INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 3, Issue 6)
Available online at www.ijariit.com

Experimental Investigation of Compressive Strength Properties of Eco-Friendly Concrete

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Abstract: ***The rapid Urbanization and Industrialization all over the world has resulted in the large deposition of Plastic waste and Waste Tyre Rubber. This waste can be utilized under the proper condition to reduce the Cement content in Concrete.M_{30} concrete is used for most of the constructional works. The strength of these concrete results has compared with concrete obtained of Plastic waste and Waste Tyre Rubber varying from 0% to 20 %.Experimental investigations comprised of testing physical requirements of Coarse Aggregates, Fine Aggregates, Cement and the modifier Waste Plastic and Waste Tyre rubber. M_{30} concrete design mix considered as per IS 10262-1982. The said percentage of modifier was blended with the cement concrete mix and the optimum modifier content was found. Cubes and Cylinders were casted and tested for 28 days strength. These tests revealed that by adding Waste plastics and rubber as a partial replacement in Fine Aggregate and Coarse aggregate by volume, the strength of concrete decreased. The cube strength decreased as the percentage replacement increased due to their poor binding properties. By using Plastic waste and Waste Tyre Rubber as modifier, we can reduce the quantity of coarse aggregate and fine aggregate by their volume, hence decreasing the overall cost of construction***

The modified cement concrete can be used in the construction of small drainage works and rigid pavement. Effective utilization of waste plastics can be done for a good cause of protecting the global environment and effective solid waste management.

INTRODUCTION

The changed lifestyle and endlessly increasing population have resulted in a significant rise in the quantity of post-consumer Plastic waste and Waste Tyre Rubber. The world's annual consumption of plastic materials has increased from around 5 million tons and 20 million tons in the 1950's to nearly 100 million tons in recent times, resulting in a significant increase in the amount of Plastic waste and Waste Tyre Rubber generation. Out of this waste, a significant part is recycled but the majority of post-consumer Plastic waste and waste tyre rubbers, like shampoo sachets, carry-bags, nitro packs, milk and water pouches and rubbers in Waste tyres etc. though recyclable, remains comparatively untouched as they are difficult to separate from household garbage. In most of the cases, such post-consumer waste either litters all around or is disposed of by land filling. The disposal of post-consumer Plastic waste and Waste Tyre Rubber in this manner poses significant environmental hazards as it results in a reduction in soil fertility, reduction in water percolation, emission of toxic gases, a health hazard to animals and birds consuming the wastes, poor drainage due to landfill, pollution of ground water due to leaching of chemicals from these waste products etc.

TYPES OFWASTE PLASTICS

1. House Hold Plastics

These are the Domestic plastic wastes generally used in a house as plastic wraps, cups, poly ethylene covers, resins, polyester clothes etc. They are less toxic in nature and are of Food Grade material which can be recycled twice or thrice.

2. E-Plastics

These wastes describe loosely discarded, surplus, obsolete, broken, electrical or electronic devices. Rapid change in the technology and low initial costs has resulted in a fast and surplus growth of electronic waste around the globe. Several tones of E-waste need to be disposed of per year. Traditional landfill or stockpile method is not an environmentally friendly solution and the disposal process is also very difficult to meet EPA regulations. How to re-use the non disposable E-waste becomes an important research topic.

3. Industrial Plastics

For Eco Friendly concrete, here we are taking the round shape small particle for the replacement of sand. These are controlled by economical, physical and chemical limitations. We are considering waste plastic as fine aggregate.

TYPES OFWASTE TYRE RUBBER

1. **Chipped Rubber:** The rubber has a dimension of about 25-30 mm. It was used to replace the coarse aggregates in concrete.
2. **Crumb Rubber:** These particles are highly irregular, in the range of 3– 10 mm. The rubber was used to replace sand.
3. **Ash Rubber:** The rubber consists of particles smaller than 1 mm. It was not prepared from Crumb rubber by grinding, but was the powder formed unintentionally during the Trituration Process, fallen from the machinery of the plant handling the waste rubber. It could be used as Filler in concrete due to its size

USAGE OF PLASTIC WASTE AND WASTE TYRE RUBBERS IN CONCRETE

It is observed that plastic waste and waste tyre rubber is used as a concrete ingredient in various forms. They are commonly used in the form of fine and coarse granular particles, powder and discrete fibers. This form of the ingredient is mainly controlled by economical, physical and chemical limitations of converting the wastes in a particular shape or form.

