International Journal of Engineering Research and Technology. ISSN 0974-3154, Volume 12, Number 11 (2019), pp. 1869-1872

Strength Properties of Concrete incorporating E-waste and Pond Ash

Rahima Shabeen S[1], Maryba. I[2], Nivetha S[2], Selvarani. M[2] and Abirami. K[2]

[1]*Assistant Professor, Department of Civil Engineering, College of Engineering Guindy, Anna University, India.*

[2]*Students, Department of Civil Engineering, College of Engineering Guindy, Anna University, India.*

Abstract

This paper presents the experimental investigation of concrete with partial replacement of coarse aggregate with e-waste plastics and fine aggregates with pond ash. The waste plastic from outer coverings of electronic appliances such as mixie and computer were considered as coarse aggregate. Traditional coarse aggregate,gravel was replaced with percentages of 8%, 16% and 25% of E-waste by volume. Pond ash, a by-product from the Ennore Thermal power plant, Tamilnadu, India was considered as fine aggregate. Fine aggregate, river sand was replaced with 30% of Pond ash. Tests were performed on fresh and hardened concrete. From the investigation, it was noted that E-waste as aggregate in concrete decreases the strength of concrete.

Keywords: Concrete, E-waste, pond ash, compressive strength.

I. INTRODUCTION

Concrete is a widely used material for construction and it uses cement, sand and gravel along with water as ingredients. Each of the ingredients has environmental issues related to them. Cement production leads to CO_2 gas emission in the atmosphere, quarrying sand from river beds and quarrying gravel from rocks leads to depletion of natural resources and changes the ecosystem. On the other hand, there are number of wastes and by-products generated and dumped in landfills causing environmental pollution. In such a scenario, these waste products could be used in concrete thereby leading to sustainable development by using lesser natural resources and effectively reusing waste generated. In this paper two such waste products are considered namely, e-waste and pond ash. E-waste is the waste from outer covering of electronic items like computer monitor. Pond ash is the by-product generated along with fly ash and bottom ash during extraction of coal in thermal power plant.

The objective of this paper is to determine the strength properties of concrete with e-waste as coarse aggregate and pond ash as fine aggregate by experimental study.

II.RELATED WORK

Many researchers have worked on plastic waste and pond ash in concrete and cement mortar. Ashwini (2016) observed that 10% replacement of plastic waste is optimum with respect to compressive strength in M20 concrete. Amir et al (2016) studied the strength properties and elastic modulus of concrete containing waste plastic as partial replacement of fine aggregate. The authors observed that upto 10% of replacement of fine aggregate with plastic waste the strength values increased and beyond which there is a decrease in compressive, tensile and flexural strength. Phani kumar and Sofi (2016) observed that there is a decrease in compressive strength with increase in pond ash content. Alqahtani et al (2017) observed that concrete with plastic waste as aggregate had a ductile failure and moderate strength properties and recommended for use in light weight and non-structural applications. Saxena et al (2018) concluded that concrete containing PET waste has better impact resistance and energy absorption capacity when compared to conventional concrete. Dhirajkumar et al (2019) observed an increase in strength of cement mortar when fine aggregate is replaced with pond ash by upto 40% beyond which it decreases. The authors further concluded that optimum percentage of replacement of cement by pond ash is 10% beyond which the strength decreases.

III. EXPERIMENTAL INVESTIGATION

III.I Materials

The materials used were ordinary Portland cement, river sand, gravel, e-waste and pond ash along with water for making concrete of grade M30. Cement used in the study was 43 grade OPC and the properties of cement are presented in Table 1. River based natural sand sourced from local area and pond ash was used as fine aggregate in the study. The coarse aggregate used in the study were natural gravel and crushed E-waste.

Waste plastic from discarded home appliances like mixie, fan, television and computer were collected from scrap dealer. The waste plastic (E-waste) were crushed to size of about 12.5 mm in a crushing machine. Fig. 1 shows the discarded plastic and the crushed aggregates obtained from crushing discarded plastics.

Pond ash was sourced from Ennore Thermal Power Plant, Chennai, Tamilnadu. The collected pond ash was air dried and sieved. Fig. 2 shows the collected and dried pond ash.

(a) Discarded plastics(b) After crushing

Fig. 1. E-waste plastic

Fig. 2. Pond ash

The properties of river sand, gravel, pond ash and E-waste were tested in the laboratory. The properties of the fine aggregate and coarse aggregate obtained from physical tests are presented in Table 2 and Table 3 respectively.

