


Some Asphalt Plants in Libya; Classification and Performance Evaluation

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ABSTRACT

The production of hot asphalt mixtures used in paving the asphaltic layers of flexible pavement is considered one of the most important stages of the implementation process. Thus production of mixtures that conform to specifications is one of the most important elements in the success of the paving project. Also, any problem that occurs during the processes of preparing materials, mixing them, transporting hot mixtures, and compacting them on the site will necessarily lead to serious damage to the road during service, such as rutting, cracks, disintegration, etc. This paper proposes a scientific procedure for monitoring and evaluating mixing plants. This study included the materials used in the production of hot asphalt mixes and the problems of quality control for asphalt mixes. The study also covered field visits to several asphalt plants in Libya. A series of checks, procedures and precautions were conducted on each quality control item for those plants. The study proposed a method for rehabilitating, evaluating and classifying hot mix asphalt production plants, in addition to the conclusions and recommendations that contribute to avoiding many problems related to the production and implementation of this type of mixture, raising the quality of asphalt concrete production and creating a spirit of competition among asphalt mixture producers. Results show that most of the visited plants were accepted and passed the evaluation method, but to varying degrees. One of them was out of the classification. Finally, proposed guidelines were prepared that include the foundations, methods and standards for qualifying and classifying asphalt plants to ensure that their production complies with the relevant engineering specifications and standards.

Keywords: hot asphalt mixtures, asphalt plants, quality control, classification, evaluation

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تصنيف وتقييم الأداء لبعض الخلطات الإسفلتية في ليبيا

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ملخص البحث

يعتبر إنتاج الخلطات الإسفلتية الساخنة المستخدمة في رصف الطبقات الإسفلتية بالرصف المر من أهم مراحل عمليات التنفيذ، وبذلك فإن إنتاج خلطات مطابقة للمواصفات يعد من أهم العناصر في إنجاح مشروع الرصف، كما أن أي خطأ يحدث أثناء عمليات إعداد المواد وخلطها ونقل الخلطات الساخنة ودمكها في الموقع سيؤدي بالضرورة إلى ظهور أضرار جسيمة في الطريق أثناء الخدمة مثل التحددات والتشققات والتفتت... الخ. تهدف هذه الورقة إلى اقتراح أسلوب علمي لمراقبة وتقييم محطات الخلط. وقد شملت هذه الدراسة المواد المستخدمة في إنتاج الخلطات الإسفلتية الساخنة، ومشاكل ضبط الجودة للخلطات الإسفلتية كما تناولت الدراسة زيارات ميدانية لعدة محطات إسفلتية في ليبيا وقد تم إجراء سلسلة من الفحوصات والإجراءات والاحتياطات على كل بند من بنود ضبط الجودة لتلك الخلطات، واقترحت الدراسة أسلوباً لإعادة تأهيل وتقييم وتصنيف مصانع إنتاج الأسفلت الساخن، بالإضافة إلى الاستنتاجات والتوصيات التي تساهم في تجنب العديد من المشاكل المتعلقة بإنتاج وتنفيذ هذا النوع من الخلطات، ورفع جودة إنتاج الخرسانة الإسفلتية وخلق روح المنافسة بين منتجي الخلطات الإسفلتية. وأظهرت النتائج أن معظم المصانع التي تمت زيارتها تم قبولها واجتازت أسلوب التقييم ولكن بدرجات متفاوتة، وخرج أحدها من التصنيف. وأخيراً تم إعداد دليل مقترح يتضمن الأسس والطرق والمعايير لتأهيل وتصنيف مصانع الأسفلت لضمان أن يكون إنتاجها متوافقاً مع المواصفات والمعايير الهندسية ذات الصلة.

الكلمات المفتاحية: الخلطة الإسفلتية الساخنة، الخلطات الإسفلتية، ضبط الجودة، التصنيف، التقييم.

