Experimental Study on Concrete by Partial Replacement of Cement with Fly Ash and Fine Aggregate with Recycled Plastic Granules

D. Srinivasulu, D. Vaneela

Abstract*: *In Order To Explore Suitable Replacement, For Concrete Constituent, An Experimental Program Was Undertaken To Replace Cement And Fine Aggregate With Flyash And Plastic Granules Of Size Less Than 4.75mm Respectively. This Research Work Therefore Deals With Studying The Performance Of Concrete By Replacing Cement With Flyash And Obtaining Optimum Percentage And Then Replacing Fine Aggregate With Plastic Granules For Optimum Percentage Of Flyash. The Cement Has Been Replaced By Flyash Accordingly In The Range Of 0%, 10%, 20%,30% & 40% By The Weight Of M30 Grade Concrete. The Various Plastic Proportions Are 0%, 2%,4%,6%,8%, By Weight Of Fine Aggregate. Compression Test, Split Tensile Test And Flexural Strength Tests Will Be Done For 7Days, 14days And 28Days The Result Will Be Compared With Conventional Specimens.

Index Terms*: *Fly Ash, Compressive Strength, Flexural Strength, Plastic Granules.

I. INTRODUCTION

Flyash is the waste solid byproduct material developed from thermal power plants. It is a major ecological concern. The problems related with their safe management and dumping has turned into a major problem to the environmentalists and scientists. Another problem is the stress on land, materials and resources to sustain the developmental activities, including infrastructure. To decrease this waste content we are using a little quantity of this material as construction material. Fly ash is the by-product of incineration of coal. Fly ash is commonly used by replacing cement up to 30% of total mass of cementations material. ACI 211[3] recommends Fly Ash replacement ranging from 15% to 35%. However, of late, researchers observed that replacement of cement by fly ash can go up to 50% with a wide range of benefits. Application of fly ash in concrete will enable concrete to be more sustainable.

Secondly considerable efforts are currently being undertaken to utilize plastic granular as an alternative fine aggregate material. Because plastic waste is being produced in huge quantity throughout the world in the form of plastic carry bags, polythen bags, plastic bottles, plastic scrap etc. Disposal of plastic waste in environment is considered to be a big problem due to its very low biodegradability and presence in large quantities. The recycle of wastes is important from different points of view. It helps to save and sustain natural resources that are not replenished, it decreases the pollution of the. Concrete plays an important role in the beneficial use of these materials in construction. Although some of these materials can be beneficially incorporated in concrete, both as part of the cementitious binder phase or as aggregates, it is important to realize that not all waste materials are suitable for such use. The strength properties and modulus of elasticity of concrete containing various types of plastic aggregate are always lower than those of a reference concrete containing normal density natural aggregate only, and they further decrease with increasing plastic aggregate content in concrete. Concrete containing plastic aggregate can stop or divert the propagation of micro cracks and improve concrete toughness, which is of great practical significance. The use of plastic waste as a natural aggregate substitute in concrete is a relatively recent concept. One of the first significant reviews on the use of waste plastic in concrete focused on the advantages and financial benefits of such use, besides their physical and mechanical properties. And more over use of plastic as aggregate gives a solution to the problems encountered with the quarrying of natural aggregate. The main objective of this investigation is to study strength properties after partially replacing fine aggregate with plastic.

II. MATERIALS AND THERE PROPERTIES

A. Flyash

Flyash is one of the naturally-occurring products from the coal combustion process and is a material that is nearly the same as volcanic ash. Volcanic ash concrete was used thousands of years ago to produce Roman concrete structures that exist and function today; e.g., the Pantheon, Coliseum, and ancient aqueducts. When coal is burned in today's modern electric generating plants, combustion temperatures reach approximately 2800°F. The non-combustible minerals that naturally occur from burning coal form bottom ash and Flyash. Bottom ash is a light-weight aggregate material that falls to the boiler bottom for collection. Flyash is the material that is carried off with the flue gases, where it is collected and can be stored in silos for testing and beneficial use classification. Specific gravity of Flyash 2.625

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Fig.1 Fly Ash

B. Cement

Ordinary port land cement (OPC) is the basic Portland cement and is best suited for use in general concrete construction.

