6. Laydown

6.1. Responsibilities and Authority of the Laydown Inspector

6.1.1 Areas of Responsibility

There are many aspects of a paving operation that require monitoring and inspection. As the laydown inspector, you have the prime responsibility for:

- Paving mix quantities and thickness
- Rolling and compaction
- Joint preparation and construction
- Raking
- Surface tolerances

You will have help in these areas from the scale operator (who measures quantities) and, on most jobs, a ticket taker.

You may also have the prime responsibility for:

- Final grade (and prime or tack) approval
- Traffic control

If others have the prime responsibility in these areas, you still must work with them. Traffic may ruin a surface that a grade inspector has approved for paving. If so, you must not allow paving until the problem is repaired and/or the grade inspector has a chance to check the area again. An approved traffic control plan may need revision as the work moves down the road. Signs can blow over. You must remain alert to these needs.

You will always share responsibility for the *quality of the paving mix*. A materials inspector does the density and asphalt content tests on the pavement, but you must make sure these are being done as required. The plant inspector is responsible for seeing that good mix leaves the plant, but you must be alert to the mix quality too. Mix can become too segregated, cold, or contaminated after it leaves the plant. Materials

testing is discussed in Chapter 3 of this manual; plant inspection is discussed in Chapter 4.

Laydown inspection can be hectic and demanding. Be sure you read the specifications, gather tools and equipment, and calculate the spread prior to the start of paving. Be sure there is good communication between you; the contractor; and the grade, materials, and plant inspector.

The laydown inspector may reject the condition of the grade as being unsuitable for paving. The laydown inspector may also reject loads of asphalt concrete based on quality, contamination, or temperature.

You must document any rejection you make and the reasons for it.

Knowing what good concrete looks like, both in the trucks and on the grade, requires some experience. The *Troubleshooting Guide* (Appendix A) lists the most common problems and their probable causes.

6.1.2 Records

Records of the paving operation may be organized differently on different projects, but they usually include *Weight Tickets,* the *Asphalt Concrete Field Book (Paving Log),* and the *Inspector's Daily Report*.

Weight tickets are issued for each truckload of asphalt concrete at the scales. They are collected at the paver and the time and location that the mix is placed is written on them. The ticket taker does this, if there is one. If there isn't, the laydown inspector must do this.

The Asphalt Concrete Field Book (Paving Log) is used to record the placement of individual loads, to calculate the yield, and to note temperature measurements, weather conditions, etc. This is discussed in more detail in Section 6.3. Placement. A sample page of a paving log is included at the end of this chapter.

The Inspector's Daily Report is used to summarize the day's activities. This includes a listing of the contractor's men and equipment and their hours and locations of work. It also includes a record of the conditions of work – the pace of it and its quality, work stoppages and the reason for them, etc. Construction problems should be noted, along with the steps taken to correct them.

On some projects the Inspector's Daily Report covers a number of items of work other than just the paving operation. This is the case on the sample report shown at the end of this chapter. If someone else is completing the Inspector's Daily Reports, the laydown inspector may limit his or her records of work to the Paving Log. Make sure you know what records you are required to keep *before* work begins.

6.1.3 Laydown Inspector's Checklists

Inspector's Equipment Checklist

- Straight edge 16'
- Air thermometer
- Surface thermometer
- Asphalt thermometer
- 50' tape
- Pavement depth gauge, ruler, or tape
- Clipboard
- Paving log
- Calculator

Preliminary Checklist (Before Paving)

- Trucks adequate (checklist in Section 6.2)
- Paver(s) adequate (checklist in Section 6.2)
- Rollers adequate (checklist in Section 6.2)
- Grade and prime (or old pavement and tack) acceptable for paving
- Weather warm enough and dry enough for paving
- Stringline or other paver guide in place
- Screed heated before paving begins
- Screed blocked to loose depth before paving begins
- Cold joint surfaces cleaned and prepared adequately

Production Checklist (During Paving)

- Paver starting and stopping minimized
- Placement location and time marked on all weight tickets
- Mix temperature within specs for laydown

Figure 6-1
Truck Dumping into Paver

- No visible segregation or contamination
- Mix appearance not too wet or dry
- Hopper never completely emptied; feed augers always at least two-thirds full
- Yield calculated periodically and thickness adjustments made as needed
- No flinging (broadcasting) or long distance raking of hand-placed material
- Joints and edges raked properly
- Rolling begins as soon as possible without shoving
- Proper rolling sequence followed
- Compaction finished before mat cools to 185°F
- Good mat surface texture without roller checking
- Surface smoothness within tolerance (including joints)
- Materials inspector makes tests as needed
- Traffic stays off mat until it cools to 140°F

6.2. Equipment

6.2.1 Hauling Units (Trucks)

Airports 401-4.3 and Highways 401-3.04 (03) contain the standard specifications for trucks. All trucks must have canvas covers to protect the hot mix from the weather if needed. Truck beds should be lightly treated with an approved bed release agent.

Diesel fuel can dissolve asphalt cement, causing it to ooze ("bleed") to the pavement surface after paving. The uncoated aggregate left behind may ravel, resulting in potholes. *Diesel is not an approved bed release agent.* For the same reason, trucks leaking fuel, lubricating oil, or hydraulic oil must not be allowed.

Truck weights must be within legal limits unless permission has been given otherwise. Ask your project engineer for the current formula or form to calculate the legal loads for the contractor's trucks. Overloads are sometimes allowed on gravel embankments before they have been paved. They should be avoided on bridges and paved surfaces (even old pavements that will be overlaid).

Truck Inspection Checklist

- Trucks are equipped with covers

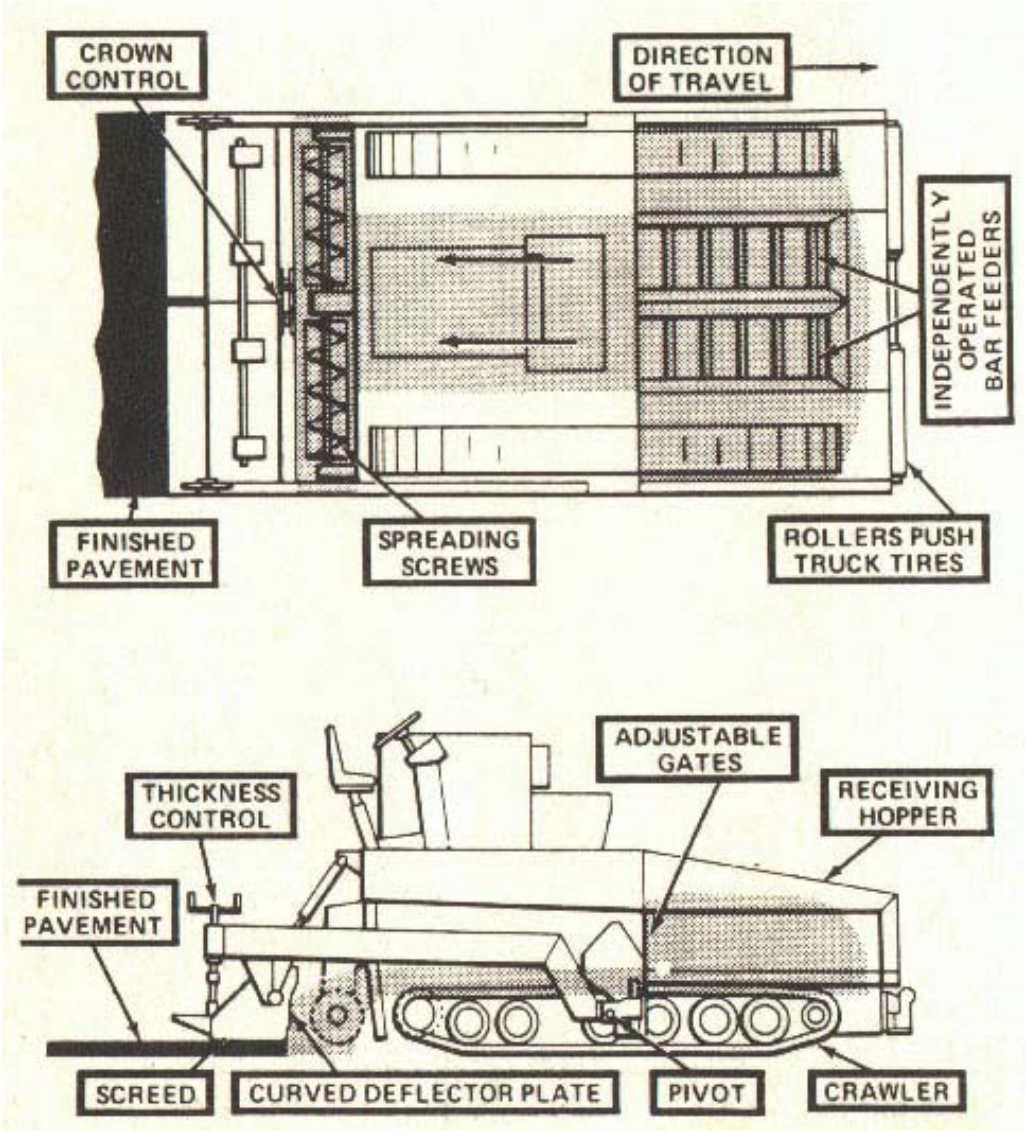


Figure 6-2
Basic Paver Components
Courtesy of the Asphalt Institute

- Approved bed release agents are used
- Legal loads are calculated for each truck
- Trucks are not leaking oils or fuels
- Truck beds are clean (free of dirt)

6.2.2 Pavers

Standards specifications for pavers are found in Highways 401-3.05(03) and Airports 401-4.4. Pavers are also called paving machines or laydown machines. They consist of a tractor unit that pulls an activated screed (see Figure 6-2). The screed spreads the asphalt concrete and partially compacts it by using either *tampers* or *vibrators*.

