Chemical Concepts

International Journal of Chemical Concepts
ISSN:2395-4256 www.chemconsai.com
Vol.03, No.03, pp 300-305, 2017

Experimental Analysis on Recycled Plastic Reinforced Concrete

R.Vanitha, A.K.Priya*, P.M.Priyanka, M.Rajeswari, M.Nithya

Department of Civil Engineering, KPR Institute of Engineering and Technology, Coimbatore, India

Abstract : Fiber Reinforced Concrete (FRC) is a composite material consisting of cement based matrix with an ordered or random distribution of synthetic plastic polymer. Dumping of the waste plastics is one of the major ecological crisis. Polyvinyl chloride (PVC's) is the synthetic plastic polymer and comparatively low cost, biological and chemical resistance and workability have resulted in it being used for an extensive range of applications. It is used for sewerage pipes and other pipe applications somewhere cost or susceptibility to corrosion confines the exploit of metal. To evade this toxic waste disaster, many new products are being produced from waste and used plastics. Due to lack in construction materials the Indian construction industry is facing several troubles. In order to arrest the cracks and to improve the properties of concrete, small, closely spaced and uniformly dispersed recycled plastic were used with concrete. In this research work PVC is used in concrete with various propositions (1% to 4%) and cubes, cylinders and prisms were casted for analyzing its compressive, flexural and split tensile strength of the concrete to solve the deficiency of construction material usage and plastic disposal problem. The research investigations were carried out on a M30 mix and tests have been carried out as per suggested procedures of applicable codes. Increase in curing period shows in improving the compressive strength of concrete. The outcome of this research gave the optional way for utilizing used plastic material as a effective construction material. Also harmful plastic material becomes eco friendly material for construction purpose.
Keywords: Fiber Reinforced Concrete, Recycled Plastics, Polyvinyl Chloride and Ecological Crisis.

Introduction

Concrete is called as artificial stone or man-made stone. In generalConcrete is very strong in compression, but its tensile strength is only about 10% of its compressive strength also concrete isbrittle in nature. Structural cracks can widenyetprior to loading, mostly due to exposure to air or other reasons such as volume changes in Plain concrete. The width of these primary cracks seldom exceeds a slight micron, apart from their other two dimensions it may be of highextent. This formation of early cracks in the concrete becomes the main cause for the decrease in the compressive strength of the concrete. In progression to arrest the initial cracks and to raise the properties of concrete, little, closely spaced and regularlydetached fibers can be added along with the concrete. This type of concrete is known as fiber reinforced concrete. Fiber used in the concrete is usually made from steel, plastic and glass are available in a variety of lengths, shapes, sizes and thickness.

In this research, plastic wastes obtained from the toys (poly vinyl chloride) have been recycled and used because these wastesare flattering a foremost stream in solid wastes. Now a day's low economic cities also producing more plastic waste due to increased use of plastic toys, plastic wrapping, plastic shopping bags, PET bottles and other domestic devices. On the other side in construction industry concrete and its ingredient materials are mostly used but the existence of concrete is turn out to be a most importantproblem because of the initial cracksformed. This research undertakes the crisis of the waste that is produced from surroundings such as (poly vinyl chloride) plastic pots, bottles etc.., In order to dispose of or slightly decrease the accretion of certain

kinds of waste, it has been recommended to recycle some of these waste materials to replace with a certain percentage of the primary materials used in the ordinary Portland cement concrete. To evaluate these replacements on the properties of the OPC mixes, a number of laboratory tests were carried out. In India, recycled plastics are originating significant damage to the surroundings and consequently a research has been made to recognize whether they can be effectively used in concrete to increase some of the mechanical properties as in the case of the steel fibers. The main intention of this analysis is to learn experimentally the properties of fiber reinforced concrete containing polyvinyl chloride as fibers (R. Kandasamyet.al.,2011).

