GENERALIZED MASK DISPOSAL PRACTICES AND REDUCTION OF COLOSSAL AMALGAMATION OF MASKS BY CONVERTING INTO VALUABLE ROAD PAVEMENT ASSET IN BANGLADESH

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ABSTRACT

Unequivocally, the Covid-19 pandemic has led to a histrionic loss of human life worldwide and marks up an unheard challenge to public health, food systems, and the world. As global carbon emission has been significantly reduced due to shutdown led to a favourable influence with leaving a trace on the entire ecosystem but a burning question leaving a new challenging ultimatum, disposal of safety equipment, has come to light adding a new dimension that might be dealt with further. This paper demonstrates the approximate amount of face masks, one of the safety equipment, and suggests the disposal way of face masks by reprocessing it into pavement material mixed with bitumen as road construction materials. The annexed paper has bottled up the working procedure including arbitrarily capturing candid photographs to spot the acceptance rate of masks, a prompt online survey to detect the type of masks, and a lab experiment to measure the fusion of polypropylene mixture and laboratory tests of a mix of bitumen with polypropylene to detect suitability inroads. Chronological analysis of snapped photographs at random places from urban and rural areas delineates a depiction of a median of 81.82% and 14.29% respectively. Simultaneously the scrutinized survey limelights that the surgical mask is hugely used about 83.9%; which is predominantly made from polypropylene. Approximately 4.45965E+11 units of surgical masks are used per day. The acceptability of characteristics including on average 36 penetration value, 87°C softening points, 32.5 cm ductility of the 10% polypropylene with Bitumen mixer are more efficient here by the tests. In a nutshell, the result of the amount of polypropylene carry-on average a single mask contains 3.10525 millilitres of a liquid mixture of polypropylene. By using these augmented used masks, 1.38483E+12 millilitres of polypropylene mixture can be produced daily which can save about 10% bitumen or asphalt cost as well as be more compatible with the environment of Bangladesh. Consequently, to prevent upcoming catastrophic impacts on the environment via face masks, the disposal way turning into road pavement material of face masks can transform contaminants into a valuable asset leaving zero doubt.

Keywords: *Polypropylene, Bitumen, Surgical mask, Pavement Asset*

1. INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) also known as the coronavirus, is the virus that causes COVID-19 (coronavirus disease 2019), the respiratory illness responsible for the ongoing Covid-19 pandemic. First identified in the city of Wuhan, Hubei, China, the World Health Organization declared the outbreak a Public Health Emergency of International Concern on 30 January 2020, and a pandemic on 11 March 2020 (Wikipedia). After the outbreak of this deadly virus, most countries have closed their borders to restrict movements via airplanes and also ascribed lockdown within the countries to restrain community transmission but the infectious rate is rapidly increasing till now and almost 221 countries are affected (worldometer, 2021). World Health Organization has recommended various guidelines to prevent the growth rate of this infectious disease and to mitigate mass community transmission including using face masks, Personal Protective Equipment (PPE), face shields, keeping social distancing, quarantining (suspicious people who have recently visited Corona occupied area).“If Covid-19 is spreading in your community, stay safe by taking some simple precautions, such as physical distancing, wearing a mask, keeping rooms well ventilated, avoiding crowds, cleaning your hands, and coughing into a bent elbow or tissue and Make wearing a mask a normal part of being around other people (World Health Organization, 2020). Several Face Mask Types, Efficacies, and Approved Models are given below (AHRMM):

Product Classification	Airborne Particle Filter Strength
Surgical N95	NIOSH-NIOSH-approved N95 respirator. FDA approved as surgical mask.
N95	>95%
N99	>99%
N100	>99.97%
R95	>95%
P95	>95%
P99	>99%
P100	>99.97%