Tractor Unit

The tractor provides power for forward motion and for spreading the asphalt concrete. The tractor unit has a hopper, feed slats, feed gates, augers (screws), engine, transmission, and controls. The feed slats, feed gates, and augers should be adjusted so that the augers and

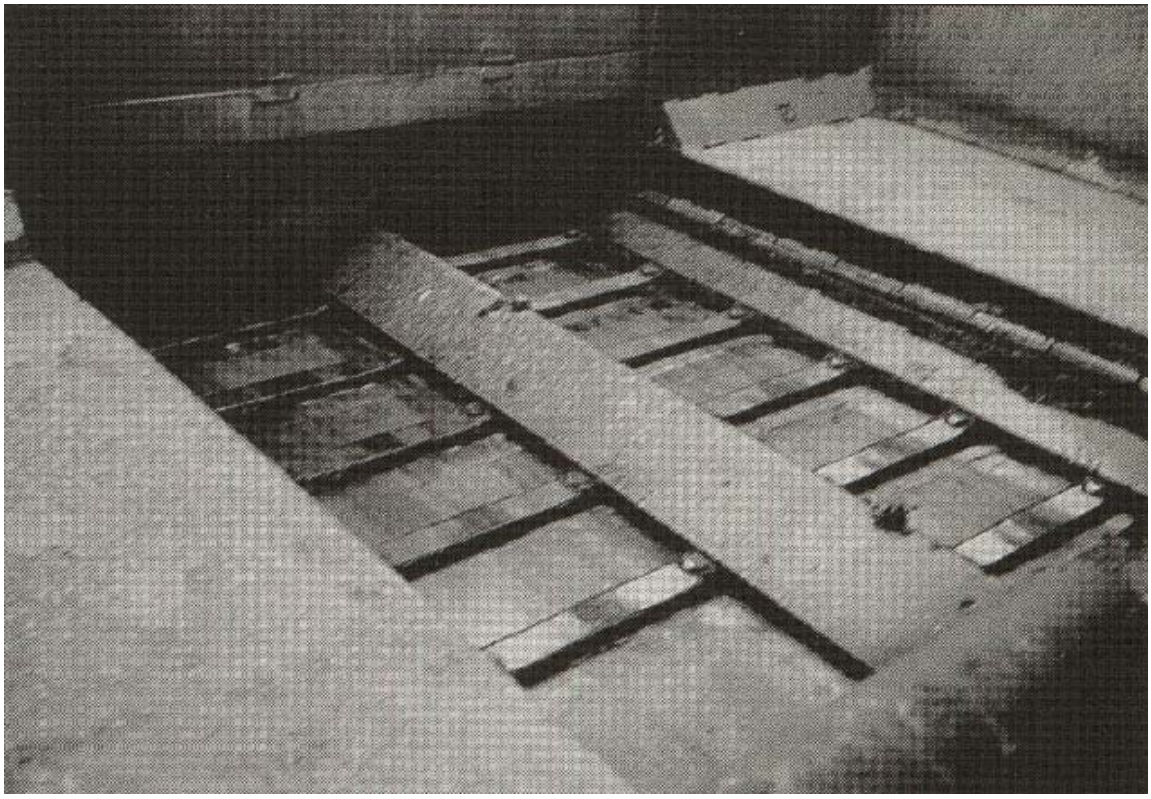


Figure 6-3
Paver Feed Slats

feed slats are running most of the time and the feed augers are about half full. Sensors that detect the amount of asphalt reaching the end of the screed control the augers. These need to be properly located and adjusted to keep the augers running most of the time and half full. The NAPA paving handbook recommends keeping the mix level at the midpoint of the augers rather than three-fourths full as recommended by the Asphalt Institute.

Screed Unit

The screed includes the tamper and/or vibrator, thickness controls, crown controls, and heater. Automatic screed controls are required (Highways 401-3.05 [03], Airports 401-4.4).

Tamper or Vibrator: The screed strikes off the surface of the asphalt concrete. Some pavers have vibrators to make the screed oscillate, which partially compacts the mix. On other pavers there are tamper bars for this purpose. Some pavers have both. About 80 percent of the compaction is accomplished by the screed. Paving crews should not be allowed to turn the vibrator off.

Thickness Controls: The screed is attached to the tractor by long leveling arms and rides on top of the new mat like a water skier towed behind a boat. This arrangement compensates for irregularities in the existing surface and helps to produce a smooth pavement. The mat thickness is controlled by the head of asphalt built up on the augers and on the screed angle. The head of asphalt on the augers should be constant under normal operation. The thickness controls change the angle of the screed. It may take about 50 feet for a paver to completely react to any adjustments to the thickness controls.

Crown Controls: These can put a vertical angle ("crown") in the front and/or back of the screed. The front of the screed should be crowned slightly higher than the rear so that asphalt flows into the "shadow" left by the auger differential. A stripe will appear down the center of the mat if this is not done correctly. The screed crown should match the crown (if any) on the grade or an existing pavement. If the screed crown is improperly set, the mat may be too

Figure 6-4
Checking Pavement Thickness

thin in places and tear during placement or too thick in places, causing an over-run in quantities.

Heater: The screed heater is used to warm the screed surfaces before paving begins. It is generally not used at other times. Overheating will cause the screed to warp and require the plates to be replaced.

Automatic Screed Controls

Automatic screed controls allow the screed to follow a smooth line, even if there are irregularities in the surface being paved. Many automatic screed controls have a long ski, which rides smoothly over the grade. A stringline or other device is used on other pavers. An automatic sensor detects any vertical movement of the ski (or stringline). The sensor signals the screed control, which raises or lowers the tow point on both sides of the screed to compensate for the grade changes.

The manual controls are used until the correct pavement thickness is achieved. The automatic controls are then switched on to maintain the required depth. If everything is working correctly, few other adjustments are needed. Once the automatic screed controls (and the hydraulic valve to the tow point hydraulic ram) are turned on, the manual screed controls no longer have any effect. The automatic controls will override them. The tow point ram should be watched to make sure it is working in conjunction with the automatic controls. It should be centered well enough so that it won't go into the stops. Check both sides of the paver.

This side slope or crown is sensed by reference to a (vertical) pendulum. The automatic controls raise or lower one side of the screed to keep the side slope at the amount set on a dial. When the side slope changes, as it does approaching the superelevation on a road curve, the "automatic" side slope controls must be worked manually.

Automatic controls do a good job when they work properly. There should be little need for tinkering with the controls, except when a side slope is changing. Even so, inspectors and operators must remain alert to what the paver is doing. When the controls go haywire, you can have a sorry mess in a hurry. The screed may jerk up and down, for instance, causing a long ripple in the pavement surface.

Paver Inspection

The standard specifications require pavers to have certain equipment, but they do not describe the equipment's required condition. Instead they require pavers to be capable of producing a pavement with a specified grade, smoothness, etc. (Highways 401-

3.05 [03], Airports 401-4.4). A paver in bad condition won't produce such a mat and is unacceptable. The following checklists will help to inspect pavers.

Paver Inspection Checklist

The tractor unit should be checked for:

- Loose or worn tracks
- Frozen or worn rollers
- Clutch adjustments
- Clean slat feeders and conveyor belting
- Tire pressure (rubber-tired pavers)
- Engine performance and governor

Tamper type screeds should be checked for:

- Worn tampers
- Tamper clearance from nose of screed plate (0.015" – 0.020")
- Tamper stroke (1/8" total and 1/64" below screed)
- Oscillating type screeds should be checked for:
- Parallel and true alignment of oscillating screed and vibrating compactor
- Vibrators adjusted and working. Paving crews should not be allowed to turn the vibrator off.

