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PERFORMANCES STUDIES ON CONCRETE WITH PARTIAL REPLACEMENT OF FINE AGGREGATE BY RECYCLED PLASTIC WASTE

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ABSTRACT

Recycling of plastic waste by using them as fine aggregate in concrete without evaluate the properties of concrete. Plastic due to its properties such as light weight and durability, we invent and create different technologies in different field by using the raw materials in our earth for human benefit. But as we do so, there are leftover by products (disposable materials) which are of no use and moreover, they pollute the earth from which we are getting the materials for production of technology.

However its excessive production has become a serious threat to the environment and human health. Then the main issues are disposal of plastic waste. Plastic waste are degrades land fertility, As 100% replacement of natural coarse aggregate is not feasible, then optimum percentage replacement of natural coarse aggregate with plastic coarse aggregate which can give the same or more strength compared to nominal concrete.

So, in this thesis, we will be trying to use disposable material, specifically plastic in the concrete. We will be taking plastic as aggregates and will be mixing it in the concrete to find out the compressive strength in the mixed concrete using IS code and compares it with the normal mix concrete. The general design mix concrete to be taken will be M25.

This experiment revealed that partial replacement of natural aggregate with plastic aggregate achieves the maximum strength of concrete in 28 days compare to other percentage of plastic replacement at various percentage were examined and optimum percentage is investigated.

Keywords: Plastic Waste, Non-Biodegrable Material, Fine Aggregate, coarse aggregate, recycled plastic waste, Compressive test.

1. INTRODUCTION

Plastic waste is one of the dangerous pollution on earth. Plastic are light in weight, colourful, versatile material ever invented, and have become a universal material, used for everything from water bottles to wing, and then use of plastic are increased. However, its excessive production has become serious threat to environment and human health.

The material plastic is a widely used synthetic polymer all over the globe. Approximately 90% of solid waste constitutes of plastic efficient disposal of plastic is the major problem faced today around the globe.

Chemically plastic is most non-biodegradable material man has ever produced. Although plastic, as a finished product, is non-toxic, the production process involves many dangerous and toxic chemicals. Therefore, burning of plastic is considered very dangerous.

Then the 3-R method used to disposed plastic they are Reduction, Reuse and Recycling. Recycling is the common process to disposal of plastic. Recycling is the temporary solution. Then for this issue searching for a permanent disposal method, we arrived at an idea of incorporating the waste plastic in concrete, which can be used for construction purpose of permanent structures.

If it is possible to replace any constituent of concrete by plastic without altering or changing the desirable properties of concrete then there lies a solution for the permanent disposal of plastic waste.

The large amount of E-waste and plastic used in replace in concrete in the place of coarse aggregate. By depending upon the chemical and physical composition of concrete E-Waste and plastic waste material are replaced in place coarse aggregate and fine aggregate.

Then the waste are utilize it as a partial replacement of coarse aggregate in mix concrete since the coarse aggregate economic cost also reduced. The partial replacement of plastic by natural coarse aggregate are not easy then we can use the some levels 5% 10%, 15% 20%, 25% by volume of aggregates were used for the preparation of the concrete on earth. Burning of plastics releases a variety of poisonous chemicals into the air, including dioxins, one of the most toxic substances.

