

USE OF CRUSHED LIMESTONE FROM BAHR AL-NAJAF AREA AS A COARSE AGGREGATE FOR BITUMINOUS MIXES

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استعمال الحجر الجيري المكسر من منطقة بحر النجف كركام خشن للخلطات الاسفلتية

Abdul Hadi M.Al_Sa'adi *

Abstract:

The main purpose of this investigation is to study the possibility of using crushed lime stone (which is not valid for cement manufacturing) and available in a huge quantity in Bahr Al-Najaf area as a coarse aggregate in a bituminous mixes instead of ordinary gravel which is provided from Sammerra area to improve the engineering specifications and to reduce the cost of bituminous concrete roads in many cities in the middle and south of Iraq.

Two types of coarse aggregate; ordinary gravel and crushed limestone were used in this investigation. Marshall stability, extraction and stripping tests are conducted to evaluate the strength properties of the mixes, degradation of aggregates and mechanical performance of bituminous mixes under physical water effects respectively.

The results indicate that bituminous mixes containing crushed limestone of Al Najaf Area as coarse aggregate are better than others containing ordinary gravel of Sammerra Area because they have a higher stability and lower stripping effect due to the roughness surface particles and high voids. Flow values of asphalt mixes (corresponding to maximum stability values) satisfy the Marshall Design criteria.

المستخلص :

الغرض الرئيسي لهذا البحث هو دراسة امكانية استعمال الحجر الجيري المكسر والمتوفر بكميات هائلة في منطقة بحر النجف كركام خشن في الخلطات الاسفلتية بدلا من الحصى الطبيعي المجهز من منطقة سامراء والذي تكون تكاليف نقله عالية وذلك لتحسين المواصفات الهندسية للخلطات الاسفلتية ولتقليل تكاليف اعمال الطرق في بعض مدن وسط وجنوب العراق.

استعمل في هذا البحث نوعان من الركام الخشن هما الحصى الطبيعي والحجر المكسر لعمل الخلطات الاسفلتية والتي اجري عليها فحوصات الثبات بطريقة مارشال والاستخلاص والتعرية لتقييم خواص الثبات للخلطات والتاكل للركام والانجاز الميكانيكي للخلطات الاسفلتية تحت التأثير الفيزياوي للماء على التوالي.

ان نتائج البحث بينت بان الخلطات الاسفلتية التي استخدم فيها الحجر الجيري المكسر من منطقة النجف كركام خشن افضل من الخلطات التي استعمل فيها الحصى الطبيعي من منطقة سامراء بسبب

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* Ass .Professor / Tech . College /Babil.

امتلاكها اعلى ثبات و اقل تأثيرا للمياه في قوة تماسكها ويعزى سبب ذلك الى خشونة السطح الخارجي للحبيبات وكثرة الفراغات. ان نتائج السيولة للخلطات الاسفلتية (المقابلة لاعلى ثبات) تطابق متطلبات مواصفة مارشال.

Introduction:

In recent few years, the shortage in coarse aggregate of asphaltic mixes appears to be a major problem in south and middle cities of Iraq. This discrepancy already produces some bad effects such rising of coarse aggregate price in the market and obstructing the works progress at the existing project under rendering. Materials with a good quality are toughly obtained to produce an asphaltic pavement with acceptable specifications. Bad asphalt concrete pavement results stripping, crushing of coarse aggregate, degradation, creeping ...etc. Poor subsurface drainage causing excessive moisture in the pavement structural layers and use of weak and friable aggregates may result in fracturing during construction and subsequently in service exposing uncoated surfaces. Excessive dust coating around the aggregates and very poor compaction of hot mix lead to the same bad consequences.

Extensive researches have been conducted on the asphalt mix production searching for other alternatives at area under interest. Crushed Limestone from Bahr Al Najaf is chosen as a new alternative to substitute the discrepancy in the coarse aggregate of the gravel from sammera Area.

