Use of Polypropylene Waste in Concrete

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***Abstract*— In recent years use of polypropylene material is increased day by day and management of polypropylene waste is the new primary challenging issue faced by the countries all over the world. It is very challenging and hectic problem that has to be tackled in an indigenous manner, use of polypropylene waste in concrete is better solution for environment. In this research an experimental study is carried out to investigate the feasibility and use of polypropylene waste in concrete for new construction. The present investigation to be focused on use of polypropylene waste materials in order to reduce construction cost and environment pollution problems faced by whole world. The strength properties of M20 grade concrete are studied with polypropylene waste percentage proportions. The polypropylene proportions are 5% by volume. We studied strength properties of these mixes. There is increase in compressive strength when the polypropylene waste is replacing 5% with sand by volume.**

I. INTRODUCTION

Concrete is the most widely used man-made construction material in the world. It is obtained by mixing cementitious materials, water, aggregate and sometimes admixtures in required proportions. Fresh concrete or polypropylene concrete is freshly mixed material which can be moulded into any shape hardens into a rock-like mass known as concrete. The utility and elegance as well as the durability of concrete structures, built during the first half of the last century with ordinary Portland cement (OPC) and plain round bars of mild steel, the easy availability of the constituent materials of concrete and the knowledge that virtually any combination of the constituents leads to a mass of concrete have bred contempt. Strength was emphasized without a thought on the durability of structures. As a consequence of the liberties taken, the durability of concrete and concrete structures is on a southward journey. The setback in the health of newly constructed concrete structures prompted the most direct and unquestionable evidence of the last two/three decades on the service life performance of our constructions and the resulting challenge that confronts us is the alarming and unacceptable rate at which our infrastructure systems all over the world are suffering from deterioration when exposed to real environments.

The Ordinary Portland Cement (OPC) is one of the main ingredients used for the production of concrete and has no alternative in the civil construction industry. Unfortunately, production of cement involves emission of large amounts of carbon-dioxide gas into the atmosphere, a major contributor for greenhouse effect and the global warming, hence it is inevitable either to search for another material or partly replace it by some other material. The search for any such material, which can be used as an alternative or as a supplementary for cement should lead to global sustainable development and lowest possible environmental impact.

Fly ash, Ground Granulated Blast furnace Slag, Rice husk ash, High Reactive Metakaolin, silica fume are some of the pozzolanic materials which can be used in concrete as partial replacement of cement. A number of studies are going on in India as well as abroad to study the impact of use of these pozzolanic materials as cement replacements and the results are encouraging. The strength, durability and other characteristic of concrete depends on the properties of its ingredients, proportion of mix, method of compaction and other controls during placing and curing.

With the passage of time to meet the demand, there was a continual quest in human being for the development of high strength and durable concrete. The history of high strength concrete is about 35 years old, in late 1960s the invention of water reducing admixtures lead to the high strength

precast products and structural elements in beam were cast in situ using high strength concrete. Since then the technology has come of age and concrete of the order of M60 to M120 are commonly used. Concrete of the order of M200 and above are a possibility in the laboratory conditions. The definition of high strength concretes is continually developing. In the 1950s 34N was considered high strength, and in the 1960s compressive strengths of up to 52N were being used commercially. More recently, compressive strengths approaching 138N have been used in cast-in-place buildings. The advent of pre stressed concrete technology has given impetus for making concrete of high strength. In India high strength concrete is used in pre stressed concrete bridges of strength from 35 MPa to 45 MPa. Presently (in 2000) Concrete strength of 75 MPa is being used for the first time in one of the flyover at Mumbai. Also in construction of containment Dome at Kaiga power project used HPC of 60MPa with silica fume as one of the constituent.

The reasons for these demands are many, but as engineers, we need to think about the durability aspects of the structures using these materials. With long term durability aspects kept aside we have been able to fulfil the needs. The concrete of these properties will have a peculiar Rheological behaviour.

Now a day the construction industry turning towards pre-cast elements and requirement of post-tensioning has made the requirement of the high strength of concrete invariable and the engineers had to overcome these drawbacks, which to a great extent we have been able to do. The construction today is to achieve savings in construction work. This has now turned into one of the basic requirement of concreting process.

II. OBJECTIVE

The objective of this experimental work is to determine the strength characteristics of Polypropylene Waste concrete through Destructive.

i. To reduce environmental pollution
ii. Increase compressive strength of concrete
iii. Increase flexural strength of concrete
iv. Increase workability of concrete
v. To reduce cost of concrete

III LITRETURE REVIEW

Some of the early research works had done using different Polypropylene Waste Material with the replacement of cement using super polypropyleneizers for the development high performance concrete. Also the development in the field of fibre reinforced concrete along with pozzolanas. So below an over view of different studies has been represented.

