



EMPIRICAL RESEARCH ON USING PLASTIC COATED AGGREGATE AND EGGSHELL AS FILLER MATERIAL IN BITUMINOUS ROAD CONSTRUCTION

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Abstract

The development of society leads to the need of better infrastructure. The flexible pavement is one of the important structure, which needs to perform well in all situations. At the same time, the disposal of waste materials is a great problem nowadays. There are lot of researches going on all over the world in order to dispose the waste materials in a safer way. This study investigates the construction of flexible pavement using waste plastics as the coating over the aggregate. Addition of certain filler materials greatly influences the performance of the bituminous mix. We made an attempt to check the strength performance of bituminous mix with shredded waste plastic as coating over aggregate with eggshell as a filler material. We have done a clear study of using filler material and plastic coated aggregate in various proportion and result showed that the maximum value obtained at 10 % plastic coating and 15% of Eggshell in its content.

Keywords: Aggregate, Bitumen, Eggshell, Plastic roads, Stability, Waste Plastics.

I.INTRODUCTION

There are two types of roads. i.e., Flexible and Rigid pavements. In Rigid Pavement, Concrete is used for construction. But in Flexible pavements, Bitumen is used. These bituminous material may be available in the form of solid or viscous liquid nature. Which composed of hydrocarbons and its derivatives. It is obtained by refinery process from petroleum products. The performance of aggregate bituminous mix can be improved by incorporating various additives in its mix. In this

work, we made an attempt to utilize waste plastics in aggregate-bituminous mix as a coating over aggregate. The plastics are available in the form of Low density Polyethylene (Film roles, fertilizer covers, sacks, carry bags, Bin linings, cosmetics, detergent items), high density Polyethylene (Bottle caps, Household articles), Polypropylene (Caps and Closures, Wrappers), Polyethylene Terephthalate (Drinking Water bottles) and Polystyrene(Fast food trays, disposable cups). We collected LDPE, Polypropylene waste plastic materials and cut these waste plastic into small pieces.

The Dry Process was followed in this work. The aggregates were heated and these shredded pieces of plastics spreaded over the hot aggregate. Subsequently, the bitumen were melted and eggshell was mixed with bitumen at different percentage. These eggshell acts as a filler material in bituminous mix. Which is added to increase the density & strength of mixture. After that, the plastic coated aggregates were mixed with bituminous mix and tested its stability.

The obtained test values of aggregates shows better resistance to crushing, abrasion, impact, water absorption and specific gravity. The plastic roads is a simple way of constructing ecofriendly infrastructure. Which is not only reduces the waste, but also increases the strength and performance of the pavements.

OBJECTIVES OF THE STUDY

The main intention is to produce the better performance and Stability nature to the road and also made an Improvement in the properties of the bituminous mix in order to provide the

solution for waste disposal in a useful way. The main objectives are as follows:

- Utilization of Waste Plastics for making flexible Pavements.
- To improve the mechanical properties of Coarse Aggregate which are used for Flexible Pavements.
- Use of eggshell as additive materials to enrich the Performance of the Flexible Pavements.
- To made a new beeline for construction of Flexible Pavements by using Waste Plastics and eggshell.

II. MATERIALS USED

NATURAL COARSE AGGREGATE

Coarse aggregate is one of the most important materials used for flexible pavement construction. Aggregates of size 20mm & 12mm are used. Which constitute the granular part in bituminous concrete mixtures and contributes 90-95% of mixture weight. Natural coarse aggregate is shown in fig. 1. Aggregate forming the main skeleton of pavement should be tested against their suitability for pavement construction with reference to the MORTH.



Fig.1 Natural Coarse Aggregate

PLASTIC COATED AGGREGATE

Here, Low Density Polyethylene (LDPE) like Carry bags, sacks, milk pouches, bin lining, cosmetics and detergent bottles, Polyethylene Terephthalate (PET) such as drinking water bottles. Polypropylene (PP) includes bottles caps and closures, wrappers of detergent, biscuit, vapours packets, microwave trays for readymade meal are collected, cleaned, shredded into small pieces. Plastic coated coarse aggregate is shown in fig. 2.



Fig. 2 Plastic Coated Aggregate

BITUMEN

Bitumen is a sticky, black and highly viscous liquid or semi-solid nature, occurs in some natural deposits. It is also the residue or by product obtained by fractional distillation from crude petroleum. 30/40 grade bitumen is used in our work. Fig. 3 shows melted Bitumen.



Fig. 3 Melted Bitumen

EGGSHELL POWDER- FILLER MATERIAL

Generally, the filler material is finely divided substance, which are insoluble in bitumen. Here, we use Eggshell as filler material in bitumen. Eggshell is white, brittle and has a grainy texture. Fig. 4 shows Eggshell powder.



