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Investigation on Kiln dust- Bentonite Composite Behavior

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ABSTRACT

This study investigates effect of addition of Kiln dust and fiber on shear behavior of the bentonite clay. To do so, a series of direct shear tests were defined and were tested on the composite materials. A constant value of 2% for fiber, and 5, 10, and 15% kiln dust (KD) was mixed with bentonite clay and the optimum moisture content (OMC) and the maximum dry density (MDD) was recorded at the first stage. In the second stage, specimens were prepared according to the acquired parameters in the compaction testing and the test conducted under three normal stress of 100, 150, and 200 kPa. The results showed that increasing the kiln dust improved shear behavior of the bentonite clay.

Key Words: Direct Shear; Clay; Fiber; Kiln Dust

1. INTRODUCTION

Soil behavior in many ways being investigated such as [1, 2]. Bentonite and clayey materials investigated in terms of their characteristic [3]. Soil stabilization using additives is a common practice in geotechnical engineering. Previous studies showed that application of fiber [4-13], fly ash [14-16], slag [17], and sawdust [18] in conjunction with different geomaterials. These studies conducted on various soil mechanical behavior such as unconfined compressive strength (UCS) [19-20], liquefaction [21-22], tire and waste [23-27] shear strength [28-30], consolidation, permeability [31-32]. While the applications of kiln dust (KD) were evident in literature [33-40], the review of the previous studies showed that no studies conducted to investigate shear behavior of the soil composite of kiln dust (KD) and fiber when mixed with clay. Fabric of soil is an important factor in stress concept [41-46] and therefore bentonite due its complex nature requires more attention. This work is continuation of previous works on fibers example [4-6,10,11,13] and waste and byproduct application in Curtin university example [14, 17,18, ,26-27]. Direct shear test is a basic but important to investigate shearing behavior of the composites in experimental geomechanics. Different normal loading can be applied on the specimens that can be representative for the soil under different loading situations. In a direct shear test, soil sample can be sheared at soaked and unsoaked conditions. This test also is representative for modelling slopes and embankments. The peak shear strength is a value that represents the highest shear strength of the soil against a specific normal stress. Running the test for a longer shear displacement can be representative for a residual shear strength that is used in landslide and ring shear testing is a more suitable experiment for this purpose. Shear displacement rate is also another important parameter. Selecting a higher shear rate value may lead to inaccurate outcomes and selection of a very low shear rate may lead to a time taking test.

2. MATERIALS

The following materials have been used to perform the experiments in this study.

2.1 Clay

Bentonite was selected as employed clay from a local source in Perth, Western Australia. The bentonite characteristics can be found in Table 1.

Table 1: Bentonite properties

Liquid Limit (LL)%	102
Plastic Limit (PL)%	31
Plasticity index (PI)%	71

2.2 Kiln Dust

Specific gravity of rice husk is 2.03 g/cm^3. Average grain size was 7.5 µm.

2.3. Fiber

Propylene fibre (PF) was employed. The length of fiber was 5mm.

3. TEST PROGRAM

A series of direct shear tests were conducted on the specimens mixed with the kiln dust (KD) and fiber. 2% fiber and 5, 10,

and 15% kiln dust were utilized. The compaction tests were conducted on the mixtures to achieve the optimum moisture content (OMC) and the maximum dry density (MDD). Table 2 shows the testing program used in this study. The device which was used in this study can be seen in Figure 1.

Figure 1 : Employed Direct Shear

Table 2: Testing program utilized in this study

Sample ID	Kiln Dust %	Fiber (%)
B-k5	5	2
B-k10	10	2
B-k15	15	2

4. TEST RESULTS

4.1. Compaction Results

Compaction results were presented in Table 3. Also, Figure 2 and Figure 3 show results of the compaction tests.

Table 3: Results of compaction rests.

