Effect of Adding Steel Filings Aggregates on The Properties of Hot Mix Asphalt

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ABSTRACT

Hot Mix Asphalt (HMA), which are used in road's courses and flexible pavement structures, consisting of fine and coarse aggregates, filler, and binder( asphal t), mixed together in percent's according to a specific specifications. The main objective of this study is to investigate experimentally the effect of adding Steel Filing Aggregate (SFA) on the properties of Hot Mixtures Asphalt for surface layers. Steel filing Aggregate is a product of filing, drilling, and cutting of steel industry which, can be used as a partial replacement for fine aggregate in the creating Hot Asphalt Mixtures, for economical, environmental, and improvement purposes.

The proposed mix designs specimens test of HMA for surface layer were prepared using: obtained Optimu m Asphalt Content (OAC) (where the asphalt of penetration grade 40 was provided from Begi Oil Refinery, which was determined to be equaled 5.07 % (of the total weight mix), ordinary portland cement as the mineral filler by 5 % (of the total weight of aggregates) and locally aggregates, and then tested according to Marshall test method (ASTM - D-1559&MS-2).

Steel Filing Aggregates (SFA), which were passing through the sieve No.4 (4.75 mm) were added to the above HMA samples in three different percentages which were 5 %, 10 % and 20 % (of the total weight of mix) in order to evaluate their effects on some of the Marshall test properties of HMA. The experimental results and calculations for Marshall Tests on mix designs specimens test of HMA showed that adding SFA by above percentages on HMA, satisfy the requirements of the Iraqi General Specification for Roads & Bridges (SORB/2003) and has given significant improvement. The results also showed that 10% of SFA (of the total weight of mix) is the optimum percent.

Keywords:
First keyword; Second keyword; Third keyword; Fourth keyword; Fifth keyword; Sixth keyword.

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1. INTRODUCTION

Hot Mix Asphalt (HMA) created from materials and the asphalt act to adhere to the aggregates. Because the characteristic of asphalt is the "glue" that will cause to hold the pavement together, pavement failure may be expected if the asphalt cannot adhere the mixture asphalt together. HMA is commonly motioned referring to the bound courses of flexible paving structures, which used in the surface course, base course of roads and airfield pavements. The design of asphalt paving mix, similar to the design of other materials of engineering is widely a matter of selecting and percent's of constituent materials to obtain the desired properties in roads and pavement structure. Commonly, in most applications, the asphalt concrete materials is mixed in high temperatures, placed as HMA then compacted at atmosphere temperature. HMA is typically layered for surface layer and binder course in 10-20 cm. thick corresponding on the design limits. The aggregates in the top layer (which known as the friction or surface...
layer) are selected for their durability and friction properties, while the aggregates in the lower layer (which known as the binder course) are selected to prevent rutting and failure. Designing HMA for specific road or pavement, the selected aggregates must be durable, strong, and have a good angular shape to prevent rutting. Mineral filler is selected to fill in the voids between the coarse particles, this property leading to increasing the bulk density of the asphalt concrete or HMA and produce load transfer between the particles of layer. The percent of asphalt content is selected to satisfy a specific specification between (4-6) % (of the total weight of mix).

Waste steel filling aggregate is a kind of industrial waste which generated during steelmaking can be used as a part of fine aggregate in producing hot asphalt mixtures for the construction of pavements due to the two great benefits may be gained, firstly in reducing the amount of aggregates, secondly in disposal problem.

In Marshall stability test method of hot-mix asphalt paving mixtures design with five percentages of asphalt contents of 4%, 4.5%, 5%, 5.5% and 6% (of total weight of mix). Three compacted specimens test for each of these percentages of asphalt contents are prepared using the selected gradation of aggregates as shown in Table (3). Ordinary portland cement by 5% (of the total weight of mix) as the mineral filler, and tested according to (ASTM-D-1559 & MS2). The results of testing are calculated and formulated as shown in Table No.(8), then drawn graphically in six curves with percent of asphalt content on the x-axis and the following properties on the y-axis.

