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Mix Delivery

Learning Outcomes:

- ❑ Understand the proper material delivery process to the job site.

Mix Delivery

Mix transport involves all actions and equipment required to convey AC from a production facility to a paving site including truck loading, weighing and ticketing, hauling to the paving site, dumping of the mix into the paver or material transfer vehicle hopper, and truck return to the AC production facility (Roberts et al., 1996).

Ideally, the goal of mix transport should be to maintain mix characteristics between the production facility and the paving site.

Transport practices can have a profound effect on mix temperature at the paving site, aggregate and/or temperature segregation of the mix and mat quality. This section will discuss the types of trucks used for mix transport and the various considerations involved with mix transport.

Mix Delivery Planning and Preparation

Rain, equipment breakdown, and traffic delays all can ruin a well-intentioned paving plan. Have alternative plans in place; spare equipment available; night paving may need to be considered, depending on the nature of the project.

Mix transport can have a large impact on flexible pavement construction quality and efficiency. Mix characteristics such as laydown temperature, aggregate segregation and temperature differentials are largely determined by transport practices. In general, there is one type of AC transport trucks used in Virginia - the end dump. In rare instances a live bottom dump (flo-boy) is used by contractors. Key considerations in mix transport are:

- Truck bed cleanliness and lubrication.
- Proper mix loading techniques in order to prevent aggregate segregation.
- Haul distance and mix temperature.
- Timely mix unloading and unloading of the correct mix.

If properly managed, mix transport can successfully move AC from the production facility to the paving site with little or no change in mix characteristics.

TOOLS AND EQUIPMENT



End dump trucks are the primary type of truck usually employed to transport the mix.

Describes what tools, equipment and tests are required to complete the job safely and with the highest level of quality.

End Dump

An end dump truck delivers the mix directly into the hopper of the paver. When the bed is raised, it should not be in contact with the hopper and should not press down on or ride on the paver.

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



The following terms will be used throughout this section:

Screed Tow Point	Tow point elevation will affect screed angle and thus mat thickness.
Paver Hopper	The hopper is used as a temporary storage area for AC delivered by the transport vehicle.
Aggregate Segregation	Segregation is a lack of homogeneity in the hot mix asphalt constituents of the in-place mat of such a magnitude that there is a reasonable expectation of accelerated pavement distress(es). <i>Stroup-Gardiner and Brown (2000)</i>

Contact between the truck bed and the paver can be a problem when large semi-tractor trailer units are used as haul vehicles, particularly when the truck bed is extended to its highest point. When the weight of the truck is being carried by the paver, care must be taken because the laydown machine may lose its ability to operate properly. Semi-trailer units typically haul more than single units and carry the maximum legal gross load. The payload depends on the number of axles, local regulations, and the empty weight of the vehicle. Normally, these trailers carry between 20 to 25 tons of mix. The disadvantages include more skill required to maneuver these units around the jobsite, overhead obstructions (wires, bridges) when the bed is raised, and a potential for segregation when loading.

BEST PRACTICES

1. When the bed is raised it should not contact the paver.
2. The truck bed should be raised slightly before the tailgate lock is unlatched.
3. Truck-paver contact should be established by allowing the paver to move forward into a stationary truck.
4. Once the paver and truck are in contact, they should remain in contact.

Describes a best practice to be utilized when possible.

1. *When the bed is raised it should not contact the paver.* Bed contact with the paver may affect the screed tow point elevation, which can affect mat smoothness.
2. *The truck bed should be raised slightly before the tailgate lock is opened.* This allows the AC to slide back against the tailgate, which will cause it to flood into the paver hopper when the tailgate is opened. AC that trickles into the paver hopper is more susceptible to aggregate segregation.
3. *Truck-paver contact should be established by allowing the paver to move forward into a stationary truck.* This ensures that the truck does not bump the paver too hard and cause the paver to lurch to a sudden stop, which could cause a rough spot in the mat.
4. *Once the paver and truck are in contact, they should remain in contact.* This ensures that no AC is accidentally spilled in front of the paver because of a gap between the truck and paver. Usually the truck driver will apply the truck's brakes hard enough to offer some resistance to the paver but light enough so as not to cause the paver tracks to slip from excessive resistance. Most pavers can also be coupled to an unloading truck using truck hitches located on or near the push rollers.

