

Making Bricks from disposable masks and PPE kits

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Abstract - The COVID-19 pandemic has resulted in the massive generation of biomedical waste (BMW) and plastic waste (PW). This sudden spike in BMW and PW has created challenges to the existing waste management infrastructure, especially in developing countries. Safe disposal of PW and BMW is essential; otherwise, this virus will lead to a waste pandemic. This paper reviews the generation of BMW and PW before and during the COVID-19 pandemic, the regulatory framework for BMW management, policy interventions for COVID-19-based BMW (C-BMW), the capacity of BMW treatment and disposal facilities to cope with the challenges, possible management strategies, and perspectives in the Indian context. This study indicated that policy intervention helped minimize the general waste treated as C-BMW, especially during the second pandemic. Inadequacy of common BMW treatment facilities' (CBMWTFs) capacity to cope with the BMW daily generation was observed in some states resulting in compromised treatment conditions. Suggestions for better management of BMW and PW include decontamination of used personal protective equipment (PPEs) and recycling, alternate materials for PPEs, segregation strategies, and use of BMW for co-processing in cement kilns. All upcoming CBMWTFs should be equipped with higher capacity and efficient incinerators for the sound management of BMW. Post-pandemic monitoring of environmental compartments is imperative to assess the possible impacts of pandemic waste.

Key Words: PPE, Bricks, Biomedical waste, masks, recycle, waste management

1. INTRODUCTION

Maharashtra topped the country in the generation of bio-medical waste at 8,317 tonnes between June 2020 and June 2021, according to a document submitted by the Ministry of Environment, Forest and Climate Change in Lok Sabha.

This is a quantum leap from 2019-20 when only 62.3 tonnes of bio-medical waste was generated. The report states that India generated 56,898.4 tonnes of Covid-19 Bio-Medical Waste (BMW) between June 2020 and June 2021. Maharashtra was followed by Kerala (6,442 tonnes),

Gujarat (5,004), Tamil Nadu (4,835), Delhi (3,995), Uttar Pradesh (3,881) and Karnataka (3,133). The bio-medical waste increased with the rise in hospitalizations in many states during the second wave and its peak during May this year. PPE kits, gloves and masks form the bulk of the Covid waste.

Wastes are materials that are not needed and are not usable economically with further processing. It may be in the form of solid, liquid, or gas. They originate from human activities such as agriculture, industry, domestic activities etc. According to the origin, waste is classified as domestic, industrial, commercial, clinical, construction, nuclear, and agricultural. According to properties waste is classified as inert, toxic, and inflammable. If these wastes remain untreated, it leads to air, water, soil or solid waste pollution. Hence, solid waste management is very essential.

In an affluent society, the per capita consumption is very high and people discard many items regularly, which increase solid waste to a large extent.

1.1 Brick 2.0

The used masks are collected in bins and are kept isolated for over 72 hours. The masks are carried to the factory and emptied in a disinfectant chamber. Here, the masks are left for about 4 to 5 hours in order to eliminate any active microorganisms. The masks are then shredded and mixed with paper sludge and binder (adhesive). The mixture is then placed in a brick-shaped mould. These bricks are immediately taken out of the mould and dried naturally (air or sundry). The produced bricks contain about 52 % of PPE material, 45% of paper sludge and 3% adhesive. This brick is 3 times stronger than the normal baked bricks.

These bricks are made in the dimensions of 20 x 10 x 5 cm. About 7 kg of biomedical waste is used to make 2 sq. ft. of bricks. These bricks are water and fire resistant and also cost only Rs. 4 per piece.

Housing Societies can collect used face masks and send to the factory. Hospitals send their waste through certified medical waste disposers. Both these wastes undergo specific treatment before they are converted into bricks.

1.2 PPE - Polyphenylene Ether

PPE material (chemically known as Polyphenylene Ether) is manufactured by Engineer in standard stock shapes for machining and is extruded in sheets and rods. PPE polymer exhibits unusually low moisture absorption because of its inherent composition. Therefore, good electrical insulating properties are achieved over a wide range of humidity and temperature conditions. Chemical attack from water, most salt solutions, acids and bases is also minimal with PPE material.

PPE MATERIAL PROPERTIES AND SPECIFICATIONS

- Good electrical insulating properties
- Long term dimensional stability
- Superior impact strength
- Light weight
- Thermoformable capability
- Good hydrolytic stability

TYPICAL PPE APPLICATIONS

- Mechanical engineering
- Food processing
- Conveying technology
- Automotive parts
- Electrical engineering
- Home appliances

CHARACTERISTICS OF PPE

The major characteristics of these assets are:

- They are acquired for use in the operations of the business - they are not for sale. If they are not used in normal business operations, they should not be classified as property, plant and equipment.
- They are long-term in nature and normally subject to depreciation. These assets represent a bundle of future economic benefits that will be received by the company over the lives of the assets. The investment (cost) in these assets is allocated, through depreciation charges for the years of economic benefits they provide.
- They possess a physical substance that is, they have a physical form that can be seen and touched.