All materials which were used in this study were locally obtained and then tested as follows:

3-1 Asphalt:
The terms of asphalt and bitumen are often referring to the mean of natural and manufactured forms of the substance. Asphalt term is commonly used for the refined residue from the distillation process of oils, while bitumen term used for the naturally occurring variety. Asphalt or bitumen is a black in color, sticky and highly viscous liquid. The asphalt is commonly used in pavements as the binder or the glue, due to its excellent characteristics in engineering such as elasticity, adhesion, and water resistance.

Asphalt grade (40-50) from Begi Refinery was brought and used in this study. Such grade is widely used in pavements and Roads construction projects. The relative characteristic indexes were tested according to the Specifications of organization of Roads and Bridges (SORB2003), and the physical properties of this asphalt used are shown in Table (1) [3].

3-2 Aggregate:
Aggregates are dominant granular materials such as sand, gravel, slag, recycled concrete, and broken stone. Aggregates are using in preparing asphalt mixtures, when mixing with asphalt to form asphalted concrete, in order to give volume, stabilizer for base and sub base courses in roads construction, and resistance to wear.

Aggregates can be classified depending upon their mineral size, chemical and physical properties into...
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fine and coarse aggregates. Fine aggregates or as its called sand are those which have the particle size between 2 mm - 4.75 mm.

Coarse aggregates are those which have particle size more than 4.75 mm. The physical properties of fine and coarse aggregates are listed in Table (2).

The combined aggregates gradation was selected approximately to satisfy the job mix limits of the gradation. Aggregate gradation was specified by the (SORB/2003) for graded dense and paving mixtures for wearing course. The coarse and fine aggregates were sieved analyzed and decomposed in the laboratory to give almost similar controlled gradation and to satisfy the selected aggregate grading (design grading) of HMA for wearing course which was used in this study shown in Table (3).

3-3 Mineral filler:

A mineral filler is the smallest particles i.e. a fine aggregate which used in asphalt mixtures and passed through the sieve number 200 (0.075mm). Ordinary Portland cement and limestone powder are the most commonly manufactured mineral filler used in HMA.

In this study, only ordinary Portland cement was used of 5 % (of the total weight of aggregates). The physical properties for this mineral filling and Steel filling aggregates (SFA) are shown in Table (4).

3-4 Steel filings aggregate:

Waste Steel Filings Aggregates (SFA) were collected from Mosul Industry Zone to be use in this research and crushed and ground to pass the standard sieves as shown in Table (6). The SFA were added to replace fine aggregate in proportion of 5%, 10% and 20% (by total weight of mix) in Hot Mix Asphalt (HMA).

SFA must be “clean”, without absorbed chemicals, clay coatings and other fine materials in concentrations that could alter the hydration and bond of the cement paste. The chemical composition of SFA is different referring to the steel making practice and the quality of steel being produced. However, in accordance with the description from Federal Highway Administration (FHWA)!

The chemical composition of steel filling aggregate is usually include four main oxides, which are lime, silica, alumina, and magnesia. Other elements include, iron, alkalis, manganese, trace, sulfur and some others. Table (7) shows the list of different ranges of compound includes in S.F.A.

There were many grades of steel filling that can be produced, and the properties of the steel filling can change significantly medium, and low, depending on the carbon content of the steel. High-grade steels had high carbon content. To reduce the amount of carbon in the steel, greater oxygen levels were required in the steel-making process.

3-5 Mechanical properties of steel filling aggregate:

The processed steel filing according to the F.H.W.A has suitable mechanical properties for general use as partial replacement of fine aggregate in construction. Due to the advantages which may produce as good abrasion resistance and high bearing strength. These properties greatly improve the performance of asphalt mixes which using in pavement allowing it to produce better skid resistance than the natural aggregate. SFA has a higher degree of internal friction and higher shear strength comparing with natural aggregate. FHWA has generated the mechanical properties of steel filling aggregate as shown in Table (7).

