Waste Polythene in Concrete - An Attempt towards its Disposal

Vikas Srivastava
Assistant Professor, Department of Civil Engineering,
SHIATS (Formerly AAI-DU),
Allahabad - 211007. India

Manish Chaudhary
Ex. P. G. Student, Department of Civil Engineering
SHIATS (Formerly AAI-DU),
Allahabad - 211007. India

Ankit Kumar
Department of Civil Engineering
Invertis University
Bareilly, U.P. 243123

***Abstract* - The present era may be termed as plastic era. Plastic in different form has become part and parcel of our life. As per estimation around one trillion plastic bags are being used around the world per year. Plastic bags have become a serious problem in terms of solid waste as being used in plenty in market and packaging. Disposal of polythene wastes in environment is considered to be a huge problem as plastic is durable and non-biodegradable. India banned the production of plastic bags below 20 µm in thickness in 2002. Plastic bags cause chocking of the municipal drainage systems. Often the sacred cows are ingesting plastic bags as they confuse it for food. This paper presents the results of an experimental investigation carried out to study the suitability of addition of waste plastic bags on mechanical properties of concrete. In the present investigation waste polythene bags in fibrous form were added in concrete and compressive and split tensile strength after 7, 28 and 56 days curing were determined besides workability in fresh state. Test results showed that workability was considerably decreased with increase in dose of waste polythene, however, both compressive and flexural strength considerably increased with addition of waste polythene.**

Keywords- Waste polythene, concrete, compressive strength, split tensile strength, workability.

I. INTRODUCTION

Solid waste management has become the area to be emphasized spatially after being considered a key point in the process of developing smart cities. Plastic industry is one of the fastest growing industries of the earth and around one trillion polythene bags are being used around the world per year, which is expected to increase by the age. Polythene bags have become a major pollutant in terms of solid waste as it is being used in packaging, carrying and delivering the various goods at different locations and by different processes. Disposal of polythene bags in environment is considered to be a huge problem as plastic is durable and non-biodegradable. The chemical bonds of polythene make it very durable and increase its resistance against the natural process of degradation. Polythene bags have become a part and parcel of our daily life which increase the plastic wastes these either gets mixed with municipal wastes or are thrown over land. The only disposal of plastic waste is either by land filling or by incineration but both processes have significant impact on the environment. If it is dumped, it causes soil and underground water pollution and if it is incinerated, it causes air pollution. Thus an alternate use of this plastic waste is required.

In India around 370 million cum per year concrete is consumed by the construction industry which is expected to increase at the rate of 30 million cum every year. Cement, aggregates and water are the three basic ingredients required to make concrete. Cement reacts with water to form hardened silicate compounds that bind all the components together into one homogenous material – concrete. Concrete's constituent materials occur naturally in all parts of the world.

Research works are on to make a use of plastics wastes effectively in the development of roads. Also recently, a new concept of using plastic wastes as additives in plain and reinforced concrete mixes for many purposes is being developed. This study attempts to find the effective use of waste polythene bags in concrete to prevent the ecological and environmental strains caused by them.

Bhogayata et al. [1] added plastic waste in fibre form (0% to 1.5% by volume of concrete) along with fly ash (0% to 30% by volume of concrete) at different water cement ratios. Different curing conditions were used to note the effect of chemical attack and corresponding change in the compressive strength of concrete mix. In another study Bhogayata et al. [2] used ordinary plastic bag having thickness less than 20 micron in the form of plastic fibres (0% to 1.2% plastic by volume in concrete) and the compressive strength was compared for manually cut and shredded plastic.It is concluded that the plastic bags should be used, preferably in shredded form to avoid difficulty in workability.Macro fibres made from bags (hand cut) are not suitable due to their low aspect ratio. Beyond 0.6% of concrete volume, the fibres made from the plastic bags having thickness less than 20 microns, reduced the strength. Kandasamy and Murugesan [12] used polymer fibres in concrete by weight of cement and reported an increment in compressive strength of 0.68% at 7 days and 5.12% at 28 days. Naik et al. [11] reported that the compressive strength decreased with the increase in the amount of plastic in concrete, particularly beyond 0.5% plastic. Rai et al. [4] used plastic pallet as fine aggregate and studied the workability, compressive strength and flexural strength of wastes plastic mix concrete with and without superplasticizer. Rebeiz[9] investigated the strength properties

of unreinforced polymer concrete using an unsaturated polyester resin based on recycled polythene terephthalate (PET). Marzuok et al. [10] studied the use of consumed plastic bottle waste as sand-substitution within composite material for building application and showed the effects of PET waste on the density and compressive strength of concrete.