The Regional Problem :

There are a big problem in the south and some of middle cities of Iraq during constructing their roads, because the required coarse aggregate for the bituminous mixes are not available in these areas, accordingly project managers costumes to consume an ordinary gravel which is transported from Samerra Area and in turn causes high cost bituminous mixes in addition to the difficulties to meet the required specifications,[1].

Purposes of the Study:

The previous reasons reflect the bad status of existing roads in the interested areas .To solve this problem, crushed limestone of Bahr Al Najaf Area is used as an alternative material for the replacement of Samerra Gravel to remedy the bad constructional and high costs consequences of the roads.

Materials:

1.Coarse Aggregate

Coarse aggregate used in this investigation are crushed limestone and uncrushed gravel Crushed limestone is brought from Bahr Al-Najaf Area (about 20 km to the west of Al-Najaf City). It is crushed to the required size by means of laboratorial mechanical crusher .There are huge quantities (about 75 million tons) of limestone is found in Bahr Al-Najaf Area(2, 3).

Table (1) shows the chemical composition of limestone, the results represent the average of three samples.

Table (1) Chemical Composition of Limestone

Oxides	Percentage (%)
Lime -CaO	38.90
Silica – SiO ₂	9.17
Magnesia – MgO	5.37
Ferric Oxide – Fe ₂ O ₃	1.16
Alumina – Al ₂ O ₃	0.89
Sulphuric Anhydride – SO ₃	0.35
Loss of Ignition (L.O.I)	43.70

Tested by the Author, 2001

These results indicate that limestone is not suitable for cement industry because it constitutes high and low percentages of Lime and Magnesia [4]. This interprets why limestone is too cheap in this part of Iraq.

The properties of limestone are determined according to ASTM Standard [5]. Specific Gravity, Loss Angeles abrasive value and percent absorption are found as 2.42, 28.6 %and 3.85 %respectively .These results are within the accepted Iraqi specification [4]. [Loss Angeles abrasive value not more than 35 %and percent absorption not more than 5.%].

Uncrushed gravel is obtained from Samerra Area and used to estimate the Specific gravity, Loss Angeles abrasive value and percent absorption; they are found to be 2.64, 14.76 % and 0.61 % respectively [5].

2. Fine Aggregate

A natural sand of 2.54 specific gravity [5] with a geologic origination of Kerbela queries is used. The combined mixture of fine and coarse aggregate samples need a preliminary sequential preparation of washing, heating up to 24hrs for drying and then gradating.

The gradation is chosen to produce significant asphaltic concrete mixes with highest density are specified for surface layer as indicated by [6]. The chosen gradation is shown in Table (2) and Fig.(1).

Table (2) Aggregate Gradation

Sieve Size		%Passing of Allowable Limits	Used of %passing
Inch	mm		
3/4	19.10	100	100
1/2	12.70	75-95	85.0
3/8	9.52	65-88	76.5
No.4	4.76	50-75	62.5

No.8	2.36	32-55	43.5
No.16	1.19	24-42	33.0
No.30	0.59	18-35	26.5
No.50	0.297	10-25	17.5
No.100	0.148	8-20	14.0
No.200	0.075	6-12	9.0

