Understanding Mat Defects

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules and precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “WARNING” as shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:
Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operation that may cause product damage are identified by NOTICE labels on the product and in this presentation.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this presentation and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made usafe by the operation, lubrication, maintenance or repair procedures you choose.

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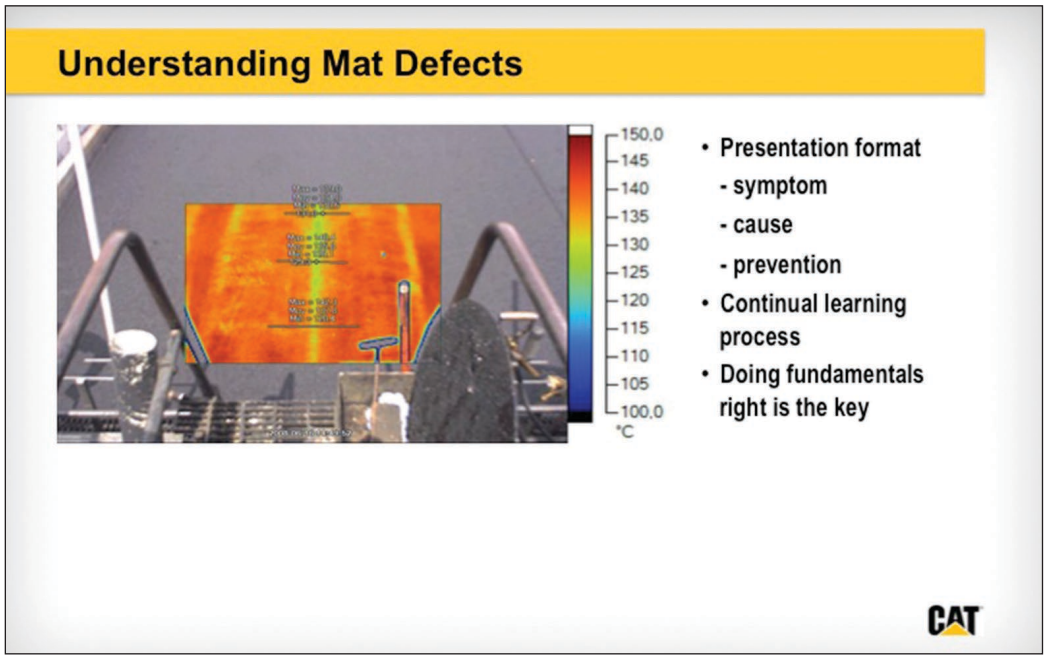

The purpose of this presentation is to help you understand more about common mat defects that may occur on any asphalt paving project. In each section, a methodical approach is taken to troubleshooting mat defects. The first step is to present the symptom, in other words, what the defect looks like by using conventional and infrared images. The next step is to show the cause or causes of the symptom (defect). Finally, there are recommended steps for preventing or eliminating the defect.

Learning how to recognize the causes and cures of mat defects is a continual process. Each project usually offers the opportunity to understand the paving process better and we should strive to approach each project with the goal of adding to our professional knowledge. One thing is certain – doing the fundamentals correctly is a key part of reducing or eliminating mat defects. When we cut corners or take shortcuts, mat defects often show up.

An experienced, well-trained paving crew knows how to recognize mat defects, knows what causes them, and knows how to prevent them. The learning process is continual because conditions change on every project. But, if the entire crew (plant, trucking, paving and compaction personnel) does the fundamental things correctly and follows the basic principles of asphalt paving, producing a smooth, uniform mat is usually the result.

There are six sections in this presentation. Section I covers mat defects that can result from poor grade conditions. Section II covers a variety of mat defects that can be traced to issues with trucking. Section III describes the four-step, truck exchange process that Caterpillar recommends in order to avoid certain mat defects. Those items which affect mat texture are covered in Section IV. Section V shows different types of segregation, what causes them and how to prevent them. Finally, Section VI provides factors that affect ride quality, or smoothness.

It is impossible to show every type of mat defect and every project variable. The intent of this presentation is to help you understand how to prevent some of the most common mat defects that you are likely to encounter.

I. Grade Conditions – Spills

- High spots caused by mix dumped on grade
- Trucks clean out pulling away from paver
- Direct trucks away from paver to clean out
- Clean up or knock down loose piles

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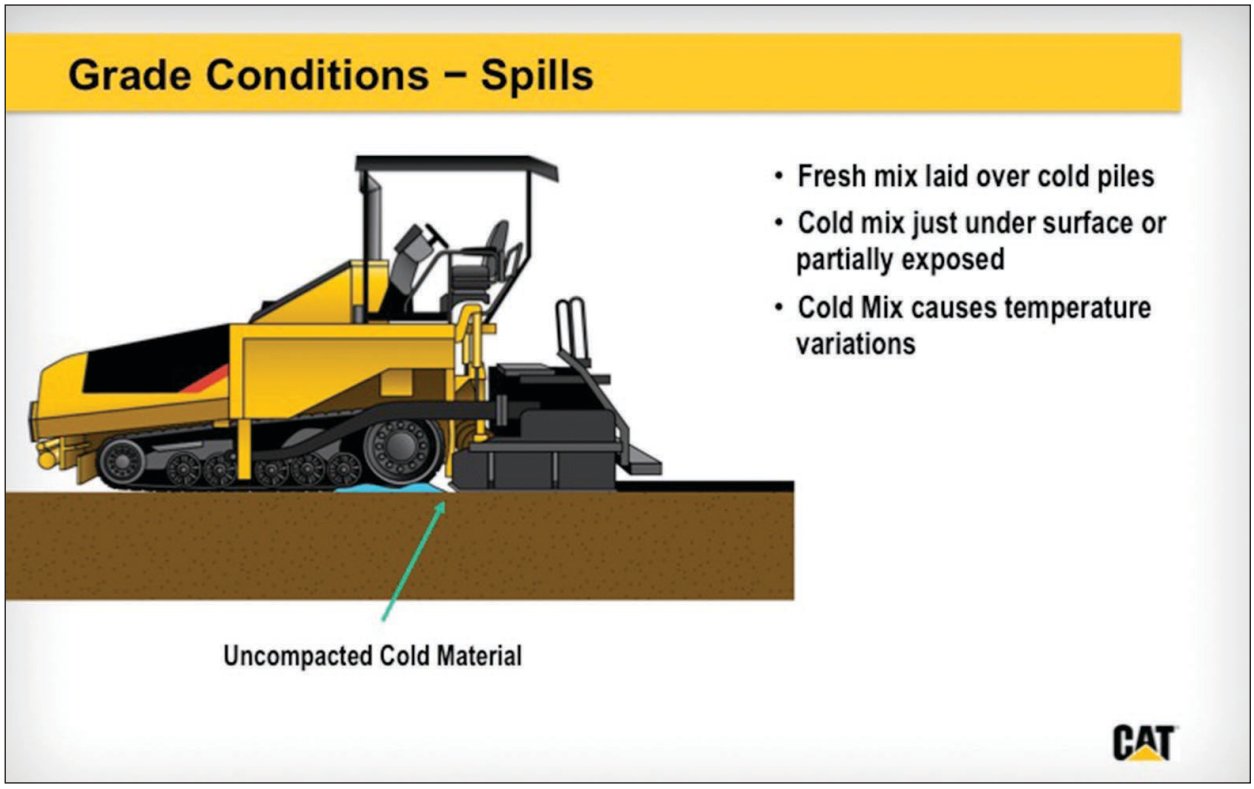
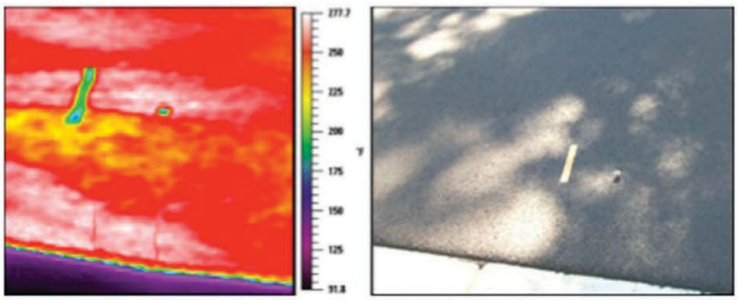
Unfortunately, on some projects grade problems are caused by the paving operation itself. Specifically, high spots in the grade are caused when material is dumped on the grade in front of the paver. This usually happens when trucks are allowed to clean out beds as they pull away from the paver or material transfer device. Trucks should never be allowed to clean out beds on the grade to be paved; they should be directed to an area away from the paver.



