EXPERIMENTAL INVESTIGATION OF RECYCLED MASK IN CONCRETE USING SELF-CURING

A

PROJECT REPORT

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Under the supervision

Of

Dr. RISHI RANA

ASSISTANT PROFESSOR (SENIOR GRADE)

by

SUKSHAM SHARMA (181636)

to

JAYPEE UNIVERSITY OF INFORMATIONTECHNOLOGY,

WAKNAGHAT, SOLAN – 173234

HIMACHAL PRADESH, INDIA

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STUDENT'S DECLARATION

I hereby declare that the work presented in the Project report entitled **"Experimental Investigation of Recycled Mask in Concrete using Self-curing"** submitted for partial fulfilment of the requirements for the degree of Bachelor of Technology in Civil Engineering at **Jaypee University of Information Technology, Waknaghat** is an authentic record of my work carried out under the supervision of **Dr Rishi Rana**. This work has not been submitted elsewhere for the reward of any other degree/diploma. I am fully responsible for the contents of my project report.

Signature of Student

Name: Suksham Sharma

Roll NO: 181636

Department of Civil Engineering

Jaypee University of Information and Technology, Waknaghat, India

Date:

CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"Experimental Investigation of Recycled Mask in Concrete using Self-curing"** in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering submitted to the Department of Civil Engineering, **Jaypee University of Information Technology, Waknaghat**, is an authentic record of work carried out by **Suksham Sharma, 181636** during a period August, 2022 and May, 2023 under the supervision of **Dr. Rishi Rana** Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

To the best of our knowledge, the preceding statement is correct and true.

Date:

Signature of Supervisor	Signature of HOD
Dr. Rishi Rana	Prof.(Dr.) Ashish Kumar
Assistant Professor (SG)	Professor and Head
Department of Civil Engineering	Department of Civil Engineering
JUIT, Waknaghat	JUIT, Waknaghat

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ABSTRACT

The disposal of single-use masks has become a significant environmental concern, leading to the exploration of alternative ways of using these masks After the COVID-19 outbreak, a ton of personal protective equipment was created and used by both healthcare professionals and individuals. Suitable plan for disposal of bio-medical waste has becomes a vital issue, It is now essential to find a solution that has a minimal adverse impact on the environment for the disposal of bio-medical waste.

The research has tried to focus on the management of these disposable masks by adding them in concrete mixture in order to improve the mechanical properties of concrete while reducing the biomedical waste. The study has evaluated the effect of adding disposable masks in different proportions (0.1%, 0.15%, 0.20%, and 0.25% by volume of concrete) on compressive strength, tensile strength, and water absorption capacity of the concrete mix. Additionally, the study also compares the performance of conventionally cured and self-cured concrete mixes in order to determine the effectiveness of self-curing admixture in concrete containing shredded disposable masks. The experimental results revealed that the addition of disposable masks in concrete mix has a positive impact on the mechanical properties of concrete. The compressive strength of the concrete mix increased by up to 25% with the addition of 0.1% disposable masks, while the split-tensile strength increased by up to 23% with the addition of 0.2% disposable masks.

Further investigation was preceded with the use self-curing mechanism by making use of PEG-6000 with varying ratio of 1% and 1.5% by weight of cement with the optimum dosage of disposable mask concrete obtained from the investigated study (as in our case it was 0.1% by volume of concrete).It was depicted from the research that the results obtained from the self-cured concrete mixes having disposable masks performed on a similar scale as to the conventionally cured concrete mixes, indicating the effectiveness of self-curing agents.

In particular, the study concluded that the addition of disposable masks in concrete production can lead to a significant enhancement of its mechanical properties. The optimum dosage of disposable masks in concrete was found to be 0.1% by volume, which provided the highest improvement in compressive strength and water absorption capacity. The use of self-curing agents in concrete mixes containing disposable masks was also found to be effective at 1%

weight of cement which shows 2.39% increase over the compressive strength and 19% increase over the split tensile strength. The findings of this study can be used to provide a sustainable solution for mask waste while improving the properties of concrete.

Keywords: Environmental Impact, Mechanical Properties, Disposable masks, Self-Curing, Concrete

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LIST OF ACRONYMS & ABBREVIATIONS

CM	Control Mix
CTM	Compressive Testing Machine
IS	Indian Standard
PEG	Poly-ethylene Glycol
SC	Self-Curing
W/C	Water Cement ratio

CHAPTER 1

INTRODUCTION

Concrete is a composite manmade material and is most widely used building material in the construction industry. The use of concrete is prevalent in almost all types of construction projects, from residential buildings to infrastructure and commercial structures. However, concrete involves use of a considerable amount of natural resources and raw materials, making it one of the major contributors towards environmental degradation. In recent years, researchers have focused on developing sustainable solutions to mitigate the impact of concrete production on the environment. Therefore, it has become imperative to explore new ways of making concrete more sustainable. Today, concrete production is a complex process that involves careful selection of materials, precise mixing, and controlled curing conditions. The quality of the raw materials, the mixing process, the curing process, and the testing processes used to assess the qualities of the finished product are some of the elements that affect the quality of the final product.

Concrete has several advantages over other construction materials, including its strength, durability, and versatility. It can be used to create structures of diverse shapes and sizes, and its strength can be adjusted by varying the proportions of the constituent materials. Despite its advantages, concrete making has a significant impact on the environment, as it requires a large amount of natural resources, such as sand, gravel, and water, and contributes to carbon emissions. As such, researchers and manufacturers are constantly looking into new technologies to reduce its nuisance on environment, including the use of alternative materials and technologies. Self-curing concrete has become a popular alternative to conventional curing due to its several benefits, such as reduction in labor costs, improved durability, and less shrinkage. This study aims to determine the potential of disposable mask concrete in self-curing and compare its performance with conventional curing. The results of this research could provide suitable ways into the sustainable utilization of disposable masks and the development of self-curing concrete technology.

1.1 CONSTITUENT OF CONCRETE

1.1.1 CEMENT

Cement is a material which has cohesive and adhesive properties in the presence of water, that is responsible for holding the other components of concrete and mortar together. There are different grades and types of cement available, and the choice of cement will depend on the specific application and requirements of the construction project. Here are some of the commonly used grades and types of cement:

1. *Ordinary Portland Cement (OPC)*: OPC is a type of cement which is mostly used in construction. It is available in different grades such as 33, 43, and 53. OPC 33 is used for plastering, brickwork, and non-structural concrete, while OPC 43 and 53 are used for reinforced concrete and structural work.

2. *Rapid Hardening Cement*: Rapid hardening cement is used in situations where quick setting and early strength development is required. It is commonly used in precast concrete and in situations where early removal of formwork is required.

3. *Portland Pozzolana Cement (PPC)*: PPC is a type of cement that is made by mixing clinker with fly ash and the waste products obtained from coal-fired power plants. PPC is used in situations where high durability is required, such as in marine structures and hydraulic structures.

4. *Sulphate Resistant Cement (SRC)*: SRC is used in situations where the chances of acid attack is more over the concrete surface, such as in coastal areas or in soil with high sulphate content.

5. *White Cement*: White cement is a type of cement that is used in situations where a decorative finish is required. It is commonly used in architectural concrete, terrazzo, and decorative tiles.

1.1.2WATER

About an average 23% of water by weight of cement is required for complete hydration of Portland cement. This water combined chemically with cement compounds and is known as bound water and this water is non-evaporable. It is further observed that 15% of water by weight of cement is required to complete the chemical reaction and to occupy the space between the gel pores.

Here are the norms given in IS 456 for water used in concrete production:

1. *Cleanliness*: The water which is used in construction should be clean and should not contain any type of impurities such as organic matter, oils, acids, alkalis, salts, and other substances that can affect the quality of the concrete.

2. *pH Value*: As per I.S. 456 the water which is used for concrete production should be greater than 6.

4. *Chloride Content*: The chloride content of the water should be limited to 200 ppm (parts per million) for reinforced concrete and 500 ppm for prestressed concrete. Excessive chloride content can cause corrosion of the reinforcement, which can result in structural damage.

5. *Sulphate Content*: The sulphate content of the water should be limited to 400 ppm for plain concrete and 3000 ppm for reinforced concrete. Excessive sulphate content can cause sulphate attack, which can result in the deterioration of the concrete.

6. *Alkalinity*: The alkalinity of the water should not exceed 200 ppm expressed as calcium carbonate. Excessive alkalinity can cause efflorescence and affect the setting and hardening of the concrete.

1.1.3 COARSE AGGREGATE

Coarse aggregates are construction material that is used in the production of cement concrete. They are used as filler in binding material in production of concrete. They makes up body of concrete occupying 70 to 80% of volume of concrete. Coarse aggregates are typically made from crushed stone, gravel, or recycled concrete, and are larger in size compared to fine aggregates. They are an essential component in concrete production as they provide bulk, stability, and strength to the mix.

1.1.4 FINE AGGREGATE

Fine aggregate, also known as sand, is an essential component in concrete production. It is a natural or manufactured material that is used to provide bulk, workability, and finish to the concrete mix. Fine aggregate is typically composed of small particles of sand, crushed stone, or gravel and is generally smaller in size compared to coarse aggregate.

1.1.5 TYPES OF FIBER

These days, a wide variety of fibers are used, each with unique qualities that allow for flexible application. The following discussion covers several fiber kinds.

1.1.5.1 GLASS FIBRE REINFORCED CONCRETE(GFRC)

GFRC is produced using specialized methods into large panels with a straightforward layout or into complicated designs. As seen in fig.1.1 below, glass fiber is depicted in a visual manner. GFRC parts were initially fastened directly to the buildings using metal studs. It was discovered that GFRC changes significantly as a result of which slip anchors are used in place of direct anchors. For different facing materials like ceramic tiles, bricks, and architectural needs, GFRC is used in a number of buildings.

Fig 1.1: Glass fiber [14]

GFRC has many advantages over traditional concrete, such as improved durability, resistance to weathering and chemicals, and reduced maintenance costs. Additionally, GFRC is a sustainable material as it can be produced with less energy and reduces the carbon footprint of construction projects.

1.1.5.2 STEEL FIBRE REINFORCED CONCRETE

Steel reinforced concrete (SRC) is made up of concrete and steel reinforcement bars or mesh. The steel reinforcement in concrete mix is to provide additional tensile strength, which helps to resist bending, cracking and structural failure. SRC is commonly used in construction as it provides the benefits of both concrete and steel, resulting in a stronger and more durable material. The use of SRC has helped to revolutionize the construction industry and has become a standard building material due to its strength, durability, and cost-effectiveness.

Fig 1.2: Steel fiber [12]

1.1.5.3 NATURAL FIBRE REINFORCED CONCRETE (NFRC)

Natural fiber reinforced concrete (NFRC) is a composite material made up of Portland cement, sand, water, and natural fibers such as jute, coir, and sisal. The use of natural fibers in concrete provides additional strength and durability to the material while reducing its weight. NFRC has become an attractive alternative to traditional concrete as it is sustainable and eco-friendly. The use of natural fibers also improves the thermal and acoustic insulation properties of the concrete. NFRC is commonly used in applications such as flooring, roofing, and cladding. The use of NFRC has helped to reduce the environmental impact of construction projects and promote sustainable building practices.

Fig 1.3: Natural Fiber [13]

1.2 CLASSIFICATION OF CONCRETE

1.2.1 MUD CONCRETE:

- Made by kneading good quality clay and water together with coarse aggregate.
- Properties are due to interlocking of irregular aggregate particles and filling voids by mud.
- It has poor impermeability, durability, strength and easily affected by moisture.

Fig 1.4: Mud concrete [4]

1.2.2 LIME CONCRETE

- As a binding medium, coarse aggregate is mixed with hydraulic lime.
- It has fairly good durability, strength, and flexibility.
- Excellent water-proofing properties, preventing sub-soil dampness in the floor and walls. It does not harden in water and grows in strength gradually.

