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"A REVIEW PAPER ON PROPERTIES OF CONCRETE WITH JUTE FIBRE REINFORCED CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT WITH METAKAOLIN"

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ABSTRACT: Construction activity has risen steadily in recent years. The advancement of concrete technology has impacted the environment to a larger extent. Concrete is one such fundamental component that has always been improved throughout time by adding several admixtures to improve the strength properties. Fibers eliminate the unexpected failure that is common in plain concrete beams. Stiffness, torsional strength, ductility, rotational capacity, and the quantity of cracks with smaller crack width are all improved. The following are some of the benefits of fiber-reinforced concrete: When compared to non-reinforced concrete, fiber-reinforced concrete has a higher tensile strength. It improves the concrete's long-term resilience. It slows the spread of cracks and improves impacts resistance. By replacing Metakaolin for cement and adding jute fibers to the mix, the strength of concrete can be increased. Jute fibers are used in concrete to increase strength while having no negative impact on the environment.

Keywords: Metakaolin, Jute Fiber, Cement, Concrete, Aggregate etc.

1. INTRODUCTION

Concrete is the greatest commonly utilized man-made element in the world because it is reasonably priced, reliable, and easily moldable into complex shapes. It also has good compressive strength and stiffness. It has low ductility, energy absorption, and tensile strength, however. Due to its shortage of tensile strength, it is reinforced with reinforcing bars or mesh (rebar's) in constructions. Concrete is among the most widespread utilized and adaptable building materials on the planet. Cement manufacturing has enhanced dramatically as the world's population and construction needs have grown. Cement production includes the emission of large amounts of dangerous CO2 gases as well as the creation of other waste materials. Innovative concepts in cement or concrete manufacturing will outcome in a lowering of hazardous environmental effects. Concrete is made from cement, which is utilized in massive amounts, but only a small amount of concrete is recycled globally. The global economies continued growth drives up demand for construction substances such as cement and sand [2].

However, this type of reinforcing is inefficient at controlling fractures. In addition, in harsh environments, this reinforcement corrodes and decays. Fiber-reinforcement is not utilized for structural strengthening; rather, it minimizes the quantity of rebar or mesh required and contributes to the improved performance of durability by holding back crack propagation. Some many cementitious materials are often used in concrete as partial and complete replacements for cement. These substances were chosen in order to enhance sustainable growth while also lowering production costs. The corrosion effect of these materials, on the other hand, has been overlooked. The experimental study looked at the effects of jute and metakaolin on concrete samples [1].

Multiple studies are being conducted on industrial by-products and other agricultural refuse substances such as wood ash (WA) or rice husk ash (RHA), jute, metakaoline, coconut shell, as well as other agriculture sector waste substances that can be utilized as cement substitutes in concrete [3].

Metakaolin is an extremely effective cementitious pozzolanic element that can quickly interact with too much calcium hydroxide produced by pozzolanic hydration of OPC to produce calcium silicate hydrate and calcium alumino silicate hydrates. The use of short discrete fibres in concrete has gained popularity in recent years due to its numerous benefits over plain concrete. Jute is a low-cost natural fiber with a large supply. As a result, combining jute fiber and concrete could be one of the most major initiatives to concrete technological development [2].

The enhanced utilization of a wide range of inclusions in concrete admixtures has highlighted require for the approaches are based on the substance's preferred durability effectiveness, particularly in harsh, aggressive environments. Because the conventional prescriptive approach to durability design is confined to stipulating variables like least cement content, minimal level compressive strength, and maximum w/b ratio, performance-based reaches are preferable. Although these limits have an effect on durability-related characteristics, they do not create well-defined circumstances for concrete to be durable. Critical characteristics associated to concrete durability, known as durability indicators, such as permeability and diffusivity, are analyzed in a performance-based methodology. This study introduces an experimental analysis of concrete mixtures made with jute and metakaolin in position of Portland cement [4].

2. LITERATURE REVIEW

Ayobamin A. Busari & Williams K. Kupolati (2020) Concrete is among the most commonly used building materials. One of the newest developments in concrete technology is the use of sustainability cementitious materials. Numerous cementitious compounds have been utilized in concrete as partial and complete replacements for cement. These materials were chosen in order to promote efficiency while also lowering manufacturing costs. The corrosive impact of these materials, on the other hand, has been overlooked. The corrosion impact of metakaolin on concrete specimens was investigated in an experimental investigation. The concrete pore solution was evaluated to achieve this. Metakaolin was employed as a partial replacement for cement at 0%, 10%, 20%, and 30%, providing the best mechanical strength.