Materials that are dropped on the grade in front of the paving process, even small volumes of uncompacted material, can create problems in the mat being placed. The materials dumped on the grade by the truck and not compacted prior to paving by the truck or paver can cause variations in mat temperature. These piles of material are cooling quickly.

As the screed passes over these materials, fresh hot material is deposited over them. Any place the dropped material is thicker than the mat, it will be sheared off. This will leave an area in the mat where the cold materials are just under the surface of the mat or are partially exposed.

Grade Conditions – Spills



- Mat may not show any visual defect from small pile of mix
- Thermal image shows cold pile spread by screed
- Uneven compaction results when temp. variation exceeds 15° C (25° F)
- Maybe a bump

CAT

Visual inspection of the mat (photo on right) may not show any apparent defect since the material dumped on the grade has been "buried". But, a thermal image of the same area (left photo) reveals a cold streak where the dumped material has been leveled and spread by the screed. The cold area will not compact the same as the rest of the mat. A bump can be produced. As a rule, try to avoid temperature variations in the surface of the mat that exceed 15 degrees C / 25 degrees F.

Grade Conditions – Spills

- Continuous spill out of hopper
- May be caused by truck bed too short
- May be caused by damaged / missing flashing
- Often run over the paver undercarriage

CAT

There may be continuous spills while a truck is discharging mix onto the paver hopper. The spill may be the result of the truck bed being too short to extend into the hopper far enough. Or, the spill may be caused by damaged or missing flashing.

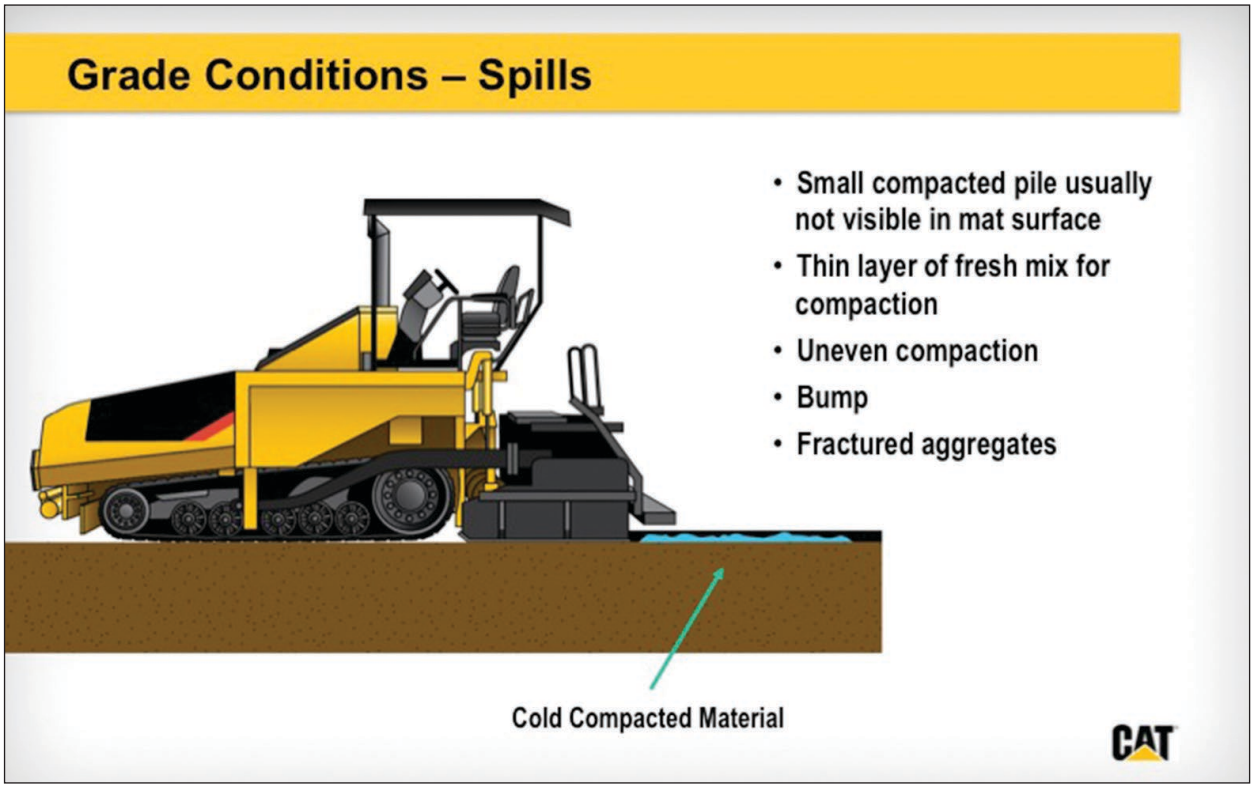
Spilled material may be run over by the paver's undercarriage.

Grade Conditions – Spills

- Pile compacted by truck or paver
- May be completely covered by mat depending on thickness

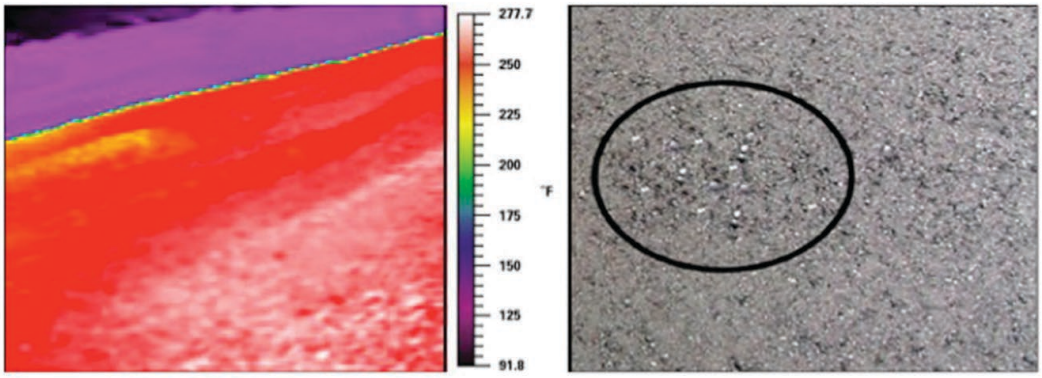
CAT

Spills that are run over by the paver undercarriage become compacted high spots in the grade. You may see the same problem when the spill is run over by a truck backing up to the front of the paver. A small amount of compacted material, depending on the thickness of the mat, may be completely covered by fresh, hot asphalt as the screed passes over the compacted pile. This compacted high spot may or may not be completely covered by fresh hot mix.



As the screed passes over the compacted pile, hot material is deposited over it. If the compacted pile is high enough, the screed may actually "lose float" and bump over the pile. Or, the small pile may simply be undetected in the mat. But when the roller passes over the pile, the thinner layer of fresh material can not be compacted at the same rate. A bump may be created and aggregates may be fractured, too.

