



# Plastic Waste Prevention System Analysis & Application

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## Abstract:

*In the post globalization era, India is witnessing significant growth in every sector which is evident by rapid growth in infrastructure developments. The country is building a huge network of expressways, national highways and rural roads and improvement programs involving large investments. But here disposal of non-biodegradable waste materials including waste plastic has become a serious problem. Prevention on it waste plastics of Polyethylene, Polystyrene and Polypropylene are collecting from dump yard or directly from houses. They cleaned and cut into a size such that it passes through 4.75mm IS sieve for maintaining informality of plastic waste partials. Temperature varying between 120°C - 160°C gives the softening point of these plastics. They do not produce any toxic gases during heating and this softened plastics have tendency to form a coating over hot aggregates. The plastic waste is effectively coated over the aggregate. Aim of this technique is not only know the effective utilization of plastic waste in the road construction but also to solve the disposal problem of plastic waste to improve the environment and reduce the cost of construction of road.*

## Keywords

*Plastic waste, aggregate, plastic waste coated aggregate, bitumen, plastic waste mix bitumen, plastic waste road.*

## 1. Introduction

Roads are the key to the development of an economy. A good road network constitutes the basic infrastructure that accelerates the development process through connectivity and opening up of the backward regions to trade and investment. Roads also play a key role in inter-modal transport development establishing links with airports, railway stations and ports. In addition, they have an important role in promoting national integration, which is particularly important in a large country like

India. In the post globalization era, India is witnessing significant growth in every sector which is evident by rapid growth in infrastructure developments. The country is building a huge network of expressways, national highways and rural roads and improvement programs involving large investments and in generally all this types of roads are come in categories of flexible pavement.

Disposal of non-biodegradable waste materials including waste plastic bags has become a serious problem and burnt for apparent disposal which cause environmental pollution. Plastic waste contains waste plastics of Polyethylene, Polystyrene and Polypropylene collecting from dump yard or directly from house and cleaned this plastic waste cut into a size such that it passes through 4.75mm IS sieve to maintaining informality of plastic waste partials. Generally temperature varying between 120°C - 160°C gives the softening point of these plastics. They do not produce any toxic gases during heating but the softened plastics have tendency to form a lamination or coating over the aggregate, when it is sprayed over the hot aggregate at 160°C. Thus, this project study objective is to know the comparative properties of aggregate and bitumen to the plastic waste coated aggregate and bitumen mix with plastic waste. For this conducted various laboratory tests performed on aggregate and bitumen by various percentages (i.e. 6%, 8% & 10%) of plastic waste is used for preparation of mixes. The aggregate is heated and the plastic waste is effectively coated over the aggregate. This plastic waste coated aggregate is mixed with hot bitumen and the resulted mix is used for construction purpose. So that by use of this innovative process will not only strengthen the road construction but also increase the road life as well as will help to improve the environment.

## 2. Study Parameters

### 2.1 Need of Study:

The necessities which come across during detail study of this project;



- i. To develop a technique to reuse a waste plastic as a resource.
- ii. To increase the road communication facility efficiently.
- iii. To increase the useful life of bituminous overlay.

## 2.2 Study Objectives:

Basic intension is to efficiently utilize the waste plastic in constructive way so that it can be beneficial to society and a comparative study has been made in polyethylene mix and natural material.

However the objectives of this project investigation are to observe the followings;

- i. To utilize the plastic waste in flexible pavement so as to avoid accumulation of waste plastic in environment.
- ii. To know the effective utilization of plastic waste in flexible pavement.
- iii. To reduce the percentage of bitumen used in bituminous concrete.
- iv. To analyse the properties of plastic coated aggregate with mineral aggregate.
- v. To analyse the properties of plastic waste mix bitumen with plain bitumen.

## 3. Methodology

### 3.1 Primary Works

#### i. Collection of Waste Plastic from Dumping yards & Houses:

As a very important ingredient to be used in our project is waste plastic. Waste plastic is most commonly generated from household. The best way we decided to collect waste from our project group member's houses. we collected different types of plastic which are out of use in the houses. But the work was not so easy, from 25th, Dec 2016 to 25th Jan 2017 around, 4 weeks takes to collect required quantity of plastic wastes from dumping yards & houses. The waste plastics mainly consist of Plastic waste only except PVC waste.