Either type screed should be checked for:

- Warped or worn-thin screed plate. A string line can be used to check the screed surface.
- Uniform heater action
- Both ends of box closed
- Augers working and correctly spaced
- Thickness and crown controls working
- Screed extensions have full augers and vibration
- Counter-flow augers used to push material under the center box are oriented correctly

Figure 6-5
Pickup Machine and Paver

6.2.3 Pickup Machines

Some contractors use belly dump trucks, which dump hot mix in windrows on the grade. Then a pickup machine (also called a windrow elevator) is used to deposit the mix into the paver. The windrows of hot mix must be the right size and in the correct location to give the proper spread without segregation.

A skilled dump man is important to good windrowing. He must tell the truck drivers where to start dumping and how fast to drive, and know when and if to adjust the truck gate widths.

Windrows tend to segregate in their long direction, with too much coarse material at the end. Long, thin windrows that overlap help compensate for the lineal segregation. Windrow length is a function of vehicle speed and belly gate width.

Windrowed asphalt concrete cools rapidly. You must carefully monitor the temperature of the windrows. If they are cooling too rapidly the contractor may have to hold the mix in the trucks longer and slow plant production. *Overheating the asphalt at the plant is not an acceptable solution to this problem.*

The pickup machine must pickup pick up as much asphalt concrete as possible. Paving mix left on the existing surface cools faster than the rest of the mix and may result in an area with low density. It may also leave a strip of segregated mix along each edge of the windrow.

6.2.4 Rollers

Standard specification for rollers is found in Highways 401-3.06 (03) and Airports 401-4.5.

Steel Wheel Rollers

Steel wheel rollers have one powered steel drum and either a steering (guide) drum or rubber-tired steering wheels. A scraper keeps the drum clean. A reservoir supplies water to wet the drum surface, which prevents asphalt pick-up. Diesel is *not* allowed as a drum wetting agent.

The weight on the drive drum should be at least 250 pounds per inch of width for breakdown and intermediate rollers. Roller weight can be adjusted by adding or removing water from the drum. Usually less weight is used for finish rolling.

The pavement surface will be smooth only if the drum surface is smooth and true. The drum face should be checked with a straight edge or string line before paving to see if it is warped. Also look for pits in the

Figure 6-6
Steel Wheel Roller

drum surface. Check the pavement surface carefully, after rolling at the beginning of the project.

The transmission, brakes, and drum bearings must be in good condition. Wheel bearing wobbling or rough starts and stops leave marks in the pavement.

Vibratory Rollers

Steel drum rollers used for breakdown rolling usually are equipped with vibrators. Both the frequency and the amplitude of the vibration can be varied to achieve the best compaction.

There should be at least ten downward impacts per foot of travel of the roller. This requires a minimum of 880 vibrations per minute for every mile per hour of roller speed. If the roller is moving too fast for the vibration rate, a short wavy pattern will appear in the asphalt surface. Use a straight edge to monitor this, and increase the frequency or slow the roller if it is a problem.

The vibration amplitude should be high enough to get the desired compaction. If set too high, however, the roller may bounce, break the aggregate, and de-compact the mat. Follow the manufacturer's recommendations. Usually low amplitude is used for pavements less than 2 inches thick, medium amplitude for pavements that are 2 to 4 inches thick, and high amplitude for pavements more than 4 inches thick.

Pneumatic (Rubber Tired) Rollers

Pneumatic rollers have smooth rubber tires instead of steel drums. They usually have two axles with three to five tires per axle. They should weigh 3,000 to 3,500 pounds per wheel. The weight can be adjusted by adding ballast.

Between tires, tire pressures should not vary more than five psi. Some pneumatic rollers have an air system that automatically adjusts the tire pressure to a given setting that is controlled by the operator. All of the tires are connected to this air system and should be the same air pressure, unless a tire has been punctured or an air line damaged. A soft tire leaves a ridge of uncompacted asphalt, which may become a string of potholes a few years later.

Pneumatic rollers are generally used for intermediate rolling. They work the aggregate with a kneading action, which provides a more tightly knit mat than

can be obtained by a steel drum roller. When used for intermediate rolling, tire pressure should be about 90 psi when hot and 70 or 75 psi when cold.

Pneumatic rollers have independent wheel suspension. They find weak spots and holes in the base course that a steel wheel roller would bridge over. This is especially beneficial in compacting leveling courses on irregular surfaces or in wheel ruts.

Fresh asphalt concrete sticks to cold tires. Sticking may be a problem the first few minutes until the tires heat up. Skirts around the base help prevent heat loss from the tires, and are especially helpful in cold and windy weather. If a pneumatic roller continues to pick up asphalt it is because the tires are still too cold. The problem can be alleviated by working the roller closer to the paver (this may require the breakdown roller to work closer to the paver as well) or by improving the skirts so more heat is held around the tires.

Roller Inspection Checklist

- Number of rollers adequate for the job
- Weight of rollers adequate and/or meets specs
- Rollers start and stop smoothly
- Steel drums not warped or pitted
- Drums have scrapers and are wetted with water
- Pneumatic roller tires have smooth treads
- Tire pressures differ by less than 5 psi

6.3. Placement

Standard specifications for placement are found in Highways 401-3.12 (03) and Airports 401-4.10.

The base and prime (or for old pavement and tack) must be inspected just before paving. Any oil puddles, soft spots, or potholes must be corrected before paving begins. Asphalt concrete must not be placed on a wet, frozen, or unstable base. Air temperature must be at least 40^{o}F (Highways 401-3.01, Airports 401-4.1 for 3" or more).

Before paving the contractor should determine what the "loose depth" of uncompacted material is needed to produce the desired compacted depth. Loose depth is usually about 25 percent more than compacted depth.

The screed should be set on blocks of loose depth thickness when starting on an unpaved grade. When starting paving against a transverse joint, the screed is set on boards resting on the end of the old pavement. The boards should be as thick as the difference between loose and compacted depth. This ensures that the paver places the full loose depth when starting.

Airport projects require test strips to assure that pavement produced will meet specifications. Test strips may be required on highway projects too.

The first strip paved on airport projects (after the test strips) is normally the highest part of the surface. On a crowned runway or taxiway, this is along centerline. On both, airport and highway projects, the contractor must have a stringline, curb or other means to align the paving. The screed must be heated before mix is added to the paver.

A bump forms every time the paver stops, so it is desirable to have the paver move continuously at a uniform speed. A balance between paver speed, plant output, the number of trucks, and the haul distance is needed to accomplish this. Trucks should be dispatched from the plant at a uniform rate during continuous paving so that the paver speed can be set to maintain a continuous operation.

Trucks should not jolt the paver when they back up to it, or a bump in the mat may result. The rollers on the paver should push against both sets of rear wheels on the trucks.

Coarse aggregate tends to roll to the tailgate of a truck. Trucks should be unloaded in a surge, which minimizes this potential cause of segregation.

Keeping the paver's hopper partially full at all times also reduces the potential for segregation. Any coarse aggregate, which rolls to the tailgate of a truck, drops into the hopper first. If the hopper is empty the coarse aggregate will all be fed to the screed at the same time. A line of coarse (segregated) material across the mat will result. If the hopper is partially full the coarse aggregate tends to mix back in with the rest of the asphalt concrete.

Figure 6-7
Pneumatic Roller

The paver should place the mix wherever possible. If it must be placed by hand, it should be shoveled to the required location. Flinging the mix with a shovel or raking it for long distances causes segregation. Surface tolerance and segregation require special care whenever pavement is placed by hand.

6.3.1 Hand Raking

Hand raking should not be done unless absolutely necessary. The most uniform surface texture can be obtained by keeping the handwork behind the screed to a minimum. The raker should be alert to a crooked edge on the mat so he or she can straighten it immediately. The raker does this by either removing or discarding the mix that bows outside the edge line or by adding mix from the hopper if the edge of the mat is indented. The raker will occasionally need to work along the longitudinal joint. If the paver follows the guideline, the back work will not be necessary.

Surplus hot-mix should not be cast across the mat surface as this will result in nonuniformity of the surface texture, even after proper compaction.

6.4. Joints

The Standard specifications for joints are found in Highways 401-3.14 (03) and Airports 401-4.12.

6.4.1 Transverse Joints

Transverse joints are placed wherever paving is ended and begun again at a later time. The cold pavement edge must be clean, tacked and in good condition. Two ways of forming a clean edge are illustrated in Figure 6-10. A lumber bulkhead must be placed just after the paver leaves, while the mat is hot. The end of the hot mat is cut to a clean, straight edge with shovels, the board placed against it, and the ramp formed against the board.

