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POLY-ETHELENE PLASTIC WASTE AS A PARTIAL REPLACEMENT OF FINE AGGREGATE IN CONCRETE MIX

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Abstract: Concrete is the most widely used construction material in the world, as well as the largest user of natural resources. Basically it consists of aggregates which are bonded together by cement and water. These material are often used in residential driveways, paving and curb, walls, house foundations and gutter applications. Sustainable concrete structures are beneficial as it consumed less energy, release less greenhouse gases into the atmosphere, and cost less to build and to maintain over the given period of time. Solid waste management is one the major environmental concerns in the country today. This paper investigates the utilization of waste plastics as replacement for fine aggregates in concrete for the production of lightweight concrete. The aim of the research is to evaluate the effect of addition of granulated plastic waste on the compression strength and density of concrete. Portland cement was mixed with the aggregates to produce the concrete composites. In this study, M25 grade cement concrete mix is considered and recycled polyethylene terephthalate (PET) plastic waste is used as the partial replacement in Concrete cubes are prepared using plastic waste as partial replacement in fine aggregates from 1%, 2%, 3%, 4%, 5% and 6% compression strength of the cubes are tested for 7, 14 & 28 days. The design concrete cubes are finalized as per IS: 10262: 2009.

Key Words: cement, fine aggregate, pet plastic, concrete, compression strength

INTRODUCTION

In this world, there is great demand of aggregate mainly from civil engineering industry for road and concrete constructions. But now a days it is very difficult problem for available of coarse and fine aggregates. So researchers developed waste management strategies to apply for replacement of these aggregates for specific need. Natural resources are depleting worldwide while at the same time the generated wastes from different areas are increasing substantially. The sustainable development for construction involves. The use of nonconventional and innovative materials, and recycling of waste materials in order to compensate the lack of natural resources and to find alternative ways conserving the environment.

Regular concrete is the lay term describing concrete that is produced by following the mixing instructions that are commonly published on packets of cement, typically using sand or other common material as the aggregate, and often mixed in improvised containers.

This concrete can be produced to yield a varying strength from about 10 MPA (1450 psi) to about 40 MPA (5800 psi), depending on the purpose, ranging from blinding to structural concrete respectively. Many types of pre-mixed concrete are available which include powdered cement mixed with aggregate, needing only water. Typically, a batch of concrete can be made by using 1 part Portland cement, 2 parts dry sand, 3 parts dry stone, 1/2 part water.

The parts are in terms of weight – not volume. For example, 1-cubic-foot (0.028 m^3) of concrete would be made using 22 LB (10.0 kg) cement, 10 LB (4.5 kg) water, 41 LB (19 kg) dry sand, 70 LB (32 kg) dry stone (1/2" to 3/4" stone). This would make 1-cubic-foot (0.028 m^3) of concrete and would weigh about 143 LB (65 kg). The sand should be mortar or brick sand (washed and filtered if possible) and the stone should be washed if possible. Organic materials (leaves, twigs, etc.) should be removed from the sand and stone to ensure the highest strength.

This paper investigates the utilization of waste plastics as replacement for fine aggregates in concrete for the production of lightweight concrete. The aim of the research is to evaluate the effect of addition of granulated plastic waste on the compression strength and density of concrete.

II. MATERIALS AND METHODS

Plastic: Waste trash bag plastics were collected from the land fill and from other locations in the environment and used to manufacture light weight aggregates. The plastic weight sheet was shaped as desired, e.g., the plastic waste aggregate was modified by heat treatment (160 ºC-200 ºC) in plastic granule recycling machine and allowed to cool at room temperature, but they were a mixture of angular shapes and around shapes, much like crushed stone. And the obtained plastic granules are ground in a grinding mill to a 20mm down size. Plastics collected from the disposal area were sorted to get the superior one these were crushed into small fraction and washed to remove the foreign particles. Then it was heated at a particular temperature so that the necessary brittleness was obtained. After extrusion the molten plastic was cooled down and collected in boulders of 100mm size approximately. These plastic boulders were crushed down to the size of aggregates. Thermal properties of the commercial applicability of polyethylene is limited by its comparably low melting point. For common commercial grades of medium and high density polyethylene the melting point is typically in the range 120 to 180 ºC (248 to 356 of). The melting point for average, commercial, low-density.