Grade Conditions – Spills



- Uncoated rock shows in mat surface
- Open texture over compacted pile
- Cold spot

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Because the mat is so thin over the pile of pre- compacted asphalt, the force of the compactor can fracture aggregates. The area in the mat that has been circled contains fractured aggregate which show as uncoated rock surfaces.

The thermal image indicates that this area is cooler because the surface texture is more open. The compaction rate will be uneven and a bump will be detected by smoothness measuring devices.

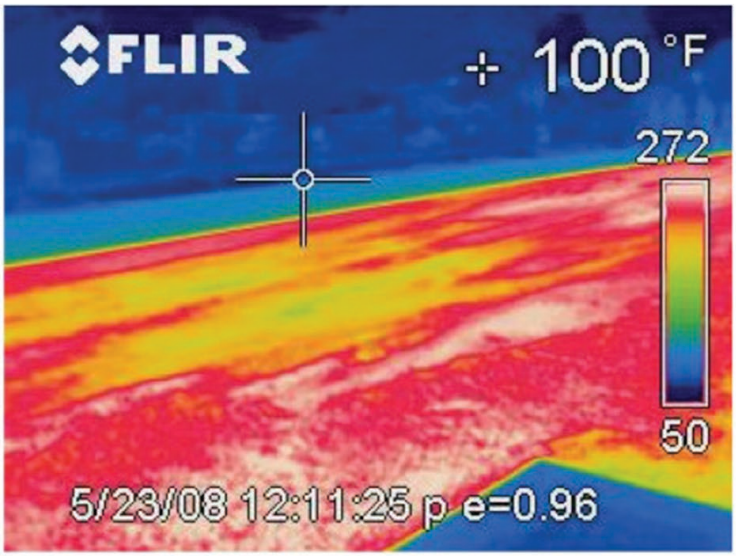
Grade Conditions – Spills

- Caused by folding hopper wings too soon
- Caused by damaged or missing flashing
- Becomes cooler mix covered by mat

CAT

Spills out of the front of the hopper can also be caused by the operator folding the hopper wings when there is too much material in the hopper. The operator should wait until the level of material in the hopper is low enough to prevent spills before folding the hopper wings. A dump person can help the operator judge when to cycle the hopper wings. Another tool that helps prevent spills when folding the hopper wings is the optional folding hopper apron.

Grade Conditions – Spills



- Spilled material dragged out by screed
- Shows up as open texture
- Infrared image shows large temp. differential
- Density variation
- Rough ride

CAT

Material that is spilled while folding the hopper wings will show up as an open texture section in the mat and there is usually a large variation in mat temperature. A density check in this area will show low density / high air voids. Also, since the cooler mix will not compact as much as the surrounding hot mix, this area will be felt as a bump by traffic.

Grade Conditions – Spills

- Mix dragged out of hopper by departing truck
- Caused by sending truck away when there is still mix in the truck bed
- Caused by hopper load imbalance while paving sloped sections
- Caused by truck driver not applying light brake pressure on downgrade

CAT

Spills can be caused by the departing truck dragging mix out of the hopper. This can happen when the truck is sent away while there is still mix in the truck bed. It is common to see this phenomenon when paving on sloped sections like super elevations. A dump person is needed to help line up the trucks so they are aligned to the high side of the hopper. Gravity will always pull mix to the low side of the hopper, but it helps to position the truck with more of the bed on the high side. This can also happen when paving on a slight downgrade and the truck driver does not apply light brake pressure, resulting in the truck rolling away from the paver before fully discharging the mix into the hopper.

Grade Conditions – Low Spots

- Mat defects from grade conditions are unrelated to paving techniques
- Low spots cause uneven compaction
- Correct grade defects prior to paving

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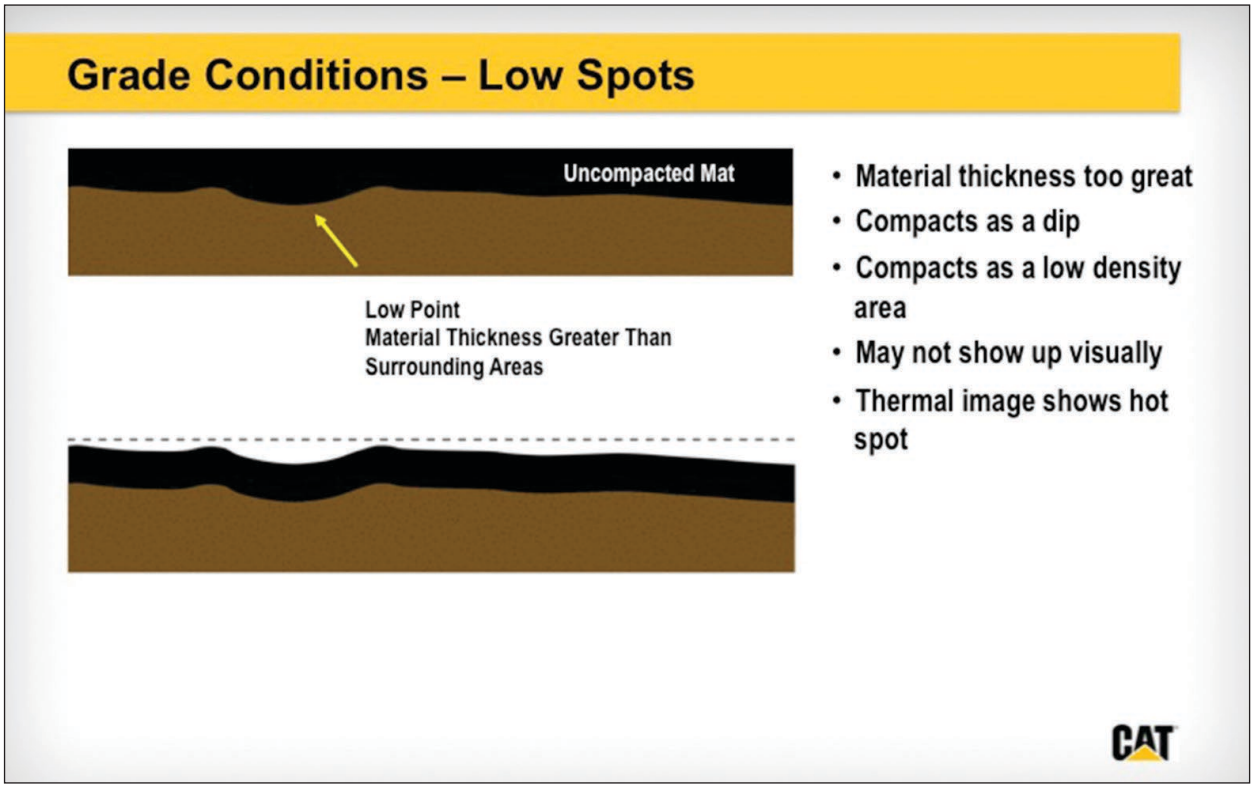
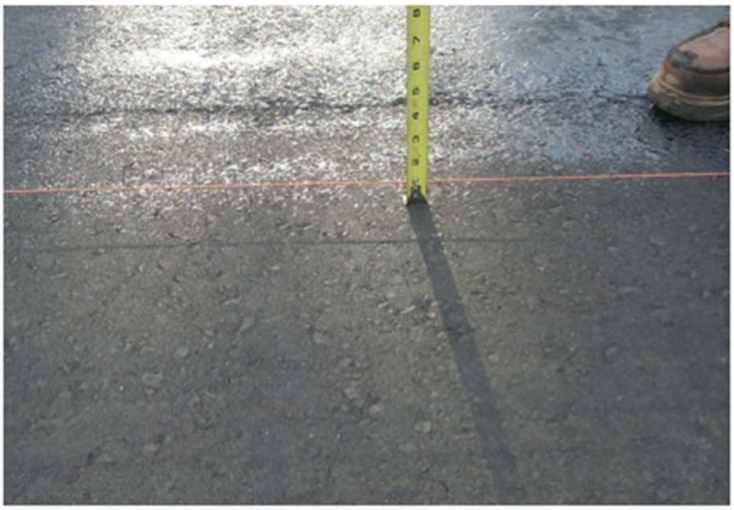
It is possible that mat defects will occur that are totally unrelated to paving techniques or screed adjustments. Poor grade conditions due to low spots are a good example. If there are low spots in the existing grade over which you are paving, you may see uneven compaction. The right course of action is to correct grade defects prior to paving. In this case, you should pre-fill this low spot prior to paving.