1.2.3 CEMENT CONCRETE

- Concrete set-in presence of water by the process of hydration
- Hydration process starts as soon as water is added in it.

Fig 1.5: Cement concrete [4]

1.3 CURING OF CONCRETE

Curing of concrete is the process of maintaining appropriate moisture, temperature and time conditions after the concrete has been placed, to promote the full hydration of cement and ensure that the concrete gains sufficient strength and durability. Curing is process to preserve moisture in concrete so that proper hydration can be maintained in our concrete so proper strength and durability can achieved in our concrete. It could be either after it has been set in situ (or when making concrete goods), allowing time for the cement to hydrate. Temperature control may also be included in the definition of curing because it impacts how quickly cement hydrates. The required properties of the concrete, the intended application, and the environmental conditions, such as the air's temperature and relative humidity, may all affect the curing period. Curing is mainly intended to keep the moisture of concrete by halting moisture loss from concrete while it is developing strength.

1.3.1 METHOD OF CURING

There are different types of curing methods used in concrete construction, including:

1. Conventional Curing Methods
2. Self-Curing
3. Hot curing
4. Membrane Curing
5. Steam Curing

1.3.1.1 CONVENTIONAL CURING

Conventional curing is a common method used to cure concrete and involves the application of moisture to the concrete surface to maintain an adequate level of hydration. Conventional curing primarily involves keeping the concrete continuously moist by applying water to the exposed surfaces. This can be achieved through various methods, such as ponding, sprinkling, or wetting the concrete surface with water-soaked fabrics like burlap or mats. The objective of conventional curing is to prevent moisture loss from the concrete by continuously replenishing it. This helps in maintaining a favorable environment for cement hydration and prevents the concrete from drying out too quickly. Conventional curing is a widely used and effective method for curing concrete, especially for small to medium-sized projects. However, it is important to consider factors such as ambient conditions, project specifications, and curing duration to ensure proper hydration and achieve the proper strength and durability of the concrete.

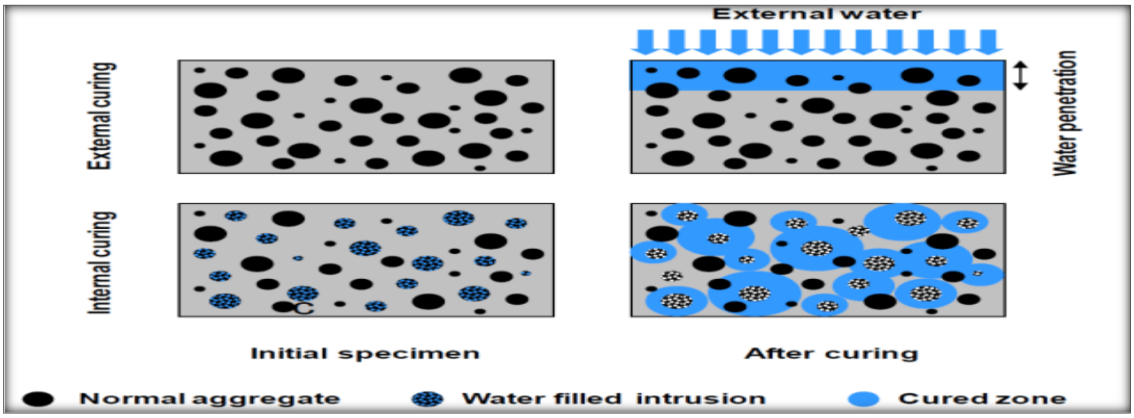

Fig 1.6: Mechanism of Curing [16]

1.3.1.2 SELF-CURING

Self-curing agents have emerged as a promising solution to address the challenges of conventional curing methods in concrete. These chemicals are designed to prevent water evaporation from concrete, hence increasing its water retention capacity and facilitating the development of desired qualities. Among the various self-curing agents investigated, water-soluble polymers have shown effectiveness in achieving the desired self-curing effect. Water-soluble polymers, such as polyethylene glycol (PEG-6000), have been extensively studied and used as self-curing admixture in concrete. These polymers have high water-absorbing capacity and can form a moisture-retaining film around the cement particles, reducing moisture loss and enhancing the curing process. PEG-6000, in particular, has been found to effectively reduce water evaporation from the concrete surface, thereby improving hydration and resulting in improved strength and durability properties.

The use of self-curing agents like water-soluble polymers offers several advantages, including reduced reliance on external curing methods, improved workability, reduced shrinkage, and enhanced resistance to cracking. It also provides greater flexibility in construction practices and offers the potential for more sustainable and efficient concrete production. Further research and development in the field of self-curing agents are expected to optimize their effectiveness and expand their application in concrete construction. The use of self-curing agents opens up new possibilities for achieving superior quality concrete with enhanced properties, even in situations where conventional curing methods are impractical or challenging to implement.

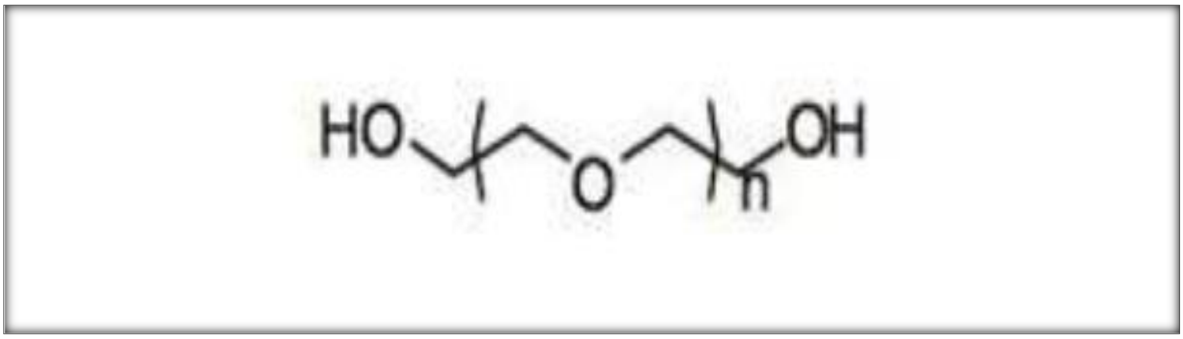

Fig 1.7: Structure of Polyethylene glycol [17]

1.3.1.2.1 DEFINITION OF SELF CURING

Traditionally, curing concrete means water is moving "from the outside to the inside" by prevent water from evaporating from the surface but "self-curing" occurs "from the inside to outside" which can take the shape of superabsorbent polymers, saturated wood fibers. A common term for "internal curing" is "self-curing.

Self-curing is ability of concrete to retain moisture and undergo hydration without the need for external curing methods or additional water supply. It also refers to concrete whose properties do not require any external curing after placement. Self-curing concrete uses an "internal curing mechanism" that involves mixing in a water-soluble polymer. Since the self-curing composition is a part of the mix, this method avoids the challenge of ensuring that the construction team uses efficient curing procedures.

Polyethylene Glycol:

Polyethylene glycol (PEG) is a water-soluble, non-toxic, and biodegradable polymer that has many applications in various industries, including construction. In concrete, PEG is used as a self-curing agent, which means that it can provide moisture to the concrete over time, thereby reducing the need for external curing.

Polyethylene glycol (PEG) is a versatile polymer compound that finds applications in various industries, including pharmaceuticals, cosmetics, and construction. It is a water-soluble substance known for its excellent solubility, low toxicity, and wide range of molecular weights. Here is some information about polyethylene glycol. The general formula for polyethylene glycol is (C2H4O) n, where "n" represents the number of repeating ethylene oxide units.

The use of PEG in concrete can improve the strength, durability, and overall quality of the concrete. PEG can be added to the concrete mix at the batching plant or directly on-site, and is usually added in a dosage 1% to 5% by weight of cement. The dosage depends on the type of cement used, the ambient temperature, and the desired strength of the concrete.

When PEG is added, it reacts with the free water present in the mix to form a gel-like substance. This gel holds the moisture and gradually releases it to the concrete, allowing it to cure and gain strength over time. PEG also helps to reduce shrinkage, cracking, and crazing in concrete, which can be particularly beneficial for large concrete structures.

PEG can also act as a plasticizer and improve the workability of the concrete mix. This can help reduce the amount of water required in the mix, which in turn can improve the strength and durability of the concrete. However, it is important to note that the use of PEG in concrete can have some limitations and challenges. For example, excessive use of PEG can lead to excessive softening of the concrete, and it may not be effective in extremely dry or hot environments. Therefore, it is important to carefully evaluate the dosage and conditions before using PEG in concrete.

In conclusion, PEG is a useful and versatile material that can be used in concrete to improve its strength, durability, and workability. Its self-curing properties make it an attractive option for reducing the need for external curing, and it can also act as a plasticizer to improve the concrete mix. However, the use of PEG in concrete requires careful consideration of dosage and environmental conditions.

Table 1.1: Specification of PEG-6000[16]

S.No.	Specification	PEG-6000
1	Mol Wt.	5500-6500
2	Appearance	White Flake
3	Colour, Boha	10 max
4	Moisture	0.5% max
5	Hydroxyl Value	16-23 (mg KOH/g)
6	pH	5-7
7	Specific Gravity	1.08-1.09
8	Dioxane	1 ppm max

1.3.1.2.2 MECHANISM OF SELF-CURING

Due to the difference in chemical potentials (free energy) between the liquid and vapor phases, moisture must be removed from an exposed surface for continuous evaporation to occur. The polymers that are added diminish the chemical potential of the molecules and lower the vapor pressure by primarily forming hydrogen bonds with water molecules. As a result, less water evaporates from the surface quickly.

1.3.1.3 MEMBRANE CURING

Membrane curing is a method of curing concrete that involves the application of a thin membrane or barrier over the concrete surface to prevent moisture loss. It is a type of external curing method commonly used in construction projects.

1.3.1.4 STEAM CURING

Steam curing is a widely used accelerated curing method in the construction industry, particularly for large concrete structures or precast concrete elements. It involves process of application of heat and moisture in form of steam to speed up the curing process of concrete.

1.3.1.5 AIR CURING

This method involves exposing the concrete surface to the ambient air, while keeping it moist by regular spraying or wetting.

Indian Standards, specifically IS 456, provide guidelines for the curing of concrete. The following are some of the important provisions: Curing should commence as soon as the concrete is hard enough to prevent damage during the curing process. The duration of curing should be a minimum of seven days for ordinary Portland cement concrete and ten days for concrete containing mineral admixtures.

After considering all the aspects and norms provided as per Indian standard, we have worked on project which focuses on the use of disposable masks in concrete production as an eco-friendly solution. Disposable masks have become ubiquitous in our daily lives due to the ongoing COVID-19 pandemic. However, the inappropriate disposal of these masks has led to severe environmental concerns, including the risk of them ending up in the oceans and causing harm to marine life. This project aims to investigate the possibility of using disposable masks in concrete production, thus providing a sustainable solution to the problem of mask waste.

The study investigates the effect of adding disposable masks in concrete in different proportions (0.1%, 0.15%,0.20% and 0.25% by volume fraction) on its mechanical and durability properties. The study analyses the compressive strength, tensile strength, and water absorption capacity of the concrete mix with varying proportions of disposable masks. The results of the study can be used to determine the optimum proportion of disposable masks that can be added to concrete and enhancing its properties and performance.

Furthermore, this study also advances to making use of self-curing, PEG-6000 admixture incorporating it with the disposable mask to further enhance the mechanical properties of concrete. The project initially investigates the effect of adding disposable masks in varying proportions (0.1%, 0.15%, and 0.20% by volume of concrete) on the compressive strength, tensile strength, and water absorption capacity of the concrete mix. The results of this study are then used to determine the optimum dosage of disposable masks in concrete, which is then followed by the addition of PEG-6000 as a self-curing admixture in varying proportions (1% and 1.5% by weight of cement.

