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Research Paper

EFFECT OF THE LOW DENSITY POLYETHYLENE CARRY BAGS WASTE ON THE ASPHALT MIXTURE

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Low Density Polyethylene (LDPE) waste goes to landfill or incineration which causes environmental pollution problems. In this work low density polyethylene carry bags waste were collected from supermarkets, cleaning and shredding then mixed with asphalt hot mix at 150°C in Shiryan Elshimal of Roads and Dams laboratory. The change in marshal stability, flow and voids due to addition of low density polyethylene carry bags waste (4%, 6%, 8%, 10%, 12%, 14%, 16% and 18%) of the asphalt weight is measured. This study was used Microsoft Excel for drawing fitting carves to compare the results. The results was improved the properties of asphalt hot mix design especially when we use 10% concentration low density polyethylene waste of the asphalt weight, consequently improved the environmental pollution by using in asphalt mixture.

Keywords: Low density polyethylene, Carry bags, Waste, Environment, Asphalt mixture

INTRODUCTION

Plastics have grown into a major industry that affects all of our lives - from providing improved packaging to giving us new textiles, to permitting the production of wondrous new products and cutting edge technologies in such things as televisions, cars and computers, and some plastics items, such as food packaging, become waste only after a short time, after purchase other plastic items lend themselves to be reused many times over and can be recycled at the end of their useful life. The worlds annual conception of plastic material has increased from around 5 million tons in 1950s to nearly 100 million tons today, that is, mainly we produce and use 20 times more plastic today than we did 50 years ago (William *et al.,* 2000).

The environmental impact varies according to the types of plastic and the production method employed, plastic production also include the use of potentially harmful chemicals, which are added as stabilizer of colorants. Many of these have not undergone environmental risk assessments and their impact on human health and the environment

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is currently uncertain, but the risk assessments of the affects of this is phthalates, which are used in manufacture on environment and health are being carried out.

Most plastic is not biodegradable and will persist in the environment for hundreds of years for example, plastic film containers last for 20-30 years while plastic bottles can last indefinitely (Agrawal, 2001). Plastic is also lightweight and moisture resistant which means it can float easily in air and water often travelling long distances. Plastic incineration also generate toxic emissions such as carbon dioxide and methane. This greenhouse gases contribution to worldwide climate change.

Polyethylene has excellent chemical resistance and is not attacked by acids, bases, or salts (it is, however, attacked by strong oxidizing agents). The other characteristics of polyethylene which have led to its widespread use are low cost, easy process ability, excellent electrical insulation properties, toughness and flexibility even at low temperatures, freedom from odor and toxicity, reasonable clarity of thin films, and sufficiently low permeability to water vapor for many packaging, building, and agriculture. As a consequence of their low density, low density polyethylene cause a greater visual impact and disposal than many other materials. Their Lightweight is a significant limitation on the recycling of plastics waste, due to high collection and transportation costs.

Utilization of low density polyethylene waste in asphalt hot mixture would be beneficial in order to find an alternative solution to reduce environmental pollution. However using virgin additives can improve asphalt mixture characteristics, it will increase road construction cost.

So, in recent years many investigations have been conducted on asphalt mixtures containing waste materials as additives (Huang *et al.,* 2007).

OBJECTIVE

The objective of this study is utilization of LDPE carries bags waste in to asphalt mixture.

Study of the effect of LDPE carry bags waste in the asphalt mixture in the stability, flow and voids of the mixture, determine the optimum percent of LDPE carry bags waste in hot mix asphalt and contribution in the reduction of the environmental impact by using scientific method to bury the LDPE carry bags waste.

MATERIALS AND METHODS

Sample Materials

4%, 6%, 8%, 10%, 12%, 14% and 18% white LDPE carry bags by weight of 60/70 grade bitumen.

Sample Preparation

The Plastic waste carry bags collected, sorted out, cleaned and dried then shredded to small pieces.

Mixer Material

Bitumen grade 60/70, 3/4“ (stone), 3/8“ (stone), C &N Sand and Filler.