3-6 Marshal method for mix design of asphalt concrete:

Asphalt mixtures are used commonly in the wearing and base courses of pavements. The asphalt mix usually consists of aggregates, mineral filler and asphalt binder. The asphalt mix design for pavements was commonly denoted by selecting and proportioning the constituent materials to satisfy the required specification for the desire road.

3-7 Procedure of marsh test method for preparation the mix design specimens of asphalt concrete:

Marshall Stability test method of mix design was used with five percentages of asphalt contents. For each of these percentages three cylindrical specimens of testing were prepared, compacted, and tested according to (ASTM-D-1559 & MS-2) in order to obtain the optimum asphalt content (O.A.C).

3-8 Preparation marsh test method for mix design of asphalt concrete:

Sample for each mix design was prepared using the selected coarse aggregate, fine aggregate, the mineral filler and percentage of asphalt content according to (ASTM-D-1559 & MS-2) and the requirements of the Organization of Roads and Bridges Specifications (SORB 2003) as listed in Table (3).

3-9 Parameters of stability and flow tests:

In conducting the stability and flow test, the specimen is immersed in a water bath at a temperature of 60°C for 30 minutes. Then, the specimen placed in the Marshall Stability and Flow Test Apparatus and loaded at a constant load rate of 5 mm per minute until failure of the specimen occurred. The obtained maximum load in KN (which causes the failure of the specimen) is recorded as Marshall Stability value. The Stability value is corrected for the height of specimen using Stability correlation ratios. The total amount of deformation of units of 0.25 mm that occurs at maximum load is
recorded as Flow value. The total amount of time between removing the specimen from the water bath and completion of the test should not exceed 30 second[8].

3-10 The Bulk Specific Gravity of (G_{ab}) :

The bulk specific gravity of the compacted specimen (G_{ab}) calculated as follow:

\[ G_{ab} = \frac{A}{B - C} \]  \hspace{1cm} (1)

Where:

- A = dry weight of the compacted specimen (g).
- B = (SSD) weight of the compacted specimen (g).
- C = submerged weight of the compacted specimen (g).[9]

3-11 Theoretical density and maximum specific gravity (G_{mm}) / AASHTO T209 :

The Theoretical Maximum Specific Gravity of Hot Mix Asphalt Paving Mixtures(G_{mm}) / AASHTO T209 calculated as follow:

\[ (G_{mm}) = \frac{A}{A + D + E} \]  \hspace{1cm} (2)

Where:

- G_{mm} = The Theoretical Maximum Specific Gravity of the asphalt mixture sample .
- A = weight of dry sample in air.
- D = weight of pycnometer filled with water at test temperature.
- E = weight of pycnometer filled with the sample and water at test temperature[10].

3-12 The Bulk Specific Gravity of aggregate(G_{sb}):

When the total aggregate consists of separate fractions, the bulk specific gravity of coarse aggregate, fine aggregate, mineral filler, and SFA with different specific gravities, of the total aggregate is computed as follows :

\[ G_{sb} = \frac{P_1 + P_2 + \ldots + P_n}{G_1 + G_2 + \ldots + G_n} \]  \hspace{1cm} (3)

Where :

- G_{sb} = Bulk Specific Gravity of aggregate.
- P_i = Percent by weight of aggregate 1, etc.,
- G_i = Bulk specific gravity of aggregate 1, etc[11].

3-13 Air voids in compacted mineral aggregate (VMA):

The air voids in the mineral aggregate (VMA) are the void spaces between the aggregate particles of the compacted mix. This void space includes the air voids and the effective asphalt content .VMA is computed as follows:

\[ VMA = 100 - \left[ \frac{G_{mm} - G_{sb}}{G_{mm}} \right] \times 100 \] \hspace{1cm} (4)

Where:

- VMA = Voids in mineral aggregate, in percent of bulk volume.
- G_{sb} = Bulk specific gravity of the aggregate ,
- G_{ab} = Bulk specific gravity of compacted mix ,
- P_s = Aggregate percent by total weight of mix[11].