1. Introduction

Road construction projects are considered among the most important and expensive engineering projects, and among the most important pillars of the countries' infrastructure that facilitate the connection between human settlements. When new roads are opened or existing roads are maintained, they are comfortable and have high specifications. With the passage of time and various factors such as vehicle loads and high temperatures, the quality of these roads decreases and therefore they need maintenance. Also, the construction of new roads or the maintenance of existing roads requires the production of hot asphalt mixes in mixing plants. When the produced mixes conform to the specifications and design standards, the implemented roads will be of high quality. When the mixes are poor, various defects will appear such as cracks and ruts, etc., and thus the life of the road will be shorter due to the lack of quality control of these mixes during their production and handling by asphalt mixers, which means a waste of public money. Therefore, controlling the quality of the mixes is a process of high technical and economic importance in countries that rely on asphalt roads for transportation, including Libya, which has a large network of asphalt roads. The presence of many companies that carry out road construction and maintenance work throughout Libya, requires the installation of asphalt mixers to produce the mixtures required to construct these roads, which are Hot Mix Asphalt (HMA) mixtures. The question that arises is whether all of these mixers produce asphalt mixtures that meet the specifications. Through observation, it was found that there is no specific method or approach through which the efficiency of these mixers is verified .

M. Musbah [1] studied the properties of the materials used in the production of these mixtures. It also provides a detailed description of the components and devices that comprise them. Then, during the study, they propose a scientific method for monitoring and evaluating asphalt plants.

A. Younes, A. Nory [2] studied the batch production plants used in Libya and proposed a mechanism to control the quality of these plants. by identifying the components of these plants and evaluating them

from several aspects, the most important of which are (mixing equipment, storage of materials, specifications of the produced mixtures, and environmental pollution).

West Virginia Division of Highways [3] studied the specifications and requirements for implementing urban roads, which aim to set technical controls for constructing urban roads on scientific foundations and methods that is consistent and compatible with the requirements of urban areas and the field of asphalt manufacturing.

In this paper, the steps required to evaluate the work of asphalt mixers and study the quality of the obtained mixtures will be presented. In addition, this paper will verify the methods of storing the raw materials used in preparing the mixture, which includes asphalt, aggregate and fine material, and then verify the mixing ratios and the extent of their conformity with the standard mixture required to be produced, in addition to monitoring the mixing processes and determining the mixing time. After completing the previous works, post-mixing works are monitored, such as loading onto trucks, and noting how to maintain the temperature of the mixture during transportation, pouring and compaction on site.

2. Materials and Methods

To reach the desired goal, the research plan included the following aspects:

1- The theoretical aspect: It includes reviewing previous research, studies, and modern sources related to quality, its concepts, development, and management systems.

2- The field side:

A) Conducting visits to entities and sites related to the research topic, conducting interviews with officials and specialists, and asking questions to obtain the required information.

B) Adopting checklists to gather data and information to be used later on in classification and evaluation processes.

After reviewing previous studies and relevant international and local standards in this field, visiting several asphalt plants and examining the production methods and techniques followed in these plants, an evaluation process should include the following items:

- Quality management system.
- Senior management obligations.
- Resource management.
- Requirements for controlling the quality of received materials.
- Production and transportation of asphalt mixtures.
- Environmental requirements.
- Evaluation of the produced mixture.
- Calibration processes of devices and equipment.
- Quality laboratory and its equipment.
- Issuance of invoices.
- Technical apparatus.
- Safety precautions and periodic maintenance

The evaluation process is carried out by calculating certain points for each mixer according to its accuracy in adhering to the items specified above [4].

- A basic evaluation to which a percentage of points (70% of the total percentage) was allocated was given to the most important items that have a significant impact on the properties and quality of the produced mixture.

- While a secondary assessment was given a lower percentage of points (30%) because it includes additional requirements.

Audit process

• Auditor

He is an experienced and qualified person to conduct evaluation, classification and approval of asphalt mixture factories.

He must be qualified from an accredited educational or training body and have experience in the field of the asphalt industry [5].

3. Theory and Calculation

Classification criteria

Asphalt plants are classified according to the following requirements:

- **Basic requirements:** The requirements that must be fully met and implemented in all factories applying for accreditation are given in Table 1.

