

# EXPERIMENTAL INVESTIGATION ON COARSE AGGREGATES BY USING WASTE PLASTICS & POLYMERS

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## ABSTRACT

In the present experimental study, an attempt has been made to use the waste plastics in bituminous and cement concrete pavements. The type of plastic used in this study is of waste plastic which contains Water bottles , Tins , Plastic Buckets The waste plastic material is shredded into small pieces and is made to stick to heated aggregate to form a thin layer of plastic over the aggregate particles. Here the plastic was used as a modifier for aggregates (plastic coated aggregates) and bitumen (polymer modified bitumen). Engineering properties for modified and unmodified materials (aggregates, bitumen) were conducted and compared. The plastic is used in various percentages and performance tests were conducted such as water absorption & Specific gravity test , impact test , abrasion test , crushing value test for bituminous concrete mix pavements. A study has been conducted on unmodified aggregates using these plastic coated aggregates, and compressive strength was found out. The test results showed better performance values than unmodified materials for bituminous concrete.

## Keywords

Aggregates, waste plastics, Polymers.

## 1. INTRODUCTION

The growth in various types of industries together with population growth has resulted in enormous increase in production of various types of waste materials, world over, posing difficult problems in developed as well as in developing countries. Today, every sector of economy, starting from agriculture, packaging, automobile, building construction, info tech , has been virtually revolutionized by the application of plastic. The various waste materials, plastic waste, tyre waste and municipal solid waste are of great concern. Plastics wastes consisting of mainly items such as carry bags, cups, and thermocols and packaging

films pose a major problem for their disposal. Various organisations and researchers have made efforts to find methods for effective utilisation of some of these waste materials. The plastic wastes could be used in road construction. Previous Research studies showed that there is an increase in strength of the aggregates comparing natural aggregates with plastic coated aggregates.

The objectives of the present study are to:

- The main objective of the study is to know about the effective utilisation of waste plastic in highway construction.
- To know the wear and tear , strength durability of modified aggregates.
- To analyse how the polymer structure varies the strength characteristics as well as the physical properties
- To evaluate the properties of aggregates by coating plastic over it and by blending the plastic in different percentages (LDPE, HDPE, PP) and comparing with unmodified materials.

## 2. MATERIALS & METHODOLOGY

### 2.1 Materials used in the study

- i. Aggregates
- ii. Waste plastics such as bottle cans, tins, plastic bucket pieces
- iii. Polymers (PP, LDPE, HDPE)

### 2.2 Tests conducted in the study are

- i. Specific Gravity test
- ii. Water absorption test
- iii. Aggregate Impact Value test
- iv. Aggregate Crushing Value test
- v. Los Angeles abrasion value test

### 2.3 Polymers used in the study and Properties

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**Table 1 : Shows the properties of polymers**

Type of plastic	Polypropylene	Low Density Polyethylene	High Density Polyethylene
Chemical unit	CH <sub>2</sub> =CHCH <sub>3</sub>	(-CH <sub>2</sub> -CH <sub>2</sub> -) <sub>n</sub>	(CH <sub>2</sub> =CH <sub>2</sub> ) <sub>n</sub>
Density(g/cc)	0.910 - 0.928	0.91-0.94	0.945-0.962
Softening point	140-160	100-120	120-130
Solubility	Nil	Nil	Nil

### 3. METHODOLOGY

Aggregate used for the study were obtained from quarry near Vijayawada. The physical properties were tested and results are shown below. The plastic wastes like Waste bottles , cans , plastic bucket pieces were shredded into pieces. The polymers used for the study are obtained from Narayana Logistics Machilipatnam.

#### 3.1 Elaboratory Evaluation

A series of tests were carried out on unmodified and modified materials that is aggregates and bitumen for different percentages of waste plastic and polymers (PP, LDPE, HDPE) as additive. The tests that were conducted include the following:

- Unmodified aggregates are sieved as per the standards and physical properties are to be satisfied.
- Aggregate Tests such as aggregate impact, aggregate crushing, Los Angeles abrasion test.
- Performance tests are conducted for different types plastic by varying % of plastic.
- Tests are repeated to know the properties of modified aggregates using polymers.

### 4. RESULTS & DISCUSSIONS

**Table 2: Results obtained for Specific gravity & water absorption**

TESTS	VALUE
SPECIFIC GRAVITY	2.86
WATER ABSORPTION	0.8%

**Table 3: Results obtained for Aggregate impact Value test**

Sample	Value
20mm aggregate	23.7%

**Table 4: Results obtained for Aggregate crushing value test**

Sample	Value
20mm aggregate	20.4%

**Table 5: Results obtained for Los angels abrasion value test**

Sample	Value
20mm aggregate	25.2%

### 4.1 RESULTS OBTAINED USING WASTE PLASTIC

**Table 6: Results obtained for abrasion value using waste plastics**

Stone aggregates	% of plastic	Los Angeles Abrasion value (%) (IS 2386 (part IV) - 1963)		
Without plastic	0	25.2%		
With Waste plastic	% of waste plastic	Water Bottles	Tins	Plastic Buckets
	1	18.56	16.68	20.44
	2	18.51	16.52	19.23
	3	18.50	15.68	18.51
	4	18.23	15.32	17.11
	5	17.48	14	16.31
	6	17.45	13.91	15.33
	7	17.43	13.84	14.21
	8	17.32	13.42	13.54
	9	17.19	13.18	12.22
10	16.41	12.12	11.42	