1.3 PPE in bricks

The world was facing a major crisis in the past two years where everyone was locked up in their homes because of the corona virus. It was made mandatory to use face masks and PPE kits outside our houses. And after usage of this masks and PPE kits proper disposal was an issue. Proper management of such waste is not done appropriately. The Covid-19 pandemic has resulted in an increase in biomedical waste in the state, worrying environmental experts as the generation of biomedical waste per day has gone up by 5.5 tons every day to 23,500 kg per day now from around 18,000 kg in 2019. So, the concept of making such bricks from masks and PPE kits is basically to utilize such waste in order to reduce the waste and consume it for a better purpose which will help society, also it will have a great contribution to the construction industry.

In this modernizing growth of the world, everything has taken a leap regarding financial expenses and many other things. The construction costs also have risen from as it was before. In consideration of such issues, this manufacturing of bricks will help the consumers a better financial state, as well as the society, will be benefited from it.

India generates 62 million tons of waste each year. About 43 million tons (70%) are collected of which about 12 million tons are treated and 31 million tons are dumped in landfill sites.

With changing consumption patterns and rapid economic growth, it is estimated that urban municipal solid waste generation will increase to 165 million tons in 2030.

2. METHODOLOGY

2.1 Processes involved in manufacturing of bricks.

So, the first difficulty was how to collect masks and PPE kit as it is our main ingredient in the project. First, we thought that we would be able to collect masks for our personal use i.e., from our family members. But later we knew this would take a lot of time. Then we requested hospitals to provide us with the used masks and PPE kit but they denied it as it was very risky to handle the infected masks and PPE. After some requests from our family doctor, they provided us with the unused PPE kit which was later not used by the doctors as the of patients was decreasing. But the collection of masks was still an issue. So, we went big from collecting masks only from our home to collecting them from our society.

We put the notice of our project and we ne ed only surgical masks on the society notice board and everyone supported our idea and helped us collect the masks. Later we made our own dustbin and place it near the elevator so they can dispose of their masks at the end of the day. This practice was started in mid-Feb and continued for 2 months.

The very next step was to disinfect the masks. For this we took a bucket and placed masks in it and added water till the masks was totally immersed in the liquid and the we added antiseptic disinfecting liquid which is available in every medical store and kept it side for at least 72hrs.

After that, we made moulds for casting the bricks and theimension we used was 20*10*10 slightly bigger than our brick size. The material we used to make our mould was an MS sheet of 0.5mm thickness which is lightweight and easy for handling and cutting. This making of Mould was carried out in the college workshop where all the equipment was available like a hammer, sheet cutting machine, heavy-duty clamp, and spot-welding machine.

Other material which we required to make brick was binder (cement), sand, oil and newspaper, admixture. This material was collected from the site. Our first step in the making of bricks was to shred the masks and PPE kit. the shredding of masks and PPE was done manually.

But when we made our first trial brick the size of the mask was too big and as we can see from the picture the mask was seen on the surface and was not bonded properly with the binder and paper sludge that we later change the process and try to shred PPE by vegetable shredder. The masks we receive were perfectly shredded but as masks were getting stuck the process was very slow so again, we change the process and started doing it with scissors into very fine pieces. Shredding paper was not a difficult task. We added water to the paper till the paper is immersed and then trying it to make paper sludge by mixing it manually. The sludge we made was very good but as we were doing it manually the process was taking a lot of time. Then we shifted from manual mixing to automatic mixing. We used a drill machine and attached blades to shred paper into small pieces and then a perfectly fine paper sludge was ready.

As mentioned earlier in our first trial brick we first took the masks and then added binding material and at the end, we added paper sludge. So, the result was not that good as we can see from the picture the materials were not properly mixed. So, in our trial 2 brick, we first took paper sludge and added binding material to it mixing it properly by hand and at the end, we added shredded masks. The result of this method was very good and later we started executing our bricks batch-wise. Before placing the mixture in the mould, we applied oil in the mould so the brick will be removed from the mould easily. After the mixture was ready, we placed the mixture in the mould in 3 layers and hand compacted it in every layer. Then keep it set for 5-6 hrs. After the brick is set properly and took the shape of the mould. Remove it from the mould and sun- dried naturally for 48 hrs.