Advantages of Waste Plastic in Concrete

i) Concrete with waste plastics has more elastic property than P.C.C. The value of young's modulus of concrete with waste plastics is also found to be more than P.C.C.
ii) Compressive strength increases substantially when compared to P.C.C.
iii) Flexural strength increases by approximately 2 to 3 times throughout the mix.
iv) Increase in cube strength of concrete.

Advantages of Waste Tyre Rubber in Concrete

i) Concretes with waste tyre rubber are found to be tougher compared to concretes.
ii) Modulus of elasticity and Energy absorption capacity of concrete is increased slightly when waste tyre rubber is used in concrete.
iii) The durability of the concrete cast with waste tyre rubbers are found to be more durable compared to conventional concretes.

PLASTICS USED FOR PRESENT INVESTIGATION

The plastics used in the present investigation are domestic waste plastics which are processed in polyethene carry bag industry and are made into granules of variable sizes which in turn are graded according to the design requirements and are used as a partial replacement for fine aggregate in concrete.

LITERATURE REVIEW

Few researchers have focused on utilizing the granular form of recycled or waste plastics to replace the sand and natural aggregate contents in the mix to reduce the exploitation of the natural resource. Marzouk OY et al utilized the Plastic waste and Waste Tyre Rubber of polythene terephthalate (PET) bottles as an aggregate substitute in the concrete mix. Authors used these Plastic waste and waste tyre rubbers in M_{20} grade concrete in form of fine and coarse aggregates to check its feasibility and effects on mechanical properties of the concrete. M. Elzafraney et al. used recycled plastic aggregate as coarse aggregate to improve the thermal properties of concrete mix. Hasan S. Dweik et al. used the waste of thermo set plastic as a sand replacement to check the feasibility of the use.

M. Sivarajaetal tested various mechanical properties of concrete specimens made by mixing the plastic fibers in concrete. The volume fraction of waste was varied from 0.5% to 1.5%.They studied the effects of addition of plastic fibers obtained from the rural waste in the reinforced concrete beam under cyclic loading. K. S. Rebeiz et al. tested the flexural behavior of concrete produced by addition of recycled Plastic waste and Waste Tyre Rubber containing unsaturated polyester resin.

Osmani M. et al. -Plastic Waste and waste tyre Rubber as a powder in the concrete mix: They experimented with glass reinforced Plastic waste and Waste Tyre Rubber in concrete by making them powder form. The glass reinforced Plastic waste and Waste Tyre Rubber was used in volume fraction in 5% to 50% as a sand replacement. Authors concluded that waste has a good contribution to concrete properties. S. S Verma proposed to use Plastic waste and Waste Tyre Rubber in roads in form of powder up to 3% to 4% volume fraction.

Mohamed Osmani et al. Mohamed Osmani et al. carried out an assessment of the compressive strength of glass reinforced Plastic waste and Waste Tyre Rubber filled concrete for potential application in construction with the concentration of 5%, 15%, 30%, and 50% by weight. Authors found improvement in compressive strength due to the addition of the Plastic waste and Waste Tyre Rubber.

PROBLEM STATEMENT

A comprehensive review of the existing literature on plastic waste and waste tyre rubbers and steel fiber reinforced concrete has stressed the need of incorporation plastic waste and waste tyre rubbers in concrete for high strength concrete and fiber reinforced high strength concrete. "Literature regarding the flexural behavior of over reinforced high strength concrete reinforced steel fibers is very less". But the utilization of high strength concrete in the construction industry is increasing at a faster rate.

It is understood that the proper introduction of plastic waste and waste tyre rubbers and fibers in high strength concrete improves both mechanical properties and durability. There is a need for further research and development in this direction to study the variation of the flexural strength of over reinforced high strength concrete and mixing of steel fibers randomly in various volume fractions.

EXPERIMENTAL INVESTIGATION

The experimental investigation was taken up on the M_{30} grade of concrete. The investigation was aimed at studying the effect of Plastic waste and waste tyre rubbers in concrete cubes cast with M_{30} grade concrete and tested under Compression testing Machine. To reach the objective of this research, an experimental laboratory study was developed using the 53 grade Portland cement, graded coarse aggregate, river sand, super plasticizer, pozzolanic material, Plastic waste and waste tyre rubbers and bore well water. The details of casting, nomenclature, Plastic waste and waste tyre rubber percentages are shown in the tables below.