R. Rajkumar, N. Umamaheswari (2020) The current study goes on to describe an investigation that was carried out to explore the flexural behavior of Reinforced Concrete beams using metakaolin as a substitute for cement and marble powder as a partial substitute for river sand in the concrete preparation method. In this research, the percentage replacement of cement by metakaolin was 0, 2, 4, 6, and 8% by weight of cement, while the percentage replacement of natural sand by marble powder was 20, 15, 10, 5, and 0%. At the ages of 7, 14, and 28, the mechanical characteristics of standard and customized concretes, such as compressive and split tensile strength, are investigated. The first fracture load, ultimate failure load, and beam deflection were all measured. This demonstrates that metakaolin and marble powder may be used in place of metakaolin.

V. Kannan, P. Raja Priya (2021) the fineness of metakaolin is greater than that of wood ash, implying more reactivity. In the same way, the physical characteristics of fine and coarse aggregates are investigated. Also tested is compressive strength, water absorbing, and fast chloride uptake. According to the test report, the maximum compressive strength accomplished in 10 percent WA + 20 percent MK blended concrete is 83 N/mm2. In a 10 percent WA + 20 percent MK mixed concrete, the lowest water absorption and chloride permeability was 2.5 percent and 348 C, respectively. All of the collected data were compared at the conclusion of the experiments. Water absorption has a strong relationship with compressive strength (R2 = 84.9%) and charge passed (R2 = 91.5%). The cost analysis was completed in the end.

Gustavo Bosel Wally (2021) the effect of silica fume and metakaolin on parameters of the durability and serviceability of concretes subjected to chloride penetration is investigated in this research. A performance-based method is employed in the examination of the durability capability of the generated concrete by evaluating durability indications. A probabilistic evaluation is done using Monte Carlo Simulation with Importance Sample selection to cover the variation that may be expected by the model parameters associated with the process of chloride penetrating into concrete. When concretes that follow the same prescriptive specifications are assessed for durability, the findings show that they might have diverse behaviors.

Roja A. Nambiar, M.K. Haridharan (2020) by partly substituting silica fume (10%) and fly ash (20%) with concrete, the researchers hope to uncover the properties of High Performance Concrete (HPC). The compressive strength of concrete values for various trial blend ratios was determined in this study. The ratios of the component are determined based on the compressive strength of the trial mixes. This result is used to cast specimens with a constant water-to-cement ration (w / c = 0.28), which are then kept for curing. The basic purpose of the research is to determine the best super plasticizer dose, replace cement with natural fiber (jute), and then investigate durability features such as sorptivity, acid attack, and so on. The following findings confirm that jute improves the mechanical and durability properties of concrete.

M Kalaivani, G Shyamala, S. Ramesh and I Rajasri Redd (2020) the impact of employing plastic waste as a fine aggregate substitute is investigated in this study. The PET plastic bottle is harmful to the environmental and people's health, thus using it in concrete will help to safeguard the environment and human health. The crucial elements in the concrete are the partial replacement of fine aggregate and coarse aggregate. In India, tonnes of plastic garbage are created each year; therefore recycling it in concrete can help reduce waste. Jute fiber is a natural fiber that is used in plastics concrete waste to boost the concrete's split tensile strength and flexural strength. Fresh and cured concrete qualities were tested and analyzed.

Nazrin Fathima Fazil M, Chithra C J (2021) this report provides an overview of the publications that have been published to investigate the effects of metakaolin in SCC. Metakaolin is derived from natural Kaolin clay and is used as a cement substitute. Metakaolin aids in the improvement of compressive strength, spline tensile strength, flexural strength, and fresh characteristics. Pump ability and slump values are considerably improved when super plasticizer is used. GLENIUM B233 is a modified polycarboxylic ether-based super plasticizer of a new generation. The freshness features of super plasticizer in SCC with metakaolin, such as pump capacity and workability, as well as the durability features, are examined. Metakaolin, GLENIUM B233, Super plasticizer, Polycarboxylic Ether, Self-Compacting Concrete

Naraindas Bheel (2021) the current research investigates the engineering features of cement concrete reinforced with nylon and jute fibres in combination. In the concrete mix, different percentages and lengths of nylon and jute fibres were used. As a result, the combined impacts of nylon and jute fibres on concrete workability, density, water absorption, compressive, tensile, and flexural strength, as well as drying shrinkage, were studied. When comparing the compressive strength, split tensile strength, and flexural strength of concrete with 1% nylon and jute fibres by volume fraction to the regulate mix at 90 days, the compressive strength, split tensile strength, and flexural strength increased by 11.71 percent, 14.10 percent, and 11.04 percent, respectively. The water absorption of concrete, on the other hand, rose as the quantity of nylon and jute fibres improved.

