# Utilization of Plastic Waste and Foundry Waste in Flexible Pavements

**J. Premlatha, G. L. Sathyamoorthy, S. Anita**

***Abstract:*** ***The materials used for pavement is bitumen, coarse aggregate, fine aggregate and soil, concerned about this throughout the globe research works are under progress to find alternative materials for pavement construction and obviously the plastic waste from municipal solid waste and foundry sand from industrial waste materials are one such category. Plastic is a toxic and persistent material. The municipal solid waste which is a major environmental threat contains about 16 to 25% of plastic. Another environmental threat is foundry sand which is the waste product from casting industries.The foundry sand can be used in various engineering applications. This will solve the depletion of regular use materials and also disposal of foundry waste. There is a need for bulk use of plastic waste from municipal solid waste and foundry sand from foundry industrial wastes in our country. This paper elaborates about the materials and its suitability for flexible pavement construction that is economically feasible. Industrial waste replaced from cumulative weight of aggregate to understand the load carrying capacity of the flexible pavement***

***Key words: plastic waste, foundry sand, bitumen***

## I. INTRODUCTION

The increase in automobile industry directly impacts the usage of roads. This in turn exploits the condition of road and makes to increase the maintenance cost. The routine maintenance depletes the natural resources such as aggregate, which insists to search of the alternate materials. Probably if the alternate materials are waste materials, then it paves way for a sustainable future. The waste materials either directly or indirectly affects the environment. The major waste hazard n our day to day life is plastics. And in major industrial cities due to the increase in production of mechanical parts, there is a tremendous quantity of waste after moulding works are done. This foundry waste also needs a place to dump and again it spoils the condition of earth. The research is a vast and developing one because the need of alternate materials has become the need of the hour.

## II. MATERIALS USED

### A. FOUNDRY SAND

The metal manufacturing industries uses sand for casting purpose. These industries uses good quality of fresh sand with uniform sized high silica content. After casting process is over, the color of sand turns darker and some quantity of metal mixes with sand. The waste sand can be recycled by separating metal pieces and reused two or three times. Later the sand cannot be reused and becomes as a waste product to be dumped that is called as foundry sand. It can be reused in many application of engineering industry and thus by solving the waste to be dumped on the land.

**Table 1: Physical Properties of Foundry Sand**

| Experiment | Results |
|---|---|
| Specific gravity | 2.46 |
| Sieve analysis<br>1)Effective Grain Size<br>2)UniformityCo efficient<br>3)Co-efficientof curvature | <br>0.17<br>2.18<br>1.104 |
| Liquid Limit | Nil |
| Plastic limit | Nil |
| Bulk Density | 1.58 g/cm³ |
| Porosity | 20.44% |
| Swell test | Nil |
| Shrinkage test | Nil |

**Table 2: Chemical Properties of Foundry sand**

| Constituent | Value(%) |
|---|---|
| O | 50.98 |
| SI | 21.73 |
| Al | 9.89 |
| Fe | 9.22 |
| Na | 3.25 |
| Mg | 2.70 |
| Ca | 1.71 |
| Ti | 0.53 |

**Fig 1. Waste Foundry Sand**

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**Fig 3.Plastic waste**

### B. PLASTIC

Plastic has become an important material in the day to day life of all the people. The current lifestyle is grown up with the plastics almost in all the activities of our routine. The major environmental threat is dumping of plastics. Being a non-biodegradable material it behaves as a major source of the many diseases. The dumping of the plastics causes the water bodies to be deplete and the soil to loose all the nutrients. The plastics dumped as municipal solid waste is 30% of plastics. And this can be of reusable and non-reusable plastics. On an average, each city produces 3500 tonnes of plastic each day. This is used in construction of roads.The type of plastics used are polyethylene, polypropylene.

**Table 3: Plastic consumption in India**

| S. No. | Year | Consumption (T) |
|---|---|---|
| 1. | 1996 | 61,000 |
| 2. | 2000 | 3,00,000 |
| 3. | 2001 | 4,00,000 |
| 4. | 2007 | 85,00,000 |
| 5 | 2012 | 1,20,00,000 |
| 6 | 2017 | 3,97,12,000 |

### C. BITUMEN

Bitumen is black colour, viscous material with great binding properties. It is found naturally and artificially. The by-product of petroleum distillate is preferred for laying roads. This is environment friendly as such the release of hydrocarbons during the usage of roads is less.

### D. AGGREGATE

By volume, aggregate generally accounts for 92 to 96 percent of bituminous concrete. Aggregate used for base and sub base courses for both flexible and rigid pavements. Aggregates can either be manufactured or natural. Physical properties of aggregate have been tested as per IS: 2386 part 1, part 3, part 4, and part 5.

