Asphalt Paving

Georgia Department of Transportation

FORWARD

Asphalt Pavement Inspection has become a complex and highly technical task. It is necessary for today's inspector to be thoroughly knowledgeable about all materials, tests, machinery, processes, and the sequence of operations involved in asphalt pavement construction. A vital quality demanded of the inspector is the ability to make accurate decisions based on knowledge of his field and sound judgment.

TO THE STUDENT...

This study course is designed to provide the background knowledge which, when coupled with experience in the field, is needed to properly inspect asphalt pavement construction in Georgia.

This is a self-instructional study course, which allows you to proceed at your own speed. The course is constructed in a logical sequence, so that at each point, in the course you will have been given all the information needed to understand what is being discussed.

The idea behind this method is for you to read and study the information, actively participate by writing or checking off answers to questions, then find out immediately if you are correct. This method reinforces what you have read and enables you to retain what you have learned for a longer period of time. The retention of information from a self-instructional study course should be far greater than from a lecture or textbook.

To get the most from this course, start at the beginning. Read each section as it comes; preparing you for the next section. To make reading easier, the information is divided into frames. At the end of some frames, you will find questions. By answering these questions, you will be able to retain what you have just read longer than by lecture or discussion.

The answers to these questions are as follows: If the questions are on an odd page, look on the following odd page. If the questions are on an even page, turn that page back and look at the preceding even page. To explain further, the answers to questions on page four can be found on page two.

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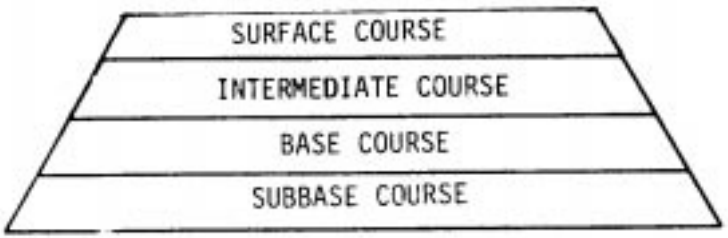
1-2 surface

1-3 19 mm

1-4 plans

CHAPTER I - INTRODUCTION

Most roadways are made up of several parts. Below is a diagram of a roadway cross-section.



This book will be concerned mainly with the top part of the roadway because the asphalt pavement inspector's job will usually begin after the subbase has been constructed.

Asphaltic Concrete is a mixture of aggregate, asphalt cement, and, usually, mineral filler. However, with newer designs, polymers and fibers are also mixed into the asphaltic concrete. The asphaltic concrete is mixed in a heated state at a plant and placed while still hot on the roadway by a paving machine. For this reason asphaltic concrete is more commonly called Hot Mix.

FILL IN THE BLANK

1-1. Another more commonly used term for asphaltic concrete is _____.

There are different types of asphaltic concrete mixes. Each of the mixes differs in composition.

A 19mm mix is used to construct a subsurface (intermediate) layer between the 25mm (Base) course and the surface course.

The plans specify what type mix is to be used for a particular job. They will also specify if a 25mm, 19mm, and a surface course are to be applied.

1-8 lifts

1-9 Top lift

1-10 wider

FILL IN THE BLANK

1-2. The top layer must be a _____ course mix.

1-3. The _____course mix forms an intermediate layer between the base and the top layer.

1-4. The _____specify the type of mix to be used on the project.

There are only certain mixes used for surface course construction.

Hot mix is used both to construct new pavement and to overlay an old one. An overlay is a new surface placed on an existing roadway.

An overlay is a new surface placed on an existing roadway.

Before going to the jobsite, inspectors should familiarize themselves with the plans, specifications, and special provisions for the particular job. These documents contain valuable details about the requirements that the contractor must meet on the job.

There is a governing order for plans, specifications, and special provisions which is valid for all jobs.

1. Plans govern over specifications and supplemental specifications.
2. Supplemental specifications govern over specifications.
3. Special provisions govern over both specifications and plans.

CIRCLE TRUE OR FALSE

1-5. True False The road inspector must know the plans, special provisions, and specifications of each job.

1-6. True False If there is a difference between the specifications and the supplemental specification, the supplemental specifications are enforced.

1-7. True False Special Provisions govern over plans, specifications, and supplemental specifications.

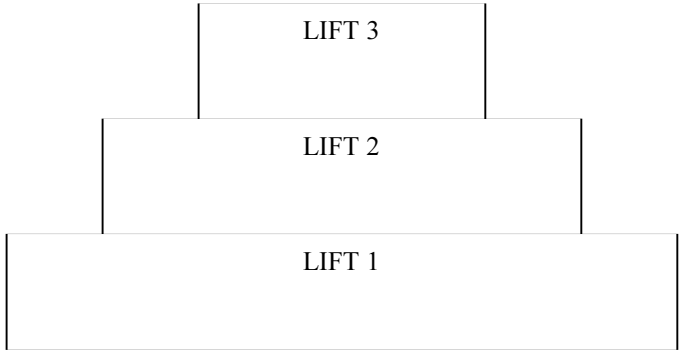
1-14 intermediate

1-15 Plans & Specifications

1-16 Special Provisions, Plans, Supplemental Specifications, Specifications

1-17 Surface, Intermediate, Base, Subbase

The plans will indicate the finished width of the top of the surface course. However, the other courses are sometimes composed of more than one layer. These layers are called lifts. The lifts are put down in decreasing widths, with the top lift being plan width. Thus, the lower lifts must be wider than the finished roadway is to be, as shown by the diagram below.



FILL IN THE BLANK

1-8. The layers of asphalt courses are called _____.

1-9. The plans give the width of only the _____.

1-10. Each lower layer should be slightly _____ than the lift placed on top of it.

There is, of course, a reason for placing lifts in decreasing widths. By not beginning construction of a lift directly atop the side of the previous lift, the chance of breaking down the edge of the just built lift is greatly reduced. This also decreases the chance of having joint failure throughout the section of pavement.

Roadway inspectors are representatives of the Georgia Department of Transportation. Their job is to insure conformance to specifications and to confirm quantities used. They must see to it that the finished roadway meets all the requirements of the plans and specifications, but also must have a working knowledge of the equipment and construction techniques used on asphalt pavement. A well-qualified inspector must know all phases of roadway construction.

CIRCLE THE CORRECT ANSWER(S):

1-11. The top part of the roadway is called the

a. base course
b. subbase
c. binder course
d. surface course

1-12. Another name for asphaltic concrete is

a. cold mix
b. black mix
c. hot mix
d. surface mix

1-13. Layers of pavement are called

a. lifts
b. layers
c. levees
d. courses

1-5 True

1-6 True

1-7 True

CIRCLE THE CORRECT WORD

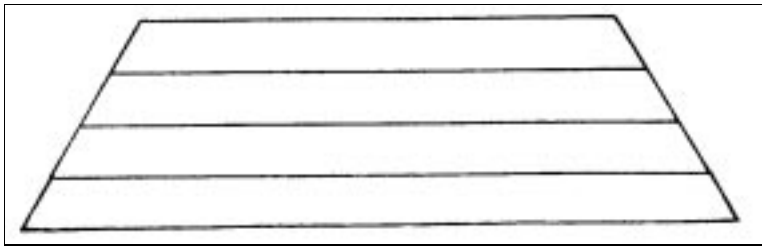
1-14. 19mm mix is used as (a top / an intermediate) layer

1-15. The (contractor / plans & specification) will determine what type of mix is to be used.

1-16. Place the terms in governing order:

Plans
Supplemental Specifications
Special Provisions
Specifications

1-17. Label the courses of this roadway design:



2-1 B.

This is the end of Chapter 1. If you missed any questions, review the appropriate frames before going on to Chapter 2.

CHAPTER II - EQUIPMENT

This chapter is concerned with the equipment used in asphalt pavement construction. Before construction begins all the contractors' equipment must be inspected to be-certain that it is in good condition. As a roadway inspector you may need to help with this inspection.

THE ASPHALT DISTRIBUTOR

In asphalt paving, an asphalt distributor (also called pressure distributor) is used to apply the tack coat. Tack is a bonding agent used to bond two layers together. The asphalt distributor is an insulated tank, equipped with a heating system, and designed to spray asphalt while mounted on pneumatic tires wide enough not to damage the road's surface. However, most distributors are now truck mounted as shown in the previous photo.

The heating unit is designed to keep the tack within a specified temperature range for application. To insure that the heating system does maintain the tack at the proper temperature, the distributor is equipped with a thermometer.

1-11 D.

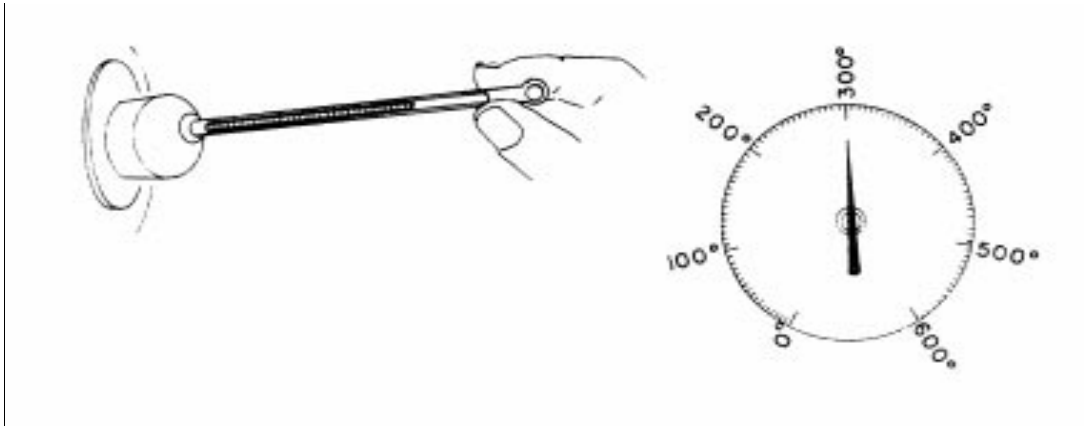
1-12 C.

1-13 A.

2-3 Feet per minute

2-4 pump

There is one of two (2) types of thermometers found on asphalt distributors. Either an armored thermometer , carried on a well on the tank, or a dial thermometer, mounted on the tank near the well.



CIRCLE THE CORRECT ANSWER(S)

2-1. An asphalt distributor is used :

a. to mix asphalt

b. to apply tack

c. to apply a surface course

d. to heat tack

2-2. The tank has:

a. a heating system

b. a thermometer

c. insulation

d. a mixing device

The distributor must also be equipped with a tachometer, which registers speed in feet per minute. New computerized distributors are now in use, where the mechanical data is tied into the computer.

Another piece of equipment required on the distributor is a power driven pump, which forces the tack out of the tank. The pump is located on the platform at the rear of the distributor.

FILL IN THE BLANK

2-3 The tachometer measures speeds in _____.

2-4 The _____ forces the tack out of the tank.

Tack is forced out of the tank through a spray bar, attached at the rear of the distributor. Correct spray cannot be obtained unless the bitumen is heated to proper spraying temperatures. Blocked or plugged-up spray nozzles could cause streaking. Nozzles should make an angle 15 to 30 degrees to the centerline of the bar.

Because it is necessary to keep a record of how much tack is used, the distributor is equipped with a dipstick. The dipstick is used to measure the amount of tack in the tank at the start and finish of each operation. To figure how much tack was used, subtract the amount of tack left at the end of the operation from the amount measured at the beginning of the operation.

2-8 gallons

2-9 In a well near the hatch or in the hatch itself

Some distributors are equipped with a gauge to measure the tack. If the gauge is in good working order, it is used. If not, a dipstick must be provided by the contractor.

2-2 b. thermometer

ANSWER THE QUESTIONS:

2-5. What is used to measure the amount of tack in the distributor?

2-6. When is the tack measured?

2-7. Why is it necessary to measure tack?

A dipstick is divided into sections like a ruler. The divisions indicate the number of gallons. In the illustrations we are using, the dipsticks are divided into sections of 50gallons. This division is arbitrary and can differ from dip-stick to dip stick. However, the dipstick will always be divided into gallons

The dipstick should be carried in a well near the hatch or in the hatch itself. Dipsticks are <u>not</u> interchangeable between distributors. They are calibrated only for the tank to which they belong.

Dipsticks come in two different types. The first one to be discussed here, is one that is inserted into the tack, much like the dip stick that is used to measure the oil in your car.

Notice how the stick is divided and numbered from the bottom end to the top.

2-12 F

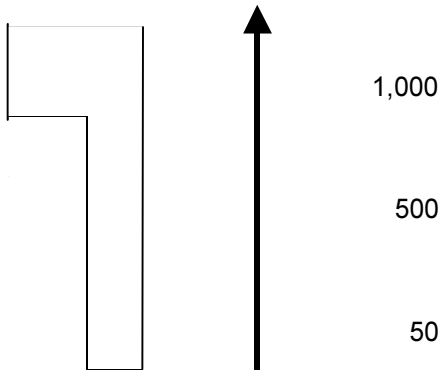
2-13 F

2-14 A.

2-15 B.

2-16 Air-filled (pneumatic)

2-17 Yes



The dipsticks are always inserted through the hatch at the top of the tank. This type of dipstick is inserted vertically into the tank until it touches the bottom of the tank, then withdrawn. The part of the stick that was in the tack will be black. So, if the stick is black to the 300 mark, there are 300 gallons left in the tank.

ANSWER THE QUESTIONS:

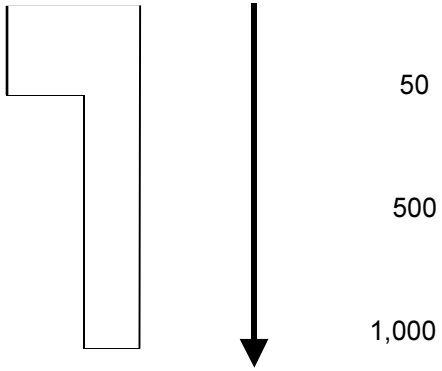
2-8 What do the divisions on a dipstick represent?

2-9 Where is the dipstick located on the distributor?

2-10 How many types of dipsticks are there?

2-11 If a dipstick is numbered from bottom to top, how far is it inserted into the tank?

The second type of dipstick looks almost exactly like the other one. The difference is that it is numbered from top to bottom. The lowest number will be found on the top of the stick.



This dip stick is inserted through the hatch into the tank until the end of it only touches the tack.

There is a fixed reference point on the inside of the hatch. (It may be an indented line.) What is measured is the distance between this point and the top of the tack. The stick is designed, so that the point on the stick that is level with the line indicates the amount of tack in the tank.

2-5 Dipstick or gauge

2-6 At the start and finish of each operation

2-7 To keep a record of how much tack is used

2-25
1. heater
2. tachometer
3. thermometer
4. tires
5. dip stick
6. Flow
7. Pressure nozzle

CIRCLE TRUE OR FALSE

2-12. True False All dipsticks are alike.

2-13. True False All dip sticks are inserted through the hatch to the bottom of the tack.

MATCH COLUMN A WITH COLUMN B

_____**2-14.** Inserted to bottom of tank

_____**2-15.** Inserted until touches tack

a. Small number at bottom

b. Small number at top

ANSWER THE QUESTIONS:

2-16. What type of tires should an asphalt distributor have?

2-17. Should the road be inspected to be sure that the tires are not harming it?

An inspection of an asphalt distributor should include the following:

1. Checking that the heater is in good working order.
2. Checking that the distributor is equipped with a tachometer.
3. Checking that the distributor tank is equipped with a thermometer.
4. Checking that the tires are of the proper width and design.
5. Checking that a dipstick is available.
6. Checking the flow of tack spray.
7. Checking that the pressure nozzle is in good working order.

FILL IN THE BLANKS:

2-18 The asphalt distributor is used for _____.

2-19 The two types of thermometers found on a distributor are_____ & _____.

2-20 The _____ forces the tack from the tank through the flexible hose.

2-21 The _____ sprays tack onto the roadway.

2-22 The distributor must have _____ tires, and their load must not harm the _____.

ANSWER THE QUESTIONS:

2-23 How do you measure tack the dipstick with small numbers at the top?

2-24 When do you measure the tack?

2-10 Two (2)

2-11 inserted through the tank to the bottom

2-25 List the inspection items on an asphalt distributor

1._____

2._____

3._____

4._____

5._____

6._____

7._____

HAUL TRUCKS

The haul truck is used to carry hot mix from the plant to the roadway. A haul truck must meet certain specifications, because it must protect the mix, as well as transport it.

A haul truck must have a smooth tight bed. Tight means free of damage, cracks, etc. The bed must also be clean. Foreign material in the bed could damage the mix.

A hole in each side of the bed shall be provided for the purpose of checking the temperature of the loaded mix. The front and sides of the truck bed shall be insulated with a suitable insulating material with a minimum "R" factor of 4.0.

2-18 Applying tack

2-19 Armored/dial

2-20 pump

2-21 Pressure nozzle

2-22 Pneumatic (air-filled)/ surface

2-23 Small numbers at the top: insert it until it touches the tack-read on matching mark on tank

2-24 Start and finish of tacking operation

2-28 True

2-29 True

2-30 False

2-31 False

All haul trucks must have an approved waterproof cover. The covers must be large enough to protect the mix against heat loss and/or dampness by completely covering the bed and extending over the sides.

The haul truck must be able to discharge the mix continuously directly into the paver hopper. The truck bed cannot touch the paver. Usually haul trucks have beds that can be elevated for ease in both discharge and cleaning. A conveyor system is also permitted.

CIRCLE THE CORRECT ANSWER(S):

2-26 Hot mix is carried from the plant to the job site in

a. a mixer

b. a paver

c. a haul truck

d. an asphalt distributor

2-27. Which of the following specifications apply to haul trucks?

a. Clean bed

b. insulated bed

c. approved waterproof cover

d. tight bed

e. bed that elevates

f. two temperature checking holes

All trucks used for carrying hot mix and all asphalt distributors must meet the Georgia Weight Laws.

During paving operations hot mix sometimes begins to stick on the bottom of the truck bed. To prevent a buildup of mix in the bed, it should be sprayed at the plant with a cleaning solution at least once a day with an approved mix release agent listed on the Georgia Qualified Products List (QPL). After spraying, the excess solution is drained off, leaving only a thin film that presents sticking. If the mix begins to stick to the bed, the truck should be cleaned. If necessary, a truck can be sprayed more than once per day. Please note that diesel is not an approved releasing agent.

2-34 Hot mix

2-35 unacceptable

2-36 free of holes

2-37 covered

2-38 Shall not

2-39 The bed needs cleaning

2-40 Truck Bed
Not damaged, insulated front & sides, clean, can be elevated, temperature checking hole
Cover
Approved waterproof material, large enough, heavy enough
Size
Paver can push easily

CIRCLE TRUE OR FALSE

2-28. True False Trucks must be cleaned at least once a day.

2-29. True False If the hot mix is sticking to the bed, It needs cleaning.

2-30. True False The bed is cleaned on the side of the road being surfaced.

2-31. True False Diesel is on the Qualified Products List for cleaning beds of trucks hauling asphaltic c oncrete.

In order to discharge its load of hot mix, the haul truck pulls up in front of the paver. (The paver is the machine used to place hot mix on the roadway.) The truck dumps mix into the hopper of the paver or it can be placed into a material transfer vehicle. The truck bed is <u>never</u> to rest directly on the paver.

Certain mixes from asphalt plants may have a segregation problem. Due to this, a plant's mix may require the use of a material transfer vehicle. Project personnel should review the "Sampling, Testing, & Inspection Manual –Volume II, QPL 45 prior to paving to see if any restrictions apply to the plant the contractor is using for his or her mix.

The paver then pushes the truck along the roadway until the truck is empty of hot mix. Then the truck pulls away and another takes its place. The haul truck must therefore be of a size and weight that the paver can push with ease. If the truck is too heavy, the smoothness of the surface and/or edge line can be ruined.

FILL IN THE BLANKS:

2-32. The haul truck must be of a size _____.

2-33. If the truck is too heavy the _____ and/or the _____ can be ruined.

A haul truck inspection should cover the following points:

A. Truck Bed
   1. Not damaged
   2. Clean
   3. Can be elevated
   4. Insulated sides and front
   5. Temperature checking holes

B. Cover
   1. Approved waterproof material
   2. Large enough
   3. Heavy enough

C. Size
   1. Will paver be able to push it with a smooth, easy movement?

If the haul truck fails to meet any of the above criteria, then it does not meet specifications and would not be acceptable.

2-26 C.

2-27 A, B, C, D, E, F

2-41 Laydown machine, spreader, finisher

2-42 To place hot mix on the roadway

2-43 Forward, reverse

2-44 Tractor, screed

2-45 roller bars, receiving hopper, feeders (flight chains), flow control gates, spreading screws (augers), engine

CIRCLE THE CORRECT ANSWER(S):

2-34. The haul truck carries (hot mix / tack).

2-35. A truck bed that had foreign material in it would be (acceptable / unacceptable)

2-36. A tight truck bed is (small / free of holes)

2-37. Haul trucks are (covered / uncovered)

2-38. The bed of the truck (shall / shall not) rest on the paver.

2-39. Mix sticking to the truck bed indicates (the mix is too hot / the bed needs cleaning).

FILL IN THE ANSWERS:

2-40. List the checkpoints of a haul truck inspection.

Truck Bed	Cover
1.	1.
2.	2.
3.	3.
4.	
5.	

Size

1.

PAVER

The paver may be called by names other than paver. It may be referred to as a laydown machine, a finisher, or a spreader. It is used to place hot mix on the roadway. A paver must have a quick and efficient steering device and be capable of moving both forward and in reverse. The paver consists of two (2) units, the tractor and the screed.

2-32 The paver can push with ease

2-33 Surface, edgeline

2-48 C.

2-49 B.

2-50 False

2-51 True

FILL IN THE BLANKS:

2-41. The paver may also be referred to as a _____, a _____ or a _____.

2-42. The paver is used _____.

2-43. The paver must move both _____ and _____.

2-44. The two (2) units of the paver are the _____ and _____.

The tractor unit contains several important parts.

They are:

roller bars	flow control gates
receiving hopper	spreading screws (augers)
feeders (flight chains)	engine

FILL IN THE ANSWERS:

2-45. List the important parts of the tractor unit:

_____ _____

_____ _____

_____ _____

There are two (2) roller bars that are located in front of the receiving hopper. The roller bars are the point of contact for the wheels of the haul truck. As was mentioned in the discussion of the haul truck, the paver pushes the truck. The haul truck backs up to within about six inches of the paver. It should not back up until it touches the paver.

The paver then moves forward until the roller bars make firm contact with the wheels of the truck. As the paver moves forward, the roller bars rotate and push against the wheels of the truck, forcing them to turn. The driver puts the truck in neutral and steers while the paver moves the truck.

CIRCLE THE CORRECT ANSWER(S):

2-46. How many roller bars are there?

a. 1

b. 2

c. 3

d. 4

2-47. The roller bars are located

a. on the wheels of the haul truck

b. on the tank of the asphalt distributor

c. on the front of the receiving hopper

d. on either side of the receiving hopper

e. in the bed of the haul truck

2-48. Approximately how close to the paver should the haul truck come when backing up?

a. until it hits the paver
b. 2 inches
c. 6 inches
d. 3 feet
e. 6 feet

2-49. The driver of the haul truck keeps the truck

a. at a low speed
b. in a neutral gear
c. in 1st gear
d. at a moderate speed

The two (2) moving parts, at the bottom of the hopper, are called feeders or flight chains. These flight chains are conveyor belts.

The flight chains move the mix through the tractor unit. There are openings at the back end of the flight chains. The mix drops through these openings onto the augers. The operator can start and stop these flight chains, controlling the amount of mix going to the roadway.

CIRCLE TRUE OR FALSE

2-50. True False At the bottom of the hopper are four (4) feeders (flight chains).

2-51. True False The flight chains are conveyor belts.

2-52. True False The flight chains move the mix across the screed.

2-53. True False The mix drops through openings onto the spreader screws (augers).

2-54. True False The operator, by manipulating the flight chains, can control the amount of mix going to the roadway.

There are two (2) gates, at the back of the hopper, called flow control gates. These gates control the amount of mix, conveyed by the flight chains, onto the augers. They can be lowered to reduce the amount of mix or raised to allow more mix to pass through.

The spreading screws, also called augers, are located behind the flight chains. They spread or "worm" the hot mix across the roadway.

2-46 B.

2-47 C.

ANSWER THE QUESTIONS:

2-55. Where are the flow control gates? What do they do?

2-56. What is the function of the augers?

2-60 True

2-61 False

2-62 True

2-63 False

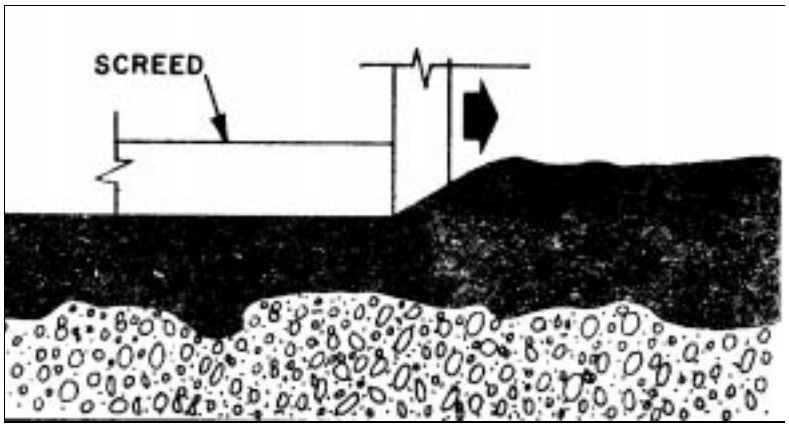
2-64 True

2-65 True

2-66 A, B, D

2-67 B

The other unit of the paver is the screed. The function of the screed is to press down and smooth the mix. The screed is attached to the tractor by two (2) pull arms. These arms are attached in such a way that the screed floats on top of the mix. The screed should leave a smooth even top surface while pressing asphalt into the contours of the base surface.



The screed is also equipped with two (2) heaters. These heaters are used to heat the screed plate at the start of the day's operation. They may also be used throughout the paving job on cool, windy days. These heaters aer not used to heat up cooled-off asphalt.

CIRCLE TRUE OR FALSE

2-57. True False The screed is an integral part of the tractor.

2-58. True False The screed "floats" on the mix.

2-59. True False The action of the screed creates a surface that reflects all the irregularities of the base course.

A pre-work inspection of the paver should include raising the screed plate to check for smoothness. Plates wear out first about 4 to 6 inches from the trailing edge. Another pre-work inspection that should be done is on the heaters. The heaters should be lit and checked for proper operation.

If extensions are used, they should be flush with and in the same true plane as the bottom surface of the screed plate.

Tampers should be examined for excessive wear, the bottom stroke of the tamper should extend 1/64 inch beyond the screed plate.

If the screed is a vibrating type, the vibrators should be started with the screed in a raised position, to be sure they are working.

At the close of the day's operation, the paver should be properly cleaned. While still warm, the hopper, flight chains, augers, tampers, and screed plates should be sprayed lightly with an approved releasing agent.

2-52 False

2-53 True

2-54 True

2-55 Back of the hopper, control the amount of mix to the augers

2-56 To spread mix across the roadway

CIRCLE TRUE OR FALSE

2-60. True False Before work begins, the screed plate should be raised and examined for wear.

2-61. True False The screed plate should be carefully examined 4 to 6 inches from the leading edge, since this point shows wear first.

2-62. True False Extensions should be flush with the bottom of the screed plate.

2-63. True False Vibrators should never be started with the screed in raised position.

2-64. True False The heaters should be lighted and checked for proper operation before work begins.

2-65. True False At the end of the day's operation the paver should be cleaned thoroughly

CIRCLE THE CORRECT ANSWER(S):

2-66. The paver may also be referred to as a
a. laydown machine
b. spreader
c. distributor
d. finisher

2-67. How many roller bars are there?
a. 1
b. 2
c. 3
d. 4

2-68. How many flight chains are there?

a. 1

b. 2

c. 3

d. 4

FILL IN THE BLANKS:

2-69. The two-(2) basic units of the paver are the _____ and the _____.

2-70. The augers _____the mix across the roadway.

2-71. The screed is attached to the paver by two (2)_____

2-72. The heaters are used to warm only the _____ _____.

2-57 False

2-58 True

2-59 False

2-73 Breakdown rolling

2-74 Drive

2-75 tiller

ROLLERS

Traditionally three types of rollers were used for compacting hot mix.
They were:

three wheel roller

tandem static roller

pneumatic roller

Formerly these three types of rollers had an assigned role in the compacting procedure. However, since the introduction of vibratory rollers these functions are no longer strictly followed.

The traditional three rollers may still be seen on the jobs. However, the most commonly used today are:

Tandem vibratory roller
Pneumatic roller
Tandem static roller

Therefore, a discussion of today's rolling method follows.

The advent of the vibrating roller has changed the traditional method of rolling with three different rollers. A vibratory roller is able to achieve compaction with fewer passes than a static roller. Most models of vibrating rollers can also be used as static rollers for finish rolling, also.

2-68 B

2-69 Tractor, Spreader

2-70 Spread

2-71 Pull arms

2-72 Screed plates

Vibrating rollers come in three wheel and two or tandem wheel rollers. On some tandem models, both drums vibrate. Some three-wheel models have three steel wheels; some have a steel front drum and two rear pneumatic tires. Most commonly seen is the tandem vibratory.

The vibratory roller is traditionally the first roller on the hot mix after it has been laid. This first division of the rolling procedure is known as breakdown rolling. The "steerable" wheel in the front is called the tiller wheel and the other wheel in the back is called the drive wheel.

FILL IN THE BLANKS:

2-73. The first division of the rolling procedure is called _____ _____.

2-74. The rear wheel is the _____ wheel.

2-75. The front wheel is the _____ wheel or steerable wheel.

The wheels of the vibratory roller are in fact steel drums. Their surfaces should be very smooth. If they are pitted, dented, or have flat spots on them, they can ruin the surface of the mix. The wheels must be fitted with scrapers and a suitable watering device. The scrapers are usually made of steel. The scraper and watering device aid in preventing the asphalt from sticking to the wheels.

The vibratory roller, like all rollers, must be able to reverse without backlash. This means, when the roller goes into reverse, there should be no sudden jerky movement that will damage the mat. The steel wheels of the roller are hollow and can be used as ballast tanks. If the roller needs to be heavier in order to insure proper compaction the wheels can be filled up, usually with water, to add extra weigh. Roller weight with ballast is sometimes listed as "loaded" weight.

An inspection of a vibratory roller should include checking the following points:

1. Steel wheels - clean, smooth, no grooves or marks
2. Scrapers and watering devices on all wheels
3. Roller capable of reversing without backlash

CIRCLE THE CORRECT ANSWER(S):

2-76. The wheels of the vibratory wheel roller are

a. solid rubber tires
b. solid steel drums
c. pneumatic tires
d. hollow steel drums

2-77. The wheels of the vibratory roller must be

a. shallow ridged
b. deeply treaded
c. smooth
d. flat in places

2-78. The roller must have

a. a watering device for the wheels
b. an oiling device for the wheels
c. an automatic transmission
d. wheel scrapers

2-79. "Loaded" weight means

a. the driver's weight plus the weight of the roller
b. ballast has been added to the roller
c. heavy pads on the wheels of the roller
d. the official weight of the roller for transport

2-80 steel

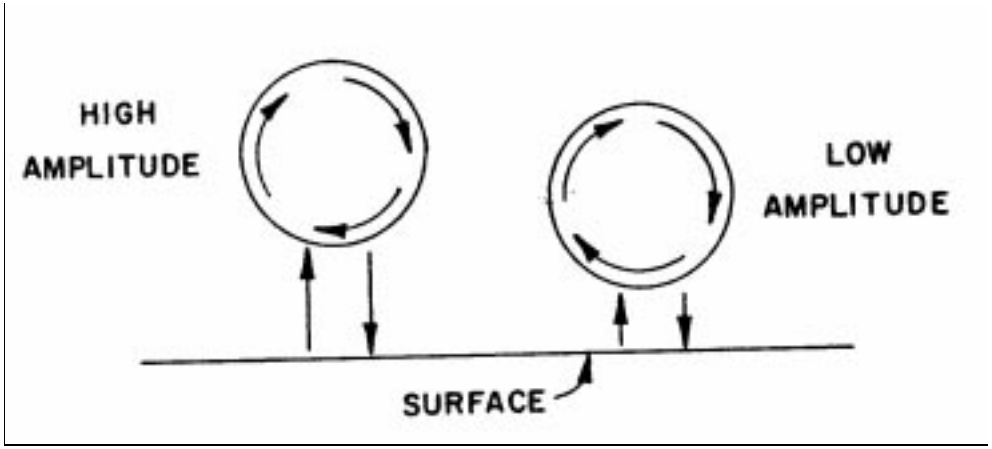
2-81 amplitude

2-82 frequency

2-83 smaller

A vibratory roller works by striking the mat with the roller at the same time as it rolls over the surface. The force of these vibrations can be expressed in terms of amplitude and frequency.

