Pavement Materials & Design

Asphalt Mixtures production, Transportation, laying

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Asphalt Mixtures

Production

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Asphalt Layer

HMA Manufacturing

- HMA is produced in a plant that proportions, blends, and heats aggregate and asphalt to produce an HMA that conforming to job mix formula (JMF) requirements.
- There are two basic types of HMA plants commonly in use today:
  - *The batch plant*
    - Produce HMA in individual batches
  - *The drum plant*
    - Produce HMA in a continuous operation
- The choice of a batch or drum mix plant depends upon
  - *business factors such as purchase price, operating costs, production requirements and the need for flexibility in local markets; both can produce quality HMA.*

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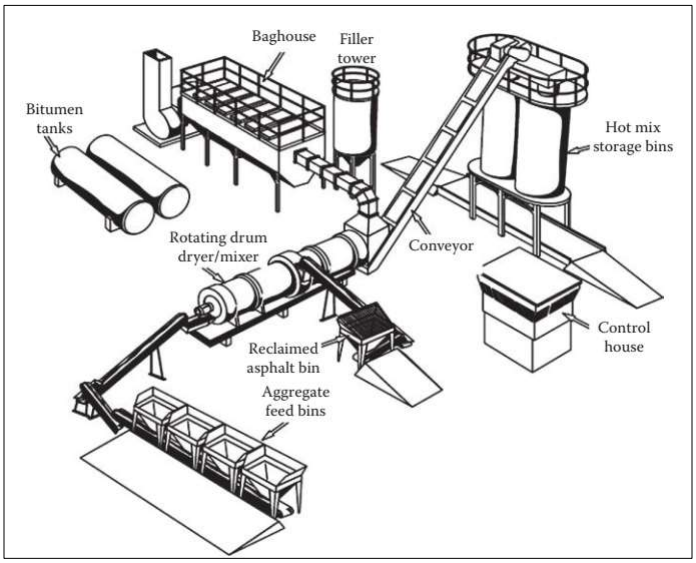
HMA Manufacturing

The drum plant

- generally, offer higher production rates than batch plants for comparable cost.
- Each type of plant can produce the same types of HMA and neither type of plant should impart any significant plant-specific HMA characteristics.



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The drum plant

https://www.youtube.com/watch?v=QIIO7MeSpP4

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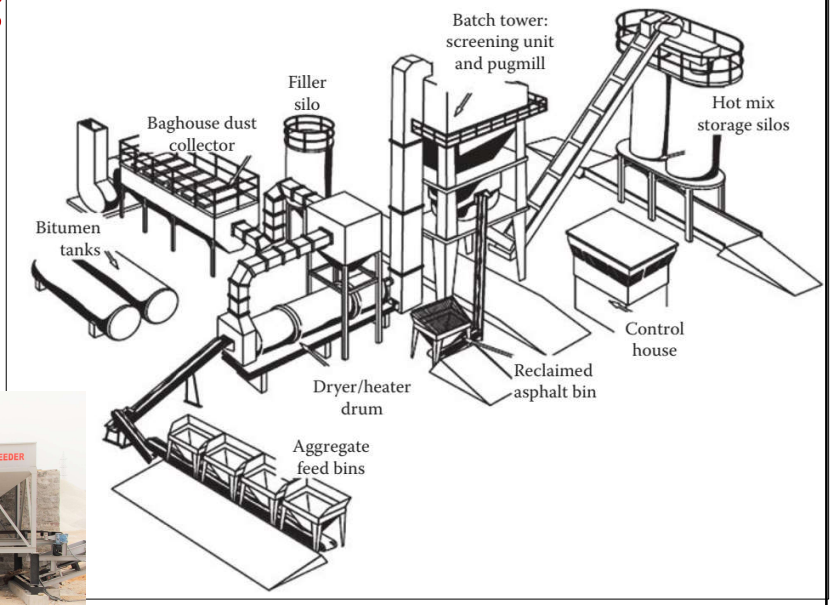
HMA Manufacturing

