

Effective Use of Waste Plastic as Bitumen Strength Modifier

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Abstract Type of shopping bag that are made from various kinds of plastic mainly from low & high density Polypropylene are carrier bags, shopping bags or plastic grocery bags. These are often called single-use bags as these are used to carrying stuff from a store to a home. The uses of these bags are increasing day by day due to rapid increase in population and growth in urban area. Plastic bags not only clog drainage systems but also contribute to flooding. Infrastructure of trash collection is less developed in Pakistan which causes a serious problem of littering. Plastics are friendly to consumer but are not environmental friendly due to their biodegradability. General methods to disposed waste plastic are either by incineration of materials or by way of land filling which are hazardous for human health and environment. This paper covers a new method to utilize waste plastic bags in modification of bitumen not to just effectively utilize waste plastics but also to improve strength properties of bitumen concrete mix of flexible pavement.

Keywords Low density polyethylene begs (LDPE), Marshall Stability, Marshall Flow and Hot Asphalt Mix

1. Introduction

Plastic bags are friendly use for a common man due to their low cost and easy use but on other hand they are a great threat to environment due to their non-biodegradability. As these cannot be disposed scientifically thus it creates ground and water pollution. These plastic bags not only clog drainage systems but also give an unaesthetic view to surrounding. As the solid waste management is not good in Pakistan which make these plastic begs a serious issue which needs to be highlighted and an alternative method should be adopted to utilize this waste plastic begs without harming and damaging the environment by any way. Thus one of great solution for this is to mix it with a suitable percentage with asphalt in road mix which not only utilize waste plastic but also modify asphalt and work as a strength modifier for asphalt. By this methods waste plastic is brought in to work without harming environment and this method is not just

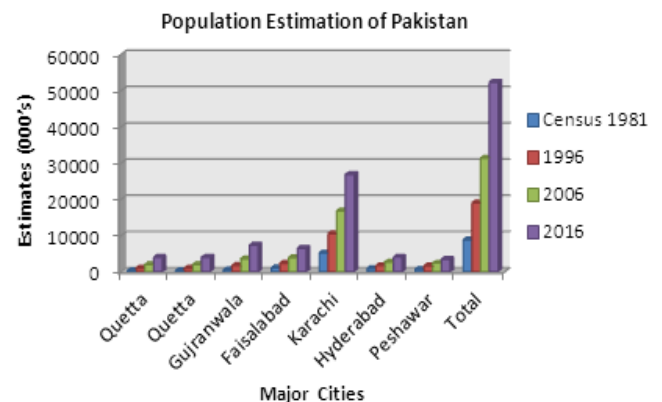
ecofriendly but also economical because some amount of asphalt is replaced by waste plastic which reduce the total cost of asphalt mix. This waste plastic modified asphalt is a great water proof which make road more resistible again water action which Coues pothole in road.

Data of Waste Plastic Generation in Pakistan

Table 1. Population Estimation of Pakistan

S. No	Major Cities	Census 1981	Estimates (000's)		
			1996	2006	2016
1	Quetta	286	1,000	2,004	4,017
2	Gujranwala	601	1,759	3,596	7,361
3	Faisalabad	1,104	2,364	3,928	6,528
4	Karachi	5,208	10,522	16,816	26,873
5	Hyderabad	911	1,733	2,661	4,085
6	Peshawar	717	1,655	2,403	3,489
	Total	8,827	19,033	31,408	52,353

Source: PEPA GUIDELNE FOR SWM 2005



The collection, disposal and transportation of solid waste have not been carried out in an adequate and suitable manner in Pakistan which result a worse sanitary and environmental conditions. During 1996 the ministry of environmental and urban division government of Pakistan undertook a study on privatization of some major selected cities solid waste management in Pakistan. From this study the Population Estimation of Pakistan, Solid Waste Generation in Pakistan

and Plastic Waste Generation in Pakistan were calculated to have a rough estimate of total amount of plastic generated in some major cities of Pakistan.

