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Latex Modified and Fibre Reinforced Pervious Concrete

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*Abstract :-*Construction is In this research, effect of Styrene-Butadiene Rubber (SBR) latex on Flexural strength and compressive strength of concrete has been studied. A locally available Sika-Latex is used as SBR Latex.It has been observed that SBR latex improves the internal structure of the latex modified concrete resulting in considerable reduction in the water absorption value at 28 days of age. However, at early age, the effect of SBR latex on water absorption is adverse. Same trend is noticed for the compressive strength; at 7 days of age, SBR latex has negative effect while at 28 days, the addition of SBR latex in concrete results in enhancement of compressive strength. Based on the results of this study, latex modified concrete made using Sika-Latex may be recommended to be used in RC structures.

I. INTRODUCTION

Polymer cement concrete have high tensile strength, good ductile behaviour, and high impact resistance capability. Consequently, the porosity is decreased and pore radius is refined because of the void filling effect of this network.In the last two decades, many research studies have been carried out on the use of different polymers suitable for admixing into fresh concrete to improve the mechanical properties. Latex is a polymer system formed by the emulsion polymerization of monomers and it contains 50% solids by weight. Styrene butadiene, polyvinyl acetate, acrylic and natural rubbers are the best examples of polymers which are usually used in latex.Styrene butadiene rubber (SBR) latex is a type of high-polymer dispersion emulsion composed of butadiene, styrene and water and it can be successfully bonded to many materials. In civil engineering field, it is used to replace cement as binder to improve tensile, flexural and compressive strengths of concrete. SBR is white thick liquid in appearance; it has good viscosity with 52.7% water content.In this present contribution, the effect of adding locally available SBR latex known as Sika-Latex on compressive strength and flexural strength of normal strength concrete has been investigated.Compressive strength and flexural strength development of the concrete in the presence of SBR latex and Steel Fiber was studied at 7, 14 and 28 days of ageindividually and then together.is essential. Despite increasing deciding to dispose of waste in landfills, these alternatives are typically considered, given that landfilling waste results in total economic loss and has a number of severe environmental effects, in addition to the fact that nations are running out of landfill sites.

2. LITERATURE REVIEW

2.1 TarannumMeraj, A K Pandey* & B K Rao CSIR-Central Building Research Institute, Roorkee 247 667, India Received 12 October 2012; accepted 1 November 2013

Flexural behaviour of latex modified steel fiber reinforced concrete

The flexural behaviour of plain concrete (PC), latex modified concrete (LMC) and latex modified steel fiber reinforced concrete (LMSFC) beams are studied under monotonic third point loading till ultimate stages. All the three types of concretes are designed

for M-30 grade concrete. In LMC styrene butadiene latex 10% of cement weight is used. LMSFC concrete crimped steel fiber of aspect ratio of 16.67 at 1% of volume of concrete and SBR latex equal to 10% weight of cement are incorporated. An experimental program consisting of tests on latex modified concrete, latex modified steel fiber reinforced concrete and plain reinforced concrete are conducted under flexural loading. Beams are reinforced with bottom longitudinal steel bars and transverse steel stirrups. Tests on PC, LMC and LMSFC beam specimens have been conducted to establish load-deflection curves. The various parameters, such as stress-strain variation, first crack load, ultimate load, deflection ductility and strain variation along the depth of the beams have been carried out and a quantitative comparison are made at various stages of loading. It is found from this study that the neglect of fiber and latex contribution may considerably underestimate the flexural capacity of latex modified fiber-reinforced concrete beams. The present study also indicates that the ductility in LMC and LMSFC is increased by 45.94% and 50.27% respectively as compared to PC beams.

