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EXPERIMENTAL STUDY ON REUSE OF WASTE MEDICAL PPE KIT IN CONCRETE

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Abstract: One of the social measures applied during the COVID-19 pandemic has been the use of personal protective equipment (PPE)—face mask, body masks and gloves. As the result, this waste category has expanded enormously. This study investigates waste management issues from multiple perspectives, like local governments, municipal corporation waste collection companies. The results of this study show that approximately 60% of local governments in the Kolkata region have applied special measures for handling and collection of waste PPE. 15% of waste collection companies have applied special collection schedules for the waste generated at quarantine collection points due to the high costs of changing collection schedules, providing additional vehicles, and paying for more worker labour. 25% of waste PPE kit dumped in waste land field which causes many diseases. The research paper focusing on new methods of using PPE waste in concrete to manufacturing the building materials like (Paver,Bricks ,kerb stone and so on).

Keywords: waste ppe kit, cement, quarry dust flexural strength, cost.

I INTRODUCTION

The novel coronavirus (COVID-19) disease has attracted global attention since end of November 2019. The first Breakout of coronavirus disease 2019 (COVID-19), which are caused by a novel severe acute respiratory syndrome, namely, coronavirus 2 (SARS-CoV-2), occurred in Wuhan city in China. Most of the countries have closed their borders to stop unnecessary travel and immigration, The confirmed cases and deaths are still increasing day by day due to increased community transmission and daily testing capacity increases. World Health Organization (WHO) and the US Centres for Disease Control and Prevention, the National Centres for Disease Control and local governments have announced various guidelines, including frequent handwashing, social distancing, and quarantine (home, local and state quarantine), to stop the spread and health risks associated with COVID-19. These institutions have recommended medical personnel and the general population to use personal protective equipment (PPE) such as medical masks or surgical mask, non-medical face masks (including various forms of self-made or commercial masks of cloth, cotton, or other textiles materials),apron, face shields, and gloves. Most of the country suggested wearing masks ,Gloves when going in public places/gathering places. The press conference study of the Joint Prevention and Control Mechanism of the State Council of China found that approximately 568.9 tons of medical waste are generated every day in association with COVID-19. On the other hand, it was found in India(Maharashtra) that the medical waste scale had reached 18,740 tons approximately 60 days after people were first infected by coronavirus in the area. Infectious waste is characterized as any material that is suspected to contain pathogens (Virus, Bacteria, parasites, or fungi) in sufficient concentration or quantity to cause disease in susceptible hosts. It comprises waste contaminated with blood, bodily fluids, organs, tissues, and sharp objects from treatment.it is also includes swabs, diagnosis, medical devices and so on. Therefore, it is very dangerous to health. Infectious waste generated materials by the COVID-19 outbreak have posed a major environmental and health concern in different countries.

Currently, millions of contaminated face masks, gloves, and materials for diagnosing, detecting, and treating SARS-CoV-2 and other human pathogens are undergoing the irreparable process of becoming infectious waste. it will cause environmental and health problems if these are stored, transported, and handled improperly way. A recent study of IMA found that human coronaviruses can remain active on inanimate hard surfaces (such as glass, metal, or plastic) for up to nine days. Developing countries that do not have sufficient resources for solid waste management. Most developing countries, such as Philippines, Cambodia, Malaysia, Thailand, Indonesia, Palestine, Bangladesh, Vietnam, and India are widely perceived to be dump solid waste in poorly managed and open landfills. This is another example where improper management of contaminated PPEs and healthcare waste may increase the spread of viral disease in the environment.

Accordingly, The major problems that will inevitably occur is contagious waste, which, if not managed properly, may be the root cause of severe diseases and environmental waste problems ,so in the research paper we are solving the problem of this waste also we are creating a building material which is made from waste PPE kit materials.