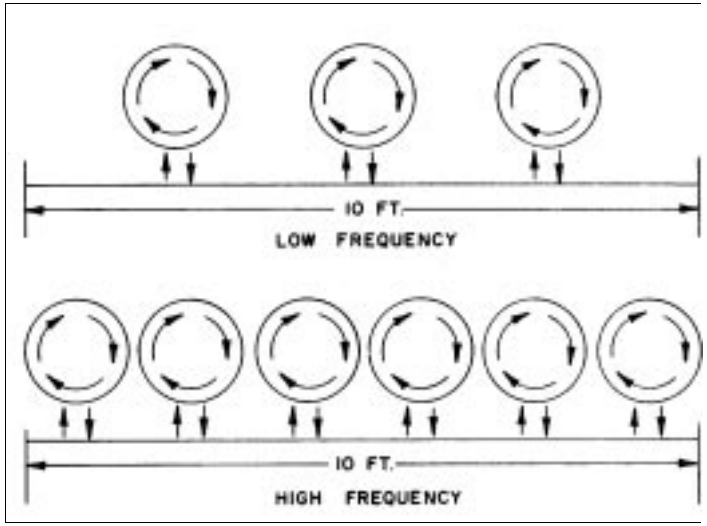
Amplitude means the strength of the impact. To adjust amplitude, the vibrating drum is set to be raised higher or lower for each stroke.



To increase amplitude the roller is raised higher for each stroke. To decrease amplitude, the roller is not raised as high.

Frequency is the number of times the drum strikes the surface as the roller moves across the mat a given distance. The higher the frequency the more often the surface will be struck.

2-84 C



Not all rollers have adjustments for amplitude and frequency. Adjusting the speed of the roller also adjusts the frequency of the vibrations. The faster the roller moves, the further apart the impacts are spaced.

2-76 D

2-77 C

2-78 A, D

2-79 B

2-88 T

2-89 F

2-90 T

2-91 T

CIRCLE THE CORRECT ANSWER(S):

2-80. The front wheel of a vibratory roller is (steel / rubber).

2-81. The strength of the roller's impact with the surface is the (frequency /amplitude).

2-82. The (frequency / amplitude) is the number of times the vibrating drum strikes the surface.

2-83. The faster the speed of the paver, the (greater / smaller) the frequency.

The roller operator must be certain to turn off the vibrations before reversing direction. Failure to do so can damage the mat. Operating the roller with too low a frequency can leave undulations in the surface, creating a washboard effect.

Tender mixes are those which are easily displaced by rolling equipment. They are usually best rolled with a combination of high frequency and low amplitude, when a vibrating roller is used. This combination also applies to thin lifts.

On occasion, the drum may begin to bounce during paving. Should this happen, the vibration should be turned off and the mat rolled with the roller static.

CIRCLE THE CORRECT ANSWERS(S):

2-84. Before reversing direction, the roller operator should
a. slow down the vibrations
b. speed up the vibrations
c. turn off the vibrations
d. increase the amplitude

2-85. The surface has undulations in it; therefore

a. the vibrations may be too weak

b. the vibrations may be too strong

c. the frequency may be too high

d. the frequency may be too low

2-86. A mix that displaces easily under rolling equipment is called

a. tender

b. stiff

c. tough

d. touchy

2-87. If the vibrating drum begins to bounce, the operator should

a. increase the amplitude

b. shut off the vibrations

c. decrease the frequency

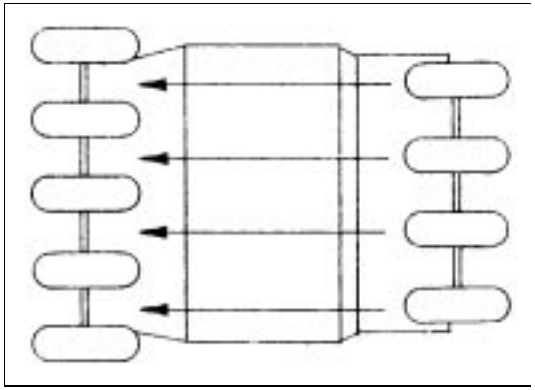
d. wait for the mix to cool

The roller that traditionally follows the breakdown roller onto the hot mix is the pneumatic roller. Pneumatic rollers have air-filled tires. The word pneumatic refers to these tires. Pneumatic rollers are self-propelled and have two axles. They also have an uneven number of tires. (For example, if the front axle had five [5] tires, the rear axle would have four [4].)

2-95 Tire inflation

2-96 Pounds per square inch

2-97 less



The tires are arranged in-groups, so that the gaps between the tires of one axle will be covered by the tires of the other.

CIRCLE TRUE OR FALSE

2-88. True False The roller that does intermediate rolling is traditionally a pneumatic roller.

2-89. True False Pneumatic rollers have steel drums for tires.

2-90. True False Pneumatic rollers could have nine (9) tires, but not eight (8).

2-91. True False The tires of a pneumatic roller are arranged so that the gaps between one set of tires are covered by the other set.

All tires on pneumatic roller must be identical. They must be of equal size, ply rating, inflation pressure and diameter. They cannot have a tread design, but must be completely smooth. Like a tandem vibratory roller, the pneumatic tire roller must be equipped with scrapers and watering devices.

2-85 D

2-86 A

2-87 B

CIRCLE TRUE OR FALSE

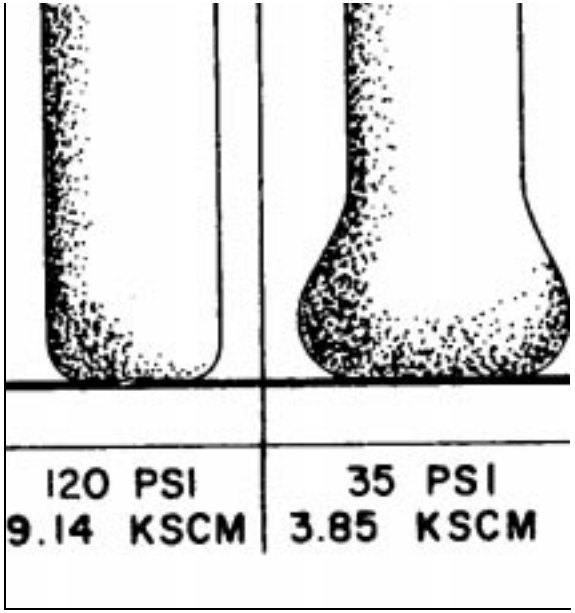
2-92. True False Pneumatic rollers have tread tires on the front and smooth tires on the rear axle.

2-93. True False The rear wheels of a pneumatic roller are smaller than the front wheels.

2-94. True False Pneumatic roller tires are equipped with scrapers and watering devices.

Inflation pressure means the internal pressure the air exerts against the sides of the tire. Inflation pressure is expressed in pounds per square inch, psi. Tires have an operational inflation pressure 35 psi to 130 psi. The higher the inflation pressure, the less the tire surface that is in contact. With the hot mix; the lower the pressure, the greater the contract surface.

2-103 C



2-104 Tandem static

2-105 finish

2-106 Hollow, smooth

Some pneumatic rollers are equipped with an automatic inflation/deflation system for the tires. This system is known as air-on-the-run. It allows the operator to adjust the air pressure of the tires from his control panel during the paving operation.

FILL IN THE BLANKS:

2-95. The pressure the air exerts against the internal surface of the tire is called _____.

2-96. Psi stands for _____.

2-97. The higher the psi, the _____ the amount of tire surface in contact with the mat.

2-98. The _____system allows the operator to adjust the inflation pressure during paving.

2-99. Tires need to be inflated to _____psi.

Some pneumatic rollers have a ballast box. This is a hollow area that can be filled with water, sand, or both, in order to increase the weight of the roller.

CIRCLE THE CORRECT ANSWER(S):

2-100. Intermediate rolling is traditionally done by a
a. screed
b. pneumatic roller
c. tandem roller
d. three wheel roller

2-101. Pneumatic rollers are characterized by
a. even number of tires
b. odd number of tires
c. air-filled tires
d. wooden rollers

2-102. The tires of a pneumatic roller should be equipped with
a. brooms
b. scrapers
c. a watering device
d. tread

2-92 False

2-93 False

2-94 True

2-103. Weight can be added to a pneumatic roller by putting sand and/or water in its

a. tires

b. hubcaps

c. ballast box

d. bags

The tandem static roller is always used for finish rolling. Finish rolling is done to remove ruts and other irregularities from the surface of the mat. Most tandem vibratory rollers can be used for finish rolling as static rollers.

The tandem static roller has smooth, hollow steel drums for wheel. Water can be added to them for extra weight if necessary. They must also be equipped withscrapers and a watering system.

FILL IN THE BLANKS(S):

2-104. In traditional rolling, the last roller will be a _____ roller.

2-105. _____ rolling removes the ruts and other irregularities left by the pneumatic roller.

2-106. The tandem roller has _____ wheels made of _____ steel drums.

The three wheel roller may still be seen occasionally on projects in the first division of the rolling procedure, breakdown rolling. The use of a three-wheel roller is more commonly seen used today in widening or shoulder paving as the breakdown roller.

The three-wheel roller has three (3) wheels. The small wheel in the front is called the tiller wheel and the two large wheels in the rear the drive wheels. The wheels of the three-wheel roller are usually hollow steel drums, too. Their surfaces should be very smooth. If they are pitted, dented, or have flat spots on them, they can ruin the surface of the mix.

FILL IN THE BLANKS:

2-107 The wheels of a three-wheel roller are usually _____.

2-108 The three-wheel roller may sometimes be used in the first division of the rolling procedure called _____ _____.

2-98 air-on-the-run

2-99 recommended

2-100 B

2-101 B, C

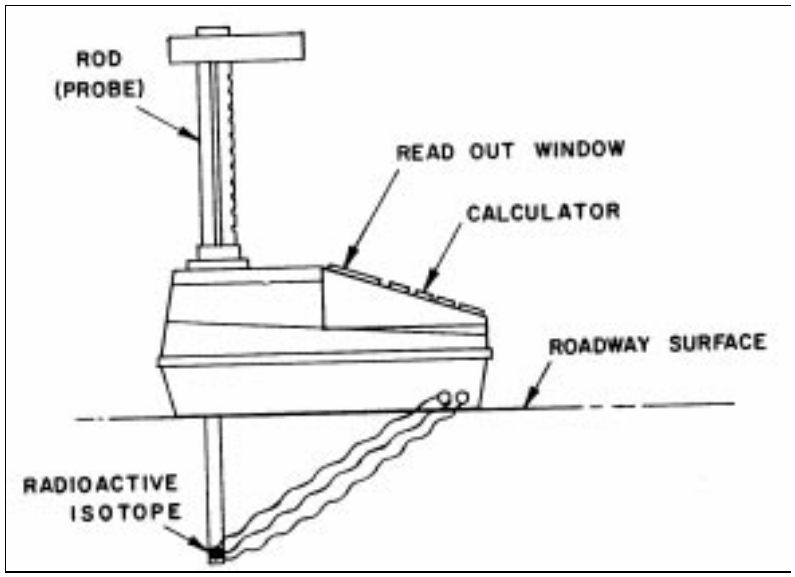
2-102 B, C

2-112 Slide scraper plate or gauge base across area to remove excess material

THE NUCLEAR DEVICE

The nuclear device is a relatively new instrument that is being used with increasing frequency on paving jobs of all types. It can be used to measure density and moisture content. In asphalt, the device is used to aid in the establishment of a proper rolling pattern in order to achieve desired compaction and density.

The nuclear device consists of a rod which contains a radioactive source and a calculator that is used to compute the information fed it by the radioactive isotope in the rod.



The radioactive source in the rod gives off rays of different frequencies. By comparing the readings of these waves against an atmospheric reference standard, it is possible to compute the density of a layer of pavement.

FILL IN THE BLANKS

2-109. The nuclear device can be used to measure _____ and _____ content.

2-110. In asphalt paving the nuclear device is used as an aid in establishing the correct _____ to achieve required compaction.

2-111. The nuclear device contains a _____ source in the rod.

2-107 smooth

2-108 Breakdown rolling

2-117 B

The usual method of testing with the device is to place the instrument on a smooth, level surface. A way to produce this surface is to put a handful of sand on the surface, then slide the scraper plate or gauge base back and forth to remove the excessive material.

After the surface has been smoothed (if necessary) and the apparatus is in place, the correct testing procedure is followed, readings recorded, and percent compaction computed.

As long as the machine indicates decreasing "counts," the percent of compaction is increasing. When the "counts" level off or rise slightly, density has reached its maximum percentage. If the "counts" begin to increase, it is an indication over compaction and loss of density. Hence, if a count is taken after each roller pass, it is possible to compute the exact number of roller passes needed to achieve maximum density.

NUMBER THE STEPS:

2-112. What is the first step for a correct testing procedure with a nuclear device.

_____ Position device on leveled surface.

_____ Begin test and compute readings

_____ Slide scraper plate or gauge base across area to remove excess material

---

2-118 Asphalt distributor

2-118 Asphalt distributor
2-119 Haul truck

2-120 paver

2-121 tandem vibratory roller, pneumatic roller, tandem roller

It is necessary to perform this test while asphalt is still warm enough for further rolling to be productive. In using the nuclear device, the rod containing the radioactive isotope can be driven into the lift.

2-122 hole

When using the nuclear device, its location should be circled with yellow keel (lumber crayon), so the device can be replaced in exactly the same spot. Altering the placement of the nuclear device when checking for density can affect the readings.

CHECK THE CORRECT ANSWER(S):

2-113. A nuclear device is used, in asphalt paving, to measure

a. aggregate content

b. moisture content

c. density

d. thickness of individual lift

2-114. A nuclear device is used for determining how many passes by the _____ are needed.

a. motor patrol

b. paver

c. asphalt distributor

d. roller

2-115. The surface on which the device is placed for a test must be

a. cold

b. level

c. granulated

d. smooth

2-116. The "counts": on the nuclear device are decreasing with every test. This indicates maximum compaction has been passed;

a. the lift is over-compacted

b. the lift is losing density

c. the asphalt is too hot for an accurate test

d. maximum density has not yet been achieved

2-109 Density, moisture

2-110 Rolling pattern

2-111 radioactive

2-129 True

2-130 True

2-131 False

2-132 True

2-133 True

2-134 False

2-135 False

2-136 True

2-137 False

2-117. Yellow keel is used

a. as a radioactive isotope

b. to mark the spot where the nuclear device was placed

c. only when back scatter testing is employed

d. to indicate that no nuclear test can be run

A nuclear testing device emits radioactivity. Its misuse is very dangerous. Only a qualified technician may operate a nuclear device. Proper precautions and care should be exercised at all times when a nuclear device is present on a job.

REVIEW: CHAPTER 2 - FILL IN THE BLANKS:

2-118. The _____is used to apply tack.

2-119. The asphaltic concrete is brought from the plant to the job site by a _____.

2-120. The hot mix is spread over the roadway by a _____.

2-121. There are three types of rollers most commonly used to compact hot mix.

They are:

_____

_____

_____

2-122. A _____ is to be provided in each side of the bed of the truck to check temperature.

2-123. A quick way of testing for density in order to establish the correct number of roller passes is to use a _____.

2-124. MATCH COLUMN A TO COLUMN B

Column A	Column B
_____ 1. insulated tank	A. paver
_____ 2. screed unit	B. haul truck
_____ 3. wheel scrapers	C. rollers
_____ 4. radioactive	D. vibratory roller
_____ 5. clean, tight bed	E. asphalt distributor
_____ 6. vibrating drum	F. nuclear device
_____ 7. tachometer	G. empty truck
_____ 8. dip stick	H. measures tack
_____ 9. Georgia Weight Laws	I. Pounds per square inch
_____ 10. psi	J. speed in feet per minute

CIRCLE TRUE OR FALSE

2-125. True False An asphalt distributor will be equipped with a thermometer.

2-126. True False The amount of tack in an asphalt distributor must be measured.

2-127. True False The bed of the haul truck should rest securely on the hopper of the paver while discharging mix so that none will spill on the surface.

2-128. True False Diesel is an approved material for cleaning haul truck beds.

2-113 density, moisture content

2-114 D, roller

2-115 B, level and D, smooth

2-116 D, maximum density has not yet been achieved

2-129. True False The screed should be inspected for wear; its heaters tested; and vibrators checked before work begins.

2-130. True False Tandem vibratory rollers are mostly used in breakdown rolling.

2-131. True False Pneumatic rollers must always be used in asphalt paving.

2-132. True False The wheels of all rollers for asphalt paving must be equipped with water and scrapers.

2-133. True False PSI stands for pounds per square inch.

2-134. True False Amplitude and frequency of vibration on a vibratory roller are never adjusted.

2-135. True False If the asphaltic concrete cools off too quickly, the screed's heaters will usually warm it sufficiently for operations to continue

2-136. True False Tender mixes are easily displaced during rolling.

2-137. True False The haul truck bed should always rest securely on the paver hopper while discharging hot mix.

This is the end of Chapter II, Equipment. If you missed any questions or feel unsure about any of the material covered, reread the appropriate section. Otherwise, go on to Chapter III.

3-1 Forward speed, angle of attack, head of material

3-2 angle of attack

3-3 the back of the spreader using the mat thickness controls

3-4 deep

CHAPTER III - ASPHALT PAVING MACHINES & THE PAVING OPERATION

Since pavers are continually being redesigned and modernized, the information contained in this section is subject to obsolescence. It would be a good idea for an inspector to obtain a copy of the operator's manual for all machines encountered on each job.

All pavers have similar basic adjustments since they are all composed of the same type parts. However, there are some noteworthy differences among the various makes of pavers. The purpose of this section is to introduce the adjustments of pavers in general, and to explain the specific variations found in different brands of pavers. Ideally, any paver should be adjusted and operated according to the manufacturer's recommendations. Also, it is the appearance of the mat itself that determines the correct settings for a paver on a particular job.

EFFECTING FORCES FOR GOOD MAT QUALITY

There are three forces that must be in balance in order to obtain a good quality mat of proper thickness. They are forward motion, the angle of attack, and the head of material.

Forward speed, obviously, is the speed at which the paver moves forward.

The screed is adjusted by the Mat Thickness Controls at the back of the spreader. The angle that is formed between the screed bottom and the grade of the road creates the "angle of attack." The more the screed is tilted, the deeper the mat will be; the less the tilt, the shallower the mat. In order to obtain the smoothest riding surface, it is generally recommended that the tilt of the screed not be changed once the correct mat depth is attained.

2-123 Nuclear device

2-124

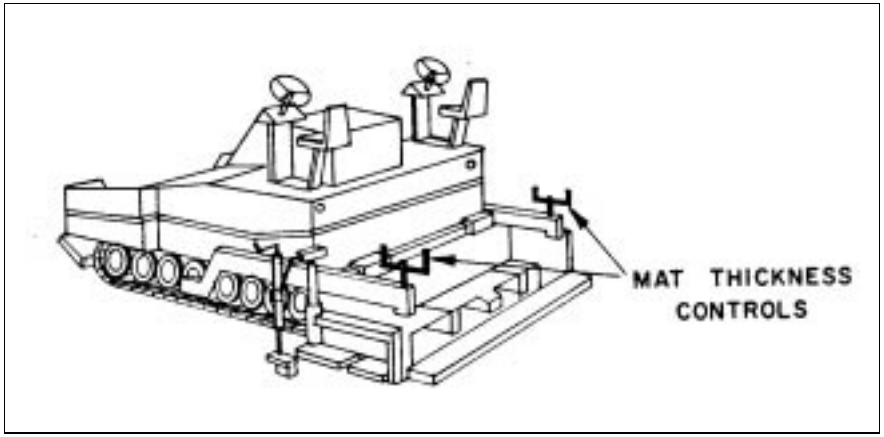
1. E
2. A
3. C
4. F
5. B
6. D
7. J
8. H
9. G
10. I

2-125 True

2-126 True

2-127 False

2-128 False



ANSWER THE QUESTIONS:

3-1. What are the three-(3) forces that affect mat quality and thickness?

3-2. What is the angle the screed makes with the horizontal surface called ?

3-3. Where is the tilt of the screed adjusted ?

3-4. If the angle of attach is large, will a shallow or deep mat result ?

The head of material is the amount of mix that is measured and pushed ahead of the screed. This element is the most important of the three forces affecting mat thickness.

FILL IN THE BLANKS:

3-5. The amount of hot mix that is measured and delivered in front of the screed is called the _____.

3-6. The _____ is the most important and most difficult element to control with regard to mat thickness.

Any disturbance of the forces just discussed that causes one or more to become out of balance will have an adverse effect on the mat.

Any of the following can result in an interruption of the smooth travel (forward speed) of the paver and be reflected in the riding surface.

1. Truck Bumping Paver - the most common cause of marks or ridges in the finished mat. Can be corrected through experience and cooperation between truck driver and paver operator.
2. Truck Holding Brakes - this can lug paver engine down or cause drive wheels of paver to break traction, causing mat deficiencies. Experience and cooperation between truck driver and paver operator will elimi nate this problem.
3. Paver Engine in Poor Operating Condition - each time a number of paver functions occur at the same time, maximum power from the engine is required. The engine will lug down, disturbing the forward motion causing variations in the mat.

4. Erratic Governor - if the governor will not maintain a constant engine R.P.M., forward motion is dis turbed.
5. Unequal Air Pressure in Drive Tires - will cause the paver to break traction and result in mat deficiencies.
6. Loose Drive Chains - can produce a surging action in the paver drive train, and will be reflected as rough ness in the finished surface.
7. Frequent Speed Changes - speeding up and slowing down without changing the angle of attach can result in a mat deficiency. Increase speeds will decrease mat thickness and decreased speeds will increase mat thickness.

The following factors are some common variables that can affect the smooth flow of hot mix (head of material) to the screed and can produce serious paving problems

1. Fluctuating mix temperature.
2. Inconsistent blend of aggregate in the mix.
3. Inconsistent moisture content of aggregate in the mix.
4. Material that tends to compact rather than flow.
5. Increasing or decreasing the depth of material in front of the screed.

A third thing that can adversely effect the mat may be the angle of attack:

1. Overcorrecting the Depth Crank - Allow length of paver to reflect one change before making another.
2. Too many “Experts” - It should be the responsibility of the screed man alone to make adjustments.
3. Incorrectly Checking Mat Thickness - check several times over a length of 20 or 30 feet before making any corrections with the depth crank. This will give an average depth and prevent premature adjustment being made from a high or low spot in the base.

4. Worn Bearings in Depth Crank Assembly - will definitely cause a constant change in the attack angle. If the angle is not positively held, the screed will cause a chatter or ripple in the riding surface.

5. Oversensitive Setting of Electronic Grade & Slope Controls - will result in a "hunting condition", a fre quent and erratic raising and lowering of the screed pull point.

SIX (6) MJOR AREAS OF PAVER ADJUSTMENTS

There are six (6) major areas of adjustment on an asphalt paver:

1. Flow control gates
2. Augers and feed conveyors
3. Lead crown
4. Tampers or vibrators
5. Speed of paver
6. Screed position

The method of initial compaction of the hot mix also varies from brand to brand. Some pavers have tamping bars immediately in front of the screed for initially compacting the mix before strike off. However, tamping bars are not used on most of the new machines and are becoming obsolete. Other pavers have a vibrating screed which provides initial compaction. Still other pavers have an oscillating strike off bar ahead of the screed. These adjustments, therefore, depend on the type of paver being used.

ANSWER THE QUESTIONS:

3-7. List the six-(6) major areas of adjustment on asphalt pavers:

_____ _____ _____

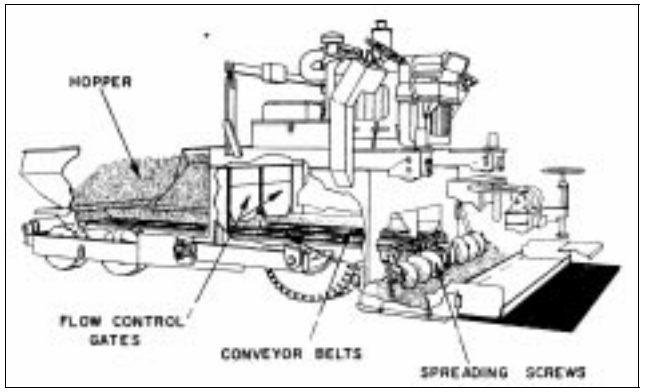
_____ _____ _____

3-8. List the three-(3) possible methods of initial compaction found on asphalt paving machines:

_____ _____ _____

3-5 Head of material

3-6 head of material



The two (2) flow control gates at the back of the hopper over each of the feed conveyors (flight chains) can be individually adjusted to control the flow of material to the augers. The flow control gates should be adjusted to a height that allows the conveyors and augers to run approximately 85 - 90 % of the time. This speed keeps the material in front of the mat stirred and results in a more uniform mat. The flow gates must always be adjusted in balance with the feeder controls, so that the conveyors keep the spreader screws approximately two-thirds covered with hot mix.

It is suggested that at the beginning of an operation the gates should be half-way open. They should then be adjusted until the optimum 85 - 90% running time for the flight chains is reached and the augers remain 2/3's covered with hot mix.

Flow gates open all the way would cause:

poor quality mat
loss of production
excessive wear on the auger

CIRCLE TRUE OR FALSE

3-9. True False The flow gates can be adjusted individually.

3-10. True False The flow gates should be adjusted so that the flight chains and augers run 100% of the time.

3-11. True False The augers should be 3/4 covered with hot mix.

The conveyor and auger on each side of the paver operate together. Thus, the feed system on each side can be individually controlled and coordinated with the flow control gate. The lowest possible auger speed that will create a mat of the desired depth and thickness should always be used. Besides regulating auger feed by means of the flow control gates, the automatic shut-off assembly can be adjusted to govern the head of material fed to the augers.

CIRCLE TRUE OR FALSE

3-12. True False Both augers work as one unit.

3-13. True False Augers should be run as fast as possible to insure completing the job by deadline.

3-14. True False The amount of material reaching the augers is affected by the adjustment of the automatic shut-off assembly.

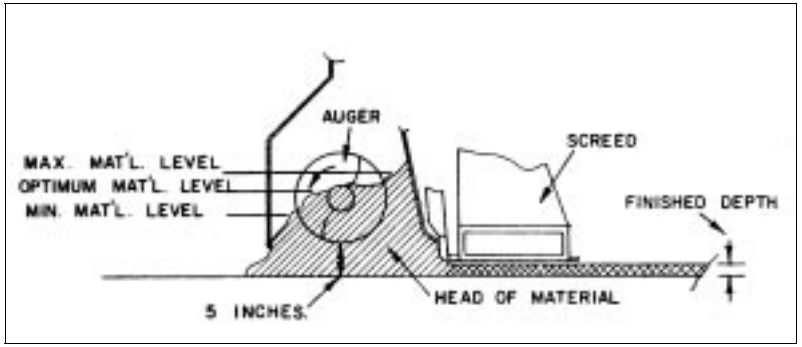
3-7 flow control gates, augers & flight chains, lead crown, tampers or vibrators, speed of paver, screed position

3-8 tampers, vibratory screed, oscillating strike off

Two (2) adjustable switches are located in front of the augers. The switches may be paddles or electronic eyes, which are set to stop the flight chains when the level of hot mix gets too high on the augers. They also activate the switches to restart the flight chains when the level of hot mix drops.

The height of material in front of the screed is thus regulated by the flow control gates and automatic shut-off switches. These controls must be set in balance to maintain a proper head of material.

Overfeeding of the augers leads to various imperfections in the mat, such as ripples, or pre-compacted areas that cause auger shadows. If the augers are underfed, or if the amount of material fed to them is not constant, a poor quality mat will result. These errors in feed cause the mat depth to fluctuate.



The best operating position for augers is about 5 inches above ground, however, mix type and mat texture will vary in height.

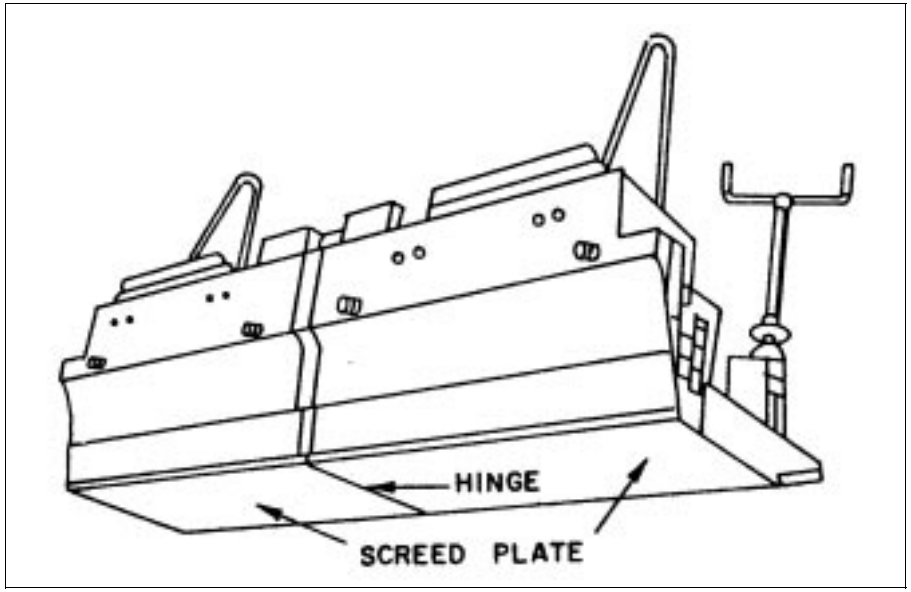
FILL IN THE BLANKS:

3-15. The automatic shut-off assembly turns the _____ on and off.

3-16. The automatic shut-off assembly aids in controlling the amount of _____ fed to the augers.

3-17. Underfeeding of the augers causes the mat _____ to fluctuate.

All screeds consist of a screed plate with a hinge.



3-9 True

3-10 False

3-11 False

3-12 False

3-13 False

3-14 True

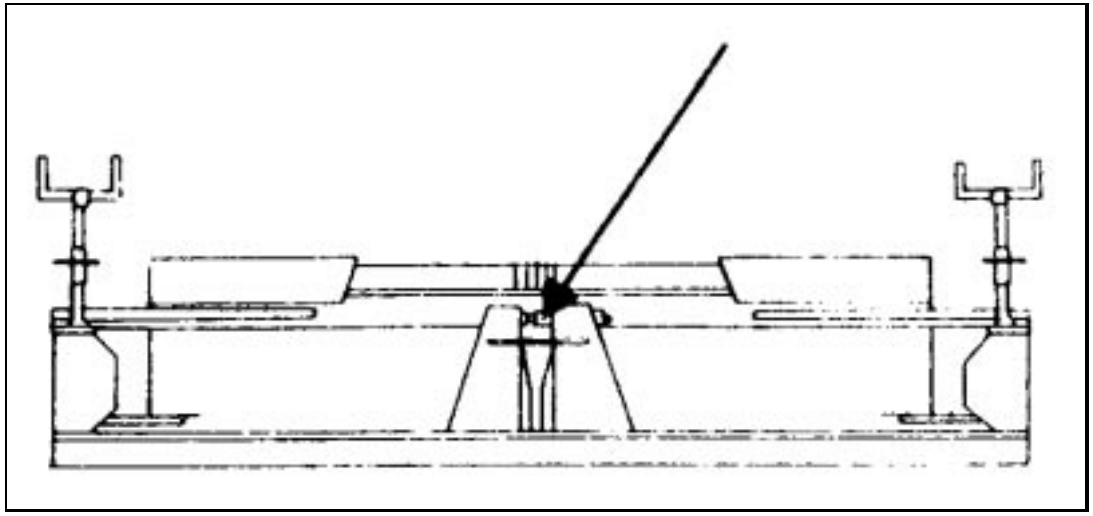
3-22 F

3-23 T

3-24 T

3-25 T

The screed plate provides the ironing action of the screed. The hinge allows the plate to be adjusted properly. The adjustment that regulates the angle of the screed plates is called the crown adjustment. The crown adjustment is located in the center of the screed platform.



The forward edge of the screed is called the leading edge; the rear edge the trailing edge. Both of these edges can be adjusted or crowned independently. The rear crown or trailing crown is also called the road crown, because it is the crown required by specifications.

