Al-Nahrain Journal for Engineering Sciences (NJES) Vol.20 No.1, 2017 pp.183 - 193

Effect of Filler Content on Properties of Asphaltic Mixtures for Marshall and Superpave Gyratory Compactor

Zaynab Ibrahim Qasim
Building and Construction Eng. Department
University of Technology
zaynab.2010@yahoo.com

Alaa Saadi Abbas
Highway and Transportation Engineering
Al Mustansiriya University
alaa202.eng2004@yahoo.com

Zahra Ibrahim Qasim
Civil Engineering Department
College of Engineering
University of Baghdad
eng.zehoor@yahoo.com

Abstract

In Iraq some pavements of the newly constructed highway appear precocious distresses with unfavorable implications especially on the safety and the frugality. Cracking and permanent deformation are main types of these failures. The filler is doubtful to be a master contributor to these failures where its content has a significance effect on the mixture stiffness, and thereby affect the HMA pavement performance. The main objective of this research is to appreciate the influence of different contents of filler on the volumetric properties of asphaltic mixtures thus performance of asphalt mixtures through Comparative Evaluation between conventional Marshall Method and Super pave system. The implementation of a detailed experimental work is carried out to achieve the study objectives through the preparation of asphalt concrete samples using aggregate from Al-Nebaie quarry, (40-50) asphalt cement from Dourah refinery and limestone dust filler with four different contents of (0%, 4%, 8%, and 12%) by weight of the total aggregate. The volumetric properties for each mix design method are evaluated using Marshall Test and the Super pave Gyratory Compacter. The influence of filler contents on the rendering of these mixtures was evaluated.

Keywords: Asphalt pavement, Limestone Dust, Marshall Mixes, Super pave Mixes

1. Introduction

In Iraq most of the recently constructed highways pavements have appear precocious distresses with coherent unfavorable repercussions on both the roadway safety and the frugality. Filler was dubitable to be major contributors to failure process; it has a great effect on the hot mixture of asphalt performance, especially in low temperatures. This amount of material passing the sieve no.200 (75-µm) has a great effect on hot mix asphalt properties [1]. Fines which are diameter less than 2 µm might become part of the asphalt binder, resulting hardening. In general, as the dust proportion increased, VMA will decrease in order to this amount of material passing sieve no.200 (75 µm) causes an increasing in the surface area of the blend of aggregate due to relationship between particle diameter and surface area. There forea lower VMA is produced as the average film thickness is thinner. Dust contents have some additional effects on HMA properties[2]:

• Extending the content of asphalt binder,
• Stiffening of asphalt binder,
• Aging properties affecting on the mixture,
•Affecting compaction characteristics and workability on the asphaltic mixtures, and,
• Changing the moisture resistance of the HMA,

Filler asphalt ratio is frequently the subject of our study. In order to determine the best range of filler asphalt ratio , the Marshall test was used to design asphalt mixtures with different filler asphalt ratio for studying the volumetric properties of mixes such as (Air voids, Mix density, Void filled with asphalt (VFA) , Voids in the mineral aggregate (VMA),....etc.)
The new Super pave System is used to determine the optimum asphalt content using the Super pave Gyratory Compactor (SGC) with mold of 150 mm in diameter, using four percent of asphalt according to the selected gradation. Also it was prepared models similar to Marshall mold diameter of 100 mm, for studying the volumetric properties of mixes for four ratios of filler in order to make a comparison between the two design methods and to determine the optimum filler to asphalt ratio.

2. Background

Many studies have shown that properties of mineral filler (especially the material passing sieve No.200) have an important impact on the HMA mixture properties [3].It has encouraged theintroduction of environmental regulation and adoption of subsequent of dust collection system to return of most of fines to the mixture of HMA.
Many agencies used maximum filler/ asphalt ratio of1.2 to 1.5, by weight of asphalt, to limit the amount of the material passing sieve no. 200. However, these fines vary in gradation, participle shape, voiid content, minerall composition, surface area, and physic- chemical properties of HMA mixtures also varies[4].Fines could works as a filller on extender of asphalt binder depending on these particle size, [5],[6],[7]. The

second case on over- rich asphaltic hot mixture, leading to rutting and/ or flushing can be resulted. In many situations, for preventing a loss of stability or bleeding pavement, the quantity of asphalt binder used in HMA should be reduced [8].The HMA mixtures become susceptible to moisture include damage because some fines [4].In the United States, water sensitivity has been reported of one source of slagbag house fines [8], in Germany, it have been cognized the moisture-sensitivity of other stones dusts [9]. Hot as phalt mixture's stripping as attached to the filler/ asphalt properties combinations has been informed in Japan (filler was obtained from operating HMA plants) [10]. To not compromising the performance parameters of HMA pavements (stripping, fatigue cracking, and, resistance to permanent deformation) It is very important to characterize the fines or filler.

3. Materials

The materials utilized in this research are locally available. It comprised asphalt cement, coarse and fine aggregate, and mineral filler. The properties of these materials were rated using conventional tests and these results are compared with requirements of the specifications SCRB (R9, 2003) [11].