#### ii. Collection of Bitumen Samples

Collection of bitumen sample from Hot Mix Plant, Nandori, Under the guidance of skilled Assistant Engineer, Sub Division PWD, Bhadrawati, Mr. R. R. Matte Sir we visited Hot Mix Plant, Quality Control Department and Testing Lab, Nandori. In the QT & LT department of the HMP check the quality of materials used in the Civil Engineering work by performing various test over the materials. Under the guidance of Assistant Civil

Engineer, Sub Division PWD, Bhadrawati, Mr. M. S. Nandeshwar Sir we collected bitumen sample from the plant with their standard test value. Also the Managing Director of Company Mr. Abhijit Maniyar giving us a valuable information about their plant and what parameter the used to maintain the quality of material.

#### iii. Initial stage is to identify the Grade & Standard Specification of Bitumen:

It was very important to know the grade of bitumen collected from different sources. So that perform penetration test over the collected bitumen sample is performed, by performing penetration test we get conformation about the grade of bitumen.

The sample collected from Hot Mix Plant, Nandori, is found to be 60/70 Grade. This grade of bitumen is use in Bituminous Concrete.

## 3.2 Process Flow

The Laboratory Experimental Test are performed in the College Laboratory and Testing Lab of Hot Mix Plant, Nandori with corrective measurement of sample and ingredient to be used in test with safety measurement.

This Process is divided in four Parts.

Part-I: Preparation of Plastic Waste

Part-II : Aggregates are coated by Plastic Waste

Part-III : Plastic waste coated aggregates and natural aggregate are used for testing

Part-IV : Plastic waste Mix Bitumen and Bitumen are used for testing.

To investigate the properties of Aggregate & Bitumen following tests were conducted:

#### A] TESTS FOR AGGREGATE

- i. Specific Gravity & Water Absorption Test
- ii. Aggregate Impact Value Test
- iii. Aggregate Crushing Value
- iv. Los Angeles Abrasion Value

#### B] TESTS FOR BITUMEN

- i. Penetration Test
- ii. Softening Point Test
- iii. Ductility Test
- iv. Flash Point and Fire Point
- v. Specific Gravity Test

## 4. 4. EXPERIMENTAL RESULTS

### 4.1 Aggregate Test:

The tests are conducted as per IS codes on aggregate and its reading shown in chart 1

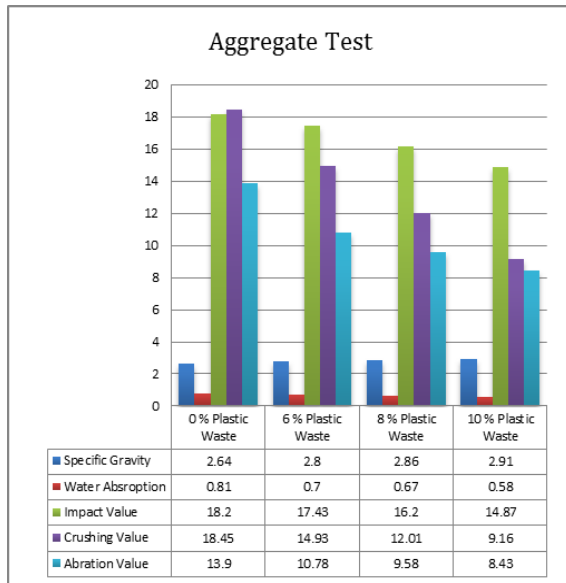


## 5. Result & Conclusion

Test results of aggregates and bitumen with different percentage of plastic waste are present in Table 1 and Table 2.