2.2 Dr.Vaishali.G.Ghorpade*, Sri. K. Munirathnam, Dr.H. Sudarsana Rao (Associate Professor, Head Of Civil Engineering Dept., JNTUA College Of Engineering, Anantapur-515002,) Effect of natural rubber latex on strength and workability of fibre reinforced high-performance - concrete with metakaolinadmixture**

To increase the applications of Natural Rubber Latex Modified Fiber Reinforced High-Performance-Concrete (NRLMFRHPC) in India, greater understanding of NRLMFRHPC produced with locally available materials such as cement , Fine aggregates , coarse aggregates, Metakaolin and Crimped Steel fibers is essential. In the present investigation, NRLMFRHPC has been produced withlocally available aggregates and mineral admixture (Metakaolin) and Natural Rubber Latex based NRLMFRHPC mixes were designed by absolute volume method. Cubes of 150X150X150 mm in dimension were cast and cured for 28 days and then tested for compressive strength to assess the strength characteristics of NRLMFRHPC. Workability has been measured by conducting compaction factor test on fresh NRLMFRHPC mixes. The experimental results indicate that Natural Rubber Latex can be utilized in producing durable Fiber Reinforced High-Performance-Concrete. The various results which indicate the effect of Steel Fibers and Natural Rubber Latex on the strength and workability characteristics of high-performance-concrete are presented in this paper to draw useful conclusions.

2.3 Classification of Latex Concrete

Natural Rubber Latex:

HeviaBrasiliensiscommonly known as rubber tree, is the most important source of natural rubber and more than 97% of the natural rubber produced is from this tree. Rubber is extracted from a milky white liquid known as latex, which is obtained from the bark of rubber tree by a process called "lapping". It is a process of controlled wounding of the plant in which a thin layer of bark is removed. The latex vessels in the region of the wound are opened by tapping and latex flows out from the tree, which is channelled into a container, attached to it.

Composition of latex

Latex is a white or slightly yellowish opaque liquid with a specific gravity in the range of 0.96 to 0.98 and having a variable viscosity. Latex in the latex vessels of rubber tree is sterile, but as it comes out of the tree is slightly alkaline or neutral and it gets contaminated by bacteria. These micro-organisms grow in the latex as it contains proteins and carbohydrates. As a result, volatile organic acids are produced and the latex gets coagulated on keeping. Field latex is a negatively charged colloidal dispersion of rubber particles suspended in an aqueous serum. The size of the rubber particles range from 0.025 to 0.3 microns. These rubber particles are surrounded by a layer of proteins andphospholipids. Latex contains a variety of other non-rubber constituents also. The proportion of these constituents varies according to season, soil, atmospheric conditions,clone, stimulation particles, tapping system etc.

In general the composition of latex is as follows:

- Rubber 30 - 40 %
- Protein 2.0 - 2.5 %
- Resin 1.0 - 2.0 %
- Sugar 1.0 - 1.5 %

- Ash 0.7 - 0.9 %
- Water 55 -60 %

2.4 Types of LatexConcrete:-

1. **Normal Polymer Concrete:-**
   I. Polymer Concrete is a mixture of aggregate as sole binder.
   II. There is no other bonding material present such that Portland cement is not used.
   III. It is manufacture in as manner similar to that of cement concrete
2. **Polymer Modified Concrete:-**
   I. Latex Modified Concrete is made by mixing cement, fine aggregate, coarse aggregate and Latex.
   II. Latex Modified Concrete is the conventional Portland cement concrete which is usually made by replacing a part of the mixing water with the Latex.
3. **Polymer Impregnated Concrete:-**
   I. Produced by infiltrating a hardened Portland cement concrete with a monomer.
   II. It is one of the widely used polymer composite.
   III. Depth Impregnation improves structure property of concrete.

Advantages

1. Rapid curing at ambient Temperature.
2. Good resistance against corrosion.
3. High Tensile, flexural and compressive strength.
4. Good adhesion to most surfaces.
5. Good long term durability.
6. Good Chemical resistance.

Disadvantages

1. The testing specimen of latex modified concrete is more costly than the ordinary concrete.
2. The monomers form polymers can be volatile, combustible & toxic.
3. These monomers are used as catalysts and harmful to human skin.
4. High in cost.

Applications

1. Used for industrial structure and rehabilitation.
2. It can be used for manufacturing electrical poles.
3. Solid surface countertops for modern kitchen and bath.
4. Ideal for many ornamental applications including park benches.
5. Commonly used in areas subjected to heavy wear and high loadings, such as car parks, roadways, industrial areas.

2.5 Effect of Confinement on Latex Modified Concrete:-

When concrete structures are subjected to earthquake forces and blast loads the critical sections of the structural members must be able to absorb strain energy, if sudden failures are to be avoided. This is possible only if the material is capable of withstanding

considerable deformations without a reduction in its load carrying capacity. It is possible to improve the ductile property of the concrete if the material is prevented from disruption and crushing into pieces when compressed to its ultimate capacity. This can be done by providing suitable confinement to the concrete under compression.