2.1 DETAILS OF DESIGN AND TEST SAMPLES PREPARED

The different proportions we used to see the possibilities affecting the properties of the brick.

- For paper sludge – 10% = 100gms
- Cement – 5% = 200gm
- Sand – 5 % = 150gms

- Masks – 10% = 50gms

We categorize the bricks T1 (trial 1 brick), T2 (trial 2 brick), B1 (batch 1 brick), B2 (batch 2 brick), B3 (batch 3 brick).

T1 BRICK

- Mask – 20% (dry) = 100 grams
- Paper sludge – 70% = 700 grams
- Binder – 5% = 150 grams

T2 BRICK

- Mask – 20% (wet) = 100 grams
- Paper sludge – 70% = 700 grams
- Binder – 5% = 200 grams
- Sand – 5% = 150 grams

B1 BRICK

- Mask – 20% (wet) = 100 grams
- Paper sludge – 70% = 700 grams
- Binder – 5% = 200 grams
- Sand – 5% = 150 grams
- Admixture – 30ml (plasticizer)

B2 BRICK

- Mask – 30% (wet) = 150 grams
- Paper sludge – 60% = 600 grams
- Binder – 5% = 200 grams
- Sand – 5% = 150 grams
- Admixture – 30ml (plasticizer)

B3 BRICK

- Mask – 10% (wet) = 50 grams
- Paper sludge – 80% = 800 grams
- Binder – 5% = 200 grams
- Sand – 5% = 150 grams
- Admixture – 30ml (plasticizer)

2.2 TESTS PERFORMED

1. Compaction Test

A compaction test was performed on the bricks. This test was performed on a Universal Testing machine. Initially, we noted down the thickness of the brick of each batch and gradually started loading with 100 KN up to 600 KN and the results we got are below:

2. Drop Test

The drop test was performed manually in which we dropped each brick from each batch from a height of 1m, 2m, 3m and 4m. We observed that even after falling from 4m of height the brick didn't break also if we further dropped it from a height of more than 4m it would also have survived. The results of the drop test are as follows:

Type of brick	1m	2m	3m	4m
B1	✓	✓	✓	✓
B2	✓	✓	✓	✓
B3	✓	✓	✓	✓

3. Water Absorption Test

In this, we soaked each brick in water for 24 hours in which we recorded the weight of the brick before soaking and after soaking and we got the following results:

4. Fire Test

Fire resistance tests are intended to assess the performance of elements of construction for their load-bearing or fire separating properties – usually termed their fire resistance – for their regulated use in buildings. We performed this by burning the bricks from a single surface and after a while we observed that the brick didn't catch fire but as paper sludge was involved in the process hence the brick was deteriorating after some time.

Type of brick	Original thickness	Thickness after 100KN	Thickness after 200KN	Thickness after 300KN	Thickness after 400KN	Thickness after 500KN	Thickness after 600KN
B1	48mm	34mm	30mm	26mm	24mm	22mm	20mm
B2	45mm	22mm	20mm	18mm	18mm	16mm	16mm
B3	49mm	26mm	22mm	20mm	20mm	19mm	18mm

3. CONCLUSION

After all the successful results found from all the tests. We found out that the Brick from batch 1 was the ideal or the best of all the proportions we assumed and performed. This brick that we made is lightweight, easy to handle, can resist a great amount of compaction, gave us an excellent result in water absorption, and was able to survive the drop test in which it was dropped from a height of more than 4m. Also, the fire test performed on the brick gave us satisfactory results. Another advantage of this brick that we would like to mention is that this brick is not brittle in nature but gives a great strength so if any structure tends to bend over a period we would get an idea that it needs to be repaired or maintained is needed it won't directly collapse it would us a kind of warning regarding the repairs.

This brick can be used in partition walls, compound walls, an unimportant structure or in any structure in which we don't want to invest much. As we know that this brick has a low density and hence porosity of the bricks are high.

Due to this water absorption of the bricks is also high. So, the future extension of the project will be to make this brick water-resistant. If the water-resistant ability becomes successful then this will simultaneously affect in the increase of compressive strength of the bricks. If bio- medical waste is used in the construction field after recycling the construction cost of the project will be drastically reduced without affecting the quality of the structure.

If this project is carried out on a large scale, not only pollution caused due to the incineration will be minimal, but also the construction cost of the structure is reduced. Brick 2.0 can be the future of the construction industry if proper awareness is spread among the people.

Type of brick	Before	After	Percentage
B1	520 grams	1201 grams	56%
B2	567 grams	1111 grams	49%
B3	640 grams	1202 grams	46%

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