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Experimental Investigation of Fly Ash Brick Using Polypropylene Fiber

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***Abstract*—This experimental investigation focuses on enhancing the performance of fly ash bricks by incorporating polypropylene (PP) fibers. Fly ash, an industrial by-product of coal combustion, is utilized to produce eco-friendly bricks with improved mechanical and thermal properties. The study examines the effect of PP fibers on compressive strength, water absorption. Experimental results reveal that the addition of PP fibers significantly enhances the compressive strength and durability of the brick while reducing water absorption. However, improper distribution or agglomeration of fibers can negatively affect brick strength. The investigation also evaluates the influence of fiber parameters, such as length and thickness, along with the curing method on the overall performance.**

I. INTRODUCTION

Fly ash bricks are a sustainable construction material made primarily from fly ash a by-product of coal combustion, mixed with other components like lime, cement and sand. These bricks are valued for their eco-friendliness, durability and cost – effectiveness. Incorporating polypropylene (pp) fiber into fly ash bricks enhances their performances by improving their strength, durability and resistance to cracking. Polypropylene is a synthetic polymer known for its high tensile strength, flexibility and chemical resistance. When added to fly ash bricks, it acts as a micro- reinforcement material, addressing issues like shrinkage and cracking that often arise during the drying and curing processes. The addition of polypropylene fiber not only increases the structural integrity of the bricks but also improves their resistance to environmental stresses such as water absorption and freeze thaw cycle. This modification makes fly ash bricks more suitable for diverse applications in construction, particularly in areas requiring lightweight and resilient buildings materials. Furthermore, the use of polypropylene fiber aligns with sustainable construction practices as it utilizes industrial waste (fly ash) and enhances the longevity of the final product. In recent years the incorporation of fibers into construction materials has garnered significant attention for improving mechanical properties. This Study investigates the potential of adding polypropylene fibers to fly ash bricks to improve their mechanical properties including compressive strength, tensile strength and impact resistance. The primary objective is to evaluate whether the synergistic use of fly ash and polypropylene fibers can lead to the development of a sustainable, durable and high-performance brick. This research also aims to provide insights into the optimal fiber content and its influence on the microstructure and behavior of fly ash bricks, paving the way for advanced material innovation in sustainable construction.

Fly Ash

Fly ash, a by-product of coal combustion in thermal power plants, is widely used as a partial substitute for cement in the construction industry. When added to cement production, it improves workability, reduces water requirements and increases durability of concrete. This helps the concrete to strengthen and work longer. By incorporating fly ash into cement, manufacturers not only reduce production costs but also reduce environmental impact by using clinker, a major component of cement a it emits a lot of carbon dioxide during manufacturing reduction because of its pozzolanic nature, which means it reacts with calcium Fly ash is widely used in the construction industry, especially in the manufacture of cement and concrete.

Polypropylene Fiber

Polypropylene fibers are increasingly used in brick manufacturing to enhance the strength and durability of the bricks. These synthetic fibers, made from thermoplastic polymer, are added to the brick mix in small quantities to improve its mechanical properties. Polypropylene fibers help reduce cracking caused by shrinkage during the drying and curing process by increasing the tensile strength and flexibility of the material. Additionally, they enhance the brick's resistance to impact, abrasion, and water penetration, making the bricks more durable and long-lasting. In construction industry, polypropylene fibers are widely used as a reinforcement. Material in concrete to improve its mechanical properties and durability.

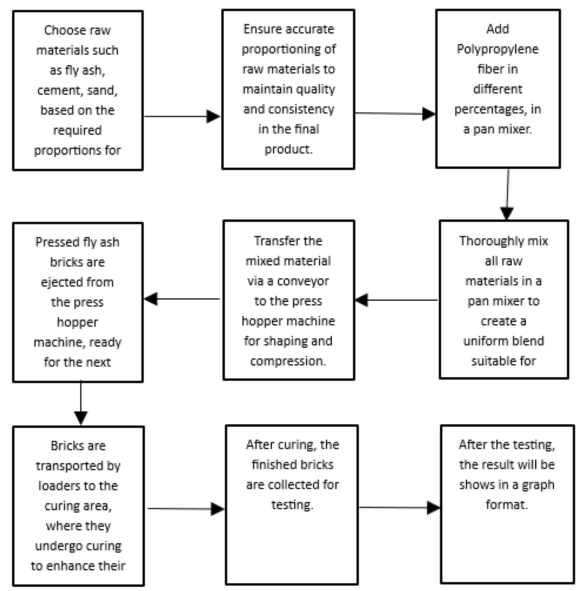
Sand

The type of sand used in fly ash brick production is typically clean and fine- grained, free from impurities such as clay, silt, or organic matter, as these can weaken the bricks. The proportion of sand in the mixture usually depends on the specific strength and application requirements of the bricks but generally ranges between 20% to 40% of the total mix. Properly graded sand not only ensures a smoother surface finish for the bricks but also contributes to the overall structural integrity, making fly ash bricks a reliable and eco-friendly alternative to traditional clay bricks. Crushed sand is made by mechanically crushing stones like granite, basalt, or quartzite to a size suitable for use in concrete, plaster, and other construction activities.

