Florida Department of Transportation

HOT MIX ASPHALT PAVING INSPECTION

HOT MIX ASPHALT PAVING INSPECTION

a training course developed

for the

FLORIDA DEPARTMENT OF TRANSPORTATION

This 2002 revision was carried out under the direction of

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FOREWORD

Hot Mix Asphalt Paving Inspection is a training course that covers the activities required to ensure proper field inspection and properly paved roadways. The major areas covered in this course include:

- equipment familiarization;
- materials acceptance and control;
- preparations for paving;
- tack coat application;
- paving and compaction operations;
- inspection of finished pavement; and
- documentation.

All of the above areas are discussed in terms of the technician's responsibilities, but it should not be taken to mean that only one person will perform all the activities. Staffing may vary according to project size and other factors, but each technician should be able to do every work activity.

TABLE OF CONTENTS

DIRECTIONS TO COURSE USERS

TRAINING TECHNIQUE

This course has been designed for self-instructional training:

- You can work alone;
- You can take it as many times as are necessary for learning -- and correct your own mistakes after each quiz; and
- You can finish the training at your own speed.

You will keep this book as your reference, so work neatly.

PREREQUISITES

It is suggested that prior to taking this course you take: Construction Math and Contract Plan Reading. For Hot Mix Asphalt Paving Inspection, you will need both. In addition, you should have completed Hot Mix Asphalt Testing or know the subject matter thoroughly.

HOW TO USE THIS BOOK

This is not an ordinary book. You cannot read it from page to page as you do other books. This book gives you some information and then asks a series of questions about that information. The questions are asked in such a way that you will have to think carefully and draw some conclusions for yourself. If you have difficulty answering the questions, review the sections that give you trouble before going on.

The answers to the questions are listed at the end of each chapter.

TO MAKE THE BEST USE OF THIS COURSE

Take time to study. Don't expect to learn well by just reading -- you must study.

Studying is not the same as memorizing all the material. Don't try to memorize everything you read. Instead, study well enough to understand everything and remember the main points and the special terms.

Be guided by how well you do on the quizzes in this text. If you cannot answer all the quiz questions easily, restudy the text until you can. If repeated study does not help, get help from your supervisor.

EXAMINATION

An examination has been developed for Hot Mix Asphalt Paving Inspection.

The examination contains questions and problems with multiple choice answers. To help you prepare for the examination, a Review Quiz is included at the end of this course. If you have no difficulty with the Review Quiz, the examination should present no problems.

CHAPTER ONE

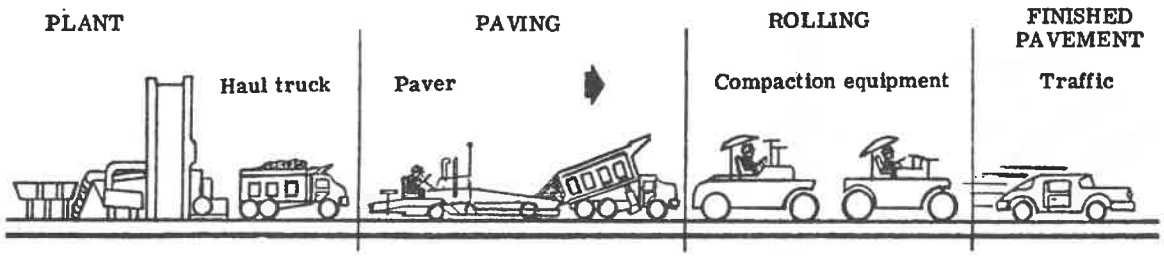
Introduction to Paving

CONTENTS

INTRODUCTION TO PAVING

HOT MIX ASPHALT CONSTRUCTION

Hot mix asphalt (HMA) paving is the operation of placing HMA on the roadway to provide a durable, smooth riding surface in compliance with the designed plan. In simplified form, the operation -- from plant to finished pavement -- is shown below.



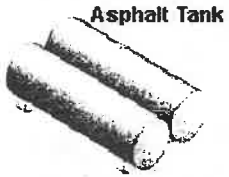
Whether placed as a result of new construction or resurfacing, HMA is the part of the roadway that the public notices the most -- in both riding quality and appearance. As a technician, your job is to ensure the quality and attractiveness of the pavement.

HOT MIX ASPHALT

In this introductory chapter, we will discuss hot mix asphalt -- what it's made of, how it is manufactured and how it is placed on the roadway.

HMA is a mixture of two things:

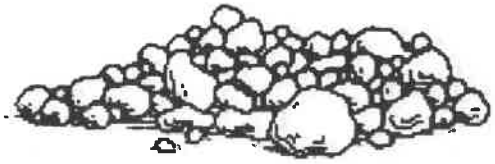
1. Aggregate 

2. Asphalt cement 

AGGREGATE

Sand, gravel and crushed stone are aggregate. They are classified as fine or coarse, according to the sizes of the particles. Sand and crushed stone screenings are fine aggregate. Aggregate larger than sand and screenings -- such as gravel, slag and crushed stone -- are coarse aggregate.

Fine Aggregates 

Coarse Aggregates 

ASPHALT CEMENT

Asphalt cement and tar are considered to be bituminous materials or bitumens. Often these terms are used interchangeably due to misconceptions resulting from their similarity in appearance. Tar is manufactured by the distillation of bituminous coal and is rarely used in paving applications. Asphalt cement is a black, cementing material that varies from solid to semisolid at normal air temperature. It is a refined product made from a petroleum crude oil. When heated sufficiently, it softens and becomes a liquid, thus allowing it to coat aggregate particles during hot mix production. When it cools, asphalt cement hardens to hold the aggregate particles together.

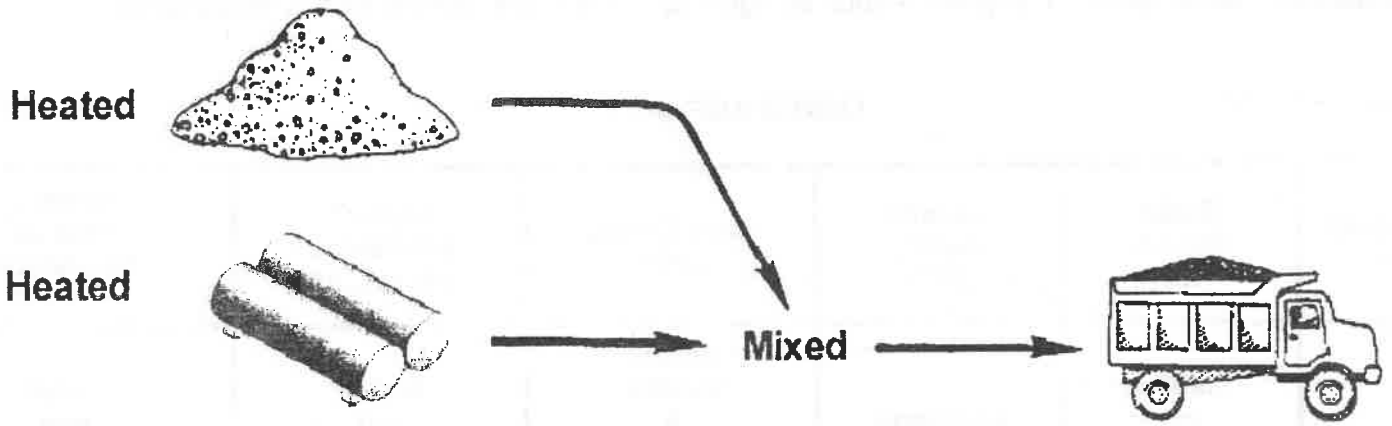
Note that there are differences between "asphalt", "asphalt cement" and "hot mix asphalt". Asphalt cement is one of the many forms of asphalt. Other forms of asphalt -- such as liquid asphalts -- are used to seal road surfaces.

LIQUID ASPHALT

Names of Liquid Asphalts	Rapid Curing (RC)	Medium Curing (MC)	Slow Curing (SC)	Asphalt Emulsions (RS, MS, SS)	Inverted Asphalt Emulsions
Ingredients	Gasoline or Naptha	Kerosene	Slowly Volatile & Non Volatile Oils	Water and Emulsifier	Water and Emulsifier
	Asphalt Cement	Asphalt Cement	Asphalt Cement	Asphalt Cement	RC, MC, or SC Liquid Asphalt

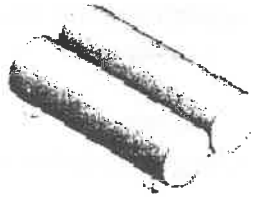
HOT MIX ASPHALT

The aggregate and the asphalt cement are usually heated separately. The asphalt cement is heated in a storage tank and the aggregates are heated in a dryer. Then the hot ingredients are blended to make hot mix asphalt (HMA). The final mixture is approximately 300°F. The HMA is discharged into a truck and taken immediately to the construction site. The mix is placed and compacted while hot. Rollers are used for compaction.



QUIZ

1. The two components of hot mix asphalt are:



(a) _____ + (b) _____

2. A refined paving asphalt used in hot mix asphalt is _____.

3. Sand and stone are two commonly used _____ in hot mix asphalt.

4. Aggregate is classified as _____ or _____, depending on the sizes of the particles.

The answers to these questions start on page 1-23.

HMA PLANT OPERATIONS

The basic function of the HMA Plant is to produce HMA containing the correct materials (aggregate and asphalt cement) in the correct percentages. The basic functions of an HMA plant are:

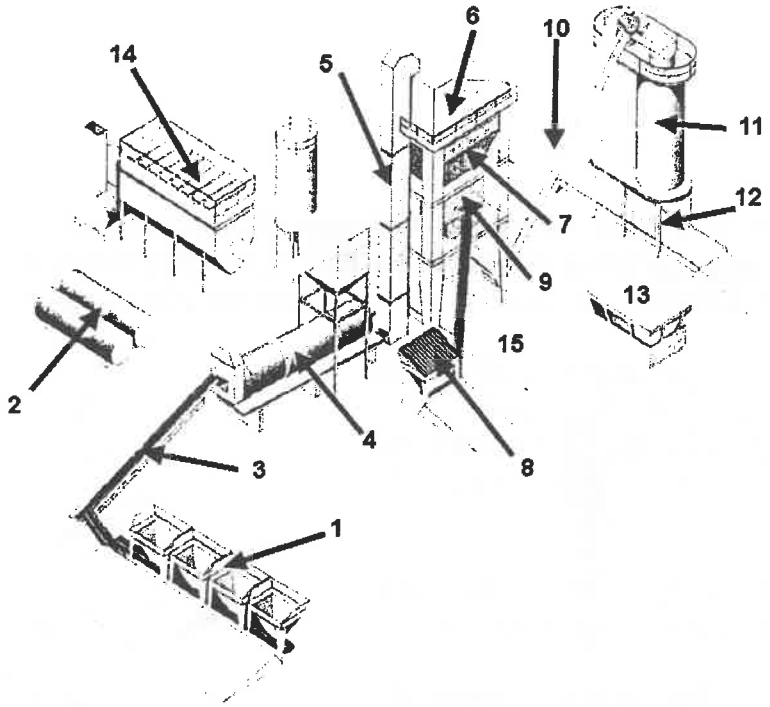
1. Proper storage and handling of HMA component materials.
2. Accurate proportioning and feeding of the cold aggregate to the dryer.
3. Effective drying and heating of the aggregate.
4. Efficient control and collection of the dust from the dryer.
5. Proper proportioning, feeding and mixing of the asphalt cement with the heated aggregate.
6. Correct storage, dispensing, weighing and handling of the finished HMA.

There are two kinds of HMA plants in general use: batch and drum mix plants. Batch plants mix HMA by placing the right quantities of aggregate and asphalt cement in a mixer and mixing one "batch" at a time. Drum mix plants do not have batching units. They keep a constant flow of aggregate and asphalt cement and are mixed to produce asphalt concrete in a continuous process. We will discuss batch plants in this section and drum mix plants later. A further discussion of asphalt plants is contained in the self-study manual, Hot Mix Asphalt Plant Inspection. A detailed discussion is provided in the three day course Asphalt Plant - Level II presented as a part of the FDOT Construction Training and Qualification Program.

BATCH PLANT OPERATIONS

BASIC PROCESS

A diagram showing the basic parts of the batch plant is shown on the next page. Batch plants get their name from the fact that they produce HMA one batch at a time. The size of each batch is controlled by the capacity of the pugmill or mixing chamber where the heated aggregate and asphalt cement are mixed. Typical batch quantities range from 3,000 to 10,000 pounds.



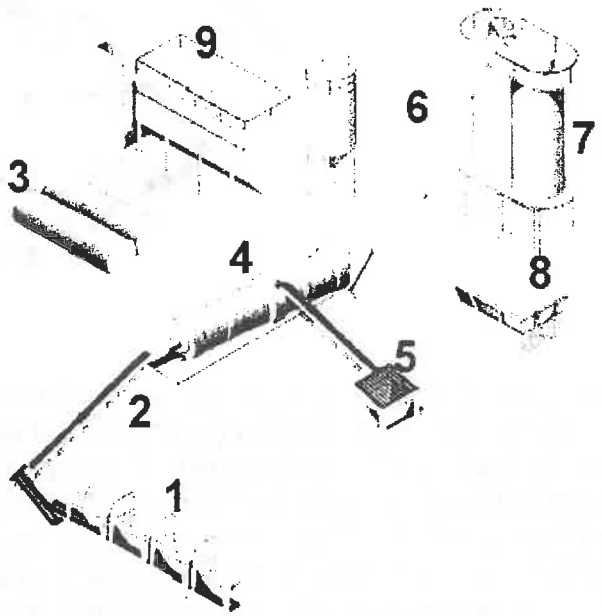
The following describes the basic process by which material flows through a batch plant. The aggregate is first stockpiled and then moved to the cold feed bins (1) which hold each of the aggregate sizes/types and from which the aggregate is proportioned for feeding into the dryer (4). The asphalt cement is stored in either horizontal or vertical storage tanks (2). The aggregate is fed up the cold feed conveyor (3) into the dryer (4) where it is dried and heated to the proper temperature (about 300°F). The aggregate is fed into the hot elevator (5) and then into a screen deck (6) where it is separated into the various sizes that will be used in the production of HMA. The various sizes of aggregate are stored in hot bins (7). If reclaimed asphalt pavement (RAP) is included in the HMA mixture, it is fed from a separate bin (8). They are combined with asphalt cement and mixed in the pugmill (9). After they are mixed they can be fed up a conveyor belt (10) to the hot storage silos (or bins) (11). The completed HMA mixture is loaded into delivery trucks at an area below the storage silos (12). The plant operation is controlled from a control house (13). The plant is also provided with an air pollution control system (14) which in this diagram is a baghouse.

DRUM MIX PLANT OPERATIONS

BASIC PROCESS

The figure below shows the typical parts of a drum mix plant. The major difference between a batch plant and a drum mix plant is where the asphalt cement and aggregate are mixed. In the batch plant they are mixed batch by batch in the pugmill. In the drum mix plant they are mixed continuously in the same drum that is used to heat the aggregate.

The basic parts of a typical drum mix plant are shown. A drum mix plant has no screening unit, hot bins or pugmill. Aggregate gradation is controlled at the cold bins and the drum both dries the aggregate and mixes it with the asphalt cement. Other parts of the plant are similar to a batch plant.



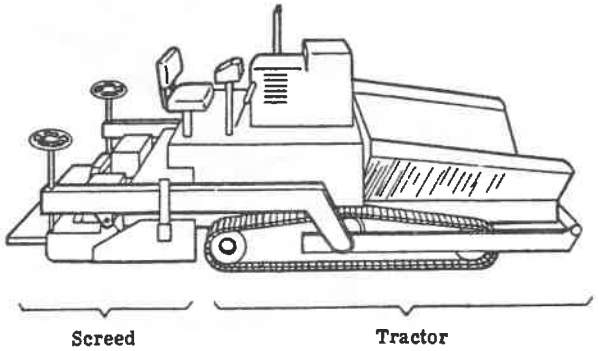
As you read the next paragraph refer to the figure on the this page and follow the flow of the aggregate through the drum mix plant.

As with the batch plant, the controlled gradations are deposited in the cold feed bins (1), from which they are fed onto the cold feed conveyor (2). An automatic weighing system attached to the conveyor monitors the weight of the aggregate flowing into the drum mixer for heating and drying. The weighing system is interlocked with the controls on the asphalt storage pump that draws the asphalt cement from a storage tank (3) and introduces it into the drum (4). The asphalt cement and the heated aggregate is mixed in the drum mixer (4). If reclaimed asphalt pavement (RAP) is included in the HMA mixture it is fed from a separate bin (5). From the drum mixer the hot mix asphalt is transported by conveyor (6) to a surge bin or storage silo (7), from which it is loaded into trucks and hauled to the paving site. The entire operation is managed from the control house (8), and the plant is also equipped with an emission control system (9).

PAVER OPERATIONS

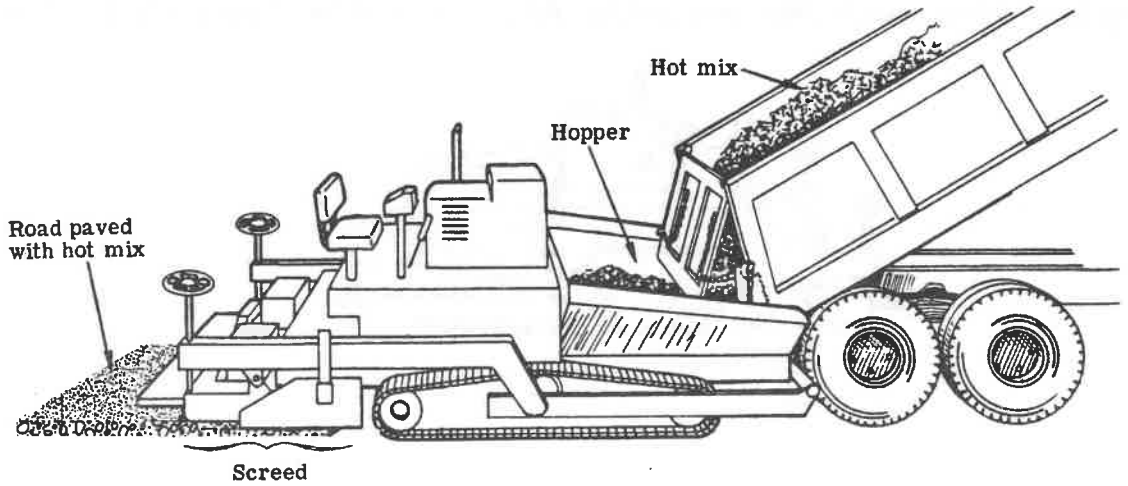
One of the most interesting machines used on paving projects is the paver. This machine "paves" the roadway by placing a hot mixture of asphalt cement and aggregate in a smooth-surface mat.

Pavers may appear complex, but they are actually quite simple. All pavers have two basic parts: a tractor and a screed.



Go to the next page to see how the paver works.

This is what happens. A truck filled with hot mix backs up to the paver and stops. The truck body is raised and hot mix falls into the paver's hopper.



As hot mix falls into the hopper, the paver pushes the truck forward, paving the road with hot mix as it goes. The hot mix is carried from the hopper to the screed. The screed strikes off and partially compacts the hot mix, leaving the new pavement even and smooth.

That's the basic paver operation. Of course, there's more to paving than that, but we will discuss the details later in this course. Right now, we will discuss some more things basic to pavement construction.

QUIZ

1. The two principal parts of the paver are the _____ and the _____.

2. Trucks dump the hot mix into the _____ of the paver.

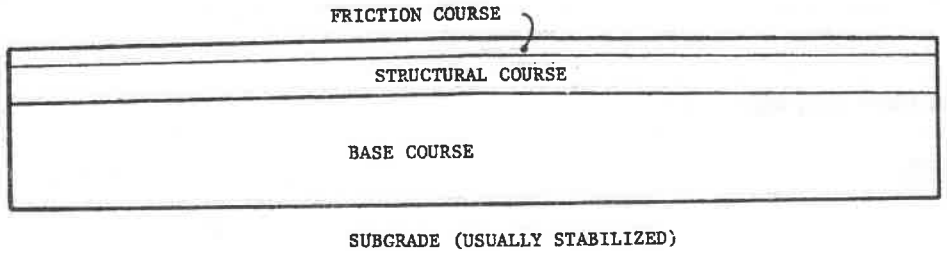
3. What does the screed do? _____

The answers to these questions start on page 1-23.

Go on to PAVEMENT COURSES.

PAVEMENT COURSES

Hot mix is used to construct pavement layers -- courses. The courses used on most new HMA construction projects in Florida are shown below:

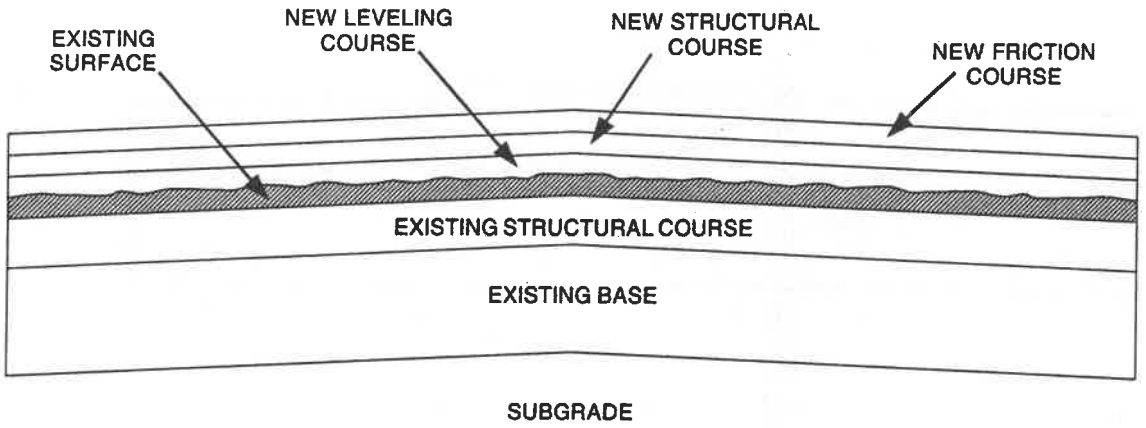


The friction and structural courses are HMA. The base course may be constructed of HMA or it may be constructed of other materials such as limerock, sand-clay, etc.

So far, we have discussed new pavements. HMA is also used to resurface -- overlay -- old pavements. Resurfacing generally consists of milling out the old asphalt layer, and replacing it with a new structural course and friction course. Milling is a common means to prepare an existing pavement for overlay. Cold planning or milling can be used to remove a deteriorated layer (oxidized or rutting), to restore ride, to mill out in gutters to restore drainage, or to mill off a flushed pavement surface to restore skid resistance. It can be used in lieu of placing a leveling course (filling in the low spots) to remove the high points in the existing surface. The main reason it is used is to remove cracked or deteriorated pavement. Equipped with automatic grade and slope controls similar to those used on an asphalt paver, the milling machine is capable of producing a level surface in one pass over an existing paved surface. The RAP produced by the milling process can be hauled back to an asphalt plant for future recycling. A milling machine can produce from 100 to 200 tons per hour, depending on the particular machine and asphalt pavement conditions. Cold milling equipment use carbide bits mounted on a revolving drum to break up and remove the surface material. Drum widths vary from as little as 1 foot to 12 feet. The carbide bits must be continually maintained and frequently replaced to provide a uniform texture with no ridges or low spots. Traditionally, a single carbide bit is mounted in a block, which is then bolted to the revolving drum. This results in a conventional bit spacing of about 0.625 inches.

Occasionally, a leveling course is used instead of milling. The leveling course is an intermediate layer between the old and new surfaces. It eliminates irregularities in the old surface, so that the new course can provide a smoother surface and give a much better ride. Two motor graders and a spreader box, instead of pavers, may be used to place the leveling courses. Because of the irregular underlying surface, the quantity of hot mix applied varies according to the conditions of the existing pavement.

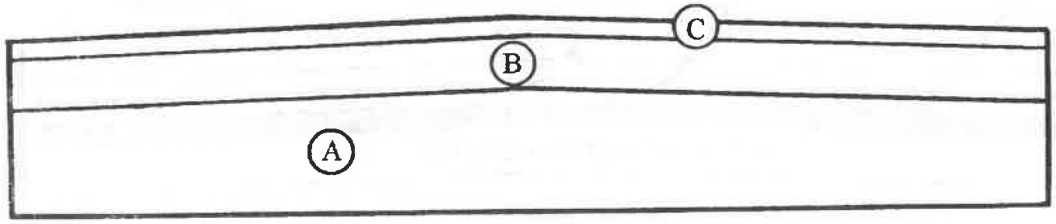
The placement of the various courses is shown below.



QUIZ

1. Layers of pavement are referred to as _____.

2. Label these pavement layers of new HMA construction:



A. _____

B. _____

C. _____

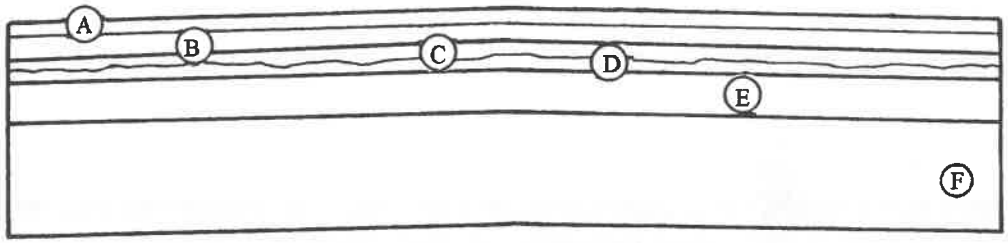
3. Can base courses be constructed of materials other than bituminous mixtures? _____

4. What is the purpose of cold milling? _____

5. Leveling courses may be placed using two _____ and a _____.

QUIZ, continued

6. Label these pavement layers of a resurfacing project:



A. _____

B. _____

C. _____

D. _____

E. _____

F. _____

The answers to these questions are on page 1-23.

Were you able to answer all the questions? If not, review this section and retake the quiz. Go on to CONTRACT DOCUMENTS when you are ready.

CONTRACT DOCUMENTS

PLANS

Plans are the part of the contract documents that show the location, character, dimensions and details of the work.

STANDARD SPECIFICATIONS

The Standard Specifications for Road and Bridge Construction set forth the directions, provisions and requirements that apply to all contractors on all projects. These include legal requirements for bidding and for performing the work, construction details, material specifications, methods of measurement, and bases of payment for work performed.

SUPPLEMENTAL SPECIFICATIONS

These are additions and revisions to the Standard Specifications.

DEVELOPMENTAL SPECIFICATIONS

When a new process, procedure, or material is developed for a project, the specification defining the new process, procedure, or material is known as a developmental specification.

SPECIAL PROVISIONS

When unusual problems or conditions arise during the design or development of a specific project and special instructions that vary from or add to the Standard Specifications are necessary, these will be covered by Special Provisions which are specific clauses adding to or revising the Standard Specifications.

TECHNICAL SPECIAL PROVISIONS

These are specifications prepared, signed, and sealed by an engineer registered in the State of Florida other than the State Specifications Engineer or his designee. These are specific to a particular project and are made part of the contract

as an attachment to the contract documents.

ROAD DESIGN, STRUCTURES, AND TRAFFIC OPERATION STANDARDS

These are plans of items which are common to many projects. They include drainage structures, maintenance of traffic standards, and signing.

DISCREPANCIES

Contract documents are ranked so that any conflicting items are resolved by the highest ranking document. The order of rank from highest to lowest are - Special Provisions; Technical Special Provisions; Plans; Road Design, Structures and Traffic Operation Standards; Developmental Specifications; Supplemental Specifications and Standard Specifications.

QUIZ

1. Name five different contract documents that may be found in an average construction contract:

   A. _____

   B. _____

   C. _____

   D. _____

   E. _____

2. Do the Contract Plans govern over the Standard Specifications? _____

3. Do the Contract Plans govern over the Special Provisions? _____

The answers to these questions start on page 1-23.

Go on to PREPAVING CONFERENCE.

PREPAVING CONFERENCE

Normally, a Prepaving Conference is held before paving begins. Some of the important topics covered in the conference are discussed below.

The Department's and Contractor's organizations -- chains-of-command -- will be outlined and discussed. You must become familiar with them and work through the proper channels during the project.

The Contractor's plan of operation will be discussed in detail. Such items as the quality control plan, hours of operation, progress schedule, location of asphalt plant, material acquisition, mix design, lift thickness, starting and ending points, paving width, number and type of rollers to be used, the staggering of joints, and the rolling pattern will be covered.

The rolling straightedge testing method, acceptable tolerances, action to be taken in the case of unacceptable pavement, and approved corrective methods will be discussed.

Hauling procedures -- such as what routes are to be used and whether or not the contractor will have a sufficient number of trucks in order to keep paving operations moving -- will be discussed.

The Special Provisions for the job will be discussed.

Traffic control -- proper signing and flagging -- and other safety features will be covered, as well as the documentation related to them (Contractor's Traffic Control Plan). You should have access to and become familiar with the Manual on Uniform Traffic Control Devices.

Proper documentation will also be discussed concerning quality control test results, daily reports, minutes of meetings, change orders, etc.

In general, the Prepaving Conference will cover information and requirements not covered in the Standard Specifications. All topics discussed will be important to the construction process.

QUIZ

1. List briefly three common topics of discussion at prepaving conferences:

   A. _____

   B. _____

   C. _____

2. Which contract document governs over the Technical Special Provisions? _____

The answers to these questions are on page 1-23.

ANSWERS TO QUESTIONS

Page 1-7

1. A. Aggregate
   B. Asphalt Cement
2. asphalt cement
3. aggregate
4. fine, coarse

Page 1-13

1. tractor, screed
2. hopper
3. It strikes off and partially compacts the hot mix.

Page 1-16 & 1-17

1. courses
2. A. Base course
   B. Structural course
   C. Friction course
3. Yes
4. To eliminate irregularities in old surfaces
5. motor graders, spreader box
6. A. New friction course
   B. New structural course
   C. New leveling course
   D. Existing surface course
   E. Existing structural course
   F. Existing base course

Page 1-20

1. *Any of the following are correct:
   Standard Specifications
   Technical Special Provisions
   Supplemental Specifications
   Standards
   Contract Plans
   Developmental Specifications
   Special Provisions
2. Yes
3. No

Page 1-22

1. *Any of the following are correct:
   Department's and Contractor's organizations
   Contractor's plan of operation
   Hauling procedures
   Special Provisions
   Traffic control and other safety features
2. Special Provisions

CHAPTER TWO

Familiarization with the Equipment

CONTENTS

FAMILIARIZATION WITH THE EQUIPMENT

In this section, we will discuss the equipment used in constructing hot mix asphalt (HMA) pavements. Before construction begins, all the equipment should be inspected to see that it is in good condition. In general, the equipment should run smoothly and have no fuel or oil leaks.

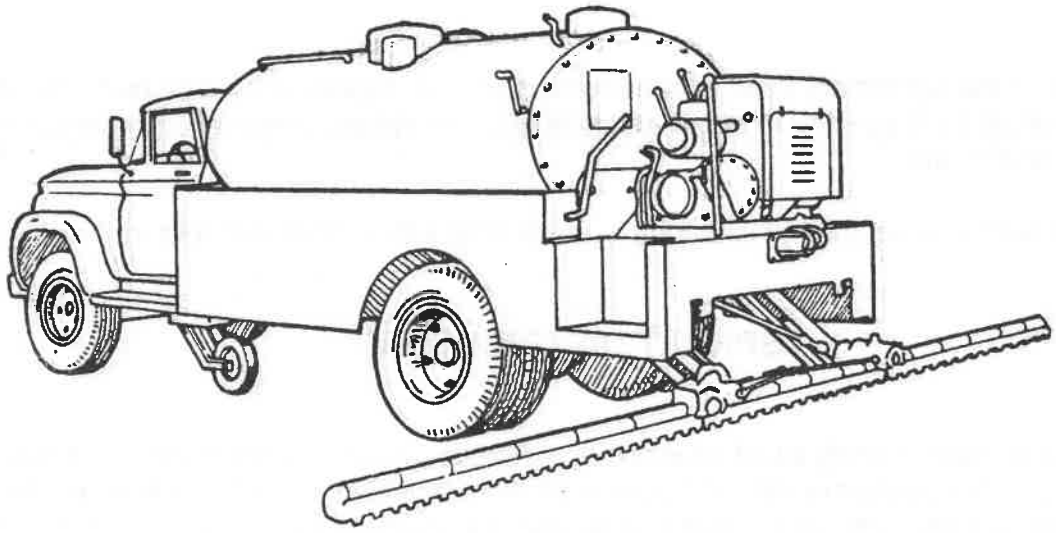
We will discuss the various pieces of equipment individually, beginning with asphalt distributors.

ASPHALT DISTRIBUTORS

In HMA paving, a distributor is used to apply liquid bituminous materials -- tack and prime coats. A tack coat is a spray application of emulsified asphalt or asphalt cement (usually a diluted emulsified asphalt) sprayed on the surface of an existing pavement prior to an overlay. The purpose of a tack coat is to promote the bond between the old and new pavement layers.

A prime coat is a spray application of a medium cutback asphalt or emulsified asphalt prime (EAP) applied to a granular (non-asphalt) base. The purpose of the prime coat is to fill the surface voids and protect the base from the weather, stabilize the fines, and to promote bonding of subsequent pavement layers. Since prime coats are related more closely to base course construction, we will not discuss them in this course.

An asphalt distributor is a truck mounted asphalt tank with pumps, spray bars, and appropriate controls for regulating the rate at which asphalt is applied to the surface area. The tank is insulated and equipped with an oil or gas fired heating system that can heat the asphalt uniformly and safely within specified temperature limits. These limits are set to provide the best application of hot liquid asphalt as the truck moves along the roadway.



Now, let's discuss the individual parts and requirements of asphalt distributors. First we will discuss distributor calibration.

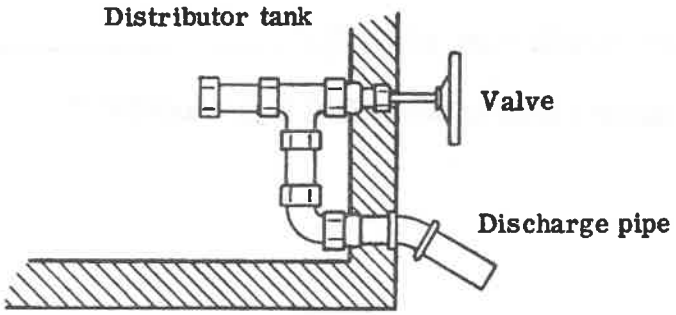
CALIBRATION

Asphalt distributor tanks are calibrated to facilitate the measuring of quantities of bituminous material applied by them. Each distributor has a calibration chart which is used to convert measurements of the distributor's contents into gallons of bituminous material.

Each distributor must have its own calibration chart. There is a calibration number on the chart that should match the number stamped on the distributor. The chart will indicate where the stamp is located on the distributor, how to measure the distributor tank, and how to convert the measurements to gallons. Measuring distributor tanks and using calibration charts will be discussed later in the course.

SAMPLING DEVICE

Asphalt distributors must have a serviceable discharge pipe or spigot from which samples can be taken. The figure at right shows such a sampling device. Normally, it will not be necessary to take samples for testing; however, you must verify that the material is the proper type and that it has been pretested. The distributor operator must have documents showing the material type and pretest number.



Now, go on to the quiz on the next page.

QUIZ

1. What are the two general requirements for all equipment used in paving operations?
   _____ and _____

2. Liquid bituminous materials -- such as tack -- are applied by _____.

3. What is the name of the asphalt cement used to bond HMA layers together?
   _____

4. Asphalt distributor tanks are:

   ___ A. insulated
   ___ B. calibrated
   ___ C. refrigerated
   ___ D. heated

5. How should you verify that the correct calibration chart is being used with the distributor? _____
   _____
   _____

6. Calibrations charts are used to convert tank measurements into _____ of bituminous material.

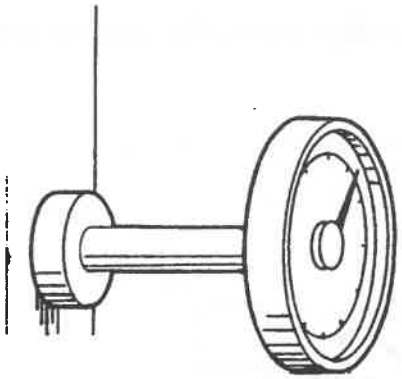
7. What must be verified before the bituminous material is used? _____

The answers to these questions start on page 2- 56.

THERMOMETERS

Since the temperature of the tack has to be within a specified range, there must be some way of checking it.

All distributors must have dial-type thermometers mounted on the tank.



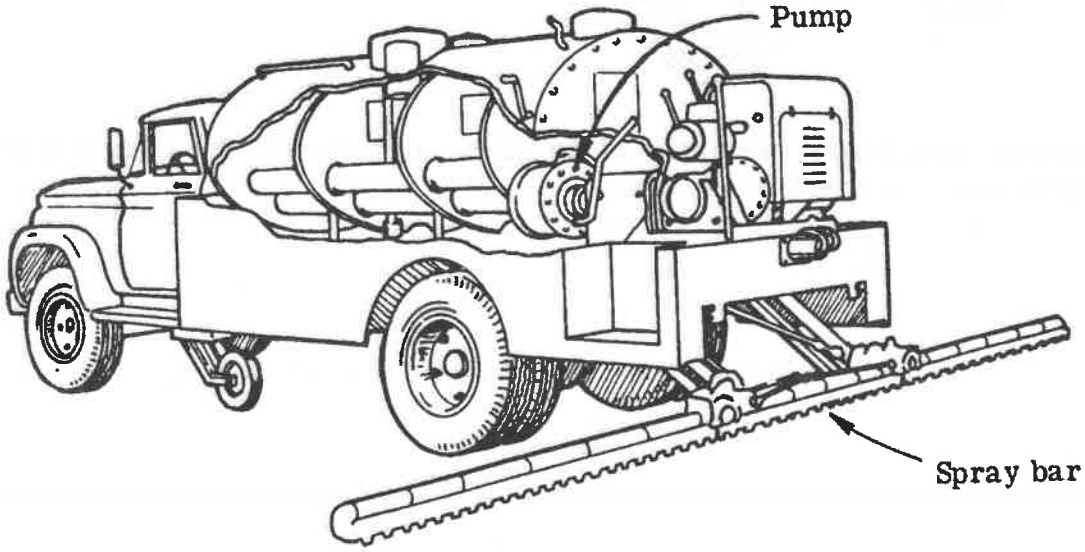
DIAL-TYPE THERMOMETER

These thermometers measure the average temperature of the bituminous material in the tank. It is an average temperature because the material in the tank is circulating.

CIRCULATION SYSTEM

The circulation system uses a pump to exert a uniform pressure, which is registered on a gauge on the distributor. The uniform pressure:

- circulates material in the tank to prevent the asphalt from solidifying and clogging the spray bar and nozzles.
- sprays material through the spray bar or hand spray.
- draws material back into the tank from the spray bar or hand spray.



QUIZ

1. What type of thermometer is required on all asphalt distributors? _____

2. The thermometers measure the average temperature of the bituminous material because the material is _____ _____ uniformly through the tank.