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II.METHODOLOGY

Properties of materials:

WASTE PPE KIT: Most of the protective efficiency of masks have made from different fibre materials. The protective efficiency of the materials from highest level to lowest, first come polypropylene, polyester-rayon, glass, and cellulose. Now a time Glass fibre are rarely used in masks because it causes irritation on the wearer's skin. But Polypropylene is the most used fibre. The main reason is both highly hydrophobic in nature and has a capacity for wicking, ensuring a dry and comfortable microclimate between the mask and face. Existing medical masks are made of three nonwoven fabric layers-a Shell fibre, a filter layer, and filter layer. The spun-bonded is innermost cover web nonwoven mat and its lies next to the wearer's skin. filter layer is between the cover web and shell fabric. it is a melt-blown nonwoven mat that primarily deters hazardous microorganisms, aerosol particles and bodily fluids. The In the outer most layer Shell fibre are exposed in the environment. These fabrics are made from a spun-bonded nonwoven mat and supports the filter layer.

The properties of Polypropylene are:

S. No	Properties	Value
1	Density(g/cm3)	0.9-0.91
2	Reaction With Water	Hydrophobic
3	Tensile Strength (MPa)	300-400
4	Elongation At Break (%)	100-600
5	Melting point(C)	175
6	Thermal Conductivity(W/mK)	0.12

Waste ppe kit

Cement: Cement is one of important binding material in concrete. Cements are made by heating of limestone (calcium carbonate) with different small quantities of other material like Silica, iron etc. it's heating around 1450 °C in a kiln, this process known as calcination, whereas a molecule of carbon dioxide (CO_2) is liberated from the limestone to form calcium oxide(CaO)/quicklime. Then it has blended with the other materials that have been included in the mixer. The cement which are using have following properties.

Sl.No	**Characteristics**	**Value**
1	Fineness (by Blaines apparatus)	<225 m2/Kg
2	Soundness	
	a) Le Chatelier method	<10
	b) Autoclave test	0.9%
3	Setting time	
	a) Initial setting time in minutes	30
	b) Final setting time in minutes	600
4	Compressive strength	
	a) 72 +/- 1 hour (3 days)	27MPa
	b) 168 +/- 2 hours (7 days)	37MPa
	c) 672 +/- 4 hours (28 days)	53Mpa

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Ordianary Portland cement53

Fine Aggregate: The aggregates are passing 4.75 mm tyler sieve and.075 mm sieve is retained. Fine aggregate (Sand) is very important civil engineering material. In construction works, sands are used as a fine aggregate material. Fine aggregate (Sand) is a form of silica (quartz) and might be siliceous argillaceous, or calcareous depends upon the composition. Natural sands are formed from weathering of rocks. The grains of sand may be angular, sharp, or rounded. Most of the fine aggregate (sand) particles should pass from No. 4 to No. 16 sieves. But most of the fine aggregate (sand) should not contain very fine particles. The various sizes of sand particles is determined by using 'Sieve Analysis.

Fine aggregate (Sand)

Quarry Dust: Quarry dust is one of byproduct of the crushing process which is a concentrated material to use as aggregates for concreting purpose, especially as fine aggregates. In quarrying activities, the rock has been crushed into Different sizes; during this process the dust generated is called quarry dust and it is formed as waste materials. So, it becomes as a useless material and also results in the air pollution. Therefore, quarry dust should be used in construction works, which will reduce the cost of construction and the construction material would be saved and the natural resources can be used properly. Most of the developing nation are under pressure to replace fine aggregate (Sand) in concrete by an alternate material. it has been used for different work in the construction industry, such as building materials (Paver, bricks), road development materials and many more places. The benefit of quarry dust are cost effective, easily available, consumption reduces the pollution in environment and effectively used to replacement river sand.

Other Properties are as follow:

- Specific gravity: 2.53
- Fineness modulus: 2.42
- Density: 1.87gm/cc

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- Void ratio: 0.41

Quarry dust

Coarse Aggregate: it is the important material used for making concrete. Aggregates occupy about72-75% of volume of concrete and they greatly influence the strength of concrete. These are cheaper than cement and admixtures. The aggregate impart density to concrete. Coarse aggregates are the particles that retain on 4.75 mm sieve. The surface area of coarse aggregate is less than fine aggregates (Sand). it acts as inert filler material for concrete.