Fig 2: Graph shows the increase of strength in impact value test

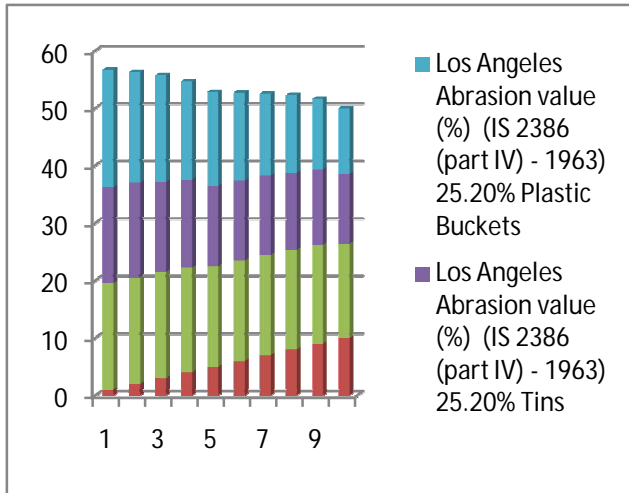


Fig 1: Graph shows the increase of strength in different percentages of waste plastic

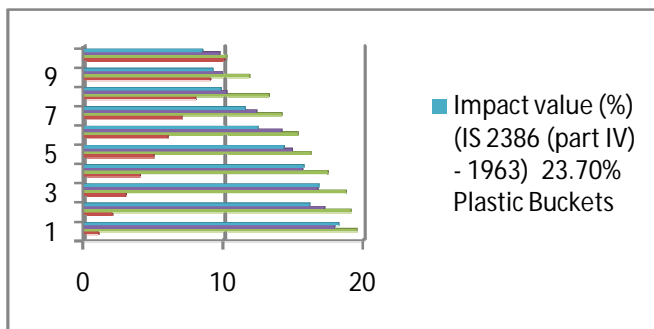
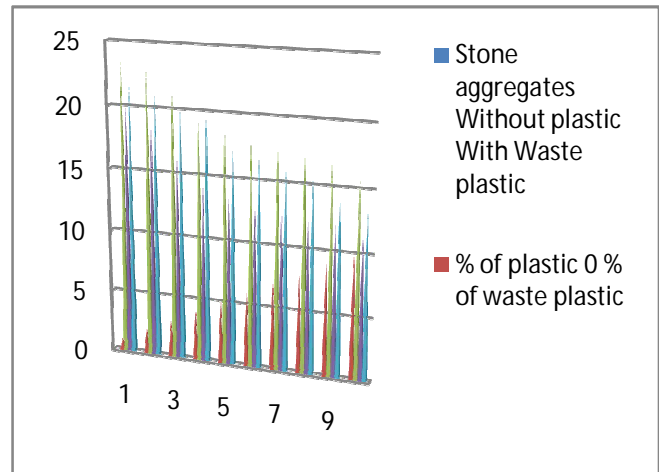
Table8: Results obtained for crushing value using waste plastics

Stone aggregates	% of plastic	Aggregate Crushing Value (%) (IS 2386 (part IV) - 1963)		
		Water Bottles	Tins	Plastic Buckets
Without plastic	0	20.4%		
With Waste plastic	1	23.4	20.19	21.56
	2	22.8	18.4	21.23
	3	21.4	16.2	20.12
	4	19.5	14.1	19.8
	5	18.5	13.5	17.4
	6	18.1	12.8	16.8
	7	17.6	12.6	16.2
	8	17.2	12.4	15.4
	9	16.8	12.1	14.1
	10	15.6	11.4	13.28

Table7: Results obtained for impact value using waste plastics

Stone aggregates	% of plastic	Impact value (%) (IS 2386 (part IV) - 1963)		
		Water Bottles	Tins	Plastic Buckets
Without plastic	0	23.7%		
With Waste plastic	1	19.5	17.9	18.2
	2	19.1	17.2	16.1
	3	18.7	16.7	16.8
	4	17.4	15.6	15.7
	5	16.2	14.9	14.3
	6	15.3	14.1	12.4
	7	14.1	12.3	11.5
	8	13.2	10.2	9.8
	9	11.8	9.9	9.2
	10	10.2	9.7	8.45

Fig 3: Graph shows the results of aggregate crushing value in different percentages of waste plastics

