

Experimental investigation on concrete by using lithium carbonate, carbon fiber and polypropylene fiber

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering in
Civil Engineering
By

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INSTITUTE OF SCIENCE AND TECHNOLOGY (DEEMED TO BE UNIVERSITY)

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DEPARTMENT OF CIVIL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **ANANTHA NITEESH (Reg. No. 39200704)**, **MULLU JAYA PRAKASH (Reg. No. 3900024)**, who carried out the project entitled “**Experimental investigation on concrete by using lithium carbonate, carbon fiber and polypropylene fiber**” under our supervision from September 2022 to April 2023.

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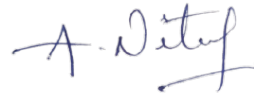
DECLARATION

We **ANANTHA NITEESH** (Reg. No. 39200704), **MULLU JAYA PRAKASH** (Reg. No. 3900024), Hereby declare that the Project Report entitled “**Experimental investigation on concrete by using lithium carbonate, carbon fiber and polypropylene fiber**” done under the guidance of Dr. **R. PADMA PRIYA, M.E., Ph.D.**, is submitted in fulfillment of the requirements for the award of Bachelor of Engineering degree in Civil Engineering.

DATE : 13.04.2023

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1.



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SIGNATURE OF THE CANDIDATE

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ABSTRACT

This Abstract is to find the experimental studies that conducted to assess mechanical characteristics of the concrete mix in which lithium carbonate, carbon fiber and polypropylene fiber is added in various volume proportions in few of the different mixtures. Tests are tested to know Performance of new concrete. Breaking Tensile strength, or tensile strength of splitting bending strength, and the modulus of elasticity is found at end of the process. The test findings show that the addition significantly improves the strength qualities of plain concrete. of carbon fibers and polypropylene fibers. as additives and lithium carbonate shows that it will decreases the setting time of concrete, and can be efficiently utilized in structural concrete.

Unless the fibre extent fraction is so high that the amount of void material content becomes excessively high, the effect of carbon fibre and polypropylene fibre addition at concrete dwellings will increase with fibre quantity fraction. Furthermore, the flexibility of the combination reduces as the fibre content material increases. Furthermore, the value will rise as the fibre content increases. As a result, a low fibre fraction is preferred as an alternative. The optimal concentration is 0.2 vol.% lithium carbonate. Fibre content as little as 0.25 vol.% works for carbon fibres, and 0.5 vol.% is efficient for polypropylene fibre, while fibre contents above 1 vol.% are not uncommon.

In the work of experimental part, High Strength concrete (HSC) was prepared using intensive mixer. Carbon Fiber in volume fraction of 0.2 vol.% in every mix 0.25%, 0.50%, and 0.75 volume fractions of polypropylene fibre, % & 0.1% and lithium carbonate in volume fraction of 0.1%, 0.2%, 0.3% & 0.4. Results of compressive and bending test proved an increase of strength value in the case of second mix of 0.2%LC, 0.2%CF & 0.5%PPF. The principal parameters considered in the study were the volume fractions of fibre and properties of the concrete.

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CHAPTER-1

INTRODUCTION

1.1. GENERAL

Due of its accessibility, affordability, long-lastingness, and capacity to withstand harsh weather conditions, cement is one of the earliest and most used building materials in the world. Concrete is an extremely brittle material with a high breaking vigour but little tensile force. In order for concrete to handle tensile pressures, it must be reinforced. Steel is frequently used to produce such reinforcement.

However, concrete was a composite material composed of cement, water, various types of coarse and fine aggregates, and a binding agent. Despite the fact that cement is only one component of concrete, many people still think of it as concrete. The use of concrete structures around the world is subject to a wide range of situations, and they are familiar with environmental factors like erosion, climate change, and pollution.

reinforced fibre concrete is an advance product of a concrete made from addition of chopped fibers with water, cement, fine & coarse aggregate. Various types Various fibres, including steel fibre, glass fibre, natural fibre, and synthetic fibre, are used to enhance the physical qualities of concrete. Early in the 20th century, studies on fibre reinforced concrete (FRC) 1970s and most of the research has used steel fibers

In 1972, All of al started the research on Carbon fibres on continous high-modulus polyacrylonitrile (PAN) fibres in cement-based matrices: A valuable improvement in the physical properties was observed. Due to the higher cost, this type of carbon fiber could not prevail. Resin based CF was introduced in Japan, in the early 1980s it was an low-cost CF modules built of coal, petroleum pitch, and significant other improvements were also seen in the physical houses of cement based materials

With the increase of fiber quantity fraction as low as 0.2% it was noticed that

physical properties like breaking strength and bending strength increase significantly. Concrete mixed with carbon fiber has a very low crack rate so it is operative in suppressing plastic shrinkage cracks. Carbon fiber concrete composite exhibits acceptable bending properties. This matrix outperforms glass steel polypropylene fibers against the property of finishing coat, thermal resistance, and chemical durability in environments of severe exposure.

The study demonstrates that the usage of lithium carbonate in the concrete as additive is used as the accelerator material that will set the cement quickly so the lithium carbonate (LC) is used in the 0.1%, 0.2%, 0.3% & 0.4% is used as the volume of the total materials.

Concrete = Aggregates + Cement + Water + Admixture (not-compulsory)

1.2. LITHIUM CARBONATE

The lithium carbonate is a chemical that is inorganic with a chemical composition of Li_2CO_3 that is the salt of lithium of carbonate. This white salts are commonly used in metal oxide processing. The carbonate of lithium is employed as a catalyst for quick setting cement and high alumina cement-based mortars. The most typical uses include self-leveling floor screeds, tile adhesives, shotcrete, and water proofing slurry. In other cases, lithium hydroxide and sulphate are also used.

Lithium carbonate can be utilised as an additive to increase the durability of concrete and resistance to damage from environmental factors. When added to concrete, lithium carbonate combines with the ions of calcium in cement in order to create a bone and teeth-lithium silicate hydrate gel, which fills within the pores and fissures of concrete and makes it more resistant to the Waters, chemical compounds, and cycles of freeze-thaw are all involved.

Lithium carbonate may also help to limit the quantity of ions of chloride that permeate the building material, which can cause reinforcing steel corrosion and structural damage. This is especially significant in locations with considerable salt being exposed, such as the coast or areas with salts for deicing roads.

Overall, the use of lithium carbonate in building material can help to improve the performance and longevity of concrete structures, making them more resistant to environmental factors and reducing the need for costly repairs or replacements over time. The chemistries also offer distinctive qualities and physical characteristics, which makes it perfect for usage in a variety of industrial applications, including air filtration, space suits, submarines, and lithium greases system

1.2.1. Uses of lithium carbonate

Lithium carbonate It may be used as a concrete additive to increase its durability and performance. Some of the uses of lithium carbonate in concrete are:

- **Concrete curing:** Lithium carbonate can be used as an accelerator in the concrete curing process. It helps to speed up the cement's hydration rate, which results in faster strength gain and improved durability of the concrete.
- **Cracking prevention:** Lithium carbonate can assist in lowering the formation of cracks in concrete. It reacts a bones and teeth-lithium silicate hydrate gel with the cement, which fills within the pores and fissures of concrete, making it more resistant to the Waters, substances, and cycles of freeze-thaw are all involved.
- **Chloride ion reduction:** Lithium carbonate can help to limit chloride ion penetration in concrete, that can cause reinforcing steel corrosion and structural damage. This is particularly important in areas with high levels of salt exposure, such as coastal regions or areas with de-icing salts on roads.
- **Alkali-silica reaction prevention:** Lithium carbonate can help to prevent the ASR in concrete is an alkali-silica reaction. ASR happens as a result of the cement's alkalis reacting with of the concrete. Lithium carbonate can reduce the expansion

caused by ASR by stabilizing the reactive silica in the aggregate.

- **Concrete densification:** Lithium carbonate can help to densify The cement, making it more durable to wear and tear. It reacts with the cement to form a Gel containing calcium -lithium silicate fills in the pores in the concrete and makes it more durable and long-lasting.

1.2.2. Manufacturing process of lithium carbonate

The lithium carbonate production method involves several steps, including:

- **Mining and extraction:** The first step in the process is to extract lithium-containing minerals from the earth, such as spodumene or brine. These minerals are typically found in areas with high concentrations of lithium, such as salt flats or mineral-rich rock formations.
- **Concentration and purification:** Once the minerals have been extracted, they are typically crushed and treated with chemicals to concentrate the lithium. The concentrated lithium solution is then purified through a series of chemical reactions, including precipitation and filtration.
- **Conversion to lithium hydroxide:** The purified lithium solution is then converted to lithium hydroxide through a process known as electrolysis. In this process, an electric current is passed through the solution, causing lithium ions to migrate to one electrode and hydroxide ions to migrate to the other electrode. The lithium and hydroxide ions then react to form lithium hydroxide.
- **Conversion to lithium carbonate:** The lithium hydroxide is then converted to lithium carbonate through a process known as carbonation. In this process, the lithium hydroxide is reacted with carbon dioxide to form lithium carbonate and water.
- **Purification and drying:** The lithium carbonate is then purified through a series of filtration and washing steps to remove impurities. The purified lithium carbonate is then dried and packaged for shipment.

