

INTI INTERNATIONAL UNIVERSITY

Faculty of Engineering and Quantity Surveying

**Investigation on Optimum Bitumen Content of Asphaltic Concrete Mix
(ACW 14) with Replacement of Fine Aggregates with LDPE**

Shahbaz Ahmed Memon

B.Eng (Hons) in Civil Engineering

Mr. Sudesh Nair

Final Year Project

2017

SUPERVISOR'S DECLARATION

This project report entitled Investigation on Optimum Bitumen Content of Asphaltic Concrete Mix (ACW 14) with Replacement of Fine Aggregates with LDPE is prepared and submitted by Shahbaz Ahmed Memon I12000520 as partial fulfillment of the requirement for Bachelor of Engineering (HONS) in Civil Engineering, INTI International University.

APPROVED BY:


.....
Sudesh Nair

Date 18/12/17.....

STUDENT'S DECLARATION

I hereby declare that the final year project is based on my original work except for quotations and citations, which have been duly acknowledge. I also declare that it has not been previously or concurrently submitted for any other degree at INTI-INTERNATIONAL UNIVERSITY or other institutions.

Signature

:



Student Name

: Shahbaz Ahmed Memon

Student ID

: I1200020

Date

: 11/December/ 2017

ACKNOWLEDGMENT

I would like to express my sincere gratitude to Allah the Almighty who gave me strength to complete this study. Secondly my parents who have been through with me through thick and thin and gave me confidence so that I can complete my work. Special acknowledgment to my supervisor Mr Sudesh who's patience and guidance put me on the right path to complete my investigation. Special mention of Miss Nurhaniza (Final year project Coordinator) is important because she has been instrumental in shaping this report. Lastly, my friends Hassan Javed, Umair Ansar, Keshantaran Murugan, Ibrahim Abuabkar who have been constant force behind me and help for the entire study.

ABSTRACT

50 % Partial replacement aggregate of size $75\mu\text{m}$ and $<75\mu\text{m}$ been done with low density polyethylene. 4%, 5%, 6% and 7% bitumen content by weight of aggregates has been added to design mix for Asphaltic Concrete Wearing Course 14mm design. the result show that at optimum bitumen content of 5.78% by weight of aggregates the stability is 14200N which above 13000N minimum required. Flow is 4.8mm which is within the range of 2mm-5mm required. Voids filled with bitumen (VFB) are 67%, also within the range of 65%-75% and Voids in total mix are 6.8% which are at the border of the range 3.0%-7.0% which is acceptable. Overall the performance of the design mix is satisfactory and complainant.

TABLE OF CONTENTS

SUPERVISOR'S DECLARATION	iv
STUDENT'S DECLARATION	v
ACKNOWLEDGMENT	vi
ABSTRACT	vii
LIST OF FIGURES	viii
LIST OF TABLES	x
LIST OF ABBREVIATION	xi
CHAPTER 1	1
1.1 General	1
1.2 Statement of problem	2
1.3 Research Objective	3
1.4 Scope Of Study	3
1.5 Significance of Study	4
CHAPTER 2	5
2.1 Introduction	5
2.2 Modes of transport	6
2.2.1 Roadways	6
2.3 Asphaltic concrete	7
2.3.1 Coarse Aggregates	7
2.3.2 Fine Aggregates	7
2.3.3 Mineral Fillers	8
2.3.4 Bitumen	9
2.4 Desired Properties of Asphaltic Concrete	10
2.4.1 High Stability	10
2.4.2 High Durability	10
2.4.3 Higher Fatigue Resistance	11
2.4.4 High Skid Resistance	11
2.4.5 Water proof	12