3-14 Air voids in compacted mixture (Va) :

The air voids in compacted mixture are small pockets or airspaces of air that take place between the coated aggregate particles by asphalt in the final compacted mixture. A correct percentage value of air voids is necessary in roads mixes although which small amounts of asphalt can flow during compaction operation. The allowable percentage of airvoids (in laboratory specimens) is between 2% - 4% for most wearing layer mixes or as specified by the designer. The durability of an asphalt concrete pavement is a function of the air value content. Va is calculated as follow:

\[ V_a = \left[ \frac{G_{mm} - G_{sb}}{G_{mm}} \right] \times 100 \] \hspace{1cm} (5)

Where :

- V_a = Percent of air voids in compacted mixture,
- G_{mm} = Theoretical maximum specific gravity of the compacted paving mixture,
- G_{ab} = bulk specific gravity of the compacted mixtures[12].

3-15 Voids filled with asphalt (VFA):

VFA can also specify the percent of the volume of the VMA that is filled with asphalt cement. Voids Filled with Asphalt is calculated as follow:

\[ VFA = 100 \times \frac{VMA - V_a}{VMA} \] \hspace{1cm} (6)

Where :

- VFA = The percent of Voids Filled with Asphalt (VFA).
- VMA = The percent voids in the mineral aggregate.
- V_a = The percent air voids of the total mix volume (CT 367)[13].

3-16 Optimum asphalt content:

The main objectives of a mix design are to select the Optimum Asphalt Content for a given aggregate source, binder source and the optimum aggregate gradation.

In Marshall test, the stability and the flow was measured in loading rate of (0.25) mm /min, and then the results of testing are drawn graphically in six
4-RESULTS AND DISCUSSIONS:

Marshall stability test method of hot-mix asphalt paving mixtures design was followed with five percentages of asphalt contents of 4%, 4.5%, 5%, 5.5% and 6% (of total weight of mix); three compacted specimens test for each of these percentages of asphalt contents are prepared and tested according to (ASTM-D-1559 & MS-2). The results of testing are calculated and formulated as shown in Table No.(8), then drawn graphically in six curves with percent of asphalt content on the x-axis and the following properties on the y-axis: Marshall Stability, Marshall Flow, (Gmb), (VMA), (Va) and (VFA), as shown in Figures (5.1 to 5.6).

The value of Optimum Asphalt Content (OAC) was obtained using the Curves in Figures (5.1, 5.3 and 5.5) as the average percent of asphalt content at the maximum stability, the maximum density (Gmb) and specified percent of air voids in total mixture (Va).

Thus OAC= 5.07 % (of the total weight of mix).

In Marshall stability test method of hot-mix asphalt paving mixtures design with the obtained OAC of asphalt contents of 5.07% (of total weight of mix) and with three percentages of Steel Filing Aggregate (SFA) of 5%, 10% and 20% (of total weight of mix), three compacted specimens test for each of these percentages of (SFA) are prepared and tested according to (ASTM- D-1559 & MS-2). The results of testing are calculated and formulated as shown in Table No. (10), then drawn graphically in six curves with percent's of SFA on the x-axis and the following on the y-axis: Marshall Stability, Marshall Flow, (Gmb), (VMA), (Va) and (VFA) as shown in Figure 5.1.

The addition of SFA to the asphalted concrete mixtures was obtained using the Curves in Figures (5.1, 5.3 and 5.5) as the average percent of asphalt content at the maximum stability, the maximum density (Gmb) and 5.5% as the optimum percent of SFA to be added on the HMA, leading to increase the Marshall stability by 4.94%, and the bulk density by 8.4%.

3- The experimental results of Marshall properties tests on the mix design of HMA for wearing course using the obtained OAC and with the addition of SFA by 10% (of total weight of aggregate) on the Hot Asphalt Mixture leading to increase the Marshall stability by 4.94%, and the bulk density by 8.4%.

