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Optimization of Latex Concrete with Hybrid Fibres

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Abstract: *Latex concrete is generally used as repair mortar. The proper mix ratio of latex concrete is still in research. Due to its high impermeability it can also be used in places where water resistant concrete is needed. This paper is based on the production of latex concrete with appropriate chemical and mineral admixtures for improved strength and durability. A hybrid fibre reinforced concrete (HFRC) is optimized with two types of synthetic fibres- Nylon Fibres and Polyethylene fibres. The fibres will be crimped, very fine and shredded in order to prevent balling effect during mixing. The fibres will have a diameter of 0.6mm and an aspect ratio of 50. Styrene Butadiene latex was added at 15% of the cement weight. Tests were carried out to determine compressive strength, flexural strength and tensile strength of HFRC. Also durability testing like sorptivity and concrete impermeability were carried out to ascertain the use of this concrete in structures for water resistance. Research from other studies has concluded that higher latex content will improve adhesion, dispersibility of the fibres and the workability of the HFRC. The latex film is also tested to have increased the flexural strength by 15% and impact resistance by 12% of the HFRC. The results were used to optimize latex modified HFRC with improved water resistance, sorptivity, flexural strength, compressive strength and durability as compared to conventional concrete.*

Keywords: *Latex-modified concrete, hybrid fibres, sorptivity, durability and water absorption*

I. Introduction

Latex concrete is generally used as a repair material and mortars as well [1], [2]. When polymers are dispersed in water to form an emulsion, it forms a synthetic latex. These emulsions when poured on concrete will be spherical in form at a molecular level which will then coalesce to form a film around the aggregate and will further prevent the penetration of external atmospheric agents like chlorine ions, carbon dioxide and moisture. The concrete formed will have greater strength, resistance to chemicals, chlorination, corrosion and the concrete will bond better due to the presence of the latex film. In order to improve the bonding strength of the latex modified mixture, two hybrid fibres are added hence forming a latex modified concrete that is optimized with the use of hybrid fibres.This mixture will have greater durability, bulk density and strength as well. Since durability and strength are very important aspects of construction since it will last longer and increase the life of the building as well. The mixture proportion of the latex modified HFRC can be customized by adding several chemical and mineral admixtures to increase the strength of concrete and improve workability. Two latex concretes that were primarily used for experimenting included styrene butadiene rubber [3] and natural rubber latex [4]. Latex concrete has been experimented with the addition of admixtures like alumina nanoparticles [5]. The cost of alumina nanoparticles is expensive and not economically viable for construction and so is natural latex, hence synthetic latex was preferred, specifically Styrene Butadiene Rubber. Instead of Alumina Nanoparticles, fibres were favoured due to its low cost and ease of availability. Different types of fibres were also used with latex concrete including nylon fibres [6]. Other fibres also included polyprolpylene [7] and glassfibres along with the fibres used in multiple combinations to improve the characteristics of concrete [8], [9], [10]. The optimum latex content was fixed at 10%. The type of curing method to be used was obtained from a study which recommended ambient curing [11]. The percentage of fibres to be used is varied to obtain a fair trial of experimentation for each type of composition for the concrete mix. With this literature review this research paper attempts to study the properties of Latex modified HFRC with polypropylene and glass fibres.

II. Materials

The materials used for aerated fibre reinforced concrete were Portland Pozzolana Cement of 53 grade (PPC–Fly Ash based) conforming to IS 1489 (part 1): 1991,pulverized fine aggregate retained having a specific gravity of 2.65. The coarse aggregate was a mixture of baby chips of size 6mm and 20mm. Specifications of fine aggregate and coarse aggregate are mentioned in Table 1 and Table 2.

Table1. Characteristics of fine aggregate

Material	Fine Aggregate
Specific Gravity	2.65
Fineness Modulus(mm)	5.56
Bulk Density(kg/m^3)	1525

Table2. Characteristics of coarse aggregate

Material	Coarse Aggregate
Specific Gravity	2.89
Coefficient of Curvature	5.56
Coefficient of Uniformity	3.92
Bulk Density(kg/m^3)	1707

A naphthalene based super plasticizer and latex were also used for this study. Glass fibres are used which has an aspect ratio of 430, a tensile strength of 1700mpa and a modulus elasticity of 72GPA. Polypropylene fibres are used which has an aspect ratio of 1600, a modulus elasticity of 600GPA and a tensile strength of 2800mpa. The hybrid fibres consisted of polyethylene fibres and glass fibres.in varying composition.

