Influence of Bagasse Ash on Compaction Behvaiour of Soil

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Abstract*: *Bagasse is one of the main by-products remaining from Sugarcane industry in tropical and subtropical regions. This by-product is used as a fuel in production of the sugar and a high amount of ash is remained due to this process. The remaining bagasse ash traditionally is used as a fertiliser, however recently it's been used as a cost-effective additive in improvement of the mechanical characteristics of the soils by practitioners. This study investigates effect of addition of different percentages of bagasse ash on improvement of the compaction characteristics of the cemented kaolinite. The results showed that addition of bagasse ash increased the optimum moisture content of the soil (OMC) and reduced the maximum dry density (MDD). The recorded increase in OMC was attributed to the extra moisture that required to add for the hydration. Also, reduction in MDD was attributed to the weightless bagasse ash in compare with kaolinite clay.

Keywords: Soil Mechanics; Compaction tests; Clay; OPC; Bagasse ash

I. INTRODUCTION

Reuse of by-products remaining from agricultural industry has been subject for previous studies (Chegenizadeh and Keramatikerman 2017; Ganesam et al. 2007 amongst others) sugar cane bagasse ash (SCBA) is a byproduct material that has the potential to be used in combination with cement (Keramatikerman et al. 2019). 1500 million tons of sugarcane is producing in nearly 110 countries every year in the world. Australia produces 35 million tons. (Modani and Vyawahare 2013). Recent studies about SCBA showed that this by-product can be classified as an admixture to cement which can improve strength of the concrete (Cordeiro et al. 2008; Payá et al. 2002).

The utilisation of a pozzolanic material such as SCBA can be beneficial as it does not need a particular treatment. Sulfate orders are improved in cement that contains pozzolanic materials, which is a promising result in application of bagasse ash in real world projects (Merida and Kharchi 2015). Kaolinite is a type of clay with very fine particles which has a plastic behaviour (Keramatikerman et al. 2017; Merida and Kharchi 2015). Kaolinite particles are able to keep water which may causes some characteristics such as shrinkage and settlement (Keramatikerman et al. 2017; Vakili et al. 2016). Soil stabilisation is mechanical improvement of soil by use of chemical or mechanical in order to reduce compressibility or ability of water to lose water while increase its shear strength (Harris 2006). As mentioned, there are mechanical and chemical strategies for soil improvement behaviour. The chemical method includes blending of soils with some additional agents in order to improve characteristic like durability, strength, and workability. Recommendation by Veith (2000) was that the csot associated with application of soil improvements should be considered as well as their technical effect. In spite of the fact that the generation of bagasse is copious due to a ceaseless increment in sugar generation around the world, the bulk sum of bagasse squander delivered in sugar manufacturing plants requires an important transfer conspire. Surveying compaction characteristics of the soil makes a difference to get it its quality, settlement, and penetrability. Within the compaction prepare, the soil densifies by implies of a mechanical handle. The optimum moisture content (OMC) and the most maximum dry density (MDD) of the soil are two significant characteristics as they appear the soil has appropriately compacted. Hence, accomplishing the compaction characteristics of the soil is the primary pivotal step to appropriately balance out the soil. This investigate has been conducted in proceed of the ponder to explore impact of SCBA on mechanical behavior of the soil in collaboration of the Arup Australia and Curtin University (Keramatikerman et al. 2019).

II. USED MATERIALS

Kaolinite clay was chosen in this study to perform the tests. The clay has a plastic restrain and versatility characteristics as mentioned in Keramatikerman (2016). Also, the used kaolinite clay had a characteristic same as clay used by Keramatikerman et al. (2016).

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The PC utilized in this think about was provided by a local provider in Western Australia.

The characteristics of used PC already mentioned in Chegenizadeh et al. (2020). The SCBA utilized in this research was sourced from MSF Sugar a company based in Innisfail in Far North Queensland (FNQ), Australia. The bagasse given had as of now been burned and prepared taking off behind fine black/brown light particles.

III. LABORATORY STUDIES

Previous studies on SCBA showed that application of 20% reduces the compressive strength of soil, whereas addition of 5% and 10% were effective to improve mentioned characteristics (Keramatikerman et al. 2019; Little 1995). Therefore, three SCBA rates of 5, 10 and 15% have been chosen in this study. The percentages of PC were acquired according to the studies performed by Chegenizadeh et al. (2017) and Sabbar et al. (2017) The testing program shown in Table 1. The modified standard compactions testing was conducted in line with the direction given in Australian Standard.