The compressive strength of conventional concrete and recycled plastic fibers reinforced concrete was determined in the laboratory. In the experimentation M30 grade concrete along with recycled fiber fractions as 1% to 4.0 % were used .After 28 days of curing the specimens were tested for its compressive strength, flexural strength and split tensile strength. In this thesis the relationship between cube and cylinder compressive strength for conventional and recycled plastic fibers reinforced concrete were recognized and prism flexural strength were also determined for both conventional and recycled plastic fiber reinforced concrete and it should be compared with its standards. (Nibudey. R.N et.al., 2013). The performance ability of recycled PVC fiber reinforced concrete was compared with that of conventional concrete for fiber volume fractions of 1% to 4%. Suitable tests were performed to compute concrete properties, Flexural tests were performed to compute the strength and ductility capability of conventional concrete members cast with recycled PVC fiber reinforced concrete. From the result it was concluded that compressive strength and elastic modulus of the concrete both decreased as fiber volume fraction increased. (Sung Bae Kimet.al., 2010)

In this research M 30 grade of concrete with (poly vinyl chloride)plastic toys as fibers added by weight 1%, 2% , 3%& 4%. The specimens of 9 cubes, cylinders and prisms of usual size, for each percentage and compared allmechanical strengths at 7, 14 & 28 days of curing and the best possible fiber contents required to attain its maximum strength.

Fiber

Fiber is a minuteportion of reinforcing material possessing firm characteristic properties. Even thougheach type of fiber has been tried out in concrete not all types of fibers can be efficiently and cost-effectively used. The fiber which used in this research work was recycled plastic toys (poly vinyl chloride).The most recent idea is to replace the steel is Recycled Plastic Fiber Reinforced Concrete . These materials, which consist of glass, carbon, polymer, plastic strands or aramidfibers put in a suitable resin to form a bar or grid, are wellestablished in the aerospace and automotive industries and should offerexceedinglysturdy concrete reinforcement. The strength of Recycled Plastic Fiber Reinforced Concrete reinforcement tends to be between that of high yield reinforcing steel and prestressing strand - about 1000 MNm^{-2} for glass fibers and 1500 MNm^{-2} for carbon fibers. However, the stiffness is generally much lower - about 45 GNm^{-2} for glass fibers and 150 GNm^{-2} for carbon fibers. All used plastic reinforced materialshave a straight line answer to failure with no flexibility.

2. Material Investigation

2.1 properties of Materials

To study the properties of materials certain tests were carried out and the following results were obtained

1. Fineness modulus of given fine aggregate = 2.38
2. Fineness modulus of coarse aggregate = 4.16
3. Percentage of bulking of sand = 8.8
4. Percentage of bulking of coarse aggregate = 5.52
5. Specific gravity of sand =2.55
6. The workability of concrete determining the compaction factor at various w/c ratios 0.84

2.1.1 Properties of Plastic Fiber

Fibers are used in concrete to prevent crack due to plastic and drying shrinkage. The fibers provides as resistant layer of concrete which controls permeability. Mostly fibers are not increases flexural strength so it is

not probable to put back for structural steel. The amount of fibers added to a concrete mix is expressed as a percentage of the total volume of the composite (concrete and fibers), typically ranges from 0.1 to 3%. In this study, Waste Plastic Fiber derived from waste plastic pot are 50 mm length and 2.5 mm width shown in fig 1, possessing aspect ratio 20 and added as 1 – 3% by weight in concrete composite. The Properties of PVC given in table 1.

Figure 1 Recycled Plastic Fiber

Table 1 Properties of PVC

S.No.	Properties	Values
1.	Tensile Strength	2.60 N/mm^2
2.	Notched Impact Strength	2.0 - 4.5 Kj/m^2
3.	Thermal Coefficient of Expansion	80 x 10^{-6}
4.	Max. Continued Use Temperature	60 ^oC (140 ^oF)
5.	Melting Point	212 ^oC (413 ^oF)
6	Glass Transition Temperature	81 ^oC (178 ^oF)
7	Density	1.38 g/cm^3

Experimental Investigation

Casting of Testing Specimen

The casting of test specimens was done by the following processes firstly by batching of the materials followed by mixing the materials forms the concrete and compaction was done for all the cubes, cylinders and prisms used in the test. The damping mild steel rods having point ends were used to stab the concrete and to make compaction complete.Finally curing was done 28 days and the result is taken at the end of 7,14 and 28 days of curing.