3. Tack is forced from the tank by the _____.

4. To check pump pressure, refer to the _____ on the distributor.

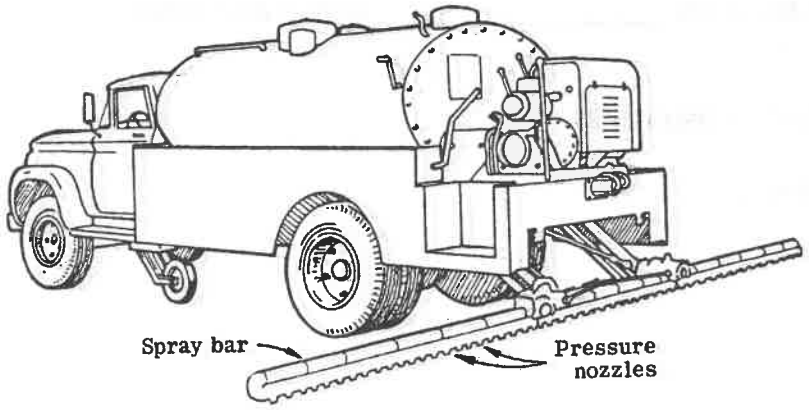
The answers to these questions start on page 2-56.

Go on to APPLICATION EQUIPMENT.

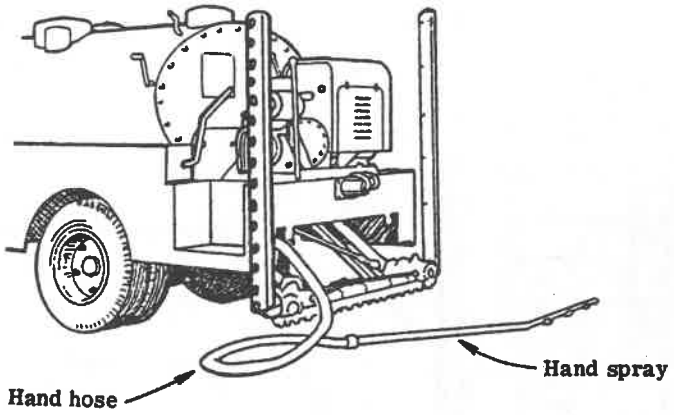
APPLICATION EQUIPMENT

Tack is applied to the roadway through a spray bar with pressure nozzles. The spray bar folds out to various application widths. By opening and closing specific nozzles, different spray widths are obtained. Spray bars also must be adjustable vertically, to increase or decrease the distance between the spray bar and the surface being paved.

The nozzles have requirements too. The distance between the centers of the openings of the outside nozzles must be equal to the width of the application required -- within a tolerance of 2 inches.



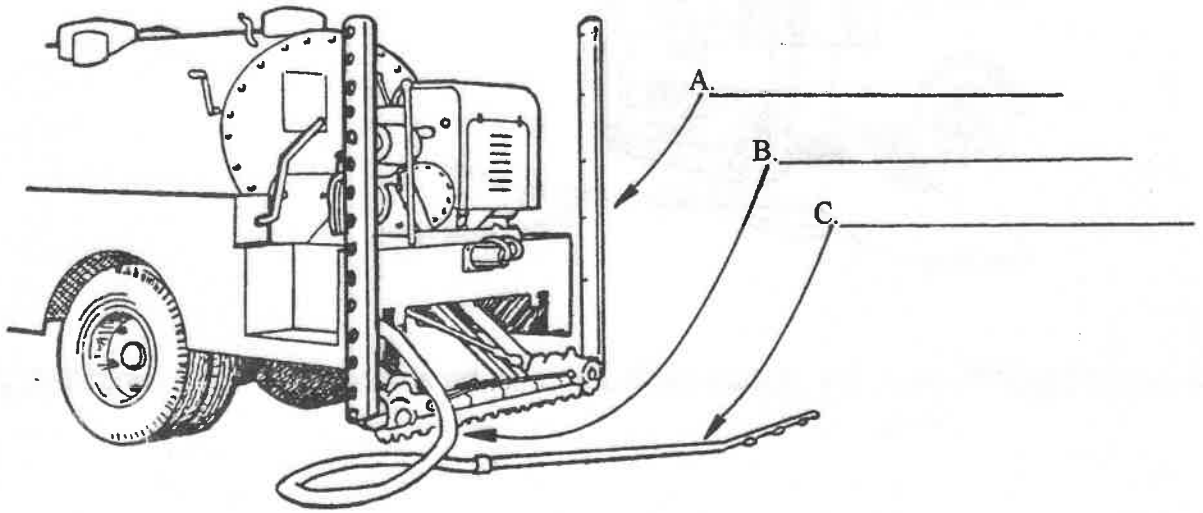
In some areas, tack may be applied to the vertical face of curbs, gutters, cold pavement joints and structures through a hose connected to the pump discharge. On the end of the hose is a hand spray.



Regardless of the method used to apply the tack, the asphalt distributor must be able to apply it at a controlled, uniform rate.

QUIZ

1. Label parts A, B and C.



2. Must spray bars be capable of being adjusted vertically? _____

3. Tack is sprayed into confined places with a _____.

4. Asphalt distributors must be able to apply tack at _____, _____rates.

The answers to these questions start on page 2- 56.
How did you do on this quiz? Be sure you answer <u>all</u> questions correctly before continuing to HAUL TRUCKS.

HAUL TRUCKS

Haul trucks are used to carry the HMA from the plant to the roadway.

When we say haul truck, we're not talking about just any truck. The haul truck not only has to transport the mix, but it must protect it as well. So, there are specifications for haul trucks to meet.

HAUL TRUCK REQUIREMENTS

First, the haul truck should have a tight body (bed). By tight, it must be free of holes, cracks, etc. Also, the body should be clean. Any foreign material in the body could damage the hot mix asphalt. Even hot mix that has stuck to the body and cooled could contaminate the next load. For a tight body to be clean, it should be smooth -- because HMA and cleaning solution slide off smooth surfaces easily.

All haul trucks must have a tarpaulin or other waterproof cover attached, of either canvas or some other suitable material. Covers may be necessary to protect the HMA against heat loss and rain. The protective covers must be large enough to cover the entire load, overlap all sides of the body and be tied down.

The truck bodies should be free of holes. However, the truck bodies must have one small hole at each side -- through which a thermometer is inserted. The temperature of the loads of hot mix are taken to verify that the mixes are within the required temperature range.

Haul trucks that have oil leaks should not be used. Leaking oil will contaminate the paving surfaces. If oil is leaking from a haul truck, the truck must be repaired before it is used to haul any more HMA to the roadway.

The outside of the truck should also be kept clean and free of extraneous materials to prevent the falling aggregate from breaking windshields of other vehicles and causing accidents.

LUBRICATING TRUCK BODIES

During the day -- as the haul truck carries loads of hot mix asphalt -- some of the mix can stick to the bottom and sides of the body. To prevent a build-up of mix, the bodies may be sprayed with a release agent -- usually at the plant site. Kerosene, petroleum products, or other deleterious materials shall not be used. Be sure that only release agents that meet specifications are being used. The coating should be applied prior to the first loading each day and repeated as necessary throughout the day's operations. After the truck bed has been coated and before any mix is placed in the bed, the bed should be raised to drain any excess liquids. However, a thin film of release agent remains in the body to prevent the mix from sticking.

Release agents may not be necessary. The thing to watch for is mix sticking to the truck bodies. If the mix sticks, then a release agent should be used.

QUIZ

1. Briefly list the requirements for haul trucks:

   A. _____

   B. _____

   C. _____

   D. _____

2. Which of the following are acceptable release agents for haul truck bodies?

   ___ A. Thin coats of soapy water
   ___ B. Approved emulsion
   ___ C. Kerosene

3. When are release agents <u>not</u> necessary? _____

The answers to these questions start on page 2-56.

Go on to PAVERS when you are ready.

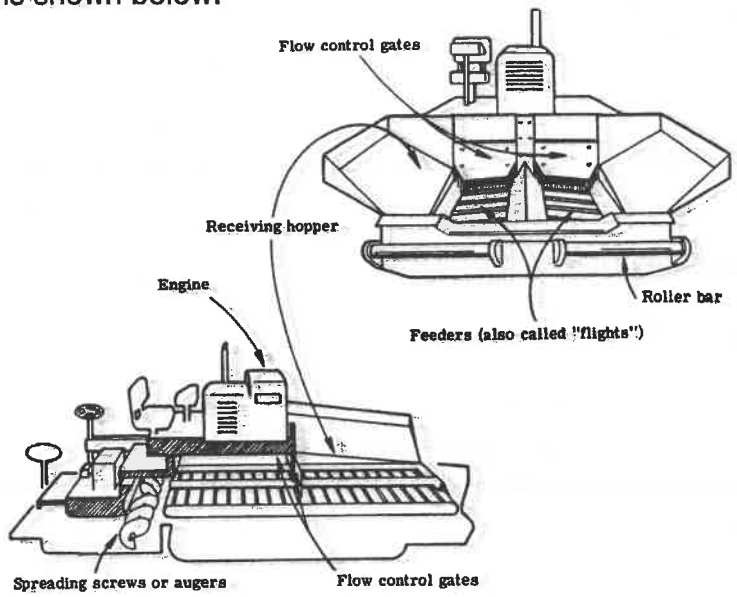
PAVERS

In this section, we will discuss the paver. Pavers are self-propelled machines designed to place and initially compact an HMA mixture to a specific depth.

As we discussed previously, the paver has two units: the tractor unit and the screed unit.

TRACTOR UNIT

The tractor unit provides the moving power for the paver's wheels or tracks and for all powered machinery of the paver. The tractor unit includes the engine, roller bars, receiving hopper, feeders, flow control gates, and spreading screws or augers. The location of each part is shown below.



You should be as familiar as possible with the workings of the paver, so each part will be discussed separately.

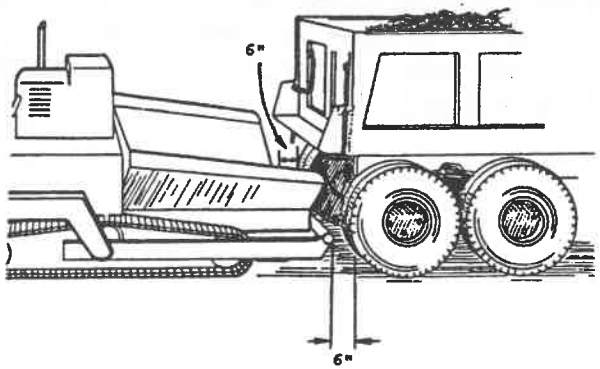
Engine

Pavers must be self-propelled and capable of pushing loaded haul trucks. These requirements are met by the engine. Like the motor of a car or truck, the engine powers the paver.

Roller Bars

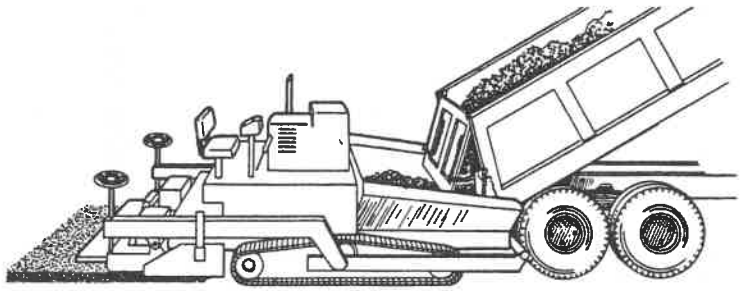
First let's consider the roller bars. There are two bars located in front of the receiving hopper. The roller bars must be in a free-turning condition -- not gummed up with asphalt. If the roller bars are cleaned on the job, be sure they are not cleaned with diesel fuel on the pavement.

The roller bars are the points of contact for the haul truck wheels. The loaded truck backs up to within about 6 inches of the paver roller bars. The truck must not back up until it hits the paver. It should not bump into the paver.



The paver should move forward -- slowly -- until the roller bars make firm contact with both wheels of the truck.

The paver starts to move forward. As the paver moves forward, the roller bars push against the truck wheels, pushing the truck forward. The truck box is elevated and the mix falls into the hopper of the paver. The paver pushes the haul truck along the roadway until the truck is empty.



Many pavers are equipped with a truck hitch that is located underneath the push rollers on the front of the paver hopper. The purpose of the hitch is to keep the truck in contact with the paver and prevent the truck driver from pulling away and inadvertently dumping mix on the pavement in front of the roller. The hitch, controlled by the paver operator, comes into contact with the rear wheels of the truck on each side of the truck. When the truck bed has been emptied, the hitch is withdrawn and the truck pulls away.

Receiving Hopper

The receiving hopper holds the hot mix asphalt after it is dumped from the haul truck and supplies a constant flow of mix to the feeders. The sides, or wings, of the hopper are movable so that the mix can be moved from the sides of the hopper into the middle of the hopper by folding the wings (sides) and allow the mix to be deposited into the area of the slat conveyors (feeders).

QUIZ

1. The paver has two units. They are the _____ and the _____.

2. The haul truck backs up to within about _____ inches of the paver roller bars.

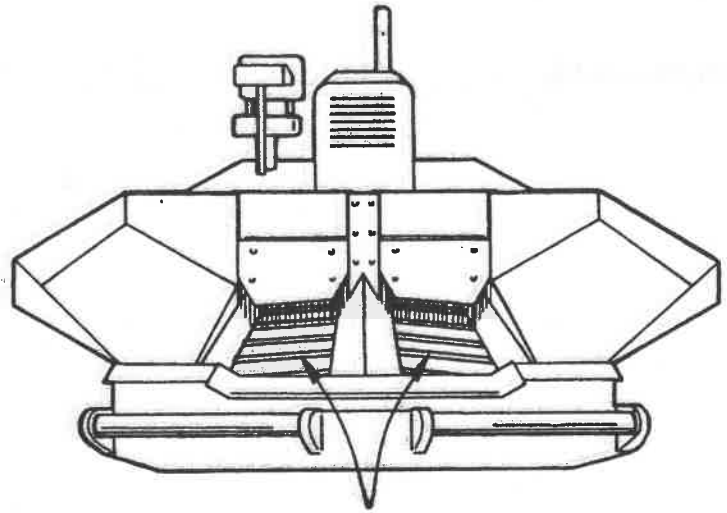
3. Should the haul trucks back up until they "bump" the paver? _____

The answers to these questions start on page 2-56.

Go on to Feeders.

Feeders

In the bottom of the hopper are two moving feeders -- sometimes called "flights". These feeders are like conveyor belts -- so you also may hear them referred to as "conveyors". The conveyor on one side of the paver operates independently from the movement of the conveyor on the other side of the machine. Thus, the amount of mix can be carried back differently. This arrangement allows the paver to pave ramps, mail box turnouts, and tapers.

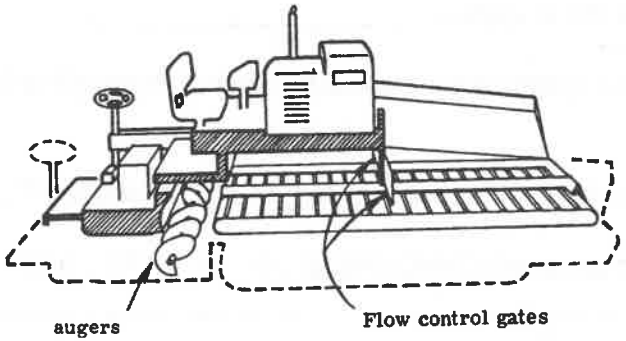


Feeders

The feeders move the mix through the tractor unit. At the back end of the feeders, there are openings -- flow control gates -- where the mix falls onto the augers. The operator can start and stop the feeders, controlling the amount of mix going to the roadway.

Flow Control Gates and Augers

At the back of the hopper are two "flow control gates". The flow of mix conveyed by the feeders onto the augers can be controlled by these gates. They can be lowered to cut down on the amount of mix or raised to allow more mix to pass onto the augers.



The feeders, flow control gates, and augers should be coordinated so that there will be an even distribution of the material in front of the augers.

The augers should distribute the hot mix asphalt evenly across the roadway in front of the screed unit. Sometimes -- in order to pave wider widths -- the augers are lengthened by attaching auger extensions. The pavers with extendable screeds can be equipped with hydraulically extendible augers. These extensions must be adjusted to provide the same performance as the main augers.

There is a new type of paver that uses twin augers in lieu of the slat conveyors to move the mix from the hopper to screed. The concept is that the augers provide an opportunity to remix the HMA as it travels through the paver, improving uniformity.

Many material feed systems have automatic feed controls. A sensor measures the head of material and controls the slat conveyors and augers such as ultrasonic, infrared, and laser sensors which can send and receive signals to measure the mix level and control the slat conveyors and augers.

QUIZ

1. The mix is carried from the hopper to the augers by _____.

2. The amount of mix carried through the machine by the feeders can be controlled by raising or lowering the _____ _____.

3. What is used to distribute the mix across the roadway in front of the screed unit? _____

4. What must be done in order to obtain an even distribution of hot mix in front of the augers?
_____

5. What can be done to pave lanes wider than the width of the augers? _____
_____
_____

The answers to these questions start on page 2-57.

Go on to SCREED UNIT.

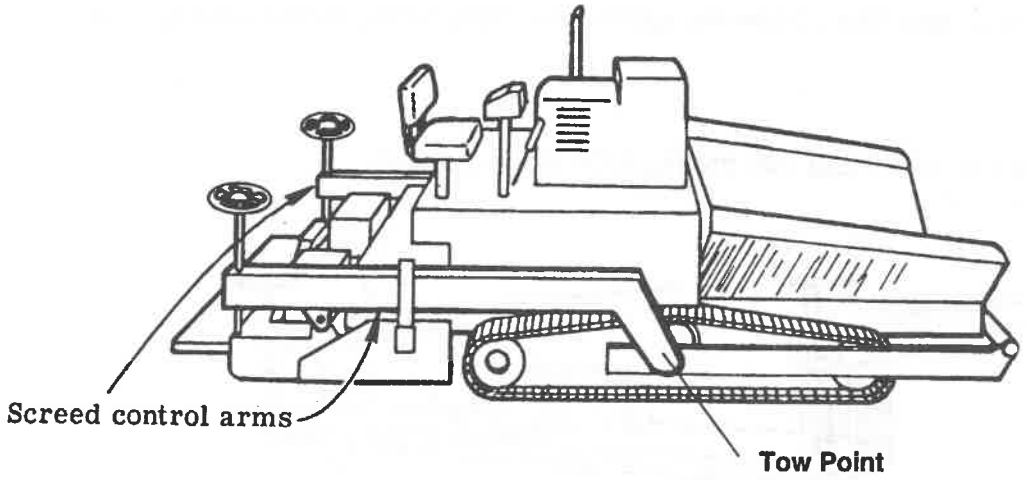
SCREED UNIT

The function of the screed unit is to strike off, partially compact, and smooth the mix.

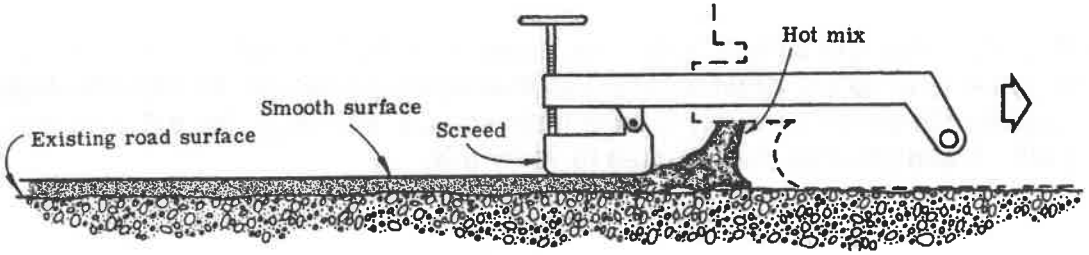
When the width to be paved is wider than the screed, extension plates may be attached to the screed to increase the effective paving width, or the paver may be equipped with hydraulic screed extensions. As with the auger extensions, screed extensions must be adjusted to perform exactly like the main screed. Primarily, the extensions must be in the same plane as the screed itself. A straightedge can be used to verify this.

Control Arms

The screed is attached to the tractor unit by two long screed control arms, as shown below:



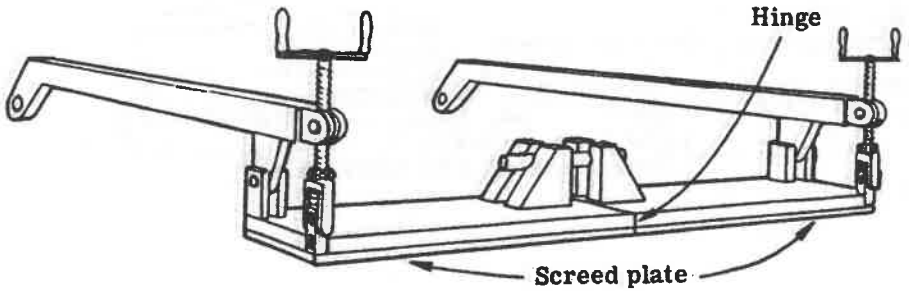
These arms are attached in such a way that the screed floats on top of the mix being laid. The bottom of the mix will follow the exact contour of the road surface being covered, but the screed will leave a smooth, even surface on the hot mix.



So far, what we have said is true of all pavers. But no two manufacturers make screed units exactly alike.

Screed Plate and Hinge

The screed plate -- shown below -- is part of the unit that provides the ironing action.



Did you notice the hinge on the figure above? The hinge is there so that the plate can be adjusted. We will discuss adjusting the screed plate after the quiz beginning on the next page.

QUIZ

1. The function of the screed is to _____, partially _____ and _____ the mix.

2. When the width to be paved is wider than the screed, _____ may be attached to the screed to increase the effective paving width.

3. How is the screed attached to the paver? _____

4. Does the screed follow the contour of the road surface being covered? _____

5. How would you describe the way the screed rides? _____

6. What is the primary requirement for screed extension plates? _____
_____

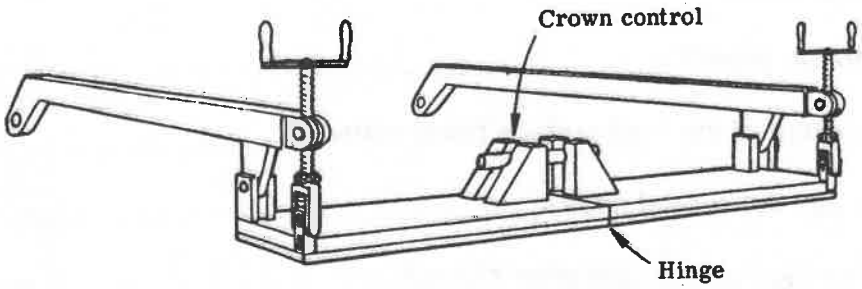
7. How can you verify that the above requirement is met? _____
_____

8. Why are screed plates hinged? _____

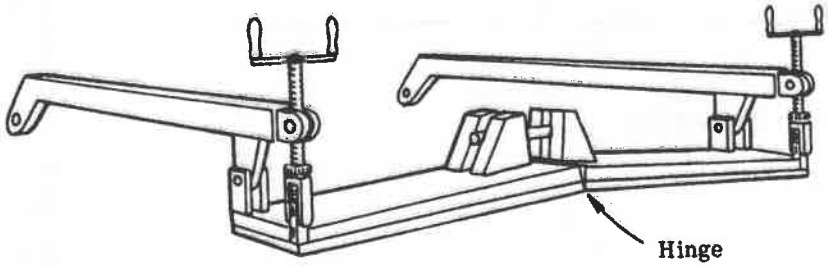
The answers to these questions start on page 2- 57.

Crown Control

The shape of the screed plate is adjusted by using the crown control located in the center of the screed platform. The screed unit may be operated so that the plate is flat across the bottom -- like this one:

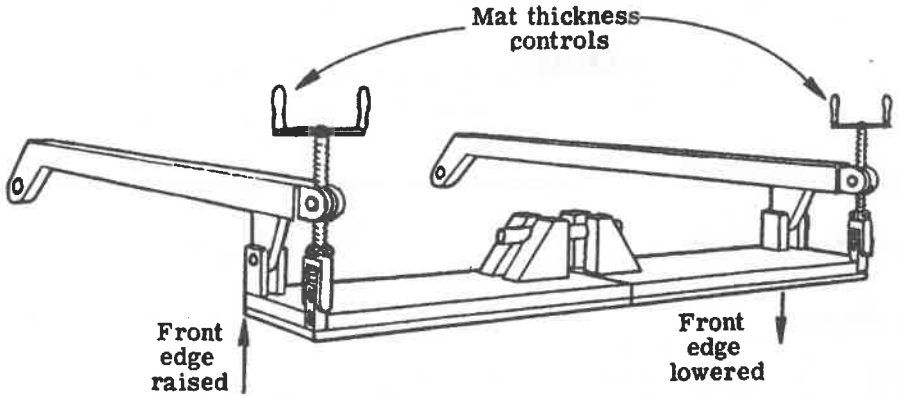


Usually, however, it is adjusted to look more like this, with the center of the screed plate slightly raised in order to achieve the appropriate crown:



Mat Thickness Controls

Mat thickness controls also are used to adjust the screed. They control the thickness of the mat -- the amount of mix allowed to pass under the screed. The controls tilt the screed, raising and lowering the front and back edges.



When the front edge is raised, more hot mix is allowed to flow under the screed -- increasing the mat thickness.

When the front edge is lowered, less hot mix flows under the screed -- decreasing the mat thickness.

Screed Heaters

Screed heaters are used to heat the screed plate to about 300°F at the start of the day's operation. This prevents the mix from sticking to the screed plate. Screed heaters are used only to warm the screed plate, never to heat the mix itself.

QUIZ

1. How is the shape of the screed plate adjusted? _____.

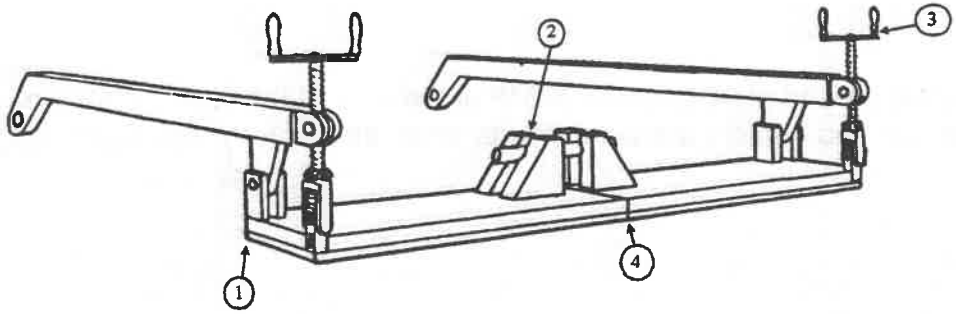
2. Normally, the screed plate is adjusted so that:

   ___ A. it is slightly raised in the center.

   ___ B. it is flat across the bottom.

   ___ C. it is raised at the ends.

3. In the figure below, which arrow points to the crown control? _____



4. _____ to keep the mix from sticking to the screed plate.

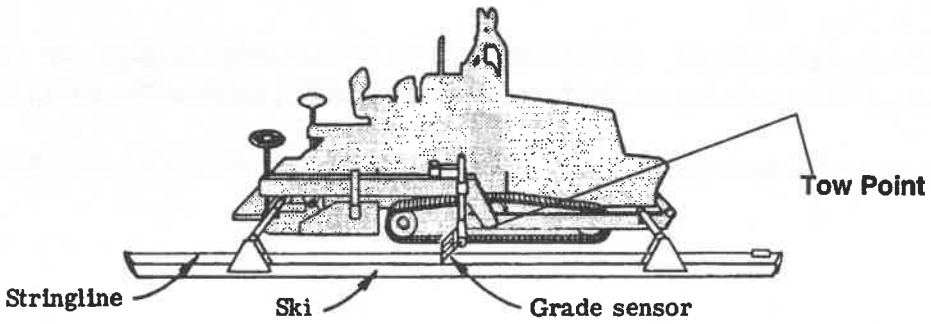
The answers to these questions start on page 2- 57.

Automatic Screed Control

The Department requires that the grade controls be operated electronically on all mixes, except when placing open-graded friction courses FC-5.

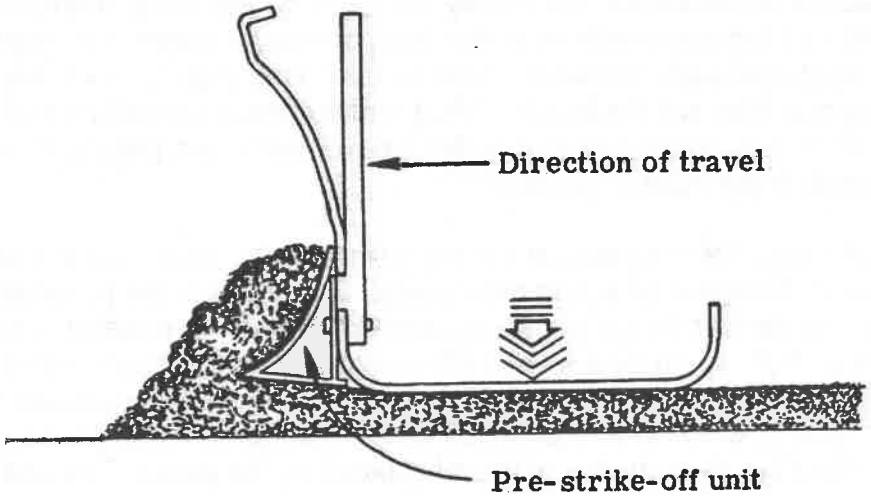
The screed unit on the paver is attached to the tractor unit at only one point on each side of the paver, called the tow (or pull) point. As the tractor follows the existing grade with its rubber tires or crawler tracks, the length of the paver wheelbase becomes the reference for the screed. Because of the reaction time required for the screed, the screed will respond more slowly to changes in grade than will the tractor. Thus under manual screed control, discussed earlier, the screed will average out deviations in the roughness of the underlying pavement layer, placing more mix over the low points and less mix over the high points in the existing pavement.

Automatic screed controls are used to keep the elevation of the tow points on the paver at a predetermined elevation relative to the reference (either a preset stringline or a long mobile ski). Deviations in the pavement surface are averaged out over the length of the reference. As the tractor unit moves up and down over the existing grade, the elevation of the tow points moves over a smaller range than would be the case if the relatively short wheelbase of the tractor provided the reference. Keeping the elevation of the tow points constant in direct relationship to the reference permits the screed to maintain a more consistent angle of attack, which in turn provides for a smoother mat behind the screed. It should be noted, however, that many factors affect the smoothness of the mix placed by the paver. The use of automatic screed controls by itself does not ensure that the mat constructed will be smooth.



Vibratory Screed

On the vibratory screed, the screed itself strikes off and compacts the mix. Vibrators -- located on top of the screed plate -- "vibrate" the screed in an up and down motion.



A pre-strike-off unit is used on the vibratory screed. It is attached to the screed and vibrates with the screed. The pre-strike-off unit controls the amount of mix going under the screed by pushing excess mix along in front of the screed.

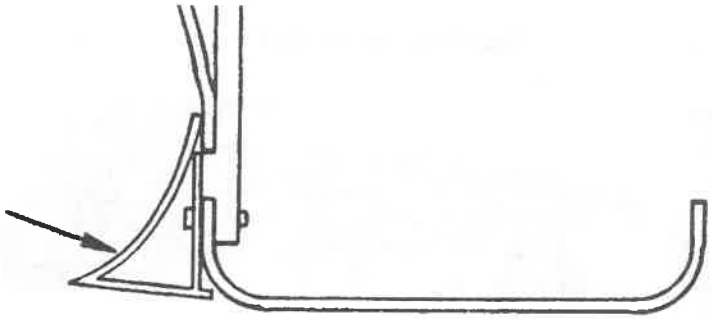
You should check the manufacturer's recommendations for vibrator frequencies for various mat thicknesses.

QUIZ

1. On the vibrating screed, some compaction is accomplished by the _____ itself.

2. The vertical motion of the screed is controlled by _____.

3. The arrow below is pointing to the _____.



4. This unit controls the _____.

The answers to these questions start on page 2-57.

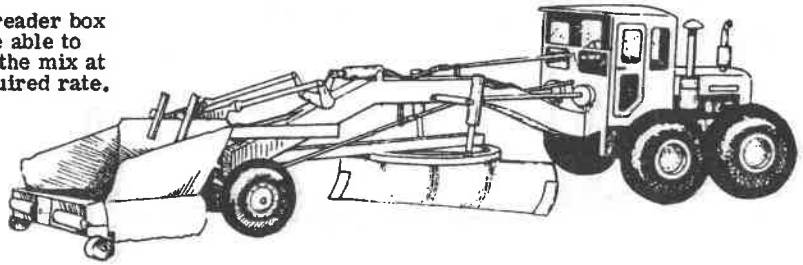
MOTOR GRADERS

Motor graders are sometimes used to place leveling courses on existing surfaces. Two graders are necessary for this operation. Generally, leveling of an existing pavement is accomplished with milling equipment.

The front motor grader must be equipped with a spreader box, as shown below.

FRONT MOTOR GRADER

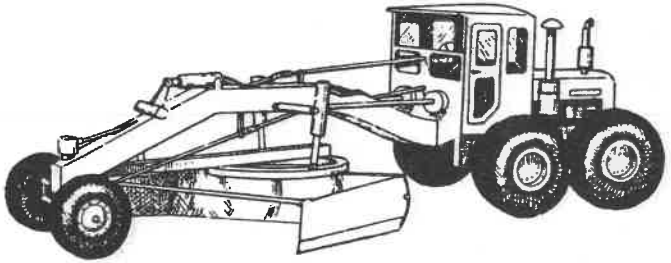
The spreader box must be able to spread the mix at the required rate.



The back motor grader must have an end dam attached to both ends of the blade, as shown below.

BACK MOTOR GRADER

The end dam must turn with the skew of the blade.



SIZE AND TYPE OF GRADERS

Motor graders used in leveling operations should be rated at not less than six tons and be self-propelled and power controlled. They must have wheel bases of at least 15 feet. The tires must be smooth tread or ribbed -- no lug type tires are permitted.

BLADES

The blade of both front and back graders must be at least two feet longer than the width of the lane being leveled. The blade suspension systems must be tight, with no loose play or excessive wear. The blades themselves should be in good condition. Straightedge checks should be made to determine the straightness of the blades. Visual checks should be made to note excessive wear in the blade edges. There must be no large nicks in the blade.

QUIZ

1. How many motor graders are required for placing leveling courses? _____

2. What must be attached to the blade of the back motor grader? _____ These must be able to turn with the _____ of the blade.

3. Motor graders used in leveling operations must be rated at not less than _____ tons.

4. Which of the following types of tires may be used on graders for leveling operations?

   ___ A. Lug types

   ___ B. Ribbed

   ___ C. Smooth tread

5. What is the length requirement for the blades? _____
   _____

6. What is the requirement for the blade suspension systems? _____
   _____

7. What should be done to determine the straightness of the blades? _____

The answers to these questions start on page 2-57.

ROLLERS

Paving operations require various combinations of rollers. The three basic types of rollers used are the steel-wheeled, pneumatic-tired, and vibratory. All rollers have some characteristics in common. We can study these characteristics before we discuss each type individually.

Steel-wheel rollers must be able to compact the mix without excessively crushing the aggregates. They must be equipped with wheel moistening systems, scrapers, and pads. These keep the hot mix from sticking to the wheels. Fuel oil must never be used because it dissolves the mix. Also for this reason, the roller should not be fueled or serviced on the new pavement. If a roller leaks oil or gas, it should be repaired before being used.

The exception to the servicing restriction is that water may be added to rollers on the new pavement. In fact, rollers should not be allowed to continue operations until they have enough water to moisten the wheels in order to avoid picking up the hot mix.

All rollers must operate smoothly. This means that there should be no excessive motion in the yokes -- where the wheel assemblies join the body of the rollers -- or in the torque converters. Excessive motion in the torque converter will cause backlash, which in turn will cause rough spots or gouges in the mat.

The wheels of all rollers must be in a straight (vertical) position in relation to the pavement.

QUIZ

1. What three basic types of rollers are used to compact asphaltic concrete pavements? _____, _____, and _____

2. What must steel-wheel roller wheels be equipped with? _____, _____, and _____.

3. Which of the following should not be used or done?

   ___ A. Rollers that leak oil or gas

   ___ B. Fueling rollers while on new pavement

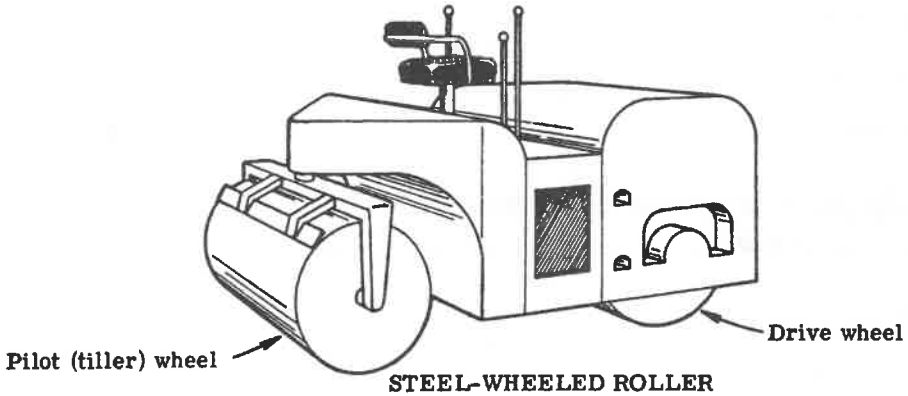
   ___ C. Adding water to rollers on new pavement

4. Rollers must not have excessive motion in the _____ or in the _____.

The answers to these questions are on page 2-57.

STEEL-WHEELED ROLLERS

These steel-wheeled rollers must be of the tandem type and must operate slowly enough that they do not gouge or shove the mix out of place. The wheels should be round and smooth -- free of flat areas, openings, or projections which mar the pavement. Also, the wheels should be equipped with scrapers and pads and moistening systems to prevent the mix from sticking to them.



STEEL-WHEELED ROLLER

To inspect the wheel surfaces for smoothness, place a straightedge across the width of the wheels. Sometimes the scraper blades are straight enough to use in these smoothness checks. Merely sight along the straightedge or scraper to note any defects in the wheel surfaces.

If you have ever looked closely at the pilot wheel of a steel-wheeled roller, you probably noticed that it is actually in two sections. The gap between the sections must be very small -- or else it will leave marks in the pavement.

Steel-wheeled rollers should compact the mat and leave a smooth surface. Irregularities are ironed out by rolling back and forth on the mat. When rollers reverse directions, there should be no jerking. This jerking when the direction is changed is called backlash. Backlash damages the surface -- so always check to see that the rollers can change directions smoothly. Also be sure that the steering is smooth and uniform -- so that the operator can control the roller properly. The steering mechanism should have no leaks that would contaminate the pavement.

QUIZ

1. When you inspect roller wheel surfaces what things should you look for?

   _____

   _____

   _____

2. What can be used to check the roller wheels for smoothness?

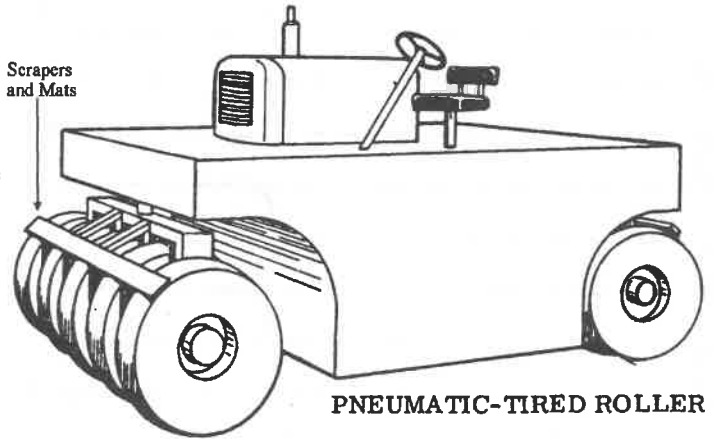
   _____ and _____

3. Is backlash undesirable? _____

See page 2-57 to check your answers. If you answered all the questions correctly, go on to the next page. If you made mistakes, review the previous page before going on.