The manufacturing process of lithium carbonate varies based on the origin of the lithium and the specific requirements of the end product. However, these basic steps are typically involved in the production of lithium carbonate.

1.3. CARBON FIBER

Carbon fibre, additionally referred to Graphite fibre, often known as carbon fibre, is an amazingly-lightweight polymer that is several times stronger and two times as stiff as steel.. Despite being more resilient and Unlike metal, carbon fibre is thinner, making it an ideal material. for many elements. These are just a few of the benefits that engineers and designers favour when it comes to manufacturing using carbon fibre.

Carbon fibre is composed of tiny, durable carbon crystalline strands that are used to strengthen things. Carbon fibre is finer than human hair & can achieve thread-like twist strength. They can be knitted together to form cloth, or carbon fibre can be moulded and coated with epoxy to achieve the desired permanent shape.

Carbon fibre can also be employed in concrete buildings as a reinforcing material. In this application, carbon fibers are typically mixed into the concrete mixture or laid out as a grid or sheet and then covered with a layer of concrete. The resulting composite material has improved strength, stiffness, and durability compared to traditional concrete.

One carbon fiber's positive attributes as a reinforcement material in concrete is its high tensile strengthConcrete has a high breaking strength but a low tension strength., which means that it is prone to cracking under tension. By adding carbon fiber to the concrete, the resulting composite material is better able to resist cracking and withstand bending and bending loads.Carbon fiber-reinforced concrete can be used for many different purposes, including constructing facades, bridges, tunnels, and other infrastructure projectsIt is also useful for repairing and strengthening existing concrete buildings. that have deteriorated due to corrosion or other factors.

Significant properties of Carbon fiber:

- Heavy stiffness
- More tensile strength
- Less weight to strength ratio
- More chemical resistance
- Extreme heat resistance
- Less thermal growing

Due to the above property Leading industries like automobiles, aerospace, military, and environment all use carbon fibre extensively. The manufacture of carbon fibreThe manufacture of carbon fibre

1.3.1 The carbon fiber manufacturing process

Carbon fibre is manufactured. A chemical & mechanical method is used to produce long strands of fibre. To prevent fibre burning, it is pulled and then warmed to an extremely heat while allowing it to come into touch with oxygen. Carbonization occurs, as atoms inside the fibres vigorously vibrate, releasing the majority of quasi-carbon atoms. As a result, the fibre is composed of Long, intertwined threads of atoms of carbon with a few non-carbon atoms.

This is a typical carbon-production sequence fibres from polyacrylonable, which includes spinning, stabilising, carbonising, surface treatment, and sizing.

1.3.1. Uses of carbon fiber

It uses carbon fibre in production of many different shapes and composites, including

- Carbon fibre is pliable.
- Carbon fibre has a density of roughly 1600kg/m³ and is chemically stable.
- It has good electrical conductivity;
- It is fire resistant; and
- Carbon fibre has a high thermal conductivity, with a value of 24.

- It has a lower thermal expansion value, making it appropriate for use in situations where small movements are critical.
- Steel has a stiffness value of 26830 N/m, while carbon fibre has a value that is twice as stiff.
- Carbon fibre has an exceptionally excellent strength-to-weight ratio..
- Having a high tensile strength, carbon fibre with a rough value of 290 kgf/cm².

These are just a few examples of the many uses of carbon fiber. Its high strength, low weight, and durability make it an attractive material for a wide range of applications.

1.4. POLYPROPYLENE FIBER

Polypropylene, also known as PP, is a thermoplastic with a linear structure based on C_nH_{2n} monomers. PP is created by reacting gaseous propylene with a catalyst such as titanium chloride. PP is also a byproduct of all refining procedures..

The majority of polypropylenes in use were extremely crystalline and mathematically regular (i.e. isotactic), whereas polystyrene, PVC, polyamide, and other polymers are not. amorphous thermoplastics whose radicals are placed randomly (ie. atactic).

PP has a greater melting point and bending strength than polyethylene and a level link low density polyethylene and crystallinity, or LDPE, and high density polyethylene (HDPE). Giulio Natta created the initial polypropylene resin in Spain, and commercial manufacturing of it began in 1957.

A synthesised linear polymer fibre produced by the synthesis of propylene is called polypropylene fibre (PPF). Its main qualities are its light pounds, tremendous strength, longevity, and resistance to corrosion. PPF is popular employed in leading industries such as chemical, energy, textile, and construction..

1.4.1. Polypropylene fiber manufacturing process

PP Conventional melt spinning can be used to turn chips into fibres or filaments, but the working conditions must be changed depending on the ultimate output. Additionally crucial technologies for producing nonwoven fibres are spun bonded and melt blown. For instance, the creation of staple fibre is depicted in the following image..

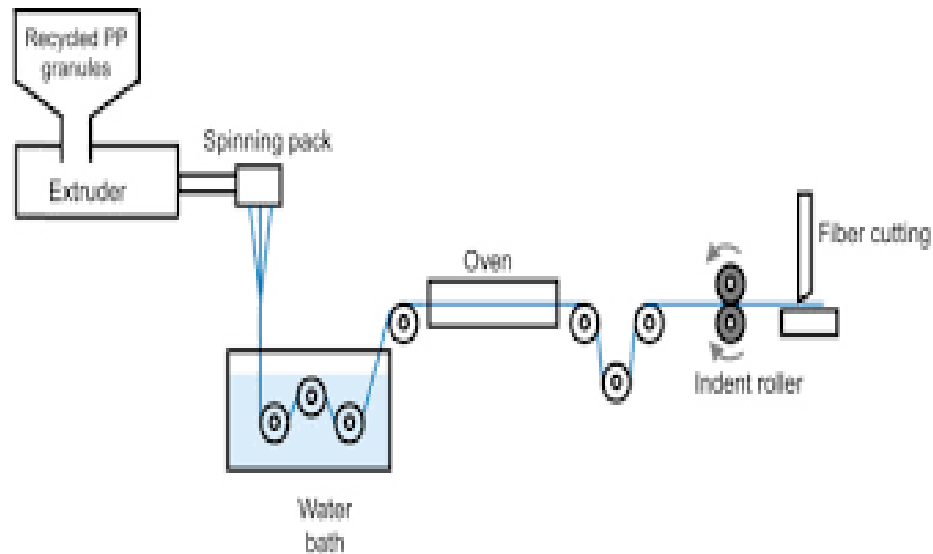


Fig 1.1: Manufacturing process of Lithium carbonate

1.4.2. Uses of polypropylene fiber

Polypropylene fibre is a type of fibre. of artificial fibre created from the polymer polypropylene. It has many properties that make it a versatile material for a variety of applications. Here are some common uses of polypropylene fiber:

- **Textiles:** Polypropylene Fibre is utilised in a multitude of applications. of textiles, involving clothing, carpeting, and upholstery. It is often blended with other fibers to improve durability and stain resistance.
- **Packaging:** Polypropylene fiber is utilized to make a range of packaging components, involving bags, sacks, and wrapping material. It is lightweight, strong, and durable, making it ideal for transporting goods.
- **Filtration:** Polypropylene fiber is used in a range of filtration applications, involving

air and water filters. It possesses superior chemical and thermal opposition, making it suitable for use in harsh environments.

- **Geotextiles:** Polypropylene fiber is used in geotextiles, which are permeable fabrics used to control soil erosion, stabilize slopes, and reinforce soil.
- **Concrete reinforcement:** Polypropylene Concrete can be made stronger and more durable by adding fibre. It helps to prevent cracking and reduces the risk of damage from freeze-thaw cycles.
- **Automotive:** Polypropylene fiber is used in the automotive industry to make components such as door panels, dashboards, and trunk liners. It is lightweight and has good impact resistance, which makes it a suitable substance for these applications.
- **Medical:** Polypropylene fiber is used in the medical industry to make non-woven fabrics for use in disposable surgical gowns, masks, and drapes.
- **Agriculture:** Polypropylene fiber is used in agriculture to make shade cloth, weed control fabric, and erosion control blankets.

