The Utilization of Waste-to-Energy Incineration Ash in Clay Fired Brick Manufacturing

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Introduction

- In the US, millions of tons of municipal solid waste (MSW) are produced annually, most of which are sent to landfills
- Waste-to-Energy (WTE) plants combusts the MSW with energy recovery, effectively reduces the weight and volume of MSW, and ends up with WTE ash
- Coarse WTE ash is suitable to be used as stone aggregate substitute in concrete production
- The fine fractions of WTE ash are difficult to incorporate in building materials due to its fine particle size
- This research aims to investigate the feasibility of using the fine fractions of WTE ash in partial replacement of clay in fired bricks.

Materials

- Kaolin (clay)
- WTE combined ash as received (max size 30 mm)
  - Separated into two samples after sieving: < 2 mm and < 9 mm
  - Ash samples were grinded for homogenization
- The base water to solid ratio of 0.35 was adjusted throughout the experiment

Sample	Kaolin clay (%)	< 2 mm WTE combined ash (%)	< 9 mm WTE combined ash (%)	Firing temperature (°C)	Water to solid ratio
Control1	100	0	0	950	0.35
Control2	100	0	0	1000	0.37
CA2	70	30	0	1000	0.35
CA9	70	0	30	1000	0.45

Table 1. Mixture of bricks and preparation parameters.

Sample Preparation

Steel balls for grinding

< 2 mm and < 9 mm WTE ash samples grinded for 2 hours in ball mill

Samples sieved through <100 um opening sieve

Figure 1. Sample preparation process.

Methods

Brick Manufacturing

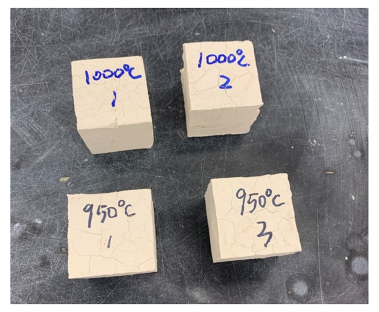
Clay-ash dry mixture mixed for 4 minutes. Water was added and mixed for 6 minutes

Mixtures pressed into three 50 x 50 x 50 mm molds and demolded

Dried in ambient conditions for 24 hours

Dried in oven at 100°C for 24 hours

Bricks were fired at either 950°C and 1000°C in furnace for 2 hours



After firing, bricks were allowed to cool down

Figure 2. Brick manufacturing process.

Compression Testing

Sample in compression testing machine

Sample post-compression test

Figure 3. Compression testing.

Results

Control 1: 100% clay, 0.35 water/solid ratio, 950°C
Control 2: 100% clay, 0.37 water/solid ratio, 1000°C
CA2: 70% clay, 30% < 2 mm WTE combined ash, 0.35 water/solid ratio, 1000°C
CA9: 70% clay, 30% < 9 mm WTE combined ash, 0.45 water/solid ratio, 1000°C

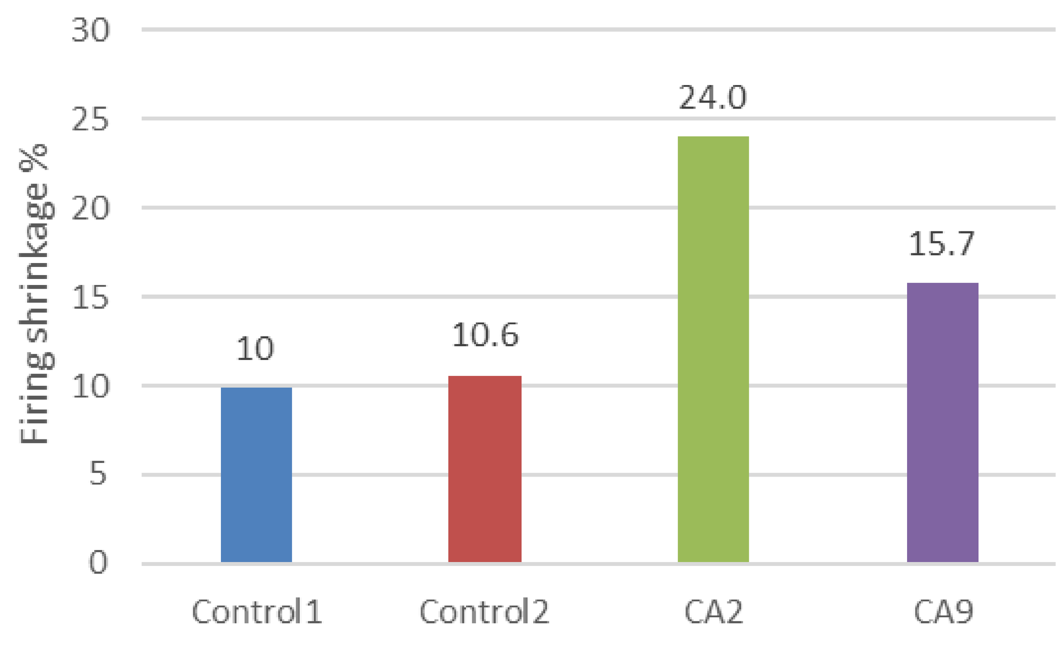


Figure 4. Firing shrinkage.

