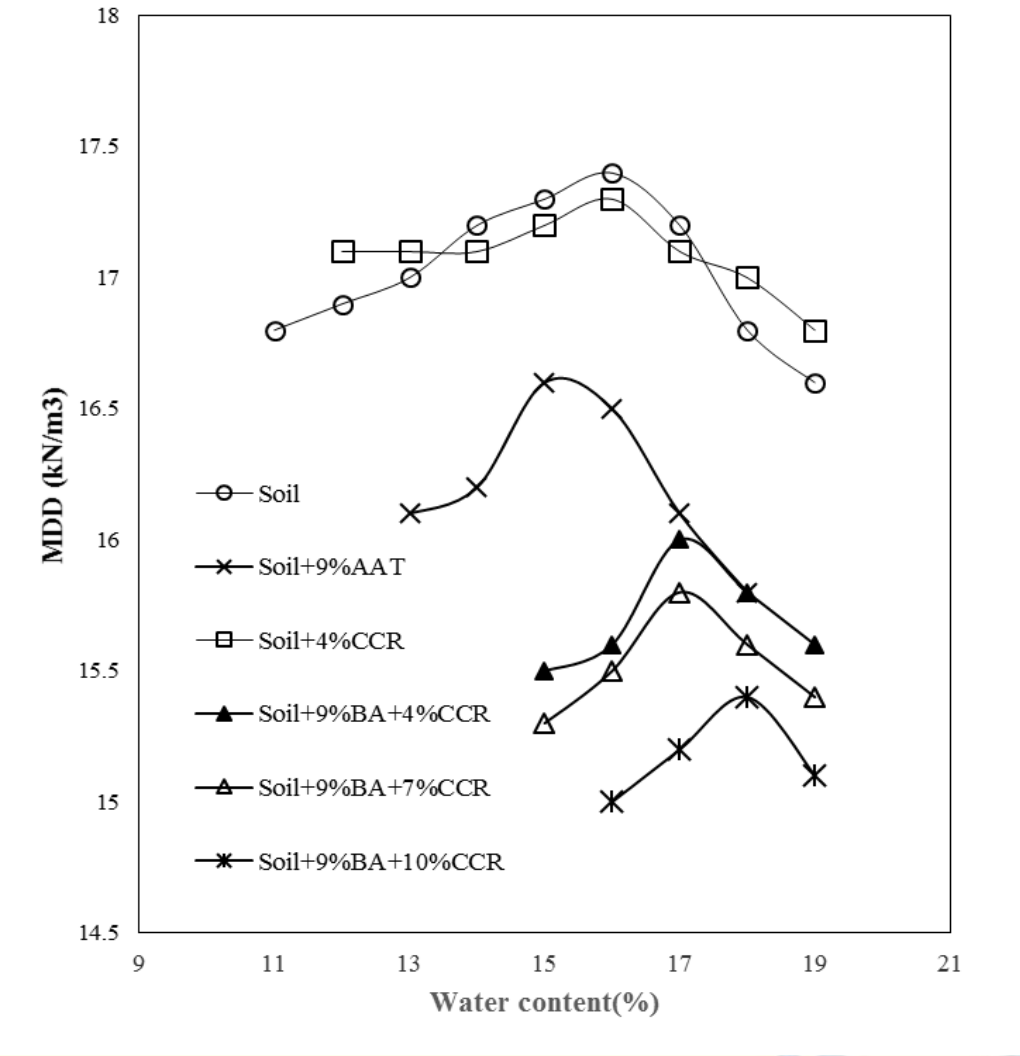
Experimental program

Lime fixation point (LFP)

The proportion of calcium carbide used in this study is **2**% (w_P = 21%), 4%(w_P = 23.5%), 6%(w_P = 23.3%), 8%(w_P = 23.1%), and 10%(w_P = 23%), therefore LFP was found **4%**. In some practical assumptions, the added proportion of calcium carbide is LFP + (3 to 6%). In this study, it was used **4%, 7%, and 10%** calcium carbide. Whereas the percentage of bagasse ash used was 9%.

Compaction

In general, all samples used in this study were prepared at (MDD) and (OMC) obtained from standard Proctor compaction tests as indicated in Fig. 2. The effects of MDD and OMC on the shear behavior of calcium carbide-fly ash stabilized soil were also analyzed. In this study, soil samples were also prepared on the water content more than and less than their optimum moisture content. It is indicated that the addition of bagasse ash to the soil resulted in the decrease of the OMC and reduction of MDD compared to those of original soil.