2. LITERATURE REVIEW

1. **Elango A and Ashok Kumar** A in 2018 performed study concrete with plastic fine aggregates. They used OPC 53 grade, River sand and crushed aggregates. They used plastic in place of fine aggregates in proportion of 10%, 20% and 30%. They test mechanical and durability properties on their concrete samples. They found the decrease in strength of concrete. [3] But found that the concrete shows good results against acid attacks and increase in elasticity. So they concluded that the plastic aggregate concrete can be used in place where we need less compressive strength but more durability.
2. **LhakpaWangmoThinghTamanget** [4] A in 2017 performed experiment on Plastics in Concrete as Coarse Aggregate. They performed the testing of mechanical properties of concrete containing Plastic aggregates They use plastic aggregates in proportion of 10%, 15%, and 20%. They found marginal reduction in strength and suggested the optimum result as 15% replacement.
3. **MB Hossain** A in 2016 performed work on Use of waste plastic in concrete as a constituent material. They replace coarse aggregates in proportion of 5%, 10% and 20%. They found that the concrete was lighter in weight. But the compressive strength was lesser than that of conventional concrete. [1] They also found that the concrete with 10% plastic aggregates shows strength nearly similar to the conventional concrete. So, the optimum result was 10% plastic aggregates.
4. **RaghatateAtul M.** A in 2012 performed study on use of plastic bags in form of fiber in concrete and test it properties. He adds fiber in proportion of 0.2%, 0.4%, 0.6%, 0.8% and 1% by weight of concrete. [9] He found that there was reduction of compressive strength with increase in plastic content, but there was increase in tensile strength with optimum strength at 0.8% addition.
5. **S. Vanitha** A in 2015 performed studies on use of waste plastic in Concrete Blocks. Paver Blocks and Solid Blocks of size 200 mm X 150 mm X 60 mm and 200 mm X 100mm X 65 mm were casted for M20 grade of concrete and tested for 7, 14 and 28 days strength. [10] Plastic was added to a proportion of 2%, 4%, 6%, 8% and 10% in equal replacement of aggregates. They found the optimum result for paver block at 4% replacement of aggregates with plastic aggregates. And 2% of plastic in case of solid blocks.

3. MATERIALS USED

A. Cement

Cement is binding material in the project. OPC is suitable for normal concrete.

For preparation of concrete 53 grade OPC cement confining to requirements of IS: 12269-1987. The fineness of cement is 3%, specific gravity of cement is 3.12, standard consistency of cement is 31%, Initial setting time is 60 minutes and final setting time is 250 minutes.

B. Plastic Material

Recycle Plastic used in this investigation is PET (polyethylene Terephthalate).The water absorption capacity is 0.12%, specific gravity is 1.32, size is below 4.75 mm,

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C. Aggregate (Coarse Aggregate & Fine Aggregate)

Aggregate provide strength to the concrete. Sand as a fine aggregate which come from basically river fine aggregate consist of particles 600 micrometer or less in size is provide. Coarse aggregate are MSA 10mm and 20mm size of coarse aggregate was used according to, IS: 383-1970. The material were tested according to ascertain their properties.

Water

It plays an important role in the chemical reaction with cement. Water Contributes in the strength development of concrete. And that is why quantity and quality if water required is looked into very carefully. The water should be free from undesirable organic and inorganic substance. In every construction work water is vital role for the mixing and curing of concrete as per IS: 456-2000. The water was clean and free from visible impurities. For this thesis work potable water is used.

Admixture

It helps to increase the workability of concrete without increasing the water concrete. As Rice Husk Ash (RHA) is very fine and it has high specific surface area, it requires more water to form workable mixture. Adding more water will reduce the strength of concrete. So super plasticizer CHRYSO Delta G820R is used up to 1% to increase the workability of concrete keeping water- cement ratio constant.

4. METHODOLOGY FOR WORK

- Collection of materials required i.e OPC (Ordinary Portland Cement),Fine aggregate i.e Sand, Course aggregate i.e Gravels and plastic aggregates (plastic waste).
- First concrete to be casted is M25.
- 5 batches of concrete will be cast. In first batch, 3 concrete cubes will be cast with plastic aggregates exchanged with fine aggregates for 5% by weight of fine aggregate of M25 concrete.
- In second batch, 3 cubes will be cast with plastic aggregates exchanged with fine aggregate for 10% by weight of fine aggregate of M25 concrete.
- In third batch, 3 concrete cubes will be cast with plastic aggregates exchanged with fine aggregate for 15% by weight of fine aggregate of M25 concrete.
- In forth batch, 3 concrete cubes will be cast with plastic aggregates exchanged with fine aggregate for 20% by weight of fine aggregate of M25 concrete.
- Similarly in five batches, 3 concrete cubes will be cast with plastic aggregates exchanged with fine aggregate for 25% by weight of fine aggregate of M25 concrete.
- Compressive strength test and workability test (slump test) will be performed for all the concrete mix.
- All the values of the results will be compared and a graph will be plotted.