This paper presents a part of the experimental programme carried out to study the workability, compressive strength and flexural strength of concrete at different doses (0.4%, 0.6% , 0.8% and 1.0%) of waste plastic in fibrous form and compare the results with conventional concrete.

II. MATERIAL AND METHODS

To study the workability slump cone was used and to determine compressive and split tensile strength of concrete, cubes and cylinders respectively were cast using a nominal mix of (1:1.65:3.). The w/c ratio is kept as 0.44. The Specimens are tested to determine compressive strength and split tensile strength after 7, 28 and 56 days of moist curing. Test set-ups for compressive strength test and split tensile strength test are shown in Fig. 2 and Fig. 3 respectively.

Cement: In this study, Portland Pozzolana Cement (PPC) of Prism brand is used throughout the investigation. The physical properties of PPC as determined are given in Table 1. The cement satisfies the requirement of IS: 1489:1991.However, similar material properties were reported by Ankit et al. [3].

S. No.	Properties	Experimental value
1.	Normal Consistency (%)	32.5
2.	Initial setting time	145min
3.	Final setting time	215min
4.	Soundness of Cement (Le-chatelier expansion)	0.70mm
5.	Fineness of Cement (%age retained on 90 micron IS sieve)	3.77%
6.	Specific gravity of Cement	2.67
7	Compressive Strength	
8.	3 Days	23.0

Fine Aggregate: Aggregate most of which passes through 4.75mm IS sieves are called fine aggregate. The specific gravity, bulk density and fineness modulus of fine aggregate are given in Table 1. However, similar material properties were reported by Ankit et al. [3].

TABLE II PHYSICAL PROPERTIES OF FINE AGGREGATE.

S. No.	Test	Result
1	Fineness Modulus	2.52
2.	Specific Gravity	2.9
3.	Bulk Density	1.688 kg/litre

Coarse Aggregate: Coarse aggregates are the stones that are retained on 4.75 mm sieve. Coarse aggregates are locally available quarry having two different sizes; one fraction passing through 20mm sieve and another fraction passing through 10mm sieve. The specific gravity of coarse aggregate for both fractions and fineness modulus for the coarse aggregate of 10mm and 20mm size are given in Table-2. Proportion of 20mm and 10mm size aggregate in concrete is maintained in the proportion of 60% and 40%. However, similar material properties were reported by Ankit et al. (3). respectively.

TABLE III PHYSICAL PROPERTIES OF COARSE AGGREGATE.

S. No.	Test	Result
1.	Fineness modulus for 20 mm	7.44
2.	Fineness modulus for 10 mm	6.68
3.	Specific Gravity	2.7
4.	Impact value	25.38%
5.	Crushing value	24.07%

Waste Polythene: The waste polythene used in this study is shown in fig. 1. It was shredded in very fine random fibre form. The specific gravity for polythene waste is 0.41 and aspect ratio lies between 250 and 500. However, similar material properties were reported by Ankit et al.[3]

.

Fig. 1 Sample of waste polythene used.

Water: Potable water is used for mixing and curing.

Superplasticizer: In this study superplasticizer of Sica company is used in 0.5% dose of weight of cement for enhancing the workability and compressive strength of cement.

Concrete: Mix design for the concrete is carried out in accordance with IS 10262(2009). The cement content used in the mix design is 380 kg/m^3, which satisfies the minimum requirement of 300 kg/m^3 in order to avoid the balling affect. In the present investigation M25 grade concrete was designed.

III. RESULTS AND DISCUSSION

A comparative study of concrete mixes is carried out to find the effect on workability, compressive strength and flexural strength of concrete by adding waste polythene.

Workability:

Slump of fresh concrete at different doses of waste polythene is shown in table 4 and these values are graphically represented in fig.2. It is observed that the slump decreases with increase in dose of waste polythene. It seems that the bonding between the plastic particles and the cement paste is weak. However, surface area of mix is increased which need more water for lubrication thus decrease the workability.

