International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 04, April-2018

Latex Modified High Performance Concrete

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***Abstract*— The inclusion of natural rubber latex and Poly Vinyl Alcohol Fiber (PVA) concrete improves the performance properties of the concrete. Natural rubber latex modifies the concrete by improving the workability of concrete through ball bearing actions. The polymer latexes present in the natural rubber gets filled up in the pores in the paste structure thus forming a bond between the cement and aggregates in the concrete. The addition of PVA Fibers improves tensile strength, modulus of elasticity and durability, and also it help to reduce the quantity of coarse aggregate in concrete. This project aims in presenting the optimum percentage weight of natural rubber latex and PVA Fiber to be made use in achieving the high strengths compared to conventional concrete**

Keywords—Natural Rubber Latex; PVA;

I. INTRODUCTION

Now a day, the construction field is looking towards the locally available and natural materials from the renewable resources to produce high performance cement concrete and thereby increasing the energy efficiency and producing an echo friendly composite. This project is conducting for increasing the mechanical properties, workability and durability of the concrete.

Natural Rubber Latex (NRL) is a natural renewable resource, which can be employed for modification of cement concrete. Natural Rubber latex obtained from Heveabrasiliensis tree by natural polymerization process and is a dispersion of poly-isoprene. The concrete with natural rubber latex improves the plain concrete from porous to an impermeable structure by forming a lining of latex film across voids, pores and micro cracks. Thus the optimum natural rubber latex in cement concrete is very effective in avoiding the chemical attacks on concrete by blocking the aggressive agents which attacks the cement paste. so that, for the better durability performance in aggressive service conditions such as marine areas, sewage plants and acidic environments, the NRL modified concrete is better as compared to the normal concrete. Also careful attention at elevated temperatures should be needed for the elastomeric effect of natural rubber latex as synthetic polymer latex.

PVA or Poly Vinyl Alcohol fiber has suitable characteristics as reinforcing materials for cement composites is also used by replacing cement. High modulus of elasticity, durability, tensile strength and bonding strength with concrete matrix are some of its desirable properties.

II. EXPERIMENTAL DETAILS

A. Materials

1. Natural Rubber latex

Natural rubber latex is obtained from Heveabrasiliensis tree by natural polymerization process and is a dispersion of poly-isoprene. It is from nearby places of Methala, Perumbavoor. Specific gravity of NRL is 1.06.

Fig.1: Natural Rubber Latex

2. Poly Vinyl Alcohol Fiber (PVA)

PVA fibres brought from Astra chemicals in Chennai. PVA consists of repeated units of–[-CH_2-CH-OH-]-. The PVA fibre reinforcement improves the quality of concrete by making corrosion resistant component. The important property of PVA is making hydrogen bonds between the fibres and cement matrix is done by the OH group present in the PVA.

Fig.2: Poly Vinyl Alcohol fiber

3. Cement

43 Grade Ordinary Portland cement (OPC) is used. A substance used for construction that sets, hardens and adheres to other materials, binding them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together and the term cement alone means a construction material. The colour of the cement is due chiefly to iron oxide. In the absence of impurities, the colour would be white.

4. Sand (Fine Aggregate)

Fine aggregate / natural sand is a combination of grains of mineral matter derived from the disintegration of rocks. It is differ from gravel only by the size of the grains or particles, but is distinct from clays in the means of containing organic materials. Sand is used for making mortar and concrete and for polishing and sandblasting.

5. Coarse Aggregate

Aggregate in any selected particular mix of concrete are selected for their durability, strength, workability and ability to receive finishes. Coarse aggregate are particulates that are greater than 4.75mm. Coarse aggregates 20mm sizes confirming to IS 2386-1963 were used in mixing of concrete. For a good concrete mix, aggregates need to be clean, hard, strong, particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete.

6. Water

Water is an important ingredient of concrete as it actively participates in the Chemical reaction with cement. The quantity and quality of water is to be carefully selected for the test conducted for the investigation. If the water is fit for drinking, then it is fit for the Concrete. The water used in the investigation is free from all the acids and organic Substances. The clean potable water is used in the investigation.

