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UTILIZATION OF E- WASTE AND PLASTIC BOTTLE WASTE IN CONCRETE

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Abstract

E-waste and plastic waste are the major problem in today scenario as these are non-biodegradable. Attempts were made in past to use them in concrete by grinding them. But it failed to give good strength because grinded particle has flattened shape. Grinded plastic and e waste mixed with concrete is a good way to dispose them with cheap concrete production.

The following paper deals with the grinding, rubbing and mixing technique to use e-waste and plastic waste in concrete. E-waste from electrical and electronic equipment, that may be old or might have reached end of life and plastic waste from plastic mineral and cold drink bottles were collected and grinded to size of 2 mm using pulverizing machine. The grinded pieces were rubbed against each other with friction roller machine designed and fabricated by the authors. It is done to develop roughness and make grinded pieces shape irregular so that they can bond well with cement when mixed with it. A mix design was done for M20 grade of concrete by IS method. Ordinary Portland cement of 43 grade was selected. Grinded E-waste and plastic waste were replaced by 0%, 2%, and 4% of the fine aggregates. Compressive strength and flexural strength were tested and compared with control concrete. Experiments done shows increase in compressive strength by 5% and reduce cost of concrete production by 7% at optimum percentage of grinded waste. Grinded waste greater than 4.75mm in certain proportion act as a good filler material in concrete and on-going experiments are done to apply gap gradation by grinding the waste into specific sizes. This will ensure better packing density and hence good strength. Moreover decorative tiles were made with the grinded waste and white cement which give appealing look to the wall and are cheaper than the vitrified tiles.

I. INTRODUCTION

Utilization of waste materials and by products is a partial solution to environmental and ecological problems. Use of these materials not only helps in getting them utilized in cement, concrete and other construction materials, it helps in reducing the cost of cement and concrete manufacturing, but also has numerous indirect benefits such as reduction in landfill cost, saving in energy, and protecting the environment from possible pollution effects. Electronic waste, abbreviated as e-waste, consists of

discarded old computers, TVs, refrigerators, radios – basically any electrical or electronic appliance that has reached its end of life. Plastic waste generated from the cold drinks or water bottle etc. is a major problem for disposal. Efforts have been made in the concrete industry to use non-biodegradable components of E waste and plastic waste as a partial replacement of the coarse or fine aggregates.

Lakshmi.R, Nagan.Sre[1] reported that e-waste can be used by crushing and grounding to the particle size. The divided particle size was assumed to be between 1.18mm – 2.36mm. The compressive strength of the mix was reported to get reduced as the percentage of the e-waste increases.

In this paper an experimental study is made on the utilization of E-waste and plastic waste particles as aggregates in mortar cubes with a percentage replacement ranging from 0% to 8%. E-waste particles were rubbed against each other to form an irregular shape of the particle by mutual friction and to develop roughness on the surface of the grinded particle. Compressive strength with and without E-waste and plastic waste as aggregates was observed which exhibits a good strength gain.

II. EXPERIMENTAL DESCRIPTION

A. Waste collection

E- waste was collected from local electronic shop and plastic bottle were collected from Nirma Institute of Technology, Ahmedabad campus itself. Homogeneous waste of quantity 2kg was grinded for both of these wastes.

B. Method of grinding

Plastic waste of packed water and cold drinks bottle and the e waste were grinded into the scrap grinder machine into small size particles passing through 4.75 mm sieve. Figure 1 shows the scrap grinding machine, the raw waste and the grinded waste. The grinded e-waste was further processed in friction roller machine in which the particles were crushed because of mutual hitting and rubbing action. Figure 2 shows the preliminary machine used for rubbing purpose. The machine was design with power window motor which rotates the friction disk. The particles trapped in between the disk brakes and develop irregular surface which in turn provide more surface area to bind with cement.

The e-waste contents are calculated as weight per cent of coarse aggregate in the control mix. The fineness modulus of coarse aggregate with various e-waste contents was between 1.86 and 2.78 .The e-waste particles can be considered as partial coarse aggregate substitute retaining mix ratio as the same. The divided particle size is assumed to be between 600 micron – 2.36mm.