Fig.1 Waste Plastic balls

Cement: Cement is the main constituent in manufacturing of concrete. The characteristics like strength and bonding of concrete will be greatly affected by changing the cement content. Cement used in this experiment is ordinary Portland cement (OPC)

Fine Aggregate: The aggregate size is lesser than 4.75mm is considered as fine aggregate. The sand particles should be free from any clay or inorganic materials and found to be hard and durable. It was stored in open space free from dust and water. In our region fine aggregate can be found from bed of Krishna River. It confirms to IS 383-1970.

Coarse Aggregate: The aggregate size is bigger than 4.75mm, is considered as coarse aggregate. It can be found from original bed rocks. Coarse aggregate are available in different shape like rounded irregular or partly rounded, angular flaky. It should be free from any organic impurities and the dirt content was negligible.

PRELIMINARY TESTS FOR MATERIALS

Specific gravity of cement: Weight a clean dry leachier flack or specific gravity bottle with stopper (W1) place sample of cement up to half of flack about 500gms and weight with its stopper (W2) add kerosene (polar liquid) to cement in flack till it's about half mix thoroughly with glass rod to remove entrapped air continue strings & add more kerosene, till its flush with graduated mark. Now weigh the bottle (W3). Now remove the cement and kerosene and clean it thoroughly. Fill bottle with kerosene and weight it (W4).

over plain concrete is 41.36% and the percentage increase ranges from 8.93 to 41.36% over normal mix. Similar trends were observed even at 60 days age. The maximum percentage increase over plain concrete is 46.45% and the percentage increase ranges from 7.83 to 46.45% over normal mix.

Table-1 Sp Gravity of Cement

Weight of empty flack	W_1 = 15gm
Weight of empty + cement	W_2 = 50gm
Weight of empty flack + cement + kerosene	W_3 = 95gm
Weight of empty flack + kerosene	W_4 =40gm
Specific gravity of kerosene	G =0.78
Specific gravity (G) = (W2-W1)/ [{W2-W1}-{W3-W4}]	3.15

Specific gravity of coarse aggregate and fine aggregate

Specific Gravity of aggregate: The pycnometer is used for aggregate less than 20mm size. Dry the pycnometer thoroughly & weigh it with cap (W1), pycnometer is filled with aggregate to about 1/3rd and weigh again (W2). Add sufficient water till top & allow the entrapped air into escape. After air bubble on the cap gently tight to a avoid leakage of water (W3), fill the pycnometer by washing with water thoroughly. Fill the pycnometer with only water as alone & weight it (W4). Repeat the test twice as more and take the average for better results.

Table-2. Sp Gravity of coarse aggregate

S.No	Properties	Values
1	Weight of empty pycnometer	673gm
2	Weight of empty pycnometer with coarse aggregate	1587gm
3	Weight of empty pycnometer with coarse aggregate and water	2154gm
4	Weight of empty pycnometer with water	1563gm
5	Specific gravity of coarse aggregate = (W2-W1)/ {(W2-W1)-(W3-W4)}	2.82

Table-3. Sp Gravity of fine aggregate

S.No	Property	Values
1	Weight of empty pycnometer	651 gm.
2	Weight of empty pycnometer with fine aggregate	1534 gm.
3	Weight of empty pycnometer with fine aggregate and water	2029 gm.
4	Weight of empty pycnometer with water	1493 gm.
5	Specific gravity of fine aggregate (W2-W1)/ {(W2-W1)-(W3-W4)}	2.54

Fineness modulus of fine aggregate and coarse aggregate: To determine the fineness of modulus of fine aggregate and coarse aggregate fineness modulus is an index used to know the mean size of particles in the total quality of aggregate. Fineness modulus is to grade the given aggregate for most economical mix and workability with less assumption of cement lower FM gives uneconomical mix and higher FM gives harsh mix. Arrange the test services with larger openings at top and smaller openings at bottom and finally bellow all keep a pan. Take 1kg of sand in to a tray and break the lumps, if any in case of fine aggregate and 10kg of samples in the case of coarse aggregate and mixed aggregate. Keep the sample in the top sieve and keep the total set in the top sieve and keep the set in the shaker. Continue sieving for a period not less than 10minutes weigh the natural retained on each sieve property. Note all the values of fine aggregate (or) course aggregate in given tabular format and Calculate the values and check the results.