CIRCLE THE CORRECT ANSWER(S):

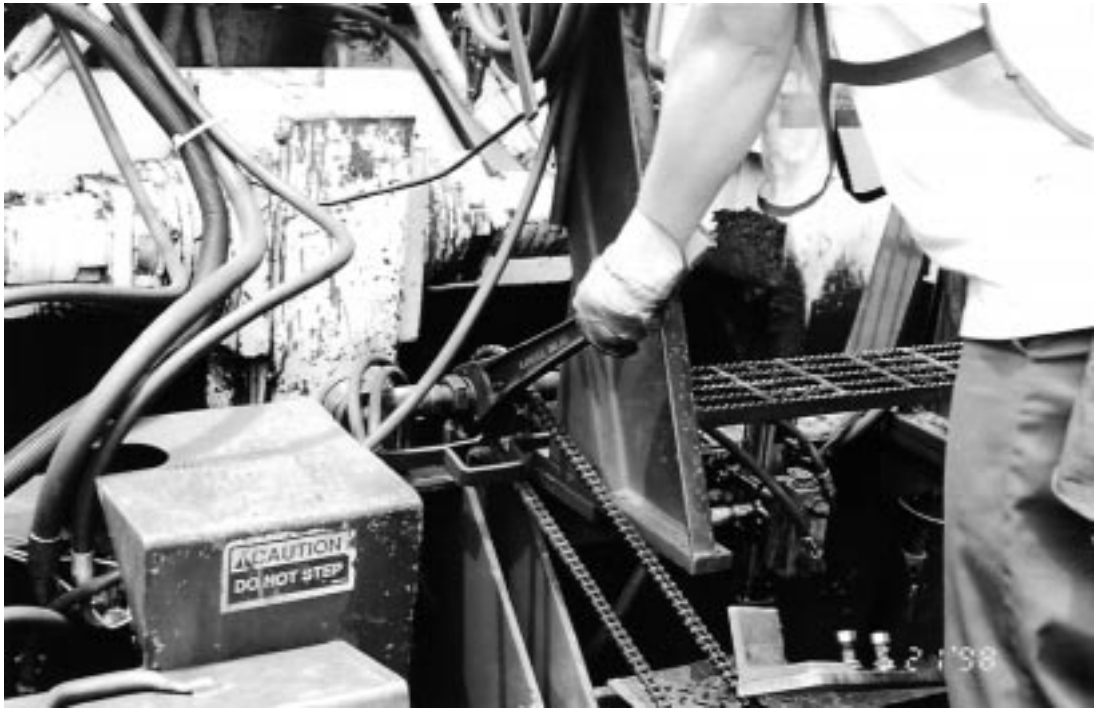
3-18. (All / Some) screeds consist of a screed plate with a hinge.

3-19. The (hinge / roller bar) allows the screed to be adjusted properly.

3-20. The adjustment that regulates the crown of the screed is called (crown / hinge) adjustment.

3-21. The (leading / trailing) edge of the screed sets road crown.

The leading edge should have slightly more crown than the trailing edge. Before the paving operation begins, the specified crown is set with the rear turnbuckle. A string is stretched underneath the trailing edge and the crown set with the rear crown station. Then, the lead crown is set in the same manner, giving the lead about 1/8 inch more crown than the rear.



3-15 Flight chains

3-16 hot mix

3-17 depth

The crown setting depicted and discussed in the foregoing frames is called positive lead crown setting. This name means that the lead crown is higher than the rear crown. It is also possible to set the rear crown higher than the lead crown. Such an arrangement is called negative lead crown. This setting is not used.

CIRCLE TRUE OR FALSE

3-22. True False The trailing edge of the screed should have more crown than the leading edge.

3-23. True False A string is used in setting crown.

3-24. True False 1/8 inch of difference between rear and lead crown is a good starting point.

3-25. True False When the leading edge is crowned higher than the trailing edge, the arrangement is called negative lead crown.

3-31 True

3-32 True

3-33 True

3-34 True

3-35 False

If the crown adjustments are not correctly balanced, the quality of the mat will suffer. Excessive lead crown will cause the mat to tear at the sides. The mat will show an extremely closed texture down the middle and loose, open texture on the sides. A screed with negative crown, no lead crown, or in-sufficient lead crown will cause the mat to tear at the center.

After paving begins, the lead crown can be adjusted as necessary to obtain a perfect mat. However, the forward turnbuckle should not be adjusted more than a quarter turn at a time. After each adjustment, the mat should be observed as the paver moves forward 10 to 20 feet.

Should it be necessary to make an extreme adjustment on the lead crown, the tail crown should be double-checked. In fact, it is always good practice to check road crown once the desired mat is achieved.

FILL IN THE BLANKS:

3-26. Excessive lead crown will cause the mat to tear at the _____.

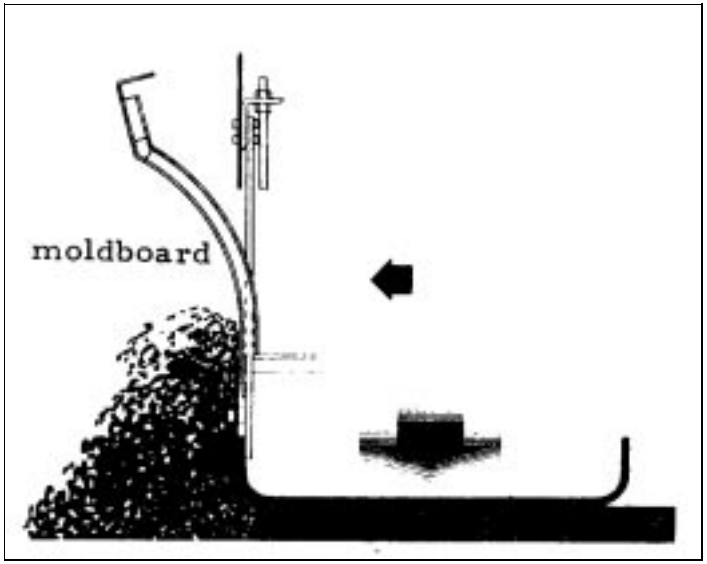
3-27. Negative crown will cause the mat to tear at the _____.

3-28. The forward turnbuckle should be adjusted only _____.

3-29. After a lead crown adjustment, the mat should be observed for _____feet, before further adjustment.

3-30. It is good practice to check _____ crown after the desired mat is obtained.

A vibrating screed strikes off, compacts, and irons out the hot mix. The screed plate of the paver is commonly 10 feet long. There is a moldboard on the front of the screed that gives a rolling action to the mix to help prevent segregation



3-18 All

3-19 hinge

3-20 crown

3-21 trailing

The frequency of vibration on the screeds can be varied. It is not a good idea to operate the screed at its maximum speed as this tends to decompact or “fluff” the mat.

Commonly, a pre-strike off unit is used to pre-compact the mix ahead of the screed. The pre-strike off is attached directly to the screed and vibrates with it. The pre-strike off is normally set 1/8 inch above the screed bottom. If a thin mat is required it can be lowered. For a mat thicker than 2 inches, it is raised.

CIRCLE TRUE OR FALSE

3-36 Up / down

3-37 Open textured

3-31. True False The screed itself strikes off, irons out, and compacts the hot mix.

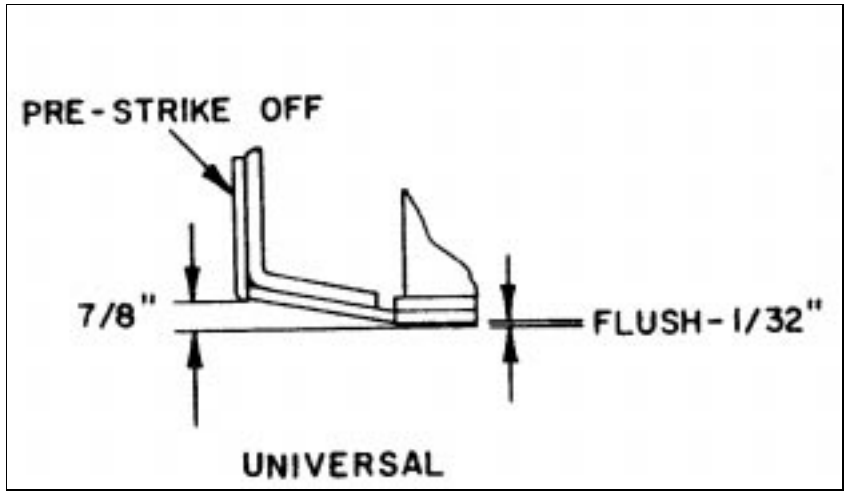
3-32. True False On the screed, the intensity of the vibrations can be adjusted.

3-33. True False There is a moldboard attached to the screed.

3-34. True False Commonly, a screed uses a pre-strike off device.

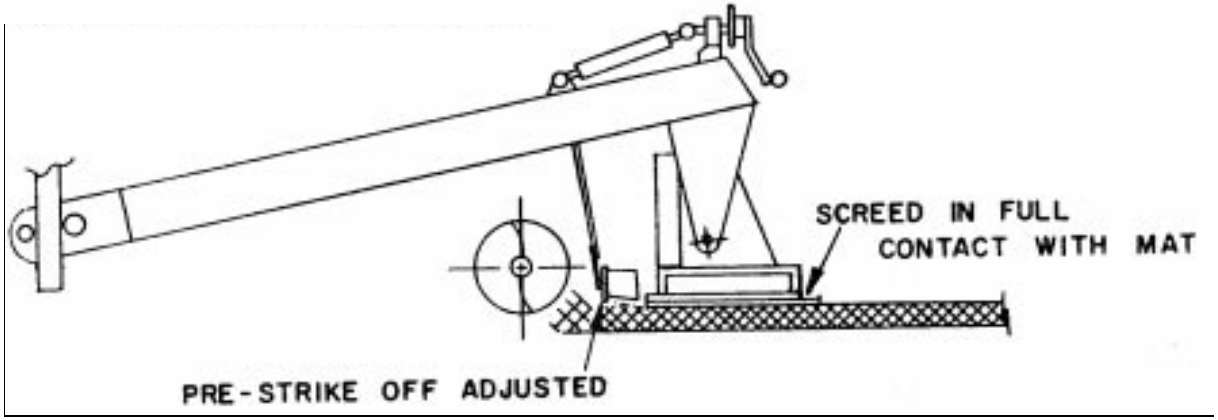
3-35. True False Operating the screed at it’s maximum vibration, compacts themat.

The strike off should be adjusted so that the distance from the leading edge of the strike off to the bottom of the screed is 7/8 inch. The trailing edge of the strike off should be flush with the bottom of the screed or less than 1/32 inch below.



The pre-strike off unit can be moved up and down by means of slotted holes. When it is necessary to lay mats less than 3 inches thick, the pre-strike off is lowered.

When the strike off / pre-strike off is properly adjusted, the entire screed should be in contact with the mat.



3-26 sides

3-27 center

3-28 quarter turn

3-29 10-20

3-30 road

Should the screed ride on its nose, lowering the pre-strike off can help. Lowering the pre-strike off is also helpful if the screed tends to rise after picking up a load of mix. However, if the strike-off or pre-strike off is adjusted too low, an open textured mat will result. Since this is not desirable, careful attention must be paid to the position of the strike-off assembly.

FILL IN THE BLANKS:

3-36. The strike off and pre-strike off units can be moved _____.

3-37. If the strike-off or pre-strike off is adjusted too low, an _____ _____ mat will result.

Several factors must be considered in determining the correct paving speed for any job:

3-45 forward speed, angle of attack, head of material

The most important element in setting paving speed is adjusting the speed of the paver to hauling capacity. Maintaining paving as a continuous operation is the key to a successful asphalt job. There should be one truck waiting to unload as soon as a paver is empty, so that the screed will not cool off between truckloads. Should the screed become too cool, it may cause the mat to tear. The mix should never be allowed to cool excessively. A too cool mix will result in a rough surface and low density.

3-46 mat thickness controls (screws)

3-47 Angle of attack

Changes in paving speed should be avoided. Applying and releasing the brakes on the paver causes changes in mat texture and thickness, and ripples in the surface.

Excessive speed usually results in a start and stop operation, causing tearing the full width of the mat, open texture, thin or fluctuating thickness, and ripples. A mat looks best when laid at very low speed, 12-20 feet per minute, but, to produce a uniform mat, the most important element is constant speed.

If paving speed is altered, the tilt of the screed must also be adjusted to assure the same mat thickness. Also, all factors controlling the head of material must be readjusted, so that the amount of mix passing under the screed will remain constant.

CIRCLE TRUE OR FALSE

3-38. True False Hauling capacity is a factor in regulating speed of paving.

3-39. True False The paver should be allowed to cool off between load.

3-40. True False The mix should be allowed to cool slightly before being placed on the roadway.

3-41. True False Changes in paving speed can cause ripples.

3-42. True False Excessive speed resulting in a start and stop operation can cause the mat to tear all the way across.

3-43. True False Constant speed is very important.

3-44. True False Whenever paving speed is changed, other adjustments must also be made to the paver.

3-59 road

3-60 center

3-61 10, 20

3-62 tail crown

3-63 hot mix

3-64 10

3-65 moldboard

3-66 A, B, C

3-67 B

3-68 D

The normal operating position of the screed is in the center. However, when laying sand mixes with mineral filler and a high percentage of asphalt, the screed should be in the forward position. This position is also used whenever difficulty is experienced in obtaining good mat texture.

When applying base material, or any mix with large aggregate, the screed should be moved back from the augers. This position allows more material to be carried ahead of the screed. Moving the screed back also creates a cushion between the augers and the tamper shields, which may eliminate ripples and auger shadows.

In order to produce a uniformly smooth mat that meets specifications, the six major areas of paver adjustment must be set so that each part operates in balance with the other five. The mat is the object of the paving operation; hence, if any flaws appear in it, which are attributable to incorrect paver settings, readjustment must be made immediately.

REVIEW QUESTIONS: PAVER ADJUSTMENTS

FILL IN THE BLANKS

3-45. List the three forces that effect mat thickness and surface quality.

_____

_____

_____

3-46. The thickness of the mat is adjusted by the _____.

3-47. The angle the tilted screed makes with the surface being paved is called the _____.

3-48. This angle primarily affects the _____ of the mat.

3-49. List the six-(6) major areas of adjustments for asphalt pavers.

_____ _____

_____ _____

_____ _____

3-50. _____ is the method of initial compaction.

3-51. Augers and conveyors should run ____-_____% of the time.

3-52. The flow control gates must be adjusted in balance with the _____.

3-53. List two (2) problems caused by opening flow control gates too far.

_____

_____

3-54. Besides the flow control gates, auger feed is regulated by the _____.

3-55. Overfeeding the augers leads to imperfections in the mat, such as _____ and _____.

3-56. The adjustment that regulates the angle of the screed plates is called the _____.

3-57. This adjustment is located in the _____of the screed platform.

3-58. Positive crown means the lead crown is _____ than the trailing crown.

3-38 True

3-39 False

3-40 False

3-41 True

3-42 True

3-43 True

3-44 True

3-71 False

3-72 True

3-73 False

3-74 True

3-75 False

3-76 grade

3-77 averaged

3-59. The rear crown is also called the _____ crown.

3-60. A negative lead crown can cause the mat to tear at the _____.

3-61. When the crown is readjusted during paving, the adjustment should be done gradually and the mat observed as the paver moves forward _____to _____ feet.

3-62. Ifan extreme adjustment on the lead crown is made, the _____ _____ should be double-decked.

3-63. A vibrating screed strikes off, compacts, and irons out the _____ _____ .

3-64. A screed plate is normally _____ feet long.

3-65. A _____ is on the front of the screed to help prevent segregation.

CHECK THE CORRECT ANSWER(S):

3-66. The vibratory screed
a. irons the surface
b. compacts
c. strikes off
d. measures the material

3-67. On the paver, the intensity of vibrations
a. is fixed
b. can be varied
c. is free
d. is on the roller

3-68. The moldboard on the paver
a. strikes off material
b. compacts
c. pre-irons
d. mixes

ELECTRONIC SCREED CONTROL

Before the development of the automatic or electronic screed, operators had to constantly adjust the grade and slope controls by hand during paving. The electronic system now continually readjusts the screed to lay a smooth mat, true to both grade and crown with a minimum of operator manipulation. There are several automatic systems presently in use. Although the control mechanisms may vary in looks and placement on the paver, all systems are essentially alike.

The automatic grade and slope control eliminates all irregularities and produces a mat to correct grade and slope. This is accomplished by controlling the elevation of the screed tow points with respect to a reference surface, such as a stringline. Grade and slope are thus correct, even though the tractor is traveling over an irregular base.

There is a sensor connected to one of the tow arms. The sensor travels along some type of grade reference. The grade reference may be an erected stringline, a traveling stringline, a gutter, a curb, or another lane. The sensor "feels" the grade reference, and whenever a change is felt, electrical impulses are sent to a control box. The control box "reads" these impulses and activates motors to make the indicated change in elevation.

The grade sensor may be used by itself or in conjunction with a slope control device. When the slope control device is tied into the grade control device any change in grade will activate motors to change the elevation of the screed, thus maintaining a constant cross slope.

The technical details of the operation of automatic screed control can be found in the operators' manuals issued by the makers. These manuals should be kept on the job at all times.

CIRCLE TRUE OR FALSE

3-69. True False Automatic grade and slope control produces a mat to correct grade and slope.

3-70. True False A reference surface must be used even with automatic screeds.

3-71. True False The sensor for the automatic devices is connected to the trailing edge of the screed.

3-48 depth

3-49 flow control gates, augers & flight chains, lead crown, tampers or vibrators, speed of paver, screed position

3-50 vibratory screed

3-51 85, 90

3-52 feeder controls

3-53 poor quality mat or loss of production or excessive wear on augers

3-54 automatic shut-off asse mbly

3-55 rippled, precompacted areas

3-56 crown adjustment

3-57 center

3-58 higher

3-72. True False Electrical impulses are involved in activating corrections in slope and grade.

3-73. True False It is not possible to separate the grade control device from the one for slope control.

3-74. True False Manufacturers manuals contain detailed information about their particular make of electronic screed control.

3-75. True False These manuals should be kept in a central office for reference and to prevent their being lost on a job.

It is very important to remember that electronic controls lay a mat to desired grade. They do not regulate mat thickness. The screed control shifts mix automatically from high places in the starting surface to low places. With automatic screed controls, the mat will not be the same thickness in all places. Thickness must be averaged — not absolute.

CIRCLE THE CORRECT ANSWER(S):

3-76. Electronic controls lay a mat to desired (grade / thickness).

3-77. With automatic screed control, mat thickness is (absolute / averaged).

These are the definitions of some terms which will be helpful in the material to follow.

Null or Null Point:	When referring to electronic controls, such as sensors, null point means that the adjustment is correct and there is no flow of electrical current to cause change in adjustment.
Sensor:	An elevation sensing device for use with asphalt pavers. It mechanically senses a predetermined grade or grade reference and maintains the controlled equipment at the desired elevation.
Cross Slope Control:	Control that simply maintains a uniform crown by a pendulum or similar sensor referenced from one side.
Grade Control	Control that regulates the longitudinal grade.
Grade Reference Follower	An attachment to the sensor which rides on the reference surface.
Traveling Stringline	An attachment to the paver, which rides on the starting surface and provides a grade reference for the follower.
Erected Stringline	A wire attached to stakes set at specified intervals along the side of the roadway being paved. The sensor travels along this wire.
Tow Arms	Side arms which attach the screed unit to the tractor unit of the paver.
Tow Point	Point at which arm is connected to the paver.

FILL IN THE BLANKS:

3-69 T

3-70 T

3-78. The point at which the arm is connected to the paver is called the _____.

3-79. A wire attached to stakes along the side of the roadway and used to control grade is called an _____ stringline.

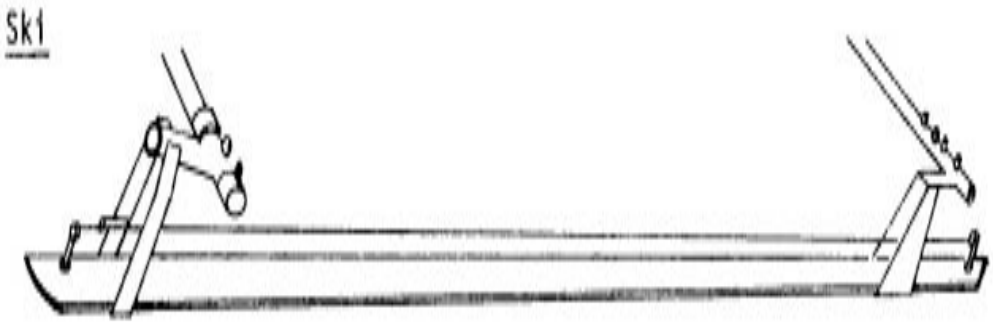
3-80. The device, attached to the sensor, which rides on the reference surface is the _____.

3-81. When sensor adjustment is correct and there is no flow of electrical current to cause change in adjustment, the sensor is at _____.

3-82. The device that maintains a uniform crown is the _____.

TRAVELING SKIS

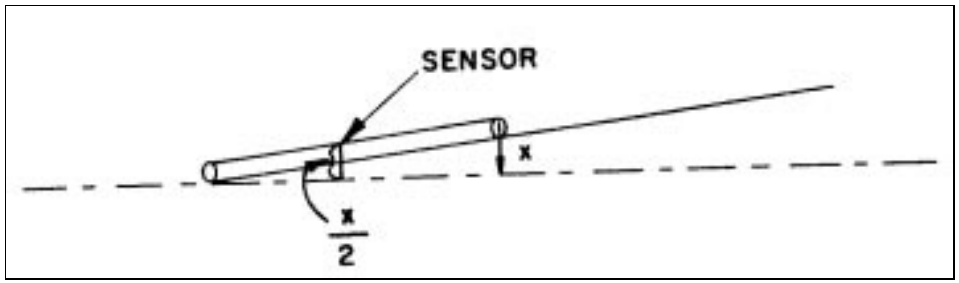
Ski



This type straightens out depressions better than a wheeled ski. The ski requires more mix to straighten out a depression, but leaves a more level surface.

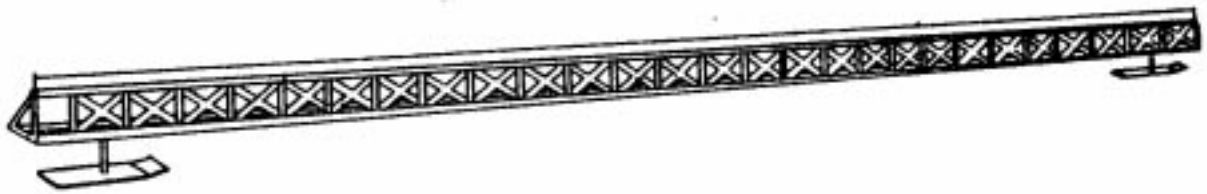
Wheeled Ski

This type is best for rises.
The sensor rides at midpoint of the ski thereby sensing the <u>average</u> elevation of the front and rear wheels.



This allows for a rise to be straightened out and results in a more level surface.

<u>Short Ski</u>



3-78 two point

3-79 erected

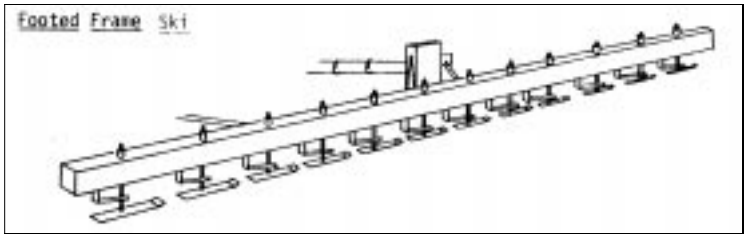
3-80 grade reference follower

3-81 null point

3-82 cross slope control

This type works on the same principle as the wheeled ski. (It is preferable to a wheeled ski as short skis do not pick up tack, small rocks, etc.)

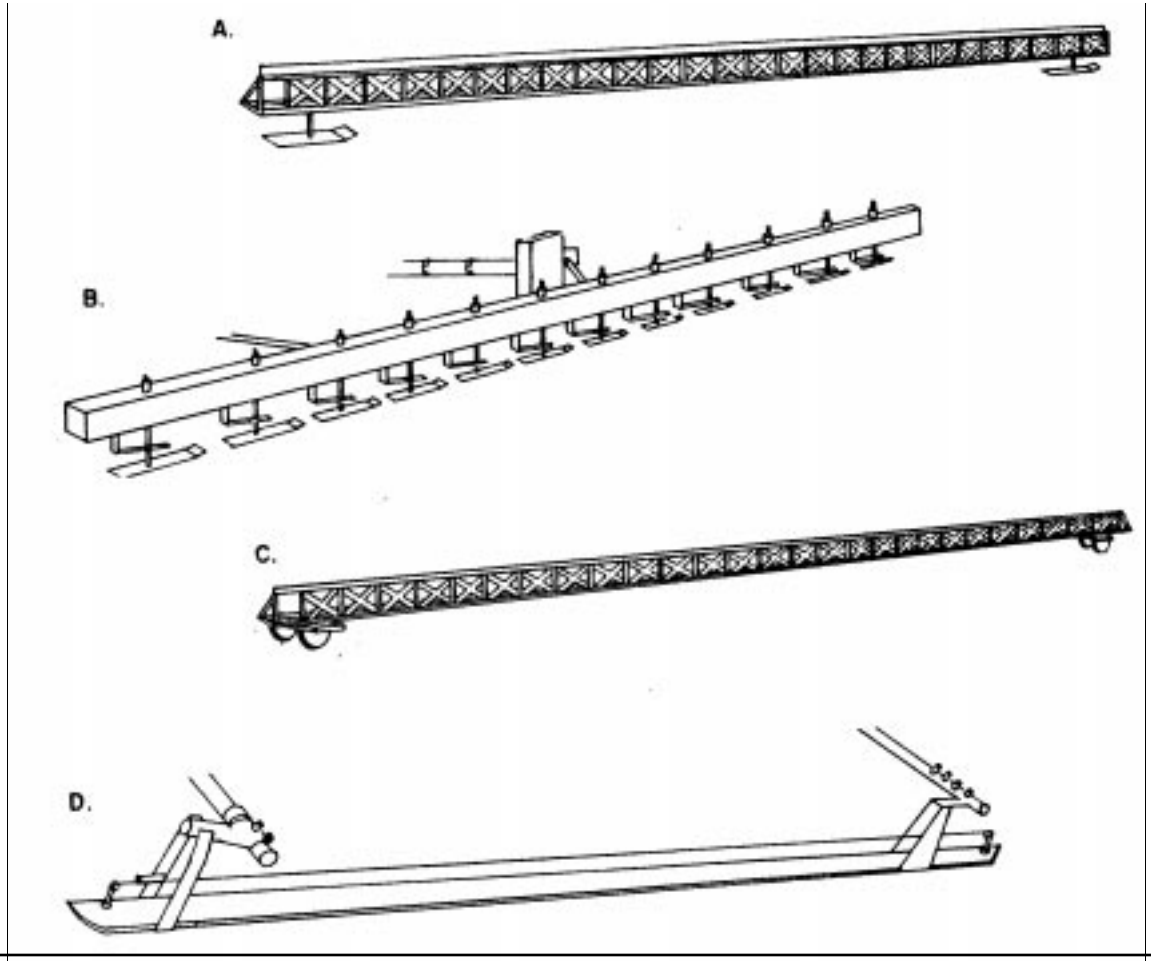
Footed Frame Ski



This type of ski is suitable for both rises and depressions. Each foot moves separately. the elevation of the grade reference is changed to follow the average reading from all the feet. Therefore, one of the feet could fall into a depression while at the same time another could be riding a rise. The average of these high/lows would reflect itself in the grade reference and the mat would be laid accordingly.

When the sensor is used to sense from a ski, the ski is usually used as close to the paver as possible. This position is necessary, because the center of the roadway normally is desirable for grade sensing. Also, because the ski is located on the traffic side of the paver, as much room as possible should be allowed for traffic.

Identify the type of skis represented by the following sketches.

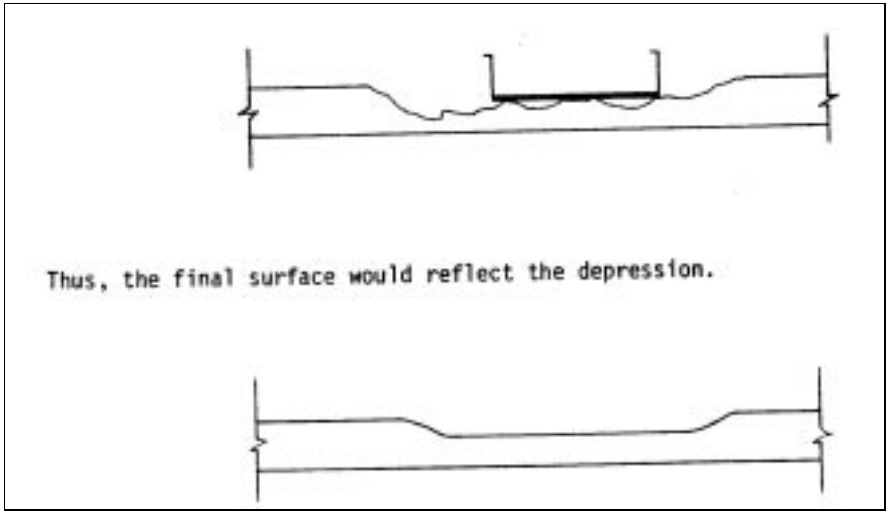


ERECTED STRINGLINES

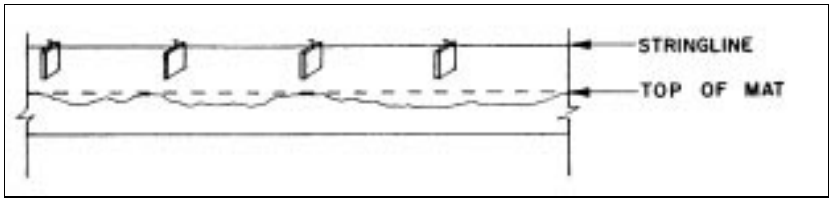
When a pavement being overlaid is in extremely poor condition, an erected stringline can be an effective device. “Extremely poor condition” means long areas of depressions or rises, or a pavement so broken up that constant adjustments would be needed if a traveling stringline were used.

3-88 True

For example, if a ski was used over a long depression, the entire device could fall into the depression.



However, with an erected stringline, this problem would not arise. The sensor would ride the stringline and not be affected by the depression.



3-89 string

3-90 tack

FILL IN THE BLANKS:

3-83. If a roadway surface is in extremely poor condition, an _____ _____ can be an effective device for setting grade.

3-84. If a _____ were used over a long depression the entire device could fall into the depression.

In setting an erected stringline the following criteria should be adhered to.

1. It is desirable to have the stakes far enough away from the mat edge to provide working space along the side of the paver and mat edge.
2. Stakes should be set approximately 25 feet apart on a straightway.
3. Stakes can be set 25 feet apart on slight bends or curves. The shorter the radius of a curve, the shorter the spacing between the stakes. A stringline cannot be stretched around a curve. It must be stretched in chords between stakes.
4. The inspector should sight down the line to double check placement of stakes and correct them, if necessary. before paving begins.

CIRCLE TRUE OR FALSE

3-85. True False It is desirable to have stakes far enough away from the mat edge to provide working space along the side of the paver and mat edge.

3-86. True False Stakes should be set no more than ten (10) feet apart.

3-87. True False The shorter the radius of the curve, the greater the spacing should be between the stakes.

A- short ski

B- Fooled Frame Ski

C- Wheeled Ski

D- Ski

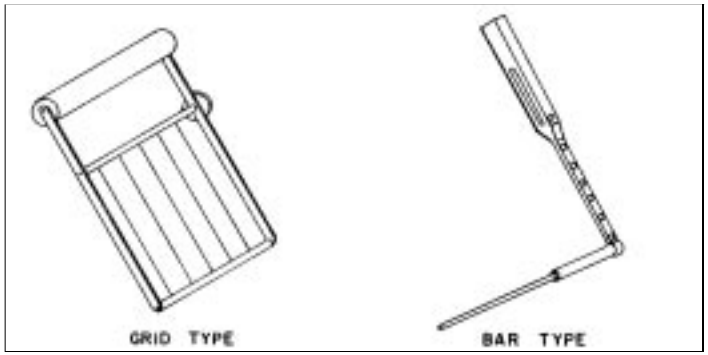
3-91 False

3-92 True

3-93 True

3-88. True False Stake placement should be double checked before paving begins.

The grade reference follower on the erected stringline will be either the grid type or the the bar type.



It is very important that the grade reference follower slide freely on the string. Tack coat on the feeder bar or string may cause erratic sensing and operation. The additional weight deposited by such coatings can unbalance the reference follower and over deflect the stringline.

3-94 opposite

3-95 does

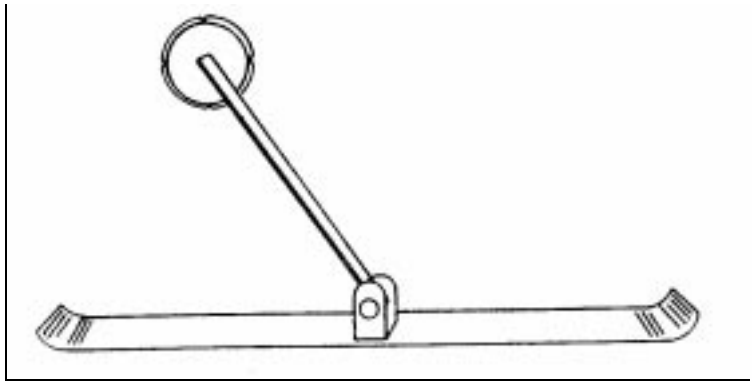
CIRCLE THE CORRECT ANSWER(S):

3-89. The grade reference follower must slide freely on the (string / ski device).

