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STUDY ON THE PROPERTIES OF NATURAL RUBBER LATEX AND NANO-GRAPHITE MODIFIED CONCRETE

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ABSTRACT

Concrete is a mixture of cement and aggregates mixed with water at correct proportions.In this experimental study, polymer and nano filler is adding in concrete. Inclusion of polymeric substances into hydraulic cement concrete has made a tremendous impact towards improving its performance properties. However, polymers to be included into concrete should neither cause damage to its mechanical capacities nor to its durability characteristics. The objective of this study is to mix fresh natural rubber latex and nano-graphite in concrete. Firstly, the rubber latex modified concrete is prepared with different proportions such as0.25%, 0.5%, 0.75%, 1%,1.25% &1% by weight of cement. Then taking the optimum percentage of rubber latex and nano-graphite is added along with the concrete at different proportions. In this study ,the 3 day and 28 day compressive strength of samples were found out.

I. INTRODUCTION

Concrete is most widely used material in the world. Humans consume no material except water in such tremendous quantities. When initially mixed, concrete attains a fluid form which on proper curing hardens on course of time. Hardened concrete is a direct product of hydration, which is a reaction between water and cement particles. When the capillary water dries out it leaves interconnected pores. When the environmental conditions are favourable, these pores become the entry points for liquid water, water vapour, different gases and chemical substances that could be damaging to concrete. As a result, cracks will be formed and finally the structure will fail. One of the solution to this problem is the inclusion of polymeric substances and nano-fillers in concrete.Concrete has high compressive strength but is relatively weak in tension and adhesion, and itsporosity can lead to physical and chemical deterioration. Polymers, on the other hand, are weaker in compression but can have higher tensile capacities, and provide good adhesion to other materials as well as resistance to physical (i.e., abrasion, erosion, impact) and chemicalattack. Combinations of these two materials can exploit the useful properties of both andyield composites with excellent strength and durability properties.

Polymers are formed by combining two or more monomers by a process known as polymerization. Here, natural rubber latex is added as a polymer modifier. Natural rubber latex is obtained from natural rubber. The latex is a sticky, milky colloid drawn off by making incisions into the bark and collecting the fluid in vessels in a process called "tapping". The latex then is refined into rubber ready for commercial processing. Natural rubber is used

extensively in many applications and products, either alone or in combination with other materials. In most of its useful forms, it has a large stretch ratio and high resilience, and is extremely waterproof.

Fillers are particles added to material (plastics, composite material, and concrete) to lower the consumption of more expensive binder material or to better some properties of the mixtured material. Nano fillers are characterized by their particle size, specific surface area, particle geometry, and chemical functionalization. Smaller filler particle sizes provide new functionalities such as improved mechanical strength and control of rheological properties. Nanofillers can be either small spherical particles or rod shaped objects and flakes with at least one critical dimension below 100nm. Fillers are widely used in the construction sector in adhesives and sealants, in paints and coatings, but also in plastics, rubber and concrete. The nano-filler used in this study is nano-graphite.Concrete can be improved by using Nano-Graphite which leads to densifying of the micro and nanostructure resulting in improved mechanical properties. The addition of Nano-Graphite to fresh concrete improves electrical conductivity, thermal conductivity and act as a good lubricant than the layered graphites. Graphite is extremely electrically conductive material and can be combined with glass fibers or other matrix materials to provide sufficient conductivity for electrostatic painting or other applications requiring electrical conductivity.

IV. LITERATURE REVIEW

Concrete is a composite material composed mainly of water, aggregate and cement.. When these ingredients are mixed together, they form a fluid mass that is easily molded into shape. Over time, the cement forms a hard matrix which binds the rest of the ingredients together into a durable stone-like material with many uses. In modern times, researchers have experimented with the addition of other materials to create concrete with improved properties, such as higher strength, electrical conductivity, or resistance to damages through spillage. Nowadays many such additions are included in the construction industry. One such addition is the usage of polymer and nano-graphite modified concrete.

