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A Review on Experimental Study on Effect of Glass Fiber on Replacement of Cement By Fly Ash

Mr. Suraj Sandeep Kharade [1] Prof. P. K. Bhandari [2]

Student M.E, Dept. of Civil Engineering, Dr. Vitthalrao Vikhe Patil College of Engineering, Ahmednagar. [1]
Assistant Professor, Dept. of Civil Engineering, Dr. Vitthalrao Vikhe Patil College of Engineering, Ahmednagar. [2]

Abstract—

Concrete is a composite material that consists of cement and fine and coarse particles that solidify over time. One of the most used building materials is concrete. The proportion of cement to water has a significant impact on a number of characteristics, including workability, strength, and durability. Cement is the primary component of concrete. Instead of using cement, use fly ash as a partial addition. The main advantage is the decrease in chemical and water permeability. By reducing the size of the pores, fly ash treatment gives concrete a denser end product. This lowers permeability and boosts strength. An investigation on the compressive strength, splitting tensile strength, and bending strength of M20 class glass fibre concrete (GFRC) using a 1:1.5:3 mixture and a 0.50 water-cement ratio to evaluate its performance.

Keyword: FRC, GFRC , Concrete , UTM , Fly Ash.

1. INTRODUCTION

In 1849, Joseph Monier, a French gardener, made the initial invention of reinforced concrete. The majority of today's structures would not be standing without this reinforced concrete. It is possible to create beams, columns, foundations, frames, and other structures out of reinforced concrete. High tensile strength, good thermal compatibility, and excellent bonding qualities are required in the reinforcing material. Smooth load transmission from the concrete to the interface with the reinforcing material and back to the reinforcing material is necessary for reinforcement. As a result, the stress in the reinforced material and the concrete must be equal.

Utilising waste products from industry and agriculture is necessary for the sustainable growth and manufacturing of greener concrete materials in the building sector. For a variety of reasons, concrete building is not viable today. Above all, it needs a significant number of original resources, which other generations would also need. Second, the primary ingredient in concrete is portland cement, whose manufacture generates enormous amounts of carbon dioxide emissions that are the primary source of the greenhouse effect, contributing to both global warming and climate change. The fact that many concrete constructions have durability issues that might squander natural resources is another crucial consideration. Consequently, it would seem that using waste materials from industry and agriculture to partially replace port earth cement is a viable strategy for both current and long-term sustainable development. Utilising waste materials for recycling and repurposing helps reduce energy consumption in the cement industry, preserve natural resources, and shield the environment from greenhouse gas emissions by reducing carbon dioxide emissions. Additional justifications include the fact that the right use of additional substances, some of which may be pozzolanic reactivities, can greatly enhance specific concrete qualities. Given its abundance and relatively high silica content, fly ash is one of the most significant and appropriate industrial waste sources for mineral additions.

Joseph Monier, a French farmer, invented concrete blocks for the first time in 1849. Construction projects can make use of reinforced concrete beams, columns, foundations, frames, etc. High tensile strength, strong bonding qualities, and good thermal compatibility are requirements for the supporting material. The reinforcement needs to distribute the weight from the concrete into the extra material and then up to the contact between the two. Steel and concrete materials must thus have the same stress. Concrete structures are no longer viable for a variety of reasons. Above all, it ought to have the same old items that will be required by future generations. 2. Silicate cement serves as concrete's primary binder. The primary contributor to greenhouse gas emissions that cause global warming and climate change is the silicate cement industry, which generates a lot of carbon dioxide. The fact that many stone buildings squander natural resources and have ongoing operating issues is another crucial preventative measure. Thus, it is imperative for present and future expansion to employ a method that substitutes commercial and agricultural waste for a portion of the port soil cement. In addition to conserving natural resources and lowering carbon dioxide emissions, recycling and reusing waste materials saves energy in the manufacture of cement. The right use of certain reactive pozzolanic components can enhance certain concrete qualities, which is another explanation. Fly ash, with its huge size and high silica concentration, is one of the most significant and essential sources of extra minerals in tailings. Components including external walls, sanitary pipes, non-recyclable ornamental pieces, and more components. Glass fibre concrete (GFC) is mostly composed of small glass fibres scattered throughout a matrix of cement, sand, water, and other aggregates. This composite's tensile and impact strengths rise as a result of the fibres breaking down. That being said, Russell Games Slayer of Owens Corning created glass wool, often known as "glass laminate," in 1938 as a means of insulation. The fibreglass brand, which was used for marketing, eventually became a trademark. It's an extremely high-quality fibreglass substance. Pressing is a simple method of production, even if its volume and strength are similar to those of steel. The most well-known and ancient fibre is glass. The most common substance in the planet is stone. It is well and frequently utilised in the building business because it is shapedable. Stone took the place of the previous building material since it was more resilient. Because stone's strength and durability may be improved by altering key components of its makeup and adding specific additives, it is appropriate for a wide range of applications.