B. Preliminary Investigations

All the materials we used are test under specified condition and the test results are tabulated below.

Table.1: Properties of materials used

Sl.no.	Proprty	Amount
1	Specific Gravity Of Cement	3.15
2	Intial Setting Time of Cement	30 min
3	Final Setting Time of Cement	550 min
4	Specific Gravity of C.A	2.69
5	Effective Size of C.A	11mm
6	Uniformity coefficient of C.A	1.5
7	Finess Modulus of C.A	6.97
8	Spesific gravity of F.A	2.5
9	Effective size of F.A	0.39
10	Uniformity coefficient of F.A	2.95
11	Finess modulus of F.A	3.52
12	Specific gravity of latex	0.91

Result Analysis

The specific gravity is normally used in mixture proportioning calculation. The specific gravity of portland cement is generally around 3.15.

Intial setting time is foud out by taking the intervel between the addition of of water to cement and the stage when needles stops to penitrate completely. The time should be about 30 min for ordinary cement.

The time at which cement completely losses its plasticity and became hard is a final setting time of cement. The time taken by cement to gain its entire strength is final setting time the maximum value is 600 min and we obtained 550 min.

The specific gravity coarse aggregate is the ratio of mass of a unit volume of aggregate including the water permiable voids, at a stated temberature to the mass of an equal volume of gas free distilled water at stated temperature. Specific gravity of coarse aggregate is between 2.4 to 3.

Size of coarse aggregate is usually greater than 4.75 mm while fine aggregate is less than 4.75mm.

The specific gravity of fine aggregate is the ratio of weight of given volume of aggregate to the weight of equal volume of water. Specific gravity of fine aggregate is lies between 2.4 to 2.9.

The Fineness modulus (FM) is an empirical figure obtained by adding the total percentage of the sample of an aggregate retained on each of a specified series of sieves, and dividing the sum by 100. The fineness modulus of Fine aggregates range from a 2.00 to 4.00, and coarse aggregates smaller than 38.1 mm range from 6.50 to 8.00.

The specific gravity of the rubber phase in latex of Heveabrasiliensis has formerly been estimated at values varying from 0.901 to 0.914.

C. Mix-Proportions

The mix proportioning for M30 grade concrete was done as per guidelines of IS 10262:1982.

Table.2: Quantity of materials required for 1m^3 (2400Kg) of concrete

Sl.no.	Material	Quantity
1	cement	443kg
2	Fine aggregate	687kg
3	Course aggregate	1085Kg
4	water	186kg
5	Water cement ratio	0.42

Table.3: Quantity of materials required for 3.8813 x10^{-3}m^3 of cube

Sl.no	Material	Quantity
1	cement	1.72Kg
2	Course aggregate	4.21Kg
3	Fine aggregate	2.67Kg
4	water	0.721Kg

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Table.4: Quantity of material required for 6.095×10^{-3} m^3 cube

Sl.no	Material	Quantity
1	cement	2.7Kg
2	Course aggregate	40187Kg
3	Fine aggregate	60613Kg
4	water	1.13Kg

PREPARATION OF LATEX CONCRETE

Mix design can be defined as the process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economically as possible. In our investigation we have made M30 grade concrete. The mix ratio obtained after the mix design is 1:1.55:2.45 : 0.42. Further, we have poured concrete mix in to cube and cylinder moulds with different dosage of latex and 1.2% of PVA and the following different samples were made.

For finding the optimum dosage of latex:

- Concrete cube with 0.395lit of latex
- Concrete cube with 0.467lit of latex
- Concrete cube with 0.526lit of latex

For finding the optimum dosage of PVA

- Concrete cylinder with 1.1 % PVA
- Concrete cylinder with 1.2 % PVA
- Concrete cylinder with 1.3% PVA

Concrete with optimum dosage of latex and PVA

- Concrete cube with optimum dosage
- Concrete cylinder with optimum dosage

III. TEST FOR OPTIMUM DOSAGE

A. Compression test

Compression test was conducted on harden concrete, because most of desirable characteristics properties concrete are qualitatively related to its compressive strength. Compression test was carried out on specimens cubical in shape. The cube specimen was of the size 15x15x15 cm.

