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Utilization of Blast Furnace Slag in Briquette Production

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***Abstract*— The main purpose of this study is to investigate the utilization of blast furnace slag (BFS) in the production of briquettes as a replacement of soil (S). To achieve this first, some physical properties of the materials used were determined. Thermal properties of the materials were examined by using differential thermal analysis- thermo gravimetric analysis (DTA-TG). Following the characterization of the materials, the samples of briquettes made with BFS. Its replacement ratios with soil were 0, 2, 5, 10, 20% in mass basis (w/w). The mixtures were prepared and sintered at 900°C in the furnace. Compressive strength tests results were presented. It can be said that BFS affected sintering behavior of the briquettes. Compressive strength results of the briquette samples indicated that BFS containing briquettes with 39.4MPa compressive strength (No#2), which was higher than the requirements of Turkish Standard Specification (TS EN 771-1) and it was also higher reference mixture's (No#1).**

***Keywords*—blast furnace slag, compressive strength, briquette**

I. Introduction

There are many industrial wastes which are used in construction industry [1-7]. One of them is BFS has been used as a mineral additive in the cement and concrete production. It has been used to evaluate and prevent the environmental pollution. Besides it has been contribute decreasing of using of natural resources. BFS is also used ceramic production, but it is rarely used to briquette production. This study investigates to utilize BFS in briquette production that has high compressive strength values.

II. Experimental

A. *Raw Materials*

The materials used in this work were S, supplied from a brick factory in Turkey, BFS was obtained from Iskenderun Iron-Steel Factory. Before the preparation of the specimens from the soil produced with these materials, chemical and some physical analysis of materials were carried out.

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To obtain particle size distribution, sieve analysis were performed (Fig.1), to determine thermal behavior of S TG analysis was performed (Fig.2).

B. *Preparation and testing of briquettes*

Different mixtures were prepared from BFS samples. Briquette dimensions were chosen as 3.6x3.6cm^2 diameter and height. The mould was made from stainless steel. BFS was added to the soil in ratio of 2, 5, 10, 20% in mass basis (w/w) and mixtures were prepared with 6% water. Before sintering, moisture of mixtures was evaporated in the oven at the 105°C. The mixtures were moulded and sintered 900°C in the laboratory in the sintering oven. After the temperature had reached the required temperature, the briquettes were not left in the sintering oven and were put out. The briquettes were produced through this process conditions were tested for compressive strength according to the Turkish Standards (TS EN 771-1) [8].

III. Results and Discussion

A. *Characterization of BFS and S*

To characterize the S and BFS, following experiments were carried out. Chemical analyses of the materials were given in Table 1. Content analyses of S sample were given in Table 2 and results are 6.4% sand, 34.6% silt and 59.0% clay. As it can be seen in Fig.1 particle size distribution of S sample was between 0.003-5.000mm, mean diameter of BFS was 7.48µm. In addition to the mentioned information, specific gravity of the BFS and S was 2.81g/cm^3 and 2.75g/cm^3 respectively.

TABLE I. CHEMICAL ANALYSES OF THE MATERIALS

Constituents (%)	S	GBFS
SiO_2	58.36	36.70
Al_2O_3	22.17	14.21
Fe_2O_3	7.09	0.98
CaO	2.61	32.61
MgO	2.46	10.12
K_2O	2.27	0.76
Na_2O	0.71	0.42
SO_3	0.34	0.99
(LOI)	3.35	*NA*

TABLE II. CONTENT OF THE SOIL SAMPLE

Content	%w/w
Gravel	0.0
Sand	6.4
Silt	34.6
Clay	59.0

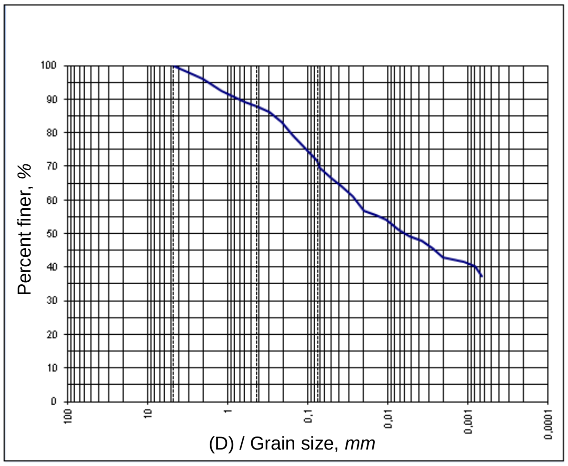

Figure 1. Grain size curve of the S.

