Experimental Analysis on Use of Polypropylene in Concrete

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Abstract- *It has been observed that massive problem of disposal of waste plastic now days .so by using waste plastic as polymer in RCC we can improve quality of concrete. As concrete have good compressive strength and by using polymer we can improve tensile strength as well. Also reuse of waste plastic can be possible .Now a days due to high global consumption of natural sand and aggregate are being depleted. So by using waste plastic we can reduce this consumption by some amount. Concrete is acknowledged to be a relatively brittle material when subjected to normal stresses and impact loads, whose tensile strength is only approximately one tenth of its compressive strength. As a result for these characteristics, concrete member could not support such loads and stresses that usually take place in majority of concrete structures. The introduction of fibres was brought in as a solution to develop concrete with enhanced flexural and tensile strength. Fibres are generally discontinuous, randomly distributed throughout the cementituous matrices. Fibre reinforced concrete has considerably enhanced toughness and strain at the peak stress due to bonding forces at the fibre-matrix interface. Almost all the commercially available fibre reinforced concretes are normally manufactured using a particular type of fibre..*

I. INTRODUCTION

Plastics: The word “plastic” means substances which have plasticity, and accordingly, anything that is formed in a soft state and used in a solid state can be called a plastic. Therefore, the origin of plastic forming can be traced back to the processing methods of natural high polymers such as lacquer, shellac, amber, horns, tusks, tortoiseshell, as well as inorganic substances such as clay, glass, and metals. Because the natural high polymer materials are not uniform in quality and lack mass productivity in many cases, from early times it has been demanded in particular to process them easily and into better quality and to substitute artificial materials for natural high polymers. Celluloid, synthetic rubber, ebonite, and rayon are these artificial materials. Presently, it is defined that the plastics are synthesized high polymers which have plasticity, and consequently substances made of these natural materials are precluded. Plastics can be separated into two types. The first type is thermoplastic, which can be melted for recycling in the plastic industry. These plastics are polyethylene, polypropylene, polyamide. The second type is thermosetting plastic. This plastic cannot be melted by heating because the molecular chains are bonded firmly with meshed crosslink. These plastic types are known as phenolic, melamine, unsaturated polyester, epoxy resin, silicone, and polyurethane. At present, these plastic wastes are disposed by either burning or burying.

The cement paste component functions to coat and "lubricate" the individual grains of sand, thereby imparting "workability" to the mortar phase. In turn, the mortar serves to lubricate the coarse aggregate particles and so give workability to the fresh concrete.

The quantities of cement paste and mortar necessary to achieve adequate levels of workability will depend on the amounts of sand and coarse aggregate present in the concrete, on the associated "grading" of constituent particle sizes, and on the actual level of workability required for the job. If there is insufficient mortar or cement paste, the mix will tend to be "harsh" and unworkable. Conversely, too much mortar or cement paste will promote the likelihood of "segregation" effects whereby the coarser aggregate fractions tend to separate out from the remainder of the mix. Contrary to popular belief, concrete does not set and harden through a physical drying-out process. Setting and hardening is due to a series of chemical reactions between the Portland cement and water present in the mixture; as a result of this so- called hydration process the original cement paste phase is transformed into a sort of "mineral glue" which acts to bind the sand and coarse aggregate fractions together.

The use of a polypropylene fibre and steel fibre at relatively low volume fractions provides concrete with improved performance characteristics at reasonable cost. In present study the structural behaviour of the fibre based concrete using hybrid fibres has been conducted.

II. LITERATURE

Debu Mukherjee, AritraMandal, ParvezAkhtar , et.al (2016) , The most commonly used construction material across the world is concrete. The construction industries are looking for making it "greener" by reducing its ecological effects on environment and they are in need of finding cost effective materials for increasing the strength of concrete structures. On the other hand, the non-recyclable pollutants like plastics, rubber, tin, etc. come out from the industries results in an increasing environmental threat. So the use of non-recyclable materials for preparation of concrete can be an encouraging act. Utilization of waste materials and byproducts can be a partial solution to environmental and ecological problems. Use of these materials not only helps in getting them utilized in cement concrete and other construction materials, but also helps in reducing the cost of cement and concrete manufacturing. It has also numerous indirect benefits such as reduction in landfill cost, saving in energy, and protecting the environment from possible pollution effects. The use of plasti-fibre in cement concrete has not yet been investigated. This paper covers the mechanical properties of plasti-fibre reinforced concrete (PFRC) prepared from hand shredded plasti-fibres consisting Polyethylene plastic bags of 40 microns and PET bottles. The compressive strength and flexural strength of normal M20 grade PFRC were evaluated after 7days, 14days &28days and compared with the conventionalconcrete i.e., normal M20 mix (1:1.5:3) by adding the plasti-fibre by 0.2% & 0.4% of total weight of concrete (30kgs) that has been the aim of this research work. The main findings of this investigation revealed that the plastic waste materials could be used successfully as an addition to concrete composites. Due to exceptionally low density, recycled polymer modified blocks and concrete can be used in non-load bearing structures, floating structures and where lightweight materials recommended.

