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Experimental Investigation on Concrete Utilizing Used Surgical Mask

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Concrete industry requires always changes with time and with present scenario of covid we have to introduce the waste of covid in concrete industry. In this paper the main aim is to utilize the mask waste in concrete. Additional amount 0% to 10% with 2.5% incremental order of mask is use in concrete and different properties is checked. From results it can be concluded that the surgical mask waste can be use in concrete.

1. Introduction

Concrete can be worked in a variety of ways. Material substitutions and additions are frequently employed. Many have tried adding recyclable materials, such fly ash, shattered glass, or torn rubber tires, to batches of concrete. Many single-use items are contaminating the planet, damaging wildlife, and putting delicate ecosystems at jeopardy. These could be repurposed into different building materials, reduced, and reused. The environmental risk of face masks rises in tandem with their manufacture and consumption. Utilizing Waste Materials in Concrete Waste materials are increasingly being used in concrete these days in an effort to lessen its negative effects on the environment. Waste materials that have been used into concrete include fly ash, glass, and tires. The environment is seriously threatened by these materials, so it is better that they be reused instead of trashed.

At the end of 2019, an unknown virus causing pneumonia was discovered in Wuhan, China. It was reported to the World Health Organization (WHO) and named corona virus disease 2019 (COVID-19). The virus rapidly spread worldwide, causing millions of infections and deaths. In March 2020, WHO declared a pandemic, the highest epidemic alert phase risk level. The Covid-19 pandemic has increased the production and use of disposable or single-use face masks. Face masks are one of the preventative measures that is being used to slow the spread of infection.

The amount of garbage produced has significantly increased as a result of people using surgical masks as a precaution during the COVID-19 epidemic. One medical mask per person, per day for a year in the UK would generate more than 124,000 tons of plastic garbage, according to study. According to estimates from the World Health Organization, around 89 million masks are required each month to manage COVID-19. Face masks made of polypropylene and other plastics, such as polyester, polystyrene, polycarbonate, or polyethylene, are a source of microplastic pollutants in indoor and outdoor air as well as water habitats. This is a significant health issue for humans and the environment at large, among other living things. As a result, some argue that the circular economy concept need to direct the formulation of laws pertaining to the disposal of medical waste, particularly single-use face masks. It provides a life cycle analysis of both reusable and single-use face masks. Numerous studies have used a variety of methods to characterize face masks since the start of the pandemic. Among other things, the investigations have mostly concentrated on mask reuse and disinfection. Thermal, morphological, and chemical evaluations were used to create the masks, which suggested that the material be recycled following thermal treatment.

The concrete industry has historically employed polypropylene fibers primarily because of their high tensile and flexural strengths, but also because of improvements in other characteristics such strong alkaline resistance and shrinkage. For this reason, waste from face masks makes excellent candidates for repurposing in cement-based materials. To stabilize fat clay soils, Rehman et al. mixed cement with silica fume and shredded face masks. In order to create cementitious materials, Kilmartin et al. added face masks, which were added up to 0.25% of the volume of concrete.

In accordance with the mixes provided by Kilmartin et al., 0.25% of concrete volume translates into 0.37% and 2.2% of concrete and cement weight, respectively. When considering the massive environmental issue of mask waste, these percentages appear to be very modest. Furthermore, the paper ignored durability considerations in favor of concentrating on the mechanical characteristics of the final mixtures.
In this study, surgical wear masks that had not been pretreated were added to concrete at a weight increase of 0% to 10%. Measurements of mechanical properties including flexural and compressive strength were made.

2. PURPOSE OF RESEARCH

After more than two years wearing surgical masks due to the COVID-19 pandemic, used masks have become a significant risk for ecosystems, as they are producing wastes in huge amounts. They are a potential source of disturbance by themselves and as micro plastic contamination in the water system. As 5500 tons of face masks are estimated to be used each year, there is an urgent need to manage them according to the circular economy principles and avoid their inadequate disposal.