TABLE IV SLUMP VALUES OF CONCRETE MIX WITH VARYING DOSE OF WASTE POLYTHENE

S. NO.	Dose of polythene (%)	Dose of Super plasticizer (% of weight of cement)	Slump value (mm)
1	0	0.45	118
3	0.40	0.45	78
3	0.60	0.45	56
4	0.80	0.45	36
5	1.00	0.45	25

Compressive strength of concrete:

The compressive strength of concrete made using polythene waste after 7, 28 and 56 days are given in table 3. It is observed that the compressive strength at 28 days was not meeting the target mean strength of M-25 grade concrete. This may be due to the use of superplasticizer which to some extent acts as retarder. However, the strength at 56 days is satisfactory. The results of compressive strength test are shown graphically in figure 4 for visual observation. It is observed that, the compressive strength increases up to the optimum percentage of waste polythene (0.75% of weight of cement) and after that it tends to decrease. However, the strength of 1% waste polythene concrete is also more than that of referral concrete.

TABLE V COMPRESSIVE STRENGTH OF CONCRETE

S. NO.	Dose of waste polythene (%)	Compressive strength (N/mm^2)		
		7 days	28 days	56 days
1	0	21.80	27.89	35.16
3	0.40	22.00	32.66	36.14
3	0.60	22.40	35.86	39.27
4	0.80	23.66	36.06	39.53
5	1.00	22.86	26.95	38.50

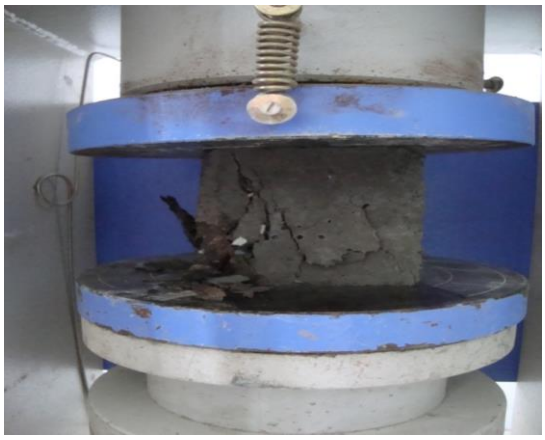

Fig. 3 Set up for compressive strength test in compression testing machine.

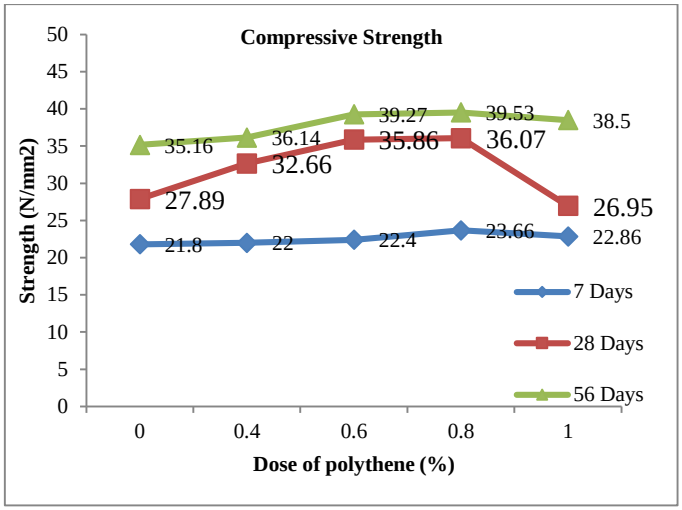

Fig. 4 Compressive strength of concrete with varying dose of waste polythene.

Flexural strength of concrete:

The flexural strength of concrete made with polythene waste after 7, 28 and 56 days is given in table 6. The experimental set up for determination of flexural strength is shown in figure 5.These results are shown graphically also in figure 6 for visual observation. It is observed that, the flexural strength increases with increase in percentage of waste polythene in concrete. However, the optimum dose of polythene is 0.75% (by weight of cement).