Result of Optimum Dosage

Table.5: Result of Optimum Dosage of Latex

Sl.no.	Sample	Compressive strength(N/mm^2)
1	Concrete with 0.395lit of latex	22.8
2	Concrete with 0.467lit of latex	36.33
3	Concrete with 0.526lit of latex	30.89

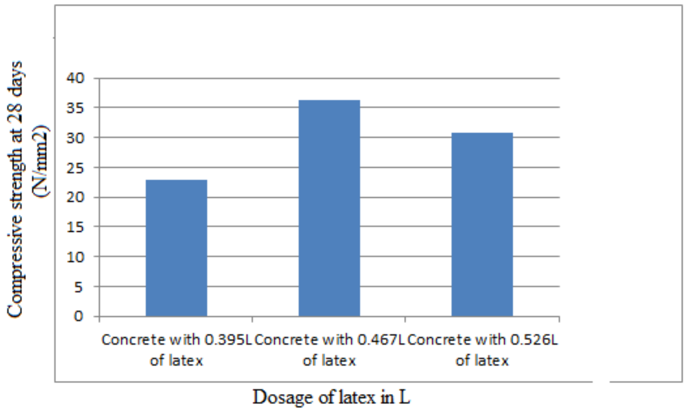

Fig.3: result of optimum dosage of a latex

B. Splitting tensile streangth

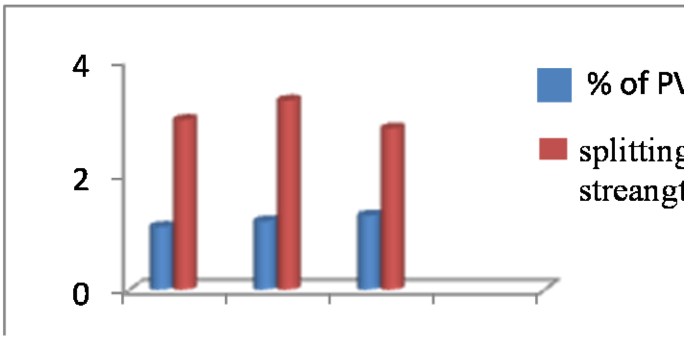

Table.6: result of optimum dosage of PVA

Sample	% of PVA	Split tensile strength (28days) N/mm2
1	1.1	2.97
2	1.2	3.31
3	1.3	2.82

Fig.4: Results of optimum dosage of PVA

Result Analysis

From the above results we obtained that the optimum dosage of latex is 0.467lit and PVA is 1.2% of cement. By using these two optimum values we prepared the third sample with latex and PVA combination, further it is compared with conventional concrete

C. Preparation of latex concrete with PVA

Preparation of cube

From the above results we added0.467L of latex and 1.2% of PVA along with conventional concrete mix. The concrete was mixed by hand mixing, that is the cement and fine aggregate were mixed in the water tight non absorbents platform until the mixture was thoroughly blended and was uniform colour. Then add the coarse aggregate into the mixed cement and sand and mix thoroughly until the coarse aggregate is uniformly distributed throughout the batch. After that water was added and mixed until the concrete appear to be homogeneous and of desired consistency. Thorough mixing of the material was done for the production of uniform concrete. To ensure that the mass become homogenous, uniform in colour and consistency. Proper compaction was done.

International Journal of Engineering Research & Technology (IJERT)
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The water curing is the best method of curing as it satisfy all the requirement of curing, namely promotion of hydration, elimination of shrinkage and absorption of the heat of hydration. The test specimen were stored in moist air for 24hr and after this period the specimens are marked and removed from the mould and kept submerged in clean fresh water until taken our prior to test.

D. Result and discussion

After mixing, we tested the concrete by use of slump test, compressive strength test and splitting tensile strength test. The results are tabulated below.