Live Bottom (Conveyor) Truck

A live bottom truck employs a conveyor belt or slat conveyor in the bottom of the truck bed to discharge the mix. This eliminates the need to raise the bed, and deposits the mix directly into the hopper of the paver as does an end dump truck.

Horizontal discharge units also can carry the legal load limit. The payload is dependent on the same factors as semi-trailers. The advantage here is that the unit can discharge directly into the paver.



Live bottom trucks are more expensive to use and maintain because of the conveyor system but they also can reduce segregation problems (because the AC is moved in a large mass) and can eliminate potential truck bed – paver contact (because the bed is not raised during discharge).

SAFETY WARNING



- All trucks must have a back-up alarm.
- Trucks must be equipped with rotating beacons.
- Trucks must have a camera system or use a spotter near the paver.

Describes a condition where personal safety may be at risk. This is used to alert personnel to operating procedures & practices which, if not observed, may result in personal injury.

Each truck type is capable of adequately delivering AC from a production facility to a paving site. However, certain situations such as the ones listed below, may make one truck type advantageous over another.

Situation	Possible Truck Type	Reason
Paving on congested city streets	End Dump	Better maneuverability because it has no trailer and is smaller than a bottom dump or live bottom truck.
Paving using a mix highly vulnerable to segregation	Live Bottom	Live bottom trucks deliver the AC by conveyor, which minimizes segregation.
Paving on rural highways	Either	

Tarps

In Virginia every haul truck must be equipped with a waterproof, tear-resistant tarpaulin to protect the mix in case of inclement weather.

Holes in the tarp are unacceptable. For safety reasons, it is desirable to use tarps that can be extended by mechanical means over the bed of the truck without the driver having to climb up on the sides of the vehicle to unroll the tarp. If there is any water on the tarp when the truck is ready to discharge mix into the paver hopper, remove the water before removing the tarp by raising the bed of the truck and letting the water runoff before the truck backs into the hopper.



Loading at the Production Facility

Loading at the production facility involves transferring AC from the storage silo or batcher (for batch plants) to the transport truck.

INSPECTION AND MEASUREMENTS



Pre-loading Inspection of Bed

The bed of the haul truck should be free of all deleterious materials before mix is placed in it. The bed should be reasonably smooth and free from any major indentations or depressions where the truck bed release agent and the AC can accumulate.

Describes inspection, Quality Assurance and/or Quality Control practices.

There are two potential issues with this transfer:

1. *Truck bed cleanliness and lubrication.* Truck beds should be clean and lubricated to prevent the introduction of foreign substances into the AC and to prevent the AC from sticking to the truck bed. Non-petroleum based products should be used for lubrication such as lime water, soapy water or other suitable commercial products (Roberts et al., 1996). Petroleum based products, such as diesel fuel, should not be used because of environmental issues and because they tend to break down the asphalt binder.
2. *Aggregate segregation.* AC should be discharged into the truck bed so as to minimize segregation. Dropping AC from the storage silo or batcher (for batch plants) in one large mass creates a single pile of AC in the truck bed. Large-sized aggregate tends to roll off this pile and collect around the base. Dropping AC in several smaller masses (three is typical) at different points in the truck bed will largely prevent the collection of large aggregate in one area and thus minimize aggregate segregation.

BEST PRACTICE



There are several mix transport considerations, or best practices, that are essential to maintaining AC characteristics between the production facility and the paving site.

These considerations are:

- Loading at the production facility
- Transport within the truck
- Unloading at the paving site
- Operation synchronization

Describes a best practice to be utilized when possible.

Release agents

Once the bed is clean, coat it with a release agent. Uniformly spray a non-petroleum based release agent (from the VDOT Materials Approved List) over the sides and bottom of the truck bed. Use the minimum quantity necessary to cover the surface area of the bed without runoff. Drain out any excess liquid in the bed of the truck prior to loading the asphalt mix.