These are just a few examples of the many uses of polypropylene fiber. Its versatility, durability, and resistance to chemicals and heat make it well-known material for a variety of applications.

1.5. OBJECTIVE OF THIS STUDY

- Researching the chemical and physical characteristics of fine aggregate, cement, and coarse aggregate. To
- establish the material properties of lithium carbonate, carbon fiber and polypropylene fiber.
- Determine the mechanical parameters of M20 grade concrete, including compression resistance, bend power, tensile strength, water absorption, and density.

CHAPTER – 2

LITERATURE STUDY

2.1. LITERATURE STUDY ON LITHIUM CARBONATE

Lithium carbonate is a chemical compound that has been investigated as an additive in concrete for several decades. It has been shown to enhance concrete's performance and durability, notably in terms of reducing the formation of cracks and increasing the resistance to chemical attack.

A. Bentur et al (2007), looked into the effect of adding lithium carbonate to concrete on the microstructure and properties of the resulting material. The researchers found that Lithium carbonate was added, and the consequence was a reduction in the dimension and quantity of pores in concrete, which improved its durability and resistance to water absorption.

Gao et al (2012), Executed a research paper that appeared in the Journal for Hazardous Materials (2012) that focused on the use of lithium carbonate in concrete to mitigate the effects of acid rain. The researchers found that adding lithium carbonate to concrete significantly increased its resistance to acid attack, and that the effectiveness of the treatment was dependent on the concentration of lithium carbonate used.

M. A. Hossain et al (2018), investigated The utilization of lithium carbonate replaced fly ash in concrete. The researchers found that the inclusion of lithium carbonate resulted in improved compressive strength and reduced shrinkage, as well as a reduction in the amount of time required for the concrete to reach its maximum strength.

K. Ogawa and colleagues (2013), investigated the effects of lithium carbonate on the resilience and robustness of concrete. Researchers found that the inclusion of lithium carbonate led to an enhance in the compressive strength and concrete's modulus of elasticity, as well as improved resistance to freeze-thaw cycles and chloride ion penetration.

J. Li and colleagues (2014), investigated the use of lithium carbonate in high-performance concrete for bridge decks. The researchers found that the addition of lithium carbonate resulted in improved freeze-thaw resistance, reduced shrinkage, and improved cracking resistance.

T. Zhang and colleagues (2020), examined using the mineral carbonate as a more environmentally friendly replacement for conventional chemical admixtures in building materials. The researchers found that the addition of lithium carbonate led to improved strength and concrete's resilience, while likewise reducing the construction industry's carbon footprint.

These studies suggest that the inclusion of lithium carbonate to concrete can increase its stiffness, durability, and resistance to various types of environmental stress. Furthermore, the use of lithium carbonate in concrete has potential environmental benefits, as it may reduce the need for traditional chemical admixtures that have negative environmental impacts top of form

2.2. LITERATURE STUDY ON CARBON FIBRE

That has been demonstrated in numerous studies that adding carbon fibre to a building material can considerably increase its strength and durability of structures as well as other concrete structures.

Lu and Huang (2006), The usage of carbon fibre reinforcement concrete in seismic-resistant constructions was examined. According to the study, adding carbon fibres to concrete significantly enhanced the durability of the structures during earthquakes.

Banthia and Trottier (2008), Bridge decks with carbon fibre reinforcement were examined. According to the study, the incorporation to carbon fibres to concrete reduced cracking, increased durability, and reduced the demand for maintenance.

Xie et al. (2016), investigation into the application of carbon fibre reinforced concrete for structural restoration. According to the study, adding carbon fibres to concrete increased the material's strength and longevity as well as the connection among the substance being repaired and the damaged structure.

Huang et al. (2019), investigation into high-rise skyscraper construction using carbon fibre reinforced concrete. According to the study, using carbon fibres allowed concrete barriers and columns to be thinner but yet preserving their structural integrity.

Zhang et al. (2021), investigation into the usage of carbon fibre reinforced concrete in wind turbine tower building. According to the study, the incorporation of carbon fibres to concrete significantly increased the stiffness and strength of the towers as well as their resilience to fatigue.

Bui et al. (2020), carried out the restoration of concrete reinforced beams using carbon fibre reinforced concrete. According to the study, the inclusion of carbon fibres to the material for repair increased its strength and load carrying ability also decreased cracking.

Vural et al. (2019), investigation into the usage of carbon fibre reinforced concrete in precast tunnel segment construction. According to the study, the inclusion of carbon fibres to concrete increased its durability and crack resistance while also reducing its ability to permeate and water absorption.

Salehi et al. (2020), undertook the study to learn more about the utilisation of carbon fibre reinforced concrete in tall skyscraper construction. According to the study, adding carbon fibres significantly reduced the overall weight and depth of concrete retaining walls and columns while preserving their structural integrity.

Qin et al. (2021), investigation on the usage of carbon fibre reinforced concrete in railway bridge building. According to the study, adding carbon fibres to concrete enhanced

its torsional strength and ductility and decreased cracking and distortion under load.

Overall, these investigations indicate that the durability, strength, and structural effectiveness of concrete structures can be significantly enhanced with the use of carbon fibre reinforced concrete. To fully comprehend the potential advantages and restrictions of this material, especially for larger-scale applications, more research is necessary.

2.3. LITERATURE STUDY ON POLYPROPYLENE FIBER

Polypropylene fiber is another material that has grown in popularity in the construction sector, especially when it comes to the reinforcing of concrete structures. Here are a few instances of research on the application of polypropylene fibre in concrete:

Chen et al. (2018), Pavement construction using a research paper that appeared in the International Journal of hazardous substances studied. According to the study, adding polypropylene fibres to concrete enhanced crack resistance and decreased rutting and deformation of the pavement.

Sun and Zhang (2017), The usage as reinforcement polypropylene fibres in the creation of precast concrete components was investigated by the researchers. According to the study, adding polypropylene fibres to concrete enhanced its flexural durability and toughness and decreased shrinkage and cracking.

Rao et al. (2018), investigation into high-rise building construction using polypropylene fibre reinforced concrete. According to the study, adding polypropylene fibres to concrete enhanced its fire resistance and decreased its tendency to crack and distort under stress.

Deebak and Kumar (2020), The usage of polypropylene fibre reinforced concrete in water tank construction was investigated by the researchers. According to the

study, adding polypropylene fibres to concrete increased its durability and crack resistance while also reducing water absorption.

Li et al. (2019), examined polypropylene fibre use reinforcement in the restoration of concrete structures that had been damaged. According to the study, adding polypropylene fibres to the material being repaired enhanced both the bonding of the replacement materials and the existing framework and boosted both strength and durability.

Zhang et al. (2021), For the building of a precast box girder bridge, polypropylene fibres in self-compacting concrete, or SCC, were explored. According to the study, Polypropylene fibres added to SCC improved the concrete's mechanical characteristics and durability and helped guard against cracking and damage brought on by shrinkage and heat stress.

Ling and Zhao (2021), the usage The researchers looked into the use of polyethylene reinforced with fibres in the construction of tunnel linings. the results of the study, adding fibres made of polypropylene to concrete improved its durability. flexibility, crack resistance, and longevity of the tunnels linings and decreased the likelihood of water leak and corrosion.

Zhang et al. (2020), The usage of polypropylene fibre strengthened concrete in the restoration of damaged bridge decks was looked into. According to the study, the Polypropylene fibres added to the repair material improved the concrete's mechanical and bonding qualities, helped stop cracking, and prevented water intrusion.

Sun et al. (2020), The usage of polypropylene fibre concrete reinforcement in the building of precast concrete shear walls was investigated by the researchers. According to the study, adding polypropylene fibres to concrete enhanced the flexibility, ductility, and absorbing capability of shear walls and helped to avoid cracking and damage

brought on by seismic stress.

Ahmadi et al. (2022), In the production of reinforced concrete beams, polypropylene fibre reinforced concrete was examined. According to the study, adding polypropylene fibres to concrete enhanced the breaking strength and elasticity of the beams and helped avoid their early failure and collapse.

Zhang et al. (2022) Polypropylene fibres are used in bridge decks built of super duper-high performing fiber-reinforced concrete (UHPFRC). the results of the study, adding fibres made from polypropylene to UHPFRC enhanced the concrete's strength, ductility, durability, and fracture resistance while also reducing its risk of early failure and collapse.

Wang et al. (2022), The usage of polypropylene concrete reinforced with fibre in windmill tower foundation building was investigated by the researchers. According to the study, the incorporation of polypropylene fibres to concrete increased the foundation's compressive force, durability, and fatigue resistance as well as aided to shield it from external influences including wind loads and cracking

Zhang et al. (2021), It was looked at whether polypropylene fibre reinforced concrete might be used to build industrial flooring. The results of the study showed that the incorporation of polypropylene fibres to concrete increased the concrete's abrasion resistance, resistance to impacts, and crack resistance as well as its service life.

