Alaska
Department of
Transportation
and
Public Facilities

Asphalt Pavement Inspector's Manual

March 2022

Foreword

The information currently available on asphalt paving would fill a small library. Furthermore, DOT&PF's Alaska Construction Manual describes procedures for the Department's staff to use on all aspects of construction projects. This manual draws on the Alaska Construction Manual and other sources but does not attempt to replace them as a reference for official Department policy. It is intended to present portions of this information needed by laydown and asphalt plant inspectors in a convenient form. It also presents information of value to paving materials inspectors. Material test procedures are so detailed, however, and test requirements so variable between projects, that this manual presents only rather general information about them.

More information on asphalt and paving is available in publications available at your construction project office or the Regional Materials office. A copy of the Alaska Construction Manual should also be at the project office.

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1. Background

1.1. Hot Asphalt Concrete Paving

Contractors or their suppliers make asphalt concrete. It is placed on airport, ferry terminal, and highway surfaces where it provides a hard, smooth driving surface, seals out water, and controls dust. The design service life for asphalt pavements is generally 10 to 20 years. Asphalt products, their placement, and inspection represent approximately 25 percent of DOT&PF's annual capital expenditures.

Asphalt concrete normally has three basic components: asphalt cement, aggregate, and an anti-strip additive (there are also some air voids). Chemical modifiers may also be used to enhance and control various properties of the asphalt. Asphalt concrete is manufactured in accordance with a mix design that defines the mix proportions, temperatures, etc.

Asphalt cement is a residual of petroleum refining. It becomes fluid at high temperatures but is relatively stable at room temperatures. These "thermoplastic" properties make it an excellent construction material.

Specifications currently require Performance Graded (PG) asphalt binder. PG asphalt is determined by the historic 7-day average high and the historic one-time low seasonal ambient temperatures. PG 52-28 asphalt has a high temperature performance (resistance to plastic deformation or rutting) at 52°C and a low temperature performance (resistance to thermal cracking) at -28°C. PG 52-28 has similar properties to the viscosity graded AC-5.

Most asphalt concretes typically contain 5 to 6 percent asphalt cement to which liquid anti-strip is added. The anti-strip agent is added to the asphalt cement at the refinery and helps to bond the asphalt to the aggregate.

Asphalt concrete gets most of its strength from the aggregate, which makes up most of the mix. The contractor or his supplier generally crushes and screens aggregate to meet a specified gradation.

Asphalt concrete or "hot mix" may be produced at either a permanent commercial plant or at a mobile plant set up in the contractor's pit. Aggregate is fed into the plant where it is dried, heated, and mixed with the asphalt cement.

Trucks haul the hot mix to the construction site where it is placed on the road or airport runway, or taxiway by a paving machine. The paving machine spreads and partially compacts the hot asphalt mix.

A series of rollers provide further compaction while the hot asphalt is cooling. Immediately behind the paver is a "breakdown" roller, which achieves most of the required compaction. It usually has two vibratory steel drums.

Intermediate rolling follows the breakdown roller and is normally done by a rubber-tired roller or a second vibratory roller

Finish rolling is done by a static (non-vibratory) steel drum roller, which removes roller marks and surface blemishes.

1.2. Airport, Highway, and Marine Facility Pavements

Airport and highway pavements are built for different types and amounts of traffic. Airport and highway pavements are therefore built with different asphalt mix designs, compaction requirements, and surface tolerances.

This manual references airport and highway Standard Specifications throughout (an example for Airports: P-401-4.11, for Highways: 401-3.13). This manual does not address marine facility specifications directly, since relatively little asphalt is used for these facilities. Marine asphalt specifications are based on highway specifications and usually require the contractor, rather than the state, to design the mix for Engineer's approval.

Airport and highway pavement construction concepts, methods and equipment are very similar. Where appropriate, this manual points out some of the similarities and differences between airport and highway construction requirements.

1.3. Safety

1.3.1. Safety Equipment Checklist

You should have:

- A hard hat
- A reflective safety vest
- Emergency phone numbers

- Knowledge of contractor’s job safety program and any required training

Inform the contractor’s on-site supervisor of your presence before moving about the contractor’s plant or equipment.

When working around hot asphalt (e.g. at plants and distributors), you should have:

- Heavy gloves
- Heavy, long-sleeved shirt or jacket
- Eye protection (goggles)

Your vehicle should have:

- A first aid kit
- A fire extinguisher
- Strobe light
- Radio for communications, at airports

You should know:

- Where the nearest hospital, clinic, or ambulance service is located
- Who on the job site has had first-aid training

Furthermore, goggles and a respirator are recommended where dust or flying rock may be a problem (e.g., near crushers). You may need noise protection around crushers and other noisy equipment. Permanent hearing loss takes only minutes at high noise levels.

1.3.2. Safety on the Paving Project

Immediately report unsafe conditions to the contractor. If the contractor does not correct the problem, inform the project engineer. Document the problem and those who were informed of it. Do not work in an unsafe situation.

1.3.3. Document Accidents

Part of your job as an inspector is documenting accidents. Ask the basic questions: Who? What? When? Where? How? Stick to the facts; don’t make judgments of right and wrong. Take plenty of photos, not only of the accident itself but also of nearby signs and other contributing factors. If the police are involved, get their report number. Inform the project engineer immediately. Use a Work Zone Accident Report (form 25D-123) to document an accident involving vehicles. There are other forms for reporting injuries and damage or theft of property and equipment. Ask your project engineer if the need arises.

Hot Asphalt Burns

Asphalt temperatures at an asphalt plant commonly exceed 300°F. Metal surfaces of plant equipment often range between 150°F and 400°F. Consequently, contact with hot asphalt or with plant equipment can severely burn exposed flesh. You should:

- Be familiar with the equipment you work around and its operation.
- Avoid hazardous situations and remain alert at all times.
- Stand back during asphalt loading operations.
- Use only safe and properly operating sampling equipment.

If a burn does occur, follow the guidelines given.

Steam and Explosions

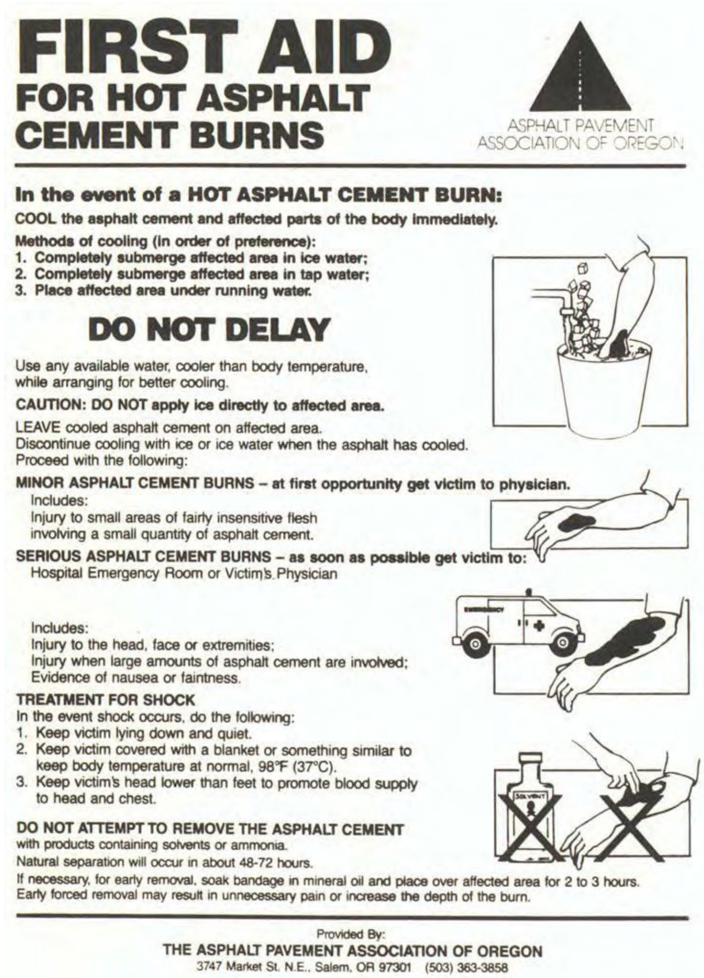
Water can expand over 1,000 times when it boils. Even a small amount of water trapped in the piping can turn to steam and explode when a distributor or tank is loaded with hot asphalt. Tanks that have been used for emulsion or which have been empty long enough for condensation to occur must be cleaned before using for heated asphalt cement.

Some asphalt products (especially rapid curing cutbacks) contain volatiles, which can explode. Partially empty asphalt tanks, such as partially empty gasoline tanks, are extremely dangerous. Tank inspections may be made using a mirror to reflect sunlight or a flashlight. Never use a match or open flame when looking into a storage tank. Never smoke around an asphalt storage tank.

Tanks can explode (burst) if pressure is allowed to build up in the tank while the contents are being heated. This may happen on some distributors if a top hatch is not opened while the contents are being heated.

Open Belts or Pulleys

Belts and hazardous machinery are required to have guards. Reciprocating feeders, cold-feed belts, etc., should have emergency electrical cutoffs. Know where these cutoffs are. Stay clear of areas you have no business in.



FIRST AID FOR HOT ASPHALT CEMENT BURNS

ASPHALT PAVEMENT ASSOCIATION OF OREGON

In the event of a HOT ASPHALT CEMENT BURN:

COOL the asphalt cement and affected parts of the body immediately.

Methods of cooling (in order of preference):

1. **Completely submerge affected area in ice water;**
2. **Completely submerge affected area in tap water;**
3. **Place affected area under running water.**

DO NOT DELAY

Use any available water, cooler than body temperature, while arranging for better cooling.

CAUTION: DO NOT apply ice directly to affected area.

LEAVE cooled asphalt cement on affected area.
Discontinue cooling with ice or ice water when the asphalt has cooled.
Proceed with the following:

MINOR ASPHALT CEMENT BURNS – at first opportunity get victim to physician.
Includes:
Injury to small areas of fairly insensitive flesh involving a small quantity of asphalt cement.

SERIOUS ASPHALT CEMENT BURNS – as soon as possible get victim to:
Hospital Emergency Room or Victim's Physician

Includes:
Injury to the head, face or extremities;
Injury when large amounts of asphalt cement are involved;
Evidence of nausea or faintness.

TREATMENT FOR SHOCK
In the event shock occurs, do the following:

1. Keep victim lying down and quiet.
2. Keep victim covered with a blanket or something similar to keep body temperature at normal, 98°F (37°C).
3. Keep victim's head lower than feet to promote blood supply to head and chest.

DO NOT ATTEMPT TO REMOVE THE ASPHALT CEMENT
with products containing solvents or ammonia.
Natural separation will occur in about 48-72 hours.
If necessary, for early removal, soak bandage in mineral oil and place over affected area for 2 to 3 hours.
Early forced removal may result in unnecessary pain or increase the depth of the burn.

Provided By:
THE ASPHALT PAVEMENT ASSOCIATION OF OREGON
3747 Market St. N.E., Salem, OR 97301 (503) 363-3858

Figure 1-2
First Aid for Hot Asphalt Cement Burns

Fumes from Asphalt Tanks

Asphalt fumes in sufficient concentrations can be harmful to your health. The intensity of the fumes when a storage tank hatch is opened is greater than you might anticipate. They can cause you to lose consciousness if you are not careful.

Hydrogen sulfide, a gas contained in some asphalts, can be lethal in high concentrations. Asphalt cement made from Alaska North Slope or Kenai crude oil is generally low in hydrogen sulfide. Asphalt cement from other crude oil sources may have high concentrations of this gas. To prevent overexposure to hydrogen sulfide and other fumes, follow these guidelines:

- Keep your face at least two feet away from asphalt tank hatch openings.
- Stay upwind of open hatches.
- Avoid breathing fumes when opening hatches or taking samples.

In case of overexposure to fumes, do the following:

- Move the victim immediately to fresh air.
- Administer oxygen if breathing is difficult.
- Have the victim examined by a physician immediately.

Rotary Broom Dust Cloud Accidents

Require water to be applied to a surface before a rotary broom begins sweeping it so visibility is not impaired. Blinking amber lights and/or red flags should be attached to all rotary brooms. In extreme cases, pilot cars may be necessary. Monitor where debris from sweeping is travelling.

Lute or Rake Handle - Vehicle Collisions

Passing vehicles or workers may not see lute handles and may run into them. It is a good idea for the rakers to put day-glow orange paint or flags on the end of the lute handles.

Operating Rollers in Late Evening

Rollers finish working after the rest of the crew quits. The contractor must quit work early enough so that rollers can finish before dark or else provide adequate lighting. Traffic control must be maintained until the rollers have left the roadway.

Slippery Surface on Prime or Tack Coat

Special caution is needed on newly primed or tacked surfaces. Rain on fresh oil creates one of the most hazardous driving conditions known. If this happens, pilot cars driving very slowly should be used to escort all traffic. Keep all traffic off tack or prime coat that hasn't broken!

Electric Lines

All electric lines around crushers and plants should be located where construction equipment cannot run over or otherwise damage them.

End dumps can also reach high voltage wires while dumping into the paver. The paving crew should be vigilant where potential hazards exist.

Blind Spots

Pavers, rollers, and trucks almost always have blind spots where the operator or driver cannot see. The inspector should be aware of these. He or she should not enter them without first getting someone's attention (the operator or driver or dump man) so they can protect the inspector. Especially avoid blind pinch points. The inspector should also protect others on the crew when they are in these blind spots.

Traffic

Above all, ensure that traffic control is in place and being heeded by both the public and the paving crew. Even then, the crew should always be aware of the nearby traffic and protect each other. Traffic causes more injuries and fatalities than any other aspect of road construction.

1.4. Plans and Specifications

The contract will generally contain most or all of the following documents. Together they describe what will be built on the project and how it will be done. When one part of the contract conflicts with another part, one portion of the contract carries more authority or "supersedes" the other. The following is the order of authority (Highway 105-1.04) (Airport GCP 50-04):

Special Provisions:

Additions to and/or changes in the standard specifications, which apply to a specific project.

Plan Sheets:

a. Typical section: shows the cross sectional view of various portions of the project, including asphalt thickness.
b. Plan view of the project
c. Tables of project improvements
d. Notes and project-specific information

Standard Modifications:

Modifications to the Standard Specifications for Highway Construction (SSHC), contain additions to or changes in the SSHC.

Standard Specifications:

Contain all directions, provisions, and requirements pertaining to performance of the work.

Standard Drawings:

Drawings showing details of the work.

1.5. Traffic Control

1.5.1. Air Traffic Control

Airports are built and maintained to provide safe landing environments for the flying public. This is the primary function of airports. Concern for the safety of the aviator is the most important aspect of airport construction.

As a member of the asphalt inspection team, you may or may not be directly concerned with the effects of the construction project on air traffic control. Ask your project engineer if you are not sure. GCP 40-04, 70-08, 70-09, 70-14, and 80-04 contain air traffic control information. The special provisions may include project-specific air traffic control information.

1.5.2. Air Traffic Control Checklist

- What are the minimums for runway length and width reduction?
- What are the requirements for temporary runway markings?
- Has written notice of the construction work activities been filed with the area Flight Service Station (FSS)?
- Has Airport Security been notified? What are their requirements?
- Does all of the contractor's equipment have identification markings?
- What radio contact with the tower is required?
- Who is the contractor's 24-hour representative? What is the representative's phone number? Have the airport authorities been given that phone number?
- Have you informed the airport authorities of any changes in operations?

1.5.3. Avoiding Accidents

Accident records indicate that the following items contribute to the majority of construction-related aircraft accidents:

- Heavy equipment that is left for long periods of time near aircraft movement areas.
- Interference in radio communication or navigational aids by contractor's equipment or stockpiles.
- Oversize equipment in flight paths. Identify these situations and have the contractor correct them immediately.

1.5.4. Highway Traffic Control

DOT&PF constructs highways for the use of the traveling public. Their safety is our primary concern. During construction it is easy to overlook this; the importance of creating a highway may seem to overshadow the reason we are building the road. The most important aspect of highway construction is the protection and guidance of the motorist.

Your duties may include inspection and documentation of some or all aspects of traffic control. Ask your project engineer if you are not sure. SSHC Section 643 contains traffic control information. Special provisions may contain project-specific traffic control information. The project plans include a traffic control plan that may be modified by the contractor.

1.5.5. Highway Traffic Control Checklist

- Do you have the approved traffic control plan? (643-1.03). Make sure the contractor adheres to this plan. Any changes require higher approval.
- Do you have the name and phone number of the contractor's 24-hour worksite traffic supervisor? (643-1.04).
- What will be the hours of operation?
- Photograph and document all signs, flagmen, pilot cars etc. A photo record of traffic control is often very important if there are court proceedings following an accident.
- Are all flagmen certified? (643-3.04) Certification is required and their flags and paddles must meet the specifications for size, shape, and reflectivity.
- Do all the devices (signs, cones, barricades, etc.) meet the requirements of the Alaska Traffic Manual? Are they clean and in good repair? Sections 643-3.04, 643-2.01.
- Vehicles, idle equipment, and stockpiles must be parked outside the clear zone at all times. Section 643-3.04. Statistics show that this is a major cause of construction zone accidents.
- Is traffic flowing smoothly and safely around the paving operation? You may discover unforeseen traffic control problems by driving through the project in daylight and darkness.
- Traffic control systems left unattended at night, especially on weekends, require special care. Night drivers often suffer from impaired vision and reflexes. Be sure that all the devices left up at night have reflectors.

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2. General Guidelines for the Inspector

2.1. Introduction

Your primary duties are to help ensure that all work on the project is performed in reasonably close conformity with the plans and specifications and that payment is made to the contractor commensurate with the work performed.

This requires that you understand the plans and specs for the work you inspect, that you stay alert to the contractor's activities, and that you keep accurate records. You also need to recognize problems when you see them, anticipate them whenever possible, and exercise diplomacy in resolving them with the contractor.

2.2. Asphalt Paving Inspection

Asphalt inspection is a team effort that consists of the following jobs:

- Inspection of aggregate production and stockpiling
- Prepaving grade inspection
- Prime and/or tack inspection
- Plant inspection
- Laydown inspection
- Materials testing
- Density testing
- Traffic control inspection

You may be responsible for any of the jobs listed. Ask your project engineer to define your duties for you if you are unsure what they are. If you are not responsible for these duties, you should know who is.