3.1 Asphalt Cement

One type of asphalt cement grade was considered: an AC 40-50 is obtained from Dourah Refinery in Baghdad. Table 1 shows the asphalt properties as below.

3.2 Aggregate

Aggregate characteristics and quality are major factors in the performance of HMA because it is the largest part in asphaltic hot mixture ;the ymake up (80–85) percent of the asphaltic mixture by volume and almost 95 percent of the asphaltic mixture by weight. [13].The aggregate used in this researcharevastly used in local asphalticpaving,it is crushed quartz obtained from quarry of Al-Nibaie in Salahdin governorate.To produce the controlled and identical gradation,

Aggregate are sieved and recombined using Sieve Shaker Vibrator in the laboratory to prepare the selected gradation and to achieve the wearing course gradation as appropriate by specification of SCRB, 2003. The results along with the specification limits as recommended by the SCRB are summed up in Table 2. Tests results show that selected aggregate gradation met the SCRB specifications.

Table 1: Properties of Asphalt Cement

Property	ASTM designation [12]	Test results	SCRB specification
1-Penetration At 25°C, 100 gm,5 sec. (0.1mm)	D-5	42	40-50
2- Softening Point. (°C)	D-36	51	……
3-Ductility at 25 C, 5cm/min,(cm)	D-113	>100	>100
4-Flash Point, (°C)	D-92	289	Min.232
5-Specific Gravity	D-70	1.041	……
6- Residue from thin film oven test - Retained penetration,% of original - Ductility at 25 C, 5cm/min,(cm)	D-1754 D-5 D-113	59.5 80	55+ 25+

Table 2: Physical Properties of Aggregate

No.	Laboratory Test	ASTM designation	Test results	SCRB Specification
	Coarse aggregate			
1	Apparent specific gravity	C-127	2.671	…
2	Bulk specific gravity	C-127	2.632	…
3	Water absorption,%	C-127	0.484	…
4	Percent wear by (Los Angeles abrasion) ,%	C-131	20.3	35-45 Max.
5	Soundness loss by sodium sulfate solution,%	C-88	3.12	10-20 Max.
6	Fractured pieces, %	D 4791	96%	95 Min
	Fine aggregate			
1	Apparent specific gravity	C-128	2.69	…
2	Bulk specific gravity	C-128	2.627	…
3	Water absorption,%	C-128	0.727	…
4	Sand equivalent,%	D-2419	55	45Min.

3.3Mineral Filler

Filler as known is the material passing sieve No.200 (0.075mm) from the aggregate sieving. The limestone dust is used as mineral filller , it was imparted from lime factory in Karbala.The physical properties are presented in Table 3below

Table 3: Physical Properties of Mineral Filler

Property	Test Result
Specific Gravity	2.71
% passing sieve No.200 (0.075)	100

These tests are the standard Marshall Test and Super pave Gyratory Compactor. The main steps to prepare the models according to the selected gradation and design optimum asphalt content. Once aggregate materials and binder have been elected, differentcombinations of these materials are estimated using the Superpave gyratory compactor SGC. Three trial blends are estimated to selection of design aggregate structure. Trial blending consists of varying the stockpile percentages of each aggregate to gain blend gradations meeting the gradations requirements for the special mixture. The blend is fine and close to the maximum criteria of the nominal maximum sieve, in addition to the restricted zone as shown in Figure1.

The selected gradation and trail blends with specification limits are presented in table 4 below

4. Testing Program:

Two major tests were conducted through the laboratory-testing program of this study.

Table 4: Percent Passing by Weight of Selected Aggregate Gradation

Sieve Size		Gradation % Passing	Iraqi Specification SCRP, R9, 2004 Wearing course		Superpave Specification			
Standard Sieves (mm)	English Sieves		Min.	Max.	Restricted Zone		Control Points	
19	3/4"	100	100	100	---	---	100	100
12.5	1/2"	95	90	100	---	---	90	100
9.5	3/8"	83	76	90	---	---	---	---
4.75	#4	59	44	74	---	---	---	---
2.36	#8	43	28	58	39.1	39.1	28	58
0.3	#50	16	5	21	15.5	15.5	---	---
0.075	#200	5	4	10	---	---	2	8

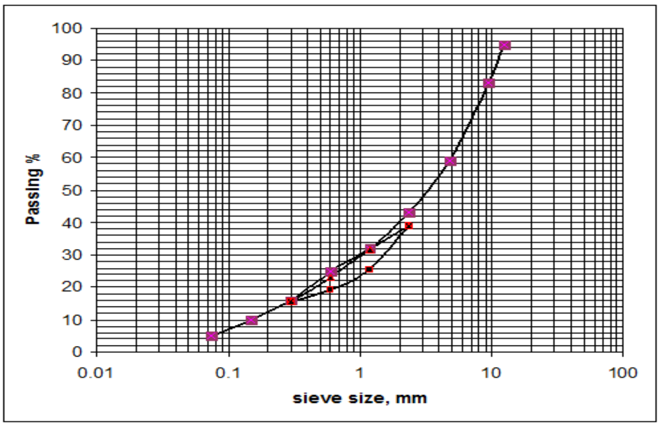

Figure1: Selected Gradation with Superpave Requirements

4.1 Marshall Test

The specimens are prepared by heating aggregate and asphalt cement for the temperature of mixing. The asphalt binder and aggregate are mixed

