Comparative Study of Utilization of Waste Product Plastic and Fly Ash in Concrete

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Abstract—**Behavior of Plastic Mixed Reinforced Concrete columns under axial compression one of the main environmental problem today is disposal of the waste plastics. The use of plastics in various place as packing materials and the product such as bottles, polythene sheets, containers, packing strips, etc. are increasing day by day. This result in production of plastics wastes from all sorts of living from industrial manufacturers to domestic users. To circumvent this pollution crisis, many products are being produced from reusable waste plastic. On the other side, the Indian construction industry is facing problems due to insufficient and unavailability of construction materials.**

So, we need to search for new construction materials as well as method to dispose the plastic waste. To find a solution to the above problems, one of them can be used to solve the

other. In this experimental study, an attempt has been made to use the waste plastic in concrete and studies have been conducted to focus particularly on the behavior compression members with various proportion of plastic waste. The plastic used in this investigation were polythene sheets, raw plastics (raw material used for straw manufacturing) road waste (waste plastic collected from road sides are melted shredded) and plastic straw.

The above plastic waste were mixed with cement concrete in various proportion and test specimen were cast (cubes and columns) to study the behavior of plastics mixed concrete in axial compression.

Keywords - Plastic, Fly ash, Concrete Mix Design, Compressive Strength.

I. INTRODUCTION

The Indian concrete industry is today consuming above 400 million tons of concrete every year and it is expected, that this may rich a billion tones in a less than a decade. All the material required produce such huge quantity of concrete come from the earth crust this depleting its resource every year creating ecological strengths. On the other hand human activities on earth produce solid waste in considerable quantities i.e., over 2500 million tonnes per year including industrial waste, agricultural waste and other waste from rural and urban societies. Disposal of such solid waste involves economical issues as well as ecological and environmental consideration. The major ecological strain in disposal of solid waste may be due to presence of waste plastic in it.

The plastic is one of the recent engineering materials which have appeared in the market all over the world. Same varieties of naturally occurring thermoplastic were known Egyptians and Romans who extracted and used these plastics for various purposes. Plastic were used in bath and sink unit, corrugated and plain sheets, floor tiles, joint less flooring, paint and varnishes and wall tiles Other than this domestically plastic were used in various forms as Cary bags, bottles, cans, and also medical utilities. There has been a steep rise in the production of plastic from the mere 30 million KN in 1955; it has touched 1000million KN at present. It is estimated that on an average 25% of total plastic production in the world is used by the building industry. The per capita consumption of plastics in the developed countries ranges from 500 to 1000 N while in our country, it is only about 2N.There is however now increase in awareness regarding the utilization of plastic as a use full building material in our country. These types of usages normally generate more amounts of wastes which are to be disposed of properly.

Environmentally sensitive aware people condemn the use of plastics for amount of pollution caused by them in disposal. However this is not a serious problem in comparison to the waste and pollution generated by a host of other industries. The non-biodegradable plastic products used for soft drink bottles, milk and juice bottles, bread bags, syrup bottles, coffee cups , plastic utensils etc., Can be conveniently recycled in to carpets, detergent bottle , drainage pipes, fencing, hand rails, grocery bags , car battery cases, pencil holders, benches,

picnic tables, road side posts etc. The developing construction field consumes a huge amount of concrete and it leads to the depletion of natural products and causes environmental pollution.

Plastic are normally stable and not bio-degradable. So, there disposal possesses problems. Research works are going on in making use of plastics wastes effectively as additives in bitumen mixes a for theroad pavement. Reengineered plastic are used for solving the solid waste management problems to great extent. This study attempts to give a contribution to the effective use of waste plastic in the concrete in order to prevent the ecological and environmental strains caused by them, also to limit the high amount of environmental degradation.

II. LITERATURE REVIEW

1. FORTA ECONO_NET manufactured by FORTA Corporation, USA is a homopolymer, polypropylene fibrous reinforcement in a collated fibrillated (network) form. This is used to reduce plastic and hardened concrete shrinkage, improves impact strength, increase fatigue resistance and concrete toughness. This product is non-corrosive, non-magnetic, chemically inert and 100% alkali proof.

2. LAKSHMIPATHY et.al (2003), have done experimental investigation to study the suitability of the use of re-engineered plastic as fiber for road pavement. The properties studied include compressive strength, tensile strength, flexural strength under reversed cyclic loading, impact resistance, plastic shrinkage and abrasion resistance etc., Efforts have been made to compare it steel fibers. The result has shown that the improvement of concrete properties at lower cost is obtained with Re-engineered plastic shred reinforced concrete.

3. PROBER DAS (2004) has suggested that plastic can be used in construction industry at various places. Proper selection material/grade and suitable design considerations can help to replace many more application. Lighter weight, design flexibility, part integration, low system cost, very high productivity and improved product appearance are the main feature for use of engineering plastic.