A somewhat similar joint can be made with paper in place of the board. Sawcut faces may be required by project specifications. They are made in cold mats just before the new pavement is laid.

Figure 6-8
Paver in Operation

The fresh mix at the joint should be "loose depth" (thicker than the previously compacted pavement). Inexperienced rakers may try to rake the hot asphalt concrete to the thickness of the cold mat. This may look better before the joint is rolled but results in a low spot along the joint after compaction.

Transverse joints should be rolled parallel to the joint (crosswise to the paving direction) before any other rolling begins on the new mat. Transverse joints must be compacted in static mode (with the vibrator off) since the vibrator may crack cold pavement.

6.4.2 Longitudinal Joints

Longitudinal joints run in the direction of paving. They are generally weak spots in the pavement and should be kept out of high traffic areas whenever possible. On highway projects they must be placed at lane lines or centerline (401-3.14) (03). On airport projects, paving strips are normally at least 20 feet wide, which minimizes longitudinal joints (Airports 401-4.10).

Most longitudinal joints are formed by placing hot asphalt concrete against cold pavement. The cold pavement edge may need sweeping (especially if vehicles have driven on it) and must be tacked.

The new mat is placed with a one or two-inch overlap on the old mat, as shown in Figure 6-9. The coarse aggregate should be raked out of this excess and wasted. The remainder of the excess is pushed back to form a bump at the edge of the new mat, as the figure shows.

Many rakers work very hard to push back the material at the edge of the joint and fling it on to the hot mat. This is a poor procedure, which will result in a weak joint and an open surface texture along the joint. If the raker does not pile up the correct amount of asphalt at the joint the asphalt at that point will be of lower density then the rest of the mat.

The breakdown roller then "pinches" the longitudinal joint with a small part of the drum on the old mat and part of the drum on the new mat. Rollers should operate in static mode, as for transverse joints. The joint should be pinched before the breakdown rolling on the rest of the mat.

If two pavers are working in adjacent lanes, a hot longitudinal joint may be formed. In this case the rollers behind the first paver should leave the edge of the mat uncompacted. The rollers behind the second paver compact this edge along with the second strip as shown in Figure 6-11.

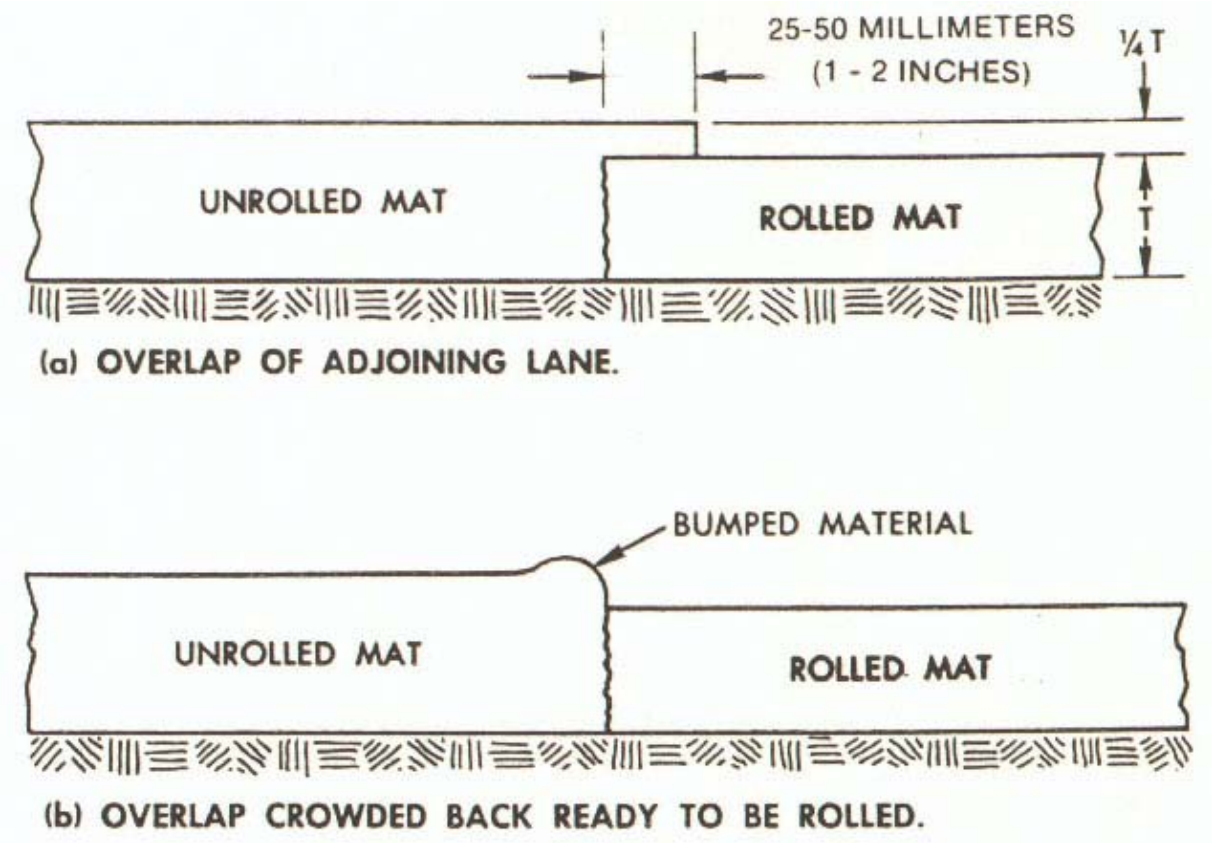


Figure 6-9
Longitudinal Joint Formed against a Cold Mat
Courtesy of the Asphalt Institute

Surface smoothness tolerances are the same at joints as everywhere else in the mat. It is a good idea to check joints with a straight edge while the material is still hot; if there is a problem, the rakers can often correct it.

6.5. Compaction

Standard specifications for compaction are found in Highways 401-3.13 (03) and Airports 401-4.11.

Proper compaction is important to the life of the pavement. It increases the strength and stability of the mix and closes gaps through which water and air can penetrate and cause damage. Insufficiently compacted pavements shove, rut, and ravel from traffic and age faster than properly compacted mats. Over-compacted pavements flush (bleed liquid asphalt at the surface) and will lose stability. Over-compaction can also loosen the mat and check (crack) the pavement surface.

Asphalt pavements are at about 80 percent density as they leave the paver. The remainder of the compaction is mostly done by initial or "breakdown" rollers (usually vibratory steel wheel) and somewhat by intermediate rollers (usually pneumatic). The pavement is then rolled with a steel wheel finish roller to remove surface irregularities.

The amount of rolling required depends on several factors, including the size of the rollers, the paving mix and mat thickness, the surface temperature, and the weather. One reason for placing test strips when paving first begins is to find out how many roller passes will be needed to get the required density.

Rollers should have the drive drum or wheels forward in the paving (that is, closest to the paver). If a steering drum precedes the drive drum onto the mix, it