Simultaneously and the samples readapted for 2 hours at the calculated temperature of compaction to permit asphalt absorption into the aggregate voids. To determine the effective

asphalt content, conditioning in the electrical oven is indispensable. Part of the asphalt binder that mixed with aggregate is imbibed into voids of aggregate and thus does not work to bind the asphalt concrete mixture jointly. The effective asphalt binder in the mix is the difference between the absorbed binder and the total binder added to the mix. For application of a suitable number of blows on each face in accordance with the expected traffic level, the samples are compacted using Marshall Hammer. The samples are allowed cooling and removing from the mould. Finally, specimens are allowed to cool to room temperature and measure for thickness and bulk specific gravity. Then samples are tested for stability and flow according to AASHTO T-245 and ASTM D5581. Samples are placed in water bath at 60°C (140°F) for about 30 to 40 minutes. Then samples are removed from the water bath and tested in the Marshall apparatus. The estimated force at top of the curve is defined as stability and its matched deformation is flow. The stability criterion is based on the height of sample. A correlation ratio value is used to adjust the estimated stability for samples ranging about 2.5 ± 0.2 inch (5.1 mm). Figure 2 show the procedure Marshall testing.

4.2 Super pave Mix Design

The HMA is prepared after the aggregate blend is selected and the trial initial asphalt binder content is determined, with the ability for simulation the field conditions such as traffic load and short-term aging of mixture before compaction. The super pave gyratory compactor SGC uses a mold of diameter of15 cm to permit for greater aggregate and monitors the compaction during the process. Two specimens are prepared at the trail asphalt content, at 0.5 percent below the trail asphalt content, at 0.5 percent above the trail asphalt content and at 1.0

Percent above the estimated asphalt binder content, about 4700 grams of the mixture is used to prepare test specimens of 150 mm in diameter and 135 mm in height. a short term aging of two hours is used after mixing to simulate what happen in HMA during the mixing, storage and placement operations. The measured bulk specific gravity of the specimen and the recorded change in height during compaction, then change in density (%Gmm) with numbers of gyration is determined and sketched on a semi- log scale. Then a corrected based on the estimated value for specific gravity due to smooth sided cylinder which assumed initially. There were three critical points (N initial, N design, and N maximum) on super pave gyratory compactor curve that are evaluated in super pave [14], [15]. The level of N design is based on the traffic levels. For this research, N initial, N design, N maximum were 8, 100, and 160 gyrations, respectively to which a sample must be compacted with the Super pave Gyratory Compactor (SGC) in National Center for Construction and Researches Laboratories (NCCRL) as shown in Figure 3. These numbers of cycles correspond to traffic levels of (3 to 10 million ESALS. For Blend1 the optimum asphalt content (4.6%) is calculated at 4 percent air- voids level and the mix properties are checked to enclose that they meet the specifications.

Figure 2: Procedure of testing and sample preparation

Figure 3: Photo of Superpave Gyratory Compactor (SGC)

5. Results and Analysis

5.1 Marshall Mixes

The volumetric properties of the HMA are highly dependent on the dust/ asphalt cement ratio. Fine materials in HMA can acts as an asphalt extender resulting in lower air voids and possible flashing. According to Marshall Mix design, the optimum asphalt content is 4.7% for the selection gradation. The Marshall Mixes design was conducted according to ASTM D 1559. Each result represents an average of three reading. Figure 4 illustrated the relationship between dust content and air voids. It observed that the air voids decrease with the increase in dust content.

Figure 5 explains the relationship between percentage of voids in mineral aggregate (%VMA) and dust content, the figure shows that (%VMA) decrease with the increase in dust content.

Figure 6 presented the relationship between percentage of voids filled with asphalt (%VFA) and dust content, the figure shows that (%VFA) increase with the increase in dust content. Figure 7 presented the relationship between Marshall Stability and dust content, Stability increase with increase dust content up to 4% then decrease. Figure 8 shows the relationship between flow and dust content. Flow increase with increase dust content up to 4% then decrease as presented in Table 5.

