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### Performance of flexible pavement by using plastic waste and egg shell powder

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#### ABSTRACT

The disposal of Waste plastic is a menace and becomes a serious problems globally due to the non-biodegradability and unaesthetic view. Since these are not disposed scientifically and possibility to create ground and water pollution. In the present paper, developed techniques to use plastic waste for construction purpose of flexible pavements and deals with investigations of use of waste plastics for coating of aggregate in bituminous mix has reviewed. Plastic wastes consists of Polyethylene, polypropylene plastics can be used as a coating over aggregates and this coated stone can be used for road construction. This mix polymer coated aggregate have show higher strength, Plastics are user friendly but not eco-friendly as they are non-biodegradable. Generally, it is disposed by way of land filling or incineration of materials which are hazardous. Softening vary between 110°C to 140°C and they donot produce any toxic gases during heating but softened plastics have tendency to form a film like structure over aggregates, when it is sprayed over the hot aggregate at 160°C. Plastic coated aggregates (PCA) is a better raw material for construction of the flexible pavements. PCA mixed with hot bitumen of different types and mixes used for road construction. The bitumen is heated and mixed with the egg shell powder as a filler material upto 20% in the bituminous mix. Plastic roads would be a boon for India's hot and extremely humid climate. In this paper, we have done a thorough study on the methodology of using waste plastic and the egg shell powder in bituminous mixes and presented the tests to be performed.

**Keywords:** Waste Plastics, Bitumen, Aggregate, Egg shell powder, Plastic roads.

#### INTRODUCTION

Flexible pavements are one of the most important infrastructures. Any damage to this may cause lots of inconvenience to the traffic, which ultimately affect future scenario of countries. At the same time, Thread of disposal of waste plastic is extremely severe nowadays. In order to improve the performance of the road surface, the plastic will be used for aggregate coating in order to increase road performance and durability.

Due to the excessive usage of the plastic materials, the availability of waste plastic is enormous, as the plastic waste become part and parcel of daily life. Plastic wastes like Low Density Polyethylene, Polypropylene, polyethylene Terephthalate, Polystyrene are used. These waste plastics are shredded into small pieces. Dry process is followed here. Aggregates are heated to a certain temperature, and the shredded plastics are spread over these heated aggregate. These plastics gets softened and forms a coating as a layer over these aggregates. Aggregates are coated with waste plastics upto 20% and tested. Properties of aggregates give good response to these coating. It shows better resistance to abrasion, Crushing, Impact, Water absorption test.

Bituminous mix is prepared and stirred well in order to get uniform mix, Then Egg shell powder is weighted and added to the hot bitumen in different percentages. This egg shell powder is used as a filler material. Until now, Various fillers like cement, flyash, textile sludge powder, coconut shell powder, etc., are used. In the present study, an attempt has been made to use waste plastics as coat over aggregate and egg shell powder as filler in bituminous mix. This mixture is laid on the road surface like a normal tar road.

One of the major concerns is the disposal of plastic waste in environment. Bituminous mix is prepared with egg shell powder is added in various proportions up to 20% and plastic coated aggregates. Marshall Method is adopted for the mix design. India consumption of plastics grew every year and is set to be the world third largest consumer of plastic in this world.

This is a very effective step towards eco friendliness compared to conventional and traditional techniques of the flexible pavement constructions. One of the important way to control environmental pollution is waste management. If we use industrial waste in more innovative and contributing in reduce negative impacts of wastes on environment.

### **OBJECTIVE**

Basic intention is to efficiently utilize the waste plastics in constructive way so that it can be beneficial to society however main objectives of current project work are:

To coat the waste plastic over the aggregate and tested its properties.

To Check the properties of bituminous mix specimen properties.

To determine the response of the bituminous mix specimen with plastic coated aggregate and bitumen with egg shell powder as filler.

To compare the results with the conventional mix.