Table1. Physical Properties of Ordinary Portland Cement

Sr. No	Characteristics	Result	IS Code requirement
1	Specific gravity	3.12	3.10-3.15
2	Initial Setting Time	37 min	>30 min
3	Final Setting Time	590min	<600 min
4	Fineness (%)	8%	<10%

C. Natural sand

Uncrushed natural river sand is used as fine aggregate in this investigation. As per IS 383:1970 fine aggregate properties were tested and concluded that the fine aggregate in this investigation falls in zone-II .The water absorption capacity is 1%, fineness modulus is 2.60, and Specific gravity is 2.65.

D. Plastic

Polypropylene is a downstream petrochemical product derived from the olefin monomer, propylene. The polymer is produced through a process of monomer connection called addition polymerization, normally by using the Ziegler-Natta catalyst system. Plastic used in this investigation is concrete. The water absorption capacity is 0.12%, specific gravity is 1.32, size is below 4.75 mm

Fig. 2. Plastic Granules

Table. 3 Properties of Polypropylene

Density:	0.855 g/cm3, amorphous; 0.946 g/cm3
formula:	$(C_3H_6)_n$
Melting point:	130 to 171 °C (266 to 340 °F)
Tensile Strength	32 MPa (4700 PSI)
Flexural Strength	41 MPa (6000 PSI)
Specific Gravity	0.91
Shrink Rate	1.5 - 2.0 % (.015 - .02 in/in)

E. Coarse Aggregate

As per IS 383:1970 the nominal size is 20 mm is used .The shape of coarse aggregate is angular, water absorption capacity is 0.5%.

Table 4 Properties of Coarse Aggregate

S. No.	Property	Value Obtained
1.	Type	Crushed
2.	Nominal Size (mm)	20-10
3.	Specific gravity	2.67
4.	Fineness modulus	7.41

F. Water

Portable water is used in this investigation.

III. EXPERIMENTAL PROGRAM

The experimental investigation consisted of making M30 concrete with various proportions of flyash as a replacement to cement. With the optimum results, plastic granules is added to the mix as partial replacement for fine aggregate and plastic granules(polypropylene fiber) is added as 2%,4%,6% and 8% and determining the Compressive strength, flexural strength and split tensile strength of concrete. M30 mix was designed as per IS 10262:2009. The required materials were weighed and mixing of concrete was carried out manually. Cube specimens of size 150 mm x150mm x150 mm are casted. Cylinder specimens of size 150mm x 300 mm. prism specimens of size 500 mm x100 mm x 100 mm is casted The specimens are demoulded after 24 hours of casting and the specimens are cured in water tank for 7days, 14days and 28days.

Table 5.Mix Proportion

Cement Kg/m^3	Fine aggregate Kg/m^3	Coarse aggregate Kg/m^3	Water l/m^3
450	630.28	1120.71	180
1	1.4	2.49	0.4

IV. RESULTS AND DISCUSSION

Tests for Compressive Strength: The compressive strength of concrete for cubes, all mixes at 7, 14 and 28 days of curing at water tank. These cubes were casted for various percentage replacements of cement by Flyash.

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The result shows that the Compressive strength increased with addition of flyash up to 20% replace by weight of cement and further addition of flyash, the compressive strength decreases. With the 20% replacement of cement with flyash, with Different percentages of plastic granules was replaced for fine aggregate. Plastic granules was added as 2%,4%,6% and 8%.The compressive strength is increased at 4% of plastic granules. There is increase in compressive strength at 20% replacement of flyash for cement with 4% replacement of plastic granules for fine aggregate.

Tests for Split Tensile Strength: This is an indirect test to determine the tensile strength of cylindrical specimens. Splitting tensile strength tests were carried out on cylindrical specimens of size 150 mm diameter and 300 mm length at the age of 7days,14 days and 28 days curing, using compression testing machine The load was applied gradually till the specimens split and readings were noted.

Tests for Flexural Strength: The test beam 100x100x500mm was symmetrically supported on two parallel steel rollers 38mm in diameter and the distance between the centers of the two rollers adjusted to 40 cm. The load is applied through one rollers mounted at the center point of the supporting span. The load is increased till the specimen fails and the maximum load sustained is recorded. The position of crack is observed and measured. The flexural strength is expressed as the modulus of rupture fb as per the BIS 516. Observations and results recorded at 7,14 and 28 days.