To obtain thermal behavior of S, TG analysis was carried out and it was found that there was 10.6% weight loss totally. Moisture and water loss of soil were 2.9% up to 156°C. In the range between 156°C and 767°C, decomposition started and water loss of soil reached up 10.6%. As it can be seen in Fig.2 after the 767°C, decomposition continued.

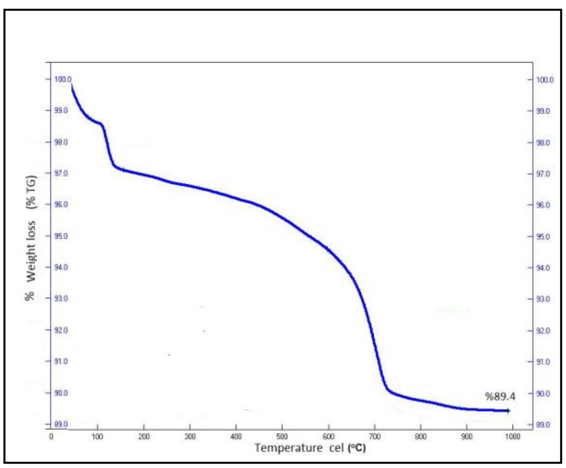

Figure 2. TG analysis of the BFS.

It can be seen in Fig.3, totally weight loss was 3.3%. Because of the high level calcium components, important chemical reactions occurred 600-800°C and exhaust gases emitted.

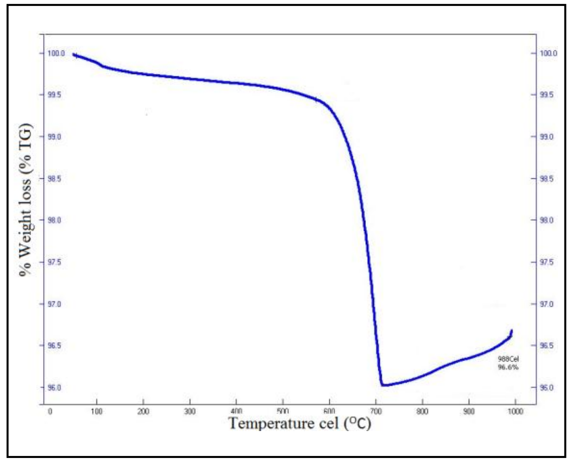

Figure 3. TG analysis of the BFS.

B. *Compressive strength values of briquettes*

After sintering of the mixtures, compressive strength tests were applied to the briquettes. Compressive strength results of the briquettes are shown in Table 3. It is concluded that briquettes with compressive strength value of 39.4MPa can be produced at 900°C. This result was obtained briquette, which was prepared with BFS in ratio of 2% and this is the best of compressive strength result than that of prepared using other mixtures. This compressive strength result is very high value because Turkish Standard (TS EN 771-1) requires (9.8-23.54 MPa). In addition to these conclusions briquettes with BFS give more compressive strength value than that of non-additive.

TABLE III. MIXTURE RATIO AND COMPRESSIVE STRENGTH RESULTS OF THE BRIQUETTES

No	Mixtures (%)	Compressive strength (MPa)
1	100K	34.6
2	98K+2BFS	39.4
3	95K+5BFS	35.4
4	90K+10BFS	27.6
5	80K+20BFS	21.6

IV. Conclusions

The following conclusions can be drawn from the experimental results. The briquette obtained from BFS in ratio of 2% gives better mechanical strength than that of prepared using other mixtures. This result is very important because BFS is an industrial waste and has higher compressive strength values than S at the same conditions. In addition to these results, all mixtures can be used according to relevant standards. This is very important result to contribute environmental pollution and decreasing of production costs.

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Dr. Özlem Çelik Sola received his BS degree from Istanbul Technical University, Turkey in 1991, and MS and PhD degrees from the Yıldız Technical University in 1999 and 2004, in Chemical Engineering. Since 1995, she has been served as a Research Assistant, Assist. Prof. Dr. and Assoc. Prof. Dr. at the Department of Civil Engineering, Istanbul University. Ozlem Celik currently working as a Associate Professor at Istanbul University.

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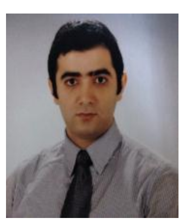

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