International Journal of Innovative Research in Engineering & Management (IJIREM)
ISSN: 2350-0557, Volume-9, Issue-2, April 2022
https://doi.org/10.55524/ijirem.2022.9.2.78
Article ID IJIR-2281, Pages 482-487
www.ijirem.org

An Experimental Analysis of Uses of Polymeric Waste Materials in Concrete

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ABSTRACT- Concrete is brittle and weak under tension, yet robust in compression. As soon as the concrete is poured, cracks begin to appear. Ordinary concrete is not allowed to be used in pavements since it causes ductility and breaking and failure. These flaws in concrete can be addressed by using fibers as reinforcement in the concrete mix.[1] Poly-ethylene and tire trash pollute the environment, resulting in a range of health problems. Poly-ethylene and used tires may both be recycled and used as concrete fibers reinforcement. Poly-ethylene, as we all know, is a synthetic hydrocarbon polymer with features such as strength, shrinkage, ductility, and others. The effects of Poly-ethylene fibers addition on the characteristics of concrete are investigated in this paper. These fibers Poly-ethylene, and tire fibers; were chopped into little 30millimeter 6millimeter pieces and employed at a rate of 1.5 % by volume.[2]
Concrete grades P--30, P--35, and P--40 were utilized. The concrete mix was designed in accordance with IRC--45:2008. The strength characteristics of Poly-ethylene fibers reinforced concrete FRChave been written down and provided in the findings of this work. In the laboratory, shear and flexure strength were determined using a double shear test and a four-point bending test. There was an 18.10% increase in 28--day compressive strength, a 39.10% increase in flexure, and a 32.0% increase in shear strength. The trials revealed a 36.10% drop in deflection in the double shear test and a 22.10% decrease in the 4-point bending test. Theoretical study of deflections was carried out using energy techniques. Within the permitted boundaries, practical values were validated by theoretical values. Finally, it is possible to infer that tire and Poly-ethylene may be employed efficiently in reinforced cement concrete.

KEYWORDS- concrete, compressive strength, mean compressive strength, polymeric, waste material

I. INTRODUCTION

Road networks are critical in providing a robust and comfortable surface for automobiles in a growing country like India. Bitumen is mostly utilized in the construction of pavements. Concrete pavements, on the other hand, are employed in some instances. Many additive mixes have been investigated for the beneficial use of concrete as a paving medium. According to a recent study, fibers reinforced concrete FRC may be utilized for pavement construction since it has a high strength and other important features.[4] "Fibers reinforced concrete," according to ACI 545, "is a concrete made of cements including fine and coarse aggregates coupled with water to create Cementitious properties and discontinuous fibers.". Steel fibers, natural or polymer fibers, and so forth are examples of fibers.[5] As previously mentioned, fibers reinforced concrete Forces a kind of concrete in which fibers are incorporated into the mix as reinforcement to improve the concrete's strength and other mechanical qualities FRC is provided to achieve a gain in compression and tension as well as a reduction in deflections and shrinkage and an increase in ductility property.
Aside from the aforementioned benefits, polymeric fibers can also be used to reduce corrosion. Typically, polyester, recrown 3s, and polypropylene have been utilized for FRC that is Fiber reinforced concrete. Other types of reprocessed fibers,[6] such as plastic, carpet waste, used tires, and other textile industry wastes, have recently been employed. These fibers' primary function is to act as crack arresters. Fibers resist tiny fractures and prevent them from growing into macro fissures. As a result, we have changed material with better qualities such as ductility and toughness to failure.
Since it has been demonstrated that fibers reinforced concrete FRCcan achieve additional strength in compression and flexure and fatigue and also impact it may be efficiently reinforced in concrete to achieve extra strength as a whole and used for pavement construction since concrete is weak in tension and impact. When fibers are mixed with concrete, the outcome is a mix that has improved early resistance to shrinkage and cracking, as well as better impact resistance and is reduced water absorption with higher flexural strength and tensile strength of concrete, and so reduces drying shrinkage cracks in concrete[7]. IRC: 044--2008[8] –Cement Concrete Mix Designs for Pavements with Fibers, IRC: SP.: 076:2008 – Guidelines for Ultra-Thin White Topping with Fibers, Vision.: 2021 by Ministry of Surface Transport and New Delhi and other standards involve the use of polymer fibers in concrete. Many national bodies; including the Central Public Works Department (CPWD) and the Airport Authority of India (AAI) and Military Engineering Services (MES) and Defense NF/Southern Railway and Airfields and ISRO (Bangalore), and others,