Coarse aggregate

III.MIX RATIO

Cement, sand, Coarse aggregate, Quarry dust and Waste PPE kit, were taken in the (1:0.75:1:0.5:0.5) proportion. which are corresponding to M-30 grade concretes. The concrete was produced by mixing all the ingredients homogeneously in concrete mixture machine. To this dry mix of concrete materials required water, which we are giving in the ratio of (w/c=0.42) and the entire concrete was again mixed in Concrete Mixture machine Homogeneously. Admixture are given to the concrete in the ratio of 0.001%. after the 10-minute mixing, this wet concrete was poured into the moulds and put this mould in vibration machine for compaction., these specimens were given smooth finish and taken out from vibration table. After 24 hours the specimens were demoulded it. these specimens were put in sunlight for 6hours to dry the materials and then after transferred to curing tanks where they were allowed to cure for required number of days. For evaluating compressive strength, specimens of dimensions 200x100x80 mm were prepared. The load is applied 140Kg/m3/minute or 5.2 KN per second as per IRC: SP:102-2014 and IS 516-1959. For evaluating the split tensile strength, cylindrical specimen of diameter 150mm and length 300mm were prepared. Split tensile strength test was carried out on 3000kN capacity compression testing machine as per IS: 5816-1959. The cast materials were cured on open-air and subsequent strength measurements were taken on 7, 14 and 28. Days.

The following parameters were used for mix design

- Grade of concrete = M25
- Type of Cement = OPC-53 Grade
- Brand of Cement = coromandel cement
- Admixture Used Hardcast from Hard&shine

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- Fine Aggregates =Zone III
- Specific Gravity of Cement = 3.19
- Specific gravity of FA = 2.63
- Specific Gravity of C.A
- 10mm = 2.67
- 6mm =2.64
- Moisture content of FA =6%

Mix Proportion for M30 grade Concrete

1) 1162.998 kg/m3 of coarse aggregate (maximum size 20mm)
2) 543.809 kg/m3 of natural river sand (sp.gr =2.63)
3) 435.409 kg/m3 of ordinary Portland Cement (O.P.C.)
4) 191.58 liters of water

RESULTS AND DISCUSSION

Testing of Concrete

After casting, specimens were tested after 7, 14 and 28 days of curing. In this article, the procedure adopted for testing of specimens for various properties like compressive strength, split tensile strength and flexure strength have been discussed.

1. Compressive Strength

Compressive Strength Test: Preparation of Specimens:M-30grade of concrete was designed by I.S 10262- 1982. Batching was done as per the mix proportions with the help of electronic weigh balance machine. Placing and Compaction was done. Concrete blocks are kept in curing tank for 7,14 and 28 days. After 28 days, concrete cubes were removed from curing tank to conduct tests on hardened concrete by using Compression Testing **Machine** (**CTM**)as shown in fig.

Compressive strength = P/A

Where, P = load in KN and A = Area of cross section

Compression Testing Machine (CTM)

Results and Discussion:

Compressive Strength of PPE Materials Concrete (N/mm2)

Curing days	0%CS	10%CS	15%CS	20%CS	30%CS
7days	18.4	16.2	18.9	18.4	16.3
14days	24.6	28.2	26.8	24.5	23.6
28days	34.9	35.7	32.9	31.3	27.4

2. Flexure Strength:

Flexural Strength Test

a) A. Details of the R.C. Beam:

b) While reviewing literature of beam come to knew that the beam size is 700X150X150 mm. As accorded to the IS (10086-1982) & IS (516-1959) minimum size of specimen for beam mould is 700X150X150mm.

