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PARTIAL REPLACEMENT OF FINE AND COARSE AGGREGATE WITH PLASTIC POWDER AND RUBBER TYRES

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Abstract - **The aim of approach is to use plastic powder and rubber tyres as the replacement of fine and coarse aggregate. Nowadays use of Industrial wastes from polypropylene (PP) and polyethylene terephthalate (PET) were studied as alternative replacements of a part of the conventional aggregates of concrete. As similar to plastic wastes the waste tires are an another important parts of solid waste which are disposed of in to landfills in day to day life but the disposal of rubber tires into landfill will cause a serious environmental problem. Thus our study explores the possibility of reusing plastic and waste tires in concrete engineering applications through enhancing the properties of concrete mix as partial replacement with fine aggregate and coarse aggregate. We make use of both plastic and rubber as fine and coarse aggregate in M_{35} grade of concrete at an increment of 10%, 20%, 30% and 5%, 10%, 15%. Several tests were made to determine the behavior of plastic and rubber tires in concrete. The compressive strength of hardened concrete with replaced materials is tested after 7 day and 28days of curing.**

Key words – polypropelene, tyres, plastic powder, landfill, reuse

I. INTRODUCTION

Concrete is one of the widely used construction material in the world. Itis a composite material consists of cement, fine aggregate, coarse aggregate, water. It can be used in diverse places in diverse shapes. Special type of concretes were arrived which are used in various situations and various regions. But the rapid increase in urbanization and industrialization has made wide consumption of the construction materials. Thus the more rate of consumption leads to the demand of materials. Many research and studies are carried to provide solution to this conflict.

II. RESEARCH SIGNIFICANCE

As the world population grows, various types of wastes are being generated. The creation of non–decaying and low biodegradable waste materials, combined with a growing consumer population has resulted in waste disposal crisis. One solution to this crisis is recycling of these waste products into useful products especially in engineering applications. Industrial wastes from polypropylene (PP) and polyethylene terephthalate (PET) were studied as alternative replacements of a part of the conventional aggregates of concrete. plastic wastes are majorly obtaining from industries and urban areas. The process of recycling will also provide the employment opportunity. In turn this will increase the economic growth of country.

III. MATERIALS AND MIX PROPORTIONS

CEMENT: Cement is a binding material in concrete which binds the other materials to form a compact mass. We used PPC (fly ash based) for our project work.

Table 1 Cement Properties

Properties	**Values**
Fineness	300 m^2/kg
Setting Time (Initial)	30 min
Setting time (Final)	600 min
Soundness	10 mm
Compressive Strength	33 Mpa

Specific Gravity	3.05

FINE AGGREGATE: River sand are used as fine aggregate in conventional concrete. They are sieved and compared with grading table from IS 383-1970 Table 3.2

Table 2 Properties of fine aggregate

Properties	Value
Fineness modulus	3.24
Specific gravity	2.66
Water absorption	1.2%
Size	Passing through 4.75 mm sieve

COARSE AGGRGATE: Aggregate must be clean and free from impurities. The aggregate used normally are of size 20 mm. They are obtained from quarry in surrounding areas.

Table 3 Properties of coarse aggregate

Properties	Value
Fineness modulus	4
Specific Gravity	2.67
Water Absorption	0.8%
Size	Passing through 20 mm sieve and retaining in 10 mm sieve

PLASTIC POWDER: Plastic powder are of various types LDPE, HDPE, PP, PS, PVC, ABS, Polyester, PC, Nylon 66, Teflon. We use Polypropelyne type of plastic powder in our project. Polypropylene is a linear hydro carbon polymer, expressed as CnH_2n. It is a polyolefin or saturated polymer. PP is the one of the most versatile polymers available with applications both as plastic and as a fiber. The properties of PP are semi-rigid, translucent, good chemical resistance, toughness, good fatigue resistance and heat resistance.The specific gravity of the plastic powder (PP) is lies between 0.90 -0.91. It can be used up to a temperature of 100 – 110°C. They are inflammable and have a ignition temperature of 300-360°C**.**

Fig 1 Plastic powder

Table 4 Properties of PP

Properties	Values
Specific gravity	0.91
Melt Temperature	210-290 degree celsius
Tensile Strength	1.25 N/mm^2
Density	0.905 g/cm^3

RUBBER TIRES: Rubber tires from industries are used by soaking them in water to remove the impurities in the surface. They are cut into required size of aggregate. Rubber tires are provided with filler materials having low physical strength. Typical

fillers include carbon black, calcium silicate, calcium carbonate and clay. The physical and the chemical analysis of tyre is as specified as follow in the table.

