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PERFORMANCE EVALUATION AND STRENGTH AUGMENTATION OF CEMENT MORTAR EINFORCED WITH TREATED JUTE FIBRE: A REVIEW

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ABSTRACT

*The concept of using fibres as a reinforcement material is not new, and have been used as reinforcement since ancient times. Hist**o**rically, horsehair was used in mortar and straw in mud bricks. In the 1900s, asbestos fibres were used in concrete. In the 1950s, the concept of composite materials came into being and fibre-reinforced concrete was one of the topics of interest.*

Concrete mortar possesses very low tensile strength, limited ductility and little resistance to cracking. Addition of small closely spaced, uniformly distributed fibres act as crack arrester i.e. control cracking due to plastic shrinkage and to drying shrinkage, substantially increase static and dynamic properties .They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibres produce greater impact, shear, abrasion, and shatter resistance in concrete.

The amount of treated jute fibre is added to a concrete mix is expressed as a percentage of the total volume of the composite (concrete and fibres), termed "volume fraction" (V_f). V_f typically ranges from 0.2 to 1%. The two best aspect ratio (l/d) is selected based on previous work. Increasing the aspect ratio of the fibre usually segments the flexural strength and toughness of the matrix. Due to the scarcity of river sand, manufactured sand is going to be used in this work by replacing natural sand by manufactured sand in 20:80 till 0:100 proportions

Keywords: Aggregates, Aspect ratio, treated jute fibre, Manufactured sand, Volume fraction.

I. INTRODUCTION

Mortar is a workable paste used to bind building blocks such as stones, bricks, and concrete masonry units together during construction of masonry block. Also to fill and seal the irregular gaps between them, and sometimes add decorative colours or patterns in masonry walls. Mortar is a mixture of cement, fine aggregate (FA) and water; where cement acts as a binding material. The proportion of cement to sand varies from 1:2 to 1:6 depending upon place and purpose of application and strength desired.

Cement Mortar is a mixture of cement, sand and water; where cement acts as a binding material. The proportion of cement to sand varies from 1:2 to 1:6 depending upon strength desired for a particular work.

The principal purpose of mortar is to adhesively bind together the individual masonry units. It also provides protection against the penetration of air and water through the joints in a masonry assembly. Mortar also bonds the non-masonry elements of an assembly such as joint reinforcement and ties. It also compensates for minor

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dimensional variations in the masonry units, and provides coursing adjustment to meet required dimensions. Finally, mortar joints contribute to the architectural quality of the masonry assembly both through colour and shadow.

Mortar mixes include ingredients that give it strength (i.e. cement) and those that promote workability and good bond with the masonry units. Good workability and water retentivity are essential for maximum bond. A mortar that has a high cement content will be stronger, but may produce less bond. Conversely, a mortar with moderate cement content will not be as strong, but will have better bond strength. · Mortar bonds masonry units together. Good bond strength will significantly contribute to a masonry wall's integrity and weather resistance. ·

The compressive strength of mortar has only a small effect on the strength of the wall, but gives it durability. A good balance of strength and bond is required. This leads to both good seismic performance and weather resistance.

Fibre is a natural or synthetic substance that is long, thin and flexible, like a length of thread. Fibres produced by plants (vegetable, leaves and wood), animals and geological processes are known as natural fibres such as jute, coir, sisal, date, bamboo, palm, hemp etc. The fibres whose chemical composition, structure, and properties are significantly modified during the manufacturing process are known as Man-made Fibres or Chemical fibres such as Nylon, stainless steel, carbon, glass, asbestos, poly olefins, polypropylene, acrylic etc.

Fibres present the ability to act as a bridge between the grains of the cement mortar matrix. When the fibres are uniformly distributed into the mortar, plastic shrinkage may be minimized and micro cracks are prevented from developing into macro cracks. Therefore the consequent strength reduction, water intake increase and subsequent decay of the mortar by free zing–thawing cycles, and aesthetic involvements may be avoided.

Research work targets to get a mortar prepare with the treated jute fibre with the variations in volume of fibre, and geometry of fibre and thickness of mortar joints along with the mortar units.

Knowing the importance of mortar in any masonry work, present research work objective is to arrive at a mortar with optimal content of cement, fine aggregate (FA), manufactured sand (MS) and fibre.

Mortar units prepared with the best mortar mix obtained through the basic tests. The prepared mortar units will undergo the process of compression and bending tests and shear tests and the results will be evaluated.

