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Use of COVID 19 Waste Facial Masks as Sustainable Construction Material

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ABSTRACT
A dramatic increase in the manufacturing and usage of single-use, disposable face masks has been seen during the COVID-19 epidemic. By failing to properly dispose of worn face masks, a new type of non-biodegradable plastic trash that will take hundreds of years to decompose endangers the environment. Therefore, there is a pressing need to recycle such garbage in a way that is ecologically benign. This study offers an effective method for producing cost-effective, green concrete that is ecologically beneficial by using waste masks that have been crushed or fibered. This study evaluated the mechanical and robustness characteristics of waste masks made using concrete. For standardized testing to assess compressive strength quick chloride penetration test, a total of six mixtures were created (RCPT),. While crushed masks were only utilized at 0.5%, the percentages of mask fibres used were 0.5, 1, 1.5, and 2% of concrete by volume. Both kinds of the mask waste were determined to be appropriate for use in concrete. It was discovered that 1% of waste mask fibres was the ideal amount to improve compressive strength and decrease chloride permeability. In addition, 0.5% crushed mask fibre also worked well, particularly when creating concrete that is more resistant and less permeable. Thus, it is confirmed that waste masks that worsen global pollution may be used responsibly to support the construction of green buildings. Circular economy, sustainability, and effective waste management are achieved by recycling discarded masks to create new concrete with greater strengths and durability

Key Words: *COVID19 ,face masks recycling ,mechanical properties ,durability , green concrete*

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INTRODUCTION

Due to the COVID-19 epidemic, the use of personal protective equipment (PPE), such as face masks, has significantly grown globally. By introducing significant amounts of plastic particle debris to the environment, the increased usage of COVID-19 sanitary masks has created new environmental issues. Every day, people use around 6600 million masks, totaling 2640.79 tonnes. Polypropylene fabric made of non-woven construction is used to make disposable face masks. For surgical and non-surgical face masks, two distinct fabrics—spun-bond polypropylene and melt-blown polypropylene—are utilised as raw materials. In a similar way, raw ingredients such as polyethylene, polyurethane, polyacrylonitrile, polyester, and cotton fibres are also used. Waste masks contaminate freshwater, marine, and coastal environments, and they introduce plastics to the aquatic ecosystem. Because of ignorance and poor management, they are frequently spotted on streets and beaches. Regulations and guidance on the waste management of PPE and the disposal of plastic waste, which also includes facial masks, have been released by a number of nations and the World Health Organization (WHO). Face masks are a primary source of microplastics and other environmental contaminants. The health of living things is harmed, and the environment is made worse by the breakdown of face masks in micro and nano plastic trash caused by numerous environmental variables (such as temperature, humidity, and salinity). A single disposable mask causes the weathering of 1.5 million microplastic particles. Similarly, incorrect face mask disposal might spread the illness and harm the environment [1,2,3,4].

The situation of plastic garbage before and during the COVID-19 epidemic was examined and discussed by Khoo, K. S., Ho, L. Y., Lim, H. R., Leong, H. Y., and Chew (2021). The process for turning plastic trash into value-added products, including sterilisation technology, incineration, and alternative technologies, was examined. [5]

According to a study by Asim, N., Badiei, and Sopian published in 2021, the COVID-19 pandemic has had an impact on the environment as well as human health and economy because of the massive amount of trash produced by abandoned personal protective equipment. In this study, potential waste management techniques connected to the waste valorization of abandoned face masks—the primary kind of waste during the COVID-19 pandemic—are investigated. This significant environmental problem will be successfully eliminated when governments, communities, and the scientific community are all aware of it. [6]
By recycling worn face masks with other waste materials in civil projects, Saberian, Li, Kilmartin-Lynch, & Boroujeni (2021) investigated a creative technique to lessen the trash produced by the pandemic. For the first time, a series of experiments were carried out in this study on blends of various percentages of the shredded face mask (SFM) added to the recycled concrete aggregate (RCA) for road base and subbase applications. These experiments included modified compaction, unconfined compression strength, and resilient modulus tests. According to the trial findings, RCA blended with three different SFM percentages (1%, 2%, and 3%) fulfilled the stiffness and strength criteria for the base and subbase of pavements. [7]
Waste DMFMs were used in sustainable green concrete in the development of a novel ecologically friendly recycling technology by Ahmed, W., and Lim, C. W. (2022). More specifically, a new fibre hybridization strategy has been developed in which fibre reinforced recycled aggregate concrete was made using two types of fibres, DMFM fibre and basalt fibre (BF) (FRAC). DMFM fibre had volume fractions of 0, 1, and 2 whereas BF had volume fractions of 0, 2, and 5 respectively. Additionally, fly ash and powdered granulated blast furnace slag were employed as mineral admixtures. According to test results, FRAC comprising hybrid fibres and mineral admixtures increased in compressive strength by about 12%, split tensile strength by about 26%, and flexural strength by about 60%. [8]
Wang, G. C., Massarra, and M. H. H. Rahat (2022).did a thorough review of the advantages and disadvantages of using plastic waste in the building sector. They came to the conclusion that using plastic trash in building will greatly increase environmental sustainability, lower construction costs, enhance construction quality, and serve as a consistent source of construction materials. Finally, topics for more investigation are also recommended in order to overcome obstacles.[9]
In order to mix discarded mask fibre and shredded mask into concrete without affecting its essential mechanical and physical qualities, research mostly relies on laboratory testing. By conducting major experiments on fiber-reinforced concrete and intensive research effort at various phases, the scope of this study was successfully completed. Concrete is strengthened structurally by fibre addition. Concrete's characteristics change depending on its kind, shape, distribution, orientation, and density. We also employed 0.5% polycarboxylic-based superplasticizer and potable water. In this study, three-ply waste masks were chosen since they are typically used and reasonably priced. Spun-bond polypropylene fabric makes up the face mask's inner and outer layers, while melt-blown polypropylene fabric makes up the majority of the intermediate layer. Spun-bond polypropylene, however, may occasionally be utilised in all three layers to cut expenses. Melt-blown polypropylene in the inner layer serves as the main barrier against viruses and contaminating particles. Initially, there was a global scarcity of melt-blown material during the COVID-19 epidemic, which resulted in higher prices. The face mask's ear loop is constructed of nylon or polyester. Due to a plastic basis with low heat conductivity, the material used to make face masks is both water- and thermal-resistant. All of these qualities make a material for building appealing.