4. CHANDRAKARAN (2004) has explained a laboratory experimental studies carried out to utilize waste plastic (in the form of strips) obtained from milk pouches in the pavement construction. Results of the study indicate that by adding plastic strips in the soil, shear strength, tensile strength and CBR values of the soil increases. In this study, plastic or polythene sheets having thickness of 0.5mm and which are made up of high density are used. Three types of plastics strips were used in this study to act as reinforcing material. The first one was cut in to 20mm x 40mm size, second one was 25mm x 50mm size and the third one was 30mm x 60mm size. These plastic strips have innumerable advantageous properties like high tensile strength, low permeabilityetc., these plastic strips act as a good barrier to gases and liquids and unaffected by cycles of wetting and drying. For all the strips used in this experimental work, an aspect ratio of 2 is maintained.

5. AGARWAL (2004) has conducted pilot level studies using industrial PVC scrap to develop PVC board. Efforts have been made in developing innovative number of such alternative building materials. These would be helpful in saving our precious forest and environment efficiently and economically on commercial exploitation. Developed materials are mostly wood alternatives used in the construction on door shutters, frames, false calling, thermal insulation and a like applications. Developed sustainable alternative building material are good economic replacement of wood and other reconstituted wood products commercially available and would be helpful in cost effective construction.

6.VASUDEVAN (2004), in his report has given most useful ways of disposing waste plastic and laying roads have come to light in a research carried out by the chemistry department of Thiyagarajar College Of Engineering. They have reported that the waste plastic may be used in block making modified light roofing, mastic flooring and polymer reinforced concrete. The novel composition of waste polymer-aggregate blend has been patented. They have suggested that utilization of waste plastic to enhance the binding property is better option that disposing or enforcing a blanket ban of the use of plastic. It has been reported that the per capita use of plastic in India is 3.5kg, with virgin plastic accounting for 3.1 million tones and recycled plastics, one million.

III. MATERIALS

In the experimentation, 43grade cement having specific gravity of 3.15 was used along with the locally available sand and aggregates. The fineness percentage of the cement used was 5%. The sand having specific gravity of 2.6 with fineness modulus of falling under zone II was used. The coarse aggregate having a specific gravity of 2.61 with 10mm down size and 20mm maximum size were used in the experimentation.

a) **Cement:** Cement composition and fineness play major role in controlling concrete properties. Fineness of cement affects the workability and water cement of a concrete mixture much like the amount of cement used in concrete does.

b) **SAND:** The sand in mortar does not add to its strength but in used as the adulterant. For economy. But it prevents the shrinkage and cracking of mortar in setting. The amount cement of required will be less when voids in the sand are less and then sand will be more economical.

c) **AGGREGATES:** Aggregate is a collective term for the mineral materials such as sand, gravel and crushed stone that are used with a binding medium (such as water, bitumen, Portland cement, lime, etc.) to form compound materials (such as asphalt concrete and Portland cement concrete.

Aggregate is also used for base and sub base courses for both flexible and rigid pavements. Aggregates can either be natural or manufactured.

Natural aggregates are generally extracted from larger rock formations through an open excavation (quarry). Extracted rock is typically reduced to usable sizes by mechanical crushing. Manufactured aggregate is often the byproduct of other manufacturing industries.

d) Plastic Used in the Investigation: The four types of plastic used in this experimental investigation were thermoplastic products. They are,

Polythene Sheet, Road Waste, Raw Plastics, Plastic Straw.

a. Polythene Sheets: The polythene sheets are organic polymers containing carbon in addition to hydrogen, oxygen, nitrogen. The thickness of the polythene sheet used in the present investigation was 205 microns.
b. Road Waste: These are nothing but the waste plastics found on the road sides, which were collected and heated. After heating the products were cooled and the resultant product was shredded. These shredded plastic products were selected to mix along with concrete. This type of plastic was mentioned as road waste.
c. Raw Plastics: The raw material used for manufacturing the plastic straw was called as plastics. These were round shaped plastic granuiesehich were white in color.
d. Plastic Straw: These are tubular plastic products used in day today life. These were mixed along with concrete after cutting them along its cross section. Then the cast specimens were de-molded next day and subjected to curing

e)FLY ASH

Fly ash is the finely divided residue that results from the combustion of pulverized coal and is transported from the combustion chamber by exhaust gases. Over 61 million metric tons (68 million tons) of fly ash were produced in 2001.

