

## **DEDICATION**

**TO MY FAMILY & TEACHERS**

## Notation

HMA	Hot mix asphalt
VCA	Void in coarse aggregate
PCS	Primary control sieve
DRC	Dry rodded condition
NMPS	Nominal maximum particle size
VMA	Voids in mineral aggregate
CA	Coarse aggregate
FA	Fine aggregate
FAf Ratio	Fine aggregate fine Ratio
Gmb	Bulk specific gravity of aggregate
Gmm	Maximum specific gravity of paving mixture
Gse	Effective specific gravity of aggregate
Pbe	Effective asphalt content, percent by total weight of mix
Pba	Asphalt content, percent by total weight of aggregate
Ps	Aggregate content percent by total weight of aggregate,
Pb	Asphalt, content by weight of aggregate
Gb	Specific gravity of asphalt
Vol	Volume of specimen
Va	Air voids in compacted mixture
B.SG	Bulk specific gravity
M.St	Measured stability
C.St	Corrected stability
OWS	Omdurman West source
JTS	Jubal Toria source
AS	Alselate source

## مستخلص

بالرغم من انه هناك حاجة موجهات لاستخدام الخلطات الاسفلتية الخشنة والناعمه، فإن المصممون مايزون يعانون عند تصميم الخلطات الأسفلتية وعليهم الالتزام باجراء العديد من الخلطات التجريبية لاختيار الخليط الركامى الأصح.

لذا لأن هناك حاجة ماسة لاستخدام طريقة تسرع بعملية التصميم وتساعد في فهم الخلطة الاسفلتية التي يتم انتاجها.

طورت هذه الطريقة من قبل روبرت بيلي من قسم النقل في اوائل الثمانينات وهي وسيلة عملية يمكن استخدامها بطريقة ناجحة لتطوير وتحليل الخلطة الاسفلتية الساخنة في المختبر والحقول.

وهي تعتبر نقطة بداية جيدة لتصميم الخلطة الاسفلتية وهي وسيلة تساعد في ضبطها بالخلط لتحسين الفراغات الهوائية air voids والفراغات المملوءة بالركام (VMA) وقابليتها للتشغيل، سواء تم استخدام طريقة مارشال أو طريقة سوبربيف.

يصف هذا البحث طريقة بيلي بالتفصيل مستعيناً بامثلة حقيقية وعملية لعينات تم اخذها من منطقة جبل طورى ومنطقة السليت ومنطقة غرب امدرمان لمساعدة المصممين والمقاولين لفهم الخلائق الاسفلتية الساخنة بصورة احسن.

## ABSTRACT

While there has been some guidance on the use of coarse and fine mixes, at this time, designers are still struggling with mix designs and have to conduct numerous trials to select proper aggregate blend. A better way to speed up the process and understand the mixes that are being produced is needed.

The Bailey method was originally developed by Robert D. Bailey of the Illinois department of transportation in the early 1980s. It is practical tool that has been successfully utilized for developing and analyzing hot asphalt in the lab field.

The Bailey provide a good starting point for mix design and valuable aid when making adjustments at the plant to improve air voids, VMA and the overall workability of the mix whether you are using Marshal or superpave.

This describes the methodology in detail with some real life examples for samples carried out from JabalToria, Alselate area and Omdurman west to help mix designers and contractors better understand the hot asphalt mixtures.

## List of Tables

Table No	Represent	Page No
2-1	Recommended Ranges of Aggregate Ratios	20
2-2	Control Sieves for Various Asphalt Mixes	23
3-1	Stability correlation Ratio	50
3-2	Aggregate sieve analysis and density from Omdurman west source	52
3-4	Suitability test for Bitumen	52
3-5	Aggregate blend using Bailey Method – Omdurman west source	55
3-6	Weight of aggregates used for prepared specimens	55
3-7	Test Data For Design By Bailey Method(Omdurman)	63
3-8	Asphalt mix properties (Bailey Method)	65
3-9	Percentages of aggregates used for Tradition Methods- OWS	65
3-10	aggregate blend using Tradition Method- Omdurman west source	66
3-11	weight of aggregates used for prepared specimens-OS	66
3-12	Test Data For Design By Tradition Method(Omdurman)	67
3-13	Asphalt mix properties (Tradition Method)	69
3-14	Aggregate sieve analysis and density from Jubal Toria source	70
3-15	Suitability test for aggregate from- Jubal Toria source	70
3-16	aggregate blend using Bailey Method –Toria source	74
3-17	weight of aggregates used for prepared specimens-TS	74
3-18	Test Data For Design By Bailey Method(Jubal Toria)	75