Table 6.Compressive Strength of Concrete at Various Percentages of Flyash

% of flyash	7 days	14 days	28 days
0%	25.11	36.46	38.30
10%	25.39	37.04	38.92
20%	29.55	37.52	39.51
30%	28.14	35.16	37.29
40%	25.81	32.55	33.07

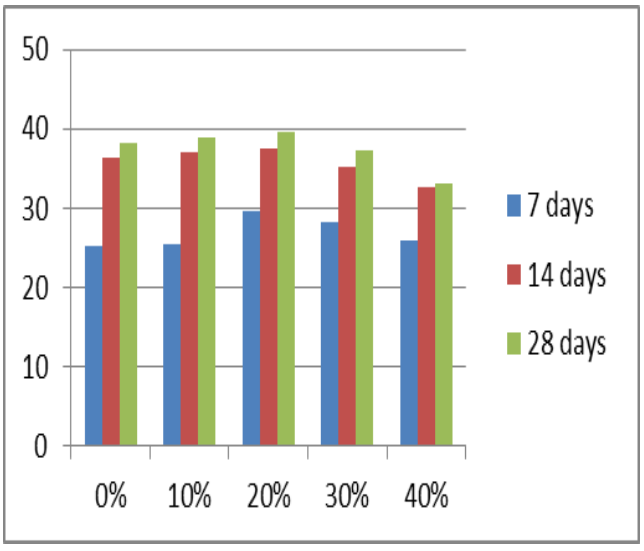

Fig.3. Compressive Strength of Concrete At Various Percentages of Flyash

Table 7. Compressive Strength of Concrete at Various Percentages of Plastic Granules

% of plastic	7 days	14 days	28 days
0%	29.55	37.52	40.26
2%	29.94	38.21	40.95
4%	30.11	39.08	42.01
6%	29.43	38.14	41.27
8%	38.67	37.88	39.83

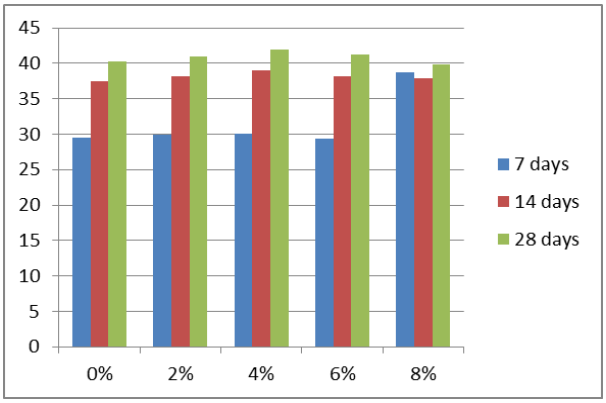

Fig 4.Compressive Strength of Concrete at Various Percentages of Plastic Granules

Table 8. Flexural Strength of Concrete at Various Percentages of Flyash

% of flyash	7 days	14 days	28 days
0%	2.62	4.18	5.76
10%	2.84	4.55	6.04
20%	3.05	4.82	6.29
30%	2.49	4.01	5.83
40%	2.06	3.43	5.77

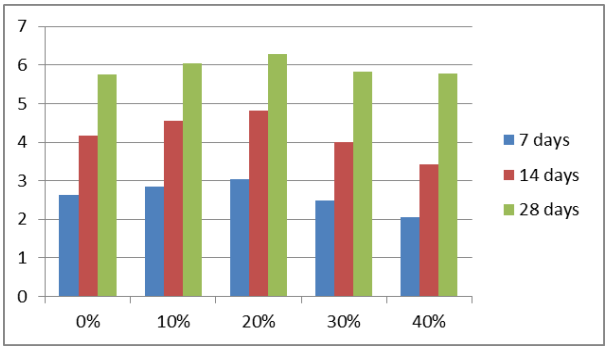

Fig 5.Flexural strength of concrete at various percentages of Flyash

Table 9.Flexural Strength of Concrete at Various Percentages of Plastic Granules

% of plastic	7 days	14 days	28 days
0%	3.05	4.82	6.05
2%	3.15	5.24	6.32
4%	3.36	5.77	6.95
6%	3.07	4.16	6.10
8%	2.41	3.74	5.92