3-90. A coating of (tack / silicone) can cause the reference to become unbalanced.

SHOE (JOINT MATCHER)

A shoe is a short grade reference follower that may be used alone or in conjunction with a ski when paving in tandem.



AUTOMATIC SCREED CONTROL

The automatic system can be set up to work in several ways. The usual method is with one grade sensor and the slope control device. The automatic system can also be set for automatic control using two (2) grade sensors. A combination of automatic and manual controls is also possible.

3-83 erected stringline

3-84 ski

3-85 True

3-86 False

3-87 False

3-96 A

3-97 B

CIRCLE TRUE OR FALSE

3-91. True False There is only one (1) way to set an automatic screed control system.

3-92. True False It is possible to use two (2) grade sensors at the same time.

3-93. True False Automatic and manual controls can be used at the same time.

Grade is sensed from one side of the paver using the chosen method of grade reference (i.e. erected stringline, ski). The other side of the screed is controlled by the slope control device. If the grade on the sensor side changes, the slope control device raises or lowers the opposite side by the same amount in order to maintain a constant cross slope.

CIRCLE THE CORRECT ANSWER(S):

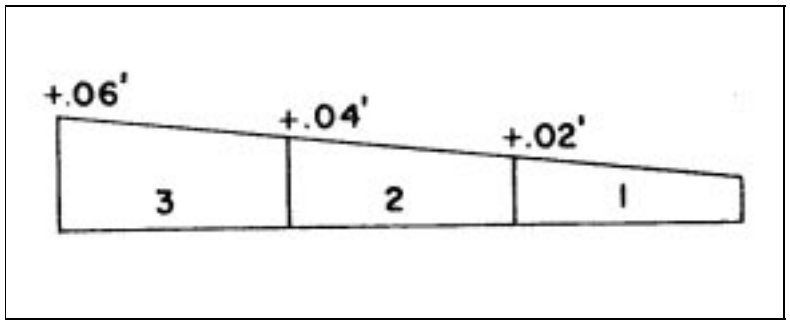
3-94. Grade and slope are sensed from (the same / opposite) side(s) of the paver.

3-95. The grade sensor (does / does not) affect the slope control device.

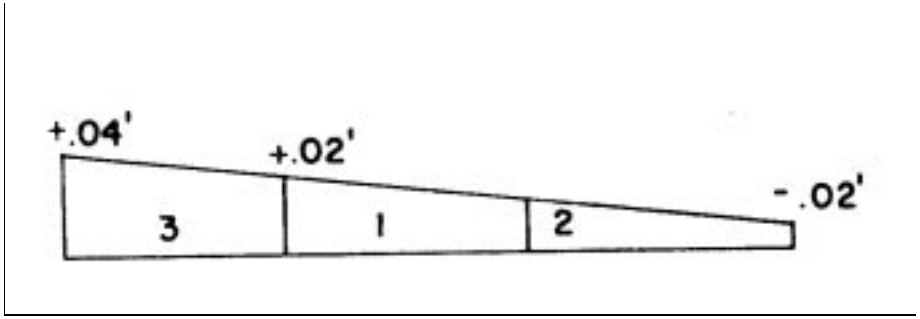
The use of two (2) grade sensors to automatically control both screed ends is often a desirable method of laying a mat. In this case, grade sensors control both sides of the screed. When two grade sensors are used, the slope device is not operated. The cross slope will, therefore, remain constant or vary depending on the relative positions of the two grade references.

When a paving job is wide enough to require laying the mat in three (3) strips, laying the center strip first offers certain advantages. When the center strip is laid first, the total of any percent of error will be reduced over the three strips. If the strips are laid in straight sequence across the road, the total error would be increased.

However, laying the center first reduces error is shown by the diagram below. If the mat is placed in 1,2,3 sequences and the slope is “off” enough to cause a .02 foot (error, the first strip will be .02 foot off; the second .04 foot off; and the third .06 foot off .



However, if the center mat was laid first, the maximum error would be .04 foot.



3-99 Screed depth or mat thickness

3-100 joint

3-101 Curb gutter

3-102 True

CHECK THE CORRECT ANSWER(S):

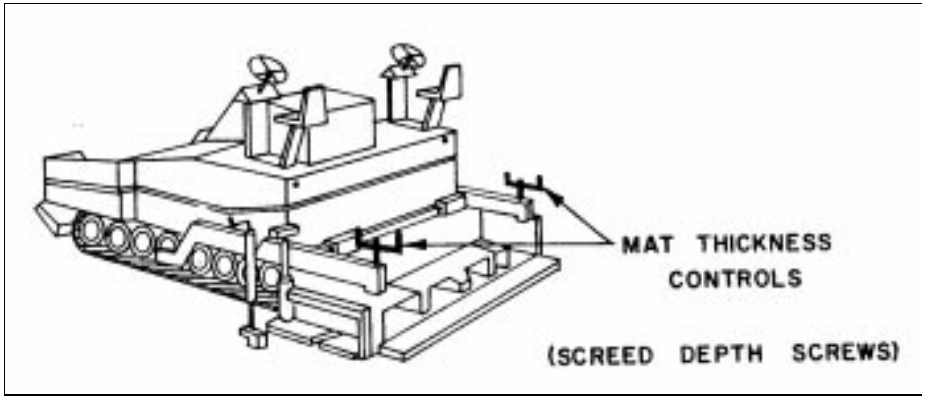
3-96. When two (2) grade sensors are used, the slope device
a. is not used
b. is constantly adjusted for both sides
c. is tied-on to the right-side sensor
d. is tied-on the left-side sensor

3-97. When laying a mat in three strips, if possible, the center strip should be laid _____ .
a. last
b. first
c. second
d. after the strip on its right

3-98. How will laying the center strip of a three strip mat surface affect total maximum error?
a. prevent any error
b. maximize
c. have no effect
d. minimize

MANUAL AND AUTOMATIC SCREED CONTROL

It may be desirable to control one side of the screed automatically with the grade sensor and manually control the opposite side. When this combination is employed, grade control is sensed by one of the usual methods and the screed depth screw (mat thickness control) controls the other by hand.



The manually controlled side may be used for joint matching and when laying a mat adjacent to a curb or gutter. This dual method of control is also good when slope is unknown and the objective is uniform mat depth across the width of the screed.

FILL IN THE BLANKS:

3-99. When both automatic and manual screed controls are used, the manually adjusted side is manipulated by the _____ screw.

3-100. The manually controlled side may be used for _____ matching.

3-101. It is also useful when laying a mat adjacent to a _____ or _____.

GRADE AND SLOPE CONTROL

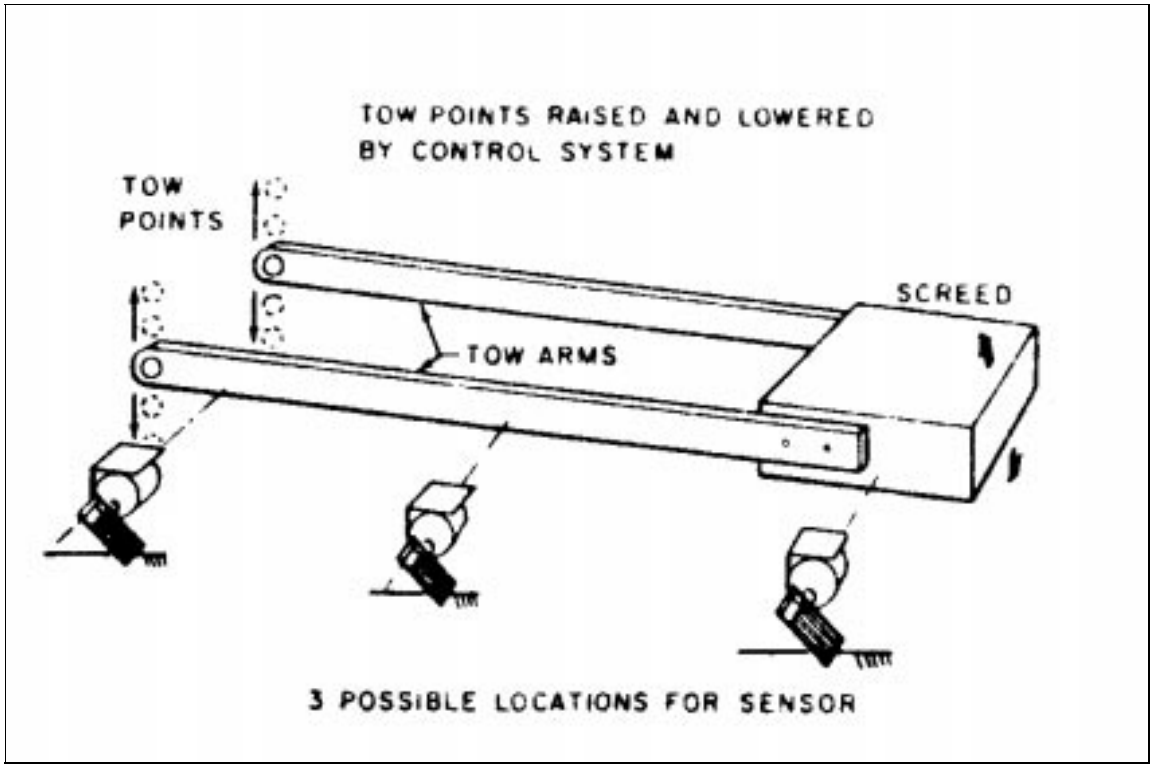
There are controls which allow you to set the sensitivity of grade and slope controls. The highest system accuracy is achieved when the sensitivity controls are set as high as possible without affecting the stability of the system. If sensitivity is set too high, the whole system will become unstable. The screed will move up and down too much. It is, therefore, necessary to maintain a balance between accuracy and stability.

CIRCLE TRUE OR FALSE

3-102. True False It is possible for the automatic grade and slope controls to be set too sensitive.

Position of Sensor

3-98 D



There is some disagreement between the automatic control manufacturers as to the best location for sensors. The above diagram shows common sensor location. If there is ever any doubt as to the placement of the sensor, it is recommended that the operator's manual for the make of controls being used be consulted.

3-115 True

3-116 thinner or rougher

3-117 Paver operator

3-118 Poor quality

3-119 Automatic paddles

3-120 In the center of the screed platform

3-121 trailing

3-122 Positive lead crown

3-123 tampers

3-124 vibratory

3-125 A

SLOPE CONTROL

The Dial Device

The slope dial is used to automatically control and gradually change slope. The face of the dial is divided into increments. The increments indicate percent of slope. The numerals run to the right and to the left of zero. Zero represents level and the numbers represent percent of slope to the right or to the left. (For example, to change the slope of a level screed 1% to the left, the dial change knob would be turned to the left until the indicator rested on the increment on the left side of zero representing 1.)

When using a dial device with either a ski or erected stringline, station stakes must be set along the edge of the curve. The desired percent of slope should be marked on each of the stakes. These markings should also indicate whether the percent of slope for that station is to the right or left on the slope dial indicator. This percent of slope should be marked near the top of the stake and each stake positioned so that the paver operator can easily read the markings, so that he can change the position of the dial as indicated.

These changes in slope are done in gradual increments while the paver is in motion, so that a smooth transition in grade is obtained. The change in cross slope must be made within the transition distance specified. Even when using an electronic screed, the top layer should be placed at a uniform thickness in order to insure a good riding surface. It is the contractor's responsibility to adjust his machinery properly. It is his responsibility to meet all specifications.

REVIEW QUESTIONS: FOR CHAPTER III

CIRCLE TRUE OR FALSE:

3-103. True False There are four (4) major areas of adjustment for asphalt paving machines.

3-104. True False Ripples in the surface of the mat may indicate that the augers are being overfed.

3-105. True False Augers should run only about 50% of the time.

3-106. True False The leading edge of the screed and the trailing edge can be crowned independently.

3-107. True False If an extreme adjustment on the lead crown is made, no other checking is needed.

3-108. True False Most screeds vibrate.

3-109. True False The most important element in adjusting paver speed is to move in accordance with hauling capacity.

3-110. True False The greater the angle of attach, the thicker the mat will be.

3-111. True False The mat thickness controls raise and lower the screed.

3-112. True False If the paver engine is not operating properly, the mat surface can be affected

3-113. True False A mat looks best when laid at a very low speed.

3-114. True False Excessive lead crown will cause the mat to tear at the sides.

3-131 B

3-132 B

3-133 B, C

3-134 A

3-135 A

3-115. True False It is a good idea for an inspector to have a copy of the operator's manual for the machine in use on the job.

FILL IN THE BLANKS:

3-116. The faster the paver moves forward, the _____the mat will be.

3-117. It is the responsibility of the _____ to make adjustments to the asphalt paver.

3-118. Flow gates open all the way will cause a _____ mat.

3-119. When the level of hot mix gets too high on the augers, the _____activate switches to stop the flight chains.

3-120. The crown adjustment is located _____.

3-121. The crown required by specifications is set by the _____ edge of the screed.

3-122. A _____ has the forward edge of the screed crowned higher than the trailing edge.

3-123. A loose, wavy mat may indicate that the _____ are out of time.

3-124. Pavers have a _____ screed.

CHECK THE CORRECT ANSWER (S):

3-125. Automatic screed controls produce a mat of correct
a. grade
b. slope
c. thickness
d. texture

3-126. Electronic controls regulate the elevation of the
a. pivot points
b. tow points
c. head of material
d. augers

3-127. The _____ travels along a grade reference
a. stringline
b. screed
c. tow arm
d. sensor

3-128. The technical details of automatic screed control can be found in
a. Asphalt Institute Manuals
b. Manufacturer's Handbooks
c. Publications of Department of Transportation
d. Office of Highways Bulletins

3-129. An attachment for the paver, which rides on the starting surface and provides a grade reference for the follower is
a. null point
b. sensor
c. grade reference follower
d. ski

3-130. If a ski were used on a surface with long depressions, it could easily
a. fall into the depression, causing a dip in the finished surface
b. take care of the depression, leaving a perfect mat
c. become stuck and break the screed
d. cause the augers to churn out too much material

3-103 True

3-104 False

3-105 False

3-106 True

3-107 False

3-108 True

3-109 True

3-110 True

3-111 True

3-112 True

3-113 True

3-114 True

4-1 Carefully examined

3-131. On a straight section, the stakes of an erected stringline should be set

a. 10 feet apart

b. 25 feet apart

c. 5 feet apart

d. 50 feet apart

3-132. On a curve, the stakes of an erected stringline should be

a. the same as on a straight section

b. closer together than on a straight section

c. further apart than on a straight section

d. 25 feet apart.

3-133. The two-(2) types of grade reference follower that can be used on an erected stringline are

a. shoe

b. bar type

c. grid type

d. short ski

3-134. A shoe can be used

a. to match joints when paving in tandem

b. to follow an erected stringline

c. in conjunction with traveling stringline

d. over a rocky base

3-135. When two (2) grade sensors are used, the slope control device

a. is not used

b. is used with one sensor

c. is doubled

d. is more accurate

3-136. In laying a three (3) strip mat, which strip should be put down first

a. center
b. right side
c. left side
d. does not matter

3-137. The automatic screed control system is too sensitive; therefore,

a. the screed will break
b. the mat will be perfect
c. there will be too much up and down movement in the screed
d. the augers will not operate properly

3-138. The (slope dial / traveling stringline) is used to automatically control and gradually change slope.

3-139. Each increment on the dial equals (.01 foot / percent of slope).

3-140. (One / Zero) represents level.

3-141. The desired (mat thickness / percent of slope) should be marked clearly on station stakes.

3-142. Changes in slope are dialed with the paver (in motion / stopped).

This is the end of Chapter III. If you missed any questions, review the appropriate material: if not, go to the next Chapter.

3-126 B

3-127 D

3-128 B

3-129 D

3-130 A

4-9 Temporary, open

4-10 Each day's

4-11 Permanent striping

CHAPTER IV - PREPARATION FOR PAVING

BASE INSPECTION

Before an asphalt-paving job begins, the inspector should examine the surface that is to be covered. Flaws in the base will show up in the surface of the newly laid asphalt. Therefore, the surface to be covered must be smoothed and prepared for paving.

There are two (2) general types of surfaces on which hot mix is used. One is an existing pavement that needs to be resurfaced. The other is a newly constructed base course that needs a surface course.

FILL IN THE BLANK:

4-1. Before new asphalt is laid, the surface to be covered must be _____.

SIGNS AND BARRICADES

Before any construction can begin, all signs, barricades or other necessary traffic control devices must be in place and approved. It is the contractor's responsibility to provide and erect all signs and other traffic control devices. The project manager will inspect and approve the signing for the project before construction begins. Construction of all signs and barricades must conform to the details and specifications shown on the plans and to the Manual on Uniform Traffic Control Devices. Placement of signs for each particular job will also be found in the plans.

The proper signs, barricades and other devices for traffic control must remain in place until the contract for a particular project has been completed and final acceptance has been made. On asphalt paving jobs, temporary striping must be in place before temporary signs are removed.

It is extremely important for the roadway inspector to check the signs for the project every day. If any signs are missing, damaged, not properly installed, or do not meet specifications in any way, the project manager should see that the contractor makes necessary corrections. Proper establishment and maintenance of warning signs and traffic control devices throughout the life of a project is essential for the protection of both the traveling public and the workers on the roadway.

The contractor's Worksite Traffic Control Supervisor (WTCS) shall be available on a 24-hour basis to maintain traffic control devices. The WTCS shall respond effectively to an emergency situation in forty-five (45) minutes with the necessary personnel, materials, and equipment.

During actual paving operations, the asphalt project must have moveable signs that are moved along the roadway as paving progresses.

ANSWER THE QUESTIONS:

4-2. When must all signs and barricades be in place for an asphaltic concrete paving operation ?

4-3. Who must approve all signs for a construction project ?

4-4. Where is the proper placement of signs for a particular project specified?

4-5. When can signs be removed from an asphalt paving project area ?

4-6. How often must the roadway inspector examine the signs on a project?

4-7. If any signs are not properly installed, are damaged, or missing, what should the inspector do ?

4-8. Why are signs important in a construction area?

3-136 A

3-137 C

3-138 slope dial

3-139 percent of slope

3-140 zero

3-141 percent of slope

3-142 in motion

4-16 increase

Besides regular warning signs and traffic control features, an asphalt paving job will require temporary centerline and/or lane line markings. These markings must be placed on each lift of asphaltic concrete surfacing over which traffic is to be allowed They must be in place on all lanes open to traffic at the end of each day's operation.

FILL IN THE BLANKS:

4-9. _____centerline and/or lane line markings must be placed on each lift of asphaltic concrete that is _____.

4-10. These markings must be in place at the end of _____ operations.

4-11. These temporary signs can be removed after _____ _____ is in place.

EMULSION, PRIME, AND TACK

A coating is applied to the surface to be paved before paving operations begins. This coating protects the surface of the base and/or bonds the base materials to the surface course. There are three (3) substances that may be used for this coating. They are emulsion, prime, and tack.

Emulsion is a mixture of asphalt and water, such as CRS-2 and SS1H. Prime is a mixture of asphalt and a medium curing petroleum distillate, such as kerosene. Asphalt's that are mixed with petroleum distillates are also referred to as cutback asphalts. Some cutback asphalts currently in use as prime are MC 30 and MC 70. (MC = medium cure) Tack may be either AC 10-20 or 30. (AC =accelerated cure)

Emulsion and prime must be allowed to cure. Curing means that the solvent (water or petroleum distillate) evaporates and only the asphalt is left. The terms medium curing and rapid curing refer to the amount of time required for the mixture to cure. Rapid curing cutback asphalt is explosive because of the solvents used in it. Proper care should always be exercised when heating it for application

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CIRCLE THE CORRECT ANSWER(S):

4-12. A coating is applied to the base (before / after) the paving operation begins.

4-13. (Emulsion / Diesel) may be used for this protective coating.

4-14. (Emulsion / Prime) is a cutback asphalt.

Tack is used when an old surface is being overlaid or if the base course is also asphaltic concrete.

On a road being newly constructed, prime is used, if the depth of asphaltic concrete is less than 5 inches. If considerable time has elapsed since the base course was laid, it may be necessary to apply a new coating before the surface course is put down. The project engineer will determine if such repair is needed.

FILL IN THE BLANK:

4-15. The _____determines if the base needs to be recoated before the surface course is added.

If traffic has been allowed over the base course since the prime was applied, it may have been stripped off. Areas that have been stripped (bare spots) will be lighter than those areas still protected by the prime. Such spots will require a reapplication of prime.

4-2 prior

4-3 project engineer

4-4 plans

4-5 after final acceptance

4-6 Each day

4-7 notify the project engineer

4-8 To protect the public and the workers

4-17 True

4-18 False

4-19 True

PATCHING

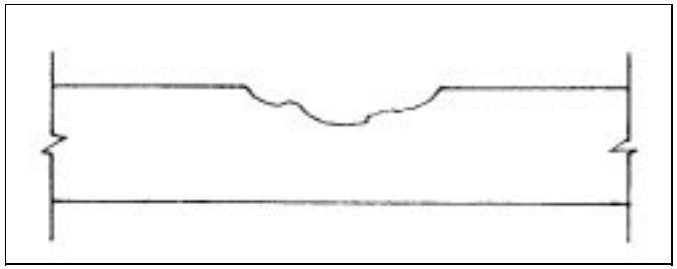
There may also be a pothole in the base course. These must be filled and reprimed before the asphalt concrete course is applied. It is the contractor's responsibility to maintain the base course in shape for paving. If the base course appears to be in very poor condition, it should be called to the attention of the contractor so repairs can be made.

CIRCLE THE CORRECT ANSWER:

4-16. Traffic's passing over the base course tends to (increase / decrease) repairs needed before the asphalt concrete course is laid.

The base course inspection in preparation for asphalt paving may reveal the need to patch the existing surface. Patching is necessary to fill potholes, ruts, or badly cracked areas.

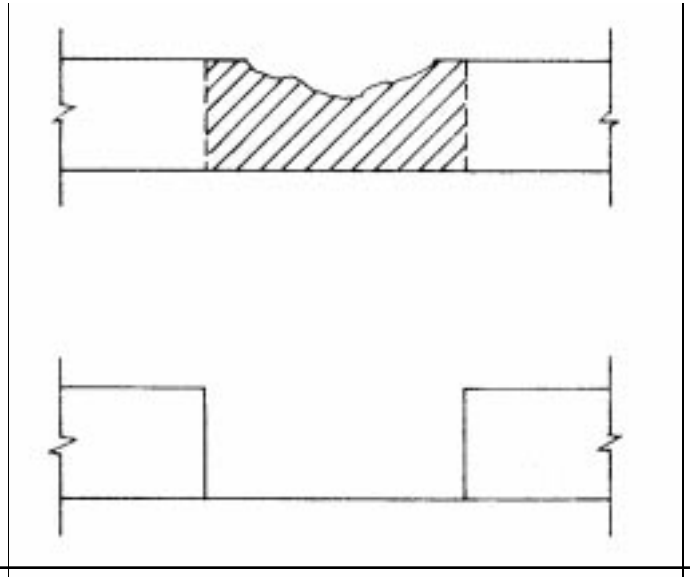
A cross section of the surface might look like this,



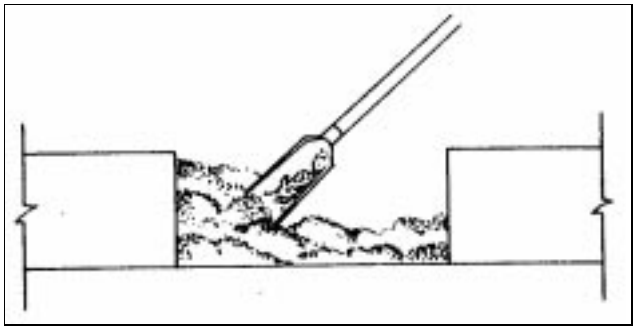
4-20 False

4-21 True

To patch such a place, it is necessary to cut back well beyond the broken area to the full depth of the course, in order to remove all the loose material.



This area must be thoroughly cleaned, then filled in.



4-12 before

4-13 emulsion

4-14 prime

4-15 project engineer

The type of material to be used for patching will be shown in Section 400.05.C-4A of the Standard Specifications. These procedures for patching will be the same for pre-existing asphaltic concrete and portland cement concrete pavements.

CIRCLE TRUE OR FALSE

4-17. True False The type of material to be used for patching is shown in the Standard Specifications.

4-18. True False Before patching, the pothole is brushed free of small stones and dust, but there is no need to cut out any extra area.

4-19. True False The Specifications determine what type of material is used for patching.

4-23 motor grader, paver

4-24 400

4-25 one (1)

If a pre-existing hot mix overlay is to be overlaid again, attention must be paid to areas where the hot mix may have deteriorated, especially near joints and cracks. Deteriorated hot mix must be removed before a new surface course is applied. The old asphaltic concrete should be cut out to the depth of the overlay and cleaned of all loose material, then filled with fresh hot mix.

Such preparatory work is usually covered in the Special Provisions and a separate pay item is provided. If this is not the case, and such work seems necessary, the project engineer should be consulted.

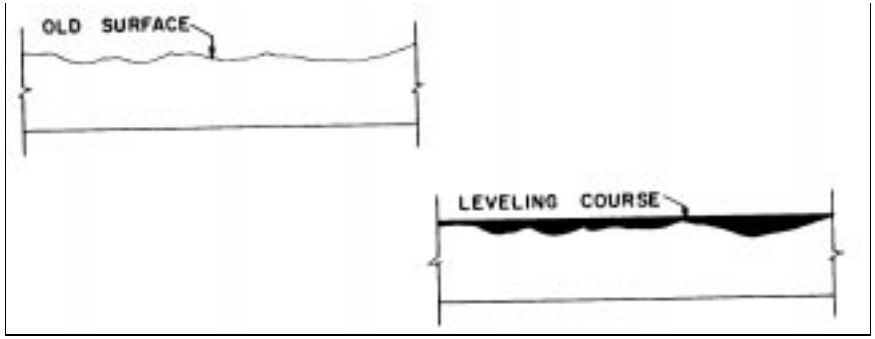
CIRCLE TRUE OR FALSE

4-20. True False Previous asphalt overlays require only a good sweeping to be ready for a new surface.

4-21. True False Extra work in preparation for paving is usually listed in the Special Provisions.

LEVELING

If the old surface is in generally poor condition, a leveling course may be needed. A leveling course is a layer of hot mix applied for the purpose of leveling an old surface, so that a smooth, durable course can be put down.



4-22. Define leveling course:

_____

_____

Preparation for a leveling course is similar to that done for any asphalt overlay. The surface must be clean of all dirt, loose gravel, etc. Then, a tack coat must be applied. On a leveling course, the hot mix can be laid by a paver or motor grader. In most cases a leveling course is less than 1 inch thick.

4-29 True

4-30 False

4-31 False

4-32 True

4-33 True

4-34 True

4-35 True

FILL IN THE BLANKS:

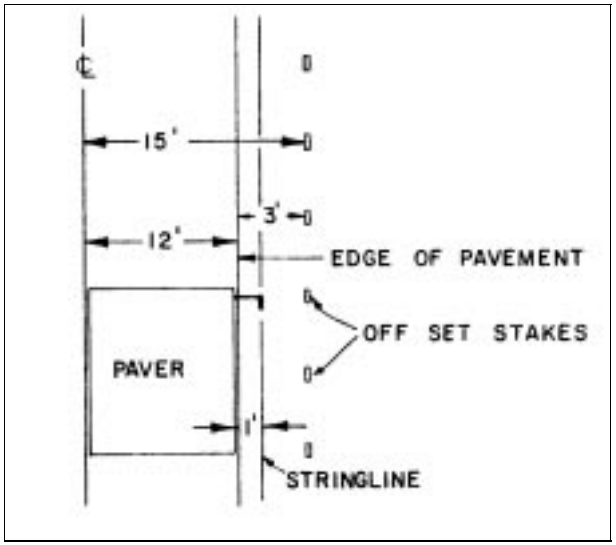
4-23. Either a _____ or a _____ may lay a leveling course.

4-24. Mix type for a leveling course is specified in Section _____ of the Standard Specifications.

4-25. A leveling course is less than _____ inch thick in most cases.

In order to insure that the edges of new pavement will be straight, some means of linear control is required. Offset stakes are often used for this purpose. Offset stakes are stakes set a fixed distance from the planned centerline of the roadway. They are usually placed at 100 foot intervals (closer on curves). A survey crew prior to the commencement of paving operations sets these stakes. The distance the stakes are set from the centerline is usually, but not always, marked on the stakes.

The contractor can use these stakes as a reference in setting an erected stringline for his paver. If the offset stakes were 15 feet from centerline, and the lane 12 feet wide, the pavement edge should be 3 feet from the stakes. If the paver's reference follower extends one foot from the paver, the contractor's stringline needs to be two (2) feet from the offset stakes.



The paver will have an arm with a grade and/or reference follower attached. As long as the reference follower is directly above or riding on the stringline, the paver will lay the mat correctly.

4-22 a layer of hot mix applied for the purpose of smoothing an old surface

FILL IN THE BLANKS:

4-26. _____ are stakes set at a fixed distance from the centerline and used for linear control.

4-27. The contractor can use offset stakes for setting an erected _____.

4-28. Offset stakes are usually _____ feet apart.

4-39 much

4-40 little

Since the offset stakes may be used as a reference for an erected stringline to be used with an electronic screed, they must mark a smooth grade. The inspector should sight down the line and correct any errors.

Offset stakes are set on just one side of the roadway. They are used when placing the initial lane. Once the initial lane is in place it is used as a guide for placing the other(s). The inspector must, however, check the width of the other lane(s).

Sometimes when overlaying an old surface, the crew will set a nail line instead of offset stakes. A nail line is a series of nails driven into the roadbed a fixed distance from the centerline. The contractor will use the nail line as he would offset stakes.

CIRCLE TRUE OR FALSE

4-29. True False Offset stakes are used for linear control.

4-30. True False The roadway inspector is responsible for placing offset stakes.

4-31. True False On curves, offset stakes are usually placed 100 feet apart.

4-32. True False You can make sure the contractor's offset stakes are set properly by measuring the width of the other lane(s).

4-33. True False The initial lane may be used as a guide for the second lane.

4-41 False

4-34. True False Offset stakes may be used as a reference in setting an erected stringline.

4-35. True False When doing an overlay job, a nail line may sometimes be used for linear control.

TACK COAT

When all flaws in the existing surface have been corrected, it is time to begin construction of a new surface. Base course that will receive less than 5 inches total thickness of asphalt concrete will be primed. On an old pavement being overlaid a tack coat will be required.

There are two (2) prohibitions to remember when applying tack.
DO NOT apply tack:

On dirty pavement
To a wet or frozen surface

Tack must be applied so that the entire area will have a uniform coverage as specified in Section 413 of the Standard Specifications.

CIRCLE THE CORRECT ANSWER(S):

4-36. Tack is required on (base / an old surface)

4-37. Tack cannot be applied to a (wet / dry) surface.

4-38. Tack may be applied the (day / week) the surface is to paved.

The application rate for tack is shown as follows and is also found in Section 400.05 of the Standard Specifications. Application rates for Bituminous Tack, Gallons per Square Yard are: An application rate of .06 to .08. for D Mix. All other mixes are an application rate of .04 to.06 unless it is a thin leveling course, which needs to be placed at an application rate of .02 to .04 gallons/square yard.

Care must be exercised in the application of tack. If too much tack is applied, the tack will act as a lubricant. Instead of bonding the hot mix to the old pavement, it can cause the mix to slide or shift. The extra tack can also bleed into the hot mix and result in an undesirable surface. If the mix absorbs the extra tack, it could lose stability. In some cases, the excess tack will flush to the surface.

4-26 offset

4-27 stringline

4-28 100

4-44 T

4-45 T

If too little tack is applied, the hot mix will not bond to the pavement. This condition can also cause the mat to slide or shift.

FILL IN THE BLANKS:

4-39. If too_____ tack is applied, the tack may bleed into the hot mix.

4-40. If too _____ tack is applied, the hot mix will not bond to the base.

As mentioned in Chapter II, an asphalt distributor is used for the tacking operation. It is important to remember to measure and record the amount of tack in the tank before beginning the tacking procedure. Tack is applied with the spray bars or in some cases the hand hose. The tack must be sprayed evenly over the surface. It is extremely important that the tack not be allowed to puddle on the roadway.

Generally, the rate of application is controlled by the speed of the distributor. In newer model distributors, the operator can preset the desired rate of application from an electronic control box inside the cab of the truck. To be sure tack is being applied in the correct amount, it is necessary to periodically check the application rate and adjust the speed of the distributor, if necessary.

CIRCLE TRUE OR FALSE

4-41. True False Measuring the amount of tack is necessary only after the tacking operation is completed.