## Continuation of table contents

Table No	Represent	Page No
3-19	Asphalt mix properties (Bailey Method)	77
3-20	Percentages of aggregates used from Tradition Method	77
3-21	Aggregate blend using Tradition Method -JTS	78
3-22	weight of aggregates used for prepared specimens-JTS	78
3-23	Test Data For Design By Tradition Method(JubalToria)	79
3-24	Asphalt mix properties (Tradition Method)	81
3-25	aggregate sieve analysis and density from Alselate source	82
3-26	Suitability test for aggregate from Alselate source	82
3-27	Aggregate blend using Bailey Method – Alselate source	86
3-28	weight of aggregates used for prepared specimens-AS	86
3-29	Test Data For Design By Bailey Method	87
3-30	asphalt mix properties (Tradition Method)	89
3-31	Percentages of aggregates used for Tradition Method Alselate source	89
3-32	Aggregate blend using Tradition Method – Alselate	90
3-33	Weight of aggregates used for prepared specimens-AS	90
3-34	Test Data For Design By Tradition Method (Alselate)	91
3-35	Asphalt mix properties (Tradition Method)	93
3-36	Aggregate blend using Two Methods for all samples	94

## List of Figures

Figure No	Represent	Page No
2-1	Example of break between coarse and fine aggregate for 19.0 NMPS mixture	10
2-2	Loose unit weight of coarse aggregate.	11
2-3	Rodded unit weight of coarse aggregate.	13
2-4	Selection of chosen unit weight of coarse aggregates	14
2-5	Rodded unit weight of fine aggregate	17
2-6	Overview of the divisions in a continuous gradation that allows an analysis of gradation.	20
2-7	An example of a design using two coarse aggregates, one fine aggregate, and MF	27
3-1	Mixing / Compaction Temp	56
3-2	Added the required asphalt weight to the aggregate in the mixing bowel	57
3-3	Mixing aggregate and the asphalt cement thoroughly until Consistency	57
3-4	Pouring asphalt mix in the mold	58
3-5	The compaction pedestal	59
3-6	Saturated surface dry S.G	60
3-7	Measuring stability and flow	61
3-8	Optimum asphalt content study (Omdurman west Bailey method)	64
3-9	Optimum asphalt content study (Omdurman west Tradition method)	68
3-10	Optimum asphalt content study J. Toria Bailey Method	76

## Continuation List of Figures

Figure No	Represent	Page No
3-11	Optimum asphalt content study (JUBL Toria Tradition method)	80
3-12	Optimum asphalt content study (Alselate Bailey method)	88
3-13	Optimum asphalt content study(Alselate Tradition method)	92

## Table of contents

Dedication.....	I
Notation.....	II
مستخلص.....	III
Abstract.....	IV
List of tables.....	V
List of figures.....	VII
Table of contents.....	VIII

### **Chapter 1 – Introduction**

1-1 General introduction.....	1
1-2 Problem statement.....	2
1-3 Objective and methodology.....	3

### **Chapter 2 -Literature review**

2-1 Definition of the Bailey Method? .....	6
2-2 Basic Principles .....	6
2-3 Analysis of the Design Blend.....	18
2-4 Example Bailey Method Design Calculation.....	27

### **Chapter 3 -Application of Bailey Method for Designing HMA using Marshall Method.**

<b>3-1 Introduction to Marshal.....</b>	<b>36</b>
<b>3-2 Marshal Test Procedure.....</b>	<b>44</b>

## **Continuation of table contents**

3-3 Designing HMA for Aggregate Samples from Omdurman West.....	51
3-3-1 Application of Bailey Method for Designing HMA .....	51
3-3-2 Application of Tradition Method for Designing HMA .....	65
3-4 Designing HMA for Aggregate Samples from Jubal Toria.....	69
3-4-1 Application of Bailey Method for Designing HMA .....	69
3-4-2 Application of Tradition Method for Designing HMA .....	77
3-5 Designing HMA for Aggregate Samples from Alselate.....	81
3-5-1 Application of Bailey Method for Designing HMA .....	81
3-5-2 Application of Tradition Method for Designing HMA .....	89
3-6 Result Analysis.....	93
<b>Chapter 4 – Conclusion and Recommendations</b>	
4-1 Conclusion.....	96
4-2 Recommendations.....	96
<b>References.....</b>	99