The batch plant



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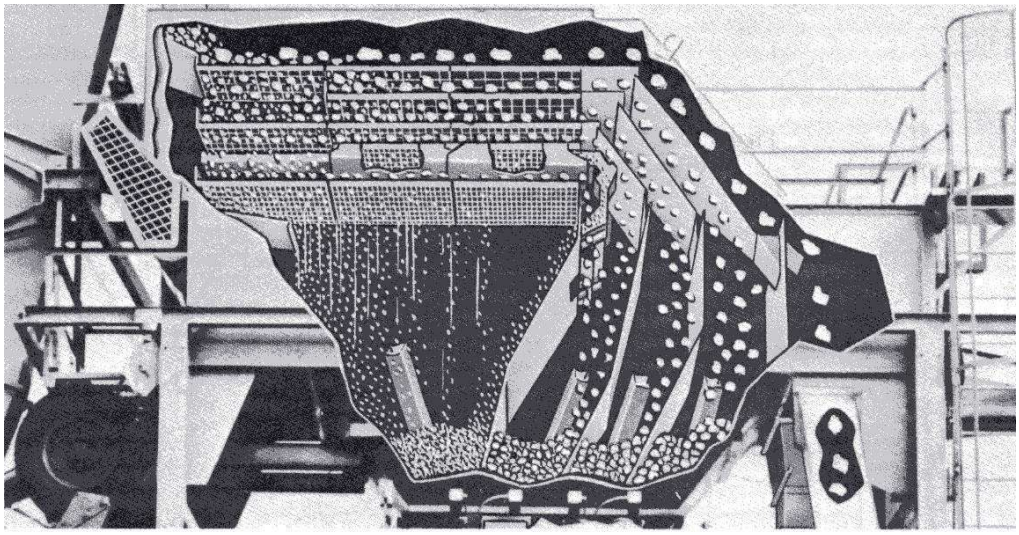
HMA Manufacturing



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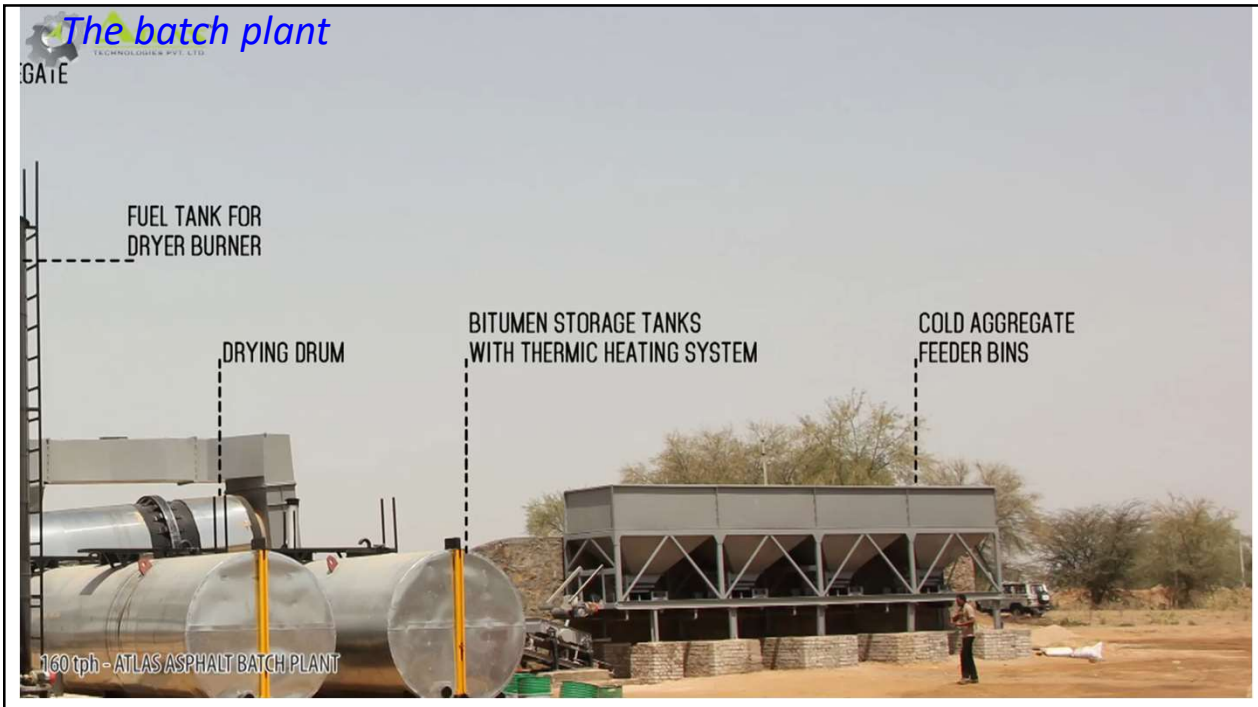
The batch plant



