

# Experimental Study on Use of Waste Hdpe, Ldpe and Chloroprene Rubber in Bituminous Concrete

Abhishek Sharma, Sandeep Singh

**Abstract:** *The population growth, consumerism, industrialization and technology development have led to the problem of uncontrollable accumulation of plastic waste. It is great importance that waste plastic should be disposed properly in Rural as well as in urban areas. It is proved that Waste plastic is used in the bituminous mixes concrete. As, we know that Bituminous concrete is most widely used all over the world for the construction of the flexible pavement and other various projects like airport, parking lots, etc. BC generally consist of Bitumen or Asphalt which are to be mixed together in the proper proportion and after that it will be laid down in layers and compacted properly. With the increase in traffic & variation in daily or seasonal temperature, there is a need of some alternative for modifying the pavement quality which gives us both the aspect i.e economy as well as strength. So, for this the waste plastic is added in order to improve the characteristics of BC and also it is good from environmental point of view. Waste Rubber is also a serious issue for environment. So, different types of plastic i.e, HDPE (3-9%), LDPE (3-9%) and Chloroprene Rubber (3-9%) is shredded and added with different percentages in the bituminous concrete mixes. This paper present a research conducted on BC with HDPE, LDPE and chloroprene rubber individually or in combinations. Chloroprene rubber has not been used so far thus create a scope of finding new thing. Then after that Marshall Test is to be conducted for flow and stability with all void analysis on all samples.*

**Index Terms:** Bituminous Concrete, HDPE, LDPE, Chloroprene Rubber, Marshall Test, Flow, Stability

## I. INTRODUCTION

Bituminous concrete mixes are widely used in all over the world for the construction of the flexible pavement. Waste plastic is a serious problem and we know that it cannot be decomposed. The different kinds of plastic are HDPE, LDPE, polypropylene, polystyrene etc. We know that plastic are made up of carbon and hydrogen known as Hydrocarbon. Plastic have various properties like high resistance to Chemicals, permeability, recyclability and resistance to breakage. Chloroprene rubber is a form of rubber which also have good property and better stability and better resistance against UV radiation. Indian industry of plastic creates beginning in 1957. The arrangement which is to be made by the manufacturing unit of Indian Polymer are classified as under: Polystyrene -1957, LDPE -1959, PVC -1961, HDPE -1968 & Polypropylene -1978. Today at that

**Revised Manuscript Received on June 7, 2019**

**Abhishek Sharma**, Post Graduation Student, Department Civil Engineering, Chandigarh University, Gharuan, Mohali, Punjab (140413), India.

**Dr. Sandeep Singh**, Assistant Professor, Department Civil Engineering, Chandigarh University, Gharuan, Mohali, Punjab (140413), India.

time 160 plastic processing machinery manufactured and are about 22000 plastic units. The per capita plastic consumption is 8% as per GDP growth. With the concern of environment the use of plastic is increasing in good ways. Plastic cannot be used but it is to be used in road construction for flexible pavement of Bituminous concrete. Waste plastic is to be shredded and to be used in BC for road construction. The main Constituents of Bituminous concrete are Fine Aggregate, Coarse Aggregate and Bitumen. Two different types of pavement based on design consideration, Rigid and Flexible pavement.

## II. OBJECTIVES

To utilize the waste plastic and waste rubber for the production of bituminous concrete mix having high performance and better stability

- Combination of Solo, Binary and Tertiary admixtures will be attempted.
- To determine the optimum bitumen content
- To evaluate and compare results of conventional and modified mix.
- Comparison of conventional and modified mix with respect to stability.

## III. METHODOLOGY

The Methodology for any experimental work is the most difficult task and important part. All the work which is to be done in research totally depend on it. It is like a blue print on which the whole work is to be carried out. The methodology which is to be adopted in this research work is listed below.

- To conduct the various standard test on aggregates.
- To conduct the various standard test for the performance of bitumen.
- To determine the optimum binder content for the mix VG40 by Marshall stability Method.
- Mixing of Shredded HDPE, LDPE and Chloroprene Rubber by different percentages (3% to 9%) in the bituminous mix.
- To find the properties of waste plastic in bituminous concrete.
- To find the Stability and outflow by conducting Marshall test on all samples.