MATERIAL AND METHODS
Surfaces have 100 times less of a probability of transmitting COVID-19 than a direct contact with an infected individual. According to other research, coronavirus may survive on plastic for up to three days and on cardboard for one day. The usage of facemasks in concrete is not problematic since there is less chance of COVID-19 spreading through facemasks due to the virus's short lifespan on plastics. But steam treatment, as advised by WHO, is another option for cleaning the masks. Given that concrete has a pH of 13, the virus's ability to survive there may also be problematic. For seven days, the masks were gathered and left. They were cleaned with an alcohol-based disinfectant spray for added protection.
The use of waste PPE as an efficient composite material for building is now being researched. The study's approach is displayed in Figure 1. The used masks are processed into fibered and square-shaped crushed forms. The masks were fibered in a machine that harvests cotton fibres since fibres are needed in concrete to increase certain qualities. At 0.5, 1.0, 1.5, and 2.0% of the concrete volume, the mask fibres were added. The fibres were not consistent in size or shape since they were taken out of a cotton fibre extraction machine; instead, they looked like a jumbled, messy cluster (see Figure 1)

figure 1 :Methodology to use waste masks in concrete.

Broken Form Using a paper cutting machine, the masks were crushed into squares of 1.5 to 2.0 mm. The easiest and most practical waste mask is this one. 0.5% of the total volume of concrete was made from crushed masks. River sand and locally accessible coarse aggregates were combined with cement to create concrete with a consistent water-cement ratio of 0.5. Crushed fibres were added to concrete at a volume of 0.5%, while fibered masks were utilised at volumes of 0.5, 1.0, 1.5, and 2.0%. In Table 1, the mix percentage is tabulated

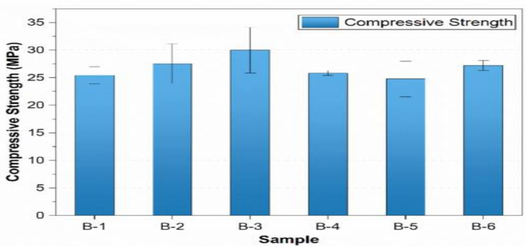
Table 1: Mix proportions of concrete with and without fiber reinforcement.

Mix	Cement (kg/m^3)	Sand (kg/m^3)	Coarse aggregate (kg/m^3)	Water (kg/m^3)	Super plasticizer %	Fiber %	Remarks
B1	422.73	516.33	1197	169	0.5 %	-	-
B2	400	500	1100	167	0.5%	0.5 %	Fibered
B3	400	500	1100	167	0.5%	1.0 %	Fibered
B4	400	500	1100	167	0.5%	1.5 %	Fibered
B5	400	500	1100	167	0.5%	2 %	Crushed

After dry-mixing the cement, sand crush, and masks for one minute, superplasticizer and water were added. For a further 2 minutes, mixing was performed. A one-minute rest was followed by two minutes of mixing once again. All of the mixtures' slumps were determined to be acceptable and to fall between 80 and 120 mm. Each batch of concrete was cast into cubes measuring 150 mm by 150 mm by 150 mm. The samples were demolded and kept in water at room temperature in a lab until the test day after being cast for 24 hours. After 28 days of curing, samples were tested for compressive strength.

Compressive Strength

Compressive strength of the mixtures at 28 days is shown in Figure 2. Compressive strength increased by 8.3% with the addition of 0.5% crushed fibre. Compressive strength rose by 17.9% up to 1% with the addition of fibre before declining. Even yet, compressive strength outperformed the control by up to 1.5%, and 2% fibre showed a little decline of 2%. Due to incorrect mixing and fibre interlocking, which prevent homogeneity in the concrete, the compressive strength decreased at a larger fibre volume. Typically, increasing the quantity of fibre results in a reduction in compressive strength. The air trapped during mechanical concrete mixing with a greater fibre content is blamed for the characteristic. Increased air content results from increased polypropylene fibre content.