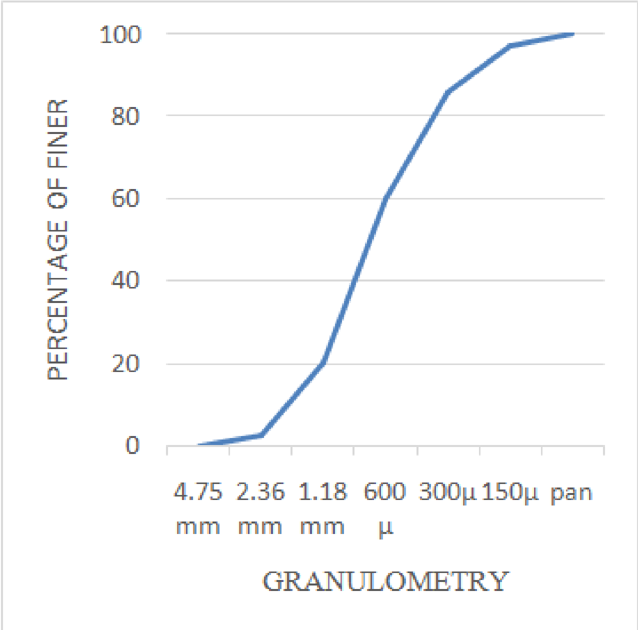

Fig.2 Sieve Analysis of Fine Aggregate

This graph represents the sieve analysis of fine aggregates. The graph is plotted using Granulometry(4.75mm-pan) on X axis and percentage of finer on Y axis.

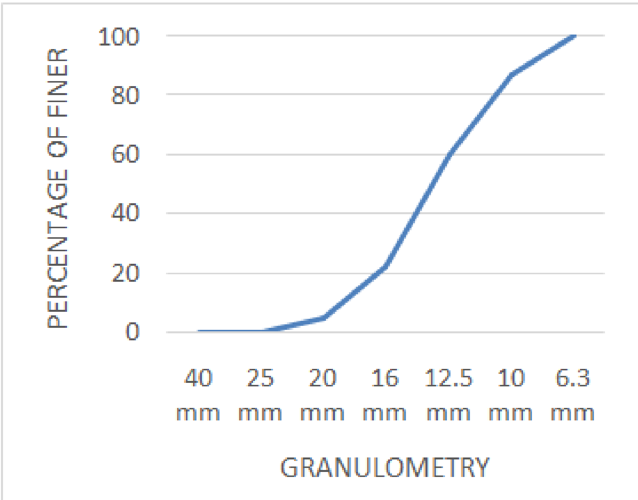

Fig.3 Sieve Analysis of Fine Aggregate

This graph represents the sieve analysis of fine aggregates. The graph is plotted using Granulometry(40mm-6.3mm) on X axis and percentage of finer Y axis.

Concrete mix design

Introduction: The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective producing a concrete of the required, strength, durability and workability as economically as possible, is termed the concrete mix design. The proportioning of ingredient of concrete of ingredient of concrete is governed by the required performance of concrete in 2 states, namely the plastic and the hardened states. If the plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability, therefore, becomes of vital importance.

The compression strength of hardened concrete which is generally considered to be an index of its other properties, depends upon many factors, e.g. quality and quantity of cement, water and aggregates; batching and mixing; placing, compaction and curing. The cost of concrete is made up of the cost of materials, plant and labour. The variations in the cost of materials arise from the fact that the cement is several times costly than the aggregates, thus the aim is produces as lean a mx as possible. From technical point of view the rich mixes may lead to high shrinkage and cracking and cracking in the structural concrete, and to evolution of high heat of hydration in mass concrete which may causes cracking.

The actual cost of concrete is related to the cost of materials required for producing a minimum mean strength called characteristics strength that is specified by the designer of the structure. This depends on the quality control measures, but there is no doubt that the quality control adds to the control cost of concrete. The extent of quality control is often an economic compromise, and depends on the size and type of job. The cost of labour depends on the workability of mix, e.g., a concrete mix of inadequate workability many results in a high cost of labour to obtain a degree of compaction with available equipment.

Requirements mix design:

The requirements which form the basis of selection and proportioning of mix ingredients are:

- The minimum compression strength required from structural consideration
- The adequate workability necessary for full compaction with the compacting equipment available.
- Maximum water-cement ratio/or maximum cement content to give adequate durability for the particular site conditions
- Maximum cement content to avoid shrinkage cracking due to temperature cycle in mass concrete.