4- Referring to the results in Table no. (10), its observed that adding SFA by 10% (of total weight of aggregate) on the Hot Asphalt Mixture leading to increase the Marshall stability by 4.94%, and the bulk density by 8.4%.

5- CONCLUSIONS AND RECOMMENDATIONS:

5-1 Conclusions:

From the studies on the addition of SFA on HMA described in this study; the following conclusions can be summarized as follow:

1 - The value of optimum asphalt Content (OAC) was determined as equal to 5.07% (of the total weight of mix).

2 - Using the results in Table no. (10), the value of the optimum percent of SFA to be added on the HMA, was chosen as equal to 10% (of the total weight of mix) which led best improvement in Marshal properties, comparing with other percent's values of SFA used in this study.

5-2 Recommendations:

The recommendations may be summarized for further studies as follow:

1) The optimum Asphalt Content (OAC) is the most important criterion in preparing the Marshall specimen tests. This is because any error in obtaining the OAC value will definitely influence the test results.
2) Using the Steel Filing Aggregate (SFA) as a replaced by the fine aggregate should be added by 10% (of total weight of aggregate), when taken the Marshall stability as the first favors choice, leading to produce asphalt concrete mixtures with higher Marshall Stability, lower voids in compacted mineral aggregate (VMA), voids in compacted mixture (VTM) comparing without adding SFA.

3) This research was executed by using petroleum asphalt of penetration 40 was provided from Begi Oil Refinery, and the OAC was determined to be equaled 5.07% (of the total weight mix).

4) The difference between Gmm and Gmb is the volume. Because the weights are the same, but the compacted HMA. So the following relationship between them is always true:

\[ G_{\text{mm}} \geq G_{\text{mb}} \]

5) From an economical and environmental scopes, investigating should be taken in account for other local waste materials could be used as mineral fillers in asphalted mixtures, such as, steelfibers, steel-slag, which might be produced from lathe machines due to cutting and drilling process of steel, which can be used as a partial substitute for fine aggregate in the production of Hot Mixtures Asphalt in improvement purposes.

6) Finally, It is recommended that SFA be used as a fine aggregate replacement for sustainable development in highway construction.
Table (5) The Sieve Analysis of Steel Filing Aggregate and Mineral Filler

<table>
<thead>
<tr>
<th>Material</th>
<th>Specific Gravity (g/cm³)</th>
<th>Passing percent weight through sieve No.200</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPC</td>
<td>3.15</td>
<td>95</td>
</tr>
<tr>
<td>Steel Filing Aggregate, SPA</td>
<td>7.38</td>
<td>11</td>
</tr>
</tbody>
</table>

Table (6) The Sieve Analysis of (SPA)*

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percentage of Passing Weight %</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8”</td>
<td>9.4</td>
</tr>
<tr>
<td>No. 4</td>
<td>4.75</td>
</tr>
<tr>
<td>No. 8</td>
<td>2.36</td>
</tr>
<tr>
<td>No. 16</td>
<td>1.18</td>
</tr>
<tr>
<td>No. 30</td>
<td>0.6</td>
</tr>
<tr>
<td>No. 50</td>
<td>0.3</td>
</tr>
<tr>
<td>No. 100</td>
<td>0.1475</td>
</tr>
<tr>
<td>N. 200</td>
<td>0.075</td>
</tr>
</tbody>
</table>

*Tested in Roads laboratory of Civil Eng. Dept. / University of Mosul

(7) The Mechanical Properties of Steel Filing Aggregate used :

- Los Angeles abrasion (ASTM131) : 20% - 25%
- Sodium sulfate soundness loss (AST C88) : < 1.2%
- Angle of internal friction : 40° - 50°
- Hardness (measured by Mohs’ scale of mineral hardness) : 6% - 7%
- California Bearing Ratio, top size 19mm : up to 300