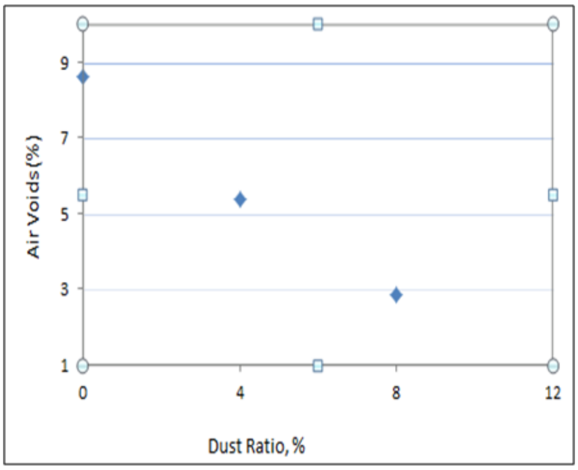

Figure 4: Relationship between Dust Content and Air Voids

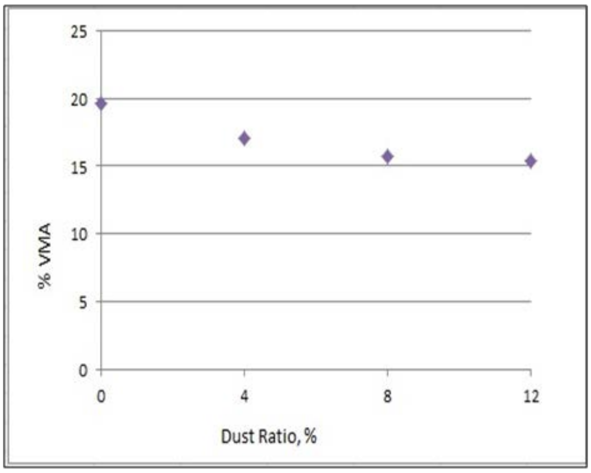

Figure 5: Relationship between Dust Content and VMA

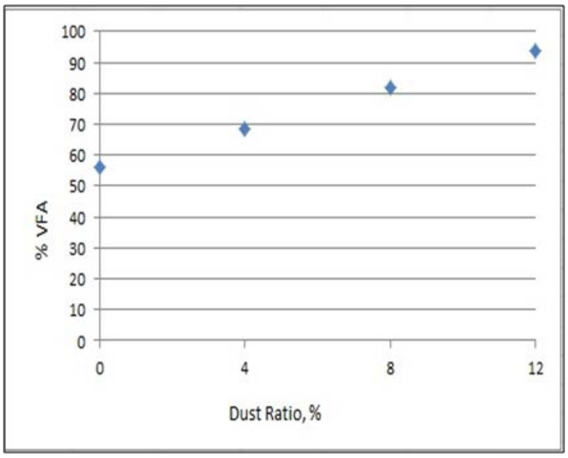

Figure 6: Relationship between Dust Content and VFA

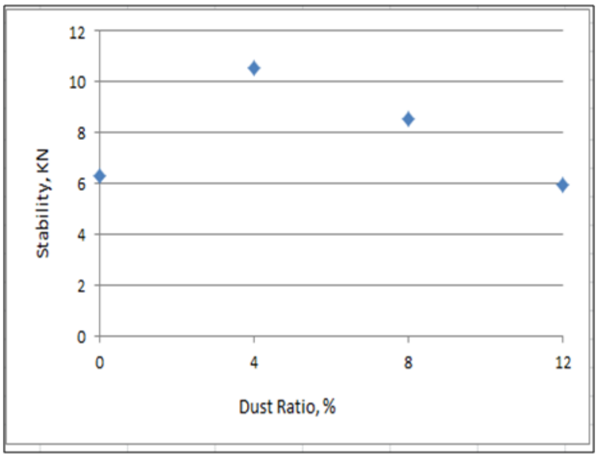

Figure 7: Relationship between Dust Content and Stability

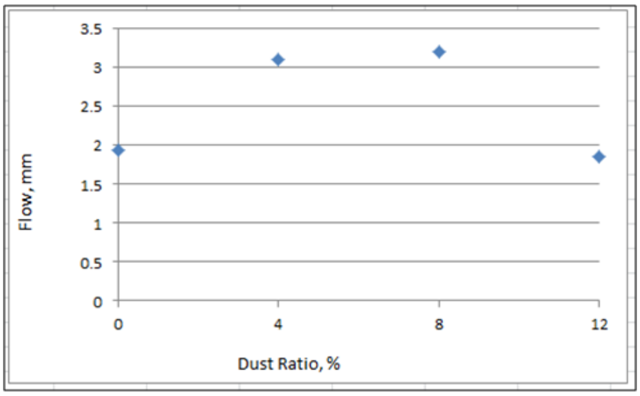

Figure 8: Relationship between Dust Content and Flow

Table 5: Volumetric Properties Results for Different Dust/ Asphalt Ratios

	Filler content percent %	0	4%	8%	12%
Ps	asphalt content by weight of total mix	4.7	4.7	4.7	4.7
Pa	Agg.content by weight of total mix ,(100-Ps)	95.3	95.3	95.3	95.3
G_{mm}	Max.specific gravity of mix,(ASTM D2041)	2.456	2.446	2.421	2.385
D	Bulk sp.gravity of Marshall specimen,(gm/cm3)	2.244	2.314	2.351	2.361
A.V%	air voids=$(G_{mm}$-D)/G_{mm}*100	8.621	5.376	2.850	0.991
VMA%	%voids in mineral aggragate,=100-(D-Pa)/G_{sb}	19.594	17.078	15.734	15.399
VFA%	%voids filled with asphalt,=(VMA%-AV%)/ VMA*100	56.001	68.520	81.886	93.560
stability	Average stability of 3 samples	6.295	10.54	8.55	5.92
flow	Average flow of 3 samples	1.933	3.1	3.2	1.86

5.2 Super pave Mixes

Tables (6) and (7) show the results concerning to finding the optimum asphalt content for four asphalt content%, which is equal to 4.6% as shown in Figures from (9) to (14).