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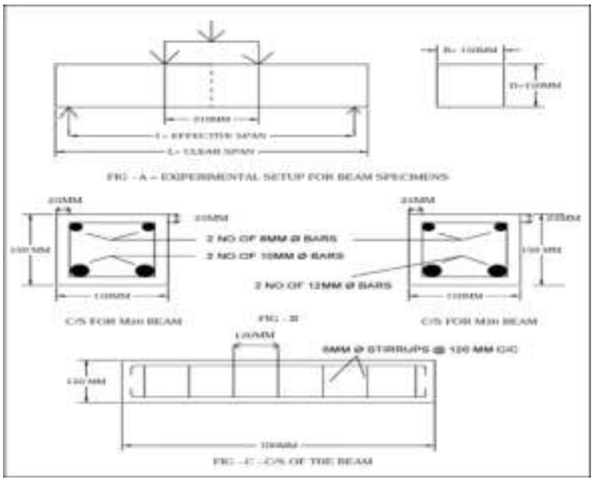
c) 

Detail of R.C Beam

B. Casting and curing of specimens:

The iron beam mould was used for casting the beam specimens. Before mixing the concrete, the moulds were kept on horizontal surface. The bottom and sides of all the moulds were greased for easy demoulding. The concrete was placed in the mould and proper care was taken for uniform compaction using tamping rod and surface finish throughout the beam.The specimen is demoulded after 24 hours and is cured for 28 days. The beam is dried in air and sunlight for 12 hours after curing before the testing.

C. Testing of specimens:

The beams were cured for 28 days to achieve the approximate flexural strength and they are tested using the Universal Testing Machine (UTM) of 1000KN capacity. The beams are tested as simply supported beam with two-point loads until failure. The load positions were spaced at 210 mm c/c which is one-third of the span. shows Flexural Strength Test on Beam using Universal testing Machine (UTM).

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Flexural Strength Test on Beam using Universal testing Machine (UTM).

Data acquisition on UTM for beam

The flexural strength was recorded ..The flexural strength is very much dependent on the physical compressive strength of coarse aggregate. Flexural strength is equal to 0.7√fck where fck is characteristics compressive strength of conventional concrete. Therefore similar to compressive strength, flexural strength also decreases with increase in CS replacement.

IV.RESULTS

All the 12 number of beams were tested at UTM machine with capacity of 1000KN and following data were obtained

%of PPE materials	**Identification of sample**	**Load carried (KN)**	**Deflection in mm**	**Avg.load(KN)**
10%	A1	77.60	4.54	76.54
	A2	72.90	4.32	
	A3	78.85	4.63	
15%	B1	71.70	3.38	72.283
	B2	70.85	3.01	
	B3	74.30	3.52	
20%	C1	59.30	3.24	60.25
	C2	58.55	3.02	
	C3	62.92	3.38	
30%	D1	53.07	2.72	55.74
	D2	56.40	2.94	
	D3	57.75	2.96	

3. **WATER ABSORPTION TEST:** it is one of the important parameters when we consider the durability of structures. According to IS code 1124-1974 water absorption test were taken. The paver blocks were placed in the oven. It was dried in the oven, and it is controlled in temperature at 110ºC for 72 hours. The gaps where the paver block is 25 mm to 30mm. After removal from the oven the paver was put an airtight container. The weight of each paver block was noted. Then after the pavers were immersed in water for 30 hours. paver block removed from the water tank and shake it to remove excess water. Further paver was wiped with soft cloth to make it dried.

% of PPE Kit	**Wet weight**	**Dry weight**	**Water absorption%**
10%	5.498	5.321	7.08
15%	5.476	5.390	1.59
20%	5.456	5.309	2.76
30%	5.432	5.313	2.23

CONCLUSION

The pollution caused by PPE KIT is ubiquitous and environmentally hazardous and generates economic and social costs. The aim of this review was to bring together the complexity of the issue to kick start a discussion on how to act in a coordinated way to reduce this pollution.
When We Added the PPE KIT into concrete to replacement of coarse aggregate. Based on the results from the present study, following conclusions were drawn:

1) The PPE materials used in the experiments are good and workable.
2) The admixture which are used in this work gave the great impact on the strength of concrete.
3) PPE kit materials have low specific gravity

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4) Lightweight Materials can be prepared by using PPE KIT in concrete.
5) The optimum replacement of coarse aggregate by Medical PPE Kit materials is obtained as 15%.So that up to 15% environmental pollution gets reduced
6) Solves problem of disposal of PPE Medical Waste that is why it leads to sustainable development.

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