18
17.5
17
16.5
16
15.5
15
14.5
MDD (kN/m3)
9
11
13
15
17
19
21
Water content(%)
Soil
Soil+9%AAT
Soil+4%CCR
Soil+9%BA+4%CCR
Soil+9%BA+7%CCR
Soil+9%BA+10%CCR

Unconfined compression and split tensile tests

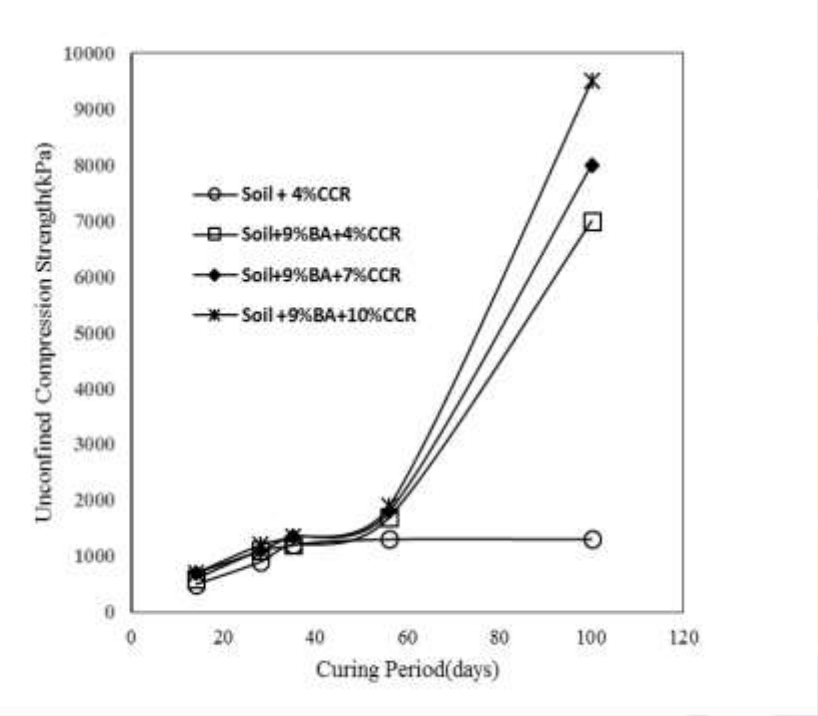
The specimens were compacted into a cylindrical mold in the condition of MDD and OMC. The dimension is 38 mm diameter and 76 mm high. Then the sample were wrapped in polybag and stored in humid chamber. The curing times were: 7, 14, 28, 36, 56 and 100 days.

Traxial test

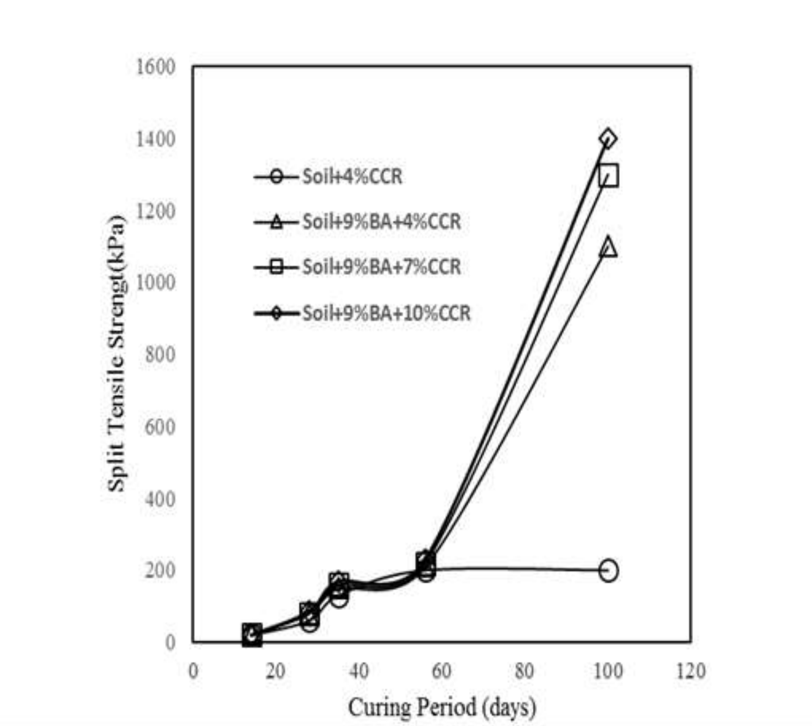
The dimension : 38 mm diameter and 76 mm high. All specimens were molded on their MDD and OMC. Confining pressures : 20, 50, and 100 kPa that are inherent with practical conditions in engineering applications. The only curing time was **28** days

RESULTS and DISCUSSION

Unconfined compression and split tensile tests



The effect of curing period on unconfined compression strength.