Equipment and Tools

Sieve Shaker – ELE International – England, Sieve - ELE International – England, Penterometer – p734 – ELE International –England, Oven – ELE International-England , Auto-Compaction – ELE International, Electronic Balance – ELE International-England, Water Bath – ELE

Table 1: Material Used for Preparation Sample Without Adding Low Density Polyethylene

Type of Material	Source of Material	Sieve Analysis % Pass Sieve Size(mm)											Specific Gravity and Water Absorption	
		25.0	19.0	12.5	9.5	4.75	2.36	1.18	0.600	0.300	0.150	0.075	Bulk Specific (SSD)	Absorp-tion %
3/4"	J . Toria	100.0	98.7	32.6	7.7	3.6	2.5	2.2	1.9	1.5	1.3	1.1	2.872	1.436
3/8"	J . Toria		100.0	98.8	90.0	18.6	1.6	1.3	1.2	1.0	0.9	0.7	2.859	1.709
C & N Sand	J . Toria, Mansourab				100.0	99.9	947	76.8	51.7	26.4	11.9	8.7	2.695	0.261
Filler	Giregreb				100.0	99.8	99.0	94.9	91.7	88.5	83.2	78.8	2.299	0.715
Bitumen	Egyptian	60/70									1.024			

International-England and Multiplex 50 – ELE International-England.

Methods

The coarse aggregate is prepared by using sieve shaker then determine asphalt properties for Penetration Test and heater to determined Flash point and Fire point .The coarse aggregate is heated to 150°C in oven and the shredded plastic waste is added into the aggregate. Immediately the hot Bitumen (150°C) is added and mixed well, as the polymer and the bitumen are in the liquid state.

Each sample is compacted with a Marshall hammer (Auto-completion) the samples will be left for 24 h before taking the weight in air and in water by Electronic Balance then all samples put in water bath at 60°C for 30 min at last measured stability and flow use Multiplex.

RESULTS

Marshal Test Results

Table 2 show amount of material which use to prepare sample without added low density polyethylene waste as percentage of aggregate weight and percent of mix weight .

Figures 1,2,3,4,5 and 6 show the test results of samples without added low density polyethylene waste from a Marshall mix design.

The sample without added low density polyethylene (among other parameters) optimum amount of Bitumen to be added to an aggregate blend @:

Maximum Unit Weight = 5.25

Maximum Stability = 5.30

Median Air Voids = 5.10

The Median = 5.20 % By Weight Aggregate.

= 4.94 % By Weight of Mix.

Table 2: Sample without low density polyethylene waste Composition of Mix

Description	3/4"	3/8"	C&N Sand	Filler	Asphalt Cement
% by weight of aggregate	30	26	40	4	5.20
% by weight of mix	28.5	24.7	38.0	3.85	4.95