IV. METHODOLOGY

The size of polythene sheets were cut in to 1 cm by 10 cm and arranged in layers in between the concrete. The plastic straw was cut across it cross section for a length of 10cm arranged as layers in between the concrete according to the calculated percentages. The percentage of addition of plastics was varied from 0.1% to 1.5% by weight and specimens were cast. The cast specimens were cured 7 days. The mix proportion used in the present investigation was 1:1.2:1.82 with water cement ratio of 0.4. The ingredients of the concrete viz. cement, sand and aggregate were weighed and mixed dry. To this dry mix the calculated quantity of road wastes (and raw materials) were added and the mixing was continued till a homogeneous mix was obtained. Then the calculated quantity of water was added and again mixed thoroughly. Whereas, for the polythene sheet (and plastic straw), the concrete was mixed well and the filled in layers by introducing the calculated quantity of polythene sheet (or plastic straw). The specimen cast was cubes, cylinders and prisms. The cast specimen after curing was subjected to compression testing, spilt tensile testing and flexural strength testing. The result as obtained are discussed (with the help of graphs) under "Results and Discussion."

V. MIX DESIGN

Concept of mix design: The design of concrete mix is not a simple task on account of the widely varying properties of the constituent materials ,the conditions that prevail at the site work, in particular the exposure condition that are demanded for a particular work for which the mix is designed. Design of concrete mix requires complete knowledge of various properties of these constituent materials, the implications in case of change on these conditions at site, the impact of the properties of plastic concrete on the hardened concrete & the complicated inter-relationship between the variables. Design of concrete mix needs not only the knowledge of material properties & properties of concrete in plastic condition; it also needs wider knowledge & experience of concreting.

Mix design can be defined as the process of selecting suitable ingredients of concrete & determining their relative proportions with the object of producing concrete of certain minimum strength & durability as economically as possible. The object is to achieve the stipulated minimum strength & durability. The second object is to make the concrete in the most economical manner.

INDIAN STANDARD CODE METHOD:

Indian standard institution has brought out mix design procedure mainly based on the work done in national laboratories this is covered in IS: 456-2000.

M40 MIX DESIGN: As per I.S.10262-1982-revised 2007/2009
Quantities of materials:
Total weight of concrete for 1 cube = Standard size of mould x density of concrete.
= 0.003375 x 2400
= 8.10kg.
1. Cement content = 8.10 / 4.02
= 2.015kg.

2. Fine aggregate = 2.015 x 1.20
= 2.418kg.
3 .Coarse aggregate = 2.015 x 1.82
= 3.667kg.
4. Water = 0.40 x 2.015
= 0.806lit.

VI. EXPERIMENTAL PROCEDURE

- The concrete mix design for M40 grade was done and the proportion was found to be: 0.4:1:1.27:2.74.
- The material consist of plastic waste 50micron, 53 grade Birla super cement, 20 mm aggregate (60%), 10 mm aggregate (40%), fly ash (30%)potable water in college premises.
- Twelve plain concrete cube were casted and also with following combination.
  1) Plastic pieces – for each cube weighing app. 8 kg app. 0.25% plastic by weight of concrete cube (16 gm) was taken. The piece of plastic of irregular shape was placed in evenly distributed two layers in each cube. In each layer about 8 gm plastic was placed. While placing care was taken not to cover whole cross section area so that bounding in two layers is not affected.
  2) Fly Ash -20% replacement by weight of cement.
  3) Plane concrete cube.
- Cube were vibrating table. The Cube is placing after curing.
- The cube was tested for compressive strength at 3, 7, 14, 28 days of curing. The recorded observations are follows