Fig 4 Eggshell Powder- Filler material

MAKING OF SPECIMEN – DRY PROCESS

- We prepared the specimen by Dry Process. First, we take the required amount of Plastics, then it has to be cleaned, dried and shredded it into 2.36-4.75 mm size.
- Aggregate is taken and it is heated to nearly 160°C and spread the shredded plastics over the hot aggregate.
- The Plastics gets softened and forms as a layer over the aggregate.
- Now the Bitumen is heated and stirred carefully in order to get the well uniform mix.
- Until now, many materials are used as filler in bituminous mixture. Here, we made an attempt to use eggshell powder as a filler material in bituminous Sample mix.
- Specimen is prepared according to the mix proportions. Normally about 1200 grams of the mix would be required. After a homogenous mix is obtained 1200 grams

of the mix is weighted and the same is placed in a preheated compaction mould.

- The mix is compacted by giving 50 blows of the hammer on the top. Then the hammer is reverse and 50 blows are again imparted.
- The freshly compacted specimens have cooled to a room temperature. The bulk density is determined by weighting the specimen first in air and then in water.
- The specimen is removed from the water bath and is placed with its axis horizontal in to the test heads. The complete assembly is quickly placed on base of the compression machine and determine its stability.

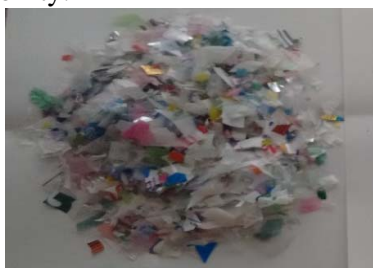


Fig.5 Shredded waste Plastic



Fig.6 Shredded plastic mixing with heated aggregate



Fig.7 Bitumen mix with Eggshell powder



Fig.8 Bitumen mix sample

III. TESTS AND ITS RESULTS

A. TEST ON NORMAL AGGREGATE AND PLASTIC COATED AGGREGATE

LOS ANGELES ABRASION TEST

Los Angeles abrasion value is determined by rubbing the aggregates with steel balls and calculate its percentage of wear due to its action.

AGGREGATE IMPACT TESTING

The impact value is the resistance measurement of coarse aggregate subjected to sudden shock or impact. Toughness is the property of material which resist impact.

WATER ABSORPTION OF AGGREGATE

Moisture content of an aggregate is defined as the weight of surface moisture (i.e., the moisture in excess of that held by aggregate in a saturated surface dry condition), expressed as a percentage of the weight of the aggregate in saturated surface dry condition.

AGGREGATE CRUSHING VALUE

Crushing is the relative measure of aggregate resistance under gradually applied compressive load. It involves the measurement of percentage of weight of crushed materials under standardized conditions.

AGGREGATE SPECIFIC GRAVITY

The specific gravity of an aggregate is considered to be a measure of the quality or strength of materials. Stones having low specific gravity values are generally weaker than those having higher value. The specific gravity of rocks varies from 2.6 to 2.9.

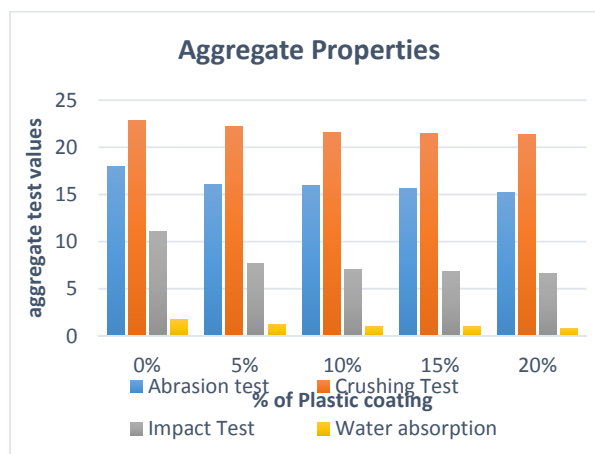


Fig.9 Comparative results of Plastic Coated Aggregate properties

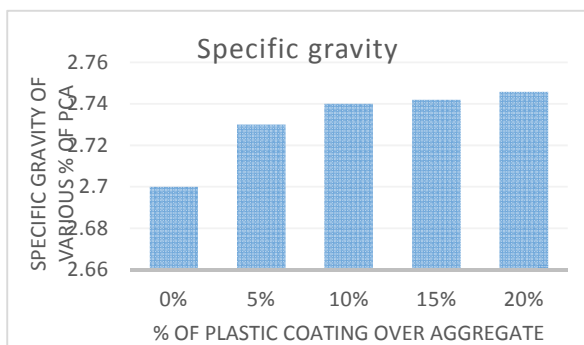


Fig.10 Specific Gravity of Plastic Coated Aggregate

B. TEST ON BITUMEN

DUCTILITY TEST

In the flexible pavement construction, Bitumen acts as a binder material, if this binder does not possess necessary ductility, it would crack and thus provide pervious pavement surface. Hence, it is necessary to check its ductility for use in pavements.