Table 2. Solid Waste Generation in Pakistan

S. No	Major Cities	Generation Kg/C/day	Waste Generated	
			Tons/day	Tons/year
1	Quetta	0.378	757.51	276491.15
2	Gujranwala	0.469	1686.52	615579.8
3	Faisalabad	0.391	1535.85	560585.25
4	Karachi	0.613	10308.21	3762496.65
5	Hyderabad	0.563	1498.14	546821.1
6	Peshawar	0.489	1175.07	428900.55
	Total		16961.3	6190874.5

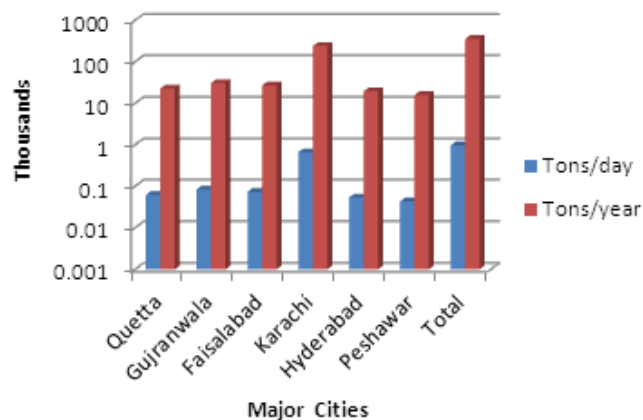
Source: PEPA GUIDELNE FOR SWM 2005

Table 3. Plastic Waste Generation in Pakistan

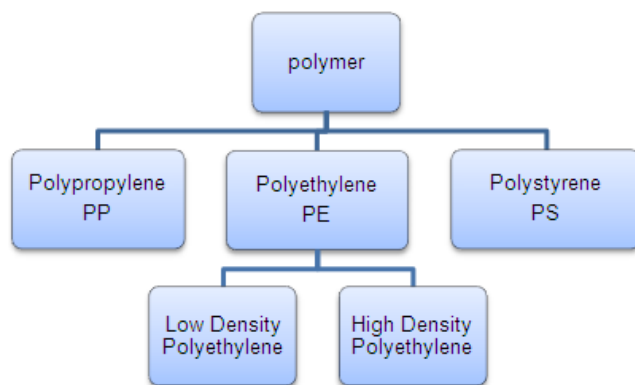
S. No	Major Cities	Plastic %	Generation Kg/C/day	Plastic Waste Generated	
				Tons/day	Tons/year
1	Quetta	8.2	0.030996	62.11582	22672.27
2	Gujranwala	5.00	0.02345	84.326	30778.99
3	Faisalabad	4.80	0.018768	73.7208	26908.09
4	Karachi	6.40	0.039232	659.72544	240799.8
5	Hyderabad	3.60	0.020268	53.93304	19685.56
6	Peshawar	3.70	0.018093	43.47759	15869.32
	Total			977.29869	356714

Source: PEPA GUIDELNE FOR SWM 2005

Plastic Waste Generation in Pakistan



Characterization of Waste Plastics



Thermal Study

Polymers thermal behavior is shows in Table 4.

Table 4. Thermal Behavior of Polymers

Polymer	Solubility in water %	Softening Temp. F	Products Reported	Decomposition Temp. F	Products Reported
Polystyrene	0	230-284	No Gas	572-662	C6H6
Polyethylene	0	212-248	No Gas	518-662	CH4,C2H6
Polypropylene	0	284-320	No Gas	518-572	C2H6

Table 5. Specification of Bitumen

S. No.	Test Description	Test Method	AASHTO* M-20	Max/Min	Units
1	Flash Point, COC	D92	232	Min	°C
2	Penetration @ 25°C	D5	60-70	-	1/10 mm
3	Ductility @ 25°C	D113	100	Min	cm
4	Solubility in Trichloroethylene	IP47	99	Min	Wt%

* American Association of State Highway and Transportation Officials

Bitumen

Bitumen is highly viscous and sticky black semi-solid or liquid form of petroleum. It can be a refined product or may be found in natural deposits. The main use of bitumen is as binder in road construction. For pavement purpose Various Grades of Bitumen are used such as Grade: 60/70; Grade: 80/100 etc. but the one used in this research paper is Grade 60/70 from Attock Refinery Limited Rawalpindi, Pakistan. The Specification of bitumen used in tests are given in table 5.