Table 1. Basic requirements necessary to be submitted for asphalt plant approval.

| SN | Items | If yes, the range is | | | |
|----|--|----------------------|------|-----|------|
| | | 1.0 | 0.75 | 0.5 | 0.25 |
| 1 | Administration system | | | | |
| 2 | Infrastructures | | | | |
| 3 | Storage and handling of materials | | | | |
| 4 | Mixing and transporting truck requirements | | | | |
| 5 | Laboratory requirements | | | | |
| 6 | Labours qualification requirements | | | | |
| 7 | Occupational safety requirements | | | | |
| 8 | Work environment recommendations | | | | |
| 9 | Mix Production requirements in hot weather | | | | |
| 10 | Received materials quality requirements | | | | |
| 11 | Asphaltic mix design | | | | |
| 12 | Performing testes | | | | |
| 13 | Conduct laboratory tests to ensure performance | | | | |
| 14 | Monitoring equipment and tools | | | | |
| 15 | Plants productivity | | | | |
| 16 | Performance evaluation | | | | |
| 17 | improvements | | | | |

- **Secondary requirements:** The special requirements to improve the performance of asphalt production plants are given in Table 2.

(A) Classification of asphalt plants

Asphalt plants are classified according to the results of the previous five evaluation criteria, according to commitment to application and implementation [2].

Accordingly, asphalt plants are classified into five groups:

- Group A: plants with excellent performance.
- Group B: plants with very good performance.

- Group C: plants with good performance.
- Group D: plants with acceptable performance
- Group (E): plants are out of classification.

Table 2: Secondary requirements necessary submitted from asphalt plants for approval.

| SN | Items | If yes the range is | | | |
|----|---|---------------------|------|-----|------|
| | | 1.0 | 0.75 | 0.5 | 0.25 |
| 1 | Administration system | | | | |
| 2 | Storage requirements and handling | | | | |
| 3 | Balances and materials precision | | | | |
| 4 | Laboratory requirements | | | | |
| 5 | Labors qualification requirements | | | | |
| 6 | Occupational safety requirements | | | | |
| 7 | Work environment recommendations | | | | |
| 8 | Received materials quality requirements | | | | |
| 7 | Asphaltic mix design | | | | |
| 8 | Asphaltic mix evaluation | | | | |
| 9 | Mix Production and transporting | | | | |
| 10 | Monitoring equipment and tools | | | | |
| 11 | Performance evaluation | | | | |
| 12 | Improvement | | | | |

(B) Classification indicators

After ensuring that all basic requirements are met, classification indicators are calculated based on the extent of the manufacturer's application.

For additional requirements as shown in the checklists, the points obtained are monitored and the mixer is then classified according to the percentage obtained as follows:

- Category A: a plant must obtain a percentage of 85% or more from the total points for its application of the basic and additional requirements.
- Category B: a plant must obtain a percentage of (75% to 84.9%) of the total points for applying the basic and secondary requirements.
- Category C: a plant must obtain a percentage of (65% to 74.9%) of the total points for applying the basic and secondary requirements.
- Category D: a plant must obtain a percentage of (50% to 64.9%) of the total points for applying the basic and secondary requirements.
- Category E: a plant must obtain less than 50% of the total points applied to the basic and secondary requirements.

This classification will result in the following actions:

- Announcement of the results of classification of asphalt plants periodically for the purpose of motivation.
- Giving preference to work in state projects to plants of Groups (A) and (B) with distinguished and very good performance.
- Group (C) plants with very good performance and Group (D) factories with acceptable performance will be monitored periodically to determine the extent of their compliance with controls and standards, and they will be contacted to clarify deficiencies and provide recommendations to be promoted to Group (A) factories, and a system of penalties will be applied to them in the event of failure. Adherence to standards and controls.

• Group (E) plants that are not classified, and in the event that their condition is not improved and their status is moved to higher levels that comply with the general specifications, standards and requirements, they will not be granted the minimum to practice the activity.

Field Visits

The field study includes visits to several asphalt plants located in different locations in Libya as depicted in Figure 1. The visit program included visiting hot mix asphalt production plants and monitoring the method of mixing and transferring the hot mix asphalt to the site. During the visit to these stations, most of the information obtained is gathered with the help of officials and supervisors of these plants. To maintain privacy, these stations were coded (1,2,3,4,5,6), where the name of the plant and the owner were not mentioned to avoid defamation, but all points were taken into account when evaluating each plant individually. During the visits, it became clear that there was a difference between the production plants in the batch, as each company has a mixer that differs from the other in terms of the method of operation, the type of devices and equipment, etc. Fieldwork included examining the mixers and identifying the devices and equipment that make them up, and the validity and accuracy of this equipment, in addition to knowing how to deal with the raw materials and the produced mixture in terms of storage and transportation. Then, special forms are filled out that provide comprehensive information about the mixing plants, such as the date of manufacture, country of origin, the maintenance procedures followed in each mixer and the properties of the produced mixture.