2. STATE OF DEVELOPMENT

The newest information from books, magazine debates, national and international media, book reviews, magazine reviews, and online research from well-known books were all used in the proper literary research.

Srinivasa R, et al. (2010) The experimental investigation involved the addition of glass fibre to concrete at a volumetric rate of 0.03%. A comparison research was carried out to show how effective it is to use fibreglass and not use it. Compressive strength has increased by 20–25% as compared to the 28-day strength. In comparison to 28-day strength, splitting tensile strength varies between 15% and 20%.

Shamsuddin H, et al. (2012) The experimental investigation involved the addition of glass fibre to concrete at a volumetric rate of 0.03%. To demonstrate the impacts of utilising and not using fibreglass, a comparison research was carried out. All composite types showed a 20% to 25% improvement in compressive strength when compared to the strength after 28 days. In comparison to 28-day strength, all composite types' flexural and splitting tensile strengths range from 15% to 20%.

Kartikey T, et al. (2013) Glass fibre was added to the concrete in this experimental investigation at a rate of 0.03%. To demonstrate the impacts of utilising and not using fibreglass, a comparison research was carried out. There is evidence that adding glass fibre to concrete reduces its performance. The bending and tensile strengths of M-20, M-30, and M-40 quality concrete were determined to be 20% to 30%, 25% to 30%, and 25% to 30%, respectively, after 3, 7, and 28 days. ., 28 Tianhou's strength and that of the white stone are comparable.

Okan Karahan, Cengiz Duran Atis [1] (2010) According to some reports, using fly ash in place of half of the cement might improve the performance of the concrete. The various classes of concrete—M15, M20, and M25—all consist of fly ash with varying percentages of cement (20%, 40%, and 60%)—were investigated in this study for their respective qualities and attributes. The workability of concrete increases as fly ash content rises when fly ash partially replaces cement. For every type of concrete, three cubes underwent compressive strength testing. The greatest strength with a 20% change in M15 quality is 14.48 N/mm2, the greatest strength at a 20% change in M20 quality is 14 N/mm2, and the greatest strength at a 20% change in M25 quality is 14.05 N/mm2. mm2. This study unequivocally demonstrates that the strength of all three levels is higher with 20% fly ash replacement after 28 days of treatment than at 40% and 60%.

Milind. Mohod, (2012) By altering the proportion of fibres in the concrete, this study examined the impact of fibres on the strength of M 30 concrete. Between 0.25%, 0.50%, 0.75%, 1%, 1.5%, and 2% of the cement volume is the range for fibre content. 500 mm rows and 150 mm x 150 mm x 150 mm cubes were cast for compressive strength testing. Prior to crushing, each sample underwent treatment for 3, 7, and 28 days. The strength of steel fibres significantly increased after 3, 7, and 28 days of testing reinforced concrete fibres with varying fibre diameters. In the pressure cube research, the fine fibre content is 1%, whereas in the beam bending strength investigation, it is 0.75%. Additionally, it has been shown that when the fibre content reaches its ideal amount, concrete gets stronger. One method for evaluating the workability of concrete is the sliding cone test. The findings of the slump cone test indicate that performance declines as fibre content increases.

