

Improvising Pavement Strength using Plastic Waste

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Abstract - The plastic waste quantity in municipal solid waste is increasing due to increase in population and changes in life style. Thus disposal of waste plastic is a hazardous and become a serious problem globally due to their non-biodegradability. Plastic roads are found to perform better than ordinary roads and therefore use of plastic road construction has gained importance these days. Plastic roads are more stable in hot season as well as non-permeable to rain in rainy season. Disposal of waste plastic bags has become a serious problem and waste plastics are burnt for disposal which causes environmental pollution.

Utilization of waste plastic bituminous mixes has proved that these enhance the properties of mix in addition to solving disposal problems. Waste like plastic bottles, polymers, cups, etc. can be re-used by powdering or blending it with crusher and can be coated over aggregate and bitumen by any heating process. Also, use of plastic waste reduces the requirement of bitumen.

Key Words: Plastic Waste, Bitumen, Disposal Problem, Utilization, Solid Waste, etc.

1. INTRODUCTION

Most of the paved roads in our country have granular sub base and base; bituminous base and wearing courses. The past practice of providing thin wearing coat of 20 mm premix carpet with seal coat was to allow deformation in granular layers to take place once road is opened to traffic. After the layers get compacted then thick bituminous wearing course was provided. Plastic is a very versatile material. Due to the industrial revolution, and its large scale production plastic seemed to be a cheaper and effective raw material. Today, every vital sector of the economy starting from agriculture to packaging, automobile, electronics, electrical, building construction, communication sectors has been virtually revolutionized by the applications of plastics. Plastic is a non-biodegradable material and researchers found that the material can remain on earth for 4500 years without degradation. Several studies have proven the health hazard caused by improper disposal of plastic waste.

1.1 Types of plastics

FULL NAME	ABBREVIATION	GENERAL EXAMPLES
High density polyethylene	HDPE	Bottles & Films
Low density polyethylene	LDPE	Films
Linear Low density polyethylene	LLDPE	Films
Polypropylene	PP	Containers, Film
Poly vinyl chloride	PVC	Blisters Packs & Bottles
Polyethylene Terephthalate	PET	Bottles for soft drinks, films etc.
Polysyrene	PS	Thermo-cole, trays, toys etc.

These are some plastic of which we all aware are. So these are main plastic for our project.

2. METHODOLOGY

We would use the dry process in our project, Described as below:

DRY PROCESS

For the flexible pavement, hot stone aggregate (170oC) is mixed with hot bitumen (160oC) and the mix is used for road laying. The aggregate is chosen on the basis of its strength, porosity and moisture absorption capacity as per IS coding. The bitumen is chosen on the basis of its binding property, penetration value and viscoelastic property. The aggregate, when coated with plastics improved its quality with respect to voids, moisture absorption and soundness. The coating of plastic decreases the porosity and helps to improve the quality of the aggregate and its performance in the flexible pavement.

We will perform the following tests on aggregate & bitumen to show the properties of aggregate & bitumen used for the contruction of flexible pavement.

2.1 Tests for bitumen

2.1.1) Aggregate Crushing Value Test. (IS:2386-PART 4-1963)

Aggregate crushing value test on coarse aggregates gives a relative measure of the resistance of an aggregate crushing under gradually applied compressive load.

In this test put the cylinder in position on the base plate & weigh the cylinder. Put the aggregate sample in 3 layers by stroking the sample using the tamping rod. Apply the load at a uniform rate, then afterwards release the load & remove the material from the cylinder. Then sieve the material & weigh the fraction passing through the IS sieve.

2.1.2) Aggregate Impact Value Test. (IS:2386-PART 4-1963)

Determine the impact value of the road aggregates,

Assess their suitability in road construction on the basis of impact value.

First of all we will perform the sieve analysis & afterwards we will put the sample in calibrating cylinder.

Aggregate is filled in 3 layers. Now we will weight the aggregate after that aggregate is filled in the impact mould.

After performing the test the aggregate are again sieved & then respective reading are noted down.

2.1.3) Los Angeles Abrasion Test (IS:2386-PART 4-1963)

Abrasion test is carried out to test the hardness property of aggregates. The principle of Los Angeles abrasion test is to find the percentage wear due to relative rubbing action between the aggregate and steel balls used as abrasive charge.

In the Los Angeles Abrasion test we will take the sample and put it in the Abrasion machine to perform the Test. 12 metal balls are also being put in the machine & afterward respective readings are noted down.

2.1.4) Water Absorption Test (IS 2386 (Part 3):1963)

This test helps to determine the water absorption of coarse aggregates.

In this first we will take the aggregate sample & keep it water for 24 hours. After 24 hour take out the sample from water then remove the extra water from the aggregate using a cotton cloth & Afterwards noted down the readings.