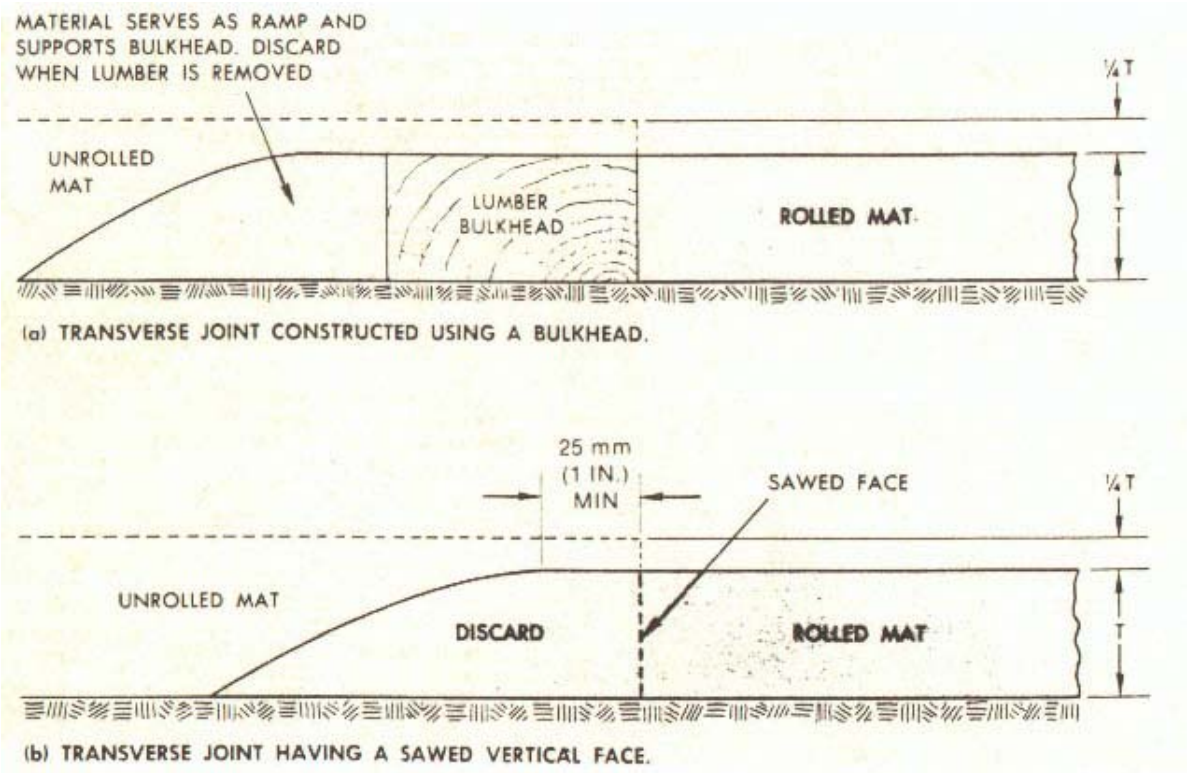


Figure 6-10
Transverse Joint Construction
Courtesy of the Asphalt Institute

can shove the asphalt instead of compacting it, as shown in Figure 6-12. This is usually less of a problem with pneumatic rollers, but the drive wheels should be forward for them too.

On highways projects the most important place to achieve compaction is along the wheel paths where truck traffic will run. Roller operators sometimes tend to roll the center of the lane more than the wheel paths. As the inspector, you should see that this doesn't happen.

Temperature

The asphalt concrete will "shove" (move out from under the roller) if the mix is rolled when it is too hot. This causes a rough surface. Rolling should begin as soon as the pavement has cooled enough to support the rollers without shoving. If the mat shoves below 275°F, you have poor mix design. Inform the project engineer immediately.

Figure 6-13 contains graphs, which show the approximate amount of time for compaction depending on the temperature of the base and the temperature of the mix at the screed. A software package named "PaveCool" is available; it factors in more variables to the cooling process in determining the amount of time for compaction.

Rolling a pavement after it has cooled below 175°F will provide little or no additional compaction, but may cause checking (cracking) of the surface.

Initial or Breakdown Rolling

Joints, if there are any, should be rolled first (see Section 6.4), except for hot longitudinal joints. They should be rolled in static mode.

The main breakdown rolling is then done with a vibrator on (if there is one). The operator should drive the roller toward the paver and then return *on the same path*. He or she then moves the roller over for the next pass. Turning movements should be made on previously compacted areas to avoid roller marks that are difficult to remove. Succeeding passes should overlap previous ones.

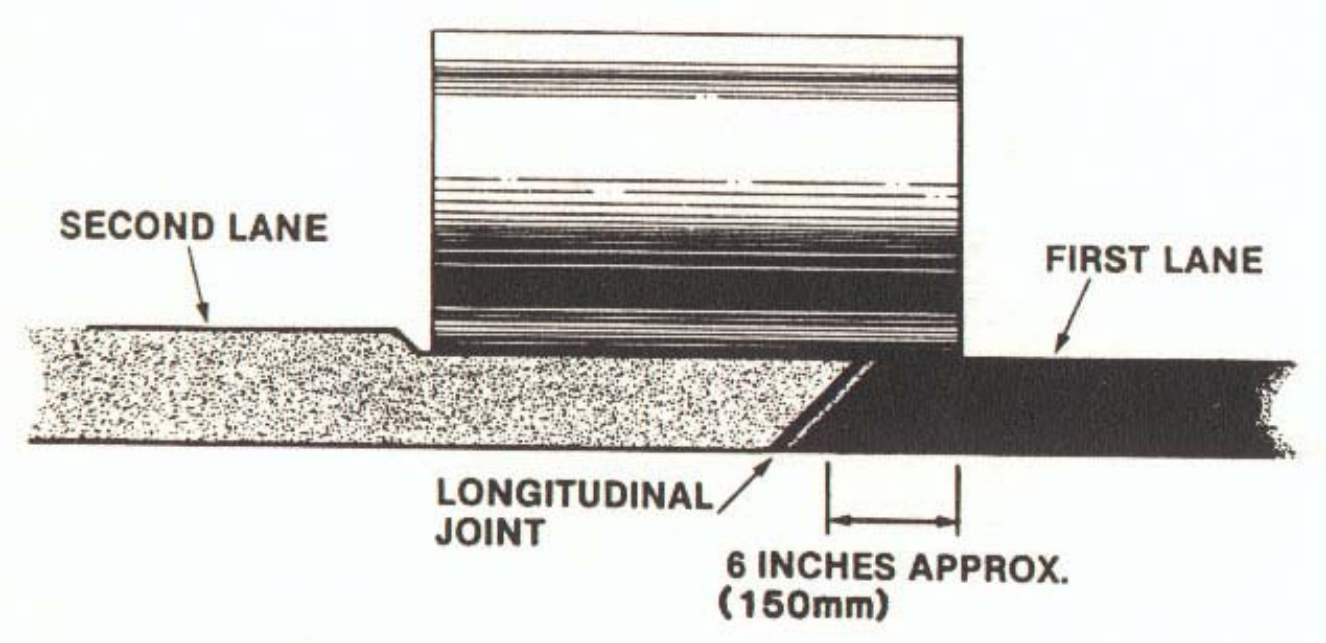


Figure 6-11
Rolling a Hot Longitudinal Joint
Courtesy of the Asphalt Institute

Breakdown rollers should make two complete passes over the entire area (or more if needed to get the required density). Maximum roller speed should be 3 mph for vibratory rollers and 4 mph for static rollers.

Rolling patterns vary with the width of paving, the equipment, the number of passes needed, etc. The standard specifications for highways require that the passes progress from the lowest side of the mat to the highest, while for airport projects the rolling begins at the longitudinal joint and progresses across the mat.

Intermediate Rolling

Pneumatic rollers usually do intermediate rolling. Intermediate rolling should consist of three complete passes over the mat (or more if needed to get the required density). The rolling should progress across the mat in the same way as the breakdown rolling.

Pneumatic rollers can sometimes help "heal" checking that may have occurred during breakdown rolling.

Some Superpave mixes have a tender zone, when the asphalt temperature ranges from 200 to 240 ^{0}F, pneumatic rollers are used as intermediate rollers. A primary reason contractors don't want to use rubber-tired rollers is the material pick-up problem. Tips to prevent the pickup problem include:

- Clean the tires. Diesel fuel should not be used to clean the tires.
- Inflate tires to the proper air pressure. Over-inflated tires may cause rutting, and underinflated tires reduce the compactive effort and increase the chance for material pickup. All tires must have equal inflation pressure.
- Prior to production, the pneumatic-tired roller operator should run the unit up and down a compacted surface for about 40 to 50 minutes. This builds heat and pre-warms the tires.
- The use of skirts is recommended. Skirts hold the heat in longer around the outer tires.
- The travel speed should never exceed 3.5 miles per hour.
- Keep cocoa mats in good repair. They consist of a material that rubs against the individual rubber tires, ensuring that release agents are spread evenly and helping prevent material buildup.