2.3. General Responsibilities of the Inspector

- Review *The Alaska Construction Manual* (ACM) Ch. 10, "Documenting & Reporting the Contractor's Progress."
- Know the plans and specifications for the pay items you are inspecting, including specifications specific to the project (special provisions, etc.).
- Be alert to any potentially unsafe conditions, or any situations that may delay construction, and report them to your supervisor.
- Identify nonconforming work or materials as early as possible; anticipate problems where possible. Notify the contractor immediately and make a record of it. Follow up on corrective work and make a record of it too. If the contractor can't or won't fix the problem, notify your supervisor.
- Avoid any inspection, testing, or other activity that could be construed as the contractor's responsibility. If you don't, the contractor may not be held accountable for his or her work if there is a claim or other contract dispute.
- Be prepared to make inspections and tests promptly. Do not make hasty or premature decisions. The contractor is expected to give you adequate notice of when he or she will be ready for inspection and testing.
- If specifications don't cover a particular situation or tolerances seem unrealistic, contact your supervisor for guidance. Report problems you can't handle and see that they get resolved before an expensive and time-consuming correction is required.

2.4. Record Keeping

Refer to the ACM Section 10.3, "Diaries, Daily Reports and Photography" for additional instruction.

Complete and accurate records of the amount and quality of the work performed are required. They document that work is performed in accordance with the plans and specifications and ensure the contractor receives proper payment for the work.

Records also provide a means to maintain control of the work during construction and they document the reasons behind decisions and actions taken.

Project records must be sufficiently clear and complete to be understood by people unfamiliar with the details of the project, and to sustain audit. Failure to keep such records is a failure to account properly for the expenditure of public funds. The importance of maintaining adequate and proper records cannot be overemphasized. Memory cannot replace valid permanent documents.

Records of the amount and quality of work performed should include the "four W's" as follows:

- **What:** Identify the pay item involved (by both name and item number) and the quantity involved.
- **Where:** List the project name and number as well as the specific location, such as project station and lane, or offset.
- **When:** Note the date and the time.
- **Who:** Sign the record, Initials are not acceptable unless your signature also appears in the record. (In a book this may be done once on an index page in the front of the book.)

It is particularly important to have a record of any problems on the job (such as nonconforming work or changed conditions). This record should include any instructions given to the contractor, or agreements made with the contractor, to resolve the problem. Remember that the records have legal importance if there is a claim or other contract dispute.

Forms are available for nearly all materials tests and for inspectors' daily reports. Pay item books and diaries may be organized somewhat differently on every project. You should know what records you are to keep and in what form they are retained before you begin work on any project; ask your supervisor.

Note suggested improvements to specifications and. designs as lessons learned on the *Inspector's Daily Report*.

2.5. Authority of the Inspector

The inspector has the authority to approve materials and workmanship that meet the contract requirements. Approval should be given promptly. SSHC Sec. 105-1.09 and airports GCP 50-09 authorizes the inspector to reject work or materials. The inspector must keep the project engineer informed of any material rejection. The inspector must thoroughly document the reason for rejection and the amount of material rejected.

The inspector does not have the authority to order the contractor to stop operation. Authority for the issuance of a stop order should be left to the judgment of the project engineer.

The inspector does not have the authority to approve deviations from the contract requirements.

The inspector should not require the contractor to furnish more than what is required by the plans and specifications, nor allow anything less.

The inspector should not under any circumstances attempt to direct the contractor's work; otherwise, the contractor may be relieved of responsibility under the contract.

Instructions should be given to the contractor's supervisors, not to the contractor's workers or subcontractors.

2.6. Relationship with the Contractor

You should maintain a professional, agreeable, and cooperative attitude with the contractor and his or her work force. Your goal should be to help build a good facility within the contract time, not to harass and delay the contractor.

- Avoid familiarity and accept no personal favors from the contractor. Use tact when pointing out deficiencies to the contractor and staff. Your behavior can improve or disrupt the relationship between the contractor, inspection personnel, and DOT&PF.
- Don't let personality differences or your opinion of the contractor interfere with your working relations. Don't pre-judge the contractor. Begin with the premise that the contractor is fair-minded and intends to do a good job. Honor commitments made during partnering with the contractor.
- Criticism of the contractor or the contractor's employees by the inspector on or off the job is unwarranted and hurts contractor relations.
- If you make a wrong decision, admit it. No one is perfect.
- Be courteous to the public and respect their rights. The resulting good public relations will benefit all concerned.
- Never get involved in the contractor's labor relations. This is the contractor's responsibility.

3. Base Under Pavement

3.1. Inspector's Check List

Verify the following:

- Profile grade has been built according to plans and has been accepted.
- Width conforms to plans.
- Compaction meets or exceeds specification, specifically the shoulders that will be under the edge of pavement. Typically pavement rollers apply more compactive force than rollers used to compact the base.
- Base materials used have met specification (MCL requirements).
- Surface meets surface preparation specifications for tack, prime, or pavement.
- Milled surface is sound and meets surface preparation requirements in the paving specification.
- Crack sealer remaining in existing pavement can cause hot pavement placed over it to "hump up" over it as it is heated and expands by the hot mix. Check specifications on how to deal with this situation.

3.2. Base Construction

Review the following SSHC specifications that define the construction of base on which pavement is to be placed. The base needs to be accepted before asphalt paving can begin. The following is a list of the types of bases:

- Unbound or Crushed Aggregate Base -Section 301
- Reconditioning - Section 302
- Asphalt Treated Base -Section 306
- Emulsified Asphalt Treated Base – Section 307
- Crushed Asphalt Base Course – Section 308
- Foamed Asphalt Stabilized Base Course – Section 318 (CR Special Provision)
- Milled surface of an existing pavement

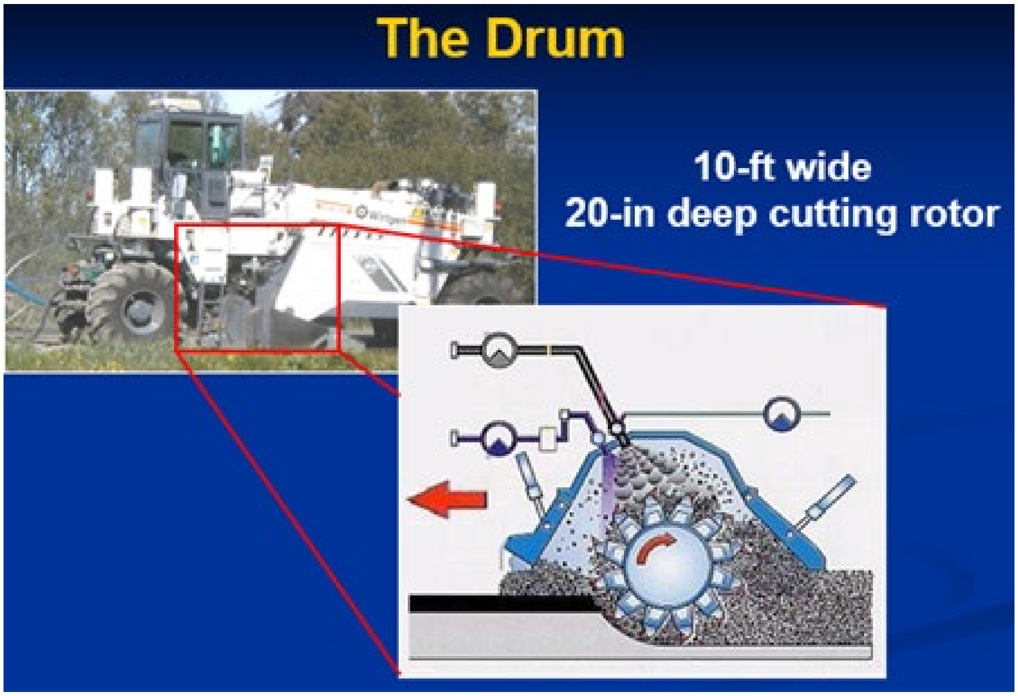

Figure 3-1
Reclaimer used for Reconditioning, Emulsion and Foam Stabilization

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4. Surface Treatment (Prime and Tack Coats)

4.1. Preliminary Inspection Checklist

- Have the prime or tack log, a 50-foot tape, and an air temperature thermometer.
- Distributor has tachometer, pressure gauges, circulating spray bar, and bitumeter/odometer.
- Tank is calibrated and has a thermometer.
- All nozzles are the same size and set at same angle.
- Plan yield (gals/sq.yd.) has been converted to gals/station for proposed shot width.
- Maximum distance that can be shot with one load has been calculated.
- Spray bar is set at proper height using test strip.
- All nozzles spray a uniform fan of material without misting or fogging.
- Yield on first small area is carefully checked and pump/truck speed adjustments made.
- Speed adjustments checked on additional small areas until proper yield is obtained.

4.1.1. Inspection Checklist for Each Shot

- Rain is not likely before tack or prime cures.
- (Tack coat): Old pavement is cleaned, leveled, and watered if needed.
- (Prime coat): Base course is tight-bladed and watered if needed.
- Surface is adequately warm.
- Building paper is used at beginning of shot.
- Time and weather are noted in log.
- Tank and air temperatures are within specs and logged.
- Beginning and ending tank readings have been weighed and logged.
- Yield calculated using volumes or spread rate.
- Location of the area primed or tacked noted on truck weight ticket.
- An approved traffic control plan is in place and Fresh Oil signs are in place at all access points if traffic is allowed on the oil.

Figure 4-1
Spraying Tack Coat

4.1.2. Routine Inspection Checklist

- (Prime coat): Base course has received grade approval and has passed density tests.
- Manholes, curbs, etc. are hand-primed or tacked.
- Bitumeter wheel is free of asphalt buildup.
- All nozzles spray a uniform fan of material without misting or fogging.
- Spray bar cutoff is positive and immediate.
- Distributor truck is weighed after each shot.
- Traffic is kept off uncured prime or tack.
- Blotter sand is available.

4.2. Tack Coat - Existing Pavement Preparation

Pavements deteriorate with time. Air, water, traffic and temperature cycles all shorten pavement life. Existing pavements are overlaid to correct surface irregularities, to strengthen the pavement structure, and to seal out air and water.

Preparation for a pavement overlay includes cleaning dirt and debris off the old pavement and applying a tack coat. Tack is an asphalt product (usually an emulsion) that is sprayed on existing pavement in a thin film. It provides a bond between old and new pavement.

If the old pavement has severe dips or ruts, it may require leveling with asphalt concrete prior to the overlay. It may also be necessary to raise manhole covers, storm water inlets, and similar objects.

4.2.1. Leveling

If a need for filling dips and ruts is anticipated, it will generally be indicated on the typical section in the plans for the project. Small holes and cracks are filled by hand with a shovel and a rake. Larger dips will require leveling with a motor grader (blade) or with a paving machine.

Normal procedure is for the inspector to stretch a string line across the dip to determine its depth and then mark the edges of dip with orange paint. Depth in the dip is marked in tenths of feet of asphalt fill required. The contractor then fills it to the depth and dimensions indicated. Deep dips must be filled in successive layers, starting at the deepest point and working radially outward. Each lift must be compacted separately with the rubber-tired roller.

All old pavement surfaces must be cleaned and tacked prior to leveling.

4.2.2. Surface Preparation for Tack Coat

The contractor must clean the old pavement if it is dirty or covered with debris (Highways 401-3.10, Airports 401-4.10). A power broom is normally used, but in extreme cases flushing with water may be necessary. The worst enemy of a tack coat is dry dust. A slightly damp (not wet) surface is preferable to a dry, dusty one. If all the dust cannot be removed, the old surface should be moistened slightly 0.05-0.10 gal/sq. yd. using a water truck with a high-pressure spray bar.

Curbs, manholes, inlets, and the like are usually dirty and require cleaning with a hand broom prior to the application of a tack coat.

All old pavement surfaces must be cleaned and tacked prior to leveling.

Figure 4-2
Surface Preparation before Applying Tack

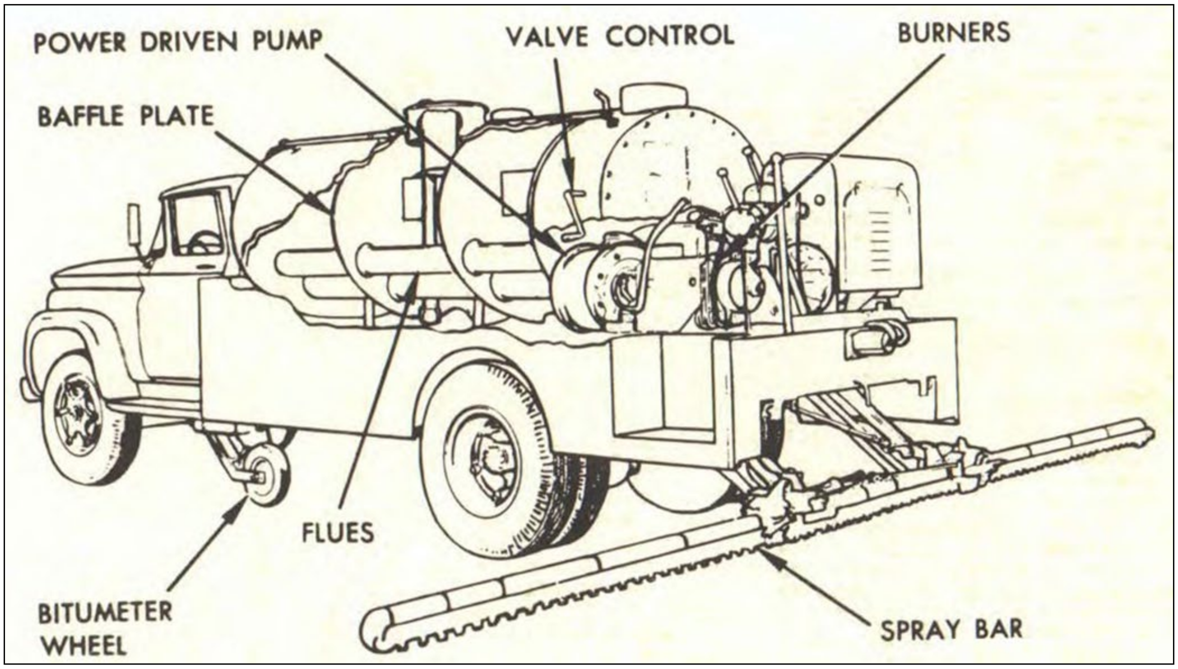


Figure 4-3
Distributor Truck

4.2.3. Tack Coat

The standard specifications call for STE-1 Emulsified Asphalt to be used for tack coats (Highways 402-2.01, Airports 603). On some contracts the special provisions may call for a heavy grade of cutback asphalt instead.

A distributor truck applies the tack coat. Proper operation of the distributor truck is the key to a good tack job. See the description of the distributor truck in Section 4.4 of this Manual for details.

Application rates vary and will be set forth in the contract (Highways 402-3.04 and Airports 603-3.3. The tack coat should give a uniform coat without excess material. The inspector may adjust the application rate if the coverage is too heavy or too light. As a general rule, a small amount of the existing pavement should show through the tack coat. Too much tack can cause slippage between old and new pavements or bleeding.

A variation of up to 0.02 gallons per square yard is acceptable (Highways 402-3.02, Airports 602-3.3). Most contractors control the spread closer than this. Even in small areas it is better to use the spray bar instead of the hand sprayer if it is possible to maneuver the truck.

Care must be taken to prevent spray overlap or missed areas at longitudinal joints between shots of tack.

Missed spots can be tacked with the hand sprayer, but the result will be better if the application is done right in the first place.

Table 4-4
Typical Tack Rates

Surface Type	Residual Rate (gsy)	Approximate Bar Rate Undiluted* (gsy)	Approximate Bar Rate Diluted 1:1* (gsy)
New Asphalt	0.02 – 0.05	0.03 – 0.07	0.06 – 0.14
Existing Asphalt	0.04 – 0.07	0.06 – 0.11	0.12 – 0.22
Milled Surface	0.04 – 0.08	0.06 – 0.12	0.12 – 0.24
Portland Cement Concrete	0.03 – 0.05	0.05 – 0.08	0.10 – 0.16

*Assume emulsion is 33% water and 67% asphalt.

At transverse joints, building paper should be placed over the end of the old shot of tack and the new shot should begin on the paper.

The tack should be applied the same day the surface is paved and must be in good condition when the paving machine reaches it. It is the contractor's responsibility to protect the tacked surface from damage until the pavement is placed.

Tack should be allowed to break before paving begins. When it breaks it will change from chocolate brown to black and from "gooey" (it will stick to your fingers) to tacky (it will feel sticky but will not stick to your fingers). Paving before the tack breaks results in the equipment picking the tack up off the road, which defeats the benefit of the tack.

Strictly adhere to weather limitations given in the contract (Highways 402-3.01, Airports 603-3.1). Rain can wash unbroken emulsion off the grade, ruining the tack and creating a serious pollution problem. It can cause a serious public relations problem with the traveling public, if this oil is splashed on their cars. And it can cause extremely hazardous driving conditions. Tacking is never allowed in rainy weather.

Tack is normally paid for by weight. Tack is applied as it is received from the supplier and may not be diluted unless directed by the Engineer.

The distributor truck is weighed before and after the application to determine the amount of tack that was placed.

Curbs, manholes, and other surfaces on which asphalt concrete will be placed or abutted must be tacked by hand prior to paving. Surfaces of curbs, etc. that will not have pavement placed on them must be protected from over spray from the distributor.

4.3. Prime Coat - Aggregate Surface Preparation

Liquid asphalt materials with high penetration qualities are used for prime coats. They are sprayed onto an aggregate surface, where they coat and bond the aggregate. Prime coats provide a temporary waterproofing of the base course surface and a permanent bond between the base course and asphalt concrete pavement. Prime coats may also preserve the finished base course for a few days if traffic must be allowed on it before paving begins, especially in wet weather. They also provide a zone of transition in asphalt content between the pavement and the untreated material below.

A good prime coat requires a base course surface that is smooth, properly crowned, and free from wash-boarding, ruts, and standing water. This must be checked immediately before the prime coat is applied (Highways 403-3.03 and Airports 602-3.3).

On very tight, dense bases, sweeping with a power broom may be needed to remove a dust seal that has built up under traffic. More often the base is "tight bladed" with a motor grader. This slightly loosens the surface, which helps the prime penetrate. It also removes any loose rock.

