Investigation on The Structural Performance of Latex Modified Reinforced Concrete Beam

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Abstract- *This study investigates the structural performance of reinforced concrete beams that have been modified with latex. The latex modification is achieved by adding a specific amount of latex to the concrete mix. The aim of this research is to determine the effect of latex modification on the strength and durability of reinforced concrete beams. The research involved the fabrication of reinforced concrete beams with and without latex modification the beams are subjected to flexural loading to determine their load deflection response, ultimate load carrying capacity and deflection characteristics compared to the control beams. Additionally, the beams with latex modification showed enhanced durability in terms of resistance to cracking and water penetration. The improved performance of the latex modified beams is attributed to the improved bond between the concrete and the reinforcement, resulting in increased tensile strength and ductility. The findings of this study demonstrate the potential of latex modification as an effective method for enhancing the structural performance of reinforced concrete beams. Design of mix for twenty one different mixes had been used with three different latex percentages 5%, 10%, and 15% with the mineral admixtures, Fly ash, GGBS, and silica fume with cement replacement levels of 30%, 30% and 8% respectively with single and double combination of mineral admixtures.*

I. LATEX MODIFIED CONCRETE

Latex modified cement concrete (LMCC) is a type of polymer composite prepared by adding organic polymers to conventional concrete at the time of mixing. Generally, water based polymer dispersion (called latexes) are used for producing polymer modified concrete.

Acrylic latex or styrene butadiene latex (SBR), polyvinyl acetate, and ethylene vinyl acetate are some of the common latex used for making concrete. The polymer dosage is generally in the range of 10-20% by weight of the Portland cement binder. Amongst the various polymers styrene butadiene rubber (SBR) has been commonly used in the past and is classified under elastomeric polymer, having two monomers styrene and butadiene. Latex is the milk white fluid suspension in water of size 0.05 mm to 0.10mm diameter. Polymerization of Latex modifies the concrete through hydration and film formation. The LMC are extensively used for floor paving, water proofing, and overlays in bridge decks. Hence its suitability for repairing concrete structure has been widely used as a good repairing material (Kuhlmann A.K., 1990).

FLY ASH (FA)

Fly ash is the residue from thermal power station. It is finely divided fuel dust obtained from the combustion of pulverized coal in boilers. It is collected by means of electrical or mechanical precipitators. It mostly consists of spherical glassy compounds of complex composition. Earlier studies established that fly ash could be transformed from a waste product to a useful by-product for use in concrete as companion to Portland cement. Fly ash is used in concrete for reasons including cost, improvements and fall in temperature rise in fresh concrete, workability and strength of hardened concrete. Fly ash makes effective use of products of hydration, which occur in the pore structure of the cement paste and the heat produced by hydration of Portland cement, a vital factor in initiating the reaction

GROUND GRANULATED BLAST FURNACE SLAG (GGBS)

Slag is the product of the metallurgical industry which generates large amount of slag. The conventional steel manufacture technology leaves slag crystalline stone. Ground granulated blast furnace slag is a molten material which appears above pig iron at the bottom furnace. It is derived from the iron, combustion residue of coke, the lime stone and other materials that have been added. Its temperature is close to that of the iron which is between 1400 ◌̊C and 1600 ◌̊C. Ground granulated blast furnace slag consists of silicates, aluminates of calcium and other bases.

II. LITERATURE SURVEY

From the literature available the following points were observed:

Polymer modified concrete or mortar is an alternative to the advancement of long serving civil engineering material - mortar and concrete.

- The utilization of each type of polymer resulted in different characteristics of composite concrete or mortar. Such applications have contributed to the improvement in terms of workability and mechanical strength, especially at higher grade of composite strength of concrete material.
- Latex addition into fresh concrete causes the effect typical for admixture as super plasticizer.
- Latex solid/water ratio is a dominant factor affecting different properties of latex modified mortars and concrete.
- SBR latex improves the internal structure of the latex modified concrete resulting in considerable reduction in the water absorption.
- In the plain concrete a marked inter transition zone around the aggregate particles was observed, However, better results were observed in concretes with silica fume and latex SBR.
- Latex modified concrete showed improved flexural, split tensile strength, improved impact resistance and better performance in resisting chloride penetration.
- High tensile strength development is attributed to the improved bonds between cement hydrates and aggregates because of the incorporation of SBR latex.
- The overall performance of LMC under slow cycle fatigue loading improves with addition of latex up to 10% of only.
- Replacing Portland cement with 15% Metakaoline and an additional 5% polymer (by weight) pro-vide the optimum improvement for Portland cement concrete on both mechanical properties and durability.
- A quantitative comparison made on significant loading stages is summarized. It is found that LMRC beams depict superior properties over RC beams.

