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# Formulation of Modified Dense Graded Bituminous Macadam with Low Density and High Density Polythene with Zykotherm Admixture

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**Abstract**
This study presents the use of waste polythene derived as carry bags from kitchen waste and pond liner polyethelene as LDPE and bottle caps as HDPE as an additive in flexible pavements. In this study we will also add a fix percentage of zykotherm. Reasons for utilizing above materials are to use earth inadmissible waste material and to build up a superior material blend to oppose expanded traffic burden and temperature impact coming about breaks in the asphalt surface. In the proposed examination the plastic waste will be cleaned and cut into a size with the end goal that it goes through 2-3mm strainer utilizing destroying machine. In this examination Dense Bituminous Macadam (DBM) blend will be proposed to get ready by utilizing plain bitumen as a control example and bitumen blended in with LDPE 2% and 4% and HDPE 2%, 3%, 4%, 5%) as by weight, with fixed level of Zykotherm as 1.5% by weight.Bitumen content is 4.5% by weight for all example. The Marshall Stability test, Penetration Test, and mellowing point test, were led on control and altered DBM blends.

**Keywords:** Zykotherm, LDPE, HDPE, Dense Bituminous Macadam, Marshall Stability.

## Introduction

Polymer altered bitumen is developing as one of the significant development materials for adaptable asphalts in view of the few reasons. The polymer changed bitumen show better properties for street development and plastics squander, in any case viewed as a contamination hazard, can discover its utilization in this cycle and this can help taking care of the issue of contamination on the grounds that the majority of the plastic waste is polymers. Adaptable asphalt can be characterized as the one comprising of a blend of asphaltic or bituminous material and totals put on a bed of compacted granular material of suitable quality in layers over the subgrade. Plastic trash is generally observed around the nation and has begun causing a few issues. Plastic waste obstructs channels, causing floods. It stifles creatures who eat plastic sacks, and so on.Non-Biodegradable wastes are those that cannot break down or degrade for many years, they cannot be changed into manure and burning of these fuels causes more pollution in the environment thus to overcome this problem it can be utilized in construction industry.

**a) LDPE**

Low Density Polyethylene (LDPE) includes house hold polythene and pond liner polyethelene gathered from neighborhood dump destinations washed with cleanser and water and destryed into size of 2mm to 3 mm.

- It has a density from 0.910 to 0.940g/cm cube.

- Specific Gravity is 0.92.
- Melting temperature is greater than 110 C.

**b) HDPE**

The thickness of HDPE is subtly higher than the low density polyethelene and inclidesbottles ,bottles caps etc. The density of HDPE can keep running from 0.93 to 0.97g/cm cube
Melting temperature is greater than 130 C.

**c) ZycoTherm**

The added substance utilized was provided and created by Zydex Industries, situated in Gujarat, India. This added substance is dissolvable in water and produces polymeric material and liquor when presented to dampness however is steady under ordinary temperatures and weights.

It comprises of 65% to 75% hydroxyalkyl-alkoxy-alkylsilyl mixes, 25% to 27 % benzyl-liquor and 3% to 5% ethylene glycol.

## 2. Literature Review

Mohd. Rosliet. al. (2017) [Performance portrayals of black-top folios and blends joining silane added substance ZycoTherm] In this investigation, 0.1wt% ZycoTherm was mixed with black-top fastener to empower creation of black-top blend at lower than ordinary temperatures, just as improve blend usefulness and compactability. The properties of control black-top fasteners (60/70 and 80/10 infiltration evaluation) and black-top folios consolidating 0.1% ZycoTherm were accounted for dependent on the entrance, relaxing point, rotational thickness, complex modulus and stage edge. In this manner, to analyze the presentation of black-top blend fusing ZycoTherm with the control black-top blend, barrel shaped examples were set up at suggested temperatures and air voids relying upon the cover types and test necessities. The examples were tried for roundabout elasticity (ITS), versatile modulus, dynamic downer, Hamburg wheel following and dampness incited harm. From compaction information utilizing the Servopak gyratory compactor, example arranged utilizing ZycoTherm show higher usefulness and compactability contrasted with the regular blend. From the blend execution test results, blends arranged with ZycoTherm indicated better execution as far as the protection from dampness harm, lasting twisting and breaking.