### **MATERIALS USED**

#### **NATURAL COARSE AGGREGATE**

Aggregate for concrete are generally derived from natural sources. Which may have been naturally reduced to size or may be required to be crushed.

#### **PLASTIC COATED AGGREGATE**

Plastics like Polyethylene, Polyethylene Terephthalate, Polypropylene collected and shredded in the range of 2.36-4.75mm size. Which are spread over the heated aggregates. These get softened and it looks like coating over the aggregate.

20mm , 10mm size aggregates are used.

Egg shell powder is used as a filler material.

#### **BITUMEN**

Bitumen is a petroleum product obtained by the distillation of petroleum crude where as road tar is obtained by the destructive distillation of coal or wood.

30/40 grade bitumen is used.

#### **WASTE PLASTIC**

Plastic waste in shredded form.

LDPE, PET, PP plastics are used.

#### **TEXTILE SLUDGE POWDER- FILLER MATERIAL**

Egg shell powder as filler material is used as an addition to these components in order to avoid the voids formed in wearing coat. When it is mixed with bitumen and aggregate it fills the cavities and avoids the formation of cracks thereby creating a dense mix and increasing the viscosity of bitumen.

The properties of binders are often improved or enhanced by using additives or modifiers to improve adhesion (stripping resistance), flow, oxidation characteristics, and elasticity. Modifiers include oil, filler, powders, fibers, wax, solvents emulsifiers, witting agents, as well as other proprietary additives.



Fig 1: Difference BETWEEN NCA And PCA



Fig 2: Bitumen Mix With Egg Powder



Fig 3: Materials To Be Used



Fig 4: Prepared Moulds

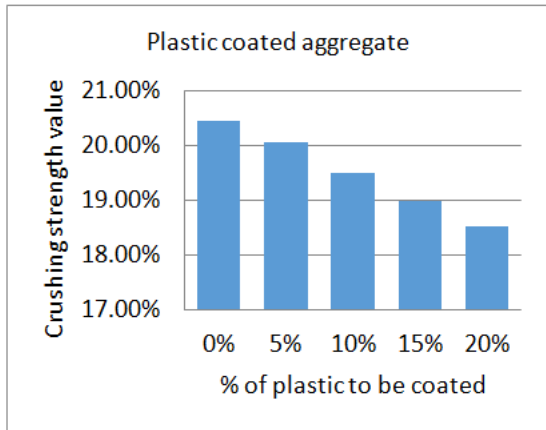
**DRY PROCESS FOR MANUFACTURING BITUMEN MIX ROAD USING WASTE PLASTIC**

- In dry process the aggregate is heated to 170<sup>0</sup>c in hot mix plant after to added the shredded plastic the equal proportion in heated aggregate. Immediately the hot bitumen 160<sup>0</sup>c is added. The mixture is transferred to the road and the road is laid.
- 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.

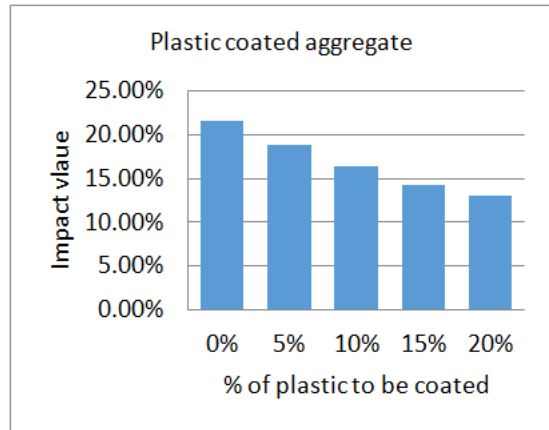
- The aggregate, when coated with plastics improved its quality with respect to voids, moisture absorption and Abrasion.
- The coating of plastic decreases the porosity and helps to improve the quality of the aggregate and its performance in the flexible pavement.