4-42. True False The tack should form small puddles across the road.

4-43. True False The speed of the distributor controls the amount of tack being applied.

When measuring and recording the amount of tack used in asphalt construction, some adjustment from the actual measurement is necessary. The same problem occurs in computing the rate of application.

Tack is a pay item. It is paid for by the number of gallons used at 60 degrees F. However, the tack in the distributor tank is heated considerably above 60 degrees F. Tack expands when heated; hence, the number of gallons measured at its actual temperature will differ from the official number at 60 degrees F.

A set of tables found in Division III of the Construction Manual is used calculating the official number of gallons at 60 degrees F. However, it may be necessary to calculate using the formula found in the Standard Specifications Section 109.02.

It reads: $V = \frac{v\ 1}{K\ (\ t - 60\ ) + 1}$

Where:

V = volume of bituminous material at 60 degrees F.

V1 = volume of hot bituminous material;

t = temperature of hot bituminous material in degrees Fahrenheit

K = the Coefficient of Expansion of the bituminous material (the correction factor).

The correction factor, K, depends upon the specific gravity (S.G.) of the bituminous material being used. The following table is based on information found in Section 109.02 of the Specifications.

K = 0.00035 per degree F. for petroleum oils having a S.G. above 0.966

K = 0.00040 per degree F. for petroleum oils having a S.G. between 0.850 & 0.966

K = 0.00025 per degree F. for Emulsified Asphalt

K = 0.00040 per degree F for Creosote Oil

4-36 an old surface

4-37 wet

4-38 day

CIRCLE TRUE OR FALSE

4-44. True False Tack's official gallonage measurements are at 60 degrees F.

4-45. True False Heated tack will be larger in volume than at 60 degrees F.

There are four (4) tables in Division III of the Construction Manual for hot bituminous material. Because A.C. used in Georgia is higher than .966 Specific Gravity, Table I is most commonly used to find the number of gallons at 60 degrees F.

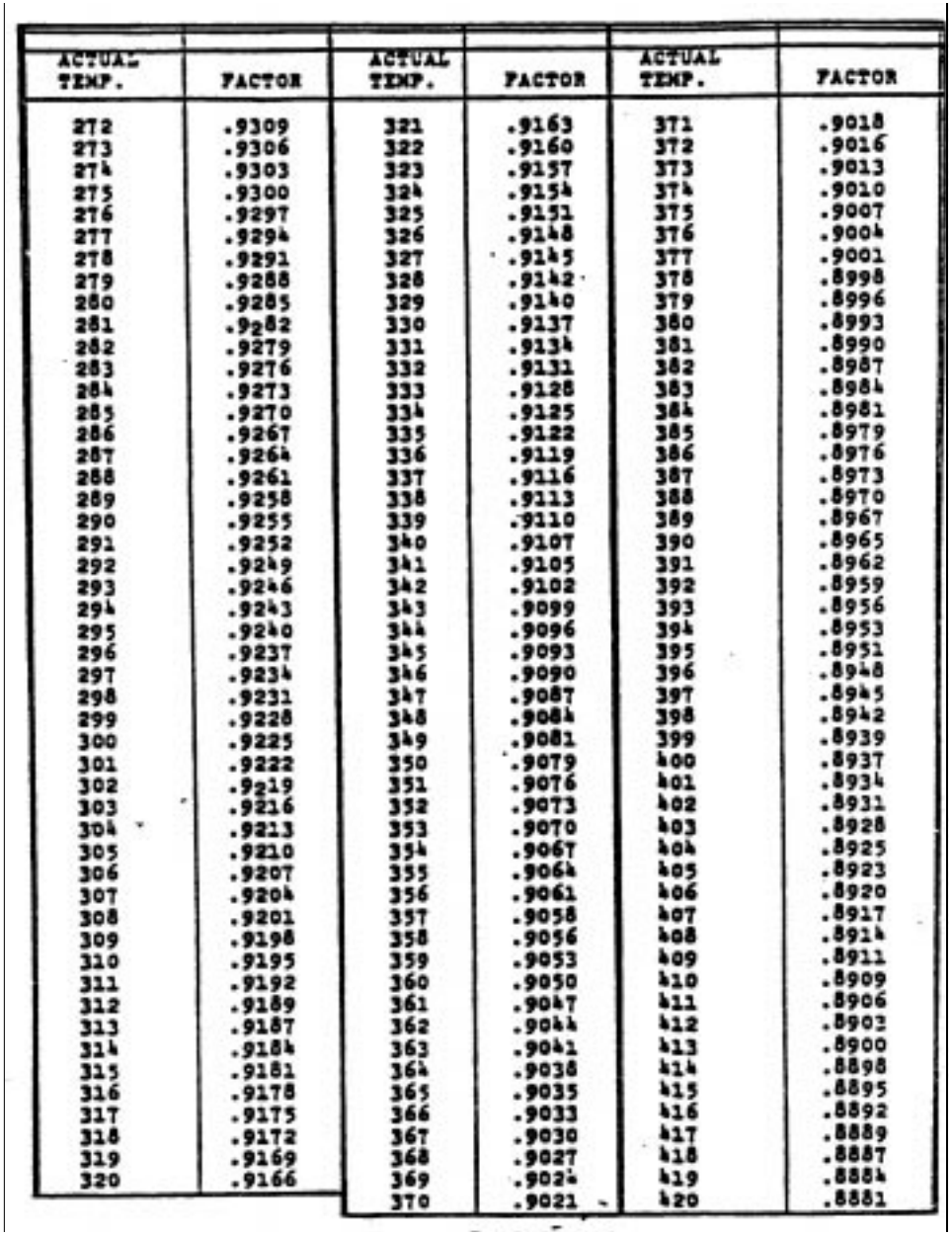
To figure the official gallons, you first find the temperature that the material was heated to on the table on the next page. Next, find the number for that temperature in the column to the right of the temperature. (This number is called the factor.) Then, multiply the actual number of gallons used by the factor. This will give you the official number of gallons at 60 degrees F.

For example: the amount of material used was 1500 gallons
the temperature the material was heated to was 350 degrees F.

Using the sample of Table I on the next page, we find 350 degrees F. has a factor of .9079

Factor: .9079
Gallons Used X1500

Sample of Table I:



ACTUAL TEMP.	FACTOR	ACTUAL TEMP.	FACTOR	ACTUAL TEMP.	FACTOR
272	.9309	321	.9163	371	.9018
273	.9306	322	.9160	372	.9016
274	.9303	323	.9157	373	.9013
275	.9300	324	.9154	374	.9010
276	.9297	325	.9151	375	.9007
277	.9294	326	.9148	376	.9004
278	.9291	327	.9145	377	.9001
279	.9288	328	.9142	378	.8998
280	.9285	329	.9140	379	.8996
281	.9282	330	.9137	380	.8993
282	.9279	331	.9134	381	.8990
283	.9276	332	.9131	382	.8987
284	.9273	333	.9128	383	.8984
285	.9270	334	.9125	384	.8981
286	.9267	335	.9122	385	.8979
287	.9264	336	.9119	386	.8976
288	.9261	337	.9116	387	.8973
289	.9258	338	.9113	388	.8970
290	.9255	339	.9110	389	.8967
291	.9252	340	.9107	390	.8965
292	.9249	341	.9105	391	.8962
293	.9246	342	.9102	392	.8959
294	.9243	343	.9099	393	.8956
295	.9240	344	.9096	394	.8953
296	.9237	345	.9093	395	.8951
297	.9234	346	.9090	396	.8948
298	.9231	347	.9087	397	.8945
299	.9228	348	.9084	398	.8942
300	.9225	349	.9081	399	.8939
301	.9222	350	.9079	400	.8937
302	.9219	351	.9076	401	.8934
303	.9216	352	.9073	402	.8931
304	.9213	353	.9070	403	.8928
305	.9210	354	.9067	404	.8925
306	.9207	355	.9064	405	.8923
307	.9204	356	.9061	406	.8920
308	.9201	357	.9058	407	.8917
309	.9198	358	.9056	408	.8914
310	.9195	359	.9053	409	.8911
311	.9192	360	.9050	410	.8909
312	.9189	361	.9047	411	.8906
313	.9187	362	.9044	412	.8903
314	.9184	363	.9041	413	.8900
315	.9181	364	.9038	414	.8898
316	.9178	365	.9035	415	.8895
317	.9175	366	.9033	416	.8892
318	.9172	367	.9030	417	.8889
319	.9169	368	.9027	418	.8887
320	.9166	369	.9024	419	.8884
		370	.9021	420	.8881

4-42 F

4-43 T

4-49
50+00 Ending Sta.
-30+00 Beginning Sta.
20+00

20+00
x100
2,000 linear feet tacked

2000 linear feet long
x 10 feet wide
20,000 sq. ft.

$\frac{20{,}000 \text{ sq. ft.}}{9}$ =2,222.2 sq. yds.

100 gal. x .9285 = 92.85 gallongs of tack per sq. yd. at 60 degrees F

92.85 / 2,222.2 sq. yds. = .042 gallons of tack per sq. yd

4-50 dry

4-51 above

4-52 6

Once the number of gallons used at 60 degrees F. is found, it is possible to determine the rate of application. First, the area covered must be figured in square yards. This is done through the use of stations. The distance between stations is 50 to 100 feet depending on what type of project.. It is also necessary to know the width of the tacked area.

For example, if the beginning station is 13+00 and the ending one is 25+00, the difference between them is 12+00 (25+00 – 13+00 = 12+00). Therefore 1200 linear feet has been tacked. Let the width of the pavement be 12 feet.

To find the total area, multiply length (1200) times width (12).

The total area is 14,400 square feet

To convert to square yard to square feet, divide by 9.

$\frac{14{,}400}{9}$ = 1600 square yards

The formula for finding the rate of application of tack is:

$$\text{gallons of tack per square yard} = \frac{\text{gallons of tack used (60 degrees F)}}{\text{square yards covered}}$$

If 40 gallons of tack @ 60 degrees F. were used and covered 1600 square yards, the computation would be as follows:

$$\text{gallons of tack per square yard} = \frac{40}{1600}$$

gallons of tack per square yard = 0.025

4-46. PROBLEM: WORKSPACE:

Figure the rate of application given the following:

1. Tack is heated to 350 degrees F.
2. Beginning tack measurement is 420 gallons.
3. Ending tack measurement is 400 gallons.
4. Area tacked was from Station 5+00 to Station 9+50.
5. Area tacked was 12 feet wide.

Gallons per square yard = _____

The rate of application for tack is controlled by adjusting the speed of the distributor or the nozzle openings. The rate of application should be checked periodically throughout each day's operation to make sure it conforms to the Specifications.

REVIEW QUESTIONS: TACK COAT

FILL IN THE BLANK

4-47. List the two-(2) prohibitions on tack application:

_____

_____

4-48. Tack is paid for as measured at _____ degrees F.

4-49. Figure the rate of application of tack given the following:

1. Tack is heated to 280 degrees F.
2. Beginning tack measurement is 500 gallons.
3. Ending tack measurement is 400 gallons.
4. Area tacked was from station 30+00 to 50+00.
5. Area tacked was 10 feet wide.

WORKSPACE:

PRIME COAT

The prime coat serves as a protective coating for the base course. It cannot be applied unless the temperature of the air is 40 degrees F or above in the shade and the surface is slightly damp.

Delays in priming the base course may require reprocessing the base course. The surface must be smooth and free of ruts or other imperfections before it is primed. If there is a delay between priming and paving, the surface may need to be cleaned, patched, and reprimed in part or completely. The prime coat must extend 6 inches beyond the plan width of the surface.

Like tack, prime is paid for per gallon measured at 60 degrees F. The same calculations apply to figuring prime as tack.

CIRCLE THE CORRECT ANSWER:

4-50. Prime can be applied only to a (dry / damp) surface.

4-51. Prime can be applied if the air temperature is (above / below) 40 degrees F.

4-52. The prime coat extends (4/6) inches beyond the surfacing width on the plans.

4-53. Prime is calculated for pay at gallons at (60 degrees F/40 degrees F)

REVIEW QUESTIONS: CHAPTER IV

CIRCLE TRUE OR FALSE

4-54. True False Emulsion, prime, and tack are all coatings that can be used on the surface of the base before hot mix is applied.

4-55. True False Emulsion is a mixture of asphalt and water.

4-56. True False The MC of MC-30 stands for medium curing.

4-57. True False Tack is used to protect a new base course, and prime to bond a new mat to an old road.

4-58. True False It is unnecessary to repair potholes in the base, because the contractor can just lay a thicker layer of hot mix in such places.

4-59. True False A leveling course is laid over an old surface

4-60. True False Offset stakes are used to keep the pavement edges straight.

4-61. True False Tack is poured from a dump truck onto the roadway.

FILL IN THE BLANKS:

4-62. Prime cannot be applied unless the air temperature is at least _____.

4-63. Prime coat must extend _____ inches beyond the plan width of the surface

4-64. Prime is paid for in number of gallons at _____ degrees F.

4-46 420 beginning gal.
- 400 ending gal.
20 gal. Used at 350° Fr.

9+50 ending Sta.
-5+00 beginning Sta.
4+50 = 450 linear feet

450 X 12 ft. = 5400 sq. ft.

$\frac{5400}{9} = 600$ sq. yds.

Convert 20 gal. @ 350° F. to standard @ 60° F. using:

$$V = \frac{v1}{K\,(t - 60) + 1}$$

v1 = 20 gal. At 350° F.

K = 0.00035 since asphalt cement used in Georgia is above S.G. of .966

t = 350 degrees F.

$$V = \frac{20}{0.00035\,(350 - 60) + 1}$$

V = 18.157

4-47 wet, dirty

4-48 60

5-3 280

This is the end of Chapter IV. If you missed any questions, review the appropriate frames. If not, go on the Chapter V.

CHAPTER V - WORK PROCESSES

TEMPERATURE REQUIREMENTS

Weather is an important factor in asphalt paving. Hot mix cannot be laid in the rain. Also, construction cannot begin until the minimum temperature is in accordance to the following table. The temperature must be checked in the shade and away from artificial light.

TABLE 400.05B

LIFT THICKNESS	MINIMUM TEMPERATURE
1" or less	55 degree F
1.1" to 2"	45 degree F
2.1" to 3"	35 degree F
3.1" to 4"	30 degree F
4.1" to 8"	Contractor's Discretion

An exception to the above is that material already in transit at the time plant operation is discontinued may be laid at the project manager's discretion, subject to the end product meeting specifications.

CIRCLE TRUE OR FALSE

5-1. True False Hot mix can be laid in a light rain.

5-2. True False All types of hot mix construction can begin as soon as the temperature is above the freezing mark, 32 degrees F.

4-53 60 degrees F

4-54 True

4-55 True

4-56 True

4-57 False

4-58 False

4-59 True

4-60 True

4-61 False

4-62 40 degrees F

4-63 6

4-64 60

5-5 T

5-6 T

The temperature of the hot mix itself is also important. The temperature of the mix as it leaves the plant will be specified in the job mix formula. The plant and roadway is allowed to vary plus or minus 20 degrees F. from the specified temperature. For example, if the job mix temperature was 300 degrees F the minimum allowable temperature is 280 degrees F.

PROBLEM

5-3. The job mix temperature is 300 degrees F. What is the minimum temperature the mix should be when it arrives at the job ?

TICKETS

As a part of the project documentation, the inspector is responsible for assuring that the weigh tickets, supplied by the asphalt plant and/or contractor, are collected and essential information is recorded on them. These tickets, along with other documentation, are used to determine how much the contractor is paid.

Simply expressed, THE WEIGH TICKETS ARE INVOICES FOR THE AMOUNT AND TYPE OF MATERIAL DELIVERED TO THE PROJECT SITE.

Each ticket is to be numbered consecutively for each item on each project. This numbering system is required by the Department's Construction Manual and SOP-15 - Certified Public Weigher.

Each weigh ticket must be marked either by imprint or by hand,(with special permission only) and contain the following information:

(a) Date
(b) Pre-printed Sequential Ticket Number
(c) Load Number (Sequential Ticket Number)
(d) Truck Number
(e) Time of Batch or Loading
(f) Tare, Net, and Gross Weights
(g) CPW Stamp or Number
(h) CPW Signatures
(I) Project Number
(j) Description of Material

Payments will not be made for tickets lacking the above information. With regard to the pre-printed sequential ticket numbers, it is not a requirement that every ticket be in strict, unbroken sequence. Tickets must be in a reasonable sequence. However, the Department reserves the right not to accept tickets grossly out of sequence. Strikeovers by plant or contractor personnel of the above-required information are generally unacceptable. However, isolated instances of strikeovers, initialed by the person making the correction, may be accepted.

In recent times, it has been additionally acceptable to allow the CPW to attach his signature electronically on to the tickets. Only the actual signature of the CPW electronically fixed onto the tickets will be accepted. Otherwise the usual typed name of the CPW with the CPW's full signature should be on each ticket.

5-1 F

It is necessary for the **project personnel** to periodically check the temperature of the mix to be certain that it is within 20 degrees F. of the approved job mix formula. It is not necessary for him to check the temperature of every truck. Each time he checks the temperature he will record it on the asphalt ticket for the truck checked.

5-2 F

CIRCLE TRUE OR FALSE

5-4. True False The temperature for every truckload of hot mix must be recorded officially for Department Records.

5-8 blue smoke

5-9 cold

5-10 asphalt

5-11 little

5-5. True False Weigh tickets, with other documentation, are used to determine how much thecontractor is paid.

5-6. True False If a load of mix is 300 degrees Farenheit at the plant and arrives at the job site at 280 degrees Farenheit, it is within tolerance.

THEORETICAL YIELD

It is sometimes necessary to calculate the approximate ending station for a truckload of mix. This is done by figuring the theoretical yield of the truck. Theoretical yield is how many linear feet the mix in the truck should cover. Since the distance between stations is 100 feet, it is possible to calculate the theoretical ending station.

The formula for this computation is:

$$\text{Theoretical yield Length (in linear feet)} = \frac{\text{tons} \times 2000}{\text{roadway density} \times \text{width} \times \text{thickness in feet}}$$

Tons	=	amount of mix in the truck
Roadway Density	=	weight of a cubic foot of mix on roadway
Width	=	width of the mat being placed
Thickness in Feet	=	the thickness of the mat in feet

Roadway Density is determined by the lab. This information is usually not available the first day of paving. Should it be necessary to do these calculations before the roadway density reports are available, the estimate of 145 lbs per cubic foot can be substituted. For mixes using other aggregates, the factors given in Standard Specifications must be applied to the 140 lbs. Per cubic foot estimate.

It is also necessary to calculate the thickness of the mat into feet since mats are measured in inches. These inches must be converted into portions of a foot. For example, a 1 inch mat = 1/12th of a foot

---

PROBLEM

5-7. Given the following information, work the formula for theoretical yield.

$$\text{Theoretical yield Length (in linear feet)} = \frac{\text{tons X 2000}}{\text{roadway density X width X thickness in feet}}$$

10 tons of mix
density = 145 lbs.
width = 12 feet
thickness = 2 inches $= \frac{2}{12}$ ft $= \frac{1}{6}$ ft

Round off the answer to nearest foot.

WORKSPACE:

After finding the number of linear feet that the mix will cover, use this information to calculate the ending station. If the beginning station is 2+00, and the mat is being laid toward increasing stations, the ending station for the just completed problem would be approximately 2+69.

If there are several different sized trucks on a job, it might be helpful to make out a chart showing the theoretical yield for each size truck. Refiguring would then not be necessary unless density, thickness, or width changes But remember that these calculations do not give accurate ending stations, only approximations. They are helpful in calculating the amount of mix needed to complete a project or to help determine if the mix is going as far as it should.

5-4 False

There are several faults that provide reason for rejecting a load of hot mix. It is up to the engineer to decide if a load of mix is acceptable or not. Experience is the most important factor in reaching this decision.

MIX DEFICIENCIES

INCORRECT TEMPERATURE OF MIX

Overheated Mix

A batch of mix that has been overheated is usually indicated by blue smoke rising from it. The temperature of such a suspect load should be checked immediately.

Cold Mix

A generally stiff appearance or improper coating of the larger aggregate particles is often indicative of a cold mixture. The temperature of such a batch should always be checked.

TOO MUCH OR TOO LITTLE LIQUID ASPHALT

Too Much Asphalt

When loads have been arriving at the roadway with the mix peaked or rounded at the top and then a load appears in which the material lies flat (slumped) and has a shiny (soupy) appearance, it may contain too much asphalt.

Too Little Asphalt

A load with this flaw may be identified by its lean, granular appearance, improper coating of aggregate and lack of shiny black luster.

FILL IN THE BLANKS:

5-8. Overheated mix may have _____rising from it.

5-9. A generally stiff appearance may mean the mix is _____ .

5-10. A soupy appearance may mean there is too much _____ in the mix.

5-11. A lack of shiny black luster shows too _____asphalt.

5-16 lean brown dull appearing, rich shiny

5-17 segregation

5-18
Overheated
Cold
Too much asphalt
Too little asphalt
Excess coarse aggregate
Excess fine aggregate
Contamination
Excess moisture
Non-uniform mixing
Segregation

Excess Coarse Aggregate

Mix with excess coarse aggregate can be mistaken for mix with too much asphalt. Both faulty mixes have the same general appearance. However, this condition can be detected by poor workability and its coarse appearance on the road.

Excess fine aggregate

The mix will have a lean, dull brown appearance much like mix with too little asphalt. It can be detected by the difference in texture from a properly graded mixture.

Contamination

Such things as spilled gasoline, kerosene or oil, rags or paper, trash or dirt, can also contaminate mix. If the contamination is not too bad, it can be removed (shoveled out). But any load that is badly contaminated should be immediately rejected.

Excess Moisture

A mix with excess moisture may have a soupy appearance like a mix with too much asphalt. As the mix is dumped into the paver, steam will rise. It may also be bubbling and popping as if it were boiling.

CIRCLE TRUE OR FALSE

5-12. True False A mix that appears coarse on the road probably contains too much asphalt.

5-13. True False A mix with too much fine aggregate in it will appear dull and brown.

5-14. True False Any load of mix that has been contaminated must be rejected immediately.

5-15. True False If steam rises from the mix, it bubbles and pops, and appears soupy, it has too much asphalt in it.

5-7

$$\text{Length} = \frac{10 \times 2000}{145 \times 12 \times 1/6}$$

$$= \frac{20{,}000}{290}$$

$$= 68.96$$

length = 69 linear feet

Non-Uniform Mix

A mix that is not uniformly mixed will have spots of lean, brown, dull appearing material mixed with areas of a rich shiny appearance.

Segregation

Segregation in hot mix means that the fine aggregates clump together and the coarse aggregates clump together. Therefore, the aggregates are not spread evenly throughout the mix. Improper handling of the mix can cause segregation. If the segregation is bad, the mix must be rejected.

FILL IN THE BLANKS:

5-16. A mix not uniformly mixed will have spots of _____ _____ material mixed with areas of a _____ _____ appearance.

5-17. The phenomena of fine aggregates clumping together and coarse aggregates clumping together is called _____.

5-18. List the possible deficiencies that can occur in a batch of hot mix.

MAT THICKNESS ADJUSTMENT

It is necessary, of course, to adjust the screed to obtain a mat of the proper thickness.

There are three (3) terms related to mat thickness.

1. Plan Thickness - the thickness the mat is supposed to be after compaction. It is the depth the designers planned the road to be.
2. Laydown Thickness - the depth of the mix behind the paver before compaction. Laydown thickness must be greater than plan thickness.
3. Compacted Thickness -the actual depth of the mat after rolling. Compacted Thickness and Plan Thickness should be the same.

The contractor is responsible for obtaining the compacted thickness shown in the plans. The correct laydown thickness can only be estimated, usually about twenty percent (20%) greater than plan thickness.
For example, if plan thickness were 2 inches, the screed would be set for 2.4 inches.
20% of 2 inches = .20 x 2" = 0.40"
0.40" + 2" = 2.40 inches

The twenty percent (20%) extra thickness in laydown will not always be correct, because not all mixes behave alike. Therefore, the contractor must experiment with adjusting the paver until the proper thickness is achieved.

CIRCLE THE CORRECT ANSWER(S):

5-19. Plan thickness is (greater / less) than laydown thickness.

5-20. The thickness of the mat after compaction is (compacted / laydown) thickness.

5-21. In order to achieve the proper compacted thickness, the laydown thickness should be about (20 / 40) percent greater than plan thickness.

5-12 False

5-13 True

5-14 False

5-15 False

5-23
Square Yard = $\frac{\text{Length x Width}}{9}$

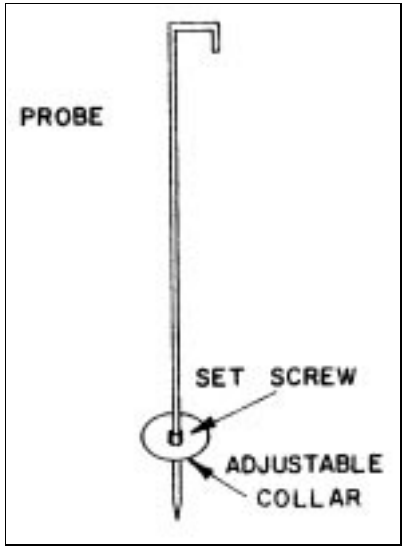
Actual Yield =
$\frac{\text{Tons Laid x 2000}}{\text{Area}}$

5-24
Theoretical Yield =
Density x 0.75 x t

5-25 inches of asphalt

5-26 D x 0.75 x 2
= 142 x 0.75 x 2
= 213 lbs. Per sq. yds.

The contractor will usually check his mat depth with an instrument designed for this purpose. (See below.) The end of the probe is inserted into the mat until it touches the base. The mat is checked all the way across in this manner. If the pole extends too far into the mix, the mat is too thick; not far enough indicates the mat is too thin.



To be certain the thickness is consistent the length of the mat, the probe should be inserted every eight to ten 8-10) feet when the job first starts and whenever the spreader requires any additional adjustment.

ACTUAL YIELD

It is also possible to figure if the mat is being laid to plan thickness by computing actual yield. Actual Yield is the number of kilogram of hot mix that is being used per square yard of pavement. This spread rate is given on the

typical section in the project plans.

To find actual yield, it is necessary to know:

1. The number of tons of hot mix laid.
2. The area, in square yard, that has been covered. The number of tons laid can be found on the haul tickets. To find the area in square yards, multiply the length paved, in feet, by the width paved, in feet. Then divide by (Nine [9], the number of square feet in a square yard.) Area = $\frac{L \times W}{9}$

The formula for actual yield is:

Actual Yield = $\frac{\text{Tons laid X 2000 (No. of lbs in a ton)}}{\text{Area}}$

PROBLEM

5-22. Work the formula for Actual Yield given the following information.

$$\frac{\text{tons laid X 2000}}{\text{Area}}$$

Area in square yards = $\frac{L \times W}{9}$

Length = 450 ft.
Width = 12 feet
Mix = 40 tons used

WORKSPACE:

5-19 less

5-20 compacted

5-21 20

5-23. Write out the formula for computing area in square yard and Actual Yield.

square yard = Actual Yield =

Actual Yield must be compared to Theoretical Yield in order to know if the mat is being laid to the proper thickness. Theoretical Yield is the pounds per square yard being used if all conditions (including mat thickness) are perfect.

The formula for Theoretical Yield is:

Theoretical Yield - D X 0.75 X t

D = Roadway density in pounds per cubic foot
t = Thickness of lift in inches (plan thickness)

It should be noted 0.75 is the volume in cubic feet of a section that is 1 square yard in area and one (1) inch in thickness. Three (3) feet X 3 feet X ½ feet = 0.75 foot.

Until the plant runs its density tests and reports actual roadway density, 145 lbs. Per cubic foot is a good estimate to use for asphalt concrete mixes.

FILL IN THE BLANKS:

5-24. The formula for theoretical yield is _____.

5-25. t = _____ in the above formula.

5-26. Calculate theoretical yield using the following information.
Density = 142.0
t = 2 inches

WORKSPACE:

By comparing actual yield to theoretical yield, an inspector can tell:

1. If actual yield is much larger than theoretical yield, the mix is probably being laid too thick.
2. If theoretical yield is much larger than actual yield, the mix is probably being laid too thin and not meeting the required spread rate.

PAVER OPERATIONS

Before a paver begins spreading the hot mix, the machinery must be checked and the screed properly adjusted and crowned. The screed plates should be preheated.

The inspector should watch the haul truck as it approaches the paver. THE HAUL TRUCK MUST NOT BACK INTO THE PAVER. The haul truck should stop within 4 to 6 inches of the paver. The paver should then move forward until its roller bars make firm contact with the truck's rear wheels. Should the truck back into the paver, it can push the paver back and cause ridges or bumps in the mat.

The right wheel of the truck must be in contact with the right roller bar and left wheel in contact with the left roller bar. If only one wheel is hitting a roller bar, when the paver begins to push the truck, the paver will "chatter" or jerk, and the mat will suffer.

CIRCLE TRUE OR FALSE

5-27. True False The haul truck must back up until it gently makes contact with the paver.

5-28. True False The truck's bumping the paver will harm the mat.

5-29. True False Each roller bar must be in firm contact with its corresponding wheel while the paver is pushing the truck.

5-22

Area = $\frac{450 \times 12}{9}$

= $\frac{5400 \text{ sq. ft.}}{9}$

= 600 sq. yds.

Pounds of mix =
40 x 2000 = 80,000 lbs.

Actual Yield =
$\frac{80{,}000}{600}$ = 133.33 lbs. Per sq. yds.

= 133

5-34 True

5-35 False

5-36 True

5-37 False

After the paver moves up, the bed of the truck is elevated, and the hot mix falls into the receiving hopper. The speed of the paver is important. The paver must not go so fast that the mat tears, nor should there be a line of haul trucks waiting to unload. The key to successful hot mix paving is to coordinate the roadway work smoothly with the speed of plant production.

As the paver pushes the truck along, the bed is raised higher and higher to empty all the mix from the truck bed. THE BED OF THE TRUCK MUST NEVER REST ON THE PAVER. When the bed of the truck makes contact with the paver, the truck is no longer resting on the roadbed, but has part of its weigh distributed on the paver. This weight pushes the paver down and mars the surface of the mat.

To observe whether or not a truck bed has made contact with the paver, watch the rear wheel(s) of the truck. So long as the truck's weight is on the roadway, each tire will be flattened where it rests on the road. If a tire rounds out, the paver is supporting the truck.

ANSWER THE FOLLOWING QUESTIONS:

5-30. What is the key to successful hot mix paving?

_____

5-31. When should the bed of the haul truck rest on the paver?

_____

5-32. How can an observer tell when the bed of the haul truck is resting on the paver?

_____

A widespread, although highly undesirable practice is casting the mix behind the paver with a shovel. Casting is the practice of taking mix out of the spreader box and shoveling it onto the mat directly behind the paver. Under certain circumstances fresh hot mix may be gently placed by hand behind the paver. However, this practice should not be encouraged.

Cast material stays on the surface until the roller passes over it. It chills rapidly. Although the roller will press the cast material into the mat, a good bond cannot be obtained. The cast material will begin to ravel out, leaving a very poor surface. For this reason, NO CASTING IS ALLOWED.

CHECK THE CORRECT ANSWER(S):

5-33. Shoveling hot mix from the spreader box onto the mat is called
a. shoveling
b. casting
c. tamping
d. patching

5-27 False

5-28 True

5-29 True

The inspector gets his first look at the mat in place after the first load of mix has gone through the paver. He should then do an initial laydown inspection.

During this inspection particular attention should be paid to the surface of the mat. It should be smooth, black, even, and without holes of any kind. Mix texture should be uniform. The top surface should be smooth, black, and glossy all over. A non-uniform texture will look black and shiny in some places; brown and dull in others. It will also feel slick in spots and grainy or sandy in others. The coarse aggregate should be uniformly distributed. There should be no oily spots or pools of oil on the mat's surface.

CIRCLE TRUE OR FALSE

5-34. True False As soon as the first load of mix has gone through the paver, the initial laydown inspection is made.

5-35. True False Following the paver, the mat should be smooth and oily.

5-36. True False The coarse aggregate should be uniformly distributed.

5-37. True False Brown dull areas should occur in a good mat.

If the inspection indicates that the mat is not good, the inspector should see that corrective steps be taken. One or more of the following could be the problem:

Something is wrong at the mixing plant.
The mix is not being hauled to the paver properly.
Something is wrong with the adjustment of the paver (See Chapter III).
The laydown temperature of the mix is out of tolerance.

ANSWER THE FOLLOWING QUESTIONS:

5-38. Match the following:

_____ Plan thickness	1. design thickness
_____ Laydown thickness	2. thickness behind paver
_____ Compacted thickness	3. actual thickness

CIRCLE THE CORRECT ANSWER(S):

5-39. Laydown thickness is normally (50 / 20) percent greater than plan thickness.

5-40. Casting (is / is not) permitted.

5-41. The depth of the mix immediately behind the paver can be checked by using a (probe / straightedge).