Dr. Malik Shoeb Ahmad (2014) [Low Density Polyethylene Modified Dense Graded Bituminous Macadam Reclaimed plastic waste got from low thickness polyethylene (LDPE/PW) convey packs from kitchen waste and plastic jugs have been utilized as added substance in adaptable asphalts. In the current examination the plastic waste was cleaned and cut into a size with the end goal that it goes through 2-3mm strainer utilizing destroying machine. In this investigation Dense Bituminous Macadam (DBM) blend has been set up by utilizing plain bitumen as a control example and bitumen blended in with low thickness polyethylene (LDPE/PW) in various extents, for example, 2, 4, 6, 8, 10 and 12% by weight.

The Marshall Stability tests were led on control and adjusted DBM blends. It has been seen that the plastic waste adjusted bitumen blend show better restricting property, soundness, thickness and more impervious to water.The test performed by creator results demonstrated that the dependability of DBM blends was improved altogether on expansion of plastic squanders to the mixes. Hence, the current examination will result lesser street fixes and utilization of plastic squanders will assist with using non biodegradable waste. The expansion of LDPE (PW) diminishes the air voids which forestalls the dampness ingestion and oxidation of bitumen by ensnared air. This has brought about improvement of Marshall Stability esteem. It has been seen that the strength estimations of blends altered in with plastic waste have been expanded fundamentally up to the tune of 14% at 12% waste when contrasted with blend arranged in with plain bitumen. This shows the improvement in quality of the blend because of expansion of plastic waste which means that the consideration of plastic waste expands the thickness of the blend. The mass thickness of the blend was additionally

expanding with increment in the plastic waste substance. The most critical level of waste is seen as 12% at which the thickness is greatest (2.51g/cc) which is about 25% more than the thickness of the blend arranged in with plain bitumen.

Rohith N, J. Ranjitha (2013) [A Study On Marshall Stability Properties Of Warm Mix Asphalt Using Zycotherm A Chemical Additive] Here the creator made an endeavor to think about the marshall properties of WMA delivered with the synthetic added substances :"ZycoTherm" and HMA for Dense Bituminous Macadam(DBM) Grade 2. The received blending temperatures for HMA was 155°C, 130°C and 115°C and the blending temperatures for WMA was 130°C and 115°C, with an added substance measurements pace of 0.1% by weight of the fastener.. The research facility study presumes that Stability and Marshall properties were improved for the WMA blend by the expansion of the added substance. The current investigation incorporates the arrangement and testing of research facility examples for Marshall Test of HMA blend at 155°C, 130°C and 115°C temperature and WMA blend at 130°C and 115°C temperature with added substance dose pace of 0.1% by weight of fastener, to the necessary particulars.

The Marshall Stability estimation of HMA examples created at 155°C has great strength esteems. When contrasted and HMA examples, the solidness and Marshall Properties of WMA examples arranged at 130°C and 115°C were improved by the expansion of Zycotherm at an added substance measurements pace of 0.1% by weight of the folio. The ideal folio content for the HMA blend at 155°C was discovered to be 5.4% and WMA blend at 130°C with 0.1% of ZycoTherm was discovered to be 5.37%. This infers that the ideal folio content for HMA and WMA blend are diverse with changing the temperature and added substance measurement rate, so the OBC ought to be discovered independently for both HMA and WMA blend for differing temperatures and added substance dose rate.

## 3. Problem Identification

The researchers have tried to find the variation in Bituminous samples which occurs due to admixtures and utilization of waste materials following are the outcomes of literature review:
Specimen prepared using ZycoTherm exhibit higher workability and compactability compared to the conventional mixture. From the mixture performance test results, mixtures prepared with ZycoTherm showed comparable better performance than the control sample in terms of the resistance to moisture damage, permanent deformation and cracking. The unique, organo-silane chemistry of ZycoTherm, gives, a strong and permanent chemical bonding (Si-O-Si–mother nature bond available in sand/quartz) between the bitumen and the aggregate surface. The permanent chemical bonding enables excellent moisture resistance, complete coating of bitumen on aggregates and allows wider temperature zone for mixing and compaction resulting in a pavement with extended life cycle. The addition of LDPE reduces the air voids which prevents the moisture absorption and oxidation of bitumen by entrapped air. This has resulted in enhancement of Marshall Stability value and more resistant to water. It has been observed that the plastic waste modified bitumen mix show better binding property, stability.