When a mat is placed over a low point in the existing grade, the material thickness is greater than the surrounding areas. When compacted, these areas will compact at a higher rate and a dip will be produced. If the low spot is smaller in diameter than the width of the roller, the roller will bridge over the low spot and a low-density area will result.

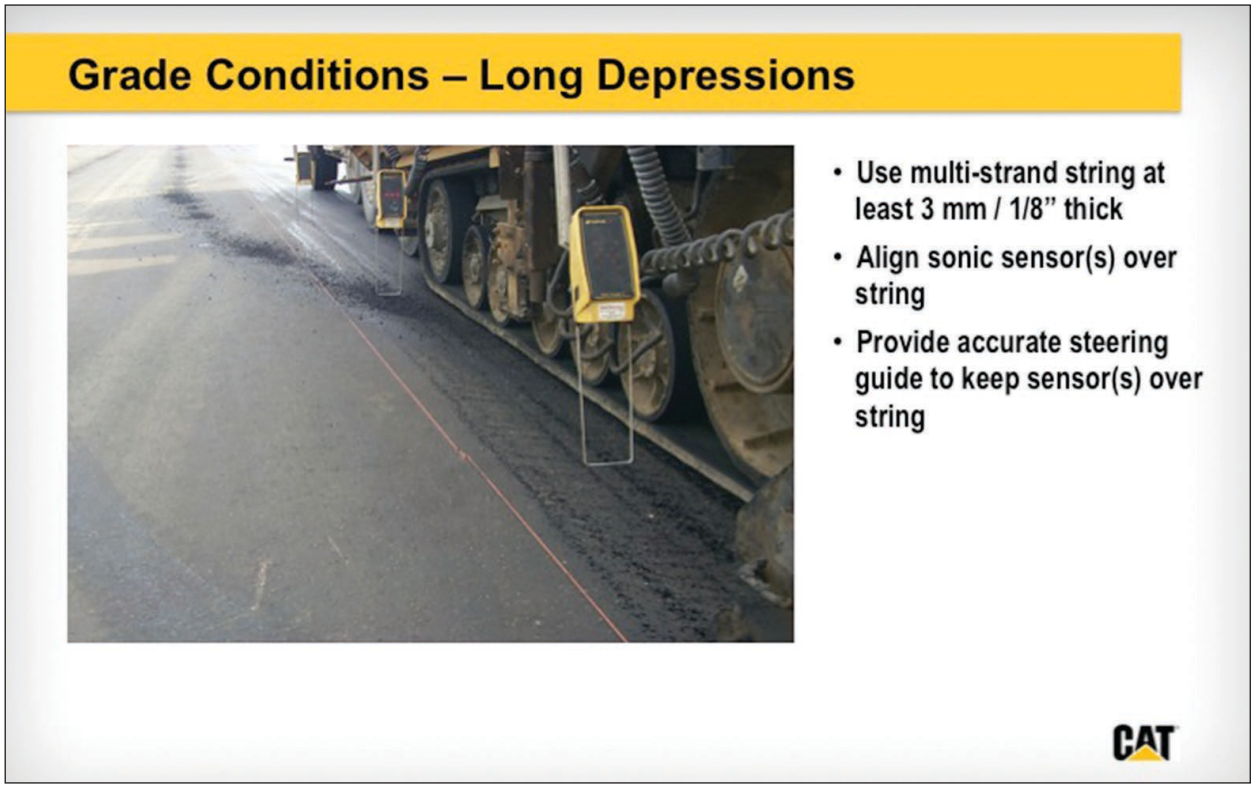
The visual appearance of an uncompacted mat that has been placed over a low spot is normally the same as the rest of the mat. But a thermal image will probably show a hot spot where the mat is thicker – that's the area over the dip.

Grade Conditions – Long Depressions



- Fill in the depression using a “leveling” course, or
- Install a string over the length of the depression
- Allow for compaction rate when positioning string over grade

When the grade you are going to pave has long swales, or depressions, there are several ways to correct this grade defect. One method is to “level” the depression with a thin layer of mix to restore the correct elevation. Another method is to install a stringline over the length of the depression. Using nails, stretch a string across the length of the depression at a height that fills in the depression and accounts for the extra compaction rate – which is normally about 6 mm per 25 mm (0.25” per inch).

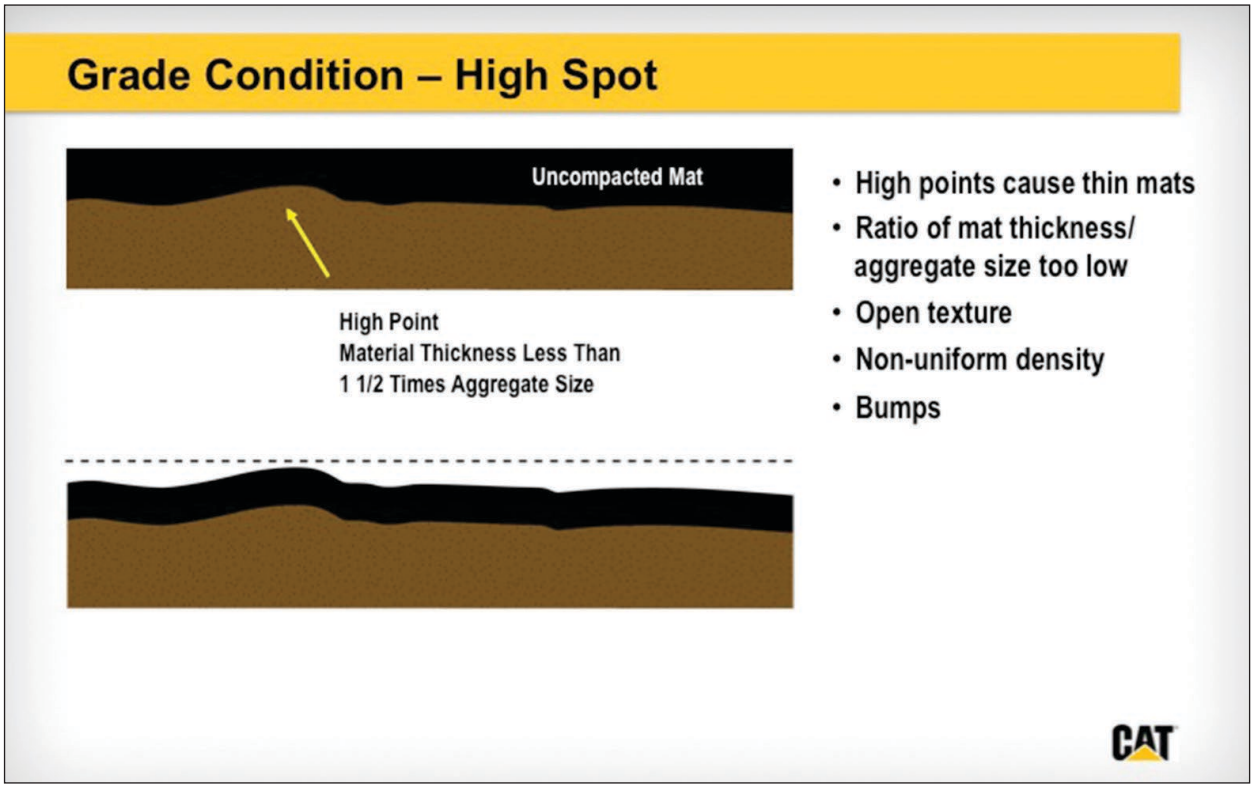


Typically you will be using sonic grade sensors to read the stringline. To give the sonic sensor a good target, be sure to use multi-strand stringline that is at least 3 mm (1/8”) thick. Position the sonic sensor(s) directly over the stringline. Provide the paver operator with an accurate steering guide so the operator will be able to keep the sensor(s) aligned over the string. The screed operator may have to move the sonic sensor to keep it centered over the stringline.