5. MIX PROPORTIONING OF CONTROL CONCRETE

SL. NO.	MATERIALS	QUANTITY
1.	Cement	380 kg/m^3
2.	Fine Aggregate	717 kg/m^3
3.	Coarse Aggregate	1170 kg/m^3
4.	Water	190 L/m^3

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Therefore, mix design ratio of M25 Grade concrete by weight is

Cement: fine aggregate: coarse aggregate = 1: 1.9: 3.1

Volume of 150 mm mould = 0.003375 m^3

Volume of 4 mould = 0.0135 m3

Total cement required for each mix = 0.0135* 380 = 5.13 kg

Total fine aggregate required for each mix= 0.0135* 717 = 9.68 kg

Total coarse aggregate required for each mix= 0.0135* 1170 = 15.8 kg

Total coarse aggregate required for each mix= 0.0135* 190 = 2.57 Litters

6. EXPERIMENTAL RESULTS

In this research papers we have observed the effect of plastic aggregate as cement, fine and coarse aggregate. We have mixed these materials is different proportion and their effect on compressive strength was noted. Also their effect with age was also observed.

Table 1: Experimental observation

MIX	REPLACEMENT	COMPRESSIVE STRENGTH (N/mm^2)		
	RECYCLED PLASTIC	7 DAYS	14 DAYS	28 DAYS
M25	0%	17.43	24.47	28 .54
M25	5%	17.23	24.54	28.43
M25	10%	17.46	24.48	28.56
M25	15%	16.49	22.98	26.56
M25	20%	14.54	21.43	24.53
M25	25%	12.20	19.21	21.32

Table 2: PERCENTAGE OF PLASTIC AND WEIGHT OF CUBE

SL.NO.	PERCENTAGE OF PLASTIC	AVERAGE WEIGHT OF CUBE (GM)
1	0%	8653
2	5%	8437
3	10%	8142
4	15%	7543
5	20%	7376
6	25%	7285

Table 3: Concrete Strength Percentage With Specific Time Period Will Be.

MIX	REPLACEMENT	STRENGTH PERCENTAGE (%)		
	RECYCLED PLASTIC	7 DAYS	14 DAYS	28 DAYS
M25	0%	69.72%	97.88%	114.16%
M25	5%	68.92%	98.16%	113.72%
M25	10%	69.84%	97.92%	114.24%
M25	15%	65.96%	91.92%	106.24%
M25	20%	58.16%	85.72%	98.12%
M25	25%	48.8%	76.84%	85.28%

7. RESULT AND DISCUSSION

In this research work we have found fluctuation in compressive strength of concrete with increase or decrease in plastic aggregate. It was observed that in mix M25 having 10% recycled plastic aggregate the compressive strength was 28.56 N/mm^2.