VII. RESULTS

A] Table no. 1 Plane Cement Concrete Cube

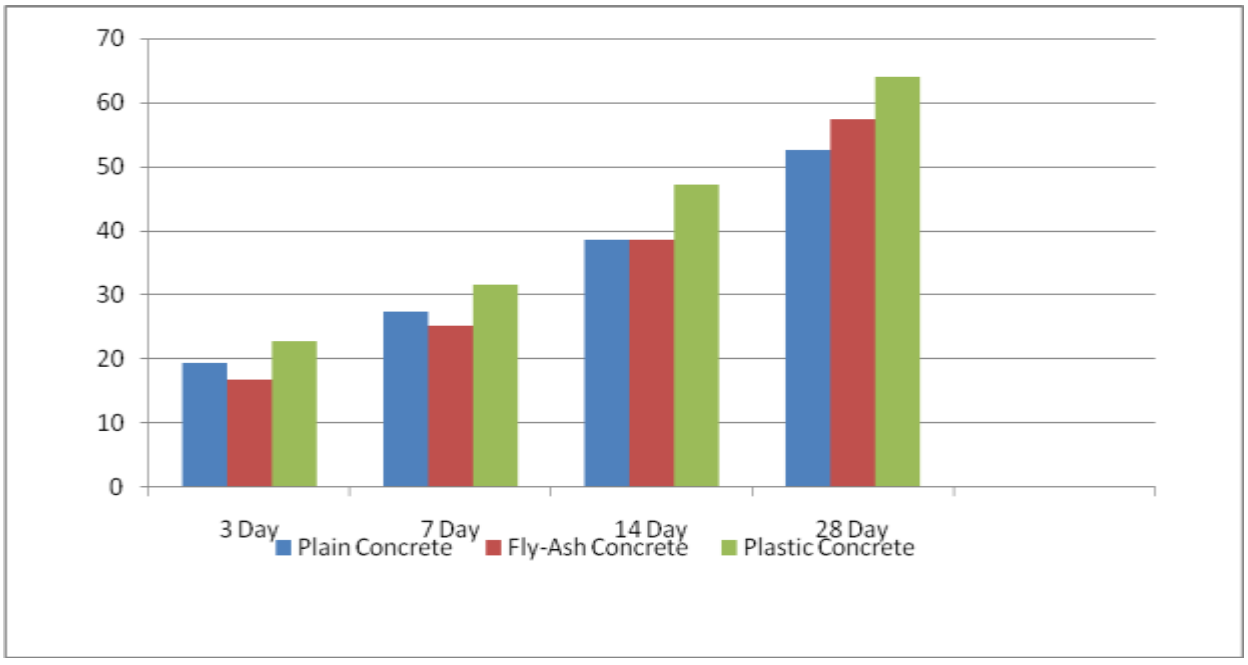
Cube no.	Curing Day	Weight (kg)	Load (kN)	Strength N/mm²	Average Value N/mm²
1	3 days	8.90	435	19.33	19.43
2		8.66	431	19.15	
3		8.38	446	19.82	
4	7 days	8.22	592.20	26.40	27.47
5		8.44	655.80	29.10	
6		8.26	607.00	26.90	
7	14 days	8.34	685.50	38.60	38.50
8		8.32	686.10	38.80	
9		8.30	674.60	38.10	
10	28 days	8.23	1172.00	52.08	52.60
1		8.32	1185.68	52.69	
12		8.34	1193.74	53.05	

B] Table no. 2 Fly-Ash Concrete Cube

Cube no.	Curing Day	Weight (kg)	Load (kN)	Strength N/mm²	Average Value N/mm²
1	3 days	8.24	343.70	15.27	16.85
2		8.42	446.00	19.82	
3		8.36	348.00	15.47	
4	7 days	8.36	582.23	25.89	25.27
5		8.20	555.30	24.68	
6		8.44	567.67	25.23	
7	14 days	8.20	849.15	37.74	38.52
8		8.30	880.43	39.13	
9		8.12	870.53	38.69	
10	28 days	8.25	1292.17	57.43	57.40
11		8.33	1302.97	57.91	
12		8.24	1279.57	56.87	

C] Table no. 3 Plastic Concrete Cube

Cube no.	Curing Day	Weight (kg)	Load (kN)	Strength N/mm²	Average Value N/mm²
1	3 days	8.66	562.60	25.00	22.74
2		8.80	430.00	19.11	
3		8.73	543.00	24.14	
4	7 days	8.36	627.10	27.80	31.67
5		8.42	781.90	34.70	
6		8.62	731.80	32.52	
7	14 days	8.44	795.90	45.00	47.27
8		8.54	855.20	48.30	
9		8.60	861.70	48.50	
10	28 days	8.35	1433.25	63.70	63.93
11		8.30	1430.55	63.58	
12		8.41	1451.25	64.50	



Graph no:1 Graphical representation of compressive strength after 3,7,14,28 days curing.

Note:

1) X- axis denoted curing in number of days
2) Y -axis denoted compressive strength in N/mm^2

VIII. CONCLUSION

- The plastic mixed concrete can be used in the plain concrete structures but also it can be used in reinforced concrete structures.
- In this experimental structure, concrete cubes were cast by optimum percentage of plastics of various designations and the compressive strength was tested.
- With the judicious analysis done, the following conclusions were arrived.
- The optimum mix percentages of the
  a. Polythene sheet is replaced by 0.25% of weight concrete
  b. Fly ash replacement with cement as 20%
- Out of the above two material gives better result in compression (for plain concrete specimens)
- When plastic is mixed in concrete we can reduce the pollution.
- Cost of concrete can be reduced by using fly ash and plastic in concrete.
- Use of waste product such as fly ash and plastic bags we can reduce environmental pollution.
- Use of plastic bags and fly ash in concrete, it reduces the require quantity of material in concrete and also reduces cost of concrete.
- If we use plastic bags and fly ash in concrete, it increases compressive strength as compare to plane cement concrete.
- Use of fly ash as a cement for certain amount of percentage we can reduce cost of cement.
- Fly ash mixed and plastic bags mixed concrete can be used P.C.C. and R.C.C. structure of building.
- From this project we have observed that strength of concrete increases by using waste product like fly ash and waste plastic bags.

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