Grade Conditions – Long Depressions

- Establish new grade reference when finished filling in the depression
- "Bench" the grade control to the new reference
- Remove the temporary stringline
- Normal joint match for adjacent lane

When you have completed filling the long depression, you must establish a new grade reference for the sensor. Be sure to "bench" the grade control system to the new reference. Finally, remove the temporary stringline. Match the height of the compacted lane when paving the adjacent lane.



High points in the existing grade will cause the mat placed over the high points to be less than the desired thickness. When mat thickness is less than two times greater than the largest aggregate in the mix, the affected area can show an open texture, pulling of material and/ or fractured aggregates. Areas with a thin mat compact at a different rate than areas where the mat is thicker. If mat thickness over the high spot is the same or less than the aggregate size, the screed will rise creating a bump.

If the thickness of material over a high point is at least two times the aggregate size or greater, the appearance of the mat will probably show no difference. But the material over these areas will not compact the same as the thicker areas. Density will be non-uniform and smoothness will be affected, too.

Grade Conditions – High Spot

- Show up as loose aggregate at surface and fractured rock
- Large temperature variations
- Look same as high spots caused by material dumped on grade

CAT

A high spot in the grade is usually detectable by the naked eye. In this example, the cold planing crew left a high spot, or hump, in the milled surface. You should also notice that the cold planer drum has several broken tools and the drum is leaving a very uneven surface. The cold planer should stop and the crew should perform drum maintenance.

Grade Conditions – High Spot

- Paving with averaging skis on both sides
- Screed fills in lows and scalps off highs
- Screed dragging rock due to poor ratio thickness: aggregate
- High spot should have been corrected prior to paving

CAT

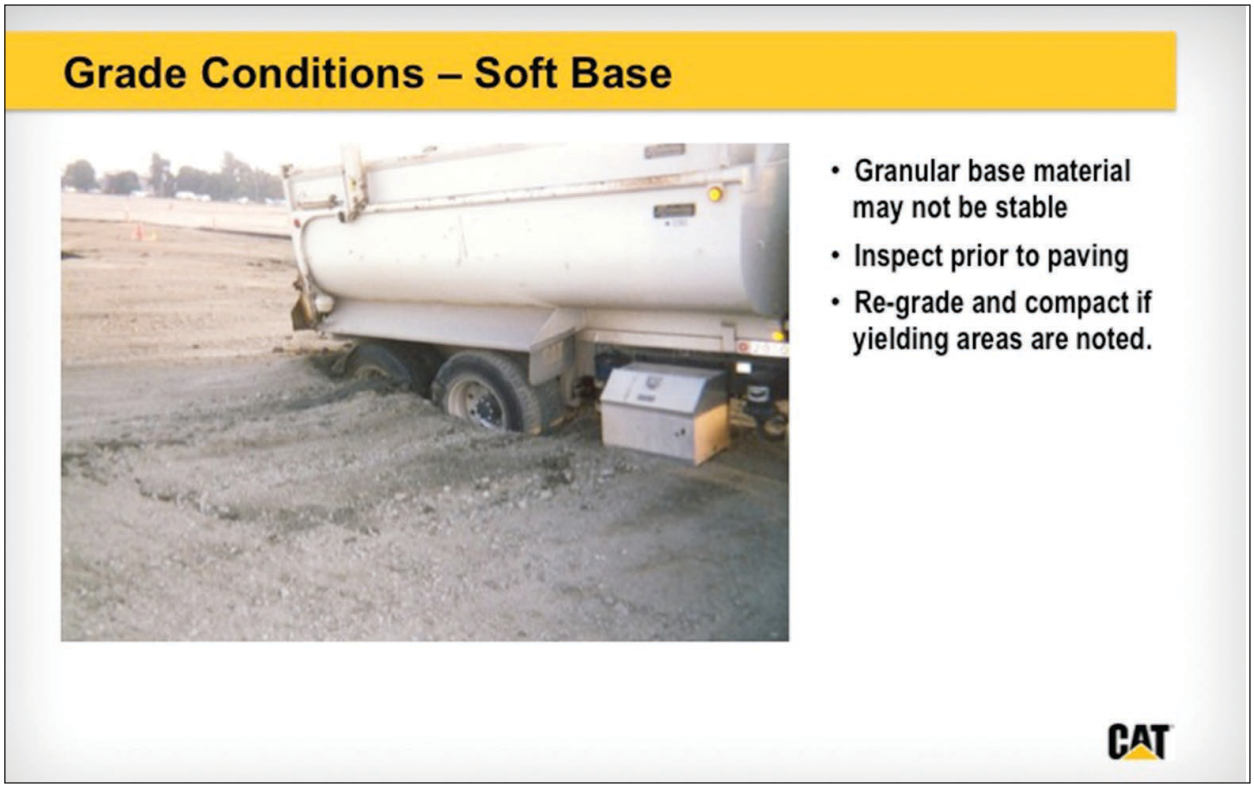
In this example, the paver is set up with grade control on both sides of the screed using two averaging skis. The averaging skis will control the screed so it fills in low spots and scalps off high spots. When the paver reached the point where the cold planer left a hump in the grade, the screed begin to lay a thin mat. The ratio of layer thickness to aggregate size dropped below the 2:1 minimum and mat developed a torn and open appearance. There is nothing the paving crew can do to prevent this. The high spot in the grade should have been correct prior to paving.

Grade Conditions – Correcting Defects

- Remove defective areas such as high spots
- Patch pave or level prior to mainline paving
- Get the quality
- Avoid rework and penalties

CAT

In this example, correction of grade defects in selected areas of an airport runway was accomplished prior to paving and the problems created when paving over highs spots or other defects were avoided. Steps such as milling out high spots and patch paving may seem expensive, but these steps are necessary to achieve quality results.



Any time you are paving over a granular base, the base must be inspected prior to paving. The base should not show significant distortion when traffic or haul units operate on the base ahead of the paver. If soft areas are detected, these should be re-graded and compacted prior to paving.

Grade Conditions – Soft Base

- Compaction process finds soft spots after paving
- Especially severe distortion by pneumatics
- Re-work necessary

If not corrected prior to paving, soft base areas will deform under compaction, especially if pneumatic compactors are in use. These portions of the mat will have to be removed and patch paved. Rework is costly and can be avoided if the base is stabilized prior to paving.

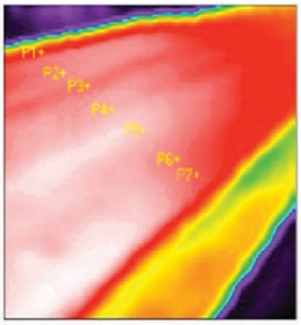
Grade Conditions – Soft Base

- Compact directly in front of the paver if necessary
- Use a pneumatic as a proof roller
- Re-grade if needed
- Stop paving and correct soft base
- Avoid re-work

CAT

To knock down distortions caused by haul units, it may be necessary to operate a smooth drum soil compactor on the base in front of the paver. A pneumatic compactor operating in front of the paving process will also help you identify soft spots in time for you to re-grade and compact. It is better to suspend paving operations and correct base defects rather than pave over poor base and come back for re-work.