Sample ID	Kiln Dust %	Fiber (%)	OMC %	MDD (gr/cm3)
B-k5	5	2	50.6	1.25
B-k10	10	2	53.1	1.23
B-k15	15	2	58	1.22

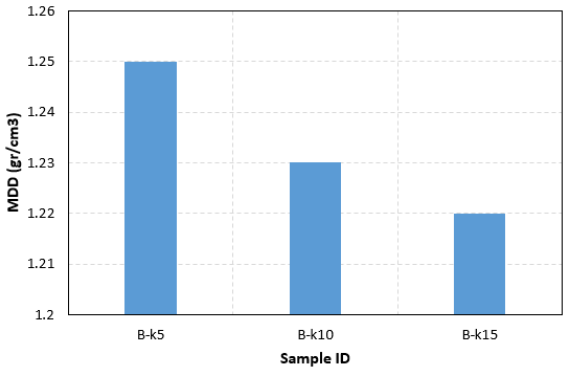

Figure 2: MDD results

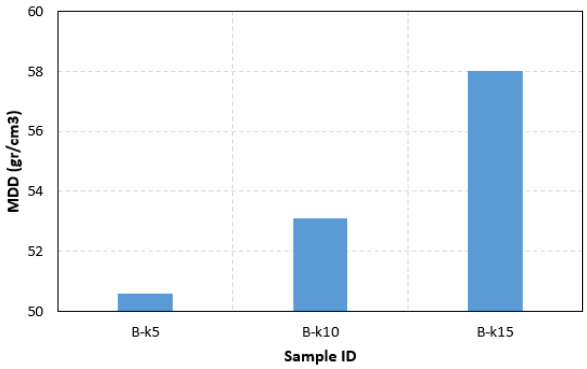

Figure 3: OMC Results

4.2. Direct Shear Tests

Direct shear testing results were presented in figure 4, 5, and 6.

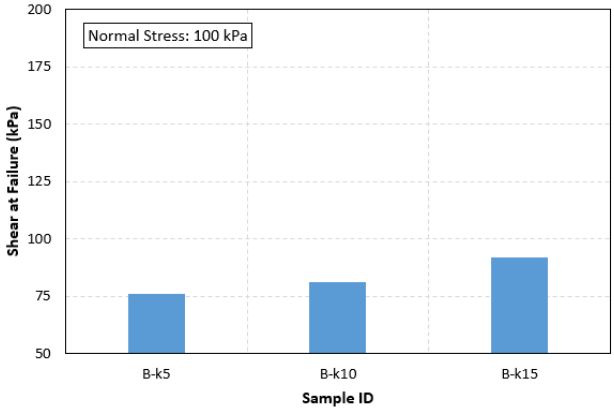

Figure 4: Direct shear tests under 100 kPa normal stress

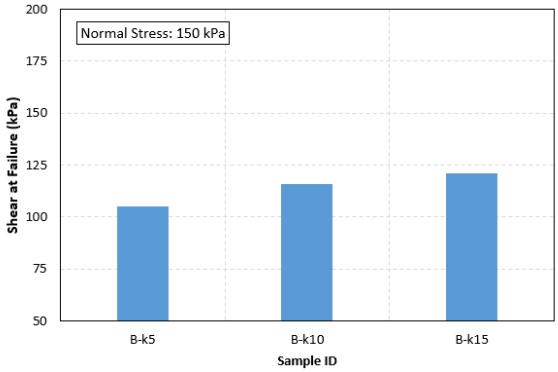

Figure 5: Direct shear tests under 150 kPa normal stress

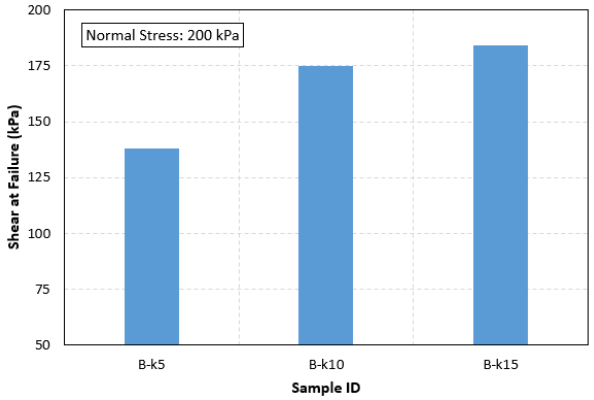

Figure 6: Direct shear tests under 200 kPa normal stress

5. CONCLUSION

Results showed that increasing the kiln dust contents increased the OMC and reduced the MDD. Also, the results showed that increasing the KD dosage improved the shear strength of the soil under three normal stresses of 100, 150, and 200 kPa. This shows a similar trend across all normal stresses.

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