Plastic bottle were also crushed into flakes passing through 10mm sieve for experimentation purpose.

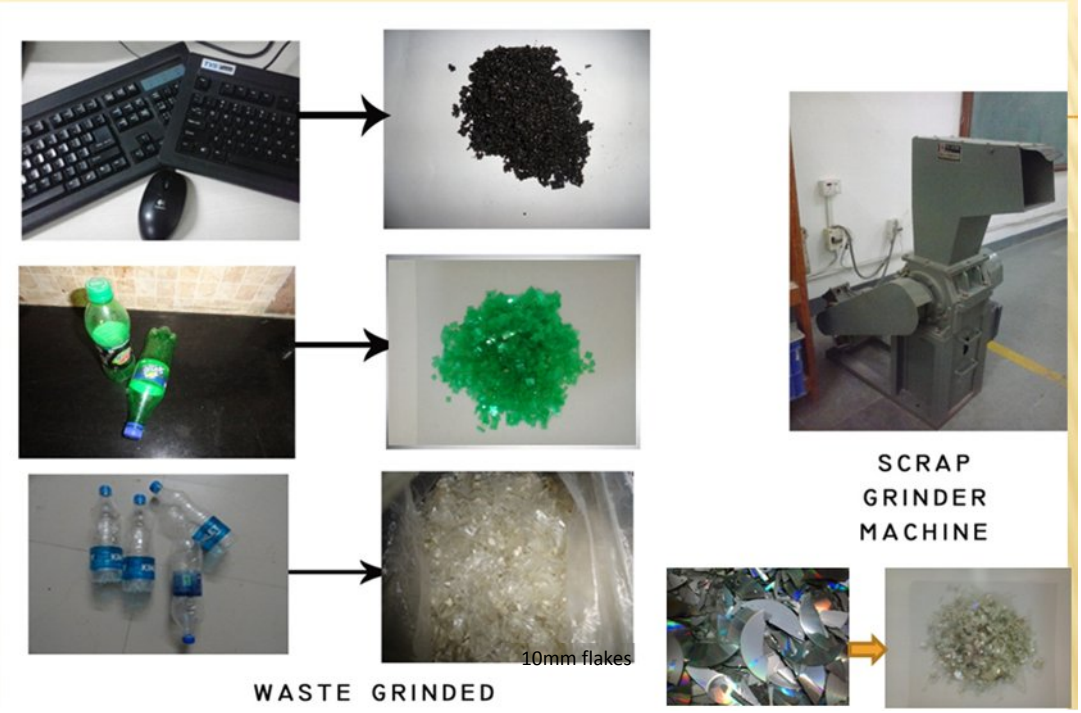

Figure 1: The scrap grinder machine and the grinded material from the base material

Figure 2: A small scale friction rolling machine

The crushed particles were tested on the following properties as shown in the **table1.**

Table 1: The physical properties of the e-waste and plastic waste

Properties	**E waste**	**Crushed plastic bottle**	**Coarse aggregate**
Specific gravity	1.2	**0.8**	2.65
Absorption (%)	<0.2	<0.2	0.5
Color	Black and white	Transparent and green	Grey
Shape	Angular	Angular	Angular

C. Mortar mixes

Cement mortar cubes of 1:3 proportions and modified with various E-waste contents as listed in Table 2. The fine aggregate used is the standard sand specified by is 650-1966 (revised). The waste was mixed as a replacement of fine sand confirming to grade 1. Fig 4 shows the making of the mortar cubes.

Table 2

Mix specification	Control mix		
Proportion of e-waste	0%	2%	4%
Proportion of crushed plastic bottle	0%	2%	4%

D. Tests

Compressive strength test was conducted to evaluate the strength development of mortar containing various E-waste and crushed plastic bottle contents at the age of 7, 14, 28 days respectively. The obtained data can be seen in table 3 and 4.

Fig.4 Casting of cubes, mortar cubes and testing of cubes

E. Plastic waste as a decorative material with white cement

E-waste has the characteristic property that the particle glitters or they have a shiny appearance. Thus experiments were done to use the waste at the exposed surface with the white cement. It has following advantages:-

1) It gives the exposed surface an aesthetic look.
2) It helps checking the crack propagation.
3) It assures less maintenance to the applied surface.
4) As the grinded waste have a shiny texture, thus if they are applied on wall with white putty they will make the wall more refectory.