2.1.1 Mix Design

The ratio of the mix used was 1:1.87:3.38. No replacement of materials was done. The materials were first dry mixed before the water was added. A naphthalene based super plasticizer was used in the latex modified HFRC mix at a dosage of 1% by weight of cement to retain the workability. Styrene butadiene was added at a dosage of 5% by weight of cement. Then the fibres were added at varying compositions with each mix. The different mixes are:

M_C – Control mix (No mineral admixtures and accelerator)
M_1- Mix with 10% latex
M_2- Mix with 5% hybrid fibres (50% each)
M_3- Mix with 5% hybrid fibres (25% glass and 75% PP)
M_4- Mix with 5% hybrid fibres (75% glass and 25% PP)

The sieve analysis graphs of fine and coarse aggregate show the fineness of each of the materials in graph 1 and graph 2 respectively. The fine aggregate sieve analysis graph shows an expected ‘S’ shaped curve while the coarse aggregate’s sieve analysis graph is deviating from the expected shape due to the combination of 20mm and 6mm size of aggregates.

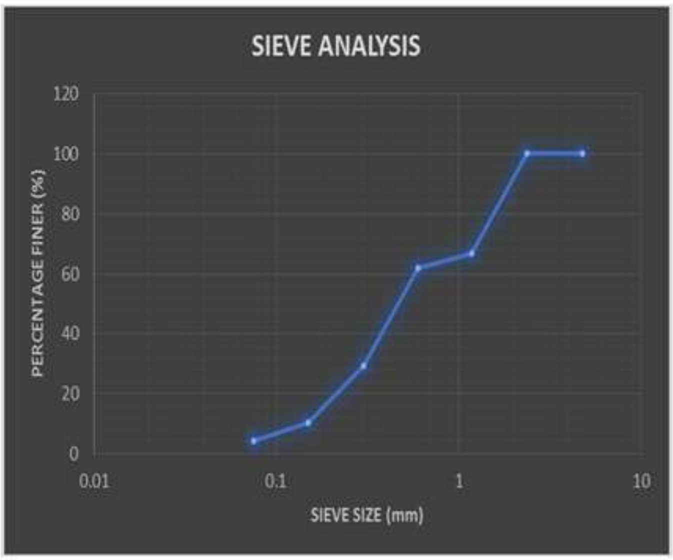


Fig. 1. Sieve Analysis of fine aggregate

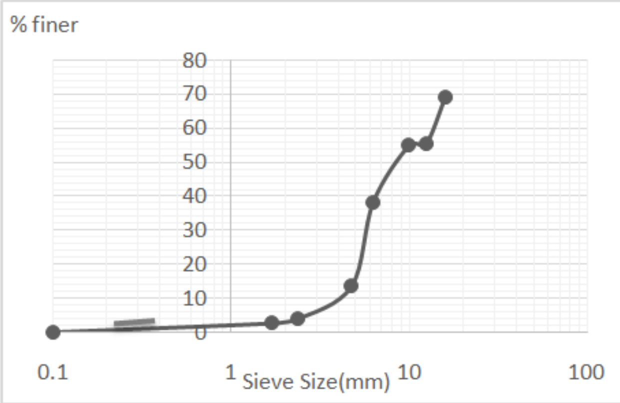


Fig. 2. Sieve Analysis of coarse aggregate

III. Results and Discussions

The tests were conducted on cubical moulds of size 100x 100 x 100mm, cylindrical moulds of height 200mm and radius 100mm, beam moulds of size 40 x 40x 160 mm moulds. The slump of the concrete reduces once latex added and further reduces when fibres are added in any combination.