As with tack coats, the worst enemy of a prime coat is dry dust. The surface of the base course should be slightly damp (not wet) for the prime to penetrate properly. Dry dust can be eliminated with a light fog of water sprayed under high pressure from a water truck. Whether to water, and how much to water, is a decision based on how moist the grade is, how hot and sunny it is, and how soon it will be primed. Too little moisture and the prime will not penetrate; too much and it will puddle up or even run off the grade.

4.3.1. Alignment, Grade, and Compaction

Alignment is the horizontal positioning of the road or runway; grade is the vertical positioning. The plans describe the alignment and grade of a "profile line" for the road, runway, or taxiway. This is most often the centerline of the structure. The alignment and grade of other points relative to the profile line is shown in one or more "typical sections" in the plans.

The alignment and grade must be checked and approved by the grade inspector prior to priming. This ensures that the road or runway is in the correct location. This sounds simple, but stakes are lost during construction and mistakes do occur.

The surface width of the road or runway must also be checked; sometimes it is narrower than the planned paving width and must be corrected. The position and slope of the crown must be checked too (or just the slope in a superelevated section).

Compaction of the base course must be checked and approved prior to priming. The check is made by density tests performed by materials inspectors.

4.3.2. Prime Coat

Highway Specifications SSHC Section 403-2.01 allows MC-30 Liquid Asphalt or CSS-1 Emulsified

Asphalt as prime coat material. Airport Standard Specification 602-2.1 allows MC-30 or CMS-2S Emulsified Asphalt. Contract special provisions may allow other materials. When emulsified asphalt is used, it is diluted with an equal amount of water prior to application.

Section 4.4 describes the distributor truck (Figure 4.3) used for spraying prime coat material.

The layout of widths and lengths to be primed should be determined before application. A small amount of material, 100 gallons or more, should be left in the distributor at the end of each shot to prevent uneven application. The area, which can be covered by a load, must therefore be calculated ahead of time.

The rate of application is usually determined from the amount of material that will be absorbed in a 24-hour period. Ideally a trial section is laid out the first day. The application rate may require adjustment by the inspector if the coverage is too heavy or too light. It is sometimes necessary to split the application into two shots.

Care must be taken to prevent spray overlap or missed areas at longitudinal joints between shots of prime.

Excess material can be mopped up from overlapped areas and missed spots can be primed with the hand sprayer, but the result will be better if the application is done right in the first place. If gaps are left in the prime coat where traffic will be allowed, the gaps will become potholes in the finished base coarse.

At transverse joints, building paper should be placed over the end of the old shot of prime and the new shot should begin on the paper (Highways 403-3.04).

Once the prime material has been absorbed enough that tires will not pick it up, traffic may be allowed on the surface. It is the contractor's responsibility to protect the surface from damage until the pavement is placed.

Strictly adhere to weather limitations in the contract (Highways 403-3.01, Airports 602-3.1). Rain can wash fresh prime material off the grade, ruining the application and creating serious pollution. Oil splashed on cars could cause negative public response. It can cause extremely hazardous driving conditions. Priming is never allowed in rainy weather.

Prime is normally paid for by weight. Emulsified asphalt is diluted with an equal amount of water prior to application. The state pays only for the undiluted emulsion, not for the dilution water. The distributor is weighed before and after the application and during the mixing process to determine the amount of prime that was placed.

If asphalt concrete will be placed against the surface of curbs, manholes, etc., these surfaces must be tacked (usually by hand). Surfaces of curbs, etc., that won't be paved must be protected from the distributor spray.

4.3.3. Blotter Material

The contractor is required to have clean sand available to use as blotter material. The contractor must also have an aggregate spreader to apply it, and a rotary broom to sweep surfaces on which blotter material has been placed (Highways 403-3.05, Airports 602-3.3).

Blotter sand is not normally used, but is sometimes spread on an uncured prime coat. The most common reasons for using it are (1) because traffic must be allowed on the prime before it has cured, and (2) because imminent rain threatens to wash uncured prime off the grade.

The use of blotter sand less than four hours after applying the prime is allowed only with written permission (Highways 403-3.05, Airports 602-3.3). It is almost impossible to apply blotter without getting thick spots that eventually "reflect" through the surface. Because of this, the use of blotter sand should always be avoided if possible. If the base will not absorb the prime material within four hours, the application rate probably needs to be reduced.

4.4. Distributor Truck

Nearly all distributors used in Alaska are truck-mounted units similar to the one shown in the diagram (Figure 4-3). The distributor tank is insulated and has a heating system (burner and flues) to maintain the asphalt material at the proper temperature. The pump circulates the material inside the tank and pumps it to the spray bar and hand sprayer. The bitumeter wheel drives a speedometer and odometer accurate at the low speeds used when priming or tacking (the speedometer usually reads in feet per minute).

Specifications require that the distributor have a pump tachometer, pressure gauges, and a tank thermometer. It must have a circulating spray bar (the material is pumped through the bar and back into the tank as well as out the nozzles). The distributor truck has a flow rate gauge; it measures gallons per minute.

The tank must be calibrated in 50-gallon increments or smaller, so volume measurements can be made.

The distributor truck is one of the most dangerous pieces of equipment on a paving spread. It has the potential for explosion from hot asphalt turning trapped water (in the piping system) into steam, from fumes being ignited, and from pressure building up during heating operations. There is also the potential of being burned at almost any time during distributor operations, either by the oil itself or the piping or the heating system. It is possible to be overcome by the fumes if proper care is not taken.

Proper operation of the distributor is the key to a good tack or prime coat. It should spray the right amount of tack or prime liquid on to the surface in a uniform film. This requires good equipment, trained operators, and proper adjustment of the following:

1. The height of the spray bar above the surface
2. The speed (pressure and capacity) of the pump
3. The speed of the truck
4. The size and angle of nozzles on the spray bar

The yield (gallons per square yard) can be calculated using three factors in the equation below: speed of the truck (feet per minute), length of the spray bar being used (feet), flow rate setting of the pump (gallons per minute):

Yield (gal/yd^2) =

flow rate (gal/min) / [Speed (ft/min) x width (ft) /

9 ft^2/yd^2]

The contractor will choose to hold the speed or the flow rate constant for a given width and yield, then calculate the remaining factors. Most distributors have a cardboard "slide rule" that makes this calculation even simpler.

Most distributors use a triple lap spray system; a few use double lap. Closing off two out of every three nozzles can check spray bar height on the triple lap system (or every other one on a double lap). This change should result in a single, uniform coverage. If there is a gap between spray fans the bar is too low; if there are doubly covered streaks the bar is too high. The test may be made on the approved surface. After the bar is set, the test area can be retacked or reprimed to bring the total coverage ("yield") up to the required amount.

The pump should be operated at the highest speed (pressure) that will not atomize the prime or tack spray. The asphalt coming out of each nozzle should look like a triangular black rubber sheet, not a fog or mist.

Contractors can usually make a good first guess of the pump and truck speeds necessary to achieve the required "yield" (measured in gallons per square yard). The quantity of tack or prime material sprayed on an initial, small area is carefully measured and the yield is calculated. Adjustments (usually to the truck speed) can then be made so that the yield matches plan amounts. Short shots should be repeated until the correct amount of tack or prime is being placed.

Nozzles ("snivvies") must all be the same size and set at the angle specified by the distributor manufacturer. This is 30° to the spray bar for Etnyre machines, 60° for Grace, 15° for Littleford, and 25° for Roscoe.

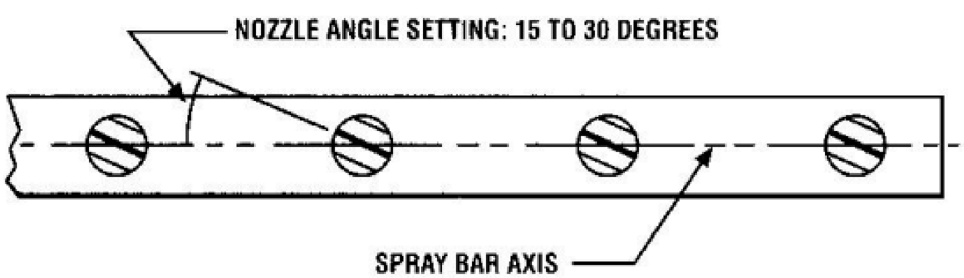


Figure 4-4
Nozzle Settings

The fan of material sprayed from a nozzle should be uniform from edge to edge. If it isn't, the nozzle is clogged, worn or damaged. The fan from all the nozzles should look the same. If they don't, the pressure may be too low or the nozzles may be different sizes or clogged.

If nozzles need to be replaced, the complete set should be changed at the same time to assure uniform operation. Distributors must be kept clean to operate properly, either with steam cleaning or scrubbing with solvent. This is particularly important if emulsions are used, since residues can set or "break" inside the equipment, fouling or clogging.

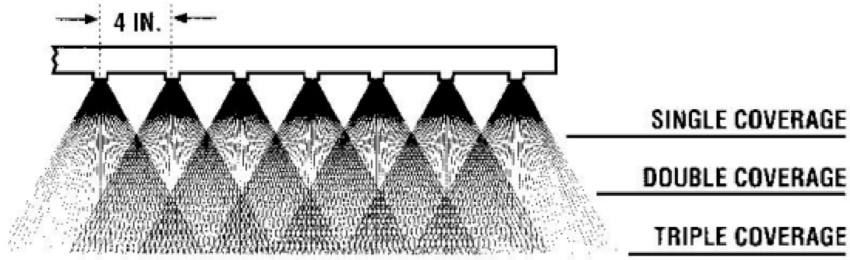


Figure 4-5
Nozzle Coverage

4.5. Prime and Tack Logs

Your measurements, comments, and other information are normally kept in a Prime (or Tack) Log, which is described in the next section. Any unacceptable or out-of-specification condition should be noted in the log. The contractor should be notified immediately of any such condition and corrective action taken prior to priming or tacking.

An example of a page from a tack and a prime log are included at the end of this section. The logbooks should be clearly marked with the name and number of the project as well as the pay item (prime or tack). Pages should be prepared with column headings, etc., ahead of time so you don't have to do this while you should be inspecting the work.

You must sign each page of the log. You can use initials only if there is an index to them in log with your signature (for example J.A.S. = John A. Smith).

Someone unfamiliar with the project should be able to look at your log and determine:

- The *location* of each prime or tack shot.
- The *area* covered by the shot.
- The *date* and *time* of the shot and the *weathe*r condition.
- The *quantity* of material used on a shot and its *temperature.*
- The *plan spread rate* ("yield") and the *actual spread rate.*

The station and lane (or offset) information show the location. The width of the shot multiplied by its length gives the area. You must note any equations and their effect to determine the length correctly. Notice that in the example log pages, the plan spread rate ("Theo. Spread") has been converted from gals/sq.yd. to gals/station. The actual spread you get on the project can then be calculated in gals/station, too. This is easier than calculating gals/sq.yd., so it saves time and reduces the chances for errors. The gallons per station method works well if most of the shots will be the same width, usually on a rural job. However, if the width of the road changes frequently, using gallons per square yard is less confusing (though more arithmetic).

The conversion is simply the plan spread (gals/sq.yd.) multiplied by the number of square yards shot per station.

The width of the shot in feet times the length (100 feet) will give the number of square feet; dividing this answer by 9 will convert the area to square yards (9 sq.ft. = 1 sq.yd.):

Width (in feet) x 100/9 = Width x 11.11 = Area in square yards, so:

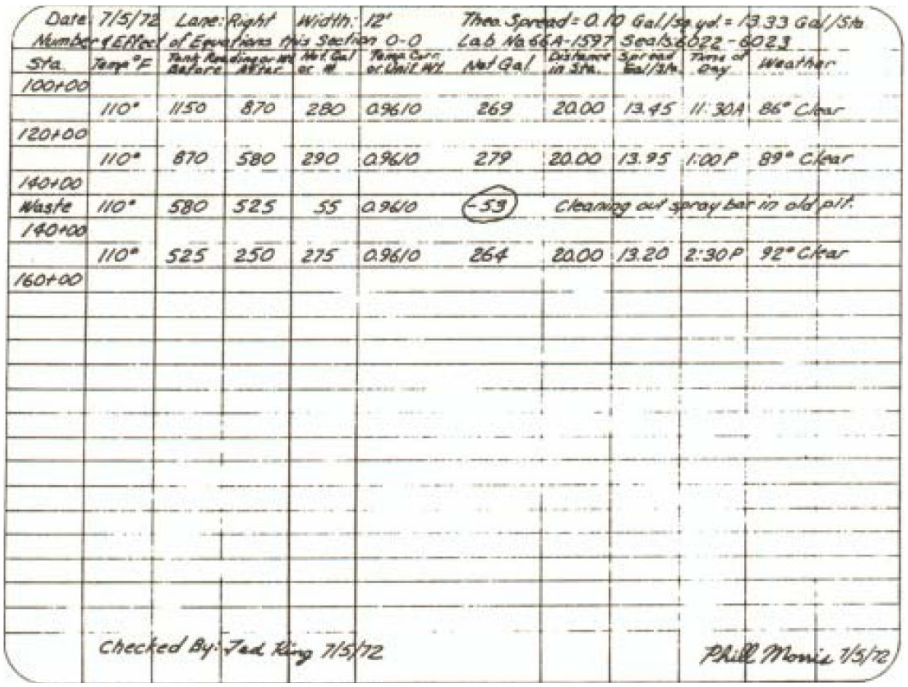
Spread (gals/sq.yd.) x width (feet) x 11.11 = Spread (gals/sta.)

Example:

The log should also note any unusual events that occur during the prime or tack operation. If any material is wasted, you should note how much and why. You should also note if the operation stops due to equipment problems or weather. If blotter sand is used, note where and the reason for it.

In the sample prime log, the plan spread rate ("Theo. Spread") is 0.30 gals/sq.yd. and the width of the shot is 13 feet, so

0.30 x 13 x 11.11 = 43.33 gals/station



Date 7/5/72 Lane: Right Width: 12' Theo. Spread = 0.10 Gal/sq.yd. = 13.33 Gal/Sta
Number of Effect of Equations this Section 0-0 Lab No. 66A-1597 Seals 6022-6023

Sta.	Temp °F	Tank Readings or Wt Before	After	Net Gal or Wt	Temp Corr. or Unit Wt.	Net Gal	Distance in Sta.	Spread Gal/Sta.	Time of Day	Weather
100+00										
	110°	1150	870	280	0.9610	269	20.00	13.45	11:30A	86° Clear
120+00										
	110°	870	580	290	0.9610	279	20.00	13.95	1:00P	89° Clear
140+00										
Waste	110°	580	525	55	0.9610	-53	Cleaning out spray bar in old pit.			
140+00										
	110°	525	250	275	0.9610	264	20.00	13.20	2:30P	92° Clear
160+00										

Checked By: Jed King 7/5/72

Phill Monie 7/5/72

Figure 4-6
Sample Tack Log

5. Asphalt Materials

5.1. Responsibilities of the Materials Inspector

5.1.1. Materials Testing Requirements

Materials are inspected and tested to ensure that they are the types and quality called for in the contract specifications. Occasionally, some of the materials testing are contracted out. Much of the testing has also been made part of the contractor's quality control responsibilities. Both you and the Regional Materials Laboratory have responsibilities in this area; you should coordinate your work with them. The Regional Lab can provide you with information about the overall materials and inspection program for your project. Since this may differ between regions and specific projects, this manual provides only general information.

The Quality Assurance Roving Materials Inspector prepares a schedule of "Materials Testing Requirements" for every project. It lists the materials standards and the type and frequency of tests required for each pay item in the contract. Ask your immediate supervisor or the project engineer if you have any questions about these requirements.

5.1.2. Test Categories

DOT&PF divides materials tests into four categories:

Quality
The state or regional Materials Laboratory generally does quality tests. They determine if raw material from a particular source, such as an asphalt supplier or a gravel pit, has acceptable qualities. Gravel, for example, is tested for hardness and durability.

Acceptance
Project materials inspectors perform acceptance tests. They document whether a specific lot of a pay item, such as asphalt concrete, meets particular specifications for the item (such as gradation). The Department accepts and pays for materials based on acceptance tests. On almost any paving project, you will be responsible for acceptance tests for density, asphalt content, gradation, fracture, and pavement thickness.

These tests are briefly described in this Section.

Assurance
The Regional Lab usually performs assurance tests. These are used as checks on your acceptance tests and ensure that you are using the right procedures and that your test equipment is working correctly.

Information
Information sampling must be approved by or undertaken at the request of the project engineer. Be cautious with sampling for informational purposes. Information tests are made on samples taken during the production of materials prior to the point of acceptance. Tests taken to investigate apparent changes in the product may detect production problems before the scheduled acceptance test, thus averting the rejection of a large quantity or the imposition of a price reduction. The gradation of aggregates, for example, is often checked as it is being crushed. Either project materials personnel or the Regional Laboratory may make information tests. Do not use information tests to replace quality control tests that are the responsibility of the contractor, as this may make DOT&PF responsible for out-of-specification material.

5.1.3. Testing Procedures

There are detailed procedures for each type of test that you must follow carefully. You should have a set of the test procedures for all tests you will be using on your project.

DOT&PF uses AASHTO, ATMM, and ASTM standards for materials and test procedures.

- AASHTO = American Association of State Highway and Transportation Officials. A "T" designates AASHTO tests (Example: AASHTO T195). An "M" designates AASHTO specifications (Example: AASHTO M156).
- ATMM = The Alaska Test Method Manual is issued by DOT&PF's Division of Statewide Design and Engineering Services, Statewide Materials Section
- ASTM = American Society for Testing and Materials.

The objective of testing is to ensure that materials meet the standards required by the contract. The objective is not to obtain the required number of passing test reports. Samples should always represent the total quantity of material for which the test is intended, not fragments of it. Never take a sample or make a test with the predetermined objective to pass or fail the material or work.

5.1.4. When to Test

The "Materials Testing Requirements" schedule normally ties the need for acceptance tests to the amount of material, such as one test per 500 tons of paving mix. To know when to test you must therefore keep track of how much material has been produced. Informational tests may be taken at any time to resolve questionable materials or to confirm the contractor's process control tests. Materials acceptance sampling and testing should be performed by project materials staff that have WAQTC certification.

To ensure your samples are representative of the total amount of a material, avoid "pattern sampling." Don't take samples at the same time every day, for example.

Although you will not do the quality or assurance tests yourself, you will probably be responsible for keeping track of them and notifying the Regional Materials Laboratory when one is needed. You may also be asked to take samples for some of these tests.

If asked to take asphalt cement samples, be sure you have read the safety section of this manual and the proper sampling procedure.