This report provides an overview of the materials used in concrete and the properties of disposable masks that make them a suitable addition to the concrete mix. It also discusses the methodology used in the study and the results obtained from the experimental investigation. Finally, the report concludes with recommendations for future research and the potential applications of using disposable masks in concrete production.

CHAPTER 2
LITERATURE REVIEW

Around the world, concrete mix design is a well-known practice. The majority of nations have standardized their approaches to concrete mix design. Concrete has developed remarkably quickly in recent years. There is ongoing study on mix design practices standardized by many nations, the effect of component diversity on the various properties of fresh and hardened concrete, and the usage of various supplemental and recycled materials. The empirical relationships, charts, graphs, and tables used in the IS and ACI methods of concrete mix design were produced through intensive trials and research utilizing their own locally accessible resources. Although the selection of the mix design parameters is essentially the same for all of these methods, there are some methodological variances between them

Several studies have argued for the use of synthetic fiber in concrete to enhance some particular features of the material. Microfibers that have been thoroughly mixed and disseminated are excellent at decreasing plastic shrinkage cracking because they postpone the process by which little microcracks combine to become macrocracks, which are huge, macroscopic cracks. The addition of synthetic fibers alters the properties of the concrete matrix in this way. Synthetic fibers are commonly added to concrete for slab-on-grade construction to increase toughness and impact resistance while decreasing early plastic shrinkage cracking. Different effects on the properties of concrete can be noticed depending on the type, length, and aspect ratio of the fibers.

Lynch et al, (2021) investigated the feasibility of using polypropylene fibers from COVID-19 single use face masks to improve the mechanical properties of concrete and discovered that using 0.20% volume of single use masks increases both compressive and tensile strength of concrete.

Marcin Koniorczyk et al, (2022) investigated the performance of concrete containing recycled masks used for personal protection during a coronavirus pandemic and discovered that the addition of processed masks slightly increased compressive strength (by about 5%) while decreasing tensile strength (by about 3%). They also discovered that the addition of fibre increases the rate of water absorption.

Wisal Ahmed et al, (2022) investigated the effective recycling of disposable medical face masks for sustainable green concrete using a new fibre hybridization technology and discovered that water absorption of FRAC increased somewhat with increasing volume percentages of DMFM fibre.

Wisal Ahmed et al., (2022) investigated the effective recycling of disposable medical face masks for sustainable green concrete using a new fibre hybridization technology and discovered that water absorption of FRAC increased somewhat with increasing volume percentages of DMFM fibre.

Madad Ali et al., (2022) investigated an Environmentally Friendly Solution for Waste Facial Masks Recycled in Construction Materials and discovered that shredded masks ranging from 0.75 to 1% increased compressive strength by 14% in a 28-day sample.

Mohammad Saberian et al, (2021) investigated the repurposing of COVID-19 single-use face masks for pavement base/subbase and discovered that adding 1-2% SFM to RCA increased the strength and stiffness of the SFM/RCA blends. (by weight), but as the amount of SFM grew, the strength and stiffness dropped. This was explained by the fact that the substantial amount of voids generated by the excessive fibre inclusion reduced the strength and stiffness of the blended sample.

Zain-Ul-Abdin et al. (2020) investigated the Effect of Pine Needle on the Properties of Cementous Mortar and concluded that the pine needle reduces the density of concrete while increasing its water absorption.

J Sravani et al. (2020) discovered that using molecules with a greater weight greater w/c ratio PEG is not favourable in their study A project Report on Comparative and Experimental Study on Self Curing Concrete.

Saurav et al. (2018) conducted an investigation to determine the optimum dose of steel fibres in concrete incorporating ultra-fine slag and discovered that there is only a marginal increase in compressive and tensile strength of concrete after 7 days of curing but a significant change in their respective strength after 28 days of curing and have maximum tensile strength when steel fibres are 1.5% by volume and strength decreases as percentage increases.

Harpreet Kaur et al. (2017) investigated the workability and compressive strength of concrete using textile mill sludge and plasticizer and discovered that 35% of the strength replacement of textile mill sludge with fine particles is optimal.

Bhupendra Kumar et al. (2015) investigated the effect of coconut concrete solid and compressive strength of concrete and discovered that adding 2% coconut fibre improves compressive strength.

Patel Manishkumar Dahyabhai et al. (2014) investigated the use of self-curing concrete in the construction industry and discovered that adding 1% PEG1500 boosts compressive strength by 37%, with 1% being the optimum dosage.

Kashiyani et al. (2013) investigated the innovative addition of polypropylene fibre in interlocking paver block to improve compressive strength and discovered that adding a 0.4% fibre in the top 15mm of paver block gave the optimum compressive strength and that adding polypropylene fibres improves the strength up to 40% and reduces water absorption with a small cost increase compared to standard paver block but increases the characteristics of standard paver block.

Jie et al, (2021) investigated COVID-19 single-use face masks for pavement base/subbase and discovered that adding 1-2% SFM to RCA resulted in an increase in the strength and stiffness of blends to SFM/RCA and that increasing the quantity of SFM beyond 2% resulted in a decrease in strength and stiffness.

2.1 SUMMARY OF LITERATURE REVIEW

- Using shredded face masks improved the compressive strength of the bio-medical waste blocks by nearly 30%.
- Optimum dosage of shredded face mask is in between 0.05% to 0.30% as volume of Concrete
- BMW blocks have a significantly higher block density than normal concrete blocks.
- The addition of disposable masks increased the technical qualities of the concrete blocks greatly.
- Optimum dosage of polyethylene glycol is varying on basis of grade and is in between 0.1% to 5%.

2.2 OBJECTIVE OF OUR WORK

- Determine the Optimum Dosage of Fiber (Mask) for M20 Grades of Concrete Specimens.
- Analysis of Upcycled Mask Concrete with different Types of Curing.
- Comparative study of different fibre specimen with Conventional Concrete and Self Cured Concrete specimen.

CHAPTER 3

METHODOLOGY

For a sustainable and economical construction, concrete should have proper proportioning of material in the order to develop a sufficient strength. This will serve its purpose during its service condition. As a result, we are employing Design Mix as per I.S. Guidelines to overcome the following issues, resulting in proper durable concrete. The methodology for the construction of concrete cube blocks and concrete cylinders in accordance with Indian Standard code is as follows:

The process of mix design of cement concrete is to determining the proportion of various materials like cement, water, aggregates, and admixtures to achieve the desired properties of concrete. It ensures the strength, workability, and durability of the concrete and is crucial for safe and reliable construction. All the necessary materials such as cement, aggregates, water, reinforcing fibers (disposable mask fiber), and self-curing admixture (PEG-6000) are procured and stored in a safe and secure manner. The materials are proportioned as per the mix design specified in the Indian Standard code.

The materials are mixed in a concrete mixer as per the Indian Standard code, ensuring that the mix is homogeneous and free of lumps. The mixed concrete is cast into cube blocks and cylinders using standard moulds, ensuring that they are properly compacted and vibrated to remove any air voids. The cube blocks and cylinders are cured as per the Indian Standard code, using standard curing methods such as water curing or steam curing, to ensure that the concrete gains the desired strength and durability. The cube blocks and cylinders are tested for compressive strength as per the Indian Standard code to ensure that they meet the desired strength requirements.

Further investigation is carried out by adding disposable mask fibers to the concrete mix in varying proportions (0.1%, 0.15%, 0.20%, and 0.25%) by volume of concrete to enhance the mechanical properties of concrete the optimum dosage of disposable mask fiber is determined, and further investigation is carried out by adding self-curing admixture (PEG-6000) in proportions of 1% and 1.5% by weight of cement to the concrete mix to evaluate the effectiveness of the self-curing admixture. The results of standard concrete, disposable mask concrete, and self-cured concrete are compared to evaluate the effectiveness of the disposable mask fiber and self-curing admixture in enhancing the mechanical properties of the concrete.

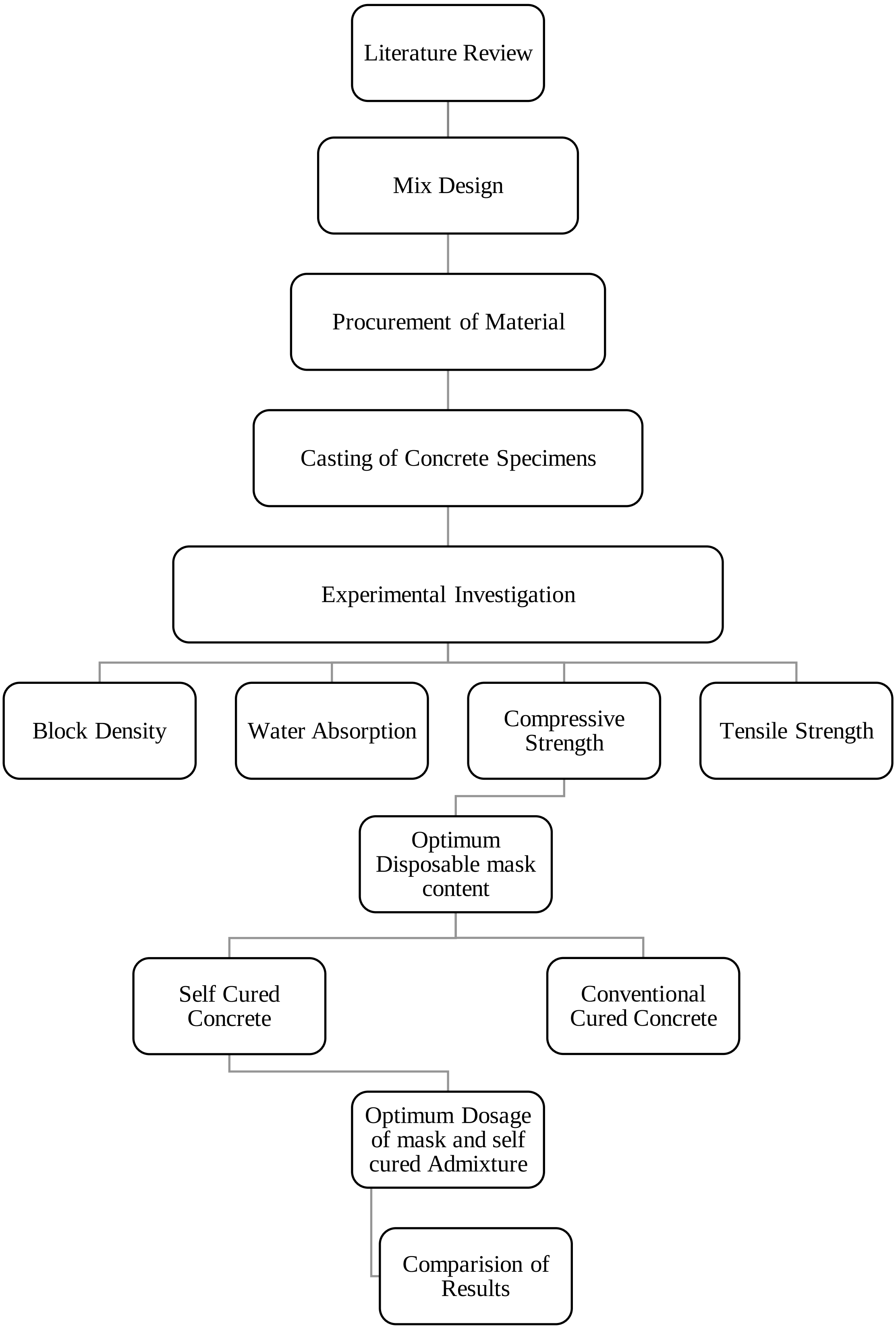

Fig 3.1: Methodology

3.1 DESIGN MIX PROPORTIONING OF M20 GRADE OF CONCRETE

The Mix Proportions of M 20 grades are proportioned by considering norms given in I.S. 20262:2019 and I.S. 456 and are as follows:

Table 3.1: Material testing data

M20	
Cement Used	PPC
Specific gravity - cement	3.12
Specific gravity - Coarse aggregate	2.66
Specific gravity - Fine aggregate	2.61