Vilela et al. (2021), The usage of polypropylene fibre concrete reinforcement in the manufacture of modular paving blocks was investigated by the researchers. According to the study, adding polypropylene fibres to concrete enhanced the blocks' mechanical characteristics and endurance and helped to shield them from cracking and deformation brought on by traffic loads and temperature stress.

Li et al. (2021), The usage of polypropylene fibre reinforced concrete in damaged concrete bridge repairs was looked into. According to the study, the repair material's cohesiveness and mechanical qualities were enhanced by the inclusion of polypropylene fibres.

Overall, these investigations indicate that the durability, strength, and structural efficiency of concrete structures can be significantly enhanced with the application of polypropylene fibre reinforced concrete. To fully comprehend the potential advantages and restrictions of this substance, particularly in larger-scale applications, more research is necessary.

CHAPTER – 3

METHODS AND MATERIALS

3.1. METHODOLOGY

Methodology describes the complete procedure from surveying of literatures to comparison of the results of behavior of concrete due to lithium carbonate, carbon fiber and polypropylene fiber. Fig 3.1 shows the methodological frame work.

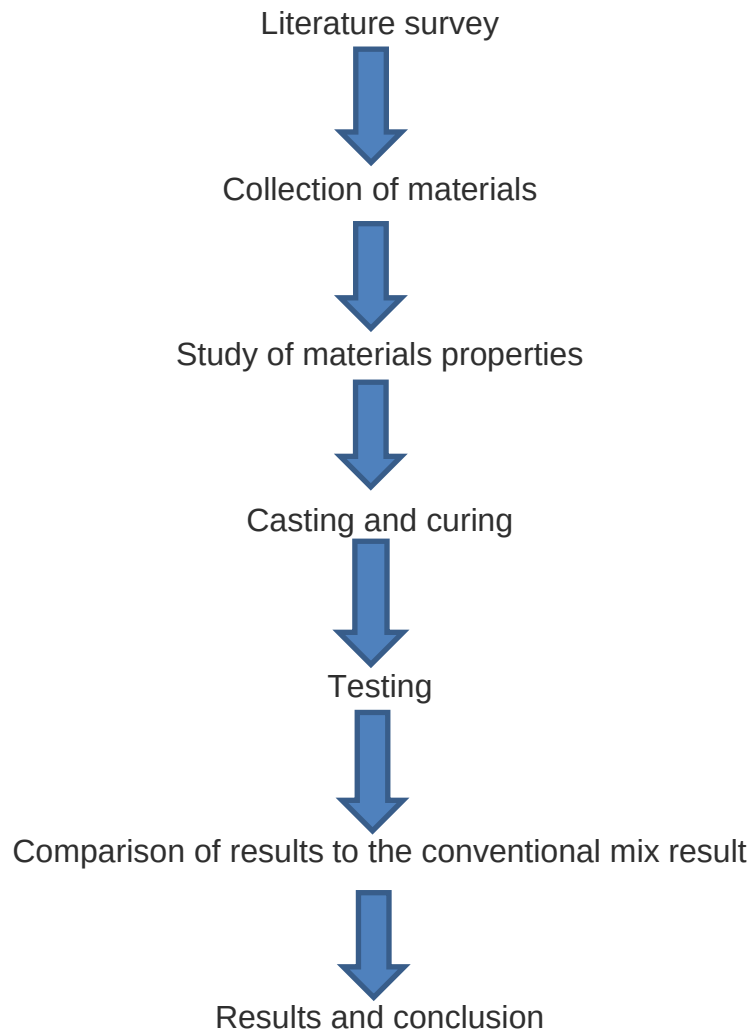


Fig 3.1: Methodology

3.2. MATERIALS USED

3.2.1. Cement

In concrete, OPC commonly used Portland cement grade 53 is a type of cement that is commonly utilised when building. It is done by grinding mixture of whitestone, clay, and other minerals) and gypsum into a fine powder. OPC grade 53 cement has a higher breaking strength compared to other grades of cement and is ideal for applications that require high strength, such as the construction of bridges, high-rise buildings, and heavy-duty industrial structures. It is also used in precast concrete products, reinforced concrete structures, and for general construction purposes. A standard Portland cement type of brand was used in this study. parasakthi and 53 grade was used.



Fig 3.2: Cement

Properties of cement:

Properties	Values
Specific Gravity	3.12
Normal Consistency	29%

Initial Setting time	65min
Final Setting time	275 min
Fineness	330 kg/m ²
Soundness	2.5mm
Bulk Density	m ³

Table 3.1 Properties of cement

3.2.2. Fine Aggregate (M-sand)

Manufacturing sand, also known as Manufactured Sand, is a type of sand that is created by smashing tough granite. or basalt rock used a vertical shaft impactor (VSI) machine. The resulting sand is cubical in shape and has sharp edges, which make it suitable for construction purposes. M sand is a substitute for Sand from rivers, which commonly used in construction but is becoming increasingly scarce due to the depletion of riverbeds and environmental concerns.

- **Consistency:** M sand is manufactured to a specific size and shape, ensuring consistent quality and reducing the need for testing and quality control.
- **Cost-effective:** M sand is typically less expensive than river sand, making it an attractive alternative for construction projects.
- **Environmentally friendly:** The use of M sand reduces the need for river sand, which helps to protect the environment.
- **High strength:** M sand is made from hard rock and has a high breaking strength, making It's appropriate for usage in concrete. and other construction materials.

M sand is utilised in a variety of situations of construction various applications, such as

production of concrete, plastering, and brickwork. It is also used in the manufacture of asphalt and is an important component in the construction of roads and bridges.



Fig 3.3: Fine aggregate(M sand)

Properties of fine aggregate:

Properties	Value
Fineness modulus	3.63
Specific gravity	2.66
Size	Passing through 4.75mm sieve
Water absorption ratio	1%

Table 3.2 properties of fine aggregate

3.2.3. Coarse Aggregate

Aggregate coarse is a type of building substance that is typically made up of crushed stone, rock or gravel. It is a crucial part of concrete because it provides strength and stability to the final product. Coarse aggregates are larger in size than fine aggregates, with typical sizes ranging from 4.75 mm to 38 mm. Natural aggregates are obtained from

natural sources such as riverbeds, quarries, and mines. They can be further categorized into three types: gravel, crushed stone, and sandstone. Manufactured aggregates, on the other hand, are produced by crushing rocks or recycled concrete. Coarse aggregate is used in a variety of construction applications like as the production of concrete, asphalt, and road base. The choice of coarse aggregate Depending on the kind of construction project, the required strength of the final product, and the availability and cost of the material. 20mm The coarse aggregate size is employed in this. project.



Fig 3.4: Coarse aggregate

Properties of coarse aggregate:

Properties	Value
Density	1830 kg/m ³
Fineness modulus	7.19
Specific gravity	2.75
Size	20mm
Water absorption ratio	1.60

Table 3.3 Properties of coarse aggregate

3.2.4. Water

Among the most crucial components water is a component of concrete. Concrete hardens through a process known as hydration as a result of water. Pure water must be used when making concrete in order to prevent weak concrete and disruptions to the hydration process. The amount of water to cement should also be taken into account since inadequate moisture fractures concrete and excessive water weakens it water renders concrete unusable. Super plasticizers

3.2.5 Super plasticizers

Super plasticizers (SPs) are Water reducers with a wide range. It is extensively utilised in the production of high-strength concrete. Plasticizers are chemical substances that enable the manufacturing of concrete with approximately 15% reduced water content. Plasticizers that are extremely effective can reduce more than 30% water content in concrete.

A super plasticizer is a kind of chemical additive that is employed in concrete to grow its workability without sacrificing its strength. It is also referred to as a tall-range water reducer because it allows for a significant reduction in the water content of concrete while still maintaining its flow ability. This results in a more fluid concrete mix that can be easily placed and consolidated, reducing the need for mechanical vibration. Super plasticizers are frequently utilised in applications involving concrete where exceptional strength, durability, and low permeability are required.

3.2.5. Lithium carbonate

Calcium Carbonate is an organic compound that is inorganic with a chemical composition of Li_2CO_3 that is the salt of lithium of carbonate. This white salts is commonly used in metal oxide processing. The carbonate of lithium is employed to serve as an activator for quick setting cement and high alumina cement-based motors.