3. LITERATURE REVIEW

a. Zoran J. Grdic et al. (2012) This study explored the effects of incorporating fibers in concrete, emphasizing their impact on tensile strength and abrasion resistance. By varying the water-cement (W/C) ratio between 0.5 to 0.7, the researchers observed that fiber reinforcement significantly enhanced the tensile strength, even under conditions where the abrasion resistance was otherwise reduced. Experimental results highlighted a direct relationship between the inclusion of fibers and the overall durability of concrete, suggesting their utility for improving performance in high-stress environments.

b. S. Sharmila et al. (2013) The research examined the behavior of reinforced concrete beams enhanced with hybrid fibers. Hybrid fibers, a combination of different fiber types, demonstrated superior performance compared to single fibers, with an 80% increase in ductility and a 160% improvement in energy absorption capacity. The experimental analysis used cyclic loading to measure beam behavior, revealing that the hybridization of fibers effectively redistributed stress, enhancing structural resilience and energy dissipation under load.

4. MATERIALS

Materials like cement, fine aggregates, coarse aggregates, face mask and water which is used in this experimental investigation is properly tested in lab. Following are the materials:

a. Cement: The ordinary Portland cement (OPC) of 43-grade was used for casting the specimens of all the concrete mixes. Cement was bought from the same source throughout the investigation work. Cement was free from the moisture and also free from any types of lumps. The colour of cement was uniform grey.

Figure 1: Cement

b. Fine Aggregates: The aggregate which passes through 4.75 mm sieve and is retained on 75 µm sieve, is called as fine aggregate (FA). The locally available river fine aggregate passing 4.75 mm sieve as per IS: 383-1970 was used as fine aggregate for this study.

c. Coarse Aggregates: The aggregate which passes through 80 mm sieve and is retained on 4.75 mm sieve, is called as coarse aggregate (CA). The coarse aggregate used for investigation was procured from the local coarse aggregate supplier as per IS: 383-1970.

d. Face Masks: Surgical masks are made from is much poorer at filtering very small particles (in range a tenth of a micrometer to a micrometre across) than that of filtering respirators (for example N95, FFP2) and the fit is much poorer. Pieces of surgical mask of size 10mm was used during this investigation.

Figure 2: Surgical Mask

e. Water: Potable water was used throughout the investigation and was taken from the same source throughout. It was used for mixing, casting and curing the concrete specimen as per IS 456-2000.

5. METHODOLOGY

In this experimental investigation M25 grade of concrete has been used. Slump test has been used to determine the workability of concrete, compressive strength, flexural strength test have been used for hardened concrete. The concrete mix design of M25 grade was made as per the guidelines given in the Indian standards namely IS: 10262 (2009) and IS: 456 (2000). The water to cement ratio was maintained at 0.45 (assuming moderate exposure conditions from IS: 456 (2000)).

0.45: 1 : 1 : 2 {Water: Cement: Fine aggregate: Coarse aggregates (20mm and 10mm)}

Batching, mixing, casting and curing are done in proper manner before testing.

6. TESTS

Slump test was conducted to check the property of fresh concrete and compressive strength, flexural strength test was performed on hardened concrete. Water permeability test was performed to check the durability properties of concrete.

a. Slump Test: In this investigation, workability of fresh concrete mixes was determined by slump cone test as per guidelines of IS: 1199-1959. This test is adopted, where nominal maximum size of aggregate does not exceed 40 mm.

b. Compressive Strength Test: Compressive Strength test was performed as per IS 516:1959 to find out the compressive strength of concrete after 7 and 28days of curing. Concrete cubes used to determining the compressive strength is shown in figure. Specimens of size 150×150×150mm were used to check the compressive strength of concrete.

Figure 3: Compressive Strength Test Machine

c. Flexural Strength Test: Flexural beam shown in figure 4 was used to check the flexural strength test as per IS: 516(1959) by two point loading test method. Two points loading method produces a constant bending moment along the central part of a test specimen. Specimen of size 100mm×100mm×500mm were used to determine the flexural strength of concrete.