Cement

Cement is an important ingredient in brick production, specifically in fly ash, concrete, and cement bricks. It acts as a binding material, holding the other components like sand, fly ash, aggregates, and water together to shape a solid, durable brick. OPC 53 grade of cement that's frequently used as a binding material to enhance energy. The traditional percentage of cement in bricks varies relying on the kind and power necessities, frequently ranging among 8% to twelve% in fly ash bricks and better in concrete bricks. Cement's hydration system, which occurs when mixed with water, creates a sturdy matrix that enhances the brick's compressive electricity, durability, and resistance to weathering. Bricks made with cement are regarded for his or her consistent shape, clean end, and potential to face up to heavy masses, making them ideal for a number of creation initiatives. Additionally, using cement in bricks reduces the dependency on conventional clay and contributes to extra sustainable production practices. It is favored in locations where there's want of rapid construction. This cement is to be had inside the market in three grades specifically OPC 33, OPC43 and OPC 53. The cement used was sparkling i.e. Used inside three months of manufacture. It needs to satisfy requirement of IS12262.

II. METHODOLOGY



The process of manufacturing fly ash bricks begins with the selection of raw materials like fly ash, cement, and sand. These materials are carefully chosen and measured in the right proportions to ensure the quality of the final product. Once measured, the materials are thoroughly mixed in a pan to create a uniform blend. This mixture is then transferred to a brick using a conveyor, where it is compressed and shaped into bricks.

After shaping, the freshly formed bricks are ejected from the press and moved to the curing area. Curing is an essential step, as it helps the bricks gain strength and durability. This process is carried out with the help of loaders that transport the bricks to the curing site. Once the curing is complete, the bricks are collected, inspected, and prepared for testing.

III. RESULT

Sample fly ash brick was tested against water absorption and compression in a compression testing machine and got the result.
Following graph shows the test result obtained.

Compressive strength of brick with fiber result (Average of 3 specimen)

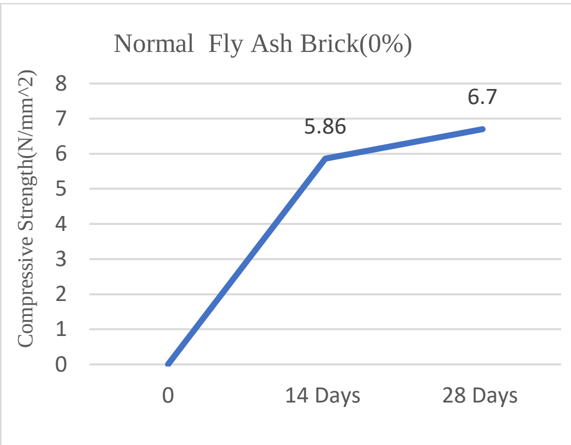


Fig No. 1

From above figure the compressive strength of fly ash brick for 14 days is 5.86 N/mm^2 and 6.7 N/mm^2 for 28 days is found out.

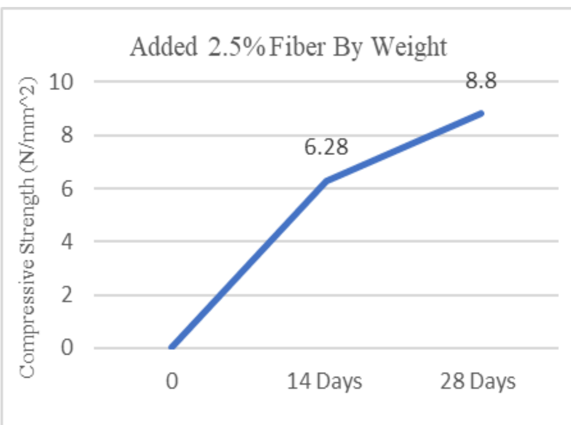


Fig. No.2

From above figure the addition of polypropylene fiber of 2.5% of the weight has increase the compressive strength of fly ash brick when compare to normal fly ash brick.