This extensive use of face masks has had several unexpected impacts on the environment and according to www.weforum.org, one study estimates that in the UK alone if every person used a single-use face mask a day for a year, it would create an additional 66000 tonnes of contaminated waste and 57000 tonnes of plastic packaging (WORLD ECONOMIC FORUM, 2020). If even only 1% of the masks were discarded incorrectly, that would result in 10 million masks per month dispersed in various ecosystems. With the weight of each mask about 4 grams, more than 40000 kilograms of plastic would soon accumulate and these plastic products break down into microplastics; they then contaminate air, water, and soil (Dybas, 2021). So these face masks should necessarily be thoroughly recycled and refined for the termination of plastic contamination and also to protect and safeguard our environment but the fact which should be kept in mind that these face masks contain infectious wastes including cough, hoast, sneeze, blood, bodily fluids, etc. and if they are not agglomerated, transited, and managed duly, this can be the reason for a serious outbreak of infections since recent research evaluated the survival of the COVID-19 virus on different surfaces and reported that the virus can remain viable for up to 72 hours on plastic and stainless steel, up to four hours on copper, and up to 24 hours on cardboard (Food and agriculture Organization of the United Nations, 2020). For these reasons, we have to ensure the sustainable and safe use of polypropylene, which is the main ingredient of face masks and our main objective of this paper is to assert that the strength and quality of bitumen-polypropylene road pavement are far better than bituminous road pavement and by using polypropylene on the road pavement, potential and stronger roads can be built and thus plastic pollution can be decremented along with the safety ensurement of our environment.

2. METHODOLOGY

2.1 Survey Pedagogy Approaches

Straight away, two types of surveys are done to determine the rate of accepting of by the local users of Bangladesh and determine the most used mask type.

2.1.1 Mask Acceptance Survey

Nowhere, the survey was conducted by taking photos at the standard resolution of 15 nos and 25 nos from the rural and urban area at different periods during and post lockdown in Bangladesh and from these photos, we have determined the number of mask and non-mask users. Thus, a scenario of the acceptance rate of face masks by rural and urban people has been reflected through the necessary graphs displayed below. The purpose of these surveys is to find out the amount of daily usage of face masks and their disposal processes and the variation in face masks usage by urban and rural people and from these surveys we will also figure out the necessary face mask waste control and further management policies.

2.1.2 The Lion's Share Mask Type Survey

Confidentially, this data was collected from 6 July 2021- 11 July to 2021 among different age ranges from 11 to 60 years of 219 persons in different divisions of Bangladesh. This online survey consists of various questions focusing on different parameters including types of masks, daily usage of face masks (single-use disposable surgical masks, Eco-friendly cloth masks, N95, FFP2, K95), disposal of these masks (on nearby open places, in dustbins, in drains or flushed in toilets, by burning, etc.), people from different divisions and age range.

2.2 Exploration to Ordain Polypropylene Mixer

At this time, our main goal is to separate polypropylene from single-use face masks, and to achieve this goal, a significant amount of face masks is heated to sunder the main ingredient, polypropylene and we will achieve this as liquid polypropylene mix due to heating. For this observation, surgical face masks of two diverse companies (Super and Unknown) were used. One surgical face mask from each company was taken into separated calibrated test tubes of 16mm x 150mm after chopping the masks into smaller pieces. Then the chopped mask pieces were heated to the melting point until the whole content was melted. At the end of this experiment, the quantity of liquid Polypropylene mix was observed. The resulted data is also used to calculate the total amount of liquid polypropylene mix. The quantity of daily face masks is estimated by using an equation adapted from Nzediegwu and Chang as follows (Sangkham, 2020):

$$D_{FM} = P \times U_p \times F_{MAR} \times (F_{MGP}/10000) \;\ldots\ldots\ldots\ldots\ldots\; (1)$$

Where, D_{FM}= Daily face mask use (pieces)

P= Population (persons)

U_p= Urban Population (percentage)

F_{MAR}= Face masks acceptance rate

F_{MGP}= Assumption that each person in the general population uses one face mask each day

2.3 Laboratory Test to Detect Suitability

Our main goal from this experiment is to use 90% bitumen and 10% polypropylene on the road pavement as a binder and to achieve this goal, various characteristics including penetration, ductility, softening point, flash and fire point tests of bitumen, bitumen and polypropylene mix, just polypropylene were done in the laboratory and for fulfilling this objective, Firstly, we cut the strips of single use surgical face masks as the strips contain several other substances which would prevent from getting the exact values. Then the weight of one mask was taken and it was 1.80 gm. Then we prepared a base plate with briquette mold and ring to pour bitumen and polypropylene mix and polypropylene for testing. After that we heated the face mask pieces to turn them into liquid polypropylene mix and we needed total 72 pieces of face masks for preparing this mixture. Then we would pour the liquid polypropylene

Figure 1: Bitumen, Polypropylene and Bitumen and Polypropylene Mix Sample prepartion

mix into briquette and ring for ductility and softening point testing. After that we heated Bitumen sample and 180 gm of bitumen and 20 gm of polypropylene had been poured into the glass beaker to prepare 200 gm of bitumen and polypropylene mixture.

