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Integration of Bio-Medical Waste into Flexible Pavements of Cold Region Area's

Benit-Ul-Islam[1], Prof. Sohan Bhaggu[2], Prof. Ajay Kumar Duggal[3]

[1]M.Tech Research Scholar, Dept. of Civil Engineering, Indo Global Group of Colleges, New Chandigarh, India
[2]Assistant Professor, Dept. of Civil Engineering, Indo Global Group of Colleges, New Chandigarh, India
[3]Associate Professor , Dept. of Civil Engineering, National Institute of Technical Teacher's Training & Research (NITTTR), Chandigarh, India

ABSTRACT

Bio-medical wastes are generated almost in every corner of world . Apart from famous hospitals of India like AIIMS,PGI Chandigarh, TATA institute Mumbia, Almost every village & town of India has its own health sub center. Every day almost on an average 20kg of biomedical waste is generated from a single hospital of India. The bio-medical waste generated from these hospitals & sub-center's is being disposed of as such either by incineration or by landfilling, but both these processes are not eco-friendly in nature. There is one of the safest mechanism to dipose of this bio-medical waste& that safest mechanism is use of such bio-medical wastes in road construction.

Keywords; Bio-medical waste, Hospitals, Flexible payments, Environment pollution, Eco-friendly environment.

INTRODUCTION

In India, there are almost 11,296 government hospitals& many more private hospitals & sub health center's . In health care system , the rank of India in global health index 2021 is 66 with a score of 42.8. Among states of India , kerela emerges as the top ranking state in terms of overall health care system. Every day almost thousands of patients visit these hospitals for treatment of various diseases & everyday kg's of plastic bio-medical wastes are generated from such hospitals including syringes, Glucose bottles etc. These syringes & gulucose bottles are disposed by incineration & by land filling. Both these processes are not eco-friendly in nature & they create various environmental hazards like soil pollution , air pollution that inturn causes many diseases. With the essence of diseases, people visit hospitals & again generation of bio-medical waste takes place. The process continues & the cycle repeats.

Its responsibility of an every individual to find some alternative ways to dispose off bio-medical wastes. As an individual we found some alternative ways to dispose off these biomedical wastes & the alternative way that we found was to use such bio-medical disposal wastes like syringes, glucose bottles in road construction. India as a developing country is in need to develop our road infrastructure more & more stable. Every year cores of rupees are spent for road development, but the outcome of our roads is not that much satisfactory? Our roads get degraded at fast rate, they develop more potholes, more spinouts& more accidents eventually takes place on such degraded roads then. The problem why these roads start degrading at such fast rate lies in the fact that bitumen, a binding material does not much stability. Bitumen, one of the important highway material is very highly unstable in terms of stability & flow value. The properties of bitumen are actually unstable that is the reason bitumen does not much that much capability to stay resist against traffic flow, against temperature. The properties of bitumen can be modified by several things, & plastic bio-medical wastes is one of them. By using mixture of plastic bio-medical wastes we can enhance the properties of bitumen, which in turn enhances our road development.

METHOLODOGY

Need of the Present Study

Road networks in India are vastly expanding. Thousands of crores of money is being invested in the maintenance and repair of these roads. The maintenance and repair of such roads in cold states of Jammu Kashmir along with Himachal Pradesh and some other northern regions is becoming hectic and troublesome due to the frequent stripping and pothole occurrence as a result of snowfall and torrential rains which create havoc in these regions.

The amount of Bio-medical plastic present provides a viable option to look for an alternative for the normal mixes by replacing them with modified mixes. This can lead to a significant reduction in the maintenance and repair costs and even the construction cost of the roads in such areas along with the visible gains in the form of durability, strength and increased service life.

The present study deals with enhancing the properties of modified mixes to deal with the problems existing in such areas.

Objectives of Study

1. To determine the optimum amount of Bio-medical plastic waste for addition to bituminous mix namely Bituminous Concrete.
2. To study the effects of addition of Bio-medical plastic in the desirable properties of Bituminous Concrete.
3. To evaluate the effect of Freeze Thaw phenomenon on various properties of bituminous mix .e.g % air voids, % optimum binder content.
4. To establish parameters for evaluation of durability and loss of properties for bituminous mixes in colder regions.

Methodology Introduction

The methods used in achievement of the objectives have been discussed in this chapter.
Discussions with regard to the test procedures and materials utilized are also provided.