II. REVIEW

2.1 Effect of Fibres in Cement Mortar

Metwally Abd Allah Abd el Aty working as faculty of engineering in structural engineering department, Tania University, Egypt in his paper "Influence of bending deflection rate on properties of fibrous mortar" inferred that the main objective is to see the durability and mechanical properties of date palm surface fibres in hot-dry climate. The study first entailed the evaluation of two different alkali pre-treatments at varying concentrations by subjecting treated and untreated bundled fibres to tensile testing. The unconfined compressive strengths, split tensile strengths as well as the flexural strengths of the cured mortar mixes at two different ages were undertaken to assess their mechanical properties. Results shows that the tensile strengths & stiffness. Properties of the fibres are generally better for those treated with Ca(OH)2 than those treated with NaOH. It can be inferred that higher inclusion of palm fibres within mortars offers better long term durability performance & advantage in resisting sulphate attack.

Vikrant S. Vairagade, Assistant Professor, Civil Engineering Dept., J L Chaturvedi College of Engineering, Nagpur, and Kavita S. Kene, Assistant Professor, Civil Engineering Dept., K D K College of Engineering, Nagpur, in their paper "Strength of Normal Concrete Using Metallic and Synthetic Fibres" deals with the study of effects of different

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type of steel fibres and fibrillated polypropylene fibres with low volume fraction on the compressive and tensile strength of plain concrete without any admixtures. They concluded that fibrillated polypropylene fibres have little effect on workability of concrete. It shows that max comp strength & max split tensile strength is obtained for 0.5% of steel fibres for M20 concrete, but for 0.4% of polypropylene fibres same max strength is obtained.

Xiangming Zhou , Seyed Hamidreza Ghaffar, Wei Dong, Olayinka Oladiran, Mizi Fan, School of Engineering and Design, Brunel University, Uxbridge, Middlesex UB8 3PH, United Kingdom in their paper "Fracture and impact properties of short discrete jute fibre-reinforced cementitious composites" inferred that the fracture and impact properties of short discrete jute fibre reinforced cementitious composites (JFRCC) with various matrix for developing low-cost natural fibre reinforced concretes and mortars for construction. JFRCC with GGBS/PC matrix achieved higher compressive strength, splitting tensile strength, and flexural strength than that with PFA/PC matrix. JFRCC mortar panels with PFA/ PC matrix possessed higher impact resistance than with GGBS/PC matrix.

R. Fujiyama, Department of Mechanical Engineering, Para Federal University, Belem PA 66075-110, Brazil, F. Darwish, Department of Civil Engineering, Fluminense Federal University, Niteroi RJ 24210-240, Brazil, M. V. Pereira, Department of Materials Engineering Catholic University of Rio de Janeiro, Rio de Janeiro RJ 22453-900, Brazil on their work "Mechanical characterization of sisal reinforced cement mortar" aims at evaluating the mechanical behaviour of sisal fibre reinforced cement mortar. Mechanical characterization of both the composite and the plain mortar was carried out using three point bend, compression, and impact tests. The use of sisal fibres decreases the mortar's compressive strength. The deleterious influence of sisal fibres on the compressive strength of reinforced mortar seems to be more significant for long fibres than for shorter ones. The presence of sisal fibres in cement mortar considerably improves fracture resistance. Results of impact tests indicate a pronounced improvement in the mortar's impact energy due to the presence of sisal fibres, particularly for the longer ones.

O. Fedaoui-Akmoussia, L. Molezb, S. Kacia, R. Jauberthieba Civil engineering Laboratory, Mouloud Mammeri University of Tizi-Ouzou, Algeria b GCGM Laboratory, INSA de Rennes, France, in their paper "Mechanical behavior and durability of fibre reinforced mortar in an aggressive environment" studied on the contribution of steel fibres and the substitution of cement by silica fume on the durability of the mortars in the various environments (wet, cyclic and sewers). The mortar with fibres (MNfm, MFsfm) showed slightly higher Strengths, when compared with the same mortars without fibres (MN, MFs), for all water cement ratios and environments. It is observed that the mortar with silica fume have slightly lower strength compared to mortar without silica fume. The flexural strength of the MNfm and MFsfm mortars was lower than the MN and MFs mortars. The ductility of the mortars with silica fume is better compared to the mortars without silica fume in the sewer environment.