## 4. Objectives

1. To study the effects of mixing LDPE, HDPE and Zykotherm in Hot mix asphalt.
2. To determine which sample is more stable and performing well in comparing all cases.
3. To determine the enhancement in properties of hot mix asphalt using LDPE. and HDPE.
4. To determine the optimum percentage of HDPE and LDPE in a mix.

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## 5. Methodology

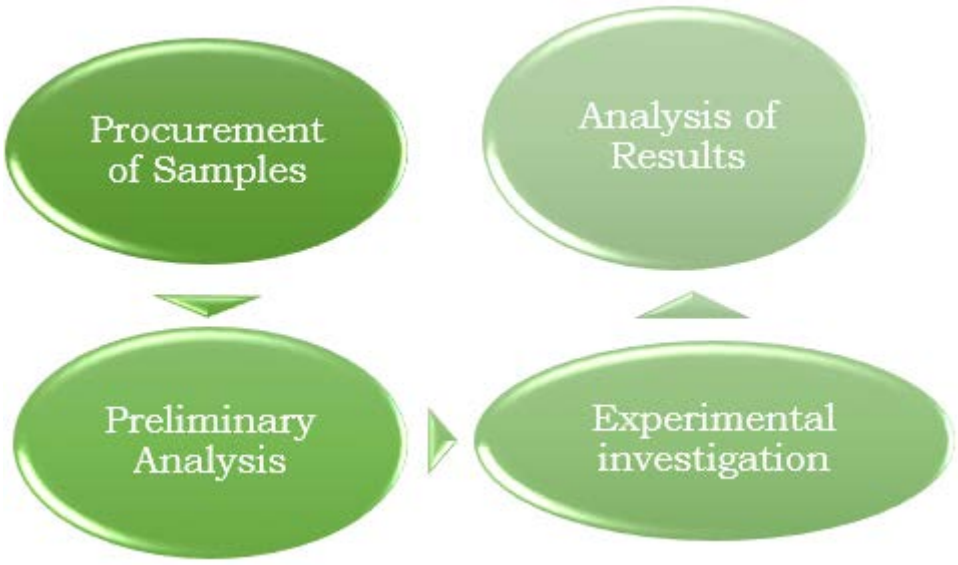


**Figure 1:** Flow chart of the study.

The procedure followed for conducting the tests is as per outline of Marshall Method (ASTM: D-1559). Marshall Tests for stability and flow are conducted on three specimens for each sample of bituminous mix without zycotherm and plastic, and with combination of Zycotherm and plastic. Bitumen content of 4.5% is constant for all the specimen. Marshal Properties have been determined for each mix with varying percentage (2-5) of HDPE &2-4% (LDPE). In the present investigation an attempt is made to study the enhancement in the properties of Hot mix Asphalt (HMA) on adding polythene (LDPE & HDPE) and combination of Zycotherm and Plastic waste.

## 6. Experimental Results

**Table 1:** 2% LDPE results.

| **Marshall Stability test with 2% LDPE** | | |
|---|---|---|
| **Type of Mix** | **Marshall Stability value (kg)** | **Flow Value(mm)** |
| **HMA mix with 2 % HDPE** | **1560** | **3.5** |
| **HMA mix with 3 % HDPE** | **1640** | **3.8** |
| **HMA mix with 4 % HDPE.** | **1700** | **4.1** |
| **HMA mix with 5 % HDPE** | **1686** | **4** |

**Table 2:** 4% LDPE results.

| Marshall Stability Test With 4% LDPE | | |
|---|---|---|
| Type of Mix | Marshall Stability value (kg) | Flow Value(mm) |
| HMA mix with 2 % HDPE | 1590 | 3.7 |
| HMA mix with 3 % HDPE | 1685 | 3.9 |
| HMA mix with 4 % HDPE. | 1752 | 4 |
| HMA mix with 5 % HDPE | 1690 | 4.2 |

**Table 3:** Penetration test for 2% LDPE.

| **PENETRATION TEST 2% LDPE** | | |
|---|---|---|
| **SAMPLE** | **HDPE %** | **VALUE (mm)** |
| **SAMPLE 1** | **2%** | **55.33** |
| **SAMPLE 2** | **3%** | **57.33** |
| **SAMPLE 3** | **4%** | **68.33** |
| **SAMPLE 4** | **5%** | **64.67** |