Table 1: laboratory Testing plan

No.	ID	PC (%)	SCBA (%)
1	K	-	-
2	3C	3	-
3	5C	5	-
4	7C	7	-
5	3C-5A	3	5
6	5C-5A	5	5
7	7C-5A	7	5
8	3C-10A	3	10
9	5C-10A	5	10
10	7C-10A	7	10
11	3C-15A	3	15
12	5C-15A	5	15
13	7C-15A	7	15

IV. RESULTS AND DISCUSSION

A noteworthy sum of compaction testing has been conducted to examine impact of SCBA on compaction characteristics of the soil. The OMC and MDD values were obtained upon application of modified standard compaction tests. As seen in Fig. 1, two components have been considered in analyzing compaction test. First, expansion of PC which clearly can be seen in Fig. 1(a).

As seen, adding 3%, 5% and 7% cement into kaolinite led in MDD values of 1.51, 1.49 and 1.49 T/m3 respectively. This shows a decreasing behaviour from kaolinite clay (i.e., 1.54 T/m3). This behaviour was due to an increase in PC and reducing the specific gravity of the cement which is lower than kaolinite (Keramatikerman et al. 2016; Vakili et al. 2016). Moreover, soil particle arrangements change the voids through by building a permeable space when cement added. This might justify the lower values of MDD (Chegenizadeh et al. 2017).

Also, the OMC rates of 22.71%, 23.10%, 23.57% and 23.70%. The reduction of MDD is due to the increment of PC and has a relation with an increase within OMC as higher moisture is needed to fill the gaps amongst soil particles (Chegenizadeh et al. 2017).

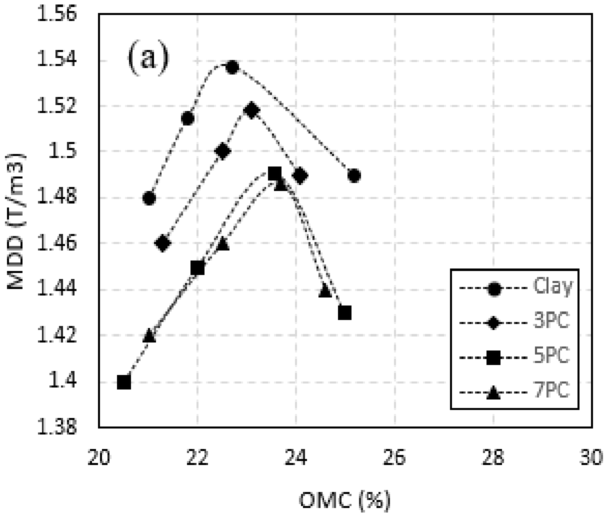
The other agent that has an impact on the compaction characteristics is the bagasse ash. In comparison to increase in PC content, the increase in bagasse ash affected the compaction same as cement. For instance, the recoded OMC values were 24.2%, 24.3% and 24.5% whilst the MDD was 1.5%, 1.5% and 1.49% T/m3 for 5%, 10% and 15% bagasse ash mixed with 3% cement respectively. Furthermore, OMC as can be seen in Fig. 1(b), are 24.6%, 24.8%, 24.8% whilst MDD are 1.5%, 1.5% and 1.5% T/m3 for 5%, 10% and 15% bagasse ash mixed with 5% cement respectively. In addition, as shown in Fig. 1(d), OMC values are 25.2%, 26.4% and 28% and the MDD are about 1.4% T/m3 for 5%, 10% and 15% bagasse ash mixed with 7% PC.

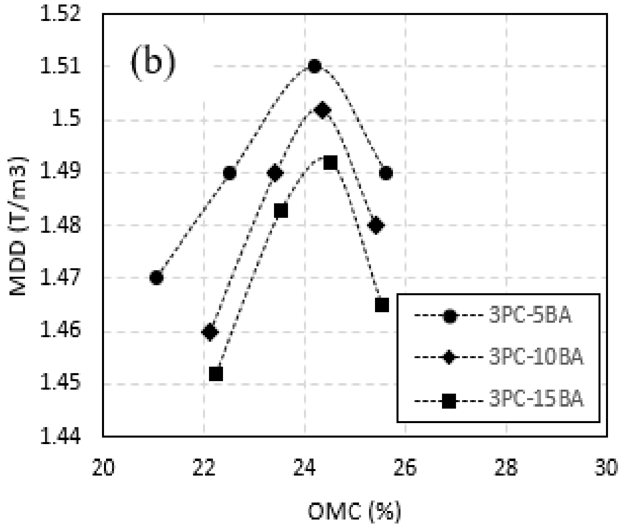
As shown, increase in OMC and a reduction in MDD was recoded as previous studies mentioned. This behaviour was due to the replacement of the soil particles with bagasse ash particles. The mixture required more water to have the same workability and therefore, the recorded behaviour was justified (Chegenizadeh and Nikraz 2011; Chegenizadeh et al. 2020).