If you have questions about when to test or how to run a test, contact the Roving Materials Inspector.

5.2. Brief Description of Tests

5.2.1. Acceptance Testing

Remember to inform the project engineer or your supervisor of all test results as soon as possible. If problems aren't reported quickly, work may have to be needlessly redone – or the Department may not get as good a facility as it is paying for. During the pre-paving meeting, the test methods to be used, the method of determining random sampling, and general protocol for determining sampling points should be discussed and agreed on.

Pavement Price Adjustment

Price adjustment procedures are usually a part of highway and airport contracts. Highway and airports use different price adjustment spreadsheets. Check each project's specifications for this requirement. The procedure provides a basis for deciding whether to accept, reduce payment, or reject the paving material depending on its degree of conformance with the specifications and its variability.

Asphalt Cement Content

Hot-mix asphalt concrete is tested to determine if it contains the asphalt cement content specified by the mix design. Samples for the determination of asphalt cement content will be taken from behind the screed prior to initial compaction or from the windrow.

Asphalt cement content is determined using an ignition oven (ATM 406) which must be calibrated to the approved mix design from samples from the Regional Materials Lab.

Gradation

A gradation describes the relative size distribution of the particles in an aggregate sample. Oven-dried aggregate is shaken through a set of sieves. Smaller particles are washed through the sieves to separate fines (clay and silt), which may be adhering to them. The weight of the material passing through each sieve size is compared with the weight of the original sample and expressed as a percentage.

English sieve sizes are given in two ways: Large sizes (sieves with holes ¼ inch or more) are named by the opening width, i.e. 1-inch, 3/8-inch, etc. Smaller sieves are numbered, i.e. #4, #200, etc. The number corresponds to the number of openings per linear inch of screen.

Metric specifications may refer to micrometer sieve sizes in decimal millimeters (0.075 mm = 75 µm).

After the mix sample has been tested for asphalt content by ignition, the aggregate remaining may be used for gradation testing. Gradation testing will be determined by ATM 408.

Fracture Testing

The fracture test, ATM 305 (Determining the percentage of fracture in coarse aggregate), is a visual determination of whether the larger aggregate particles are sharp-edged or rounded. Samples for fracture testing are taken from the aggregate cold-feed belt at the asphalt plant or completed from the gradation sample.

The degree of fracture specified may vary with projects. Since the requirement may vary, check the specifications for your project, or ask the Roving Materials Inspector.

Table 5-1
Equivalent Metric Sizes

English	Metric
4”	100 mm
3”	75 mm
2”	50 mm
1 ½”	37.5 mm
1”	25 mm
¾”	19 mm
5/8”	16 mm
½”	12.5 mm
3/8”	9.5 mm
¼”	6.3 mm
#4	4.75 mm
#6	3.35 mm
#8	2.36 mm
#10	2.00 mm
#16	1.18 mm
#20	850 µm
#30	600 µm
#40	425 µm
#50	300 µm
#60	250 µm
#70	212 µm
#80	180 µm
#100	150 µm
#200	75 µm

Density and Depth

Compaction tests are taken on the pavement after final rolling by Specific Gravity Testing on samples cored from the pavement, in accordance with ATM 408 (bulk specific gravity of compacted bituminous mixtures): Just prior to coring, the state inspector should mark the location for mat density. If the specifications require joint density, the core should be centered over the joint so both mats are in the core.

In the specific gravity test, the samples are weighed while submerged in water, after removing them from the water and patting the surface dry, and again after oven drying. The specific gravity is computed from these three weights.

5.2.2. Quality Requirements and Documentation

Aggregates

Project personnel must make sure that only approved sources are used for making aggregates. Materials sources are approved for the project based on quality tests done by the Regional Lab. Brief descriptions of some of these tests are given below for your information.

- Micro-Deval measures resistance of coarse aggregates to degradation by abrasion. It is a measure of the abrasion resistance and durability of aggregates resulting from grinding in the presence of steel balls and water.
- Fracture: Single or double face relates to internal particle friction or interlock of coarse aggregates (> #4 sieve).
- Fine Aggregate Angularity (Uncompacted Voids) is a Superpave test for aggregate smaller than #8 sieve.
- LA Abrasion measures resistance to coarse aggregate abrasion and mechanical degradation during construction and in service.
- Nordic abrasion measures the hardness of coarse aggregate.
- Soundness (Sodium Sulfate) estimates the resistance to in-service weathering especially freeze thaw aggregate breakdown due to absorbed moisture.

Asphalt Cement

Asphalt cement is specified as a Performance Grade, where performance is measured at a high and low temperature measured in degrees Celsius. Thus PG 52-28 will resist plastic deformation or rutting at 52°C and thermal cracking at -28°C. Typically higher temperatures are achieved by adding polymer to the asphalt and lower temperatures are achieved by adding extender oils.

Specifications require the asphalt cement to be sampled from the supply to the plant at a specified frequency, typically at 200-ton intervals.

Asphalt cement delivered to the project must be accompanied by the supplier’s certification that the shipment has passed the required quality tests. Check the certification and keep a record of the deliveries.

Sampling is performed by hot plant personnel in the presence of the inspector at a specified frequency. Three samples are taken at the plant before it is mixed with the hot aggregate. Samples are taken after the sample line is purged of residual asphalt. DOT&PF personnel take immediate possession of these samples and send one to the Regional lab for assurance testing.

Check Marshall Tests

Check Marshall tests may be made on the project produced mix to determine if it conforms to the approved mix design. Regional Laboratory performs these tests, but project materials inspectors may be asked to obtain the samples.

5.2.3. Materials Handling

Asphalt Cement

Special care is required to work safely around hot asphalt storage tanks. Follow contractor plant safety protocol before approaching an asphalt storage tank.

Asphalt products must be kept free of contamination and must not be overheated. Storage tanks are heated to keep the asphalt fluid, but overheating causes oxidation or property changes of the asphalt. This will result in premature aging of the pavement.

The storage temperature generally must be no more than 330 ºF for asphalt cement and 50-125 ºF for prime or tack coats. A thermometer should be located on the asphalt cement tank. Storage temperatures are discussed in the Highways Specification 702-2.04 (there is no equivalent airport specification). The specifications may be different on your particular project, so check them. The Job Mix Design will specify the allowable mixing temperature range for your project.

Aggregates

Proper stockpiling is the responsibility of the contractor. The stockpile site must be cleared and leveled prior to stockpiling. Stockpiles of different materials should be kept separate to prevent contamination.

Poor stockpiling techniques result in larger particles rolling to the bottom of the stockpile, leaving the fines behind. This separation of different sizes is called segregation. Segregation results in out-of-specification asphalt concrete (some with too much large aggregate, some with too little). Both types result in weak pavement that will deteriorate rapidly.

It is the inspector’s responsibility to watch for and report segregation any time the aggregate is handled or moved. Stockpiles should be built in layers to prevent segregation. Specifications allow only rubber-tired equipment on stockpiles. Steel-tracked equipment will crush the aggregate, causing excess fines, failing tests, and inferior pavement.

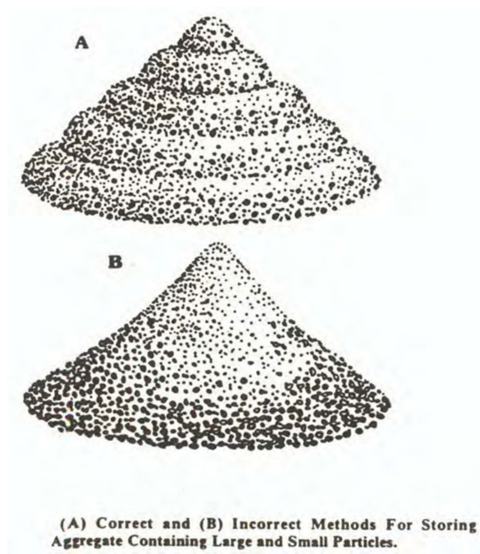


Figure 5-1
Stockpile Layers

5.3. Asphalt Mix Design

Asphalt paving mixtures for DOT&PF are designed by the Regional Materials Laboratory or by an AASHTO accredited lab hired by the contractor. All asphalt mix designs must be approved by the Regional Materials Engineer before it can be used to make asphalt mix for a project.

Typically, the asphalt mix design is made using the Marshall Design Method (ATM 417) based on contractor provided samples of aggregate, asphalt cement, and any other materials to be incorporated into the asphalt mix. The contractor provides a target aggregate gradation and other material documents specified. Project materials inspectors do not design paving mixes, but need some understanding of the process and the mix design report.

The asphalt mix design becomes part of the contract, with acceptance based on conformance to the aggregate gradation and quality, asphalt content and quality, and density relative to the maximum mix density all of which are listed on the approved mix design. The contractor provided materials must produce a mix that meets the requirements of the mix design.

Any change in materials used in the approved mix design must be approved through the project engineer by the Regional Materials Engineer.

This section contains basic information about mix design. You can find more complete information in the Asphalt Institute publication Mix Design Methods for Asphalt Concrete (MS-2). Standard specifications relating to mix design are found in Highway Specification Sections 401-2.09, 702, and 703 and in Airport Specification Section P-401-3.2.

5.3.1. Marshall Method

Samples of the proposed mix materials are used in the design procedure. Careful sampling is very important to the quality of the design and the pavement built from it. If the aggregate or asphalt source changes, you must prepare a new mix design.

Aggregate is mixed with different percentages of asphalt cement in the lab. For each amount of asphalt, compacting the mix in a mold makes several test specimens. The specimens are tested for specific gravity and voids content. They are also tested for stability and flow under compression in a testing machine.

Stability is a measure of how much load the specimen can sustain. Flow is a measure of how much the specimen deforms under the load. The optimum asphalt percentage in the mix is determined from the results of this testing. The results are given in a Mix Design Report.

5.3.2. The Mix Design Report

The mix design report contains information needed by project materials inspectors. The next page shows a sample mix design. The following information can be determined from the mix design:

1. Mix Type: Defines the aggregate gradations and mix design method specified.
2. Aggregate Source: The contractor selects the aggregate source and it is noted on the approved mix design.
3. Asphalt Cement Source: The contractor selects the supplier of the asphalt cement and anti-strip which is noted on the approved mix design. The asphalt used on the project must be from the same source as that used in the mix design.
    a. Asphalt Cement Performance Grade (PG): Project specifications state the PG grade of asphalt to be used. PG indicates the high - low temperature performance range of asphalt cement.
    b. Percentage of liquid anti-strip additive required added to the asphalt cement.
    c. Warm mix additives; percent added to the asphalt cement and brand are noted (if required).
4. Mixing Temperature: The recommended plant mixing temperature range
5. Compacting Temperature: The recommended temperature range for the initial “breakdown” compaction rolling.
6. Optimum Asphalt Content: The target value of asphalt content at which the mix has the best combination of stability, air voids, and density. An asphalt price adjustment is based on mix meeting the optimum asphalt content.
7. Mix Design Criteria: Includes the desired;
    a. Stability and flow, compaction (50 or 75 blows per side),
    b. Dust-asphalt ratio,
    c. Void relationships that were used to design the mix. (These are not acceptance or field specifications.)
    d. Unit Weight at Optimum.
    e. The maximum lab density of the designed mix, expressed in pounds per cubic foot and specific gravity.
8. Aggregate: The size distribution of the asphalt aggregate particles. The percentage of the aggregate passing on a given sieve size must meet the mix design target value ± the allowed tolerance. An asphalt mix price adjustment is based on the aggregate gradation in the mix meeting the gradation on which the mix design was based.

25-229
R-1/2000
S.E. REGION

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

ASPHALT MARSHALL MIX DESIGN (U.S. STAND.)

PE ✓ INSP ____ SEC ____

TEST OF ASPHALT CONCRETE PAVEMENT, TYPE II / B — ITEM NO. 401 — LAB NO. 00C-460

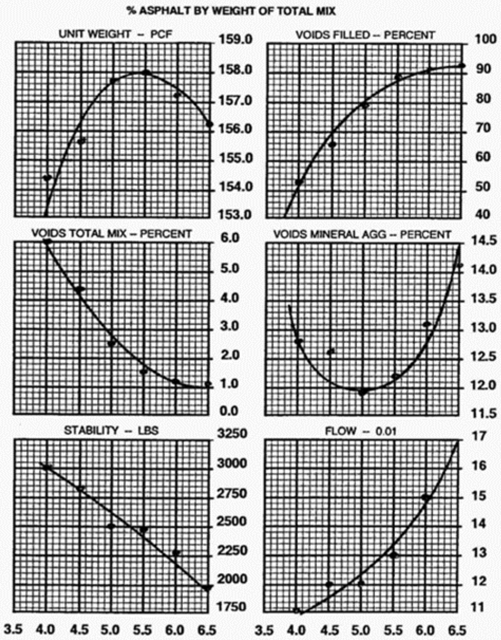
PROJECT NO.	STP-0904(1)	PROJECT NAME	KTN THIRD AVENUE EXTENSION		
SAMPLED FROM	CONTRACTOR	EXAMINED FOR	AASHTO T 27/11, 84/85, 209, 166, 269, 245, ASTM D 4791, 5821		
DEPTH	N/A	FIELD NO.	N/A	DATE SAMPLED	CONTRACTOR
SOURCE	SEE BELOW	SUBMITTED BY	CONTRACTOR	DATE RECEIVED	10/21/00
LOCATION	KETCHIKAN, ALASKA	REPRESENTS	1 / SOURCES	DATE REPORTED	10/25/00

% PASSING	AS RECEIVED CSE	INT	FNE	TARGET	SPECS
ASPH CONTENT					
AGG BLEND %	15	85			
1-1/2"					
1"					
3/4"	100	100		100	100
1/2"	84	88		86	79 - 93
3/8"	48	73		69	62 - 76
#4	4	47		45	38 - 52
#8	1	35		32	26 - 38
#10					
#16	1	26		24	18 - 30
#20					
#30	1	20		19	14 - 24
#40					
#50	1	15		14	10-18
#80					
#100	1	11		10	7-13
#200	1.0	8.0		6.6	4.6 - 8.6
FRACTURE %				100	> 80
THIN ELONG %					
BULK SPG				2.724	
SD SPG					
APPARENT SPG					
ABSORPTION %					
BLEND AVG				2.784	
EFFECTIVE SPG				2.815	

MIXTURE AT TARGET

	MARSHALL	SPECS
ASPHALT CONTENT %	5.2	4.8 - 5.6
UNIT WEIGHT--PCF	157.8	
VOIDS FILLED--%	82	
VOIDS TOTAL MIX--%	2.4	2-5
VOIDS MINERAL AGG--%	12.0	
STABILITY--LBS	2600	> 1400
FLOW--0.01 MM	13	8-16
MAXIMUM SPG	2.582	
MAX UNIT WEIGHT--PCF	161.1	
NUMBER OF BLOWS	50	50
MIX TEMP--DEG F	300	
COMP TEMP--DEG F	280	
ASPHALT BRAND	U.S. OIL	
ASPHALT TYPE	PG 58-28	
ASPHALT SPG	1.030	
ANTI STRIP	ARMAZ	0.3%

% ASPHALT BY WEIGHT OF TOTAL MIX



REMARKS: 15% MOORES QUARRY CSE CONCRETE AGG
85% MOORES QUARRY INT CONCRETE AGG

APPROVED
SUBJECT TO FIELD INSPECTION
BRUCE E. BRUNETTE, P.E.
REGIONAL MATERIALS ENGR. 10-25-00

PNH

THE MATERIAL AS SUBMITTED CONFORMS TO SPECIFICATIONS
YES ( ) NO ( ) N/A

CHECKED BY: Jeffrey A. Hart
JEFFREY A. HART, LAB. SUP.

SIGNATURE: Bruce E. Brunette
BRUCE E. BRUNETTE, P.E.

STATE OF ALASKA
49TH
Bruce E. Brunette
PE 9707
REGISTERED PROFESSIONAL ENGINEER

THE TEST RESULTS ARE ONLY REPRESENTATIVE OF THE MATERIALS SUBMITTED
TESTS ARE PERFORMED IN ACCORDANCE WITH STANDARD AASHTO/ASTM OR FHWA/FAA APPROVED ATM TEST PROCEDURES

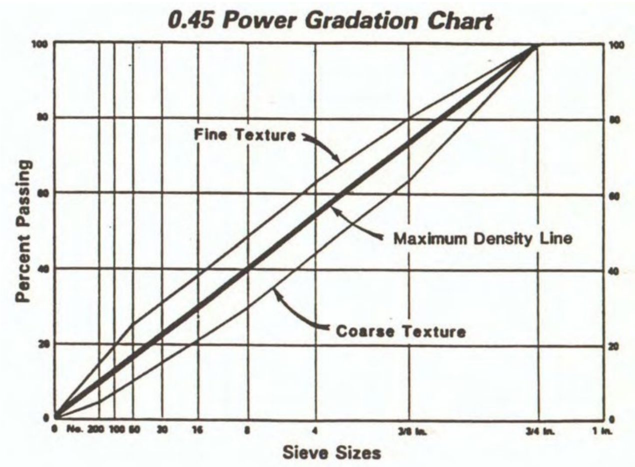
Figure 5-2
Sample Mix Design Report

5.3.3. Aggregate Gradation 0.45 Power Chart

Nearly all the volume of dense-graded asphalt pavement is filled by aggregate particles. The remaining spaces (voids) are filled with asphalt or air. In general, the fewer the voids, the stronger and more waterproof the pavement.

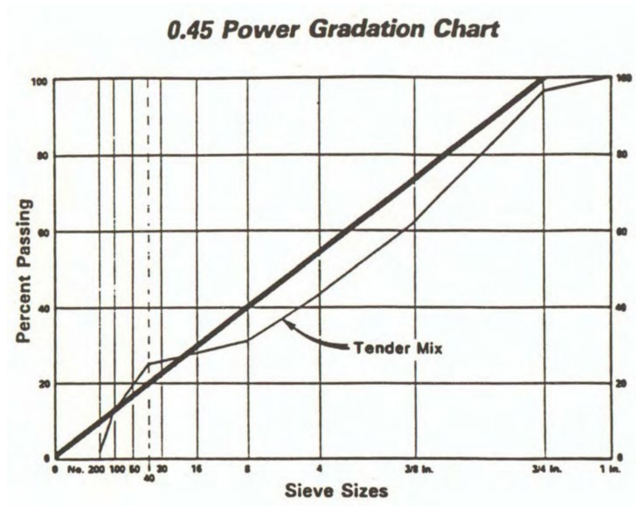
The mix must have some voids, however. Beyond a certain point, a reduction in voids lowers stability. It can also lead to asphalt “bleeding” out of the mix under compaction, which creates a slick driving surface.