Nanofillers can be either small spherical particles or rod shaped objects and flakes with at least one critical dimension below 100nm. In general, the properties of filler materials are determined through particle size, particle geometry and chemical coatings, or functionalization. Smaller particles provide new functionalities such as control of rheological properties, improved mechanical properties, an increased transparency or electrical conductivity, or enhanced flame retardancy. They can be also used to ensure the free flow of powders and to prevent the settling of pigments. Fillers are widely used in the construction sector in adhesives and sealants, in paints and coatings, but also in plastics, rubber and concrete (Michael Gleiche 2011).Different non – hydrocarbon substances were present in the rubber latex. Concretes modified with latexes containing higher non-hydrocarbon substances especially volatile fatty acids (VFA) and zinc was observed to suffer significant compressive strength losses. Indeed, 12.4% loss in compressive strength was recorded against concrete modified with the latex having the highest contents of VFA and zinc.(BalaMuhammed et.al 2012). Another experimental study was conducted on the evaluation of compressive strength and water absorption of styrene butadiene rubber (SBR) latex modified concrete. In this study a locally available “RIPSTAR-148”is used as SBR latex. By using polymer cement concrete, the porosity is decreased because the material fills the pores and there is improvement in the transition zone also. SBR is replaced in cement by 10%, 15%, and 20%. From the result, the slump test

value of SBR latex has increased. This shows that latex has plasticizing effect. The compressive strength is increased at 28 days strength but the water absorption at 28 days for SBR latex is decreased. This is due to the formation of polymer film that makes the concrete water tight.(Prof.G.N.Shete et al 2014)

III. EXPERIMENTAL PROGRAM

3.1. Materials

3.1.1. Natural Rubber Latex

Natural rubber also called India rubber or caoutchouc, as initially produced, consists of polymers of the organic compoundisoprene, with minor impurities of other organic compounds plus water. . Natural rubber is used extensively in many applications and products, either alone or in combination with other materials. In most of its useful forms, it has a large stretch ratio and high resilience, and is extremely waterproof.Fig 1shows the rubber latex. Table 1 shows the properties of Natural Rubber Latex.

Fig.1. Natural Rubber Latex(NRL)

Table 1. Properties of NRL

Parameters	Values
Total Solid Content(TSC)	61.27%
Dry Rubber Content (DRC)	60.03%
Non Rubber Content(NRC)	1.24%
Ammonium Content(NH_3%)	0.6%
Volatile Fatty Acid No. (VFA No)	0.021
Mg Content	3ppm

3.1.2. Nano-Graphite

Graphite is a three dimensional carbon based material made up of millions of layers of graphene. It is an allotrope of carbon. Graphite is a nonmetallic showing high electrical conductivity.Graphite is composed of extremely strong fibers made of series of stacked parallel layer sheets. It is a typical layered polymeric crystal. The material is black in colour and optically opaque. It is used for applications in paints, carbon additives, electrical brushes, conductive coatings, batteries, dry-film lubricants etc. Fig 2 shows the nano-graphite in powdered form.Table 2 shows the properties of nano-graphite.

Fig.2. Nano-Graphite

Table 2. Properties of Nano-Graphite

Parameters	Values
Form	Powder
Particle size	<20µm
Melting point	3652-3697ºC

3.1.3. Cement

The type of cement used in this experimental work is Portland pozzolana cement. Portland Pozzolana cement produces less heat of hydration and offers greater resistance to the attack of aggressive waters than normal Portland cement. Table 3 shows the properties of cement.

Table 3. Properties of cement

Properties	Value Obtained
Standard consistency	30%
Initial Setting Time	135 minutes
Specific gravity	2.75

3.1.4. Fine Aggregate

Fine aggregate used in this study is M sand. Fine aggregates are the aggregates whose size is less than 4.75mm. Sand is generally considered to have a lower size limit of about 0.07mm, also free from clay, minerals and salt. The specific gravity of fine aggregate was found out using pycnometer and sieve analysis was carried out to find out the grading zone of aggregate.Table 3 shows the properties of fine aggregate.

Table 3. Properties of Fine Aggregate

Properties	Value Obtained
Specific Gravity	2.65
Fineness Modulus	3.28
Grading Zone	Zone I

3.1.5. Coarse Aggregate

Locally available coarse aggregate with maximum size of 20 mm were used in this project. Table 4 shows the properties of coarse aggregate.

Table 4. Properties of Coarse Aggregate

Properties	Value Obtained
Specific Gravity	2.79
Bulk Density	1.32 g/cc
Water absorption	0.151%

3.1.6. Water

According to IS 456:2000, water used for mixing and curing shall be clean and free from injurious amounts of oils,acids,alkalis,salts,sugar,organic materials or other substances that may be deleterious to concrete or steel. Portable water is generally considered satisfactory for mixing concrete. The pH value of water shall not be less than 6

3.2. Laboratory Work

3.2.1. Mixing

Cement concrete is prepared by mixing graded stone of nominal size as specified with fine aggregate and cement in specified proportions with required quantity of water.