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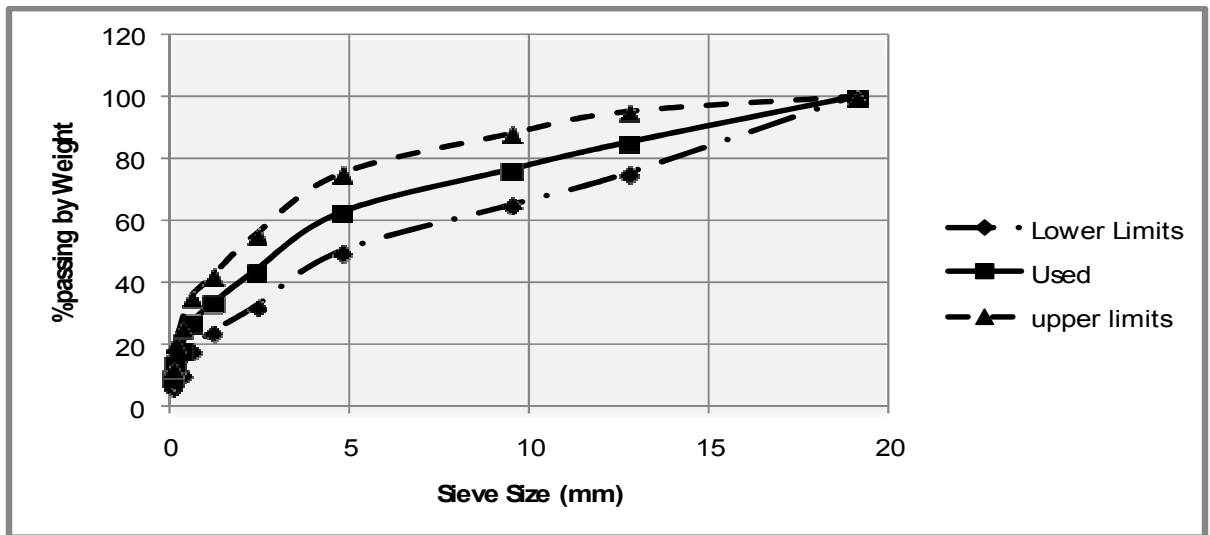


Fig.(1)Sieve Analysis of Coarse Aggregate

1- Filler

Ordinary Portland Cement of Al Kufa Cement Factory is used as a filler in this research .Filler\Asphalt ratio (F\A) is usually included as a requirement for mix design in many specifications .According to Iraqi State Corporation of Roads and Bridges [7], the job mix specification requires a minimum F/A of 1.5 for pavement construction, which is used over this study .Specific gravity of cement is found to be 3.11 and 89 %passing by weight sieve No.200, [8].

Asphalt Cement

Asphalt sample of (85-100) penetration of Al Dowra Refinery is used as a cemented substance with a specific gravity of 1.041 according to (D-70 , Annual Book, ASTM Standard),[6].

Testing Methodology

To prepare specimens for testing, a specified grading of aggregate (1200gm per a single batch) is necessarily prepared up to be mixed thoroughly with a suitable weight of asphalt (sequential increment of 1 %of asphalt is added to prepare the requested necessary samples starting with lowest percentage of 3 %up to the highest one of 8 % under 150 c□), [9]. The samples are molded in the form of cylinder with 2.5" in height and 4" in diameter .Twelve of such sample should be obtained to be enough for heavy traffic mix design (75 blows for each face). The samples are compacted [6] and

then tested for both types of aggregate using Marshall Methodology to determine the stability and flow values after warming the samples by water bath under 60c□ for 30 minutes .Such stability is well known as “dry stability”.

To meet the requirements of SORB specification [7], 12 samples are prepared)six for each types of aggregate (and tested for retained strength according to AASHTO T165-85, [10].

The degradation effect (the deviation of grading from the original one) for 4 specimens (the average of 2 specimens at optimum bitumen content for each type of aggregate) is obtained by separating the bitumen from the aggregates for the compacted specimens using centrifugal extraction test, [2].

Results and Discussion

Fig(2) shows the physical effect of aggregate types on Marshall Stability values per various asphaltic content .The curves show the stability variation with asphaltic percentage increasing .The figure shows that the stability reaches the maximum and then drops with further increasing of asphaltic content .It is also can be concluded that limestone yields higher stability than natural aggregate .This is due to the roughness of particle surfaces and irregularities of limestone .Consequently (in the mixes contain limestone as coarse aggregates), maximum stability is obtained with larger asphaltic content which in turn increase the cost of the resulted mixes, whereas *flow values* are found to be less for the corresponding asphalt content as shown in Fig.(3).