A more practicable method of confining concrete in structural members appears to be the use of steel spirals around the periphery of the core concrete in compression. Considering the above, a preliminary experimental programme is carried out to study the effect of confinement on the strengthand behaviour of latex modified concrete under uniaxial compression. The outcome of this preliminary experimental programme has been suitably made use of in the studies on the effect of confinement in compression zone of reinforced concrete flexural members discussed in the subsequent sections.

2.6 Fiber-Reinforced Concrete (FRC)

Introduction:-

Fiber-reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers – each of which lend varying properties to the concrete. In addition, the character of fiber-reinforced concrete changes with varying concretes, fiber materials, geometries, distribution, orientation, and densities.

- Concrete is relatively brittle, and its tensile strength is typically only about one tenths of its compressive strength.
- Regular concrete is therefore normally reinforced with steel reinforcing bars.
- For many applications, it is becoming increasingly popular to reinforce the concrete with small, randomly distributed fibers.
- Their main purpose is to increase the energy absorption capacity and toughness of the material, but also increase tensile and flexural strength of concrete.
- Concrete containing a hydraulic cement, water, fine or fine and coarse aggregate, and discontinuous discrete fibers is called fiber-reinforced concrete (FRC).
- It may also contain pozzolonaand other admixtures commonly used in conventional concrete.
- Fibers of various shapes and sizes produced from steel, plastic, glass, and natural materials are being used; however, for most structural and non-structural purposes, steel fiber is the most commonly used of all the fibers.
- There is considerable improvement in the post-cracking behavior of concretes containing fibers. Although in the fiber-reinforced concrete the ultimate tensile strengths do not increase appreciably, the tensile strains at rupture do.
- Compared to plain concrete, fiber-reinforced concrete is much tougher and more resistant to impact.

2.7 Types of Fiber-Reinforced Concrete

1.Steel Fiber-Reinforced Concrete:-

It is basically a cheaper and easier to use form of rebar reinforced concrete. Rebar reinforced concrete uses steel bars that are laid within the liquid cement, which requires a great deal of prep work but make for a much stronger concrete.

Steel fiber-reinforced concrete uses thin steel wires mixed in with the cement. Thisimparts the concrete with greater structural strength, reduces cracking and helps protect against extreme cold. Steel fiber is often used in conjunction with rebar or one of the other fiber types.

2.Glass Fiber Reinforced Concrete:-

Uses fiberglass, much like you would find in fiberglass insulation, to reinforce the concrete. The glass fiber helps insulate the concrete in addition to making it stronger. Glass fiber also helps prevent the concrete from cracking over time due to mechanical or thermal stress. In addition, the glass fiber does not interfere with radio signals like the steel fiber reinforcement does.

3.Synthetic Fiber Reinforced Concrete:-

It uses plastic and nylon fibers to improve the concrete's strength. In addition, the synthetic fibers have a number of benefits over the other fibers. While they are not as strong as steel, they do help improve the cement pumpability by keeping it from sticking in

the pipes. The synthetic fibers do not expand in heat or contract in the cold which helps prevent cracking. Finally synthetic fibers help keep the concrete from spalling during impacts or fires.

4.Plastic Fiber

Fibre such as polypropylene, nylon, acrylic, aramid and polyethylene have high tensile strength but low young's modulus thus inhibiting reinforcing effect. Amount of plastic fibre added to concrete is about 0.25 to 1% by volume. Polypropylene and nylon fibers are found to be suitable to increase the impact strength.

Advantage

- Improved durability of the structure
- Increased tensile and flexural strengths
- Higher resistance to later cracking
- Improved crack distribution
- Reduced shrinkage of early age concrete
- Increased fire resistance of concrete
- Improved homogeneity of fresh concrete

Disadvantage

- Increase in specific gravity of the concrete. This means that the concrete will be heavier than the normal concrete.
- Higher cost because of its production issues as well as the cost of raw material is high.
- Corrosion of steel fiber
- Low modulus of elasticity.