The effect of curing time on split tensile strength

Short curing period does not show improvement ---cation exchange reaction. ---Ca^{++} in calcium carbide replaces the position of Na^{+} and K^{+} in the soil ---reduces the plasticity index--- does not change the shear stress parameters of stabilized soil.

Long curing period, after 60 days---significant improvement of both unconfined compression and split tensile strength of stabilized soil due to chemical pozzolanic reaction between bagasse ash–soil and lime in calcium carbide. The formation of calcium silicate hydrate (C-S-H) that is the first stage of pozzolanic reaction takes place after 36 days curing time.

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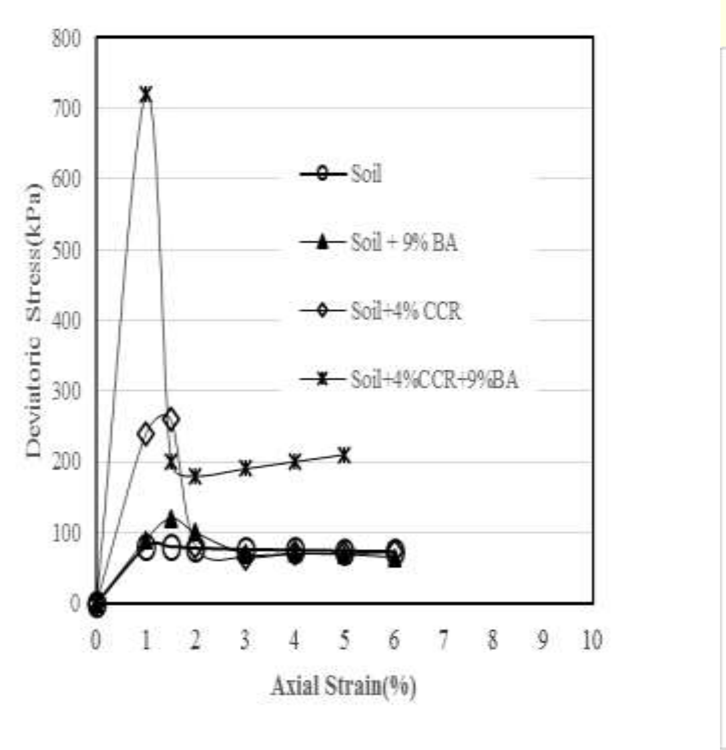
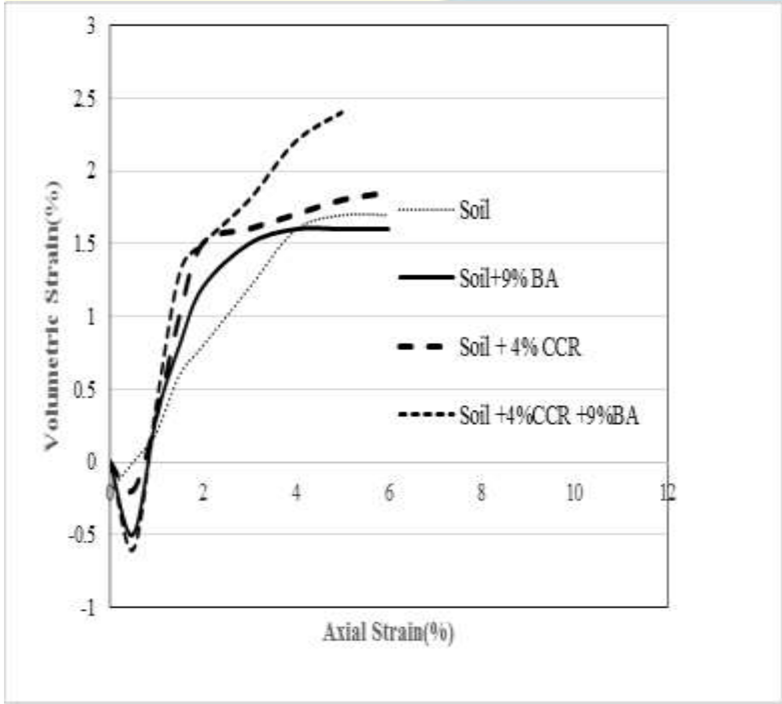
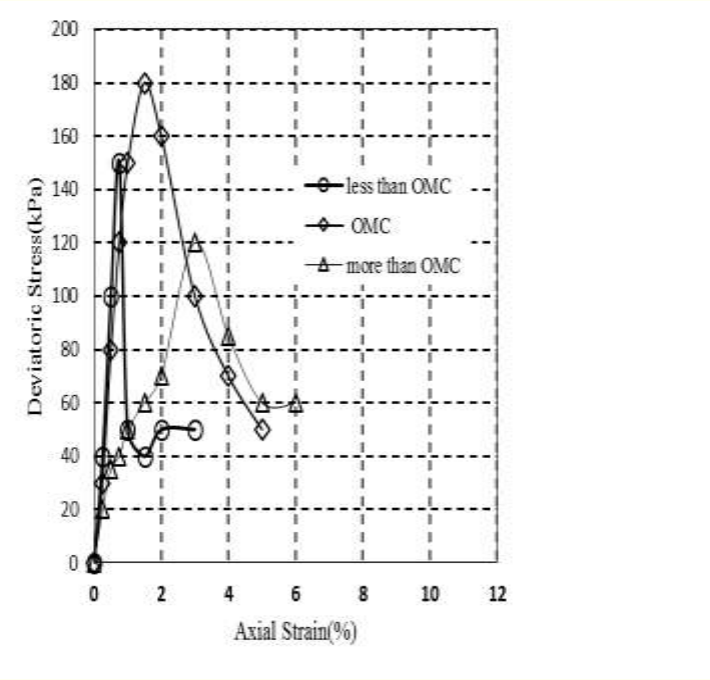
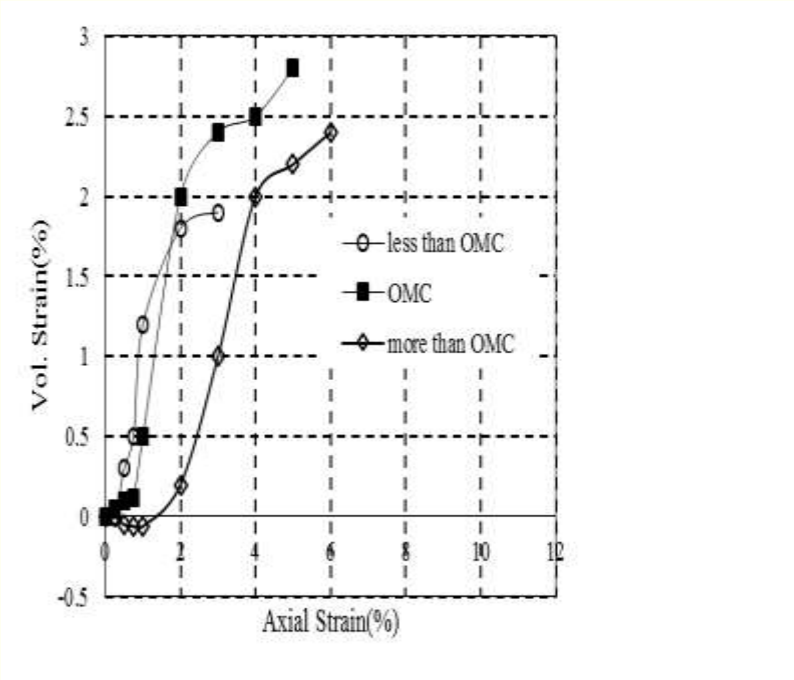
Triaxial Test





strain response and volumetric-axial strain of compacted stabilized soil : 20 kPa Confined Pressure and 28 days curing time.





Axial strain response for compacted samples without curing time

Volumetric-Axial strain for compacted samples without curing time

Conclusions

1. The addition of calcium carbide residue significantly increased the shear strength and stiffness of calcium carbide- stabilized soil.
2. The addition of bagasse ash on calcium carbide soil was required to meet the short term and long term pozzolanic reaction.
3. Curing time, curing temperature and compaction parameters significantly influence of stress strain behavior of carbide lime-bagasse ash stabilized soil.
4. The unconfined compression and split tensile strength of calcium carbide bagasse ash stabilized soil were significantly improved on 56 days curing time that may due to long term pozzolanic reaction.
5. Based on three-axial compression test, the maximum stiffness and shear strength of carbide lime bagasse ash soil mixtures occurred on stabilized soil specimens compacted on their optimum water content. After 28 days curing time, however, improvement of stiffness and shear strength happen on stabilized soil samples compacted on less than their optimum water content.