2. Methodology

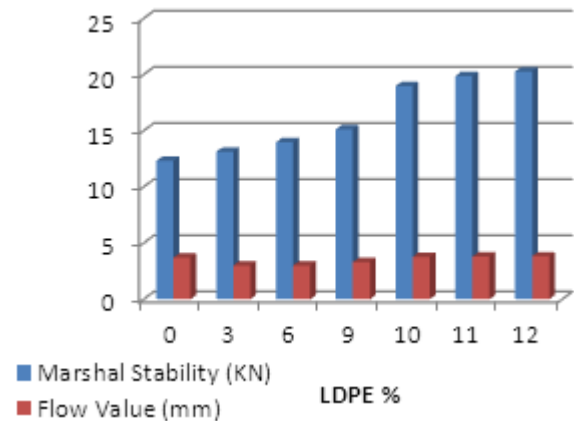
Plastic bags were collected from dumpsites, garbage trucks, roads, rag pickers and waste-buyers at Rs 10-15 per kg. Used plastic bags were also collected from houses for project work. The plastic bags that were collected was classified to required thickness and plastic bags with up to 60 micron was selected because the mixing of these bags with bitumen were easy at laboratory level with a mixing temperature about 160°C-170°C as it's the softening point of LDPE. The bags were first cleaned and then were cut to small pieces so that it could pass sieve no. 4. The plastic bags pieces retained on sieve no. 4 were rejected. Bitumen was heated to 160°C-170°C and plastic pieces were slowly added with constant stirring for about 30 minutes. Then pre heated aggregate was added and hot asphalt mix was prepared and Marshall Moulds were prepared with 75 blows compaction on each side and these sample were then tested to find the difference between normal bitumen and polymer modified bitumen in term of Marshall Stability and Flow values the plastic value was increased with keeping bitumen value constant to see the effect of plastic on strength and flow.

3. Result

The results show that initially the strength was increased by the addition of plastic where the flow was decreased but as the plastic percentage was increased the strength got increasing but on the other hand flow also started getting increased. but at 10% the flow was almost the same as it was for the 0% plastic so up to 10% plastic can be added to modify bitumen for more strength with same flow as that for 0% plastic.

Table 6. Test Result

S. No.	LDPE %	Bitumen %	Marshall Stability (KN)	Flow Value (mm)
1	0	3	12.32	3.70
2	3	3	13.13	3.00
3	6	3	13.98	3.01
4	9	3	15.125	3.3
5	10	3	18.97	3.775
6	11	3	19.87	3.8
7	12	3	20.285	3.825
8	15	3	22.18	4.05



4. Conclusions

To discover useful ways to reutilize the waste plastic was the key purpose of this paper. Polypropylene, polystyrene and polyethylene are major polymers that show adhesion property in their molten state. The strength parameter of Hot Asphalt Mix that is Marshall Stability value shows increasing trend and the highest values have improved by about 65 % by addition of 10% of LDPE by the weight of bitumen where the flow is the same as it was for 0% plastic. This will provide more stable and durable mix for the flexible pavements. The serviceability and resistance to moisture will also be better when compared to the conventional method of construction. This study not only constructively utilizes the waste plastic but it has also effectively enhanced the important parameters which will ultimately have better and long living roads. Hence the best way for easy disposal of waste plastics is to utilize it as bitumen modifier for flexible pavements. This will not only improve the life and performance of pavement but will also provide a use full disposable of waste plastic with reducing usage of bitumen. The procedure is environment affable. Let us adopt this newer technology to not only to clean our environment from waste plastic but also to have long life roads with great strength and weather resistance.

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