MATERIALS USED

Concrete is an artificially engineered material made from a mixture of Portland cement, aggregates, and water. It is most commonly used construction material in the world. It is strong, cheap and durable. Portland cement combines with water due to hydration to bond the aggregates together into a solid whole. The materials used in the present investigation are cement, fine aggregate, coarse aggregate, water, super plasticizer, plastic wastes and waste tyre rubbers.

Portland Cement

Portland cement is made from heating limestone and chalk, combined with silicates. Portland cement holds the aggregates together and is available in different grades and colors. The type of Portland cement generally available in hardware or lumber store is gray in colour. The cement used in this investigation is Orient Gold make, 53-grade Portland, for the casting of the cubes, cylinders, and prisms. The physical properties of the Portland cement used are given in Table- 3.1.

Table: Physical Properties of Cement

S. No	Property	Value
1	Grade	53
2	Specific Gravity	3.1
3	Standard Consistency	32%
4	Initial Setting Time	35 Minutes

Fine Aggregate

Sand is generally used as fine aggregate for production of the concrete. The sand should be sharp to grab the cement onto it. This sharp sand is also called as brick sand or mortar sand. The grains of sand from pit run sand are usually too round. Stone dust, a waste product from quarries or stone works can also be added to produce concrete, and usually for smooth mixtures for small scale concrete production.

Coarse Aggregate

Crushed hard granite stone or gravel of size less than 10mm is used as coarse aggregate. Stone adds strength to larger work and also controls shrinkage. Stone is cheaper than cement. The coarse aggregate is procured from Jayagiri, Hanamkonda and used for investigation.

Waste Plastic

The Word plastic means, the substances which have plasticity and accordingly anything that is performed in a soft state and used in a solid state can be called a plastic. These can be separated into two types. The first type is which can be melted for recycling in the plastic industry, ex: Polyethylene, propylene, polyamide, polyoxythylene. The second type is Thermosetting plastic cannot be melted by heating because the Molecular chains are bounded firmly with meshed crosslink, ex: Phenolic.

Waste Tyre Rubber

The rubber concrete reduces the concrete strength; however, this may be used where M_{10} and M_{15} grade concrete is needed. With proper mix design, about 20 percent density will be reduced in comparison to control mix when 30percent rubber aggregate is replaced with a coarse aggregate of control mix. Khatib and Bayomy (1999) reported that the rubber waste should not exceed 17-20% of the total aggregate in volume for better results in cement concrete.

Water

It should be free of impurities and clean. The water is from bore well and is Potable. This water is used for both casting and curing. The temperature of the mixing water was maintained constant.

Mix Design

In this study, the normal strength concrete of M_{30} grade is considered. BIS code procedure as per IS: 10262-1982 was followed for finding the mix proportions of all the concrete specimens. Water cement ratio, fine aggregate and coarse aggregate proportions considered for M_{30} grades are shown in the table.

Table: Mix Design of Concrete

Water	Cement	Fine aggregate	Coarse aggregate
186kg/m^3	490 kg/m^3	590 kg/m^3	1184kg/m^3
0.38	1	0.8135	2.291

SCHEME OF PROJECT

In the present investigation three no. of cubes and three no. of cylinders were casted. The scheme of the project in the above lines is given in the table.

Table: Scheme of Project

S.NO	% OF WASTE PLASTIC REPLACEMENT	% OF WASTE TYRE RUBBER REPLACEMENT	NO.OF CUBES CASTED	NO.OF CYLINDERS CASTED	TOTAL
1	0	0	3	3	6
2	2.5	2.5	3	3	6
3	5	5	3	3	6
4	7.5	7.5	3	3	6
5	10	10	3	3	6

MIXING

The mixing process should be good for any concrete to get good results. The exact proportion of every material has to be considered according to the calculated quantity. For every mix weighing of material was needed. Waste Plastic, Waste tyre rubber for mixing had to be taken as per the standard size of fine and coarse aggregate. The mixing for making concrete is done in the following steps.

TESTS ON FRESH CONCRETE

The tests were conducted on fresh concrete for their slump and compaction factor values, the tests were:

(1) Slump test (2) Compaction factor test.