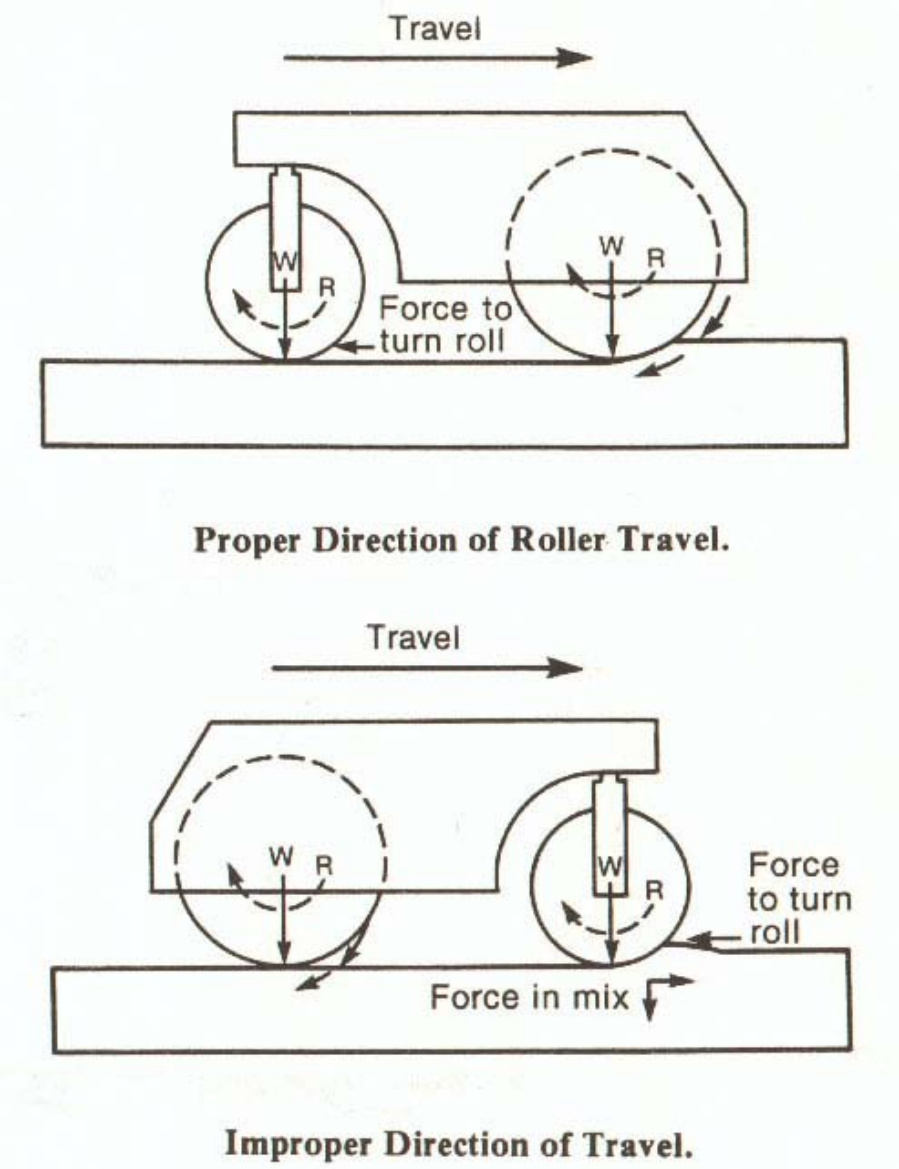


Figure 6-12
Proper & Improper Rolling Direction
Courtesy of the Asphalt Institute

Finish Rolling

The finish roller removes any roller marks and smoothes surface imperfections. You should inspect the new pavement, using a straight edge as needed. Inform the roller operator if any areas need surface improvement. Occasionally the finish roller will crack the new asphalt as it rolls. This is usually caused when the top and bottom surfaces of the asphalt have hardened (cooled) while the center is still soft (hot). Typically this happens in the surface temperature range of 150-170^{o}F. The finish roller needs to work either closer to or farther back from the paver to prevent this problem. The rubber-tired roller can usually drop back and fix these cracks if they occur.

Traffic Control

Traffic should be kept off the finished pavement until it cools to 140^{o}F. Traffic on a hot pavement can cause bleeding, rutting, or checking, and may leave permanent marks in the surface. You should make sure that traffic control is maintained in the area, until regular traffic patterns can be resumed.

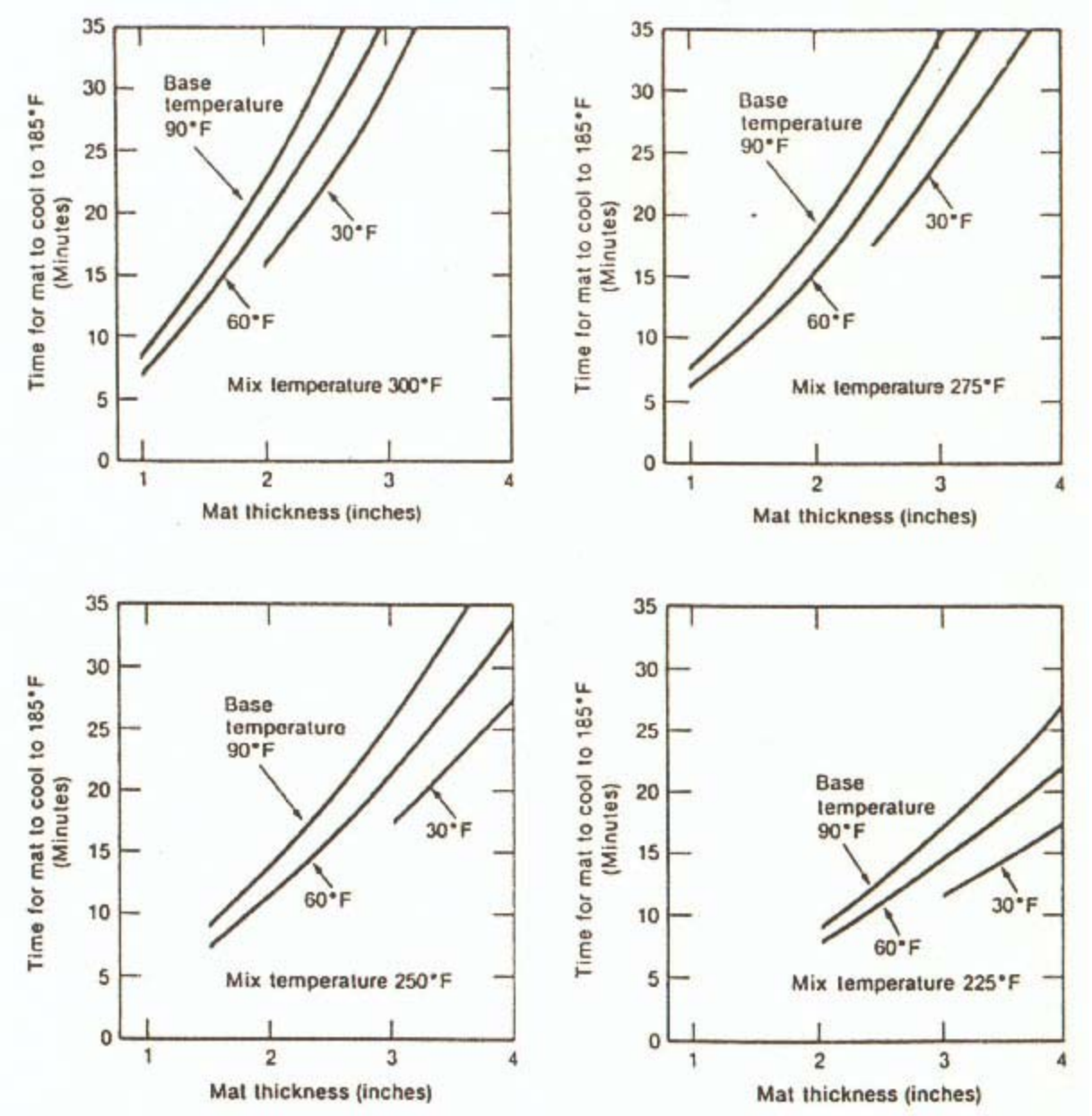


Figure 1 — Times for asphalt to cool to 185°F.

Wind velocity—10 knots. Atmospheric temperature—same as base.

Note: "Base Temperature" is the temperature of the surface upon which the asphalt mat is placed.

*185°F is the temperature of the mat measured ¼ to ½ inch below the mat surface. The average temperature of the entire mat thickness when this temperature is reached, is approximately 175°F.

On a subgrade (base temperature) of 30°F, placing of thicknesses less than those shown on the curves is not recommended.

Figure 6-13
Time Allowed for Compaction
Courtesy of the Asphalt Institute

6.6. Spread Calculations and Control

Asphalt concrete is expensive, so quantities must be carefully controlled. Screed operators usually monitor paving by checking the mat thickness with a metal probe rod or other device. The mat just behind the paver must be thicker than shown in the plans (by about 25 percent) so that it will be the same as on the plans after the rollers compact it. One reason for test strips is to determine what the "loose depth" must be.

Paving inspectors should check loose depth periodically and record it in the Asphalt Concrete Field Book (Paving Log). This procedure isn't very exact, however, nor does it directly monitor what is actually paid for, which is almost always the *weight* of asphalt concrete, not the thickness or volume.

By carefully monitoring the *weight* of asphalt concrete used and the *area* over which it is spread, you can calculate how many lb/yd^2 are actually being used. This figure, called the "spread" or the "yield," can then be compared with the "theoretical" amount needed based on the plan thickness and the "target" density from the mix design.

The figures for yield calculations are kept in the Paving Log; a sample page is shown in Figure 6-15. You should also keep track of the total (cumulative) yield for the project and inform the project engineer of any potential quantity over-runs or under-runs.

Project engineers may ask the inspector to keep the yield a little under the theoretical value (that is, to keep the pavement a little thinner than planned) as a contingency against an asphalt quantity over-run. This is undesirable, since pavement life is roughly proportional to the *square* of the thickness. Project funding constraints, however, may make this an economic necessity.