2.2 EFFECT OF ASPECT RATIO OF FIBRES ON CEMENT MORTAR

Semsi Yazıcı, Gozde Inan, Volkan Tabak, Civil Engineering Department, Ege University, 35100 _ Izmir, Turkey in their paper "Effect of aspect ratio and volume fraction of steel fiber on the mechanical properties of SFRC, the effect of aspect ratio (l/d) and volume fraction (V_f) of steel fibers on the compressive, flexural and split tensile strength and ultrasonic pulse velocity of SFRC were assessed. For this purpose, hooked-end bundled steel fibers with three different l/d ratios of 45, 65, and 80 were used.

Three different fiber volumes were added to concrete mixes at 0.5%, 1.0%, and 1.5% by volume of concrete. Average compressive strength of concrete was selected as 40 MPa. After 28 days of standard curing, compressive,

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split and flexural strength as well as ultrasonic pulse velocity were determined. Fibers with selected l/d ratios and fiber volumes in this study decreased the workability of concrete mixtures. Especially, workability of reinforced concrete mixture is dramatically decreased for fibers with l/d ratio of 80 and V_f of 1.0% and 1.5%. Unit weight of concrete is increased with using fibers .This increase varies with the aspect ratio and volume of fibres. Usage of steel fiber in concrete increases the compressive strength of concrete by 4–19%.

Soon Poh Yap, Kuan Ren Khaw, U. Johnson Alengaram, Mohd Zamin Jumaat, Department of Civil Engineering, Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia, in their work "Effect of fibre aspect ratio on the torsional behaviour of steel fibre-reinforced normal weight concrete and lightweight concrete" presents the works on the comparison between the torsional behavior of OPSC and NWC, as well as the effect of hooked-end steel fibres of different aspect ratios in both types of concrete. Previous literature has shown that the addition of steel fibres enhanced the ultimate torsional strength and post-cracking torsional behaviour of concrete including called oil palm shell concrete (OPSC). The addition of 0.50% steel fibre resulted in a 40% and 70%reduction in the slumps in the NWFRC and OPSFRC mixes compared to the NWC and OPSC control mixes, respectively; however, all the mixes achieved satisfactory compaction and finishing. Both the control OPSC and NWC mixes showed comparable compressive strength, but the tensile strength and modulus of elasticity of OPSC was slightly lower than for NWC and OPSC and showed a higher brittleness ratio. However, the steel fibre reinforcement compensated for the weaker tensile strength of OPSC by producing competent splitting tensile strength, flexural strength and brittleness ratio relative to the NWFRC mixes.

2.3 EFFECT OF REPLACEMENT OF NATURAL SAND BY MANUFACTURED SAND CEMENT MORTAR

Priyanka A. Jadhav, Research Scholar, Civil Engineering Department, Indian Institute of Technology, Bombay, Maharashtra Dilip K. Kulkarni, Assistant Professor, Civil Engineering Department, Rajarambapu Institute of Technology, Rajaramnagar, Islampur, Maharashtra, in their paper "Effect of replacement of natural sand by manufactured sand on the properties of cement mortar find out the effect of replacement of natural sand by manufactured sand with 0%, 50% and 100% on hardened properties of cement mortar. The experimental work includes the casting, curing and testing of specimens. Material properties. Mortar mix is prepared with proportion of 1:2, 1:3 and 1:6 with water cement ratio of 0.5 and 0.55 respectively. Mortar mixes revealed an increase of compressive strength up to 14.53%, 46.95% and 60.62% for proportion of 1:2, 1:3 and 1:6 with water cement ration as 0.5 as result of replacement of manufactured sand up to 50% respectively.

Mr. Rushank Ravindra Patil and Mr. D. N Shinde, P.V.P.I.T Civil Engineering Department, Budhgaon, Sangli, in their work "Effect of Replacement of River Sand with Artificial Sand on Properties on Cement Mortar" . The use of Artificial sand at any level of replacement as a fine aggregate in concrete/mortar reduces the workability of concrete/mortar. It is due to the fact that as the finer material increases, more is the surface area and hence more water is required for wetting the surface. For the given fixed quantity of water as the finer material increases the workability decreases. As the percentage replacement of natural sand by Artificial sand increases the resulting compressive strength is also increases. For 20% of replacement the compressive strength is nearly the same but for beyond 40 % of replacement the compressive strength increases considerably. For the 100 % replacement natural

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sand by Artificial sand the increase in compressive strength is nearly 16.78% at 28 days. This increase in strength is mainly due to the good bond characteristics of Artificial sand.