SLUMP RESULTS

The results of slump c one test are represented in the table:

Table: Slump Cone Test Results

PERCEN TAGE REPLACEMENT	RESULT
0	29.5
5	29
10	28.5
15	28
20	28

COMPACTION FACTOR TEST RESULTS

The Compaction factor test results are shown in Table

Table: Compaction Factor Test Results

PERCENTAGE REPLACEMNET	RESULT
0	0.87
5	0.87
10	0.86
15	0.86
20	0.85

CASTING OF SPECIMENS

Standard cast iron moulds (150x150x150) cube and (150diax300mm) cylinder were used for casting the specimens. All the moulds have been cleaned and oiled before every use. Moulds are being cast by placing them over the neat surface. A mix generally requires much fewer vibrations to move the mix and consolidate it into the moulds. The compactions of the specimens have been done using a tamping rad. The casting work was done in three batches for preparing three numbers of cubes of size 150mm x 150mm x 150mm. I.S Code method was used to obtain the mix proportions for an M30 grade of concrete. The coarse aggregate used in the casting was of size 20 mm. The waste plastic and waste tyre rubber were incorporated in the above mix proportion 0, 5, 10, 15, 20 percentages of Fines aggregate and coarse aggregate by weight. The mixing of plastic waste and waste tyre rubber and Fine aggregate is shown above in fig 3.3. After obtaining the mix proportions with Fine aggregate+ coarse aggregate, plastic waste and waste tyre rubber for an M_{30} grade of concrete, mixing of concrete constituents are detailed in table 3.5.Details and placing the mould is shown below in fig 3.6. The cubes were cured in a pond for 28 days. The specimens were taken out of the curing pond and kept under shade for surface dry. Then the specimens were tested in the laboratory.

CURING

The method adopted was ponding method. Standard cast iron moulds of the cube (150mmx150mmx150mm) and cylinder (150diax300mm height) were used for casting the specimen and after 24 hours of age they were demoulded and are placed in the curing tank for curing.

Fig: Curing

TESTS CONDUCTED ON HARDENED CONCRETE:

The cube specimens after curing for different ages viz; 28 days were removed from the curing pond and were allowed to dry under shade for a while and are tested under 200 Ton capacity Compression Testing Machine.

Compressive Strength

Results for average compressive strength at all the curing age, with different Replacement Percentages, are summarized in Table of chapter-4. The Proportional decrease in the Compressive strength of ecofriendly concrete was observed for the increased waste plastic and waste tyre rubber replacement levels. The arrangement of cubes and cylinders under CTM is shown in Figs.

Fig: Cubes under CTM

Fig: Cylinders under CTM

RESULTS AND DISCUSSION OF TEST RESULTS
CUBE COMPRESSIVE STRENGTH RESULTS

The results of Compressive Strength with various % replacement of plastic waste and Waste tyre rubber are given in Table 4.1. These results for 0%, 5%, 10%, 15% and 20% replacements are shown in Fig.

Table: Test Results of Cube Specimens

No. of Samples	0%	5%	10%	15%	20%
Sample 1	47.7	40.5	31.3	26.1	26.1
Sample 2	45.6	41.2	31.3	27.3	25.4
Sample 3	47.9	39.6	33.2	28.1	25.4