Maslehuddin et. al. ,(1989) studied the weight-based replacement of fly ash for sand in storage, using sand substitution percentages of 0%, 20%, and 30% and water-to-cement ratios of 0.35, 0.40, 0.45, and 0.50. What quantity of cement? Replacing sand with a fly ash mixture increases corrosion resistance and compressive strength more. In addition, the 30% replacement level is where steel bar corrosion in concrete is lowest.

Khadake S.N.Konapure C.G. (2014) discovered a 10–20% improvement in compressive strength when comparing the compressive strength of glass fibre blends made of various materials to the results obtained after 28 days. Lower bleeding can strengthen the stone's structure, smoothing it out and lowering the chance of fracture. According to their research, adding 0.5%, 1%, 2%, and 3% glass fibre to cement decreased the likelihood of cracking under various load scenarios. Research has shown that adding glass fibre to concrete improves its performance by 1%. The M-20 class concrete's splitting tensile strength, bending strength, and compressive strength all showed increases of more than 1% after seven and twenty-eight days. Glass garbage is another resource we may utilise to make fibre.

Dr. N. Ganesan, Dr. P.V.Indira, Mr. P.T. Santhosh Kumar (2006) attempted to investigate the characteristics and strength of glass fibres treated using polymers. This task involved the casting of twenty beams. There are two fiberless PMFRC beams among them. The aspect ratios (0, 15, 25, and 35) and fibre percentages (0, 0.25, 0.5, and 0.75) varied in this study. It was discovered that adding fibre enhanced fracture initiation and post-crack behaviour. The ultimate strength showed a small improvement. Fibres considerably boost ductility when added. It was determined that a 0.5% fibre volume percentage was ideal for both ductility and strength. Glass fibre strengthens concrete's tensile and breaking strengths. The material becomes more brittle as a result of this addition. Additives enhance ductility, or pseudo-ductility, and increase deformability. Bending strength rises as a result, and fracture toughness and performance rise as well. The contact between PMFRC and glass fibre is greater than that of ordinary concrete as a result of the increased PMFRC mud content.

Sivakumar. A, (2007) investigated the effects of 0.5% volume fraction composite fibers—a metal and non-metal combination—reinforcing high-strength concrete. The mechanical characteristics of concrete, including its compressive strength, tensile strength, flexural strength, and flexural toughness, were evaluated using several hybrid fibre combinations, including steel-polyester, steel-steel, and steel-glass. The sample's flexural strength was assessed using the four-point bending test in accordance with the Japan Concrete Institute's (JCI) guidelines. According to research, adding fibre increases the region before and after the load-deflection curve's peak, increasing the material's toughness and bending strength. Non-metals slow down the creation of microcracks, although the presence of steel fibres generally contributes to the energy absorption mechanism (strengthening effect). The flexural strength of steel-polypropylene hybrid fibre concrete is similar to steel fibre concrete when compared to other hybrid fibre concretes. Due to the decreased non-ferrous metal composition, hybrid fibre systems have more fibre, and it is thought that this is because non-ferrous metals can seal tiny microcracks, which improves the result.

Varma A.U and Kumar A.D (2013) According to a study, there was a % improvement in compressive strength among various groups of glass fibre composites when compared to compressive strength after 28 days. between 10% and 20%. Cutting down on bleeding improves the stone's surface homogeneity, integrity, and resilience against fractures.

Ravi kumar C. Selin, and Thandava moorthy T. S. (2013) In general, the compressive strength of concrete is strong, whereas its tensile strength is poor. Because it is fragile, concrete will shatter under increased force. The addition of fibres to the concrete helps regulate the development and spread of microcracks as the tensile stress increases. Fibre usage in concrete keeps rising as a result of the building sector's explosive growth. Because of its large surface area to weight ratio, fibreglass is helpful.