2.5 Hot Mix Asphalt	12
2.6 Dense Graded Asphalt	13
2.7 Pavement	14
2.7.1 Flexible Pavement	14
2.8 Effects of waste plastic on environment	16
2.9 Improvement of HMA by addition of materials as fillers	17
2.9.1 Addition of copper slag	17
2.9.2 Addition of Rice Husk Ash as mineral filler	18
2.9.3 Use of recycled aggregates in HMA	18
2.9.4 Addition of Ordinary Portland Cement, lime Stone Powder, Waste glass powder	19
2.10 Effect of addition recycled plastic in HMA	22
CHAPTER 3	31
3.1 Introduction	31
3.2 Penetration Test	33
3.2.1 Apparatus Required (INTI Lab Manual).	33
3.2.2 Procedure (INTI Lab Manual)	34
3.3 Sieve Analysis	34
3.3.1 Apparatus	35
3.3.2 Procedure	35
3.4 Dry Method	36
3.5 Marshall Mix Design	37
3.5.1 Apparatus	38
3.5.2 Procedure	39
3.6 Bulk Specific gravity	39
3.7 Voids Filled with Bitumen	40
3.8 Voids Total Mix	40
3.9 Marshall Stability and Flow Test	41
3.9.1 Procedure	41
3.10 Expected Outcome	41
CHAPTER 4	42
4.0 Introduction	42
4.1 Penetration Test	44
4.2 Sieve Analysis	45
4.3 Preparation of Specimen	48
4.4 Marshall Mix Design Results	49
4.5 Bulk Specific Gravity	50

4.5.1 Sample Calculation	50
4.6 Void Filled with Bitumen (VFB)	52
4.7 Void Total Mix (VIM)	54
4.8 Marshall Stability and Flow	55
4.9 Optimum Bitumen Content	57
CHAPTER 5	58
5.1 Introduction	58
5.2 Recommendation	60
REFERENCES	61
Appendix A	65
APPENDIX B	69

LIST OF FIGURES

	DESCRIPTION	PAGE
Figure 2.1	Highway	6
Figure 2.2	Expressway	6
Figure 2.3	Rural Road	6
Figure 2.4	Dense Graded Asphalt	13
Figure 2.5	Aggregates grading for Asphaltic Concrete Mixture (AASHTO)	13
Figure 2.6	Flexible pavement Structure (Mishra,2017)	15
Figure 2.7	load distribution in a flexible pavement (Mishra, 2017)	15
Figure 2.8	Marshall Stability Vs Bitumen % (Kazmi and Rao, 2015)	24
Figure 2.9	Marshall Flow Vs Bitumen % (Kazmi and Rao, 2015)	24
Figure 2.10	Plastic Content % VS Stability (Menaria and Sankhla, 2015)	25
Figure 2.11	Plastic content Vs Flow (Menaria and Sankhla, 2015)	26
Figure 2.12	Plastic content Vs VFB (Menaria and Sankhla, 2015)	26
Figure 2.13	Plastic content Vs VFB (Menaria and Sankhla, 2015)	27
Figure 2.14	Air Void IVs Bitumen % (Wayal and Wagle, 2013)	28
Figure 2.15	Density VS Bitumen % (Wayal and Wagle, 2013)	28
Figure 2.16	VFB Vs Bitumen % (Wayal and Wagle, 2013)	29
Figure 2.17	Flow Vs Bitumen % (Wayal and Wagle, 2013)	29
Figure 2.18	VMA Vs Bitumen % (Wayal and Wagle, 2013)	30
Figure 2.19	Stability Vs Bitumen % (AL- Saffar, 2013)	20
Figure 2.20	Flow Vs Bitumen % (AL- Saffar, 2013)	20
Figure 2.21	VTM vs Vs Bitumen % (AL- Saffar, 2013)	21
Figure 2.21	VTM vs Vs Bitumen % (AL- Saffar, 2013)	21
Figure 3.1	Penetrometer (Rajcoscientific.com, 2017)	33

Figure 4.1	Sieving of aggregates	45
Figure 4.2	Mechanical shaker at work	45
Figure 4.3	sieve of size 75 μ m	45
Figure 4.4	Weighing of the aggregates	45
Figure 4.5	Aggregate gradation	47
Figure 4.6	Marshall Flow and Stability test	49
Figure 4.7	Specimen After Failure	49
Figure 4.8	Bitumen % versus Bulk Specific Gravity	51
Figure 4.9	Bitumen % vs VFB %	53
Figure 4.10	Bitumen % VS VTM %	54
Figure 4.11	Stability Vs Bitumen %	55
Figure 4.12	Flow VS Bitumen %	56

LIST OF TABLES

	DESCRIPTION	PAGE
Table 2.2	Summary of Marshall Test AL- Saffar, 2013	23
Table 2.1	Comparisons of Marshall Results and Transportation ministry Oman (Kazmi and Rao, 2015)	19
Table 3.1:	Design parameter for modified Asphaltic Concrete (JKR/SPJ/rev2008)	37
Table 4.1	Design parameters for ACW14 (JKR/SPJ/rev2008)	42
Table 4.2	Penetration test results	44
Table 4.3	Results of sieve analysis	46
Table 4.4	Quantity of Bitumen Required	48
Table 4.5	Summary of Marshall test	49
Table 4.6	Optimum Bitumen content	57