**TESTS ON AGGREGATES  
AGGREGATE CRUSHING VALUE**

The aggregate crushing value gives a relative measure of the resistance of an aggregate to crushing under a gradually applied compressive load.



Comparison of test results for crushing strength



Comparison of test results for Impact Value

**AGGREGATE IMPACT VALUE**

The aggregate impact value is a measure of resistance to sudden impact or shock, which may differ from its resistance to gradually applied compressive load.

**AGGREGATE SPECIFIC GRAVITY**

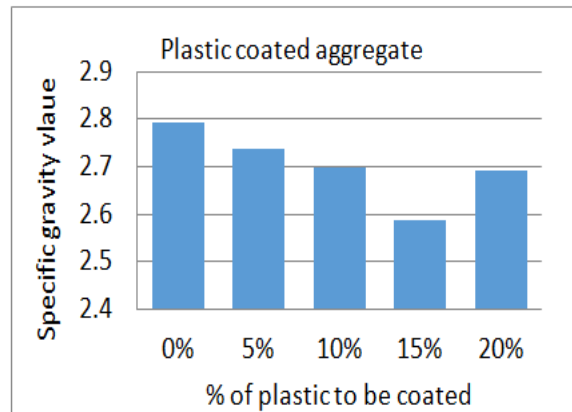
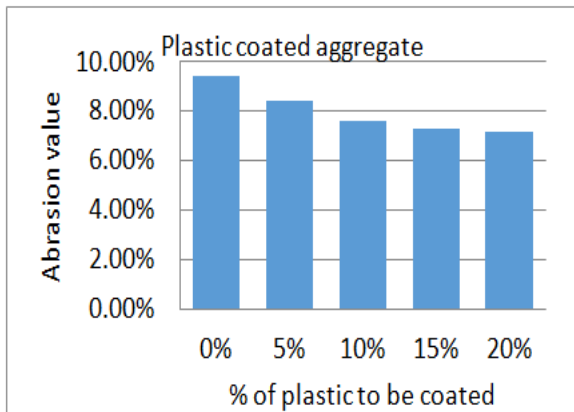
The specific gravity of an aggregate is considered to a measure of the quality or strength of materials. Stones having low specific gravity values are generally weaker than those having higher value.

**LOS ANGELES ABRASION VALUE**

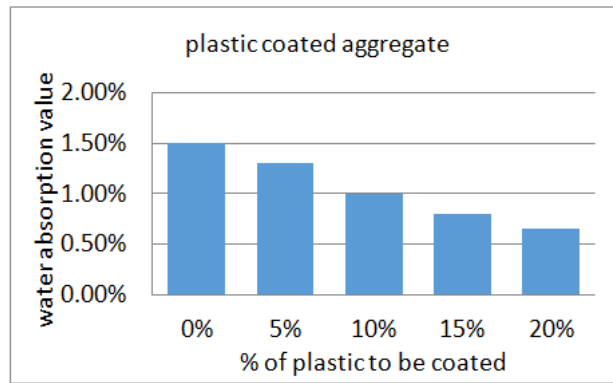
The percentage wear of the aggregate due to rubbing with steel balls is determined and is known as Los Angeles Abrasion Value.

**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.



Comparison of water absorption Value for different % of plastic Coated aggregate  
Comparison of test results for Abrasion Value Comparison of test results of specific gravity



**Comparative Physical Properties of aggregate**

Physical Properties	NA	5% PCA	10% PCA	15% PCA	20% PCA
Water Absorption	1.5%	1.3%	1%	0.8%	0.65%
Specific Gravity	2.793	2.736	2.698	2.587	2.690
Abrasion Test	9.4%	8.4%	7.6%	7.3%	7.14%
Impact Test	21.57%	18.77%	16.37%	14.30%	13.10%
Crushing Test	20.46%	20.07%	19.49%	18.99%	18.53%

**TESTS ON BITUMEN**

**Penetration**

The penetration test determines hardness of materials by measuring depth in tenth of a millimetre to which a standard needle will penetrate vertically under specified conditions of standard load and temperature.