Video Source: https://www.youtube.com/watch?v=hxWinuC-Tas

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The batch plant

https://www.youtube.com/watch?v=gOovBYrHOA

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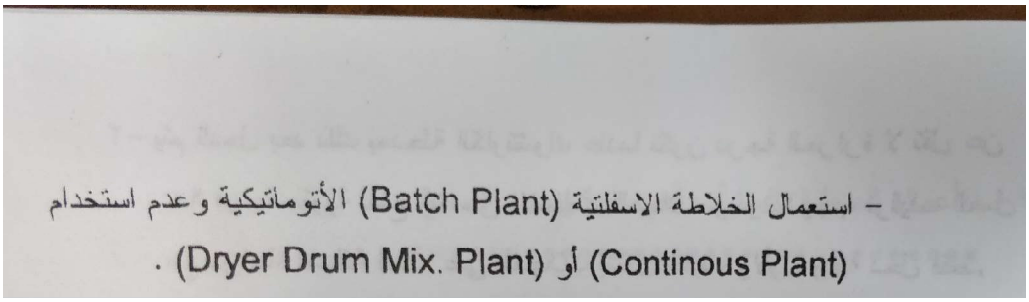
Jordanian National Building council

Specifications for highway and bridge construction



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Asphalt Mixtures

Transportation

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Asphalt Mixtures Transport

Transport

- Mix transport involves everything required to convey HMA from a production facility to a paving site including
  - *truck loading, weighing and ticketing, hauling to the paving site, dumping of the mix into the paver or material transfer vehicle hopper, and truck return to the HMA production facility*
- Ideally, the goal of mix transport should be to maintain mix characteristics between the production facility and the paving site.

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Asphalt Mixtures Transpor

Truck Types

- End dump
  - *End dump trucks unload their payload by raising the front end and letting the payload slide down the bottom of the bed and out the back through a tailgate .*
  - *They are the most popular transport vehicle type because they are plentiful, maneuverable and versatile.*

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Asphalt Mixtures Transport

Truck Types

- Live bottom (or flo-boy).
  - *Live bottom dump trucks have a conveyor system at the bottom of their bed to unload their payload.*
  - *HMA is discharged out the back of the bed without raising the bed.*
  - *Live bottom trucks are more expensive to use and maintain because of the conveyor system but they also can reduce segregation problems and can eliminate some detrimental types of truck bed – paver contact (because the bed is not raised during discharge).*

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Asphalt Mixtures Transp

Truck Types

- Bottom dump (or belly dump).
  - *Bottom dump trucks unload their payload by opening gates on the bottom of the bed.*
  - *Internal bed walls are sloped to direct the entire payload out through the opened gates. Discharge rates can be controlled by the degree of gate opening and the discharge is usually placed in an elongated pile, called a windrow, in front of the paver by driving the truck forward during discharge. Windrows require a special MTV to feed the HMA into the paver.*