Figure 1. Location of visited asphalt-producing plants.

Table 3 presents the technical specifications for visited asphalt plants.

Table 3: Evaluation results for the visited plants.

| SN | Type of Plant | Productivity (Ton/hr) | Year of production |
|----|---------------|-----------------------|--------------------|
| 1 | Batch plant | 240 | 2007 |
| 2 | Batch plant | 160 | 2004 |
| 3 | Batch plant | 160 | 2013 |
| 4 | Batch plant | 240 | 2002 |
| 5 | Batch plant | 240 | 2007 |
| 6 | Batch plant | 160 | 1997 |

4. Results and Discussion

The results of the evaluation of asphalt mixing plants are shown in Table 4 below. It is clear that most of the plants passed the evaluation method but to varying degrees. Station (4) had the highest score, as its equipment worked accurately and produced an asphalt mixture that conformed to the required technical specifications, in addition to storing the materials appropriately. The tests indicate that the materials used

in this plant were of high quality, however, plants (2), (3), (5), and (6) were using trucks transporting the mixture in a way that did not conform to the specifications. They used regular trucks without spraying them with anti-stick materials, which led to the accumulation of the mixture sticks to the truck boxes. There are other reasons that negatively affect the evaluation result for those plants such as; the inaccuracy of the scales for aggregates and asphalt in some mixing plants that causes disruption in the mixing ratios, resulting in a mixture with non-standard mixing ratios. In addition, it was noted that there were no calibration certificates for laboratory devices and mixing equipment.

Plant (6) was out of the classification and the lowest in the evaluation. The equipment of the plant was not working properly, and the raw materials were stored in a bad condition, which led to obtaining an asphalt mixture that was outside the specifications limits, in addition to the fact that the results of the material tests were not at the required level and the trucks were not used as required.

Table 4: Evaluation results for the visited plants.

| SN | The item | | Percentage (%) | Classification |
|----|----------------------------------|---------------------------------------|----------------|----------------|
| | Basic requirement (70 points) | Secondary requirements (66 points) | | |
| 1 | 56 | 35 | 66.9 | C |
| 2 | 54 | 30 | 61.7 | D |
| 3 | 62 | 35 | 71.33 | C |
| 4 | 63 | 40 | 75.73 | B |
| 5 | 34 | 48 | 60 | D |
| 6 | 35 | 30 | 47.8 | E |

5. Conclusions

By applying the above quality control procedure to the asphalt-producing plants under study, the following points were concluded:

1. A series of tests, procedures and precautions were conducted on each item of quality control for the targeted plants, and a method was proposed to qualify, evaluate and classify asphalt plants.
2. Proposed guidelines were prepared that include the foundations, methods and standards for qualifying and classifying asphalt mixers to ensure the production of asphalt mixtures that comply with the relevant engineering specifications and standards.
3. It was noted in some sites that the supervision engineers were incompetent, some of whom were recent graduates and some of whom were outside the field of traffic engineering and did not have sufficient experience in the work, which made the companies operate without any noticeable supervision.
4. The inaccuracy of the scales for aggregates and asphalt in some mixing stations causes disruption in the mixing ratios, resulting in a mixture with non-standard mixing ratios.
5. It was noted that there were no calibration certificates for laboratory devices and mixing equipment.
6. Transporting the asphalt mixture over long distances without using heat-proof covers, which results in a cold and non-compactable asphalt mixture.
7. The absence of any regulatory body or authority that controls the quality of the work of asphalt plants in Libya, and the weakness of the supervisory bodies has a negative impact on the progress of work in the required manner.

6. Recommendations

In order to control the work of asphalt plants in a manner appropriate to the standard specifications, the following recommendations must be followed:

1. Cooperation with relevant authorities such as the Roads Authority and the National Center for Standards and Metrology to establish a special department that adopts a specific method or style through which the quality of the work of asphalt plants is controlled in Libya.
2. Prepare specialized courses to raise the performance of the supervision and production staff.
3. The study should be extended to cover other asphalt plants that have been operating for a long time to verify the efficiency of their equipment and devices. In addition to provide a more accurate database on the work of asphalt mixers in Libya.

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