GRAPH OF COMPRESSIVE STRENGTH V/S % REPLACEMENT 7 DAYS

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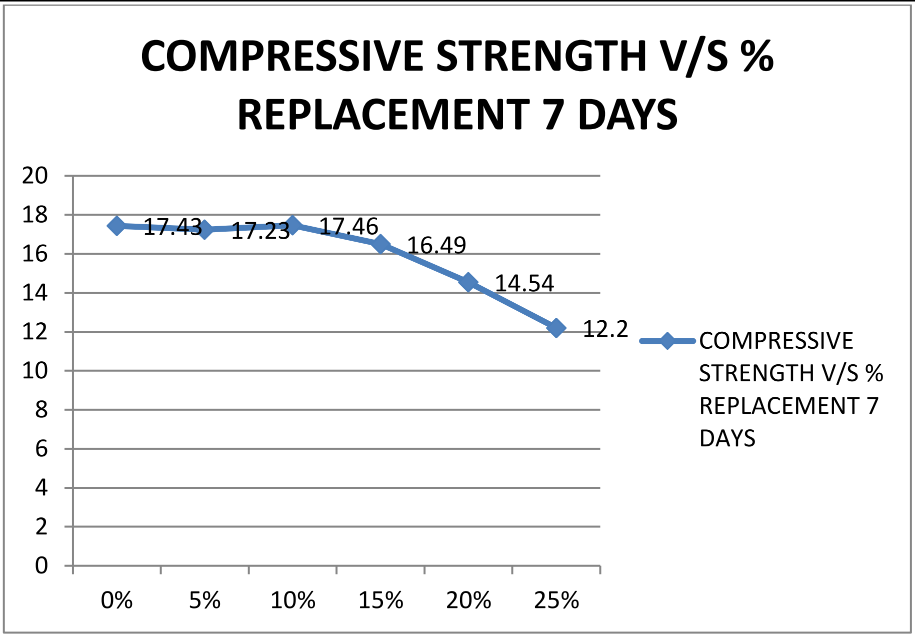
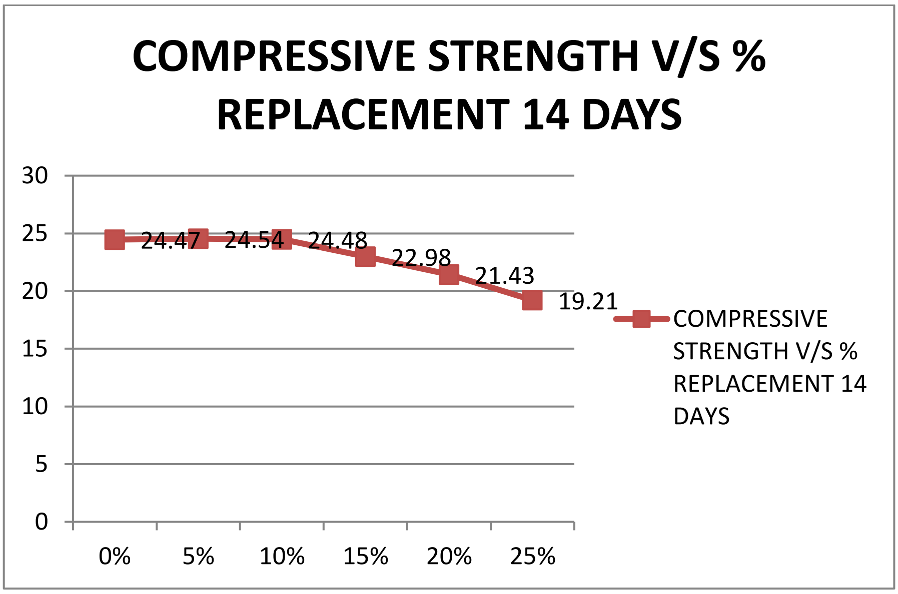
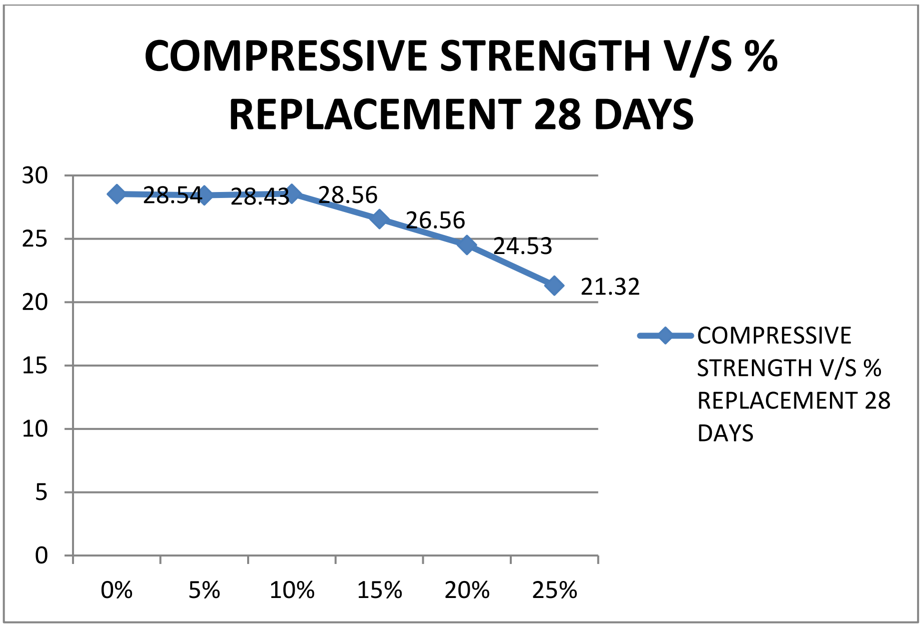