1. Charudatta P. Thosar, Dr. M. Husain (2017) they studied on **Reuse of Polypropylene Waste as Replacement of Sand in Concrete** with the help of G Sarangapani , H S Suresh Chandra and B G Nareshkumar of Wast Polypropylene Concrete blocks , N.I.E. , Mysore , India , Journal of civil Engineering Technology and Research. In the present scenario the construction cost as scarcity of sand is increasing day by day in order to counteract this problem, sand is partially replace by polypropylene waste material. Polypropylene waste is recycled for the production of new material which can be used as alternative component in concrete and is one of the best solution for disposing of polypropylene waste. Also this techniques proves to be highly cost effective than conventional method.

2. B. Harini & K. V. Ramana (2015) they studied on **Use of Recycled Polypropylene Waste as Partial Replacement for Fine Aggregate in Concrete** with the help of Alexandra M. da Silva, Jorge de Brito ,Rosário Veiga," Incorporation of fine polypropylene aggregates in rendering mortars ",Construction and Building Materials. Concrete is combination cement, aggregates and water. Due to enormous growth in concrete, aggregates are facing crisis. Apart from this growth of polypropylene has provoked the methods to solve environmental issue caused by polypropylene. They have made an experiment by partially replacing fine aggregate with polypropylene an investigation has been carried out. The strength properties of M30 grade concrete are studied with different polypropylene percentage proportions. The various polypropylene proportions are 5%, 6%, 8%, 10%, 15%, 20% by volume. They studied strength properties of these mixes. There is decrease in compressive strength when the ratio of polypropylene to aggregate was increased .They have taken the mix for which compressive strength was least and to that mix they have partially replaced

cement with silica fume of 5%,10%,15% by weight. The strength properties were again studied, it was noticed that when cement was partially replaced by 10%, 15% of silica fume was higher than reference mix.

3. Kshiteesh Gaur, Jyotsana, Anil Kumar Arya, Neelesh Kumar Singh (2017). They discussed on **Use of Polypropylene as Partial Replacement of Fine Aggregate in Fibre Reinforced Concrete** with help of

Hassani, A., Ganjidoust, H., Maghanaki, Use of polypropylene waste (poly-ethylene terephthalate) in asphalt concrete mixture as aggregate replacement. Waste Management & Research.

Modern activities in India lead to use of polypropylene bags in excess. Polypropylene being non-biodegradable material, it takes years to decompose. Polypropylene bags have main constituent as poly-ethylene. The poly-ethylene when combusted produces a by-product of Carbon dioxide which leads to global warming. In this, we study the efficiency of reusing polypropylene waste in concrete by comparing compressive strength of concrete whose fine aggregate is partially replaced by polypropylene(5%,10%,15%,25%) with control concrete of M20 grade. To compensate for the strength lost due to replacement, iron fibres of diameter 1-2 mm are used in fixed amount.

4. D.W.Gawatre, Vivek S.Damal , Saurabh S.Londhe , Ajinkya B.Mane ,Hrishikesh Ghawate (2015) they studied on **Environmental Issues of Polypropylene waste use in Concrete** with help of P.M.Subramanian, "Polypropylene recycling and waste Management in the US" Resources, Conservation and Recycling vol. Now a day's concrete roads are used commonly because concrete roads have more life span than the bitumen roads.

In large cities now a day's concrete roads are used because concrete roads are more durable, strengthen and having more life span than bitumen roads. Non recycling Waste materials are posing serious pollution problems to the human and the environment. So, new effective waste management options need to be considered. In India, bitumen pavements are commonly used for highways. Due to the increasing traffic intensity, distress such as rutting and cracking of pavements are very common bin Indian roads. Under varying seasonal temperature, flexible pavements tend to become soft in summer and brittle in winter.