The 0.45 power chart, shown can help to avoid this. To use it, plot the results of a test on the chart. Then draw a straight line from percent passing the largest sieve size retaining aggregate to the origin (0 percent retained /0 sieve opening).



The straight line is called the maximum density line. If the plotted lies on or very close to this line, there will not be enough voids in the compacted mix. In a good mix, all the plotted points will lie 2 to 4 percent above the line (a fine textured mix) or 2 to 4 percent below the line (a coarse-textured mix).

The shape of the curve connecting the plotted points indicates some properties of the mix. If it crosses the maximum density line, the mix is “gap graded” and will tend to segregate. A hump in the fine sand portion (#40 to #80 sieve) may indicate a “tender” mix, which is hard to handle, difficult to compact, and may be too soft after it cools.



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6. Asphalt Plant

6.1. Inspector's Plant Check List

1. Stockpiles
    a. Segregation in stock piles
2. Cold Feed Bins
    a. No overflow into adjacent bins
    b. All bins are feeding
    c. Collector conveyor feeds onto a scalping screen that is working
    d. RAP feed is uniform and oversize is screened off on RAP scalping screen
3. Control House
    a. Dept. of Environmental Conservation (DEC) permit – note TPH (tons per hour) relative to specs
    b. Burner daily chart (if spec requires) to register start & stops and discharge temperature of mix or aggregate
    c. Note moisture correction for aggregate crossing belt scale on drum plant
4. Asphalt Cement Storage Tanks
    a. Note storage temperature
    b. Note sampling location
    c. Check that tanks have hot oil heating system and not direct fired heaters
    d. Review all delivery tickets that asphalt meets specification, antistrip is added, WMA has been added if required
5. Silo
    a. Batch hopper on top of silo working
    b. Truck load out: 3 drops- front, back, middle
    c. Contractor HMA process control

6.2. Introduction

Asphalt plants heat and dry the aggregate and mix it with the appropriate amount of asphalt cement, in accordance with the project mix design. There are two main types of asphalt plants: batch plants and dryer drum plants. These are briefly described below.

SSHC Specification 4.01-3.05 requires that the asphalt plant be calibrated as specified in AASHTO M-156. Airport Specification 401-4.2 requires the asphalt plant to conform to ASTM D 995.

The Asphalt Institute's Manuals MS-3 Asphalt Plant Manual and MS-22 Principles of Construction of Hot-Mix Asphalt Pavements contain much more information on asphalt plants.

6.2.1. Asphalt Batch Plants

Batch plants (Figure 6-1) make asphalt concrete one batch at a time. Typical batches of hot mix are 3000 to 6000 lbs. This is done by placing measured amounts of different-sized aggregate and asphalt cement in a "pugmill," where they are mixed. The pugmill is then emptied and the process repeated. The aggregate and asphalt cement are heated before they are placed in the pugmill.

Aggregate at the plant starts at the cold bins. There are usually three or four bins for different sizes of aggregate. The aggregate empties through the bottom of the bins through feeders (most operate with a small belt or a vibrator). The feeders are equipped with adjustable cold feed gates.

Aggregate in different bins is released at different rates to form the proportional combination of material for the mix design. The correct aggregate feed proportions are obtained by calibrating the gates and adjusting the variable speed feeder belt. Aggregate from all the feeders is deposited on a main cold feed conveyor.

The cold feed conveyor carries the proportioned aggregate to the dryer, which heats and dries it. The dryer consists of an inclined revolving cylinder, a large burner, and a fan. The revolving cylinder is lined with long vanes called "flights" which lift and drop the aggregate into a veil to ensure proper drying. When the burner is located at the lower end of the dryer the aggregate is moving down towards it, the hot gases are moving up. This is known as "counter flow."

The exhaust gases from the dryer contain dust that is removed in the baghouse or wet scrubber before the hot gases are released into the atmosphere. These emissions are regularly tested. A permit issued by the State of Alaska Department of Environmental Conservation is posted at the plant.

Theses fines, called mineral filler, are recycled into the hot aggregate or additional mineral filler can be imported and added into a separate cold feed bin where it is added to other aggregate.

The hot stone elevator is a bucket elevator that carries the hot aggregate from the dryer up to the top of the batch plant, dropping it on to a screening unit.

Motors shake the aggregate through a set of screens, where it then drops into aggregate bins below called hot bins that contain different sizes of aggregate. Oversize particles are discharged through the reject chute.

Below the hot bins is the weigh hopper. The weigh hopper is filled and weighed successively with aggregate from each of the hot bins to make a “batch” of aggregate meeting the mix design gradation. If mineral filler is used, it is taken from the mineral filler storage and also measured into the weigh box at this time.

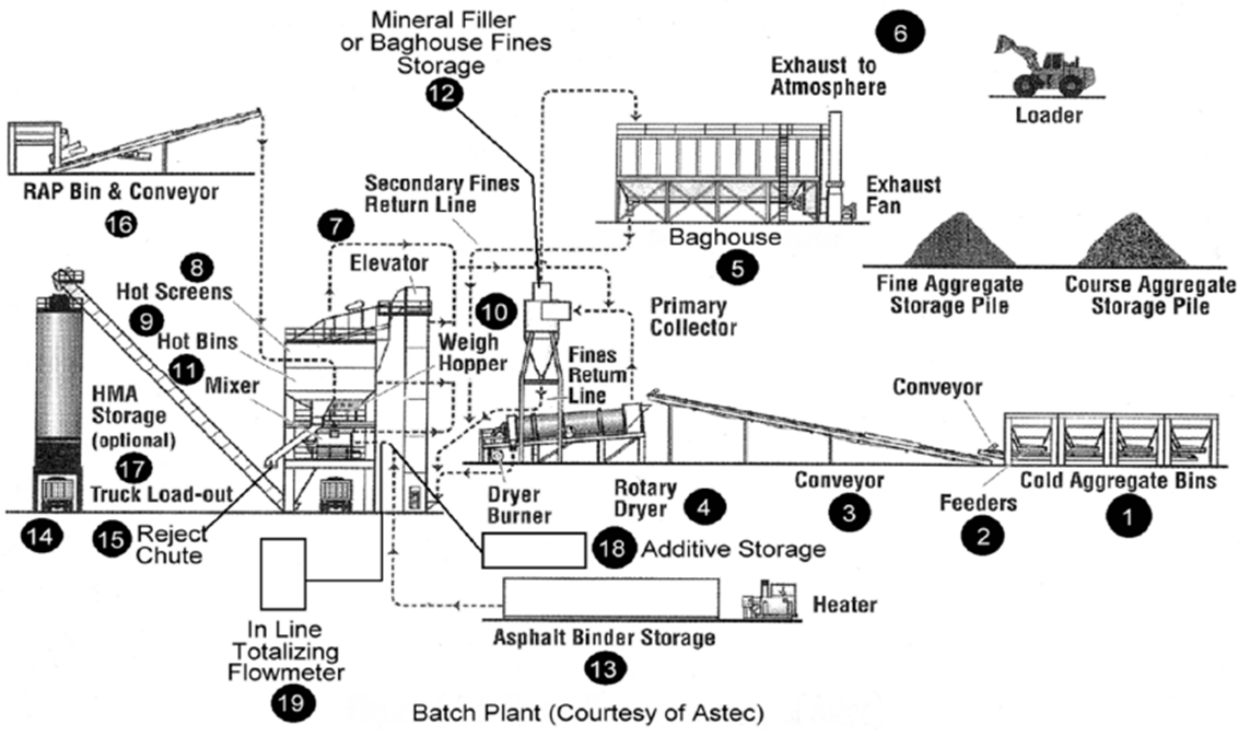
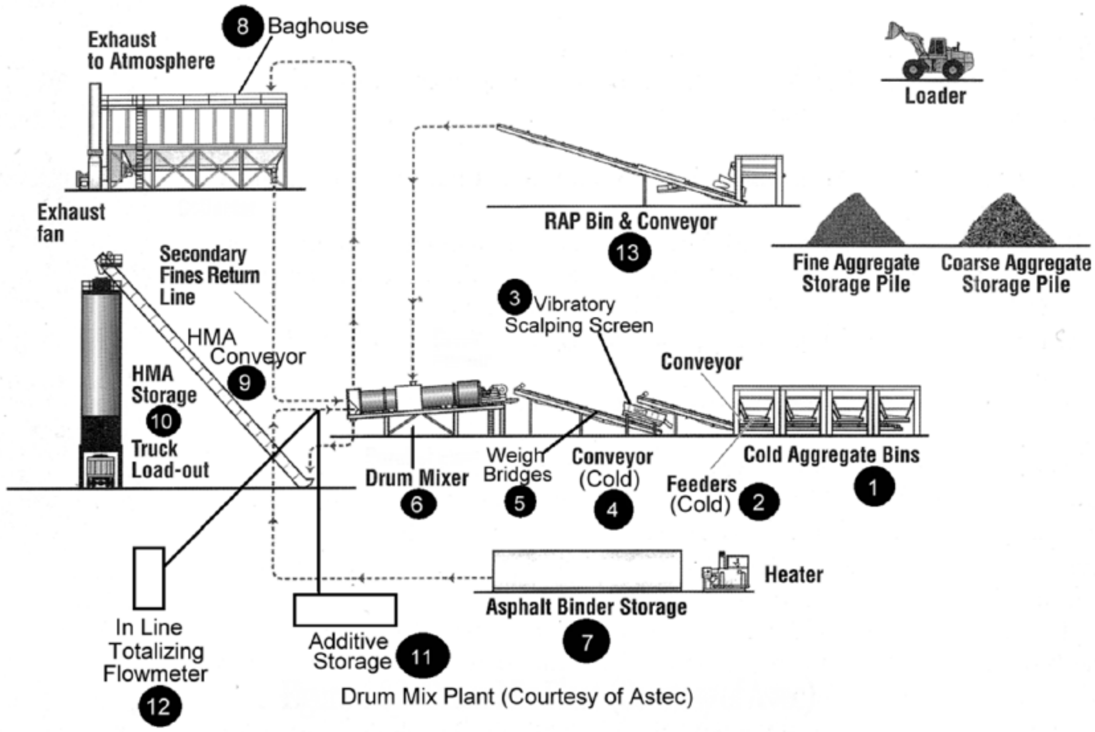


Figure 6-1
Major Batch Plant Component

The amounts are controlled to produce a batch of aggregate with the correct weight, which is then released into the pugmill. The aggregate is “dry mixed” briefly before the asphalt cement is added.

The asphalt cement is continuously circulated from hot asphalt cement storage tanks through a piping system. Both asphalt storage tanks and the piping are heated. Asphalt cement can be drawn from the piping into the asphalt weigh bucket, which measures the amount needed for a batch of paving mix. Once asphalt cement is added to the hot aggregate in the pugmill, the batch is “wet mixed” just long enough to coat the aggregate with asphalt. The mix is then discharged into trucks either directly or after being temporary stored in a “surge silo.”

6.2.2. Asphalt Drum-Mix Plants



Dryer drum-mix plants combine and heat aggregate and asphalt cement continuously. Measured amounts

Figure 6-2
Basic Drum Mix Plant

of different sized aggregate are fed into the upper end of the dryer. The asphalt cement with the mineral filler from the bag house is added approximately 2/3 down the length of the dryer near the discharge in a mixing area of the drum where it mixes with aggregate, which has already been heated and dried.

The aggregate at a drum dryer plant starts at a set of cold bins, just like at a batch plant. The gates on the bin feeders are calibrated and adjusted to release the correct proportions of the different sized aggregate onto the cold feed conveyor. The conveyor has a belt scale which electronically is interlocked with the asphalt pump so that (when properly calibrated) the correct amount of liquid asphalt is added to the aggregate in the dryer. Since the asphalt must be delivered in proportion to the dry weight of aggregate, the metering system must be adjusted to account for the moisture content of the aggregate.

The hot asphalt storage tanks and circulation system are similar to those for batch plants.

The drum mixer consists of a revolving cylinder lined with flights, a large burner, and a fan, like a batch plant dryer. Unlike batch plant dryers, asphalt cement is pumped into the dryer, where it mixes with the aggregate in a mixing zone where the dryer flights only tumble the mix.

Recycled asphalt can be added into the drum-mixer just before the mixing zone where asphalt and mineral filler are added or can be added into a drum on the outside of the dryer in an Astec “ Double Barrel” plant.

A drum mix plant can mix in “parallel flow” where the burner and the aggregate feed conveyor are at the high end of the drier. In this case the flame in a drum dryer should be short and “bushy.” Parallel flow and a short flame are used so that the gases are cool enough by the time they reach the lower end of the drum. Aggregate and hot gases travel in parallel down the drum.

A drum mixer plant can mix in “counter flow” manner with the burner located on the discharge end of the drier that discharges a flame into a tube that transfers the hot gases beyond the mixing and recycle entrance before being released to dry the aggregate. This provides a more efficient heat transfer into the aggregate with the hotter gases flowing in the opposite direction of the aggregate in the drum.

As with batch plants, hot gases leaving the drum pass through a dust collector and baghouse which filters dust from the hot gases before it is discharged from the exhaust stack. Fines from the bag house are recycled back into the mix.

The hot mix is discharged from the drum into heated slat conveyor up to the top of the surge silo, into a batch or "gob" hopper. This hopper drops HMA into the silo in batches to minimize segregation in the silo. HMA is discharged into trucks.

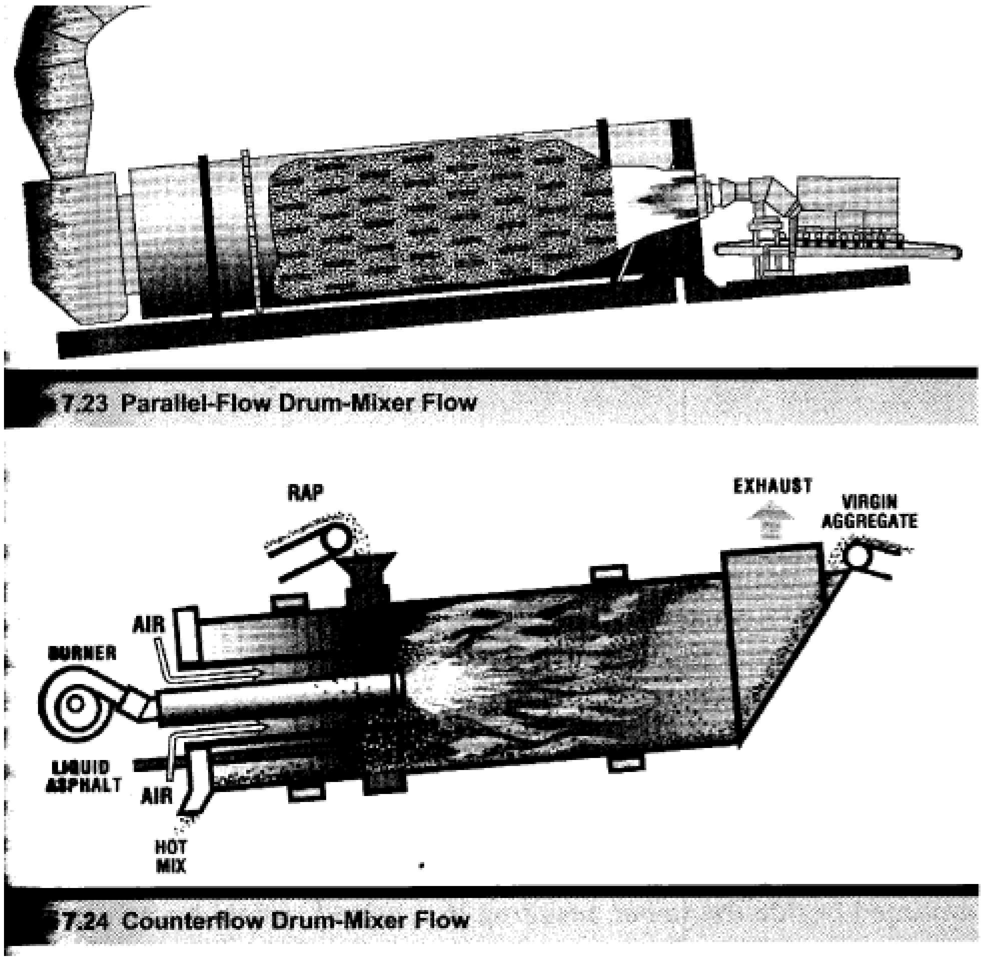


Figure 6-3
Drum Mixer Flow Types

6.3. Plant Operation

6.3.1. General

The best and most consistent asphalt concrete will result when it is produced steadily at the rate needed by the paving operation. Startups and shutdowns, as well as constant tinkering with gate openings and other controls, are signs of a poor operation. Major adjustments should be made before a production run. Only fine-tuning should be needed during the run.

The entire plant must be brought up to operating temperature before the start of a production run. Running "dry" aggregate (no asphalt) through the plant does this. The "dry run" aggregate may be checked for moisture, which avoids wasting out- of-spec "wet" paving mix. In continuous mix plants, when no asphalt is added, a check of the aggregate gradation at the end of the process may be done. Running dry aggregate results in heavy dust emissions, so most operators add a small amount of asphalt to avoid violating their environmental permits.

6.3.2. Stockpiling

A good mix will not come out of a plant if the aggregates going into it are not blended correctly to meet the mix design gradation. Many problems in mix production can be traced back to the cold feed aggregate. Even if uniform, in-specification material comes out of the crusher, it may be possible that this material become contaminated or segregated during stockpiling or cold bin loading.

6.3.3. Cold Feed-Bins

The gates on cold bins should be calibrated to determine how much material they release at different settings. Proper operation of the cold feed is crucial to the entire plant operation and depends on the gate settings.

Calibration charts, rather than trial-and-error methods, should guide any adjustments to the gates. Gate adjustments should seldom be needed during production. Frequent adjustments may indicate improper initial setup or variation in the aggregates due to crushing or stockpiling problems.

The level of material in each bin should be maintained so that there is no danger of them running out. Overfilling or careless loading, however, can result in one aggregate size spilling over into a bin for another. Cold bins need to be watched to ensure material is flowing smoothly from the gates. Aggregate, especially sand sizes, can plug up or “arch over” in the bins.