PNEUMATIC-TIRED ROLLERS

Pneumatic-tired rollers (also called rubber tire rollers or traffic rollers) are used to compact HMA pavement between the seal and final rollings of the steel-wheeled rollers. Pneumatic means "air" and refers to the air-filled tires of this type of roller.

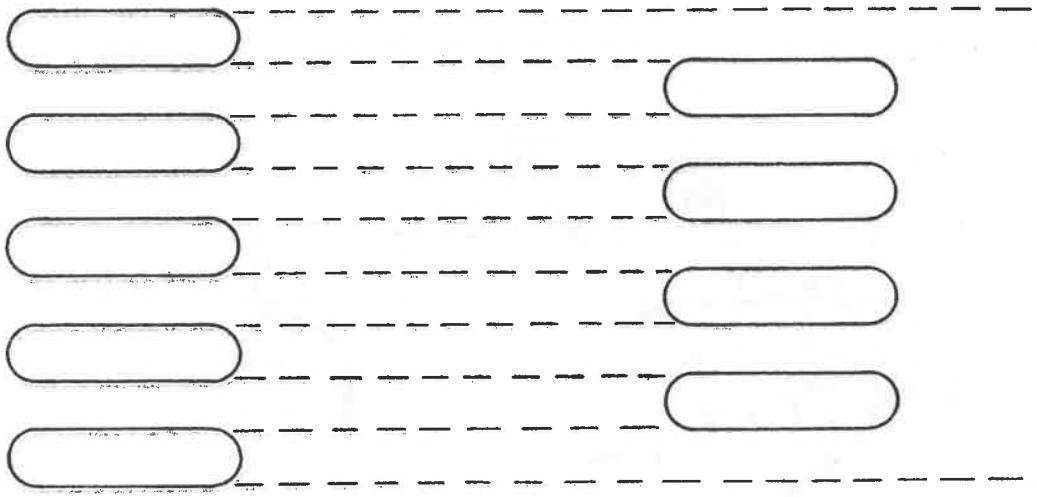


PNEUMATIC-TIRED ROLLER

These rollers should be self-propelled, able to move forward and backward on any grade encountered, and have two axles mounted on a rigid frame. The steering requirements are the same as for steel-wheeled rollers. Of course, as with steel-wheeled rollers, backlash must not be present and the rollers must be able to turn and reverse without scuffing the pavement surfaces. The weight of these rollers should be between 8 and 12 tons. Pneumatic-tired rollers have an uneven number of wheels. The roller you probably will see most often has five wheels on one axle and four wheels on the other. But, no traffic roller should have fewer than seven wheels. "Wobble-wheeled" rollers are not permitted.

The scrapers and mats shall be installed to keep the tires clean.

The tires are arranged so that the gaps between the tires of one axle will be covered by the tires of the other, as shown below:



All tires should be identical. They should be of equal size, ply rating, diameter, and inflation pressure. Inflation pressures for the tires of a roller should be in the 50 - 55 psi range, as indicated in the Standard Specifications, or as required by the manufacturer. Each tire should be completely smooth -- no treads, cuts or excessive wear.

Tire inflation pressure affects the amount of compactive effort applied to the pavement by the rollers. The tire inflation pressure should be checked periodically with an air gauge.

QUIZ

1. Pneumatic-tired rollers also are referred to as _____ rollers.

2. What are the weight limits for pneumatic-tired rollers? _____

3. Which of the following must be identical for all the tires of a roller?

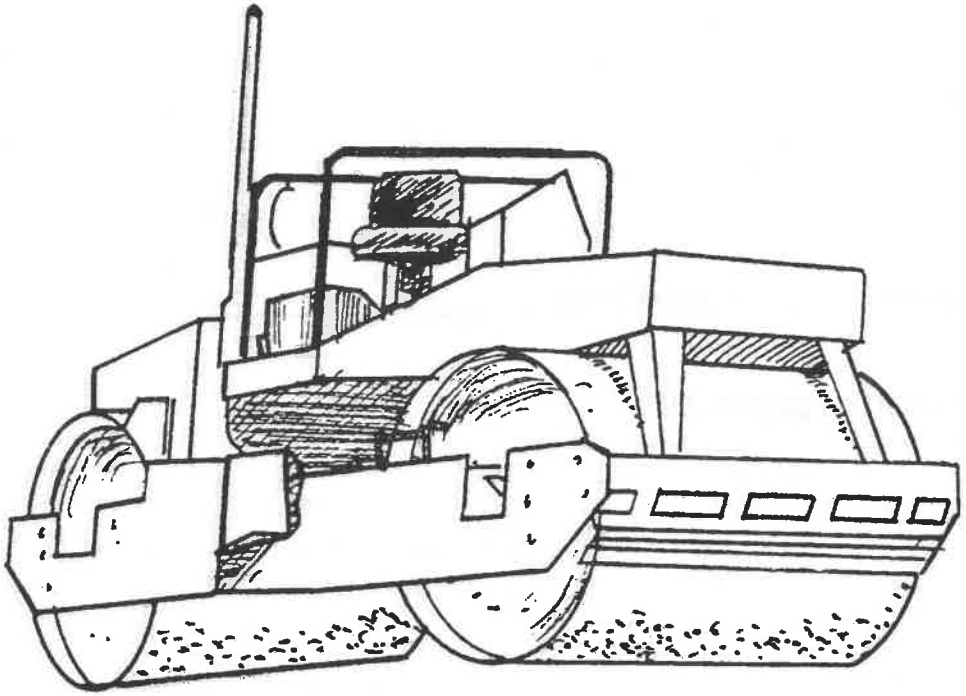
   ___ A. Ply rating
   ___ B. Inflation pressure
   ___ C. Size
   ___ D. Diameter

4. What are the permissible tire inflation pressure limits? _____

The answers to these questions start on page 2- 58.

VIBRATORY ROLLERS

Vibratory rollers, when properly used, can compact HMA in thicker lifts and to higher densities with the same or fewer number of passes than the combined efforts of the steel-wheel and traffic rollers. They consist of two smooth-surfaced steel drums 3 to 5 ft in diameter and from 2 to 7 tons in weight.



Operating Principles

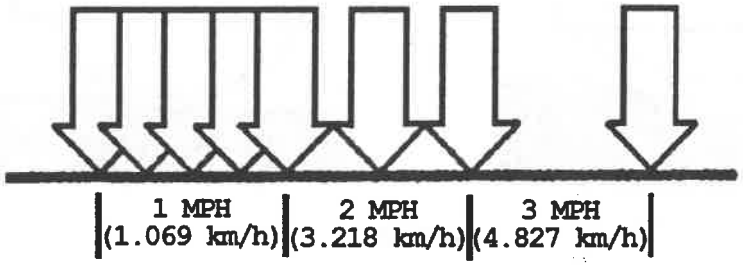
The formidable array of variables involved in using vibratory rollers requires considerably more skill and knowledge on the part of the roller operator. Improper use of the vibratory roller can be far more damaging to the mat than improper use of the other two types of rollers. However, the complexity is far outweighed by the capability and versatility of the vibratory roller.

Vibratory rollers achieve compaction through weight and impact forces. The impact forces are generated by vibration of the compaction drum and are regulated by the frequency and amplitude of vibration.

Amplitude and Frequency

Vibrations are generated by eccentric weights on independent counter-rotating shafts. The rotational speed of the shaft determines the frequency. The mass of the eccentric weight, its location, and the mass of the drum determine the amplitude of the roller drum.

Frequency is the speed of rotation of the eccentric weight in terms of vibrations per minute (vpm). Selection of the proper vibrations is critical to the densification process and to the smoothness of the pavement surface. The frequency selected will also hinge on the forward speed of the roller. The frequency should be such that there will be in the range of 10 - 12 impacts per foot of travel.

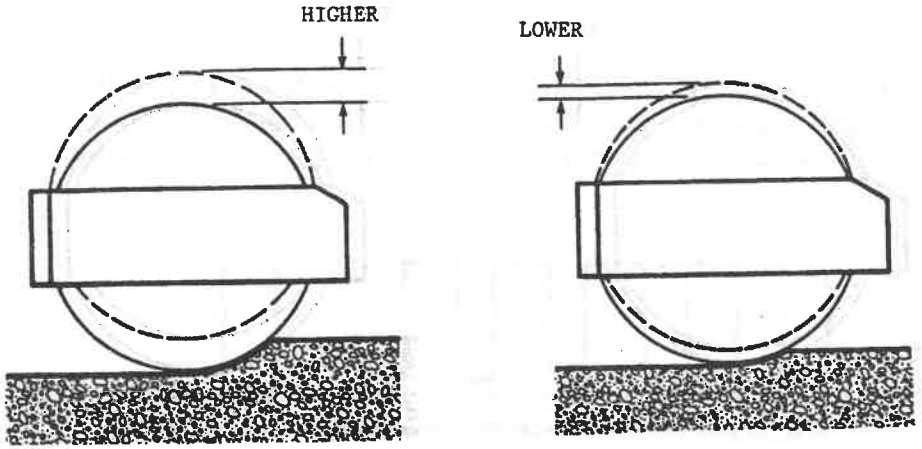


Relationship Between Speed and Frequency

The frequency of vibration for rollers used on asphalt is generally in the range of 2000-3000 vpm. Some models provide one or two settings for frequency while others provide a full range within certain limits (1800-2400 vpm). The frequency of the vibratory roller can be measured with a reed tacheometer.

Amplitude is the total vertical (up and down) motion of the drum caused by the rotation of the eccentric weight, measured in micrometers (thousandths of an inch). The amplitude is a measure of how hard the drum strikes the pavement each time the eccentric rotates. The greater the amplitude, the harder the drum strikes the mat. For asphalt pavements, the normal range for amplitude is between 0.01 and 0.04 in.

The proper amplitude is the maximum that can be absorbed by the mixture without being transmitted to the underlying course. Too great an amplitude can damage the lower course and the elastic rebound can decompact the mixture being rolled.



AMPLITUDE

On medium layers, use a high frequency and a low amplitude and on thick layers use a high amplitude and a low frequency. Do not use vibrators on lifts of 1" or less.

QUIZ

1. Vibrations are produced by _____ weights.

2. The number of times the drum vibrates per minute is called the _____.

3. Vibratory rollers achieve compaction through _____ and _____ forces.

4. The _____ is a measure of the impact force of the drum.

5. For thicker layers, the _____ should be increased and the_____ should be decreased from the settings used on thinner layers.

6. Vibratory rollers should not be used on lifts of _____ or less.

7. The frequency should be such that there are a minimum of _____ to _____ impacts per foot of travel.

Check page 2-58 to see if your answers are correct.

OTHER EQUIPMENT

The basic equipment used in the construction of HMA has been discussed. Now, we will discuss briefly some other basic equipment that you will encounter on some or all asphaltic paving jobs.

CLEANING AND SWEEPING EQUIPMENT

The Standard Specifications require that the existing surface be cleaned thoroughly before any HMA is laid on it. The Contractor may use a variety of equipment -- from hand brooms and shovels to power brooms and power blowers.

HAND EQUIPMENT

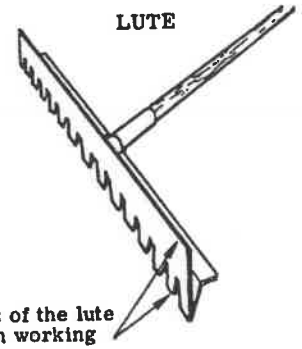
Although most of the work of HMA paving is done by machines, hand equipment is still necessary. The hand equipment is used in preparing the existing surface to be paved, in constructing joints, in working with the freshly laid mat, and in cleaning up after paving.

Basic hand equipment includes lutes, rakes, shovels, scrapers, and brooms. Usually, these are carried on the paver during spreading operations. Lutes, rakes, and shovels are used in working with the hot mix -- smoothing rough spots and filling in slight depressions. Scrapers and brooms are used in cleaning the roadway and equipment after paving.

Axes, picks, and shovels may be used in constructing joints in the pavement. You may even see power saws used sometimes in cutting joints.

Lutes and rakes are important items of hand equipment. They are used to spread and smooth the hot mix laid by the paver. This is necessary because the paver sometimes leaves minor defects in the mat. They are also used extensively when the mix must be laid by hand in small areas where the paver cannot operate.

Lutes -- as shown at right -- have teeth that are wider than the teeth on ordinary rakes. Also, the spaces between the teeth are smaller.



Both edges of the lute are used in working the hot mix.

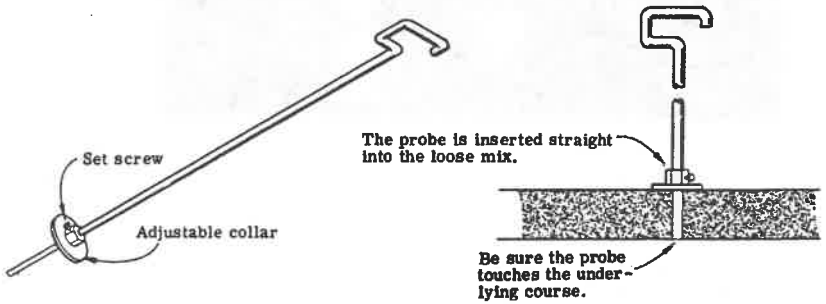
COMPACTION EQUIPMENT

We discussed the basic compaction equipment in this chapter -- steel-wheeled, pneumatic-tired, and vibratory rollers. Other equipment may be used if approved by the Engineer. Such equipment may include trench rollers, mechanical (vibratory) tampers, and hand tamps.

Trench rollers are used for compacting sections of base courses that are widened and which cannot be compacted by ordinary rollers because of the narrowness of the pavement. Hand or mechanical tampers also are used in compacting pavement in confined areas -- such as those adjacent to curbing, abutments and other structures.

TOOLS FOR CHECKING MAT THICKNESS

Small rules, adjustable try squares and other types of probes may be used to check the mat thickness behind the paver.

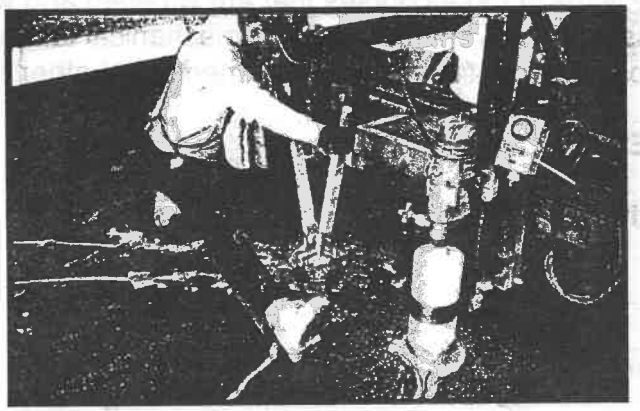


STRAIGHTEDGES

Rolling straightedges and 15-foot manual straightedges are used to check the surface tolerances of HMA pavement. Procedures for checking surface tolerances are discussed in Chapter Six.

CORING EQUIPMENT

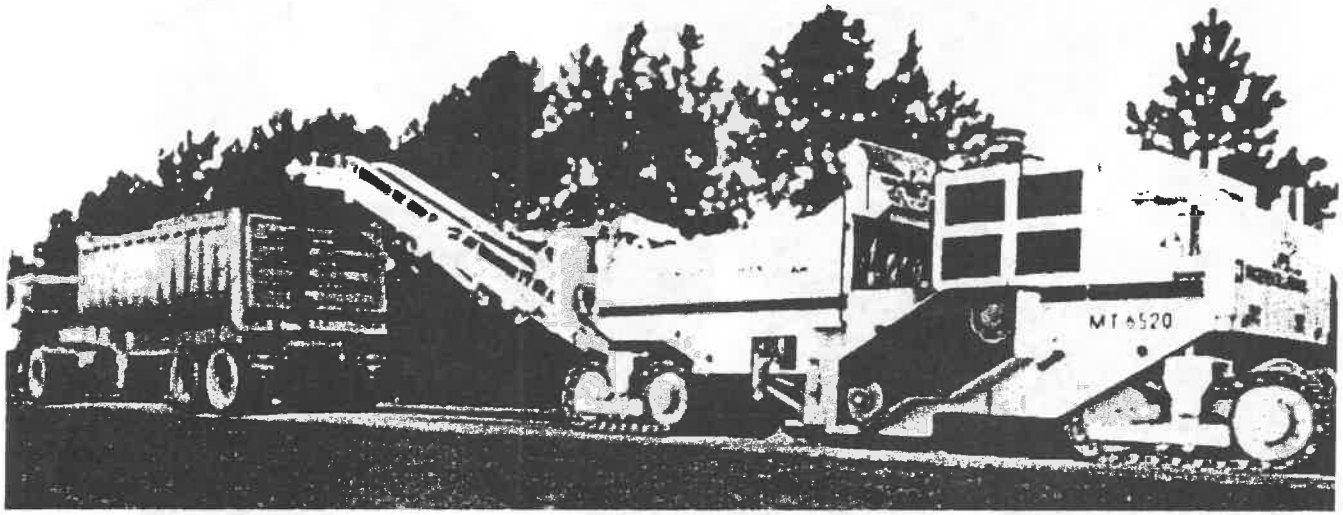
Coring equipment -- such as a suitable saw or drill -- must be provided to obtain the required cores for density tests and determining pavement thickness.



MILLING EQUIPMENT

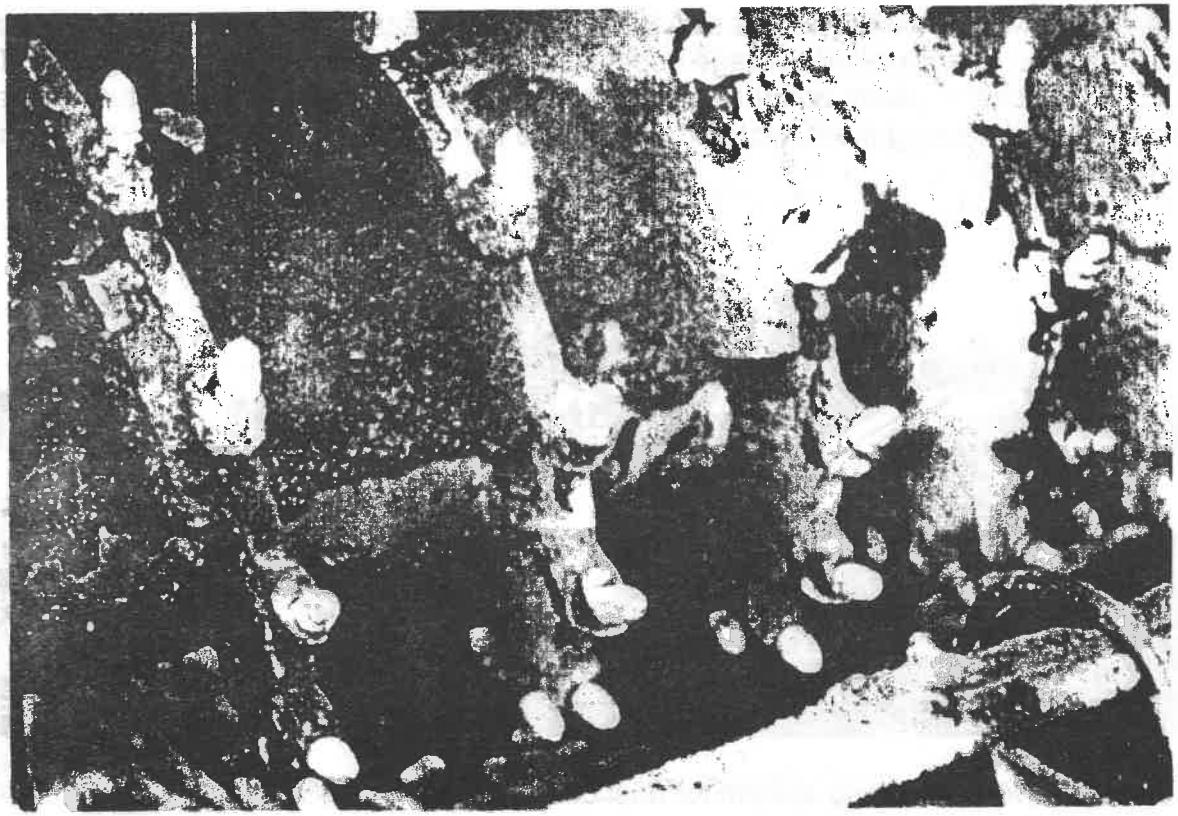
The process of milling and recycling asphalt pavements was first used in Florida in the late 1970s. In 1980, the process was adopted as a standard method of rehabilitation. Currently, Florida leads the nation in the volume of recycled mix used in asphalt paving.

A typical milling machine for highway construction is a self-contained unit at least eighteen feet long with a minimum cutting width of six feet. It can cut to a specified average depth while maintaining a desired profile grade. The unit must have a built-in automatic grade control system controlling both the transverse grade and the longitudinal grade. Any commercially built milling machine meeting these requirements will be permitted to start a project. If it cannot perform satisfactorily, it is to be rejected.



The machine must be equipped with a watering system for dust control during the milling operation.

The machine must have a mandrel and cutting teeth to produce a RAP material with a reasonable and acceptable gradation for recycling. It must produce a uniform texture on the milled surface that is suitable for traffic. Replace the cutting teeth one-half at a time so the cutting, texture, and gradation of the RAP material are not radically affected.



MATERIAL TRANSFER VEHICLE

The material transfer vehicle (MTV) is used to deliver HMA to a paver. An MTV is basically a surge bin on wheels that can hold up to 70,000 lbs. of mix, depending on the size of the unit. HMA is deposited from an end-dump or live-bottom truck into the hopper on the front of the vehicle, which may be equipped with a remixing auger or augers. The purpose of the auger system is to reblend the coarse and fine particles of the HMA and reduce any segregation and temperature variation that may have occurred in the mix as a result of the operation of the surge or storage silo or truck-loading procedures. The mix is carried from the hopper through the augers and then to a conveyor, which delivers the mix into a vertical extension or insert in the hopper.

The MTV should allow the paver to operate almost continuously, without stopping between truckloads of mix, as long as a continuous supply of mix is available from the asphalt plant. Therefore, the paver operator can keep the head of material in front of the screed constant by supplying a continuous amount of mix back to the screed and obtain a smoother mat. Use of an MTV also eliminates the problems of the haul truck bumping the paver and the truck driver holding the brakes on the truck when being pushed by the paver. As noted, however, the MTV is essentially a mobile surge bin; when it runs out of material, the paver must stop, and a continuous paving operation is not possible. Keeping a constant stream of trucks in front of the paver or MTV is therefore necessary if a continuous paving operation is to be achieved. If a gap occurs, the MTV should be stopped without being completely emptied when waiting for trucks, so that a consistent minimum amount of mix is retained on the augers to mix with the new, possibly segregated, material delivered from the next haul truck. In addition, the paver should be stopped with the hopper half full so that the amount of HMA in front of the paver screed remains constant and the proper smoothness of the mat is achieved. Indeed, the head of material in front of the paver screed is the most important factor in obtaining a smooth-riding pavement layer.

The MTV can be operated directly in front of the paver or off to one side. Because of the weight of this piece of equipment when full of mix, it is necessary to determine ahead of time that the pavement over which this machinery will be operated can support the loaded weight without being overstressed and damaged. Several smaller, simpler MTVs have been developed by various equipment manufacturers. Because of the limited surge capacity of most of these smaller devices, however, it is more likely that the paving operation will have to stop because of the MTV running out of material.

QUIZ

1. Name some of the equipment that may be used when cleaning and sweeping are required:

   _____

   _____

   _____

   _____

2. Axes, picks and shovels may be used in constructing _____ in the pavement.

3. What important pieces of hand equipment often are used to correct minor defects in the mat?

   _____

   _____

   _____

4. What equipment is used to compact widened sections of base course? _____

5. Small rules and adjustable try squares are two tools often used for checking _____.

6. Contractors are required to provide a _____ and a _____ for checking pavement surface tolerances.

7. Are calibration charts interchangeable among distributors? _____

8. Which of the following are requirements for the covers on haul trucks?

___ A. Capable of covering entire load of hot mix

___ B. Capable of being tied down

___ C. Waterproof

___ D. Capable of overlapping all sides of the body

9. What are the two main units of the paver?

A. _____

B. _____

10. Is it necessary for both roller bars of the paver to make contact with the wheels of the haul truck? _____

11. What part of the paver distributes the mix across the roadway in front of the screed? _____

12. Which of the following actions describe the purpose of paver screeds?

___ A. Strikes off mix

___ B. Heats mix

___ C. Partially compacts mix

___ D. Smooths mix

13. How is the mat thickness affected by the raising of the front of the screed? _____

14. The front motor grader in leveling operations must be equipped with a _____.

15. What is the length requirement for motor grader blades? _____
_____

16. Steel-wheel rollers must be equipped with _____, _____ and _____.

17. What are the weight limits for steel-wheeled rollers used in final rolling? _____

18. What four things must be identical for all the tires of a pneumatic roller?

A. _____

B. _____

C. _____

D. _____

Check page 2-58 to see if your answers are correct.

You have completed Chapter Two. If you had trouble understanding some of the equipment requirements, review those areas before continuing. Being familiar with the equipment is an important aid in inspecting asphaltic concrete paving. When you feel ready, go on to Chapter Three.

ANSWERS TO QUESTIONS

Page 2-6

1. Run smoothly
   Have no fuel or oil leaks
2. asphalt distributors
3. Tack
4. A, B, D
5. Check to see that the calibration number on the chart is the same as the one stamped on the distributor
6. gallons
7. Pretest number

Page 2-9

1. dial
2. circulated
3. pump
4. gauge

Page 2-12

1. A. Spray bar
   B. Hand hose
   C. Hand spray
2. Yes
3. hand hose
4. controlled, uniform

Page 2-15

1. A. Tight, clean, smooth bodies
   B. Waterproof covers large enough to cover load
   C. No leaks
   D. Small holes in the side
2. A, B
3. When mixes do not stick to truck bodies

Page 2-19

1. tractor, screed
2. 6
3. No

Page 2-22

1. feeders
2. flow control gates
3. Augers
4. The feeders, flow control gates and augers must be coordinated
5. Auger extensions may be attached to the augers and adjusted to the same performance

Page 2-25

1. strike off, compact, smooth
2. extension plates
3. By screed control arms
4. No
5. It floats on top of the mix being laid.
6. They must extend in the same plane as the screed.
7. By checking the screed and extension plates with a straightedge.
8. So that they can be adjusted.

Page 2-28

1. By using the crown control
2. A
3. 2
4. Preheat the screed

Page 2-31

1. screed
2. vibrators
3. pre-strike-off unit
4. amount of mix going under the screed

Page 2-34

1. Two
2. End dam, skew
3. 6
4. B, C
5. They must be at least two feet longer than the width of the lane being leveled.
6. They must be tight, with no loose play or excessive wear.
7. Make straightedge checks.

Page 2-36

1. Steel-wheeled, pneumatic tired, vibratory
2. Moistening systems, scrapers, pads
3. A, B
4. yokes, torque converters

Page 2-38

1. Smoothness
   Roundness
   Gap width
2. Straightedge, scraper blade
3. Yes

Page 2-41

1. traffic or rubber-tired
2. 8 to 12 tons
3. All of them
4. 50 to 55 psi

Page 2-45

1. eccentric
2. frequency
3. weight
   impact
4. amplitude
5. amplitude, frequency
6. 1"
7. 10, 12

Page 2-53 thru 2-55

1. Hand brooms
   Shovels
   Power Brooms
   Power Blower
2. Joints
3. Lutes
   Rakes
   Shovels
4. Trench Rollers
5. Mat Thickness
6. rolling straightedge, 15-foot manual straightedge
7. No
8. A, B, C, D (all of them)
9. A. Tractor
   B. Screed
10. Yes
11. Spreading screws
12. A, C, D
13. It increases
14. spreader box
15. 2 ft longer than the width of the lane being leveled
16. scrapers, pads, and moistening systems
17. 8 to 12 tons
18. A. Equal Size
    B. Ply Rating
    C. Diameter
    D. Inflation Pressure

CHAPTER THREE

Preparing for Paving Operations

CONTENTS

PREPARING FOR PAVING OPERATIONS

After the proper equipment is made available and is determined to be in compliance with the specifications, other preparations for paving must be made. Before HMA pavements are constructed, the existing surfaces must be properly prepared. The surfaces must be cleaned, repaired, and milled or leveled as necessary. Alignment controls must be established for the paver to follow. It will also be necessary to apply tack in order to bond the new pavement to the old surface. Finally, weather limitations must be observed. All of these operations will be discussed -- beginning with cleaning, repairing, and milling or leveling the existing surface -- in this chapter.

CLEANING, REPAIRING AND LEVELING EXISTING SURFACES

CLEANING

Before the HMA is placed, the existing base or pavement must be cleaned of all loose and foreign materials. Loose and foreign materials could prevent the new pavement from bonding properly to the existing surface and could eventually produce pavement failures.

As discussed briefly in the preceding chapter, power brooms and blowers are generally used in the cleaning operation. Hand brooming may be necessary to supplement the power equipment. The cleaning must be thorough.

REMOVING EXCESS JOINT MATERIAL

Often the material placed in cracks and joints of concrete pavement and bridge deck-slabs is squeezed out. This squeezed out material must be removed before resurfacing takes place or else it will bleed up through the asphalt layer. There are many ways to remove excess material.

EXCESS MATERIAL AT JOINT EXCESS MATERIAL REMOVED

The surface on the right is ready to pave -- the excess material has been removed. The remaining joint material is flush with the existing pavement.

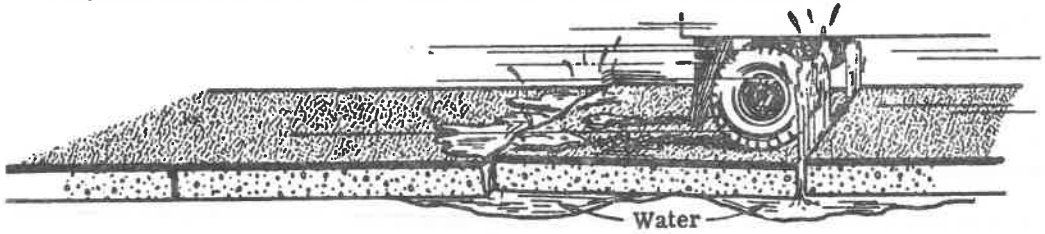
SEALING CRACKS

FDOT typically does not crack seal prior to overlay since milling is the prevalent means for pavement preparation. However, if milling is not used to take care of the cracks, sealing cracks will be performed for the paving preparation. Typically, cracks less than 10 mm wide are too small to be filled effectively because the sealant does not enter the crack. Cracks must be cleaned and prepared prior to the filling. Do not overfill the cracks, as the heat from the new asphalt overlay may cause bleeding.

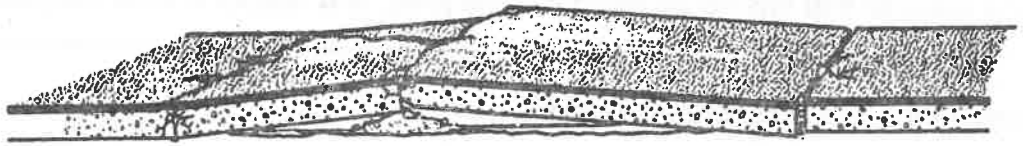
CORRECTING DEFECTIVE CONCRETE PAVEMENTS

Overlaying portland cement concrete (pcc) pavement demands special preparations. A determination must be made as to whether the existing concrete slabs are in suitable condition for repair and if they are stable or moving under traffic. The following diagrams show two problems associated with concrete pavements -- pumping (caused by heavy traffic and a weak supporting layer) and heaving (caused by environmental conditions). When the condition is severe, the problems can be repaired by slab replacement, cracking, and reseating, or rubblization.

BROKEN SECTIONS OF PAVEMENT THAT PUMP UNDER TRAFFIC



BLOWN-UP OR HEAVED SECTIONS AT CRACKS OR JOINTS



Such conditions must be corrected before paving. Methods for correcting the pavements may vary: replacing the bad pavement with new concrete, cracking and reseating the bad pavement and rubblizing are typical methods. The bad pavements must be corrected before being resurfaced with HMA. Rubblization is the process of fracturing the slab into smaller pieces, generally 1 to 6 inches in size. This reduces the portland cement concrete pavement to a crushed aggregate base.

QUIZ

1. Why must loose and foreign materials be cleaned from existing surfaces before paving begins? _____

2. What should be done to material that has squeezed out of the joints and cracks in concrete pavements? _____

3. List two common failures that occur in concrete pavements:

   A. _____

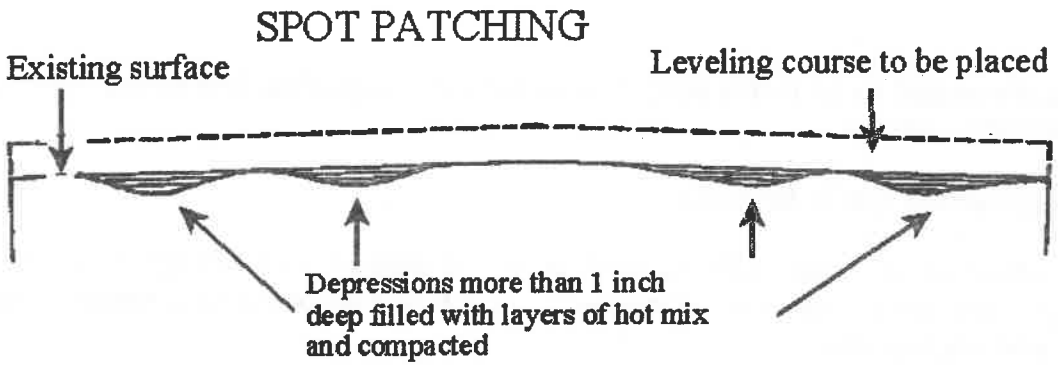
   B. _____

4. Besides replacing bad concrete pavement with new concrete, what is another typical method of correcting concrete pavement failure? _____

The answers to these questions start on page 3-55.

PATCHING DEPRESSIONS

If a project is not going to be milled and before a leveling course is placed, all depressions more than 1" deep in the existing surface should be patched. This operation is referred to as "spot patching" or "spot leveling". The depressions should be filled with layers of leveling course mixture. Each layer should be compacted after it is placed.



INSPECTING FOR SUFFICIENT CURING OF EXISTING SURFACES

When HMA is to be placed over primed bases or ARMI layers, you should check these existing surfaces to be sure that they have cured sufficiently. Also inspect ARMI layers to be sure that all "fatty" spots and loose material have been removed. "Fatty" spots are areas with excessive asphalt rubber.

PLACING LEVELING COURSES/OVERBUILD

The purpose of leveling courses is to bring existing surfaces to proper grade and cross section before new structural and friction courses are constructed. Leveling is placed with a motor grader, overbuild is placed with a paver.

Preparing for Leveling

In general, the preparations discussed so far in this chapter -- for cleaning, repairing, and curing existing surfaces -- are made before the leveling course is placed.

In addition, the following preparations should be made:

- All structures which will be in contact with the leveling course mixture -- excluding the vertical faces of existing pavements, curbs and gutters -- must be painted with a thin tack coat of asphalt cement. This coating produces closely bonded, water-tight joints.

- The existing surfaces to be leveled must be tacked, as well as, each course of the leveling operation. However, freshly primed bases do not need to be tacked, unless required by the Engineer. Tacking procedures will be discussed later in this chapter.

- To avoid creating bumps at bridge ends, part of the existing pavement may need to be milled off before the leveling course is placed. This will allow the overlay to be placed flush with the top of the bridge deck, rather than above it, providing a smooth transition from roadway to bridge deck.

QUIZ

1. Before a leveling course is placed, all depressions greater than _____ deep must be patched.

2. You should check for sufficient curing when leveling or surface courses are to be placed over _____ or _____.

3. The purpose of leveling courses is to bring existing surfaces to proper _____ and _____ _____ before a new structural and friction courses are constructed.

4. Should the vertical faces of existing pavements, curbs and gutters be painted with asphalt cement before leveling courses are placed? _____

5. Must tack be applied between leveling courses? _____

The answers to these questions are on page 3-55.

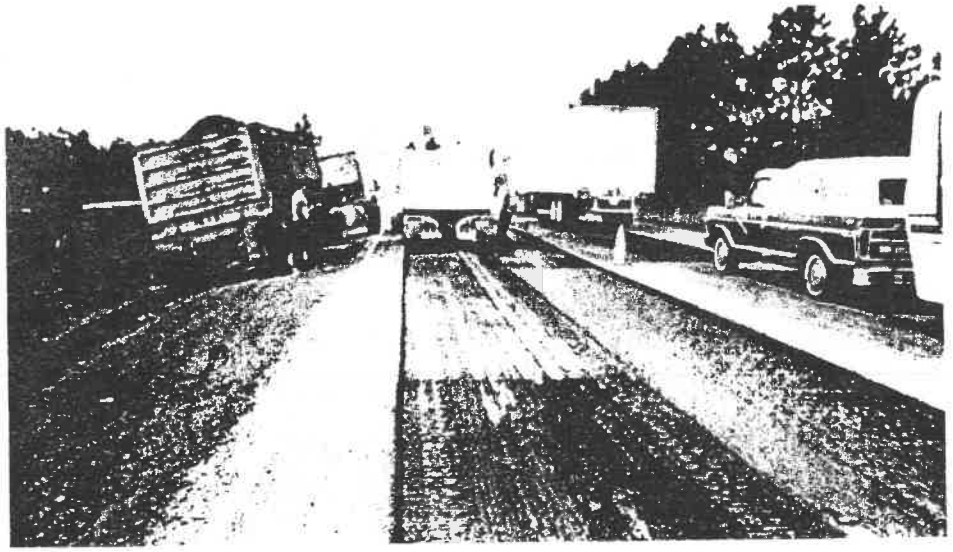
THE MILLING OPERATION

The machine cutting width and the mode of operation may result in contamination of the milled material with soil and other materials. A motor grader should remove the unwanted soil from the path of the milling machine.

Once the milling operation starts, the speed of the milling machine should be noted. Milling speed is important in controlling and maintaining uniform gradation of RAP material. It also affects the pattern of striations, which affects ridability when the milled surface is opened to traffic. Once a satisfactory speed is determined, maintain that speed to control the uniformity of the RAP material, as well as, the uniformity of the striations.

Factors that impact the operation and the gradation of RAP material are:

1. Depth of cut
2. Condition of teeth
3. Speed of the machine
4. Hardness of existing pavement



Milling Operation

The plans specify the average depth of cut to be removed and the cross slope of the milled surface. The contractor has the right to remove the entire depth in one cut or remove it in two or more passes.

It is the technician's responsibility to check the depth of the cut and the cross slope of the milled surface throughout each day's operation.

If the total thickness of asphalt pavement is being removed, don't bother checking the leveling ability of the milling machine. Usually, all of the pavement is not removed. Some of the pavement is left to protect the base and carry traffic before the new pavement is placed. In these situations, the milling machine must level as it mills. Check the depth of cut to determine the average thickness being removed and be sure the machine is leveling and the cross slopes of the milled surface is in compliance with the contract plan.