Table 6: Summary of Mixture volumetric Properties for AC (40-50)

Asphalt Content%	% Air voids	%VMA	%VFA	% Dust proportion
4.3	4.99	16.245	69.27	1.18
4.8	3.13	15.714	80.04	1.02
5.3	2.33	15.265	84.68	0.88
5.8	2.01	15.737	87.2	0.79

Table7: Design Mixture Properties at 4.6% Binder Content		
Mix Property	AC (40-50)	Superpave Criteria
%Air voids	4	0.04
%VMA	15.8	13.0% min.
%VFA	74	65%-75%
Dust Proportion	1.03	0.6-1.2
%Gmm @ N initial	86.28	less than 89%
%Gmm @ N des.	96.07	96%
%Gmm @ N max.	97.62	less than 98%

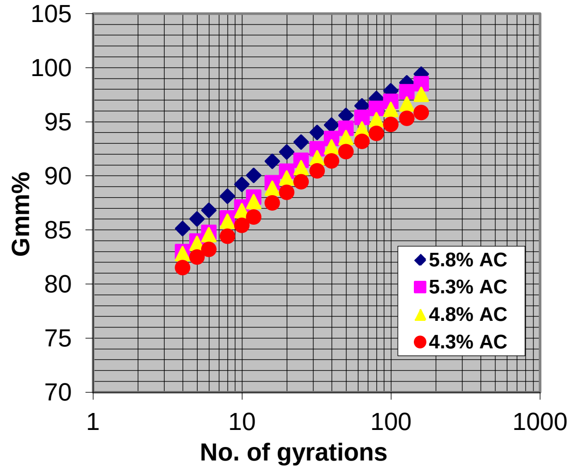

Figure 9: Average Densification Curves for Blend1, Varying Asphalt Binder Content

