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Assessment of Using PCCA in Green Concrete Production

Amal Zamrawi Hassani Hamdnallah

Abstract: ***The disposal of using recycled aggregate in concrete production raises in the last two decades. Some Green concrete mixes were also prepared from a recycled aggregate. This paper presents a study of using porosity crushed ceramic aggregate (PCCA) as replacement of coarse aggregate in concrete production. The result indicated that PCCA can replace Coarse aggregate by different ratios.***

Keywords: PCCA - green concrete – compressive strength – tensile strength

1. Introduction

During the last decades, it has been recognized with growing concern that wastes from a construction are of large volume and that this volume is increasing year by year. Most waste material are left as landfill material or illegally dumped. Environmental impact can be reduced by making more sustainable use of this waste[1].Waste management is one of priorities of every community and it has become evident that good waste management can enhance the quality of life. The main principle of a quality waste management is in lowering the mass production of new, finding ways to recycle and reuse existing, safe and ecologically acceptable depositing of unused waste [2]. The mechanical behavior of the recycled concrete was better than that of conventional concrete [3] It was observed that the greatest increase in compressive and splitting tensile strength compared to conventional concrete was achieved by substituting natural coarse aggregate with recycled ceramics aggregate [3]. The inclusion of ceramic aggregate causes a refinement of pore system increasing the volume of capillary porous and decreasing the volume of macropores [3].The interfacial transition zone (ITZ)between recycled ceramic and aggregate-paste was much more compact and less pores that was the case for that of the natural aggregate [3].Properties of ceramic sanitary ware waste don't depart from properties of traditional natural aggregate and therefor it may be used as concrete aggregate[4]. Ceramic sanitary ware waste aggregate can be used for concrete production such aggregate allows to compose workable concrete mixes, which after strengthening turn into concrete displaying high strength parameters [4].

2. Experimental Program

Experimental work was divided into two parts. First part three different ratios were prepared PCCA replacement with coarse aggregate 0%, 50% &100 %.

The 100% fail to be hardened the second part of the experimental work three different ratios were obtained with PCCA replacement 20%, 35% &50%.

Material properties

Water, cement, fine aggregate (sand) coarse aggregate Crushed stone and PCCA and were used in the mix design. Potable water was used. Yellow sand with properties shown in **Table 1**. Crushed stone was used as coarse aggregate with properties shown in **Table1**. PCCA was used as a replacement of coarse aggregate Properties of crushed ceramics was shown in **Table 1**.A sieve analysisshows that a good grading between Coarse aggregate and crushed stone see **Fig.1**

Table 1: Properties of Used Materials.

Description	Fine Agg.	Coarse Agg.	PCCA
Dry Unit Weight (t/m^3)	1.98	1.7	1.8
Specific Gravity	3.35	2.75	2.27
Fineness Modulus	2.85	---	---
Dust and Fine Materials	1%	---	---
Organic Materials	-------		---
Void Ratio	34 %	37 %	---
Absorption %	---	0.9 %	7.5 %
Crushing factor	---	11.4	10.5

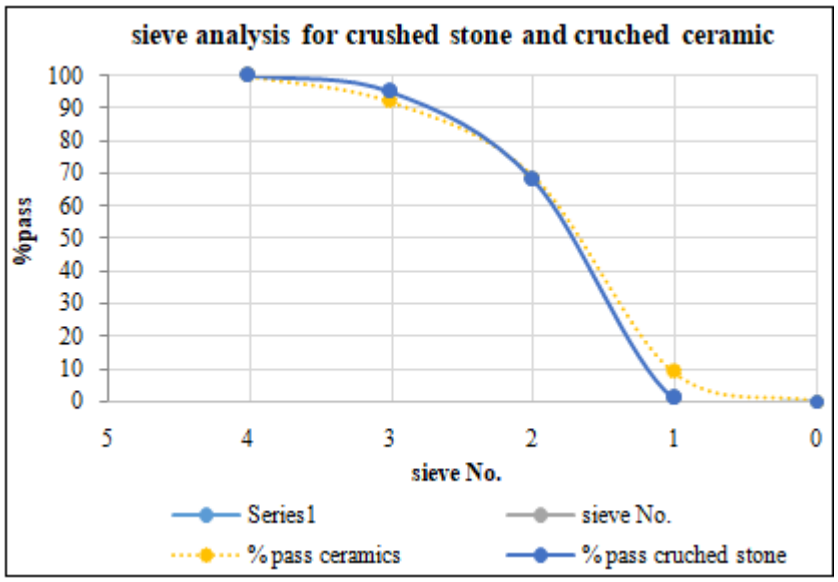

Figure 1: Sieve analysis

Mix proportions

In this investigation, cement, sand, gravel, water andPCCA with different ratios. Cement: sand: Gravel: water/cement,1:1.3:4.44:0.5 respectively. PCCA ratios to coarse aggregate were 20%, 35% & 50%.

Mixing procedure

PCCA was wet both sand and gravel were dry. The mixer was washed by water before mixing. The cast specimens were demolded after one day and put in a moisture for about one week. After a suitable period of curing the compressive strength tests was carried out.

Compressive strength

The results obtained for compressive strength carried out on 15 x15 x 15 cm. Cubes were tested after two months from casting. Compressive strength increases as the percentage of ceramic waste used to substitute the natural aggregate increase see **Fig.2**.

With a substitution percent of 50% the concrete presented a 15% increase in compressive strength with respect to reference concrete.

(a) **(b)**

Figure 2: (a) Test cubes (b) Failure shape

Table 2: Test Results

PCCA%	Cubes (MPa)			Cylinders (MPa)	
0	25	28.9	27.5	2.4	2
20	29.8	27.5	28	2.15	2
35	29.6	31.8	32.7	2.2	2.1
50	28.7	30.9	34.2	2.12	2.23

The results showed that PCCA could replace coarse aggregate successfully.

Tensile strength

Splitting tensile strength was carried out on 15 x 30 cm test cylinder at two months from casting. As regards splitting tensile strength didn't increases as the compressive strength. It's nearly equal to the control specimen.

Tensile strength calculated from equation (1)

$$F_t=\frac{2P}{\pi DL} \quad (1)$$

Where P: load applied

D : diameter of cylinder = 15 cm

L: length of cylinder = 30 cm
Obviously PCCA could replace Coarse aggregate perfectly. Also, failure shape is similar for both cylinders the control and 50% replacement of coarse aggregate

As shown in **Fig.3**the cylinder was cut into two halves by means of tenson force tension force of cylinder from normal aggregate & cylinder from PCCA is nearly equal as shown it **Table 2**

(a) **(b)**

Figure 3: Failure shape of cylinder (a) 0% & (b) 50% PCCA

3. Conclusion

The result of this investigation confirmed the use of PCCA in green concrete in order to reduce environmental impact.

1) Compressive strength raises to about 15 % by replacement of 50% PCCA with coarse aggregate.
2) Tensile strength nearly equal in case of replacement PCCA with coarse aggregate.
3) Failure shape is the same in case of cube or cylinder.

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Author Profile

Dr. Amal Zamrawi. Instructor of concrete structures at the faculty of engineering, Helwan university. Well experience in concrete structure design.
Education PhD in Civil and environmental Engineering University of Helwan, Cairo, Egypt September 2019. M. Sc. Of structural Engineering- Mataria, Helwan University, Cairo, Egypt April 2013. B.S. in Civil Engineering , grade excellent with honor degree Faculty of Engineering- Mataria, Helwan University, Cairo, Egypt May 2009