have permitted or approved the use of polymer fibers reinforced concrete FRC[9].

II. OBJECTIVES

This project aims to use two polymeric wastes and Poly-ethylene and tire fibers as reinforcing materials in concrete pavements. The primary goal of this research is to evaluate and use the benefits of such waste materials to improve the compressive strength and flexure strength and shear strength of the final concrete also as well as to reduce the deflection characteristics of the final concrete, as well as to determine deflections in laboratory testing and compare them to theoretical deflections to see if errors are within the allowable limits of 20.10%. The primary goal of the effort is to employ waste materials such as Poly-ethylene and tire fibers to improve the strength qualities of concrete in order to reprocess them into something usable, thus helping to reduce the environmental effect that both have.

III. METHODOLOGY

The following experiments will be carried out in order to assess the different restrictions of fibers reinforced concrete FRC (F.R.C) on which the planned life of a pavement is influenced with little maintenance:

A. Aggregate tests

- Aggregate abrasion resistance
- Test for impact resistance
- Aggregate crushing resistance test

B. Concrete test

- Concrete physical examination
- Compressive strength examination (28-days strength)
- Flexural--bending test
- Shear strength test

The flexural--bending strength test is a 2-point load test (4-point bend test), while the shear strength test is a double shear test.

Table 1: Test on aggregates & Test on aggregates

L.A. ---AN ABRASION TEST;	**IMPACT-- VALUE TEST;**	**CRUSHING— VALUE TEST;**
Max perm Isabel value in fiber reinforced concrete = 30.0% Average experimental values;= 23.601%	Max perm Isabel value in fiber reinforced concrete = 45.0% Average experimental values; =21.801%	Max perm Isabel value in fiber reinforced concrete = 30.0% Average experimental values;= 21.301%

Table 2: Compressive strength of conventional concrete cubical blocks & Compressive strength of conventional concrete cubical blocks

Grade of concrete	**Specimen No.**	**Failure load (Ton's)**	**Compressive strength (N/millimeter2)**	**Mean compressive strength (N/millimeter2)**
P--30	01.	84 Ton's	36.89 N/millimeter2	37.184 N/millimeter2
	02.	85 Ton's	37.37 N/millimeter2	
	03.	85 Ton's	37.37 N/millimeter2	
P--35	001.	96 Ton's	42.24 N/millimeter2	42.667 N/millimeter2
	02.	98 Ton's	43.13 N/millimeter2	
	03.	97 Ton's	42.67 N/millimeter2	
P--40	01.	105 Ton's 109 Ton's	46.25 N/millimeter2 48.06 N/millimeter2	46.966 N/millimeter2
	02.			
	03.	107 Ton's	46.67 N/millimeter2	

Table 3 shows the Compressive strength of Fiber reinforced concrete (F.R.C) cubical blocks & Compressive strength of Fiber reinforced concrete (F.R.C) cubical blocks

Grade of concrete	**Specimen No.**	**Failure load**	**Compressive strength (N/millimeter2,)**	**Mean compressive strength (N/millimeter2,)**	**Strength gain (%)**
P--30	04.	991 Ton's	44.00 N/millimeter2	43.854 N/millimeter2	17.94%
	05.	991Ton's	44.00 N/millimeter2		
	06.	981 Ton's	42.56 N/millimeter2		