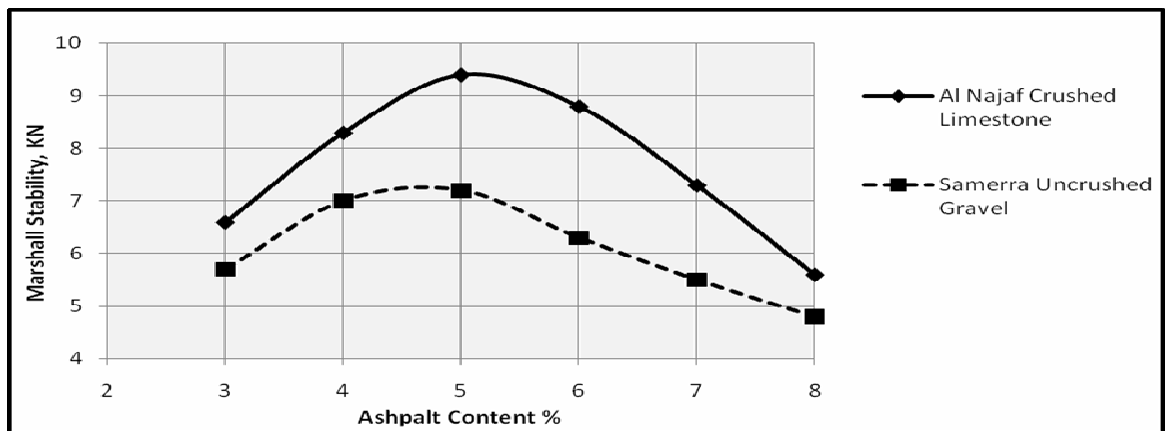
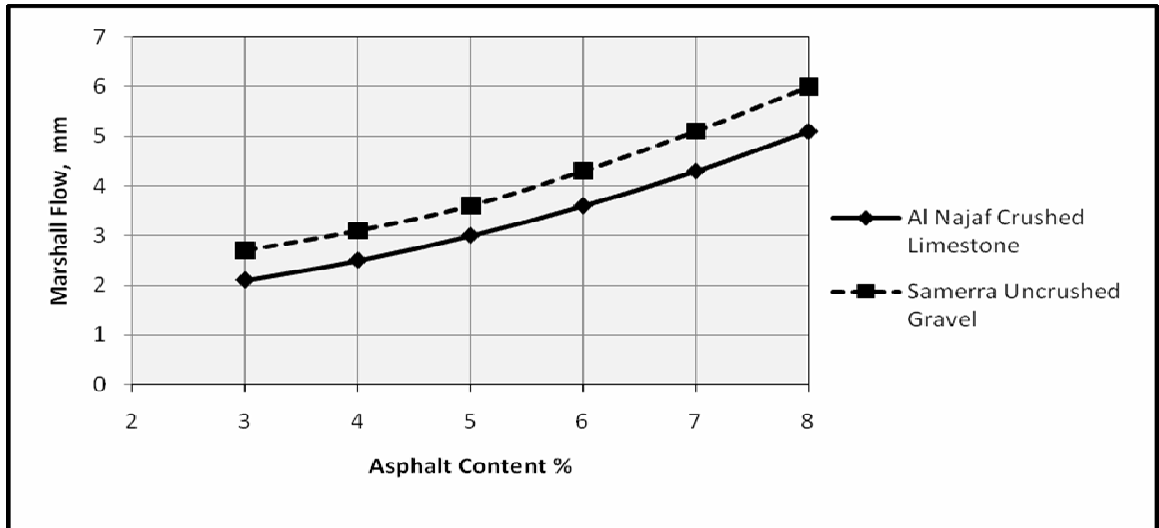


Fig.(2).Marshall Stability Values Versus Asphalt Content



Fig(3) Marshall Flow Values Versus Asphalt Content

Table (2) shows that the crushed limestone aggregate degraded more than natural gravel because of the high value of Loss Angeles abrasion percentage for the crushed limestone compared with that of natural gravel, in addition to the more angularity concerns for the

crushed limestone than that of natural gravel which is broken during compaction of sample preparation into smaller part to produce a finer degradation aggregate sample.