5-42. To make sure the laydown thickness is consistent across the mat check the thickness every (3 / 6) feet.

5-43. To make sure the laydown thickness is consistent the length of the mat check the thickness every (8-10 / 20-25) feet.

JOINT CONSTRUCTION

There are two types of joints that need to be constructed in asphalt pavement:

longitudinal joints
transverse joints

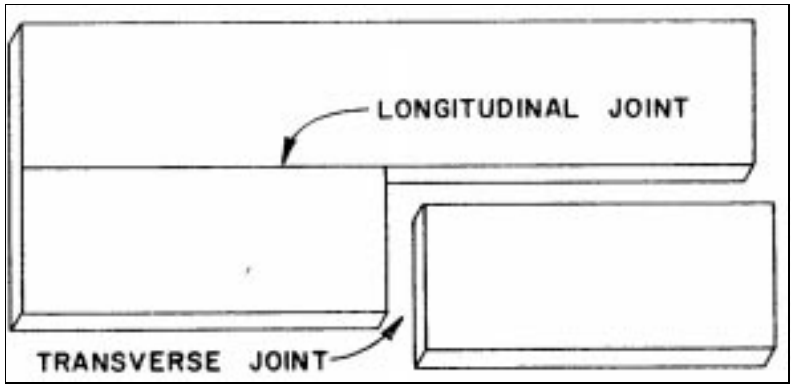
A longitudinal joint runs the length of the pavement; a transverse joint runs across the pavement.

5-30 coordination of roadway operations with handling capacity

5-31 never

5-32 watch the rear wheel of the truck; when the wheel rounds out the bed is on the paver

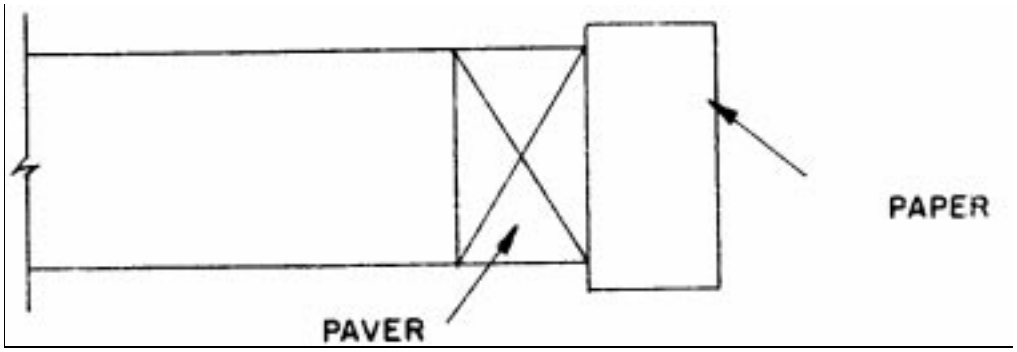
5-33 b.



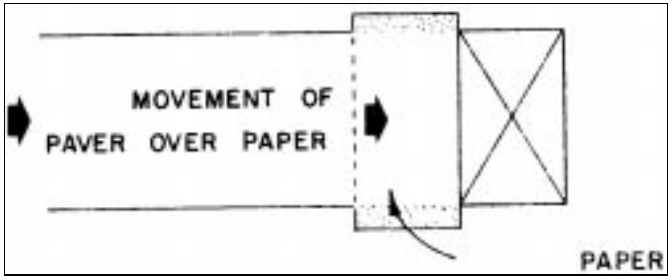
A transverse joint occurs when there has been a break in the paving operations. This happens when the job shuts down at the end of the day, or whenever it is necessary to stop paving operations.

A longitudinal joint occurs when two lanes are placed together. Again, a longitudinal joint runs the length of the pavement.

In order to construct a transverse joint, the paver is run until there is a small amount of mix left in the hopper. A piece of paper is placed on the roadway in front of the paver.



Then the paver is restarted and run until the hopper is empty. Allowing the paver to run out of mix leaves a rough, uneven mat.



5-38
1. plan thickness
2. laydown thickness
3. compacted thickness

5-39 20

5-40 is not

5-41 probe

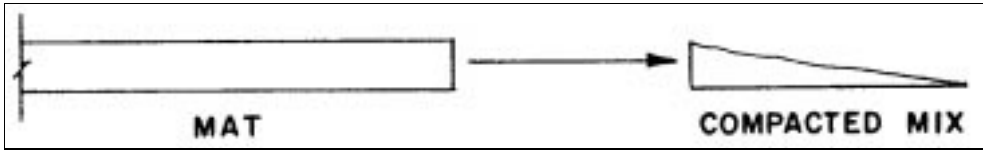
5-42 3

5-43 8-10

This rough mat will have to be featheredged. Featheredging is a process used to taper mix to the surface being overlaid. To featheredge this rough, uneven mix, the large aggregates must first be raked from the pile and wasted. The remaining mix is then worked with rakes until it tapers smoothly and evenly to the surface. It should then be compacted.

When it is time to restart construction, a transverse joint must be constructed.

1. Remove the paper and compacted mix.



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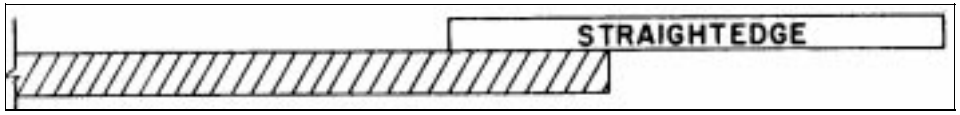
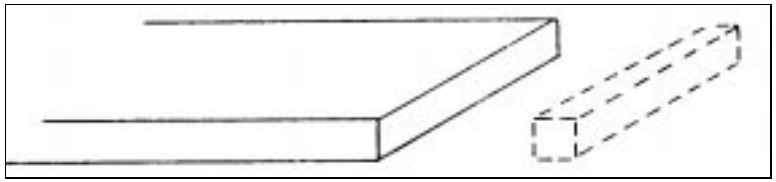
2. Straightedge the surface of the mat at the joint. The joint must be straightedged to make sure the surface of the mat is level, so that when the joint is made there will be no bump or dip at the joint. If the mat is not level at this point, it will be necessary to saw it further back.



3. The end of the mat is then cut away so that the full depth of the mat is exposed as a cross section. This step will be unnecessary if the mat is already at the proper thickness and the end of the mat is vertical.



5-44 longitudinal
transverse

5-45 True

5-46 True

5-47 True

5-48 False

5-49 False

5-50 True

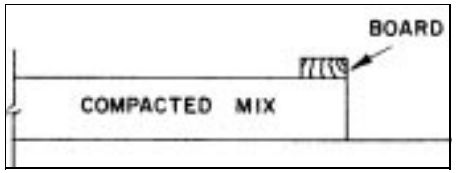
4. Before placing more hot mix to construct the joint, the end of the mat must be painted with a coat of tack to insure a good bond.

---

5. When beginning to lay the new mat, the compacted mat must be flush with the original mat. Since the laydown thickness must be about 20% greater than the final thickness, the level of the original mat must be temporarily increased. A board is used for this purpose. It must be as thick as the extra amount of mix required.

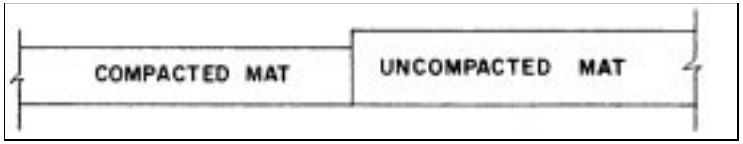
   i.e. If compacted thickness is 2 inches, laydown thickness 2.4 inches, the board would need to be 0.4 inches thick.

The board is placed atop the mat.

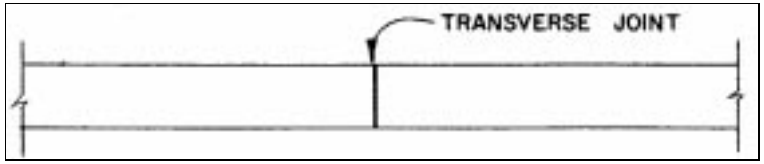


The paver is backed up to the mat and the screed allowed to rest on the board.
The screws are run until filled with mix; then, the paver can move forward.

6. The result will look like this.



When the new mat is compacted it should be the same height as the original mat.



FILL IN THE BLANKS

5-44. What are the two types of joints that must be constructed in asphalt paving?

_____

_____

CIRCLE TRUE OR FALSE

5-45. True False A transverse joint runs across the road. It is constructed whenever paving operations are stopped.

5-46. True False A longitudinal joint joins two lanes.

5-47. True False For a transverse joint, the paver should run itself out of mix over a piece of paper.

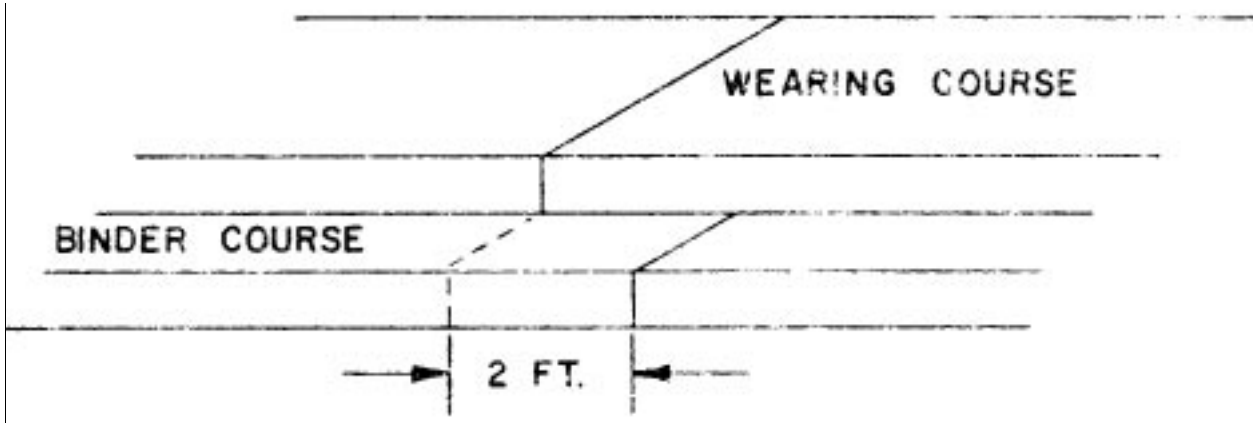
5-48. True False The rough uneven area of mat is tapered and tacked, then the paver lays an even mat on top of it.

5-49. True False There should be a small bump at the joint so that it will be easy to locate in the future.

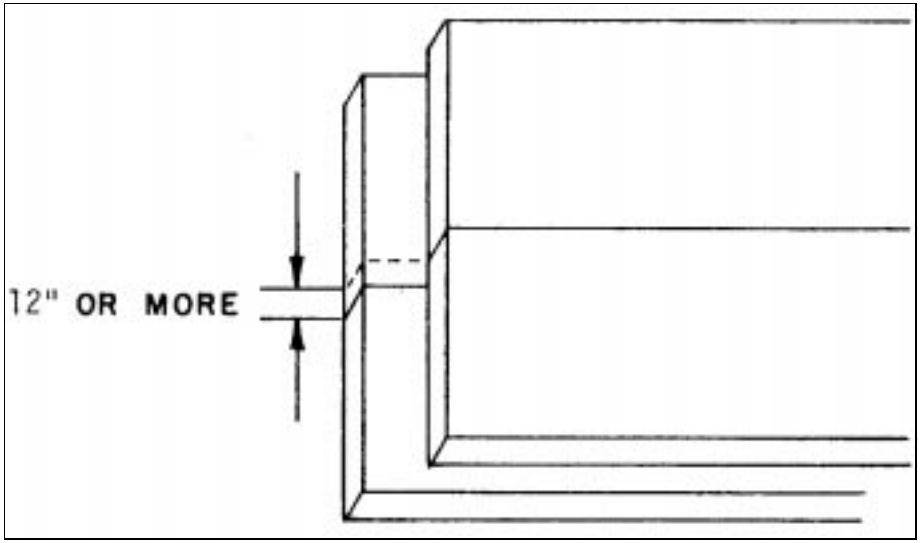
5-50. True False To insure that the new mat will be level with the old one, a board is placed on the end of the old one to make it equal to laydown thickness of the mat.

To construct a longitudinal joint, it is necessary to have one lane already in place. The edge of the lane where the longitudinal joint occurs must be clean and free of foreign matter. The edge is then tacked.

Joints are never stacked. Pavement is usually placed in two or more lifts. A joint in one lift should not be placed directly over another joint. Transverse joints should lie at least two feet apart.



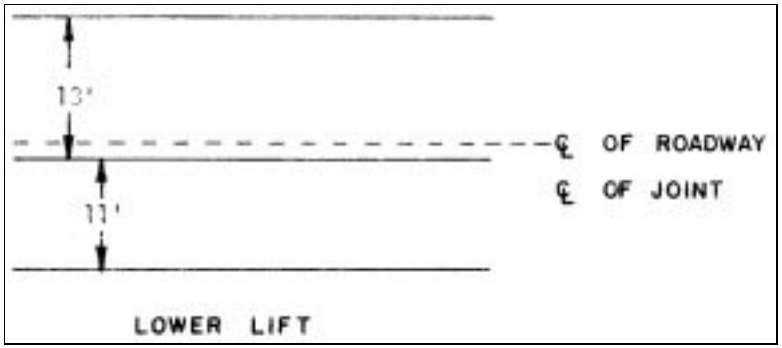
Longitudinal joints should be at least 12 inches apart.



It is simple to not stack transverse joints. The joint in the lower lift can be seen. If it appears that a joint will need to be made near it in the upper lift, the paver is simply stopped at least two (2) feet from that point.

Keeping longitudinal joints apart is a little more difficult. The longitudinal joint of the uppermost lift should always fall at the centerline or at lane lines on a multi-lane highway. Therefore, the longitudinal joints of the lower lifts should be offset from the previous lift a minimum of one (1) foot.

For this reason, the lanes of the lower lifts must be offset. For example, if a two-lane roadway is to be 24 feet wide, the two lanes of the upper lift should be 12 feet wide. The longitudinal joint in the lift below would have to be at least 12 inches off of centerline. Therefore, one lane would need to be 13 feet and the other lane 11 feet.



CHECK THE CORRECT ANSWER(S):

5-51. Transverse joints should be

a. directly above each other

b. 6 feet

c. 3 inches

d. 2 feet

5-52. Longitudinal joints should be

a. directly above each other

b. 3 feet apart

c. 12 inches apart

d. 2 feet apart

5-53. The lanes of the upper lift of a highway should be jointed

a. .2 feet off center

b. at the centerline

c. four (4) feet from the edge

d. 3 inches off center

THE ROLLING OPERATION

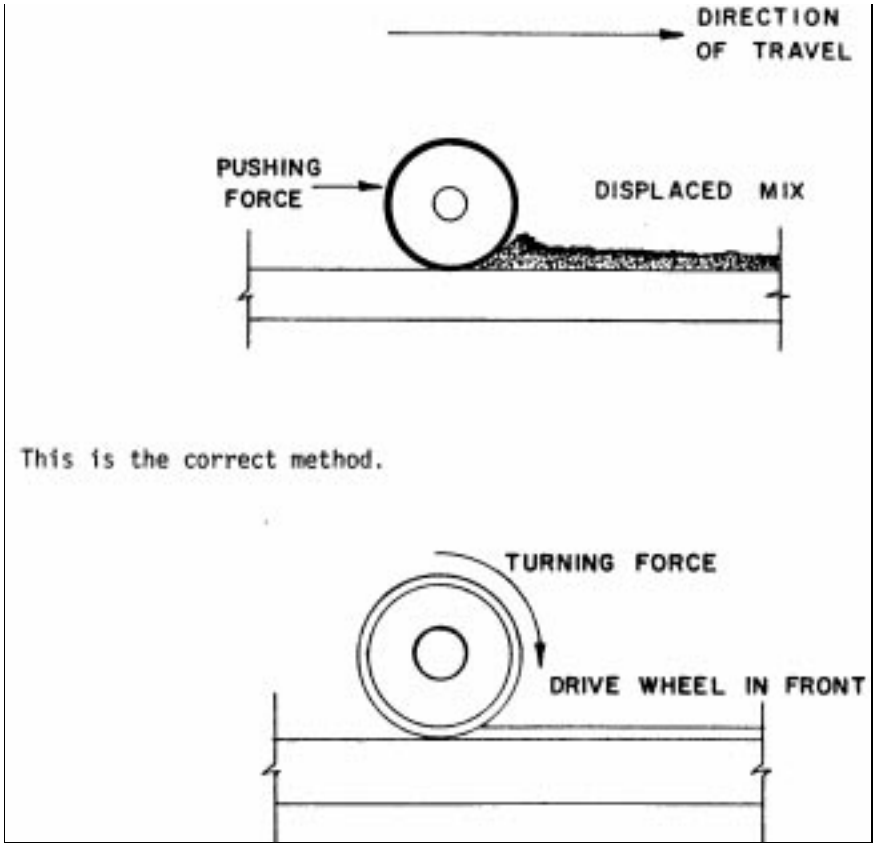
As mentioned Chapter II, there are three phases of rolling if traditional rolling methods are employed. A steel roller, tandem or three-wheel, static or vibratory performs the first phase, breakdown rolling. Rolling should begin as soon as the mat will carry the roller without displacing the mix.

The rollers are usually operated with the drive wheels forward.

5-59 drives onto existing pavement then onto the new mix

5-60 uses 2 boards the same height as the compacted mix. Goes from compacted mix to uncompacted mix.

If the roller is operated with the tiller wheel forward, the mix will be pushed up in front of the wheel.



The weight of the drive wheel carries out the compaction while the turning force tucks the material under the front of the wheel.

There are some special cases when the steel wheel roller is operated with the tiller wheel forward. This may be necessary when high super elevations are being constructed or when the grade being placed is excessive. Due to these high grades, the drive wheels of the roller will sometimes begin to chatter on the mat. This causes displacement of mix and a very rough surface. When this happens, the roller should be turned around so that the tiller wheel can compact the mix enough for the drive wheels to proceed over it.

FILL IN THE BLANKS:

5-54. The mat must be a certain_____ as determined by the laboratory.

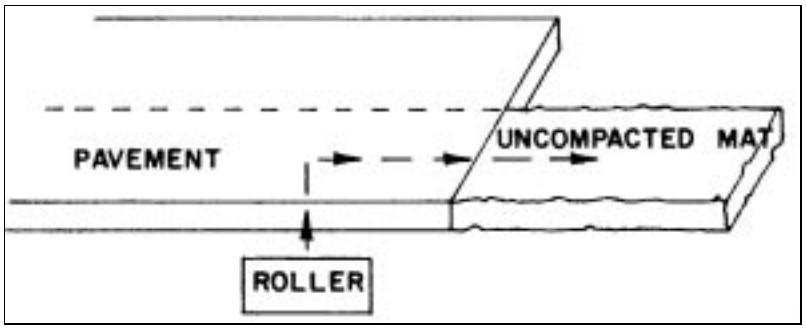
5-55. Breakdown rolling is done with a _____ roller, either 3 wheel or tandem.

5-56. Either static or _____ rollers must be used.

5-57. Steel rollers are operated with the _____ wheel(s) forward.

5-58 The _____wheel may have to be in forward position on high super elevations.

Before beginning a rolling pattern, the contractor must move the roller onto the mat without damaging the edge of the pavement. When a new pavement is connected to an existing one, it forms an abutment from which the roller can approach the new mat. The roller is driven onto the old pavement and from there onto the uncompacted mix. See below.



5-51 d.

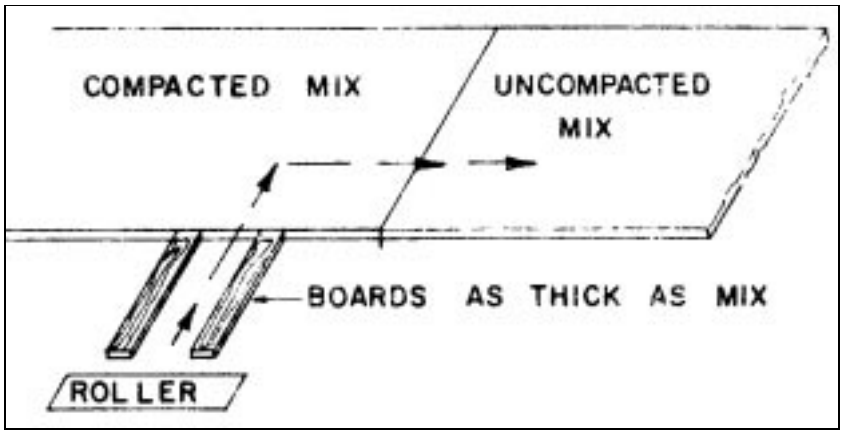
5-52 c.

5-53 b.

5-61 True

5-62 True

If the entire stretch of pavement is newly laid, the roller cannot be driven over the edge of the newly compacted mix. The roller would break down the edge. To prevent damage to the edge of the pavement, two boards the same thickness as the newly compacted mix are placed at right angles to the newly compacted surface. The roller gets onto the mat by using the boards and does not damage the mat edge.



ANSWER THE QUESTIONS:

5-59. How does a roller get onto newly laid mix adjacent to an existing pavement?

_____

_____

5-60. How does the roller get onto uncompacted mix without damaging a newly laid, compacted section of the mat?

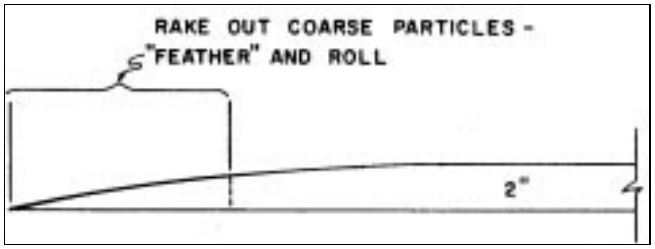
_____

_____

When overlaying an existing surface, the paver cannot start out laying the full laydown thickness of the overlay. If it did, the new pavement would cause a bad bump in the pavement.

The paver starts out placing the mat at a thickness slightly greater than the maximum diameter of the aggregate used in the mix. (When a mat is thinner than the diameter of the largest aggregate, the larger aggregate is crushed, damaging both the screed and the mix.) The mat thickness is then slowly increased to the desired depth.

The mat would look like this.



Even with the paver starting off like this, the beginning point of the mat must be worked by hand. The largest aggregate is raked from the mix and the mix is tapered to the surface being overlaid. Then the roller is brought onto the uncompacted mat

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5-54 density

5-55 steel wheel

5-56 vibratory

5-57 drive

5-58 tiller

5-70 True

5-71 True

CIRCLE TRUE OR FALSE

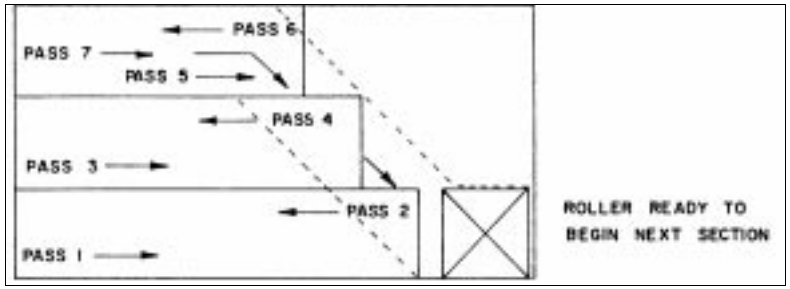
5-61. True False When overlaying an existing mat, the paver begins by laying a thin mat and gradually increasing it to the required laydown thickness.

5-62. True False The tapered end of an overlay mat is worked by hand to insure a smooth transition from the old pavement to the new.

The rolling operation is normally established by Department personnel. The contractor is responsible for maintaining it.

For breakdown rolling, the roller usually works from the outside edge of the mat toward the inside edge. On the first pass the roller should actually overhang the edge of the mix by 2 or 3 inches. To prevent causing a dip across the mat, the roller should stagger its reversal spots

The final pass of the roller, to its new starting position should cut across all reversal points. This will eliminate any dips caused by reversal. The following diagram illustrates an acceptable rolling pattern.



CIRCLE THE CORRECT ANSWER(S):

5-63. Normally, the (DOT. / contractor) establishes the rolling pattern.

5-64. For breakdown rolling, the roller rolls from the (outside / inside) edge toward the (outside / inside) edge.

5-65. The roller should always reverse in (the same / a different) place.

5-66. The final pass should (avoid cutting / cut) across the reversal points of previous passes.

When the transverse joint occurs, the joint must be rolled first. Should the joint occur in an initial lane, it will be necessary to place two boards, the same thickness as the mat, at right angles to the mat. The roller will then use the boards to get onto the mat without harming the mat edge. The first pass should cover about 6 inches of uncompacted material. The roller will then make the necessary number of passes over the joint. After the joint is compacted, the roller turns on the previously compacted section of the mat and begins its rolling pattern over the new material.

When two lanes are joined together, the roller compacts the longitudinal joint first. After rolling the joint, the roller moves to the outside edge of the mat and follows the established rolling pattern.

When both a longitudinal and a transverse joint occur, the roller begins by rolling a few feet of the longitudinal joint. Then it returns to the transverse joint and rolls it. After rolling the transverse joint, the roller finishes the longitudinal joint, then goes to the outside edge. Boards are not needed when rolling a transverse joint in a second lane. The roller used the initial lane instead.

CIRCLE THE CORRECT ANSWER(S):

5-67. When a transverse joint occurs, the joint is rolled (first / last).

5-68. When two lanes are joined together, the (longitudinal joint / mat edge) is rolled first.

5-69. When both a longitudinal and a transverse joint occur, the transverse joint is rolled (before / after) the longitudinal joint is finished.

5-78 alligator cracking

5-79 pneumatic roller

5-80 True

5-81 False

5-82 False

5-83 True

5-84 True

5-85 True

If the three traditional rollers are being used, the next step, intermediate rolling, is done with a pneumatic roller.

The purpose of intermediate rolling is to obtain maximum density in the pavement. A pneumatic roller can have the drive wheels facing toward or away from the paver. The pneumatic also works from the outside edge inward. However, the pneumatic roller must be kept at least 6 inches from the unsupported centerline joint when only one lane is in place. Yet, when both lanes are in place, the centerline joint must be overlapped at least 6 inches to obtain additional sealing of the joint. The number of passes the pneumatic should make is set by the Department.

Unlike steel rollers, the pneumatic does not make two passes in the same path, but moves over and overlaps the previous path. The more passes the pneumatic must make for complete coverage of a lane, the more the paths need to overlap. The roller must be in motion before any attempt is made to change paths. The roller must also be turned very gently.

The pneumatic roller operator should be careful not to reverse his machine exactly where the breakdown roller reversed. The pneumatic must also exercise care not to roll over mix that has not been compacted by a steel-wheeled roller. After being rolled by a pneumatic roller, the mat will have a slightly rutted appearance. The pneumatic tires knead the mix, providing a more closely-knit surface. The ruts should not exceed ¼ to 3/8 inch If they do, the mix has been displaced.

CIRCLE TRUE OR FALSE

5-70. True False The purpose of intermediate rolling is to achieve maximum density.

5-71. True False Overrolling may cause loss of density.

5-72. True False Large aggregates rising to the surface is called flushing.

5-73. True False Pneumatic rollers used exactly the same rolling pattern as steel wheel rollers.

5-74. True False A pneumatic roller should never roll an area of mix that has not been compacted by a steel wheel roller.

5-75. True False The ruts made by the pneumatic roller are at least 3 to 4 inches deep.

In traditional rolling, a tandem static roller does the final rolling. It smoothes the ruts left by the pneumatic roller. If a vibratory roller is used, the vibrations are turned off, and the roller makes a static pass to insure a smooth surface.

The tandem static roller should not begin rolling until the mix has cooled to about 120-150 degrees F.. The static also rolls from the outside edge of the mat to the inside. It will make only as many passes as are necessary to achieve a smooth surface. Too much rolling can cause alligator cracking and reduce density. A tandem static roller follows a path similar to that of a pneumatic. However, the tandem does roll the edge of the mat.

FILL IN THE BLANKS:

5-75. A _____ _____roller follows the pneumatic onto the mix.

5-76. A vibratory roller operator will _____ and make a static pass to achieve a smooth mat.

5-77. The mix should be about _____ to _____ degrees F. before final rolling is done.

5-63 contractor

5-64 outside, inside

5-65 a different

5-66 cut

5-67 first

5-68 longitudinal joint

5-69 before

5-78. Too much rolling can reduce density and cause _____.

5-79. A tandem roller follows a path similar to that of a _____ roller.

Occasionally, a mix may not be able to support the rollers without displacement. Such mix is said to be the rollers without displacement. Such mix is said to be tender . If allowing the mix to cool somewhat does not help, the mix may have to be adjusted.

Here are a few rolling rules that can aid in avoiding problems.

1. The roller should be operated slowly enough to prevent displacement of the mix.
2. The speed of a roller should be changed gradually. It should never be "gunned" or "braked" sharply.
3. The directions of a roller should always be changed gradually. A roller should never make sharp turns.
4. Watch for any mix piling up in front of the roller wheel.
5. Watch for mix shifting from one place to another.
6. Watch for sinking of the roller into the mix.

CIRCLE TRUE OR FALSE

5-80. True False Intermediate rolling follows breakdown rolling.

5-81. True False Intermediate rolling does not achieve any compaction of the mat.

5-82. True False The pneumatic roller should overhang the edge of the mat by 2 inches on its first pass.

5-83. True False Intermediate rolling begins at the outside edge of the mat.

5-84. True False The pneumatic does not make two passes over the same path.

5-85. True False Rollers should not be allowed to make sharp turns.

5-86. True False Pneumatics should reverse in exactly the same spots as the steel wheeled roller.

5-87. True False The tandem static roller follows the pneumatic roller onto the mat.

5-88. True False The final rolling achieves very little, if any, compaction.

5-89. True False The tandem roller should not roll the outside edge of the mat.

5-90. True False There is something wrong if mix shifts from one place to another when being rolled.

5-91. True False A roller should change its speed rapidly.

5-92. True False Mix is supposed to pile up in front of the wheels of a roller.

5-93. True False You can reduce the density of a mix by overrolling it.

5-72 False

5-73 False

5-74 True

5-75 False

5-75 tandem

5-76 turn off the vibrations

5-77 120, 150

PAVING IN TANDEM

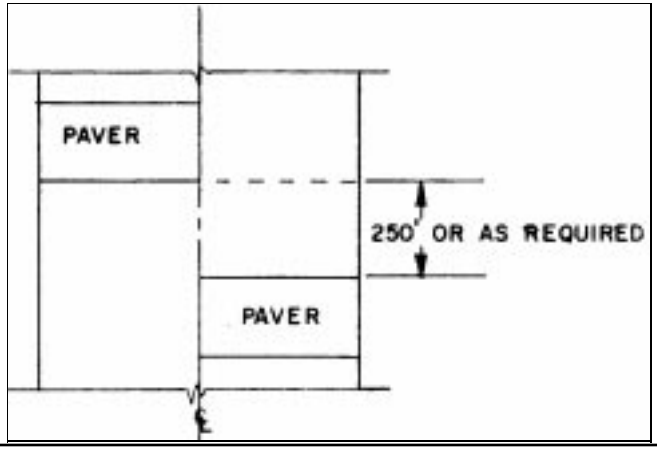
Paving with two laydown machines at the same time is a construction practice known as paving in tandem. This construction procedure might be used on a four-lane highway overlay, or two-lane pavement with no traffic, or on new pavement. (The project this method of construction is used on should be one that can be accomplished satisfactorily and economically. The matter of economics concerns the contractor only. The Department will pay no more than the contract price regardless of the cost of construction to the contractor.)

The hot mix plant should be capable of producing a mix that will meet specifications in a quantity that will enable the paving operation to be continuous. The contractor should have enough trucks to keep the mix flowing to the roadway. The contractor must not only provide two pavers, he must also have enough rollers to keep up with the paving operation.

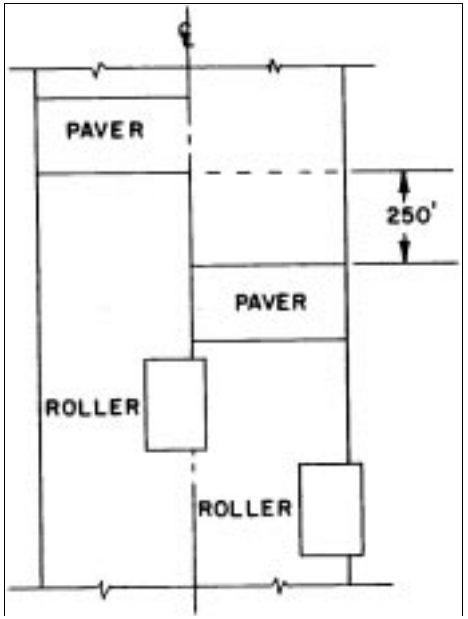
The two main benefits of paving in tandem are:

1. A reduced time of construction
2. A better longitudinal joint

To achieve a good longitudinal joint the pavers must pave adjacent lanes and should operate approximately 250 feet apart. The distance between pavers may be adjusted as conditions require.