Research Methodology

So as to achieve the whole extent of study, Evaluation of mixes shall be made using Marshall Method of Design. For this purpose various materials viz aggregates, binder, waste Glucose water bottles were used. Optimum binder content was selected. Grading was done according to the specifications. The procedure involved in this study is as:

1. The material to be used were collected from the nearby area of Srinagar.
2. The Bio-medical waste plastic material was collected from a nearby hospital of Srinagar namely SKIMS Soura. The bio-medical waste collected included waste glucose bottles. These bottles were cleaned well before use and were used in shredded form of size 5mm.
3. Bitumen of grade VG-10 was to be used.
4. Optimum binder content for normal mix was determined.
5. Optimum Bio-medical plastic waste was kept as 5-6% for addition to the mix.
6. The effects on the mix by the addition of Bio-medical waste plastic was examined by Marshall Stability Tests.
7. Testing of Samples prepared with Bio-medical Waste Plastic will be done at -7 degree.
8. Samples shall be prepared by the addition of Bio-medical Waste plastic.
9. The samples were subjected to multiple cycles freeze thaw and then tested. The number of cycles can be 05 and 10.
10. The results obtained were then compared to examine the effects of addition of Bio-medical waste plastic.
11. From the above test information, the test outcomes might be investigated to make reasonable interpretation regarding our objective.
12. The tests for the study will be completed at Civil Engineering Department, SSM college of Engineering and Road research lab Srinagar.

RESULTS AND ANALYSIS

Properties of Various Materials Used In the Study.

For performing this study various materials were used.
These are as:

i. Bio-medical Plastic waste(Glucose water bottles)
ii. Aggregates , size 13.2mm
iii. VG10 bitumen.


Fig 1 Aggregates fig 2 bitumen

According to MORTH various tests conducted on aggregates and bitumen are as

Table 1: Physical Properties of Aggregates

Physical Properties	13.2mm	Requirements as per MORTH(Revision 5th)
Specific Gravity	2.7	2.6-2.8
Elongation Index (%)	13	Max 30% (combined)
Flakiness Index (%)	12	
Impact Value (%)	17	Max 24%
Water Absorption (%)	0.8	Max 2%
Stripping Value (%)	2-3	<5%
Aggregate crushing value Abrasion value	3 28	Not mentioned Max 30%

Table .2: Physical Properties of Binder

Properties	VG-10 Grade		Test Method
	Determined	Required	
Penetration	89	80-100	IS: 1203-1978
Softening point	41.4	40 min.	IS : 1205-1978
Specific gravity	1.3	0.99 min.	IS: 1202-1978

Tests Performed on Bituminous mix

Marshal Test

Marshall Stability Test is used for finding the Stability Of bituminous mixes. Marshall Stability Test implements the Principle that the Stability of the bituminous mix is its resistance to flow when loaded on lateral surfaces. In general, it may be defined as the capacity of load which the mixes can carry at 60°c. The measuring unit of Stability is kg. Flexibility of mixes can be determined by using Flow value. It is measured as deformation in 0.25 units from the application of load to the point when the load is maximum.

Procedure followed

a. First selection of proportions of coarse aggregate and filler is done in order to meet the requirements as per IRC. The weight of mix should be kept as 1200g.
b. The aggregates are heated to 170°C and bitumen is heated to 163°C respectively.
c. Mix the materials and transfer the material to the compaction mould arranged on the compaction pedestal.
d. 75 Blows are given on both sides of the sample specimen with a standard hammer (4.86 kg, 45cm- free fall).
e) Keep the specimen in the mould for few minutes for cooling
f) Remove the specimen by gently pushing it from the mould.
g) The specimen is marked and cured at room temperature.
h) A number of specimens are prepared by same method with 6% bio-medical waste content And control mix
i) Test the samples both control mix & bio-medical mix by applying the load on the specimen at the rate of 5cm/min. Check the Stability and Flow Value of the samples.

Figure 03, Marshal Stability test

Determination of Job mix formula for Bituminous Concrete control mix by Marshall Method.
The Grading of different aggregates was done for obtaining virgin mix. The results are as shown in following table:

Table 3: Grading of Aggregates for Control Mix

IS Sieve Size	% passing (required)	% passing 19mm	% passing 13.2mm	% passing Stone dust	% passing Cement	Grading
19mm	90-100	90.1	100	100	100	98.1
13.2mm	59-79	12	99	100	100	76.34
9.5mm	52-72	2.23	77.1	100	100	70.1
4.75mm	35-55	0.07	5	97.1	100	45.32
2.36mm	28-44	0	0.03	76.4	100	31.40
1.18mm	20-34	0	0	62.3	100	27.1
600mm	15-27	0	0	41.8	100	22.5
300mm	10-20	0	0	33.0	99	17.2
150mm	5-13	0	0	21.2	97.9	8.97
75mm	2-8	0	0	32.9	99	7.3

After grading of aggregates, ratio of the blend is calculated. It was done using a programme in Ms-excel and the ratio used was 55:42:3

Quantity of Aggregates used
After determining the ratio of aggregate blend, the quantity of aggregates required for the mix is calculated. This is given in the following table.

Table 4: Percentage and Quantity of Aggregates for Control Mix

Size of Aggregates	Percentage used	Weight of Aggregates(grams)
13.2	55%	660
Stone Dust	42%	504
Cement	3%	36

Marshall Stability Test results for Control Mix

Table 5: Marshall Stability Test results for Control Mix

Bitumen Content	5.5%	6%	6.5%
Specific Gravity of Bitumen	1.0	1.0	1.0
Density (g/cc)	2.321	2.356	2.326
Specific Gravity of Aggregate Blend	2.68	2.68	2.68

Volume of Bitumen, V_b(%)	12.006	12.597	14.01
Volume of Aggregate, V_a(%)	82.21	82.65	81.68
Voids in Mineral Aggregate, VMA (%)	17.79	17.35	18.32
Voids Filled with Bitumen, VFB (%)	67.48	72.60	76.47
Air Voids, %	5.784	4.753	4.31
Stability, kg	1767	2132	1925
Flow Value, mm	3.46	3.73	4.25

Determination of optimum binder content
After performing Marshall Stability Test, the optimum binder content was known to be 6%.The quantity of bitumen in accordance to its percentage was calculated as 72grams.