P--35	04.	112 Ton's	49.33 N/millimeter2	49.484 N/millimeter2	15.99%
	05.	111 Ton's	49.78 N/millimeter2		
	06.	114 Ton's	49.78 N/millimeter2		
P--40	04.	125 Ton's	55.11 N/millimeter2	54.574 N/millimeter2	16.15%
	05.	123 Ton's	54.22 N/millimeter2		
	06.	123 Ton's	54.22 N/millimeter2		

C. Point Bend Test (2--Point Load Test)

The flexural strength/bending strength of concrete is an important feature. The flexural strength/bending strength or flexural toughness of concrete is defined as its resistance to bending. In a 4-point bend test machine, the casted beams are evaluated for flexural strength.

Method/Procedure

- The length of the loading pins and support is modified.
- The casted beam is then mounted on the support pin, ensuring that both ends have equal clearance.
- The loading pins are carried in such a way that they make touch with the beam's upper surface.
- The deflection of the point is measured using a dial gauge.
- The failure point load and center point deflection are measured using a same approach for both conventional and fibers reinforced concrete FRC beams.
- Beam deflection at various load intervals is calculated and a load vs deflection graph is provided for a single specimen/sample of each grade (P--30, P--35, and P--40) and type of concrete (conventional and fibers reinforced concrete).
  - The flexural/bending strength of beams is estimated using the following formula:
  - Sigma = (RL3/wd2)
  - Where R = load applied
  - L = effective span = 400millimeter w = width of the specimen = 100millimeter
  - d = depth of the specimen = 75millimeter

Table 4: Load & deflection of conventional concrete & fiber introduced concrete beams(P--35) & Load & deflection of conventional concrete & fiber introduced concrete beams(P--35)

The Conventional concrete		**A fiber introduced concrete**	
Load (KN)	**Deflection (millimeter)**	**Load (KN)**	**Deflection (millimeter)**
00 KN	00 millimeter	00 KN	00 millimeter
01 KN	0.0180 millimeter	01 KN	0.0080 millimeter
02 KN	0.0320 millimeter	02 KN	0.0170 millimeter
03 KN	0.0440 millimeter	03 KN	0.0260 millimeter
04 KN	0.0610 millimeter	04 KN	0.0310 millimeter
05 KN	0.0780 millimeter	05 KN	0.0370 millimeter
5.66 KN	0.0860 millimeter	06 KN	0.0440 millimeter
		07 KN	0.0520 millimeter
		7.92 KN	0.0650 millimeter

Table 5: Load & deflection of conventional concrete & fiber introduced concrete beams (P--40) & Load & deflection of conventional concrete & fiber introduced concrete beams (P--40)

Conventional concrete		**Fiber introduced concrete**	
Load (KN)	**Deflection (millimeter)**	**Load (KN)**	**Deflection (millimeter)**
00 KN	00 millimeter	00 KN	00 millimeter
01 KN	0.0112 millimeter	01 KN	0.00701 millimeter

02 KN	0.0182 millimeter	02 KN	0.01301 millimeter
03 KN	0.0312 millimeter	03 KN	0.02401 millimeter
04 KN	0.0482 millimeter	04 KN	0.0311 millimeter
05 KN	0.0632 millimeter	05 KN	0.03801 millimeter
5.93 KN	0.0791 millimeter	06 KN	0.04601millimeter
		07 KN	0.05201 millimeter
		08 KN	0.06102 millimeter
		8.071 KN	0.06102 millimeter

IV. RESULTS

Theoretical values of deflection are computed, and the results are compared to the results of the respective tests.The following are some examples of standard values that are taken into account:

- A Poisson's ratio (mu.) =00.2
- The Modulus of elasticity (E) = 5000 √f ck, Where f ck = characteristic strength of concrete So, for P--30, E =27386.15 MPa; P--35, E = 29580.45 MPa; P--40, E = 31622.79 MPa;

As in the case of fiber reinforced concrete the average value of the cube strengths considered, same will be the case for conventional concrete.