Varying the feeder belt (or vibrator) speed controls the amount of aggregate fed into the plant, not bin gate openings. The gates should be preset so that during normal operation the belts run at 50 to 80 percent of their maximum speed.

Feeder belt (or vibrator) speeds are usually adjusted to match plant production with the demand from the mix (that is, the rate of paving). Cold feed adjustments must be coordinated with burner adjustments on the dryer. For a given burner setting, a slower feed rate results in a higher output temperature, and vice versa. Watch for loss of calibration due to spillage or drag caused by misalignment of the feeder belt.

On a drum dryer plant, the weighing system and belt speed on the main cold feed conveyor control the asphalt feed rate. It is important to check the belt speed indicator for slippage, especially when a plant first starts a production run. Watch for loss of calibration due to belt tension errors caused by buildup of aggregate at the tail roller, misalignment of the belt, and frozen rollers. Also watch for friction or obstruction of the belt scale load cell mechanism.

6.3.4. Asphalt Cement Storage

Most plants have at least two hot asphalt storage tanks, which must be level for tank stick measurements to be accurate. Both the tanks and the circulation system piping must be insulated and heated. Asphalt oxidizes quickly at high temperatures, so exposure to air needs to be minimized. Keeping the storage temperature at the specified mixing temperature (usually about 325°F) minimizes oxidation and the danger of explosion.

Direct fired heating of asphalt cement in the storage tank is not permitted, this is where a burner discharges hot gasses into an exhaust tube in the bottom of the tank and then vertically out of the top of the tank to discharge the hot exhausted gases into the air. Asphalt in contact with the burner tube will coke and alter the property of the asphalt cement.

Indirect heating of the asphalt in the tank is required with lines filled with hot heating oil (not asphalt). A coil of the hot oil lines lie in the bottom of the asphalt tank with a hot oil heater mounted external to the storage tank. The hot oil is continuously circulated to maintain a set temperature.

The asphalt pump continuously circulates the hot asphalt cement during plant production. For this reason the circulation return line must discharge into the bottom of the asphalt tank. There is a 3-way valve in the circulation line to divert asphalt cement into a line to pipe asphalt plant that is computer controlled to either supply asphalt to the plant or to recirculate it back into the asphalt storage tank. An asphalt sampling port is in the asphalt line.

The asphalt supply line to the plant has a flow meter in line to synchronize the asphalt supply with the hot aggregate in the plant. The flow meter has to be calibrated to provide the correct proportion of asphalt cement to the aggregate required by the mix design. The flow meter is normally calibrated by pumping asphalt into a truck that is then weighed.

If payment for asphalt cement is made using Method 2 in the specification (401-4.01 (2)) where pay is based on supplier invoices minus waste, diversion and remnant in the plant’s asphalt storage tanks, tank stickings (volume) has to be temperature-corrected to

60°F to convert the volume to weight since asphalt expands with rising temperatures.

Carefully document asphalt deliveries regardless of which payment for asphalt cement is used.

6.3.5. Aggregate Dryer

The temperature of the aggregate leaving the dryer is affected by the feed rate, aggregate moisture content, the time the aggregate stays in the dryer, and the burner setting. Residence time in the dryer is usually three to four minutes. Dryers are usually tilted about 3 to 8 degrees from horizontal; the steeper the tilt, the faster the aggregate passes through.

For consistent and efficient heating, the dryer should drop the aggregate in an even veil across the diameter of the drum. This is affected by the arrangement of the flights and the speed of the drum (usually about 8 to 10 rpm).

Burner and draft fan adjustments are also important to dryer operation. In an efficient dryer there is complete combustion of the fuel and the exhaust gases leave the drum about 20 degrees hotter than the aggregate. Incomplete fuel combustion is indicated by oily residue on the aggregate and/or black, oily exhaust. This is bad for the mix and increases air pollution and fuel costs.

The production rate of the entire plant is dependent upon the dryer's efficiency. Asphalt concrete can't be produced any faster than the aggregate can be heated and dried.

6.3.6. Drum-Mixer Dryer

The information about batch plant dryers also applies to drum-mixer dryers. Residence time in the dryer of a drum-mix plant is very important since it is also the mixer. If residence time is too short, the aggregate may not be completely coated with the asphalt. Over-mixing, on the other hand, leads to oxidization (premature aging and embrittlement) of the asphalt cement.

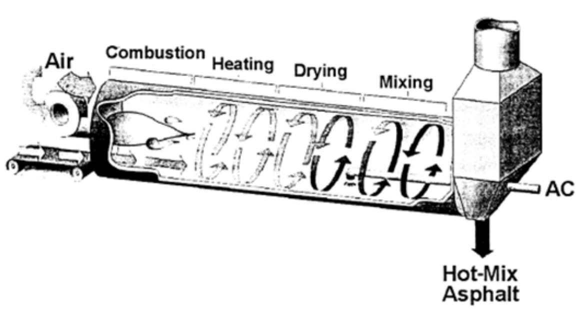


Figure 6-4
Parallel-Flow Drum Mixer Zones

6.3.7. Dust Collector

Good operation of the dust collection system not only reduces air pollution but also helps produce a good mix. Stack particulate emissions are required to pass environmental standards on a regular testing frequency and the plant must display the EPA permit in the control house.

The pressure drop in a baghouse is typically 2 to 6 inches of water. If the bags become plugged, the pressure drop increases and the draft will be retarded. This results in poor fuel combustion and a bad paving mix.

If fines from the dust collector are recycled back into the mix, the feed must operate smoothly. If the flow of fines is uneven, the plant will produce a bad mix, with alternately too many and too few fines.

6.3.8. Hot Mix Storage and Loading

Heated slat conveyors transport HMA up from the drum mixer or the batch plant discharge into up a batcher or "gob hopper on top of the storage silo. The batcher discharges its batch into the silo each time it is filled. It is used to minimize segregation in the silo.

Segregation is the biggest problem in storage and loading. It can be minimized during silo loading by baffles or batching mechanisms. Trucks should be loaded by dumping the mix in a series of overlapping heaps. Dribbling or flinging the mix when loading either silos or trucks leads to segregation and should be avoided.

Segregation in a silo is more likely if it is completely emptied while loading trucks. Use of a strain gauge bin level indicator is desirable since most high/low bin indicators are unreliable. It is desirable to always keep the silo one-third full. Cooling is a problem if the mix is held too long in a silo, especially if the amount of mix is small or the silo is not insulated

6.3.9. Batch Plant Screening Unit

Proper, consistent aggregate in a batch plant depends on the hot screening operation. Motors and bearings must be in good condition to ensure adequate screen speed. Worn screens develop holes, which allow oversize aggregate to fall into the bins for smaller material.

The opposite problem can also occur. Aggregate must stay on the finer screens long enough for the smaller material to pass through them. An excessive feed rate results in "carryover" of the smaller particles into the coarse aggregate bins. Carryover may also result if the screens are plugged.

6.3.10. Batch Plant Hot Bins

Temperature control is best when production is steady and material is not allowed to stay in the hot bins too long. Bin gates must not leak when closed. Bins should have telltales to warn if a bin is nearly empty and automatic cutoffs to stop batching if a bin is completely empty. The plant must continue to operate to refill the empty bin.

Overflow chutes on hot bins must be kept clear to prevent material from one bin from spilling into the next, which results in an improper gradation mix. Overflow usually indicates improper gradation of the aggregate entering the plant, i.e. a problem with the crusher, the stockpiling, the cold feed bin loading, or gate settings. It may also result from problems with the hot screening unit (worn screens or carryover).

6.3.11. Batch Plant Aggregate Weigh Hopper

The scales operate in a dusty environment, so the accuracy and cleanliness of the system should be checked daily. Scales may become inaccurate if fulcrums, knife edges, or other parts become dirty or if moving parts bind against each other. A weight indicator (dial or beam), which does not move freely or go to zero at no-load needs immediate attention. A load cell at the end of the beam electronically transmits weight data to the plant computer.

Weigh box gates should not leak when closed.

6.3.12. Batch Plant Asphalt Cement Weigh Bucket

Asphalt scales and meters need to be checked and calibrated for accuracy. Asphalt and dust may build up on or in the bucket, so its' empty (tare) weight must be checked often. Cutoff valves must not allow excess asphalt to drip into a pugmill batch.

6.3.13. Batch Plant Pugmill

Mix time should be the minimum needed to adequately coat the aggregate with asphalt. Over mixing leads to oxidation (premature aging and embrittlement) of the asphalt.

Excessive clearance between paddle tips and the pugmill liner result in "dead spots" of unmixed material in the mixer. Paddles wear with time, so the clearance needs periodic adjustment to stay within specifications. The clearance between paddle tips and pugmill is generally 3/8 inch to 5/8 inch.

Nonuniform mixing will result if the mixer is filled higher than the reach of the paddles or, conversely, if there is very little material in the batch. This is avoided by following the manufacturer's recommended batch sizes.

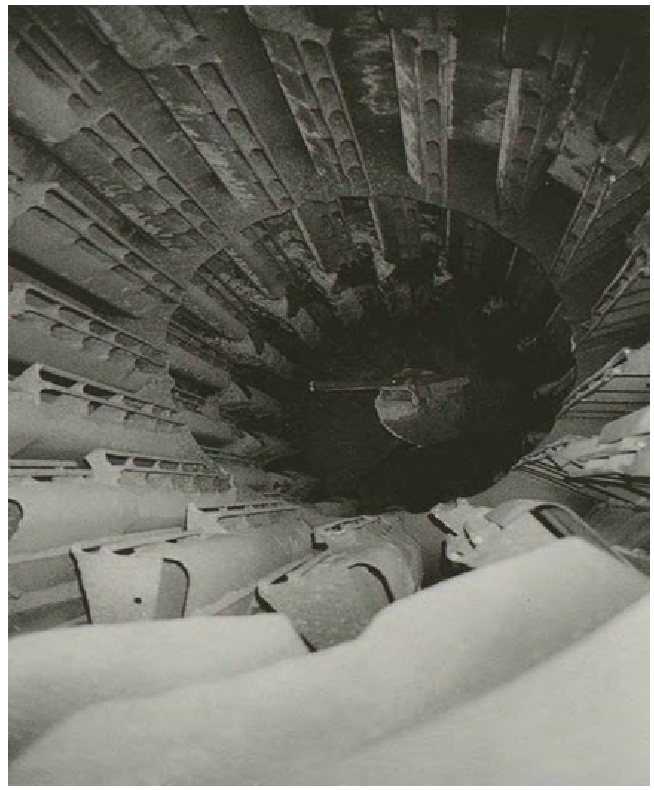


Figure 6-5
Flights in an Asphalt Plant Dryer

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7. Laydown and Compaction

7.1. Inspector's Checklist

Inspector's Equipment Checklist

- 10-ft. straight edge
- Air thermometer
- Surface thermometer
- Asphalt thermometer
- 50-ft. measuring tape
- Pavement depth gauge, ruler, or tape, smart level for cross slope
- Clipboard
- Paving log
- Calculator

Preliminary Checklist (Before Paving)

- Approved traffic control plan
- Trucks adequate (checklist in Section 7.3)
- Paver(s) adequate (checklist in Section 7.3)
- Rollers adequate (checklist in Section 7.3)
- 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 height before paving
- Cold joint surfaces cleaned and prepared adequately

Production Checklist (During Paving)

- Approved Test Strip if required
- Paver starting and stopping minimized
- Placement location and time marked on all weight tickets
- Mix temperature within specs for laydown
- No visible segregation. lumps or contamination in mat
- Mix appearance not too wet or dry
- Paver 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
- Typically compaction is completed before mat cools to130°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 140ºF or mat is able to support traffic

7.2. Responsibilities and Authority of the Laydown Inspector

7.2.1. 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 and 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 project materials inspector does the density and asphalt content tests on the pavement, but you must make sure these are being done as required and be informed of the results. 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 and plant inspection have been previously discussed.

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 inspectors.

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.

Document any rejection and state 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.

7.2.2. 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. 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. Understand what records must be kept before work begins.

7.3. Equipment

7.3.1. Hauling Units (Trucks)

Airports 401-4.3 and Highways 401-3.04 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
- 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)
- Check truck haul route for HMA droppings

7.3.2. Pavers

Standards specifications for pavers are found in Highways 401-3.07 and Airports 401-4.5. Pavers are also called paving machines or laydown machines. They consist of a tractor unit that pulls an activated screed (see Figure 7-1). The screed spreads the asphalt mix and partially compacts it by using either tampers or vibrators.

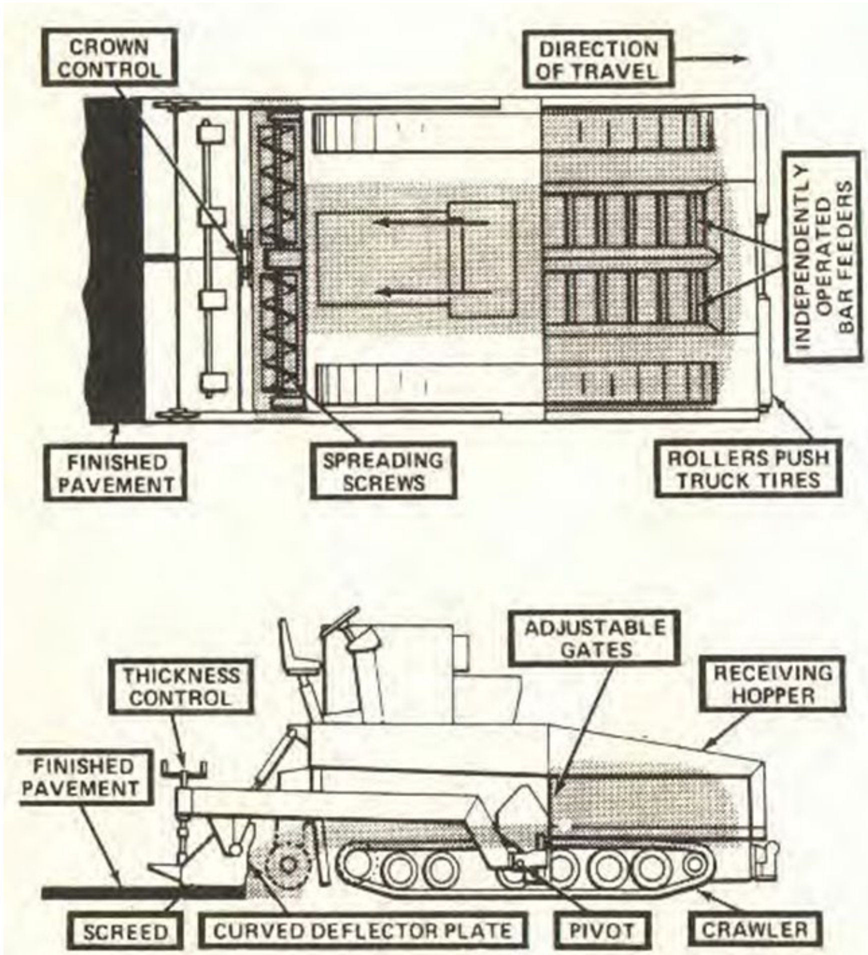


Figure 7-1
Tractor Unit Pulling Screed

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 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.

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.

Checking Uncompacted Pavement Thickness

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. If this is not done correctly a stripe will appear down the center of the mat. 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 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 transitions to 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 become erratic, you can have a defective mat. The screed may jerk up and down, for instance, causing a long ripple in the pavement surface.

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 401-3.07, Airports 401-4.5). A paver in bad condition won't produce such a mat and is unacceptable.

Paver Inspection Check List

- 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.
  - 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

Paver Innovations

- **Joint heaters (infrared)** (Figure 7-2) can be attached to the side of the paver to heat existing pavement on the longitudinal joint to produce higher joint density when the hot mix from the paver is abutted against it.

Figure 7-2
Infrared Joint Heater

- **Step Taper shoe with Compactor** (Figure 7-3) can be placed at the end of the screed to produce a compacted step tapered joint along the unconfined edge of the hot mat. Sometimes called a “safety edge” as it eliminates a vertical pavement edge for vehicles.

Figure 7-3
Step Taper Shoe With Compactor

- **Temperature Measuring Bar** (Figure 7-4) attached to the back of the screed that measures and displays in real time the mat temperature behind the screed to reveal potential for thermal segregation that can cause differential density (areas of low density) if mat temperatures vary more than 25°F.

Figure 7-4
Temperature Measuring Bar

7.3.3. 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 typical pick up machine can store up to 25 tons of hot mix and the paver hopper insert can store an additional 15 tons of mix.

This allows for a moving surge capacity that can be utilized by the dump man to adjust the material supply and a continuous paving operation which will make for a smoother pavement.

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.

Typically, only 1 or 2 truckloads of mix are dumped in front of the pickup machine holding other trucks to maintain mix temperature and adjust the quantity.

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 pick up as much asphalt concrete as soon 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.

Figure 7-5
Pickup Machine Feeding Paver

7.3.4. Rollers

Standard specification for rollers is found in Highways 401-3.08 and Airports 401-4.6. The following chart illustrates the typical rollers used for compaction of hot mix asphalt.

Vibratory Rollers

Steel drum rollers used for breakdown and intermediate 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.

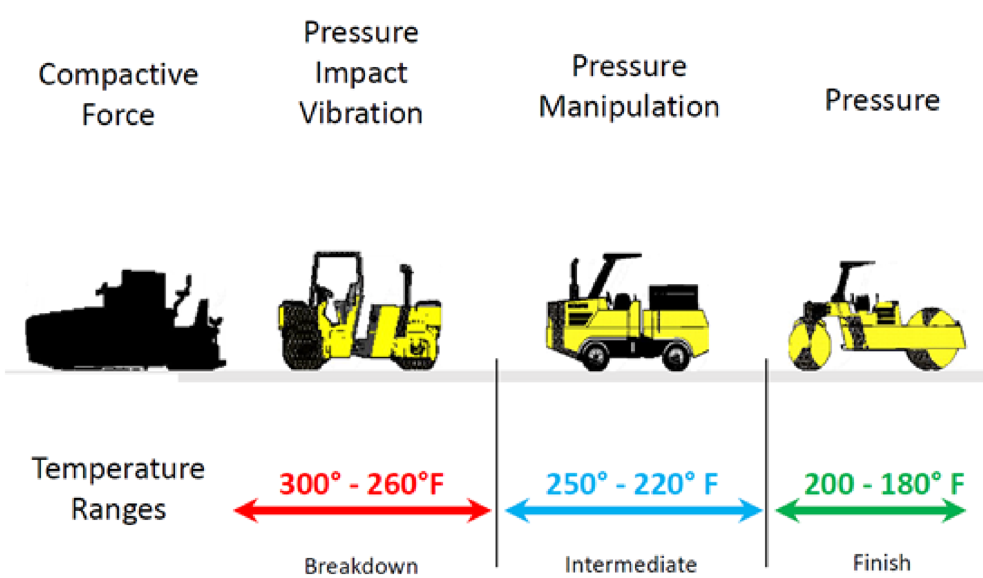


Figure 7-6
Types of Rollers

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 5 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.