Lithium carbonate can be utilised as an additive in concrete to make it more durable

and resistance to damage from environmental factors. When added to concrete, lithium carbonate combines with the ions of calcium in cement to form a calcium-lithium silicate hydrate gel.



Fig 3.5: Lithium carbonate

Properties of lithium carbonate:

Appearance	White powder
Boiling Point	1310 °C
CAS Number	554-13-2
Density	2.11 g/cm ³
EINECS Number	209-062-5
IUPAC Name	Lithium Carbonate
Main Hazards	Irritant
Melting Point	723 °C
Molar Mass	73.891 g/mol
Molecular Formula	Li ₂ CO ₃
Refractive	1.428
Solubility	13.2 g/l

Table 3.4 Properties of lithium carbonate

3.2.6. Carbon fiber

Carbon fibre is made up of microscopic, durable graphite crystalline threads that are used as reinforcement materials. Carbon fibre is thinner than human hair and has thread-like twist strength. They can be woven to make fabric, or fibres made of carbon can be kept in a mould to be coated with resin. to provide the desired permanent shape.

The use for carbon fibre reinforced composites concrete can lead to significant improvements concrete's structural performance, durability, and strength structures. However, further To completely comprehend, additional research is require the potential benefits and limitations of this material, particularly in larger-scale applications.

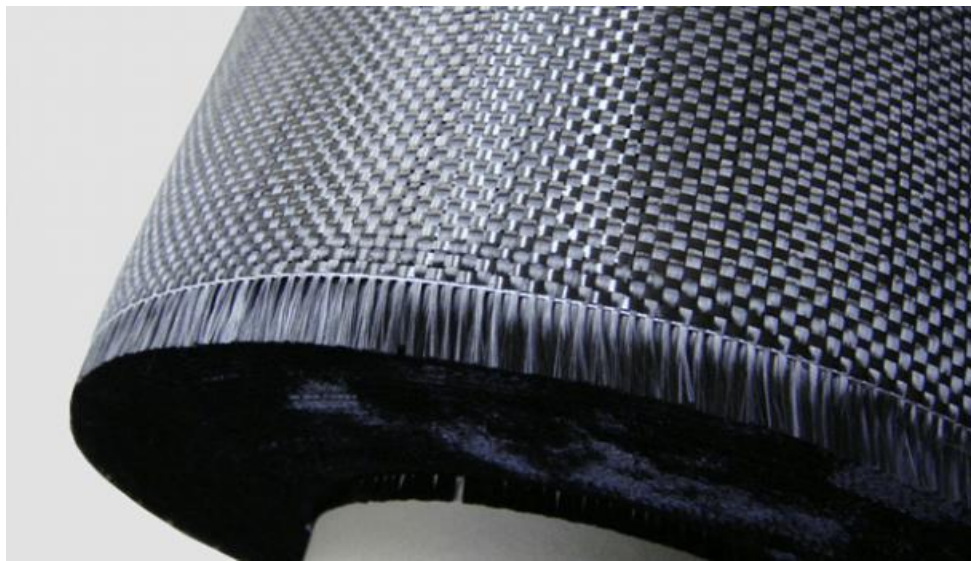


Fig 3.6: Carbon fiber

Properties of carbon fiber:

Properties	Values
Phase at STP	solid
Density	2000 kg/m ³
Ultimate Tensile Strength	4000 MPa

Yield Strength	2500 MPa
Young's Modulus of Elasticity	500 GPa
Melting Point	3657 °C

Table 3.5 Properties of carbon fiber

3.2.7. Polypropylene fiber

A synthesised linear polymer fibre created through the synthesis of propylene is called polypropylene fibre (PPF). Its main qualities are its small weight, tremendous strength, longevity, and resistance to corrosion. PPF is frequently used in leading industries such as chemical, energy, fabric, and construction. fields.



Fig 3.7: Polypropylene fiber

Properties of polypropylene fiber:

Tensile strength	3.5 – 5.5 grams per denier
Melting point	165 C
Starts to soften	140 C
Specific gravity	0.91 grams per cc
Elongation@break	40 – 100%

Abrasion resistance	Very good
Resistance to chemicals	Normally show very good resistance to chemicals
Effects of mildew	Has very good resistance to mildew and bacteria
Electrical conductivity	Very poor conductor of electricity. it gets used as insulator of electricity

Table 3.6 properties of polypropylene fiber

3.3. MIX DESIGN

The designed mix proportion 1:2.48:3.55 It was used (cement: finer aggregate: coarse aggregate). for all the mixes and quantity of lithium carbonate, carbon fiber and polypropylene fiber is changed and added In mixes as per the percentage content required.

Mix Design for M20 grade as per (IS10262:2019)

- Type of cement: OPC
- Exposure: Severe
- Slump: 65mm
- Max. cement: 450/m³
- Chemical admixtures: Super plasticisers
- S.P gravity of cement:2.88
- C.A: 2.74
- F.A: 2.65
- Chemical Admixtures: 1.45
- Water Absorption- C.A: 0.5%
- F.A: 1.0%

Target Strength fck

$$f'_{ck} = f_{ck} + 1.65S$$

$$= 20 + 1.65 \times 4.0 \text{ [value of } S \text{ from table 2, IS10262:2019]}$$

$$= 26.6 \text{ N/mm}^2$$

or

$$f'_{ck} = f_{ck} + x$$

$$= 20 + 5.5 ; \text{ Table 1, } m_{20} = 5.5$$

$$= 25.5 \text{ N/mm}^2$$

$$\text{Greater } f'_{ck} = 26.6 \text{ N/mm}^2$$

aggregate maximum nominal size = 20mm

The entrapped air as a percentage of concrete volume = 1.0

Correct water cement ratio for PPC, curve 2 can be used

Target strength = 26.6 N/mm^2

Approximately for 26.6 N/mm^2 water cement proportion = 0.55

For extreme cases condition, $w/c \neq 0.45$

$$w/c = 0.45$$

Water content:

For 20mm CA, water content = 186kg

$$\text{Interpolating} = 0 + (3 - 0) / (15 - 50) \times (65 - 50)$$

$$= 1.8\%$$

Increase by 1.8%

$$\text{Increased water content} = 1.018 \times 186$$

$$= 176 \text{ kg/m}^3$$

Reduction due to super plasticizer for 1.0% of weight of cement, 23% of water can be reduced. assume 1% A super plasticizer is employed. the amount of water = 0.77×189.35
= 145.80kg.

Calculation of cement content:

Water content ratio= 0.45 =w/c

Cement content= water content ÷ 0.45

= 145.80 ÷ 0.45

=320kg/m³

As per IS456, table 5 For extreme exposure, the minimum cement content is =320kg/m³
therefore, cement content=320kg/m³

Volume of coarse and fine aggregate:

Assume zone 2, 20mm CA [table 5]

The amount of CA per total aggregate volume unit: 0.62

For 0.5 w/c

For every 0.05 reduction in w/c, increases 0.01

For 0.45 w/c = C. A = 0.63

F. A = 1-0.63

=0.37

Mix Calculation:

Assume, total quantity = 1m³

Quantity of entrapped air =0.01m³

Quantity of cement = wt of cement/sp. Gravity * 1/1000

=324/2.88*1/1000

= 0.113m³

(d) Quantity of water = 145.5/1*1/1000

= 0.146

(e) Volume of plasticizers = 3.24/1.145*1/1000

= 0.0028m³

(f) Volume of aggregate=1-0.01 = 0.113-0.146-0.0028

=1-0.273

$$= 0.73\text{m}^3$$

$$(g)\text{Mass of CA}=(f)*\text{ratio of CA*SP gravity*1000}$$

$$= 1182\text{kg}$$

$$(h)\text{Mass of FA}= (f)*\text{ratio of FA*specific gravity*1000}$$

$$=0.73*0.037*2.65*1000$$

$$= 794\text{kg}$$

Cement= 320 kg/m³, Water= 176kg/m³, FA= 794 kg/m³ and CA= 1138kg/m³

3.3.1. Concrete mixes

Designation	Cement (Kg/m ³)	Fine aggregate (kg/m ³)	Coarse aggregate (kg/m ³)	Lithium carbonate (Kg/m ³)	Carbon fiber (kg/m ³)	Polypropylene fiber kg/m ³
CC M20	320	794	1138	-	-	-
M1	320	794	1138	2.328	5.82	5.82
M2	320	794	1138	4.656	5.82	11.64
M3	320	794	1138	6.984	5.82	17.46
M4	320	794	1138	9.312	5.82	23.28

Table 3.7 Quantity of materials per m³ of concrete

Fives concrete mix are designed with varied LC, CF and PPF contents:

CC M20 - Concrete of fck 20 N/mm²

M1 0.1LC (F) - Concrete with 0.1%LC, 0.2%CF, 0.25%PPF

M2 0.2LC (F) - Concrete with 0.2%LC, 0.2%CF, 0.5%PPF

M3 0.3LC (F) - Concrete with 0.3%LC, 0.2%CF, 0.75%PPF

M4 0.4LC (F) - Concrete with 0.4%LC, 0.2%CF, 1%PPF

3.3.2. Number of specimens

Mixes	Compressive strength	Tensile strength	Flexural strength	Water absorption
CC M20	Cubes of dimension 0.15m*0.15m three for seven days three for fourteen days three for twenty-eight days	Cylinder of dimension 0.15m*0.3m two for fourteen days two for twenty-eight days	Prism of size 0.1m x0.5m two for twenty-eight days	Cubes of dimension 0.15m*0.15m three for seven days three for fourteen days three for twenty-eight days
M1	Cubes of dimension 0.15m*0.15m three for seven days three for fourteen days three for twenty-eight days	Cylinder of dimension 0.15m*0.3m two for fourteen days two for twenty-eight days	Prism of size 0.1m x0.5m two for twenty-eight days	Cubes of dimension 0.15m*0.15m three for seven days three for fourteen days three for twenty-eight days
M2	Cubes of dimension 0.15m*0.15m three for seven days three for fourteen days three for twenty-eight days	Cylinder of dimension 0.15m*0.3m two for fourteen days two for twenty-eight days	Prism of size 0.1m x0.5m two for twenty-eight days	Cubes of dimension 0.15m*0.15m three for seven days three for fourteen days three for twenty-eight days
M3	Cubes of dimension 0.15m*0.15m three for seven days three for fourteen days three for twenty-eight days	Cylinder of dimension 0.15m*0.3m two for fourteen days two for twenty-eight days	Prism of size 0.1m x0.5m two for twenty-eight days	Cubes of dimension 0.15m*0.15m three for seven days three for fourteen days three for twenty-eight days
M4	Cubes of dimension 0.15m*0.15m three for seven days three for fourteen days three for twenty-eight days	Cylinder of dimension 0.15m*0.3m two for fourteen days two for twenty-eight days	Prism of size 0.1m x0.5m two for twenty-eight days	Cubes of dimension 0.15m*0.15m three for seven days three for fourteen days three for twenty-eight days

	days			
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Table 3.8 Number of specimens

All the constituents are measured and mixed in a mixer. The aggregates are mixed for more than 2 minute and The cement is then added. After another minute of mixing, water was added. in the mixer

For CF mixtures, Within the dry mixFibres are added. and thoroughly combined. The dry mix is gradually supplemented with fibres. and the mixes are churned for another three minutes in order to ensure that the fibres are evenly distributed. It is manually assured that all fibres are blended.

After mixing thoroughly, it is moulded in cubes, cylinder and prism moulds. Cubes are 150x150x150 mm in dimension, 150 x 300mm cylinders and beams are 100 x100 x 500mm. Moulds are after 24 hours, removed and specimen cube & beam are kept in water for curing for 28 days

3.4. CASTING

Concrete casting refers to the process of pouring liquid concrete into a mold or formwork and allowing it to harden into a solid shape. This process is commonly used in the building industry to produce a diverse array of structures, including building foundations, walls, beams, columns, and other structural elements.

Concrete casting involves several steps, including the preparation of the formwork or mold, the mixing and pouring of the building material, and the curing of the building material until it reaches its full strength. Once the concrete has hardened, the formwork or mold can be removed to reveal the solid concrete structure.

Concrete casting is a versatile and durable construction method that offers several advantages over other materials. Concrete is strong, durable, and can be molded into a a variety of forms and sizes. Additionally, it is resistant to fire, water, and weather, making

it a popular choice for a variety of construction applications.

Here the casting work is done for 9 cubes, 4 cylinders and 2 prisms for each mix and 3 Cubes are tested after seven, fourteen, and twenty-eight days, while cylinders are tested after twenty eight days. for fourteen and twenty eight days and prism are tested for 28 days.



Fig 3.8: Casting of mould



Fig 3.9: Casting

3.5. CURING

This procedure, which occurs immediately after concrete was compacted, pays specific attention to its moisture level and the ability of the concrete to expand as it dries. This method is critical for avoiding durability issues like as cracking.

Curing concrete in water is an efficient method of curing as it provides a uniform and constant supply of moisture to the concrete, which helps in the hydration process and prevents the concrete from drying out. The water also helps to regulate the temperature of the concrete, which is critical for achieving the desired durability and strength.

Curing concrete in water is particularly useful for large concrete structures, such as dams, bridges, and underwater structures, where the is continuously exposed to water. By curing the concrete in water, it can achieve a high level of impermeability and resistance to chemical attacks, making it suitable for use in harsh environments. However, curing concrete in water requires careful monitoring and control of the water temperature and quality, as well as the duration of immersion. If the water temperature is too low or too high, it can affect the hydration process and Reduce the concrete's strength. Furthermore, if the water is of low quality or includes significant quantities of pollutants or salts, it can cause damage to the concrete over time.



Fig 3.10: Curing of concrete

3.6. TESTING

3.6.1. Compressive strength test

Compressive strength refers to a structure or material's capacity to withstand stresses applied to its surface without breaking or bending. A material's size often decreases when it is compressed, while it typically increases when it is stretched. The point of breaking formula of any material is the load applied at the point of breakdown on the area of its cross-section on the part of its exterior on where the force was applied..

3.6.2. Procedure of compressive strength test for cube

Breaking strength test is a widely used method to determine the strength of building materials. The procedure for conducting a breaking strength test on a concrete cube after curing is as follows:

- **Preparation of the specimen** Following the concrete has been cast and cured for a sufficient period, usually 7, 14 and 28 days, the specimen is prepared. The specimen should be a cube with a side length of 150 mm. The ends of the cube should be flat and perpendicular to the sides of the cube.
- **Placing the sample in the examining device:** The sample is laid out on the testing machine's base plate. The bottom plate must be neat and level. The

example is then centered on the center of the plate with the polished side facing up.

- **Applying the load:** A hydraulic load is applied to the sample at a uniform rate. The load is applied through the top of the cube, using a steel platen that is in touch with the specimen's top surface.
- **Recording the results:** The highest load absorbed by the test piece before collapse is used as the concrete's breaking strength. The next formula is employed to calculate breaking strength:

$$\{\text{Compressive Strength} = \text{Load (P)} / \text{Cross-sectional Area (A)}\}$$

Where: P = maximum load sustained by the sample A = cross-sectional area of the sample

- **Interpretation of the results:** Concrete's breaking strength is a crucial factor in determining the material's quality. It serves as a measure of the concrete's resistance to cracking stresses, which are frequently encountered in application. Concrete's breaking strength can vary based on elements such the mix design, the curing environment, and the amount of time of the concrete.



Fig 3.11: Compressive strength test

3.6.3. Tensile strength of concrete

Masonry strength, or Tensile strength is a concrete's ability to endure a tens or stress. The masonry method's split cylinders test is used to measure the compressive durability of concrete. Tensile strength of concrete is measured in terms of pressure per area of cross-section. (N/Sq.mm. or Mpa).

3.6.4. Procedure of splitting tensile test:

The splitting tensile examination is a popular method for determining the breaking point of concrete. The following is the process for performing the split tensile test after curing:

- **Preparation of the sample:** After the concrete has been cast and cured for a sufficient period of time, usually 28 days, the specimen is prepared. The specimen should be cylindrical in has a circumference of 150 millimeters and an overall height of 300 millimeters. The ends of the specimen should be flat and perpendicular to the axis of the cylinder.
- **Applying a hydraulic load:** A hydraulic load is applied to the specimen in order to create a tensile force along its length. This is achieved by placing the specimen between two compressive platens of a machine for testing.
- **Placing the specimen on the supports:** The specimen is placed on two steel bearing strips on the testing machine. The steel bearing strips are placed parallel to the axis of the cylinder, and are positioned so that the compressive platens of the testing machine are in contact with the top and bottom of the specimen.
- **Applying the splitting force:** The splitting force is applied to the specimen by means of two steel blocks placed at 150 mm apart, along the axis of the cylinder. The force is applied at a uniform rate until the specimen fractures.
- **Recording the results:** The tensile strength for splitting of the concrete is measured as the highest load that the specimen could withstand before failing.

The tensile stiffness is equated using the following formula:

Tensile strength = $2P/\pi D \cdot L$

Where: P = maximum stress sustained by the specimen D = diameter of the cylinder L = height of the cylinder

- **Interpretation of the results:** The splitting tensile stiffness is a key factor for evaluating the concrete's quality. It is often used to determine the strength of concrete ability to withstand tensile stresses, which are common in structural applications.