Compressive Testing Machine

The compressive testing machine (2000 KN capacity) consists of a loading unit, a Motorized pumping unit, a digital load indicator, which are able to illustrate drawing. Load Frame of a steel cross head and machined steel base with solid plates between the base and the cross head. The hydraulic jack is preset on the base. The upper platen has a self aligning action and is attached to a block protruding from the cross head. The lower platen rests on the jack ram and is located centrally with the help of a centering pin. Loading is expert by the upward movement of the lower platen.Motorized Pumping Unit**,** driven by an A.C. electric motor, for lifting the lower platen. The pressure release valve and slow-fast lever are mounted on the unit. On-off button switch is fixed on the panel for easy operation. A Digital Load Indicator has a digital display of load in KN. This unit has speed rate setting capability this provide the speed rate in KN/sec. Rate of loading used for concrete specimen is 315 KN/min (5 KN/sec) as per IS: 516.

Methodology

In the middle of the hydraulic jack ram and the lower platen introduce required height of spaces so that when the specimen to be tested is positioned on the lower platen, the top of the specimen is no more than 10 mm from the upper platen. The specimen to be tested is kept centrally on the lower platen so that little clearance is left between the upper platen and the top of the specimen under test. Lock the pressure release valve.

Formulate the digital display to read '0000' by adjusting the zero knobs. Put the display unit on the "Peak hold" mode to hold the maximum load reading. Start applying the load at the specified speed rate which could be maintained by adjusting the slow fast knob so that the pace bar graph display responds to the difference of the real loading rate from the set rate by lighting the red or yellow light emitting diodes depending on the amount and the direction of the deviation. If the deviation is on the higher side, red light emitting diodes are lit and if on the lower side, yellow light emitting diodes are lit. If there is no deviation i.e., the set rate and the actual rate coincide, and then only the green light emitting diodes in the center is lit.

Immediately after the sample fails, release the pressure slowly by opening valve. The digital display will be asset the maximum load reading at which the sample has failed. Before starting another test, bring the digital display to '0000'by depressing the 'Reset' switch'

Comparison of Compressive Strength Test Results of 7, 14 & 28 Days

Comparison ofCompressive Strength

Table 2 Result Comparisons of Compressive Strength

S. No.	Type of Concrete	Average CompressiveStrength (N / mm^2)		
		7 Days	14 Days	28 Days
1.	Conventional Concrete	33.80	38.43	45.39
2.	RPFRC 1% FIBER	35.40	41.36	46.89
3.	RPFRC 2% FIBER	40.05	44.51	48.00
4.	RPFRC 3% FIBER	42.23	46.95	49.42
5	RPFRC 4% FIBER	45.56	48.62	51.20

Split Tensile Strength Test Results of 7, 14 & 28 Days

Comparision of Split Tensile Strength

Table 3 Result Comparisons of Split Tensile Strength

S. No.	Type of Concrete	Average Split TensileStrength (N / mm^2)		
		7 Days	14 Days	28 Days
1.	Conventional Concrete	3.31	3.20	3.27
2.	RPFRC 1% FIBER	3.40	3.39	3.39
3.	RPFRC 2% FIBER	3.48	3.48	3.48
4.	RPFRC 3% FIBER	3.53	3.53	3.56
5	RPFRC 4% FIBER	3.58	3.59	3.69

Flexural Strength Test Results of 7, 14 & 28 Days

Comparison of Split Tensile Strength

Table 4 Result Comparisons of Flexural Strength

S. No.	Type of Concrete	Average Split Flexural Strength (N / mm^2)		
		7 Days	14 Days	28 Days
1.	Conventional Concrete	4.11	4.35	4.61
2.	RPFRC 1% FIBER	4.31	4.48	4.69
3.	RPFRC 2% FIBER	4.46	4.53	4.86
4.	RPFRC 3% FIBER	4.54	4.69	5.31
5	RPFRC 4% FIBER	4.61	4.76	5.86

Results &Discussion

From the above mentioned comparison of the compressive, split tensile and flexure strength of the conventional concrete and RPFRC, it is incrediblyobvious that RPFRCprovidesimproved results than the conventional concrete. It is also obviously noticeable that 4% is the optimum percentage of RPFRC to attain maximum compressive, tensile and flexural strength. Consequently, adding up of small percentage of recycled plastic fiber in concrete mix will give additionalmechanical strength.