Table 3. Slump value of fresh concrete mix

Mix	Slump(mm)
M_c	62
M_1	48
M_2	43
M_3	38
M_4	32

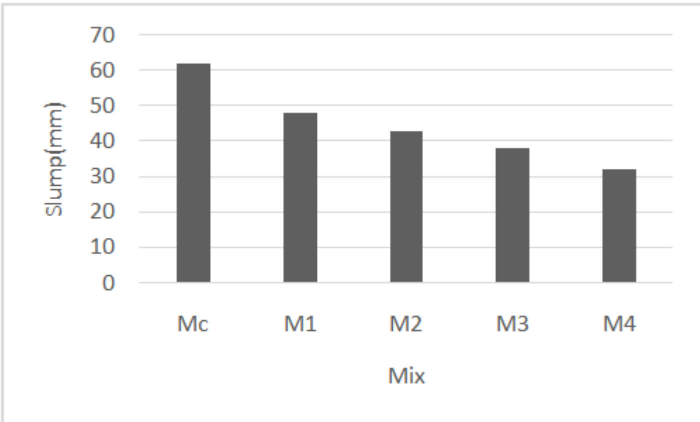


Fig 3. Slump values for each mix

On testing for bulk density, it is observed that it is maximum for the mix that has 75% glass fibres and 25% polypropylene fibres,
Table 4 shows the respective values for each mix.