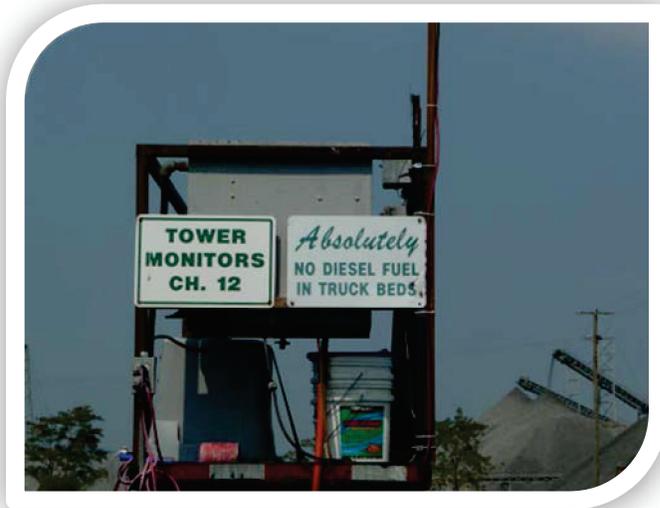


AWARENESS/IMPORTANT



Never use diesel fuel as a release agent for the truck bed. Diesel fuel can cause changes in the properties of the asphalt mix material with which it comes in contact. Diesel fuel can also contribute to environmental problems as it evaporates or if it soaks into the ground.

Highlights a step in the procedure which is either unusual or very particular to this procedure. May also indicate awareness (additional information) or a cautionary concern in the procedure.



Transport within the Truck

Truck transport affects AC characteristics through cooling. AC is usually loaded into a truck at a fairly uniform temperature between 250°F to 350°F. During transport, heat is transferred to the surrounding environment by convection and radiation and the AC surface temperature drops.

This cooler AC surface insulates the interior mass and thus transported AC tends to develop a cool thin crust on the surface that surrounds a much hotter core. Things such as air

temperature, rain, wind and length of haul can affect the characteristics and temperature of this crust.

Several measures that can be taken to minimize AC cooling during transport are:

1. *Minimize haul distance.* This can be accomplished by choosing an AC production facility as close as possible to the paving site. Closer production facilities create shorter haul times and result in less AC cooling during transport. Unfortunately, many paving locations may not be near any existing production facilities and economics may prohibit the use of a mobile production facility.
2. *Insulate truck beds.* This can decrease AC heat loss during transport. Insulation as simple as a sheet of plywood has been used on the exterior of the truck bed.
3. *Place a tarpaulin over the truck bed.* A tarp over the truck bed provides additional insulation, protects the AC from rain and decreases heat loss. A study by the Quality Improvement Committee of the National Asphalt Pavement Association (NAPA) studied truck tarping and found that the AC surface temperatures of tarped loads dropped more slowly than untarped loads but temperatures 100 mm (4 inches) below the surface between tarped and untarped loads were not significantly different (*Minor, 1980*).

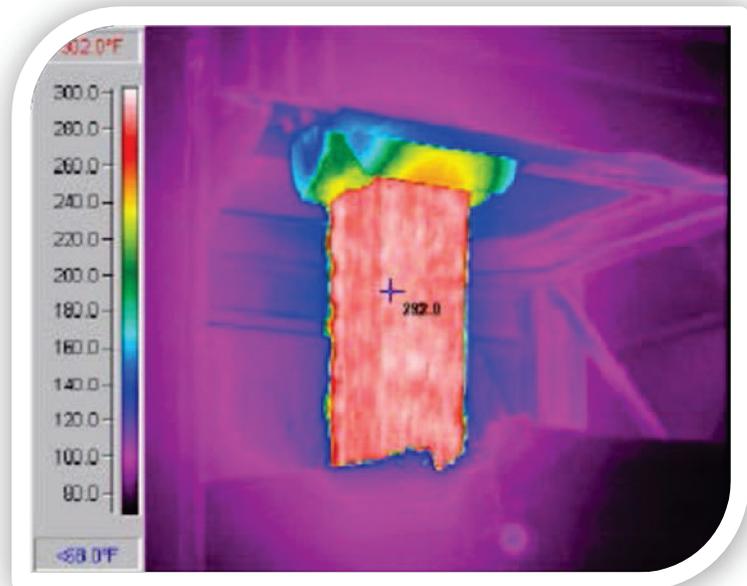


Figure: Infrared picture of an AC storage silo loading a truck showing the hot uniform temperature of the mix

In most cases, truck transport appears to cool only the surface of the transported AC mass; however, this cool surface crust can have detrimental effects on overall mat quality if not properly dealt with.

Actions such as reducing transport time, insulating truck beds or tarping trucks can decrease AC surface cooling rate. Additionally, since the majority of the AC mass is still at or near its original temperature at loading, mixing the crust and interior mass together at the paving site (“remixing”) will produce a uniform mix near the original temperature at loading.

