Utilization Of Waste Printed Circuit Boards as Partial Replacement for Fine Aggregate in Concrete.

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Abstract— Every year tonnes of waste printed circuit boards are produced which is serious threat to our environment. Waste printed circuit boards (PCB) may generate from computer, TV remote, cell phones and other electric appliances. Utilization of this material is a optimum solution to the ecological problem and which help in reduction of cost in concrete. In this research, waste printed circuit boards of non metallic powder form is used as a partial replacement for fine aggregate in concrete at 10%,20%, 30% ,40% , 50% along with a 30% replacement of fly ash for cement and a complete study on behaviors of M25 concrete is done . The test result shows a significant decrement in strength of partially replaced concrete. Since there is decrement in strength it can be used for non load bearing structures.

Keywords-waste printed circuit boards;concrete;fine aggregate;waste managment

I. INTRODUCTION

Electronic waste management is a critical issue arising now a day in various countries. Many of the trends in consumption and production processes are unsustainable and pose serious challenge to environment and human health. In this 21st century, usage of electronic appliance and their components drastically increased which result in environmental pollution. Many countries fail to handle this waste printed circuit board due to lack of infrastructure, equipment and knowledge. According to the Central Pollution Control Board (CPCB), in 2005 estimated India's e-waste at 1.47 lakh tones or 0.573 MT per day. A study released by the Electronics Industry Association of India (ELCINA) at the electronics industry expo – "Componex Nepcon 2009" had estimated the total e-waste generation in India at a whopping 4.34 lakh tones by end 2009. The CPCB has estimated that it will exceed the 8 lakh tones or 0.8 MT mark by 2012.There are 10 States that contribute to 70 per cent of the total e-waste generated in the country, while 65 cities generate more than 60 per cent of the total e-waste in India. And the waste generation is expected to increase by 10%-15% per year. PCB form the basic component for most of the electronics, but after its life time the material is not recycled properly either it is directly dumped into land or burnt as it contain hazardous toxic substance which affect the surroundings to a great extent. Printed circuit boards are mainly made up of glass reinforced plastic, metals and with other electronic connections. It can be found in TV's, washing machine, remotes, cell phones, memory cards etc.After the complete removal of precious and useful metals like gold, copper the non metallic waste PCB are not properly recycled. Due to economical growth in India, there is a rapid increase in infrastructure and it lead to consumption of more natural resources. As we know that availability of sand in river bed and other sources are constantly depleting. Optimal and efficient use of natural resources, minimization of waste, development of cleaner products and environmentally sustainable Recycling and disposal of waste are some of the issues which need to be addressed by all concerned while ensuring the economic growth and enhancing the quality of life.

II. LITREATURE REVIEW

Research on E- plastic waste was done by various persons but study on PCB's in concrete is very less. Ru Wang ,Tengfei Zhang and Peiming Wang have done research on mortar cubes with non metallic printed circuit boards as admixture but there is decrease in strength compared to normal control mix. Bulk density, water absorption or water retention and air content in concrete also found. Senthil Kumar and Baskar have presented on E-plastic waste as construction material and the results shows that there is decrease in strength for compressive, tensile and flexure but up to certain percentage of replacement it shows a good result and the concrete with partially replaced E-waste is recommended for non structural elements which lead to reduction of electronic waste. They also done research on high-impact polystyrene (HIPS) as coarse aggregate and found the response of fresh and hardened properties of concrete. By this research it is inferred that when the percentage of HIPS increases, the slump value decreases at the same time it decreases the density so it can reduce the self weight of concrete. Along with this study, shear strength also found for various proportions of HIPS as coarse aggregate. The shear strength decrease with increase in E-waste and the ductility of concrete is increased. This type of concrete can be used for partion walls, light weight walls etc. Lakshmi and Nagan have investigated on durability characteristic of E-plastic waste incorporated concrete such as chloride attack test,sulphate attack test, permeability test,Saturated water absorption, Porosity and Sorptivity. For the above test, the concrete with E-plastic waste shows a good result. Apart from this, they have studied the concrete with same E-plastic waste. Inference of above research paper is E-plastic waste and other electronic waste can be used for concrete as fine or coarse aggregate which help us in formation of new green building material and to conserve the natural recourses for future generation. It acts as good substitute for materials in concrete and it make possible to reuse the non recyclable waste.