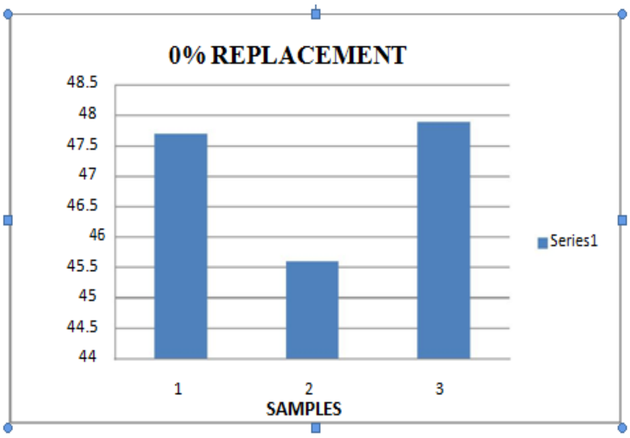

Fig: Compressive Strength Results for 0% Replacement of Plastic Waste

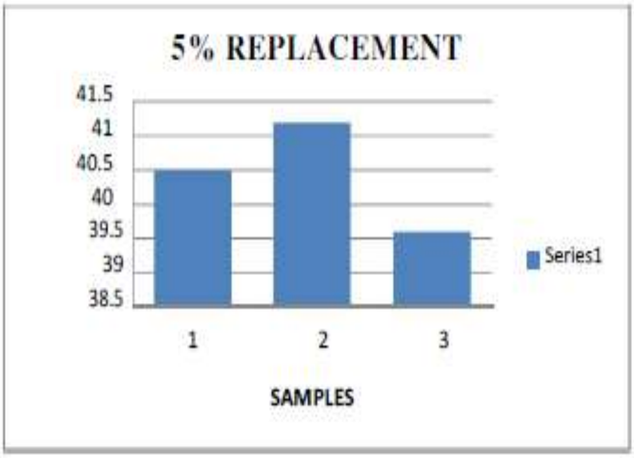

Fig: Compressive Strength Results for 5% replacement of plastic waste

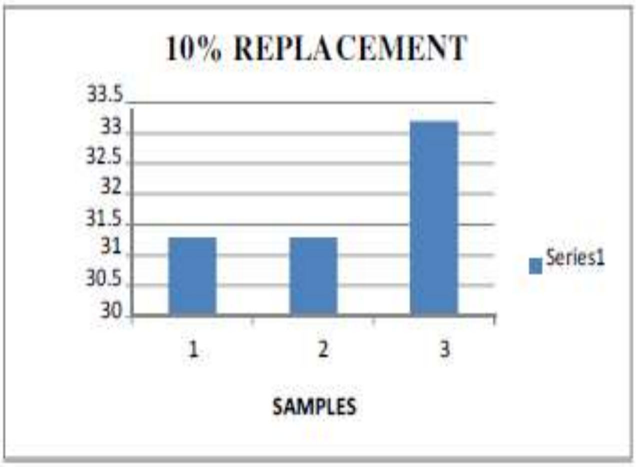

Fig: Compressive Strength Results for 10 % replacement of plastic waste

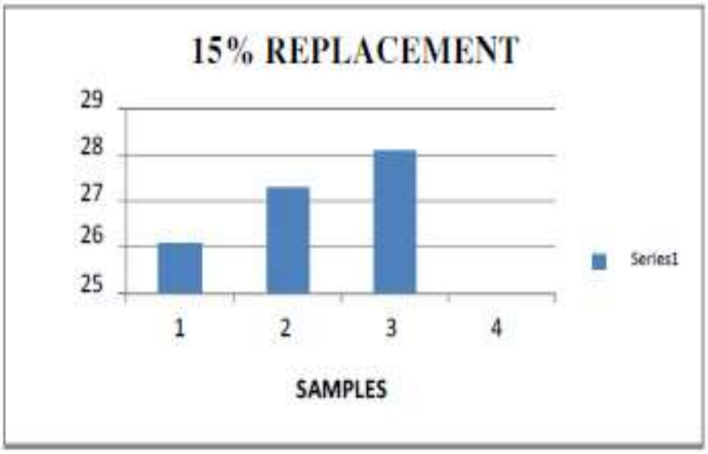

Fig: Compressive Strength Results for 15 % replacement of plastic waste

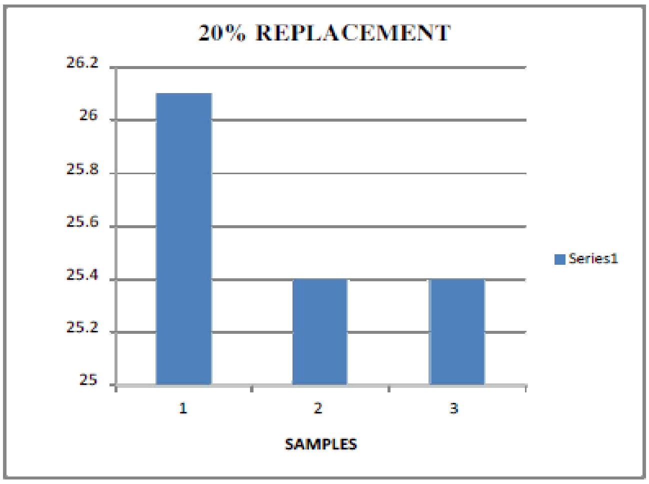

Fig: Compressive Strength Results for 20 % Replacement of Plastic Waste

THE STRESS-STRAIN BEHAVIORGRAPHS

The stress-strain behavior of ecofriendly concrete studied in this thesis with partial replacement is as follows, at every replacement three samples were casted and tested for the stress-strain results and are represented by graphs.