1. **Target Strength of Design Mix**

$$f_m = f_{ck} + 1.65\sigma$$

$$f_m = target\ average\ compressive\ strentgh\ at\ 28\ days$$

$$f_{ck} = characterstic\ compressvie\ strength\ at\ 28\ days$$

$$\sigma = standard\ deviation$$

$$\sigma = 4N/mm^2$$

target mean strength = 20+1.65×4

= 26.6 N/mm^2

2. **Calculation of w/c ratio**

adopt Water Cement ratio = 0.56 @ Fig: 1 I.S.20262:2019

Max water cement ratio = 0.60

(Moderate exposure in reinforced concrete)

Therefore, adopting w/c = 0.56

Hence OK

3. **Calculation of water content**

For 20mm aggregate, maximum water content =186 kg/m^3(25-50mm slump)

4. **Calculation of weight of Cement**

w/c ratio = 0.56

cement content = 186/0.56 = 332.1 kg/m^3

332.1 kg/m^3> 250 kg/m^3

5. **Calculation for Volume of cement, water**

Volume of cement= 332.1/3120 = 0.106m^3

Volume of water = 186/1000 = 0.186 m^3

Total Volume, V_1 = 0.292m^3

6. Finding remaining Volume in 1 cum

V_2= 1-V_1= 1- 0.292= 0.708m^3

This is occupied by coarse and fine aggregate

V_2 is volume of all in aggregate

% Coarse Aggregate= 0.62

% Fine Aggregate = 1- 0.62 = 0.38

Mass of Coarse Aggregate = 0.708×0.62×2660 = 1168 Kg

Mass of Fine Aggregate = 0.708×0.38×2620 = 705 kg

Mix Proportion of Trial mix of 1 m^3 of concrete

- Cement = 332 kg/m^3
- Water = 186 kg/m^3
- Fine Aggregate = 705 kg/m^3
- Coarse Aggregate = 1168 kg/m^3
- w/c ratio = 0.56

Design Ratio: 1: 2.12: 3.51

3.1.1 CALCULATION OF PERCENTAGE OF FIBER

x% of fiber in concrete (vol./vol.) It means adding x% volume of fiber in 100% volume of concrete. So, taking 1 $m^3$of concreteand 0.1% fibre.

1 m^3 of concrete contains 1/1000 m3 of fibre

So, 1000 m^3 of concrete contains 1 m3 of fibre

Similarly, 1000 cm^3 of concrete contains 1 cm^3 of fibre

Since, Specific gravity of fiber = 0.9

Therefore, 1000 cm^3 of concrete contains 1 x 0.9 = 0.91 gm of fibre.

Now,

Vol. of one cube specimen = 15 x15 x 15 = 3375 cm^3

Vol. of 6 cube specimen = 3375 x 9 = 30375 cm^3

Vol. of one cylindrical specimen = πr^2h = 3.14 x 7.5^2 x 30 = 5300 cm^3

Vol. of 6 cylindrical specimen = 5300 x 6 = 31800 cm^3

Total vol. of concrete casted at once = 30375 + 31800 = 62175 cm^3

Therefore, weight of 0.1% fiber required = 0.91 x 62175/1000 = 56.579 gm = 57 gm

Considering losses that some of the fiber get sticked to the inner surface of mixer, we have added 60 gm of fiber as 0.1% fiber.

Similarly, to calculate the weight required for 0.15% and 0.20% fiber multiply that of 0.1% with 1.5 and 2 respectively i.e.,1.5 x 60 = 90 gm for 0.20% and 2 x 60 = 120 gm.

Table 3.2: Design Mix with different Fiber composition

Sample	W/C	Cement (kg/m^3)	Fine Aggregate (kg/m^3)	Coarse Aggregate (kg/m^3)	Mask Content (kg/m^3)
CM 0	0.56	332	705	1168	0
CM 10	0.56	332	705	1168	0.91
CM 15	0.56	332	705	1168	1.37
CM 20	0.56	332	705	1168	1.82
CM 25	0.56	332	705	1168	2.38

3.1.2 CALCULATION OF SELF-CURING ADMIXTURE (PEG-600)

The self-curing admixture to be used is PEG-6000 and is used in two different proportion as 1% and 1.5% by weight of cement with the optimum dosage of shredded mask fiber as obtained from our investigation

Table 3.3: Design mix of self-cured specimen

Sample	W/C	Cement (kg/m^3)	Fine Aggregate (kg/m^3)	Coarse Aggregate (kg/m^3)	Mask Content (kg/m^3)	PEG-600 (kg/m^3)
CM 0 SC 1	0.56	332	705	1168	1168	3.32
CM 0 SC 1.5	0.56	332	705	1168	1168	4.98
CM 10 SC 1	0.56	332	705	1168	1168	3.32
CM 10 SC 1.5	0.56	332	705	1168	1168	4.98

3.2 SPECIFICATION OF MATERIAL USED

The systematic sequence of laboratory tests was carried out to meet the study's aims. The precise specification and description of the materials used in experiments are included in this section. Additionally, the fundamental assessments of cement, sand, and aggregates are made, ensuring their suitability for future studies.

3.2.1 PORTLAND POZZOLONA CEMENT (PPC) (I.S. 1489-1991)

PPC (Portland Pozzolana Cement) is a form of hydraulic cement made by combining pozzolanic ingredients with Portland cement clinker and gypsum. The pozzolanic ingredient, which can be fly ash, volcanic ash, or calcined clay, combines with the calcium hydroxide generated during cement hydration to form more cementitious compounds, yielding a denser and more durable concrete.

The pozzolanic action is shown below:

Calcium hydroxide + Pozzolana + water →C – S – H (gel)

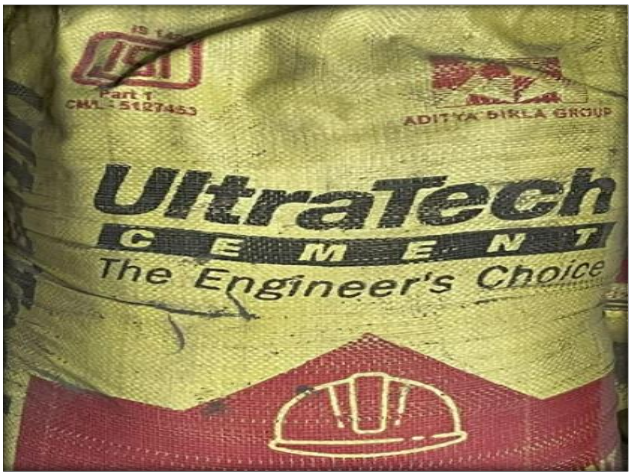

Fig 3.2: Ultratech cement bag

During the manufacturing process of PPC, the raw materials, including limestone, clay, shale, and pozzolanic material, are crushed and blended to a fine powder, which is then heated in a kiln at high temperatures to form clinker. The clinker is then ground with gypsum to produce the final product. PPC is widely used in various construction applications, including residential, commercial, and infrastructure projects, due to its enhanced durability, reduced heat of hydration, and lower carbon footprint. It is also suitable for use in marine and coastal construction due to its higher resistance to chloride and sulphate attacks.When mixed with water, PPC undergoes a chemical reaction called hydration, which results in the formation of a paste that binds the aggregates together to form concrete.

3.2.1.1 TEST ON CEMENT

3.2.1.1.1 SOUNDNESS TEST

The soundness test is an important test conducted on cement to determine its ability to resist volume changes that occur after it has set. The test is performed by mixing a cement paste and filling it into a mould. The mould is then placed in a steam bath at a temperature of 27 degrees Celsius for 16 hours. After this, the mould is removed from the steam bath and allowed to cool. The paste is then removed from the mould and immersed in water for 24 hours.

If the cement is sound, the paste will not show any signs of cracking or distortion, indicating that it has retained its volume and strength. However, if the cement is unsound, the paste will show cracks and distortion, indicating that it has undergone a volume change is because of the presence of excessive amounts of unburnt lime or magnesia

The outcomes of lab test are listed below:

Soundness/expansion of cement = $S_1 - S_2$

S_1=Measurement taken after 24 hours of immersion in water at a temp. of 27 ± 20 C

S_2=Measurement taken after 3 hours of immersion in water at boiling temperature.

S1= 2.3cm

S_2= 1.8cm

Soundness = 2.3 - 1.8 = 5mm

The maximum value of PPC soundness by Le-Chatelier's test technique is 10 mm, however our result is 5 mm, indicating that the cement used in this study is reasonably sound. This conforms to IS:1489-1991 (part 1).

3.2.1.1.2 NORMAL CONSISTENCY

A standard cement paste is one that allows a vicat plunger with a 10 mm diameter and 50 mm length to penetrate to a depth of 5-7 mm from the mould's bottom. The normal consistency for PPC, according to our lab test, is 36%.

3.2.1.1.3 INITIAL AND FINAL SETTING TIME

The time between adding water to the cement and the point at which a 1 mm square section needle inserted 5 to 7 mm from the bottom of the Vicat's mould is unable to penetrate the cement paste is referred to as the initial setting time.

Final setting time is defined as the time between the addition of water to the cement and the point at which a 1 mm needle leaves an impression on the paste in the mould but a 5 mm attachment leaves no trace.

The outcomes of lab test are listed below:

Initial setting time = $t_2 - t_1$

Final setting time = $t_3 - t_1$

t_1=first time when water is added to cement

t_2=Time when needle fails to penetrate 5 mm to 7 mm from bottom of the mould

t_3=Time when makes an impression but the attachment fail.

t1 = 0 mins, t2 = 40 mins, t3 = 8 hrs. 15 mins

So, IST**= 40 mins and FST= 8 hrs. 15 mins**

According to IS code, the lowest value for IST is 30 minutes, while the maximum value for FST is 600 minutes or 10 hours. We are able to clearly discern that our values fall within the parameters specified in the IS code.

3.2.2 AGGREGATE USED

Aggregate is a necessary component of concrete. They provide body to concrete, reduce shrinkage, and have an economic influence. Aggregates were formerly assumed to be chemically inert materials, however it is now known that some aggregates are chemically active and that when mixed with paste, some aggregates form chemical connections. Given that aggregates account for 70-80% of the volume of concrete, it is obvious that they have a substantial impact on the material's varied characteristics and properties. grasp concrete requires a better grasp of the aggregates, which make up the majority of the volume. Concrete research would be incomplete without a thorough evaluation of the aggregate.

3.2.2.1 TEST ON AGGREGATE

3.2.2.1.1SPECIFIC GRAVITY OF COARSE AGGREGATE

The specific gravity of coarse aggregate is a measure of its density relative to the density of water. It is an important property of coarse aggregate because it affects the weight, volume, and strength of the concrete.

Fig 3.3: coarse aggregate 20mm

The specific gravity of coarse aggregate is calculated first by washing and drying the aggregate to remove any dirt or debris. Then, a sample of the aggregate is weighed and placed in a container filled with water. The weight of the container and the aggregate is recorded, and the container is then agitated to remove any trapped air bubbles. The weight of the container and the aggregate submerged in water is recorded, and the specific gravity of the aggregate is calculated as the ratio of the weight of the aggregate to the weight of an equal volume of water.

The specific gravity of coarse aggregate typically ranges from 2.5 to 2.9, with higher values indicating denser and stronger aggregate. This information is important in determining the mix design of concrete and in ensuring that the concrete meets the required strength and durability standards.

The lab Result of test are as follows:

Specific Gravity = $\frac{Weight\ of\ dry\ aggregate}{Equivalent\ weight\ of\ water}$

$= \frac{2.64}{2.64-1.65}$

= **2.66**

$Weight\ of\ dry\ aggregate$ = 2.64

$Equivalent\ weight\ of\ water$ = 1.65

3.2.2.1.2 SPECIFIC GRAVITY OF FINE AGGREGATE

The specific gravity of fine aggregate is a measure of its density relative to the density of water. It is an important property of fine aggregate because it affects the weight, volume, and strength of the concrete.