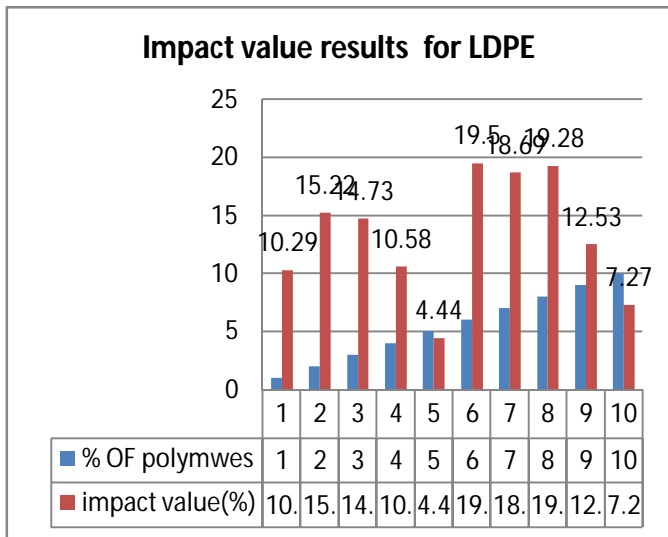


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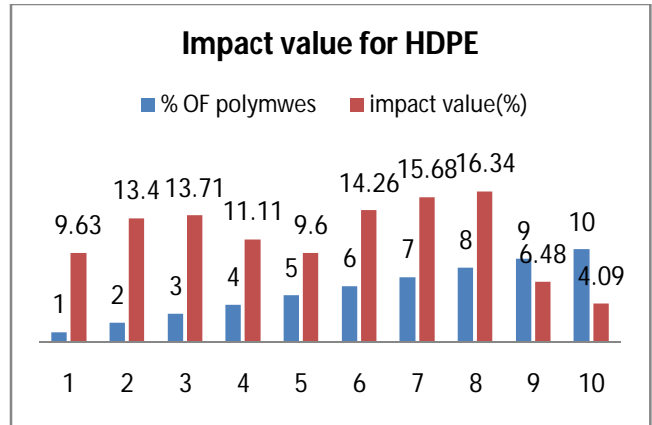
**4.2 RESULTS OBTAINED FOR MODIFIED AGGREGATES**

**Table9: Shows the modified aggregate results in AIV**

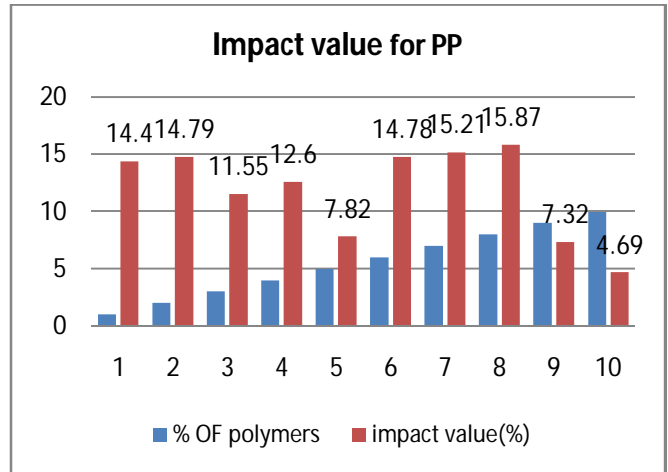
Stone aggregates	% of plastic	Aggregate impact value (IS 2386 (part IV) - 1963) %		
Without plastic	0	23.7 %		
With plastic		LDPE	HDPE	PP
	1	10.29	9.63	14.4
	2	15.22	13.4	14.79
	3	14.73	13.71	11.55
	4	10.58	11.11	12.60
	5	4.44	9.6	7.82
	6	19.5	14.26	14.78
	7	18.69	15.68	15.21
	8	19.28	16.34	15.87
	9	12.53	6.48	7.32
10	7.27	4.09	4.69	



**Fig 4: The above graph shows the strength value for 10% of Low Density Polyethylene(LDPE) .It was taken as optimum point for modified aggregates**



**Fig 5: The above graph shows the strength value for 10% of Low Density Polyethylene(LDPE) .It was taken as optimum point for modified aggregates**



**Fig 6: The above graph shows the strength value for 10% of Low Density Polyethylene(LDPE) .It was taken as optimum point for modified aggregates**

**5. CONCLUSIONS**

The generation of waste plastics is increasing day by day. Therefore by using these plastic wastes in road construction may reduce the disposal problem and helps to strengthen the properties of materials. From the study of waste plastic utilization it was found that,

- By using the waste plastic as a coated material to the aggregates, properties of aggregates were improved with different Waste plastics.
- It is showed better values than conventional aggregates. By this the poor quality of aggregates will be improved by using plastic as a modifier and can be used in construction.
- The water absorption property has decreased and by this there will be less porosity and provide better resistance to water and water stagnation.
- Plastic coated aggregate exhibit good nature in abrasive charge and in impact tests.

- The use of the innovative technology not only strengthened the road construction but also increased the road life as well as will help to improve the environment and also creating a source of income.

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