Tarun R Naik.,(1989). Researchers looked at the possibility of employing bottom ash as a pozzolanic material. The findings demonstrated that, depending on the quality of the ash, cement sludges with 10–30% virgin ash or ground ash had a longer start-up time than cement sludges. In comparison to cement mortar, fly ash mortar uses more water, but it also requires less water overall. One can utilise bottom ash as a pozzolanic material if it is powdered and less than 5% of it remains after passing through a 325 micron screen.

Gornale Avinash and Quadri S. Mehmood (2012) Griffiths studied glass fibre reinforced polyester polymer concrete's mechanical characteristics. The modulus of rupture of polymer concrete with 20% polyester resin and around 79% fine silica aggregate, according to the author, is roughly 20 MPa. The addition of around 1.5% chopped glass fibres to the material will result in a 20% improvement in fracture toughness and a 55% increase in fracture modulus.

Kothapalli Sindhu Rani1 , N.D Anusha Griffiths studied the characteristics of glass fibre reinforced polyester polymer concrete. The authors discovered that polymer concrete with 20% polyester resin and around 79% silica fine aggregate had a compressive strength of about 20 MPa. Chopped fibreglass up to 1.5% in the mixture will raise the blast's structure to 20% and the bone's hardness to 55%. It was determined what the characteristics of glass fibre reinforced geopolymer concrete with fly ash, alkaline liquid, fine and coarse particles, and glass fibre were. The study examined the impact of glass fibre on the hardened area of geopolymer concrete composite (GPCC) in terms of density, compressive strength, and flexural strength. Set at a ratio of 0.35 between alkaline liquid and fly ash, fly ash completely replaces regular silicate cement. Adding 1.00 glass fibres (0.01%, 0.02%, and 0.03% concrete volume) to the mixture while using alkaline liquids combined yields the sodium hydroxide solution to sodium silicate solution ratio.

Dr. Mrs. S. A. Bhalchandra , Mrs. A. Y. Bhosle examined how the inclusion of glass fibre affected the hardened geopolymer concrete composites' (GPCC) density, compressive, and flexural characteristics. Set at a ratio of 0.35 between alkaline liquid and fly ash, fly ash completely replaces regular silicate cement. Using alkaline solutions together adjusts the sodium hydroxide to sodium silicate ratio to 1.00. At different rates of 0.01%, 0.02%, 0.03%, and 0.04% concrete by volume, glass fibre was added to the mixture. The test findings showed that glass fibre reinforced geopolymer concrete outperformed geopolymer concrete and regular silicate cement concrete in terms of durability in a short amount of time (three days).

Avinash Gonale, et al conducted research on the strength of glass fibre reinforced concrete. According to studies, the M20, M30, and M40 quality concrete's compressive, bending, and tensile strengths improved from 20% to 30%, 25% to 30%, and 25% to 30% in 3, 7, and 28 days, respectively. indicated a rise. Compared to regular concrete with the addition of glass fibre

Avinash gomale, S lbrahim Quadri, et. al. (2012) Griffiths looked at the characteristics of glass fibre reinforced polyester polymer concrete in his research. The authors discovered that polymer concrete with 20% polyester resin and around 79% silica fine aggregate had a compressive strength of about 20 MPa. Chopped fibreglass up to 1.5% can boost the product's bone strength by around 55% and its fracture toughness by about 20%. Glass fibres increase the energy required to fracture and increase the strength of the material by increasing the energy necessary to deform, according to a research conducted by Sorousshian on the relative efficacy of various types of steel fibres in concrete. The inclusion of fibre, according to the authors, decreased the performance of freshly mixed concrete; greater aspect ratio fibres showed this impact. It seems that the fibre has no effect on the new composite's performance in terms of transition and decay time as well as academics.