The breakdown rollers should be behind the last paver and operate as close to it as possible.



One breakdown roller should roll the longitudinal joint then move to the outside edge of one lane and begin rolling toward the center. The other roller rolls the outside edge of the other lane and progresses toward center. After the center joint is rolled, the rolling pattern is the same as the pattern when only one roller is used.

The pneumatic rollers follow the breakdown rollers in the same pattern as if a single lane were being rolled. The tandem static rollers then follow the pneumatics, just as if only a single lane were being done. It is important to note that all specifications must be met when paving in tandem.

FILL IN THE BLANKS:

5-94. Paving with two pavers is called _____.

5-95. The rollers follow the _____ paver onto the mat.

5-96. Why do contractors pave in tandem ?

_____

_____

5-97. The first passes made by the breakdown rollers are on the _____ joint and the _____edge.

5-98. Other than the first passes of the breakdown rollers, the rolling pattern for tandem paving is the _____ as the regular patterns.

5-86 False

5-87 True

5-88 True

5-89 False

5-90 True

5-91 False

5-92 False

5-93 True

CONSTRUCTION OF CONTROL STRIPS AND DETERMINING TARGET DENSITY

To determine Target Density , a control strip for each type of mix shall be constructed at the beginning of work on each pavement course. The control strip technique is the procedure to determine the maximum density that can be obtained through controlled compactive efforts under project conditions.

Control strips are to be constructed on each type of mix at the beginning of work. It should be at least 500 feet in length and placed at the same width and thickness specified by design. Because of the critical nature of this operation, the engineer should approve the compactive equipment used on the control strip. Close attention should be paid to the temperature at the time of rolling.

The Responsibilities are as follows:

A. Control strips should be constructed at the direction of the project engineer.

B. The construction foreman should be present to direct his operators in proper rolling procedures.

C. A testing technician shall be present to perform the necessary testing.

D. The area bituminous technical services engineer shall be utilized for technical advice on any problems that may arise.

Generally, control strips are constructed while being monitored with a nuclear density gauge . The Department of Transportation and the contractor agree upon a trial-rolling pattern for each roller. This rolling pattern is defined as on coverage over any particular area in one direction. A return coverage over the same area is a second pass.

Intermittent readings are taken between passes of the breakdown roller. (See Section 2-75 for an explanation of breakdown rolling). The readings are monitored, trying to reach the highest density possible. The passes are varied to monitor not only the change in density, but also to observe the roadway for surface texture problems that could occur from over or under rolling. Usually, two to four passes, made uniformly over the entire control strip, are sufficient with a breakdown roller. The breakdown roller should be selected according to project conditions.

ANSWER THE QUESTIONS:

5-99. What are control strips used to determine? _____.

5-100. How long should the control strip be ?

5-101. Who does the necessary testing ?

5-102. What generally monitors control strips? _____.

5-103. Who must agree on the trial-rolling pattern ?

5-104. During the breakdown rolling, what is sought ?

5-105. What two reasons are given for varying the passes made by the breakdown roller?

Readings with the nuclear gauge can be taken between passes of pneumatic tire roller, but generally, these readings are misleading due to the uneven tire marks that leave air voids between the base plate of the gauge and the road-way surface. The roadway should be observed during this compaction period for excessive surface distortion from the tires. (A flushing or shiny appearance may appear if there is too much asphalt cement in the mix. This should be watched carefully.)

The pneumatic tire roller must be in good mechanical condition; proper tire inflation is essential. Scrapers or pads must be installed to keep fines from accumulating on the tires. Pneumatic tire rollers should be rolling whenever possible. The tires should be kept warm to eliminate mix buildup on the tires. Care should be taken when changing directions as to prevent digging into the mat by the tires. The speed of the roller is critical. A roller operating too fast may bounce and leave the road rough. Generally, after five to seven uniform passes the mat is ready for the finish roller.

The finish roller should begin rolling after the pneumatic roller has finished. Its function is to seal the roadway and leave the finished mat smooth and free of roller marks. Two passes will usually be sufficient. Readings are again monitored to achieve the lowest count.

5-94 Paving in tandem

5-95 last

5-96 economical, better long joint

5-97 long, outside

5-98 same

When the highest density is reached from the most practical rolling pattern, the mix is allowed to cool and the actual control strip is run. Sites are pre-selected, using random numbers for five sublots within the controlled compaction area.

Nuclear gauge readings are taken at the pre-selected sites, with three readings made at each location. The areas across the lane are pre-determined by random numbers. The three readings of each sublot are averaged together. When the readings are complete, there will be one reading for each sublot.

Random Numbers

TABLE OF RANDOM NUMBERS

1		2		3		4		5		6		7	
0.576	0.730	0.430	0.754	0.271	0.780	0.732	0.721	0.998	0.239	0.053	0.899	0.554	0.627
0.892	0.948	0.858	0.025	0.935	0.114	0.153	0.058	0.749	0.291	0.810	0.159	0.225	0.163
0.669	0.726	0.501	0.402	0.231	0.505	0.009	0.420	0.517	0.858	0.081	0.277	0.035	0.039
0.609	0.482	0.809	0.140	0.396	0.025	0.937	0.310	0.253	0.761	0.982	0.468	0.334	0.921
0.971	0.824	0.902	0.470	0.997	0.392	0.892	0.957	0.640	0.463	0.095	0.801	0.576	0.417
8		**9**		**10**		**11**		**12**		**13**		**14**	
0.427	0.760	0.470	0.040	0.904	0.993	0.509	0.025	0.794	0.850	0.917	0.887	0.751	0.608
0.549	0.405	0.285	0.542	0.231	0.919	0.371	0.059	0.164	0.838	0.289	0.169	0.569	0.977
0.860	0.507	0.081	0.538	0.986	0.501	0.165	0.996	0.356	0.375	0.654	0.979	0.815	0.592
0.690	0.806	0.879	0.414	0.106	0.031	0.477	0.535	0.137	0.155	0.767	0.187	0.579	0.787
0.251	0.884	0.522	0.235	0.398	0.222	0.788	0.101	0.434	0.638	0.021	0.894	0.324	0.871
15		**16**		**17**		**18**		**19**		**20**		**21**	
0.698	0.683	0.566	0.815	0.622	0.548	0.947	0.169	0.817	0.472	0.864	0.466	0.897	0.877
0.796	0.996	0.901	0.342	0.873	0.964	0.942	0.985	0.123	0.086	0.335	0.212	0.875	0.969
0.348	0.743	0.470	0.682	0.412	0.064	0.150	0.962	0.925	0.355	0.909	0.019	0.190	0.696
0.358	0.595	0.068	0.242	0.667	0.356	0.195	0.313	0.396	0.460	0.740	0.247	0.341	0.688
0.698	0.539	0.874	0.420	0.127	0.284	0.448	0.215	0.833	0.652	0.601	0.326	0.846	0.355
22		**23**		**24**		**25**		**26**		**27**		**28**	
0.209	0.862	0.428	0.117	0.100	0.259	0.425	0.284	0.882	0.227	0.552	0.077	0.454	0.731
0.109	0.843	0.759	0.239	0.890	0.317	0.428	0.802	0.464	0.658	0.629	0.269	0.069	0.998
0.757	0.283	0.666	0.491	0.523	0.665	0.919	0.146	0.123	0.791	0.503	0.447	0.659	0.463
0.587	0.908	0.865	0.333	0.928	0.404	0.892	0.696	0.116	0.120	0.721	0.137	0.263	0.176
0.831	0.218	0.945	0.364	0.673	0.305	0.195	0.887	0.836	0.206	0.914	0.574	0.870	0.390
29		**30**		**31**		**32**		**33**		**34**		**35**	
0.716	0.265	0.058	0.075	0.636	0.195	0.614	0.486	0.629	0.663	0.619	0.007	0.296	0.456
0.917	0.217	0.220	0.659	0.630	0.673	0.665	0.666	0.399	0.592	0.441	0.649	0.270	0.612
0.994	0.307	0.631	0.422	0.804	0.112	0.331	0.606	0.551	0.928	0.830	0.841	0.602	0.183
0.798	0.879	0.432	0.891	0.360	0.193	0.181	0.399	0.564	0.772	0.890	0.062	0.919	0.875
0.104	0.755	0.082	0.939	0.183	0.651	0.157	0.150	0.800	0.875	0.205	0.446	0.648	0.685

Five cores shall then be cut to calibrate the nuclear gauge reading to the actual roadway compaction. A reading is taken with the gauge and a core is taken from the exact spot. This is repeated four times. Through calculations, the gauge is calibrated. The calibration is then applied to the readings from the control strip and the TARGET DENSITY is determined.

If a particular phase of construction is placed where the nuclear gauge will not be used to run acceptance compaction testing, roller patterns shall be established and cores are cut when the mix is cool. The core densities are averaged and the target density is determined.

If the average density is less than 94 percent of the theoretical voidless mixture based on the effective specific gravity of the aggregates used, the engineer may order the construction of another control strip or at his discretion, establish a maximum practical density to be used as the Target Density . Before a new control strip is constructed, changes in the mixture composition or rolling patterns or equipment may be necessary.

The following is an example:

The contractor is to place 165 pounds per square yards of an asphaltic concrete “E”. Upon checking the contract, it was noted that the minimum air temperature for placement of the mix of this thickness is 45 degrees F.. The engineer checks the temperature on the project prior to delivery of the mix. The rolling equipment is checked. The rollers are of sufficient size and type to give an adequate control strip density .

The number of passes for each roller is agreed upon between the engineer and the contractor. The breakdown roller is to make four passes uniformly over the entire mat, the pneumatic tire roller is to roll five passes uniformly over the mat and the finish roller is to roll two passes uniformly.

The mix is delivered to the project at 305 degrees F. Immediately after placement has begun, the depth is checked and verified as correct, and the placement of the control strip begins. The breakdown roller begins, being careful to roll according to earlier plans. By monitoring the density with the nuclear gauge, it was found that between the third and fourth pass, the density fell off indicating over-rolling. The number of passes with the breakdown roller was reduced to three and a new control strip was started.

The density was again monitored. The pneumatic tire roller made its passes uniformly over the control strip area. The density was not monitored after the pneumatic tire roller, but the surface texture was checked closely.

The finish roller made its two passes and the density was monitored. The maximum density appeared to have be achieved. The finished mat appeared tight but had a slight dull color with no flushing or shiny appearance, indicating that the mixture may be a bit low in asphalt cement content.

5-99 maximum density

5-100 500 feet

5-101 Lab

5-102 nuclear gage

5-103 DOT and Contractor

5-104 highest density

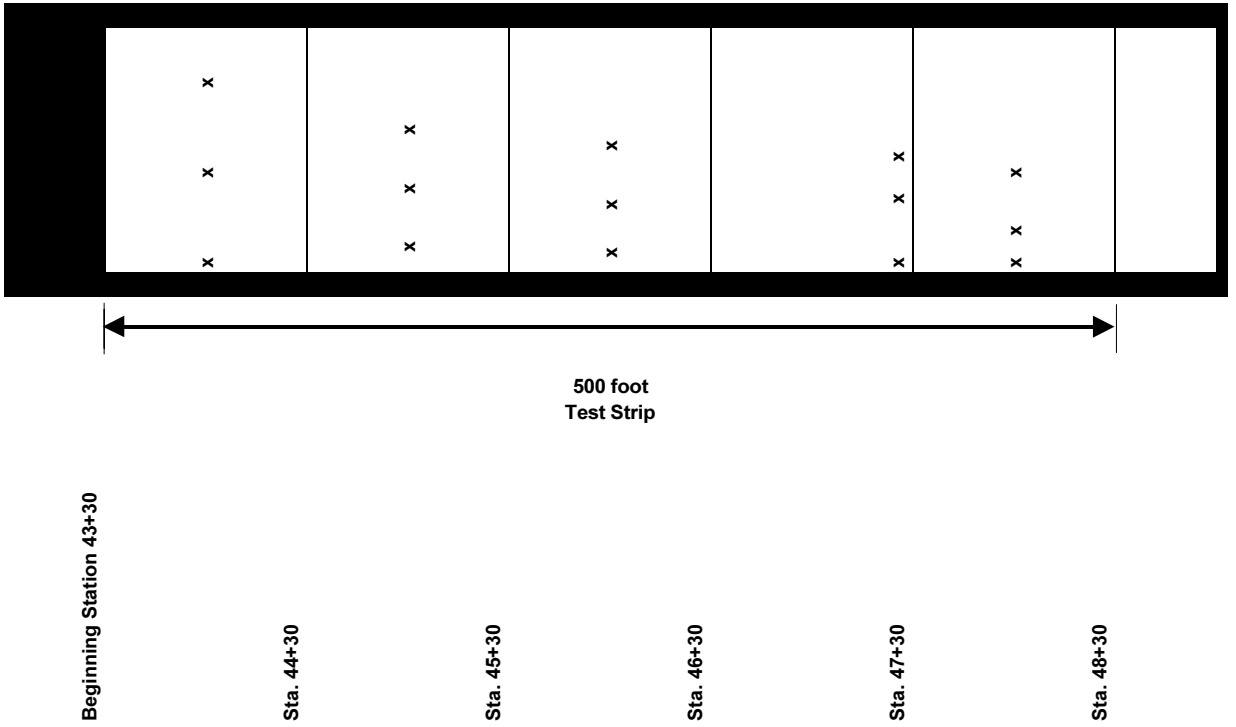
5-105 change in density, observing the surface

To get the control strip densities the control strip is divided into five equal sublots. Since the control strip is 500 feet long, the sublots are each 100 feet long. From the Table of Random Numbers, five numbers are selected to determine the test locations. They were: .581, .303, .894, .643, and .226. These are multiplied by 100 feet to give the distance from the beginning station number. The beginning station number is 43+30.

This will give us:

.581 X 100 feet = 58.1 feet
.303 X 100 feet =30.3 feet
.894 X 100 feet =89.4 feet
.643 X 100 feet =64.3 feet
.226 X 100 feet =22.6 feet

We will add these last numbers to our beginning points for <u>EACH SUBLOT</u> beginning with our beginning station number.



This will give a chart like this:

43 + 30 + 58.1 = 43 + 88.1
44 + 30 + 30.3 = 44 + 60.3
45 + 30 + 89.4 = 46 + 19.4
46 + 30 + 64.3 = 46 + 94.3
47 + 30 + 22.6 = 47 + 52.6

The X's on the diagram mark the relative locations to be tested.
(Scale is approximate).

Random locations across the width of the pavement are selected by selecting three new numbers from the Table of Random Numbers. This is done for each of the five sublots; thus giving 15 individual compaction locations. The three at the individual sublot locations are averaged together to give one average compaction per sublot. These results are the actual control strip densities, which will become TARGET DENSITY, if these averages are accepted.

To calibrate the gauge readings to the core results, five cores are taken from the roadway. Prior to cutting a core, a gauge reading is taken. When the five cores are taken, the nuclear gauge readings are calibrated to the actual core densities by establishing a correction factor to be applied to each reading.

The correction factor is then applied to the gauge readings from the control strip. The densities are then averaged to get the Target Density. In accordance with Section 400.05.F of the Standard Specifications, 94 percent of the theoretical voidless mixture is desired for the Target Density.

The Target Density from our example ran 92.8 percent. If you recall that in compacting the control strip, the mixture appeared dry and dull and since the maximum density was achieved through the selected rolling pattern, the mixture was reviewed for possible changes. The gradation is set at the desired gradation to yield a well-balanced mix. The asphalt cement content can be raised slightly without fear of flushing or surface distortion.

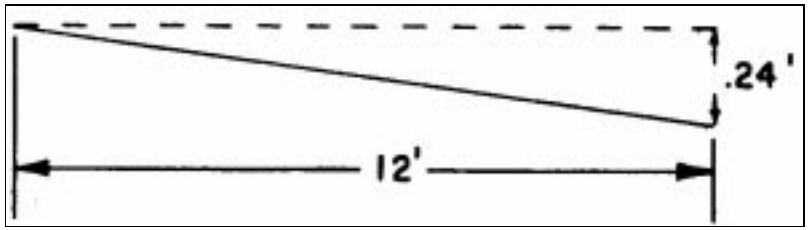
The asphalt cement content was raised .2 percent and another control strip was established. The nuclear density gauge is again used to monitor the density. The mixture change is minor and not expected to alter the gauge calibration; therefore, the new densities are known immediately. When rolling is complete, the density locations are pre-selected using the Table of Random Numbers. The average density ran 94.2 percent of the theoretical voidless mixture. Therefore, this density will be used as the Target Density.

The original Target Density (92.8%) will be used to compute the roadway densities prior to establishing the new Target Density of 94.2%. For this reason, it is essential to limit placement of asphaltic to a controlled amount until an acceptable Target Density is reached.

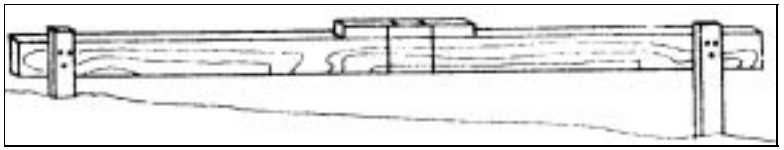
CROWN, SMOOTHNESS, AND WIDTH CHECKS

All roads are subject to testing for conformity to acceptable standards as established by the Standard Specifications and Special Provisions. Among these are the crown (transverse slope of the surface), the smoothness of the pavement's surface, and the width of the road.

The crown must be the same as is shown on the plans. There are several methods of checking crown; one of the most common ways is using a slope template. This is how a slope template is used. For example: If a 12 foot lane is supposed to slope 0.02 foot per foot, the high side of the lane must be 0.24 foot higher than at the low side. (12 X 0.02 = 0.24)



A slope template must be constructed to measure this slope. The template is made out of wood.



The long leg is exactly 0.24 foot longer than the short one. The level is placed on the top in the center of the 12 foot board. To check slope, the short leg is placed on the high point of the lane and the long leg at the low point.

The level then indicates if the template is sitting on a flat surface. If so, the slope is correct. If the slope is incorrect, the position of the bubble in the level shows which side is too high or low. The bubble will always move to the high side of the lever.

FILL IN THE BLANKS:

5-106. The crown must be the _____ as is shown on the plans.

5-107. One of the most common ways of checking slope is to use a _____.

5-108. The difference in the height of the legs of a slope template is the same as the difference in the _____and _____ sides of the lane.

5-109. If the bubble in the level of the slope template moves to the right side, then that side of the lane is too _____.

5-112 five (5)

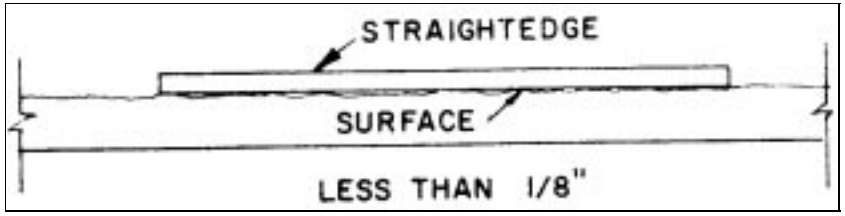
5-113 next day

5-114 inspector

5-115 random number tables

The surface of the pavement should be very smooth and even. So smooth and even, in fact, that no part of the pavement can be more than a specified distance from a 10 foot straightedge. These distances are given in the Standard Specifications, Section 400.07.C.

The pavement must be checked both transversely and longitudinally. To check pavement transversely, a 10 foot metal, straightedge must be used. This means that if a 10 foot straightedge were placed on the surface of the asphalt concrete course, no part of the surface should be farther below the straightedge than the distance indicated in the Standard Specifications.



SURFACE TOLERANCE

Testing for surface course tolerance will be conducted by the Laser Profiler method in accordance with test procedures GHD-93. This testing shall be performed only on surface courses and only on the mainline of the roadway and on ramps more than one-half mile in length. Pavement courses to be overlaid with a friction course are considered surface courses for the purpose of this provision. Other asphalt paving shall be subject to straightedge and visual inspection and the correction of irregularities. The minimum requirements for straightedge and Profiler are found in section 400.07.C1 of the Standard Specifications.

The proper width of the lane is shown on the plans.

To check width:

1. Use a measuring tape. (A 50 foot or 100 foot metallic tape is recommended.)
2. Select at random, several places to measure.
3. Measure the distance from the centerline to the top of the edge.
4. Measure the complete width of the roadway from the outside edge to outside edge.
5. If the distance from one side to the other of a two-lane pavement differs from plan width, tell the contractor. He should correct it.

CHECK THE CORRECT ANSWER(S):

5-110. Where is the proper width of a lane shown ?

a. in the Standard Specifications

b. in the lab report

c. on the plans

5-111. What is used to measure lane width ?

a. a 25 foot metal tape

b. a cloth tape

c. a 12 foot metal tape

d. a 50 or 100 foot metal tape

5-106 same

5-107 slope template

5-108 high, low

5-109 high

In order to have roadway density checked, samples of the compacted mat will have to be taken. Five (5) samples per lot must be taken. The testing technician is in charge of selecting the points from which the samples are to be taken. (He should again use the Random Number Tables, Materials Sampling Manual GHD-73).

FILL IN THE BLANKS:

5-112. At least _____ samples must be taken per day for new construction.

5-113. Samples must be taken by at least the _____ after a pavement is laid.

5-114. The _____ decides where the sample is to be taken.

5-115. In order to decide where the sample will be taken, the testing technician should consult the _____.

The technician can use either a saw or a water-cooled diamond drill to remove the sample. The sample must be cut to the full depth of the lift. The inspector should make sure that the sample is sawed out slowly and carefully to prevent any change in the density. He should also measure the thickness of the sample.

After the sample is removed, there is a hole in the pavement. The contractor is responsible for filling in the hole with new mix from one of the haul trucks. The mix in the hole must then be tamped or rolled. It is the inspector's responsibility to see that this is done.

The testing technician should identify the samples by numbering them and marking them with the station and side of the centerline from which the sample was removed. A good numbering system is one, which includes lot number.

5-110 c.

5-111 d.

For example:

the first sample from Lot 1, would be	1-1;
the second, from Lot 1 would be	1-2;
the third, from Lot 1would be	1-3;
the fourth, from Lot 1 would be	1-4;
the fifth, from Lot 1 would be	1-5.

The second lot would be numbered 2-1, 2-2, etc.

The testing technician will determine the exact numbering system to be used.

CIRCLE TRUE OR FALSE

5-116. True False The technician can use a saw or a water-cooled diamond drill to cut samples.

5-117. True False Samples must be 6 inches in diameter.

5-118. True False Samples should be only 1 inch deep.

5-119. True False Since the Department requires the samples, it is the Department's responsibility to patch the pavement.

5-120. True False The testing technician should identify the samples by numbering them and marking them by station and side of the centerline.

5-125 c.

5-126 b.

5-127 d.

5-128 a.

5-129 b.

The five samples should represent mix of a full day's operation. The technician will compare the density of the roadway sample to that of the Target Density. The results of your samples will be returned the same day they are taken. If the samples fail to meet density requirements, every effort should be made to find out what the problem is. The fault may be in the mix itself, the equipment, or the rolling pattern. Samples must be handled carefully. A sample is no good if cracked, broken or damaged in any way.

This chapter has covered work processes and possible mat problems. Following is in chart form a list of problmes and causes of imperfections in finished pavements.

TABLE A-11 POSSIBLE CAUSES OF IMPERFECTIONS IN FINISHED PAVEMENTS

Insufficient or Non-Uniform Tack Coat	Improperly Cured Prime or tack Coat	Mixture Too Coarse	Excess Fines in Mixture	Insufficient Asphalt	Excess Asphalt	Improperly Proportioned Mixture	Unsatisfactory Batches in Load	Excess Moisture in Mixture	Mixture Too Hot or Burned	Mixture Too Cold	Poor Spreader Operation	Spread in Poor Condition	Inadequate Rolling	Rolling at the Wrong Time	Over-Rolling	Rolling Mixture When Too Hot	Rolling Mixture When Too Cold	Roller Standing on Hot Pavement	Overweight Rollers	Roller Vibration	Unstable Base Course	Excessive Moisture in Subbase	Excessive Prime Coat or Tack Coat	Poor Handwork Behind Spreader	Excessive Hand Raking	Labor Careless or Unskilled	Excessive Segregation in Laying	Faulty Allowance for Compaction	Operating Finishing Machine Too Fast	Mix Laid in Too Thick Course	Traffic Put on Mix While Too Hot	Types of Pavement Imperf That May be Encounter Laying Hot Plant Mix Pa Mixtures.
					X		X																X								Bleeding
				X				X	X																						Brown, Dead Appearance
					X	X	X																X				X				Rich or Fat Spots
		X	X			X	X			X	X	X	X	X	X	X								X	X	X	X		X		Poor Surface Texture
X	X	X				X	X			X	X	X	X	X		X	X	X	X	X	X			X	X	X	X				Rough Uneven Surface
		X		X		X	X			X	X	X	X	X			X							X	X	X	X				Honeycomb or Ravelling
		X								X	X	X	X	X		X	X				X			X	X	X	X	X			Uneven Joints
			X		X	X				X			X	X		X	X	X	X							X					Roller Marks
X	X		X		X	X	X	X			X	X		X		X			X	X	X				X					X	X	Pushing or Waves
			X	X		X								X	X	X			X		X	X									Cracking (Many Fine Crack
															X				X		X	X									Cracking (Large Long Crac
		X				X				X	X	X		X	X	X			X												Rocks Broken by Roller
		X		X		X			X	X	X	X							X		X					X			X		Tearing of Surface During La
X	X		X		X	X		X		X			X	X	X		X		X		X	X	X									Surface Slipping on Base

REVIEW QUESTIONS:

CIRCLE THE CORRECT ANSWER(S):

5-121. The mix should not drop over _____ from the minimum allowable plant temperature.

a. 20 degrees F.
b. 30 degrees F.
c. 50 degrees F.
d.15 degrees F.

5-122. Roadway density is determined by

a. the technician
b. the roadway inspector
c. the project engineer
d. the contractor's foreman

5-123. Blue smoke rising from a truckload of mix means

a. the mix is too cold
b. the mix is too hot
c. the mix is the right temperature
d. the mix contains too much asphalt

5-124. Badly contaminated mix should be

a. rejected
b. used, and then the contaminated picked out
c. cleaned up as much as possible, then used
d. reheated to purify the contamination

5-116 True

5-117 False

5-118 False

5-119 False

5-120 True

5-135 d.

5-136 a.

5-137 a.

5-138 c.

5-139 c.

5-125. When fine aggregate clump together and the coarse aggregate clump together, this is called
a. separation
b. clumping
c. segregation
d. aggregation

5-126. The actual depth of a mat after rolling is called
a. plan thickness
b. compacted thickness
c. laydown thickness
d. theoretical thickness

5-127. The depth of the mat is usually checked with a
a. diamond drill
b. saw
c. ruler
d. probe

5-128. The number of pounds of hot mix that is being used per square yard of pavement is called
a. actual yield
b. theoretical yield
c. pound yield
d. tonnage yield

5-129. Haul trucks should
a. back in the paver
b. allow the paver to make contact
c. let their beds rest on the paver
d. be painted green

5-130. In order to tell when a truck has begun to rest on a paver, an inspector should

a. listen for a loud “clang”
b. listen for a grating sound
c. watch the rear wheel
d. check the mat after the paver has passed

5-131. The two types of joints that occur in asphalt paving are

a. mortise
b. longitudinal
c. transverse
d. beveled

5-132. The process of tapering a mix is called

a. angular paving
b. grading
c. smoothing
d. featheredging

5-133. How far apart should longitudinal joints be ?

a. 3 feet
b. 12 inches
c. 3 centimeters
d. 3 yards

5-134. Three wheel rollers are operated with the _____ wheels forward.

a. drive
b. tiller
c. steel
d. back up

5-121 a.

5-122 a.

5-123 b.

5-124 a.

5-135. When both a longitudinal and transverse joint occurs, the roller

a. completely rolls the longitudinal joint first

b. completely rolls the transverse joint first

c. rolls part of the transverse joint, then the entire longitudinal joint

d. rolls part of the longitudinal joint, then the entire transverse joint

5-136. The problem of fines coming to the surface is called

a. flushing

b. segregation

c. separation

d. clumping

5-137. A mix that cannot support the rollers without displacement is said to be

a. tender

b. flushed

c. segregated

d. soupy

5-138. Paving with two pavers at the same time is called paving

a. double-time

b. in duo

c. in tandem

d. twice

5-139. The two pavers should be about _____apart.

a. 250 yards

b. 25 meter

c. 250 feet

d. 25 feet

5-140. Crown is checked with a

a. slope template

b. rolling straightedge

c. static straightedge

d. colored water tank

5-141. For hot mix paving, how many density samples must be taken per day ?

a. 2

b. 3

c. 4

d.5

5-142. Cracked samples

a. are O.K.

b. must be judged individually

c. are no good

d. are acceptable if crack is less than 1” long

This is the end Chapter V. If you have missed any questions, review the appropriate material; if not, go on to Chapter VI.

5-130 c.

5-131 b.,c.

5-132 d.

5-133 b.

5-134 a.

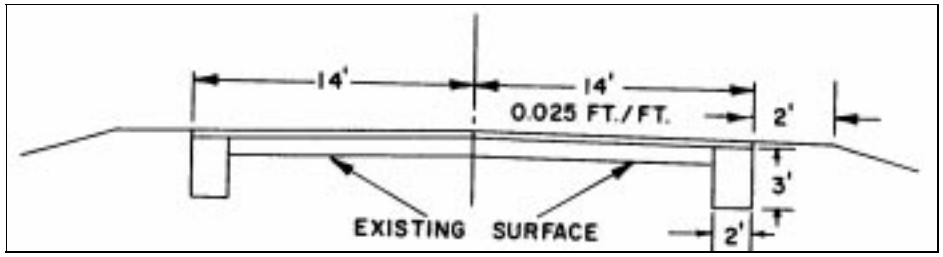
CHAPTER VI - SPECIAL CONSTRUCTION

This chapter deals with construction that does not occur in every paving operation. Special construction here refers to widening, curbs, patching, construction at bridges, and friction courses.

WIDENING OPERATIONS

Hot mix is often used to widen old pavements. Before any widening operations begin, the inspector should examine the plan typical sections, the contract, the special provisions, and the specifications to determine the dimensions of the widening.

This is an example of a typical section.



In order to widen a roadway, trenches must be dug along the sides and filled with hot mix. The width and depth of these trenches are shown on the plan typical section. The inspector should see that the trenches are dug to the width and depth shown on the typical section.

It is the contractor's job to dig the trenches. He should not be allowed to dig trenches that cannot be filled during the day's operation. If he does, the trench must be backfilled with the excavated material, soil or other suitable material. Operations cannot be halted for the day until the trenches have been backfilled and compacted. This is done to protect the traveling public.

5-140 a.

5-141 d.

5-142 c.

During road widening operations, signs warning motorists of low shoulders should be posted. Trenched material should be removed or displaced as soon as possible. Weep holes are needed if threatened by rain.

ANSWER THE FOLLOWING QUESTIONS:

6-1. What documents should the inspector examine before paving operations begin?

_____
_____
_____
_____

6-2. In the preceding diagram, how deep and how wide must the trench be dug ?

_____ _____

6-3. Before operations can be halted for the day, what must the contractor do ?

_____

6-4. Why must trenches be filled the same day?

_____

The edge of the pavement that is to be widened must be cleaned properly and tacked. Haul trucks are used to bring the mix to the roadway. The inspector must collect the weight tickets and keep them for his records. When it arrives at the roadway the mix cannot have dropped more than 20 degrees F. from the minimum allowable plant temperature.

6-8 T

6-9 T

6-10 T

A widening machine

The mix can be placed in the trench by a spreading machine. The mix may be placed in one or more lifts. The contractor may use any combination of approved rollers to compact the mix to the density required. The engineer must approve the roller pattern. Hot mix used in widening must meet specification just as hot mix used on the roadway does. Therefore, plant control is unchanged for the widening operation.

After the mix has been placed and compacted, it is the inspector's responsibility to see that the mix is sampled for density testing. A core must be cut through the complete thickness, measured, and recorded by the testing technician. Consult the Sampling, Testing, and Inspection Manual for methods and frequency of sampling.

CIRCLE THE CORRECT ANSWER(S):

6-5. The requirements for asphalt mix for a widening operation are (the same as / different from) regular hot mix paving.

6-6. The mix can be placed in the trench by a (haul truck / spreading machine).

6-7. The mix must be sampled for (texture / density) after it is placed.

Joints occur in widening, as well as in normal paving operations. If no backfill was placed against the previously laid widening, joints are constructed by tacking the end of the joint of the in-place widening and place the new mix against it. If backfill material was placed against it, then the end of the previously laid widening must be thoroughly cleaned (or cut back to expose clean material). Then the clean surface is tacked and the operation continued.