**Table-1–** Aggregate test result analysis with different percentage of plastic waste used

Sample	Plastic Waste (%)	Specific Gravity	Water Absorption (%)	Impact Value (%)	Crushing Value (%)	Abrasion Value (%)
1	0	2.64	0.81	18.20	18.45	13.90
2	6	2.80	0.70	17.43	14.93	10.78
3	8	2.86	0.67	16.20	12.01	9.58
4	10	2.91	0.58	14.87	9.16	8.43
<b>Recommended Values</b>	<b>6 to 10</b>	<b>2.5 to 3.0</b>	<b>0.1 to 2.0</b>	<b>10 to 20</b>	<b>&lt; 30 to 35</b>	<b>&lt; 35</b>
<b>Analysis</b>	<b>Under control</b>	<b>Increase strength</b>	<b>Reduce water absorption</b>	<b>Reduce impact failure</b>	<b>Reduce crushing failure</b>	<b>Reduce abrasion</b>



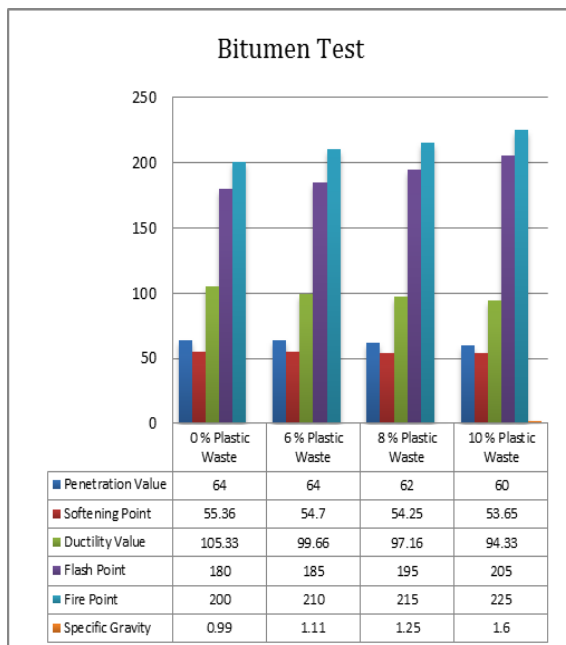
**Chart-1:** Comparison of plastic waste content aggregate and plain aggregate

**Table 2–** Bitumen test result analysis with different percentage of plastic waste used

Sample	Plastic Waste (%)	Penetration value (mm)	Softening Point (°C)	Ductility Value (cm)	Flash & Fire Point (°C)	Specific Gravity
1	0	64	55.35	105.33	Flash 180, Fire 200	1.08
2	6	64	54.70	99.66	185, 210	1.11
3	8	62	54.25	97.16	195, 215	1.25
4	10	60	53.65	94.33	205, 225	1.60
<b>Recommended Values</b>	<b>6 to 10</b>	<b>60 to 70</b>	<b>45 to 60</b>	<b>75 min</b>	<b>175 min +5 min</b>	<b>0.97 to 1.02</b>
<b>Analysis</b>	<b>Under control</b>	<b>Within Limit</b>	<b>Within Limit</b>	<b>Reducing Ductility</b>	<b>Controlling Temperature</b>	<b>Increase</b>

### 4.2 Bitumen Test:

The tests are conducted as per IS codes on bitumen and its reading shown in chart 2



**Chart-2:** Comparison of plastic waste content bitumen and plain bitumen

This project study includes a comparative study on prevention system analysis and application of plastic waste in Flexible Pavement.

Plastic waste improve the properties of aggregates uses for road construction work. Using plastic waste in mix will help reduction in need of bitumen by around 6% to 10%, increase the strength and performance of road, avoid disposal of plastic waste by incineration and land filling and ultimately develop a technology, which is eco-friendly. By modification of bitumen with plastic waste the problems like bleeding in hot temperature regions and it ultimately improves the quality of road. The



bituminous mix plastic is suitable to use in hot climatic areas. Increased traffic conditions will and are reducing the life span of roads. Plastic waste roads are means of prevention and ultimately will be the cure. It will save large expenses in future and reduce the amount of resources used for construction.

Plastic waste coating on aggregates and plastic waste mix with Bitumen are gives much better results and it can be used for the better performance of roads. This helps to have a better binding of bitumen with plastic waste coated aggregate due to increased bonding and increased area of contact between plastic waste and bitumen. The construction of roads by use of plastic waste can be withstand heavy traffic and show better durability.