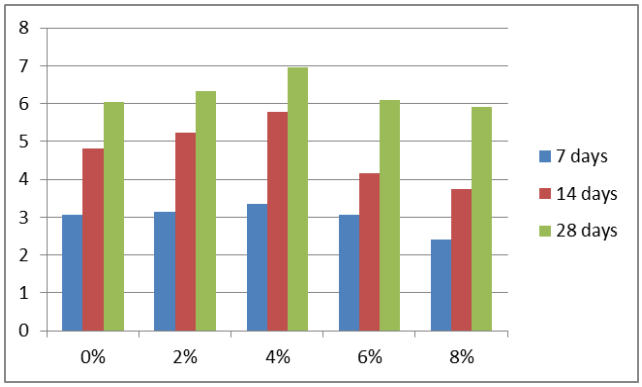

Fig 6. Flexural Strength of Concrete at Various Percentages of Plastic Granules

Table 10. Spilt Tensile Strength of Concrete at Various Percentages of Flyash

% of Flyash	7 days	14 days	28 days
0%	2.86	3.12	3.85
10%	2.18	2.93	3.75
20%	2.83	3.18	4.12
30%	2.06	2.19	3.28
40%	1.26	1.52	1.83

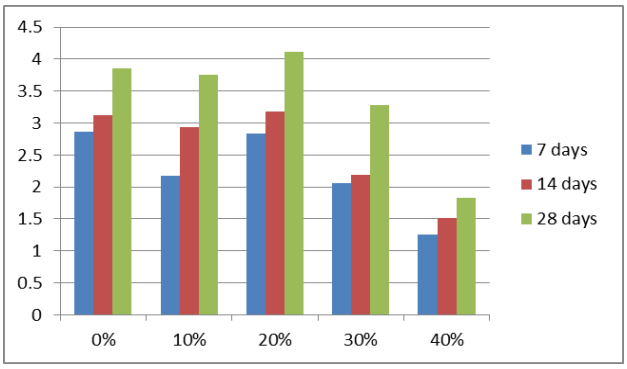

Fig 7. Spilt Tensile Strength of Concrete at Various Percentages of Flyash

Table 11. Spilt Tensile Strength of Concrete at Various Percentages of Plastic Granules

% of plastic	7 days	14 days	28 days
0%	2.86	3.12	4.67
2%	2.95	3.52	4.91
4%	3.01	3.76	5.06
6%	2.83	3.43	4.32
8%	2.11	3.07	4.10

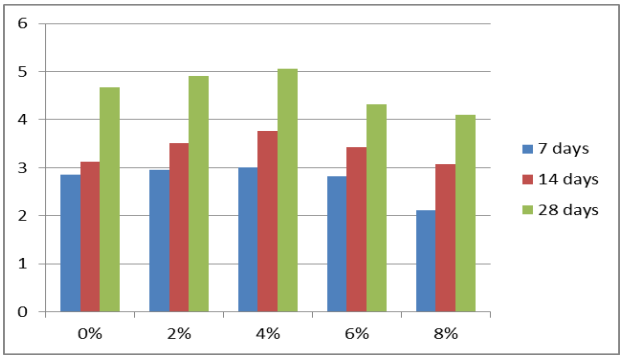

Fig 8. Spilt Tensile Strength of Concrete at Various Percentages of Plastic Granules

V. CONCLUSION

The following conclusions can be drawn from this research study:

1) As the Flyash content increases there was increase as well as decrease in the strength of concrete.
2) It was observed with replacement of 20% Flyash concrete compressive strength was increased at 7,14 and 28 days period of curing.
3) As percentage of plastic increases workability also increases because the plastic which is used as aggregate is smooth .As well as water absorption capacity of plastic is also low.
4) It was observed that the compressive strength increased up to 4% replacement of the fine aggregate with plastic fibres and it gradually decreased for 6% and 8% replacements. Hence replacement of fine aggregate with 4% replacement will be reasonable.
5) The tensile strength and flexural strength increases when fine aggregate is partially replaced by 4% of plastic however replacing plastic more than 4% to the fine aggregate will lead to decrement in tensile strength.
6) The density of concrete decreased when plastic content increased. Because plastic has more water tightness capacity when compared to natural aggregate this can help in arresting micro cracks.
7) By using recycled waste plastic in concrete can reduce the land fill and environmental issues.
8) This research concludes that Flyash can be innovative supplementary cementations Construction Material but judicious decisions are to be taken by engineers.
9) Based on experimental study, the use of plastic granules in concrete has a potential to reduce the death weight of concrete, thus, can reduce the earthquake risk of a building, and it could be helpful in the design of an earthquake resistant building.

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