- Moment of inertia (I)

= wd3/12
= 100*753/12
= 3215624.00 millimeter4

The effective length used is taken as the length of the specimen
So,
L = L eff = 400.00 millimeter

- Point bendtest;

Deflection at the center of the span IS given as:

Delta = (25RL3/1294 EI) * [1+ {215d2(1+ mu)/116L2}]
For Delta < L/900, Delta = 1.50Delta For, Delta > L/900, Delta = 08Delta

Table 6: Theoretical & experimental deflection of conventional concrete & Theoretical & experimental deflection of conventional concrete

GRADE-OF CONCRETE	SPECIMEN-NO.	A FAILURE-LOAD (KN)	THEORETICAL-DEFLECTION (millimeter)	EXPERIMENTAL-DEFLECTION (millimeter)
P--30	01.	5.450 KN	0.0931 millimeter	0.0879 millimeter
	02.	5.501 KN	0.09451 millimeter	0.0921 millimeter
	03.	5.601 KN	0.0966 millimeter	0.0912 millimeter
P--35	01.	5.662 KN	0.0918 millimeter	0.0863 millimeter
	02.	5.573 KN	0.0910 millimeter	0.0864 millimeter
	03.	5.762 KN	0.0916 millimeter	0.0833 millimeter
P--40	01.	5.772 KN	0.0910 millimeter	0.0791millimeter
	02.	5.653 KN	0.0859 millimeter	0.0771 millimeter
	03.	5.911 KN	0.0910 millimeter	0.0762 millimeter

Table 7: Theoretical-experimental deflection of fiber introduced concrete & theoretical-experimental deflection of fiber introduced concrete

GRADE OF CONCRETE	SPECIMEN-NO.	FAILURE-LOAD (KN)	THEORETICAL-DEFLECTION (millimeter)	EXPERIMENTAL - DEFLECTION (millimeter)
	04.	7.560KN	0.080 millimeter	0.070 millimeter
P--30	05.	7.580 KN	0.079 millimeter	0.070 millimeter
	06.	7.570 KN	0.079 millimeter	0.069millimeter
P--35	04.	7.921 KN	0.080 millimeter	0.066 millimeter
	05.	7.923 KN	0.080 millimeter	0.068 millimeter
	06.	7.932 KN	0.077 millimeter	0.069 millimeter
	04.	8.072 KN	0.077 millimeter	0.065 millimeter

P--40	05.	8.079 KN	0.078 millimeter	0.065 millimeter
	06.	8.130 KN	0.078 millimeter	0.64 llimeter

A. *Double Shear Test*

Deflection at center of the span is given as:

Delta = (97RL3/5078EI)

For Delta < L/900 Delta = Delta/1.7 For Delta > L/900, Delta = Delta/2.1

Theoretical deflection values are calculated using the aforementioned formula. Table-5.4a & Table-5.5a show the deflection values determined theoretically and empirically for ordinary concrete and fibers inserted concrete. Table 5 and 6 showing a comparison of them (theoretical data against experimental data).Table-8 shows the Theoretical experimental deflection of conventional concrete

Table 8: Theoretical-experimental deflection of conventional concrete

THE GRADE- OF CONCRETE	THE SPECIMEN-NO.	A FAILURE-LOAD (KN)	THE THEORETICAL DEFLECTION-(millimeter)	AN EXPERIMENTAL DEFLECTION-(millimeter)
P--30	01.	64.22KN	0.81millimeter	0.67 millimeter
	02.	64.30 KN	0.82 millimeter	0.71 millimeter
	03.	64.37 KN	0.83 millimeter	0.85 millimeter
P--35	01.	64.51 KN	0.81 millimeter	0.65 millimeter
	02.	64.60 KN	0.83 millimeter	0.68 millimeter
	03.	64.70 KN	0.85 millimeter	0.75 millimeter
P--40	01.	65.05 KN	0.80 millimeter	0.67 millimeter
	02.	65.11 KN	0.81 millimeter	0.67 millimeter
	03.	65.17 KN	0.83 millimeter	0.67 millimeter