2.3.1.1 Penetration Test

The main equipment used for this penetration test were penetration apparatus, penetration cup (diameter- 55 mm and height- 35 mm), needle (length-55 mm), thermometer, timer, water bath and this test was conducted according to ASTM D5. This test was conducted for two type samples: bitumen and the mixture of bitumen plus polypropylene mixer (10% polypropylene).

Figure 2: Pentration Test Apparatus

Firstly, the needle holder was examined and guided to establish the absence of water. A penetration needle was cleaned with toluene and other suitable solvent, and was dried with a clean cloth and then the needle was inserted in the penetrometer. The total load of 100±0.1 gm was made for needle and attachment. The transfer dish containing the sample on the stand on the penetration apparatus was placed and it was penetrated immediately. Then four penetration values were taken for bitumen and bitumen and polypropylene mix. Before each test, the needle was cleaned with a clean cloth moisture with toluene to remove all adhering substances and then the needle was wiped with a dry clean cloth. The needle was adjusted to contact with the surface of the sample and dial reading was adjusted to zero. With the help of timer, the needle was released for exactly 5 seconds and finally the dial reading was recorded. The table below shows the penetration value of bitumen, bitumen and polypropylene mix.

2.3.1.2 Softening Point Test

Figure 3: Softening Point of Polypropylene Mixer

The sample was melted and thoroughly mixed to present air bubbles. Then, the melted sample was poured into ring by placing a brass plate containing amalgamate to prevent sticking and the excess sample should be remained at room temperature for 30 mins and then the excess sample was cut off. Then, the boiled water at glass vessel and the ball were kept at bath separately. The ring was kept 25 mm from bottom of the apparatus and the balls were loaded. After that, the whole system was heated up and when the balls touched the bottom, then separate reading should be taken as softening temperature. The table below shows the softening temperature of bitumen, bitumen and polypropylene mix.

2.3.1.3 Ductility Test

A mixture was made of equal part of glycerine and dextrin and was applied to the surface (inner and outer) and the interior part of the briquette specimen. It would help to prevent sticking off the sample to the surface. Then liquid sample was placed into the mold. The molds were placed into testing machine and started pulling apart. Then, additional water was added (temperature of water = 25℃) so that sample couldn't sag downward. The side part was removed and initial reading was set to 0. After pulling out at a specific rate, the middle part of the sample would be thin and would start to tear off.

Figure 4: Ductility Test of Polypropylene Mixer

2.3.1.4 Flush and Fire Point Test

The sample materials were heated to a temperature until it became fluid. Then the brass cup which was cleaned with appropriate solvent, had been dried in hot air oven and cooled to a point of at least 56℃ below the expected flash point before using. Then the test cup was filled with the sample up to the filling line. The temperature of the test specimen was increased rapidly at first and then at a slower constant rate as the flash point was approached. At specified intervals, a test flame was passed across the cup and thus flash point of the sample material was obtained. But to determine the fire point, the test was continued until the application of the test flame caused the test specimen to ignite and sustain burning for a minimum of 5 second.

3. OBATAIN RESULT DATA

3.1 Survey Reports

Photo survey indicates 80.74% (median = 81.82%) on average people living in urban area use masks where on average 18.92% (median= 14.29%) of rural people use safety masks.