Figure 4: Flexural Beam

d. Water Permeability Test: The water permeability of specimens was determined as per guidelines of DIN 1048 using water permeability test apparatus shown in Figure 5. The specimens of size 150×150×150 mm were used after 28 days curing. A constant water pressure of 5 kg/cm^2 along with constant air pressure of 10 to 15 kg/cm^2 was maintained by using an air compressor throughout the experiment for a specified period of time. Depth of water penetration was determined after 72 hours of testing period after splitting the cube in two parts.

Figure 5: Water Permeability Test Apparatus

7. RESULTS & DISCUSSIONS

Various tests are conducted in laboratories and the results are obtained. The results and conclusions are as follows:

a. Slump Test: The slump value for referral concrete was obtained as 80mm. The value of slump decreases as percentage of surgical mask increases. The value of slump decreases to 60mm at 10% of surgical mask. Slump value at 2.5%, 5% and 7.5% of surgical mask were observed as 75mm, 70mm and 68mm respectively.

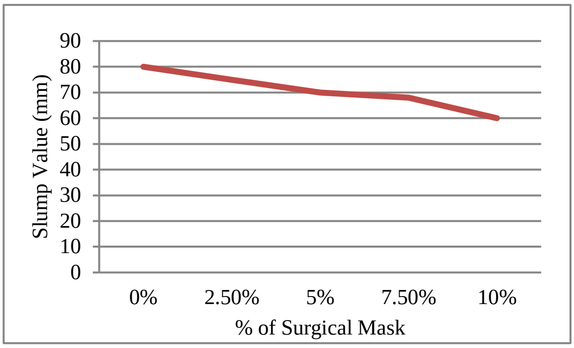

Figure 6: Slump Variation of Concrete

b. Compressive Strength: The compressive strength of concrete was tested at 7days and 28days of curing. Figure 7 shows the compressive strength variation at 7 days of curing with different % of surgical mask. The compressive strength of referral concrete was obtained as 16.25N/mm^2. It can be seen from figure that the compressive strength increases as in creases in % of surgical mask up to 5% after it started to decreases.

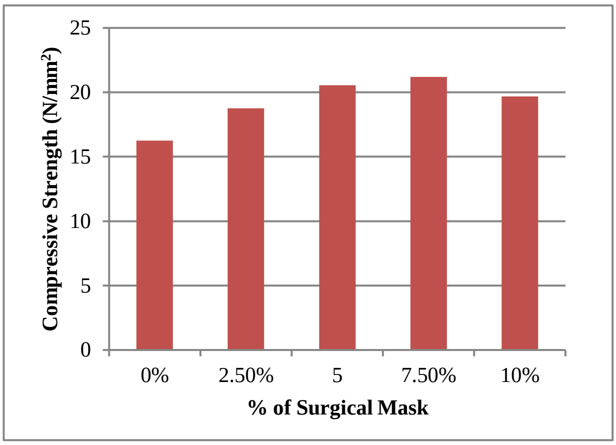

Figure: 7 Days Compressive Strength of Concrete

The Compressive strength variation at 28 days of curing is shown in figure 8. The compressive strength for referral concrete is obtained as 27.8N/mm^2. It can be seen from figure that the compressive strength of concrete increases to 30.56N/mm^2 at 5% level of surgical mask. The compressive strength for 2.5% 7.5% and 10% level of surgical mask is observed as 28.38N/mm^2, 29.86N/mm^2 and 29.2N/mm^2. The compressive strength at different % of surgical mask is more than the referral concrete.