6.6.1 Spread and Yield Ratio Calculations

The following information is needed to make the calculations:

Data	Source
1. Pavement thickness	Typical section (plans)
2. "Target" density	Mix design sheet (Marshall Weight)
3. Paver width	Measured in the field
4. Distance paved	Measured in the field
5. Asphalt weight tickets	Project scales via the truck driver

Theoretical Yield

The first two figures are used to calculate the "theoretical yield" in pounds per square yard (#/sq.yd.). This can be done using the following formula:

Theoretical yield = 0.75 x thickness (in) x target density (pcf)

For a 2" thickness and a lab density of 152 pcf the theoretical yield is 0.75 x 2 x 152 = 228 #/sq.yd. This is the "Theo. Yield" shown on the Sample Plant Mix Log page (Figure 6-15).

If the lane width remains constant, the theoretical yield can be converted to pounds per station (#/sta). This saves calculating areas in the field. In the Sample Plant Mix Log, the lane width is 12', so there are 1200 square feet of pavement per station. The theoretical yield is therefore 1200/9 (sq.ft./sq.yd.) x 228 = 30,400 #/sta, which is the figure shown in the log.

Actual Yield

The truck driver should have his ticket marked with gross, tare, and net weights for each load of mix. Inform the contractor of any overweight trucks. The lane and stationing where the load is placed should be marked on the back of the tickets, along with the time. All the information needed to calculate the yield is thus on the ticket.

The first entry in the sample shows that a truckload of mix with a net weight of 30,880 pounds was used to pave 70 feet or 0.70 stations. The *actual* yield for that truck was 30880/0.70 = 44144 #/sta, which is rounded 44,110 in the log. The inspector has noted "off on yield" in the log, since this is much more than the theoretical yield.

Usually the weight of four or five truckloads is added together and yield is calculated for the combined total. This has been done for the other loads recorded in the sample Paving Log.

If lane widths don't remain constant, you can't calculate the theoretical yield in pounds per station. This happens when paving approaches left turn pockets, gores, etc.

In these situations you must first calculate the area paved (in square yards). You can then calculate the actual yield in pounds per square yard. Alternatively, you can calculate the "theoretical" weight for the area and compare it to the actual weight used. This is simpler when a similar area occurs repeatedly on a job. You might calculate the "theoretical" weight needed to pave any residential approach on the project, for example. This can be done ahead of time, saving work in field.

Yield Ratio

The actual spread or yield divided by the "theoretical" one is called the *yield ratio*. If the actual yield is the same as the theoretical one the yield ratio will equal to 1.00. A yield ratio greater than one indicates a thicker pavement than planned. A yield ratio less than one indicates a thinner pavement than planned. The *yield ratio* for the first truckload in the sample log is 44,110/30,400 = 1.45. This indicates the pavement is 45 percent too thick (almost an inch).

6.6.2 Adjusting the Spread

If the actual yield you calculate differs from the theoretical one, your distance estimate may be inaccurate. For an accurate estimate the paver must have the same amount of asphalt in it at the beginning and end of the yield calculation section.

Small errors in your distance are less significant on longer sections. Don't ask for thickness adjustments based on the yield for a single truckload. But if the yield is consistently high after several loads the pavement is being placed too thick. Similarly, if the actual yield is consistently low, the pavement is too thin.

When this happens the screed operator should adjust the thickness controls. It takes as much as 50 feet for the paver to completely react to an adjustment. Let the screed stabilize to the new conditions before making a new yield calculation to check the adjustment. Making adjustments too rapidly can create a bump in the mat. Limit adjustments to ¼ turn in 50 feet.

The point here is that you have to control the spread without demanding constant tinkering with the controls. Checking the yield at 1,000-foot intervals is usually adequate to maintain depth control after the first few loads of the day. Jacking the screed up and down will result in rough pavement as well as destroy your credibility.

Remember that *you must not operate the screed controls yourself*. If you do, the Department will be held responsible for any improper work rather than the contractor. If the screed operator will not correct the asphalt thickness problems, contact the paving foreman and the project engineer.

6.7. Inspecting the Finished Mat

The main areas of concern in the finished mat are the final *density,* the surface *smoothness*, and the surface *texture* (appearance).

Density testing is the materials inspector's responsibility, but you need to coordinate with the materials inspector to make sure the needed tests are done promptly so any problems can be corrected quickly.

Smoothness should be tested with a 16' straight edge for highway work (401-3.15) and 12' for airports (401-5.2[f][5]). The variation of the mat surface from the straight edge must not exceed 3/16" for highways or ¼" for airports in either the longitudinal or transverse direction. Smoothness tolerances are just as strict for joints as for the rest of the pavement.

It takes some experience to judge the appearance of a finished mat, but some problems are obvious. The texture of the mat should be uniform; that is, there should be no sign of segregation or raveling. There should not be pieces of wood, large stones, or other contamination in the mat, nor should there be "fat" (oily) spots or bleeding. There should be no cracking (checking) or tearing of the mat. The *Troubleshooting Guide* (Appendix A) lists these and other common

problems to look for, along with the most probable causes of them.

Defective areas of pavement must be marked, cut out, and replaced by the contractor. These patched areas, however, are almost never as high in quality as a pavement that is mixed and placed correctly in the first place.

Most defects in the finished mat can be avoided by careful inspection of the production and placement processes. Correcting defects is also easier the earlier in the process they are detected. If a consistent mix is produced, the pavement is placed in a dry weather on a firm base, and a good rolling pattern is established and followed, there should be no problem achieving required density. With good quality control, there should be no segregated or contaminated areas to be cut out and replaced. If the base is good and joints are properly built, the surface smoothness should be within tolerance.

