VALORISATION OF STEEL SLAG THROUGH PELLETISATION AND CO_2 SEQUESTRATION

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ABSTRACT

Steel slag is an alkaline residue from steel-making processes. Through accelerated carbonation it can be neutralized and stabilized into a calcium carbonate based material. This paper aims to develop artificial green aggregates via granulating slag powder into pellets and solidifying by CO2 curing. The result shows that carbonation of steel slag pellets significantly contributes to the crushing strength development and water absorption reduction of the artificial green aggregate. The carbonated pellets possess a high CO2 uptake of 96 g/kg with outstanding properties, creating an alternative for the shortly supplied local aggregates.

INTRODUCTION

Steel slag, an alkaline residue from steel-making industry, has been applied as aggregate or cement replacement in concrete. However, the incorporation of free CaO and the low cementitious reactivity due to the thermal history significantly hinders the development of steel slag market. Steel slag shows high reactivity to carbonation on basis of the high CaO content. Therefore, this paper aims to develop steel slag aggregates via granulating and CO2 solidifying in order to solve the shortage of natural aggregates.

METHODS AND MATERIALS

Basic oxygen furnace slag (BOFS) powder with the mean particle size of 6um was used in this study. It consisted of 42.1% CaO, 21.7% Fe2O3, 16.5% SiO2, 6.7% MgO, etc. Pelletization was carried out in a customized pan pelletizer with 100% BOFS powder for 20 minutes. Liquid to solid ratio was controlled at 0.16. The fresh pellets with the diameters of 4.75-20mm was obtained and cured in CO2 chamber (T=20°C, RH=65%, CO2%=20%) or lab shelves (T=15°C, RH=50%.) which was designated as PC and PA respectively. Loose bulk density, water absorption, crushing strength, CO2 uptake, free CaO content was tested after curing.

RESULTS

The final aggregates shown in Figure 1 a) were brownish. The loose bulk density of PA and PC were similar, about 1200kg/m3 as shown in Figure 1 b), which is higher than the threshold set for lightweight aggregate in EN 13055-1 and ASTM C330. The highest strength of 5.24MPa was recorded for PC-14d and the strength of PC pellet was about 3 times higher than the PA pellet regardless of ages. Precipitation of calcium carbonate during CO2 penetration filled the pores inside the pellets and thus lead to the enhancement of crushing strength. water absorption was significantly reduced from 14% to 11% when CO2 curing was applied. (Figure 1)

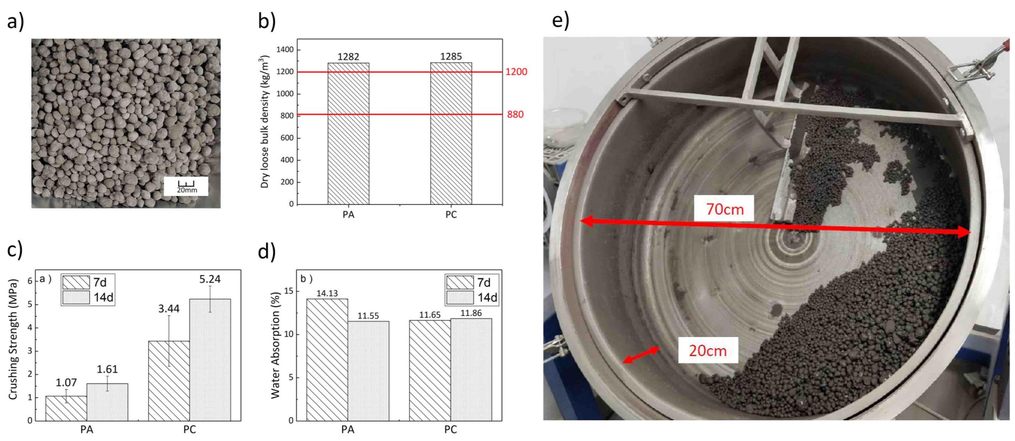

Figure 1: a) final pellets after curing, b) dry loose bulk density, c) crushing strength and d) water absorption.

The f-CaO in the BOFS was reduced from 1.4% to 0.3% after carbonation, which was believed not to cause any soundness problems. Besides, TGA result showed that the CO2 uptake of PC pellets was 9.64%. (Table 1)

Table 1. f-CaO content and CO2 uptake of PC group

Group	f-CaO (before carbonation)	f-CaO (after carbonation)	CO2 uptake
PC	1.4%	0.3%	9.64%

CONCLUSIONS

✓Artificial green aggregates possessed the crushing strength of up to 5.24MPa.
✓The water absorption of the pellets was about 11%, significantly lower than some pellets made from other waste materials.
✓Carbonation can also stabilize the BOFS by reducing f-CaO content to an extremely low level and the CO2 uptake was believed to be an added-value for the green pellets.

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