AT 0% 1

Load	Left	Right	Mean	Area	Strain	Stress
0	0	0	0	0.0565	0	0
2	4	7	5.5	0.0565	0.000055	1.110265428
4	5	9	7	0.0565	0.00007	2.220530856
6	7	11	9	0.0565	0.00009	3.330796284
8	9	13	11	0.0565	0.00011	4.441061713
10	10	17	13.5	0.0565	0.000135	5.551327141
12	13	21	17	0.0565	0.00017	6.661592569
14	14	26	20	0.0565	0.0002	7.771857997
16	19	36	27.5	0.0565	0.000275	8.882123425
18	20	39	29.5	0.0565	0.000295	9.992388853
20	22	41	31.5	0.0565	0.000315	11.10265428
22	23	47	35	0.0565	0.00035	12.21291971
24	33	54	43.5	0.0565	0.000435	13.32318514
26	47	59	53	0.0565	0.00053	14.43345057
28	50	60	55	0.0565	0.00055	15.54371599
30	73	70	71.5	0.0565	0.000715	16.65398142
32	80	72	76	0.0565	0.00076	17.76424685

34	86	83	84.5	0.0565	0.000845	18.87451228
36	110	90	100	0.0565	0.001	19.98477771
38	125	94	109.5	0.0565	0.001095	21.09504313
40	142	97	119.5	0.0565	0.001195	22.20530856

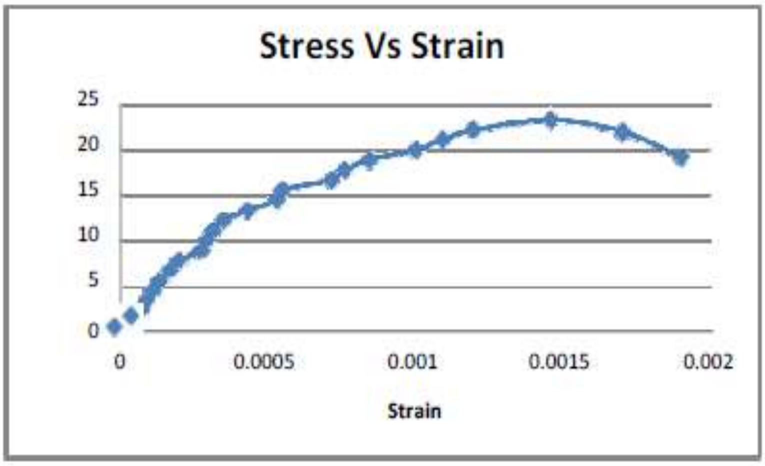

Fig: Stress Strain Graph for 0% for sample 1

AT 0%2

Load	Left	Right	Mean	Area	Strain	Stress
0	0	0	0	0.0565	0	0
2	5	10	7.5	0.0565	0.000075	2.220530856
4	7	15	11	0.0565	0.00011	3.330796284
6	11	20	15.5	0.0565	0.000155	4.441061713
8	17	25	21	0.0565	0.00021	5.551327141
10	30	35	32.5	0.0565	0.000325	6.661592569
12	47	45	46	0.0565	0.00046	7.771857997
14	80	55	67.5	0.0565	0.000675	8.882123425
16	85	61	73	0.0565	0.00073	9.992388853
18	97	74	85.5	0.0565	0.000855	11.10265428

20	100	81	90.5	0.0565	0.000905	12.21291971
22	120	90	105	0.0565	0.00105	13.32318514
24	140	95	117.5	0.0565	0.001175	14.43345057
26	120	97	108.5	0.0565	0.0013	14.754
28	110	93	125	0.0565	0.00139	14.12754575
30		93	93	0.0565	0.00147	11.1854545