F. Making of the tiles

10cm*10cm*1cm tiles were made using white cement by selecting a suitable water cement ratio. The white cement paste was filled in the mould and the grinded e-waste and plastic bottle waste was sprinkled over it. As the cement sets, it holds the sprinkled particle. The sprinkle particle which is not holds if removed after setting of the cement. Various shapes and designed were made on tile using the black and green plastic waste. Figure 3 shows some picture depicting the waste used as a material of art.

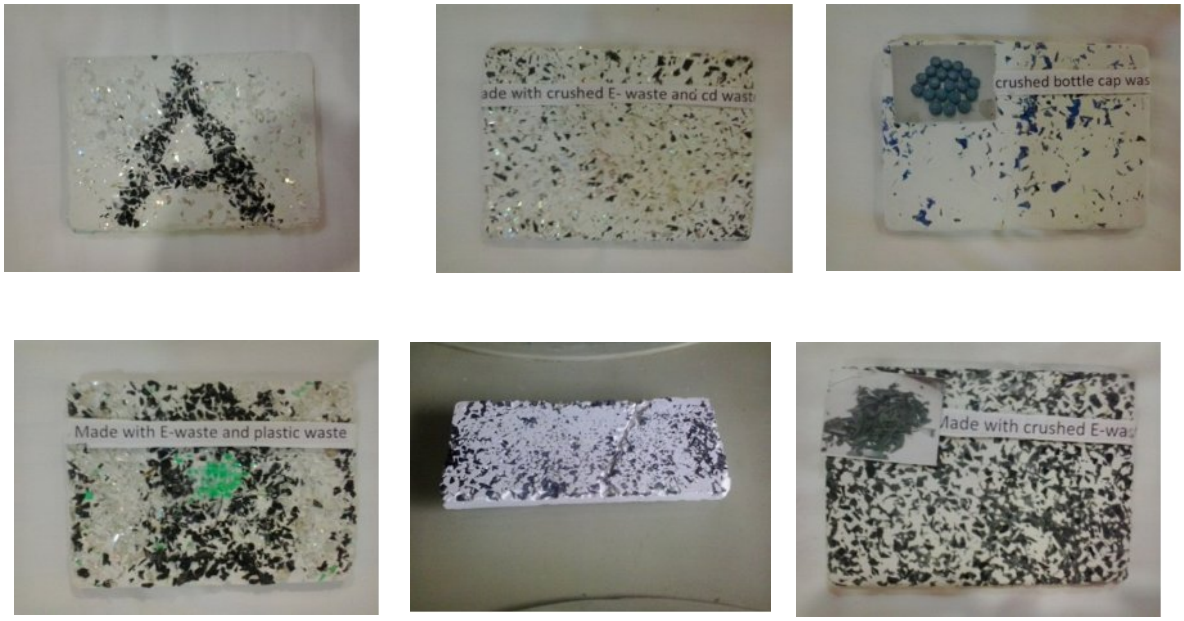

Figure 3: Tiles casted with white cement and waste material

III. RESULTS AND DISCUSSIONS

Compressive strength test was conducted to evaluate the strength development of concrete containing various e-waste contents at the age of 7, 14, 28 days respectively.

Table 3: Compressive strength test results in N/mm^2

Mix Specification	Control mix(A0)	A1	A2
Proportion of E-waste	0%	2%	4%
7 days	22.33	21.02	20.23
14 days	32.67	30.28	29.84
28 days	55.23	55.36	54.25

Table 4: Compressive strength test results in N/mm^2

Mix Specification	Control mix(B0)	B1	B2
Crushed plastic bottle waste	0%	2%	4%
7 days	22.33	20.02	18.26
14 days	32.67	29.36	28.56
28 days	55.23	52.47	48.54

Table 5: Compressive strength test results in N/mm^2

Mix Specification	Control mix(C0)	C1	C2	C3	C4
Crushed e-waste(pulverized by friction roller machine)	0%	2%	4%	6%	8%
7 days	22.33	21.25	23.52	20.15	20.47
14 days	32.67	30.52	33.65	30.21	28.59
28 days	55.23	50.57	58.96	48.84	45.53