## IV. MATERIALS

### 4.1 High Density Polyethylene(HDPE)



# Experimental Study on Use of Waste Hdpe, Ldpe and Chloroprene Rubber in Bituminous Concrete

Waste Plastic i.e HDPE is to be used for this study which is obtained by crushing and shredding pipes, milk jugs, detergent bottle and it passes from 2.36 mm sieve. The HDPE added to different percentages (3%, 6%, 9%) in the mix. Its physical properties are given in the Table 1.

**Table 1:** Physical properties of HDPE

S.No.	Particulars	Values
1	Specific Gravity	0.90-1.0
2	Density	0.935-0.960 g/cm <sup>3</sup>
3	Tensile Strength	0.20-0.40 N/mm <sup>2</sup>
4	Melting Point	126 °C

(Source: ACCU-TEX Sales and services, Chandigarh)



**Fig 1: HDPE**



**Fig 2: LDPE**

## 4.2 Low Density Polyethylene(LDPE)

The other form of Plastic i.e LDPE is to be used in this study which is obtained by shredding of LDPE like waste plastic bags, chips Packets, Bread packets and after that passes from 2.36 mm sieve. The LDPE added at various i.e., (3%, 6%, 9%). Its physical properties are given in the table 2.

**Table 2:** Physical properties of LDPE

S. No.	Particulars	Values
1	Specific Gravity	0.91-0.95
2	Density	0.912-0.928 g/cm <sup>3</sup>
3	Tensile Strength	10 N/mm <sup>2</sup>
4	Melting Point	90°C

## V. METHODOLOGY

The Methodology for any experimental work is the most difficult task and important part. All the work which is to be done in research totally depend on it. It is like a blue print on which the whole work is to be carried out. The methodology which is to be adopted in this research work is listed below.

- To conduct the various standard test on aggregates.
- To conduct the various standard test for the performance of bitumen.
- To determine the optimum binder content for the mix VG40 by Marshall stability Method.
- Mixing of Shredded HDPE, LDPE and Chloroprene Rubber by different percentages (3% to 9%) in the bituminous mix.
- To find the properties of waste plastic in bituminous concrete.
- To find the Stability and outflow by conducting Marshall test on all samples.

## VI. MATERIALS

### 4.1 High Density Polyethylene(HDPE)

Waste Plastic i.e HDPE is to be used for this study which is obtained by crushing and shredding pipes, milk jugs, detergent bottle and it passes from 2.36 mm sieve. The HDPE added to different percentages (3%, 6%, 9%) in the mix. Its physical properties are given in the Table 1.

**Table 1:** Physical properties of HDPE

S.No.	Particulars	Values
1	Specific Gravity	0.90-1.0
2	Density	0.935-0.960 g/cm <sup>3</sup>
3	Tensile Strength	0.20-0.40 N/mm <sup>2</sup>
4	Melting Point	126 °C

(Source: ACCU-TEX Sales and services, Chandigarh)



**Fig 1: HDPE**



Fig 2: LDPE

#### 4.2 Low Density Polyethylene(LDPE)

The other form of Plastic i.e LDPE is to be used in this study which is obtained by shredding of LDPE like waste plastic bags, chips Packets, Bread packets and after that passes from 2.36 mm sieve.The LDPE added at various i.e, (3%,6%,9%).Its physical properties are given in the table 2.

Table 2: Physical properties of LDPE

S. No.	Particulars	Values
1	Specific Gravity	0.91-0.95
2	Density	0.912-0.928 g/cm <sup>3</sup>
3	Tensile Strength	10 N/mm <sup>2</sup>
4	Melting Point	90 <sup>0</sup> C

#### 4.3 Chloroprene Rubber

Waste Rubber i.e Chloroprene is to be used in this study by shredded into small size passes from 2.36 mm sieve.It gives better resistance to ozone cracking , heat aging and chemical attack.The different percentages added in the mix is (3%,6%,9%).Its physical properties are given in the table 3.

Table 3: Physical Properties of Chloroprene Rubber

S.No	Particulars	Values
1	Specific Gravity	0.99-1.0
2	Density	0.9598 g/cm <sup>3</sup>
3	Tenslie Strength	7-17 N/mm <sup>2</sup>
4	Melting Point	140 <sup>0</sup> C



Fig 3: Choloprene rubber

### V. EXPERIMENTAL WORK

In the experimental work the test on aggregate and Bitumen is conducted in order to find the values as to check that these values lies within the limit .Then after that Marshall test is to be conducted for flow and stability with all void analysis on all samples.