Fig 3.4: fine aggregate

$$\text{Specific Gravity} = \frac{d}{a-(b-c)}$$

$$= \frac{530}{550-347}$$

= 2.61

a= weight of saturated surface-dry aggregate in gram

b= weight of pycnometer containing water in gram

c= weight in of pycnometer containing only water

d= weight of oven-dried aggregate in gram.

The specific gravity range for aggregates, according to IS: 2386 - Part - 3, is between 2.5 and 3, and since our results fall within this range, the aggregates we used are acceptable.

3.2.3 FIBRE USED

For conducting experimental investigation in this project, we have used disposable 3 ply surgical face mask under the brand name SAFESHIELD having dimension of 17.5*9.5 cm and they are also commonly known as polypropylene fibrillated fibre.

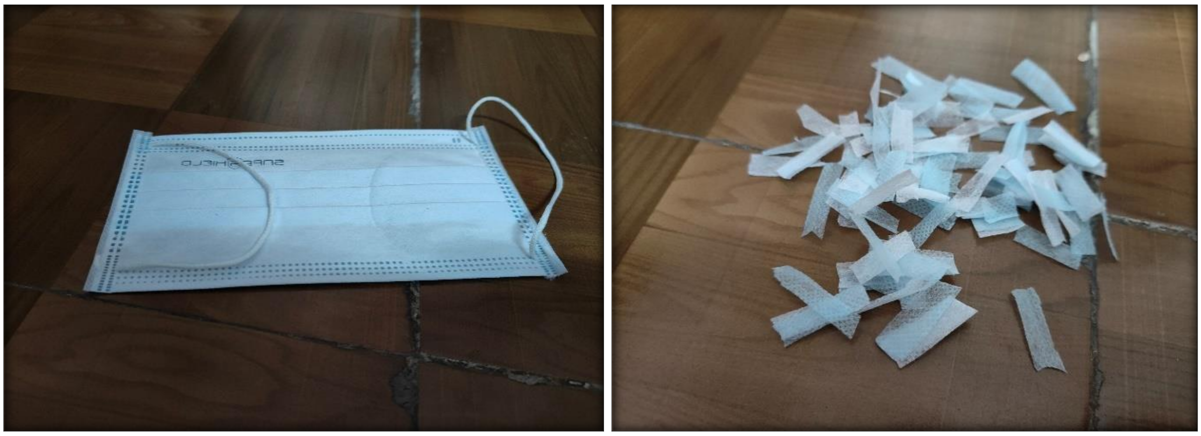

Fig 3.5: Shredded disposable face mask

For the Casting purpose in our investigation, they are shredded in 2*0.5 cm dimensions. If the dimensions are greater than preferred then there are chances of forming clumps into the wet concrete and get not properly distributed in our concrete and not serve the purpose of reinforcing the fiber and if the fiber used are smaller than preferred then the fiber may not provide suitable bonding action into the concrete.

The specification of mask used in our study are as follows:

Table 3.4: Physical Properties of Disposable mask

Physical Properties	SFM (Shredded Face Mask)
Specific Gravity	0.91
Melting Point (C)	160
Water Absorption 24h (%)	8.9
Tensile Strength (Mpa)	3.97
Aspect Ratio	24

3.2.4 CASTING PROCEDURE

The casting procedure for concrete specimens is adopted as per the Indian standard code (IS 516:1959) is as follows:

1. The moulds for casting the concrete specimens (cubes or cylinders) made of cast iron should be cleaned, and free from rust or other foreign material.

2. The moulds are then should be coated with a thin layer of oil or grease to facilitate the removal of the hardened concrete.

3. The concrete mix is prepared as per the design mix, and the ingredients should be thoroughly mixed to achieve a homogeneous mixture in the rotating mixer. Th following precaution should be taken care during the casting of concrete specimens

a. All the ingredient should be clean and not contain any foreign impurity in material and all the material should be tested before casting.

b. The shredded masks are added after dry mixing of all the material.

c. The shredded mask is added in 3 layers so that the proper uniformity of shredded mask can be maintained and reduce the chances of forming clumps into the wet concrete.

Fig 3.6: Dry mixing with shredded face mask

4. The moulds should be placed on a level, smooth, and rigid surface, and the concrete mix should be poured into the moulds in three layers, each layer is vibrated on vibrating table.

5. After the final layer is added, the surface of the concrete should be finished off smoothly and left to set.

6. The mould should be kept undisturbed for 24 hours.

7. After 24 hours, the specimens should be removed from the moulds and marked with the relevant information such as date of casting, batch number, and type of specimen.

Fig 3.7: Demolding after 24h

8. The specimens should then be cured as per the relevant curing procedure, and tested as per the relevant standards.

Cube Specimens description

Cube size: cube mould of size 150*150*150mm

Total Number of cube casted: 81

Cylinder Specimen description

Cylinder size: cylinder mould of 300mm height and 150 mm diameter

Total number of cylinder casted: 54

3.2.5 TESTING PROCEDURE

The cube and cylinder specimens are tested on 3,7, and on 28th day in compressive testing machine for determine the compressive and split tensile strength respectively

3.2.5.1 CONCRETE CUBE TESTING

The specimens were tested using compression testing machine with a 2000kN capacity in accordance with IS 516:1969. With the help of a control valve, we can regulate the rate of loading and uniform rate of loading 140 kg/cm²/min is maintained. The maximum load that the cube can withstand is recorded and the compressive strength of the cube is calculated as load upon area of cube specimen. The maximum load at failure at which the specimen breaks and the average value of 3 specimen is taken as the mean strength on 3,7, and on 28th day respectively.

Fig 3.8: Testing of concrete cube

3.2.5.2 CONCRETE CYLINDER TESTING

The cylinder specimens are tested in accordance to IS 5816:1999. The load must be applied gradually and continuously at a nominal rate between 1.2 N/ (mm^2/min) and 2.4 N/ (mm^2/min) and maintained until failure and maximum load is noted. The rate of load increase can be determined using the following equation: (1.2 to 2.4) $* \frac{\pi}{2} * h * d$N/min. In this test, compression loads are applied along two diametrically opposed axial lines to a cylinder with a 150mm diameter and 300mm height.

Fig 3.9: Testing of Cylinder

The split tensile strength is calculated as

$$f_t = \frac{2p}{\pi h d}$$

P = maximum load at failure in N

h = height of specimen in mm

d = diameter of specimen in mm

CHAPTER 4

RESULTS AND DISCUSSION

The result and analysis chapter of this report is aimed at presenting and interpreting the findings obtained from the experimental investigation. In this chapter, we will provide a detailed account of the tests conducted on the concrete specimens prepared using different proportions of disposable masks and PEG-6000 as a self-curing admixture. The main objective of this investigation was to determine the optimum dosage of disposable masks and self-curing admixture to enhance the mechanical properties of concrete. The analysis of the results will involve the interpretation of the data and the correlation between the experimental findings and the theoretical framework. This chapter will provide a comprehensive understanding of the effect of the disposable mask and self-curing on mechanical properties of concrete. The findings of this study will contribute significantly to the body of knowledge on the use of disposable masks and self-curing admixtures in the production of concrete.

4.1 DENSITY OF CONCRETE SPECIMENS

The density of various concrete specimen is shown below:

4.1.1 DENSITY OF CONCRETE CUBE

Table 4.1: Density of concrete cube specimens (Units of Density is (Kg/ m^3))

Sample	CM 0	CM 10	CM15	CM 20	CM 25
1	2397	2406	2418	2433	2326
2	2424	2451	2409	2411	2374
3	2401	2389	2415	2427	2323
4	2409	2439	2427	2409	2385
5	2379	2377	2421	2439	2397
6	2415	2421	2421	2421	2374
7	2432	2437	2385	2417	2463
8	2397	2396	2467	2435	2398

9	2386	2423	2414	2429	2412
Average Density (Kg/ m^3)	2404	2415	2420	2424	2383

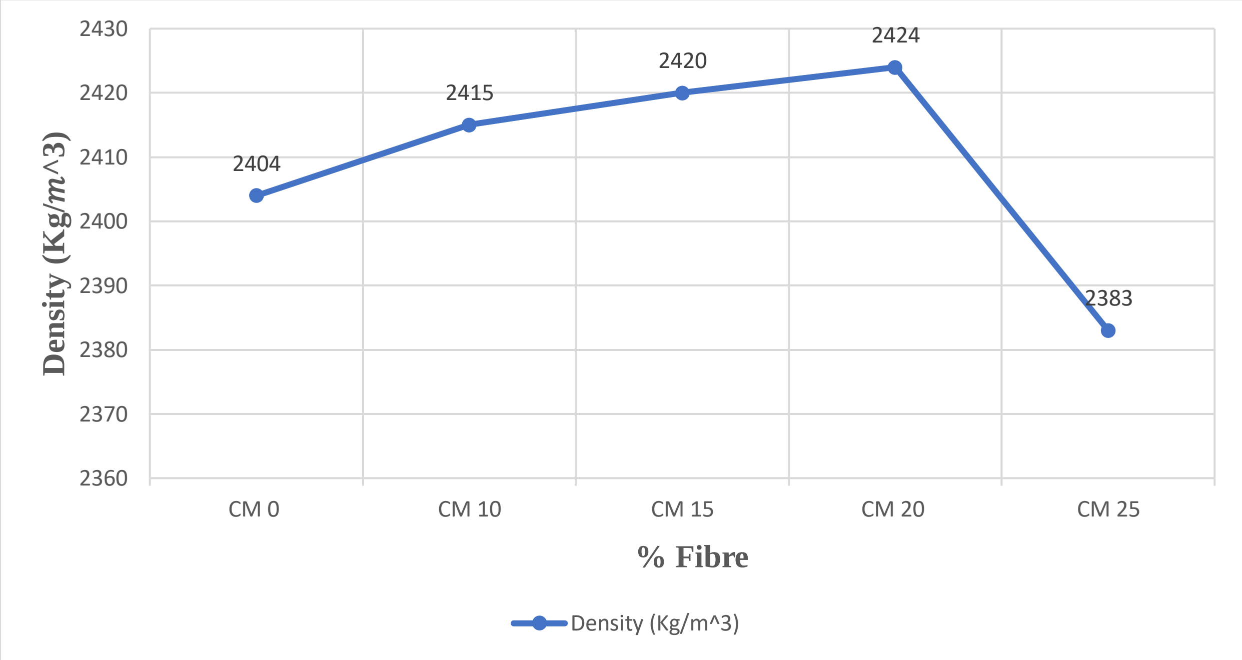

Fig 4.1: Density of concrete cube specimens

4.1.2 DENSITY OF CONCRETE CYLINDERICAL

Table 4.2: Density of concrete cylinder specimens (Units of Density is (Kg/ m^3))

Sample	CM 0	CM 10	CM 15	CM 20	CM 25
1	2281	2337	2328	2328	2324
2	2372	2371	2431	2326	2379
3	2362	2343	2396	2389	2341
4	2460	2393	2387	2467	2406
5	2298	2339	2417	2413	2399