Figure 1: VTM

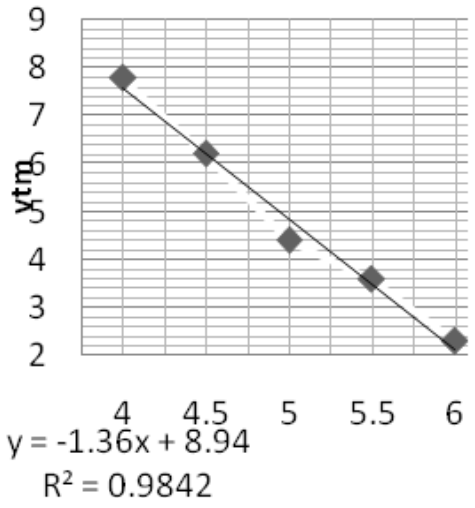


Figure 2: Specific Gravity

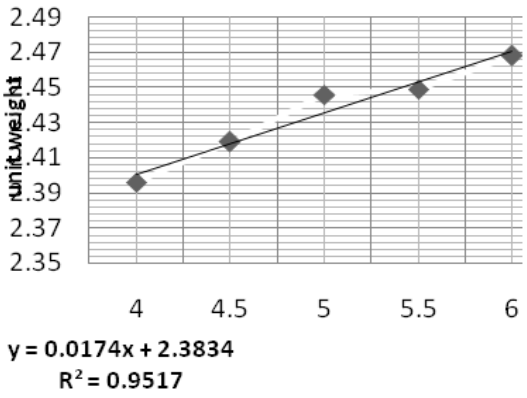


Figure 3: VMA

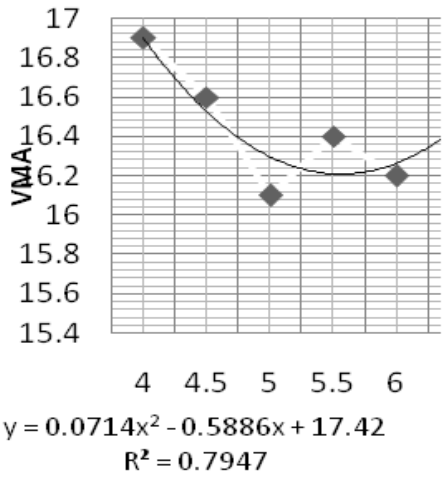


Figure 4: Stability

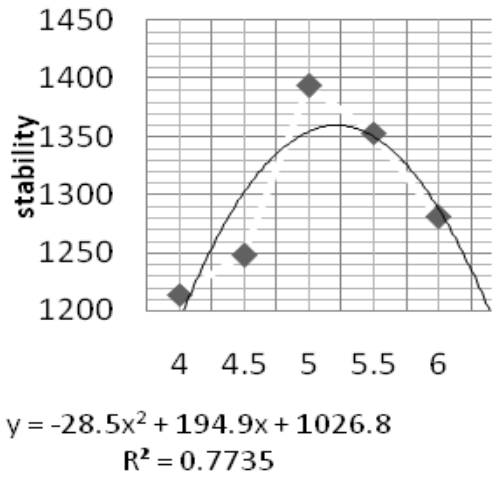


Figure 5: VFA

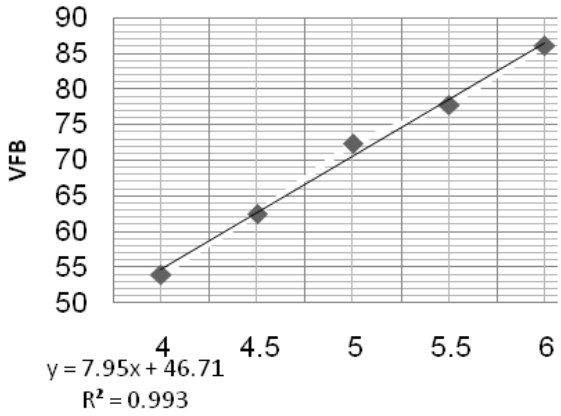


Figure 6: Flow

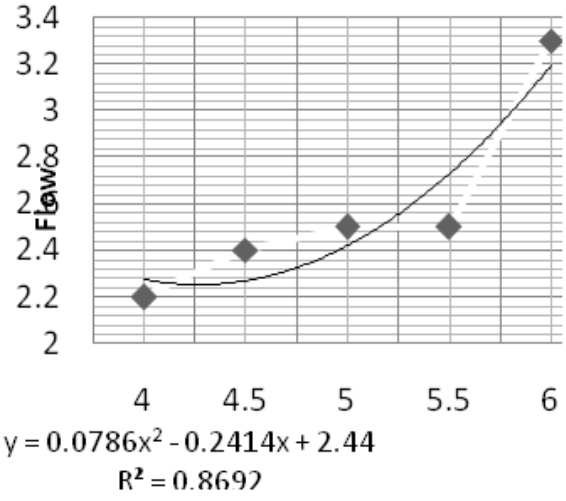


Table 3: Sample Without Add Low Density Polyethylene Properties of Proposed Mix

Description	Result	Project Specification
Asphalt content %	4.94	5-6
Stability kg	1380	Min 1000
Flow mm	2.5	2-4
Air Voids %	4.9	3-6
VMA %	16.0	Min 13
VFB %	71.0	70-85

The properties of proposed mix of the optimum amount of Bitumen were as the result in Table 3. After preparing optimum amount of Bitumen proposed mix, low density polyethylene waste was added to the mix as the percent of optimum amount of Bitumen to the material which was used to prepare sample without added low density polyethylene waste (Table 1), and the Marshal test was presented in the Table 4.

From Figures 1, 2, 3, 4, 5 and 6, optimum amount of low density added to the mix @:

Maximum Unit Weight = 4

Maximum Stability = 18

Median Air Voids = 8

The median = 10% By Weight of Bitumen.

DISCUSSION

Comparison between conventional asphalt mixture and asphalt mixture of added LDPE bags waste, it was found that stability of the mixtures content LDPE bags waste was higher than conventional asphalt mixture.

Flow of the low LDPE content mixtures was higher than the conventional asphalt mixture.

The air void (VTM) proportion of the LDPE carry bags waste content mixture was higher than the conventional asphalt mixture.

Void of Mineral Aggregate (VMA) percentage increased when the LDPE carry bags waste added on, but at 12% LDPE carry bag waste concentration was started decreasing (Figure 3). But all the samples are within specification.