Investigations revealed that properties of concrete can be better than bitumen roads. Waste polypropylenes and E-waste (electronic waste) both by domestic and industrial sectors can be used in the production of asphalt mix. Waste polypropylene, mainly used for packing are made up of polyethylene, polypropylene, polystyrene. Electronic waste, abbreviated as e-waste, consists of discarded old computers, TVs, refrigerators; radios, etc are basically any electrical or electronic appliance that has reached its end of life. An experimental study is made on the utilization of E-waste particles as fine aggregates in concrete with a percentage replacement ranging from 0 % to 21.5% i.e. (7.5%, 15% and 21.5%) on the strength criteria of M30 Concrete. Compressive strength Concrete with and without E-waste polypropylene as aggregates was observed which exhibits a good strength. The feasibility of utilizing E-waste polypropylene particles as partial replacement of fine aggregate has been presented. In the present study, compressive strength was investigated for Optimum Cement Content and 7.5% E-polypropylene content in mix yielded stability and very good in compressive strength of 43 grade cement.

IV. ANALYSIS AND DESIGN CALCULATION

Design of M20 concrete mix as per IS: 10262-2009

Step 1 Target mean strength

$f_{ck} = 20$ n/mm^2

$f'_{ck} = f_{ck} + t \times s$

$= 20 + 1.65 \times 4$

$= 26.6$ N/mm^2

Step 2 Selection of water-cement ratio

From graph w/c ratio = 0.50

Maximum w/c ratio = 0.55

Adopt w/c ratio = 0.50

Step 3 Estimation of air content

For maximum size of aggregate of 20 mm the air content is taken as 0.2%

Step 4 Selection of water and sand content

Quantity of water per m^3 of concrete = 186 lit.

Sand content = 35 %

Table 3.3 Selection of water and sand content

Sr. No.	Change in condition	Adjustment required	
		Water content	% sand in total Agg.
1	For decrease in w/c ratio 0.6 – 0.5 = 0.1 $\frac{0.1}{0.05}$ x 1 = 2.0	0	- 2.0
2	For increase in c.f. 0.9 – 0.8 = 0.1 $\frac{0.1}{0.1}$ x 3 = 3	+ 3	-
3	For sand conforming to zone – iii of table 4 of is: 383-1970 Zone – iii is assumed	-	- 1.5
	Total	+ 3	- 3.5

Required water content = 186 + (186*(3/100))
= 186 + 5.58
=191.58 = 191.6 lit/ m^3

Required sand content as percentage of total aggregate by absolute volume

P = 35 – 3.5
= 31.5 %

Step 5: Cement content

w/c = 0.50
water = 191.6 kg
191.6/C = 0.50
Cement = 383 kg/m^3 > 300 kg/ m^3…..hence ok.

Step 6 : Determination of fine and coarse aggregate content :

Consider volume of concrete = 1 m^3
But, entrapped air in wet concrete = 2 %
Absolute volume of fresh concrete = $1 - \frac{2}{100}$
v = 0.98 m^3

- **Fine aggregate**

$v = [w + \frac{C}{Sc} + \frac{1}{P} X \frac{fa}{Sfa}] \times \frac{1}{1000}$

$0.98 = [191.6 + \frac{383}{3.15} + \frac{1}{0.315} X \frac{fa}{2.69}] \times \frac{1}{1000}$

980 = 313.187 + 1.18 f_a
f_a = 565.09 kg mass of F.A.

- **Coarse aggregate**

$v = [w + \frac{C}{Sc} + \frac{1}{(1-P)} X \frac{ca}{Sca}] \times \frac{1}{1000}$

$0.98 = [191.6 + \frac{383}{3.15} + \frac{1}{1-0.315} X \frac{ca}{2.78}] \times \frac{1}{1000}$

980 = 313.18 + 0.525 c_a
c_a = 1270.12 kg mass of C. A.

Mix proportions:

Table 3.4 Mix proportion

Water	Cement	F.A	C.A
191.6	383kg	565.09kg	1270.12kg
0.50	1	1.48	3.32

Step 7: Quantities for 1 bag of cement

Table 3.5 Quantities for 1 bag of cement

Water	Cement	F.A	C.A
25 lit	50 kg	74 kg	166 kg

4.4 Results of cube of concrete

After property study of various material cubes where cast using fresh material. Concrete grade M20 was selected for the mix design. Mix design was followed as given in previous chapter in detail. After casting cubes were remoulded after 24hours and placed for curing in water. Curing was given for 7, 28 days conduct compressive test on cube conclude following result given below:

Table 4.8 No. of cubes required for normal and 5%, 10%, 15% addition of polypropylene waste

Concrete Grade	Days	Normal	5% polypropylene waste	10% polypropylene waste	15% polypropylene waste
M20	7	3	3	3	3
	28	3	3	3	3
Total:		**6**	**6**	**6**	**6**
M20 total:		**24**			

Table 4.9 Compressive strength of concrete cube for mix proportion M20 with 5% of polypropylene waste