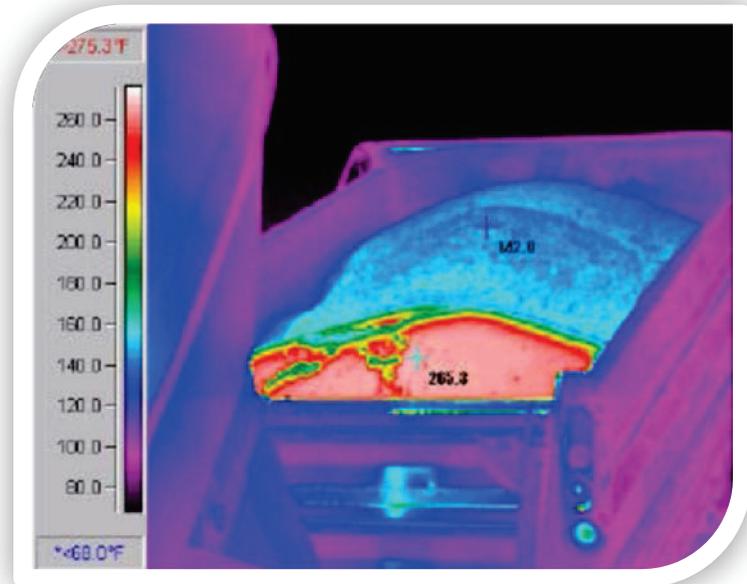


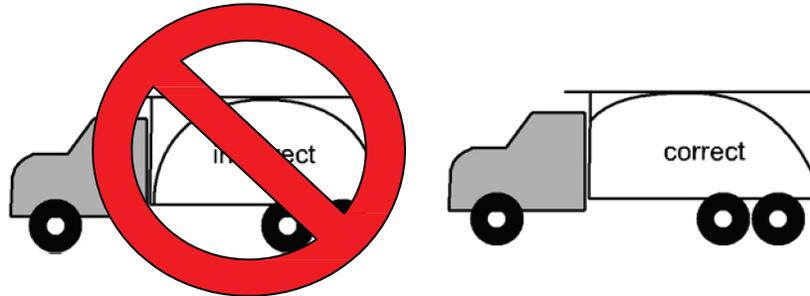
Figure: Infrared picture of a truck dumping AC showing the cold surface layer crust (blue) and the hot inner mass (red)

There is no set limit as to how far a load of AC can be transported. The key factors are the workability of the mix while it is passing through the paver and the ability to get the mix compacted. Both of these factors are highly dependent on the temperature of the mix.

The slight crust thickness that forms during transport should break up completely as the mix is discharged from the haul vehicle into the paver, is carried by the slat conveyors back to the augers, and is passed under the paver screed. As long as chunks of asphalt mix do not affect the quality of the mat behind the paver, the crust that forms on top of the mix during delivery will not be detrimental to the long-term performance of the mix.

Axle Weights vs. Load Distribution

Most haul trucks need to be loaded with the load slightly forward in the truck bed to comply with axle weights and load distribution regulations.



Loading Sequence

One objective of the truck-loading operation is to get the vehicle filled with mix and on its way to the paver as quickly as possible. This objective must be balanced, however, with the need to minimize segregation of the mix that occurs during the loading process.

Some mixes are more prone to segregation than others and special care must be taken to ensure the mix load is as uniform as possible. Some mixes are not prone to segregation and conventional load out procedures work fine. There is no one correct way to load a truck. The method will depend on the mix type, truck type, and a host of other factors. Use the method that will minimize the potential for segregation to occur during the loading. This loading plan should be discussed and agreed upon at the pre-construction conference.

The load method will depend upon the mix type, truck type and other contributing factors. The method selected should be the one that minimizes the potential for segregation.

The following scenarios assume the mix being loaded has a tendency to segregate and multiple drops are needed.