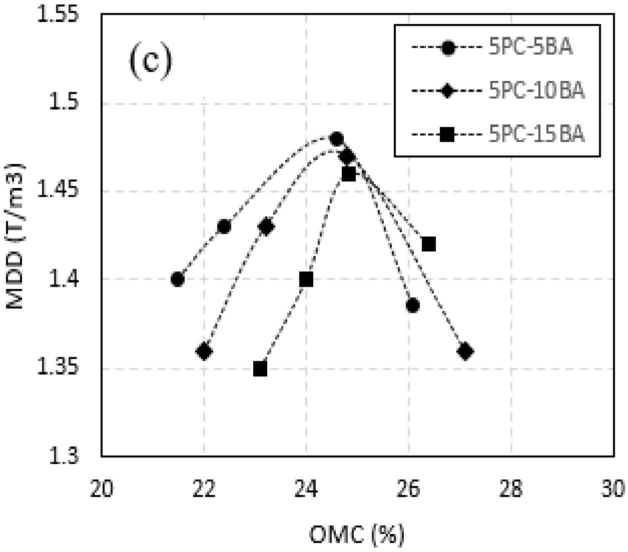
Moreover, some admixtures from next figures for 5BA by keeping the cement concentration, it can be seen that the MDD are 1.51, 1.48, and 1.44 T/m3 for 3%, 5% and 7% PC respectively. The recorded behvaiour reinforces the past expression that increase of cement reduces MDD. An overview of all the obtained OMC and MDD for all mixtures shown in Table 2.

Table 2: Summary of Compaction Test Results

ID	OMC, (%)	MDD, (T/m^3)
K	22.71	1.537
3C	23.1	1.518
5C	23.57	1.491
7C	23.70	1.486
3C-5A	24.20	1.510
3C-10A	24.34	1.502
3C-15A	24.52	1.492
5C-5A	24.60	1.480
5C-10A	24.80	1.470
5C-15A	24.84	1.460
7PC-5A	25.20	1.440
7C-10A	26.40	1.430
7C-15A	28.00	1.410







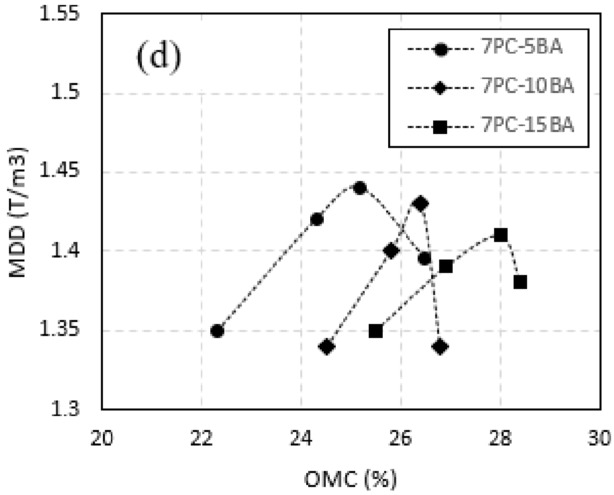


Fig. Compaction characteristics of the tested mixtures.

V. CONCLUSIONS

Maximum dry density (MDD) and optimum moisture content (OMC) are vital compaction characteristics in soil adjustment that speak to how distant fill materials are inclined to settlement. The capacity for compaction of soils may be a coordinate parameter of its dampness substance. An exhaustive examination was conducted to decide compaction characteristics of the sugarcane bagasse ash (SCBA) on cement settled clay. An add up to number of 52 compaction endeavors were carried out and the comes about were displayed as takes after:

- Addition of PC diminished the MDD and expanded the OMC. This is often since more moisture is needed to fill the discussed gaps that are made through the compaction efforts.
- A comparative slant was recorded by expansion of SCBA into the PC balanced out clay examples. This drift credited to the substitution of the soil by the SCBA which brought about the blend requiring more water and a lower thickness.
- To accomplish an ideal esteem of the soil thickness and a legitimate settled soil blended with SCBA, more dampness substance would be required to be included into the blend.
- This appears that bagasse ash can be utilised as soil improvement agent to decrease settlement behaviour of cemented clay.

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