Table 1. Physical properties of cement

S. No.	Properties	Requirements as per IS codes	Test results
1	Consistency	26-33%	30 %
2	Specific Gravity	3.12 – 3.19	3.14
3	Initial setting time	30 min (min.)	39 mins
	Final setting time	10 h (max)	180 mins
4	7-day Compressive strength	33 MPa	35.0 MPa
	28-day Compressive strength	43 MPa	44.3 MPa

Table 2. Physical properties of fine aggregate

S. No.	Properties	River Sand	Pond Ash
1	Specific Gravity	2.74	2.3
2	Colour	Grayish yellow	Grey
3	Fineness Modulus	2.46	3.14

Table 3. Physical properties of coarse aggregate

S. No.	Properties	Natural Gravel	E-waste
1	Specific gravity	2.62	1
2	Shape	Angular	Angular
3	Color	Black	Multi-coloured (Black, White, Green, Red)
4	Impact value (%)	35.75	95.76

III. II Mix Proportion

M25 grade concrete mix was proportioned according to IS 10262:2009. Coarse aggregate was replaced with E-waste in replacement percentages 8%, 16% and 25%. Fine aggregate was replaced with pond ash in replacement percentage 30%. The details of the replacement levels of coarse and fine aggregate are presented in Table 4. The details of the mix proportion are presented in Table 5.

Table 4. Fine and coarse aggregate replacement

Material		P30E0	P30E8	P30E16	P30E25
Fine Aggrgate	River sand	70%	70%	70%	70%
	Pond ash	30%	30%	30%	30%
Coarse Aggrgate	Gravel	100%	92%	84%	75%
	E-waste	0%	8%	16%	25%

Table 5. Concrete mix proportion

Material	P30E0	P30E8	P30E16	P30E25
Cement	438	438	438	438
River sand	611 kg	611 kg	611 kg	611 kg
Pond ash	192 kg	192 kg	192 kg	192 kg
Gravel	1005 kg	994 kg	983 kg	970 kg
E-waste	-	11 kg	22 kg	35 kg

III. III Test on Fresh Concrete

Workability characteristics of concrete in fresh state were measured using slump cone test. The test was performed as per IS 1199.

III.IV Compressive Strength Test

Compressive strength of concrete was conducted on a cube of size 150 mm x 150 mm x150 mm. The cubes were cast as per mix proportion and the compressive strength was tested after a curing period of 28 days.

III.V Tensile Strength Test

Tensile strength of concrete was found by conducting split tensile test on cylinders of height 300 mm and diameter 150 mm. The tensile strength was tested after 28 days of curing.

IV. RESULTS AND DISCUSSIONS

IV.I Compressive Strength

Compressive strength of concrete containing E-waste and pond ash is presented in Table 6. The compressive strength of concrete without E-waste is 29.6 MPa which reduces to 24.7 MPa at 25% replacement. The presence of pond ash at 30% replacement level decreases the compressive strength from 29.6 MPa to 26.5 MPa. The variation of compressive strength is

shown in Fig.3. The strength of concrete with increasing replacement levels of E-waste is progressively decreasing. There is negative correlation of compressive strength with replacement levels of E-waste and pond ash.

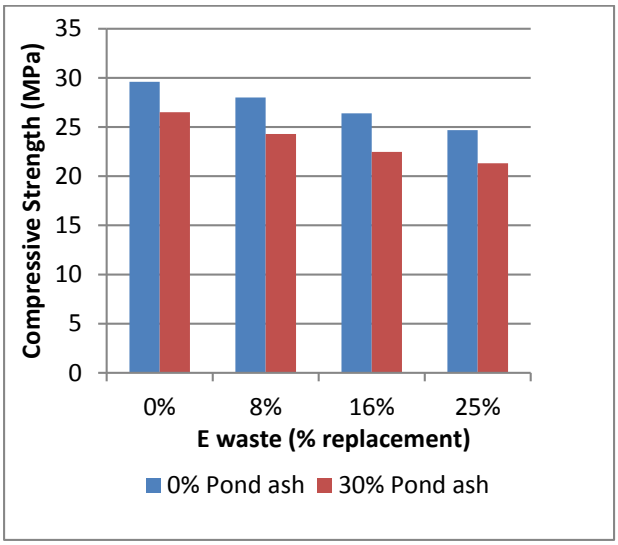

Fig. 3. Compressive strength of concrete with E-waste and pond ash

Table 6. Compresive strength of Concrete with E-waste and pond ash

Compressive strength (MPa)		Pond ash	
		0%	30%
E-waste	0%	29.6	26.5
	8%	28	24.29
	16%	26.4	22.47
	25%	24.69	21.31