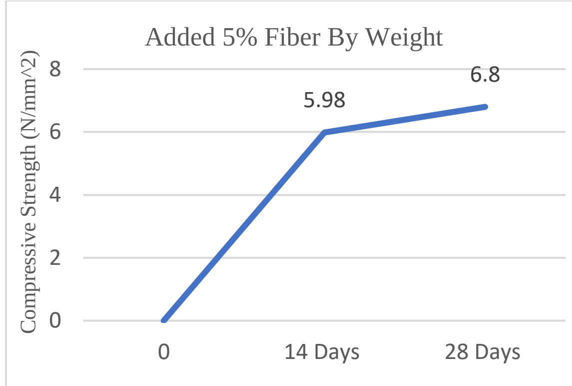
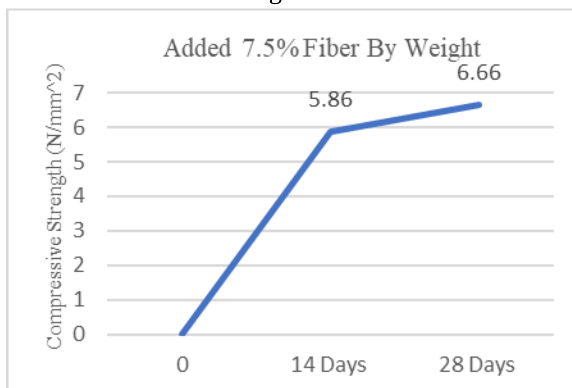


Fig No. 3

From above figure the addition of polypropylene fiber of 5% of the weight has increase the compressive strength of fly ash brick when compare to normal fly ash brick.

Fig No.4



From above figure the addition of polypropylene fiber of 7.5% of the weight has slightly decrease the compressive strength of fly ash brick when compare to normal fly ash brick.

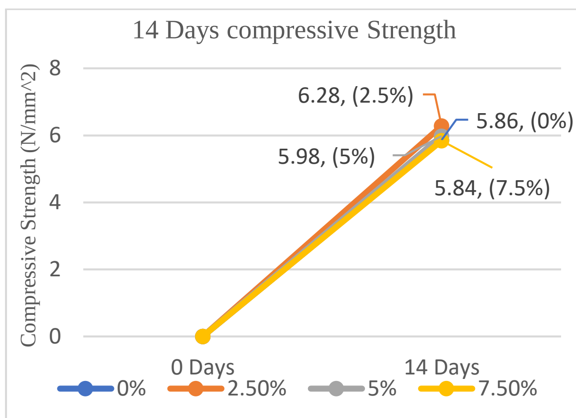


Fig No.5

From above figure the maximum compressive strength increases as 6.28 N/mm^2 for 2.5% polypropylene fiber fly ash bricks when compared to the other bricks when measured after 14 days.

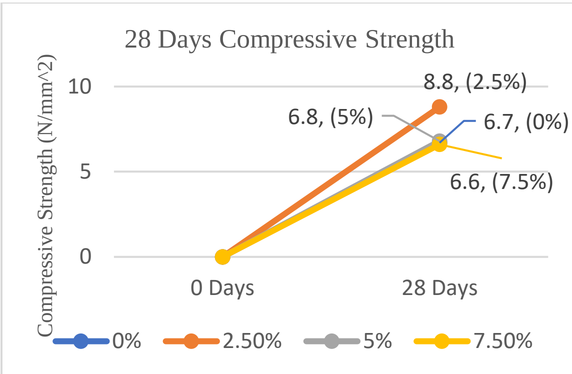
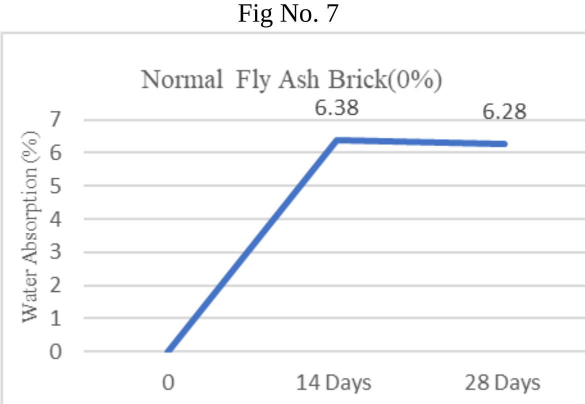


Fig No.6

From above figure the maximum compressive strength increases as 8.8 N/mm^2 for 2.5 % polypropylene fiber fly ash bricks when compared to the other bricks when measured after 28 days.

Fig No. 7



From above figure the water absorption of normal fly ash brick for 14 days is 6.38% and 6.28% for 28 days is found out.

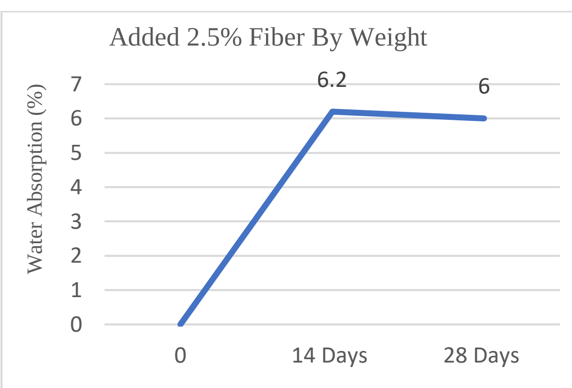


Fig No.8

From above figure the water absorption of 2.5% polypropylene fiber fly ash brick for 14 days is 6.2% and 6% for 28 days is found out.