Table.7: slump test results

SlNo	Type of Concrete	Slump Value(Mm)
1	Conventional concrete	55
2	Latex modified concrete	60
3	Latex modified concrete with PVA	65

The table.7 shows the comparison study of conventional concrete with latex modified concrete and latex modified concrete with PVA. The value of slump of conventional concrete is 55 mm. The value of slump is increasing by the addition of latex to the concrete to 60 mm and by the addition of latex and PVA again the slump value is increased to 65mm. The maximum slump value is obtained by the addition of PVA along with latex. From the above results medium range of degree of workability was obtained.

Table.8 Compressive strength test result

SlNo	Sample	Compressive Strength In N/Mm2
1	Conventional concrete	34.55
2	Latex modified concrete	36.33
3	Latex modified with PVA	34.22

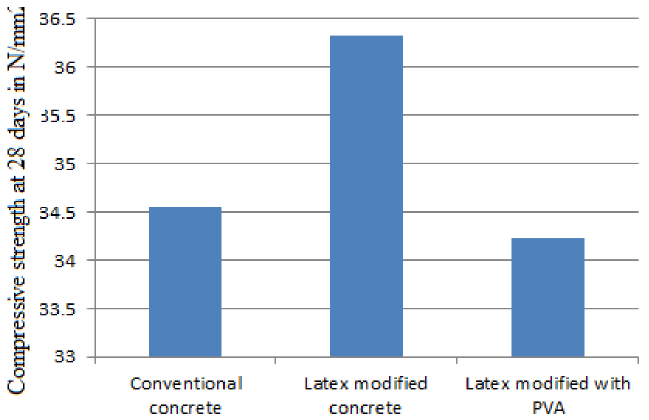

Fig.5: Variation of compressive strength

RESULT ANALYSIS

Compressive strength of these three samples were obtained from the test .From the test result we obtained that the strength of conventional concrete, latex modified concrete and latex modified with PVA is 34.55 N/mm2 , 36.33 N/mm2 , 34.22 N/mm2 respectively. From the analysis of result we obtained that the latex modified concrete have low value of compressive strength compared with conventional concrete and also latex modified with PVA fibre has an increase in compressive strength of concrete.

Table.9: Result of splitting tensile test

Sl No	Sample	Split Tensile Strength At 28 Days (N/Mm2)
1	Conventional concrete	3.64
2	Latex concrete with PVA	4.03

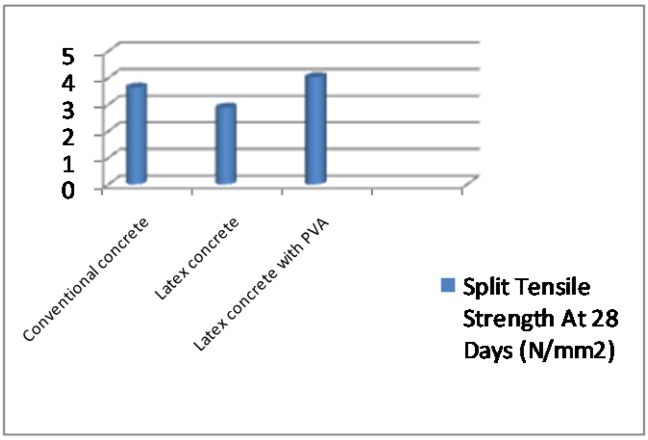

Fig.7: Result of splitting tensile test

RESULT ANALYSIS

From the analysis of result splitting tensile strength test, we obtained that the tensile strength of conventional concrete and latex modified concrete is 3.64N/mm2 and 4.03N/mm2 respectively. From this it is clear that the tensile strength of latex concrete with PVA is greater than that of conventional concrete.

IV. CONCLUSION

In this project, the mix design for concrete grade of M30 has been design as 1:1.55: 2.45.

- It is found that the optimum dosage of natural rubber latex is 0.467 L and PVA is 1.2 % of cement.
- There is an improvement in compressive strength of latex modified concrete compared with conventional concrete.
- Compressive strength of the latex modified with PVA has an approximately equivalent value of conventional concrete.
- Splitting tensile strength of latex concrete with PVA is greater than that of conventional concrete.
- The slump value obtained by the addition of latex along with PVA is more than conventional concrete, but the result of this concrete is in medium range of degree of workability.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
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