S.D. Gupta[1]*, T. Islam (2021) this work explores the possibility of using Rice Husk as a partial replacement for cement and non-metallic natural fibres (Jute fiber) in concrete to build an FRC material, with the goal of improving 28-day strength and reducing plastic shrinkage cracks. In this investigation, different amounts of 13mm jute fiber (0.1 percent, 0.2 percent, and 0.3 percent) and Rice Husk were mixed into concrete with a water-cement ratio of 0.38. It shows that adding both jute fibres and rice husk enhances compressive strength by up to 2.03 percent when compared to ordinary concrete. As the amount of fiber and rice husk added increases, the compressive strength of the concrete decreases, resulting in poor workability.

Aamir Mahmood (2021) the effect of fiber reinforcement on the characteristics of geopolymer concrete composites made of fly ash, ground granulated blast furnace slag, and metakaolin is discussed in this research. Due of their low tensile strength, traditional concrete composites are fragile. The addition of fibrous material to concrete changes its brittle behavior and improves its mechanical qualities, such as toughness, strain, and flexural strength. Ordinary Portland cement (OPC) is primarily utilized in concrete composites as a binding agent. However, modern environmental consciousness encourages the use of other binders, such as geopolymers, to replace OPC since the manufacture of OPC emits a substantial amount of CO2, which pollutes the environment. [10]

3. COMPRESSIVE STRENGTH

- With the replacement of cement with a mere 10% to 30% of the metakaolin, there was an increment in the compressive strength for about 5% [1].
- Partial replacement of cement with marble powder led to a reduction in compressive strength, but replacement of fine aggregates with marble dust caused an increment in the compressive strength [2].
- Amongst all the trail mixes, the maximum compressive strength was attained with 10% wood ash and 20% metakaolin intermingled in concrete [3].
- With all the trail mixes, the compressive strength saw a change of merely 1 Mpa, so clearly it was not considered as a major point of difference [4].
- With 1% addition of fiber, the compressive strength showed a positive increase, but with 2% addition of fiber, the value got decreased [5].
- The concrete with the replacement of sand by 10% plastic waste aggregates gave maximum compressive strength, but for optimum results, 0.25% of jute fibers were added [6].
- Although, the compressive strength increases in the initial phase, with 24% of metakaolin in place of cement, has optimum results [7].
- The compressive strength rose to 8% with 0.3% of 25mm fiber introduction [8].
- With only 10% of rice husk and 0.2% of 13mm jute fibers, the results showed maximum compressive strength [9].

4. WORKABILITY

- Metakaolin reduced the workability of the concrete [2].
- Due to the fineness of the metakaolin blended concrete, the workability got reduced [3].
- To increase the workability, the poly functional additive should have been used [4].
- The increment of jute fibers in the concrete led to a decrement in the workability of the concrete [6].
- From the slump test, it was concluded that the addition of jute and nylon fibers reduced the workability of the concrete [8].
- The addition of rice husk and jute fibers decreased the compressive strength led to reduced workability of the concrete [9].

5. TENSILE STRENGTH

- When 15% of metakaolin was placed instead of cement, it led to an increment in the tensile strength of the concrete [1].
- When 2 and 4% metakaolin was added with 20% and 10% marble powder as a partial replacement of cement and fine aggregate respectively, the split tensile strength came out to be maximum [2].
- The introduction of natural fiber like jute into the plastic waste incorporated concrete led to an increment in the tensile strength of the concrete [6].
- The maximum tensile strength results were obtained with 15% replacement of cement with metakaolin [7].
- With only 1% of nylon and jute fibers, maximum enhancement of tensile strength was observed [8].

6. SETTING TIME OF CEMENT

- The addition of metakaolin paced the setting time of concrete [2].
- Metakaolin consists of a high percentage of alumina and silica, which helped in the acceleration of the setting time of concrete [3].

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