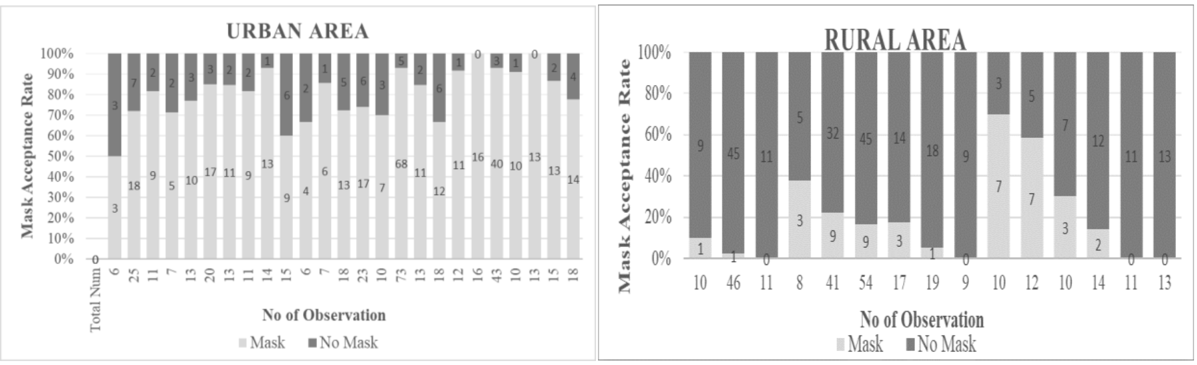

Figure 5: Variation of Acceptance of Face-mask as primary Safety Need

From the online survey, surgical face-mask is observed as the highest priority in day to day life having 84% share of total use. Among all, 66.5% poeple use a single mask per day where 22% of them use two masks per day.

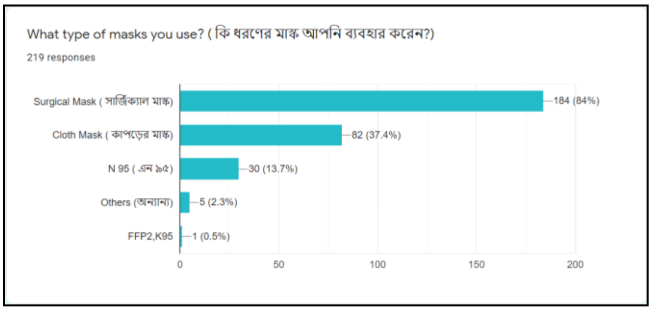

Figure 5: Most Adopted Mask

3.2 Polypropylene Mixer from Mask

The following test result displays the average milliliter of polypropylene liquid mixer per mask obtained during the experiment and the daily facemark amout and it's probable serviceability using equation (1) as follows:

Table 1: The Amount of Polypropylene Mixer Obtained from Masks

	Test-01 (ml)	Test-02 (ml)	Average (ml/mask) (without rubber)	Total daily surgical	% use	Total amount of polypropylene (ml)
Super	3.285	3.348	3.10525	4.45965E+11	10%	1.38483E+12
unknown	2.909	2.879				

3.3 Laboratory Test Data

3.3.1.1 Penetration Test

This test was conducted to obtain the average penetration value of each sample. The obtained values helped us to determine best penetration grade sample.

Table 2: Penetration Value Data from Lab Tests

Observation No.	Bitumen Penetration Value	Bitumen and Polypropylene mix Penetration Value	Polypropylene Penetration Value
1	60	35	N/A
2	62	36	N/A
3	60	36	N/A
4	62	37	N/A

3.3.1.2 Softening Point Test Data

This test was conducted for checking if the softening point value of each sample is less than the highest temperature of our country and this test also determined the best of the three samples.

Table 3: Softening Point Data from Lab Tests

Time consumed while softening of Bitumen and Polypropylene Mix	Time consumed while softening of Polypropylene	Softening temperature of Bitumen and Polypropylene Mix	Softening temperature of Bitumen	Softening temperature of Polypropylene
22 min 39 sec	27 min 12 sec	87°C	47°C	>100°C

3.3.1.3 Ductility Test Data

This test was conducted to determine the ductile behaviour of these 3 samples and to determine if these samples were brittle or tough and which of these 3 materials are the most eligible for road pavement.

Table 4: Ductility Data from Lab Tests

Ductility of Bituminous Material	Ductility of Bitumen and Polypropylene Mix	Ductility of Polypropylene
121 cm	32 cm	N/A
127 cm	33 cm	N/A

3.3.1.4 Flash and Fire Point Test Data

Flash and Fire point test for polypropylene and bitumen were conducted in the laboratory and the following table displays the necessary test results.