**Table 4:** Penetration test for 4% LDPE.

| **PENETRATION TEST 4% LDPE** | | |
|---|---|---|
| **SAMPLE** | **HDPE %** | **VALUE (mm)** |
| **SAMPLE 1** | **2%** | **61.33** |
| **SAMPLE 2** | **3%** | **62.67** |
| **SAMPLE 3** | **4%** | **69.33** |
| **SAMPLE 4** | **5%** | **63** |

**Table 5:** Softening point test.

| LDPE % | HDPE % | Marshall stability | Penetration(67.69) | Softening point(47.5$^{O}$ C) |
|---|---|---|---|---|
| 2% LDPE | 2% HDPE | 1560 kg | 55.33 mm | 54.1 $^{O}$C |
| 2% LDPE | 3% HDPE | 1640 kg | 57.33 mm | 54.7 $^{O}$C |
| 2% LDPE | 4% HDPE | 1700 kg | 68.33 mm | 55.1$^{O}$C |
| 2% LDPE | 5% HDPE | 1686 kg | 64.67 mm | 55.8 $^{O}$C |
| 4% LDPE | 2% HDPE | 1590 kg | 61.33 mm | 54.8 $^{O}$C |
| 4% LDPE | 3% HDPE | 1685 kg | 62.67 mm | 55.3 $^{O}$C |
| 4% LDPE | 4% HDPE | 1752 kg | 69.33 mm | 56.3 $^{O}$C |
| 4% LDPE | 5% HDPE | 1690 kg | 63 mm | 56.2 $^{O}$C |

From this study the following results are obtained which is shown in Tables and graphs Marshall Properties, Penetration value and Softening point of various Bituminous Mixes. In all cases percentage of Zycotherm is fixed as 1.5% and LDPE polythene as 2% and 4% by weight whereas percentage of HDPE polythene percentage varies from 2 to 5 % by weight.

**7. Cost Analysis.**

| Bitumen 100% | Nos | L(m) | B(m) | D(m) | QUANTITY | UNIT | RATE (Rs.) | AMOUNT (Rs.) |
|---|---|---|---|---|---|---|---|---|
| **Providing and laying semi dense bituminous concrete with Appropriate batch type HMP using crushed aggregates of specified grading, premixed with bituminous binder @ 4.5 to 5 per cent of mix and filler, transporting the hot mix to work site, laying with a hydrostatic paver finisher to the required grade, level and alignment, rolling with smooth wheeled, vibratory and tandem rollers to achieve the desired compaction as per MORTH specification clause No. 508 complete in all respects** | **1** | **1000** | **5.5** | **0.02** | **110** | **Cum** | | |
| **Grading II layer Thickness (25-30 mm) Bitumen (VG-30)** | | | | | **17.38725** | **Cum** | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Quantity of extra widening at Curves (As per Annexure-A1)** | | | | | **0** | | | |
| **Extra Widening of CD portion (As per Annexure-A2)** | | | | | **2.671875** | **Cum** | | |
| **Extra Quantity of Juntion portion (As per Annexure-A3)** | | | | | **130.059125** | **Cum** | **9188** | **1194983.241** |
| **As per 4% Ldpe& 4% Hdpe** | | | | | **119.654395** | **Cum** | **9188** | **1099384.581** |
| **Saving** | | | | | **10.40473** | **Cum** | **9188** | **95598.65924** |
| **SOR MP PWD September 2017** | | | | | | | | |

## 8. Conclusion

In this study we stated that with the use of LDPE, HDPE polythene and fixed proportion of zycotherm we can increase the property of the sample as well as the binding property of the sample also increases. This study is valuable for highway construction as it can help in settling the non- biodegradable waste as well as increases bitumen (flexible) pavement life.

**From the above tests conducted the following conclusions were drawn out:-**

- Marshall Test conducted on bituminous mix with combination of 4% LDPE and 4% HDPE and 1.5% Zycotherm have higher value of stability 1752 kg correspondingly the values of flow is 4.
- It is observed that by addition of polyethylene HDPE to the mixture, the resistance to moisture susceptibility of mix also increases.
- From the study it is concluded that zycotherm increases the binding property of the mix in a natural way.
- As per the cost cutting in construction this method is very valuable and as it is very helpful in cost cutting of bitumen in a mix By the use of zycotherm.

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