Mixing of concrete:

Cement being mixed with sand and water to form concrete. Thorough mixing is essential for the production of uniform, high quality concrete. Therefore, equipment and methods should be capable of effectively mixing concrete materials containing the largest specified aggregates to produces uniform mixture of the lowest slump practical for the work. Separate paste mixing has shown that the mixing of cement and water in to a paste before combining these materials with aggregates can increases the compression strength of the resulting concrete. The paste is generally mixed in a high speed, shear-type mixer at a w/cm (water to cement ratio) of 0.30 to 0.45 by mass.

The cement paste premix may include admixtures, e.g., accelerators are retarders, plasticizers, pigments or fumed silica. The later id added to fill the gaps between the cement particles. This reduces the particles distances and leads to a higher final compression strength and a higher water permeability. The premixed paste is then completed in conventional concrete mixing equipment.

Vibration:
Vibrating compactors are used for concrete compaction, e.g., in foundations for roads, railways or buildings. Concrete vibrators are used to consolidate fresh concrete so that entrapped air and excess water are released and the concrete settles firmly in place in the form work. Improper consolidation of concrete can causes product defects, compromise the concrete strength, and produces surface blemishes such as bug holes and honeycombing.

III. EXPERIMENTAL PROGRAM

General:The experimental program was carried out on cubes, cylinders and beam. The details of the materials used of these specimens and testing procedure incorporated in the test program are presented in the subsequent sections.

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Tests on concrete:
There are many tests which are conducted to check the quality of concrete. These tests are basically divided into two categories

Slump cone test: The internal surface of the mould is thoroughly cleaned and applied with light coat of oil. The mould is placed on a smooth, horizontal, rigid and non-absorbent surface the mould is then filed in hour layers with freshly mixed concrete, each approximately to one fourth of the height of the mould. Each layer is tamped 25 times by the rounded end of the tamping rod (strokes are distributed evenly over the cross section). A after the top layer is tamped, the concrete is struck off the level with a trowel. The mould is removed from the concrete immediately by raising it slowly in the vertical direction. The differences in level between the height of the mould and that of the highest point of the subsided concrete is measured. This differences in height in mm is the slump of the concrete

Specimen Preparation: The sample of concrete is placed in the upper hopper up to the brim cubes specimens are of sizes 150 X 150 X 150 mm, were prepared and tested at 7,14,28days curing of water, controlled the laboratory conditions are casted for testing of compression strength. The top door is opened so that the concrete falls into the lower upper up to the brim. The trap- door of the lower hopper is opened and the concrete is allowed to fall in to the cube. The cylinder is filled with fresh concrete and 3 layers of compacting with the cube helps from the rod.After compacting 24hours. Remould from the moulds Then cubes are through with the tub and 24hours watering from the cubes.

Curing: Curing is done for casted specimens with normal water, of all these specimens are cured water, in normal water is the main process to get the strength for the specimens. The water of curing is free from the impurities and high salinity. The cubes should be remoulded after 24hours of casting and after that keep the specimens in required solutions for curing at room temperature with a relative humidity. The specimens are tack in to the 7days, 14days, and 28days for testing. For calculating durability studies normal water is done for the specimens

TESTING OF CONCRETE

Compression Strength Test: According to IS 516-1959:After 7, 14 &28days of curing. The cubes were taken out from curing tank, dried and tested using a compression testing machine. These cubes were loaded on their sides during compression testing such that the load was exerted perpendicularly to the direction of casting. The cubes were placed in the compression testing machine and the loads are applied gradually at rate. The average value of compression strength of three cubes was taken as the compression strength. The compression strength of conventional concrete was found. The compression strength of concrete with both crusher value note.

Compression strength = P/A
Where, P = Compression load (KN)
A = Area of the cube (150 X 150 X 150mm)

In the cubes are tested for compression strength of sizes 150 X 150 X 150 mm, are commonly used after 24hours these moulds are removed and test specimens are put in water for curing. These specimens are removed and test specimens are put in water for curing. These specimens are tested by compression testing machine after 7days, 14days and 28days of curing.

IV. RESULTS AND DISCUSSION

Compressive strength for nominal mix: The following are various results obtained for concrete and the values are tabulated as below. A bar graph is plotted between curing time (days) on X axis and Compressive strength on Y axis. On observing the graph, strength is increasing for 7, 14 and 28 days.

