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Effect of Natural Rubber Latex (NRL) - Clay Powder Mixture On The Strength Of Portland Concrete.

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Abstract*: The strength of concrete mainly depends upon the porosity. Concrete has high compressive strength and low tensile strength. Earlier natural rubber latex was added to the concrete, which were able to reduce the porosity. The work mainly aims to improve the strength of concrete by replacing the conventional rubber latex with rubber latex-clay mixture. For experimental investigation, clay powder at various percentages (wt/vol of rubber) was dispersed in rubber latex and was subjected to tests on tensile strength and hence the optimum percentage of clay was obtained. The selected NRL-clay mixture was mixed with cement, sand and aggregates to prepare the specimen. Concrete cubes of 150*150*150 mm were cast and cured for 28 days and were subjected to tensile and compressive strength tests. The results obtained indicate that the NRL-clay mixture has superior elastic properties as compared to rubber latex alone. The tensile strength of NRL-clay mixture was increased with increase in clay powder concentration. 7 day compressive strength decreases with addition of NRL-clay mixture. 28 days compressive strength increases with increase in percent of NRL – clay mixture. Concrete containing 40% of NRL- clay mixture has a maximum compressive strength of 47Mpa which is 17.5% higher than normal concrete.*

1 INTRODUCTION

The idea that concrete can be strengthened by polymer inclusion was put forward by Porter in 1910.The weak matrix in the concrete, when mixed with rubber latex gets uniformly distributed across its entire mass. Therefor the matrix behaves as a composite material with properties different from conventional concrete.

Natural rubber is a best example of a natural polymer and an elastomer. Elastomers are substances that stretch readily. They retract rapidly to their original form when it is released. The reason for usage of polymers in the concretes is they have good binding and good adhesion with aggregates. They have chain structure, which helps for developing long-range network structure for bonding. As a result polymer materials provide superior compressive strength to the concrete. Some polymer materials selectively provide higher tensile strength for the structure compared to compressive strength.

Ohama in 1973 has studied the properties of polymer modified mortars. The same author also deals with the systems in both mortars and concretes. Polymer dispersions were added to mortars and concretes to improve their certain desired properties including improved bond strength to concrete constituents, increases flexibility, resistance to penetration by water, and resistance to frost action.

Due to increasing demand for the concrete industry to serve the needs in construction field, researchers are responding positively by introducing new mixes using other materials. Incorporating a polymer material, Natural Rubber Latex into the concrete has contributed to this demand in the society. The reason for usage of polymers in the concretes is that they have good binding properties with aggregates. Polymer materials may selectively provide higher tensile and flexural strength to the concrete structure compared to compressive strength. They provide good adhesion to the other material as well as resistance to physical damage and chemical attack. For the first time synthetic rubber (instead of natural rubber) latex was used for the latex-modified systems in 1931.

Improved synthetic resin latexes (which include polyvinyl acetate latexes) were used in the modified systems, and by the end of the 1930 the inventions clearly suggests that all types of polymers could be used in concrete modification. Since the late 1940s, latex-modified concretes has been used to various applications such as bridges, paving flooring, Stevens in 1948 and Griffiths in 1951 conducted many feasibility studies on the applications of rubber modified systems.

2 EXPERIMENTAL PROGRAMMES

2.1 Materials

2.1.1 Rubber latex

Centrifuged Latex of 60% of Dry Rubber Content (CENEX)

Centrifuging involves the separation of field latex into two fractions, one containing 60% dry rubber and other containing 4-6% rubber.

Cenex with high ammonia (min.0.7% of ammonia) is used for the experimental purposes, which is collected from JOSEPH RUBBERS PRIVATE LIMITED, KOTTAYAM.

SI NO	PROPERTIES	CENEX
1	Dry rubber content, wt %	60.05
2	Total solid content, wt%	61.32
3	Non rubber content ,wt%	1.27
4	Alkalinity-ammonia, wt%	0.70
5	Volatile fatty acid	0.03
6	KOH NO	0.50
7	PH-value	10.50
8	Mechanical stability, Sec	1000
9	Coagulum, wt%	0.004
10	Sludge, wt%	0.006
11	Chemical Stability (ZST),sec	140
12	Viscosity, cps	70
13	Copper, ppm	Trace
14	Manganese, ppm	Trace
15	Odour after neutralization with boric acid	Sweet
16	Colour	White
17	Particle size	0.2 microns
18	Specific gravity	0.94

Table 1 properties of rubber latex

2.1.2 Clay powder

Kaolin clay is a naturally occurring clay substance mostly found in soils that have developed from the chemical weathering of rocks in hot, moist climates. It is mainly used as a filler, extender, and ceramic raw material .Kaolin clay powder is collected from KERALA CERAMICS, KOLLAM

SI NO	PROPERTIES	KAOLIN
1	Appearance	White powder
2	Brightness	85.0+/-.5
3	Grit on 300 mesh (max)	0.05%(Max)
4	Loss on ignition	14% Max
5	PH of 20% aqueous solution	4 to 6
6	Particle less than 2 micron	82% (Min)
7	Bulk density	0.8 gm/cc
8	Moisture	1-2 % (Max)
9	Iron as ferric oxide	0.50%
10	Silica	45.17%
11	Alumina	37.59%

Table 2 properties of clay powder.