	Normal (kg/ cm²)		5% polypropylene waste(kg/ cm²)	
	7 days	28 days	7 days	28 days
Cube 1	12.58	22.18	13.28	22.58
Cube 2	12.22	21.54	12.11	22.32
Cube 3	13.72	22.17	14.26	21.94
Avg.	**12.58**	**21.96**	**13.22**	**22.28**

Table 4.10 Compressive strength of concrete cube for mix proportion M20 with 10% of polypropylene waste

Type	Normal Cube(kg/ cm²)				10% polypropylene waste(kg/ cm²)			
Days	Cube no. 1	Cube no. 2	Cube no. 3	Avg.	Cube no. 1	Cube no. 2	Cube no. 3	Avg.
7	12.58	12.22	13.72	**12.84**	15.28	14.6	14.13	**14.67**
28	22.18	21.54	22.17	**21.96**	19.82	17.5	23.02	**20.11**

Table 4.11 Compressive strength of concrete cube for mix proportion M20 with 15% of polypropylene waste

Type	Normal Cube(kg/ cm²)				15% polypropylene waste(kg/ cm²)			
Days	Cube no. 1	Cube no. 2	Cube no. 3	Avg.	Cube no. 1	Cube no. 2	Cube no. 3	Avg.
7	12.58	12.22	13.72	**12.84**	6.57	7.22	7.08	**6.95**
28	22.18	21.54	22.17	**21.96**	13.44	9.82	12.28	**11.85**

4.5 Results of Concrete Beam

After property study of various material beams where cast using fresh material. Concrete grade M20 was selected for the mix design. Mix design was followed as given in previous chapter in detail. After casting beams were remoulded after 24hours and placed for curing in water. Curing was given for 7, 28 days conduct flexural test on beam conclude following result given below:

Table 4.12 Results of concrete beam

Concrete Grade	Days	Normal	5% polypropylene waste	10% polypropylene waste
M20	7	3	3	3
	28	3	3	3
Total		6	6	6
M20 total	18			

Table 4.13 Flexural strength of concrete Beam for mix proportion M20 with 5% or 10% of polypropylene waste

Type	Normal beam		Avg. (Kg/ cm²)	5% polypropylene beam		Avg. (Kg/ cm²)	10% polypropylene Beam		Avg. (Kg/ cm²)
	Beam no.1	Beam no.2		Beam no.1	Beam no.2		Beam no.1	Beam no.2	
7 days	7.985	6.785	**7.385**	6.37	6.85	**6.61**	4.904	4.785	**4.844**
28 days	8.568	7.185	**7.876**	10.665	8.667	**9.666**	7.630	4.978	**6.304**

V. CONCLUSION

From the results presented in this Final Year Project Report, using material lick Cement, Fine Aggregate, Coarse Aggregate, waste material of Polypropylene Waste and Mix Design the main conclusions are:

- The concrete for M20 grade have a nominal compressive strength is 20 N/mm2. Replacement of sand by polypropylene waste material in 5% increase in the compressive strength of concrete.

- Compressive strength of concrete cube for mix proportion M20 is increase from 21.96 kg/cm² in normal concrete cube to 22.28 kg/cm² in concrete cube with 5% of polypropylene waste.
- Flexural strength of concrete beam for mix proportion M20 is increase from 7.876 kg/cm² in normal concrete cube to 9.666 kg/cm² in concrete beam with 5% of polypropylene waste.
- The concrete mix using polypropylene waste material are gives the increase in workability as increase in percentage replacement of polypropylene waste material so from this by using polypropylene waste in concrete, the concrete mix should be more workable than conventional concrete.
- The use of waste polypropylene in concrete is relatively new development in the world of concrete technology and this research must prove that the replacement of polypropylene waste in concrete is possible as sand.
- "Use of polypropylene waste as replacement of sand in concrete" can be conveniently used as an alternative research to the convectional concrete in the construction.
- As percentage of polypropylene increases workability also increases because the polypropylene which is used as aggregate is smooth As well as water absorption capacity of polypropylene is also low.
- By partially replacing fine aggregate with 15% of polypropylene in concrete the compressive strength has been decreased by percentage when compared to reference mix.
- The tensile strength increases when fine aggregate is partially replaced by 5% of polypropylene however replacing polypropylene more than 5% to the fine aggregate will lead to decrement in tensile strength.

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8. Materials, Processes and Environment, University Algeria research on the valorization of waste in civil engineering is an important sector to the extent that the products to be obtained are not subjected to rigorous quality standards too.