Fig.4 Preparation of cubes

Fig.5 Curing of cubes

Fig.6 Testing of cubes

Table 4: Compressive strength values for nominal mix at 7, 14 and 28 days

S.No	Time (days)	Compressive Load(KN)	Compression Strength (N/mm^2)	Average Strength (N/mm^2)
1	7	475	21.11	21.55
		500	22.22	
		480	21.33	
2	14	550	24.44	24.88
		530	23.55	
		600	26.66	
3	28	620	27.55	26.88
		525	25.55	
		620	27.55	

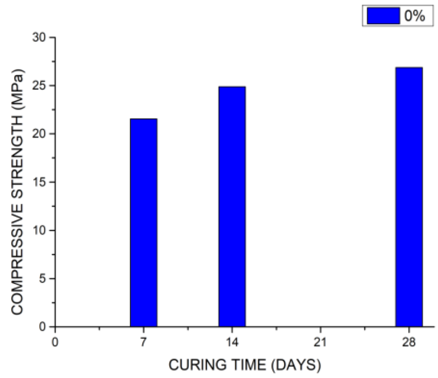

Fig.7 Graph representing compressive strength values for 0% plastic mix

Compressive strength for 1% Plastic mix:

The following are various results obtained for concrete and the values are tabulated as below. A bar graph is plotted between curing time (days) on X axis and Compressive strength on Y axis. On observing the graph, strength is increasing for 7, 14 and 28 days.

Table 5: Compressive strength values for 1% plastic mix at 7, 14 and 28 days

S.No	Time (days)	Compressive Load(KN)	Compression Strength (N/mm^2)	Average Strength (N/mm^2)
1	7	475	21.11	22.14
		500	22.22	
		520	23.11	
2	14	550	24.44	26.21
		600	26.66	
		620	27.55	
3	28	625	27.77	28.51
		675	30	
		625	27.77	

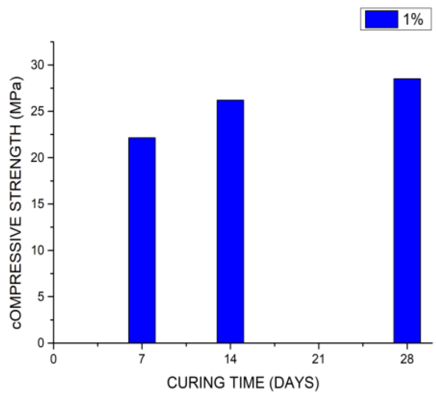

Fig.8 Graph representing compressive strength values for 1% plastic mix

Compressive strength for 2% Plastic mix:The following are various results obtained for concrete and the values are tabulated as below. A bar graph is plotted between curing time (days) on X axis and Compressive strength on Y axis. On observing the graph, strength is increasing for 7, 14 and 28 days.

Table 6: Compressive strength values for 2% plastic mix at 7, 14 and 28 days

S.No	Time (days)	Compressive Load(KN)	Compression Strength (N/mm^2)	Average Strength (N/mm^2)
1	7	550	24.44	24.40
		520	23.11	
		580	25.77	
2	14	675	30	30.07
		700	31.11	
		650	28.88	
3	28	725	32.22	31.11
		700	31.11	
		675	30	

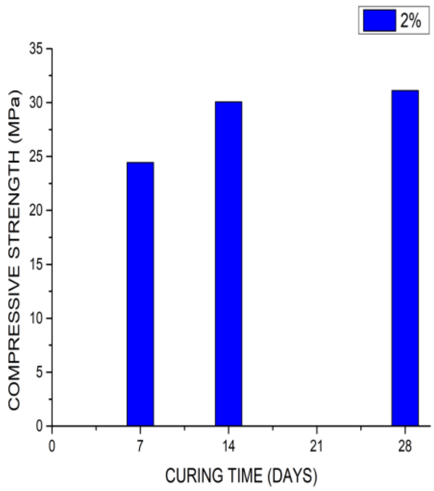

Fig.9 Graph representing compressive strength values for 2% plastic mix

Compressive strength for 3% Plastic mix The following are various results obtained for concrete and the values are tabulated as below. A bar graph is plotted between curing time (days) on X axis and Compressive strength on Y axis. On observing the graph, strength is increasing for 7, 14 and 28 days. Graph representing compressive strength values for 3% plastic mix.