#### 5.1 Test on Bitumen

**5.1.1 Bitumen:**The bitumen VG40 is to be used in this research work.The standard test for this bitumen is shown.

Table 4: Test on Bitumen VG40

S.no	Bitumen test	Obtained value	Acceptance limits
1	Penetration Test (ASTM D5)	40mm	35-50
2	Ductility Test (ASTM D113)	51.3cm	>60
3	Specific Gravity Test (ASTM D70)	1.030	1.0-1.1
4	Softening Point Test (ASTM D36)	51.23 <sup>0</sup> C	50-58

#### 5.2 Test On Aggregates

**5.2.1 Aggregates:** The test conducted in this research for the aggregate as per IS 383:2016 are as under.

Table 5: Test On Aggregate

S.no	Aggregate test	Obtained values	Acceptance limits
	Aggregate Crushing Test (IS 2386 Part 4)	22.60%	30%
2	Aggregate Abrasion Test (IS 2386 Part 4)	22.5%	30%
3	Aggregate impact Test (IS 2386 Part 4)	15.36%	24%
4	Specific Gravity Test	2.2	2.1-3.2
5	Flakiness And Elongation Test (IS 2386 Part 1)	26.84%	40%

5.3 Marshall Test

For the preparation of the bituminous mix, firstly 1200g aggregate are to be taken which include coarse aggregate, fine aggregate and filler and kept in pan. The Pan was kept in the oven at a temperature of 175°C for 2 hours.

After that the bitumen was heated in the another oven at a temperature of 100- 150°C.

The required amount of plastic and chloroprene rubber was taken according to different percentages. After 2 hours the aggregate was taken out from the oven and plastic was mixed with it in the mixing pan. The mixing was done in that manner that plastic should mix with aggregate completely and after that bitumen was added into it. The mixing method was done for 15-20 minutes until a uniform colour was not obtained. After that side by side compaction mould assembly prepared and when the mix was ready put the sample in the casting mould and give 75 blows from both the sides and after that sample was allowed to cool. The sample was extracted from casting mould and kept at room temperature for 24 hours. Before testing, the weight in air and in water was calculated so as to know about the calculations of void properties and after that the sample was put in water bath for 20-30 min at a temperature of 60°C.

After that the value of stability and flows was taken out with all void analysis.



Fig. 4: Sample Placing



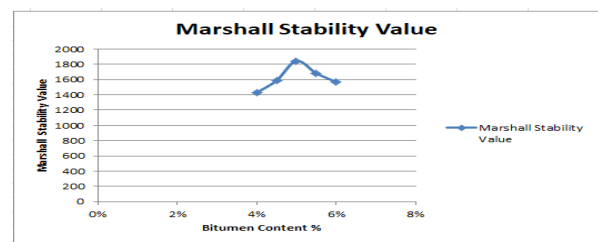
Fig. 5 : Marshall Testing Machine

5.4 Marshall Test Results

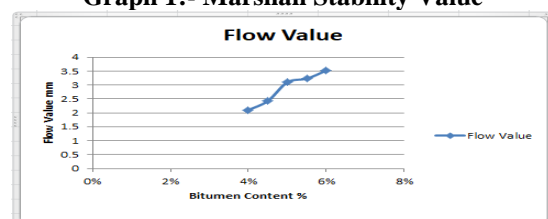
Table 6: Marshall Values without waste plastic and Rubber

Bitumen Content	Marshall Stability Value (kg)	Marshall Flow Value (mm)	VA	VMA	VFB
4	1430	2.10	6.0	15.90	58.20
4.5	1588	2.43	6.5	16.54	60.70
5	1845	3.10	4.54	15.88	71.47
5.5	1682	3.23	3.91	15.60	81.3
6	1563	3.52	3.29	14.61	94.31