For mixing, a drum mixer was used. The aggregates were prepared in saturated surface dry condition. For NRL modified concrete the calculated amounts of ingredients are mixed together till a uniform mix is obtained. The amounts of latex adopted are 0.25%, 0.5%, 0.75%, 1%, 1.25%, 1.5% and 2% of cement. Latex mixed with water is added and a uniform mixture is prepared. The concrete mixture is then placed in the mould and compacted and surface should be finished. Six cubes were casted and cured. The compressive strength for 7 day and 28 day is determined. From this experiment ,the optimum percentage of rubber latex can be identified.

For rubber latex and nano-graphite modified concrete, the aggregates and cement were mixed together with the help of mixer. Then rubber latex, graphite powder and water should be mixed thoroughly and added in to the mixture. Optimum percentage of rubber latex should be taken from the NRL modified concrete and varying the percentage of graphite. The amounts of nano-graphite adopted are 0.25%, 0.5%, 0.75%, 1%, 1.25%, 1.5% and 2% of cement.

Cubes with 15 cm × 15 cm × 15 cm, cylinders with 10 cm × 30 cm and beams with 50 cm × 10 cm × 10 cm sizes were casted and compacted properly.

3.2.2. Curing

The filled concrete specimens were allowed to remain the mould for the first 24 hours at ambient condition. After that these were demoulded with care so that no edges were broken and were placed in the tank at the ambient temperature for curing. The cubes were water cured till test date.

3.3. Mix Proportion

Mix design is 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. A Mix design was conducted as per IS 10262- 1982 to arrive at M30 mix concrete.

Cement = 384 kg/m^3

Water = 192 kg/m^3

Fine aggregate = 708.504 kg/m^3

Coarse aggregate =1118.9 kg/m^3

Water Cement ratio is 0.5

Mix Ratio=1:1.84:2.91

3.4 Compressive Strength

150 mm × 150 mm × 150 mm cubes were casted for carrying out compression strength test. 7 day and 28 day strength of the specimens were measured. The specimens were tested on a compression testing machine with capacity of 3000 kN. The results are as follows:

3.4.1 7Day Compressive Strength of NRLModified Concrete

The 7 day compressive strength of the sample obtained a maximum strength of 23.85 N/mm^2. The 7 day maximum strength was obtained for 0.75% addition of rubber latex by weight of cement. The strength reduction between 0.25% and 1.5% modification could be the result of excess latex over the optimum quantity for maximum strength. Excess latex beyond that which is just sufficient to occupy voids and micro structural cracks present in the hardened concrete might prevent the aggregate particles from being closely packed thereby developing weak regions for undue cracks during compression test. Fig 3 shows the graphical representation of 7 day compressive strength of natural rubber latex.

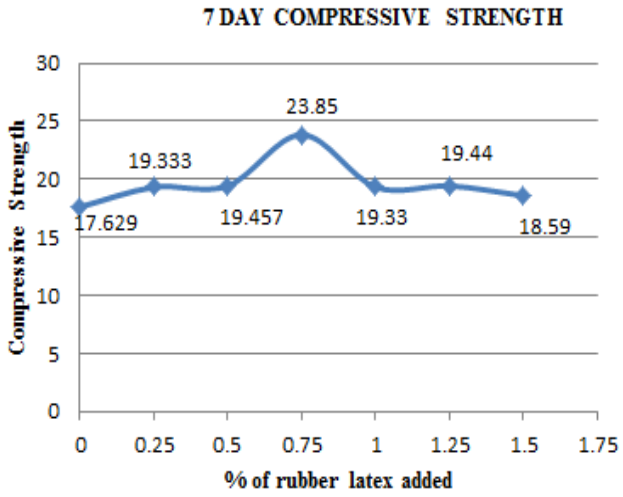

Fig.3. 7 Day Compressive Strength

3.4.2. 28 Day Compressive Strength

The 28 day compressive strength was also maximum for 0.75% addition of rubber latex added by weight of cement. Fig 4 shows the graph for 28 day compressive strength of natural rubber latex modified concrete. . It is clear that a rapid strength development is obtained by increasing the latex polymer dosage from 0.25% to 0.75 % later it is showing reducing up to 1.5%. From the graph, we can see that there is a reduction in compressive strength while adding excess latex.