Table 5: Flush and Fire Point Data from Lab Test

Observed Flash Point		Observed Fire Point	
Bitumen	Polypropylene	Bitumen	Polypropylene
305 °C	302 °C	348°C	310 °C

3.3.1.5 Variation of Test Data among Bitumen, Bitumen and Polypropylene Mix and Polypropylene

From the table, it is seen that the average penetration value of Bitumen and Bitumen and Polypropylene Mix are 61 and 36 grades respectively. We know that the higher the penetration value, the softer the consistency. So, Bitumen and polypropylene mix is certainly better than bitumen alone. Then in the case of softening point, value of Bitumen is 47 and Bitumen and polypropylene mix is 87. In the case of softening point, binding material of road pavement must have a softening point greater than the highest temperature of that country otherwise ruts will develop and adhering or binding material bleeding will occur.

Table 6: Variation of Test Data among Bitumen, Bitumen plus Polypropylene and Polypropylene

Properties	Bitumen	Bitumen and Polypropylene Mix	Polypropylene
Average Penetration Value	61	36	N/A
Softening Point Value	47°C	87°C	>100°C
Average Ductility Value	124 cm	33 cm	N/A
Flash Point Value	305°C	N/A	302°C
Fire Point Value	348°C	N/A	310°C

Here, the samples have softening point greater than the highest temperature of our country, but the more the softening value, the more eligible the material and so, bitumen and polypropylene mix is more useful for road pavement but not the polypropylene alone. The reason behind this is the ductility value. Polypropylene is a very brittle material and it broke off during experiment, so bitumen and bitumen and polypropylene mix are better option in this case.

3.4 Interpretation of Test Results

In this context, disposable mask wastes are used to make this usable by using it on road pavement along with principal binding material, bitumen. From the above test results, it has been proven that the properties of bitumen and bitumen and polypropylene mix are approximately similar and in some cases, even bitumen and polypropylene mix is better than the bitumen alone like the penetration and softening point value is showing better characteristics in the context of practical situation. It becomes liquid after heating but after cooling, the mix becomes solid and so gets less penetration value than bitumen alone. In the ductility test, it broke off while conducting an experiment on ductimeter and if polypropylene was not so brittle we could certainly use it on road pavement; which is a limitation of this mix. The flash and fire point value of polypropylene is quite similar to bitumen. Hence this polypropylene mix can be used in road pavement in place of bitumen as a principal binding material. Due to inadequate lab access, if 5% of polypropylene mix can be used instead of 10% in these tests, maybe properties would be more practical to use. But overall it has come to an agreement that the properties of liquid bitumen and polypropylene mix are similar to bitumen and can be a good binding material like bitumen. The graphical analysis represents that most people use surgical masks but their disposal is the indispensable part that must be taken under action. Penetration test and ductility test have the data polypropylene mix penetration value whereas softening point test data depicts softening temperature of bitumen and polypropylene mix. These results are optimized for analysis behaviour of mask to exhibit the chronological experimental approaches.

4. CONCLUSIONS

This study explored the extensive use of face masks during coronavirus pandemic, the enormous plastic ingredients contamination on the environment and how the main ingredient polypropylene can be used along with road construction binding material, bitumen to enhance the road pavement strength. From the test results, it can be seen that a mixture of bitumen and polypropylene can create a more reliable, valuable pavement material than the bitumen alone as it is proved from the penetration test value and it is known that the smaller the penetration value, the better the binding material. (the mixture of bitumen and polypropylene penetration value is in the 30s range, where the bitumen penetration value is in the 60s range). A higher softening point of polypropylene mix than bitumen also indicates better suitability in hotter weather like our country, Bangladesh. So, to attain more strengthened, durable, reliable road pavement, proper usage of a mixture of bitumen and polypropylene can be the next better solution instead of bitumen alone. This will help to significantly reduce the face masks or polypropylene and other plastic ingredients contamination on the environment and can be a more favourable option to save the environment and also can reuse the plastic waste for the durability of road pavement.

ACKNOWLEDGEMENTS

We would like to express our special thanks to gratitude to H.M. Iqbal Mahmud, Professor of Khulna University of Engineering and Technology (KUET), who gave us the golden culminated opportunity to do these wonderful experiments on corresponding transportation labs.

We are like to acknowledge and give our warmest thank to Mr. Mahmud, Lab assistant of Transportation Engineering Lab, who made these experiments smoothly possible. It is beyond saying that my thanks our relatives, neighbours and friends who collaborated a lot in finalizing the whole survey within the limited time frame.

We are overwhelmed in all humbleness and gratefulness to acknowledge our deep respect to all those who have helped us to put these ideas, well above level of simplicity and into something concrete despite of their busy schedules.

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