Grade Conditions – Variable Grade

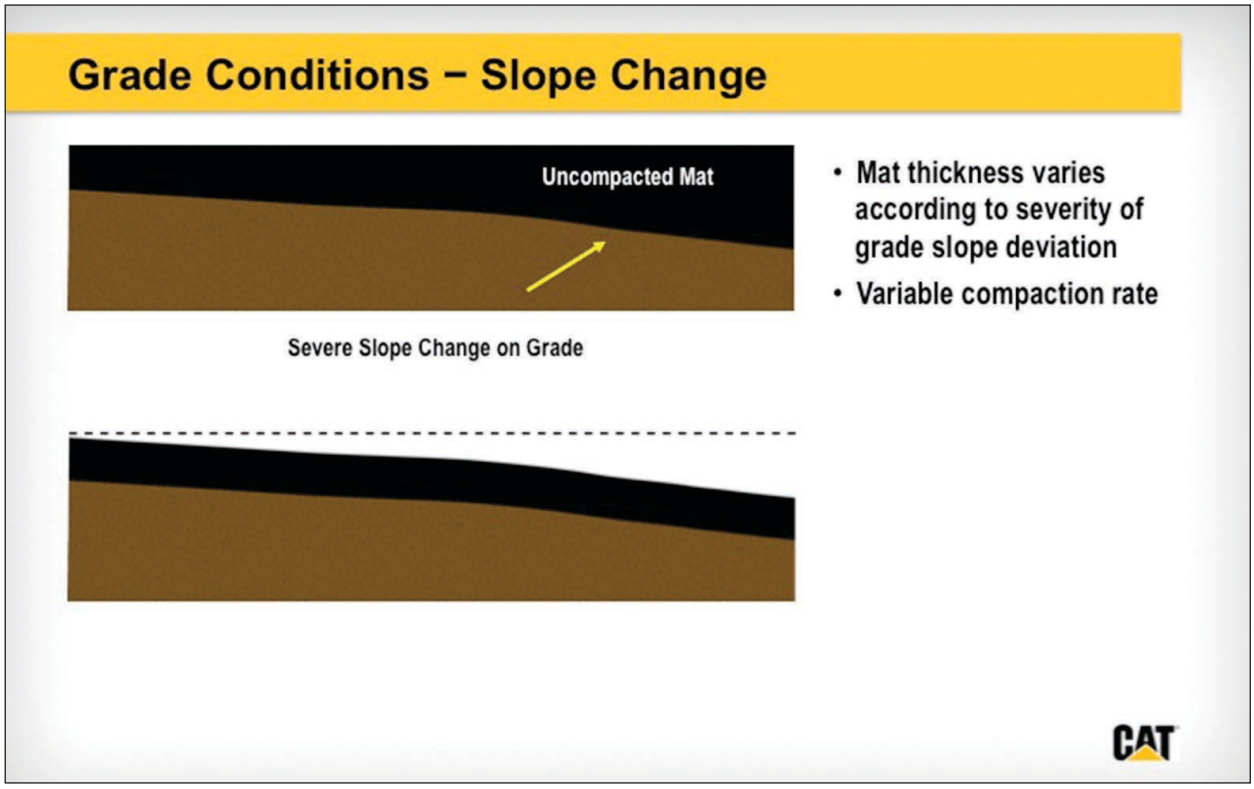


- Step between shoulder and driving lane
- Mat thinner over shoulder portion
- Visually little difference
- Large temperature difference
- Density variation

CAT

A variable grade is another condition that can produce mat defects. In this example, the 0.9 m (3') wide shoulder was not milled prior to paving, but the 3.0 m (12') driving lane was milled. This resulted in a step in the grade to be paved, with the shoulder being higher than the driving lane. A 9 mm (3/8") mix was paved to a depth of 50 mm (2') over the driving lane. The mat over the shoulder portion was only about 25 mm (1") thick. Visually comparing the driving lane and shoulder areas, there is only a slight texture difference in the mat. However, a significant temperature difference can be seen. The shoulder compaction will be different since the mat is thinner and cooler.

In this instance, expect a longitudinal crack to appear along the interface between shoulder and driving lane.



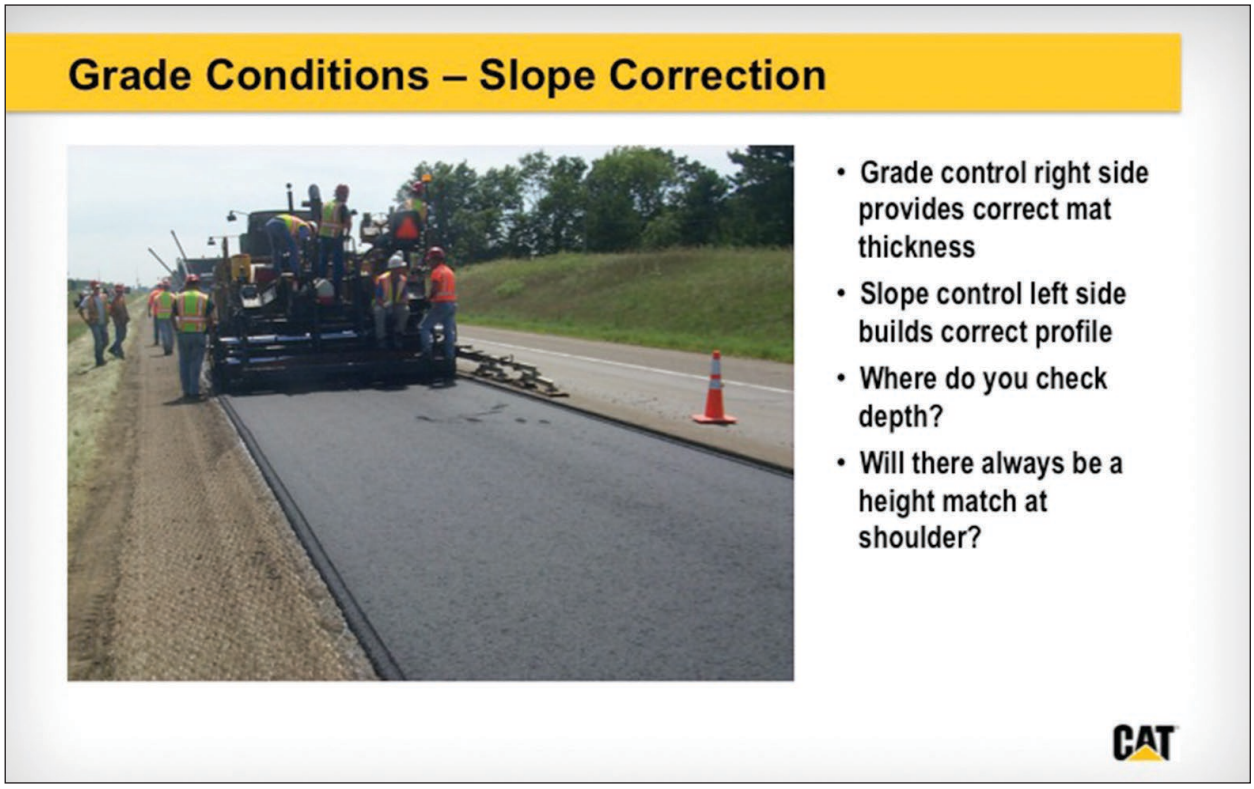
The slope of the existing grade may create a problem if it varies significantly from the mat placed over it. For example, if the slope of the grade is running at 4% and a mat with 2% slope is placed over it, the mat thickness will vary correspondingly. Or, if the slope of the grade changes significantly at some point, the mat thickness will change at that point also. The mat will compact at a different rate and it is likely the specifications for density and smoothness will not be met.