Table 4. Bulk density values for each mix

Mix	Bulk density (kg/m^3)
M_c	2418
M_1	2442
M_2	2448
M_3	2439
M_4	2489

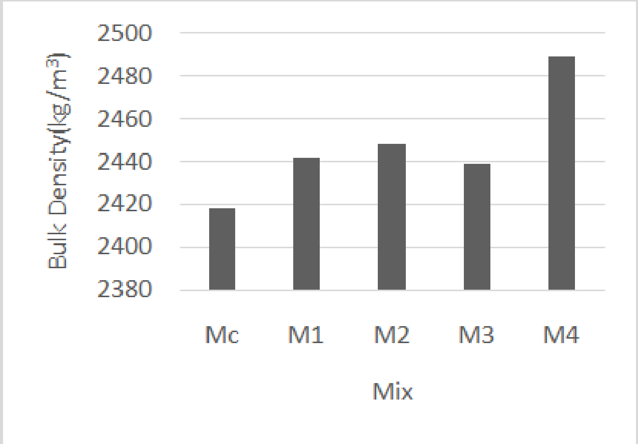


Fig 4. Bulk density for each mix

Table 5. Compressive strength of each mix

Mix	**Compressive strength (MPa)**
M_c	36.8
M_1	41.52
M_2	43.8
M_3	48.3
M_4	46.8

Table 5. Split tensile strength values for each mix

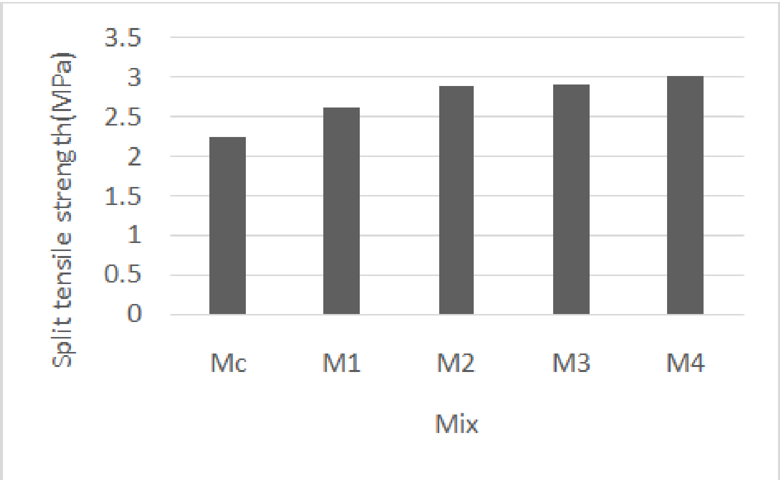


Fig 5. Compressive strength for each mix

Table 6. Flexural strength values for each mix

Mix	**Flexural strength (MPa)**
M_c	1.87
M_1	1.93
M_2	2.41
M_3	2.53
M_4	2.91

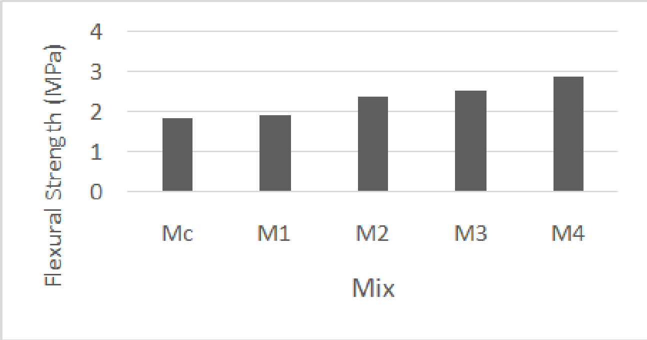


Fig6. Split tensile strength values for each mix

Sorptivity testing has also been done. These properties are particularly important in concrete, as well as being important for durability. It can be used to predict concrete durability to resist corrosion. Absorption capacity is a measure of the porosity of an aggregate; it is also used as a correlation factor in determination of free moisture by oven-drying method. The absorption capacity is determined by finding the weight of surface-dry sample after it has been soaked for 24 hour and again finding the weight after the sample has been dried in an oven; the difference in weight, expressed as a percentage of the dry sample weight, is the absorption capacity.Absorption capacity can be determine using BS absorption test. The test is intended as a durability quality control check and the specified age is 28-32 days. The fig 7 shows the sorptivity test which has been conducted. Hence, the sorptivity tests shows that the M4 mix has the least sorptivity value and it can be inferred that it has the highest durability amongst all of the mixes. The test results are shown in following tables:

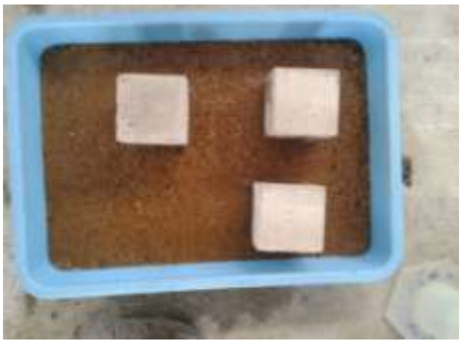


Fig 7: Sorptivity testing done for the sample

Table 7. Sorptivity of each mix

Mix	**Sorptivity in 10^{-5}(mm/min$^{0.5}$)**
M_c	0.432
M_1	0.261
M_2	0.138
M_3	0.126
M_4	0.118

Table 8. RCPT of each mix.

Mix	**Sorptivity in 10^{-5}(mm/min$^{0.5}$)**
M_c	0.432
M_1	0.261
M_2	0.138
M_3	0.126
M_4	0.118

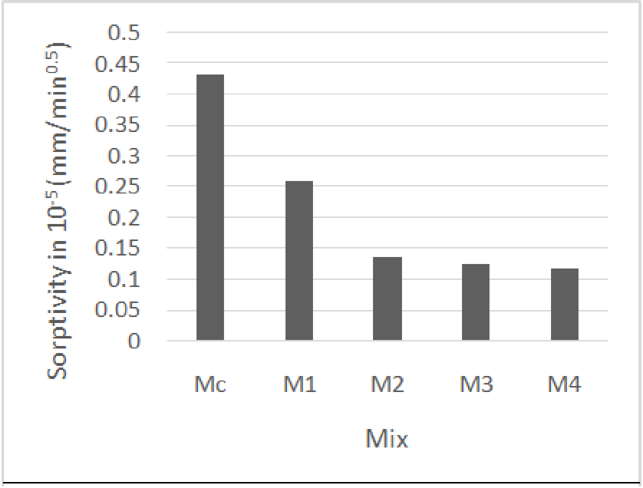


Fig 8. Sorptivity values for each mix

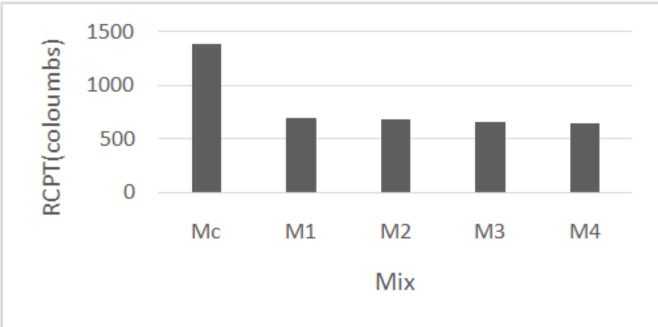
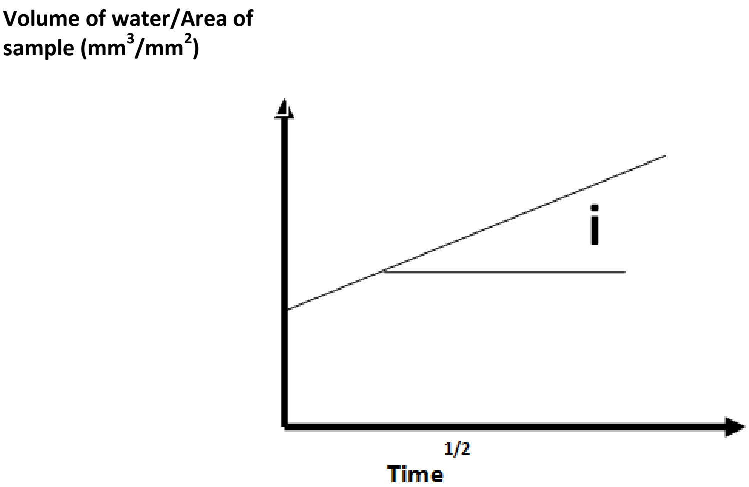