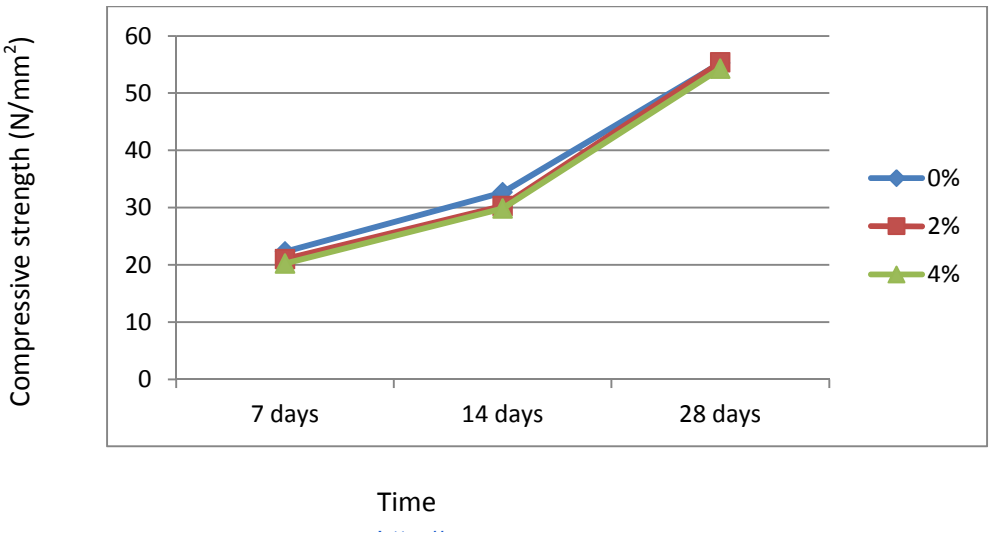

Fig 4: Proportion of E-waste

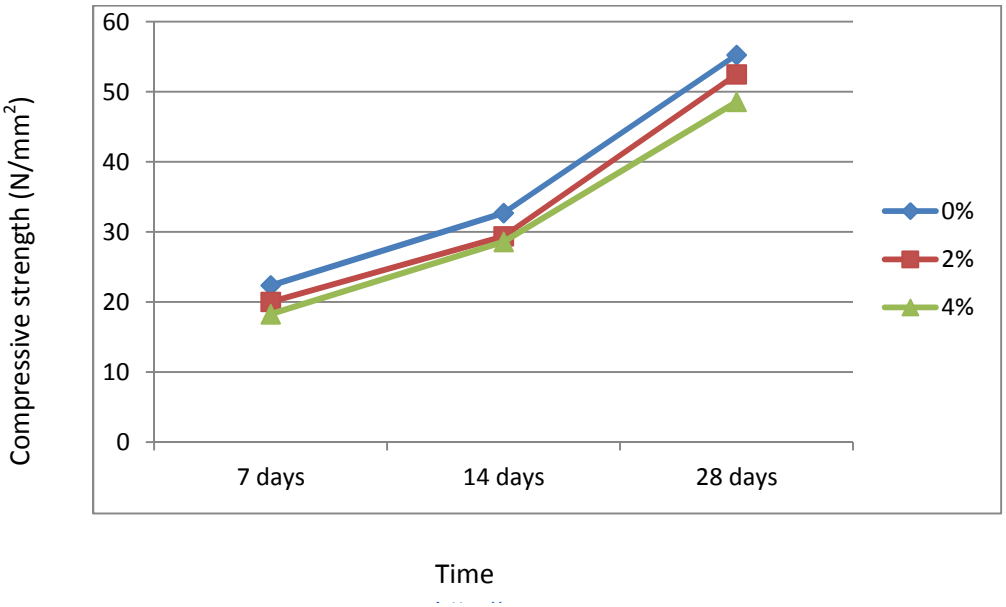

Fig 5: Crushed plastic bottle waste

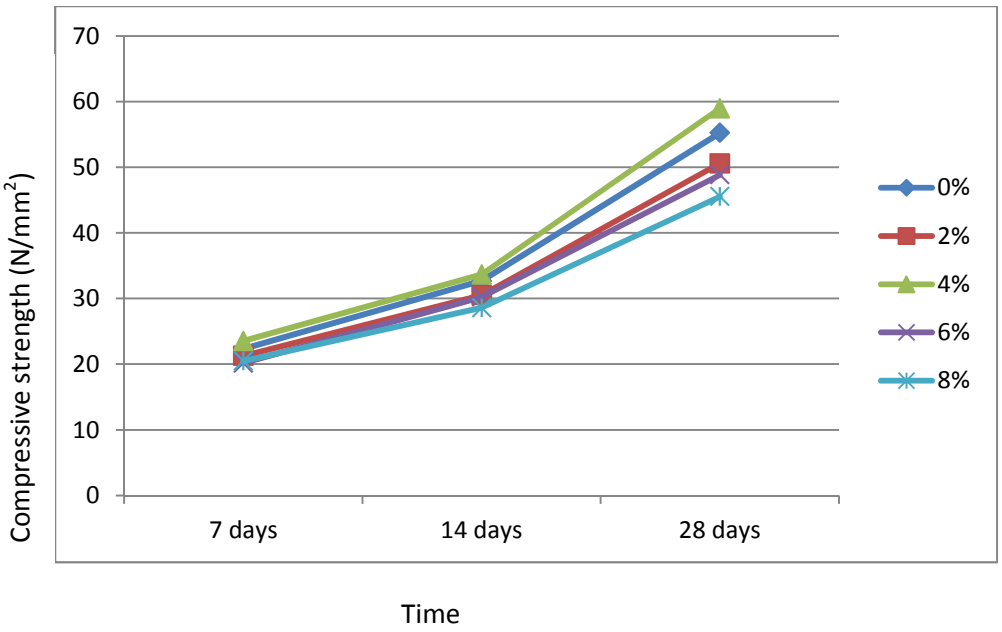

Fig 6: Crushed e- waste (pulverized by friction roller machine)

IV. DISCUSSIONS

An analysis was made on the strength characteristics by conducting the tests on e-waste mortar cubes with grinded e-waste and plastic bottle waste. Figure 4 shows the reduction in the strength of the cubes. It was because of the grinded waste does not possess cementitious property. It does not bind well with the cement and thus the strength was subsequently reduced. Figure 5 shows the strength versus percentage of grinded plastic bottle waste. Due to the flaky nature of the grinded bottle waste the strength was reduced with the increase in proportion of the waste. In the case of crushed e-waste which was pulverized by friction rolling machine strength in figure 6, increases till 4% and subsequent reduction was observed in the strength after that. This fall in strength was because of the decrease in the packing density. Making of tiles out of white cement and e-waste

V. CONCLUSIONS

This study intended to find the effective ways to reutilize the waste plastic waste particles as replacement of aggregate. Analysis of the strength characteristics of mortar cubes containing recycled waste plastic gave the following results:-

1) The strength slightly reduced in case of grinded e- waste was used. This shows that it can be used to replace fine aggregate.
2) The strength varies with the size of the particle of the waste added to the mortar cubes.

3) The strength reduced approx. 12% at 28 day when plastic flakes of 10mm obtained from crushed bottles were used. As the surface area of the plastic was less thus the compressive strength reduces considerably.
4) Study shows that for certain use the flaks can be used as a filler material where more compressive strength is not required for example making of paver blocks.
5) It can be concluded that 4% of e-waste aggregate can be incorporated as fine aggregate replacement without any long term detrimental effects and with acceptable strength development properties.
6) Making of tiles with white cement and crushed e-waste were 20% cheaper than the vitrified tiles of same dimension.

VI. FUTURE SCOPE

1) Specimens are being casted to check the flexure strength and tensile strength by mixing the waste in various proportions.
2) Emphasis has been given to grind the waste into fine powder and mix into such proportion so as to achieve maximum packing density which may result to increase in compressive strength.
3) More verity of the tiles will be made which will increase its popularity in the common mass.

VII. REFERENCES

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