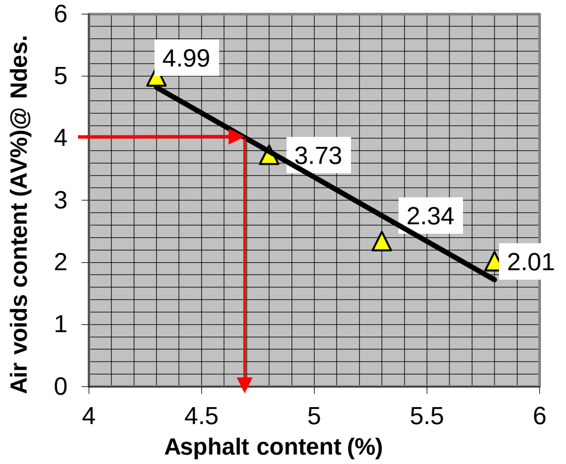

Figure 10: Relation between Asphalt content% and Air voids%

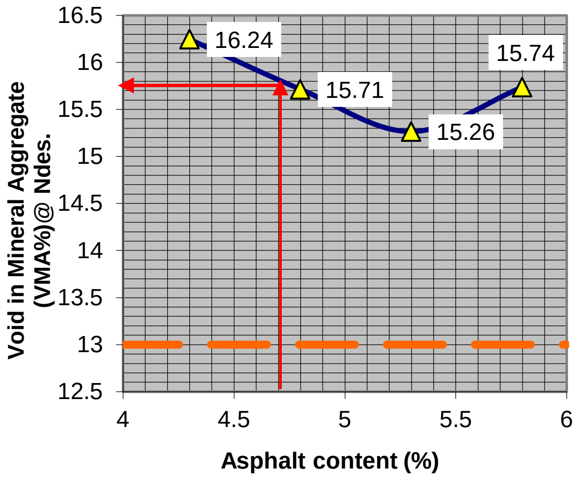

Figure 11: Relation between Asphalt content% and VMA%

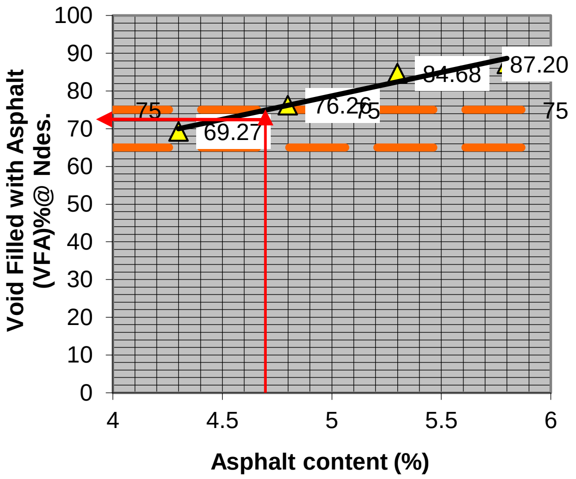

Figure 12: Relation between Asphalt content% and VFA%

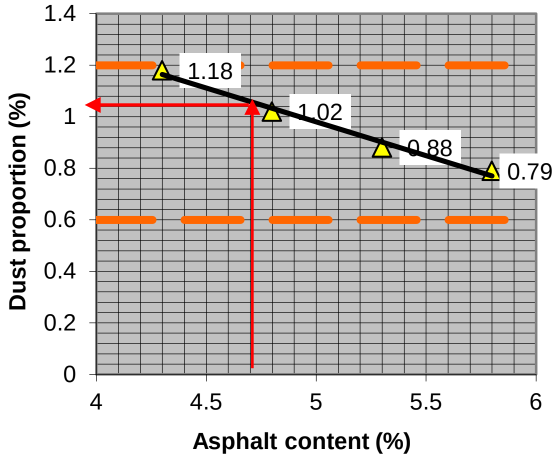

Figure 13: Relation between Asphalt content% and Dust proportion%

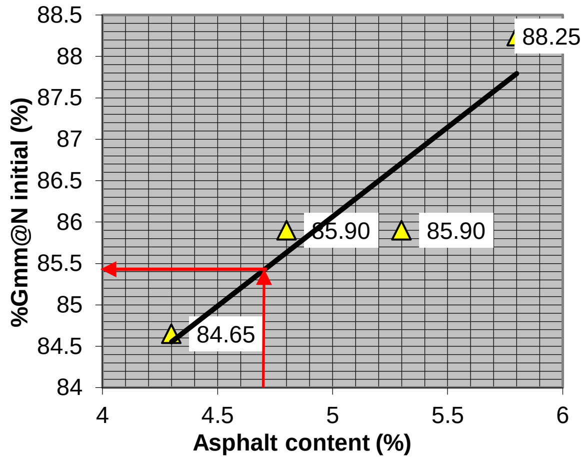

Figure 14: Relation between Asphalt content% and G_{mm}%

Table (8) shows the volumetric properties for super pave asphaltic mixtures results for different contents of dust filler. Figures 15 to 20 show for super pave mixtures as below:

Figure 15 shows the relationship between filler content and air voids. It observed that the air voids decrease by 89% with the increase in filler content by 12%. Figure 16 presented the relationship between voids percentage in mineral aggregate (%VMA) and filler content, the figure shows that (%VMA) decrease with the increase in dust content. Figure 17 shows the relationship between percentage of voids filled with asphalt (%VFA) and dust content, the figure shows that (%VFA) increase with the increase in dust content.

Figure 18 presented the relationship between Dust proportion and filler content , the figure present that the dust proportion increased by 21% when filler content increased from 4% to 8%, then decrease to 1.395% when filler content is 12%. Figure 19 shows the Bulk specific gravity increase with increase filler content. Figure 19 shows that Maximum specific gravity decrease with increase filler content. In all the performed test super pave mixtures proved their superiority over marshal mixtures.

Table 8: Estimated Mixture Volumetric Properties @ N_{design}

Trial Blend	Trial %AC	%Filler	% G_{mm} @ N_{des}	%Air Voids	%VM A	%VFA	Dust Proportion	Bulk specific gravity	Max.s pecificg ravity
Blend 1	4.70%	0%	84.68	15.32	25.48	84.30	0	2.11	2.456
Blend 2	4.70%	4%	95.85	4.15	16.00	75.00	0.736	2.34	2.446
Blend 3	4.70%	8%	96.87	3.13	15.97	74.96	0.894	2.36	2.421
Blend 4	4.70%	12%	98.35	1.65	15.96	74.94	1.395	2.38	2.385
Criteria	-	-	less than 89%	4.00%	13.0%	65% - 75%	0.6 - 1.2	-	-