After milling, the surface must be cleaned of all dust and fine particles before opening to traffic or paving. In rural areas, this can be accomplished by a power rotary broom. Be careful that the dust does not cause a hazard to traffic. The fines should not be swept into any drainage system. In general, the milled surface shall be repaved no later than the day after it was milled or the plans shall specify the exceptions.

In urban areas or other sensitive locations, the contractor may have to use special equipment. A truck vacuum, power pickup sweeper, self-contained sweeper, or other such equipment can do the job. The key to effective dust removal is to use water.

Each day, for that portion of pavement milled but not replaced, the contractor should cut weep holes in the shoulder at regular intervals in order to provide for drainage.

The time a milled surface can be left open before replacement of the pavement will vary from job to job depending on factors related to safety, traffic volume, and speed.

When traffic is allowed on a milled surface before pavement replacement, the following should be checked prior to opening to traffic:

(1) maximum drop off between adjacent lanes 1 ½ inches,
(2) the milled surface has been adequately cleaned,
(3) striations are acceptable to maintain traffic safety,

(4) drainage weep holes have been cut in shoulder, and
(5) traffic has been warned of the unusual condition ahead.

If the milled surface is to be paved immediately, it must be cleaned to ensure a good bond and then tacked or covered with an ARMI layer.

QUIZ

1. Give four factors that impact the operation and gradation of RAP material.

   A. _____

   B. _____

   C. _____

   D. _____

2. What specifies the average depth of the cut to be removed? _____

3. After milling, what must be done prior to opening the surface to traffic?

   _____

4. List three things that must be checked by the inspector prior to opening the road to traffic.

   A. _____

   B. _____

   C. _____

Check your answers on page 3-55.

Spreading Leveling Courses

As explained in the last chapter, leveling courses are spread by a spreader box attached to the first of two motor graders. The spreader box places the correct amount of mix on the road. The back of the spreader box can be raised or lowered to lay the proper quantity of mix. The blades of the two motor graders spread the mix laterally, achieving the proper width, grade, and cross section of mat.

It is very important that the required amount of mix be placed in each station, so that there will not be a large excess of mix to waste. The motor graders are not designed to carry large amounts of mix very far longitudinally.

The proper pattern for the graders to follow is:

- The blade of the lead motor grader is angled to drift the mix toward the center of the roadway
- The blade of the rear motor grader is angled to drift the mix from the center toward the outer edge of the roadway

On the first pass, the blades should brush the high places and fill the low spots. At no time should the blades be positioned perpendicular to the centerline of the pavement -- they must always be at a skew.

Rate of Application

Normally, leveling consists of more than one course, depending on the rate at which the mix is to be spread. When using Type SP-9.5 (fine graded) for leveling, do not allow the average spread rate of a layer to be less than 50 lbs/yd^2 or more than 75 lbs/yd^2.

Usually, the quantity of mix shown in the plans for leveling is an average for the entire job. In Chapter One, it was mentioned that the amount of leveling mixture placed varies because of the irregularities in the underlying existing surfaces. In fact, the engineer may increase or decrease the application rate as necessary at certain locations. Also, when widening construction is specified in connection with leveling, the engineer may require placing all the leveling mix prior to the widening operation.

Placing Leveling Over Broken and Reseated Concrete Pavement

When leveling courses are placed over broken and reseated concrete pavement (with or without asphalt surface) the first

leveling course must be placed as soon as possible after the concrete is cracked and reseated. The maximum time limit for beginning the first leveling course is not later than two days (48 hours) after the cracking and reseating work on any section. The remaining leveling courses then should follow in the normal sequence of operations.

QUIZ

1. For leveling operations, motor grader blades should be positioned:

   ___ A. parallel to the centerline of pavement.

   ___ B. at a skew to the centerline of pavement.

   ___ C. perpendicular to the centerline of pavement.

2. The blade of the lead motor grader should drift the mix toward the_____ of the roadway. The blade of the rear motor grader should drift the mix from the _____ toward the _____ of the roadway.

3. The average spread rate for Type SP-9.5 should be between _____ and _____ lbs/yd^2.

The answers to these questions are on page 3-55.

Compacting Leveling Courses

Self-propelled pneumatic-tired rollers are required for rolling leveling courses, including spot patching and wedges. The recommended procedure is to compact the leveling course with the pneumatic-tired roller followed by a steel wheel roller.

When the first leveling course is placed over broken concrete pavement, the pneumatic-tired roller must weigh at least 15 tons.

SUMMARY

After cleaning, repairs, milling, and leveling (when required) have been completed, the surface to be paved with HMA should be in a dry condition with no holes, depressions, or weak areas. Grade and cross slope checks should be made to verify that the prepared surface complies fully with the plans.

TACKING

Along with cleaning, repairing, and leveling existing surfaces, tacking is another important preparation for HMA paving. In this section we will discuss tack materials, application requirements, distributor operations, determination of rates and quantities of tack applied, and the documentation related to tacking operations. First, let's talk about the tack itself.

TACK

Tack is a liquid bituminous material used to provide a bond between an HMA layer and:

- other HMA layers
- milled surfaces
- roadway structures

Tack is heated for application and applied by asphalt distributors through either spray bars or hand hoses. A tack coat should not be used in lieu of cleaning the existing surface -- removing the accumulated dust and dirt by mechanical brooming or by flushing with air or water.

There are many types and grades of tack in existence, but the Department specifies undiluted emulsified asphalt, grade RS-1 or RS-2. Emulsified asphalt is a mixture of asphalt cement and water. For night paving, the Department specifies the use of AC-5 unless it can be demonstrated that the emulsified asphalt can set or cure properly at night.

APPLICATION REQUIREMENTS

Since we mentioned, in a general way, where tack should be applied, we must also mention where it should not be applied. Usually, tack is not needed on recently primed bases, since the fresh prime accomplishes the same result as would fresh tack. Bases not recently primed have often become excessively dirty and cannot be cleaned, or have cured so much that they have lost all ability to bond to the overlying course -- and therefore need tack. Also, asphalt base layers, laid the same day and not exposed to traffic, require little or no tack coat.

Before tacking can begin all necessary equipment must be on hand -- including a power broom, a pressure distributor and other equipment and tools as needed to perform the work satisfactorily. The surface to be tacked should be clean, dry, and fully prepared.

Tack must be heated for application. The best results usually are obtained at 140°F to 180°F.

For night paving, use AC-5 tack coat which must be heated to a temperature of 250°F to 300°F.

Protection of tack from traffic is an important consideration. Traffic should be kept off the tack to prevent a safety hazard. Usually, the contractor will tack 0.5 to 1 mile sometimes even more, and cover it in one to two hours. If the tack is placed too early there is a risk that the tack will be picked up by track (either contractor or traveling public) or it may be absorbed into the pavement surface. Also, if it is placed too early the roadway may present a traffic hazard to the traveling public because an uncovered layer of asphalt on the roadway can be quite slippery.

On the other hand, the tack coat operation must be far enough ahead of the paving operation to permit the tack to "break" (cure). Proper breaking is obtained when the tack changes from brown to black and from slippery to a sticky texture which bonds to the underlying course. Paving should not be done until it has broken. "Breaking" means that the water has evaporated, leaving only the asphalt.

The Standard Specifications require that tack be applied at a rate of between 0.02 and 0.08 gallon per square yard. Tack

should be applied uniformly to the surface to be paved and on structures that come in contact with the hot mix. These structures include approach slabs and wingwalls -- but not the vertical faces of existing pavements, curbs, or gutters.

Care should be taken when applying tack. If too much tack is applied, the tack acts like a lubricant. Instead of bonding the pavement courses, it can cause the mix to slide or shift. Also, the extra tack can bleed into the mat and result in an undesirable surface. If the mix absorbs the extra tack, the mix could lose stability. In some cases, excess tack will "bleed" -- or flush to the surface. On the other hand, if too little tack is applied, the new mat will slide or shift instead of bonding to the existing pavement. Tack must cover the surface of the pavement completely and evenly -- with no bare spots or puddles. Handheld spray method can be used for inaccessible places.

The contractor should take steps to protect all structures next to the tacking operation. They should not become marred or spattered during tacking. Heavy paper is one means of covering surfaces to protect them from tack. If surfaces not to be tacked become spattered anyway, they will have to be cleaned.

QUIZ

1. Which of the following surfaces do not normally need tack before asphaltic concrete is placed on them?

   ___ A. Newly placed asphaltic concrete base courses

   ___ B. Broken and reseated concrete pavement

   ___ C. Recently primed bases

2. Which of the following are reasons why tack should not be applied too early?

   ___ A. Tack may be picked up by traffic.

   ___ B. Tack may not break.

   ___ C. Tack may become a safety hazard to traffic.

   ___ D. Tack may be absorbed into underlying surface.

3. What are the application rate limits established by the Standard Specifications? _____

4. Which of the following characteristics describe tack that has broken?

   ___ A. Changed from black to brown

   ___ B. Changed from sticky to hard substance

   ___ C. Changed from slippery to sticky texture

   ___ D. Changed from brown to black

5. Sliding or shifting in overlying mats can be caused by both too much and too little tack. True or false? _____

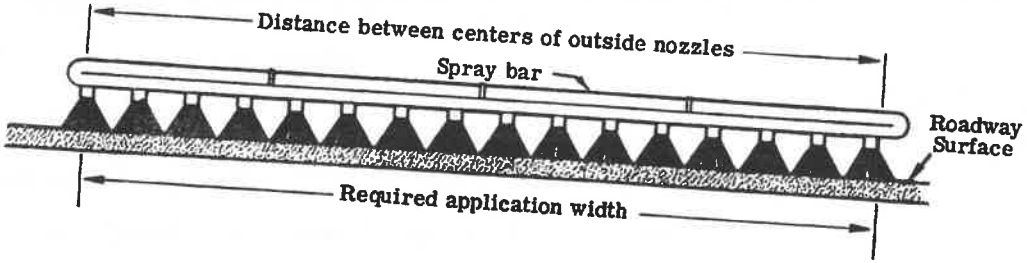
6. The Contractor should take steps to protect all _____.

Check your answers on page 3-55. Do you understand tack application requirements? If not, review this section until you do. When you are ready, go on to ASPHALT DISTRIBUTOR OPERATIONS.

ASPHALT DISTRIBUTOR OPERATIONS

Distributors used to apply tack must be capable of applying it at the correct rate uniformly along the entire width and length of the spread. It is the contractor's responsibility to obtain satisfactory tack coats.

The distributor spraybar -- connected to the pump discharge on the distributor -- has several pressure nozzles that should distribute the liquid asphalt evenly as the distributor moves along. As we mentioned earlier in the course, the distance between the centers of openings of the outside nozzles must be equal to the width of application required within a tolerance of 2" -- as shown below. The outside nozzle at the end of each spray bar is to have an opening of not less than 25% or more than 75% in excess of the other nozzles. The application width can be adjusted by closing or opening nozzles.



All the spray nozzles should be opened uniformly to achieve a uniform coverage.

All pressure nozzles must be clean, unclogged, and adjusted properly. Nonuniform nozzle openings and clogged nozzles will produce a nonuniform tack coat -- streaks of thick or thin coverage or bare pavement.

In Chapter Two we said that uniform tack application can be achieved by holding the speed of the distributor and the pump (spray) pressure constant. From the preceding discussion we see that nozzle cleanliness and proper adjustment are also necessary in obtaining uniform tack coverage.

In summary, uniform tack coats can be achieved consistently when:

- the asphalt emulsion is heated to the correct temperature.
- the spray equipment is clean and properly adjusted.
- the spray pressure is correct and constant.
- the speed of the distributor is correct and constant.

Visually, you will recognize good tack coats by their thin, web-like and uniform coverage. We will discuss how to determine actual application rates and quantities after the quiz.

QUIZ

1. The required tack application width on a certain job is 12 feet. The centers of openings of the outside nozzles of the spray bar are 11 feet 11 inches apart. Is this within the tolerance for spray bar width? _____

2. Briefly describe a good tack coat's appearance. _____

3. Which of the following are important in achieving uniform tack coats?

   ___ A. Distributor's speed

   ___ B. Tack temperature

   ___ C. Equipment condition and adjustment

   ___ D. Spray pressure

Check your answers on page 3-55.

APPLICATION RATES AND QUANTITIES

In inspecting tack operations, you often will need to determine the actual rate at which the tack is being applied. To find the correct application rate, you must consider the temperature of the tack. As we have said, the tack in the distributor is heated for use. When tack is heated it expands. For example, 100 gallons of tack at 100°F will have a volume of about 105 gallons when heated to 200°F. When large quantities of bituminous material are involved, the differences are, of course, much greater.

To standardize the measuring of volumes of bituminous material, all quantities are based on the volumes of the material at 60°F. The Department provides three tables with correction factors for converting volumes of bituminous material at any temperature to the 60°F volumes. The different tables are for the different types and grades of liquid bituminous materials used in road and highway construction in the state.

Correction tables for converting volumes of tack are shown on pages 3-26 and 3-27. Look them over briefly now.

These tables are used to make temperature-volume corrections. The tables are in degrees F. The tack in the distributor is at 150°F. The beginning measurement showed that there were 350 gallons in the tank. When the ending measurement was taken, there were 300 gallons left in the tank. This means that 50 gallons at 150°F were used. To convert 50 gallons at 150°F to gallons at 60°F you would:

1. Go to the table.
2. Find 150°F in the "TEMP." (temperature) column. (Notice that you read the table from left to right.)
3. Find the corresponding correction factor in the column to the right of 150°F. It is 0.9780.

To convert 50 gallons at 150°F to gallons at 60°F, multiply 50 gallons by 0.9780.

50 gallons x 0.9780 = 48.90 gallons

This means that 50 gallons at 150°F is equal to 48.9 gallons at 60°F. Got that?

Let's see. Check yourself by taking the quiz on page 3-28.

TABLE III - BITUMINOUS MATERIAL VOLUME CORRECTION FACTORS BASED ON TEMPERATURE - USE WITH ASPHALT GRADE RS-1 (K=0.00025 PER 1973 SPECIFICATIONS)

TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.
0=1.0152	1=1.0150	2=1.0147	3=1.0145	4=1.0142	5=1.0139	6=1.0137	7=1.0134	8=1.0132
9=1.0129	10=1.0127	11=1.0124	12=1.0121	13=1.0119	14=1.0116	15=1.0114	16=1.0111	17=1.0109
18=1.0106	19=1.0104	20=1.0101	21=1.0098	22=1.0096	23=1.0093	24=1.0091	25=1.0088	26=1.0086
27=1.0083	28=1.0081	29=1.0078	30=1.0076	31=1.0073	32=1.0070	33=1.0068	34=1.0065	35=1.0063
36=1.0060	37=1.0058	38=1.0055	39=1.0053	40=1.0050	41=1.0048	42=1.0045	43=1.0043	44=1.0040
45=1.0038	46=1.0035	47=1.0033	48=1.0030	49=1.0028	50=1.0025	51=1.0023	52=1.0020	53=1.0018
54=1.0015	55=1.0013	56=1.0010	57=1.0007	58=1.0005	59=1.0002	60=1.0000	61=0.9998	62=0.9995
63=0.9993	64=0.9990	65=0.9988	66=0.9985	67=0.9983	68=0.9980	69=0.9978	70=0.9975	71=0.9973
72=0.9970	73=0.9968	74=0.9965	75=0.9963	76=0.9960	77=0.9958	78=0.9955	79=0.9953	80=0.9950
81=0.9948	82=0.9945	83=0.9943	84=0.9940	85=0.9938	86=0.9935	87=0.9933	88=0.9930	89=0.9928
90=0.9926	91=0.9923	92=0.9921	93=0.9918	94=0.9916	95=0.9913	96=0.9911	97=0.9908	98=0.9906
99=0.9903	100=0.9901	101=0.9899	102=0.9896	103=0.9894	104=0.9891	105=0.9889	106=0.9886	107=0.9884
108=0.9881	109=0.9879	110=0.9877	111=0.9874	112=0.9872	113=0.9869	114=0.9867	115=0.9864	116=0.9862
117=0.9860	118=0.9857	119=0.9855	120=0.9852	121=0.9850	122=0.9847	123=0.9845	124=0.9843	125=0.9840
126=0.9838	127=0.9835	128=0.9833	129=0.9830	130=0.9828	131=0.9826	132=0.9823	133=0.9821	134=0.9818
135=0.9816	136=0.9814	137=0.9811	138=0.9809	139=0.9806	140=0.9804	141=0.9802	142=0.9799	143=0.9797
144=0.9794	145=0.9792	146=0.9790	147=0.9787	148=0.9785	149=0.9782	150=0.9780	151=0.9778	152=0.9775
153=0.9773	154=0.9770	155=0.9768	156=0.9766	157=0.9763	158=0.9761	159=0.9758	160=0.9756	161=0.9754
162=0.9751	163=0.9749	164=0.9747	165=0.9744	166=0.9742	167=0.9739	168=0.9737	169=0.9735	170=0.9732
171=0.9730	172=0.9728	173=0.9725	174=0.9723	175=0.9721	176=0.9718	177=0.9716	178=0.9713	179=0.9711
180=0.9709	181=0.9706	182=0.9704	183=0.9702	184=0.9699	185=0.9697	186=0.9695	187=0.9692	188=0.9690
189=0.9688	190=0.9685	191=0.9683	192=0.9681	193=0.9678	194=0.9676	195=0.9674	196=0.9671	197=0.9669
198=0.9667	199=0.9664	200=0.9662	201=0.9660	202=0.9657	203=0.9655	204=0.9653	205=0.9650	206=0.9648
207=0.9646	208=0.9643	209=0.9641	210=0.9639	211=0.9636	212=0.9634	213=0.9632	214=0.9629	215=0.9627
216=0.9625	217=0.9622	218=0.9620	219=0.9618	220=0.9615	221=0.9613	222=0.9611	223=0.9608	224=0.9606
225=0.9604	226=0.9602	227=0.9599	228=0.9597	229=0.9595	230=0.9592	231=0.9590	232=0.9588	233=0.9585
234=0.9583	235=0.9581	236=0.9579	237=0.9576	238=0.9574	239=0.9572	240=0.9569	241=0.9567	242=0.9565
243=0.9563	244=0.9560	245=0.9558	246=0.9556	247=0.9553	248=0.9551	249=0.9549	250=0.9547	251=0.9544
252=0.9542	253=0.9540	254=0.9537	255=0.9535	256=0.9533	257=0.9531	258=0.9528	259=0.9526	260=0.9524
261=0.9522	262=0.9519	263=0.9517	264=0.9515	265=0.9512	266=0.9510	267=0.9508	268=0.9506	269=0.9503
270=0.9501	271=0.9499	272=0.9497	273=0.9494	274=0.9492	275=0.9490	276=0.9488	277=0.9485	278=0.9483
279=0.9481	280=0.9479	281=0.9476	282=0.9474	283=0.9472	284=0.9470	285=0.9467	286=0.9465	287=0.9463
288=0.9461	289=0.9459	290=0.9456	291=0.9454	292=0.9452	293=0.9450	294=0.9447	295=0.9445	296=0.9443
297=0.9441	298=0.9438	299=0.9436	300=0.9434	301=0.9432	302=0.9430	303=0.9427	304=0.9425	305=0.9423
306=0.9421	307=0.9418	308=0.9416	309=0.9414	310=0.9412	311=0.9410	312=0.9407	313=0.9405	314=0.9403
315=0.9401	316=0.9399	317=0.9396	318=0.9394	319=0.9392	320=0.9390	321=0.9387	322=0.9385	323=0.9383
324=0.9381	325=0.9379	326=0.9376	327=0.9374	328=0.9372	329=0.9370	330=0.9368	331=0.9365	332=0.9363
333=0.9361	334=0.9359	335=0.9357	336=0.9355	337=0.9352	338=0.9350	339=0.9348	340=0.9346	341=0.9344
342=0.9341	343=0.9339	344=0.9337	345=0.9335	346=0.9333	347=0.9331	348=0.9328	349=0.9326	350=0.9324
351=0.9322	352=0.9320	353=0.9317	354=0.9315	355=0.9313	356=0.9311	357=0.9309	358=0.9307	359=0.9304
360=0.9302	361=0.9300	362=0.9298	363=0.9296	364=0.9294	365=0.9292	366=0.9289	367=0.9287	368=0.9285
369=0.9283	370=0.9281	371=0.9279	372=0.9276	373=0.9274	374=0.9272	375=0.9270	376=0.9268	377=0.9266
378=0.9264	379=0.9261	380=0.9259	381=0.9257	382=0.9255	383=0.9253	384=0.9251	385=0.9249	386=0.9246
387=0.9244	388=0.9242	389=0.9240	390=0.9238	391=0.9236	392=0.9234	393=0.9231	394=0.9229	395=0.9227
396=0.9225	397=0.9223	398=0.9221	399=0.9219	400=0.9217	401=0.9214	402=0.9212	403=0.9210	404=0.9208
405=0.9206	406=0.9204	407=0.9202	408=0.9200	409=0.9198	410=0.9195	411=0.9193	412=0.9191	413=0.9189
414=0.9187	415=0.9185	416=0.9183	417=0.9181	418=0.9179	419=0.9176	420=0.9174	421=0.9172	422=0.9170
423=0.9168	424=0.9166	425=0.9164	426=0.9162	427=0.9160	428=0.9158	429=0.9155	430=0.9153	431=0.9151
432=0.9149	433=0.9147	434=0.9145	435=0.9143	436=0.9141	437=0.9139	438=0.9137	439=0.9135	440=0.9132
441=0.9130	442=0.9128	443=0.9126	444=0.9124	445=0.9122	446=0.9120	447=0.9118	448=0.9116	449=0.9114
450=0.9112	451=0.9110	452=0.9107	453=0.9105	454=0.9103	455=0.9101	456=0.9099	457=0.9097	458=0.9095
459=0.9093	460=0.9091	461=0.9089	462=0.9087	463=0.9085	464=0.9083	465=0.9081	466=0.9079	467=0.9076
468=0.9074	469=0.9072	470=0.9070	471=0.9068	472=0.9066	473=0.9064	474=0.9062	475=0.9060	476=0.9058
477=0.9056	478=0.9054	479=0.9052	480=0.9050	481=0.9048	482=0.9046	483=0.9044	484=0.9042	485=0.9040
486=0.9038	487=0.9035	488=0.9033	489=0.9031	490=0.9029	491=0.9027	492=0.9025	493=0.9023	494=0.9021
495=0.9019	496=0.9017	497=0.9015	498=0.9013	499=0.9011	500=0.9009	501=0.9007	502=0.9005	503=0.9003

TABLE III - BITUMINOUS MATERAL VOLUME CORRECTION FACTORS BASED ON TEMPERATURE - USE WITH ASPHALT GRADE RS-2 (K=0.00045)

TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.
-18 = 1.0151	-17 = 1.0146	-16 = 1.0141	-15 = 1.0137	-14 = 1.0132
-13 = 1.0128	-12 = 1.0123	-11 = 1.0118	-10 = 1.0114	-9 = 1.0109
-8 = 1.0105	-7 = 1.0100	-6 = 1.0095	-5 = 1.0091	-4 = 1.0086
-3 = 1.0082	-2 = 1.0077	-1 = 1.0073	0 = 1.0068	1 = 1.0063
2 = 1.0059	3 = 1.0054	4 = 1.0050	5 = 1.0045	6 = 1.0041
7 = 1.0036	8 = 1.0032	9 = 1.0027	10 = 1.0023	11 = 1.0018
12 = 1.0014	13 = 1.0009	14 = 1.0005	15 = 1.0000	16 = 0.9996
17 = 0.9991	18 = 0.9987	19 = 0.9982	20 = 0.9978	21 = 0.9973
22 = 0.9969	23 = 0.9964	24 = 0.9960	25 = 0.9955	26 = 0.9951
27 = 0.9946	28 = 0.9942	29 = 0.9937	30 = 0.9933	31 = 0.9929
32 = 0.9924	33 = 0.9920	34 = 0.9915	35 = 0.9911	36 = 0.9906
37 = 0.9902	38 = 0.9898	39 = 0.9893	40 = 0.9889	41 = 0.9884
42 = 0.9880	43 = 0.9876	44 = 0.9871	45 = 0.9867	46 = 0.9862
47 = 0.9858	48 = 0.9854	49 = 0.9849	50 = 0.9845	51 = 0.9841
52 = 0.9836	53 = 0.9832	54 = 0.9828	55 = 0.9823	56 = 0.9819
57 = 0.9815	58 = 0.9810	59 = 0.9806	60 = 0.9802	61 = 0.9797
62 = 0.9793	63 = 0.9789	64 = 0.9784	65 = 0.9780	66 = 0.9776
67 = 0.9771	68 = 0.9767	69 = 0.9763	70 = 0.9758	71 = 0.9754
72 = 0.9750	73 = 0.9746	74 = 0.9741	75 = 0.9737	76 = 0.9733
77 = 0.9729	78 = 0.9724	79 = 0.9720	80 = 0.9716	81 = 0.9712
82 = 0.9707	83 = 0.9703	84 = 0.9699	85 = 0.9695	86 = 0.9690
87 = 0.9686	88 = 0.9682	89 = 0.9678	90 = 0.9674	91 = 0.9669
92 = 0.9665	93 = 0.9661	94 = 0.9657	95 = 0.9653	96 = 0.9648
97 = 0.9644	98 = 0.9640	99 = 0.9636	100 = 0.9632	101 = 0.9627
102 = 0.9623	103 = 0.9619	104 = 0.9615	105 = 0.9611	106 = 0.9607
107 = 0.9602	108 = 0.9598	109 = 0.9594	110 = 0.9590	111 = 0.9586
112 = 0.9582	113 = 0.9578	114 = 0.9574	115 = 0.9569	116 = 0.9565
117 = 0.9561	118 = 0.9557	119 = 0.9553	120 = 0.9549	121 = 0.9545
122 = 0.9541	123 = 0.9537	124 = 0.9532	125 = 0.9528	126 = 0.9524
127 = 0.9520	128 = 0.9516	129 = 0.9512	130 = 0.9508	131 = 0.9504
132 = 0.9500	133 = 0.9496	134 = 0.9492	135 = 0.9488	136 = 0.9484
137 = 0.9480	138 = 0.9476	139 = 0.9471	140 = 0.9467	141 = 0.9463
142 = 0.9459	143 = 0.9455	144 = 0.9451	145 = 0.9447	146 = 0.9443
147 = 0.9439	148 = 0.9435	149 = 0.9431	150 = 0.9427	151 = 0.9423
152 = 0.9419	153 = 0.9415	154 = 0.9411	155 = 0.9407	156 = 0.9403
157 = 0.9399	158 = 0.9395	159 = 0.9391	160 = 0.9387	161 = 0.9384
162 = 0.9380	163 = 0.9376	164 = 0.9372	165 = 0.9368	166 = 0.9364
167 = 0.9360	168 = 0.9356	169 = 0.9352	170 = 0.9348	171 = 0.9344
172 = 0.9340	173 = 0.9336	174 = 0.9332	175 = 0.9328	176 = 0.9324
177 = 0.9321	178 = 0.9317	179 = 0.9313	180 = 0.9309	181 = 0.9305

QUIZ

1. When tack is heated it _____.

2. To what temperature do you correct volumes of liquid bituminous material? _____

3. Your beginning measurement shows 755 gallons. Your ending measurement shows 710 gallons. The tack is at a temperature of 160°F. Using the table on the next page, calculate how many gallons of tack at a temperature of 60°F were used? _____

Check your answers on page 3-55.

TABLE III - BITUMINOUS MATERIAL VOLUME CORRECTION FACTORS BASED ON TEMPERATURE - USE WITH ASPHALT GRADE RS-1 (K=0.00025 PER 1973 SPECIFICATIONS)

TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.
0=1.0152	1=1.0150	2=1.0147	3=1.0145	4=1.0142	5=1.0139	6=1.0137	7=1.0134	8=1.0132
9=1.0129	10=1.0127	11=1.0124	12=1.0121	13=1.0119	14=1.0116	15=1.0114	16=1.0111	17=1.0109
18=1.0106	19=1.0104	20=1.0101	21=1.0098	22=1.0096	23=1.0093	24=1.0091	25=1.0088	26=1.0086
27=1.0083	28=1.0081	29=1.0078	30=1.0076	31=1.0073	32=1.0070	33=1.0068	34=1.0065	35=1.0063
36=1.0060	37=1.0058	38=1.0055	39=1.0053	40=1.0050	41=1.0048	42=1.0045	43=1.0043	44=1.0040
45=1.0038	46=1.0035	47=1.0033	48=1.0030	49=1.0028	50=1.0025	51=1.0023	52=1.0020	53=1.0018
54=1.0015	55=1.0013	56=1.0010	57=1.0007	58=1.0005	59=1.0002	60=1.0000	61=0.9998	62=0.9995
63=0.9993	64=0.9990	65=0.9988	66=0.9985	67=0.9983	68=0.9980	69=0.9978	70=0.9975	71=0.9973
72=0.9970	73=0.9968	74=0.9965	75=0.9963	76=0.9960	77=0.9958	78=0.9955	79=0.9953	80=0.9950
81=0.9948	82=0.9945	83=0.9943	84=0.9940	85=0.9938	86=0.9935	87=0.9933	88=0.9930	89=0.9928
90=0.9925	91=0.9923	92=0.9921	93=0.9918	94=0.9916	95=0.9913	96=0.9911	97=0.9908	98=0.9906
99=0.9903	100=0.9901	101=0.9899	102=0.9896	103=0.9894	104=0.9891	105=0.9889	106=0.9886	107=0.9884
108=0.9881	109=0.9879	110=0.9877	111=0.9874	112=0.9872	113=0.9869	114=0.9867	115=0.9864	116=0.9862
117=0.9860	118=0.9857	119=0.9855	120=0.9852	121=0.9850	122=0.9847	123=0.9845	124=0.9843	125=0.9840
126=0.9838	127=0.9835	128=0.9833	129=0.9830	130=0.9828	131=0.9826	132=0.9823	133=0.9821	134=0.9818
135=0.9816	136=0.9814	137=0.9811	138=0.9809	139=0.9806	140=0.9804	141=0.9802	142=0.9799	143=0.9797
144=0.9794	145=0.9792	146=0.9790	147=0.9787	148=0.9785	149=0.9782	150=0.9780	151=0.9778	152=0.9775
153=0.9773	154=0.9770	155=0.9768	156=0.9766	157=0.9763	158=0.9761	159=0.9758	160=0.9756	161=0.9754
162=0.9751	163=0.9749	164=0.9747	165=0.9744	166=0.9742	167=0.9739	168=0.9737	169=0.9735	170=0.9732
171=0.9730	172=0.9728	173=0.9725	174=0.9723	175=0.9721	176=0.9718	177=0.9716	178=0.9713	179=0.9711
180=0.9709	181=0.9706	182=0.9704	183=0.9702	184=0.9699	185=0.9697	186=0.9695	187=0.9692	188=0.9690
189=0.9688	190=0.9685	191=0.9683	192=0.9681	193=0.9678	194=0.9676	195=0.9674	196=0.9671	197=0.9669
198=0.9667	199=0.9664	200=0.9662	201=0.9660	202=0.9657	203=0.9655	204=0.9653	205=0.9650	206=0.9648
207=0.9646	208=0.9643	209=0.9641	210=0.9639	211=0.9636	212=0.9634	213=0.9632	214=0.9629	215=0.9627
216=0.9625	217=0.9622	218=0.9620	219=0.9618	220=0.9615	221=0.9613	222=0.9611	223=0.9608	224=0.9606
225=0.9604	226=0.9602	227=0.9599	228=0.9597	229=0.9595	230=0.9592	231=0.9590	232=0.9588	233=0.9585
234=0.9583	235=0.9581	236=0.9579	237=0.9576	238=0.9574	239=0.9572	240=0.9569	241=0.9567	242=0.9565
243=0.9563	244=0.9560	245=0.9558	246=0.9556	247=0.9553	248=0.9551	249=0.9549	250=0.9547	251=0.9544
252=0.9542	253=0.9540	254=0.9537	255=0.9535	256=0.9533	257=0.9531	258=0.9528	259=0.9526	260=0.9524
261=0.9522	262=0.9519	263=0.9517	264=0.9515	265=0.9512	266=0.9510	267=0.9508	268=0.9506	269=0.9503
270=0.9501	271=0.9499	272=0.9497	273=0.9494	274=0.9492	275=0.9490	276=0.9488	277=0.9485	278=0.9483
279=0.9481	280=0.9479	281=0.9476	282=0.9474	283=0.9472	284=0.9470	285=0.9467	286=0.9465	287=0.9463
288=0.9461	289=0.9459	290=0.9456	291=0.9454	292=0.9452	293=0.9450	294=0.9447	295=0.9445	296=0.9443
297=0.9441	298=0.9439	299=0.9436	300=0.9434	301=0.9432	302=0.9430	303=0.9427	304=0.9425	305=0.9423
306=0.9421	307=0.9418	308=0.9416	309=0.9414	310=0.9412	311=0.9410	312=0.9407	313=0.9405	314=0.9403
315=0.9401	316=0.9399	317=0.9396	318=0.9394	319=0.9392	320=0.9390	321=0.9387	322=0.9385	323=0.9383
324=0.9381	325=0.9379	326=0.9376	327=0.9374	328=0.9372	329=0.9370	330=0.9368	331=0.9365	332=0.9363
333=0.9361	334=0.9359	335=0.9357	336=0.9355	337=0.9352	338=0.9350	339=0.9348	340=0.9346	341=0.9344
342=0.9341	343=0.9339	344=0.9337	345=0.9335	346=0.9333	347=0.9331	348=0.9328	349=0.9326	350=0.9324
351=0.9322	352=0.9320	353=0.9317	354=0.9315	355=0.9313	356=0.9311	357=0.9309	358=0.9307	359=0.9304
360=0.9302	361=0.9300	362=0.9298	363=0.9296	364=0.9294	365=0.9292	366=0.9289	367=0.9287	368=0.9285
369=0.9283	370=0.9281	371=0.9279	372=0.9276	373=0.9274	374=0.9272	375=0.9270	376=0.9268	377=0.9266
378=0.9264	379=0.9261	380=0.9259	381=0.9257	382=0.9255	383=0.9253	384=0.9251	385=0.9249	386=0.9246
387=0.9244	388=0.9242	389=0.9240	390=0.9238	391=0.9236	392=0.9234	393=0.9231	394=0.9229	395=0.9227
396=0.9225	397=0.9223	398=0.9221	399=0.9219	400=0.9217	401=0.9214	402=0.9212	403=0.9210	404=0.9208
405=0.9206	406=0.9204	407=0.9202	408=0.9200	409=0.9198	410=0.9195	411=0.9193	412=0.9191	413=0.9189
414=0.9187	415=0.9185	416=0.9183	417=0.9181	418=0.9179	419=0.9176	420=0.9174	421=0.9172	422=0.9170
423=0.9168	424=0.9166	425=0.9164	426=0.9162	427=0.9160	428=0.9158	429=0.9155	430=0.9153	431=0.9151
432=0.9149	433=0.9147	434=0.9145	435=0.9143	436=0.9141	437=0.9139	438=0.9137	439=0.9135	440=0.9132
441=0.9130	442=0.9128	443=0.9126	444=0.9124	445=0.9122	446=0.9120	447=0.9118	448=0.9116	449=0.9114
450=0.9112	451=0.9110	452=0.9107	453=0.9105	454=0.9103	455=0.9101	456=0.9099	457=0.9097	458=0.9095
459=0.9093	460=0.9091	461=0.9089	462=0.9087	463=0.9085	464=0.9083	465=0.9081	466=0.9079	467=0.9076
468=0.9074	469=0.9072	470=0.9070	471=0.9068	472=0.9066	473=0.9064	474=0.9062	475=0.9060	476=0.9058
477=0.9056	478=0.9054	479=0.9052	480=0.9050	481=0.9048	482=0.9046	483=0.9044	484=0.9042	485=0.9040
486=0.9038	487=0.9035	488=0.9033	489=0.9031	490=0.9029	491=0.9027	492=0.9025	493=0.9023	494=0.9021
495=0.9019	496=0.9017	497=0.9015	498=0.9013	499=0.9011	500=0.9009	501=0.9007	502=0.9005	503=0.9003

Did you get the correct answer for the quiz problem? If not, did you:

1. Find that there were 45 gallons used at a temperature of 160°F?

   755 - 710 = 45 gal

2. Find that the correction factor for 160°F is 0.9756?

TEMP.	CORR.
160°F	0.9756

3. Multiply 45 by 0.9756?

   45 x 0.9756 = 43.902 rounded to 43.9 gal

Once you've found the number of gallons used at 60°F, you can determine the application rate in gallons per square yard. But first, you must calculate the square yards covered.

For example, if the beginning station of the tacking operation is 2+13 and the ending station is 7+62. The difference between the two is 549 feet. Right? 7+62 - 2+13 = 549 ft. This means that 549 feet have been coated with tack. If the width is 12 feet, then 6,588 square feet have been covered.

549 feet x 12 feet = 6,588 square feet

To get square yards, divide square feet by 9.

$$\frac{6{,}588 \text{ square feet}}{9 \text{ square feet per square yard}} = 732 \text{ square yards}$$

The formula for finding the application rate of tack is:

$$\text{Gallons per square yard} = \frac{\text{gallons of tack at } 60°F}{\text{square yards covered}}$$

$$\text{Gallons per square yard} = \frac{43.9 \text{ gallons at } 60°F}{732 \text{ square yards}} = 0.06 \text{ gal/yd}^2$$

Go on to the quiz.

QUIZ

Using the following information, answer the questions below.

The tack in a distributor tank is at 163°F. Your starting measurement shows that 1,430 gallons of material are in the tank. After a 12-foot strip of roadway between stations 55 + 80 and 77+40 is tacked, there are 1,312 gallons remaining in the tank.

1. How many gallons of tack at 60°F were applied? _____(Use the table for an RS-1 asphalt)

2. How many square yards of roadway were tacked? _____

3. What was the application rate? _____

Check your answers on page 3-55.

MEASUREMENT OF TACK IN DISTRIBUTORS

You know how to correct quantities of liquid bituminous materials to their 60°F volumes using the correction tables. And, you know how to determine application rates by dividing gallons of tack at 60°F by the square yards covered. But, we need to back up for a moment. Just how do you measure the amounts of tack contained in the distributors? We will discuss that now.

Using Calibration Charts

As you know, we must determine the quantity of tack material in the distributor at the start of the operation and again at the end of the operation. You may recall our discussion of distributor calibration charts in Chapter Two. Each distributor must be calibrated by a reliable and recognized firm engaged in calibrating tanks.

The charts relate depth measurements of the tack in the distributors to exact quantities of gallons of material. The charts are in the form of computer printouts, although you may actually use smaller copies of the charts in the field. Each chart consists of several pages.

The first page of a typical calibration chart is shown on the next page. Look it over and then carefully read the explanation on the following pages.

Table A

* CALIBRATION CHART FOR TANK NO. DOT 2027

*TYPE OF TANK DISTRIBUTOR

*OWNER JULINA E JOHNSON & SONS INC. P.O. BOX 37049 JACKSONVILLE FLA. 32205

*MAKE OF TANK ETNYER SERIAL NO. J-5317 OWNER NO.

*COMPARTMENTS ONE OVERALL LENGTH 10 FT. 11 INCHES

*HEIGHT OF DOME ABOVE SHELL 4 INCHES OVERALL WIDTH OR DIA. 7 FT. 4 INCHES

*DEPTH FROM TOP OF DOME TO BOTTOM SHELL 54 8/16 INCHES

*COIL DATA 2@ 8 INCH 2@ 6 INCH

*CALIBRATION DATE AND LOCATION 6-3-75 GAINESVILLE, FLA.