Fig 2 Tire pieces

Table 5 Physical Properties:

Properties	**Values**
Density	0.83 g/cm^3
Size	Nearer to 20 mm size
Elongation	420
Specific Gravity	1.529

Table 6 Chemical analysis

Materials	**Mass %**
Rubber	54
Carbon black	29
Textile	2
Oxidized zinc	1
Sulfur	1
Additives	13

ADMIXTURE: The admixtures are used to improve workability, reduce the water cement ratio, to accelerate the heat of hydration. Bonding admixtures are used to get bond between the constituents of concrete.

Fig 3 Admix

MIX PROPORTION

Table 7 Mixes (percentage of plastic powder and rubber tyres)

Mixes	**Proportion of Plastic (%)**	**Proportion of Rubber tires (%)**
Mix 1	10 %	5 %
Mix 2	20 %	10 %
Mix 3	30 %	15%

Fig 4 Mix proportion

Table 8 Proportions of Plastic Powder and Rubber Tyres for One Cube 150x 150 x 150 Mm

Percentage of Plastic Powder	Percentage of Rubber tires	W/c	Cement Kg	Fine aggregate Kg	Coarse aggregate Kg	Plastic powder Kg	Rubber tire Kg
10%	5%	0.45	1.18	2.24	3.77	0.06	0.105
20%	10%	0.45	1.18	2.18	3.57	0.120	0.210
30%	15%	0.45	1.18	2.12	3.37	0.180	0.315

IV. TESTS ON FRESH CONCRETE

SLUMP TEST: Slump test is the most commonly used method of measuring workability of concrete. The apparatus consists of a slump cone and a tamping rod. Bottom diameter of cone is 20 cm, top diameter of cone is 10 cm and have a height of 30 cm. The tamping rod will be 16 cm in diameter and 0.6 m long.

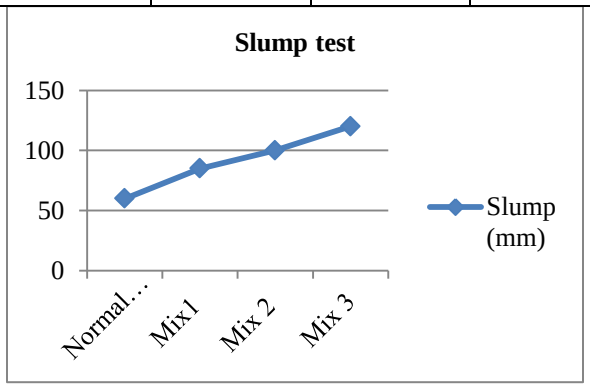

Fig 5 Slump test of various mixes

Table 9 Slump of concrete

S.no	Test Series	Slump (mm)
1.	Normal concrete	60
2.	Mix1	85
3.	Mix 2	100
4.	Mix 3	120

FLOW TEST TABLE: The flow table test gives an indication of quality of concrete with respect to consistency, cohesiveness and the proneness to segregation. In this test concrete is subjected to jolting. The flow or spread of concrete is measured and its flow is related to workability. The apparatus consists of a flow table of 76 cm dia, mould in the form frustum of a cone of top diameter 17 cm, bottom diameter 25 cm and height of 12 cm, tamping rod of 1.6 cm dia and 61 cm long.

Flow percent =(Spread diameter – 25)/25 x 100

Nominal Mix =(40.6 – 25)/25 x 100=62.4 %

Mix 1 = (49.4 – 25)/25 x 100 = 97.6 %

Mix 2 = (51.8 – 25)/25 x 100 = 107.2 %

Mix 3 = (58.3 – 25)/25 x 100 = 133.2 %

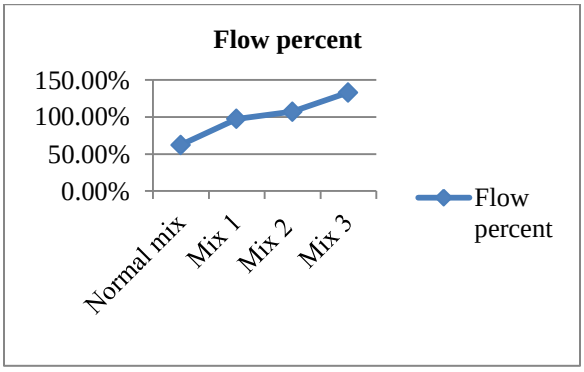

Fig 6 Flow table test of various mixes

V. TESTS ON HARDENED CONCRETE

DETERMINATION OF UNIT WEIGHT: The unit weight values used for the analysis of this section are measured from the concrete cube samples after 28 days of standard curing.