SOFTENING POINT TEST

Bitumen does not suddenly change from solid to liquid state but as the temperature increases it gradually becomes softer until its flows readily. All semi-solid bitumen grades need sufficient fluidity before they are used for application with the aggregate mix. For this purpose bitumen is sometimes out back with a solvent like kerosene. This common procedure however is to liquefy the bitumen by heating. The softening point is the temperature at which the substance attains particular degree of softening under specified condition of test.

VISCOSITY TEST

Viscosity of a liquid is the property that retards its flow due to internal friction and it is a measure

of resistance to flow of the liquid. The flow of liquid under an applied force will depend on its viscosity, higher the viscosity, slower will be its movement or rate of flow. As bituminous binders are mixed with aggregates or applied in road works in the liquid form at different temperatures. It is important that the viscosity of different types of bituminous binders (such as hot bitumen, cutback bitumen or bitumen emulsion) used in road construction vary considerably depending on the type and grade of the binder and the temperature of application.

PENETRATION

It is used to measure the hardness of material by measuring its depth. It involves the usage of standard needle, which will penetrate vertically under specified condition of load and temperature. The number of penetration will be greater, if the bitumen is soft.

I. Bitumen test results

Sl.No	Bitumen Properties	Bitumen Value
1.	Penetration	35
2.	Viscosity	3300 poise
3.	Softening Point	48°C
4.	Ductility	25.33cm

MARSHALL STABILITY NUMBER AND FLOW VALUE

Maximum load required to produce failure in specimen. When preheated and load applied at constant strain (5cm/min). Deformation at failure point expressed in the units of 0.25 is called flow value.

$$5\% \text{ of bitumen} = \frac{5}{100} \times 1200 = 60 \text{ grams}$$

II. Stability test results for the PCA with Eggshell filler

S.No	BITUMEN (%)	EGGSHELL POWDER (%)	PLASTIC (%)	STABILITY (Kg)
1	5% (60 grams)	0%	0%	147.6
2		5%		154
3		10%		162
4		15%		177.2
5	5% (60 grams)	0%	5%	169.6
6		5%		179.2
7		10%		197

8		15%		235
9	5% (60 grams)	0%	10%	189
10		5%		215
11		10%		296
12		15%		389.2
13	5% (60 grams)	0%	15%	190.6
14		5%		219
15		10%		268
16		15%		312
17	5% (60 grams)	0%	20%	195.8
18		5%		215
19		10%		245
20		15%		307

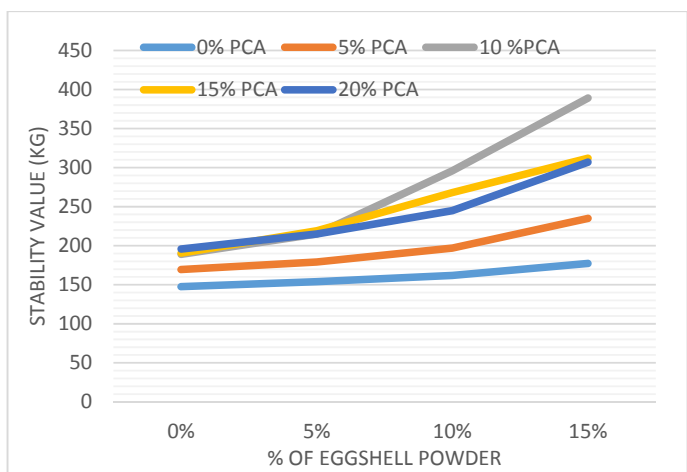


Fig.11 Comparison of Stability Value for different percentage in mix

IV. CONCLUSION

- The results indicates that Plastic Coated Aggregate and Eggshell powder incorporated pavements are better when compared to conventional one.
- In short, we can conclude that, using 10% of Plastic Coated aggregate and Bitumen with addition of Eggshell up to 15% is more favourable for the Flexible Pavement Construction.
- From the detailed study, it can be concluded that the deploy of plastics and eggshell proved as effective one for the construction flexible pavements and acts as a boon to the society.

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