**Viscosity**

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

**Softening Point of Bituminous Material**

Softening point of bitumen is the temperature at which substance attains particular degree of softening.

**Ductility Of The Bitumen**

The Ductility test gives a measure of adhesive property of Bitumen and its ability to stretch.

**Table 1: Bitumen Properties**

SI.NO	BITUMEN PROPERTIES	BITUMEN VALUE
1	Penetration	46.5
2	Softening Point	47.8°C
3	Ductility	35cm
4	Viscosity test	10.8 sec

**Marshall Stability Value on Bituminous Mix**

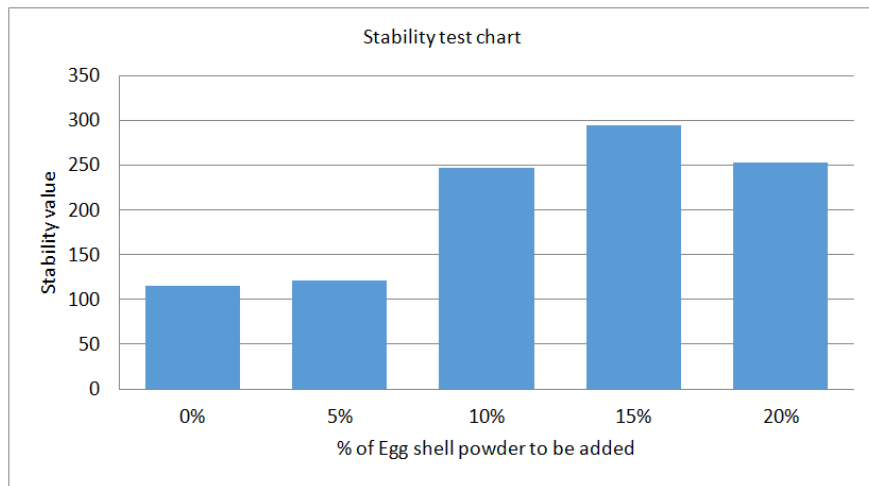
Maximum load required to produce failures in specimen when preheated and load applied at constant strain ( 5cm/min). Deformations at failure point expressed in the units of 0.25 mm is called flow value.

**Table 2: Stability test results for the Stability Values**

S.No	Bitumen%	ESP (%)	Plastic (gm)	Aggregate (grams)	Dia(MM)	Height	Stability
1	5%	0%	0%(0 g)	1140 grams	105 mm	85 mm	115 kg

2	5%	5%	10% (6 g)	1130 grams	105 mm	85 mm	121 kg
3	5%	10%	10% (6 g)	1134grams	105 mm	85 mm	247 kg
4	5%	15%	10% (6 g)	1133.5 grams	105 mm	85 mm	295 kg
5	5%	20%	10% (6g)	1134 grams	105 mm	85 mm	253 kg

**Comparison of Stability Value for different percentage of mix**



**OPTIMUM BINDER CONTENT DETERMINATION**

Percentage of bitumen in asphalt mix design at which the Marshall stability is maximum. Amount of binder added to the bitumen mixture cannot be too excess/little.

- Weight of Sample taken(W1 gm) = 500 grams
- Weight of sample after extraction (W2) =470 grams
- Percentage of binder in the total mix =6%

**CONCLUSION**

The obtained test results show that, that the addition of

plastic waste like low density polyethylene, Polypropylene, Polyethylene Terephthalate and filler material like Egg shell powder improves the stability value of the bituminous mixes. It shows the good resistances to properties of the aggregates like Abrasion, Crushing, Impact and moisture Absorption. It improves the overall performance of the mix. Generally, We cannot ban the use of plastic and egg powder, so we can make the waste obtained from this things in effective manner by utilize it in flexible road construction in a proper way.

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