Table 10 Unit weight of concrete

Types of concrete	Unit weight (Kg)	% of Reduction
Normal concrete	8.2	0
Mix 1	7.670	6.46
Mix 2	7.374	10.07
Mix 3	6.982	14.85

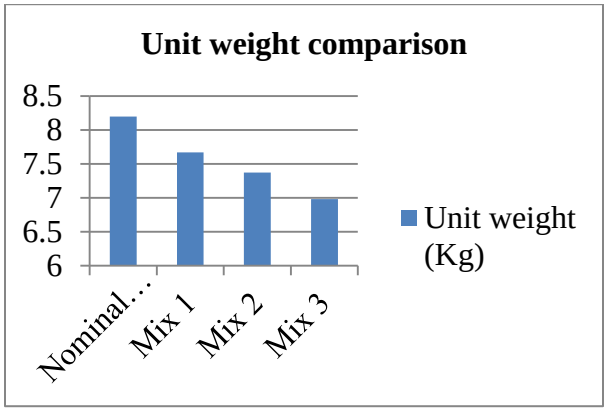

Fig 7 Unit weight of concrete

COMPRESSIVE STRENGTH TEST: The compressive test is carried out on cubical or cylindrical specimen. Prism is also used sometimes. The cube specimen is of the size 15 X 15 X 15 cm. Cylindrical specimens are commonly 15 cm in diameter and 30 cm long

Table 11 Average Compressive Strength

Mixes	Average compressive strength 7 day (N/mm^2)	Average compressive strength 28 day (N/mm^2)
Mix 1	28.30	42.04
Mix 2	25.97	37.10
Mix 3	20.86	29.60
Normal Mix	28.16	40.77

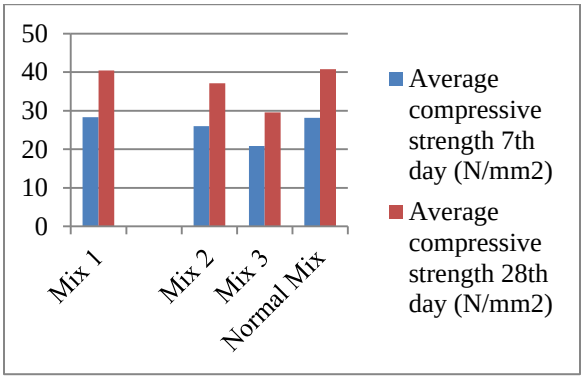

Fig 8Average compressive strength

Fig 9 Tested Specimens

VI. CONCLUSION

Thus from the above experimental results we concluded that the use of plastic and rubber tires in concrete influence the properties of concrete. The workability will be high with the use of plastic and rubber. The compressive strength will be maximum and optimum to nominal concrete at first mix ratio, but it gets reduced slightly when the materials added incrementally. The flexibility will be high. The unit weight of concrete is gets reduced when the plastic and rubber materials are added at high rate. This light weight quality is suitable for architectural application, false facades, stone baking, interior construction, in building as an earthquake shock wave absorber. Thus the rubberized concrete is recommended to use in road curbs and non load bearing walls.

COST ESTIMATE:

Rate of Cement per bag = Rs. 400

Rate of sand per cum = Rs. 176

Rate of blue stone per cum = Rs. 1239

Transportation cost = Rs. 1500

Rate of admixture per bottle = Rs. 400

Rate of Plastic powder per cum = Rs. 600

Rate of Rubber tyres

(Labour charge) = Rs. 600

Transportation cost of replaceable materials

= Rs. 1000

For normal concrete

= 2800 + 176 + 1239 +1500 = Rs. 5715

For concrete with 10%, 5% replacement of plastic powder and rubber tyres

= 2800 + 160 + 500 + 600 +400 + 1000

= Rs 3760

The cost of concrete with the replaceable materials is considerably economical in cost as compared to the cost of conventional concrete.

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