M A Kamaruddin, M M A Abdullah, M H Zawawi ,et.al (2017) , Plastic associates products based have been considered as the world most consumer packaging solution. However, substantial quantities of plastic consumption have led to exponential increase of plastic derived waste. Recycling of plastic waste as valued added product such as concrete appears as one of promising solution for alternative use of plastic waste. This paper summarized recent progress on the development of concrete mixture which incorporates plastic wastes as partial aggregate replacement during concrete manufacturing. A collection of data from previous studies that have been researched which employed plastic waste in concrete mixtures were evaluated and conclusions are drawn based on the laboratory results of all the mentioned research papers studied.

III. EXPERIMENTAL PROGRAMME

To achieve the objectives of research program, an experimental investigation has been carried out on FBC. The cubesof size 150x150x150 mm5%and on 7% percentages of fibre volume fraction.

A. Materials.

- Cement: Cement is the main part of the concrete which imparts the strength to concrete.OPC 53 grade was used. The test were carried out according to the IS 456- 2000 standard.
- Aggregates: One of the major contributing factors to the quality of concrete is the quality of the aggregates. In this study only the vital parameters of aggregateshave been studied as per the procedures laid down in IS 456-2000 standard.

Table 1: Physical Properties of Aggregate

S.No	Characteristics	Requirement as per IS 383 : 1970	Tested values
PHYSICAL PROPERTIES OF FINE AGGREGATE			
1.	Specific Gravity	2.6-2.7	2.64
2.	Fineness Modulus	2-3.5	3.022
3.	Water Absorption (%)	-	1.78
4.	Moisture Content (%)	-	0.50
5.	Grading	-	Zone II
PHYSICAL PROPERTIES OF COARSE AGGREGATE			
1.	Specific Gravity	2.6-2.7	2.68
2.	Fineness Modulus	5.5-8	6.55
3.	Water Absorption (%)	-	0.50
4.	Moisture Content (%)	-	Nil
5.	Texture	-	Rough

B. Mix Proportion

Design of Concrete Mix:
Design of stipulations

1) Characteristics compressive strength = 25N/mm²
2) Maximum size of aggregate = 20mm
3) Degree of workability = 0.92 (As per IS 456-2000 – compaction factor)

Test data of materials.

1) Cement used = Opc 53grade.
2) Specific gravity of cement = 3.10
3) Specific gravity of sand = 2.75
4) Specify gravity of metal (aggregate) = 2.78
5) W.A Of coarse aggregate(20 mm) = 0.3%
6) W.A Of coarse aggregate(12.5 mm) = 0.4 %
7) W.A Of fine aggregate = 4 %
8) Initial setting time = 90minutes.
9) Final setting time = 540minutes.
10) Compressive strength of cement. 3 days = 29.33N/mm²

Selection of water - cement ratio.

From IS 456 – 2000, table no.5 maximum free water cement ratio required for mix design moderate condition M_{25} is 0.50. So we are taking W/C ratio is 0.45 Selection of water and sand content.

From IS 10262 -2009 table. No 2&3 For 20 mm size of aggregate.

1) Maximum water content = 186 liter.
2) Volume of C.A. = 62 % = 0.62
3) Volume of F.A. = 100-62 = 38% = 0.38

Assume slump = 100 mm As per IS 10262 – 2009
(increase 3% for every increase of slump above 50 mm.)
Estimated water = 197.16 kg/m³
From table. 5 IS 456 – 2080
Clause 8.24.2 maximum water content = 300 kg/m³
Hence ok.