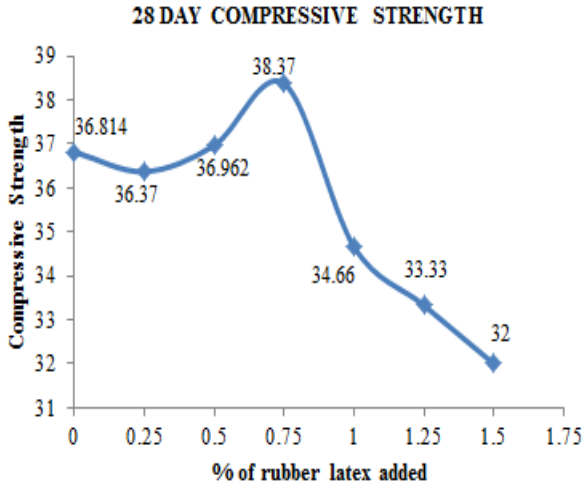

Fig.4. 28 Day Compressive Strength

3.4.3 7 Day Compressive Strength of NRL and nano- graphite modified concrete

Fig 5 shows the 7 day compressive strength of NRL and nano-graphite modified concrete. For NRL and nano-graphite modified concrete,the optimum percentage of rubber latex got from the above experiment is 0.75 and varying the percentage of nano-graphite. The 7 day compressive strength of NRL and nano-graphite modified concrete is maximum for 0.5%.

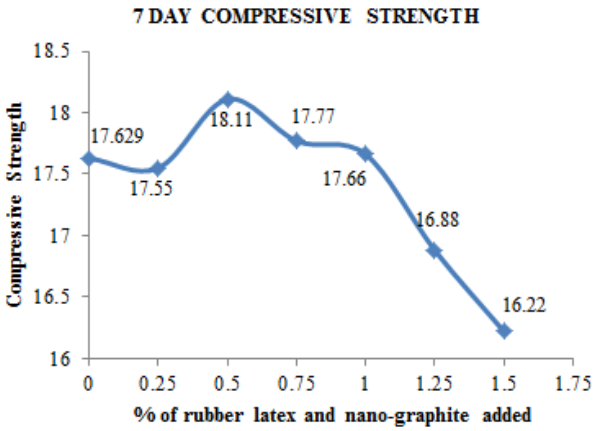

Fig.5. 7 Day Compressive Strength of NRL& Nano-Graphite Concrete

3.4.4. 28 Day Compressive Strength of NRL and nano- graphite modified concrete

For the 28 day compressive strength of NRL and nano-graphite modified concrete also the maximum strength is attained for 0.5%.Fig 6 shows the 28 day compressive strength of NRL and nano-graphite modified concrete. Compressive strength results envisages that a dosage of 0.75% of rubber latex and 0.5% of nano-graphite is observed to be the optimum dosage in both the 7 day and 28 day to achieve complete polymerization and subsequent improvement in performance. The important feature of this material is that a large proportion of the void volume is filled with polymer, which forms a continuous reinforcing network. It was also observed that the use of nano-graphite decreases the total porosity of concrete. The decrease of porosity could be caused by the improved degree of hydration in the nano-graphite

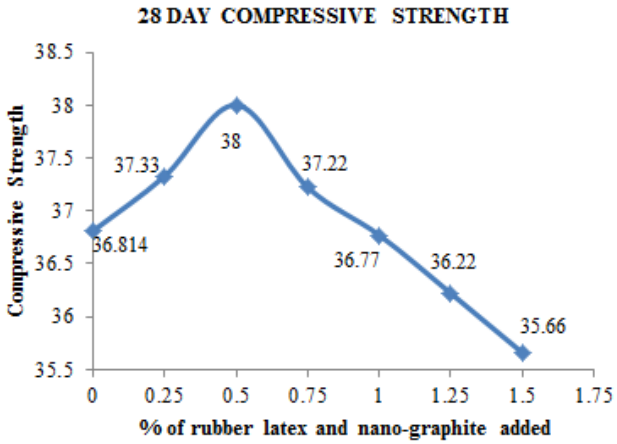

Fig.6. 28 day compressive strength of NRL & nano-graphite concrete

IV. CONCLUSION

- The 7 and 28 day strength of NRL modified concrete was increased by 35% and 4% respectively when compared to conventional concrete.
- The optimum percentage of rubber latex was found to be 0.75 by weight of cement.
- The compressive strength is increased by 3% for NRL and nano-graphite modified concrete when compared to conventional concrete.

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