6	2362	2479	2335	2391	2353
Average	2355	2377	2382	2385	2367

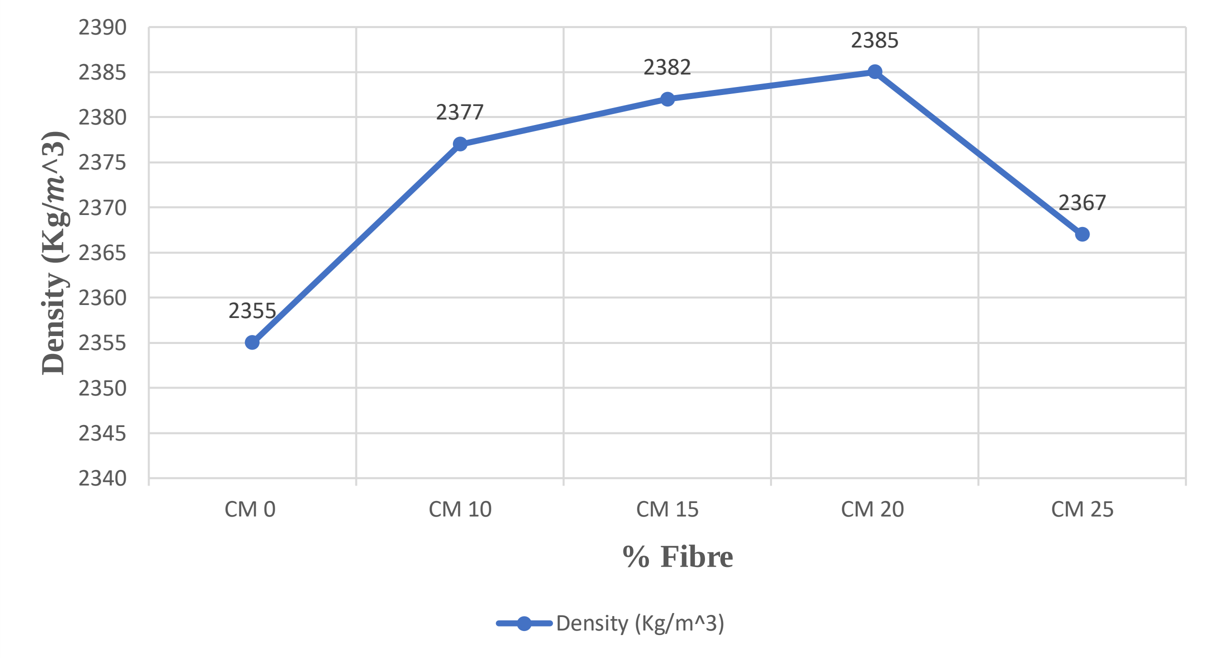

Fig 4.2: Density of concrete cylinder specimens

The density of standard concrete lies in the range of 2300-2500 Kg/m^{3}. It can be concluded from the results that the density of cubes and cylinder is lying within the standard range indicating that the cubes were well compacted. Also, it can be well concluded from the results that density of concrete cube specimen is increasing as we are increasing the mask percentage up to 0.2% addition of shredded disposable masks and the maximum density is obtained at 0.2% fiber content after then the density starts decreasing. Moreover, the fibers can help to reduce the porosity of the concrete by filling the voids between the aggregates, which can lead to a denser and more compact concrete matrix.

4.2 WATER ABSORPTION (%) OF CONCRETE SPECIMENS

The water absorption of various concrete specimen is shown below in table below:

4.2.1 WATER ABSORPTION OF CONCRETE CUBE

Table 4.3: water absorption (%) of concrete cube specimens

Sample		CM O	CM 10	CM15	CM 20	CM 25
1	3-days	0.37	0.49	0.59	0.60	0.73
2		0.33	0.58	0.55	0.59	0.65
3		0.37	0.54	0.57	0.60	0.69
Average water absorption		0.36	0.54	0.57	0.59	0.69
4	7-days	0.43	0.54	0.69	0.73	0.72
5		0.49	0.61	0.61	0.62	0.75
6		0.46	0.58	0.55	0.68	0.74
Average water absorption		0.46	0.57	0.61	0.67	0.74
7	28-days	1.12	1.25	1.10	1.34	1.50
8		0.98	1.46	1.29	1.43	1.41
9		1.05	1.36	1.20	1.39	1.46
Average water absorption		1.05	1.35	1.20	1.38	1.45

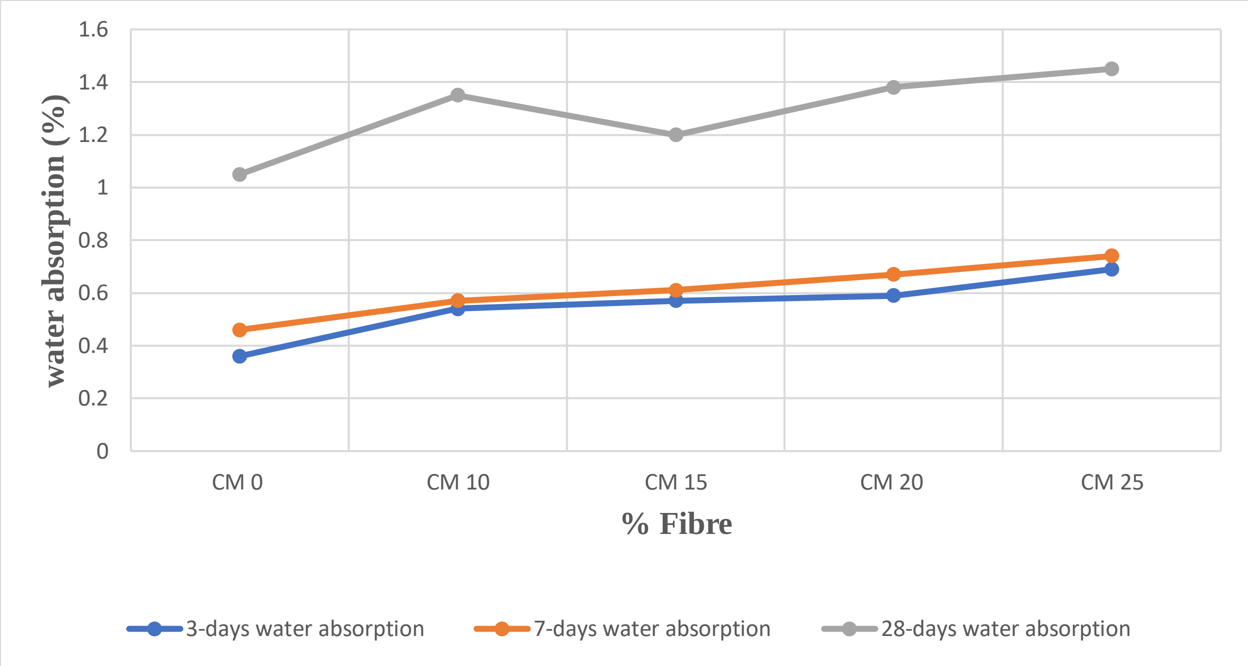

Fig 4.3: water absorption (%) of concrete cube specimens

4.2.2 WATER ABSORPTION (%) OF CONCRETE CYLINDER

Table 4.4: water absorption (%) of concrete cylinder specimens

Sample		CM 0	CM 10	CM 15	CM 20	CM 25
1	3-days	0.19	0.32	0.37	0.41	0.54
2		0.23	0.37	0.42	0.49	0.52
Average water absorption		0.21	0.34	0.39	0.45	0.53
3	7-days	0.41	0.48	0.47	0.65	0.61
4		0.44	0.51	0.49	0.58	0.69

Average water absorption		0.42	0.49	0.48	0.62	0.65
3	28-days	0.73	0.81	0.98	1.10	1.22
		0.78	0.92	0.98	1.13	1.38
Average water absorption		0.75	0.86	0.98	1.11	1.3

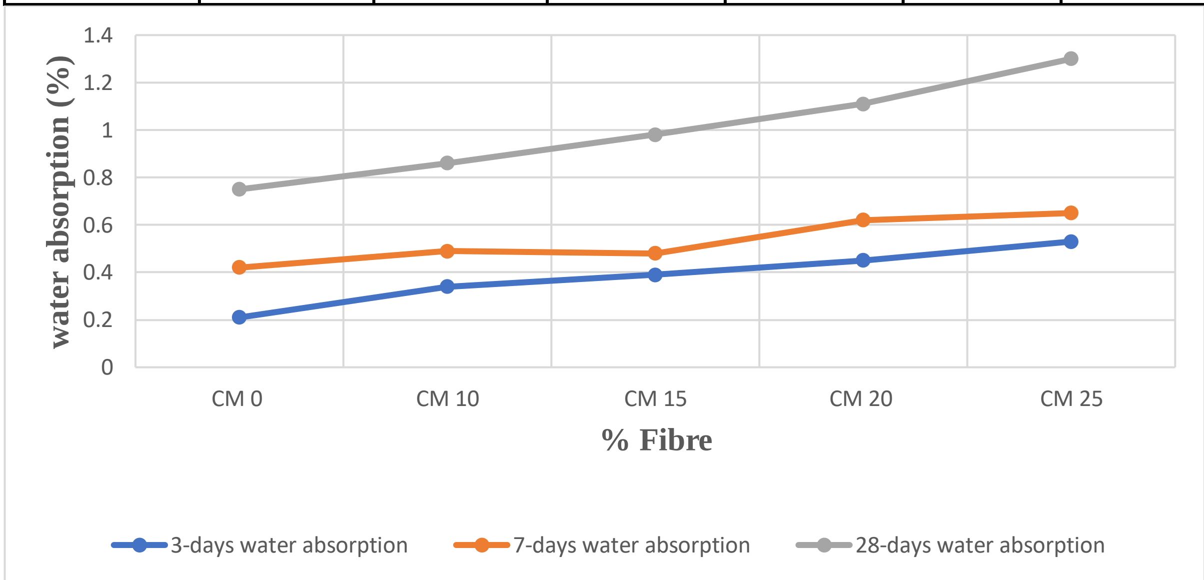

Fig 4.4: water absorption (%) of concrete cylinder specimens

From the above data we can conclude that the water absorption is increasing gradually as we are increasing the disposable mask content and the maximum water absorption is obtained at 0.25% fiber of mask content on 3-days, 7-days and on 28th day. The increase in water absorption of concrete after reinforcing with disposable masks can be attributed to the fact that the masks are made of non-woven polypropylene fibers, which are highly porous and hydrophilic in nature. During the mixing process, these fibers absorb water from the mix and remain saturated, leading to an increase in the overall water content of the concrete mix. This excess water can cause an increase in the porosity of the concrete and decrease its strength and durability. Additionally, the voids created by the fiber in the concrete can act as channels for water ingress, further increasing the water absorption of the concrete.

4.3 COMPRESSIVE STRENGTH OF CONCRETE CUBE SPECIMENS

Table 4.5: Compressive Strength of concrete cube specimens

Sample		CM 0	CM 10	CM15	CM 20	CM 25
1	3-days	9.32	18.36	15.33	15.37	14.44
2		10.19	16.47	15.10	14.93	15.55
3		9.65	17.82	15.88	15.22	14.08
Average Compressive strength		9.72	17.55	15.43	15.17	14.69
4	7-days	15.73	20.31	18.84	17.86	16.69
5		15.52	23.56	18.71	17.29	15.31
6		16.36	21.23	18.84	17.89	16.89
Average Compressive strength		15.87	21.7	18.79	17.68	16.29
7	28-days	26.69	33.56	29.29	24.62	26.8
8		26.64	32.97	30.84	25.13	23.64
9		26.79	33.53	30.28	25.62	25.71
Average Compressive strength		26.71	33.35	30.13	25.12	25.38