TABLE VI FLEXURAL STRENGTH OF CONCRETE

S. NO.	Dose of waste polythene (%)	Flexural strength (N/mm^2)		
		7 days	28 days	56 days
1	0	3.15	4.05	4.35
3	0.40	3.52	4.35	5.85
3	0.60	3.45	5.10	5.40
4	0.80	3.60	6.15	5.70
5	1.00	3.15	4.80	5.70

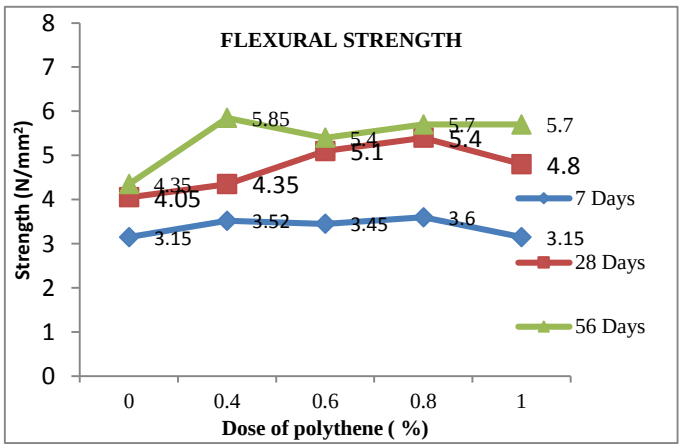

Fig. 6 Flexural strength of concrete with varying dose of waste polythene.

IV. CONCLUSION

Based on the experimental data the following conclusions are made:

1. Workability is reduced with increase in the dose of waste polythene in concrete.
2. Compressive strength is increased on inclusion of waste polythene in concrete at all ages.
3. The flexural strength increases with inclusion of waste polythene in concrete at all ages.
4. Optimum dose of waste polythene in concrete is 0.75% of cement weight in respect of both compressive and split tensile strengths.
5. The concept of mixing of waste polythene in concrete could be a very environment friendly method of disposal of solid waste in the country.

REFERENCES

[1] Bhogayata, K. D. Shah, B. A.vyas, N. K. Arora " Feasibility of wastes metallised polythene used as concrete constituent" in International Journal of Engineering and Advanced Technology (IJEAT),Volume-1, Issue-5, June 2012

[2] Bhogayata, K. D. Shah, B. A.vyas, N. K. Arora"Performance of concrete by using Non recyclable plastic wastes as concrete constituent" in International Journal of Engineering and Advanced Technology (IJEAT),Vol. 1 Issue 4, June – 2012

[3] Ankit Kumar, Vikas Srivastava and Rakesh Kumar , "Effect of waste polythene on compressive strength of concrete", Journal of Academia and Industrial Research, Volume 3, Issui 3, August 2014 pp. 152-155.

[4] Baboo Rai,S. Tabin Rushad,2 Bhavesh Kr, and S. K.Duggal"Study of wastes plastic mix concrete with plasticizer" in International Scholarly Research Network ISRN Civil Engineering Volume 2012, Article ID 469272, doi:10.5402/2012/469272

[5] IS: 456. 2000. Indian Standard "Plain and Reinforced Concrete" - Code of practice. Bureau of Indian Standards, New Delhi

[6] IS: 516. 1959. Indian Standard "Methods of Tests for Strength of Concrete"- Code of practice. Bureau of Indian Standards, New Delhi.

[7] IS: 10262. 2009. Indian Standard "Recommended Guidelines for Concrete Mix Design"- Code of practice. Bureau of Indian Standards, New Delhi

[8] IS: 383. 1963. Indian Standard "Specification for Coarse and Fine Aggregates from Natural Sources for Concrete"- Code of practice. Bureau of Indian Standards, New Delhi.

[9] K. S. Rebeiz, "Precast use of polymer concrete using unsaturated polyester resin based on recycled PET waste" inConstruction and Building Materials, vol. 10, no. 3, pp. 215–220, 1996

[10] Marzouk OY, Dheilly RM, Queneudec M. "Valorisation of Post Consumer Waste Plastic in Cementitious Concrete Composites", Pub Med, U.S. National Library of Medicine, National Institute of Health, vol. 27 (2), Issue-12, 310- May, 2006

[11] Naik, T.R., S.S. Singh, C.O. Huber and Broderson, 1996 "Use of post consumer waste plastic in cement based composites". Cem.Concr. Res26: 1489-149

[12] R. Kandasamyand R. Murugesan"Fibre reinforced concrete using domesticwastes plastics as fibres" in ARPN Journal of Engineering and Applied Sciences, Vol. 6, No. 3, March 2011.