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Asphalt Mixtures Transport

Truck Types

- **Material pickup machine.**

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Asphalt Mixtures Transport

Diesel fuel is an unacceptable release agent

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Asphalt Mixtures Transport

Pothole caused by overlaying of spilled diesel fuel

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Asphalt Mixtures

Laying/Paving

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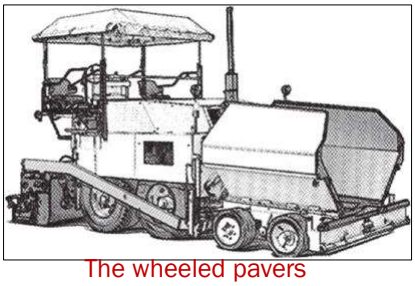
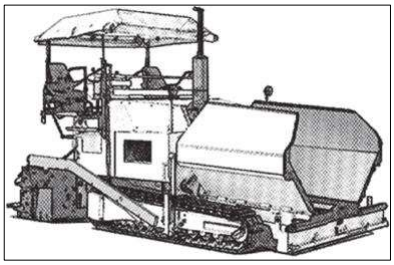
Asphalt Mixtures Laying/Paving

- Laying of the hot asphalt is carried out with special motorized units called pavers.
- Pavers are available in a wide variety of sizes capable of laying mats from as narrow as 1 m to up to 16 m wide.
- The minimum and the maximum range of paving width vary from one manufacturer's model to another.
- The pavers are distinguished from the type of their traction, and there are two types:
  - *The wheeled pavers*
  - *The tracked pavers.*



The wheeled pavers



The tracked pavers

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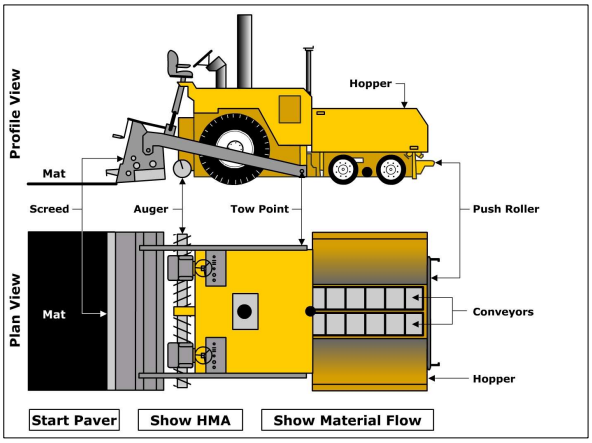
Asphalt Mixtures Laying/Paving

Paver Schematic

- This set of functions can be divided into two main systems:
  - *Tractor*
    - The tractor contains the material feed system, which accepts the HMA at the front of the paver, moves it to the rear and spreads it out to the desired width in preparation for screed leveling and compaction.
  - *Screed*
    - The most critical feature of the paver is the self-leveling screed unit, which determines the profile of the HMA being placed.
    - The screed takes the head of HMA from the material delivery system, strikes it off at the correct thickness and provides initial mat compaction.



Source: https://pavementinteractive.org/reference-desk/construction/placement/

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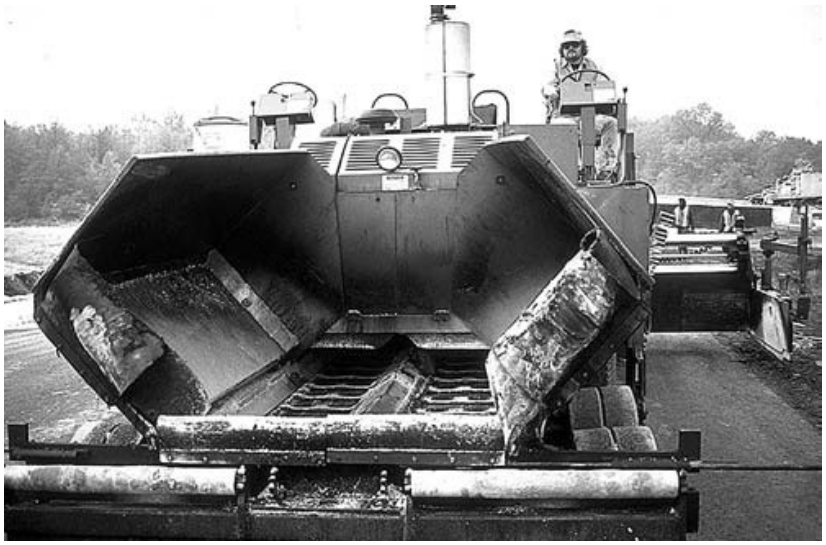
Asphalt Mixtures Laying/Paving