Determination of optimum Bio-medical waste plastic content.
Like above , optimum Bio-medical Waste plastic content was found to be 6%. And marshal test was conducted.
Marshall Stability Test results for Mix with 6% BMWP

Table 6: Marshall Stability Test results for Mix with 6% BMWP

Bitumen Content	5.5%	6%	6.5%
Specific Gravity of Bitumen	1.0	1.0	1.0
Density (g/cc)	2.293	2.284	2.279
Specific Gravity of Aggregate Blend	2.557	2.557	2.557
Volume of Bitumen, V_b(%)	12.45	12.927	12.91
Volume of Aggregate, V_a(%)	84.80	84.26	84.15
Voids in Mineral Aggregate, VMA (%)	15.2	15.74	15.85
Voids Filled with Bitumen, VFB (%)	82.64	81.48	88.64
Air Voids, %	3.07	2.4	2.16
Stability, kg	2100	2815	3210
Flow Value, mm	4.12	4.47	4.71

3.7 Tests results after Repetitive Freeze Thaw cycles (05& 10 days)
Samples were made using job mix formula for control mix at bitumen content of 6%, mix with 6% Bio-medical waste .Samples were subjected to repeated freeze thaw cycles for 05 and 10 days. The results of tests performed are as:

Table 7, Results after 05 days Table 8, results after 10 days

Bitumen Content (05 days)	Control mix	BMWP mix 6%	Bitumen Content (10 days)	Control mix	BMWP mix 6%
Specific Gravity of Bitumen	1.0	1.0	Specific Gravity of Bitumen	1.0	1.0
Density (g/cc)	2.34	2.285	Density (g/cc)	2.327	2.285
Specific Gravity of Aggregate Blend	2.65	2.41	Specific Gravity of Aggregate Blend	2.68	2.557
Volume of Bitumen, V_b(%)	14.04	13.71	Volume of Bitumen, V_b(%)	13.17	12.933
Volume of Aggregate, V_a(%)	81.91	84.30	Volume of Aggregate, V_a(%)	81.91	84.30
Voids in Mineral Aggregate, VMA (%)	17.1	14.6	Voids in Mineral Aggregate, VMA (%)	19.09	14.7

Voids Filled with Bitumen, VFB (%)	69.7	80.3	Voids Filled with Bitumen, VFB (%)	72.65	83.37
Air Voids, %	5.1	3.61	Air Voids, %	4.07	2.19
Stability, kg	1578	2572	Stability, kg	1110	2004
Flow Value, mm	2.65	3.4	Flow value mm	2.45	3.0

CONCLUSION

1. Mixes having bio-medical waste glucose bottles can be utilized in the construction of BC pavements. Mixes with 6% BMWP show good results and can hence replace aggregate in virgin mixes.
2. The optimum amount of BMWP for mix in BC was found to be 6% at a bitumen content of 6%
3. It was observed that after comparing the results of the mixes prepared by the addition of bio-medical waste provided better results in terms of Retained Marshall stability and Marshall Quotient.
4. The comparative study of the results obtained for mixes with 6%BMWP and control mix after 05 and 10 repeated Freeze Thaw cycles also indicate much better Stability and Marshall Quotient values for Mix with 6% BMWP.
5. By exposing the mix to 10 repetitive Freeze Thaw cycles, majority of the Stability is lost by the both Control Mix and Mix with BMWP...
6. From the observation of results, it can be concluded that mixes with 6% BMWP have greater durability and Strength as compared to the mixes with control mix.
7. .It was observed that control mix after being subjected to repeated Freeze Thaw cycles can lose more than 50% of its original strength; hence modification to the mix should be done by addition of 6% BMWP which highly enhances the strength of the mix.
8. The mixes with 6% BMWP even after 10 Freeze exhibit stability values similar to that of control mix under ideal conditions. Thus, it can be concluded that 6% BMWP should be added to the mix for use in places having low day and night temperatures.
9. Bio-medical mix exhibits more stability as compared to control mix, that indicates the fact that biomedical wastes improves the properties of bitumen , and use of biomedical wastes in road construction is a welcoming step.
10. Use of Bio-medical wastes in road construction proves to be one of the safest mechanism to dispose off bio-medical waste plastic.
11. Use of bio-medical wastes in road construction does not create any kind of environmental hazard.
12. Using bio-medical wastes in road construction prevents spread of transmissible diseases like aids & all.
13. Also by using Bio-medical waste plastic, roads constructed in such areas can prove to be economical.

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