Plotting Curves for Marshall Values Without adding Plastic

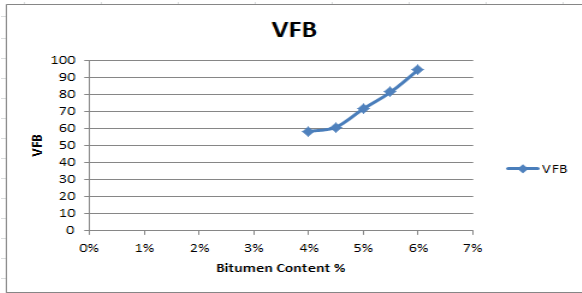


Graph 1:- Marshall Stability Value

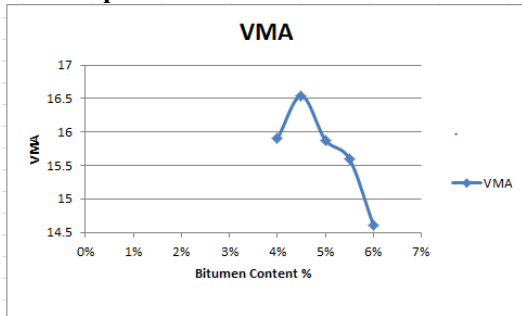


Graph 2:- Flow Value





Graph 3:- Void Filled With Bitumen



Graph 4:- Volume of Mineral Aggregate

From these Marshall values it is found that optimum value of Bitumen is 5% and at that optimum value further Marshall test are to be conducted for different percentages of HDPE, LDPE and Chlorprene Rubber.

Table 7: Marshall Value with addition of HDPE

Bitumen content	Percentage of Plastic	Marshall Stability value(kg)	Flow (mm)	V A	VM A	VFB
5%	3	1684	2.2	5.78	16.97	72.93
5%	6	1854	2.53	4.10	15.23	74.23
5%	9	1745	2.98	3.23	14.70	75.16

Table8: Marshall Value with addition of LDPE

Bitumen Content	Percentage of Plastic	Marshall Stability Value(kg)	Flow (mm)	V A	VM A	VFB
5%	3	1646	2.15	5.12	17.54	71.89
5%	6	1906	2.90	4.23	16.23	73.45
5%	9	1654	3.20	3.54	15.29	74.12

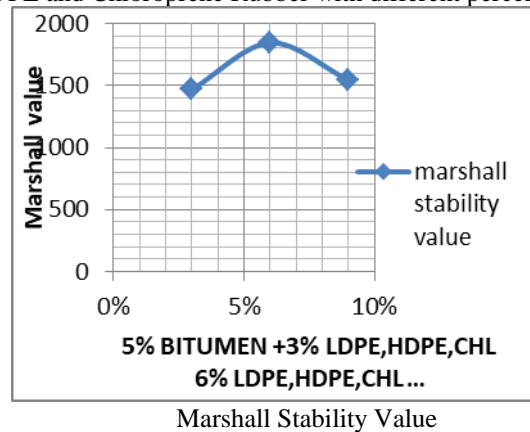
Table 9: Marshall Value with addition of Chlorprene Rubber

Bitumen Content	%age of Plastic	Marshall Stability Value(kg)	Flow (mm)	VA	VMA	VFB
5%	3	1489	2.98	4.92	16.75	68.12
5%	6	1775	3.01	4.35	16.20	69.76
5%	9	1643	3.78	3.70	15.66	71.03

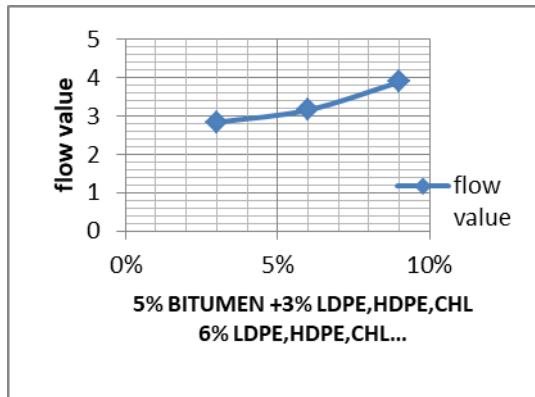
Table 10: Marshall value with addition of HDPE , LDPE and Chlorprene Rubber

Bitumen Content	HDE+ LDPE + RUBBER	Mars hall Stability Value	Flow (mm)	V A	VM A	VF B
5%	3% + 3% + 3%	1468	2.84	4.83	13.10	72.65
5%	6% + 6% + 6%	1845	3.16	4.08	12.60	74.90
5%	9% + 9% + 9%	1545	3.89	3.65	11.90	75.40