Fig 3.12: splitting tensile strength

3.6.5. Flexural strength

Bending strength serves as an approximate measure of concrete tensile strength. It is a measurement of the greatest strain on the tension side of a slab or beam of unreinforced concrete at the point of bending failure. It is determined by loading concrete beams 150 x 150 mm (or 100 x 100 mm) with a span that is at least twice the depth.

By using either the ASTM C78 (third-point load) or Asme C293 (center-point loading) standard test procedures, the bending strength is quantified as the Modulation of Rupture (MR) in MPa. Comparisons or criteria should be based on the same specimen size and kind of loading since these factors do affect the measured bending strength. The MR determined by quarter-point stressing (ASTM C78) is typically fifteen percent less compared to that measured by middle-point loading (ASTM C293).

Depending on the proportions of the mixture and the kind, size, and amount of coarse aggregate used, flexural strength ranges from ten to fifteen percent of bend strength. To estimate the MR for building member design, follow these steps:

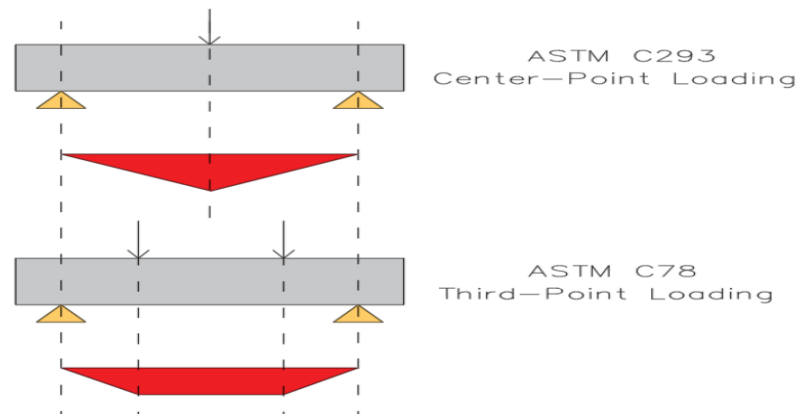


Fig 3.13: Flexural load points

$$F_r = 7.5 \sqrt{f'_c}$$

Where,

The MR is denoted by F_r , while the prescribed bending strength is denoted by F'_c .

When MR is crucial to design, laboratory experiments for specific mixes and materials are done to determine the best approximation.



Fig 3.14 Flexural strength test

CHAPTER – 4

RESULTS AND DISCUSSION

4.1. INTRODUCTION

Mechanical properties like compressive, tensile, or splitting strength, as well as flexural strength, water absorption and density of concrete are presented in this chapter.

4.1.1. Compressive strength

The following Fig 4.1 shows the 7, 14 and 28days compressive strength of various mixes. It has been discovered that the strength of compression for M20 mix is high compared to the other mixes.

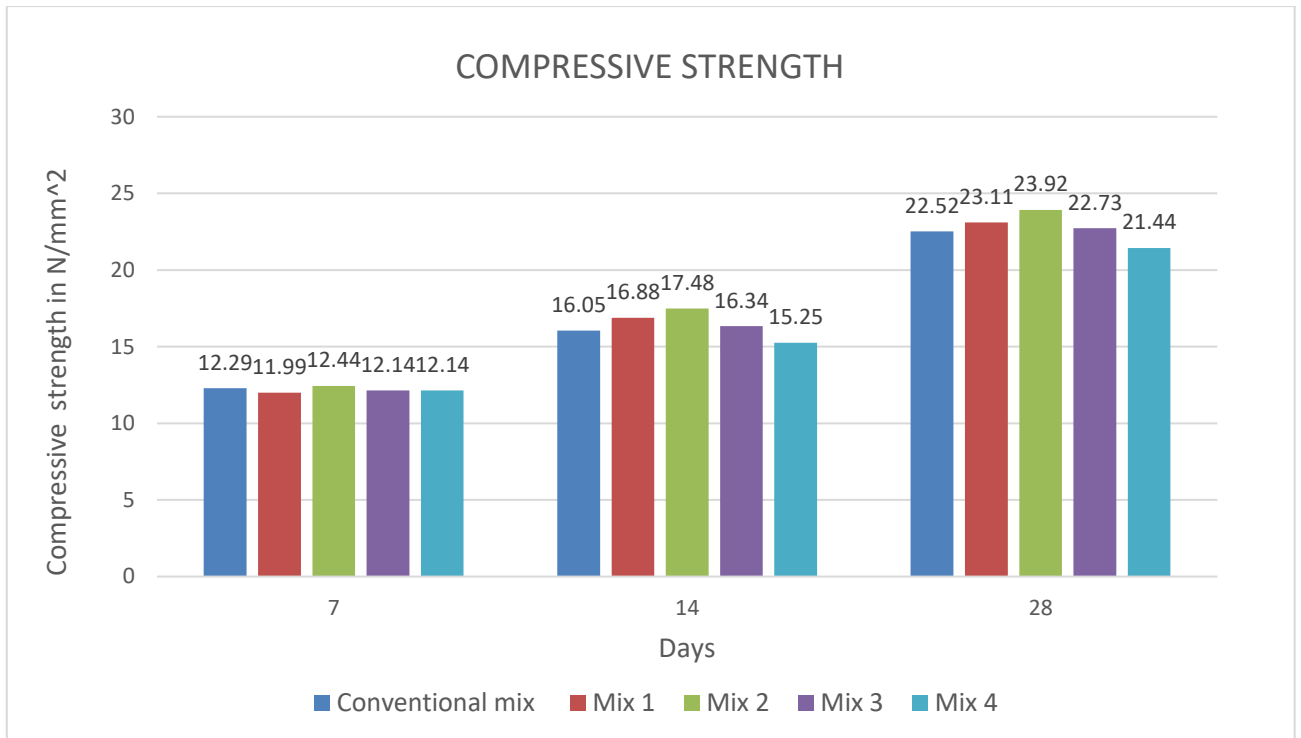


Fig 4.1: Comparison of compressive strength

Lithium carbonate can potentially increase the concrete's ability to break, it should be used with caution and in accordance with recommended guidelines to ensure optimal performance and durability. The addition of fibers provides a reinforcement in concrete, but When the fibre concentration increases, the homogeneity gets disrupted. This disruption in concrete by fiber causes a decrease in the breaking strength of concrete.

Concrete loses some of its with an increase in fibre content, compressive strength for this study, the Mix 2 (0.2%LC, 0.5% PPF and 0.25%CF) content is found to be with maximum breaking strength which is of 10 – 20% increases in to conventional concrete.

4.1.2. Tensile strength

The following Fig 4.2 shows the 14 and 28days Tensile stiffness of different mixtures It has been discovered that the strength of tensile is for M2 mix is high compared to the other mixes.

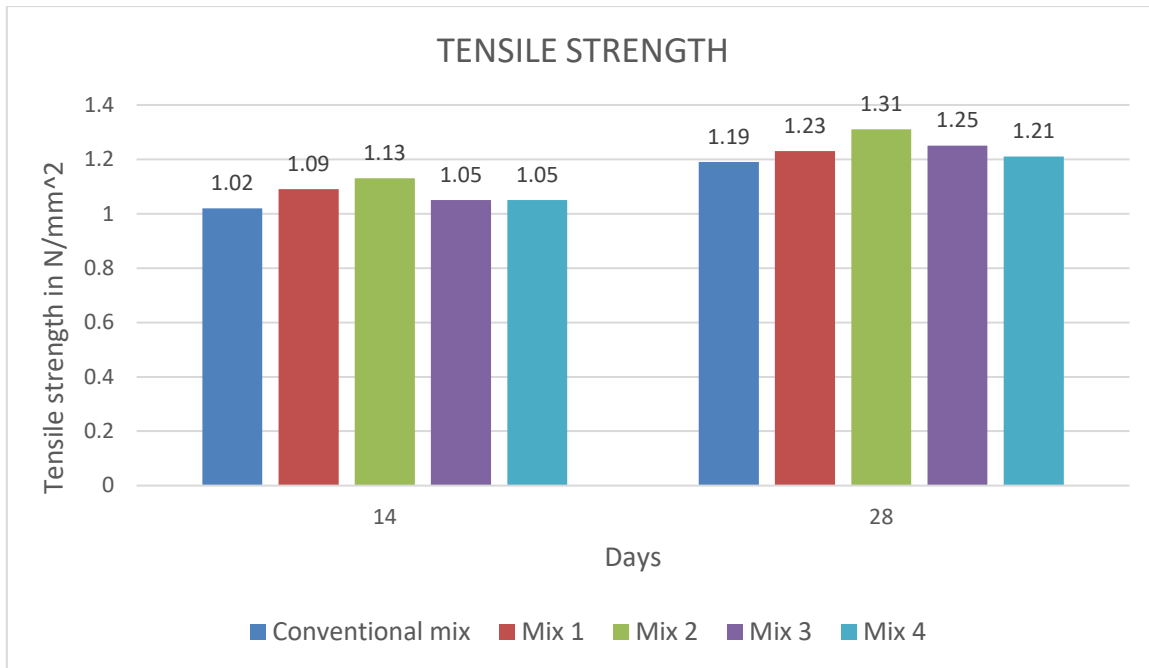


Fig 4.2 Comparison of tensile strength

Lithium carbonate can increase the tensile stiffness of building material by reducing the porosity and increasing the connection between the particles and cement matrix. Concrete's tensile strength can be considerably increased by the inclusion of fibres. This is because fibers, such as carbon and polypropylene, provide additional reinforcement to the concrete.