Void Filled with Asphalt (VFA) for LDPE carry bags waste decreased as the add on of LDPE carry bags waste until it reaches the lowest value

Table 4: Average Sample With Plastics Marshall Test Result

Plastic % By weight of bitumen	Bitumen %	Specific Gravity	Void in Total mix (VTM)	Void in Mineral Aggregate (VMA)	Void Filled With Bitumen (VFB)	Flow	Stability
4	4.8	2.497	3.4	14.4	76.4	2.4	1383
6	4.7	2.497	3.7	14.7	75.6	2.7	1490
8	4.6	2.491	4.0	14.8	72.2	2.7	1383
10	4.5	2.486	4.3	14.9	70.7	2.6	1503
12	4.4	2.479	4.7	15.0	68.5	2.9	1806
14	4.3	2.460	4.9	15.0	66.9	3.1	1643
16	4.2	2.477	5.1	14.9	66.4	3.5	1717
18	4.1	2.477	5.3	14.8	64.5	4.1	2047

Table 5: Comparison Between 10% and 0% Plastics Add-on

Description	Equation	0% PlasticsBy weight of Bitumen	10% Plastics By weight of Bitumen	Project Specification
Stability kg	$Y=9,488x^2-3,654x+139R^2=0$ .799	1396±279.2	2381±478.7	Min 1000
Flow mm	$y=0.207x+ 2.067R^2=0.826$	2.067±0.36	4.3±0.74	2-4
Air Voids %	$Y=0.278x+3.171R^2=0.989$	3.2±0.04	6.0±0.07	3-6
VMA %	$Y=-0.029\ x^2+o.316x+14.13R^2=0.980$	14.1±0.28	14.4±0.29	Min 13
VFA %	$Y=-1.754x+78R^2=0.975$	78±1.95	73±1.09	70-85
Amount of asphalt %		5	4.5	