Scenario 1: From Pugmill

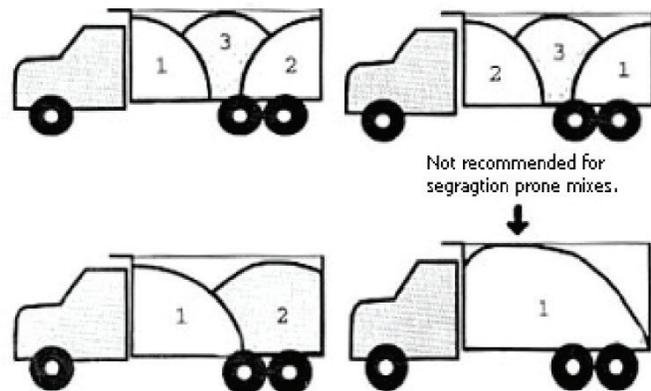
If it takes three batches of mix to reach the capacity of the haul truck, one pugmill batch should be loaded into the front of the truck bed. The truck should then be moved forward and the second batch of mix should be discharged into the rear of the truck, just in front of the tailgate. The third batch of material should be delivered into the center of the bed.

Scenario 2: From Silo

Segregation of the mix can occur when mix discharged from the surge silo is deposited into the haul truck in a single drop. This segregation problem can be minimized by loading the truck in multiple drops of mix from the silo, similar to the procedure used for loading from the batch plant pugmill. However, some silos are specially designed for mass flow for a single drop. These silos will not cause segregation when operated properly. The number of drops used depends on the length and capacity of the truck; the type of asphalt plant and the type of storage or surge silo used.

Scenario 3: For End Dump Types

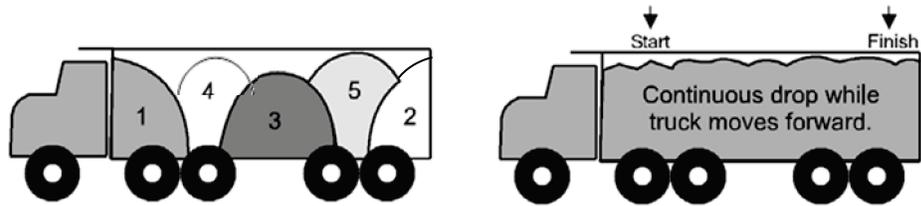
For other numbers of batches, multiple drops of mix should be used, with the first batch delivered to the front of the truck bed, the second batch deposited at the tailgate end of the bed, and the remaining drops of mix placed evenly in between the first two. Such a loading sequence will



minimize the distance the coarse aggregate particles can roll and thus minimize the amount of segregation that is produced in the mix. Some states have reversed this order. The first drop is placed at the tailgate, the second placed at the front, and the third placed in the middle.

Scenario 4: For Semi-Trailer Type

When a semi-tractor trailer truck is to be loaded, at least five and probably seven different discharges of mix should be made before the truck capacity is reached. In every case, the mix should first be deposited at the front of the bed and then at the tailgate of the truck. The space in between the first two drops should be filled in with small, separate piles of mix placed between the initial “batches” of mix. The use of multiple drops of mix is slower than loading the truck in a single discharge of material from the silo.

**Topping Off**

There is a tendency for the plant operator to fill the truck to its legal capacity to reduce haul costs, particularly if the truck is sitting on a scale under the silo. Although this is good economic practice, it should **not** be accomplished by dribbling mix into the truck from the silo after the majority of the mix is already in the truck. The discharge of small amounts of mix from the silo greatly increases the chance for segregation of the mix.

IMPORTANT**Overloading**

Overloading is illegal, dangerous, and can cause extreme stresses in pavements. Modern electronic weighout equipment and printed tickets have helped to eliminate this.

Highlights a step in the procedure which is either unusual or very particular to this procedure. May also indicate awareness (additional information) or a cautionary concern in the procedure.

Unloading the Mix

1. AC should be unloaded quickly when it arrives at the paving site. This will minimize mix cooling before it is placed.
2. Before AC is loaded into the paver, the inspector and/or foreman should be certain it is the correct mix. Occasionally, paving jobs require several different mix designs (i.e., one for the leveling course and one for the wearing course) and these mixes should not be interchanged.

Once loaded, ticketed, and tarped, the haul truck should proceed immediately to the jobsite. Stagger the asphalt deliveries to the project to reduce the time trucks have to wait before dumping the asphalt into the paver but not be spaced so far apart that the paver has to stop and wait for deliveries.



Waiting on Site

Haul trucks should park in designated areas and attempt to minimize tracking of tack coats. Trucks should stay far enough ahead of the paving train as to not interfere with operations, but close enough to back to the paver to keep the operation moving. Communication is again the key. Drivers should be informed about the paving plan.