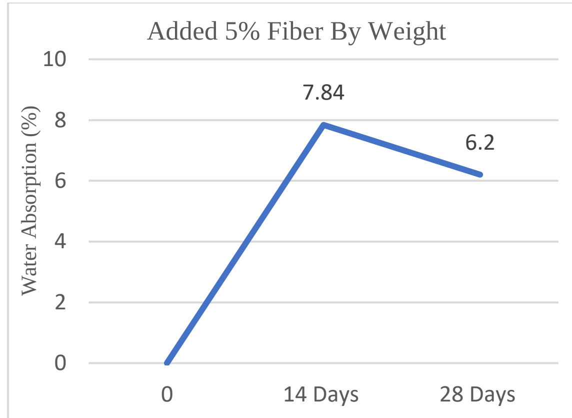


Fig No.9

From above figure the water absorption of 5% polypropylene fiber fly ash brick for 14 days is 7.84% and 6.2% for 28 days is found out.

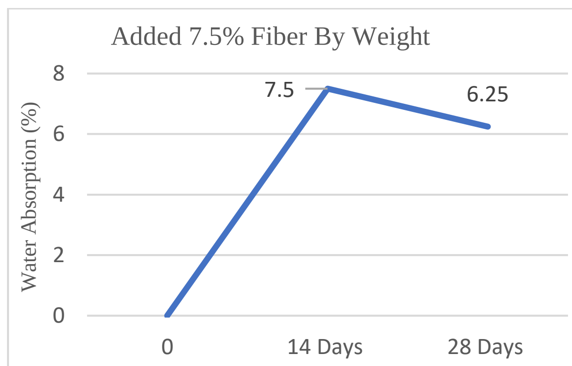


Fig No.10

From above figure the water absorption of polypropylene fiber fly ash brick for 14 days is 7.5% and 6.25% for 28 days is found out.

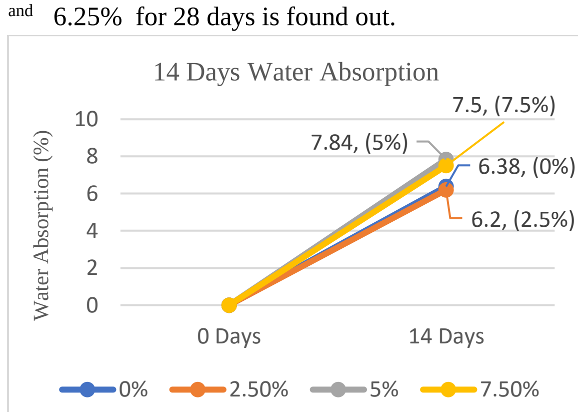


Fig No.11

From above figure the water absorption was reduces to 6.2% for 2.5% polypropylene fiber fly ash brick when compare to other bricks after 24 hours of 14 days curing.

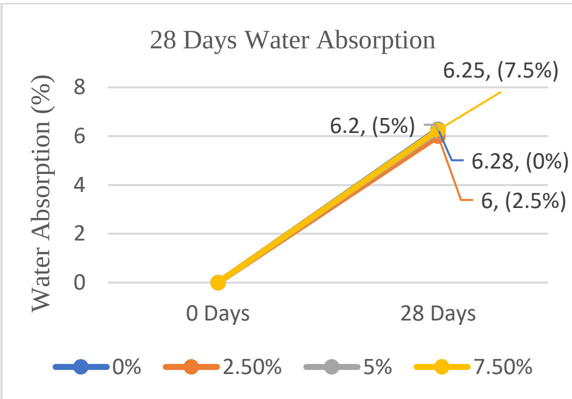


Fig No.12

From above figure the water absorption was reduces to 6% for 2.5% polypropylene fiber fly ash brick when compare to other bricks after 24 hours of 14 days curing.

IV. CONCLUSION

From the investigation on the effect of polypropylene fiber on fly ash brick the following conclusion were drawn.

- 2.5% of polypropylene fiber is superior to all other mixes.
- The maximum compressive strength increases as 6.28 N/mm^2 for 2.5% polypropylene fiber fly ash bricks when compared to the other bricks when measured after 14 days.
- The maximum compressive strength increases as 8.8 N/mm^2 for 2.5% polypropylene fiber fly ash bricks when compared to the other bricks when measured after 28 days.
- Water absorption was reduced to 6.2% for 2.5% polypropylene fiber fly ash brick when compare to normal bricks after 24 hours of 14 days.
- Water absorption was reduced to 6.2% for 2.5% polypropylene fiber fly ash brick when compare to normal bricks after 24 hours of 14 days.

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