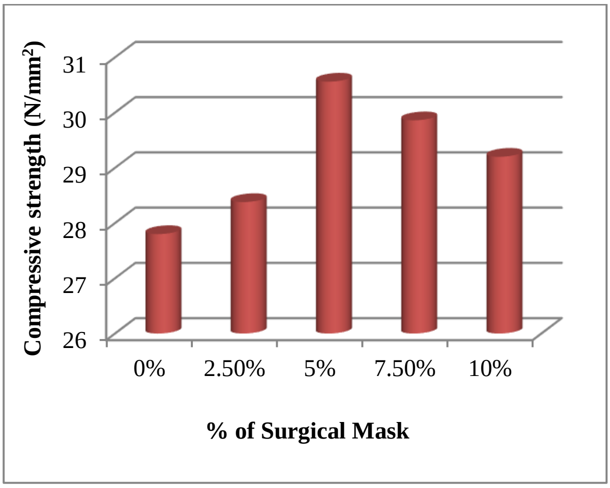

Figure 8: 28 Days Compressive Strength

c. Flexural Strength Test: The flexural strength test was conducted after 28 days of curing. The variation of flexural strength is shown in figure 9. The flexural strength of control mix was obtained as 4.16N/mm^2. Flexural strength of concrete increases with increase in % of surgical mask up to 5%. Flexural strength of concrete at 2.5%, 5%, 7.5% and 10% level of surgical mask is observed as 4.22N/mm^2, 4.36N/mm^2, 4.32N/mm^2 and 4.27N/mm^2 respectively.

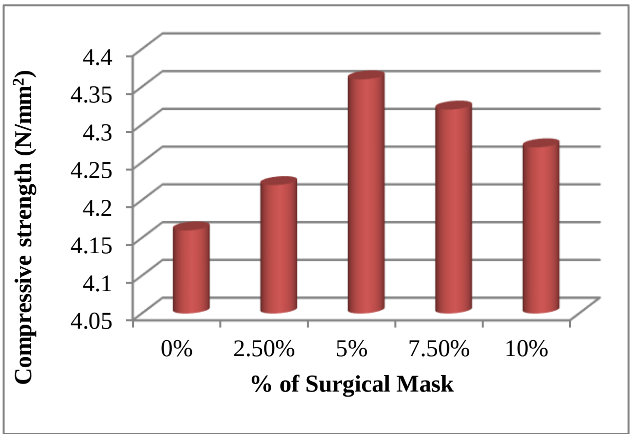

Figure 9: Flexural Strength at 28 days of curing

d. Water Permeability Test: Water permeability test for concrete is checked after 28 days of curing. The depth of water penetration at different proportion of surgical mask is shown in figure 10. The depth of water penetration for referral mix was obtained as 25mm and the depth is increases with increase in % of surgical mask. The depth of water penetration at 2.5%, 5%, 7.5% and 10% were observed as 27mm, 32mm, 38mm and 40mm respectively.

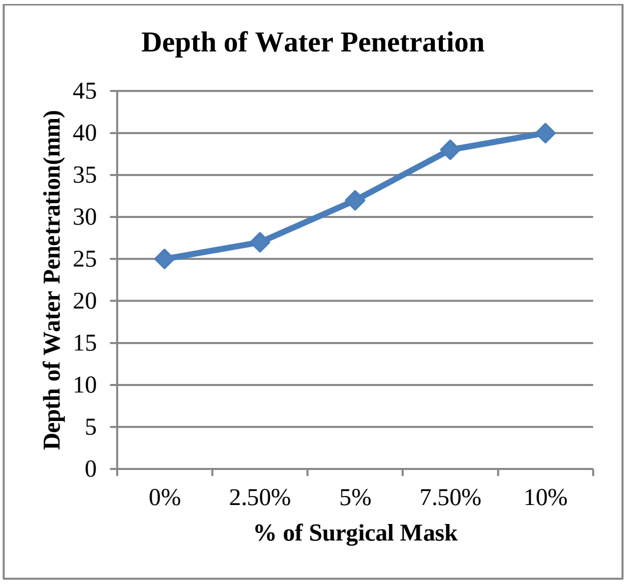

Figure 10: Depth of Water Penetration

8. CONCLUSION

It can be concluded from the research that the uses of mask can be beneficial for concrete industry as well as for environment concern. From this research we concluded that the properties of concrete can modified as the consumption of waste mask are also obtained, due to that the waste of used mask can be minimized.

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