As offrom the comparison of the compressive strength of the conventional concrete and RPFRC, it is obviouslyable to be seen that every percentage increase in plastic fiber increases the compressive strength. Addition of fiber by 4% provides 12.8% increase in compressive strength than that of conventional concrete specimen. Split tensile strength of RPFRC performed exceptionally well compared than Conventional concrete in all the percentages. Specially 4% addition of fiber in concrete mix gives nearly 12.87% increases in tensile strength compared with conventional concrete. Each increment of fiber increases the tensile strength marginally good compared than that of conventional concrete. And the flexural strength of RPFRC performedvery well compared than conventional concrete in all the percentages. Particularly 4% addition of fiber in concrete mix gives nearly 27.11% increases in flexural strength compared with conventional concrete. Hence it proves that the added percentage of fiber reins the cracks and arrests the pores available in concrete. Addition of 0.5 % polythene bags as fibres increases the cube compressive strength of concrete in 7 days to an extent of 0.68% and 28 days strength is an extent of 5.12% and also the split tensile strength increases upto 1.63%.(R. Kandasamy et.al.,2011). The maximum percentage increase in compressive strength, split tensile strength and flexure strength at 1% of fibercontent were 5.26 %, 15.47% and 17.32% for aspect ratio 35 and 7.35%, 24.91% and 24.105% for aspect ratio 50 respectively over control concrete (0% fibers). It can be analysed fromthe test results that development in strengthswas superior for aspect ratio 50, (Nibudey. R.N et.al., 2013).

Conclusion

Each percentage of recycled plastic fibers in concrete increases its compressive, tensile and flexural strength. Addition of fibers by 4% in concrete attained maximum compressive tensile and flexural strength. It is noticeably identified that the crack arresting and properties of the concrete increases with the increment of fiber.Addition of minimal percentage plastic fiber itself increases the compressive strength in higher manner. So, it is preferable and economical when the places required high compressive strength instead of going special cements.Plastic Fiber Reinforced Plastic Concrete (PFRC) are eco friendly, non-hazardous and easily get dispersed in the concrete mix.Hence PFRC can be used as an effective plastic waste management practice in future.

References

1. Batayneh M., Marie I., Asi I., (2006), Use of selected waste materialsin concrete mixes, Waste management, 27, pp 1870–1876
2. DoraFoti., (2011), Preliminary analysis of concrete reinforced with waste bottles PET fibers, Construction and building materials, 25, pp 1906-1915
3. Gambir. M.L. (2000), " Concrete Technology", Tata Mc. Graw Hill Publication, New Delhi.
4. Hisu.L.S. &Hisu C.T.T. (Jul- Aug 1994), "Stress-Strain Behaviour of Steel Fiber High Strength Concrete under Compression"- ACI structural Journal., Vol. 91, NO. 4.
5. IS:10262:2009,recommended guidelines for concrete mix design, Bureau of Indian standards, New Delhi.
6. IS:456.2000.IndianStandard"Plain and Rein forced Concrete" - Code of practice. Bureau of Indian Standards, New Delhi.
7. Kandasamy.R and Murugesan.R 2013 , Fibre Reinforced Concrete using Domestic Waste Plastics as Fibres, ARPN Journal of Engineering and Applied Sciences
8. Nibudey R.N, Nagarnaik P.B, Parbat D.K, Pande A.M., (2013), Strength and fracture properties of post consumed waste plastic fiber reinforced concrete, International journal of civil, structural, environmental and infrastructure engineering research and development,3(2), pp 9-16
9. SungBae Kim, Na Hyun Young Kim, Jang-Ho Jay Kim, Young-Chul Song., (2010), Material and structural performance evaluation of recycled PET fiber reinforced concrete, Cement and concrete composites, 32, pp 232-240.
10. Saadatmanesh.H (May - Jun 1994),"Fiber Composite for New and Existing Structures"-, ACI structural Journal, , Vol.91 No.3.
11. Vares.S.Nordic (1994), "Frost Resistance of steel Fiber High- Strength Concrete"- concrete research, Publication NO. 15.
12. Victor Li (1994), " Properties of high performance fiber reinforced cement composites", ASCE Concrete Journal vol. 15.

*****