Grade Conditions – Slope Correction

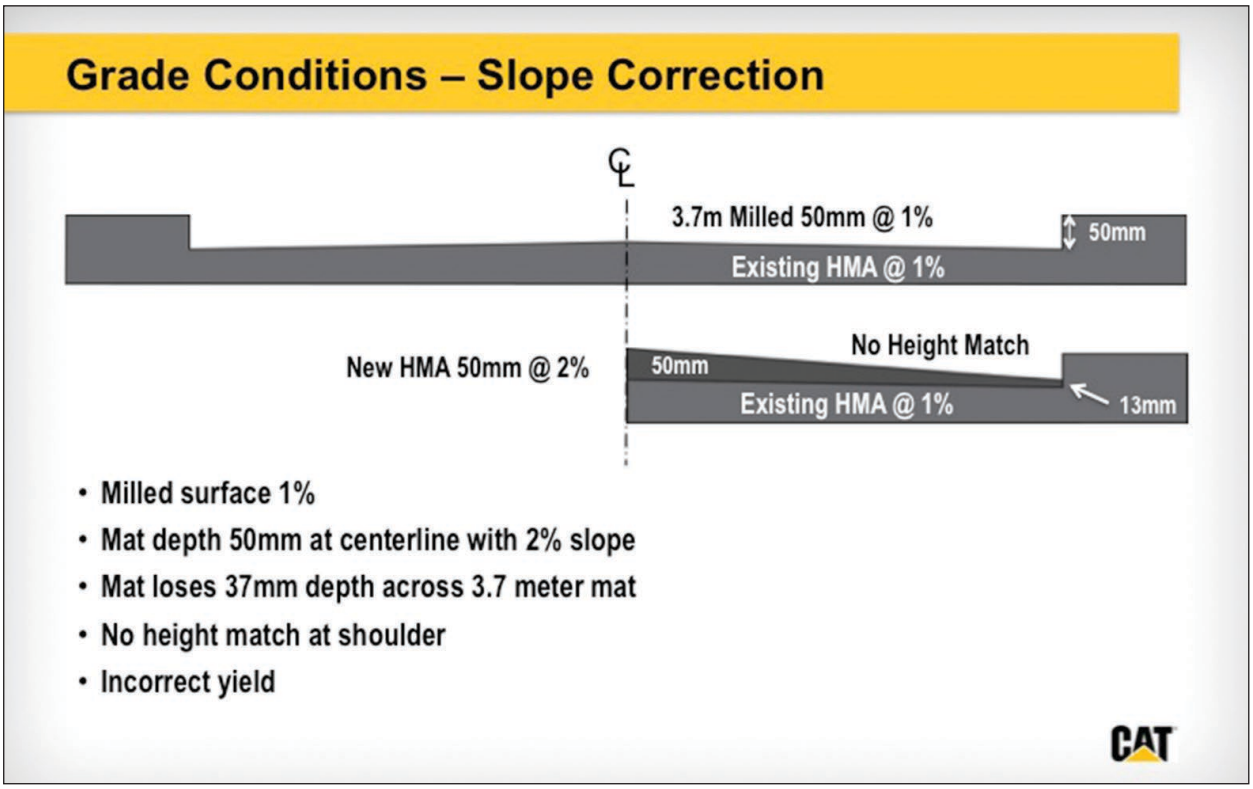
- Check slope prior to paving
- Adjust set-up when required
- If slopes correct, pave with grade control
- If slopes incorrect, pave with slope control

CAT

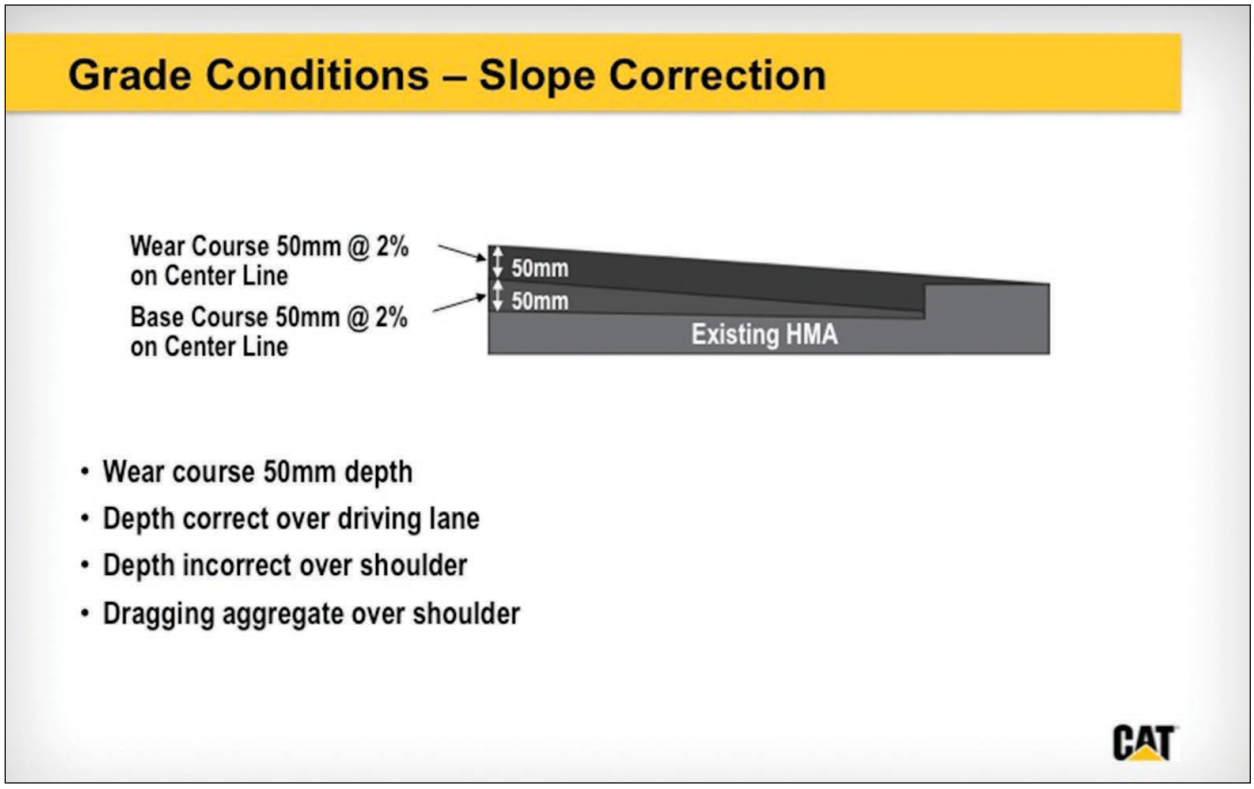
Most projects have a requirement for the slope of the mat in order to have the correct drainage and get water of the surface of the road. Prior to paving, verify that the slope of the surface – either milled surface, existing surface or granular base – is correct. If the slopes are correct, Caterpillar recommends paving with grade control for more precise yields and improved smoothness. If you need to make slope corrections, pave with one side of the screed under slope control. You can decide whether to use automatic slope control or manual slope control (Indicate mode).