*Tested in Roads laboratory of Civil Eng. Dept. / University of Mosul

Table (7) Marshall Properties at O.A.C

<table>
<thead>
<tr>
<th>Property</th>
<th>Value of O.A.C</th>
<th>Specified Limits of (S.O.R.B:50%) for Wearing Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marshall Stability (Number of Blow - 2575), (KN)</td>
<td>9.202</td>
<td>8 (KN (min.))</td>
</tr>
<tr>
<td>Marshall Flow value, (in 0.25 mm unit)</td>
<td>2.802</td>
<td>2 - (4mm)</td>
</tr>
<tr>
<td>Bulk Specitic Gravity, (G_m) , g/cm³</td>
<td>2.908</td>
<td>-</td>
</tr>
<tr>
<td>Percent Voids in compacted mineral aggregate , (VMA), %</td>
<td>4.203</td>
<td>8% - 3%</td>
</tr>
<tr>
<td>Air Voids Filled with Asphalt, (VFA), %</td>
<td>69.238</td>
<td>60% - 80%</td>
</tr>
<tr>
<td>Index Retained Strength, %</td>
<td>74.000</td>
<td>70% (max.)</td>
</tr>
<tr>
<td>Optimum Asphalt Content, (O.A.C)</td>
<td>5.070</td>
<td>4 - 6 (max.)</td>
</tr>
</tbody>
</table>

*Tested in Roads laboratory of Civil Eng. Dept. / University of Mosul

Table (8) Marshall Properties with Different percent of SPA at O.A.C*

<table>
<thead>
<tr>
<th>Properties</th>
<th>Value</th>
<th>0%</th>
<th>5%</th>
<th>10%</th>
<th>20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marshall Flow value, (in 0.25 mm unit)</td>
<td>2.057</td>
<td>2.083</td>
<td>2.159</td>
<td>2.032</td>
<td></td>
</tr>
<tr>
<td>Bulk Specitic Gravity, (G_m) , g/cm³</td>
<td>2.297</td>
<td>2.390</td>
<td>2.490</td>
<td>2.720</td>
<td></td>
</tr>
<tr>
<td>Percent of Air Voids in compacted mixture , (V_A, VTM), %</td>
<td>5.000</td>
<td>4.454</td>
<td>3.836</td>
<td>3.214</td>
<td></td>
</tr>
<tr>
<td>Percent of Air Voids Filled with Asphalt, (VFA), %</td>
<td>78.066</td>
<td>78.663</td>
<td>78.934</td>
<td>78.428</td>
<td></td>
</tr>
</tbody>
</table>

*Tested in Roads laboratory of Civil Eng. Dept. / University of Mosul

Table (11) The comparison of Marshall Properties at O.A.C before and after adding SPA by 10% with SORB2000 specifications :

<table>
<thead>
<tr>
<th>Properties</th>
<th>Ordinary mix at O.A.C</th>
<th>S.F.A mix with 10%</th>
<th>Specification of S.O.R.B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marshall Stability (ASTM D159), (KN)</td>
<td>9.202</td>
<td>9.171</td>
<td>8 (KN (min.))</td>
</tr>
<tr>
<td>Marshall Flow value, mm</td>
<td>2.802</td>
<td>2.159</td>
<td>2 - (4mm)</td>
</tr>
<tr>
<td>Bulk Specitic Gravity, (G_m) , g/cm³</td>
<td>2.308</td>
<td>2.490</td>
<td>-</td>
</tr>
<tr>
<td>Percent of Voids in compacted mineral aggregate , (VMA), %</td>
<td>16.086</td>
<td>15.670</td>
<td>14 % (min)</td>
</tr>
<tr>
<td>Percent of Air Voids in compacted mixture , (V_A, VTM), %</td>
<td>4.203</td>
<td>3.301</td>
<td>3% - 5%</td>
</tr>
<tr>
<td>Percent of Air Voids Filled with Asphalt, (VFA), %</td>
<td>69.278</td>
<td>78.934</td>
<td>60% - 80%</td>
</tr>
</tbody>
</table>

*Tested in Roads laboratory of Civil Eng. Dept. / University of Mosul
Fig (5.1) The relationship between Marshall Stability and Asphalt percentage.