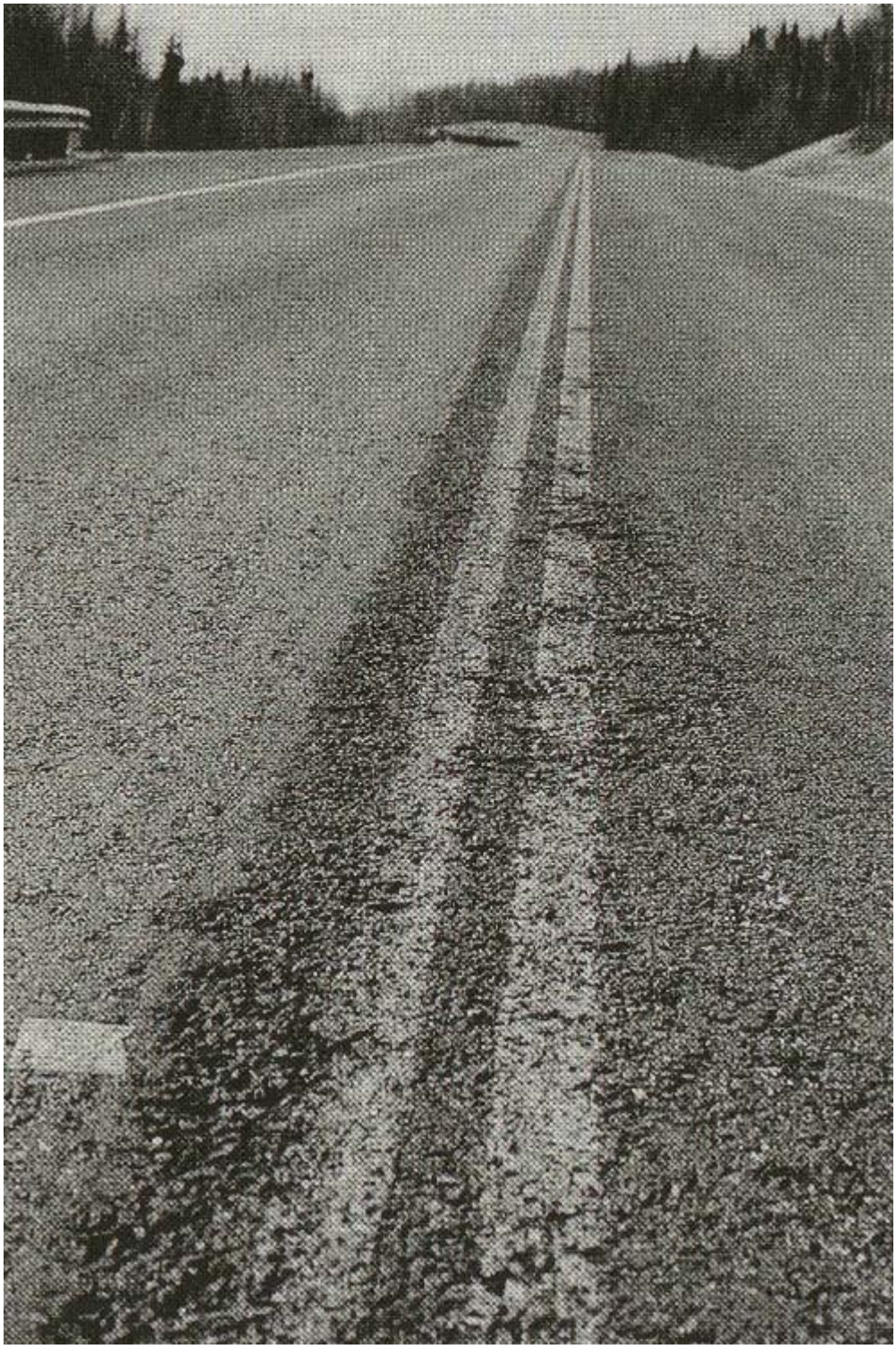


Figure 6-14
Segregation Visible in the Finished Mat

SAMPLE PLANT MIX LOG

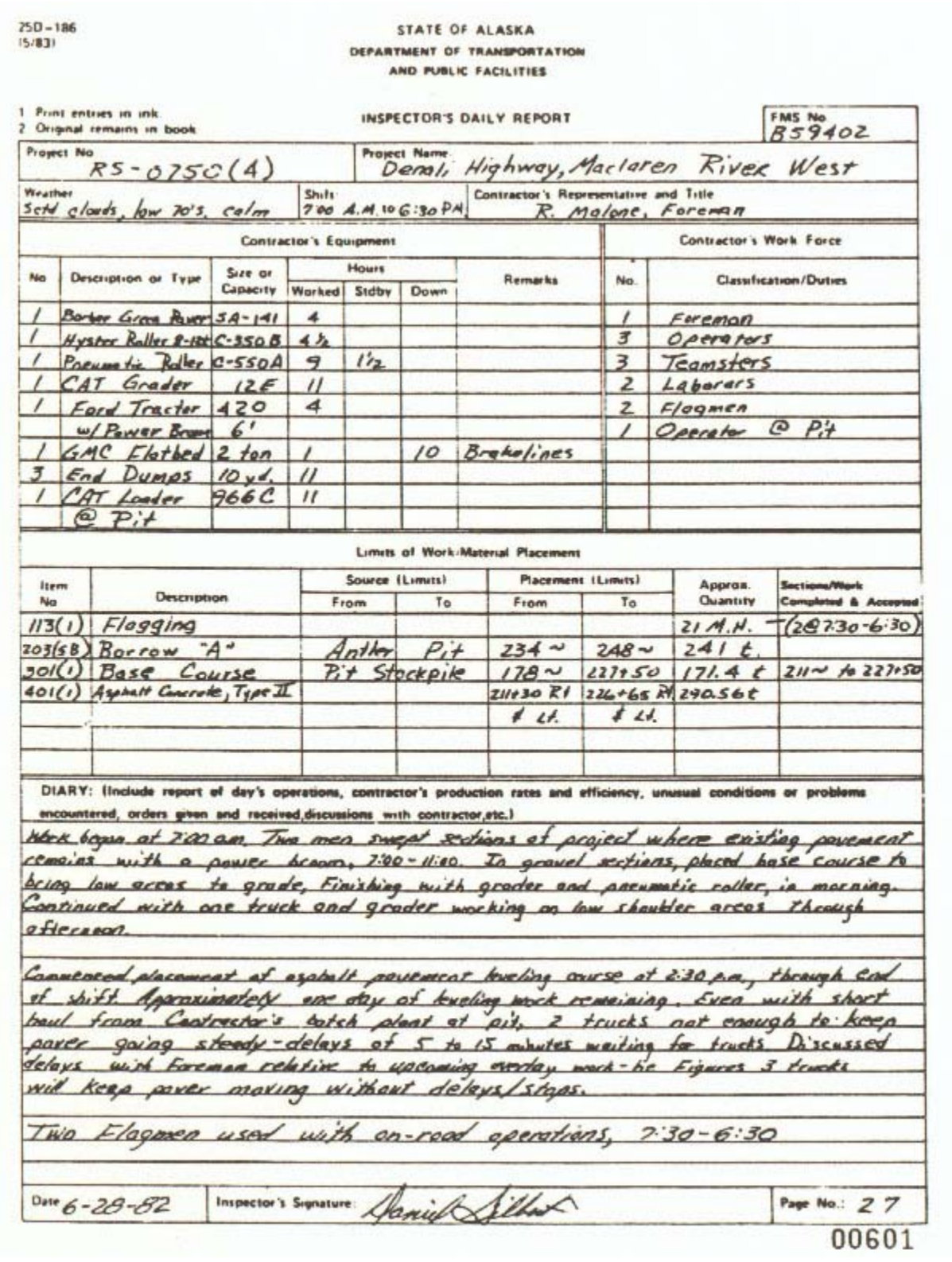
Date: 8/6/72 Lane: Left Width: 12' Theo. Yield = 228 #/sq. yd. = 30,400 #/sta. 27

Number & Effect of Equations this Section: 1-758' Spec. Delivery Temp = 280 °F to 320 °F

Sta.	Ticket Number	Load Wt. in #	Yield Wt. in #	Distance in Sta.	Yield #/sta.	Temp °F	Time of Day	- - - Loose Depths or Remarks - - -
1005+45								
	1649	30,880	30,880	.70	44,110	295	5:32 A	2 5/8, 2 3/4, 2 5/8 Off on Yield
1004+75								61° Clear
	1650	28,960						
	1651	29,490				292		
	1652	30,290						
	1653	30,420				284		
	1654	28,780					6:00A	
999+60			147,940	5.15	28,730			
	1655	29,020						
Equa.	1656	28,720				296		Equa. = 998+50 Ahd 990+92 Bk -758'
	1657	28,880						
	1658	30,660				295	6:30A	66° Clear Last Load
988+70			117,280	3.32	35,330			

Checked by: Ted King 8/8/72 Paul Morris 8/6/72

Figure 6-15
Sample Plant Mix Log



250-186
(5/83)

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

1 Print entries in ink
2 Original remains in book

INSPECTOR'S DAILY REPORT

FMS No B59402

Project No: RS-0750(4)
Project Name: Denali Highway, Maclaren River West
Weather: Scttd clouds, low 70's, calm
Shift: 7:00 A.M. to 6:30 P.M.
Contractor's Representative and Title: R. Malone, Foreman

Contractor's Equipment

No	Description or Type	Size or Capacity	Hours Worked	Hours Stdby	Hours Down	Remarks
1	Barber Green Paver	SA-141	4			
1	Hyster Roller 8-10t	C-350B	4½			
1	Pneumatic Roller	C-550A	9	1½		
1	CAT Grader	12E	11			
1	Ford Tractor w/Power Broom	420 6'	4			
1	GMC Flatbed @ Pit	2 ton	1		10	Brakelines
3	End Dumps	10 yd.	11			
1	CAT Loader @ Pit	966C	11			

Contractor's Work Force

No.	Classification/Duties
1	Foreman
3	Operators
3	Teamsters
2	Laborers
2	Flagmen
1	Operator @ Pit

Limits of Work/Material Placement

Item No	Description	Source (Limits) From	Source (Limits) To	Placement (Limits) From	Placement (Limits) To	Approx. Quantity	Sections/Work Completed & Accepted
113(1)	Flagging					21 M.H. (2@7:30-6:30)	
203(5B)	Borrow "A"	Antler Pit		234 ~	248 ~	241 t.	
301(1)	Base Course	Pit Stockpile		178 ~	227+50	171.4 t	211 ~ to 227+50
401(1)	Asphalt Concrete, Type II			211+30 RT & Lt.	226+65 RT & Lt.	290.56 t	

DIARY: (Include report of day's operations, contractor's production rates and efficiency, unusual conditions or problems encountered, orders given and received, discussions with contractor, etc.)

Work began at 7:00 am. Two men swept sections of project where existing pavement remains with a power broom, 7:00 - 11:00. To gravel sections, placed base course to bring low areas to grade. Finishing with grader and pneumatic roller, in morning. Continued with one truck and grader working on low shoulder areas through afternoon.

Commenced placement of asphalt pavement leveling course at 2:30 p.m., through end of shift. Approximately one day of leveling work remaining. Even with short haul from Contractor's batch plant at pit, 2 trucks not enough to keep paver going steady - delays of 5 to 15 minutes waiting for trucks. Discussed delays with Foreman relative to upcoming overlay work - he figures 3 trucks will keep paver moving without delays/stops.

Two Flagmen used with on-road operations, 7:30 - 6:30

Date: 6-28-82
Inspector's Signature: Daniel Gilbert
Page No.: 27

00601

Figure 6-16
Sample Inspector's Daily Report