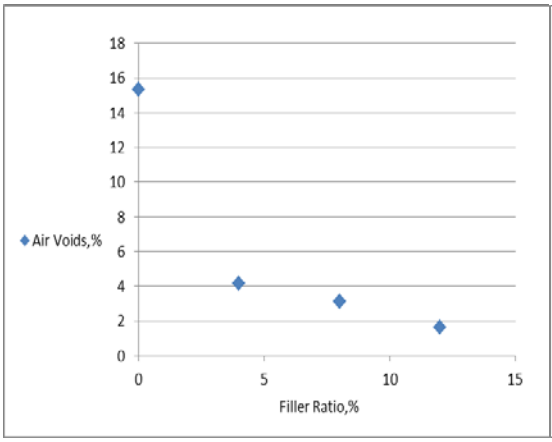

Figure 15: Relationship between Filler Content and Air Voids

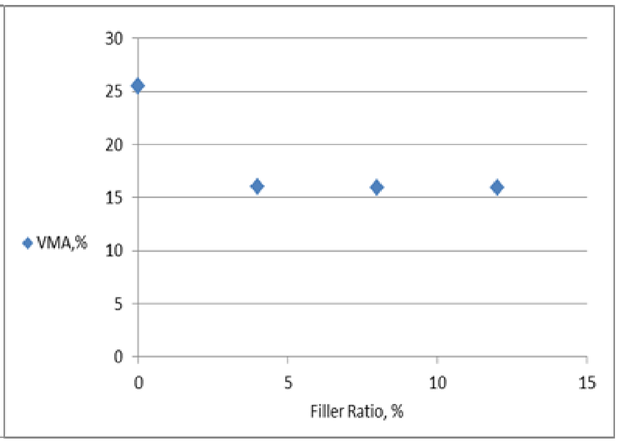

Figure 16: Relationship between Filler Content and VMA%

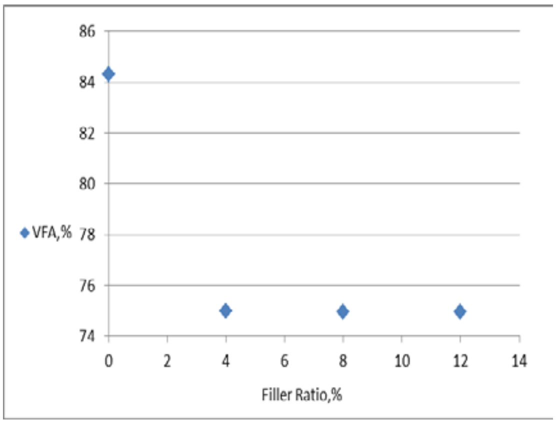

Figure 17: Relationship between Filler Content and VFA%

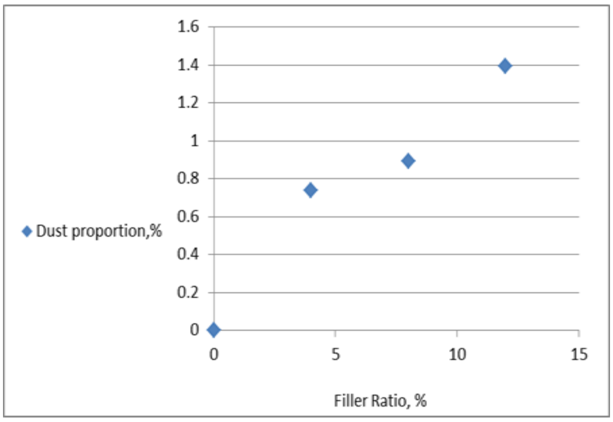

Figure 18: Relationship between Filler Content and Dust proportion

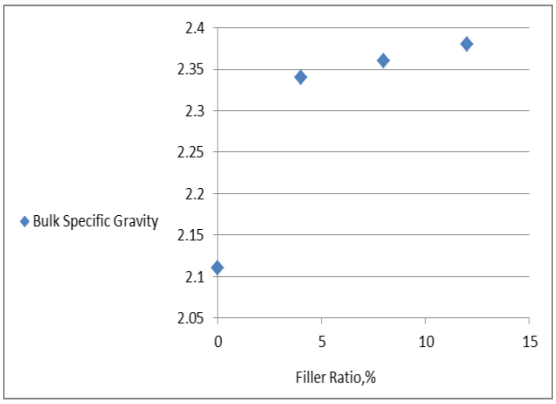

Figure 19: Relationship between Filler Content and Bulk specific gravity

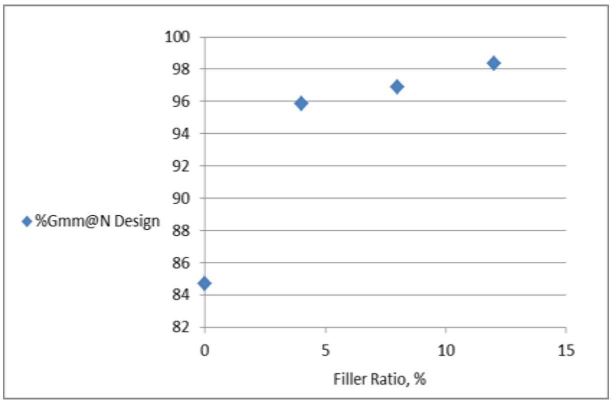

Figure 20: Relationship between Filler Content %Gmm at Ndes.

6. Conclusions

1. It is substantial to know that durability, and not fatigue or rutting, is the major failure occurred in mixtures for different dust content. As an outcome, it is expected that greater binder content is relative to mixtures designed for medium or high traffic level. For a selected gradation and aggregate type, the optimum asphalt binder content OAC is mainly related to the numbers of gyrations utilized for compaction the specimens for calculating the bulk specific gravity. In this study, 100

gyrations of compaction effort were used for Superpave mixtures and 75 blow for Marshall Test Mixtures. The Superpave mixtures had less optimum asphalt binder contents OAC than the Marshall mixtures. The available data indicates the superpave system is more economical than Marshall Method for mixes.
2. The laboratory evaluation using SGC clarified dust content, gradation, and voids in total mix.

Both Superpave mix design and the Marshall methods used VMA percent to encloseless asphalt binder content.

Yet, VMA percent considered as an indirect measure of effective asphalt binder content or dust/asphalt content .but Superpave achieves less air voids content of the Marshall Mixes; this prevents additional compaction a result of traffic loads. Additionally, Superpave mixes result in lower asphalt content of the Marshall Mixes. As a result it has better economic point of views than Marshall Mixes.

Acknowledgements

The researchers would like to express their deepest thanks and gratitude to the National Centre for Construction Laboratories and Researches (NCCLR) in Baghdad for their help throughout the preparation of this work.

7. References

[1] Anderson,D.A., R.Dongre., H.U. Bahia and Rheological Propertiess of Mineral Filer Asphalt Mastics and it's Importance to Pavement Performance.Amarican Society for Testing and Materials, STP, 1147, 1992.