2.1.3 Cement

Dalmia cement of grade 43 has been used for experimental purposes. The specific gravity of cement is 3.137.

2.1.4 Fine aggregates

Commercially available M sand having a particle size of 6mm has been used as the fine aggregate. The specific gravity of fine aggregates is 2.688 with a fineness modulus of 2.879.

2.1.5 Coarse aggregates

Coarse aggregates having a size of 20mm have been used. The specific gravity of coarse aggregates is 2.76 with a fineness modulus of 7.

2.1.6 Water

Fresh water which is free of suspended impurities has been used for mixing concrete.

2.2 Preparation of Rubber Latex Clay Powder Mixture.

Clay powder at various concentrations (wt/vol of rubber) was mixed with rubber latex manually, until a uniform mixture is obtained. Since clay is

insoluble in rubber latex a uniform dispersion of clay particles in latex was formed. NRL-clay mixture at various concentrations was tested to determine the optimum value. Clay concentration of 15 %(wt/vol) shows superior elastic property as compared to other concentrations, therefore it is used for preparing the concrete specimen.

2.3 Mix Design

Concrete of grade M20 has been selected for experimental purposes .Mix proportion of cement, fine aggregate, coarse aggregate and water was kept at **1:1.5:3:0.55**. The volume of NRL-clay mixture added is based on the volume of water. Cement, fine aggregates, coarse aggregates are mixed together until a uniform dry mix is obtained. Then NRL-clay mixture along with water is added to the dry mixed constituents to prepare concrete specimen.

SI NO	% MIX (wt/vol)	CEMENT (Kg)	SAND (Kg)	COARSE (kg)
1	10	4.932	7.398	14.796
2	20	4.932	7.398	14.796
3	30	4.932	7.398	14.796
4	40	4.932	7.398	14.796
5	50	4.932	7.398	14.796

Table 3 designed mix proportion.

SI NO	% MIX (wt/vol)	WATER (ml)	LATEX (ml)	CLAY (g)
1	10	2441.34	271.26	14.24
2	20	2170.08	542.52	28.48
3	30	1898.82	813.78	42.72
4	40	1627.56	1085	56.96
5	50	1356.3	1356.3	71.25

Table 4 designed mix proportion.

2.4 CASTING

Steel Cubes of 150 x 150 x 150mm dimension were selected as the mould. The components were mixed thoroughly by manually. Moulds were kept on table vibrator and concrete was poured into the moulds in three layers. The moulds are kept in vibration for ten seconds and it was maintained constant for all the specimens. Three cubes were cast for each mix.

2.5 CURING

The specimens were removed from the mould after 24 hours and cured in water for 28 days. After 28 days the specimens were subjected to compressive and tensile tests.