CURBS

When specified, hot mix can also be used to construct curbs. Hot mix curbs are constructed with automatic curbing machines.

6-1 typical section, specifications, special provisions, contract

6-2 three (3) feet, two (2) feet

6-3 fill in the trench and compact

6-4 protect the public

These automatic machines lay, compact, and finish straight or curved curbs without the use of any additional equipment. Changing the template (mold) in the curbing machine can change the shape of the curb.

In constructing curbs, the duties of the roadway inspector are as follow:

1. To see that the surface upon which curbs are to be constructed is clean and properly tacked.
2. To see that the curb is constructed to proper line and shape. (Plans will indicate the proper line and shape.)
3. To check the temperature of the mix in the truck. To collect and issue tickets as discussed earlier in this course.
4. To measure the amount of tack used.
5. To measure and document length of curb construction during day's operation.

CIRCLE TRUE OR FALSE

6-8. True False If backfill has been placed against previously laid mix, theBsurface must be cleaned before it is tacked.

6-9. True False Hot mix curbs are constructed with an Automatic Curbing machine.

6-10 True False The roadway inspector must check mix temperature during curbing operation.

Asphaltic curb is paid by the linear foot. These measurements are made in linear measurement along the face of the curb. No roadway samples are taken and curbs must meet no density requirements.

Some deficiencies that may occur in the construction of hot mix curbs are:

1. Curb out of alignment
2. Curb not bonding properly to pavement
3. Curb crumbling
4. Voids in the surface of the curb
5. Wrong cross-sectional shape of curb

FILL IN THE BLANKS:

6-11. Asphalt concrete curb is paid for by linear _____.

6-12. _____ roadway samples are taken of asphalt curbs.

6-13. List three possible deficiencies that can occur in an asphalt curbing operation.

_____

_____

_____

TRANSITIONS AT BRIDGES

Hot mix is not usually placed on a bridge. Bridges are usually built with approach slabs of Portland Cement Concrete.

6-5 the same as

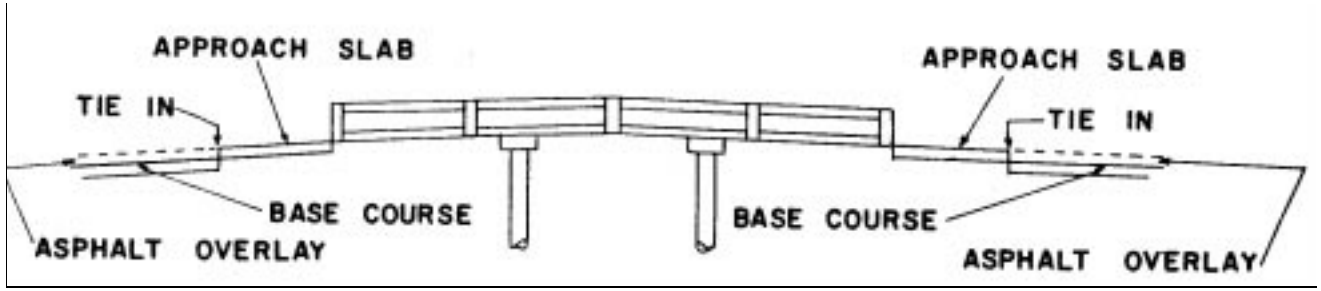
6-6 spreading machine

6-7 density

6-17 transition

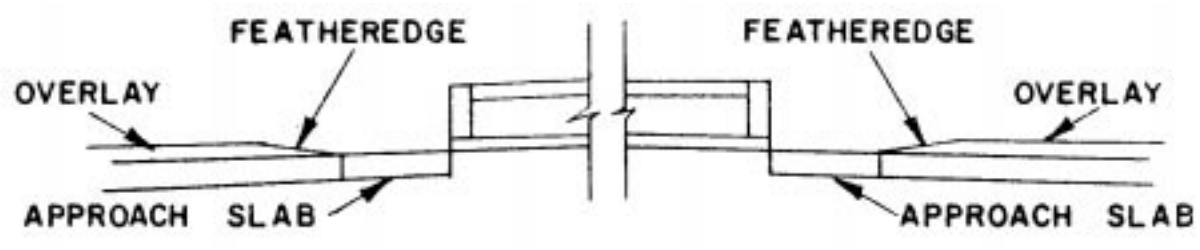
6-18 hand

6-19 rakes



The hot mix will be abutted to the approach slab, so that there is no dip or bump where the mix and approach slab joins. It is critical that the compacted thickness of the mat be exactly right at this point. When new pavement is joined to the approach slab, a tie-in is made.

Sometimes an overlay will begin or end at the bridge approach slabs. In this case, the overlay mat must be feathered to the approach, as shown below.



If the overlay begins or ends at the bridge itself, rather than at the approach slabs, the overlay will probably be placed in a continuous mat with the joints of the approach slabs being overlaid.

CIRCLE TRUE OR FALSE

6-14. True False Hot mix is a typical bridge pavement material.

6-15. True False When new pavement is joined to the bridge approach slab, a tie in is made.

6-16. True False Overlays must always stop at the bridge approach slabs.

6-11 foot

6-12 no

6-13 curb not bonded, not straight, curb crumbling

6-25 False

6-26 True

6-27 False

6-28 True

On new highways, the roadway is usually widened at bridges in an effort to construct safer highways. The change in width is called a transition. These transitions are triangular in shape in a plan view. (A bridge located in a curve is, naturally, an exception.) The transition is usually from zero to 2 feet wide by 200 feet long on each side of the roadway surface.

The placing of hot mix at transitions should be done by hand. This is done by removing the side plate, at the end of the spreading screw on the paver, when a transition is reached. The screw is allowed to "worm" the mix out into a windrow as the paving operations progress. (A windrow is a long, narrow ridge of material.)

When a sufficient amount of mix has been windrowed, the mix should be placed by hand to the required line and grade. When the mix is placed, hand casting should not be permitted. The material is placed into position, not thrown. The mix should then be carefully worked with lutes or rakes so as not to cause segregation of the aggregate. After the mix is placed, it is rolled as usual.

The widening, with all the hand placing, raking, etc., should be done on the outside edge of the pavement. The outside edge will need a lot of work; it should have a neat and true line

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CIRCLE THE CORRECT ANSWER:

6-17. The widened section of a highway as it approaches a bridge is called a (transition / slab).

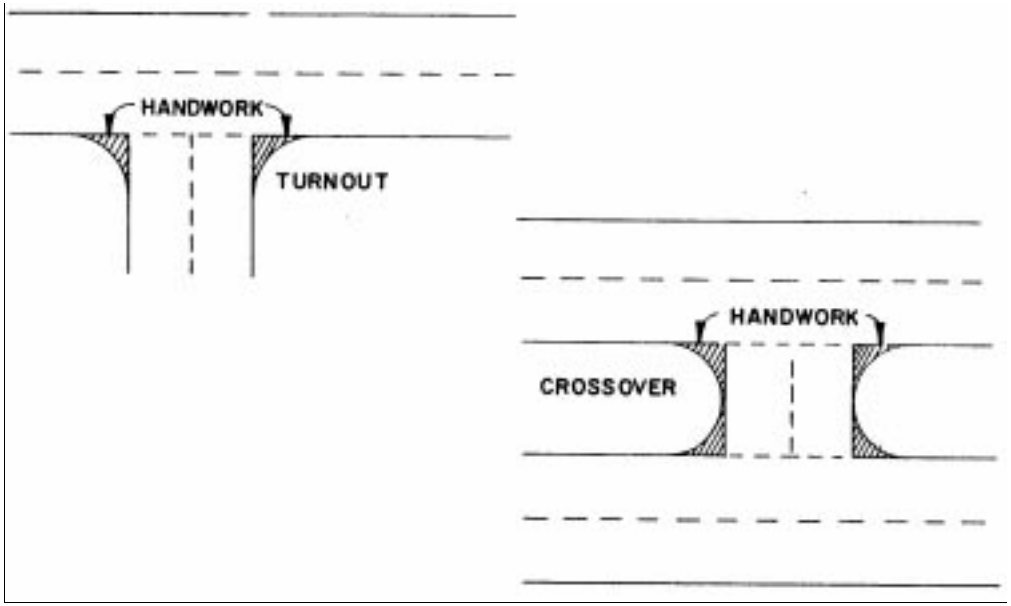
6-18. The placing of hot mix at transitions is done by (hand / paver).

6-19. The hot mix must be worked with (rakes / shovels) to prevent segregation.

HANDWORK

It is necessary to do handwork in areas that the paver cannot reach, such as areas around manholes and curbs. For example, a paver will place mix as close to a manhole as possible. The area around the manhole must then be filled in by hand. Fresh mix is shoveled into the area and carefully placed. The rollers then compact the mix as close as they can to the manhole. The area not compacted by the rollers must be hand tamped.

Handwork is also necessary on crossovers and turnouts. The paver will cover as much of the area as possible, but the curved shape of crossovers and turnouts makes it almost impossible for the paver to cover the total area of each.



Because of the size and shape of the paver, the shaded areas will be left.
Mix may be placed in these areas by

1. removing the side plate from the screed and worming the mix into the uncovered places.
2. hand shoveling the mix.
3. After the mix is in place, it is compacted.

Mix that is place by hand should be placed to the full thickness of the lift, not spread in thin layers.

6-14 False

6-15 True

6-16 False

6-32 False

6-33 True

6-34 True

6-35 False

6-36 True

CIRCLE TRUE OR FALSE:

6-25. True False Areas to be worked by hand are usually small; therefore, there is no need to worry about them.

6-26. True False Mix should always be carefully placed, never thrown.

6-27. True False Mix placed by hand need not be compacted.

6-28. True False Mix placed by hand should be placed to full thickness of the lift, not spread in thin layers.

ASPHALTIC CONCRETE OPEN GRADED FRICTION COURSE

An asphaltic concrete friction course is laid to provide skid resistance. The uniform size of the aggregate in the mix allows water to flow through the mat rather than collecting on top. This permeability helps prevent vehicles from hydroplaning (wheels riding on the surface of the water, not on the pavement). The shape of these aggregates creates an abrasive surface that also aids skid resistance.

The mix used for an asphaltic friction course is called D-mix. Such a mix is composed of asphalt cement with anti-stripping additive and/lime and Group II, Class A, aggregate. The job mix formula and design limits are shown in Section 828, Standard Specifications.

There are certain weather limitations on the laying of an asphaltic concrete D-mix. Paving operations must be discontinued when the ambient temperature falls below 60 degrees F. and cannot resume unless this temperature is at least 60 degrees F.

Caution must be maintained against overheating of “D mix”, and excessive temperature can cause fat spots and flushing in the mat. Because “D” mix cools so quickly, the temperature of the mix in any truck making a long haul (in excess of 40 miles), should be checked carefully. The inspector should exercise extreme caution regarding the temperature of “D” mix. Even within the acceptable temperature limitations, the asphalt in the mix can segregate from the aggregate and seep to the bottom of the truck. Therefore, the bottom of the haul truck requires careful attention. If such segregation occurs, the bottom section of the mix should not be placed on the road

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A fat spot is caused by raw asphalt cement flushing through the aggregate and appearing on the surface of the mat. Should a fat spot appear behind the paver, it should be removed to the depth of the lift using hand shovels. Fresh mix should then be carefully placed in the area prior to rolling.

FILL IN THE BLANKS:

6-29. An asphaltic concrete “D” mix is laid to provide_____ _____.

6-30. The mix used for a friction course is called _____.

6-31. “D” mix cannot be placed unless the ambient temperature is at least _____ degrees.

Asphaltic concrete “D” mix is rolled only with self propelled, steel wheel rollers. Pneumatic rollers are not used; nor are vibrations used with vibratory rollers. The mat must be compacted to the satisfaction of the engineer.
Tests for extracted aggregate gradation are run by the Department’s personnel at the hot mix plant in accordance with the Sampling, Testing, and Inspection Manual.
The roadway inspector is responsible for checking spread rate.

6-41 c.

6-42 a.

6-43 a.

6-44 c.

6-45 c.

The surface on which the Asphaltic Concrete "D" is to be laid must be cleaned and tacked prior to paving. For "D" mix, the tack coat can be a maximum of 0.08 gallons per square yard This is greater than the maximum of 0.06 gallons per square yard for normal asphalt paving.

Handwork is very difficult with "D" mix because it cools so rapidly. If handwork is necessary, the hottest mix out of the truck should be used and the work should be completed as quickly as possible.

Traffic should not be allowed to travel on a freshly laid "D" mix. This is especially important if the vehicles have traveled through the tack coat. Tack on vehicle tires can cause the mat to peel off the roadway. The mat must be allowed to cool sufficiently before traffic is allowed to pass over it.

CIRCLE TRUE OR FALSE:

6-32. True False Asphaltic concrete "D" mix is rolled only with 10-ton pneumatic rollers.

6-33. True False Department personnel run extracted aggregate gradation tests on Asphaltic Concrete "D" mix.

6-34. True False The roadway inspector is responsible for spread rate checks.

6-35. True False The maximum amount of tack allowed for a "D" mix is the same as for a surface course.

6-36. True False Handwork is very difficult on asphaltic concrete "D".

REVIEW QUESTIONS

CHECK THE CORRECT ANSWER(S):

6-37. Which documents should an inspector check before beginning a widening operation ?

a. plan typical sections
b. contract
c. special provisions
d. specifications
e. all of the above

6-38. When widening, the contractor should dig trenches

a. for the entire job
b. for each day's work
c. continually
d. each evening for the next day's work

6-39. The mix can be placed in the trench by a

a. paver
b. haul truck
c. asphalt distributor
d. road widener

6-40. Hot mix curbs are made by

a. a paver with a side attachment
b. a factory, then installed with tack
c. a curbing machine
d. hand with special shovels

6-29 skid resistance

6-30 "D" mix

6-31 60 degrees F.

6-51 a.

6-52 d.

6-41. Which of the following is not a possible deficiency of an asphalt curb ?

a. out of alignment
b. crumbling
c. not meeting density requirements
d. not bonding to pavement

6-42. Where an asphalt mat meets a bridge approach slab a(n) _____ is made.

a. tie-in
b. connection
c. buffer
d. abutment

6-43. Overlays must be _____ to be even with the approach slabs.

a. featheredged
b. thickened
c. beveled
d. tacked

6-44. A long, narrow ridge of hot mix is a(n)

a. pile
b. hill
c. windrow
d. rise

6-45. An electronic screed can use a _____ to gradually increase the slope.

a. stringline
b. computer
c. dial device
d. sensor

6-46. The numbers on the dial device indicate

a. inches

b. 0.01 feet

c. degree of grade

d.percent of slope

6-47. Areas around turnouts, crossovers, manholes, etc. must be paved and compacted

a. with special machinery

b. by hand

c. with a paver and a roller

d. by any of the above ways

6-48. The mix used for an asphaltic friction course is called

a. dust seal

b. hydroplane

c. asphaltic concrete “D” mix

d. slurry seal

6-49. The asphalt in asphaltic concrete “D” sometimes

a. rises to the top in the truck

b. falls to the bottom in the truck

c. catches on fire in the truck

d. solidifies in the truck bed

6-50. Spread rate checks for asphaltic concrete “D” mix are

a. not necessary

b. recorded on the Project Diary

c. recorded on D.O.T. 159-5

d. taken by personnel from the District Laboratory

6-37 e.

6-38 b.

6-39 d.

6-40 c.

7-2 False

7-3 True

7-4 True

6-51. The maximum amount of tack that can be applied for a friction course is _____ per square yard.

a. 0.08 gal.
b. 0.05 gal.
c. 0.01 gal.
d. 0.005 gal

6-52. Tack on vehicle tires that pass over a freshly laid mat of asphaltic concrete “D” mix

a. can help compact the mat
b. can cause fat spots
c. can cause flushing
d. can cause the mat to peel off the roadway

CHAPTER VII: ASPHALT PLANTS

Modern hot mix asphalt production facilities have evolved into two basic types of plants: “batch” and “continuous flow”. Both type of facilities, regardless of plant age, can be equipped with all the requirements for modern, up-to-date production, including automation, recycling systems, and additional equipment for bulk and liquid material additives. Either type facility can produce consistent, high quality, hot mix, load after load to meet the required Job Mix Formula.

FILL IN THE BLANKS:

7-1. There are two kinds of asphalt plants: _____ and _____.

BATCH TYPE PLANTS

Batch type facilities have been common since the turn of the century, and have changed little in their overall concept. They produce hot mix asphalt a “batch” at a time; that is the aggregates are weighed up individually, asphalt is weighed up individually, then they are mixed together and dispensed into a truck or storage equipment a “batch” at a time.

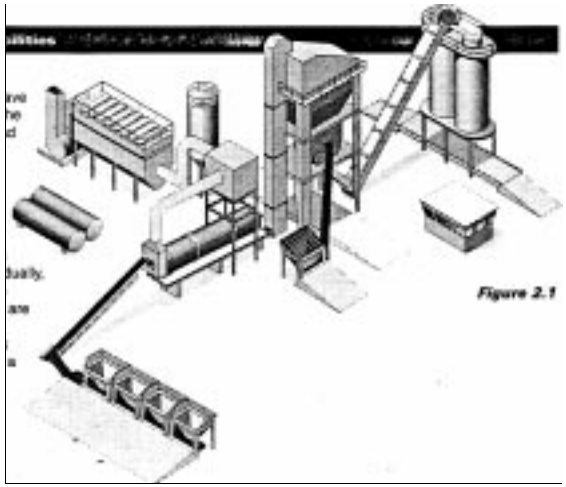
6-46 d.

6-47 b.

6-48 c.

6-49 b.

6-50 c.



In a batching style facility, once aggregate is dried, it is conveyed to the top of the screening section with a bucket elevator. (Modern facilities use enclosed bucket elevators, and enclosed screening towers for dust control.) At the screening unit, the aggregate passes over different screens where the aggregate is separated into different sizes, depending on the screen cloth installed in the screening unit.

CIRCLE TRUE OR FALSE

7-2. True False Batch type plants produce two (2) batches at a time.

7-3. True False In a batch type plant, aggregates and asphalt are weighed up individually then mixed together.

7-4. True False Aggregates pass over screens that separates the aggregate into different sizes.

Sized aggregate is stored in the “hot-bins”, so called because they contain the hot, dried aggregate, which is waiting to be dispensed into the aggregate weigh hopper. These bins are also called “supply bins”. The gates below them are frequently referred to as “supply gates”.

FILL IN THE BLANKS

7-5. Hot bins contain_____ _____ _____.

7-6. Supply bins is another name for an _____ _____ _____

7-7. _____ _____ are located under the supply bins.

The batch person either manually, or automatically, “draw” material from each “hot bin”, depending on the mix formula, and weighs the aggregate in the aggregate “weigh hopper”, which is positioned directly below the “hot bin” gates.

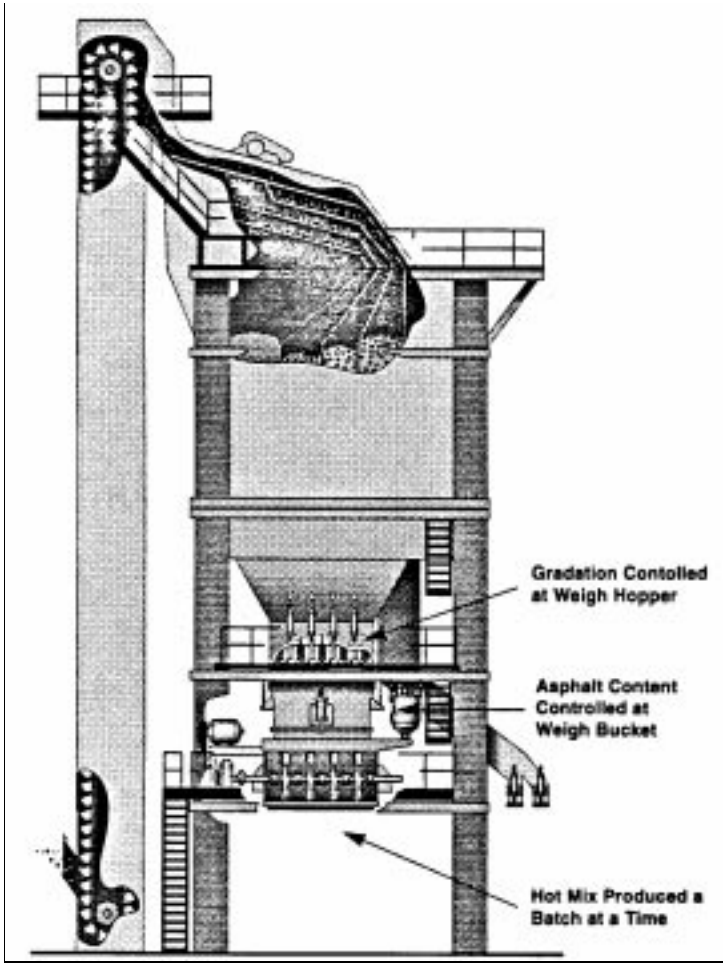
Asphalt is pumped into the asphalt weigh bucket, where it is weighed to the required amount. With modern, automated plants, the aggregate weighing and asphalt weighing is done simultaneously to shorten the batch cycle.

The aggregate is discharged from the aggregate “weigh hopper” into the pugmill, where it is mixed for a brief period of time without asphalt cement to thoroughly mix the aggregates from each supply bin. This is called the “dry mix cycle”. After the “dry mix cycle“, the asphalt cement is discharged into the pugmill where it is mixed with the blended aggregate in a “wet mix cycle”. From there, the hot mix is dispensed into a waiting vehicle or transfer equipment for storage in a silo.

ANSWER THE QUESTION:

7-8. What is a dry mix cycle?

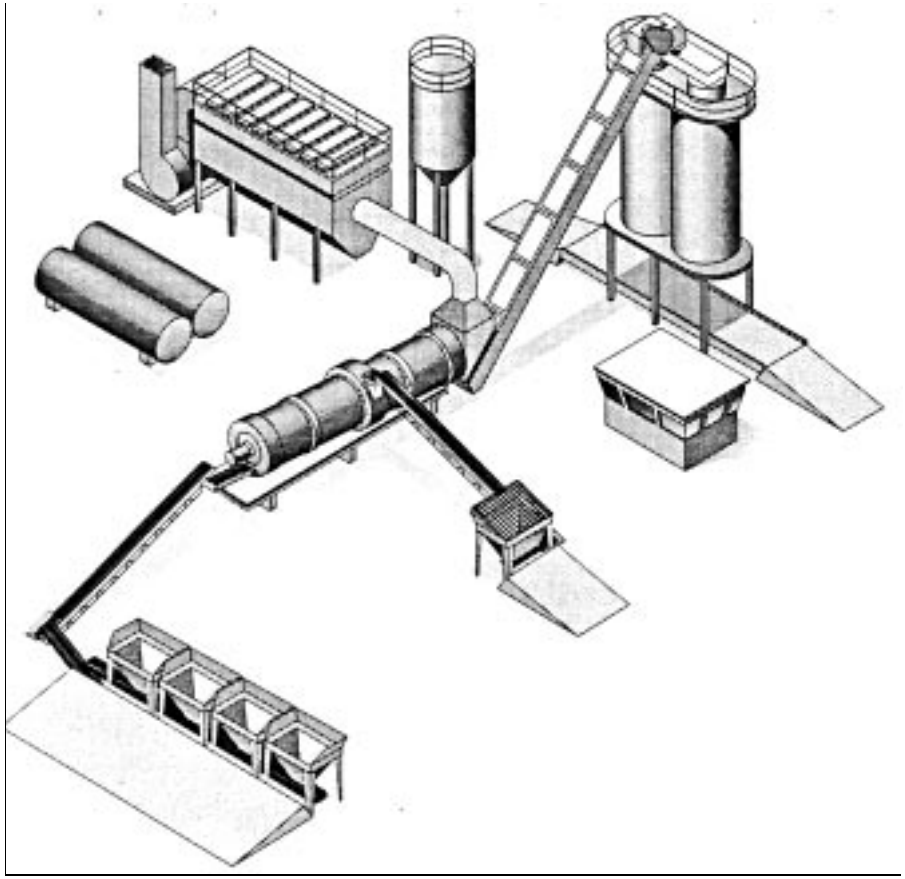
7-1 batch, continuous flow



The size of the “batch” will depend on the size of the facility, and the discretion of the plant operator. Batch plants are sized in tonnage or poundage. While facilities have been producing over the years from .7 to 20 tons; Typical size found in the field range from 2 ton to 5 ton.

Final aggregate gradation is determined in the “tower” from the “supply bins”. The asphalt content is determined with the asphalt “weigh bucket”, and mix is produced a “batch” at a time.

DRUM-MIX PLANTS



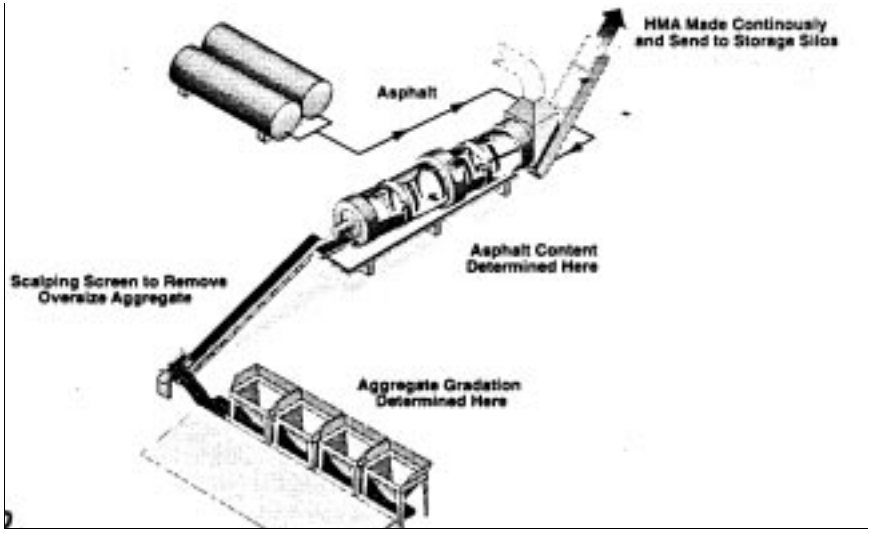
7-5 hot dried aggregate

7-6 aggregate weigh hopper

7-7 Weigh hopper

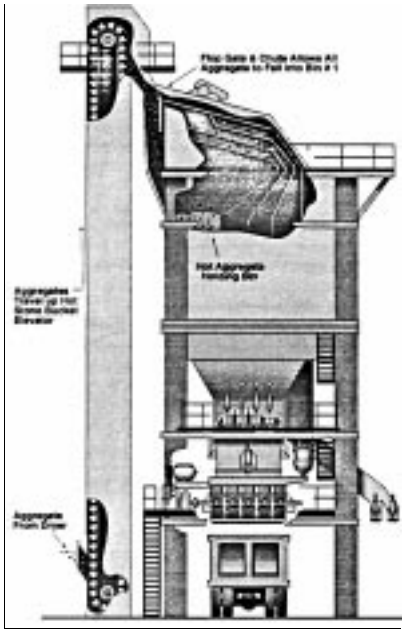
7-8 aggregate is discharged from the weigh hopper into the pugmill, where it is mixed for a brief period of time with out asphalt cement to thoroughly mix the aggregates from each supply bin.

The concept of continuous flow drum mix plant facilities is not new, and has come and gone since the early part of the century. The “continuous flow” or “drum -mix” facilities we are familiar with, mostly include parallel flow drum-mixers popular from the early 1970’s to the late 1980’s; the counter-flow drum-mixers popular since the late 1980’s, and the modern dryer/mixer facilities such as the “double barrel” plant.



There are a quantity of plants now operating in the field designed around variations of the dryer/mixer theme. Most of these plants use aggregate dryers feeding external mixing devices. The primary difference between these "continuous flow" or "drum-mix" facilities and a "batch" style facility is that aggregate is sized, blended, dried, and mixed with liquid asphalt in a one-step continuous basis, rather than the batch-at-a time basis common with the batching style facility.

Unlike a batching style plant that has sizing screens at the top of the batching tower to size the aggregate, and holding bins and a weigh scale for proportioning the mix formula; all "drum-mix"/"continuous flow" plants control gradation at the aggregate feeders. Plants take as given that properly sized aggregates are being delivered to each of the cold feed bins. The plant automation controls the proportioning of each aggregate by varying the flow rate from each cold feed bin, typically with electronically controlled variable speed belt conveyers at the individual feeders.



FILL IN THE BLANK(S):

7-9. Another name for a modern dryer/mixer plant is a _____ _____ or _____ _____ plant.

7-10. A drum mix plant mixes all the ingredients in a _____ _____ continuous basis.

7-11. A drum mix plant controls gradation at the _____ _____.

7-12 True

7-13 False

7-14 True

The only screens installed in continuous flow plants are for “scalping purposes” – rejecting oversized tramp materials from the mix blend.

AC (Asphalt cement) is also proportioned and blended on a continuous basis. The combined aggregate is weighed as it enters the dryer, typically with a belt scale. The asphalt cement is then proportioned on a continuous basis with the aid of a flow meter and flow control system to match the weight of this aggregate stream.

The responsibility for the proper proportioning and the proper timing of the asphalt cement flow falls on the electronic, automated controls. Because the mix is being produced on a continuous basis, the finished product must be stored for dispatch into a haul truck. This is typically done with overhead storage silos.

The popularity of drum-mix and continuous flow plants has had many batch plant operators to modify their batching plants by removing the sizing screens on the tower and controlling gradation at the cold feed like a drum-mix plant or continuous-flow plant. This is typically referred to as “screenless mixing” with a batch plant.

Asphalt is still weighed a batch at a time; so the two functions occurring are one aggregate pull and one asphalt pull. This fact further reinforces that several variations of the two basic plant configurations of “batch” and “continuous flow” do exist. The term “drum-mixer” is typically, although technically inaccurate, used in the field to denote a “continuous flow” type plant. In the 1970’s and 1980’s a vast quantity of parallel-flow drum-mixers were manufactured and sold. All plant manufacturer’s used the term “drum-mixer” to refer to this style facility. Regulatory specifications and educational materials had to be re-written to include this new style of continuous flow plant. The terms “batch plant” and “drum-mix plant” became a common reference for the two types of modern hot mix facilities.

In the late 1980’s, however, plant manufacturers began experimenting with more environmentally sensitive designs for recycling, drying, and mixing. Each manufacturer’s goal was to create a plant design with the cleanest possible emission discharge and the highest possible percentage of reclaimed pavement that could be used in the new hot mix.

Several new styles of hot mix plants evolved from this design period, and today we have counter-flow drum-mixer facilities, unitized dryer/mixer facilities, and separate dry-mixer facilities. To minimize confusion, and to standardize specifications by regulatory agencies, all of these facilities are typically referred to under the umbrella of "drum-mix facilities" or "drum-mix plants". Ultimately the choice between a batch plant and a drum-mixer plant depends on business factors - purchasing costs, operating costs, and the flexibility required for local market conditions; and not on the individual advantages of one facility of another. Both type plants can produce equal quality virgin or recycled mix for the required job.

Batch facilities offer greater flexibility when making different types of hot mix from one truck to another, particularly in small lots. Batch plants are favored in metropolitan markets, or in markets where unpredictable quantities and types of mixed must be produced from the plant each day, and load to load. To gain the same type of mix flexibility with a drum-mix plant you need additional silos. Even with many silos, it is difficult for a drum-mix plant to produce small quantities, say ten ton or less, for and individual load.

New batch facilities are more expensive to purchase than drum-mix facilities. When a plant is being purchased for a specific large project, or contract work involves a discreet mix is to be produced at a given time, contractors typically lean toward purchase of a drum-mix facility. There is more equipment associated with a batch style plant than with a drum-mix style plant.

Batch plants, because of their additional moving and wearing parts, are more expensive to operate and maintain than drum-mix plants. Batch facilities carry slightly higher variable costs, or operating costs for the owner. There is more equipment to run and maintain. There are more electric motors to consume energy. Purchase of a new batch plant, therefore, is weighed carefully against the advantages a batch plant might offer in a given local market.

7-9 continuous flow or drum mix

7-10 one step

7-11 aggregate feeders

TRUE OR FALSE

7-12. True False Batch plants offer less flexibility than drum mix plants.

7-13. True False It is easy for a drum mix plant to produce small quantities.

7-14. True False Batch plants are more expensive to operate and maintain than a drum mix plant.

CHAPTER VIII - DOCUMENTATION

With computers being added to the work place, the Department is constantly changing and thus improving recordkeeping for both Construction and Office of Materials and Research Personnel. With the implementation of the "Sitemanager" Software Program, the Department will have engaged in the latest of available technological support for all recordkeeping and contractor payments. Recordkeeping is a necessary and more increasingly important part of our jobs. But due to the constant changes being made in both Construction and The Office of Materials and Research, it is in the best interest of this text for you to reference all current guidelines, memorandums, and manuals in recordkeeping and contractor payment for further information and/or instruction.