Table (2) Degradation Analysis Results

Grains Size, mm	Used Grading % Passing by Weigth	Al Najaf Crushed Limestone	Samerra Uncrushed Gravel
0.075	9	10.5	9.6
0.148	14	16	14.8
0.297	17.5	19.8	18.6
0.59	26.5	29	27.3
1.19	33	35.9	34.2
2.36	43.5	46.2	44.8
4.76	62.5	65.3	64.1
9.52	76.5	79	78
12.7	85	88.1	86.3
19.10	100	100	100

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The effect of stripping is shown in Fig.(4). In general, the index of retained stability increases with increasing asphalt content for both two types of aggregate . This is attributed to the increasing of binder thickness films that coats the aggregate surface resulting in occupying the interior air voids of the sample asphalt concrete body causing the reduction of stripping .The figure also indicates that Al Najaf crushed limestone offers higher *index of retained stability* values .This also attributed to the rough grains surfaces of limestone which exaggerates the adhesive bonds and high porosity which allowing the binder to penetrate the pores to reduce stripping property.

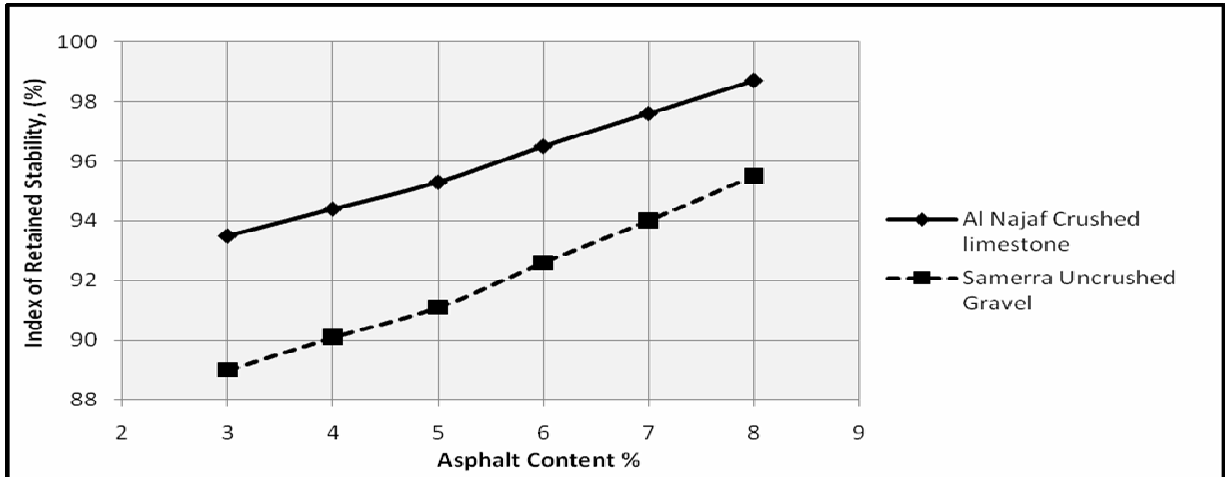


Fig.(4)Index of Retained Stability Versus Asphaltic Content

Conclusions:

The use of Bahr Al-Najaf Limestone in the industry of Asphaltic mixes is accompanied with many advantages and disadvantages i.e .they are:-

- 1- It increases Marshall Stability about 30.%
- 2- It increases the index of retained stability about 4.%
- 3- It decreases Marshall Flow but still within the required specification.
- 4- It increases bitumen consuming by 20% which accordingly produces a small increment of total mixes cost.
- 5- It increases the degradation of asphaltic concrete body under the applied stresses (but the resulting degradation within the allowable limits).

Recommendation:

The following considerations are recommended:-

- 1- We recommend a studying the physical effects of Bahr Al-Najaf Limestone in the production of high strength concrete.
- 2- The using of Bahr Al-Najaf Limestone in middle and south of Iraq is recommended.

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