This study shows that increase in the fiber content will gradually increases the tensile stiffness compared to the conventional mix because the fiber is worked as the reinforcement in the concrete. The Mix 2 (0.2%LC, 0.5% PPF and 0.25%CF) content is found to be with maximum tensile strength which is of 5 – 10 % increases in to conventional concrete.

4.1.3. Flexural strength

The following Fig 4.2 shows the 28days bending strength of various mixes it is observed that the bending strength for M2 mix is high compared to the other mixes.

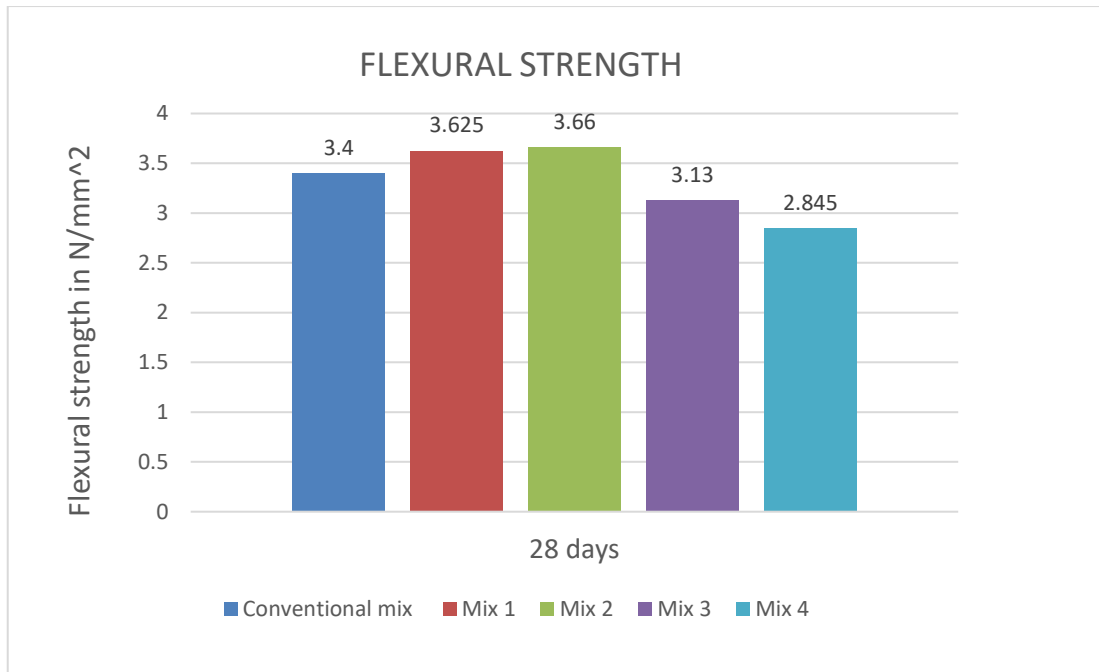


Fig 4.3 Comparison of flexural strength

Here it is informed that the breaking strength of concrete improves as the temperature rises in fiber content in the concrete mixture. In mix 1 and mix 2 the bending strength increased by 6.6 and 7.7 percent respectively compared to conventional mix. the growth in the bending stiffness is noticeable in Mix2(0.2%LC, 0.25%CF and 0.5%PPF).

4.1.4. Water absorption

The following Fig 4.4 shows the 28days water absorption in different mixtures. Observations show that water is used for absorption for M2 mix is low compared to the other mixes.

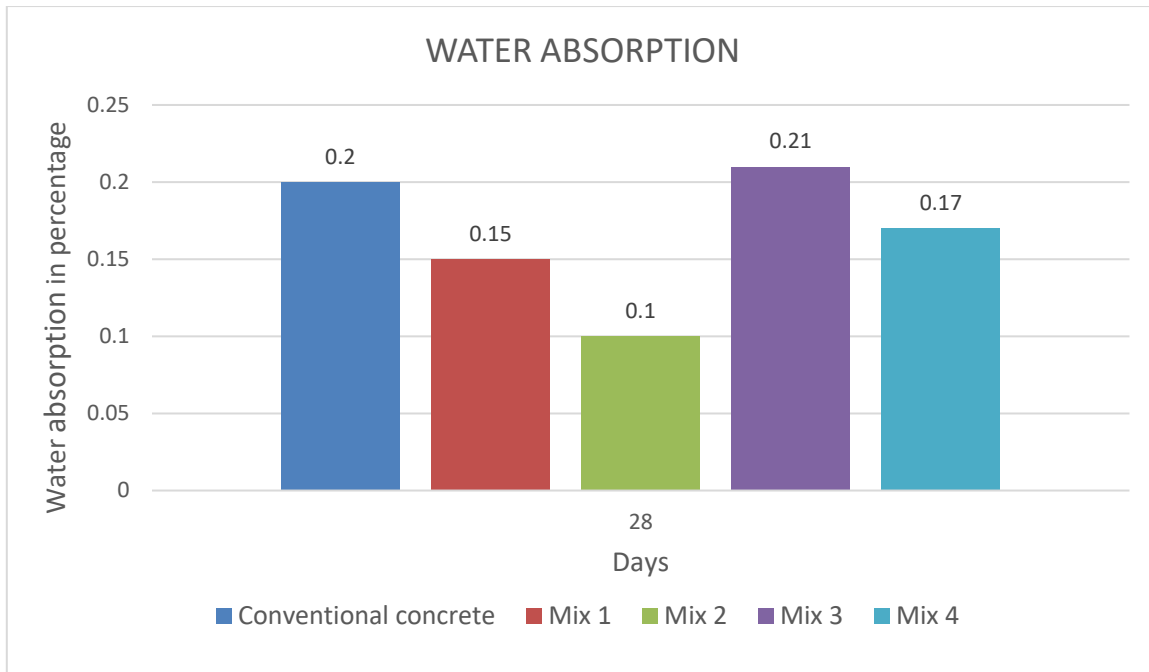


Fig 4.4 water absorption test

In mix 1 and mix 2 the water absorption decreases by 25 and 50 percent respectively compared to conventional mix. The reduction in the water absorption of concrete is noticeable in the Mix 2(0.2%LC, 0.25%CF and 0.5%PPF).

4.1.5. Density of concrete

The following Table 4.1 represents the 28days density of concrete of cube for various mixes it is observed that the for M2 mix is high in density compared to the other mixes and the involvement of fiber will increase in density of concrete so here we can see the increase in density of hardened concrete of M1 and M2 compared to the conventional mix.

Mixes	Weight of fresh concrete per (m ³)	Weight of hardened concrete of cube (kg)	Density of concrete (kg/m ³)
Conventional mix	2328	8.390	2485.92
Mix 1	2328	8.480	2512.59
Mix 2	2328	8.590	2545.16

Mix 3	2328	8.480	2512.59
Mix 4	2328	8.360	2477.03

Table 4.1 density of concrete

CHAPTER – 5

CONCLUSION

5.1. CONCLUSION

- The strength of concrete decreases with an increase of fiber content for this study, because increase in fiber content tends more air content and voids in concrete and here in every mix, we have added both carbon and polypropylene fiber so the air content and voids in concrete will be more.
- Lithium carbonate will hydrate the cement quickly it has the fly ash properties any how it should be used in an required amount only.
- Optimum level of inclusion of fibres and lithium carbonate content is the Mix2 (0.2%LC, 0.5% PPF and 0.25%CF) it is found to be with giving maximum strength and beyond increasing the materials proportions the strength is found to be reduced.
- M2 produced a good result overall compared to the Conventional mix, M1, M3 and M4.

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