HMA paver with wings lifted



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Asphalt Mixtures Laying/Paving

Paver auger

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Asphalt Mixtures

Laying/Paving

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Asphalt Mixtures

Compaction

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Asphalt Mixtures

Compaction

- The compaction of asphalt layers is possibly the most critical stage of asphalt works.
- It is needed to achieve proper and uniform compaction, which in turn ensures a better long-lasting performance.
- During compaction,
  - *The coated aggregates are compressed, are re-oriented and take such positions that the distance between them becomes the smallest possible.*
  - *As a consequence, the air voids decrease, and the mixture density increases.*
  - *Because of aggregate re-orientation, the stability of the mix and the strength of the asphalt and of the pavement increase.*
- The aim during compaction is to
  - *achieve an optimum void content*
  - *and at the same time to ensure a smooth surface.*

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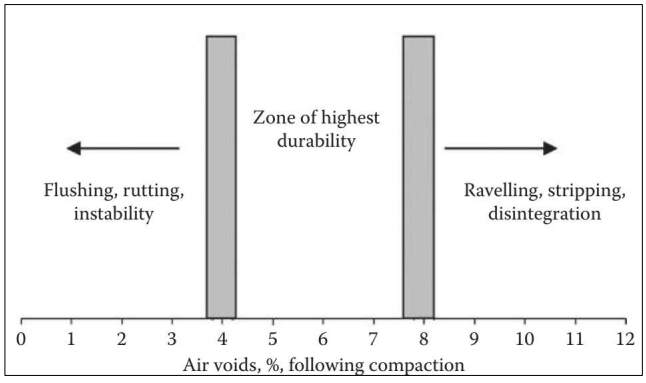
Asphalt Mixtures

Compaction

- An asphalt concrete immediately after laying has a void content ranging from 15% to 20%, using conventional screeds.
- The task of the rollers is to reduce this content to approximately 8% or less.
- Air voids of less than 3.5% after compaction should be avoided,
  - *since rutting, flushing and instability of the mix will most certainly occur.*



The effect of air voids obtained during compaction on the durability of asphalt concrete layer

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Asphalt Mixtures

Factors affecting compaction

- The factors affecting compaction are
  1. *Aggregate material*
  2. *Bitumen grade and compaction temperature*
  3. *Environmental conditions*
  4. *Layer thickness*
  5. *Compaction equipment*
  6. *Compaction procedure*

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Factors affecting compaction

Compaction equipment

Three-wheel static roller

Double-drum vibrating roller

Pneumatic-tyre roller

Combination roller

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Factors affecting compaction

Compaction procedure

To achieve proper and effective compaction of asphalt layers, the following points are recommended:

A. Rolling should start as quickly as possible after asphalt has been laid

B. Rolling consists of three consecutive phases:

1. *The initial or breakdown rolling*
   - ❖ Most of the compaction is achieved during breakdown rolling
2. *The intermediate rolling*
   - ❖ Increases the density of the mix further and minimizes all surface pores
3. *The finish rolling*
   - ❖ During finish rolling, all roller traces and other surface deficiencies are removed