INSPECTION AND MEASUREMENTS



When mix is delivered to the job site, two items must be checked.

1. First, is the right mix being delivered to the right job site. During the height of paving season, a single plant may be producing two or three different AC mixes. Occasionally the wrong mix is loaded into a truck or a truck driver goes to the wrong project.
2. Second, is the mix being delivered at the correct temperature. For most mixes, the maximum delivery temperature should not exceed 350°F. For polymer modified mixes using PG 76-22 binder, a temperature less than 350°F may be specified. The minimum mix temperature delivered in the field is a function of the production process. For surface AC materials not produced through a warm mix technology, the minimum temperature depends on the base temperature, number of rollers, application rate and virgin binder. With intermediate and base mixes not produced through a warm mix technology, the minimum placement temperature is 250°F. For those mixes produced using a warm mix technology, no minimum placement temperature is specified. Details on the specifications will be provided later in this manual.

Describes inspection, Quality Assurance and/or Quality Control practices.

Backing

When an end dump or a live bottom truck is used to deliver mix to the paver, the truck driver should back the truck up to the laydown machine but stop just short of the push rollers on the front of the paver. It is very important that the truck be centered before the paver contacts it. Off-center positioning can push the paver out of alignment, create problems as the mix floods the hopper, and cause the truck bed to contact and damage the hopper wings.

In addition, project personnel tend to tune out back-up alarms and are vulnerable while walking in the driver's blind spot. This is the area between the tailgate and the paver hopper. Too many accidents occur in this area.



SAFETY WARNING



Project personnel tend to tune out back-up alarms and are vulnerable while walking in the driver's blind spot. This is the area between the tailgate and the paver hopper. Too many accidents occur in this area.

Describes a condition where personal safety may be at risk. This is used to alert personnel to operating procedures & practices which, if not observed, may result in personal injury.

Truck Hitches/Contact/Configuration

Once the truck has come to a halt and the driver has released the brakes on the vehicle, the paver operator should pick up the stopped truck. The key to this process is that the paver picks up the truck instead of the truck backing into and bumping the paver. As much as possible, the paver should maintain a constant speed throughout the paving operation. Use of the proper procedure will reduce the incidence of screed marks and roughness in the mat.

Dumping Into a Hopper - Raising Bed

If an end dump truck is used and the mix has a tendency to segregate, the bed of the truck should be raised a short distance in order to allow the mix in the bed to slide against the tailgate before the tailgate is opened.



Popping Gate and Flooding Hopper

Once the tailgate is opened, the mix is discharged from the truck in a mass and floods the hopper of the paver, reducing the possibility of segregation behind the paver screed. The same procedure should be employed, if possible, when a live bottom truck is used to transport the mix.



“Banging the Gate”

A common practice is to leave the truck gate up, speed up and stop quickly to bang the tailgate to expel any remaining mix. This should be discouraged.

Dumping into a Material Transfer Vehicle (MTV)

This piece of equipment is basically a surge bin on wheels. Asphalt mix is deposited into the hopper on the front of the MTV. The mix is transported from the hopper to a conveyor, which delivers the mix to the extended hopper on the paver. The material transfer vehicle also allows the paver to be operated almost continuously when a continuous supply of mix is available from the asphalt plant. This provides for a smoother mat behind the



paver screed by permitting the paver operator to keep the head of material in front of the screed constant. The equipment also eliminates the problem of the haul trucks bumping the paver and truck drivers holding the brakes on the truck when being pushed by the paver. Because of the weight of this piece of equipment when it is full of mix, it must be determined ahead of time that the pavement over which this machinery will be running can support the weight of the device without being overstressed and damaged.

Steering

While paving, the driver must focus not only on the dump person but in front of the truck also. The driver is responsible for steering within the “pull” of the paver, and keeping a slight pressure on the brakes to maintain contact with the paver and rollers.

Braking

Too much braking force from the haul truck may cause the paver to slip and affect the mat.

Pulling Away

Once the final mix has exited the truck bed, the bed should be lowered so the apron can clear the hopper guards. The truck should immediately depart from the area to a clean up station, and let the next truck back up.

BEST PRACTICE



On Site Clean Up

The contractor should designate a cleanup area for the drivers to clean the remaining mix from their trucks, the tailgate, and the apron.