3 RESULTS AND DISCUSSION

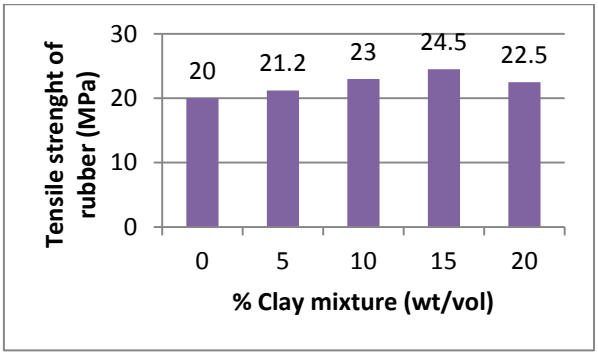

Figure 1 tensile strength of NRL- clay mixture

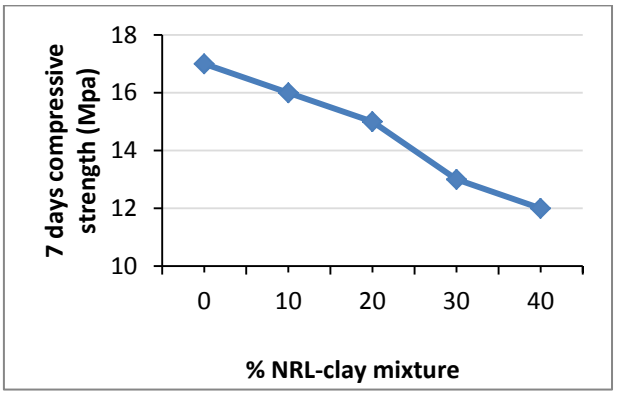

Figure 2, 7 days compressive strength

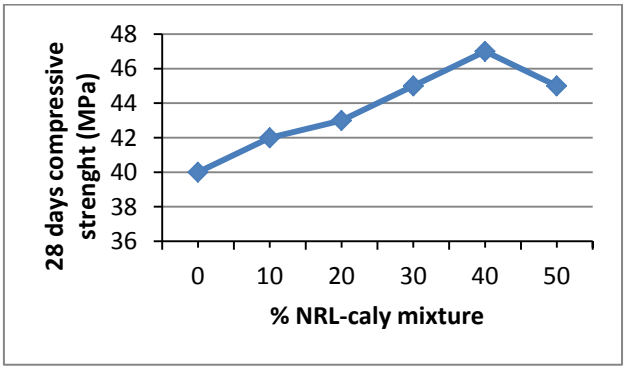

Figure 3, 28 days compressive strength

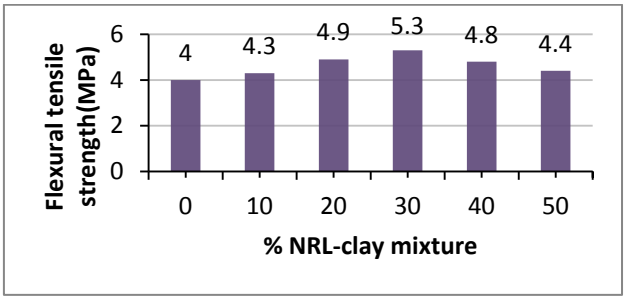

Figure 4, flexural tensile strength of concrete.

From fig 1 it can be observed that the tensile strength of NRL-clay mixture increased with increase in clay powder concentration. Tensile strength of NRL-clay mixture containing 5% and 10% clay powder increased by about 6% and 15% respectively in comparison to NRL alone. The maximum tensile strength obtained was 25.5Mpa (at a clay concentration of 15%) which is 22.5% higher as compared to NRL. Further addition of clay powder reduces the tensile strength i.e. at a clay concentration of 20% the tensile strength reduces by 8%. The observed improvement of tensile strength of NRL is due to the reinforcement of clay powder which increases the cross link density between the rubber monomers which stiffens the rubber. But higher concentrations of clay powder disturb the bonding structure which decreases the tensile strength.

From fig 2 it can be observed that the 7days compressive strength decreases with the addition of NRL-clay mixture. The normal 7days compressive strength of concrete was observed as 17Mpa. By the addition of 10% NRL-clay mixture the compressive strength reduces by 1.5%.

From fig 3 it can be observed that the 28 days compressive strength increases with increase in percent of NRL – clay mixture. Concrete cubes containing 10% and 20% NRL- clay mixture was having a compressive strength 5% and 7% higher than normal concrete respectively. Concrete containing 40% of NRL- clay mixture has a maximum compressive strength of 47Mpa which is 17.5% higher than the normal concrete. Higher concentration of NRL- clay mixture leads to the reduction in compressive strength. The improvement in the compressive strength is due to the significant effect of NRL-clay mixture on the porosity of concrete. As the concrete becomes more porous the weaker it will be. Addition of NRL- clay mixture uniformly binds the various components together and leads to a greater aggregate matrix bond which reduces the porosity.

From fig 4 it can be observed that the flexural tensile strength of concrete increased with the addition of NRL- clay mixture. The normal tensile strength of concrete was 4Mpa and the concrete containing 10% of NRL- clay mixture is having a flexural tensile strength of 4.3Mpa which is 7.5% higher. The maximum strength obtained is 5.3 which have a NRL- clay concentration of 40%, thereafter the addition of mixture reduces the strength. The improvement of flexural tensile strength is due to the elastomeric influence of NRL- clay mixture. The elastomeric effect was able to reduce the brittleness of concrete, which leads to higher tensile strength. The decrease in tensile strength at higher concentrations of mixture is due to the fact that the brittleness of concrete cannot be removed after a certain limit i.e., concrete as a whole is brittle in nature.

4. CONCLUSIONS

- The tensile strength of NRL-clay mixture was increased with increase in clay powder concentration .The maximum tensile strength obtained was 25.5Mpa (at a clay concentration of 15%) which is 22.5% higher as compared to NRL.
- 7 day compressive strength decreases with addition of NRL-clay mixture.
- 28 day compressive strength increases with increase in percent of NRL – clay mixture Concrete containing 40% of NRL- clay mixture has a maximum compressive strength of 47Mpa which is 17.5% higher than normal concrete. Higher concentration of NRL- clay mixture leads to the reduction in compressive strength.
- The flexural tensile strength of concrete increased with the addition of NRL- clay mixture. . The maximum strength obtained is 5.3Mpa which have a NRL- clay concentration of 40%, thereafter the addition of mixture reduces the strength.

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