Figure 7: Stability with Plastic

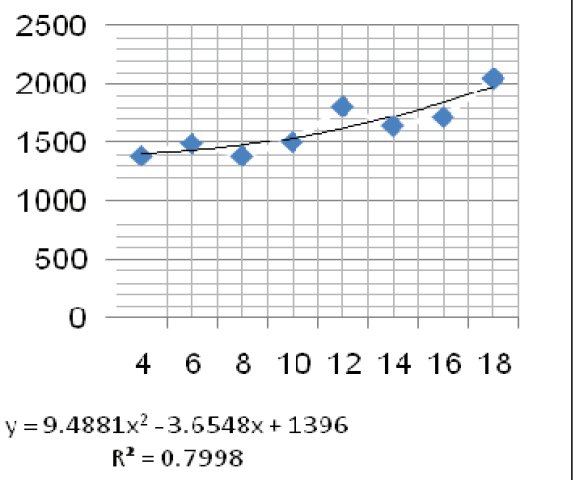


Figure 10: VTM with Plastic

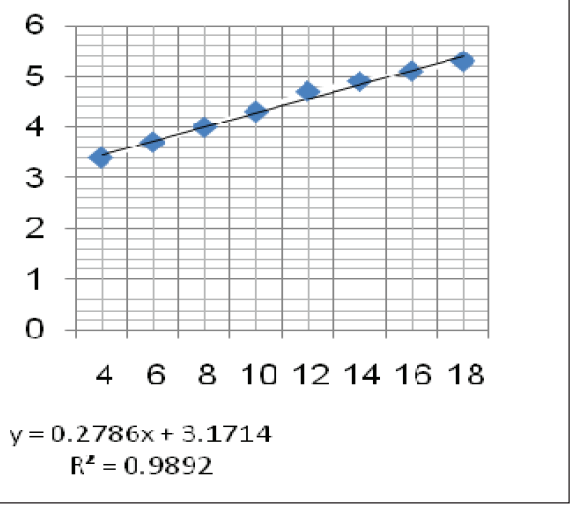


Figure 8: Specific Gravity with Plastic

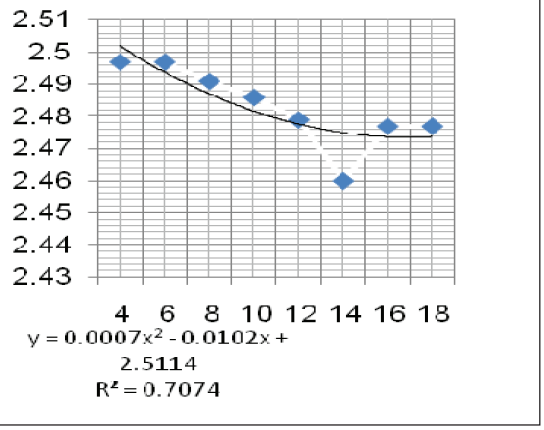


Figure 11: VTM with Plastic

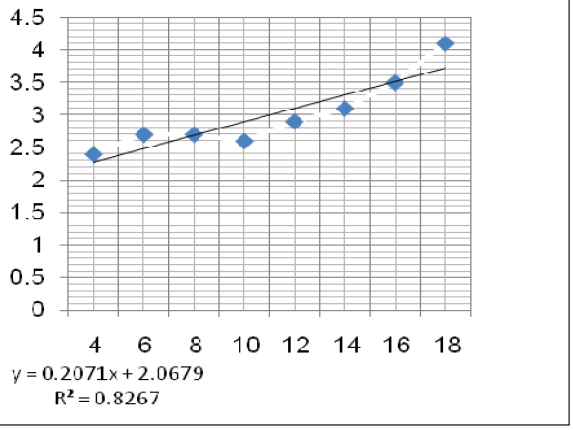


Figure 9: VMA with Plastic

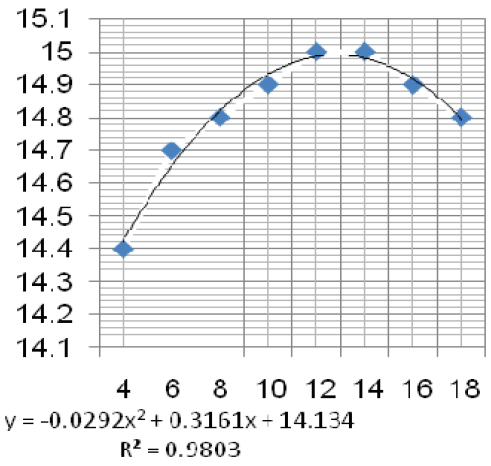
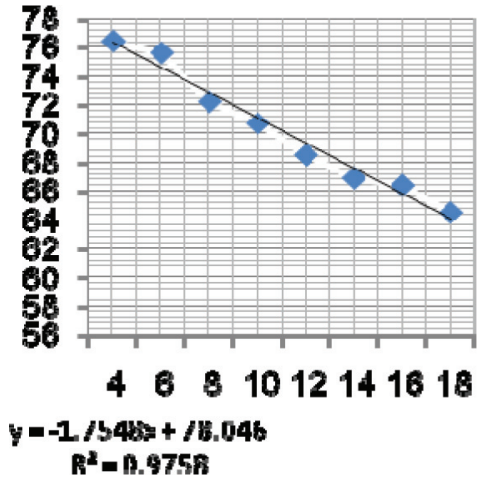


Figure 12: VFA with Plastic



at 10% concentration of LDPE carry bags waste (Figure 6).

The optimum modifier content was selected as the content that satisfies the minimum (VFA).

The minimum (VFA) (70) was reported for asphalt mixture modified with LDPE waste 10% by weight of bitumen.

From Table 5, the stability was reported of asphalt mixture modified with 10% LDPE is 2381 kg, while the stability of conventional asphalt mixture was 1396 kg, else Flow, air voids (VTM) and VMA for the mixture modified with 10% of LDPE waste are within specification

CONCLUSION

In this study used of LDPE carry bags waste in asphalt hot mixture improved the stability, flow and voids more than conventional asphalt mixture.

The optimum LDPE waste content was 10% measured by weight of bitumen contend.

The mixture content 10% LDPE carry bags wastes had the highest stability, minimum VFA and satisfied the specification for flow, VMA and VTM.

The result of the study indicate that modified mixture (4% to 12%) had higher stability and VMA percentage compared with non-modified mixture. This would positively influence the rutting resistance of these mixtures.

The optimum modifier content 10% which equals only of all aggregate particles.

The amount of LDPE waste content in the mixture can be increased by more than 10% when VFA is increased by using big stone size.

Due to properties LDPE, the LDPE carry bags waste in asphalt mixture reduced pavement deformation, increased fatigue resistance and provided better adhesion between the asphalt and aggregate.

This research changed that hazardous LDPE waste by mixing bitumen binder in asphalt hot mix design which resulted in improving its properties and decreasing the amount of bitumen required in recipe which implied saving money in road building.

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