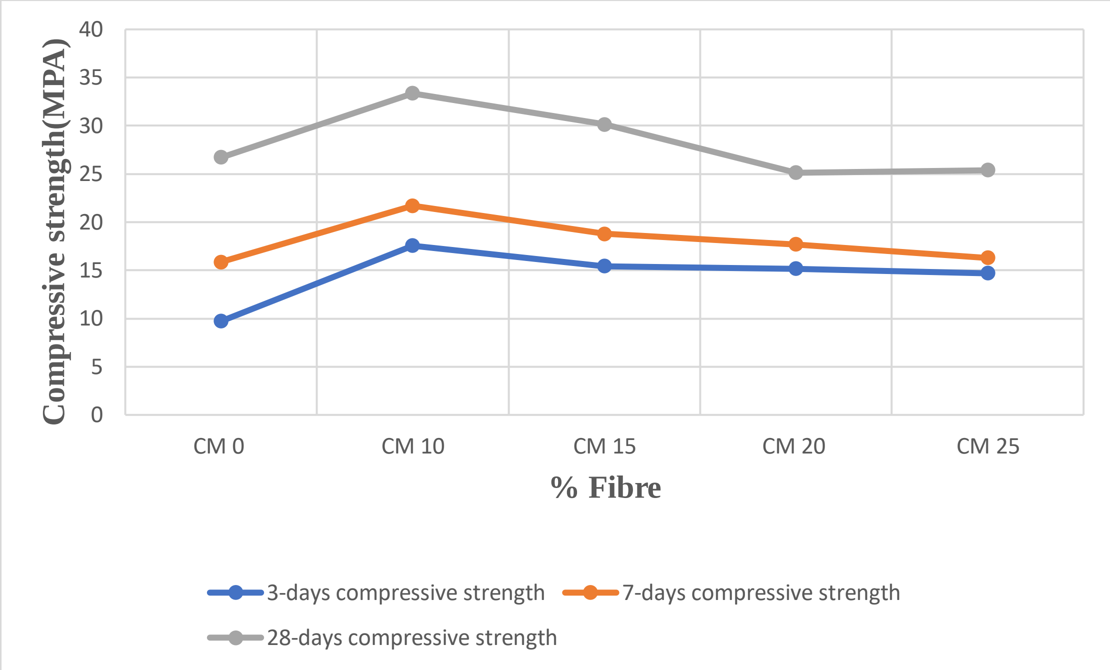

Fig 4.5: Compressive strength of concrete cube specimens

The 3-days compressive strength of standard cubes should be near to 45% of strength of cube (0.45×20 = 9 MPA) and from the above data we can conclude that compressive strength of all the cubes is greater than 9 MPA. The 7 days compressive strength of standard cubes should be near to (0.65×26.6 = 17.29 MPA) and the 28-day compressive strength is greater than 20MPA as desired. From the above data we can also conclude that the maximum 3-days, 7-days and 28-day compressive strength is obtained at 0.1% mask content which shows the increase of 24.85%over the compressive strength further increase in mask content is reducing the compressive strength of concrete. Due to addition of shredded disposable masks providing better bonding between the constituents and fibers act as a barrier to the propagation of cracks, which can lead to improved resistance to cracking and spalling, and therefore, an increase in compressive strength.

4.4 SPLIT-TENSILE STRENGTH OF CONCRETE CYLINDRE SPECIMENS

Table 4.6: Split-tensile strength of concrete cylinder specimens

Sample		CM 0	CM 10	CM 15	CM 20	CM 25
1		0.75	1.43	1.49	2.29	1.36

2	3-days	0.89	1.44	1.56	2.06	1.84
Average split-tensile strength		0.82	1.43	1.53	2.16	1.60
3	7-days	1.64	1.95	2.05	2.64	1.92
4		1.57	1.87	2.64	2.43	2.27
Average split-tensile strength		1.61	1.91	2.34	2.53	2.09
5	28-days	2.90	3.40	3.37	3.48	3.00
6		2.98	3.28	3.37	3.79	3.82
Average split-tensile strength		2.94	3.34	3.37	3.63	3.41

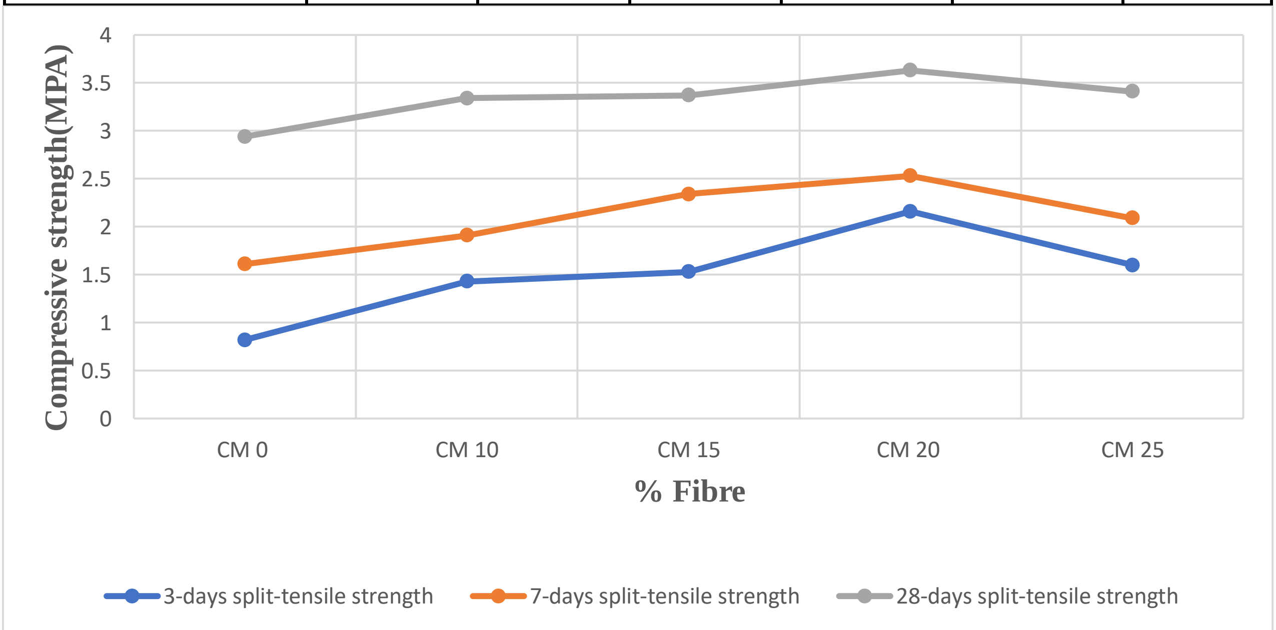

Fig 4.6: Split-tensile strength of concrete cylinder specimens

The 28-days split tensile strength of the standard cylinder is near to 2-3MPA and from the above data we can conclude that all the specimens are lying near to that range. From the above data we can also conclude that the maximum 3-days, 7-days and 28-days split tensile strength is obtained at 0.2% mask dosage. The addition of disposable mask in concrete enhances its tensile strength because the fibers in the mask act as reinforcement and help to distribute the load more evenly throughout the concrete. This results in a reduction of localized stress concentration, which in turn increases the concrete's resistance to cracking and failure under tensile loading.

4.5 DENSITY OF SELF-CURED CONCRETE SPECIMENS

4.5.1. DENSITY OF SELF-CURED CONCRETE CUBE

Table 4.7: Density of self-cured concrete cube specimens

Sample	CM 0 SC 1	CM 0 SC 1.5	CM 10 SC 1	CM 10 SC 1.5
1	2413	2385	2437	2387
2	2423	2439	2416	2432
3	2412	2433	2442	2395
4	2409	2403	2412	2467
5	2429	2419	2370	2413
6	2429	2426	2400	2431
7	2395	2384	2441	2413
8	2387	2412	2397	2420
9	2415	2405	2432	2397
Average Density	2412	2411	2416	2417

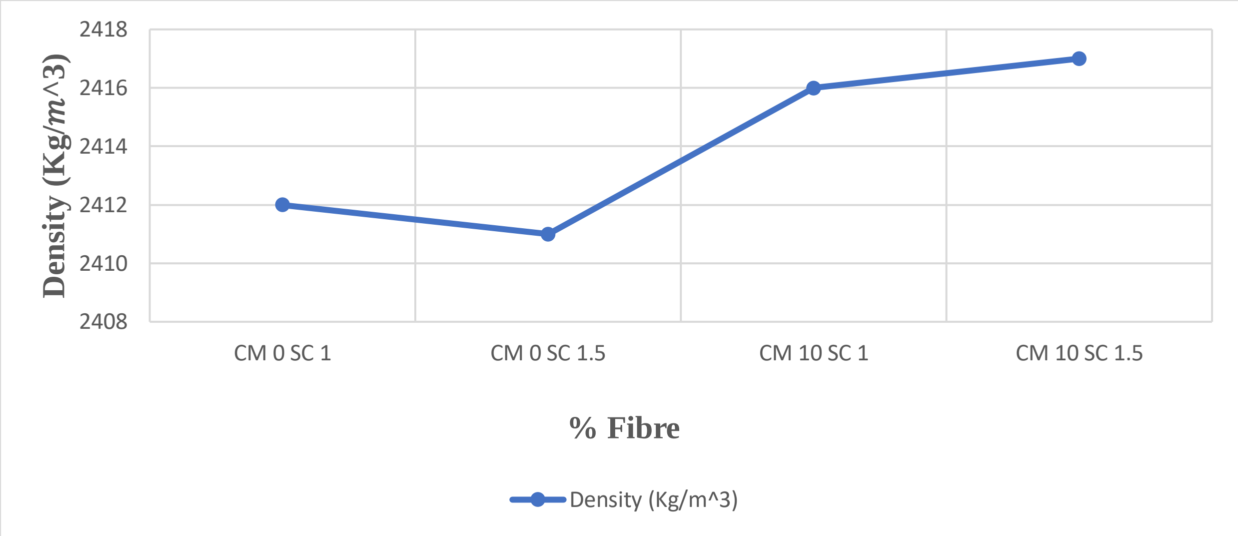

Fig 4.7: Density of concrete cube specimens

4.5.2 DENSITY OF SELF-CURED CONCRETE CYLINDER

Table 4.8: Density of self-cured concrete cylinder specimens

Sample	CM 0 SC 1	CM 0 SC 1.5	CM 10 SC 1	CM 10 SC 1.5
1	2378	2415	2363	2362
2	2365	2362	2402	2413
3	2413	2356	2417	2378
4	2405	2416	2342	2412
5	2314	2354	2392	2389
6	2387	2398	2408	2379
Average Density	2377	2383	2387	2388

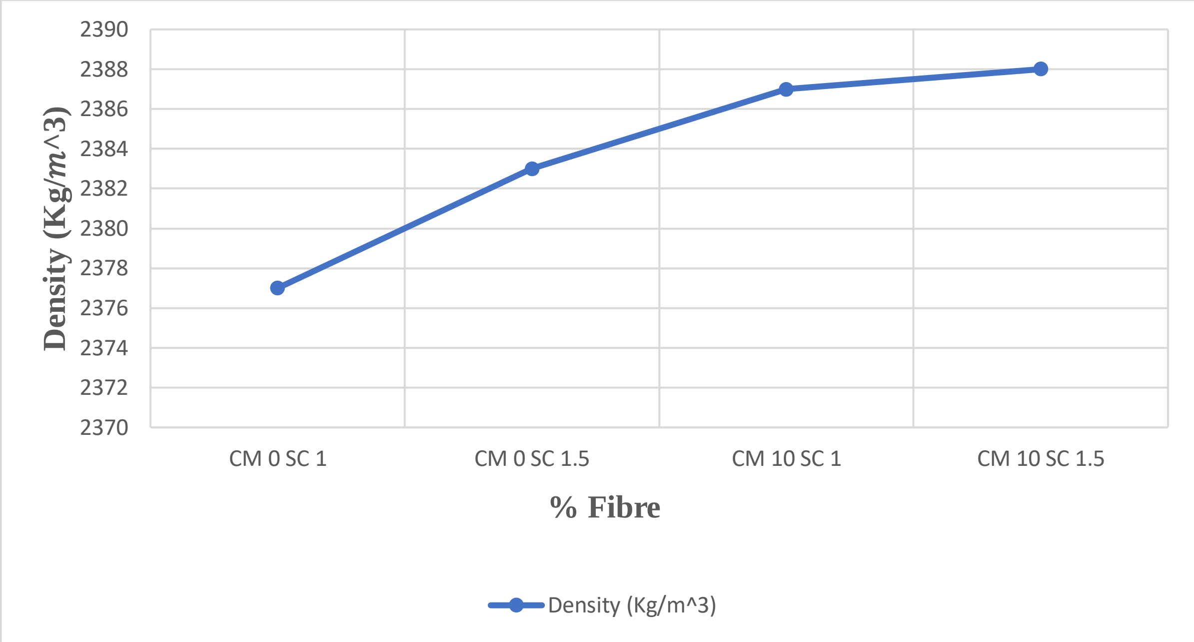

Fig 4.8: Density of concrete cylinder specimens

The density of standard cylinder is in between 2300 (Kg/ m^3) to 2500 (Kg/ m^3) and from the above data we can conclude that the density of self-cured concrete cubes is lying in the standard range which shows the concrete cubes are well compacted. From the above data we can conclude that there is no appreciable change in density of concrete cubes after the addition of self-curing admixture. We can also interpret that there is there is not that much significant amount of increase over density even after the addition of shredded disposable masks.