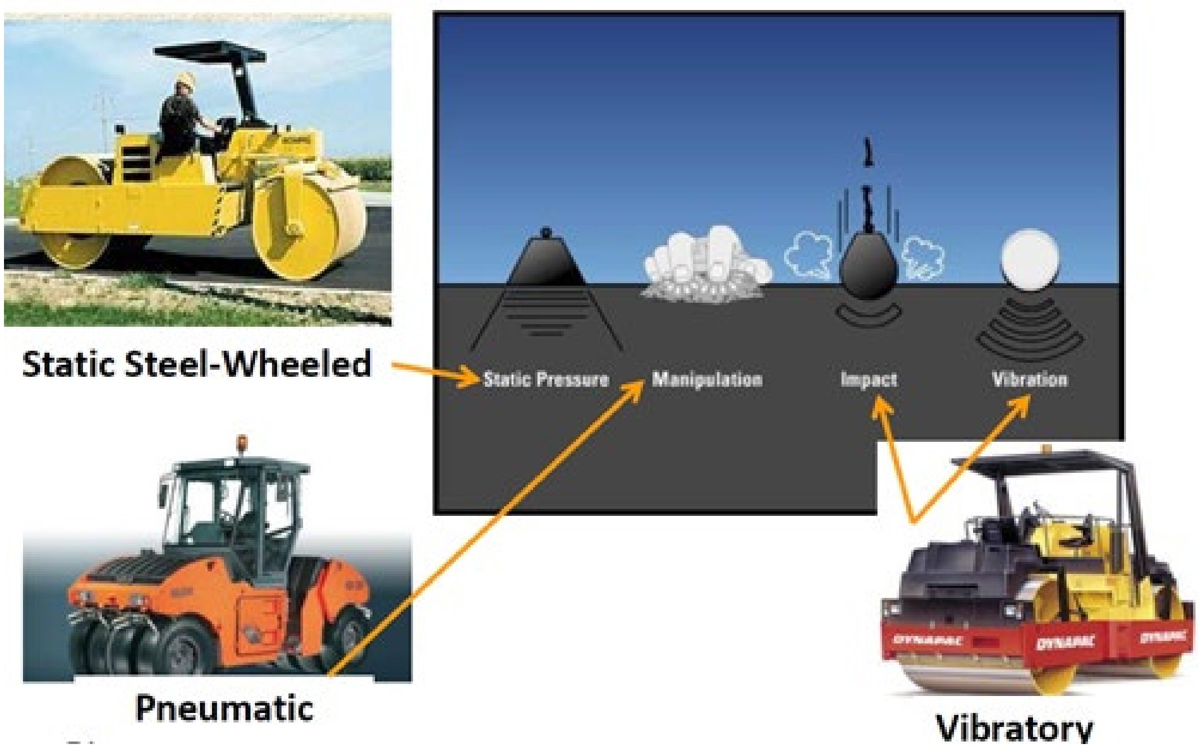


Figure 7-7
Rollers

Figure 7-8
Steel Rollers

Static 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 of the 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 static 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 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.

Roller Innovations

Intelligent compaction equipment can be attached to rollers to give:

- Mat temperature,
- GPS position and coverage
- Mat stiffness (vibration response of mat)
- Proof roll existing aggregate base before paving

Horizontal oscillation for compaction:

- Does not break aggregate in the HMA
- Provides better aggregate orientation during compaction than vertical impact
- Does not “spread” the HMA mat during compaction

Roller Inspection Checklist

- Number of rollers adequate for the job
- Weight of rollers adequate and meets specifications

- Rollers start and stop smoothly, with breakdown rollers stopping in a curved path going forward.
- Steel drums not warped or pitted
- Drums have scrapers and are wetted with water. Release agent can be added to the water.
- Pneumatic roller tires have smooth treads and wetted pads to prevent pickup of mix.
- Tire pressures differ by less than 5 psi.

7.4. Placement

Standard specifications for placement are found in Highways 401-3.15 and Airports 401-4.11. Attend a pre-paving meeting with the contractor and determine if a test strip is required.

Inspect the base (line, grade, density) or existing pavement surface 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 or pavement surface temperature must meet minimum specifications (Highways 401-3.03, 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 bump 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 and 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.

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.

7.4.1. Hand Raking

Hand raking should not be needed during main line paving. 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 they 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.

7.5. Joints

The Standard specifications for joints are found in Highways 401-3.17 and Airports 401-4.13.

7.5.1. 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 7-9. 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. 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.

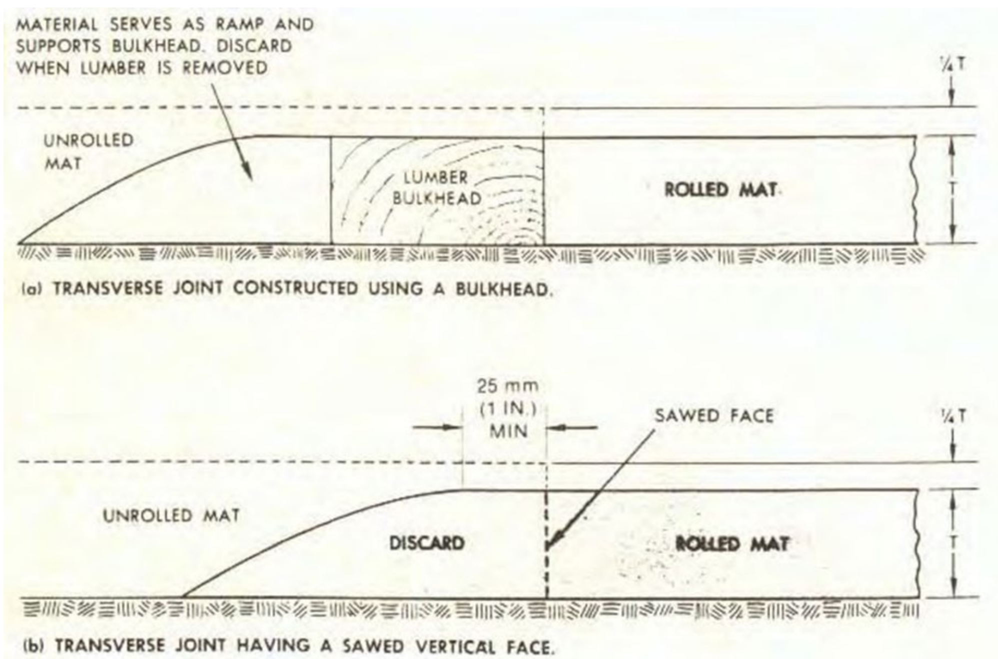


Figure 7-9
Transverse Joint

7.5.2. 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 (401-3.17). On airport projects, paving strips are normally at least 20 feet wide, which minimizes longitudinal joints (Airports 401-4.11).

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 7-10. 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 7-10. 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.

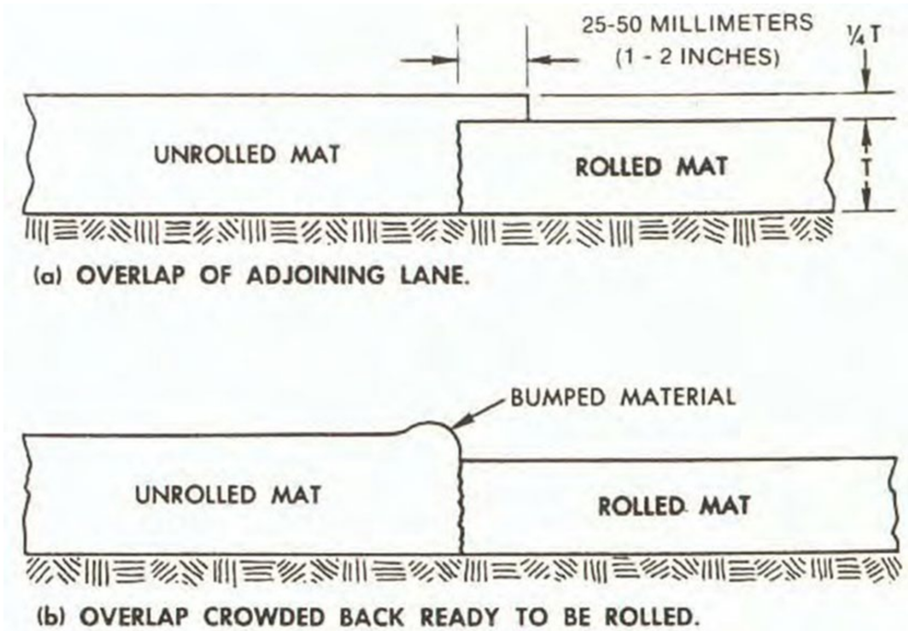


Figure 7-10
Longitudinal Joint

7.6. Compaction

Standard specifications for compaction are found in Highways 401-3.13 and Airports 401-4.12. Test strips will develop proper rolling patterns to achieve specified density.

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 can shove the asphalt instead of compacting it, as noted in Figure 7-8. This is usually less of a problem with pneumatic rollers, but the drive wheels should be forward for them too.

Table 7-1
Mix Permeability vs Density (Air Voids)

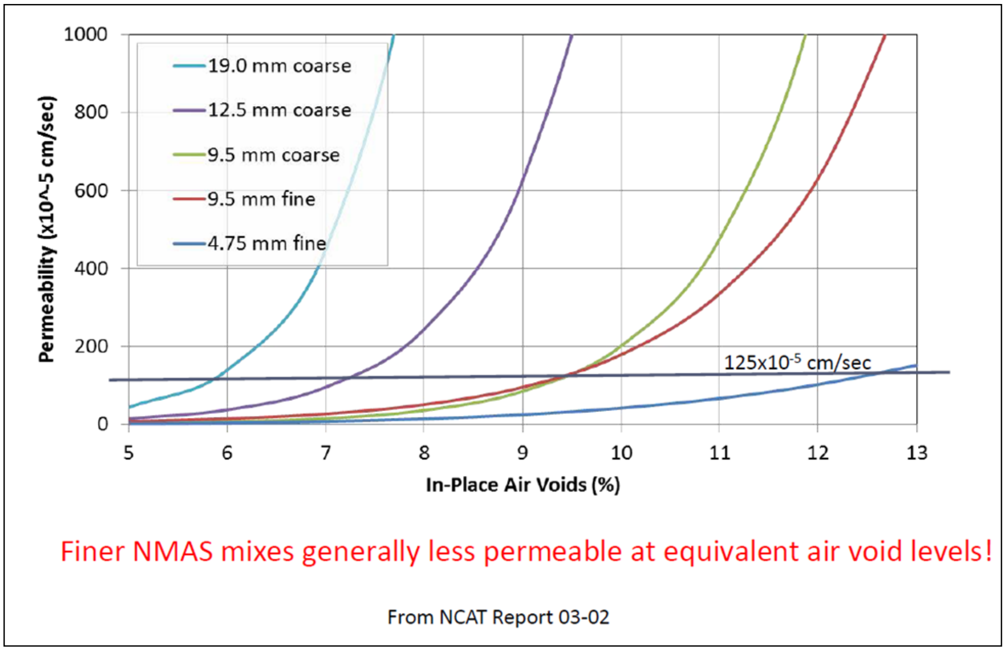
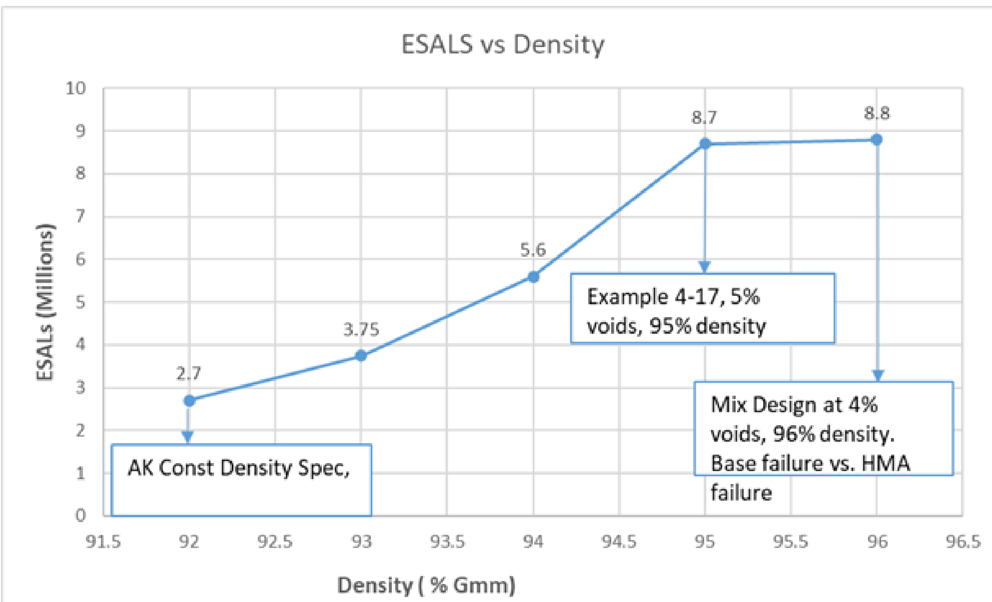


Table 7-2
Traffic (ESALS) vs Density



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 does not happen.

Check the construction specifications for mat and joint density are being increased as well as the incentive and disincentive price adjustments.

Connected air voids in the compacted mix are noted by the horizontal line in Table 7-1. Note that Field Density (% Gmm) = 100% - Compacted Mix air voids

The NCAT (National Center for Asphalt Technology) report 16-02 (2016) cites "*A 1% decrease in air voids was estimated to improve fatigue performance of asphalt pavements between 8.2% and 43.8%, to improve rutting resistance by 7.3% to 66.3% and to extend the service life by conservatively 10%.*"

Table 7-2 demonstrates why mat density is so important to meet mix design criteria. It is shown that fatigue allowable ESALs almost triples when field density increases from 92% to 95% (i.e. in-place air voids decrease from 8% to 5%).

7.6.1. 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 a poor mix design. Inform the project engineer immediately.

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

7.6.2. Initial or Breakdown Rolling

Joints, if there are any, should be rolled first, 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.

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.

7.6.3. 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°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 water and release agents are spread evenly and helping prevent material buildup.

7.6.4. Finish Rolling

The finish roller removes any roller marks and smoothens 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°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.

7.6.5. Traffic Control

Traffic should be kept off the finished pavement until it cools. 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.

7.7. 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/yd2 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 Plan Mix Log; a sample page is shown in Figure 7-11. 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 thickness squared. Project funding constraints, however, may make this an economic necessity.

7.7.1. Spread and Yield Ratio Calculations

The following information is needed to make spread and yield ratio calculations:

Table 7-3
Spread and Yield 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 weighttickets	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-inch 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 7-11).

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 1,200 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).

7.7.2. 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 spread should be controlled without 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.

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.

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					6:00 A	
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	6:30 A	66° Clear Last Load
988+70			117,280	3.32	35,330			

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

Figure 7-11
Sample Plant Mix Log

7.8. 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 10' straight edge for highway work (401-3.18) and 12' for airports (401-5.2). 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, or "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.

7.9. Density Measurement Innovations

HMA density is currently determined by coring the mat and the joint; however, newer technology has been developed where density can be measured by means of a Density Profiling System (DPS), using a ground penetrating radar (GPR) and global positioning system (GPS). One such DPS device is manufactured by GSSI and is called PaveScan Rolling Density Meter or PaveScan RDM.

A cart with the equipment is pushed along with the sensor continuously measuring density along a joint or a location on a mat. Software averages density, in half (1/2') foot increments. This method is a provisional specification in AASHTO. The following is a sample of comparison of core density to RDM Density for the Glenn Highway.

Note that in Figure 7-12**,** the offset refers to the distance from the edge of pavement, 0' offset is the joint or edge of pavement. Mat cores were taken according to current density specifications.

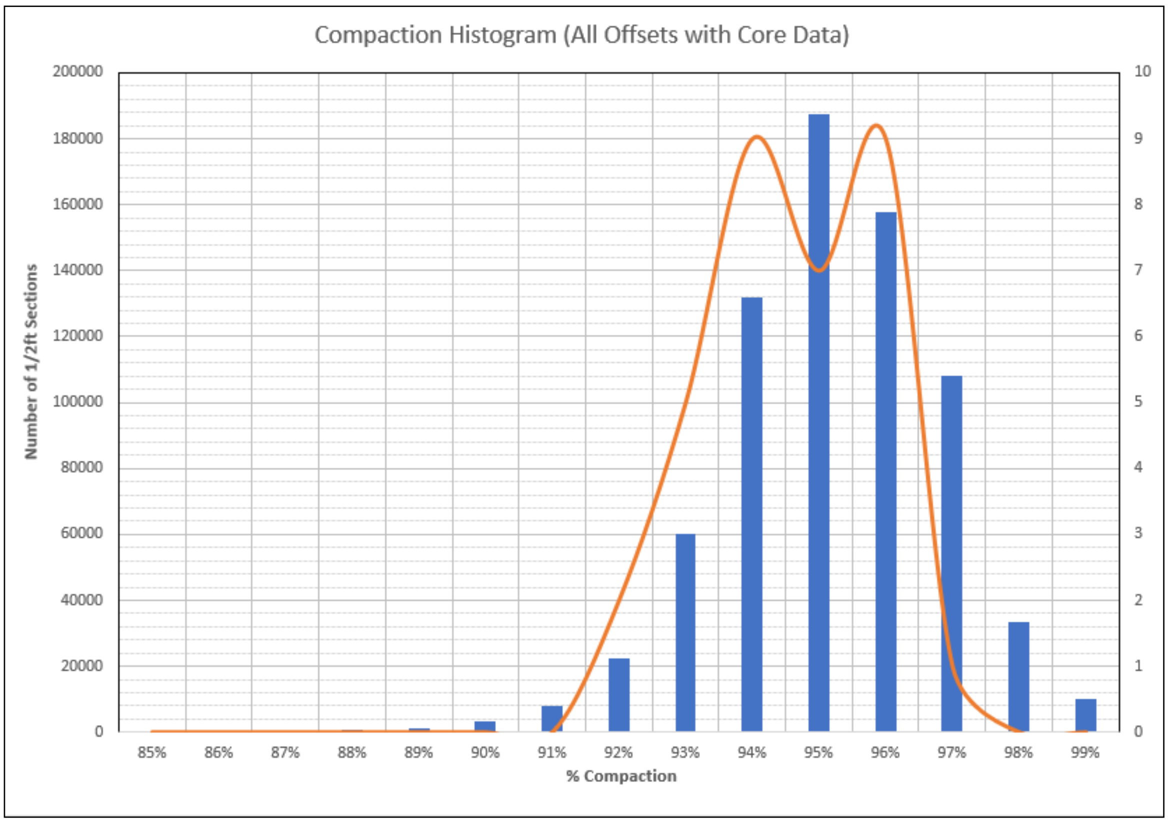


Figure 7-12
Compaction Histogram (Cores vs RDM)

8. Recycled Asphalt Pavement

8.1. Recycled Asphalt

Recycling can produce a good quality pavement at a low cost. It also reduces the amount of asphalt and high-quality aggregate needed.