III. NEED FOR THE STUDY

The polymers in the latex form and mineral admixtures possess several advantages; therefore, our interest of research is to develop latex modified concrete with mineral admixture such as fly ash, ground granulated blast furnace slag and silica fume. A study on the above materials helps to improve the strength properties, durability properties and structural performance of latex modified concrete.

IV. METHODOLOGY

In this study concrete mix M30 was considered as control concrete (C).The mix design for the above grade of concrete was done based on IS: 10269:2009 for the workability range of 50-75mm. The control concrete mixture was comprised of Portland cement, water, coarse and fine aggregate.

Latex modified concrete compositions containing 5 %, 10 % and 15% SBR latex by mass of cement were prepared by modifying control concrete. Fly ash (FA) of 30%, GGBS of 30% and Silica fume (SF) of 8% by mass of cement was replaced and added with latex modified concrete to explore the possibility of strength reduction which may take place due to the latex addition. Concrete mixtures of total 21 numbers were designed with latex modification and single combination of mineral admixture and latex with double combination of mineral admixtures. The test specimens for compression 150 x 150 x 150mm cubes, flexural strength 100 x 100 x 500mm prisms, and modulus elasticity of the concrete 150mm dia x300mm height cylinders are used.

The compressive strength, flexural strength and modulus of elasticity of the latex modified concrete with and without mineral admixture are to be found from the experimental test results. Based on the test results of compressive strength and flexural strength, best suited mixes are to be identified for the study of elastic modulus, flexural behaviour of latex modified reinforced concrete beams and durability of latex modified concrete with and without mineral admixture. The beam specimen size of 125mm x 250mm x3200mm will be cast to study the flexural behaviour of latex modified reinforced concrete beams.

V. SCOPE

The present research focused to study the combined effect of latex and mineral admixture on the strength and durability property of the latex modified concrete and flexural, ductility and energy absorption characteristics of latex modified reinforced concrete beams. Mineral admixtures such as fly ash, ground granulated blast furnace slag, silica fume were added to explore the possibility of compensating the strength reduction which may take place due to latex addition.

- M30 grade of concrete to be considered for latex modified concretes.
- The percentages of latex addition to be considered are 5, 10 and 15 by weight of binder

- Fly ash, GGBS and silica fume are to be used as mineral admixture with a replacement level of 30%, 30%, and 8% respectively by weight of cement.
- Study of mechanical properties of latex modified concrete to identify the suitable percentage of latex.
- Flexure test on beams to be conducted with a four point bending using a load cell of 300kN capacity with a least count of 0.83kN and deflection to be measured using dial gauges with a least count of 0.01mm
- Study of flexural behaviour of latex modified concrete beams with mineral admixture designed as 125 x 250 x 3000mm under reinforced section with 2- Y12 Fe415 tension reinforcement at bottom, 2-Y8 at top as hanger bars and 6mm diameter stirrups at 150mm c/c.

OBJECTIVES

The main objective of this thesis is to study the flexural behaviour of latex modified concrete beam with mineral admixture when compared to conventional and latex modified concrete beam. The mechanical properties of latex modified concrete for the various percentage of Latex with constant percentage of fly ash, ground granulated blast furnace slag, and silica fume are studied. Based on the result, the percentage of latex for constant percentage of mineral admixture is selected for beam