2.4 EFFECT OF TREATED JUTE FIBRES ON CEMENT MORTAR

Sumit Chakraborty, Sarada Prasad Kundu, Aparna Roy, Basudam Adhikari, S.B. Majumder, Materials Science Centre, Indian Institute of Technology, Kharagpur, in their paper "Polymer modified jute fibre as reinforcing agent controlling the physical and mechanical characteristics of cement mortar investigated the effect of jute fibre as a reinforcing agent to cement mortar". For homogeneous distribution of jute fibre into the cement matrix we have modified both the chemical composition as well as surface properties of jute fibre. Addition of diluted SBR based latex in alkali modified jute-fibre reinforced mortar is found to systematically increase the flow-table value and density, while reducing the water absorption and apparent porosity of the mortar. Using optimal polymer content in emulsion (0.0513%) substantial improvement in Compressive strength and Modulus of rupture values has readily been achieved. The flexural toughness is also markedly increased when 0.0513% polymer modifier is used. Irrespective of the polymer contents the flexural modulus is decreased with the increase in the polymer content in emulsion (%). We have observed that the toughness index as well as the post cracking resistance energies is substantially improved in polymer modified jute reinforced mortars.Byung Wan Jo, Sumit Chakraborty and Heon Kim in their work "Efficacy of alkali-treated jute as fibre reinforcement in enhancing the mechanical properties of cement mortar" has performed the alkali treatment of the fibre surface, however, the effectiveness of alkali-treated fibres on the physical and mechanical behaviour of cement composites still has to be explored. In this context, the effectiveness of alkali-treated jute fibre as fibre reinforcement in cement composite was studied. Use of jute (untreated and treated) as fibre reinforcement enhances the overall properties of cement composites. The alkali treatment of jute fibres increases the tensile strength and elongation at fracture of fibres which in turn contributes an enhancement of the mechanical strength of cement composites. As increase of the effective surface area of fibres for bonding by alkali-treatment and fibre matrix compatibility mainly contribute to the enhancement of the mechanical properties of alkali treated jute fibre reinforced cement composites.

Bhanu K. Goriparthi, Mechanical Department, GITAM University, Visakhapatnam, K.N.S. Suman , Mechanical Department, Andhra University, Visakhapatnam, Nalluri Mohan Rao, Mechanical Department, JNT University, Kakinada, in their work Effect of fiber surface treatments on mechanical and abrasive wear performance of polylactide/jute composites inferred that their aim is to improve the adhesion of jute fiber with polylactide (PLA). For this purpose, surface of the jute fiber was modified by alkali, permanganate, peroxide and silane treatments. The surface modified fibers were characterized by FTIR spectroscopy. Unidirectional composites were prepared with treated jute fibers and PLA matrix by hot pressing of solvent impregnated prepregs. Surface treatments resulted in enhancement of tensile and flexural properties and reduction in Izod impact. It can be observed from the histograms that the fiber treatments had significantly influenced the tensile strength and moduli of the composites. This can be attributed to increase in interfacial adhesion as confirmed by morphological studies and by observation of the adhesion parameter curves. Alkali, permanganate and peroxide treated composites exhibited lower thermal stability, whereas silane 1 and silane 2 treated composites showed a higher thermal stability when compared to untreated composites. It is observed that fiber matrix adhesion affected the abrasive wear resistance of the jute fiber reinforced

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composites. Silane 2 treated jute fiber composite with better fiber matrix adhesion exhibited maximum abrasive wear resistance.

III. SUMMARY

The above stated work have used alternative materials such as fibres in the cement mortar , replacement of natural sand by manufactured sand , the effect of aspect ratio of fibres in cement mortar, and also the effect of treated jute fibres in the cement mortar. Tests are carried out to calculate compressive strength, flexural strength, tensile strength, modulus of rupture and durability. Thus it is very essential to incorporate all the factors using jute fibre.

IV. PROPOSED RESEARCH WORK

For the selected mortar mix 1:4 cement content is kept constant. Fine aggregate (FA) will be replaced by manufactured sand (MS) in the increment of 20% till 0: 100 proportions. For each of the above combinations, treated jute fibres are added with two different aspect ratios based on previous expert's work and incorporated from 0.2% to 1% in the increment of 0.2%. .

Mortar cubes are prepared for each combination of FA and MS ratio and aspect ratio. Each of such mortar cubes would be subjected to water absorption test, compressive strength test, flexural strength test, standard fire tests by following standard time temperature curve and chemical attack tests to understand the behaviour of the optimal mortar mix to severe exposure conditions.

Mortar units are built into panels and shear test is being carried out.

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