Applications

It is used on account of the advantages of increased static and dynamic tensile strength and better fatigue strength. It has been tried on overlays of air-field, road pavements, industrial footings, bridge decks, canal lining, explosive resistant structures, refractory linings etc. Used for the fabrication of precast products like pipes, boats, beams, stair case steps, wall panels, roof panels, manhole covers etc.

It is also being tried for the manufacture of prefabricated formwork moulds of "U" shape for casting lintels and small beams.

- Thin sheets
- Shingles
- roof tiles
- pipes
- prefabricated shapes
- panels
- curtain walls
- Slabs on grade
- precast elements
- Composite decks
- Vaults, safes.
- Impact resisting structure

3.METHODOLOGY

Materials -:

1. Locally available polymer 'Sika-Latex' will be investigated in this study. (Sika-Latex is a type of Styrene butadiene rubber (SBR) latex)
2. Steel Fiber.
3. Ordinary Portland will be used for this study.
4. Locally available sand and crushed stone will be used as fine and coarse aggregates, respectively.
5. Water.

Methods-:

1. Mix Design-:

- The ordinary concrete mixture will be comprised of Portland cement, water, coarse and fine aggregates.
- M25 grade of concrete will be used.
- OPC 43 Grade of Cement will be used.
- The Latex Modified concrete mixture will be comprised of Portland cement, water, coarse and fine aggregates and SBR Latex.
- The Fiber reinforced concrete mixture will be comprised of Portland cement, water, coarse and fine aggregates and steel fibers.
- The Latex Modified concrete and Fiber reinforced concrete mixture will be comprised of Portland cement, water, coarse and fine aggregates SBR Latex and steel fibers.

2. Ordinary Concrete-:

- Concrete cubes will be cast by using the ordinary concrete mixture to perform compressive strength and flexural strength test.

3.Latex Modified Concrete (LMC):

- In this research, latex modified concrete compositions containing 5%,10% and 15% SBR latex by weight of concrete will be prepared.
- Concrete cubes will be cast by using this latex modified concrete mixture to perform compressive strength and flexural strength test. Since the SBR latex used in this study contained 60% of water, the quantity of water required to be added in the concrete will be accordingly adjusted to mix design.

4.Fiber Reinforced Concrete-:

- In this research, fiber reinforced concrete compositions containing 0.5%,1.0% and 1.5% steel fibers by weight of concrete will be prepared.
- Concrete cubes will be cast by using this fiber reinforced concrete mixture to perform compressive strength and flexural strength test.

5.Latex modified and Fiber Reinforced Pervious Concrete-:

- In this research, Latex modified and Fiber Reinforced Pervious Concrete compositions containing mix proportion of SBR latex and steel fibers by weight of concrete will be prepared.
- Concrete cubes will be cast by using this Latex modified and Fiber Reinforced Pervious Concrete mixture to perform compressive strength and flexural strength test. Since the SBR latex used in this study contained 60% of water, the quantity of water required to be added in the concrete will be accordingly adjusted to mix design.

6. Sample Preparation:

- All concrete mixtures (Ordinary concrete, Latex modified concrete, Fiber reinforced concrete and Latex modified and Fiber Reinforced Pervious Concrete) will be prepared using a mechanical mixer.
- Specimen Cubes of size (150mm X 150 mm X 150 mm) will be cast for compressive strength test. The specimens will be cured in a curing room at 30ºC temperature and 90% relative humidity.
- Beam mould of size (15 x 15x 70 cm) will be cast for flexural strength test.

All concrete cubes made of (Ordinary concrete, Latex modified concrete, Fiber reinforced concrete and Latex modified and Fiber Reinforced Pervious Concrete) will be tested at 7, 14 and 28 days of age to get compressive strength and flexural strength value of mixtures.

7. Compressive strength:

- The compressive strength of all concrete cubes will be determined by following Compression strength testing procedure of Concrete.
- The compressive strength tests will be conducted on a Compression testing machine.
- For each concrete composition three specimen cubes will be tested.
- In the future report, average value of all the samples will be reported.

8. Flexural strength-:

- The flexural strength of all concrete cubes will be determined by following Flexural strength testing procedure of Concrete.
- The flexural strength tests will be conducted on a Flexural testing machine.
- For each concrete composition three specimen cubes will be tested.
- In the future report, average value of all the samples will be reported.

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