IV.II Tensile Strength

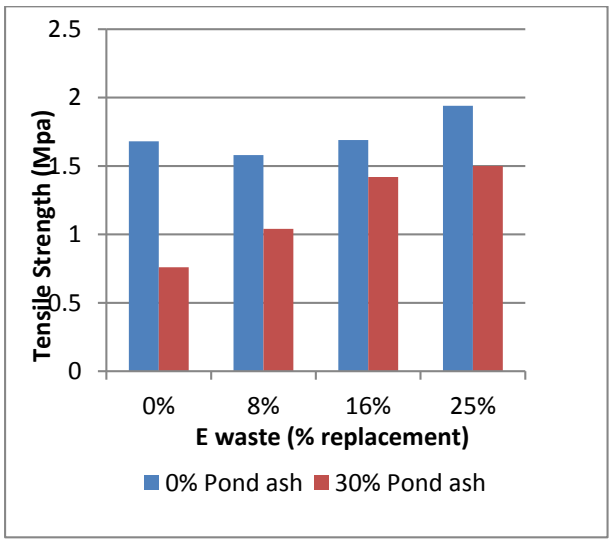

Fig. 4. Tensile strength of concrete with E-waste and pond ash

Tensile strength of the tested concrete cylinder specimens with E-waste and pond ash are shown in Fig. 4. Tensile strength of concrete without E-waste is 1.68 MPa and marginally reduces to 1.58 MPa when 8% of coarse aggregate is replaced by E-waste. However, the tensile strength of concrete with increasing percentage of E-waste keeps increasing progressively. A similar progressively increasing behavior is observed in concrete with pond ash and varying percentages of E-waste.

IV.III Workability

The results of the slump cone test to find the workability are shown in Fig.5. The workability of concrete measured using slump cone test shows a increasing trends with increasing percentage of E-waste. The slump of concrete increases from 15mm for concrete without E-waste to 25 mm when the concrete has 25% E-waste instead of natural gravel. This may be due to lesser friction at the surface of the plastics and also, plastics absorb lesser or no water. Hence, the workability of concrete increases.

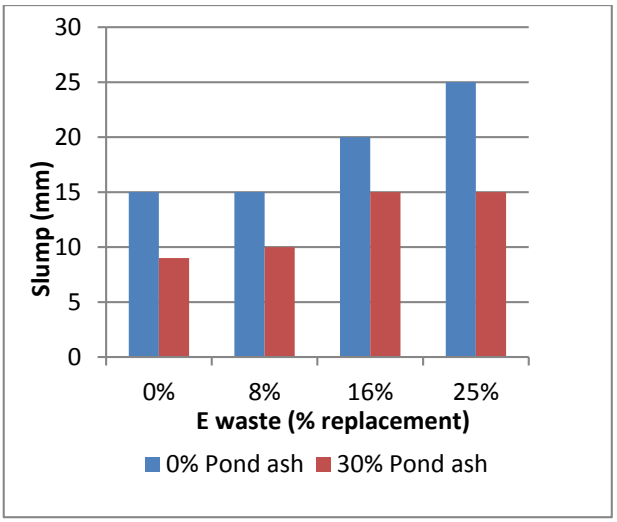

Fig. 5. Workability of concrete with E-waste and pond ash

VI. CONCLUSION

This paper aims to determine the compression strength, tensile strength and workability properties of concrete with pond ash and varying percentages of E-waste. Based on the limited study and test results the following conclusions are made.

1. The compressive strength of concrete decreases with increasing E-waste replacement. Compressive strength decreases by about 16% at a E-waste replacement level of 25%.
2. The tensile of concrete with E-waste increases with the increase in E-waste replacement levels. But addition of pond ash decreases the tensile strength.
3. The workability of concrete increases with increase in E-waste content.
4. The addition of pond ash decreases the compressive strength, tensile strength and workability of concrete when compared to concrete without pondash.
5. It can be concluded that E-waste and pond ash have a negative correlation with compressive strength. Hence,

the use of concrete with E-waste and pond ash should be explored in non-load bearing application.

REFERENCES

[1] Ashwini Manjunath B T. Partial Replacement of E-plastic Waste as Coarse-Aggregate in Concrete. Procedia Environmental Sciences.2016; 35: 731-73.

[2] Amir Mahyar Azhdarpour, Mohammad Reza Nikoudel, Milad Taheric. The effect of using polyethylene terephthalate particles on physical and strength-related properties of concrete; a laboratory evaluation. Construction and Building Materials. 2016; 109: 55-62.

[3] Phanikumar B R, Sofi A. Effect of pond ash and steel fibre on engineering properties of concrete. Ain Shams Engineering Journal. 2016; 7(1) : 89-99

[4] Alqahtani F K, Gurmel Ghataoraa, Iqbal Khan M, Samir Dirar. Novel lightweight concrete containing manufactured plastic aggregate. Construction and Building Materials. 2017; 148(1): 386-397.

[5] Saxena Rajat, Salman Siddique, Trilok Gupta, Ravi K.Sharma, Sandeep Chaudhary. Impact resistance and energy absorption capacity of concrete containing plastic waste. Construction and Building Materials. 2018; 176: 415-421.

[6] Dhirajkumar Lal, Aniruddha Chatterjee and Arunkumar Dwivedi. Investigation of properties of cement mortar incorporating pond ash – An environmental sustainable material. Construction and Building Materials. 2019; 2019: 20-31.