Fig (5.2) The relationship between Flow and Asphalt percentage.

Fig (5.3) The relationship between Bulk Density (G. m. b) and Asphalt percentage.

Fig (5.4) The relationship between (VMA) and Asphalt percentage.

Fig (5.5) The relationship between (V الس, VTM) and Asphalt percentage.

Fig (5.6) The relationship between (V.E.A) and Asphalt percentage.

The relationships between Marshall Properties of HMA and Asphalt percentage.
The relationship between...
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تأثير إضافة ركام برادة الحديد على خواص الخلطات الخرسانية الإسفلتية الساخنة

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المستخلص

الخرسانة الإسفلتية أو الخلطة الإسفلتية الساخنة (HMA) هي مادة مركبة تُستعمل كثيراً في مشاريع الرصف المرئ منها الطرق والمطارات. تتألف من ركام حنف، زائد مادة مالئة، والأسفلت، التي جمعها في حالة واحدة وتُمزج مع بعضها البعض بنسب وزنية وفقاً لمواقف قياسية معينة. وذلك في أفران ساخنة لمعامل خاصة بإنتاجها. 

الهدف الأساسي من هذا البحث هو إعداد دراسة نظرية وخبرية حول تقييم تأثير إضافة ركام برادة الحديد على الخواص الفيزيائية للخلطات الإسفلتية الساخنة للطبقات السطحية.

ركام برادة الحديد هو تلك المادة الصناعية الناتجة من بقايا عملية البرادة والتتليق والقطع للحدد الصناعي في بعض الورش والمعامل الصناعية، والتي يمكن استخدامها كديل جزئي عن الركام الناعم المستخدم في إنتاج الخلطات الخرسانية الإسفلتية الساخنة وذلك لأسباب بيئة (من جراء الخلل من هذه النفايات) والاقتصادية (من حيث تقليل كلفة الإنتاج). هذا فضلاً عن تعزيزها بعض الخصائص الإجابية للخلطات الإسفلتية الساخنة.

تم إعداد مختبرات عدة نماذج فحص قياسية لتمثل خلطات إسفلتية ساخنة للطبقات السطحية، وذلك باستخدام نسبة المستقلة (درجة نفاذية 40-50 الورد من مصفاة بيجه) المعينة (OAC)، وتكونت مقداراً 5% (من الوزن الكلي للمزج)، واستخدام الإسمنت البورتلندي العادي كمادة مالئة بنسبة 5% (من الوزن الكلي للمزج)، وركام محلي.

أضيف ركام برادة الحديد (SFA) العابر من المحلى القاسي رقم 4.75 (4.75 ملم) إلى نماذج الخلطات الإسفلتية الساخنة للطبقات السطحية أعلاه، بوتلال نسبة وزنية مختلفة وهي 5, 10 و 20% (من الوزن الكلي للركام)، وذلك لتقييم مدى تأثيرها على خصائص فحص مارشال لها.

أظهرت نتائج الاختبارات الإضافية ركاما برادة الحديد (SFA) للخلطات الإسفلتية الساخنة بهذه النسب الثلاثة وهي: 5%, 10% و 20% (من الوزن الكلي للمزيج) أن خصائص فحص مارشال لها تقع ضمن حدود السماوات العامة للطرق والجسور العراقية للطبقات السطحية بصورة عامية. وأعطت هذه الاختبارات تحسيناً إيجابياً عليها من حيث زيادة الكثافة والثبات والدفع وحجم الفراغات الهوائية. والثوابت في هذه النماذج تعود إضافة الركام الجديد بنسبة 10% مقارنة مع يقينة نسب الإضافة السابقة.