Badrinarayan Ratha et. al. (2021) In terms of coal output, Chhattisgarh is the third-most productive state in India. The central state of Chhattisgarh mines a significant quantity of coal every day. Consequently, the area saw the construction of several steel and power facilities. Large landfills are the final destination for the massive volumes of fly ash and ash produced daily by these power stations. This generator releases carbon dioxide into the surrounding air, which contaminates it and causes carbonation issues in nearby structures. RCC constructions corrode more quickly in this heavily industrialised area because of increased CO2 emissions. Thus, to determine how durable concrete is, it is necessary to replace cement and sand with garbage from the area in order to partially test the material's strength and endurance. Using 20% lake ash by volume and 40% fly ash by weight in place of cement and sand, respectively, and adding them to the constant, this study aims to thoroughly examine the properties, strength, and longevity of concrete. dosage of glass fibre. The novel fly ash fibre concrete underwent a number of tests at varying speeds, including rheology, shrinkage, resistivity, thermal conductivity, leakage testing, compressive strength, and flexural strength. These findings lead to the proposal of a composite design technique that uses locally obtainable commercial items to prepare durable concrete.

P. Mahakavi et. al. (2021) Examining the improved performance and mechanical characteristics of glass fibre reinforced concrete (GR) with fly ash and recycled materials is the primary goal of this project. In varying proportions, such as 5%, 10%, 15%, 20%, and 25%, it substitutes regular silicate cement ingredients. There were two concentrations of glass fibres (6 mm in length): 0.5% and 1%. According to experimental findings, fly ash decreases early compressive strength values when added to the concrete mixture; yet, as time goes on, the strength of combined information improves. In comparison to the control mixture, the modified fly ash also shown decreased adsorption, higher acid resistance, and water absorption values. Glass fibres increased the GR combination's strength assessment; nevertheless, fibre additions lessened the new characteristics of the GR mixture. Scanning electron microscopy analysis of GR and fly ash containing fibres also revealed that fly ash, recycled, and cement combined to form C-S-H gel and cement compounds. In addition to its financial advantages, experimental results demonstrate that concrete created using fly ash and recycled materials is appropriate for the building of environmentally friendly and sustainable concrete block work.

G Ramya et. al. (2023) One of the most often utilised materials in the world today is stone. One essential ingredient in concrete is cement. Concrete's limited strength, low tensile strength, and poor resistance to cracking are its key drawbacks. Fly ash production has expanded along with the generation of electrical energy, and improper fly ash disposal might have a negative impact on the environment. Concrete may have its tensile strength, impact resistance, bending strength, and ductility increased by adding glass fibre. This study used glass fibre containing 0%, 0.5%, 1%, and 2% glass fibre and F class fly ash in place of cement in concrete, adding 20% fly ash in the process. This study's primary goal is to determine why the M30 ratio is 1:1.75:2.03. The pozzolanic effect of the glass fibre and fly ash resulted in improvements to the compressive strength, splitting tensile strength, and flexural strength. The addition of glass fibre at 2% and fly ash at 20% yields the strongest results.

3. CONCLUSION & FURTHER STUDY

- The development of concrete strength, such as work, compressive strength, tensile strength, and flexural strength, is further investigated by adding some fibres to beacons or ordinary concrete to create the strength of concrete, which is fibre reinforced concrete (FRC).
- This is based on an analysis of numerous scientific data points that indicate natural stone is the most commonly used stone in the construction industry and worldwide.
- Concrete's limited strength, low tensile strength, and poor resistance to cracking are its principal drawbacks.
- As electrical energy production has expanded, fly ash output has also increased. Improper handling of fly ash disposal might have a negative impact on the environment.
- Concrete may have its tensile strength, impact resistance, bending strength, and ductility increased by adding glass fibre. Reduce bleeding to strengthen the concrete's surface integrity, promote homogeneity, and lower the likelihood that it will fracture. Studies have shown that adding fibreglass to cement can lessen the likelihood that certain products would crack.

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