Table 7: Compressive strength values for 3% plastic mix at 7, 14 and 28 days

S.No	Time (days)	Compressive Load(KN)	Compression Strength (N/mm^2)	Average Strength (N/mm^2)
1	7	570	25.33	26.36
		620	27.55	
		590	26.22	
2	14	675	30	31.14
		725	32.22	
		700	31.11	
3	28	750	33.33	32.66
		725	32.22	
		730	32.44	

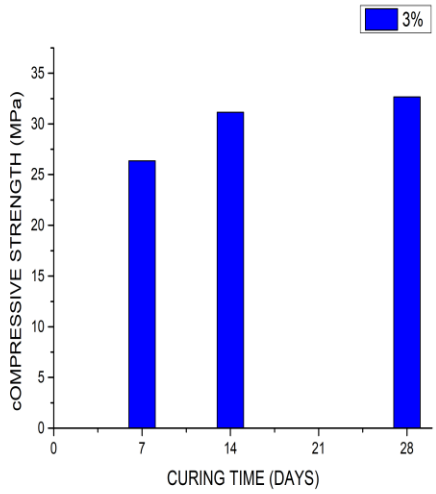

Fig.10 Graph representing compressive strength values for 3% plastic mix

Compressive strength for 4% Plastic mix:The following are various results obtained for concrete and the values are tabulated as below. A bar graph is plotted between curing time (days) on X axis and Compressive strength on Y axis. On observing the graph, strength is increasing for 7, 14 and 28 days.

Table 8: Compressive strength values for 4% plastic mix at 7, 14 and 28 days

S.No	Time (days)	Compressive Load(KN)	Compression Strength (N/mm^2)	Average Strength (N/mm^2)
1	7	600	26.26	26.26
		575	25.55	
		625	27.27	
2	14	700	31.11	31.48
		725	32.22	
		700	31.11	
3	28	750	33.33	32.96
		725	32.22	
		750	33.33	

Compressive strength for 5% Plastic mix The following are various results obtained for concrete and the values are tabulated as below. A bar graph is plotted between curing time (days) on X axis and Compressive strength on Y axis. On observing the graph, strength is increasing for 7, 14 and 28 days

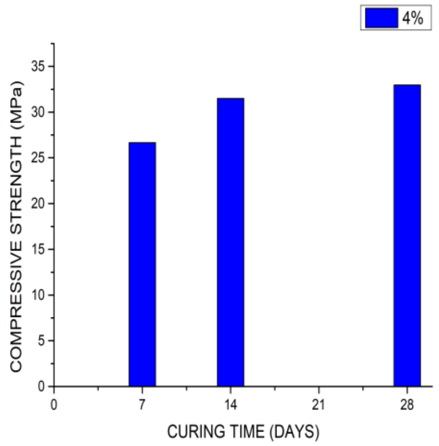

Fig.11 Graph representing compressive strength values for 4% plastic mix

Table 9: Compressive strength values for 5% plastic mix at 7, 14 and 28 days

S.No	Time (days)	Compressive Load(KN)	Compression Strength (N/mm^2)	Average Strength (N/mm^2)
1	7	500	22.22	25.18
		550	24.44	
		650	28.88	
2	14	650	28.88	28.88
		625	27.77	
		675	30	
3	28	700	31.11	31.11
		675	30	
		725	32.22	

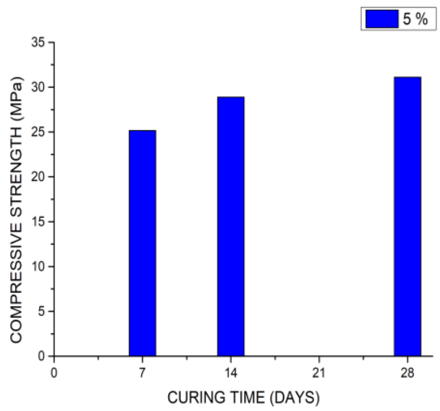

Fig.12 Graph representing compressive strength values for 5% plastic mix

Compressive strength for 6% Plastic mix :The following are various results obtained for concrete and the values are tabulated as below. A bar graph is plotted between curing time (days) on X axis and Compressive strength on Y axis. On observing the graph, strength is increasing for 7, 14 and 28 days

Table 10: Compressive strength values for 6% plastic mix at 7, 14 and 28 days

S.No	Time (days)	Compressive Load(KN)	Compression Strength (N/mm^2)	Average Strength (N/mm^2)
1	7	500	22.22	22.22
		480	21.33	
		520	23.11	
2	14	525	23.33	23.03
		500	22.22	
		530	23.55	
3	28	600	26.66	26.66
		575	25.55	
		625	27.77	