* BY: A. LORD

*NOTE MEASUREMENTS FROM TOP OF DOME TO SURFACE OF LIQUID

* REPRESENTS GALLONS REMAINING IN TANK.

* MEASUREMEMTS ARE IN INCHES AND SIXTEENTHS OF AN INCH.

* ALL MEASUREMENTS MUST BE MADE ONLY WHEN TANKS ARE LEVEL.

* DOT 2027 STAMPED ON LT REAR BUMBER OF TANK.

* ZERO GALS INDICATE TANK WAS TILTED & DRAINED.

* TOTAL CAPACITY 1650 GALLONS

* ALL MEASUREMENTS MUST BE MADE FROM ONLY DOME.

DEPTH	GAL	DEPTH	GAL	DEPTH	GAL	DEPTH	GAL	DEPTH	GAL	DEPTH	GAL
0/00	1650	0/01	1650	0/02	1650	0/03	1650	0/04	1650	0/05	1650
0/08	1649	0/09	1649	0/10	1649	0/11	1649	0/12	1649	0/13	1649
1/00	1648	1/01	1648	1/02	1648	1/03	1648	1/04	1648	1/05	1648
1/08	1648	1/09	1648	1/10	1647	1/11	1647	1/12	1647	1/13	1647
2/00	1647	2/01	1647	2/02	1647	2/03	1647	2/04	1646	2/05	1646

Notice the following information especially:

This calibration chart pertains to a specific tank -- No. DOT 2027. For verification that the correct chart is used with this distributor tank, compare the tank number on the chart to the one stamped on the left rear bumper of the distributor.

- Data concerning the owner, make, dimensions and calibration of the tank are provided.
- Starting with "*NOTE," instructions are given as to how and where to measure the tank:
  - -- All measurements must be made from the top of the dome to the surface of the tack and only when the tank is level.
  - -- Measurements must be made in inches and sixteenths of an inch. These measurements represent the number of gallons remaining in the tank.
  - -- The tank must be tilted and drained in order to obtain a measurement equaling zero gallons.

Can you read and understand the chart on the opposite page? Notice the circled figures at the bottom of Table A on page 3-34. (The 2/03 means 2-3/16 inches. Right? When your measurement from the top of the dome to the surface of the tack is 2-3/16 inches, there are 1,647 gallons of tack in the tank.)

Now try the quiz on the next page.

QUIZ

1. Shown below is a section of a page from the calibration chart we just discussed. If you measured the tack in Tank No. DOT 2027 as 21-14/16 inches, how much bituminous material is in the tank?_____

DOT NO. 2027															
DEPTH	GAL	DEPTH	GAL	DEPTH	GAL	DEPTH	GAL	DEPTH	GAL	DEPTH	GAL	DEPTH	GAL	DEPTH	GAL
20/08	1191	20/09	1188	20/10	1186	20/11	1184	21/12	1181	20/13	1179	20/14	1177	20/15	1174
21/00	1172	21/01	1169	21/02	1167	21/03	1165	21/04	1162	21/05	1160	21/06	1157	21/07	1155
21/08	1152	21/09	1149	21/10	1147	21/11	1144	21/12	1141	21/13	1139	21/14	1136	21/15	1133

Check your answers on page 3-56.

Taking the Measurements

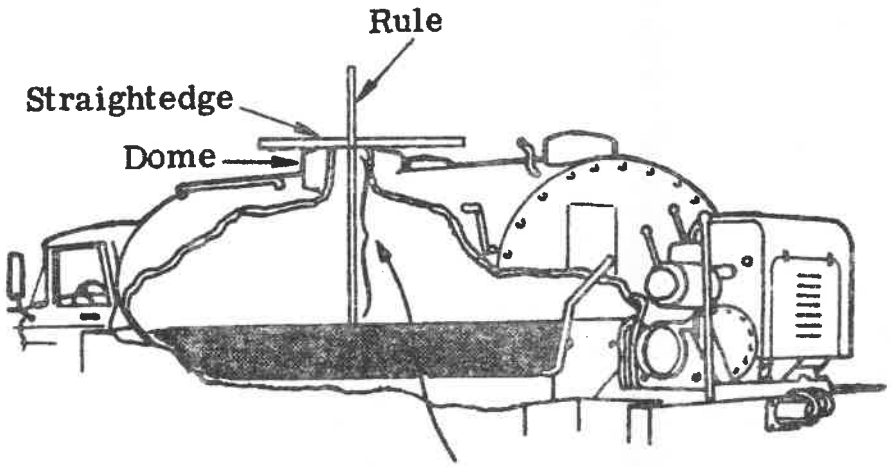
To measure from the top of the tank dome to the surface of the bituminous material (or tack), you should use a straightedge and a rule in the following manner:

1. Being sure that the tank is level, lay the straightedge across the center of the open dome.

2. Measure from the bottom of the straightedge to the surface of the material. The bottom of the straightedge is at the same level as the top of the dome. Be sure to just touch the surface of the material.

3. Read the measurement in inches to the nearest sixteenth of an inch.

The diagram below illustrates the procedures. Follow the same steps in taking both starting and ending measurements. To obtain ending measurements of "zero gallons" the tank must be tilted and drained.



SAFETY IS ESSENTIAL. When taking these measurements safety is a must. The material in the tank may be very hot. The following guidelines should be followed:

1. Make sure the truck engine is off and the brakes set.

2. Gloves are mandatory

QUIZ

1. When measuring the level of bituminous material (tack) in a tank, lay the straightedge _____ _____.

2. You should use a _____ to measure from the _____ of the straightedge to the _____ of the tack.

3. Read your measurement to the nearest _____.

4. To obtain ending measurements of "zero gallons" the tank must be _____ and _____.

Check your answers on page 3-56.

RECORD OF BITUMINOUS MATERIALS

The qualified paving technician will be required to document the application of tack by completing a Record of Bituminous Materials in the Asphalt Roadway - Daily Report of Quality Control (Contractor) and Asphalt Roadway - Verification Report (Department).

The Record of Bituminous materials is simple to complete. Its completion involves the same procedures we have discussed in this section of the chapter:

- verifying that correct calibration charts are used with the distributor tanks
- measuring the starting and ending depths of bituminous material in the tanks
- using calibration charts to determine quantities of material based on material depths
- calculating quantities of tack applied to roadway
- correcting heated quantities of tack to their volumes at 60°F
- calculating square yards covered and application rates

The Daily Report contains the Record of Bituminous Materials section shown on the next page.

RECORD OF BITUMINOUS MATERIALS				
Pay Item No.				
Grade Of Asphalt				
FDOT Calibration Tank No.				
Beginning Inch / MM				
Gallons / Liters				
Ending Inch / MM				
Gallons / Liters				
Time of Day after Unloading	AM PM	AM PM	AM PM	AM PM
Temperature °C/°F				
Net (HOT) Gallons / Liters				
Correction Factor				
Prev. Gallons / Liters @ 60°F/15°C				
Today's Gallons / Liters @ 60°F/15°C				
Accum. Gallons / Liters @ 60°F/15°C				
SY / SM Covered				
Spread Rate Gal/SY L/SM				

Refer to the form on the previous page and note the following:

- The FDOT (tank calibration) Number must be recorded.
- The Beginning and Ending tank measurements must be entered to the nearest sixteenth of an inch and the calibration chart must be consulted to determine the number of gallons in the tank at each time.
- The Temperature of the heated tack must be recorded.
- The Net Gallons (HOT) must be determined -- by subtracting the After Gallons from the Before Gallons -- and entered.
- Correction Table III must be consulted to determine and record the Correlating (correction) Factor.
- The Net Gallons (HOT) must be corrected to Gallons at 60°F -- by multiplying the Net Gallons (HOT) by the Correction Factor -- and entered.
- The Sq. Yds. Covered by the tack must be computed and entered.
- The Spread (application rate) must be calculated -- by dividing Gallons at 60°F by Sq. Yds. Covered -- and recorded.

QUIZ

Refer to the completed Record of Bituminous Materials on the next page to answer the following questions:

1. How many different asphalt distributors were involved? _____

2. Why was the Correction Factor different in the third column? _____

3. The Spread Rate in the last column has not been determined and recorded. Calculate it. _____

Check your answers on page 3-56.

RECORD OF BITUMINOUS MATERIALS				
Pay Item No.				
Grade Of Asphalt				
FDOT Calibration Tank No.	1746	1801	1746	1801
Beginning Inch / MM	19/01	11/01	25/00	24/10
Gallons / Liters	1195	1482	950	966
Ending Inch / MM	38/08	23/12	38/00	31/09
Gallons / Liters	378	1003	398	666
Time of Day after Unloading	AM PM	AM PM	AM PM	AM PM
Temperature °C/°F	160 °F	160 °F	155 °F	160 °F
Net (HOT) Gallons / Liters	817	479	552	300
Correction Factor	0.9754	0.9754	0.9768	0.9754
Prev. Gallons / Liters @ 60°F/15°C	465	498	744	473
Today's Gallons / Liters @ 60°F/15°C	797	467	539	293
Accum. Gallons / Liters @ 60°F/15°C	1,262	965	1,283	766
SY / SM Covered	13,166	14,345	21,735	15,247
Spread Rate Gal/SY L/SM	0.06	0.03	0.02	

ASPHALT RUBBER MEMBRANE INTERLAYER (ARMI)

A crack relief layer is a very effective method of reducing reflective cracking in an asphalt pavement. In Florida, an Asphalt Rubber Membrane Interlayer (ARMI) is used for a crack relief layer. An ARMI not only serves as a crack relief layer, but also as a moisture barrier, minimizing both reflective cracking and moisture damage.

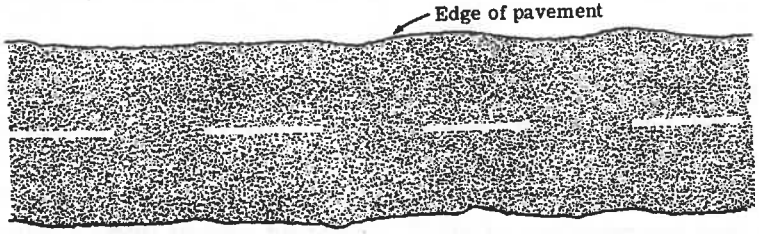
An ARMI is made up of two parts: a layer of asphalt rubber that is sprayed on the pavement and a layer of cover material that is applied on the asphalt rubber.

Asphalt Rubber - The asphalt rubber that is used in an ARMI is an ARB-20, which is an AC-20 modified with 20 percent ground tire rubber. The asphalt rubber is applied at an application rate of from 0.6 to 0.8 gallons per square yard (the actual target is set by the Engineer) and at a temperature between 350°F and 375°F. As with tack coat (discussed in the next section) the application rate is calculated based on measurements of the amount of material in the distributor and it also has to be converted back to a standard temperature of 60°F. (Asphalt rubber uses a different set of temperature correction factors than emulsified asphalts).

Cover Material - The cover material (No. 6 stone) is applied almost immediately after the asphalt rubber (within 300 feet). It is spread with a chip spreader at a rate of from 0.26 to 0.33 cubic feet per square yard - the exact rate is set by the Engineer. The application rate of the aggregate should be high enough to completely cover the asphalt rubber in a single layer of rock. Too much rock can lead to a slippage or rutting problem. Too little rock and the pavement may bleed. It is then rolled by traffic rollers to seat the aggregate into the asphalt rubber.

HORIZONTAL ALIGNMENT CONTROLS

Now we will talk about another important step in preparing for paving -- setting alignment controls for the paver. The paver operator cannot merely watch the road ahead and lay the pavement to the correct alignment. He must have a guide. Without some sort of guide, the pavement might look like this:

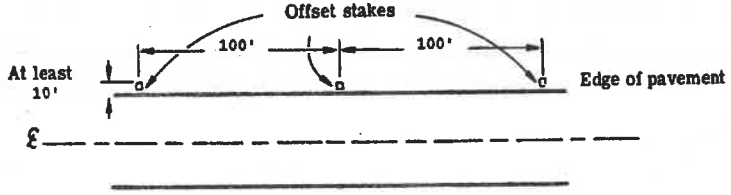


This would be called a disaster in polite circles. To prevent this, stringlines are set from reference points and are used as guides.

OFFSET STAKES

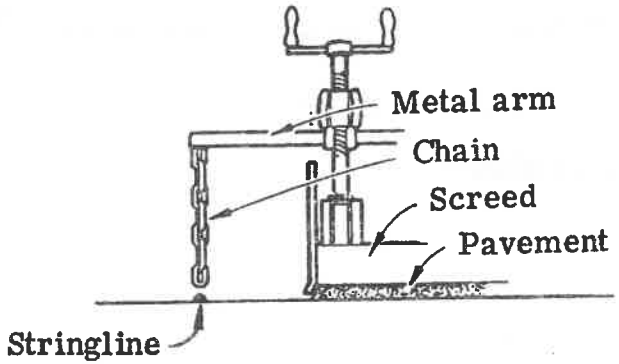
Offset stakes sometimes are used to establish horizontal alignment. Normally, a survey crew places the offset stakes sometime before construction begins. They are placed fixed distances from and at right angles to known control lines. You will know the exact offset distance because it is marked on the stake. The station number is also marked on the stake.

Here is an example of how offset stakes are placed. These are 10 feet from the edge of pavement. And they are at appropriate intervals along the roadway -- for example, 100 ft or 200 feet -- in order to establish horizontal control. This is the normal placement for tangent sections. On curves, the stakes are placed closer together.



STRINGLINES

Exactly where the Contractor sets his stringline depends on what kind of paver or guide arrangement he plans to use. In many cases, a metal arm with a chain hanging on one end is attached to the side of the paver. An operator steers the paver so that the chain hangs over the stringline.



Of course, the above arrangement is just one of several ways to guide a paver. However, the stringline method is required in all cases -- except when paving is done adjacent to curb and gutter sections of other true edges. The important thing is to obtain an accurate, uniform alignment of the pavement edge. When the paving operation is over, the stringline shall be removed as soon as possible.

QUIZ

1. Offset stakes sometimes are used to establish _____control.

2. Who normally places offset stakes? _____

3. What two references are shown on offset stakes?

   A. _____

   B. _____

4. What guide does the paver follow to obtain an accurate, uniform alignment of the pavement edge? _____

5. Can the paver operator use the curb and gutter as a guideline when paving in areas where it exists? _____

Check your answers on page 3-56.

TRAFFIC CONTROL

Traffic control is yet another important area of preparation for hot mix asphalt paving. Of course, it is also a primary concern during paving. An outline of your responsibilities concerning traffic control is given below:

- Make sure that the working crew wears safety vests and other safety equipment at all times.
- As mentioned early in this course, the printed material you must have available to you on the job includes the Manual on Uniform Traffic Control Devices and the Contractor's Traffic Control Plan. Become familiar with and follow the guidelines in the Manual.
- The responsibility to see that driveway connections are maintained is that of the technician. Access to homes and business must be provided at all times.
- Be sure that the Contractor has an adequate supply of the required traffic signs and control devices and arrange features in accordance with approved MOT plan before work begins.
- During paving operations, be sure that the Contractor properly maintains the traffic control devices -- including signs, lighting systems, barricades, cones, flag persons, etc.
- Also, you will see that temporary striping or raised retro-reflective pavement markers are placed where it is required.
- A lighting system for night paving shall be established to furnish a minimum intensity of 5 ft-cd and the lighting must be arranged to prevent interference with traffic or produce glare to property owners. Safety must be emphasized to all individuals working at night around traffic and paving operations.

Proper preparation and inspection in this area will ensure greater safety and better public relations. Sometimes, detour facilities are necessary to divert traffic from existing roadway/construction areas. When the construction is finished, all the unnecessary MOT features shall be either covered or removed from the jobsite.

WEATHER LIMITATIONS

Weather conditions place limitations on the paving operations.

TACK

Tack coats must be applied only when the air temperature is suitable for paving. All other conditions must be suitable; namely, tacking should not be attempted in rain or strong wind. Additionally, all weather conditions must be suitable for paving before beginning to tack. The specifications require that the air temperature in the shade and away from artificial heat must be 40°F or greater.

PAVING

Limitations on paving are very important, since the Standard Specifications require that HMA shall not be transported from the plant to the roadway unless the conditions for paving are suitable. The air temperature must be at least 40°F in the shade for all paving over one inch in thickness. For one inch or less thickness, the temperature must be 45°F or above. For open-graded friction courses, the temperature must be 60°F or above for FC-2 and must be 65°F or above for FC-5. Also, there must be no evidence of frozen base. Loads of hot mix caught in transit by sudden rains may be placed when the rain has stopped and the water has been removed from the tacked surface to the satisfaction of the Engineer and the temperature of the mixture caught in transit still meets the requirements of the specification. Hot mix asphalt must never be placed while rain is falling or when water is standing on the surface to be paved. Hot mix asphalt must not be placed when winds prevent adequate compaction of the mat -- or deposit sand, dust or other debris on surfaces to be paved to the extent that the bond between courses weakens.

QUIZ

1. What documentation must you have on hand as a guide to proper traffic control? _____ _____ and _____

2. You have the responsibility to see that _____ are maintained, since access to homes and businesses must be provided at all times.

3. You must be sure that the Contractor has an adequate supply of the proper _____ _____ before work begins.

4. What is the air temperature requirement for spreading tack coats and placing hot mix for mat thickness 1 inch or less? _____ Over 1 inch? _____ For open-graded friction courses (FC-5)? _____

5. What must be done if the Contractor chooses to place a load of mix that was caught in transit by a sudden rain -- and then the mix proves to be unsatisfactory after placement? _____ _____ _____

6. As a paving Technician, what is your responsibility concerning bad concrete pavements that will be resurfaced? _____ _____

7. Why is it necessary to clean and tack existing surfaces before paving them? _____

8. For leveling operations, how should motor grader blades be positioned in relation to the roadway centerline? _____

9. Before a leveling course is placed, all depressions greater than _____ must be patched.

10. Proper tack application rates are from _____ to _____ gallons per square yard.

11. What does a proper tack application look like? _____

12. Describe tack that has properly broken: _____

13. Can a change in any one of the following affect tack coverage? _____

- Spray pressure
- Condition and adjustment of spray bar and nozzles
- Distributor's speed

14. Using the information given below and the excerpts from the Correction Table and Calibration Chart, complete the Record of Bituminous Materials.

Today, asphalt distributor number DOT 2027 arrived on the project to spread tack in a 12-foot width from station 23 +00 to station 64 + 70. The driver handed you delivery ticket number 14599. Your starting measurement of the tack was 23-2/16 inches. The tack was spread at a temperature of 157°F. Your ending measurement of the tank level was 29-5/16 inches.

RECORD OF BITUMINOUS MATERIALS				
Pay Item No.				
Grade Of Asphalt				
FDOT Calibration Tank No.				
Beginning Inch / MM				
Gallons / Liters				
Ending Inch / MM				
Gallons / Liters				
Time of Day after Unloading	AM PM	AM PM	AM PM	AM PM
Temperature °C/°F				
Net (HOT) Gallons / Liters				
Correction Factor				
Prev. Gallons / Liters @ 60°F/15°C				
Today's Gallons / Liters @ 60°F/15°C				
Accum. Gallons / Liters @ 60°F/15°C				
SY / SM Covered				
Spread Rate Gal/SY L/SM				

Excerpt from Correction Table III

TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.
126=0.9838	127=0.9835	128=0.9833	129=0.9830	130=0.9828	131=0.9826	132=0.9823	133=0.9821	134=0.9818
135=0.9816	136=0.9814	137=0.9811	138=0.9809	139=0.9806	140=0.9804	141=0.9802	142=0.9799	143=0.9797
144=0.9794	145=0.9792	146=0.9790	147=0.9787	148=09785	149=0.9782	150=0.9780	151=0.9778	152=0.9775
153=0.9773	154=0.9770	155=0.9768	156=0.9766	157=0.9763	158=0.9761	159=0.9758	160=0.9756	161=0.9754
162=0.9751	163=0.9749	164=0.9747	165=0.9744	166=0.9742	167=0.9739	168=0.9737	169=0.9735	170=0.9732
171=0.9730	172=0.9728	173=0.9725	174=0.9723	175=0.9721	176=0.9718	177=0.9716	178=0.9713	179=0.9711

Excerpt from calibration chart for distributor tank no. 2027

Depth	Gallons	Depth	Gallons	Depth	Gallons	Depth	Gallons	Depth	Gallons	Depth	Gallons	Depth	Gallons	Depth	Gallons
22/08	1109	22/09	1107	22/10	1104	22/11	1101	22/12	1099	22/13	1096	22/14	1093	22/15	1091
23/00	1088	23/01	1085	23/02	1083	23/03	1080	23/04	1077	23/05	1074	23/06	1071	23/07	1068
23/08	1065	23/09	1062	23/10	1058	23/11	1055	23/12	1052	23/13	1049	23/14	1046	23/15	1043
24/00	1040	24/01	1037	24/02	1035	24/03	1032	24/04	1029	24/05	1027	24/06	1024	24/07	1021
24/08	1019	24/09	1016	24/10	1013	24/11	1011	24/12	1008	24/13	1005	24/14	1003	24/15	1000
25/00	997	25/01	994	25/02	991	25/03	988	25/04	985	25/05	982	25/06	978	25/07	975
25/08	973	25/09	969	25/10	966	25/11	963	25/12	960	25/13	957	25/14	954	25/15	951
26/00	949	26/01	946	26/02	943	26/03	940	26/04	937	26/05	934	26/06	931	26/07	929
26/08	926	26/09	923	26/10	920	26/11	917	26/12	914	26/13	911	26/14	909	26/15	906
27/00	903	27/01	900	27/02	897	27/03	894	27/04	891	27/05	889	27/06	886	27/07	883
27/08	880	27/09	877	27/10	875	27/11	872	27/12	869	27/13	867	27/14	864	27/15	861
28/00	859	28/01	856	28/02	853	28/03	851	28/04	848	28/05	845	28/06	843	28/07	840
28/08	837	28/09	834	28/10	831	28/11	828	28/12	825	28/13	822	28/14	818	28/15	815
29/00	812	29/01	809	29/02	806	29/03	803	29/04	800	29/05	798	29/06	795	29/07	793
29/08	790	29/09	788	29/10	785	29/11	783	29/12	780	29/13	778	29/14	775	29/15	773

Compare your work with the answers on page 3-57. When you complete this Quiz, you will have finished Chapter Three. Review any parts of this chapter you feel unsure of before you begin the next chapter. Proceed to Chapter Four when you are ready.

ANSWERS TO QUESTIONS

Page 3-6

1. Loose and foreign material will prevent proper bond between new and existing pavement.
2. It must be removed flush with surface
3. A. Broken sections that pump
   B. Blown-up or heaved sections
4. Breaking, reseating, and pumping concrete

Page 3-9

1. One inch
2. primed bases, surface treatments
3. grade, cross section
4. No
5. Yes

Page 3-13

1. A. Depth of cut
   B. Conditions of teeth
   C. Speed of machine
   D. Hardness of existing pavement
2. The plans
3. Must be cleaned of all dust
4. Any of the following are correct:
   A. Max. drop off between adjacent lanes 1 ½"
   B. Milled surface has been cleared
   C. Striations are acceptable to maintain traffic safety.
   D. Drainage weep holes have been cut.
   E. Traffic has been warned of the unusual condition ahead.

Page 3-16

1. B
2. Center, center, outer edge
3. 50, 75

Page 3-20 & 3-21

1. A, C
2. A, C, D
3. 0.02 to 0.08 gals./sq. yd.
4. C, D
5. True
6. structures

Page 3-24

1. Yes
2. Thin, web-like and uniform coverage
3. All of them

Page 3-28

1. expands
2. 60°F
3. 43.9 gallons

Page 3-30

1. 115
2. 2880
3. 0.04

Page 3-36

1. 1,136 gallons

Page 3-39

1. across the center of the open dome
2. rule, bottom, surface
3. sixteenth of an inch
4. tilted, drained

Page 3-43

1. four
2. two
3. Temp is lower
4. 0.02 gal/sq. yd.

Page 3-48

1. Horizontal alignment
2. Survey crews
3. A. Station number
   B.
   offset distance
4. Stringline
5. Yes

Page 3-51 thru 3-54

1. Manual on Uniform Traffic Control Devices and Contractor's Traffic Control Plan
2. driveway connections
3. signs and traffic control devices
4. 45°F or above in shade
   40°F or above
   65°F or above
5. The engineer will evaluate the pavement and a penalty will be applied including removal and replacement at no cost to the FDOT.
6. Be sure that they are corrected before resurfacing begins
7. To ensure proper bond between courses
8. skewed
9. one inch
10. 0.02, 0.08
11. Thin, web-like and uniform coverage
12. Black and sticky
13. Yes

14.

RECORD OF BITUMINOUS MATERIALS	
Pay Item No.	
Grade Of Asphalt	
FDOT Calibration Tank No.	2027
Beginning Inch / MM	23/02
Gallons / Liters	1083
Ending Inch / MM	29/05
Gallons / Liters	798
Time of Day after Unloading	AM PM
Temperature °C/°F	157 °F
Net (HOT) Gallons / Liters	285
Correction Factor	0.9763
Prev. Gallons / Liters @ 60°F/15°C	0
Today's Gallons / Liters @ 60°F/15°C	278
Accum. Gallons / Liters @ 60°F/15°C	278
SY / SM Covered	5,560
Spread Rate Gal/SY L/SM	0.05

CHAPTER FOUR

Inspecting Paving Operations

CONTENTS

INSPECTING PAVING OPERATIONS

Good pavements don't just happen. They result from careful work, good QC operations and thorough inspection. It is desirable to use two technicians for the paving operations (good quality control operations) -- one to receive and verify delivery tickets, check temperatures, and observe the paving operations; the other to observe and verify the rolling procedures, field density coring, and straightedging.

The inspection starts with the hot mix. You can check it as the truck is rolling up to the site. It is better to reject bad mix than it is to reject bad pavement. So, spot the bad mixes before they become bad pavements.

MIX DEFICIENCIES

There are several mix deficiencies that may be reasons for rejecting a truckload of mix. Usually, the Plant Technician will spot these deficiencies before the haul trucks leave the plant -- and will reject the hot mix. But often it will be up to you to determine when to reject a load. Experience is the best teacher here. Remember, you are responsible to see that no unacceptable hot mix goes on the roadway. In this section are listed some of the things you should watch for.

Too Hot: You can detect an overheated batch of mix when it arrives at the roadway. Blue smoke rising from the mix usually indicates an overheated batch. The temperature of the mix should be checked immediately.

The range for hot mix asphalt temperatures is established by the mix design which you will know in advance. The master range for all mix designs will be the established temperature from the mix design ± 30°F. Hot mix asphalt with a temperature outside the master range should be rejected. (Note that certain modified asphalt mixtures will be heated to higher temperatures. Refer to the specific project specifications for these mixtures.) You should check the temperature of the first five loads each day and then at least every fifth load afterwards. When you check the temperature of the HMA at the roadway the temperature should be recorded on the right side of the temperature reading taken at the plant on the front of the delivery ticket. Check the loads before they are dumped into the paver, using a thermometer as we discussed in Chapter Two. If there is an excessive difference between the plant and road temperatures of the mix (considering the

length of haul) you should check your thermometer for accuracy.

Besides the master range requirement, the requirement of the mix temperature must be met. Each mix design used at the plant has an established mix temperature set by the Contractor. All loads must have temperatures within 25°F of the established temperature. For example, suppose the established temperature is 295°F. To be within the established temperature range, hot mix loads should be from 270 to 320°F (295 ± 25°F).

Here is an example of how you should use the requirements for the master range and the established temperature in an actual situation:

Suppose the established temperature is 300°F. The temperature of the first load of hot mix arriving at the road is 273°F. This temperature is not within the established temperature range (300 ± 25°F), but is within the master range (300 ± 30°F). Do not reject this first load, but advise the Plant Technician so that he can exercise closer control at the plant. Loads shipped from the plant after notification should be within the range of 275°F to 325°F. Any loads outside the master range should be rejected. Anytime a single load is out of the established temperature range, accept it and inform the Plant Technician of the problem. However, never accept loads of hot mix that are more than 335°F and do not allow the Contractor to place overheated loads after they have cooled down to within the master range.

Other deficiencies typically found in an asphalt mix include the following:

Too Cold: A generally stiff appearance, or improper coating of the larger particles may indicate a cold mixture. Take the temperature immediately.

Too Much Asphalt: When a load of mix lies flat -- slumped -- and has a shiny, soupy appearance, it may contain too much asphalt.

Too Little Asphalt: A load with too little asphalt can be identified by its lean, granular appearance, improper coating and lack of shiny black luster.

Too Much Coarse Aggregate: Mix with too much coarse aggregate can be mistaken for mix with too much asphalt. Both faulty mixes have the same general appearance. These conditions can be detected by the poor workability of the mix and its coarse appearance on the road.

Too Much Fine Aggregate: Mix with too much fine aggregate will have a lean, dull brown appearance much like mix with too little asphalt. Its texture is much different from that of a properly graded mixture.

Too Much Moisture: Mix with too much moisture can be detected by the steam rising from the mix as it's being dumped into the paver. The mix may bubble and pop as if it were boiling. It may, in appearance, resemble a mix that has too much asphalt.

Contamination: Contamination can be caused by a number of things. Diesel fuel, gasoline, kerosene, oil, rags, paper, roots, trash, or dirt can contaminate the mix. Contamination can be removed -- shoveled out -- if it can be properly separated from the rest of the load. Then the rest of the load can be used; but, do not use a load that is completely contaminated. Reject it immediately.

Segregation: Another mix deficiency is segregation. The fine aggregates may lump together and the coarse aggregates may lump together. The aggregates are not spread evenly throughout the mix. Segregation sometimes may be serious enough to cause rejection of the mix. Frequently, segregation can be caused by how the mix is loaded from the plant into the truck and from the truck into the paver hopper.

Non-uniform Mix: Every now and then you might run across a mix that has not been mixed uniformly. A non-uniform mix will have spots of lean, brown, dull material mixed with areas of rich, shiny material.

In general, loads of mix that are mostly defective must be rejected. Loads of mix having isolated defective areas can be used, if these areas can be thoroughly separated and removed from the rest of the loads.

Of the deficiencies we have discussed, mix temperatures will be the most common problem you will encounter. The other deficiencies are more difficult to spot and should be observed first by the Plant Technician anyway. However, it is a good idea for you to be familiar with the kinds of problems that hot mixes can develop.

QUIZ

1. What usually indicates an overheated batch? _____

2. Which of the following individual load temperatures would be in the acceptable range if the established mix temperature were 305°F?

   ___ A. 270°F

   ___ B. 321°F

   ___ C. 336°F

   ___ D. 298°F

3. The established mix temperature is 280°F. A load of mix arrives at the road at a temperature of 252°F. What should you do? _____

4. The next load arrives at a temperature of 345°F. What should you do? _____

5. Although the plant is only 10 minutes from the paving site, you are obtaining mix temperatures about 14 degrees lower than the temperatures taken at the plant. What should you do? _____

6. How often should you check the temperatures of the mix? _____

7. A load of mix that lies flat in the truck and has a shiny, soupy appearance may have which of these defects?

   ___ A. Too many coarse aggregates

   ___ B. Too much asphalt

   ___ C. Too cold

8. A load of mix arrives at the road with three small areas of contamination. Under what conditions would you accept the load? _____

Check your answers on page 4-45, if you got the correct answers, continue - if not go back over the material.

DELIVERY TICKETS

As each haul truck arrives at the road, you should collect the delivery ticket from the driver. Delivery tickets give information about each load of hot mix and serve as a record of the material received and placed on the road.

The asphalt plant must be equipped with one of the following three electronic weigh systems capable of automatically printing a delivery ticket:

1. Automatic batch plant with printout.
2. Electronic weigh system on hopper beneath a surge or storage bin.
3. Electronic weigh system on the truck scales.

The printed delivery ticket contains, as a minimum, the following information:

a. Sequential load number
b. Project number
c. Date
d. Name and location of plant
e. Type of mix
f. Place for hand-recording mix temperature
g. Truck number
h. Gross, tare and net weights (as applicable)
i. Accumulated total of mix
j. Tons

The ticket is printed with an original and three copies. The original goes to the FDOT technician at the plant, one copy to the FDOT technician at the paving site, one copy to the Contractor at the plant and one copy to the Contractor at the paving site.

At the road, the Contractor must check and record the temperatures of the loads at the frequency mentioned in the first section -- the first five loads each day and every fifth load thereafter. The Department's Technician shall verify the Contractor's work at least once per day. The temperature should be recorded on the delivery ticket.

QUIZ

1. Two copies of the delivery ticket leave the plant. One of these copies goes to the Paving Technician. Where does the other copy go? _____

2. Which of the following are not required to be given on the delivery ticket?

   ___ A. Project number

   ___ B. Weights of mix components

   ___ C. Truck driver's name

   ___ D. Date

   ___ E. Thickness of course

   ___ F. Type of mix

   ___ G. Temperature of Load

   ___ H. Technician's signature

Check your answers on page 4-45, if you got the correct answers, continue - if not go back over the material.

MAT THICKNESS AND MIX QUANTITY

There are two methods of payment for asphaltic concrete: by the ton or by the square yard.

When payment is by tonnage, we are concerned with plan quantity -- the number of pounds of mix that should cover one square yard of roadway. The total tonnage to be paid for is calculated from the delivery tickets.

When payment is by square yards, we are talking about plan thickness -- the depth the mat should have after compaction. The Contractor cannot tell precisely what paving thickness to set to obtain the plan thickness, but there is a general rule of thumb. For each one inch of mat thickness desired, lay 1-1/4 inches of loose (uncompacted) mat, as shown in the diagram below.

The plan quantities or thicknesses of HMA pavements will be shown on the plans. The contractor is responsible for obtaining the proper mat thickness or rate of placement [pounds per square yard]. The technician is responsible for verifying that the contractor does it right.

To check the contractor's control of thickness and spread, you should probe the mat (to determine thickness) and compute the rate of placement frequently. Probing will be discussed in a few pages and calculating spread rates will be discussed in Chapter Six.

QUIZ

1. What are the methods of payment for asphalt concrete?

   _____

   _____

2. Which method of payment is related to plan thickness? _____

3. The other method of payment is related to _____.

4. To obtain asphalt concrete pavement 3 inches thick, approximately how many loose inches of asphalt concrete should be placed? _____

Check your answers on page 4-45, if you got the right answers, continue - if not go back over the material.

PAVER OPERATIONS

SCREED HEATERS

Before a paver can begin spreading hot mix, the screed should be heated to a temperature near that of the mix. This will prevent the mix from sticking to the screed.

CROSS SLOPE CONTROL

Prior to paving, the screed plate should be adjusted so that a mat of the desired cross section is produced behind the paver. As we mentioned earlier in the course, the screed plate normally is raised slightly in the center. This is accomplished by adjusting the crown control. Also, the leading edge of the screed should be adjusted to have from 1/16 to 1/8 inch more crown than the back edge. The slightly higher front edge allows the mix to pass under the screed without producing a torn or rough mat.

PAVER CONTACT WITH HAUL TRUCKS

Watch each haul truck as it approaches the paver to be sure the haul truck does not bump into the paver. The haul truck should back to within a few feet of the paver and stop. The paver should then be moved up until its roller bars make firm contact with the rear wheels.

The reason for having the paver move up to the truck is simple. If the truck backs into the paver, it might bump the paver and push it back. This would cause ridges or bumps in the mat.

Both roller bars should make contact with both truck wheels at the same time. If only one roller bar is in contact, only one side of the paver does the pushing. This will cause the paver to "chatter" -- or jerk. The surface of the hot mix asphalt will suffer.

PAVER SPEED

After the paver moves up, the truck body is elevated, the hot mix asphalt begins to fall into the receiving hopper, and paving begins. The speed of the paver is important. The paver should go slow enough so that the screed does not pull or tear the mat. The speed of the paver should be governed by the number of haul trucks used -- so as to provide a continuous paving operation -- and will be determined by the Contractor.

CASTING AND FANNING HOT MIX (THROW BACK)

A highly undesirable practice is casting the mix behind the paver with a shovel. If you have ever seen hot mix being laid, you have probably seen some casting. This is the practice of shoveling excess mix off the side of the roadway and throwing it onto the uncompacted mix.

Cast material stays on the surface until the roller passes over it. In the meantime, it cools rapidly. Although the roller will press the cast material into the mat, a good bond cannot be obtained. The cast material eventually will ravel out and the area will have a rough appearance. Casting also produces a non-uniform texture and appearance after the rolling is complete.

The only time it is permissible to place mix, by shovel, onto the uncompacted mat, is when minor irregularities are observed on the surface of the mix. In these locations, mix may be taken from the paver hopper in shovelfuls and "fanned" onto the mat. The fanned mix must be immediately luted to bond it to the mat. At the completion of the luting, the coarser particles should be removed from the surface.

Fanning should not become a constant practice. The need for constant fanning may indicate problems in other areas -- such as screed out of adjustment or serious mix deficiencies, which need to be corrected.

QUIZ

1. The screed should be heated to a temperature near that of the _____.

2. Should the center of the screed plate be lower than the outside edges? _____

3. What do you suppose would happen if the screed plate were not adjusted properly? _____
_____

4. How close should haul trucks back up to pavers? _____

5. What might happen if a truck backs into the paver? _____

6. What may happen if the paver moves too fast? _____

7. The speed of the paver will be set by the _____ and governed by the number of _____ _____ used.

8. Why is casting not a good practice? _____
_____

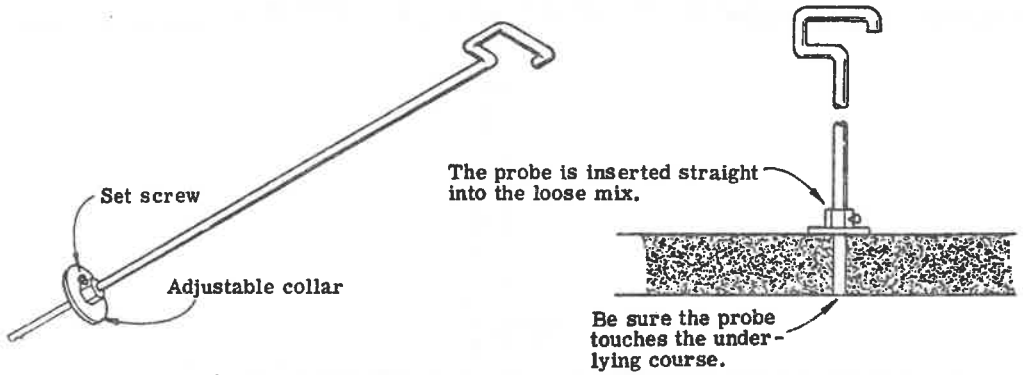
9. How may minor irregularities be corrected in the mat surface? _____
_____

Check your answers on page 4-45, if you got the correct answers, continue on to Mat Thickness Control - if not go back over the material.

MAT THICKNESS CONTROL

The paving crew should check the mat thickness immediately behind the paver, using a suitable probing tool as we discussed briefly in Chapter Two.

One type of probe is shown below. To check a loose mat that is 2-1/2 inches thick, you would adjust the collar to 2-1/2 inches from the end.



If the collar just touches the mat, the thickness is right. If the collar does not touch the mat, the mat is too thin. If the collar sinks into the mat, the mat is too thick.