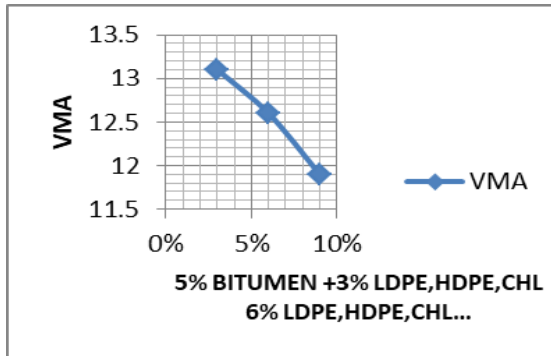
Plotting Curves for Marshall Values With addition of HDPE, LDPE and Chlorprene Rubber with different percentages



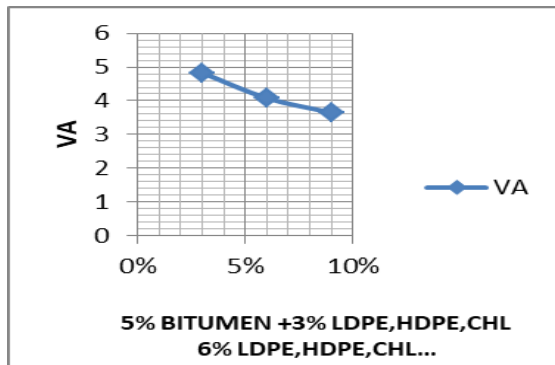
# Experimental Study on Use of Waste Hdpe, Ldpe and Chlorprene Rubber in Bituminous Concrete



Marshall Flow Value



Void in Mineral Aggregate



## VI. CONCLUSION

1. The Marshall Stability value improves after adding waste plastic and rubber in the mix.
2. From the research it was found that good stability value was attained.
3. In this research work we found that the melting point of bitumen increase after adding waste plastic in it.
4. Optimum bitumen content of virgin bitumen comes out at 5% but after adding waste plastic and rubber in it, the optimum content is 6% and after that value decreases.
5. Good stability and flow value was attained at 6% plastic and rubber content.
6. From the research it was observed that the value Marshall stability is increased after addition of plastic content upto 6% by weight of bitumen.
7. Use of this innovative technology increase the strength and life of road and also helps in reducing the environmental pollution.

## REFERENCES:

1. Rajput Pratiksha Singh &Yadav R. K “Use of Plastic Waste in Bituminous Road Construction” (International Journal of Science Technology & Engineering) ( vol. 2 ,pp. 509-513 , 10 April 2016
2. S.A.Dawale” Use of Waste Plastic Coated Aggregate in Bituminous Road Construction “(International Journal of Advancement in Engineering Technology Management and Applied Science) ( vol.3 , PP.118-126 , 6 june 2016)
3. Soyal Pradeep “Use of Waste Polythene in Bituminous Concrete Mixes “(International Research Journal of Engineering and Technology) ( vol.2 , PP.1114-1116 , 7 oct 2015)
4. Kazami Sukaina & Govardhana Rao Dubasi “ Utilization of Waste Plastic Material as Bitumen – Blends for Road Construction in Oman “ (Scholars Journal of Engineering and Technology) ( 2015: 3(1A):9-13,ISSN 2321 -435X , PP.9-13
5. Prasad K. V. R et al. “ Study on Utilization of Waste Plastic in Bituminous Mixes for Road Construction” (Proceeding of the International Conference on Futuristic Innovations & Development in Civil Engineering , International Conference on Futuristic Innovations & Development in Civil Engineering, Bangalore, Karnatak, India,18-20April.2013, pp.198-203
6. H. Islamic, H.C. Leong, “Curing characteristics and mechanical properties of natural rubber/chloroprene rubber and epoxidized natural rubber/chloroprene rubber blends” 20 (2001) 509-516

## AUTHORS PROFILE



**Abhishek Sharma** is currently doing M.E in Transpotion Engineering at Chandigarh University , Gharuan , Mohali, India.



**Dr. Sandeep Singh** currently Assistant Prof. in Civil Engg. Dept. at Chandigarh University , Gharuan , Mohali , India.