Fig 8. RCPT values for each mix

The procedure used to calculate sorptivity is as shown below:



$$i = \frac{\Delta W}{\rho \times A}$$

Fig 8: Graph between volume of water/area of sample to square root of time

Where, i-change in specimen weight (gm)
ρ-density
A-Cross sectional area (mm^2)

Rapid chloride permeability test According to ASTM C1202 test, a water-saturated, 50 mm thick, 100 mm thick diameter concrete specimen is subjected to a 60 v applied DC voltage for 6 hours using the apparatus and the cell arrangement is shown in Figure-10. In one reservoir is a 3.0% NaCI solution and in the other reservoir is a

0.3 M NaOH solution. The total charge passed is determined and this is used to rate the concrete according to the criteria included as Table-8.

Fig 9. RCPT apparatus

The values obtained on testing show that the least value from RCPT is for the M4 mix which indicates that the concrete has been well internally sealed and has greater durability to it.

IV. Conclusion

The following conclusions are:

1) The mix with 75% glass fibres and 25% polypropylene fibres shows a much greater increase in flexural, tensile and compressive strength as opposed to other mixes.
2) It has also been proven that for the same mix the durability is much higher as well and the porosity of the concrete is low.
3) This material can be used in water-based structures like water tanks due to its low porosity.

References

[1]. Oh, Ri-On Kim, Dong-Hyun, Park, Chan-Gi, Durability performance of latex modified nylon fiber reinforced concrete for precast concrete pavement applications, IJEMS Vol.21(1) [February 2014]

[2]. P.S. Songa, S. Hwangb, B.C. Sheub, Strength properties of nylon- and polypropylene-fiber-reinforced concretes, P.S. Song et al. / Cement and Concrete Research 35 (2005) 1546–1550

[3]. Vikrant S. Vairagade, Kavita S. Kene, Experimental Investigation on Hybrid Fiber Reinforced Concrete, ISSN: 2248-9622 Vol. 2, Issue 3, May-Jun 2012, pp.1037-1041

[4]. Dongqing He1, Min Wu1, and PengyuJie, Study on Mechanical Properties of Hybrid Fiber Reinforced concrete, IOP Conf. Series: Earth and Environmental Science 100 (2017) 012111

[5]. Kannan.S, Study on Strength Properties of Hybrid Fibre Reinforced Concrete, International Journal of Scientific & Engineering Research, Volume 7, Issue 4, April-2016 61ISSN 2229-5518

[6]. James Colville, Amde M., and M. Miltenberger, Tensile Bond Strength of Polymer Modified Mortar, Journal of Materials in Civil Engineering / February 1999 / 1

[7]. Joshua B. Kardon, Polymer-Modified Concrete: Review, J. Mater. Civ. Eng., 1997, 9(2): 85-92

[8]. Oh, Ri-On Kim, Dong-Hyun Park, Chan-Gi, Durability performance of latex modified nylon fiber reinforced concrete for precast concrete pavement applications, IJEMS Vol.21(1) [February 2014]

[9]. M. S. Shobha, Mechanical Properties of Latex Modified High Performance Concrete, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 11, Issue 1 Ver. III (Jan. 2014), PP 13-19

[10]. F.A. Shaker, A.S. El-Dieb, and M.M. Reda,Durabilityof Styrene-Butadiene Latex Modified Concrete, Cement and Concrete Research, 27(5), 711-720, 1997

[11]. Mehmet Emiroglu, Ala EddinDouba, New Polymer Concrete with Superior Ductility and Fracture Toughness Using Alumina Nanoparticles J. Mater. Civ. Eng., 2017, 29(8): 04017069