III . Materials and Methods

In this research, non metallic waste printed circuit boards powder is used as fine aggregate in concrete at various percentages as 10%, 20%, 30%, 40% , 50% with constant 30% replacement for cement .Ordinary Portland cement (OPC 53 grade) with specific gravity of 3.15 was used in all concrete mixtures , coarse aggregate which pass through 20mm sieve, specific gravity of 2.67 ; river sand was used for fine aggregate with a maximum size of 4.75 mm, specific gravity of 2.6 ; powdered pcb's with size varying from 4.75mm to 2 mm,specific gravity of 1.4 was used as fine aggregate. The powdered waste printed circuit board is very finer, without any metals as shown in Figure 1. A concrete mix of M25 grade with a water to cement (w/c) ratio of 0.45 was used .Potable water available in college campus was used in all concrete mixes.

Figure 1: Powdered waste printed circuit board

IV RESULTS AND DISCUSSION

Fresh concrete prosperities

Slump

Slump cone test is done for the specimen and it compared with the control mix with designed value of 25-50mm.From the experiments results, it is clear that there is very minor change in slump value and the Figure 2 shows that slump is almost same with increase in powdered waste printed circuit boards at 10%, 20%, 30% and at 40%, 50% it shows decrement in slump value.

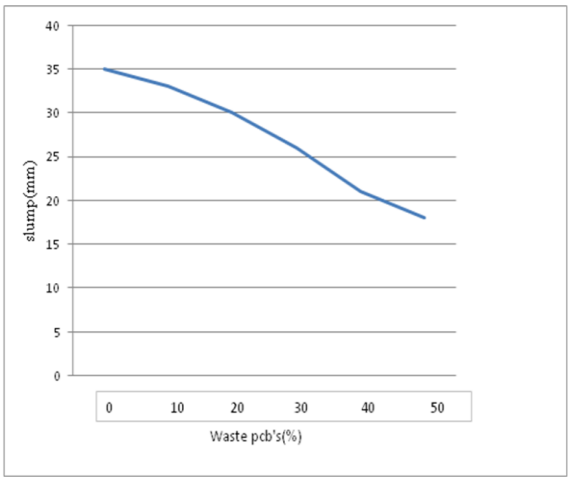

Figure 2:Slump vs PCB %

Fresh and dry density:

Both fresh and dry density of the concrete decreases gradually with addition of waste PCB.As the amount of waste PCB increases at rate of 10,20,30,40 and 50 %, the fresh and dry density tend to decrease. Figure 3 represent the fresh and dry density of concrete at various percentage of waste PCB.

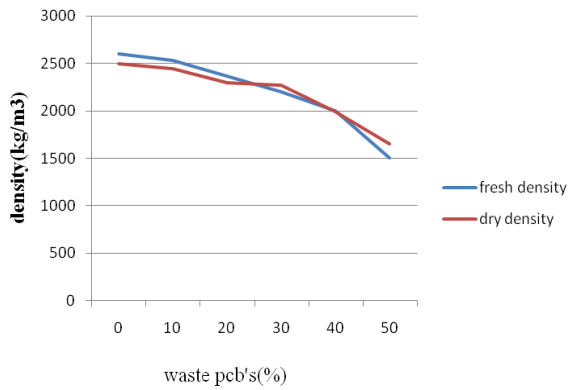

Figure 3: Density vs PCB %

Compressive Strength

Concrete specimens are tested by compression testing machine of capacity 2000KN.The concrete with partially replaced waste PCB's as fine aggregate has low compressive strength at W/C ratio of 0.5.Figure 4 shows the specimen under compression testing machine. The specimens at 10,20,30,40 and 50% replaced fine aggregate tend to decrease in strength when compared control mix concrete as shown in Fig. 5.And Figure 6 shows the characteristic compressive strength at 28 days.