Table 9: Theoretical-experimental deflection of fiber introduced concrete & Theoretical-experimental deflection of fiber introduced concrete

GRADE OF CONCRETE	SPECIMEN NO.	FAILURE LOAD (KN)	THEORETICAL DEFLECTION (millimeter)	EXPERIMENTAL DEFLECTION (millimeter)
P--30	04.	84.42KN	00.54 millimeter	00.43 millimeter
	05.	84.45 KN	00.52 millimeter	00.44 millimeter
	06.	84456 KN	00.53 millimeter	00.45 millimeter
P--35	04.	85.40 KN	00.51 millimeter	00.44 millimeter
	05.	85.69KN	00.50 millimeter	00.45 millimeter
	06.	85.97 KN	00.51 millimeter	00.45 millimeter
P--40	04.	86.31 KN	00.46 millimeter	00.53 millimeter
	05.	86.41 KN	00.47 millimeter	00.54 millimeter
	06.	86.50 KN	00.78 millimeter	00.57 millimeter

Table 10: Comparison of theoretical - experimental deflection & Comparison of theoretical experimental deflection

TYPE-OF CONCRETE	GRADE- OF CONCRETE	MEAN-THEORETICAL DEFLECTION (millimeter)	MEAN-EXPERIMENTAL DEFLECTION (millimeter)	%AGE OF VARIATION;
The Conventional concrete	P--30	0.81 millimeter	0.73millimeter	12.98%
	P--35	0.82 millimeter	0.70 millimeter	17.95%
	P--40	0.81 millimeter	0.65 millimeter	19.51%
A fiber	P--30	0.52millimeter	0.45 millimeter	16.99%
	P--35	0.52 millimeter	0.44 millimeter	13.83%

introduced concrete-	P--40	0.47 millimeter	0.44 millimeter	10.50%

V. CONCLUSION

- Following conclusions have been reached from studies on concrete containing Poly-ethylene and tire fibers: 1. There is an expansion of around 18.63%, 16.08%, and 17.10% in the compressive quality of (P--30, P--35, and P—40) grade concrete, respectively.
- Flexural quality improvements were noted to be around 37.44 %, 39.74 %, and 39.76 % for all (P--30, P--35, and P—40), respectively. Furthermore, specific redirection decrements were of 23.22 %, 24.54 %, and 21.77 % around.
- Shear quality is increased by the critical sum. Shear quality improvements were seen to be around 31.43 %, 32.57 %, and 32.71 % (P--30, P--35, and P—40), respectively. Furthermore, individual declines in redirection were found to be 39.69%, 36.20%, and 34.76%, respectively.
- Based on the impressions presented above, it is clear that the increase in flexural quality outweighs the increase in shear quality. In any case, middle point redirection due to shear power is far less than avoidance due to flexure.
- Based on a hypothetical analysis of the results, it can be seen that when a 4-point twist test is performed, the rate variety of redirection in fibers reinforced cement is significantly higher than that of traditional cement, and it expands with increasing trademark quality for both fibers presented concrete (FPC) and traditional cement.
- The rate of diversion in normal cement is found on an around 5.66 %. 6.60 %, 12.60 %, and 7.00 % for all (P--30, P--35, and P—40), respectively, while it is 7.00 % for all fibers presented concrete (FPC). 14.00 %, 17.4 %, and 19.41 % were observed.
- However, due to the twofold shear test, the rate variety of avoidance in fibers presented concrete (FPC) is much the same as that of conventional cement, and also it expands with increase in trademark quality npt for normal cement but also for diminishes for fibers presented solid pillars.
- The rate of diversion in the conventional cement is 12.20 %, 18.56 %, and 20.05 % (P--30, P--35, and P—40) separately, and it seems to be around 17.00 %, 14.61 %, and 10.50 % all for fibers presented concrete (FPC).
- Based on the findings, it is reasonable to assume that the use of discarded Poly-ethylene and tire filaments in fibers reinforced cement has a significant and positive influence on its mechanical qualities.

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