- To design a mix for M30 grade of concrete using IS: 10262:2009 for the workability of 50-75 mm slump.
- To arrive the mix design for Latex Modified concrete with 5%, 10% and 15% percentage of latex with and without mineral admixtures such as Fly ash (30%), GGBS (30%) and Silica Fume (8%) for the workability of 50-75 mm slump.
- To study the mechanical properties of the Latex modified concrete with and without mineral admixtures (compressive strength, flexural strength and modulus of elasticity).
- To select the best selected mix ratio for latex modified concrete with and without mineral admixtures (Fly ash, GGBS, Silica Fume) based on mechanical properties.
- To study the flexural behaviour, ductility, energy absorption, crack width
- characteristics of latex modified reinforced concrete beams with and without mineral admixture.
- To study the durability property of the latex modified concrete for the value of latex with and without mineral admixtures.
- To develop regression analysis for mechanical property and load deflection of latex modified concrete with and without mineral admixture
- To develop the analytical model using the ANSYS software to compare the flexural behaviour of the LMC beams with and without mineral admixtures.
- To compare the predicted results with experimental values.
- To validate the present research with previous research using formulated regression equations.

VI. MIX PROPOTIONING

In this study concrete mix M30 was considered as control concrete. The mix design for the above grade of concrete as done based on IS: 10262 - 2009, for the workability range of 50-75mm. The control concrete mixture was comprised of Portland cement, water, coarse and fine aggregate. No admixture is designed for the control concrete mix. In this research latex modified concrete (LMC) composition containing 5% (CL5), 10% (CL10) and 15% (CL15) SBR latex by mass of cement were prepared by modifying the control concrete. Since the SBR latex used in this study contained 50% of water required to be added in the concrete was accordingly adjusted. Some additional percentage of water to mass of binder and also adjusted to maintain the slump between 50-75mm.The mixes of 30% Fly ash (FA), 30% ground granulated blast furnace slag (GGBS), and 8%and Silica fume (SF) by mass of cement as a replacement was added with latex modified concrete with single combination of mineral admixture and double combination of mineral admixture with latex modified concrete to explore the possibility of strength reduction which may take place due to the latex addition.

Concrete mixtures of total 21 numbers were designed with latex modification, single combination of mineral admixture and latex modification with double combination of mineral admixtures. The designation of concrete mix details are presented in the Table 4.9. Based on trial mixes for the workability of slump of 50-75 mm, the mixes were finalized. The details of water binder ratio (W/B), polymer binder ratio (P/B), slump values and the quantity of material designed for one cubic meter of concrete is presented.

The Material required for per cubic meter of concrete mix is showed in Table pinned below

PROPERTIES OF FRESH CONCRETE

The property of fresh concrete is workability is measured in terms of slump. The slump test was conducted as

per Indian standards IS: 7320-1974.The slump values measured for different mixes of latex modified concrete are shown in Fig

FIG: SLUMP CONE TEST

VII. CONCLUSION

Many researchers have worked on the behaviour of latex modified concrete and mortar in the past decades. Recent researches proved that latex modified concrete is a proven material for improved mechanical and durability properties. In this research a systematic study was carried out to enhance the strength and performance of latex modified concrete using SBR latex and mineral admixtures such as fly ash, GGBS and silica fume.

Literature reviews have been made to understand the mechanical properties of the latex modified concrete without mineral admixtures and with mineral admixtures. Design of mix for twenty one different mixes had been used with three different latex percentages 5%, 10%, and 15% with the mineral admixtures, Fly ash, GGBS, and silica fume with cement replacement levels of 30%, 30% and 8% respectively with single and double combination of mineral admixtures.

REFERENCES

[1] ACI Committee Report 544 (1988), *ACI 544.4R-88*, (1988) 563-580.
[2] Farnoud R M, Sasan P &Izni S I, *Adv Mater Res*, 214 (2011) 144-148.
[3] Giuseppe C & Maria L M, *EngStruct*, 30 (2008) 2970-2980.
[4] Byung H O, *J StructEng, ASCE*, 118 (1992) 2821-2836.
[5] Mukesh S, *Int J Earth SciEng*, 4 (2011) 843-846.
[6] Barrera G M, Santiago E V, Gencel O &HaggLobland H E,
[7] *J Mater Educ*, 33 (2011) 37-52.
[8] Radomir J F &Vlastimir S R, *ACI Mater J*, 95 (1998) 463-468.
[9] Bayan S N &Abdulkader I H, *J EngDev*, 13 (2009) 89-110.
[10] Fowler D W, *CemConcr Compos*, 21 (1999) 449-452.
[11] IS: 8112, *43 Grade Ordinary Portland cement – specifications*, Bureau