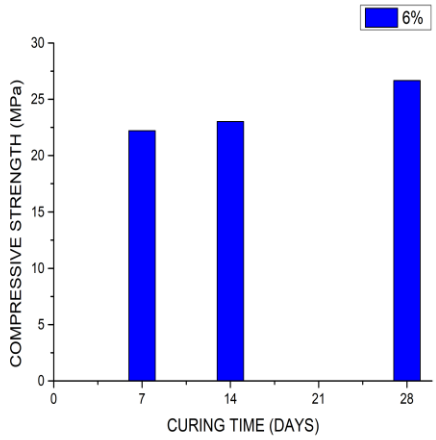

Fig.13 Graph representing compressive strength values for 6% plastic mix

Comparing the compressive strength for 7, 14 and 28 days: The following are various results obtained for concrete and the values are tabulated as below for 0 to 6% of plastic mix. And On observing the graph, optimum strength has occurred at 4% and there after strength has been decr:eased gradually.

Table.11:Summary

Percentage of plastic	curing days(time)	Compression strength (MPa)
0%	28	26.88
1%	28	28.51
2%	28	31.11
3%	28	32.66
4%	28	32.96
5%	28	31.11
6%	28	26.66

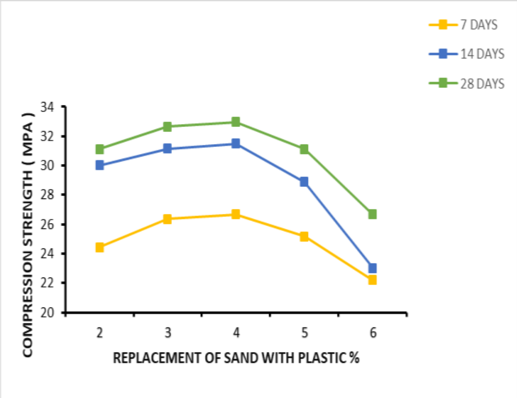

Fig.12 :Comparison graph of compressive strength values at 7, 14 and 28 days

V. CONCLUSION:

In this study cubes are prepared using M25 grade and recycled plastic waste is used has partial replacement in fine aggregate. Concrete cubes are prepared by replacing plastic waste from normal mix, 1%, 2%, 3% 4%, 5%, and 6% in fine aggregate and compression strength those cubes are tested for 7, 14 & 28respectively. By observing the graph whish are created using compression strength at different percentage we can say that up to 4% of plastic waste can replaced in the total weight if fine aggregate. When compacted compression strength of the cubes which are replaced with plastic to the compression strength of nominal mix the strength values are in acceptable range

Future scope: Further tests like split tensile strength and flexural strength should be conducted by preparing the specimens and testing them for 7, 14 and 28 days. Super plasticizer can be added to concrete to increase the workability and strength of concrete. Tests should be conducted on concrete (which is mixed with super plasticizer and PET plastic as fine aggregates) like compressive strength, split tensile strength and flexural strength. Results which are obtained by conducting tests like compressive strength, split tensile strength and flexural strength with super plasticizer is compared with the results obtained by conducting tests like compressive strength, split tensile strength and flexural strength without super plasticizer.

REFERENCES

[1] M Mahesh, B Venkat Narasimha Rao, CH Satya Sri (2016). Re use of polyethylene plastic waste in concrete. Journal of personality and social psychology. ISSN: 2321-9939.

[2] Nabila.I.Khan, S.D.Agrawal, D.Y.Kshirsagar (2017). Study of concrete by using wast plastic bottle caps as partial replacement of coarse aggregate. Journal of personality and social psychology-ISSN: 2395-0056.

[3] B.K.Kolhapure, Amit.chavan, Adil Ieshd (2018). E-ISSN: 2395-0056, e-ISSN: 2395-0072. Journal of personality and social psychology. Eco-friendly concrete by partial replacement of sand by shredded pieces of pet plastic bottles. Manhal A Jibrael and Farah peter (2016). Strength and behaviour of concrete contains waste plastic. . Journal of personality and social psychology. ISSN: 2157-7625.

[4] https://en.m.wikipedia.org/wiki/Polyethylene (PET plastic)

[5] M.S.Shetty,S.Chand.-ISBN:9788121900034 :Concrete Technology.