LIST OF ABBREVIATION

BI	Bitumen
FA	Fine Aggregates
CA	Coarse Aggregates
VTM	Voids Total Mix
VFB	Void Filled Bitumen
OBC	optimum bitumen content
Gmb	Bulk Specific Gravity
%	Percentage
LDPE	Low Density Poly Ethylene
CA	Coarse Aggregates
FA	Fine Aggregates

CHAPTER 1

INTRODUCTION

1.1 General

Transportation is necessary for human beings to survive on this planet. There are many ways of transport that human race has created. Among all the various ways modes of transportations, the most important and essential way through paved roads. Paved roads or in engineering terms pavements can be of many kinds. Use of asphaltic concrete is the most used material to constructing pavements or paved roads (Keane, 1996).

Asphaltic concrete is mixture of coarse aggregates, fine aggregates and bitumen. There are many methods in which these materials can be mixed together to achieve desired specifications. specifications contain durability, braking efficiency, load bearing capacity and permeability (Keane, 1996). Road construction is important for infrastructure development. People welfare and economic activity is directly affected by the roads they travel on. Initial construction cost in for road development are usually low and economical to bear. However, rapid increasing traffic volumes and traffic loads can cause rapid decrease in the road surface and quality. There can be various number of reasons for deformation such as environmental factors and poor workmanship. Due to all these above-mentioned conditions, maintenance cost in the long run can be a huge burden on the concerned parties (Keane, 1996).

Therefore, engineers are trying to modify characteristics of asphaltic concrete with extensive research. Previously different types admixtures and methodologies have tried and tested. One such way is to add materials that are adhesive in nature to bitumen and modify the characteristic of bitumen mixture. Testing of waste material and other materials have been undertaken to reduce the cost of road constructions (Keane, 1996). Also, at the same researcher have been heavily invested in modifications and improvement in asphaltic concrete mixture. One of way of modifications and cost reductions can be the use recycled plastic powder as filler. Plastic are adhesive in nature and can have positive effects of asphaltic concrete.

1.2 Statement of problem

Road development is expensive but important. Developing countries are still suffering from lack of infrastructure due to lack of funds for infrastructure development. Employing techniques and materials which reduce the cost of the construction, without compromising on the standard specification and constructions codes is a real-world problem to solve.

Secondly, increasing the efficiency of asphaltic mixture to resist permanent deformations such as rutting, shoving, bleeding, raveling and fatigue is also an aim to be achieved. This is important for road safety and longevity of the pavement which can be huge factor and cost reduction.

Effective use of waste produced is necessary for survival and betterment of environment. Plastics have adhesive quality and they are available in huge quantities for cheap price. Use of recycled High Density Poly Ethylene (HDPE) and Low Density Poly Ethylene can be an effective way to reduce negative effects on environment and waste disposal.

1.3 Research Objective

- 50 % replacement of size 75 μ m and <75 μ m aggregates of recycled Low-density polyethylene (LDPE) in ACW 14
- Dry method will be employed for preparing the samples.
- Investigations and rigorous testing needs to be carried out to find optimum bitumen content.

1.4 Scope Of Study

The scope study to achieve the research objective will be limited to:

- a) Hot mix asphaltic concrete of ACW 14 (14mm asphaltic concrete in wearing course).
- b) Use of dry method to prepare the samples.
- c) LDPE (low density poly-ethylene) is used for replacement of aggregates.
- d) 3 Specimen of 4 %, 5%, 6%, 7% bitumen content are tested.
- e) 2 tests (STABILITY and SPECIFIC GRAVITY) will be carried out. The values of Marshall Stability and Marshall Flow is measured by using Marshall Compression Machine. The different graphs will be plotted showing the relation of Bitumen with different properties of Asphalt like
 - Bitumen content versus Marshall Stability
 - Bitumen Content versus Marshall Flow
 - Bitumen content versus % Air Voids
 - Bitumen content versus Voids Filled
 - Bitumen Content versus Density

The optimum bitumen content is found by using these graphs after doing the tests.