GRAPH OF COMPRESSIVE STRENGTH V/S % REPLACEMENT 14 DAYS



GRAPH OF COMPRESSIVE STRENGTH V/S % REPLACEMENT 28 DAYS



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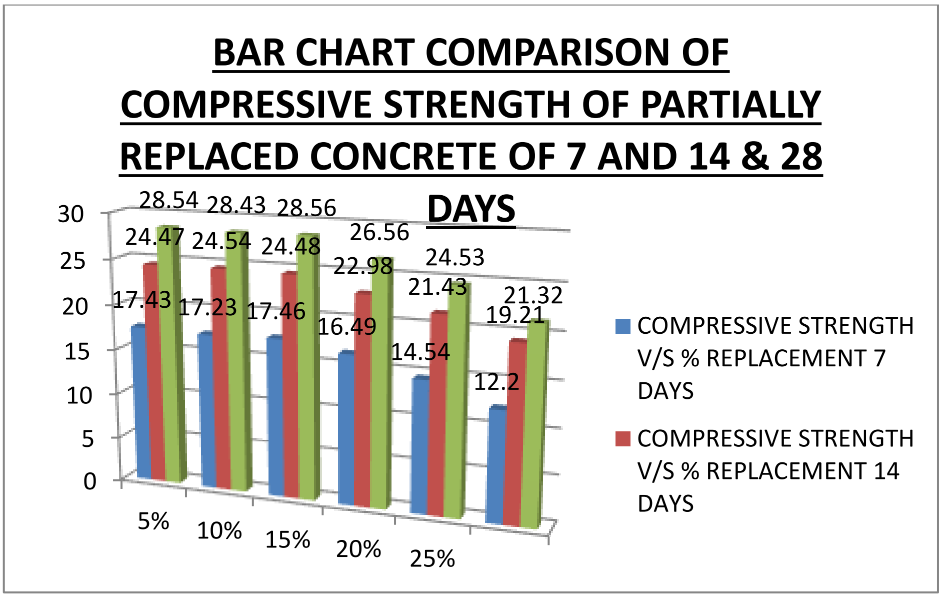
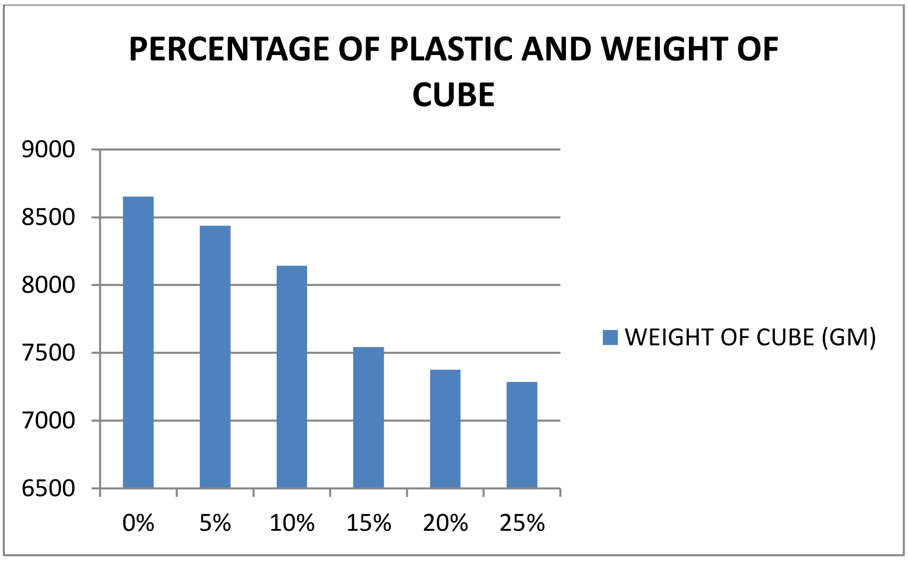
COMPARISON OF COMPRESSIVE STRENGTH OF PARTIALLY REPLACED CONCRETE OF 7 AND 14 & 28 DAYS