2.1.5) Penetration Test (IS: 1203-1978)

Penetration value test on bitumen is a measure of hardness or consistency of bituminous material. ...Penetration test is used for evaluating consistency of bitumen. It is not regarded

as suitable for use in connection with the testing of road tar because of the high surface tension exhibited by these materials

The penetration test is used to measure the hardness or softness by measuring the depth in tenths of a mm. Penetrometer consists of a needle assembly is used, the test should be conducted in the specific temperature of 25° C.

2.1.6) Ductility Test (IS: 1208-1978)

Ductility is the property of bitumen that permits it to undergo great deformation or elongation. Ductility is defined as the distance in cm, to which a standard sample or briquette of the material will be elongated without breaking.

In this the bitumen sample is heated & poured in the mould & after that sample with moulds are cooled in the air & then the water bath.

2.1.7) Softening Point Test (IS:1205:1978)

Softening point denotes the temperature at which bitumen attains a particular degree of softening under the specification of test.

In the softening point test of the bitumen we will use the Ring & Ball Apparatus to perform the test. It helps to determine the temperature in which substance start to change from solid to liquid. The excess bitumen is cutted & the surface is leveled using a hot knife. Then further process is being performed.

2.1.8) Flash & Fire Point Test (IS: 1209-1978)

In this test first of all we will pour the bitumen in the Cup Heat it up & we will rise the temperature using the temperature gauge & we will note down the Flash & Fire point for the bitumen.

3) MATERIAL

The material used for our project are aggregate of 10 & 20mm & Bitumen of grade 60/70 & 80/100 are used.

AGGREGATE

Aggregate of 10mm & 20mm

BITUMEN:

Bitumen of grade 60/70, 80/100.

4.) RESULT & DISCUSSION

In our project, we have used materials and then performed experiments on materials and then found that they were abiding the IRC recommendations.

Later on we performed Marshall's stability test on conventional mix to find optimum binding test then again

performed using this percentage of bitumen with varying plastic content to find optimum plastic content.

This way we found the proper combination of bitumen and plastic content to give maximum stability.

The major aim of our project is to determine the optimum % of plastic which is required in road construction having economy as well as long life i.e. better performance over a period of time.

We are here trying to find the better performance of the road constructed by analyzing the Marshall Stability Values.

Waste plastic, when added to hot aggregate will form a fine coat of plastic over the aggregate and such aggregate, when mixed with the binder is found to give higher stability, approximate 1.5 times more.

(A =6% Bitumen)	4%	6%	8%	10%	IRC SP-53-2002 RECOMMENDATION
Marshall's stability (kg)	1490	1570	1630	1510	>1200

To get max load taking capacity, 5% bitumen + 8% Plastic combination can be used in bitumen mix for road.

% of bitumen (x=8% plastic)	4%	5%	6%	7%	IRC SP-53-2002 RECOMMENDATION
Marshall's stability (kg)	1440	1650	1630	1470	>1200

4.1). Aggregate:

- i). Water Absorption test- 0.6%
- ii). Impact value test- 21.62%
- iii). Crusing value test- 18.31%
- iv). Abrasion test- 18%

4.2). Bitumen:

- i). Penetration test- 4.8mm
- ii). Ductility test- 77.65 cm

iii). Softening point test-54.6°c

iv). Flash & Fire point test- 189° c & 190.5° c

S.NO	EXPERIMENT NAME	PARAMETER READING
1	Impact value test	22% < 30%
2	Los angles abrasion	18% < 30%
3	Crushing value test	18.13% <30%
4	Water absorption	0.6% < 0.62%
5	Softening point	54.6°c (35° C – 70° C)
6	Ductility test	77.85cm > 75cm
7	Penetration test	4.8mm (2.5mm – 20mm)
8	Flash & Fire point	189° C < 160° c & 190.5 < 180° C

Later on Marshall's Stability Test have been performed on Conventional Bituminous Mix Sample as well as Plastic Added Bituminous Mix Sample.

4.3). CONVENTIONAL BITUMINOUS MIX (FINDING OBC = 'A')

OBC = 'A' = binding content of at which max stability

is attained = 6%

4.4). Plastic added Bituminous Mix (finding OPC = 'X' with 'A'% Bitumen)

OPC = 'X' = Plastic Content of at which max stability is attained = 8%

4.5). Plastic added Bituminous Mix (finding 'B' % of bitumen with 'X'% plastic)

So final combination giving max stability is 5% bitumen + 8% Plastic

BINDING CONTENT	4%	5%	6%	7%	MOST RECOMMENDATION
MARSHALL'S STABILITY TEST (KG)	930	1230	1250	1020	>900

5). CONCLUSION

In addition to the improvement of the quality of the road, this technology has helped to use the waste plastics obtained from domestic and industrial packing materials. This has added more value to the dry process as this process helps to dispose 80 percentages of the waste polymers usefully by an eco-friendly method. This has already been accepted by the Central Pollution Control Board, New Delhi. They have already released a guideline on the technique of the road laying by dry process and its advantage. By this technique, which is in- situ, waste polymer like carry bags, foam, laminated sheets, cups are all used for road laying.

6). REFERENCES

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