. Figure 2 : Compressive strength of waste mask-incorporated concrete at 28 day

Rapid Chloride Permeability Test (RCPT)

The samples' permeability to chloride was tested. Better corrosion resistance is shown by a lower chloride permeability. Figure 3 demonstrates how the addition of waste mask fibre to concrete, up to 1% fibre, caused the permeability to drop initially. However, the permeability rises beyond 1% fibre. It can be concluded that permeability may be reduced by 9.4% at 1%, which is the ideal value. By blocking the action of pores, polypropylene fibre decreases permeability and enhances resistance to chloride penetration at lower concentrations.

After 1%, however, fibre increases permeability and brings about air entrainment. A larger air content results from a greater volume of polypropylene fibres. The presence of air voids may also be caused by improper fibre mixing and inhomogeneity un the mixture. Due to more air being trapped by the fibre at 2%, permeability rises. The pattern of compressive strength, which rises up to 1% as a result of little air entrainment, may be explained by the trend. At 1.5 and 2%, mechanical mixing results in a greater quantity of air being trapped, which lowers compressive strength. For the crushed mask, the permeability has decreased by 39.1%. The square-cut pieces of the impermeable masks prevent water or ions from passing through them, significantly reducing the permeability of the concrete sample. After being subjected to freeze-thaw cycles, the samples' RCPT findings are shown in Figure 3. A 0.5% crush value outperformed the control sample and displayed 16.6% less permeability. Additionally, 1% fibre exhibited a 38.6% reduction in permeability compared to control samples while 0.5% to 1.5% fibre offered greater resistance.

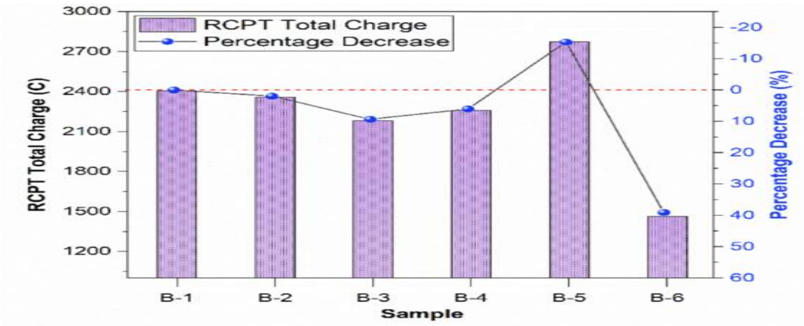


Figure 3 :RCPT values of different concrete samples at 28 days

When used in concrete, waste masks offer superior protection against freeze-thaw assaults than regular concrete. Because of their air void content, synthetic fibres, particularly PVA, are good against frost resistance, according to Nam et al. By enabling frozen water to seep into and expand inside spaces, evenly distributed air voids may boost frost resistance. As a result, higher frost resistance results from the fact that the growth of the ice within the vacuum does not put pressure on the concrete. Concrete's mechanical characteristics and flexural behaviour were enhanced by using 1% fibered waste mask (increase in split tensile strength and compressive strength). Additionally, it reduced permeability, as seen by the findings of the RCPT. Therefore, the best method for employing waste masks in concrete was to use one percent fibered waste mask.

CONCLUSIONS

Crushed and fibered masks were added to concrete, which changed its properties. While reducing tensile strength by 13.4%, the inclusion of 0.5% crushed mask boosted compressive strength by 8.3%. Concrete's compressive and tensile strengths improved (by 17.9% and 23.3%, respectively) when fibre addition reached 1% before starting to decline. In order to improve mechanical qualities, using mask fibres at 1% of concrete volume was the ideal amount. Crushed mask had extremely low permeability compared to regular concrete, while one percent waste mask fibre demonstrated negligible chloride permeability. As a result, concrete incorporating waste masks has a considerably greater corrosion resistance, especially in crushed form. In a similar vein, the fast chloride permeability test revealed that following freeze-thaw cycles, mask-incorporated concrete had a lower permeability value than regular concrete. Waste mask fibre at 2% shown much higher permeability and slightly lower compressive strength, and it shouldn't be utilised in concrete. In order to increase concrete's durability, waste masks with a fibre content of 1% or less should be applied. Concrete can benefit from crushed waste masks at 0.5%, particularly to increase water resistance. Due to the COVID19 epidemic, there is an enormous amount of waste mask production, usage, and garbage, and their disposal poses a serious environmental risk. Concrete waste masks are an eco-friendly addition to the material. The circular economy benefits from the recycling of used masks. Additionally, it is a significant step towards attaining environmental sustainability in terms of problems with waste disposal, resource conservation, and decreased environmental contamination. The best proportion to increase the mechanical and durability attributes of concrete is discovered to be 1% by volume of waste masks put to concrete.

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