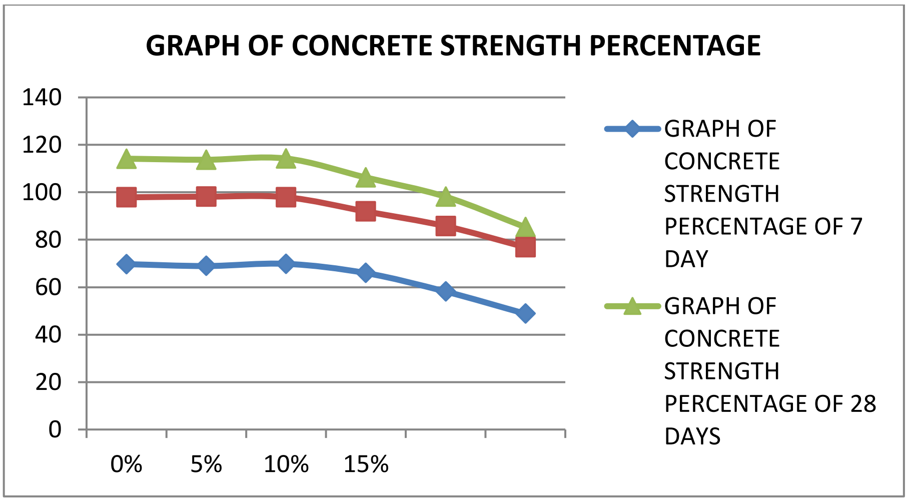
It was observed that compressive strength varies with age also. The mixes where 10% of recycled plastic waste, the increase of strength from 7-14 days to 28 days,



BAR CHART OF PERCENTAGE OF PLASTIC AND WEIGHT OF CUBE



COMPARISON OF CONCRETE STRENGTH PERCENTAGE OF PARTIALLY REPLACED CONCRETE OF 7 AND 14 & 28 DAYS



8. CONCLUSION

The findings from these studies indicated that plastic waste can be used as a partial replacement of recycled plastic aggregate. From there result obtained from these studies the following conclusions can be drawn:

1. The test conducted on material like Cement, Sand, Recycled plastic aggregate having all the results within permissible limit as per IS codes.

2. The density of concrete decreases when plastic content increases

3. Optimum 10% of recycled Plastic waste is to be allowed

4. Higher percentage (Upto 12%) of waste plastic can be used in Concrete for temporary Structures.

5. Overall construction and maintenance cost is reduced.

6. Using recycled waste plastic in concrete we can minimized the use of natural aggregates.

9. FUTURE SCOPE

There are areas which needed details analysis, like:

1. Tests to analysis its behavior in flexure and tension. Some of the tests are flexural strength test, split tensile strength test etc.
2. Tests to find out the behavior of wet concrete, workability test is one of them.
3. Tests to find out its durability like water penetration test, chlorides penetration test etc.

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