### E. TESTING METHODOLOGY

The mix ratio for the wearing coat made of bitumen and aggregates is designed using Marshall Stability test. The aggregates are sieved as per stipulated sieve sizes in dry condition. The plastic and foundry sand are added in various proportions to the aggregate. Then the bitumen is heated to mixing temperature and thoroughly mixed with aggregates. The specific gravity is noted both in air and water. Then the stability of the mix is found by the load carried. Based on this experiment the mix design is finalised.

**Fig 4 Marshall Stability Test**

Batching is very important in such a way it helps to maintain the gradation of aggregates and uniformity for the entire construction. The proportion of materials used for the testing process is takenas the percentage by weight in which 6% of 12.5 mm aggregate, 26% of 10 mm aggregate, 7% of 4.75 mm aggregate, 17% of 2.6 mm aggregate and remaining 40% of Filler materials, normally sand.The Bitumen is taken as 6% by weight. The foundry sand and plastic are added in various proportions and the flow value is tested using Marshall Stability test.

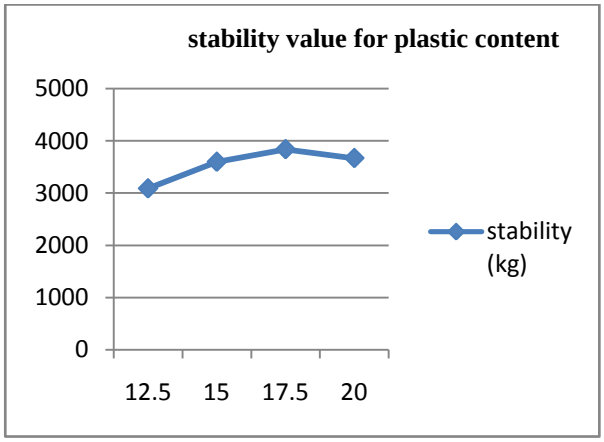
## III. RESULTS AND DISCUSSIONS

This table results will show the Variation in plastic content

**Table 4: Marshall Stability Values with Plastic content**

| Bitumen(%) | Plastic content(%) | Stability(kg) |
|---|---|---|
| 6 | 0 | 2995 |
| 6 | 12.5 | 3092 |
| 6 | 15 | 3600 |
| 6 | 17.5 | 3840 |
| 6 | 20 | 3671 |

The stability increases as the plastic content is increased. And after 17.5%of plastic content, the value gets decreased. So fix the plastic content as 17.5%

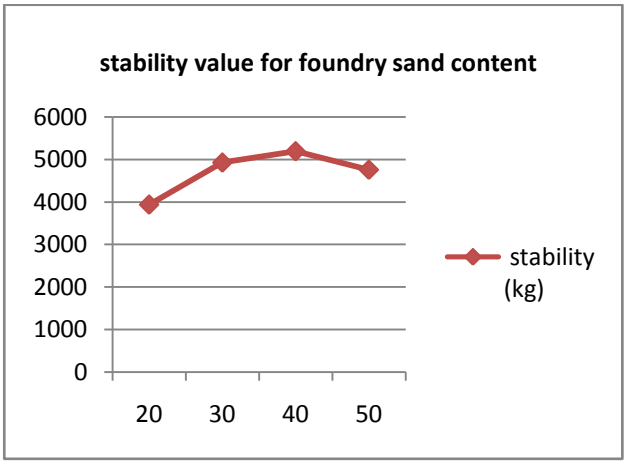



This table shows the replacement of foundry sand in the filler material weight.

**Table 5: Marshall Stability Value with Plastic content and Foundry sand**

| Bitumen (%) | Plastic content (%) | Foundry sand (%) | Stability(kg) |
|---|---|---|---|
| 6 | 17.5 | 20 | 3937 |
| 6 | 17.5 | 30 | 4927 |
| 6 | 17.5 | 40 | 5193 |
| 6 | 17.5 | 50 | 4758 |

The stability values get increased in 40% replacement of foundry sand in filler material. So use the plastic content as 17.5%, foundry sand as 40% replacement in filler material.




Comparison of the conventional bitumen pavement and pavement with foundry sand and plastic content is done. The rates will be as per PWD schedule. Saved cost is 7% from the original cost.

## IV. CONCLUSION

It reduce the total cost of construction up to 10%, Effectively use the municipal plastic waste & industrial foundry sand waste in flexible pavement, Eco friendly The stability of the mix and durability of the roads can be increased while the foundry sand and plastic waste is added.

Plastic will increase the melting point of the bitumen. This innovative technology not only strengthened the road construction but also increased the road life.Theplastic also gives a good binding along with the bitumen.

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