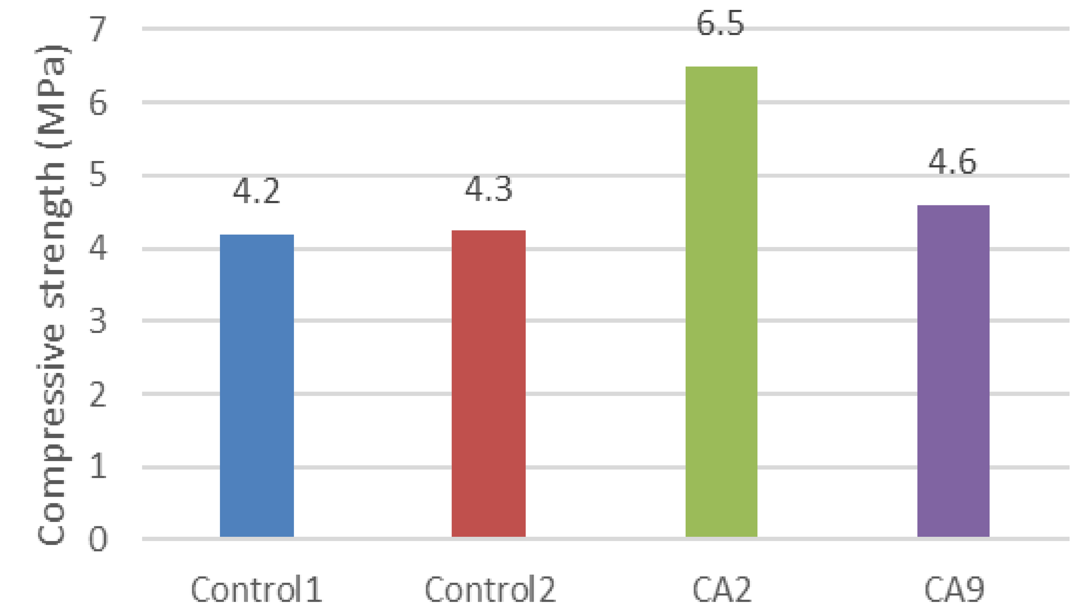


Figure 5. Compressive strength.

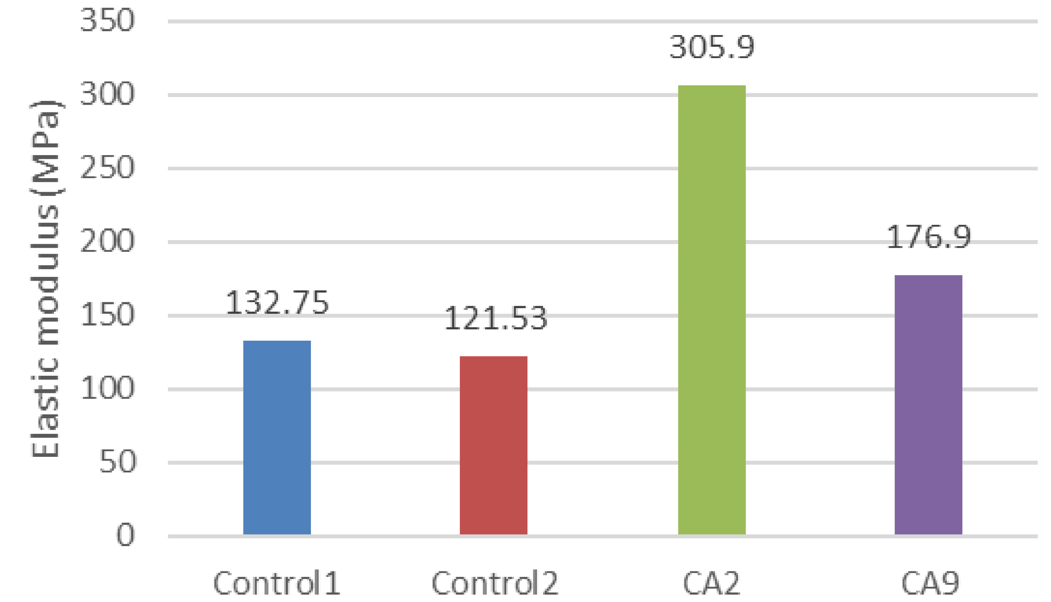


Figure 6. Elastic modulus.

Discussion

- All samples experienced microcracking during firing to some degree
- The CA2 sample had the greatest firing shrinkage, while also having the highest compressive strength and elastic modulus
- The Control1 sample had the lowest firing shrinkage, while also having lowest compressive strength and low elastic modulus

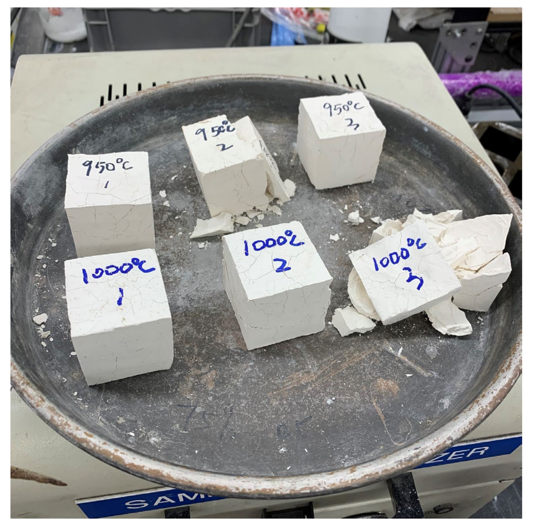


Figure 7. Bricks after firing.

Future Work

- After firing, many bricks cracked. One solution might be to hydraulically press the clay into the molds for a more uniform molding process.
- Other parameter combinations of drying times, firing temperatures, water to solid ratios, and ash replacement should be investigated to improve workability and mechanical properties
- Leaching tests should be performed to determine the environmental risk of these bricks in building applications

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