[2] Chadbourn B.A., S. Spindler, E.L. Skok.Jr., B.L. Crow, and D.E. Newcomb. The Effect of Voidss in Mineral Aggregate (VMA%) on Hot-Mix Asphalt Pavements, Minnesote Department of Transportation, St. Paul, Minnesota, 1999.

[3] Kandhal, P.S., Frazier, JR.P,and. Lynn,C.Y.Characterizationn Tests for Mineral Filler Related to Performancce of Asphalt Paving Mixturas, NCAT Reports No.98-2, 1998.

[4] 4-Kandhal, P.S. Evaluation of Baghousa Fines in bituminouse Paving Mixtures. Journal of AAPT The Association of Asphalt Paving Techno;ogists, Vol. 50, 1981.

[5] Puzinausks, V.P. Filer in Asphalt Mixtures. Proceeding, Canadian Technical Asphalt Association, CTAA, Vol.13, 1968.

[6] Anderson, D.A., D.Brock, J.P. Tarrisand. Dust Colector Fines and Theire Influence on Mixture Design. AAPT Journal of Association of Aspalt Paving technologist, Vol. 151, 1982.

[7] Tunnicliff, D.G. Binding Effect on Mineral Fillers. AAPTProceedings, Association of asphalt Paving Technologists, vol.36, 1967.

[8] Schrimshar, t. Baghose Dust and its Effects on Asphaltic Mixture. California Department of Transportation,Research Report CA- -3140-1-76-50, October, 1976.

[9] Breuer,J.V.Testings ofthe Water Sensitivity of Stone dusts Fillers, Bitumen (Germany), Vol.29, No.3, May 1967.

[10] Yamashite, H., and K. Sakate. Stripping of Asphalt Concrete Mixture as Related to the Properties of Fillers/ Asphalt Combination. Proceedings, 12 the Japan Road Congress, JRG, September, 1975.

[11] ASTM, Annual Book of ASTM Standards, Volume 04.03,Roads and Paving Materials, American Society for Testings and Materials, Philadelphpe, USA. (2000),

[12] SCRB/R9, General Specifications for road and Bridges , Section R/9, Hot Mix Asphalt Concrete Pavements, Revised Edition, Ministry of Housing and construction, Republic of Iraq,(2003).

[13] WesTrack, M.W., H.V. Quintus, T. Pellinen, M. El- Basyouny, and K. Kaloush, (2001), "Simple performance Test for Superpave Mix Design", NCHRP report 465.

[14] Superpavve Mix Design Asphalt institute Serise No. 2 (SP-2), Asphalt institutee, Lexington, KY, 1996.

[15] Roperts, F.L., E. R.Brown, T.W.KennedyD.Y.Leee and P.S.Kandhal,.Hot Mix Asphalt Materials, Mixture Desiign, and Construction.National Asphalt Pavement Association (NAPA) Research and edducation foundation, Lanham, MD, 1996.

تأثير نسب المادة المالئـة على خواص الخلطة الاسفلتية المصممة بطريقة مارشال والدمك الدوراني عالي الاداء

د. زينب ابراهيم قاسم
الجامعة التكنولوجية- قسم هندسة البناء والانشاءات

الاء سعدي عباس
الجامعة المستنصرية- قسم هندسة الطرق والنقل

زهراء ابراهيم قاسم
قسم الهندسة المدنية
جامعه بغداد- كلية الهندسة

الخلاصة:
تحدث في بعض من ارصفة الطرق المبنية حديثاً في العراق حالات فشل لها تأثيرات سلبية على كل من امان الطرق واقتصادها. الانواع الرئيسية لحالات الفشل هي التشققات والتشوهات الدائمية (التخدد). المواد المالئة تعتبر من العوامل المساهمة لحالات الفشل هذه حيث تؤثر نسب المادة المالئة بصورة اساسية على صلابة الخلطات الاسفلتية وبالتالي فأنها تؤثر على اداء التبليط للخلطات الاسفلتية الحارة. الهدف من هذه الدراسة هو تقييم نسب محتوى المادة المالئة على الخصائص الحجمية للخلطات الاسفلتية وبالتالي اداء هذه الخلطات بالاضافة الى عمل مقارنة تقيمية للخلطات المصممة حسب طريقة مارشال التقليدية ونظام السوبربيف الحديث. يتم تنفيذ العمل التجريبي تفصيلي لتحقيق أهداف الدراسة من خلال إعداد عينات الخرسانة الإسفلتية باستخدام الركام من مقلع النباعي، القير صنف (40-50) من مصفى الدورة وغبار الحجر الجيري كمادة مالئة بأربعة نسب مختلفة(0٪ ، 4٪ و 8٪ و 12٪) من الوزن الكلي للركام. تم تقييم الخصائص الحجمية لكل أسلوب تصميم باستخدام اختبارمارشال وجهاز الدمك الدوراني حسب نظام السوبربيف وتمدراسة تأثيرمحتوىالحشوعلىأداء هذهالخلطات .

الكلمات الرئيسية:التبليط الاسفلتي،غبار الحجر الجيري،خلطات مارشال، الخلطات الاسفلتية حسب نظام Super pave