## 6. Applications

From the study, results, discussion and conclusion, we come to the following recommendations for application of plastic waste in construction:

- i. Plastic coated aggregate can be used for Bituminous Concrete for flexible pavement
- ii. Plastic waste is used as a stabilizing material in bituminous mix for flexible pavement.
- iii. Plastic waste applicable on poor rocks to improve the strength.
- iv. High temperature area.
- v. Plastic waste application in rural roads in India.

Plastic waste reduces the cost of work and helping to improve the strength of constituents used in bituminous concrete.

## 7. References

1. K [1] Bindu C.S., Beena K.S. (2010), "Waste plastic as a stabilizing additive in SMA", International Journal of Engineering and Technology, Volume 2, pp. 379-387.
- [2] Gawande A., Zamare G., Renge V.C., Tayde S. And Bharsakale G. (2012), "An overview on waste plastic utilization in asphaltting of roads", Journal of Engineering Research and Studies Vol. III/ Issue II.
- [3] Justo C.E.G., Veeraragavan A (2002), "Utilization of Waste Plastic Bags in Bituminous Mix for Improved Performance of Roads", Centre for Transportation Engineering, Bangalore University, Bangalore, India.
- [4] Katara S. D et. al. "Comparative study on the economical process for mix for flexible pavement", International Journal of Engineering and Technical Research (IJETR) Vol 2, Issue 4, 2014.
- [5] Khan I. and Gundaliya P. J. (2012), "Utilization of waste polyethylene materials in bituminous concrete mix for improved performance of flexible pavements", Journal of applied research, volume 1, issue 12, pp. 85-86.
- [6] Moghaddam T. B. and Karim M. R. (2012), "Properties of SMA mixtures containing waste Polyethylene Terephthalate", International Journal of Chemical and Biological Engineering 6, pp. 188-191.
- [7] MORTH specification (2001).
- [8] Ministry of Road Transport and Highways (MORTH). Government of India. Manual for Construction and Supervision of Bituminous Works. New Delhi; 2006.
- [9] IRC SP-79 (2008), "Tentative specification for SMA", Indian roads congress, New Delhi.
- [10] IS: 1203 (1978), "Methods for testing tar and bituminous materials: determination of penetration", Bureau of Indian Standards, New Delhi.
- [11] IS: 1205 (1978), "Methods for testing tar and bituminous materials: determination of softening point", Bureau of Indian Standards, New Delhi.
- [12] IS: 2386 (1963), "Methods of test for aggregates for concrete (P - I): Particle size and shape", Bureau of Indian Standards, New Delhi.
- [13] IS: 2386 (1963), "Methods of test for aggregates for concrete (P-III): Specific Gravity, Density, Voids, Absorption, Bulking", Bureau of Indian Standards, New Delhi.
- [14] S. Shankar and C.S.R.K. Prasad, "Evaluation of Rutting Potential for Crumb Rubber Modified Bitumen in Asphaltic Mixes," Emirates Journal for Engineering Research, pp.91-95, 14 (2), 2009.
- [15] Standard test procedure manual 204-22.
- [16] Sangita, Reena G. and Verinder k. (2011), "A novel approach to improve road quality by utilizing plastic waste in road construction", Journal of Environmental Research and Developmen, Volume 5, pp. 1036- 1042.
- [17] Sichina W.J., "Characterization of Polymers Using TGA"
- [18] Swami V., Jirge A., Patil K., Patil S., Patil S. and Salokhe K. (2012), "Use of waste plastic in construction of bituminous road", International Journal of Engineering Science and Technology, Volume 4, pp. 2351- 2355.
- [19] T. Awwad Mohammad and SheebLina, "The Use of Polyethylene in Hot Asphalt Mixtures", American Journal of Applied Sciences 4 (6) pp-390-396, 2007.
- [20] Vasudevan R., Nigam S.K., Velkennedy R., Ramalinga Chandra Sekar A., Sundarakannan B. Utilization of Waste Polymers for Flexible Pavement and Easy Disposal of Waste Polymers, International Conference on Sustainable Solid Waste Management, 5 - 7, Chennai, India pp-105-111, 2007.