4.6 COMPRESSIVE STRENGTH OF SELF-CURED CONCRETE CUBE SPECIMENS

Table 4.9: Compressive Strength of self-cured concrete cube specimens

Sample		CM 0 SC 1	CM 0 SC 1.5	CM 10 SC 1	CM 10 SC 1.5
1	3-days	10.93	10.78	10.36	11.27
2		10.93	10.26	9.79	11.67
3		11.12	10.26	10.68	9.37
Average Compressive Strength		10.99	10.43	10.27	10.77

4	7-days	15.64	14.18	15.13	15.60
5		16.22	14.62	16.06	15.51
6		16.19	14.89	15.43	16.34
Average Compressive Strength		16.02	14.56	15.54	15.82
7	28-days	27.89	23.37	27.91	24.69
8		25.44	24.49	26.86	25.35
9		27.56	22.57	27.28	25.93
Average Compressive Strength		26.96	23.48	27.35	25.32

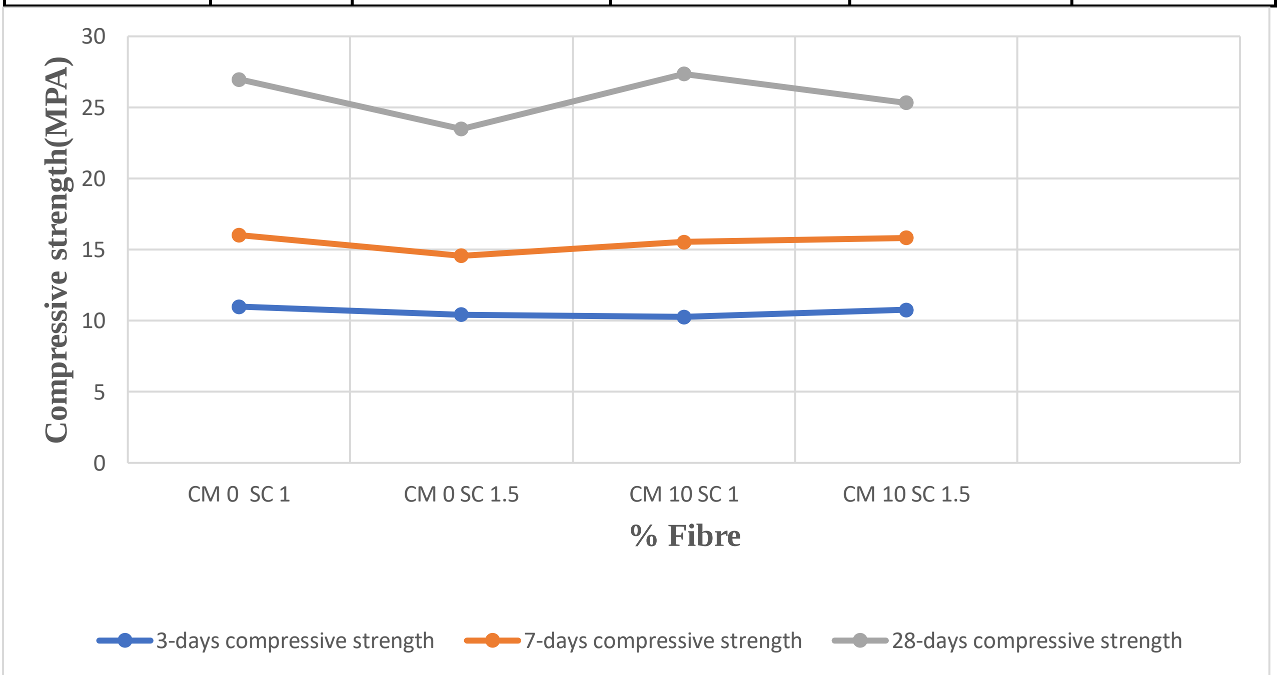

Fig 4.9: Compressive Strength of self-cured concrete cube specimens

From the above data we can conclude that the maximum 3-days,7-days and 28-days compressive strength is obtained at 0.1% mask dosage and 1% PEG-6000. Due to unavailability of external curing water self-cured disposable mask concrete is not able attain as much strength as compared to that disposable mask concrete getting with that of conventionally cured disposable mask concrete because PEG-6000 works on reducing the moisture by evaporation from the concrete. Although there is increase of 0.94% of compressive strength of self-cured concrete at 1% of PEG-6000 dosage and 2.39 % of increase over compressive strength at 1% PEG-6000 content of self-cured concrete containing disposable mask.

4.7 SPLIT-TENSILE STRENGTH OF SELF-CURED CONCRETE CYLINDER SPECIMENS

Table 4.10: Split-tensile strength of self-cured concrete cylinder specimens

Sample	CM 0 SC 1	CM 0 SC 1.5	CM 10 SC 1	CM 10 SC 1.5
1	0.81	0.78	0.85	0.92
2	0.82	0.87	0.92	0.85
Average split-tensile strength	0.81	0.83	0.88	0.88
3	1.45	1.55	1.42	1.22
4	1.33	1.53	1.38	1.53
Average split-tensile strength	1.39	1.54	1.40	1.37
5	3.02	2.86	3.32	3.15
6	2.89	2.75	3.72	2.89
Average split-tensile strength	2.95	2.81	3.52	3.02

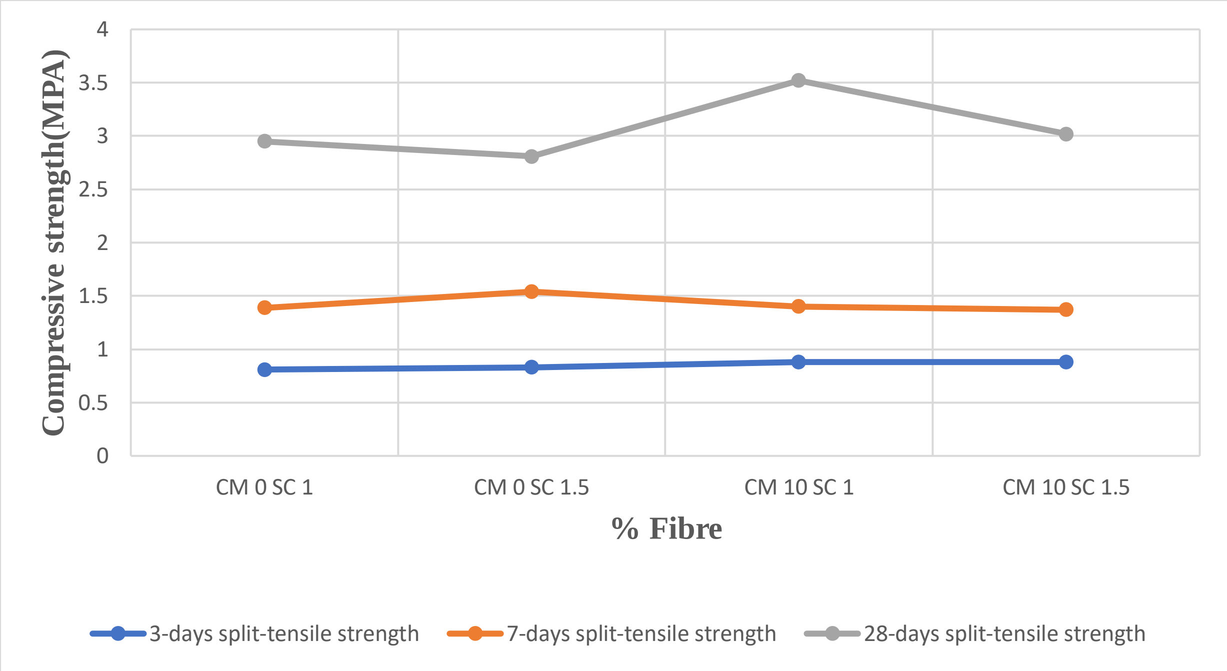

Table 4.10: Split-tensile strength of self-cured concrete cylinder specimens

From the above data we can conclude that the maximum 28 days split-tensile strength is obtained at 0.1% mask content when self-curing admixture is 1% which shows the increase 0.34% over the split tensile strength of self-cured concrete specimens and 19.72% of self-cured concrete specimens containing disposable mask at 0.1% mask content and 1% PEG-6000 content.

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

The project aimed to investigate the effect of reinforcing concrete with disposable masks and PEG-6000 as a self-curing agent. Through experimentation and analysis, it was observed that the use of disposable masks in concrete resulted in an increase in density and compressive strength and tensile strength as well indicating an improvement in the mechanical properties of the concrete. Moreover, the use of PEG-6000 as a self-curing agent resulted in improved curing of the concrete, which further enhanced its strength and durability.

From the study we have concluded that Density of Concrete increases with increase in percentage of fiber content and the maximum density is obtained when disposable mask content is 0.2% and the increase is 0.8% of density obtained from standard cube and density of concrete start decreasing at 0.25% of mask content. The water absorption of specimens is increasing gradually as we are increasing as we are increasing the mask content in concrete specimens and the maximum 3-days,7-days and 28-days water absorption is obtained at 0.25% mask content which is 0.69%, 0.74% and 1.45% respectively. There is increase over 24.85% of compressive strength of M20 grade of concrete at 0.1% of disposable mask content, hence the optimum dosage of concrete for M20 grade of concrete is 0.1% which provides a sustainable solution for disposing off the bio-medical waste. It is also concluded there is increase of 23.46% over split tensile strength is obtained at 0.2% of mask content. There is no appreciable change over the density of self-cured specimens the density over the different mask proportions and different PEG-6000 proportion doesn’t make any significant effect over the density. The Optimum dosage of PEG-6000 is 1% of weight of cement when the mask content is 0.1% shows the increase of 2.39% over compressive strength. It is noted that self-cured specimen does not show significant increase over the compressive strength but is a good alternative for the area’s having scarcity of water and provides the sustainable solution for conserving the water. The maximum split tensile strength of self-cured specimen is obtained 1% of PEG-6000 content and 0.1% of mask content which shows 2.72% increase over the standard 1% PEG-6000 cured specimen

Comparison Analysis

The optimum dosage for M60 grade of concrete is 0.2% as volume fraction [5] and our research study for grade of M20 the optimum dosage is 0.1% as volume fraction and hence we can conclude that with the variation in grade there is change in proportioning of dosage of disposable mask. There is no huge increase over the self-cured concrete and self-cured containing shredded disposable mask concrete. The best solution for disposing biodegradable medical waste mask is with conventional curing where we get 24.85% increase over the compressive strength and 2.39% with respect to self-cured shredded disposable mask.

FUTURE SCOPE:

1. The work can be proceeded with use of light weight aggregate and plastic aggregate to analyze their effect and provide other alternative solutions for disposing of environmental waste.

2. The effect of shredded disposable mask on the microstructure and combined effect of shredded disposable mask with self-curing admixture on the concrete requires additional study.

3.The findings can be also used for light weight concrete where we can increase the strength of light weight concrete and proportion of mask may vary light weight concrete.

The findings of this study suggest that disposable masks and PEG-6000 can be used as effective additives in concrete production, providing a sustainable solution for waste management and improving the overall quality of the concrete. The future scope of this study can involve further investigation into the long-term durability and performance of disposable mask-reinforced concrete, as well as exploring the use of other waste materials as additives in concrete production.

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