An Experimental View on Partial Replacement of Aggregate by Recycled Plastic Waste

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Abstract

Inclusion of polymer waste in concrete can be a proper utilization of this valuable property. Thus, utilization of waste polymer material in making concrete/mortar can be good solution to this environmental hazard. Very few information is available regarding recycling of polyurethane formaldehyde (PUF) -based polymer wastes and its use as construction materials. The safe use of plastic waste (plastic bags or plastic containers such as water bottle) is very important because plastics are normally stable and not biodegradable.

Keywords – *Partial replacement, material, concrete.*

I. INTRODUCTION

The easiest way for a consumer to identify the type of plastic used in a product is to find the resin identification code (also known as the material container code),is usually moulded, formed or imprinted in or close to the centre on the bottom of the container. This system of coding was developed in 1988 by The Society of the Plastics Industry (SPI), which is the Washington, D.C.-based trade association representing the U.S. plastics industry. The intent was to provide plastic recyclers – which urged the industry to develop such a system – with a consistent national system to facilitate recycling of post-consumer plastics through the normal channels for collecting recyclable materials from household waste.

The coding system is voluntary for plastic manufacturers, but its use has become relatively standard on plastic products sold in the U.S. and internationally. In Canada, the system is in use and is endorsed by the Canadian Plastics Industry Association (CPIA), which provides details on the system through its Environment, Health & Safety strategic unit and its Environment and Plastics Industry Council (EPIC) .The purpose of the coding system is to make it easier for plastics to be recycled, but the codes also provide consumers with a simple, handy technique for identifying the type of plastic resin used to make a particular product. In accordance with SPI guidelines, the code is deliberately placed in an inconspicuouslocation on the product because the industry intent is not to influence the consumer's buying decision, just to facilitate recycling of the product.

Advantages:

1. Plastics can be used to replace some of the aggregates in a concrete mixture. This contributes to reducing the unit weight of the concrete. This is useful in applications requiring nonbearing lightweight concrete, such as concrete panels used in facades.
2. For a given w/c, the use of plastics in the mix lowers the density, compressive strength and tensile strength of concrete.
3. The effect of water-cement ratio of strength development is not prominent in the case of plastic concrete. It is because of the fact that the plastic aggregates reduce the bond strength of concrete. Therefore, the failure of concrete occurs due to failure of bond between the cement paste and plastic aggregates.
4. Introduction of plastics in concrete tends to make concrete ductile, hence increasing the ability of concrete to significantly deform before failure. This characteristic makes the concrete useful in situations where it will be subjected to harsh weather such as expansion and contraction, or freeze and thaw.
5. The inclusion of recycled aggregates in the concrete of the buildings under investigation has been shown to be advantageous from an energy point of view. The use of plastic aggregates helped in keeping the interior cooler, when the outside temperature is raised, as compared to the corresponding control concrete

II. METHODOLOGY

The plastic waste used as aggregate was collected from a plastic recycling plant. The plant mainly recycles post-consumer PET bottles collected as compressed bales that come from urban and industrial collection sites. The bales of PET-waste mostly consist of dirty PET-bottles, which are usually contaminated with other materials and with some non-PET containers such as PVC, HDPE and poly propylene, bottles.

In this plastic waste treatment plant, several steps are adopted to recycle waste plastic. The coarse flakes and fine fractions were obtained after mechanical grinding of PET wastes followed by cleaning and separation by physic-chemical

methods. The plastic pellet is produced from plastic flakes. This material consists of predefined and even-sized PET-grains, free of contamination at the microscopic level.

For coarse aggregate:-

IS Sieve Analysis	Wt. Retained	% Wt. Retained	Cumulative % Retained	% Passing
	(A) grams	(B)	(C)	(100-C)
40 mm	0	0	0	100
20 mm	200	10	10	90
12.5 mm	880	44	54	46
10 mm	100	40	94	6
4.75 mm	800	5	99	1
Pan	20	1	100	0
Total	**2000**			

Workability Test Results (Slump Cone Test)

Volume Fraction	Slump (mm)
Quality Control	140
2.5%	140
5%	111
8%	100

Compressive strength test results with different percent of plastic waste

DAYS	Quality Control (N/mm^2)	Avg	2.5% (N/mm^2)	Avg	5% (N/mm^2)	Avg	8% (N/mm^2)	Avg
7	21.64	21.68	16.53	16.03	17.51	16.74	12.91	11.39
	22.44		16.0		16.88		9.42	
	20.97		15.55		15.82		11.84	
28	28.97	33.12	29.64	29.3	29.28	26.94	18.8	18.79
	37.28		29.42		26.31		16.84	
	33.11		28.84		25.24		20.75	

Tensile strength test on cylinder result with different percent of plastic waste

DAYS	Quality Control (N/mm^2)	Avg	2.5% (N/mm^2)	Avg	5% (N/mm^2)	Avg	8% (N/mm^2)	Avg
7	4.11	3.64	2.276	2.12	3.078	3.13	0	0
	3.52		2.0		3.17		0	
	3.28		2.09		3.14		0	
28	4.65	4.72	3.96	3.93	3.72	3.44	2.66	2.6
	4.44		4.08		3.56		2.60	
	5.07		3.75		3.06		2.55	

III. CONCLUSION

Workability

- Workability Decreases with addition of large size of plastic
- Workability Increases with addition of small size of plastic as compared to long plastics.

Compression Strength and Split Tensile Strength

- A reduction in bleeding is observed by addition of plastic waste in the concrete mixes.
- When the plastic waste added in concrete then density of concrete also decreases.
- Synergic effect was observed due to both large size plastic & small size plastic in different proportions.

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