Table: Stress Strain Calculations at 0 % Replacement for Sample 2

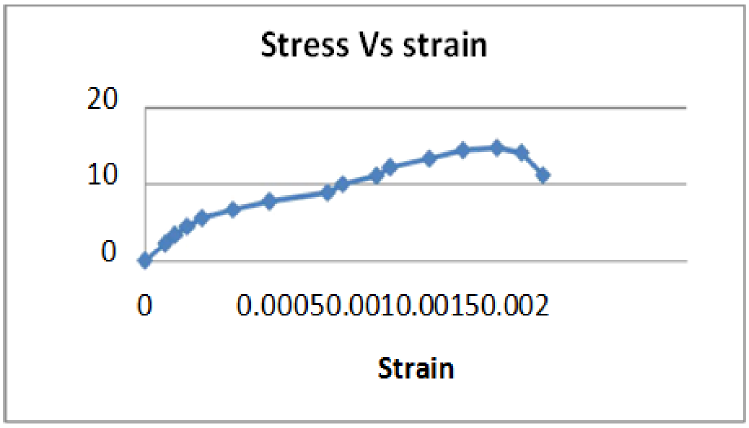

Fig: Stress Strain graph for 0% for Sample 2

RESULT ANALYSIS

The present investigation shows that, at 0% replacement cubes had good strength and at 20% replacement cubes had very less strength. As the percentage replacement increases the strength decreased continuously. The maximum load taken by the replacement of materials 0%, 5%, 10%, 15%, 20% of cubes are as 110kN/mm^2, 95kN/mm^2, 75kN/mm^2, 65kN/mm^2, and 60kN/mm^2. The M_{30} grade concrete cannot bear a heavy load. So, it is useful as pavement concrete and the results show that it is non-structural concrete. The slump values were decreased because the replacement material cannot absorb more water like a fine and coarse aggregate. These materials have a smooth surface. As the percentage replacement of material increases the slump and compaction factor values decreased.

CONCLUSIONS AND SCOPE FOR FURTHER STUDY

Based on the above study following conclusions are presented:

1. Fresh concrete properties such as Unit weight and Slump decreased with the higher replacement levels of rubber and plastics.
2. Air content of fresh concrete increased with a decrease in particle size and increase amount of rubber and plastic.
3. Increase in waste tyre rubber and waste plastic content decreased the compressive strength of the concrete significantly.
4. The minimum and maximum compressive strength of cubes are as 25.4 MPa and 47.9 MPa.
5. In the present investigation the cubes and cylinders were casted and tested for 28 days of age, the cube strengths were decreased as the percentage replacement increased due to their poor bounding properties.
6. The properties of waste plastic and waste tyre rubbers are not useful for structural concrete. But it is cheaper than normal concrete and hence, this Eco friendly concrete can be used for non-structural works such as pavements, drainage, CC flooring and for small works.
7. The utilization of these plastic waste materials will also help in disposal of plastic waste and will help environmental upgradation.

FUTURE SCOPE

Various other combinations can be used to get high strength concretes and study the necessary modifications to make it suitable for structural concrete works also.

REFERENCES

1. AFPC-AFREM. (1997) "Methods Recommenders Pour LA Measure Des Grandeurs Physiques Associées À LA Durabilité", Compterendu Des Journées Techniques DU11AU 12 Décembre, Toulouse, France.
2. Albano C., Camacho N., Reyes J., Feliu J. L. And Hernandez .M (2005), "Influence of Crap Rubber Addition to Portland I Concrete Composites: Destructive and Nondestructive Testing", Composite Structures, 71(3-4), PP.
3. AL-Hadidy A. I. And YI-QIU T. (2009), "Effect Of Polyethylene On Life Of Flexible
4. Allan, M. L., and Kukacka L. E. (1995), "Strength and Durability of Polypropyl Fiber Reinforcement Grouts", Cement And Concrete Research, 25(3), PP.
5. Côte D'ivoire Normalisation. (2002), "Normesivoiriennes Pour Les Pavés De Voirie Enbéton", 2ème Edition.
6. Courard .L, Degeimbre R., Darimont A., Laval A. L., Dupont L and Bertrand L. (2002), "Utilisation Desmâchefer SD' incinérateurd'or duresménagèresdans LA FABRICATION DES PAVÉSENBÉTON", MATERIALS AND STRUCTURES, 25(7), PP 365-372.
7. Hannawi K., Prince W., and Kamali- Bernard .S (2010), "Effect of Thermoplastic Aggregates in Corporation on Physical, Mechanical and Transfer Behavior.
8. Hinislioglu S. and Agar E. (2004), "Use Of Waste High Density Polyethylene as Bitumen Modifier in Asphalt Concrete Mix", Materials Letters, 58(3-4), PP.
9. Hui L., Zhang M. H. and OU J. P. (2006) "Abrasion Resistance Of concrete Containing Nano Particles for Pavement", Wear, 260(11-12).
9. Rebeiz K., S. and Craft A. P. (1995), "Plastic Waste and Waste Tyre Rubber Management in Construction: Technological and Institutional Issues", Resources, Conservation and Recycling, 15, PP 245-257.