➢ *Between the three phases, there should be no time delay.*

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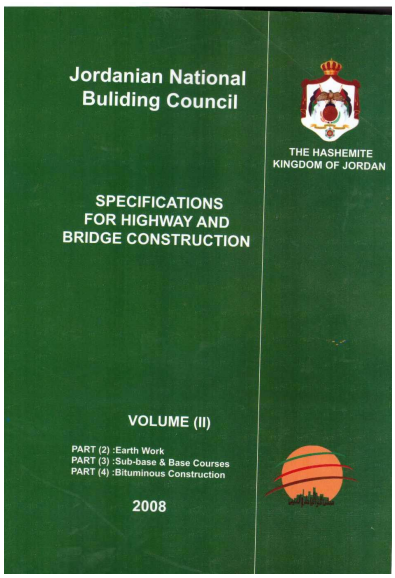
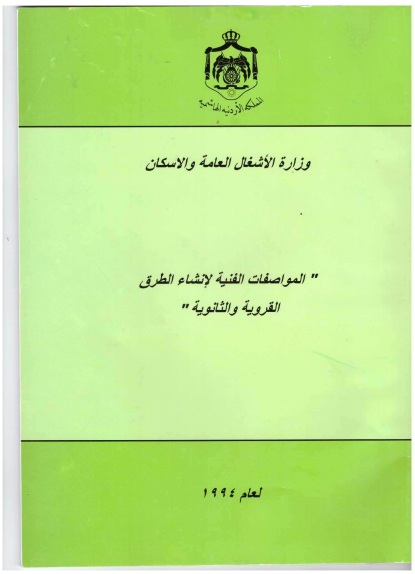
Specifications for highway and bridge construction





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Jordanian National Building council

Specifications for highway and bridge construction

و- عملية الدحل :

يجب أن يتم الدحل كما هو موضح تاليا" الا اذا كانت هناك وسائل حديثة غير ذلك وحسب موافقة المهندس :

١- يجب أن يتم الدحل الأولي (Breakdown Rolling) بحيث لا تكون درجة الحرارة أقل من ١٢٠ درجة مئوية بواسطة مدحلة الحديد مع مراعاة أن تكون العجلات الجارة هي أول ما يدخل على الخلطة .

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Specifications for highway and bridge construction

٢- يتم الدحل بعد ذلك بمدحلة الكاوتشوك عندما تكون درجة الحرارة لا تقل عن ٩٠ درجة مئوية لمنع التصاق الاسفلت بالعجلات وبدونها يجب توقيف العمل مع مراعاة اضافة الماء على العجلات بشكل خفيف ولأول وجه دحل فقط, وعند الضرورة لضمان عدم انخفاض درجة الحرارة للخليط .

٣- يتم الدحل بعد ذلك (Finishing Rolling) مع ملاحظة أنه لا جدوى من الدحل اذا انخفضت درجة حرارة الخليط عن ٧٠ درجة مئوية وعليه يجب أن ينتهي الدحل النهائي قبل وصول حرارة الخليط الى هذه الدرجة .

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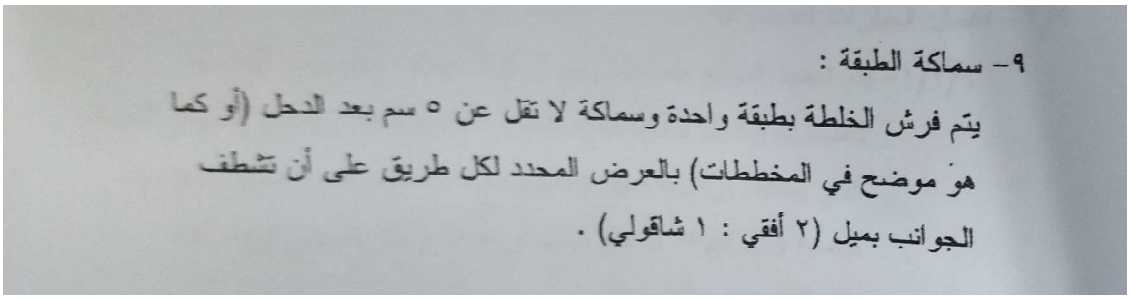
Specifications for highway and bridge construction



٩- سماكة الطبقة :

يتم فرش الخلطة بطبقة واحدة وسماكة لا تقل عن ٥ سم بعد الدحل (أو كما هو موضح في المخططات) بالعرض المحدد لكل طريق على أن تشطف الجوانب بميل (٢ أفقي : ١ شاقولي) .

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