C. Testing details

The test carried out on three type of concrete summarized below:

Case 1. For Conventional Concrete
Case 2. For 5% Polypropylene Concrete
Case 3. For 7% Polypropylene Conventional Concrete

The test carried out concrete are:

- Compression Strength
- Split Tensile Strength
- Flexural Tensile Strength

COMPRESSION STRENGTH TEST

The compression strength of the concrete is very important parameter as it decides the other parameters like tension and flexure. So it is very necessary to carry out the test carefully on the specified testing machine. Compressive strength test were carried out on 150 mm x 150 mm x150 mm cubes with compression testing machine of 2000kN capacity. The specimen, after removal from curing tank was cleaned and dried. The surface of the testing machine was cleaned. The specimen was placed at the centre of the compression testing machine and load was applied continuously, uniformly and without shocks.The load was increased until the specimen failed. The maximum load taken by each specimen during the test was recorded. The compressive strength was found after 7 and 28 days in order to compare the strengths for different percentage of fibres in concrete. From the results it is observed that the addition of the polypropylene fibre in the control mix has a little effect on the compressive strength.

SPLITTING TENSILE STRENGTH TEST

The splitting test is easy to perform and gives more uniform results compared to the other tension test. In this test (IS 5816-1999), a specimen was loaded in a compression on its side along a diameter plane. Failure occurs by the splitting of the cylinder along the load plane. In an elastic homogeneous cylinder this loading produces a nearly uniform tensile strength across the loaded plane. For studying the split tensile behavior, cylinders of fibrous concrete were tested on universal testing machine in structures lab of Padmashri Dr. V. B. Kolte College of Engineering. The failure load was observed and the strength was calculated.

FLEXURAL STRENGTH TEST

Concrete members are not generally subjected to direct tension. However, in flexural members, though tension is taken by reinforcement, yet knowledge of tensile strength of concrete is essential to determine first crack load. Of all types of cracks, flexural cracks are largest in width. Cracks not only create discontinuity but also allow environmental agents to penetrate into the core of the structure leading to corrosion of the reinforcement etc, Flexural tensile strength or modulus of rupture of concrete has been determined by applying the failure load on prismatic specimen.

Flexural Strength Formula: $\sigma = 3PL/2bd^2$
Where,
P = the maximum force applied,
L = the length of the sample = 750mm,
b = the width of the sample = 150mm and,
d = the depth of the sample = 150mm.

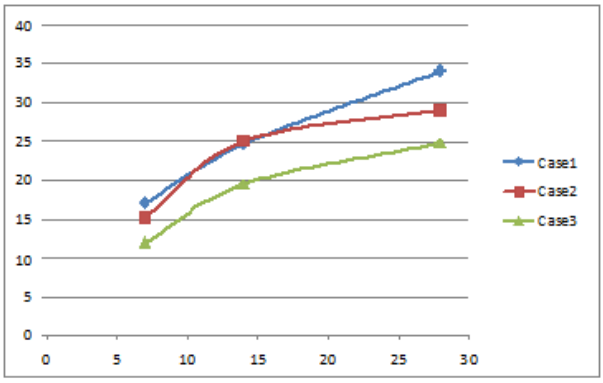
IV. RESULT AND DISCUSSIONS

- Compression Strength Comparison:

(Strength in N/mm^2)

Table 2: Compression Strength Comparison

Days	7	14	28
Case 1	17	24.65	34.02
Case 2	15.18	24.98	29
Case 3	11.92	19.48	24.76



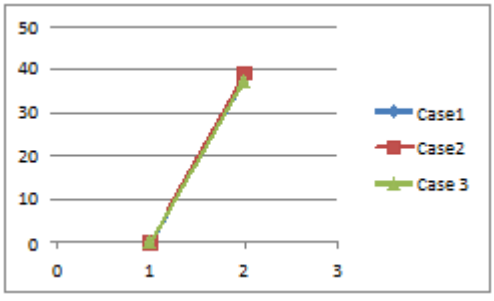
(X axis = Strain;
Y axis = Stress.)

Compression Strength Comparison Graph

- Flexure Test Comparison

Table 3: Flexure Test Comparison

Days	Avg P (kN)	σ (kN/mm^2)
Case 1	37.74	0.0126
Case 2	39.13	0.0130
Case 3	37.25	0.0124



(X axis = Flexure Strength;
Y axis = Load Carried.)