Figure 4:Specimen under compression

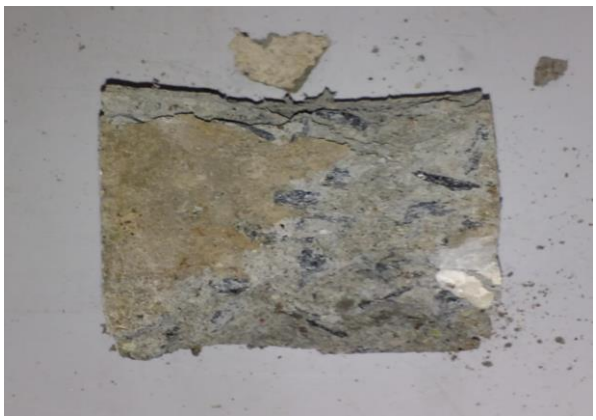

Figure 5:Specimen after failure

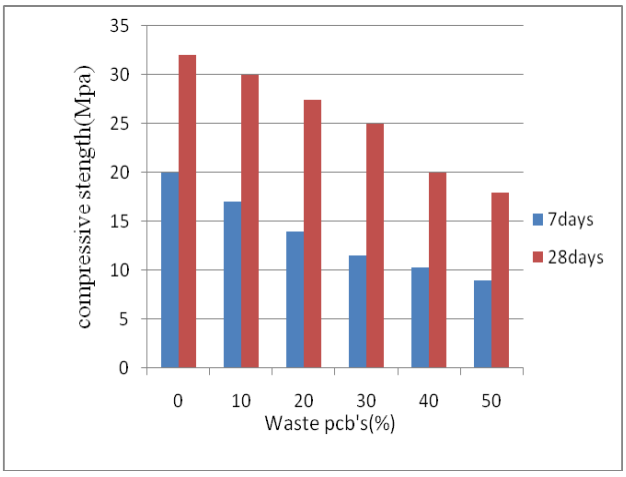

Figure 6:compression strength VS PCB%

Split tensile strength

Split tensile test is done for the specimen and it compared with the control mix .From the experiments results, it is clear that there is a minor change in the values and the Figure 7 shows that values is slightly decreasing with increase in powdered waste printed circuit boards at 10%, 20%, 30%, 40% and 50%.The failure of the concrete specimens under the ultimate load as shown in figure 8.

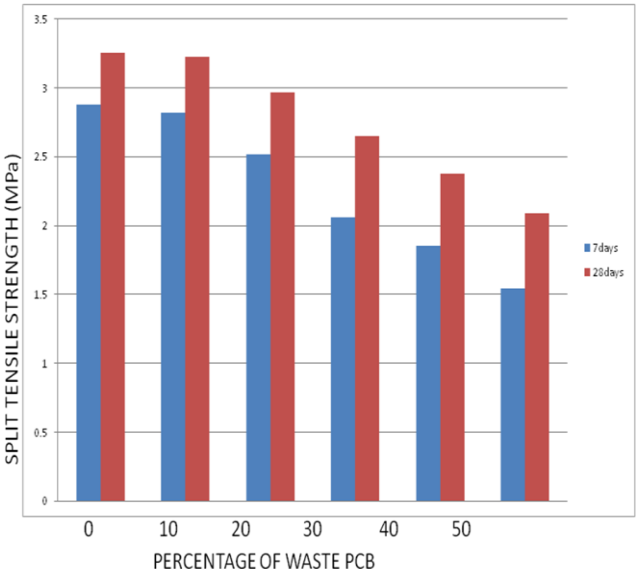

Figure 7: Split tensile strength VS PCB content.

Figure 8 : Failure mode of concrete specimen

Flexural strength

The specimens were tested under flexural testing machine at constant loading rate. Figure 9 shows the failure mode of replaced concrete with waste PCB. As the PCB has poor bonding with coarse aggregate, the flexural strength of concrete decreases with increase in PCB content. The graph between percentage of PCB and reduction in flexural strength was shown in figure 10.

(a)

(b)

Figure 9 : Specimen after flexural test

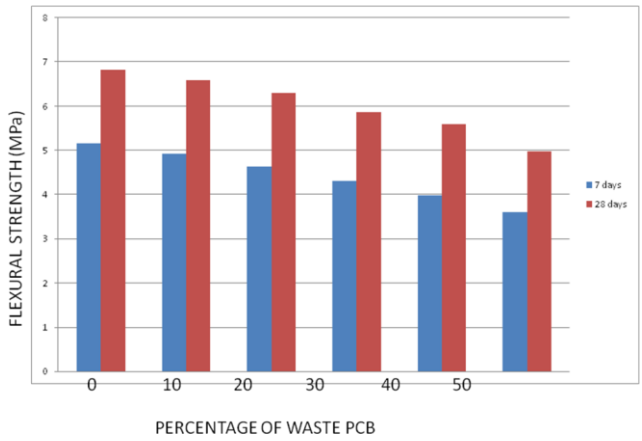

Figure 10 : Flexural strength VS PCB content.

V CONCLUSION

After performing various test and studies on partially replaced waste pcb as fine aggregate obtained from various electronic components it is found that this type of concrete can be used for non load bearing structures.Since it have less compressive strength when compared to normal control mix.But at the same time the density of the concrerte is very less so it can used for light weigth structures.It is recommended for load bearing structures upto 10% of replacement.Finally waste pcb's can be recommeded for concrete for various purposes.By using this material, environment can protected from toxic substances and it make us to reuse and sustaning the construction field with a new material.

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