Describes a best practice to be utilized when possible.

Spillage on Pavement

“Banging the gate” and some other practices tend to drop some small piles of mix on the roadway which are subsequently rolled over by other trucks. If these piles are not removed, they affect the quality of the finished mat. If a spill occurs, the mix should be removed.



Summary

Ideally, AC production at the plant, truck transport and laydown at the paving machine should be synchronized to the same rate to minimize accumulation of excess AC in any one of the three segments. Realistically, however, this synchronization can be quite difficult because of varying laydown rates, unpredictable truck travel times and variable plant production.

If possible, all operations are designed to meet optimal mat laydown rates. However, these rates can vary based on paving width and lift thickness. Also, complicated paving locations such as intersections or near manholes and utility vaults can temporarily increase or decrease the laydown rate.

Truck transport should be planned such that the AC transport rate (expressed in tons/hr) closely matches plant production rate and laydown rate. Some factors to consider are:

- Number of trucks to be used
- Truck type
- Average truck hauling capacity
- Production facility output rate
- Availability and condition of storage silos at the production facility
- Time to lubricate the truck bed before transport
- Waiting time at the production facility
- Loading, weighing and ticketing time at the production facility
- Time to cover the load (tarps are required at all times)
- Distance between the production facility and the paving site
- Average truck speed

Traffic plays a large role in AC delivery rates because it affects truck speed. Especially in congested urban areas, heavy and/or unpredictable traffic may substantially increase, or at least vary, truck travel time. As truck travel time increases, more trucks are needed to provide a given AC delivery rate. Therefore, as traffic gets worse, trucking costs increase. Additionally, the unpredictability of traffic may result in either long paver idle times as it waits for the next truckload of AC or large truck backups as several trucks all reach the paving site or production facility at the same time.

Finally, production facility output is typically controlled to match haul or laydown rate. However, this can result in suboptimal plant efficiency or AC uniformity, which may increase plant exhaust output, shorten emission control device lifetimes, and affect contractual payment if payment is tied to AC uniformity. It may often be more economical to run the production facility at maximum rate and store excess material in storage silos for discharge into trucks as they arrive. Storage silo insulation has progressed to a state where dense-graded AC can be stored in them for up to a week at a time without significantly affecting AC characteristics.

In conclusion, synchronization should be the goal but it is often difficult to achieve (based on varying laydown rates, haul time and traffic) and may result in plant inefficiency and AC quality degradation. If a production facility has modern well-insulated, airtight storage silos and is producing a dense-graded AC, it may be beneficial to run the plant at maximum production rate and store the mix until needed rather than try and match haul or laydown rate.

Chapter Three Knowledge Check

1. When an “end dump” truck raises its bed to deliver mix into the hopper of the paver, the bed should not be in contact with the hopper and should not press down on or ride on the paver.
 - a. True
 - b. False
2. Contact between the hauling truck bed and the paver is never a problem.
 - a. True
 - b. False
3. In Virginia, haul trucks are required to be equipped with tarps _____
 - a. Only during rain storms.
 - b. Only when the roadway temperature goes below 40F.
 - c. All the time.
 - d. Only when your supervisor tells you to put one on.
4. The bed of the haul truck should be free of all deleterious materials before mix is placed in it.
 - a. True
 - b. False
5. When using diesel fuel as a release agent the residue must be dumped:
 - a. In a container listed on the Department's approved list.
 - b. Onto the ground in a well drained area.
 - c. Diesel fuel should never be used as a release agent.
 - d. Only at a VDOT Residency.
6. Some mixes are more prone to segregation than others and special care must be taken to ensure the mix load is as uniform as possible.
 - a. True
 - b. False
7. When a semi-tractor trailer is to be loaded, the mix should first be deposited at the _____
 - a. Back of a trailer.
 - b. Middle of the trailer.
 - c. Front of the trailer.
 - d. Middle and work towards the back.

Chapter Three Knowledge Check - continued

8. When using an end dump or live bottom truck to deliver mix to the paver, the truck driver should back the truck up to the laydown machine but stop just short of the push rollers on the front of the paver.
 - a. True
 - b. False

9. The crust that forms on an asphalt mixture is acceptable if the temperature of the mix is greater than 225F.
 - a. True
 - b. False

10. Too much braking force from the haul truck may cause the paver to slip and affect the mat.
 - a. True
 - b. False