Flexure Test Comparison Graph

V. CONCLUSION

The results of the project show that there is only comparable difference in properties compared to normal Concrete which concludes that Polymer Concrete can be implemented using the Indian Standard code (IS 456:2000). Analysis was performed on the Polymer Concrete with grade M25 and the results have concluded that Polymer Concrete have the same load carrying capacity compared to that of conventional Concrete in load which is specified in IS(456:2000)

The various sources of waste plastic found are market and the best plastic waste that can used to replace fine aggregate is polypropylene .From the results obtained from tests it is observed that, the properties of polypropylene concrete do not change much as compared to conventional concrete

From the Test results it can be concluded that, Compression Strength of M25 grade of poly-concrete is almost same as that of the Convention M25 grade Concrete. **Hence polypropylene concrete is suitable for using as a constituent in concrete manufacturing.**

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REFERENCES

[1] M Mahesh, B VenkatNarsimhaRao, CH. Satya Sri , Re-Use Of Polyethylene Plastic Waste In Concrete(2016 International Journal Of Engineering Research And Technology IJEDRT| Volume 4, Issue 4 | ISSN: 2321-9939)

[2] YoucefGhernouti, Bahia Rabehi, Brahim Safi And RabahChaid, Use Of Recycled Plastic Bag Waste In The Concrete (Journal Of International Scientific Publications: Materials, Methods And Technologies Volume 8, ISSN 1314-7269Year)

[3] S. Vanitha, V. Natrajan And M. Praba , Utilisation Of Waste Plastics As A Partial Replacement Of Coarse Aggregate In Concrete Blocks (Indian Journal Of Science And Technology, Vol 8(12),DOI10.17485/Ijst/2015/V8i12/54462, June 2015

[4] Zainab Z. Ismail , Enas A. AL-Hashmi , Use Of Waste Plastic In Concrete Mixture As Aggregate Replacement international Journal Of Engineering Research And Technology IJEDRT Aug2007

[5] R. N. Nibudey , Dr. P. B. Nagarnaik , Dr. D. K. Parbat , Dr. A. M.Pande, Strengths Prediction Of Plastic Fiber Reinforced Concrete (International Journal Of Engineering Research And Applications (IJERA) ISSN: 2248- 9622Vol. 3, Issue 1, January -February 2013,Pp.1818-1825)

[6] P. Sravanya, Ch. Srinivas , Variations In Strength Of Concrete By Using Waste Plastic As Coarse Aggregates Replacement Material (International Journal Of Innovative Technologies, ISSN 2321-8665 Vol.05,Issue.04, April- 2017

[7] F.J. Baldenebro-Lopez, J.H. Castorena-Gonzalez, J.I. Velazquez-Dimas, J.E. Ledezma-Sillas, C.D.,R. Martinez-Sanchez, J.M. Herrera-Ramirez,Influence Of Continuous Plastic Fibers Reinforcement Arrangement In Concrete Strengthened (IOSR Journal Of Engineering (IOSRJEN) ISSN (E):, ISSN (P): 2278-8719 Vol. 04, Issue 04 (April. 2014), ||V1|| PP …15-23)

[8] Ravikumar G And Manjunath M , Investigation On Waste Plastic Fibre Reinforced Concrete Using Manufactured Sand As Fine Aggregate (International Research Journal Of Engineering And Technology (IRJET) , Volume: 02 Issue: 04 |July-2015

[9] R. Kandasamy And R. Murugesan , Fibre Reinforced Concrete Using Domestic Waste Plastics As Fibres (ARPN Journal Of Engineering And Applied Sciences , VOL. 6, NO. 3, ISSN 1819-6608 , MARCH 2011)

[10] Chien-Chung Chen, Nathan Jaffe, Matt Koppitz, Wesley Weimer, Albert Polocoser. Concrete Mixture With Plastic As Fine Aggregate Replacement,(International Journal Of Advances In Mechanical.And Civil Engineering, ISSN: 2394-2827 Volume-2, Issue-4,Aug.-2015

[11] Praveen Mathew, Shibi Varghese, Thomas Paul, Eldho Varghese, Recycled Plastics As Coarse Aggregate For Structural Concrete, (International Journal Of Innovative Research In Science, Engineering And Technology Vol. 2, Issue 3, March 2013)

[12] BabooRai, S. TabinRushad, Bhavesh Kr, And S. K. Duggal , Study Of Waste Plastic Mix Concrete With Plasticizer , (International Scholarly Research Network ISRN Civil Engineering Volume 2012, Article ID 469272, 5Pages)