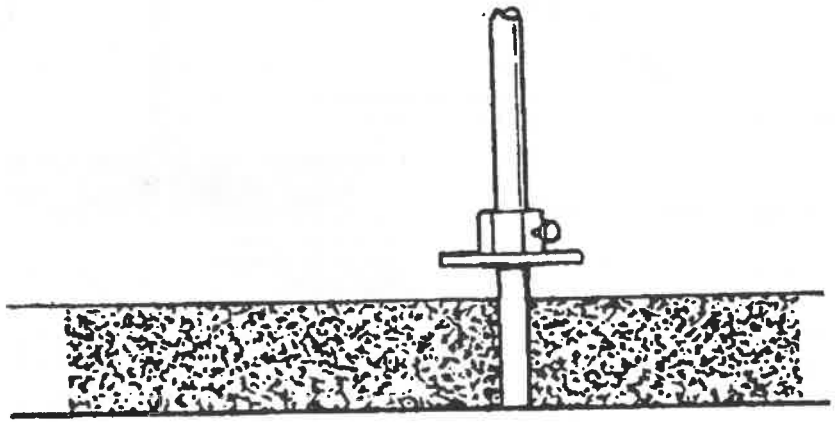
Just because the thickness is not correct in one spot does not mean the whole mat is that way. After mat thickness is checked crosswise and lengthwise, you might discover that the mat is consistently too thick or too thin. When this happens, adjustments must be made to the screed.

If an electronically controlled screed is not being used, the mat thickness should be checked more often. It's easier for the thickness to be off when the paver is manually operated than when it is electronically controlled.

QUIZ

1. You may want to check the mat thickness more often if a _____ operated screed is used.

2. If the probe has been adjusted for the proper depth, what is wrong with this mat? _____

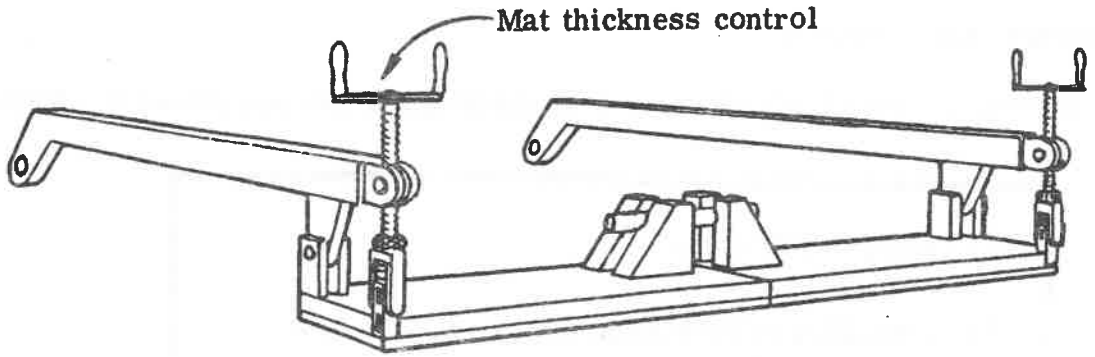


The answers are on page 4-45. If you got the correct answers, GREAT, continue on to Manual Screed Control. If not go back over the previous material.

MANUAL SCREED CONTROL

Since the screed can be manually controlled, you need to know what the controls are and what they do.

Manually controlled screeds respond slowly when adjusted. The machines are designed this way to avoid making bumps in the pavement. In Chapter Two, we discussed the mat thickness controls; they are shown again below.



After the thickness control is turned, it will take about 5 times the length of the leveling or tow arms for the screed to adjust to the new depth. This means that if the length of the leveling arm is 9 feet, the paver would have to move forward for a distance of at least 45 feet before the required input to the thickness-control device was completely carried out by the paver screed.

The thickness control should be adjusted no more than 1/4 turn every 3 feet. Let's say the screed should be adjusted so that the uncompacted mix is 1/8 inch thicker. If it takes one full turn to adjust the screed 1/8 inch, it will take four quarter turns of the thickness control and 24 feet before the screed can make the adjustment. This is illustrated on the following page.

This is how we come up with 24 feet:

1. Make first quarter turn, wait 3 feet and
2. Make second quarter turn, wait 3 feet and
3. Make third quarter turn, wait 3 feet and
4. Make fourth quarter turn; 15 feet after this turn the screed makes the total adjustment of 1/8 inch.

T1 - Indicates first turn

A1 - Indicates point screed adjusts to first turn

T2 - Second turn

A2 - Indicates point screen adjusts to second turn

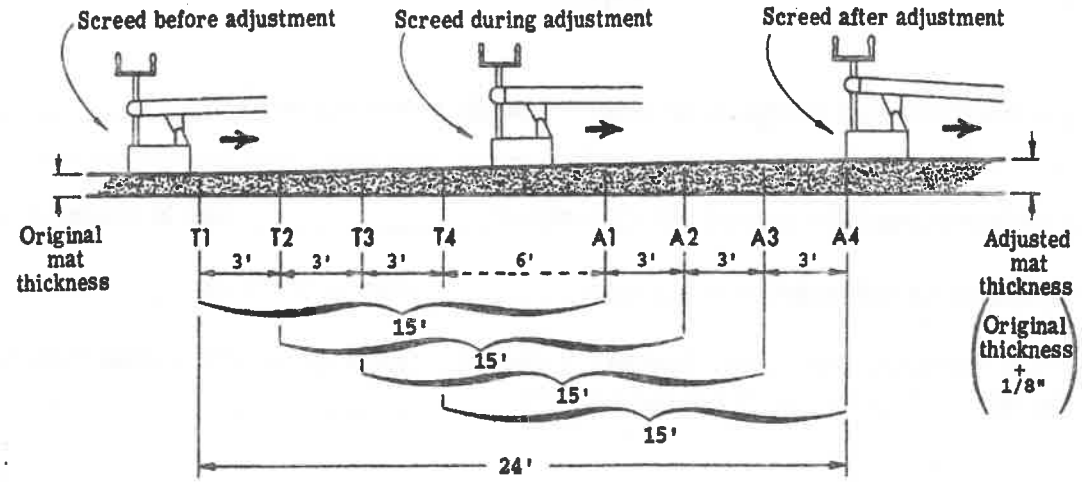
T3 - Third turn

A3 - Indicates point screed adjusts to third turn

T4 - Fourth turn

A4 - Indicates point screed adjusts to fourth turn

As a technician, you should watch the paving crew to be sure that they do not make screed adjustments too frequently.



QUIZ

1. Why are manually controlled screeds designed to respond slowly when adjusted? _____
_____

2. After the thickness control is turned the screed will take about _____ feet to adjust to the new depth.

3. The thickness control should be adjusted no more than _____ turn every 3 feet.

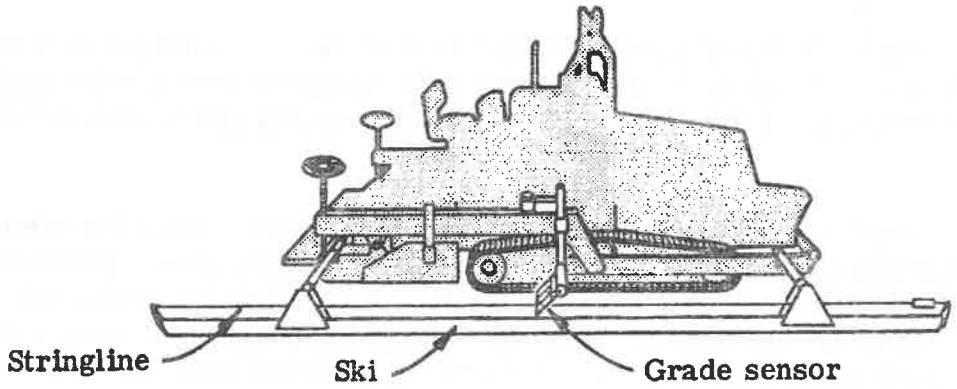
4. If it takes one-half turn of the thickness control to make a desired adjustment in the screed, how many feet will the paver travel before the screed can complete the adjustment? _____

Check your answers on page 4-45, if you got the correct answers, continue - if not go back over the material.

AUTOMATIC SCREED CONTROLS

The screed unit on the paver is attached to the tractor unit at only one point on each side of the paver, called the tow (pull) point. As the tractor follows the existing grade with its rubber tires or crawler tracks, the length of the paver wheelbase becomes the reference for the screed. Because of the reaction time required for the screed, the screed will respond more slowly to changes in grade than will the tractor. Thus under manual screed control, discussed earlier, the screed will average out deviations in the roughness of the underlying pavement layer, placing more mix over the low points and less mix over the high points in the existing pavement.

Automatic screed controls are used to keep the elevation of the tow points on the paver at a predetermined elevation relative to the reference (either a preset string-line or a long mobile ski). Deviations in the pavement surface are averaged out over the length of the reference. As the tractor unit moves up and down over the existing grade, the elevation of the tow points moves over a smaller range than would be the case if the relatively short wheelbase of the tractor provided the reference. Keeping the elevation of the tow points constant in direct relationship to the reference permits the screed to maintain a more consistent angle of attack, which in turn provides for a smoother mat behind the screed. It should be noted, however, that many factors affect the smoothness of the mix placed by the paver. The use of automatic screed controls, by itself, does not ensure that the mat constructed will be smooth.



Types of Grade References

Grade sensors are used to monitor the elevation of the existing pavement surface in a longitudinal direction. Three basic types of grade references can be used to maintain the elevation of the screed tow points: (a) erected string-line, (b) mobile reference or ski, and (c) joint matching shoe. On paving projects with proper sight distance, a laser system can also be used.

Each type of grade reference can be used alone on either side of the paver; each can also be used on both sides of the paver at the same time. The same type of grade reference can be used on both sides of the machine, or a different type can be mounted on each side. For example, a preset string-line can be used on one side and a mobile reference on the other. This use of double grade references makes it possible to average out the variations in the profile of the existing pavement surface on both sides of the lane being paved. However, use of double grade references generally will not produce a uniform cross slope for the new asphalt layer unless a preset string-line is used on both sides of the paving machine. An effective approach is to combine the use of grade and slope controls. When a grade reference is used in conjunction with a slope control device, the grade sensor is typically positioned on the centerline side of the paver, with the slope control determining the depth of the mat on the outside edge of the pavement.

The grade sensor or wand is in contact with the reference in all but sonic systems. As the grade of the reference changes, the wand senses that change and sends an electrical signal to the control panel on the paver. A signal is then sent, in turn, to the tow points on either side of the paver and their elevation is changed relative to the change sensed by the grade sensor.

If a sonic or noncontact system is used, a sound pulse is sent out from a transducer toward the reference-stringline, mobile reference, or existing pavement surface. When the sound pulse hits the reference, a position of that pulse is reflected back to the transducer, which also acts as a receiver. The time required for the sound to travel to the reference and back is measured and the distance is calculated on the basis of the speed of sound. Thus the elevation of the tow points is controlled without the sensor actually coming in contact with the reference itself. On one sonic system, a "working window" is used to prevent the system from making a major change in the elevation of the tow points when a false signal is received. This window is ± 2.4 in. from the elevation of the reference. If the distance measured by the sonic system is greater than the window range, the control of the grade sensor is switched to manual, and no changes are sent to the tow points.

Erected Stringline

The use of an erected stringline provides for placement of the smoothest possible asphalt mat behind the paver screed. The stringline can be made of wire or nylon cord. This method of supplying elevation input provides the most consistent reference for the paver tow points, enabling a predetermined grade to be matched very accurately if the controls are used properly.

The elevation of the erected stringline must be set by a surveying crew. The accuracy of the elevation of the line and the resulting pavement smoothness are directly dependent on the care taken during erection. If the grade set by the surveyors is incorrect in any way, the paver screed will duplicate that error in the pavement surface.

The stringline must also be very taut when it is set. Typically, the string is supported at intervals of 25 ft on metal posts and rods. The string or wire is first anchored at one end of its length and then pulled tight and anchored at the other end. It is extremely important that there be no dips or sags between the support rods. If the string is not stretched tightly, the sensor wand on the paver, which can run either atop or below the stringline, will react to the sags in the line and duplicate those sags in the new pavement surface. Even when high-strength line is used, it is not always possible to keep the line tight enough to prevent small sags from occurring.

The haul trucks and all paving personnel must keep away from the line and not disturb it in any way. Once the line has been set at the proper elevation, it must remain untouched both before and after passing of the paver sensor over the line. Any change in the elevation of the line will result in a change in the input to the grade sensor and movement of the tow points on the paver level arms.

With a properly set and maintained stringline, the mat placed by a paver equipped with automatic screed controls can be very smooth and at the correct elevation, primarily because of the extended length of the reference being used as compared with the more limited length of a mobile reference. However, unless smoothness or compliance with a predetermined grade reference is extremely important, as with an airport runway where a consistent longitudinal and transverse profile is required, it is questionable whether the added expense of erecting and maintaining a stringline is cost-effective for the typical HMA paving job. Thus for the vast majority of highway paving projects, an erected stringline is not used.

Mobile Reference

The various paver manufacturers use different types of mobile reference devices to extend the relative wheelbase for the automatic screed control system. The operation of these reference systems, however, is essentially the same. The purpose of the mobile reference is to average the deviations in the existing pavement surface out over a distance that is greater than the wheelbase of the tractor unit itself.

One version of a mobile reference employs a rigid tubular grade reference (pipe) that is 20, 30, or 40 ft in length. For this version, the pipe or tube rides directly on the existing pavement surface. A spring-loaded wire is typically stretched along the ski on top of the pipe. The grade sensor that inputs the electrical signal to the paver tow points rides on tip of the wire. As the ends of the pipe move up and down over the existing grade, the stretched wire on the ski is used to average out the differences in elevation that occur under the mobile reference.

Another floating-beam mobile reference consists of a series of feet or shoes attached to the bottom of a beam. One or more of the feet can pass over a singular high or low point in the existing pavement surface without altering the slope of the entire beam. The feet are spring loaded so they can be deflected by a large stone on the pavement surface, for example, without pushing the sole beam upward. The grade sensor usually rides directly on the beam at its midpoint. As with the other types of mobile references, this floating-beam system averages out the variation of the existing grade over a 30 or 40 ft. distance.

On mobile reference systems, other than the floating-beam type, the grade sensor should be located in the center of the length of the beam to ensure that the input to the paver tow points will be made equally over the length of the reference. If the grade sensor is not located in the center of the length of the mobile reference, the ski will not average out the changes in elevation in the existing pavement surface uniformly.

Of the mobile reference devices described above, the floating-beam type with multiple feet or shoes typically results in a smoother pavement because of its ability to ignore isolated deviations in grade (a rock on the roadway, for example). Moreover, the longer the grade reference used, within reason, the better the paver will average out variations in the elevation of the existing pavement surface. A mobile reference will not, however, ensure that the mix being placed is at the proper elevation. The elevation is controlled by the elevation of the underlying pavement surface and the thickness of the mat being laid.

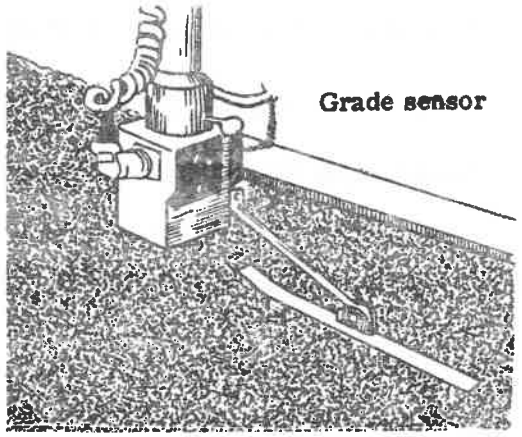
Joint-Matching Shoe

The joint-matching shoe consists of a short ski [approximately 1 ft. long] that is used to reference the grade of an adjacent pavement lane. This type of mobile reference is used only when the grade being sensed is relatively smooth. The shoe rotates around its own pivot point and when displaced, supplies an electrical input signal to the paver tow points. The shoe should be checked to ensure that it is free to rotate properly.

When placing the second lane of a base course or a binder course layer, it may be better to use a longer mobile reference [a ski 30 ft long] instead of a joint-matching shoe. The mobile reference will provide better input for constructing a smooth pavement surface than will the joint-matching shoe. For a surface course layer, however, the joint-matching shoe may be used to ensure that the elevation of the mix on both sides of the longitudinal joint is the same, although the use of a longer mobile reference is still better paving practice.

Lasers

Laser technology has been used successfully on a number of paving projects. For locations where the sight distance is adequate and the pavement being placed has a constant slope, a laser system can be employed to control the elevation of the tow points on the paver. A transmitter sends a laser signal to a receiver unit on the paving machine. This signal controls the grade of the mat by regulating the tow point location in relation to the laser beam. When used properly, the laser grade control system is capable of providing a very smooth mat behind the paver. To keep the tow points from moving randomly if a haul truck or other object passes through the laser beam, a delay is built into the control system so that the beam can be interrupted briefly without changing the position of the tow points. The command panel and the grade sensor feed electric impulses to the control box. The control box then activates motors or hydraulic actuators to change the position of the screed control arms. This, in turn, adjusts the tilt of the screed. In this way, an electronically controlled screed compensates for surface irregularities and produces a smooth mat.



QUIZ

1. The three basic types of grade references are:

   _____

   _____

   _____

2. Can two different types of grade systems be used on the paver at the same time? _____

3. The elevation of the stringline is set by _____.

4. The stringline is supported at intervals of _____ and supported by _____.

5. What is the length of the rigid tubular grade reference beams on a mobile reference system?_____

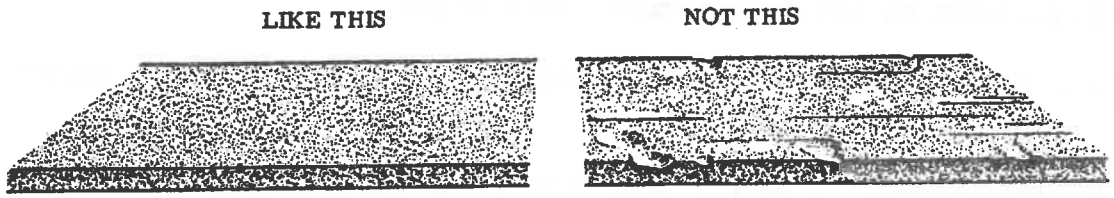
6. How long is the joint-matching shoe? _____

The answers to these questions begin on page 4- 46.

MAT QUALITY

You get the first look at the mat in place when the first load of mix has gone through the paver. This is the time for your initial paving inspection. You will have to watch for many things.

Check the surface of the mat. Watch for any differences in the smoothness. The mat should be uniform, even-textured and free of holes of any kind.



We discussed inspecting the mix while still in the haul truck. Sometimes, defects in the mixes that are not easily seen in the trucks may become apparent in the freshly paved mat. You should watch for sandy spots and streaks, segregation, and fat or lean areas (areas too rich or deficient in asphalt cement). Defects such as these normally stem from batching and mixing problems at the plant.

Defects, such as open-textured, pulled, or torn mat, usually indicate the need for screed adjustment. A rippled mat is caused by an incorrect adjustment of the feeders or gates at the paver. We talked about adjusting the crown control of the screed to obtain a smooth mat. Another adjustment to achieve a better mat -- on pavers using vibratory screeds -- is to vary the vibrations of the screed.

As a Paving Technician at this point, you are responsible for several things:

- When mat defects are caused by improperly adjusted equipment or deficiencies in the mix, be sure that adjustments are made where necessary -- at the plant or in the paver.
- When adjustments are made, be sure that they correct the problem.
- If adjustments do not correct the situation, stop the paving until the contractor can either correct or replace his equipment.

In summary, if your inspection indicates that you are not getting a good mat, you need to determine the reason. The problems probably can be traced to one of the following general areas:

- Something is wrong at the plant.
- The mix is not being hauled or handled properly before being deposited in the paver.
- Something is wrong with the adjustments to the paver.

If you are not getting a good mat, corrective action shall be taken. Do not allow paving to begin again until corrections have been made to your complete satisfaction.

QUIZ

1. Defects such as sandy spots or streaks, segregation, and fat or lean areas normally stem from _____
_____.

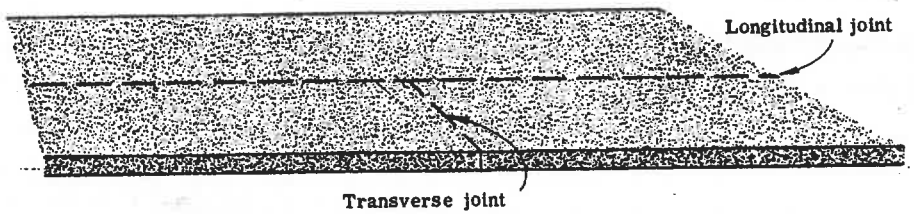
2. Defects such as open-textured, pulled or torn mat usually indicate the need for _____
_____.

3. Defects are appearing in the mat. You inform the contractor's foreman, and he stops the paver. Adjustments are made, but when paving begins again, the problem reappears. What should you do? _____
_____
_____
_____

Check your answers on page 4-46, if you got the right answers, continue - if not go back over the material.

JOINT CONSTRUCTION

During paving operations, joints of two basic types will be required: transverse and longitudinal. A transverse joint runs across the pavement perpendicular to the centerline. A longitudinal joint runs the length of the pavement, on or parallel to the centerline.



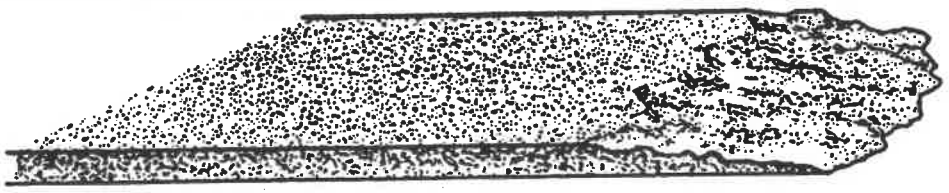
A transverse joint is formed when there is a break in the paving operations. This always happens when the Contractor closes down for the day or when some problem arises and you have to stop operations for a significant period of time.

A longitudinal joint will be formed when less than the full width of pavement is placed at one time.

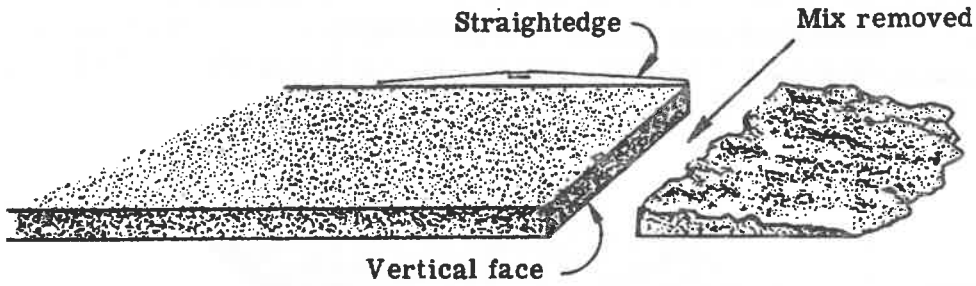
TRANSVERSE JOINTS

Ready to construct a joint? Let's take the transverse joint first. The last load of mix to be placed is in the paver. The paver is allowed to run until there is a small amount of mix left. Then, the crew stops the paver feeders and augers and pulls the paver out of the way.

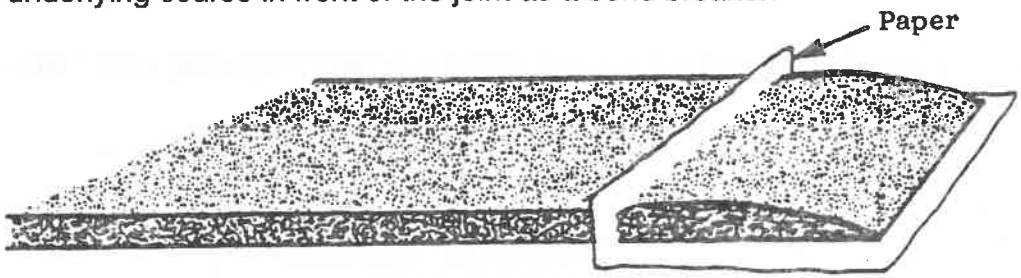
1. A rough uneven mat will be left, as shown here.



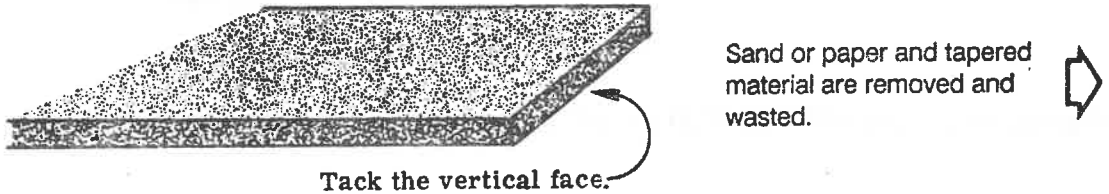
2. Now you must determine -- by using a straightedge -- how far back the mat must be removed to obtain a good starting point for the joint. When this point is determined, the end of the mat is cut off and a narrow section of the mix is removed. Be sure that a vertical face is left on the mat end.



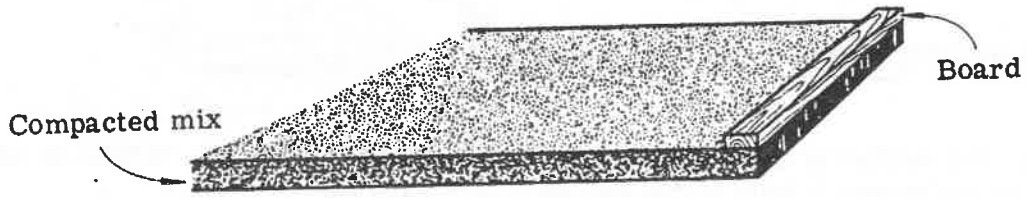
3. Paper is placed against the vertical face and the area in front of the face where the ramp is to be built. Or sand can be placed on the underlying course in front of the joint as a bond breaker.



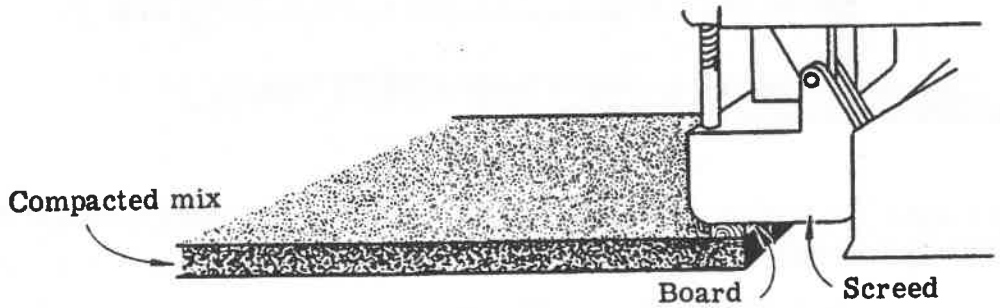
4. When paving is to begin again, the sand or paper and tapered material are removed, exposing the vertical end of the mat. This vertical face is then tacked.



5. Now butt the new mat up against the mat in place so that no bump or dip occurs. How? Remember that we expect the mix to compact about 1/4 inch for each 1-1/4 inches of loose mat thickness (20 %). So if the compacted mat should be 2 inches thick, the paving thickness should be approximately 2-1/2 inches thick. So you want to start laying the new mix approximately 2-1/2 inches thick. Here's how -- a board 1/2 inch thick may be used. The board is placed on the end of the compacted mat.

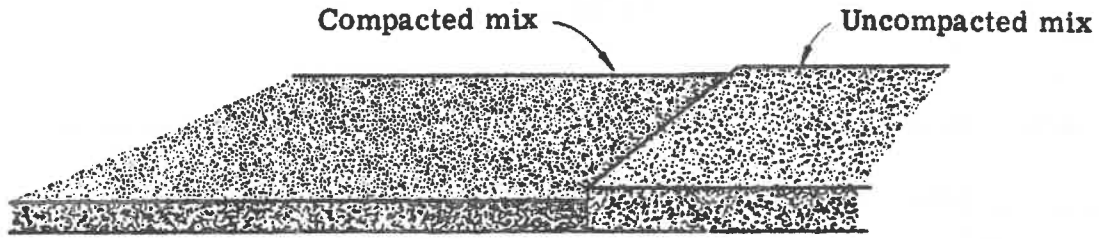


6. The paver is backed up to the end of the compacted mat, and the screed is lowered until it sits on top of the board.

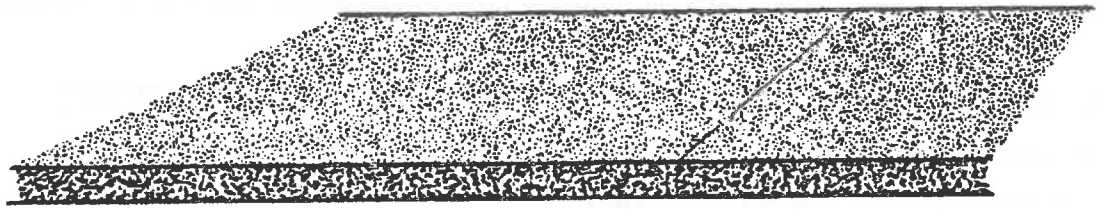


The screws are run until the space is filled with mix; then the paver is allowed to move forward.

7. This will be the result:



When the new mix is compacted, it should be the same thickness as the mat in place -- and there should be a smooth transition from one mat to the other. Be sure that the joint is straightedged immediately. If the joint needs further work, see that it is done immediately as well. When corrections require considerable time, stop the paving (with a full load of mix in the hopper) until the joint is finished and acceptable.



QUIZ

1. Which kind of joint runs the length of the pavement, on or parallel to the centerline? _____

2. A _____ joint runs across the pavement, perpendicular to the centerline.

3. A transverse joint should be formed when operations are stopped for _____.

4. When will a longitudinal joint be formed? _____
_____

5. Number the following steps in making a transverse joint in the correct order:

___ A. When ready to being paving again, remove sand or paper and tapered material and tack vertical face of mat.

___ B. Allow paver to run until only a small amount of mix remains. Then, pull paver out of the way.

___ C. Compact the new mix at the joint and straightedge the joint immediately.

___ D. Place sand or paper prior to placing the wedge.

___ E. Place board of proper thickness on the end of the compacted mat.

___ F. Determine the starting point for the joint by straightedging the mat. Cut off the end of the mat.

___ G. Back the paver up and lower the screed to sit on top of board. Begin paving.

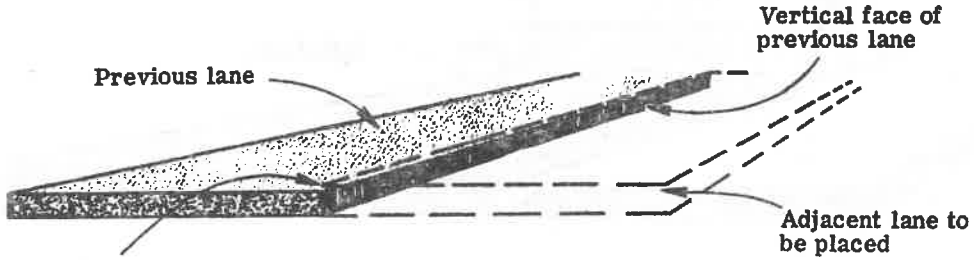
Check your answers on page 4-46, if you got the right answers, continue - if not go back over the material.

Now we will discuss LONGITUDINAL JOINTS.

LONGITUDINAL JOINTS

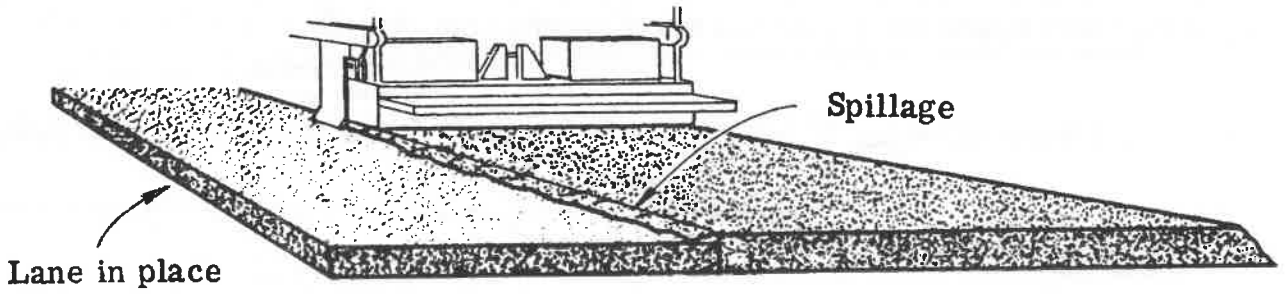
Now let's discuss the construction of the longitudinal joint between lanes.

As each lane of pavement is placed, its entire width will be rolled. When the adjacent lane is paved, the mix will be placed against the vertical face of the previous lane and will be "pinched" by the roller. The "pinching" packs the fresh mix tightly against the vertical face of the previous lane and produces a smooth longitudinal joint. Study the diagram below:

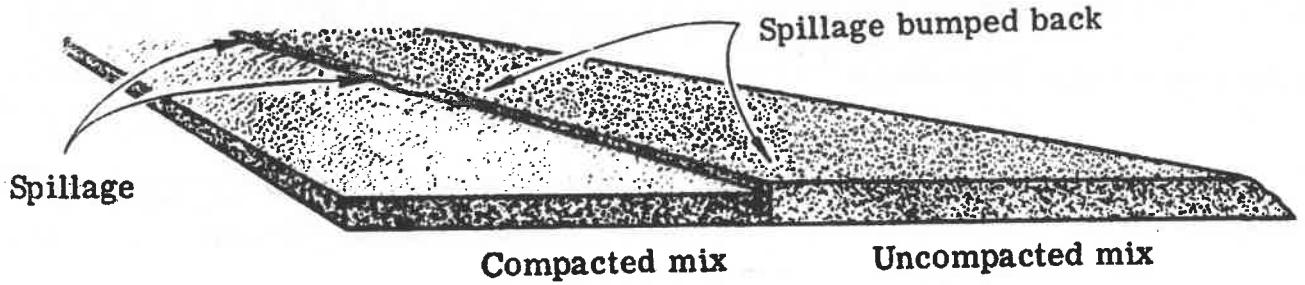


In some cases, the first paved lane is opened to traffic and there is considerable crossing traffic that beats down the vertical face of the joint. In such cases, it may be necessary to trim the vertical face of this first lane to provide a uniform joint against which the adjacent lane will be placed.

Now, let's see how the adjacent lane is placed. The end of the paver screed should overlap the lane in place slightly -- sufficient to ensure that the joint will be completely filled and sealed. However, the screed should not be overlapped so that an excessive amount of material is spilled onto the adjoining lane. There will be some spillage onto the lane in place, as shown below.



The spillage should be "bumped" back onto the new ("hot") lane to form a tight joint. This is accomplished by pushing the loose mix with the lute.



Spillage will be considered excessive if it all cannot be bumped back onto the hot lane so that the roller can crowd the small excess into the side of the joint. When the spillage is excessive, the excess material should be trimmed off so that the bumped ridge of material along the joint is uniform. Then the joint can be rolled.

One major problem with longitudinal joint construction is an excessive amount of overlap of the paver screed over the previous placed mat. Because this extra asphalt mix cannot be pushed into the compacted mat, the material is usually

raked or luted onto the new mat. During the raking process, there is a tendency for too much material to be pushed off of the joint, leaving the level of mix adjacent to the longitudinal joint at the same elevation on both sides of that joint. In some cases, so much mix is raked off the joint that a dip occurs at the longitudinal joint. Even before compaction occurs, it becomes impossible to obtain the required density at the joint. In general, excessive raking of the longitudinal joint is detrimental to the long-term performance of the joint.

Excellent longitudinal joints can be constructed without raking the joint at all. If the proper amount of overlap of the new mix on the previous placed mat has been done, raking can be eliminated.

We will discuss rolling operations in the next chapter. Now, go on to the quiz on the next page.

QUIZ

1. As each lane of pavement is placed, its _____ will be rolled.

2. Before the adjoining lane is placed, it may be necessary to _____ the vertical face of the first lane.

3. When placing the adjoining lane, the end of the paver screed should:

   ___ A. be directly above the joint.

   ___ B. be several inches on the hot lane side of the joint

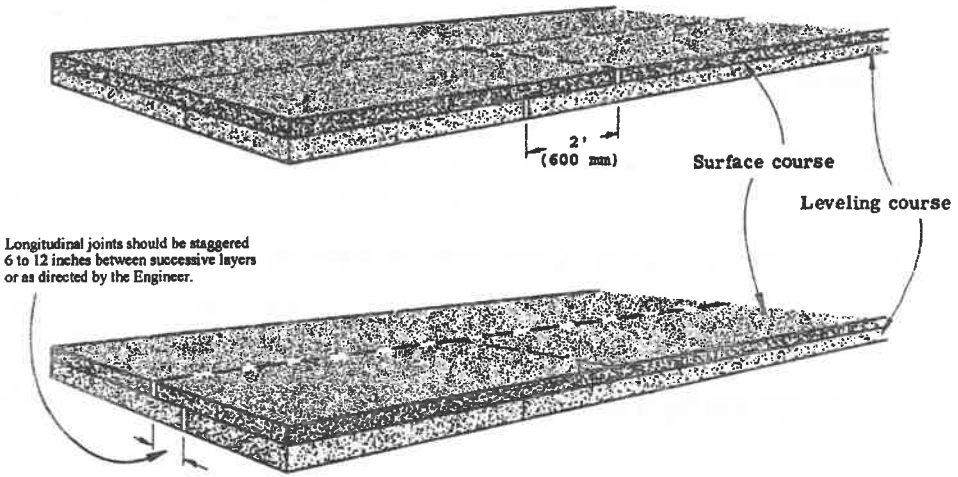
   ___ C. slightly overlap the lane in place.

Check your answers on page 4-46, if you got the right answers, continue - if not go back over the material.

OFFSETTING JOINTS

Asphalt concrete pavements are usually placed in two or more lifts (layers). The joints in one lift should not be placed right on top of the joints in another lift. This "stacking" of the joints could weaken the pavement structure.

Transverse joints should lie at least 2 feet apart.



It's a simple matter to keep from stacking transverse joints. You can see the joints in the lower lift. Be sure the paver stops at least 2 feet or more from lower joints. Actually, it would be highly unusual to even have to worry about stacking transverse joints. Transverse joints rarely fall close together.

Keeping longitudinal joints apart requires a little more attention. The longitudinal joint of the upper lift should always fall at the centerline or at lane lines on a multi-lane highway. This means that the longitudinal joint of the lower lift should not fall at centerline or at lane lines.

For this reason, the lanes of the lower lift must be offset. By this we mean that the lanes of the lower lift must be placed in different paving widths, so that the longitudinal joint of the lower lift is staggered from that of the upper lift.

QUIZ

1. Why should joints not be stacked? _____
_____

2. Transverse joints should lie at least _____ apart.

3. Longitudinal joints should be staggered _____
_____.

4. To prevent stacking of longitudinal joints, the lanes of the lower lift may be _____
_____.

Check your answers on page 4-46, if you got the right answers, continue - if not go back over the material.

BASE COURSE PAVING AND WIDENING

The equipment and procedures for hot mix asphalt base course paving and base widening are basically the same as those for leveling and structural courses.

Of course, the surface tolerance requirements are not as strict for bases as they are for structural and friction courses. Also, a single compacted base course layer may be a maximum of 3 inches thick.