8.1.1. Reclaimed Asphalt Pavement (RAP)

Reclaimed asphalt pavement (RAP) is old asphalt pavement that is broken up by heavy equipment or by special cold planing machines. Generally RAP is screened and oversized material reprocessed prior for reuse.

Asphalts age over time. The asphalt cement in old pavements is harder and more brittle than when it was new. Recycling agents are added to RAP to restore desired properties to the old asphalt cement. Recycling agents are organic compounds, usually a light grade of asphalt (or an emulsion) with special additives.

RAP should not be stockpiled more than 10 feet high. Above this height the weight will cause the particles to stick together. For the same reason, do not allow heavy equipment on the stockpile. RAP tends to hold moisture, so you may need to cover stockpiles in rainy weather.

8.1.2. Hot Asphalt Recycling

Hot-mix recycling is a process where reclaimed asphalt pavement (RAP) is combined with a recycling agent, new asphalt cement, and new aggregate in a central mixing plant.

Asphalt plants may have to be modified to permit recycling. RAP contains old asphalt cement, which will burn if exposed to the burner flame in the dryer.

Batch plants operate in the normal manner, at least as far as the hot elevator. The new aggregate, however, is heated to a higher temperature than normal. RAP is sometimes metered into this aggregate into the weigh box from its own steep-sided bin. The heat from the aggregate heats the RAP to the desired temperature. The recycling agent is added to the pugmill with the asphalt. Pugmill mixing and laydown is done in a normal manner. Batch plants can handle about 30 percent RAP and 70 percent new material.

In a dryer drum plant, clean aggregate is brought into the drum and heated in the normal manner. RAP is fed into the midpoint of the drum along with the asphalt and recycling agent. The drums used in these plants may be longer than normal.

Laydown and compaction of hot mixes containing RAP are the same as for conventional mixes.

8.1.3. Cold-Mix Recycling

Cold-mix recycling may be done in place or at a central plant. Recycling agents and new materials may or may not be added to the RAP.

If no new asphalt cement is used, the re-laid material forms a sort of asphalt treated base course, which "sets up" to some degree under compaction and traffic, especially in warm weather. Cold-mix RAP can be used without additives as a surfacing course for gravel roads.

If new asphalt cement is added in the cold mix recycling process, it is normally an emulsion. Cold mixes using RAP, recycling agents, emulsions, and new aggregate can be designed, placed, and compacted in a manner similar to hot asphalt pavements, using all new materials.

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9. Other Surface Treatments

Other surface treatments used in pavements include:

Seal coats

- Fog seal
- Sand seal
- Scrub seal

Chip seals

- Single shot
- Double shot
- Triple shot
- High Float

Many types of surface treatments are applied to unbound base course and existing pavements and are discussed in more detail in the Department's "Asphalt Surface Treatment Guide", found at: https://dot.alaska.gov/stwddes/research/assets/pdf/fhwa_ak_rd_01_03.pdf

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A = Applies to batch and drum-mix facilities B = Applies to batch facilities C = Applies to drum-mix plant facilities

Types of deficiencies that may be	Asphalt cont. doesn't check job mix formula	Agg. Grad. doesn't check job mix formula	Excess fines in mix	Uniform Temperatures difficult to maintain	Truck weights do not check batch weights	Free asphalt on mix in truck	Free dust on mix in truck	Large aggregate uncoated	Mixture in truck not uniform	Mixture in truck fat on one side	Mixture flattens in truck	Mixture Burned	Mixture too brown or gray	Mixture too fat	Mixture smokes in truck	Mixture steams in truck	Mixture appears dull in truck	Problems with asphalt mixture
Poor quality aggregate	A	A	A				A	A								A		
Aggregate too wet				A			A						A			A		
Inadequate bunker separation		A	A															
Aggregate feed gates not properly set	A	A	A									A						
Over-rated drier capacity				A				A					A			A		
Drier set too steep				A				A					A			A		
Improper drier operation				A				A				A	A		A	A	A	
Temperature indicator out of adjustment				A				A				A	A		A	A	A	
Aggregate temperatures too high												A			A		A	
Worn out screens		A																
Faulty screen operation		A	A						A				A					
Bin overflows not functioning		A	A						A									
Leaky bins		A	A		B				A									
Segregation of aggregates in bins		A	A						A									
Carryover in bins due to overloading screens		A	A						A									
Aggregate scales out of adjustment	B	B	B		B	B			B					B				
Improper weighing	B	B	B		B	B			B					B				
Feed of mineral filler not uniform		A	A						A					A				
Insufficient aggregates in hot bins		A	A						A					A				
Improper weighing sequence					B		B		B	B								
Insufficient asphalt	A							A					A				A	
Too much asphalt	A					A					A			A				
Faulty distribution of asphalt to aggregates	A					A		A	A	A	A			A				
Asphalt scales out of adjustment	B					B		B	B		B		B	B				
Asphalt Meter out of adjustment	C					C		C	C		C		C	C				
Undersize or oversize batch	B	B	B		B	B		B		B	B		B	B				
Mixing time not uniform	B		B					B	B	B								
Improperly set or worn paddles	A	A				A		A	A	A								
Faulty dump gate		A					B		B									
Asphalt and aggregate feed not synchronized	C	C	C			C		C	C		C		C	C				
Occasional dust shakedown in bins		A	A						A									
Irregular plant operation				A				A	A	A	A	A	A	A	A	A	A	
Faulty sampling	A	A	A															

Figure 10-1
Deficiencies in Plant Mix Pavements

Causes	Wavy surface—short waves (ripples)	Wavy surface—long waves	Tearing of mat—full width	Tearing of mat—center streak	Tearing of mat—outside streaks	Mat texture-nonuniform	Screed marks	Screed not responding to correction	Auger shadows	Poor precompaction	Poor longitudinal joint	Poor transverse joint	Transverse Cracking (checking)	Mat shoving under roller	Bleeding or fat spots in mat	Roller marks	Poor mix compaction	Mat problems
Cold mix temperature			X	X	X	X		X		X	X	X					X	
Variation of mix temperature	X	X	X			X		X					X	X	X	X	X	
Moisture in mix			X										X	X	X		X	
Mix segregation	X	X	X			X			X									
Improper mix design (asphalt)	X		X			X			X				X	X	X		X	
Improper mix design (aggregate)	X		X			X			X				X	X	X		X	
Parking roller on hot mat		X														X	X	
Reversing or turning too fast of rollers		X												X		X	X	
Improper rolling operation	X										X	X	X	X		X	X	
Improper base preparation	X	X				X				X			X	X		X	X	
Truck holding brakes		X					X											
Trucks bumping finisher		X					X											
Improper mat thickness for maximum aggregate size			X			X		X		X								
Improper joint overlap											+							
Sitting long period between loads		+				+												
Grade reference inadequate	+	+																
Grade control wand bouncing on reference	+										+							
Grade control hunting (sensitivity too high)	+										+							
Grade control mounted incorrectly	+	+						+			+							
Vibrators running too slow							+			+								
Screed extensions installed incorrectly						+	+											
Screed starting blocks too short												+						
Incorrect nulling of screed												+						
Kicker screws worn out or mounted incorrectly				+														
Feeder gates set incorrectly		+		+	+													
Running hopper empty between loads		+				+												
Moldboard on strikeoff too low					+													
Cold screed			+	+	+	+												
Screed plates not tight	+					+		+				+						
Screed plates worn out or warped			+	+	+	+												
Screed riding on lift cylinders	+	+				+		+		+	+	+						
Excessive play in screed mechanical connection	+	+					+	+				+						
Overcorrecting thickness control screws		+									+							
Too little lead crown in screed				+														
Too much lead crown in screed					+													
Finisher speed too fast	+		+			+		+		+								
Feeder screws overloaded	+	+				+			+		+	+						
Fluctuating head of material	+	+				+					+							

Find the problem above. 2. +'s indicate causes related to the paver. X's indicate other problems to be investigated. Note: Many times a problem can be caused by more than one item, therefore, it is important that each cause listed is eliminated to ensure solving the problem.

Figure 10-2
Mat Problem Troubleshooting Guide

Possible causes of imperfections in	Surface slipping on base	Tearing of surface during laying	Rocks broken by roller	Cracking (large long cracks)	Cracking (many fine cracks)	Pushing or waves	Roller marks	Uneven joints	Honeycomb or raveling	Rough uneven surface	Poor surface texture	Rich or fat spots	Brown, dead appearance	Bleeding	Types of pavement imperfections
Insufficient or non-uniform tack coat	X					X				X					
Improperly cured prime or tack	X					X				X					
Mixture too coarse		X	X					X	X	X	X				
Excess fines in mixture	X				X	X	X				X				
Insufficient asphalt		X			X				X				X		
Excess asphalt	X					X	X					X		X	
Improperly proportioned mixture	X	X	X		X	X	X		X	X	X	X		X	
Unsatisfactory batches in load						X			X	X	X	X		X	
Excess moisture in mixture	X					X							X		
Mixture too hot or burned		X											X		
Mixture too cold	X	X	X				X	X	X	X	X				
Poor spreader operation		X	X			X		X	X	X	X				
Spreader in poor condition		X	X			X		X	X	X	X				
Inadequate rolling	X						X	X	X	X	X				
Rolling at the wrong time	X		X		X	X	X	X	X	X	X				
Over-rolling	X		X	X	X						X				
Rolling mixture when too hot			X		X	X	X	X		X	X				
Rolling mixture when too cold	X						X	X	X	X	X				
Roller standing on hot pavement							X			X					
Overweight rollers	X		X	X	X	X	X			X					
Roller vibration						X				X					
Unstable base course	X	X		X	X	X		X		X					
Excessive moisture in subsoil	X			X	X										
Excessive prime coat or tack coat	X											X		X	
Poor handwork behind spreader								X	X	X	X				
Excessive hand raking						X		X	X	X	X				
Labor careless or unskilled							X	X	X	X	X				
Excessive segregation in laying		X						X	X	X	X	X			
Faulty allowance for compaction								X							
Operating finishing machine too fast		X								X	X				
Mix laid in too thick course						X									
Traffic put on mix while too hot						X									

Figure 10-3
Imperfections in Finished Pavements

Aggregate		
Smooth Surfaced	Low interparticle friction	Use light rollers Lower mix temperature
Rough Surfaced	High interparticle Friction	Use heavy rollers
Unsound	Breaks under steel-wheeled rollers	Use sound aggregate Use pneumatic rollers
Absorptive	Dries mix – difficult to compact	Use asphalt in mix
Asphalt		
Viscosity		
High	Particle movement restricted	Use heavy rollers Raise temperature
Low	Particles move easily during compaction	Use light rollers Lower temperature
Quantity		
High	Unstable & plastic under roller	Decrease asphalt in mix
Low	Reduced lubrication – difficult compaction	Increase asphalt in mix Use heavy rollers
Mix		
Excess Coarse Aggregate	Harsh mix – difficult to compact	Reduce coarse aggregate Use heavy rollers
Oversanded	Too workable – difficult to compact	Reduce sand in mix Use light rollers
Too Much Filler	Stiffens mix – difficult to compact	Reduce filler in mix Use light rollers
Too Little Filler	Low cohesion – mix may come apart	Increase filler in mix
Mix Temperature		
High	Difficult to compact – mix lacks cohesion	Lower mixing temperature
Low	Difficult to compact – mix too stiff	Raise mixing temperature
Course Thickness		
Thick Lifts	Hold heat – more time to compact	Roll normally
Thin Lifts	Lose heat – less time to compact	Roll before mix cools Raise mix temperature
Weather Conditions		
Low Air Temperature	Cools mix rapidly	Roll before mix cools
Low Surface Temperature	Cools mix rapidly	Increase mix temperature
Wind	Cools mix – crusts surface	Increase lift thickness
* Corrections may be made on a trial basis at the plant or job site. Additional remedies may be derived from changes in mix design.		

Figure 10-4
Influences of Compaction

Type of Distress	Possible Causes	Rehabilitation Alternatives
Rutting	Structural deficiency Hot Mix Concrete mix design Asphalt cement properties Stability of pavement layers Compaction (density) – all layers	Cold milling including profile requirements, with or without overlay Heater scarification with surface treatment or thin overlay Replacement (particularly applicable to corrugations in localized areas)
Raveling	Low asphalt content Excessive air voids in Hot Mix Asphalt Concrete Hardening of asphalt Water susceptibility (stripping) Aggregate characteristics Hardness and durability of aggregate	Dilute emulsions or rejuvenating "fog seal" Seal coat with aggregate Slurry seal Thin Hot Mix Asphalt Concrete overlay
Flushing (Bleeding)	High asphalt content Excessive densification of Hot Mix Asphalt Concrete during construction or by traffic (low air void content) Temperature susceptibility of asphalt (soft asphalt at high temperatures) Excess application of "fog" seal or rejuvenating materials Water susceptibility of underlaying asphalt stabilized layers together with asphalt migration to surface	Overlay of open graded friction course Seal coat (well designed with good field control during construction) Cold milling with or without seal coat or thin overlay Heater-scarification with seal coat or thin overlay Heat surface and roll-in coarse aggregate
Alligator Cracking	Structural deficiency Excessive air voids in Hot Mix Asphalt Concrete Asphalt cement properties Stripping of asphalt from aggregate Construction deficiencies	Seal coat Replacement (dig-out and full depth Hot Mix Asphalt Concrete replacement in failed areas) Overlay of various thickness' with or without special treatments to minimize crack reflection Recycle (central plant or in-place) Reconstruction
Longitudinal Cracking	Load Associated Structural deficiency Excessive air voids in Hot Mix Asphalt Concrete Asphalt cement properties Stripping of asphalt from aggregate Aggregate Gradation Construction deficiencies Non Load Associated Volume change potential of foundation soil Slope stability of fill materials Settlement of fill or in-place materials as a result of increased loading Segregation due to laydown machine Poor joint Construction Other construction deficiencies	Crack sealing Seal coat (applied to areas with cracking) Replacement (dig-out and replace distressed areas) Thin overlay with special treatment to seal cracks and minimize reflection cracking Asphalt-rubber membrane with aggregate seal or thin overlay Heater-scarification with a thin overlay
Transverse cracking	Hardness of asphalt cement Stiffness of Hot Mix Asphalt Concrete Volume changes in base and subbase Unusual soil properties	Crack sealing Seal coat Overlay with special treatment to seal cracks and minimize reflection cracking Asphalt-rubber membrane with aggregate seal or thin overlay Heater scarification with a thin overlay
Roughness	Presence of physical distress (cracking, rutting, corrugations, potholes, etc.) Volume change in fill and subgrade materials Non-uniform construction	Overlay Cold milling with or without overlay Heater scarification with overlay Heater planing with overlay (primarily for local areas and areas with corrugations) Recycle (central plant or in-place)

Figure 10-5
Pavement Distress, Possible Causes and Rehabilitation Alternatives

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11. References

Alaska DOT&PF Materials & Pavement Information and Resources:

- https://dot.alaska.gov/stwddes/desmaterials/mat_pav_engineer.shtml
- Technology Transfer maintains a library of books, videotapes, manuals, reports and other information. Search engine is at: https://dot.alaska.gov/stwddes/research/resources.shtml
- Construction Manual: https://dot.alaska.gov/stwddes/dcsconst/assets/pdf/constman/2021/acm_all.pdf
- Soil Stabilization Manual: https://dot.alaska.gov/stwddes/research/assets/pdf/60392.pdf
- Asphalt Surface Treatment Guide: https://dot.alaska.gov/stwddes/research/assets/pdf/fhwa_ak_rd_01_03.pdf

Asphalt Institute Publications and Resources:

- MS-3 "Asphalt Plant Manual"
- MS-4 "The Asphalt Handbook"
- MS-6 "Asphalt Pocket Book of Useful Information"
- MS-8 "Asphalt Paving Manual"
- MS-19 "The Basic Asphalt Emulsion Manual"
- MS-22 "Construction of Quality Asphalt Pavements"
- "Asphalt Inspector Certification" Series:

  https://www.asphaltinstitute.org/training/seminars/paving-inspector-certification-pic/

FHWA Resources & Information:

- NHI 131139 Course: Constructing and Inspecting Asphalt Paving Projects: https://www.nhi.fhwa.dot.gov/
- Distress Identification Manual: https://highways.dot.gov/sites/fhwa.dot.gov/files/docs/research/long-term-pavement-performance/products/1401/distress-identification-manual-13092.pdf

Other Resources:

- National Center for Asphalt Technology (NCAT) research: https://eng.auburn.edu/research/centers/ncat/
- NCAT Airfield Asphalt Pavement Construction Best Practices Manual:

  https://eng.auburn.edu/research/centers/ncat/files/aaptp/Report.Final.05-01.pdf

  Webinar at: http://eng.auburn.edu/ncat-videos/webinar1.wmv
- FAA / COE Asphalt Paving Handbook:

  https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1025447
- AASHTO TCCC HMA Paving Inspection Course:

  https://store.transportation.org/Item/TrainingDetail?ID=2473
- National Asphalt Pavement Association (NAPA) manuals: https://www.asphaltpavement.org/
- Mat Defects: Causes and Cures:

  http://www.mn-aapt.org/wp-content/uploads/2016/12/Mat_Defects_CAT-cond.pdf

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