There are some differences in equipment requirements for base widening. Pavers are not required for laying base widening strips less than 6 feet wide. Also, vibratory rollers, trucks, motor graders, trench rollers and other approved compaction equipment may be used to compact such areas -- and other areas too restricted to accommodate regular rollers.

We will discuss rolling operations in detail in the next chapter. But first, review what you have learned in this chapter by taking the quiz beginning on the next page.

QUIZ

1. What is the master range of temperatures for hot mix asphalt (HMA)? _____

2. The established mix temperature is 290°F. What should you do if a load arrives at the road with a temperature of 320°F? _____

3. What should you do if a load arrives with a temperature of 345°F?
_____

4. You discover an isolated area of contamination in a load of mix. What should you do? _____
_____

5. Should you receive the originals of delivery tickets at the roadway? _____

6. After checking the temperatures of the first five loads of mix for the day, how often should you check the temperatures of the other loads? At least every _____ load.

7. If a compacted asphalt concrete pavement layer of 1 inch is desired, what loose thickness should be placed on the road? _____

8. Should the center of the screed plate be adjusted higher than the outside edges? _____

9. Which of the following can produce a poor quality mat?

   ___ A. Improperly adjusted screed

   ___ B. Defective mix

   ___ C. Too fast speed of paver

   ___ D. Casting

10. Complete the following sequence for fanning (throw back):

    1. Shovelfuls of hot mix are taken from the paver hopper.
    2. The mix is fanned thinly onto minor mat irregularities.
    3. _____

11. It is necessary to check the mat _____ more often if a manually controlled screed is being used.

12. The screed takes about _____ feet to adjust after the thickness control is turned.

13. Defects such as open-textured, pulled, torn or rippled mat usually indicate the need for _____ _____.

14. A transverse joint should be formed:

    ___ A. at the end of each day's paving operation.
    ___ B. when the paver breaks down for an extended period.
    ___ C. when less than the full width of pavement is placed at one time.
    ___ D. parallel to the roadway centerline.

15. Number the following steps in making a transverse joint in the correct order:

___ A. Place paper or sand and compact the mat and tapered material.

___ B. Compact the new mix at the joint and straightedge the joint immediately.

___ C. Determine the starting point for the joint by straightedging the mat. Cut off the end of the mat.

___ D. Back the paver up and lower the screed to sit on top of board. Begin paving.

___ E. When ready to begin paving again, remove sand or paper and tapered material and tack vertical face of mat.

___ F. Allow paver to run until only a small amount of mix remains. Then, pull paver out of the way.

___ G. Place board of proper thickness on the end of the compacted mat.

Check your answers on page 4-47.

Be sure you understand the material presented in this chapter. If you had trouble with certain parts, review the text and retake the quizzes as necessary. When you are confident that you understand everything, go on to Chapter Five.

ANSWERS TO QUESTIONS

Page 4-6 & 4-7

1. Blue smoke
2. B, D
3. Inform plant technician and monitor the temperature closely
4. Reject the mix; it is too hot
5. Check thermometer for accuracy
6. First five loads and every fifth load thereafter
7. A, B
8. If the defective areas can be thoroughly separated and removed

Page 4-9

1. To the contractor at the paving site.
2. B, C, E, G, H

Page 4-11

1. Tonnage
   Square yds.
2. Square yds.
3. plan quantity
4. 3-3/4"

Page 4-14

1. hot mix
2. No
3. The mix would not flow smoothly under the screed–surface might be torn or rough
4. A few feet
5. It could cause ridges or bumps in the mat.
6. The mat may be pulled or torn.
7. Contractor, haul trucks
8. It causes raveling and leaves a non-uniform surface texture and appearance.
9. By fanning shovelfuls of mix from hopper onto mat and then luting immediately.

Page 4-16

1. manually
2. It is too thin

Page 4-20

1. To avoid making bumps in pavement
2. 15 feet -- After the thickness control is turned, it will take about 5 times the length of the leveling or tow arms for the screed to adjust to the new depth
3. 1/4
4. 18 feet

Page 4-26

1. Erected string-line
   mobile reference
   joint matching shoe
2. Yes
3. A surveying crew
4. 25 ft, metal posts or rods
5. 20 to 40 ft.
6. Approximately one foot

Page 4-29

1. batching and mixing problems at the plant
2. screed adjustment
3. Stop paving again and be sure that contractor either corrects or replaces his equipment before paving starts again.

Page 4-34

1. Longitudinal
2. transverse
3. an extended period of time
4. When less than full width of pavement is placed at one time
5. A. 4
   B. 1
   C. 7
   D. 3
   E. 5
   F. 2
   G. 6

Page 4-38

1. entire width
2. trim
3. C

Page 4-40

1. Stacking may weaken the pavement structure
2. two feet
3. 6 to 12 inches between successive layers or as directed by the engineer
4. Offset (placed in different widths)

Page 4-42 thru 4-44

1. The established temperature from the mix design ± 30°F
2. Accept it, but inform Plant Technician.
3. Reject it (It's outside the master range)
4. Accept the load -- if the Contractor thoroughly separates and removes the contaminated mix.
5. No
6. fifth
7. 1-1/4 inches
8. Yes
9. All of them
10. The corrected areas are luted immediately.
11. thickness
12. 15 feet
13. screed adjustment
14. A and B
15. A. 3
    B. 7
    C. 2
    D. 6
    E. 4
    F. 1
    G. 5

CHAPTER FIVE

Inspecting Rolling Operations

CONTENTS

INSPECTING ROLLING OPERATIONS

Once the hot mix is on the roadway, it must be compacted. The purpose of compaction is to increase the density of the hot mix -- thereby making the roadway more stable, durable and pleasing to the traveling public. Compaction is accomplished by rolling -- rollers must be used properly to attain good results.

Density and compaction go hand-in-hand. Density -- weight per unit volume -- depends on the amount of compaction. Compaction results in increased density.

All asphalt construction falls into one of two categories as related to density. The first category includes leveling courses, variable thickness overbuild courses (lower thickness less than one inch), structural courses less than one inch thick, initial base layers placed on subgrade and small projects less than 1,000 feet in length. These require the contractor to use the standard rolling train and procedures as spelled out in the specifications. Density determinations will <u>not</u> be made for these asphalt courses.

Other asphalt construction - all structural and base courses (including shoulders and base widening) one inch or greater in thickness and dense-graded friction courses -- fall into the second category, which requires the determination of density and payment based on the core method for Superpave mixes.

Right now, let's discuss the rolling operations. Rolling normally involves these three phases: breakdown rolling, pneumatic tire rolling and final rolling. Breakdown rolling achieves most of the compaction. Pneumatic tire rolling knits the fine aggregates around the larger particles and completes the sealing of the mat surface. Final rolling is to attain surface smoothness -- by ironing out the other rollers' marks -- more than anything else. The details of rolling -- including numbers, types and weights of rollers to be used on a specific job -- are controlled by the specifications and special provisions, and by what the contractor needs to achieve density.

QUIZ

1. Why is hot mix asphalt compacted? _____
   _____

2. List three phases of rolling:

   _____

   _____

   _____

3. Which phase achieves most of the compaction? _____

Check your answers on page 5-25, if you got the right answers, continue - if not go back over the material.

Okay, go on to BREAKDOWN ROLLING.

BREAKDOWN ROLLING

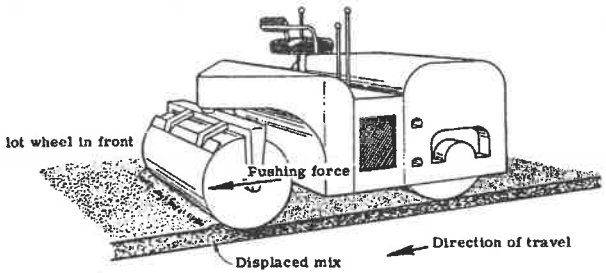
TYPE AND POSITION OF ROLLER

Tandem steel-wheeled rollers weighing from 5 to 12 tons or vibratory rollers are used for breakdown rolling. Breakdown rolling should begin as soon as possible behind the paver. For this reason, it often is called initial rolling. "As soon as possible" means as soon as the mat will carry the roller without displacing, cracking, shoving or blistering the mix. Blistering occurs when the mix is too hot -- the top 1/2 inch of the material immediately under the roller will separate from the rest of the material. The relative position of the seal roller to the paver will depend on such varying factors as mix and air temperatures, weight of the roller, and stability of the mix.

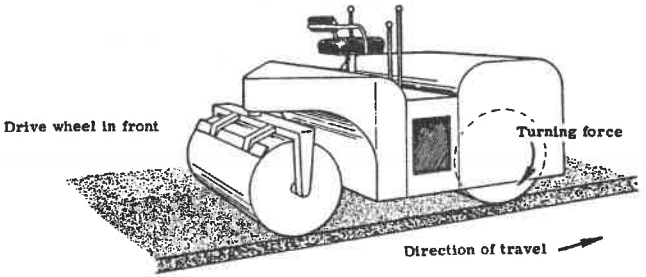
SPEED AND DIRECTION OF OPERATION

The roller must move slowly enough to avoid displacing the mix. When displacement occurs, it must be corrected by raking and luting -- and by adding fresh mix if necessary. The roller, usually, is operated with the drive wheel forward -- toward the paver. See the following diagrams.

<u>WRONG</u>
This is the wrong method:



<u>RIGHT</u>
This is the correct method:



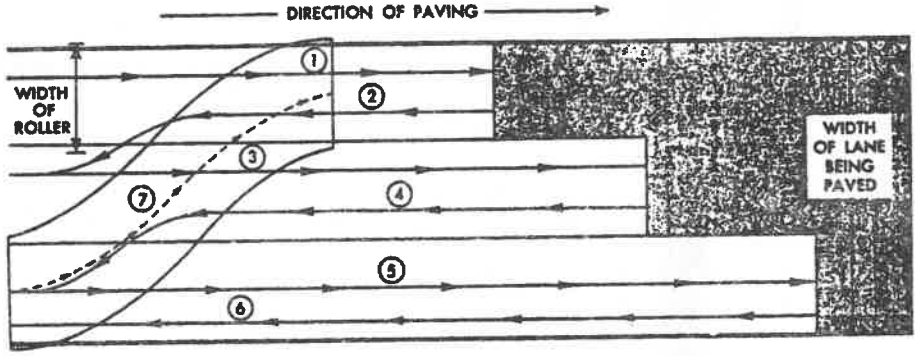
There are special cases when the roller is operated with the pilot wheel forward. This may be necessary when rolling on high superelevations or steep grades, or when maneuverability is limited. On steep grades, the drive wheel of the roller may chatter on the mat, causing displacement of mix and a very rough surface. When this happens, the roller should be turned around -- then the pilot wheel can compact the mix so that the drive wheel can proceed over it.

COVERAGE AND DENSITY

A pass is defined as the entire roller moving past a reference point one time.

A coverage is defined as the roller moving over the entire width of the mat one time. Since the width of the roller is almost always less than the width of the mat, it takes multiple passes to cover the mat.

When using a standard rolling pattern, seal rollers are required to give double coverage to the mat. A suggested rolling pattern is shown below. In this particular patten, the roller is making two coverages with seven passes.



▲
Reference Point

QUIZ

1. List three of the problems that may occur if seal rolling is begun too close behind the paver.

   _____

   _____

   _____

2. When rolling on high superelevations or steep grades -- or where maneuverability is limited -- the roller may be operated with the pilot wheel _____.

Check your answers on page 5-25, if you got the right answers, continue - if not go back over the material.

ROLLING PATTERNS

A rolling pattern is necessary to ensure the proper coverage, compaction and efficiency of the rolling operation. Because of varying conditions and preferences, different rolling patterns may be used. However, we will discuss the best procedure here.

Rolling should be performed longitudinally in the following order:

1. Longitudinal joint (or exposed edge)
2. Lower edge of pavement
3. Remaining pavement.

Of course, not every lane of new mat will have a longitudinal joint. For example, the initial lane of pavement will not have a longitudinal joint until the adjoining lane is placed. However, the initial lane should be rolled full width even though there is no longitudinal joint to pinch.

When transverse joints are formed, they should be rolled first. However, a slightly different pattern should be used when both a longitudinal joint and a transverse joint are present.

We will discuss each of these situations, beginning with the longitudinal joint.

Longitudinal Joint

Let's put a second lane down and see how it is rolled. When two lanes are joined together, the roller typically compacts the portion of the mat closest to the longitudinal joint first.

There are three ways to compact a longitudinal joint.

The oldest method is to roll the joint from the cold side with most of the drum on the previously placed mat, overlapping approximately 6 to 12 inches. On the next pass, the roller should move further onto the uncompacted mat. The problem is that this is the most inefficient method since most of a roller pass is wasted. Vibratory rollers should not operate in the vibratory mode on this first pass. Of the three methods, this one produces the lowest density on the joint.

An additional method that can be tried is to roll from the hot side but, hold the drum away from the joint about six inches,

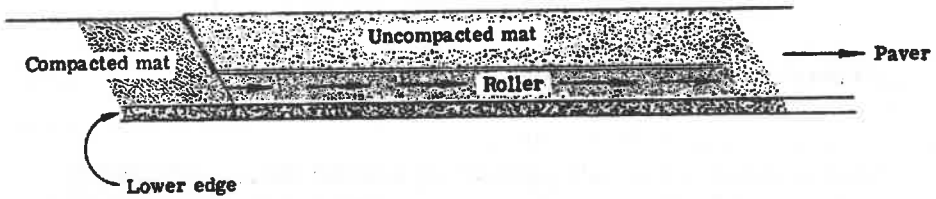
leaving a ribbon of uncompacted material. A subsequent pass will be made to compact this ribbon with an attempt to force more mix into the joint area and allow the mix to remain in contact with the joint longer prior to compacting. This method does require an additional pass and is not as efficient as rolling from the hot side.

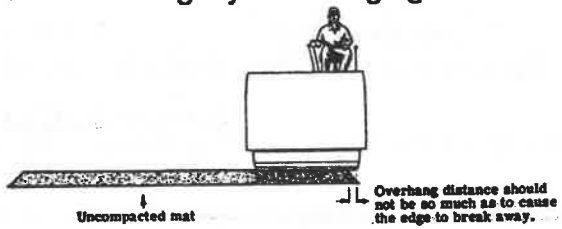
On thicker lifts, another technique is to keep the first pass of the roller 1 ft inside the unconfined edge and make the second pass over the remaining strip. With the roller coming back here on the fourth pass, lateral displacement is also reduced since the mix is cooler. This technique has been used successfully on thick lifts of Coarse SP-19 mm Superpave mixes.

Lower Edge

After the longitudinal (or the exposed edge) is compacted, the lower edge of the lane should be rolled. In general, the rolling should proceed from the lower side of the mat to the higher side to avoid lateral displacement of the mix. Sometimes the longitudinal joint is on the lower side of the mat -- and the roller can just continue across the mat after rolling the joint. However, when the joint is on the higher side of the mat, the roller should move down to the lower side after compacting the joint.

When a joint is not present -- such as in an initial lane of pavement -- the lower edge is rolled first. It is rolled with the drive wheels forward. The roller makes one pass with the rear wheel flush with or slightly overhanging the mat edge.





When the roller overhangs the mat edge, you should be sure that no breaking away of the edge occurs. Overhanging is sometimes necessary to obtain the desired compaction. Experienced roller operators know how much they can overhang without damaging the mat.

QUIZ

1. List the order of rolling patterns recommended in this section:

   a. _____

   b. _____

   c. _____

2. When transverse joints are formed, what should be rolled first? _____

3. To compact a longitudinal joint properly, the roller first pinches _____ inches of the uncompacted mat.

4. Why should rolling proceed from the lower side of the pavement to the higher side? _____
   _____

5. Is it ever possible that the longitudinal joint and the lower edge will be on the same side? _____

6. When no transverse or longitudinal joint is present, what part of the pavement should be rolled first? _____
   _____

7. Is it permissible for the roller to overhang the mat edge? Why or why not? _____
   _____

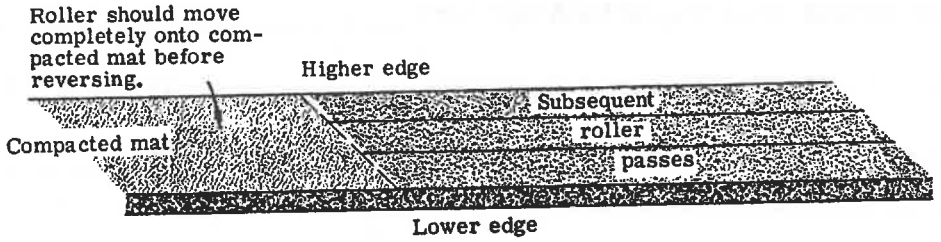
Check your answers on page 5-25, if you got the right answers, continue - if not go back over the material.

Go on to Remaining Pavement.

Remaining Pavement

After rolling the longitudinal joint and/or lower edge, the remaining pavement should be rolled. For these passes the roller moves over on the previously compacted mat, then reverses and starts back toward the paver. Each succeeding trip should overlap the previous path by only a few inches. The rolling is continued until the entire width of the mat is compacted. The higher edge is rolled in the same way that the lower edge was rolled.

These steps are shown in the diagram below:



Be sure that the roller works from the low side to the high side.

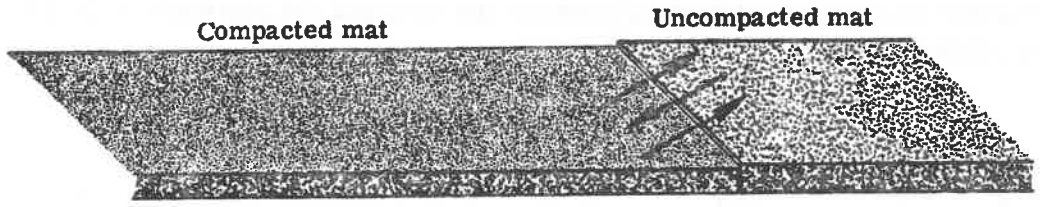
Reversing the roller on the uncompacted mat is an important maneuver. If the roller reverses carelessly, it will scuff the pavement or, possibly, create a depression in it. Also, if the roller reverses at the same place on each pass, a dip will occur across the mat.

To avoid creating a dip, the roller passes should end at approximate 45° angles to the pavement centerline. The final pass on a section can then cross the reversal points of the other passes and return to the lower edge of the pavement to begin compacting a new section, as shown below.

Other crossing patterns may work. This is not the only way to roll out the reversal points of the seal rollers. The goal is to be sure that whatever method or pattern is followed, the reversing of the rollers does not leave marks in the mat.

Transverse and Longitudinal Joints

When a transverse joint is made, it should be rolled at a 45° angle by half-lapping -- as shown below.



This procedure creates a better bond and smoother transition at the joint than would straight longitudinal rolling.

When both a transverse joint and a longitudinal joint are present, the transverse joint normally should be rolled before the longitudinal joint. However, first the roller pinches a few feet of the longitudinal joint. Then it returns to roll the transverse joint. The steps can be listed like this:

1. Pinch the longitudinal joint for a few feet.
2. Roll the transverse joint diagonally.
3. Pinch and roll the rest of the longitudinal joint.
4. Roll the lower edge of the lane, then the rest of the pavement.

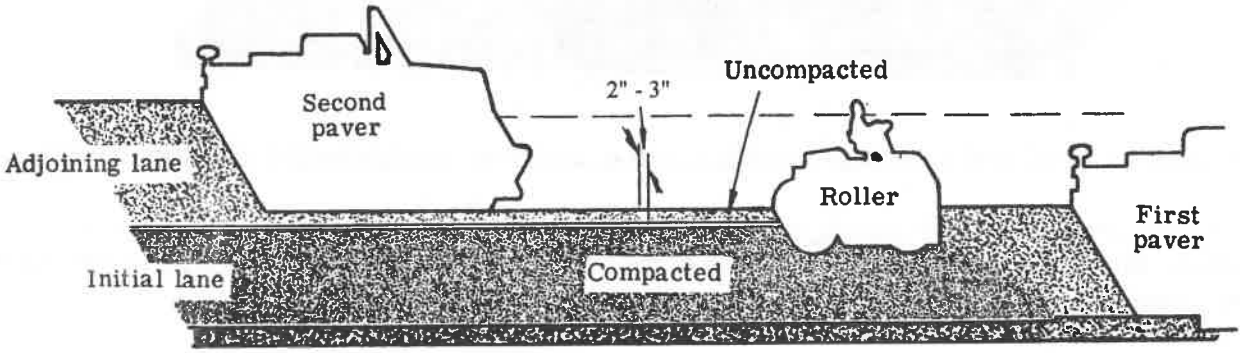
Now, we will discuss the rolling operations in echelon paving. Go on to the next page.

Echelon Paving

Echelon paving -- also called tandem paving -- is done with more than one paver. One paver lays down the initial lane and the others follow.

Rolling is the same except that the rollers rolling the initial lane do not compact the mix within 2 or 3 inches of the longitudinal joint -- where the adjoining lane is to be placed.

Like this:



The rollers in the adjoining lane compact the mat that was not compacted in the initial lane. Go on to the quiz.

QUIZ

1. Whenever possible, the roller should reverse on _____.

2. Should all the roller passes end at the same point on the pavement? _____ If they do, what will occur? _____
_____

3. What is your goal concerning the reversing of rollers on uncompacted mat? _____
_____

4. How should transverse joints be rolled? _____

5. Number the following steps -- for when both a transverse and longitudinal joint are rolled -- in the correct order:

___ A. Roll the lower edge of the lane, then the rest of the pavement.

___ B. Roll the transverse joint diagonally.

___ C. Pinch and roll the rest of the longitudinal joint.

___ D. Pinch the longitudinal joint for a few feet.

Check your answers on page 5-25, if you got the right answers, continue - if not go back over the material.

PNEUMATIC TIRE ROLLING

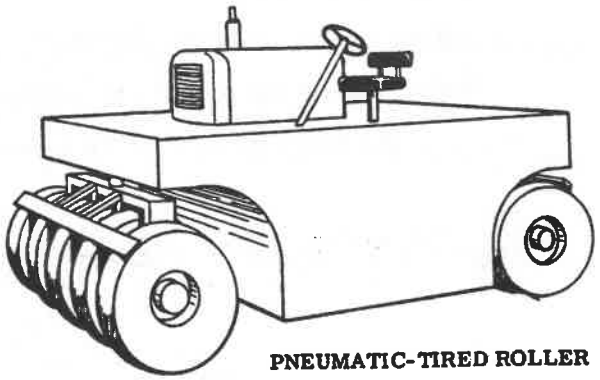
Pneumatic tire or intermediate rolling is used to knead the pavement, etc. It is very important on leveling courses since it helps to obtain the required density and stability in a variable thickness mat. It also improves the seal near the surface, which will help keep out water.

Once the pneumatic rolling has moved far enough ahead to permit another roller to work, traffic rolling should start. Pneumatic rolling is done with one or more pneumatic-tired rollers. The number of rollers required is the number necessary to keep all paving and rolling operations moving smoothly, without sacrificing the proper coverage of the pavement.

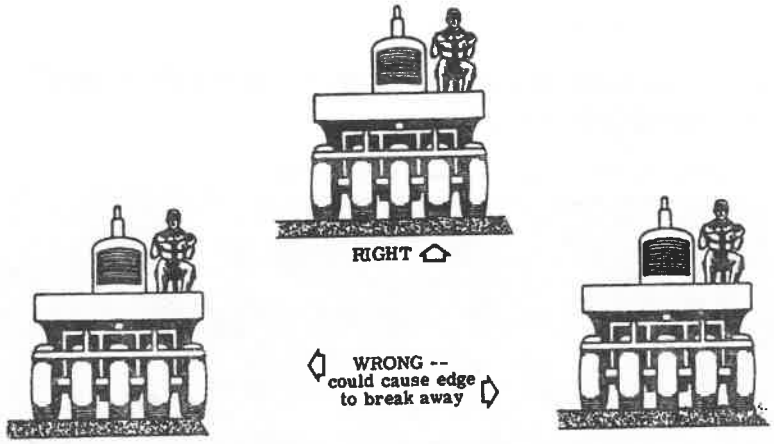
Like steel-wheeled rollers, pneumatic-tired rollers should operate with the drive wheels toward the paver. They should move at a speed of 6 to 10 miles per hour.

The pneumatic tires must have an operational inflation pressure of 50 to 55 pounds per square inch, or as recommended by the manufacturer.

When the pneumatic-tire roller makes its first pass, it should stay as close to the lower edge as possible without breaking it away. This rule is mainly for thicker courses, since thinner courses are not as likely to break away. Overhanging the edges of thicker courses should definitely be avoided with pneumatic rollers.



PNEUMATIC-TIRED ROLLER



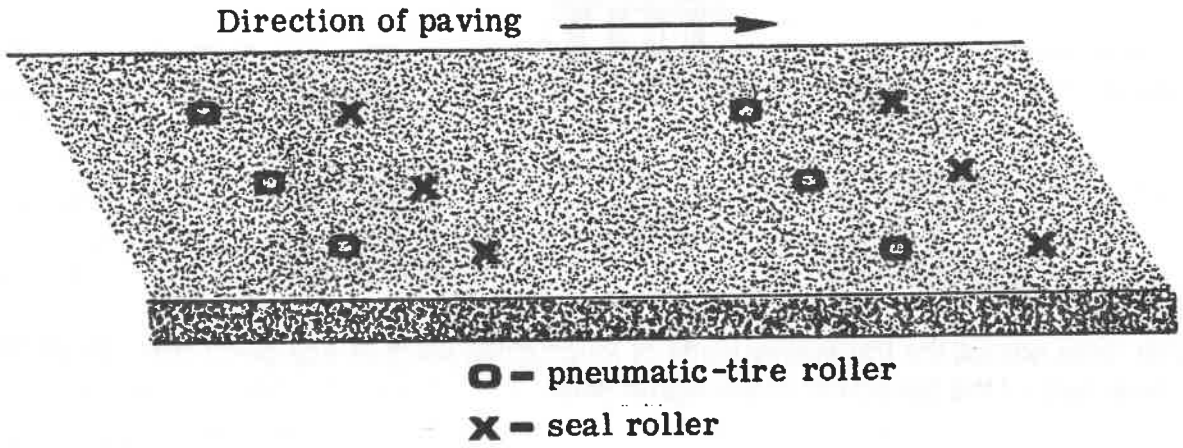
The pneumatic-tired roller does not roll the transverse joints or longitudinal joints at any given time. It just rolls longitudinally from the lower side of the pavement to the higher side.

However, the roller should not make two passes in the same path -- it should simply edge over a bit by cutting the wheels a little. The roller should be rolling before any turn of the steering is attempted.

The roller should slowly edge over onto another path. The wheels of the roller should not be cut too sharply; the process of getting from one path to the other should not be too fast.

Again, the roller should be in motion before any attempt is made to change paths. The rolling equipment must be turned very gently, or else the mat will be damaged.

The operator of the pneumatic-tire roller should be careful not to reverse his machine exactly where the seal roller reversed. Here's an example of good reversing procedures.



Notice that the pneumatic-tired roller never rolls past the spot where the seal roller stopped and reversed. The pneumatic-tired roller should never set one wheel on mix that the seal roller has not compacted.

QUIZ

1. Which of the following are true about pneumatic-tired rolling?

   ___ A. Obtains most of the required density

   ___ B. Helps to obtain the required density and stability

   ___ C. Improves the seal near the surface

   ___ D. Removes all roller marks from pavement

2. What is the proper range of speeds for pneumatic-tired rollers? _____

3. May more than one traffic roller be used at one time on the job?_____

4. How should pneumatic-tired rollers roll the edges of pavement? _____
   _____

5. Which of the following practices for changing paths with a pneumatic roller are acceptable?

   ___ A. Turn the wheels sharply.

   ___ B. Turn the wheels while the roller is motionless.

   ___ C. Turn the wheels while the roller is moving.

   ___ D. Turn the wheels slightly and gently.

6. When possible, the pneumatic rollers should be reversed <u>exactly</u> where the seal roller reversed.
   True or false? _____

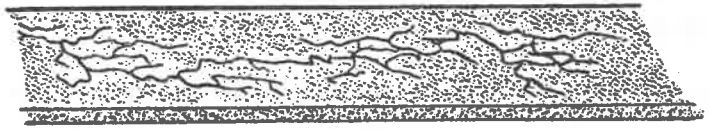
7. The pneumatic-tired roller should never roll past the spot where the seal roller stopped and reversed.
True or False? _____

Check your answers on page 5-25, if you got the right answers, continue - if not go back over the material.

FINAL ROLLING

A tandem steel-wheeled roller weighing between 8 and 12 tons or a vibratory roller may be used for final or finish -- rolling. The finish roller should begin while the mix is still warm enough -- at least 175°F -- to get the roller marks out of the mat.

The finish roller rolls from the lower edge of the mat to the higher edge. Familiar? Rolling should continue until all roller marks are eliminated. But improper rolling can cause undue displacement, cracking and shoving, and can reduce density.



Cracking

The roller operator should make as many passes as necessary to remove marks, grooves and other irregularities in the surface. He should be careful to keep the roller's speed slow. Also, he should use the same caution in rolling the edges for final rolling as were used in the traffic rolling -- as close as necessary to obtain the proper finish without breaking down the mat.

When the finish roller is done, the pavement should have a completely smooth surface.

ROLLING OPEN-GRADED FRICTION COURSES (OPFC)

Rollers are used on OGFC only for seating the mix firmly in place, not for compaction and increasing the density. Over-rolling, which can crush the coarse aggregate, is detrimental to the mat's service life. To avoid over-rolling, the pounds per linear inch exerted by the roller cannot be more than 135. The equation for this is as follows:

$$PLI = \frac{Roller\ Wt.\ (lbs.)}{Drum\ Widths\ (inch)}$$

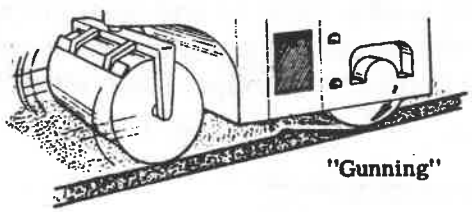
"Roller Wt." is the total weight of the roller plus any additional ballast weight and the "Drum Widths" can be attained by adding the widths of the drums together.

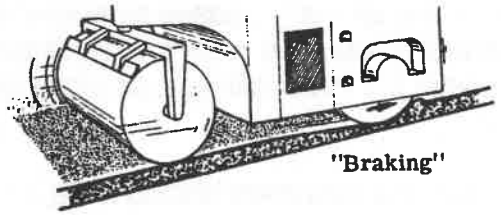
RULES OF ROLLING

Roller operators should follow these rules of rolling. Most of them are common-sense rules that experienced operators follow automatically.

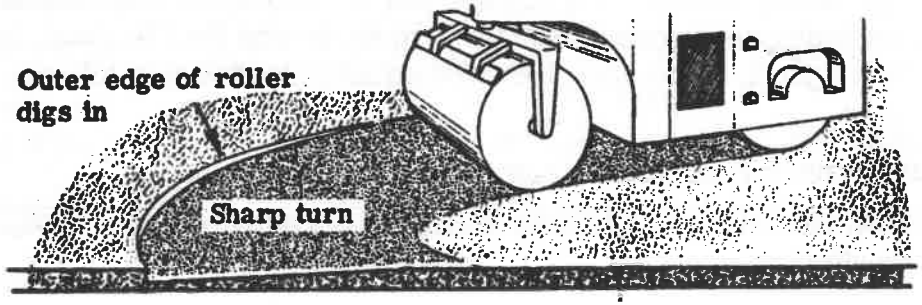
1. Operate the roller slowly enough to prevent displacement of the mix.

2. Change the speed of a roller gradually. Never "gun" a roller. Never "brake" a roller.

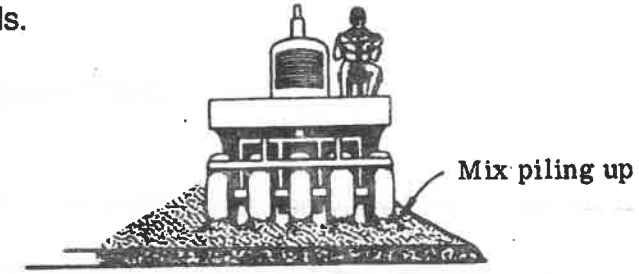




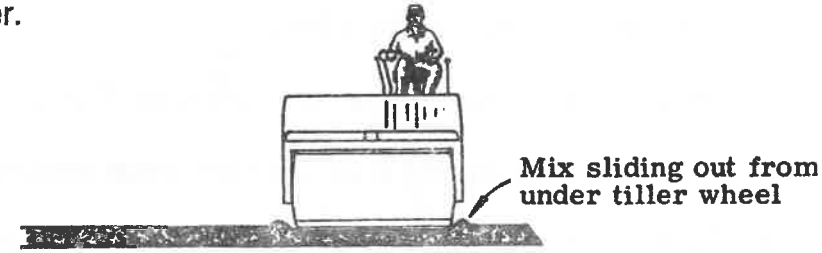
3. Change the direction of the roller gradually. Never make sharp turns. Of course in tight spots, such as bridge abutments, sharp turns will have to be made – but carefully.



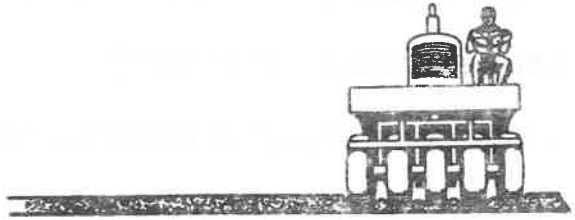
4. Do not allow mix to pile up in front of the roller wheels.



5. Do not allow mix to be shifted from one place to another.



6. Watch to see that the roller does not "sink" into the mix.



7. Do not allow rollers to park on freshly compacted mat. When parking on pavement that has been finished rolled, the rollers should park diagonally in relation to the centerline of the road to minimize the effects that any created depression might cause.

All of these rules say one thing: **"Be watchful, don't go to sleep on the job."** There are too many things that can go wrong on an asphalt concrete paving job.

CHECKLIST

The checklist below is a brief summary of your responsibilities as a technician during rolling operations:

- Observe that the Contractor has the required number and types of rollers for each operation.
- Check the coverage of the rollers.
- Observe the compacted mat for any irregularities caused by the rolling, and request corrections.
- Keep the rollers moving at all times and have them stay as close to the paver as possible.
- Check the tire pressures of the traffic rollers periodically.
- Inspect the water dispersing systems and wheel pads and scrapers.
- Monitor the temperature of the mat properly.

Now take the quiz starting on the next page as a review of this chapter.

QUIZ

1. The final rolling should take place while the mat still has a temperature of _____ or above.

2. Final rolling should continue until all _____ are eliminated.

3. Normally, the _____ wheel of the pneumatic roller should be toward the paver.

4. How much should the roller overlap the uncompacted mat when making the first pass on a longitudinal joint?
   _____

5. To avoid lateral displacement of the mix, rolling generally should proceed from the _____ side of the pavement to the _____ side.

6. Reversal points should be crossed by subsequent roller passes at an angle of _____.

7. Number the following steps -- for when both a transverse and longitudinal joint are rolled -- in the correct order:

   ___ A. Pinch and roll the rest of the longitudinal joint.

   ___ B. Roll the lower edge of the lane, then the rest of the pavement.

   ___ C. Pinch the longitudinal joint for a few feet.

   ___ D. Roll the transverse joint diagonally.

8. What is the proper range of speeds for pneumatic-tired rollers? _____

9. What is the acceptable range of inflation pressures for the tires of pneumatic rollers? _____

10. Should the wheels of pneumatic rollers be turned only when the rollers are in motion? _____

11. Should the pneumatic roller roll any areas that have not been covered by the breakdown roller? _____

Check your answers on page 5-26, if you got the right answers, continue - if not go back over the material.

We have completed the rolling step of the overall paving operation, but some important inspection duties remain to be performed. We will discuss these in Chapter Six.

Continue when you are ready.

ANSWERS TO QUESTIONS

Page 5-3

1. To increase its density, making it more stable, durable and pleasing
2. Seal
   Traffic
   Final
3. Seal

Page 5-6

1. Any of the following are correct:
   Displacing
   Cracking
   Shoving
   Blistering
2. forward

Page 5-9

1. a. Longitudinal joint (or exposed edge)
   b. Lower edge of pavement
   c. Remaining pavement
2. Transverse joint
3. 6 inches
4. To avoid lateral displacement of the mix
5. Yes
6. Lower edge
7. Yes - as long as it does not break the edge

Page 5-13

1. previously compacted mat
2. No, Dip (depression)
3. To be sure that they do not leave marks in the mat
4. At 45° angles by half-lapping
5. A. 4
   B. 2
   C. 3
   D. 1

Page 5-17 & 5-18

1. B, C
2. 6 to 10 miles per hour
3. Yes
4. As close to edge as possible without breaking it away
5. C, D
6. False
7. True

CHAPTER SIX

Inspecting the Finished Pavement

CONTENTS

INSPECTING THE FINISHED PAVEMENT

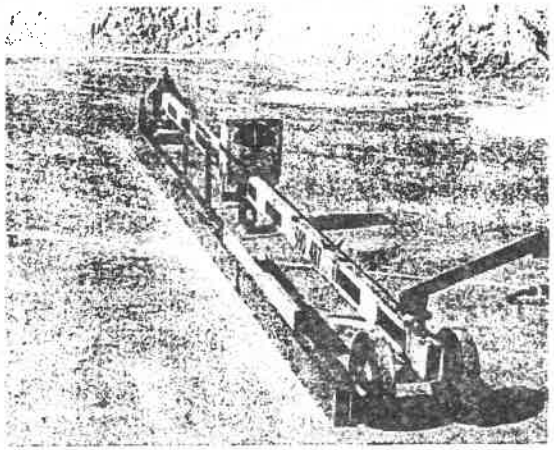
The procedures and requirements discussed in this chapter are as important as those discussed in any other part of this course. Your inspection in the areas of surface tolerance and texture, density, and final documentation show whether or not high quality asphalt concrete pavements have been constructed.

SURFACE TOLERANCE AND TEXTURE

The primary purpose of a friction course of a pavement is for it have good frictional characteristics. But since it is also the final layer of pavement placed on the project, it is also very important that it look good and have a smooth ride as well. Although some of the high spots and depressions in a pavement can be detected visually behind the paver, the best method of detection is by using a rolling straightedge. In Florida, the smoothness of the pavement is determined by a 15-foot rolling straightedge. This assures that the pavement will have an acceptable ride quality. However, if the underlying layers are not smooth, it will be very difficult to make the friction course smooth without either having to place the friction course too thick or too thin, or else having to come back with a separate operation to correct the rough areas. So it's also necessary to determine that the underlying layers meet the specification requirements for smoothness as well.

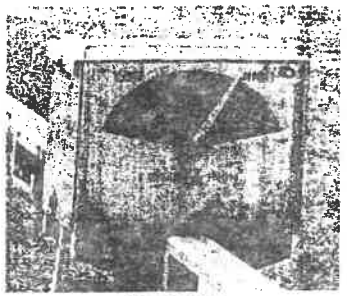
GENERAL STRAIGHTEDGING REQUIREMENTS

It is the Contractor's responsibility to perform the testing with a CTQP Asphalt Paving Level I Technician and to give the Engineer at least 48 hours notification before they begin the straightedging operations. To perform the straightedging, the Contractor must provide two types of straightedges: a 15-foot rolling straightedge and a 15-foot manual straightedge, both shown in the photograph below. The Engineer (either the project engineer or the roadway inspector) should observe the straightedging operation to assure that it is performed in accordance with the specifications. Straightedging is performed on all pavement lanes and ramps (in the outside wheel path) where the width is constant, using a standard 15-foot rolling straightedge.



Manual Straightedge, Rolling Straightedge, and Smart Level

The calibration of the 15-foot rolling straightedge should be checked before the operation is performed. During the operation, the Contractor's Asphalt Paving Level I Technician will continuously observe the indicator for highs and lows in excess of 3/16 inch, and will record the locations and magnitude of each out-of-tolerance deficiency. The technician will mark the location on the pavement with spray paint or other marking method. Project personnel will document this operation on the ***Daily Report of Construction, Form No. 700-010-13***.



Dial Gauge

INTERMEDIATE LAYERS

On intermediate layers, it is the Contractor's option to straightedge the pavement. However, if the intermediate layer is to be opened to traffic, the Engineer may require that the Contractor straightedge the project and correct all deficiencies in excess of 3/8 inch.

LAST LAYER PRIOR TO FRICTION COURSE

On the last layer placed prior to placing the friction course (the last structural layer), the Contractor is required to straightedge the pavement and correct all deficiencies greater than 3/16 inch. Since the friction course is placed on top of this layer, it is essential that it be as smooth as possible, otherwise the bumps and low spots might also occur in the friction course layer. Repairing deficiencies in the friction course layer can result in the pavement having a "patched up" appearance and should be avoided if at all possible. Consequently, the correction of these deficiencies in the final structural layer is generally considered mandatory.

FINAL SURFACE OR FRICTION COURSE LAYER

On the friction course (or final surface layer if the project does not have a friction course), the Contractor is also required to straightedge the pavement. Any deficiencies in excess of 3/16 inch must be corrected, unless the Engineer determines that the deficiencies do not significantly affect the ride quality of the pavement and corrections would unnecessarily "mar" the finished pavement surface. In those instances when the Engineer waives the corrections, the area of the pavement that would have been corrected (typically the length of the deficiency ± 50 feet) is left in place at no pay.

CORRECTIONS

All straightedge deficiencies requiring corrections must be corrected at no cost to the Department by either 1) removing and replacing the full depth of the deficient layer (extending at least 50 feet on each side of the defective area), 2) overlaying the deficient area across the full width of the roadway (extending at least 50 feet on each side of the defective area) or 3) other methods as approved by the Engineer on a case-by-case basis. The most common of these other methods is milling.

Prior to making the corrections, the Contractor will send a letter to the Engineer indicating the location and magnitude of

the surface irregularities. The Contractor will also indicate what method of correction he plans to use. If the Contractor plans to use corrective methods other than (a) Removing and Replacing or (b) Overlaying as specified in ***Section 330*** of the ***Standard Specifications for Road and Bridge Construction***, he must request approval for his proposed methods in writing to the Project Engineer. The Project Engineer will typically send the Contractor's request and a copy of the list of surface irregularities to the District Bituminous Engineer requesting comments/recommendations. The District Bituminous Engineer will respond back to the Project Engineer and the Project Engineer will provide the Contractor with a response to his request. During the corrections, the Engineer (either the Project Engineer or the Roadway Inspector) should be present to determine that each surface irregularity was eliminated or brought within the allowable tolerance as established in the specifications.

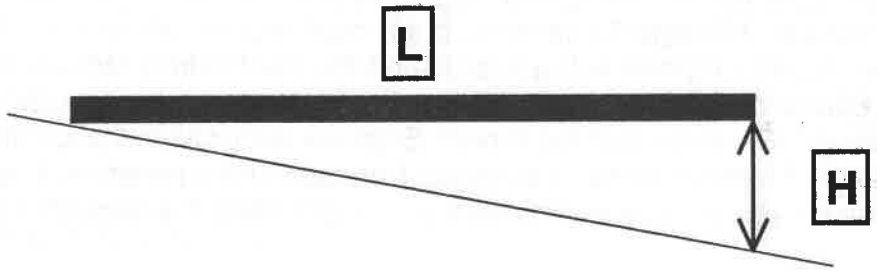
TEXTURE

The final pavement surface should have a uniformly smooth texture, have no pulled, torn, loosened or crushed areas; sand streaks or spots; or ripples. These requirements apply to paved areas and areas where it is necessary to apply hand work. In addition, the Contractor is not permitted to use aggregate that causes a different appearance (for example oolitic limestone versus granite in the friction course) in sections shorter than one mile long and across the full-width of the roadway. This keeps the road surface looking uniform and also assures the public of consistent frictional characteristics.

CROSS SLOPE

Pavement cross-slope is a very important characteristic in terms of rapidly removing water from the pavement surface. A roadway might have minimal rutting, but if there is inadequate cross-slope, the water will remain on the surface -- potentially creating a hazardous situation for motorists. Specifications require that the cross-slope be measured as part of the Contractor's Quality Control operations and also be verified by CEI personnel. Cross-slope is typically checked in one of two ways: 1) by using a simple level and a ruler or 2) by using a smart level.

To manually check the cross-slope of the pavement, the simple level is placed transversely across the pavement. The low end of the level is then raised until it is level. Then, the distance between the end of the level and the pavement is measured. This distance along with the length of the level make it easy to determine the cross slope of the pavement.



% Slope = (H / L) * 100

As an example, if the length of the level is 4 feet (48 inches), and the measured distance from the end of the level to the pavement is 1 inch, then the slope would be calculated as follows:

% Slope = (1 in / 48 in) * 100 = 2.1%

If the cross slope is measured with a smart level, then the cross slope is taken directly from the digital readout and recorded.

PROTECTING THE FINISHED PAVEMENT

As a Technician, you also must be sure that none of the hot mix asphalt pavement courses are damaged. Do not allow traffic on them before they have sufficiently hardened, especially excessive loads. Never allow materials to be stockpiled or bladed on the pavements. Also, be sure that no leaky equipment (dripping oil or fuel) is allowed to park on the pavement. To prevent rutting or other distortion, protect sections of newly finished dense-graded friction courses from traffic until the surface temperature has cooled below 160°F.

QUIZ

1. Correcting straightedge deficiencies in the final structural layer is _____.

   A. mandatory

   B. the contractor's option

   C. a good way to prevent deficiencies in the friction course

   D. not necessary with open-graded friction courses

2. What is the required length for straightedges? _____

3. What are the two ways of checking cross-slopes?

   _____

   _____

4. If a 6-foot simple level is used to check the cross slope and the distance from the end of the level to the pavement is 1 inch, what is the cross slope? _____

5. What are the two methods for correcting noncomplying pavement areas?

   _____

   _____

6. In order to protect finished pavements, which of the following should NOT be allowed on them?

____ A. Manual straightedges

____ B. Stockpiles of aggregates

____ C. Rollers that leak fuel

Answers begin on page 6-21, if you got the right answers, continue on to RANDOM SAMPLING - if not, go back over the previous material.

RANDOM SAMPLING

When we sample for quality control (Contractor) or verification (FDOT) purposes it is essential that we select the sample locations using random sampling procedures. True random sampling guarantees that every possible portion of the material or construction to be sampled has an equal chance of being selected. The key words here are every possible portion and equal chance. This concept is very important because the objective in sampling is to obtain an unbiased, representative estimate of the material characteristics. In addition, this sampling technique protects against known defects in material, unknown defects, cycles and patterns and process irregularities; and the technique is highly reliable. Most important, however, is the fact that unless the samples are chosen at random, the statistical methods used to analyze the data cannot be correctly applied.

The selection of the sample within the LOT must be entirely random. "Random" does not mean "haphazard"; it means that it is selected without bias. Bias in sampling is the exclusion or inclusion of certain parts of the LOT into the sample, sometimes consciously, sometimes unconsciously.

RANDOM TEST LOCATIONS

Before the Contractor begins producing mix for a project, they identify to the Engineer the size of the LOT that will be used. The first LOT is called the "Initial Production LOT" and is 2000 tons, subdivided into four sublots of 500 tons each. (The following LOTs can either be 2000 tons or 4000 tons, again subdivided into four sublots.) After the Contractor determines the LOT size and before they begin producing mix, the Verification technician at the plant inputs the LOT size into a computer spreadsheet, and generates the plant and roadway random number worksheets.

The Verification technician at the plant then gives the roadway random number worksheet to the roadway Verification technician in a secure manner. It is essential that the random numbers never be disclosed to the Contractor until it is actually time to core the roadway so that the results don't become biased. An example of the Random Number Worksheet for Roadway Density Cores is shown below.

There are five roadway cores taken and tested by the Contractor per sublot. But remember, although the Contractor cuts and tests the cores, the core locations are identified by the Roadway Verification Technician based on the random

number worksheet, and the actual testing of the core is verified by the Plant Verification technician.

Florida Department of Transportation

Asphalt Plant - Random Number Worksheet for Roadway Density Cores

MATERIALS

Project Information

Specification Version 07/01/02

Contractor: **Caledonia Paving**			Fin. Project ID: **123456-7-89-10**
Mix Type: **12.5**	Design No.: **01-2345**	Plant No.: **A0707**	Generated By: **JCW**
LOT #: **1**	Lot Size: **2000**	Tons/sublet: **500**	Date Generated: **2/2/2002**
Width **12**	Prom. Description: **The Road to Dundee**		

Roadway Density Core Random Numbers

CORE ID#	(tons)	Offset (ft)	18 Station Number / Load No. / Lift # of #
1 - 1 - 1	48	4	
1 - 1 - 2	109	6	
1 - 1 - 3	207	6	
1 - 1 - 4	386	9	

Random Number Worksheet for Roadway Density Cores

The Random Number Worksheet for Roadway Density Cores will contain an assortment of information, among them the Core ID, the ton and the offset of where the core should be taken. A more detailed description of these is as follows:

Core ID# - This is the identification of the roadway core, with the LOT, sublot and core number identified. For example, 1-1-1 is LOT 1, sublot 1, Core 1 or the first core taken from LOT 1, sublot 1; 3-2-4 is LOT 3, sublot 2, Core 4 or the forth core taken from LOT 3, sublot 2.

Tons - This is the longitudinal location of where the roadway core will be located. For Core 1-1-1, its location is 48 tons into LOT 1. Assuming approximately 20 tons per truckload of mix, this would be about 8 tons into load number 3 (20 tons in the first load, plus 20 tons in the second load equals 40 tons. 48 tons minus 40 tons equals 8 tons!) 8 tons out of 20 (8/20 = 0.40 or 40%) is 40% of the way through load number 3. So if the roadway inspector knows how far a load of mix

will typically cover (say for example 150 feet), then the location of the core can be identified by taking 40% of 150 feet (0.40 x 150 = 60 feet). So, 60 feet into load number 3 is where Core 1-1-1 would be cut. So if the truck carrying load number 3 first begins to unload the mix (when the mix hits the hopper on the paver) at Sta 141+77, the core would be cut at Sta 142+37 [ie. (141+77) + (60) = (142+37)].

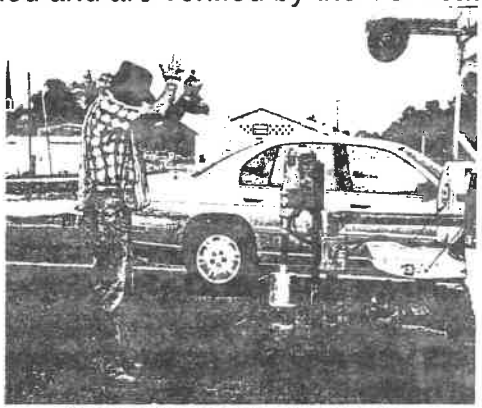
Offset - The offset is the distance in feet that the roadway core is taken from the left edge of the paved lane.

Station Number/Load No./Lift # of # - The station number, load number and lift number would be recorded on the worksheet. After the rolling operation was completed, the core location could then be marked on the pavement.

LOCATING THE CORES

Once the core location is established based on the offset and longitudinal location, the Verification technician marks the pavement where the core is to be taken. The Contractor is then responsible for cutting the core with a core rig. In some instances, it might be necessary to cool the pavement with a bag of ice prior to cutting the core. When taking the core, caution should be used to keep from damaging it. The coring operation may be observed by the Verification technician.

After the cores are taken, they are properly identified with the LOT/sublot/CORE ID. They are then carefully transported back to the asphalt plant where they are trimmed to the proper thickness by the Contractor and then tested for density. The cores are retained and are verified by the Verification technician as described in the specifications.



Locating the Core Rig Prior to coring

Removing the core from the core hole

QUIZ

1. The random numbers for the core locations on the roadway are generated by the _____ using a computer _____.

2. The first LOT on a project is called the _____ and is _____ tons.

3. How many cores are taken per sublot? _____

4. The distance that the core is taken from the left edge of the pavement is called the _____.

5. A CORE ID # of 4-3-2 represents LOT ___, sublot ___, and core number ___.

Answers begin on page 6-21, if you got the right answers, continue on to DENSITY; if not, go back over the material.

DENSITY

As you learned in Chapter Five, asphalt concrete pavements are compacted to increase their density - making them more stable, impermeable, durable and pleasing to drive on. The densities of finished pavements must be measured to determine whether or not the roadways were compacted properly. Density is sometimes determined with a nuclear density device for process control purposes, but for Acceptance, the Department requires the use of cores actually cut from the roadway for density.

ACCEPTANCE OF THE MIXTURE ON THE ROADWAY

The asphalt mix is accepted on the roadway with respect to density. Under the Contractor Quality Control specifications, acceptance is based on the Contractor's Quality Control test results that have been verified by the Department. The density is evaluated by the use of 6 inch diameter roadway cores, taken from random locations as described in the previous section. There are five cores taken per sublot and then the cores are transported back to the lab at the asphalt plant where the Quality Control technician tests them and determines the average bulk specific gravity (G_{mb}) for the sublot. This G_{mb} is compared with the maximum specific gravity (G_{mm}) to determine the average density for the sublot.

Density testing for acceptance is not required on shoulders with a width of 5 feet or less, open-graded friction courses, variable thickness overbuild courses, leveling courses, the first layer of asphalt base, or any layer with a spread rate less than 105 lb/yd^2. Density testing for acceptance is also not required for the following areas when they are less than 1,000 feet in length: cross-overs, intersections, turn lanes, acceleration or deceleration lanes, or ramps. These areas get compacted as described in the Contractor's Quality Control Plan. Stop the placement of the mix if the rolling procedure deviates from the approved procedure.

Five cores are taken randomly from each sublot within the LOT. At the completion of the LOT, a pay factor is determined for density based on either the Percent Within Limits (PWL) specification or else a small quantity pay table, depending on the number of sublots in the LOT. (Under the PWL specification, payment is based not only on the average value, but also on how variable the values are.)

Once the density pay factor is determined for the LOT, a Composite Pay Factor is determined, which combines all of the

pay factors for the mix characteristics. This includes density, air voids, asphalt binder content, and the percent passing the No. 200 and No. 8 sieves. The pay factors are weighted before they are combined. The weighting for each characteristics is as follows:

Density	35%
Air Voids	25%
Asphalt Binder Content	25%
Passing No. 200	10%
Passing No. 8	5%

QUIZ

1. Density testing is NOT required for:

   ___ A. shoulders with a width of 5 feet or less.

   ___ B. first lift of asphalt placed on limerock base.

   ___ C. intersections less than 1000 feet in length.

   ___ D. layers with a spread rate less than 105 lb/yd^2.

2. The composite weighting for density is _____.

3. Payment for density is based on either the Percent Within Limits specification or _____.

4. The density for a sublot is determined by dividing the average _____ of the sublot by the _____ of the sublot.

Answers begin on page 6-21, if you got the right answers, continue; if not, go back over the material. Go on to CALCULATING MIX SPREAD.

CALCULATING MIX SPREAD

In checking for proper application of asphalt concrete, you will often need to determine the mix spread. This is the rate of application of the mix in pounds per square yard.

You calculate spread as follows:

1. Collect and write down this data:
   - cumulative pounds of mix spread from delivery tickets
   - width of mat as placed
   - distance paved (by referring to stationing)
2. Then calculate the spread on scratch paper:
   - $\text{square yards covered} = \frac{\text{length (feet) x width (feet)}}{\text{9 square feet per square yard}}$
   - pounds placed = sum of net weights on delivery ticket
   - $\text{spread rate (lbs/yd}^2\text{)} = \frac{\text{pounds placed}}{\text{square yards covered}}$

Let's, look at an example on the next page.

We will say that paving was done from station 525+00 to station 543+00 in a 12 foot width. The cumulative total of the delivery tickets was 388,400 pounds. Our calculations should look like this:

Length of section: (543+00) - (525+00) = 1800 ft.

Square yards covered = (1,800 feet x 12 feet)/(9 ft^2/yd^2) = (21,600 ft^2)/(9 ft^2/yd^2) = 2,400 yd^2

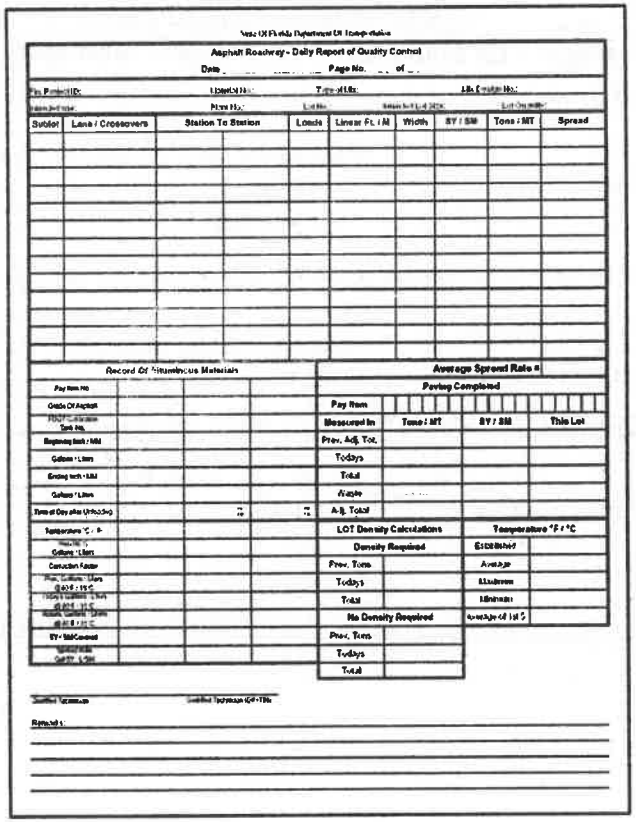
Pounds placed = 388,400 lbs

Mix spread rate = (388,400 lbs)/(2,400 yd^2) = 161.8 lbs/yd^2

By comparing the spread to the plan quantity, we can see if the desired coverage was obtained. You should make spot checks during the paving to be sure the plan quantity is being spread.

DOCUMENTATION

During the construction operations, it is very important that all of the asphalt paving related activities be properly documented. All operations under the responsibility of the Quality Control personnel are documented on the Asphalt Roadway - Daily Report of Quality Control, on a daily basis. The verification activities are documented on the Asphalt Roadway - Verification Report, at the conclusion of every LOT.



Asphalt Roadway - Daily Report of Quality Control

Date _____ Page No. _____ of _____

Sublot	Lane / Crossovers	Station To Station		Loads	Linear Ft. / M	Width	SY / SM	Tons / MT	Spread

Record Of Bituminous Materials

Average Spread Rate =

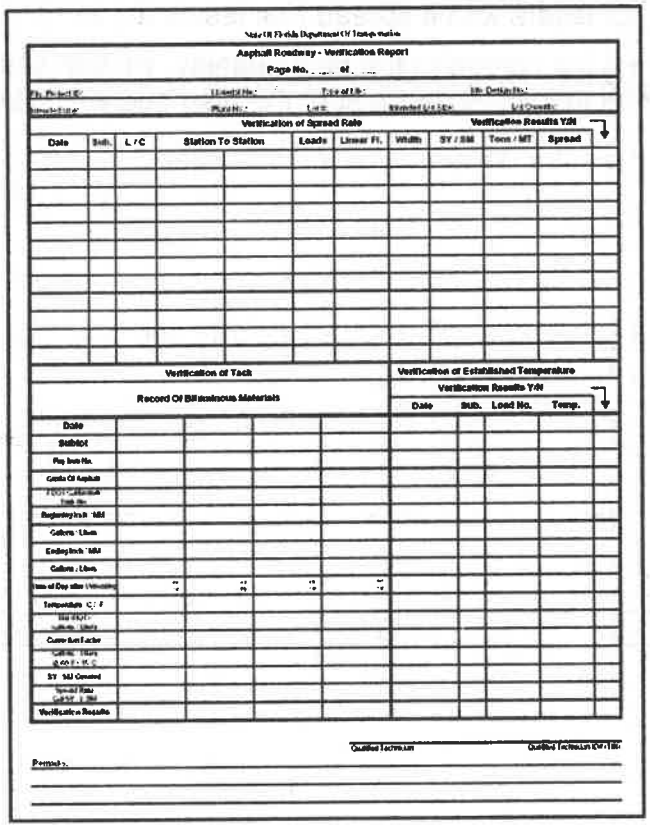
Paving Completed

Pay Item			
Measured In	Tons / MT	SY / SM	This Lot
Prev. Adj. Tot.			
Todays			
Total			
Average			
Adj. Total			

LOT Density Calculations	Temperature °F / °C
Density Required	Established
Prev. Tons	Average
Todays	Maximum
Total	Minimum
No Density Required	Average of 1st 5
Prev. Tons	
Todays	
Total	

Qualified Technician _____ Qualified Technician ID / Title _____

Remarks: _____



Asphalt Roadway - Verification Report

Page No. _____ of _____

Verification of Spread Rate

Verification Results Y/N

Date	Sub.	L / C	Station To Station		Loads	Linear Ft.	Width	SY / SM	Tons / MT	Spread

Verification of Tack

Verification of Established Temperature

Verification Results Y/N

Record Of Bituminous Materials

Date	Sub.	Load No.	Temp.

Date					
Sublot					
Pay Item No.					
Grade Of Asphalt					
FDOT Calibration Tank No.					
Beginning Inch / MM					
Gallons / Liters					
Ending Inch / MM					
Gallons / Liters					
Time of Day after Unloading	:	:	:	:	
Temperature °C / °F					
Net FDOT Gallons / Liters					
Correction Factor					
Gallons / Liters @ 60°F / 15°C					
SY / SM Covered					
Spread Rate Gal/SY / L/SM					
Verification Results					

Qualified Technician _____ Qualified Technician ID / Title _____

Remarks: _____

QUIZ

1. What is the surface tolerance for final asphalt concrete surface courses? _____

   _____

2. If the Engineer requires straightedging of an intermediate layer, the contractor must correct all deficiencies in excess of _____ .

3. When using a six foot simple level, for a 2% cross slope what should the distance be from the end of the level to the pavement? _____

4. What are the two methods for correcting noncomplying pavements?

   _____

   _____

5. If a straightedge deficiency is left in place at no pay, the area that is left in place at no pay is:

   A. the entire day's pull.

   B. the length of the deficiency ± 100 feet.

   C. the length of the deficiency ± 50 feet.

   D. the length of the deficiency.

6. To prevent rutting or other distortions, dense-graded friction courses should be protected from traffic until the surface temperature drops below _____°F.

7. The "initial production LOT" is _____ , subdivided into four sublots of _____ each.

8. There are _____ roadway cores taken and tested by the Contractor per sublot.

9. Who is responsible for cutting the roadway cores? _____

10. At the completion of the LOT, depending on the number of sublots, a pay factor is determined for density based on either:

    _____

    _____

11. Paving is done between stations 234+20 and 249+20 in a 10 foot lane. The cumulative total of the delivery tickets was 279,340 pounds. Calculate the spread to the nearest tenth of a pound. _____

Check your answers on the next page.

ANSWERS TO QUESTIONS

Page 6-7 & 6-8

1. A, C
2. 15 feet
3. Simple level and ruler
   Smart level
4. 1.4%
5. Full-depth replacement of pavement layer
   Overlaying the noncomplying areas
6. B, C

Page 6-12

1. Plant Verification technician, spreadsheet
2. Initial production LOT, 2000
3. 5
4. offset
5. 4, 3, 2

Page 6-15

1. A, C, D,
2. 35%
3. small quantity pay table
4. G_{mb}, G_{mm}

Page 6-19 & 6-20

1. No greater than 3/16 inch from 15-foot straightedge
2. 3/8 inch
3. 1.44 inches
4. Full-depth replacement
   Overlays
5. C
6. 160
7. 2000 tons, 500 tons
8. five
9. Contractor
10. Percent Within Limits, Small Quantity Pay Table
11. 167.6 lbs/yd^2

CONGRATULATIONS. You have completed the training course in HOT MIX ASPHALT PAVING INSPECTION. Before taking the examination, you will want to quiz yourself on the entire course. Chapter Seven, the REVIEW QUIZ, will serve this purpose.

CHAPTER SEVEN

Review Quiz

Things which you learned in this course are going to help you do a better job as a technician. This Review Quiz is designed to help you know how well you have learned. It is also designed to prepare you for the Examination.

Listed below are instructions on how to take the Review Quiz.

1. Do not take this quiz immediately after you finish Chapter Six of the course.

2. Do not cram the night before you take the quiz. Remember that the objective is not to test your memory. The objective is to help you evaluate how well you have learned the material and how well you can think through your everyday work problems.

3. When you take this quiz, make sure that you will not be disturbed for about two hours.

4. Attempt all questions.

5. You may refer to the course material if you get stuck on a question. But first try to reason out the problem.

6. Finally, keep track of your wrong answers. Instructions on how to grade yourself follow the Review Quiz. If you score less than 90% on the quiz, do not be disappointed. Go back and study the course materials once again and reattempt the quiz.

GOOD LUCK

REVIEW QUIZ

1. List the ingredients of asphalt concrete:

   _____

   _____

2. What two basic types of plants produce hot mix?

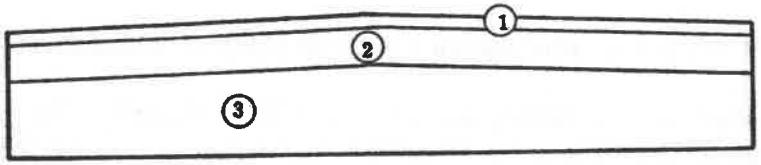
   _____

   _____

3. The two principal parts of the paver are the _____ and the _____.

4. Write the names of the courses numbered in the diagram below. (The diagram represents new asphalt construction.)

   1. _____
   2. _____
   3. _____



5. What is the purpose of leveling courses? _____

6. List, in their governing order, the five documents which you should study before going out on a paving job. (Begin with number 1 as highest authority.)

   1. _____
   2. _____
   3. _____
   4. _____
   5. _____

7. What meeting should you attend before paving begins? _____

8. Which of the following will likely be discussed at this meeting?

   ___ A. Traffic control and other safety features
   ___ B. D.O.T.'s and contractor's organizations
   ___ C. Contractor's plan of operation
   ___ D. Special Provisions

9. What type of thermometer will be used on asphalt distributors? _____

10. Should the spray bars and spray nozzles on asphalt distributors be adjustable? _____

11. Tack is applied in confined places with a _____.

12. Briefly list the requirements for haul truck:

A. _____

B. _____

C. _____

D. _____

13. List four requirements for the covers of haul trucks:

A. _____

B. _____

C. _____

D. _____

14. On pavers, the amount of asphalt mix carried onto the augers by the feeders can be controlled by raising or lowering the _____.

15. Which part of the paver distributes the mix across the roadway in front of the screed unit?

_____

16. The function of the screed is to _____, partially _____ and _____ the mix.

17. A thinner mat is produced when the front of the screed is _____.

18. What keeps the mix from sticking to the screed plate? _____

19. _____ are used to keep the elevation of the tow points on a paver at a predetermined elevation relative to either a preset stringline of a long mobile ski.

20. Leveling courses are placed by two _____.

21. The leading piece of machinery referred to in the preceding question must have an approved _____ _____ attached in front.

22. Which of the following, if any, is permissible?

___ A. Fueling rollers while on new pavement

___ B. Using rollers that leak oil or gas

___ C. Adding water to rollers on new pavement

23. What must steel-wheel rollers be equipped with to prevent the mix from sticking?

_____

_____

_____

24. Name the four things which should be identical with all tires of a pneumatic-tired roller:

A. _____

B. _____

C. _____

D. _____

25. For vibratory rollers used on thicker layers, the _____ should be increased and the frequency should be decreased from the settings used on thinner layers.

26. Vibratory rollers should not be used on lifts of _____ or less.

27. List three important pieces of hand equipment often used in working the newly laid mix:

_____

_____

_____

28. Small rules and adjustable try squares are tools often used for checking _____.

29. What is the air temperature requirement for placing hot mix and spreading tack coats for layers more than one inch? _____ For layers one inch or less? _____ For FC-2 open-graded friction courses? _____ For FC-5 open-graded friction courses? _____

_____

30. Why is it necessary to clean and tack existing surfaces before paving them? _____

_____

31. Before the initial course is placed, all depressions greater than _____ must be patched.

32. Describe tack that has properly broken: _____

33. Proper tack application rates are from _____ to _____ gallons per square yard.

34. What does a proper tack application look like? _____

35. A change in which of the following can affect tack coverage?

___ A. Spray pressure

___ B. Condition and adjustment of spray bar and nozzles

___ C. Distributor's speed

36. When measuring the level of tack in a distributor tank, you should measure from the _____ down to the _____.

Using the information given below and the following two charts, answer the next 4 questions.

Today, asphalt distributor number DOT 2027 arrived at the road to spread tack in a 12-foot width from station 116 ft + 00 to station 129 ft + 60. The driver handed you delivery ticket number 23470. Your starting measurement of the tack was 20 10/16 inches. The tack was spread at a temperature of 162°F. Your ending measurement of the tack level was 33 3/16 inches.

37. What is the correction factor? _____

38. How many gallons were used? _____

39. How many yards were covered? _____

40. What was the spread rate? _____

Excerpt from Correction Table III

TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.	TEMP./CORR.
126=0.9838	127=0.9835	128=0.9833	129=0.9830	130=0.9828	131=0.9826	132=0.9823	133=0.9821	134=0.9818
135=0.9816	136=0.9814	137=0.9811	138=0.9809	139=0.9806	140=0.9804	141=0.9802	142=0.9799	143=0.9797
144=0.9794	145=0.9792	146=0.9790	147=0.9787	148=09785	149=0.9782	150=0.9780	151=0.9778	152=0.9775
153=0.9773	154=0.9770	155=0.9768	156=0.9766	157=0.9763	158=0.9761	159=0.9758	160=0.9756	161=0.9754
162=0.9751	163=0.9749	164=0.9747	165=0.9744	166=0.9742	167=0.9739	168=0.9737	169=0.9735	170=0.9732
171=0.9730	172=0.9728	173=0.9725	174=0.9723	175=0.9721	176=0.9718	177=0.9716	178=0.9713	179=0.9711

Excerpt from calibration chart for distributor tank No. 2027

Depth	Gallons	Depth	Gallons	Depth	Gallons	Depth	Gallons	Depth	Gallons	Depth	Gallons	Depth	Gallons	Depth	Gallons
20/08	1191	20/09	1188	20/10	1186	20/11	1184	20/12	1181	20/13	1179	20/14	1177	20/15	1174
21/00	1172	21/01	1169	21/02	1167	21/03	1165	21/04	1162	21/05	1160	21/06	1157	21/07	1155
21/08	1152	21/09	1149	21/10	1147	21/11	1144	21/12	1141	21/13	1139	21/14	1136	21/15	1133
32/00	680	32/01	677	32/02	673	32/03	670	32/04	667	32/05	663	32/06	660	32/07	657
32/08	653	32/09	650	32/10	647	32/11	643	32/12	640	32/13	637	32/14	634	32/15	631
33/00	629	33/01	626	33/02	623	33/03	620	33/04	617	33/05	614	33/06	611	33/07	609
33/08	606	33/09	603	33/10	600	33/11	597	33/12	594	33/13	591	33/14	589	33/15	586

41. What is the master range of temperatures for asphaltic concrete? _____

42. The established mix temperature is 305°F. What should you do if a load arrives at the road with a temperature of 275°F? _____

43. Assuming the same established mix temperature as above, what should you do if a load arrives with a temperature of 340°F? _____

44. You discover an isolated area of contamination in a load of mix. What should you do? _____
_____

45. Should you receive the originals of delivery tickets at the road? _____

46. After checking the temperatures of the first five loads of mix for the day, how often should you check the temperatures of the other loads? At least every _____ load.

47. If a compacted asphaltic concrete pavement layer of 1-1/2 inches is desired, what loose thickness should be placed on the road? _____

48. Normally, should the center of the screed plate be adjusted higher than the outside edge? _____

49. Which of the following can produce a poor quality mat?

___ A. Improperly adjusted screed

___ B. Defective mix

___ C. Too fast speed of paver

50. Complete the following sequence for fanning (throw back).

1. Shovelfuls of hot mix are taken from the paver hopper.
2. The mix is fanned thinly onto minor mat irregularities.
3. _____

51. You may want to check the mat _____ more often if a manual screed is being used.

52. The screed takes about _____ feet to adjust after the thickness control is turned.

53. Defects such as open-textured, pulled, torn or ripped mat usually indicate the need for _____ _____.

54. A transverse joint should be formed:

___ A. when the paving operation stops for an extended period of time.

___ B. when less than the full width of pavement is placed and opened to traffic.

___ C. at the end of each day's paving operation.

55. Number the following steps in making a transverse joint in the correct order.

___ A. Determine the starting point for the joint by straightedging the mat. Cut off the end of the mat.

___ B. Back the paver up and lower the screed to sit on top of board. Begin paving.

___ C. Compact the new mix at the joint and straightedge the joint immediately.

___ D. Allow paver to run until only a small amount of mix remains. Then, pull paver out of the way.

___ E. Place paper or sand and compact the mat, and tapered material.

___ F. When ready to begin paving again, remove paper/sand and tapered material and tack vertical face of mat.

___ G. Place board of proper thickness on the end of the compacted mat.

56. Which rolling phase kneads, or knits, the aggregate particles and completes the sealing of the mat surface?
_____

57. Which rolling phase is accomplished by tandem steel-wheeled rollers weighing from 5 to 12 tons?
_____

58. Normally, the _____ wheel of the steel wheeled roller should be toward the paver.

59. How much should the roller overlap the uncompacted mat when making the first pass on a longitudinal joint?
_____

60. To avoid lateral displacement of the mix, rolling generally should proceed from the _____ side of the pavement to the _____ side.

61. The reversal points of rollers should be crossed at an angle of _____ by the subsequent roller passes.

62. Number the following steps -- for when both a transverse and longitudinal joint are rolled -- in the correct order.

___ A. Roll the transverse joint diagonally.

___ B. Roll the lower edge of the lane, then the rest of the pavement.

___ C. Pinch and roll the rest of the longitudinal joint.

___ D. Pinch the longitudinal joint for a few feet.

63. What is the proper range of speeds for pneumatic-tired rollers? _____

64. What is the acceptable range of inflation pressure for the tires of pneumatic rollers? _____

65. During traffic rolling, should the wheels of the rollers be turned only when the rollers are in motion? _____

66. Should the traffic rollers roll past the spots where the seal roller stopped and reversed? _____

67. The final rolling should take place while the mat still has a temperature of at least _____.

68. How long should final rolling continue? _____

69. Describe the surface tolerance requirement for final asphaltic concrete surface courses. _____
_____

70. One method for correcting noncomplying pavements is to overlay the noncomplying areas. What is the other approved method? _____

71. When checking pavement cross-slope, if the length of the level is 4 feet and the distance from the end of the level to the top of the pavement is 1 inch, what is the % slope? _____

72. In order to protect finished pavements, which of the following should NOT be allowed on them?

___ A. Manual straightedges

___ B. Stockpiles of aggregates

___ C. Rollers that leak fuel

73. To prevent rutting, newly finished dense-graded friction courses should be protected from traffic until the surface temperature has cooled below _____.

74. The first LOT on a project is called the _____ and is _____ tons.

75. How many cores are taken per sublot? _____

76. The distance from the left edge of the pavement to where the core is taken is called the _____.

77. A CORE ID# of 5-3-1 represents LOT _____, sublot _____, and core number _____.

78. Density testing is NOT required for:

___ A. shoulders with a width of 5 feet or less.

___ B. first lift of asphalt placed on limerock base.

___ C. intersections less than 1,000 feet in length.

___ D. layers with a spread rate less than 105 lb/yd^2.

SCORE YOUR OWN REVIEW QUIZ

The Review Quiz contained about 130 possible answers. If you scored 90 percent or better -- that's 117 or more correct answers -- you should be ready for the Examination.

If you had 13 or more wrong answers, take the course again -- and spend more time studying the things that give you trouble. After you have retaken the course, work the Review Quiz again. Your score should be at least 90 percent.

Good luck on the Examination.

ANSWERS TO QUESTIONS

1. Asphalt Cement; Aggregate
2. Batch; Drum-mix
3. tractor; screed
4. 1) Friction course
   2) Structural course
   3) Base course
5. To eliminate the irregularities in the old pavement
6. 1) Special provisions
   2) Technical special provisions
   3) Contract plans
   4) Supplemental specifications
   5) Standard specifications
7. Prepaving conference
8. A, B, C, & D
9. Dial
10. Yes
11. hand spray
12. A. Tight, clean smooth bodies
    B. Waterproof covers, large enough to cover load
    C. No leaks
    D. Small hole on each side
13. A. Cover the entire load of HMA
    B. Tied down
    C. Waterproof
    D. Overlap all sides of the truck body
14. flow control gates
15. Augers
16. strike off, compact, smooth
17. lowered
18. Screed heaters
19. Automatic screed controls
20. motor graders
21. spreader box
22. C
23. Moistening systems
    scrapers
    pads
24. A. Ply rating
    B. Inflation pressure
    C. Size
    D. Diameter
25. amplitude
26. 1 inch
27. Lutes
    Rakes
    Shovels
28. mat thickness
29. 40°F or above in shade
    45°F or above
    60°F or above
    65°F or above
30. It could prevent the new pavement from bonding to existing surface
31. One inch
32. Black and sticky
33. 0.02, 0.08

34. Thin, web-like and uniform
35. A, B, & C
36. top of the dome, surface of the tack
37. 0.9751
38. 552 gallons
39. 1813 yd^2
40. 0.30 gal/yd^2
41. The established temperature from the mix design ± 30°F
42. Accept it; inform the Plant Technician that it was outside the established temp. range
43. Reject it; it was outside of the master range
44. Accept the HMA load if the Contractor thoroughly separates and removes the contaminated mix
45. No
46. Fifth
47. 1 7/8 inches
48. Yes
49. All of them
50. The corrected areas are luted immediately
51. thickness
52. 15
53. screed adjustment
54. A & C
55. A. 2
    B. 6
    C. 7
    D. 1
    E. 3
    F. 4
    G. 5
56. Pneumatic-tire rolling
57. Breakdown rolling
58. drive
59. Six to twelve inches
60. Lower, higher
61. 45°
62. A. 2
    B. 4
    C. 3
    D. 1
63. 6 to 10 mph
64. 50 to 55 psi
65. Yes
66. No
67. 175°F
68. Until all roller marks are eliminated
69. No part of the pavement may be more than ± 3/16 inch from a 15 foot straightedge placed parallel to the centerline.
70. Full depth replacement of the noncomplying layers
71. 2.1%
72. B & C
73. 160°F
74. Initial production LOT; 2000
75. 5
76. offset
77. 5, 3, 1
78. A, C, D