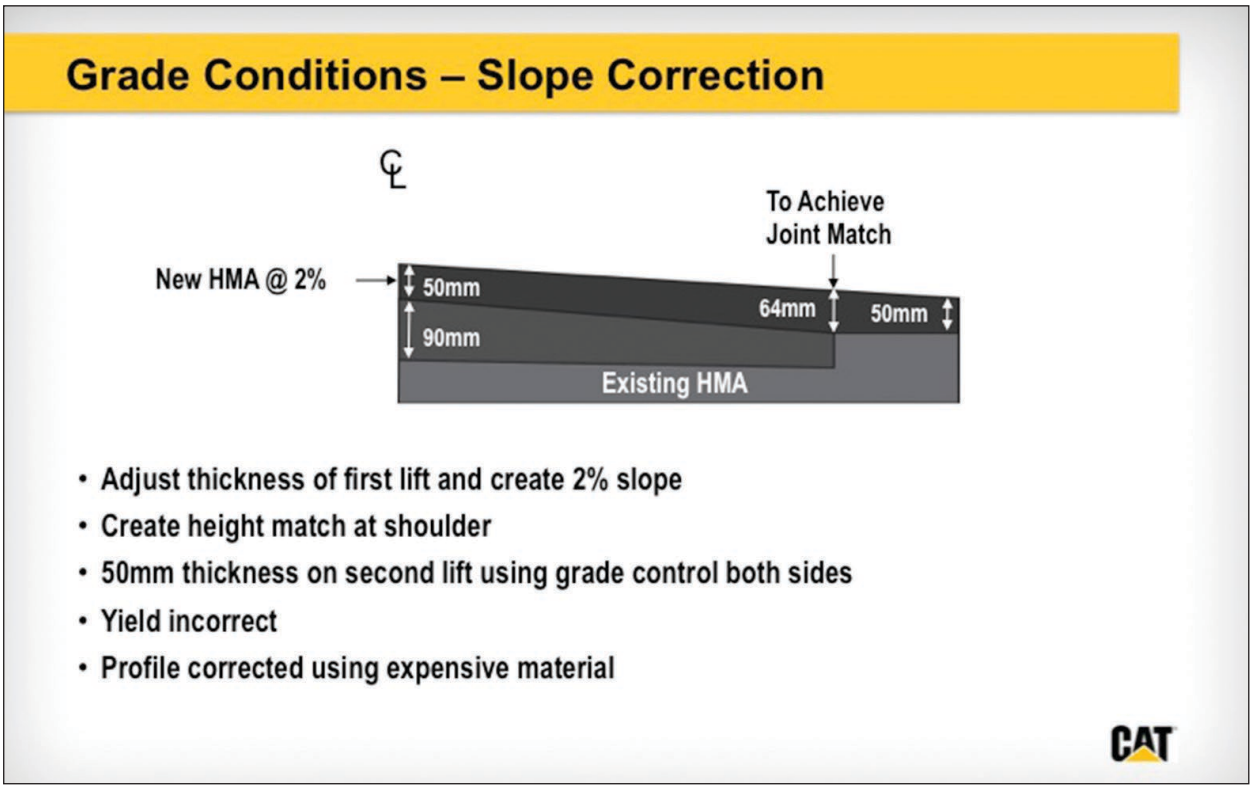
In this example, the crew has set up to correct the slope of the structure. They are paving with grade control, using an averaging ski on the right side of the screed. They are using slope control to create the specified right to left slope for drainage. In this situation, the only consistent depth control will be at the extreme right edge of the mat. Thickness can vary across the width of the mat depending on the amount of slope correction. Also, depending on the slope of the milled surface, there may or may not be a height match at the shoulder on the left edge of the mat.



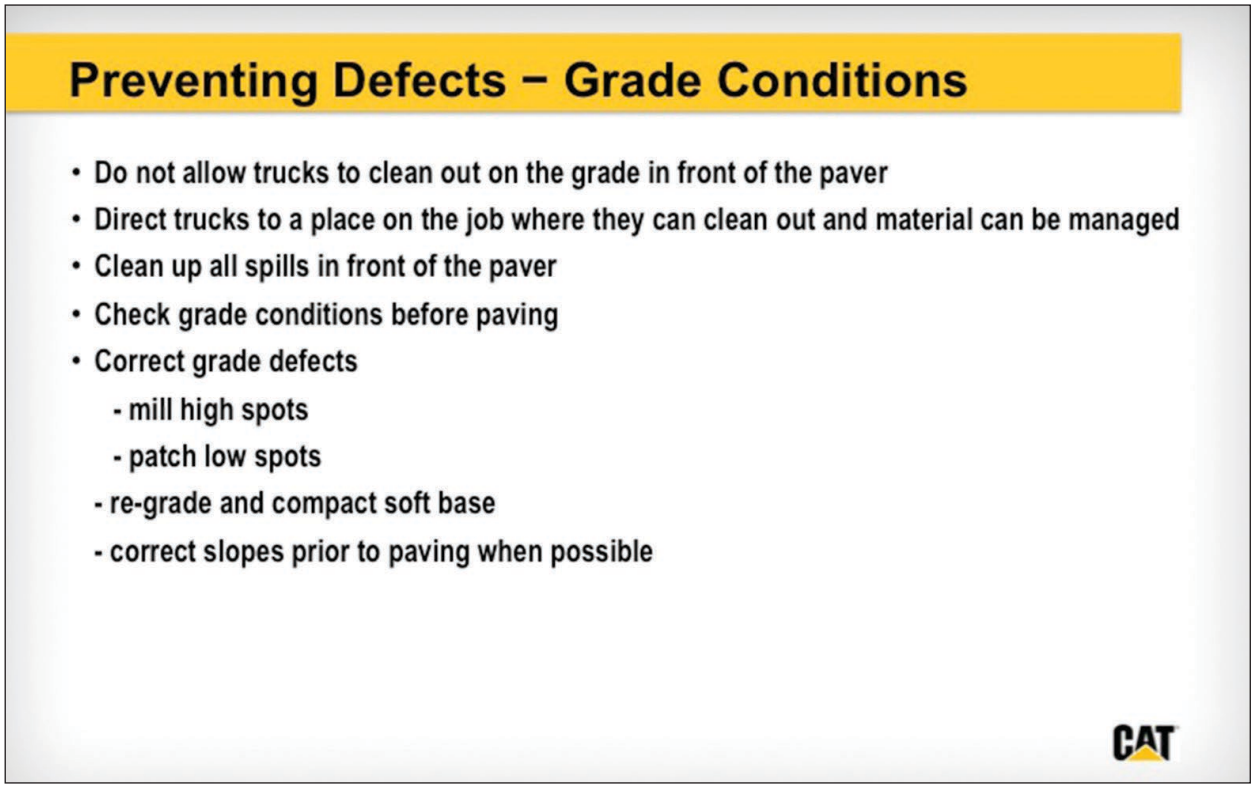
In this example, the slope of the milled surface is 1%. The crew lays down a mat that is 50 mm (2”) thick at the centerline with a 2% slope across the 3.7 m (12-foot) mat. Using the formula – 10 mm/m (1/8” per foot) for 1% slope correction – the mat will lose 37 mm (1.5”) depth across the 3.7 m (12-foot) mat. In this example, there is no height match at the shoulder and the yield will low in this section of the project.



When the wear course is laid down, the mat thickness will be correct over the 12-foot driving lane. However, the depth will vary over the shoulder which has the incorrect slope. You are likely to see open texture with dragging aggregates over the shoulder.



You can correct the profile of this structure by increasing the mat thickness at the centerline during the first pass. The mat will be 3.5" thick at the centerline, but with the 2% slope, the mat will match the height of the shoulder. Since the slope is now correct, pave the second lift using grade control on both sides to produce a 2" thick mat all the way across the driving lane and the shoulder. The yield for the project in this area will be incorrect, but the profile for drainage will be correct. Of course, it would have been more cost effective to use quality control during the milling step to create the correct profile prior to paving. In addition, in this example, there will be a differential compaction rate and stresses on the mat during compaction due to a thicker mat (50 to 64 mm) over the milled step to the shoulder. This could lead to longitudinal cracks forming during or after compaction that may show up immediately or weeks or months after compaction.



Mat defects related to grade conditions are most commonly associated with trucks dumping material on the grade in front of the paver. This practice can be, and must be, eliminated. Designate a location on the job site where trucks can clean out and manage the dumped material as salvage.

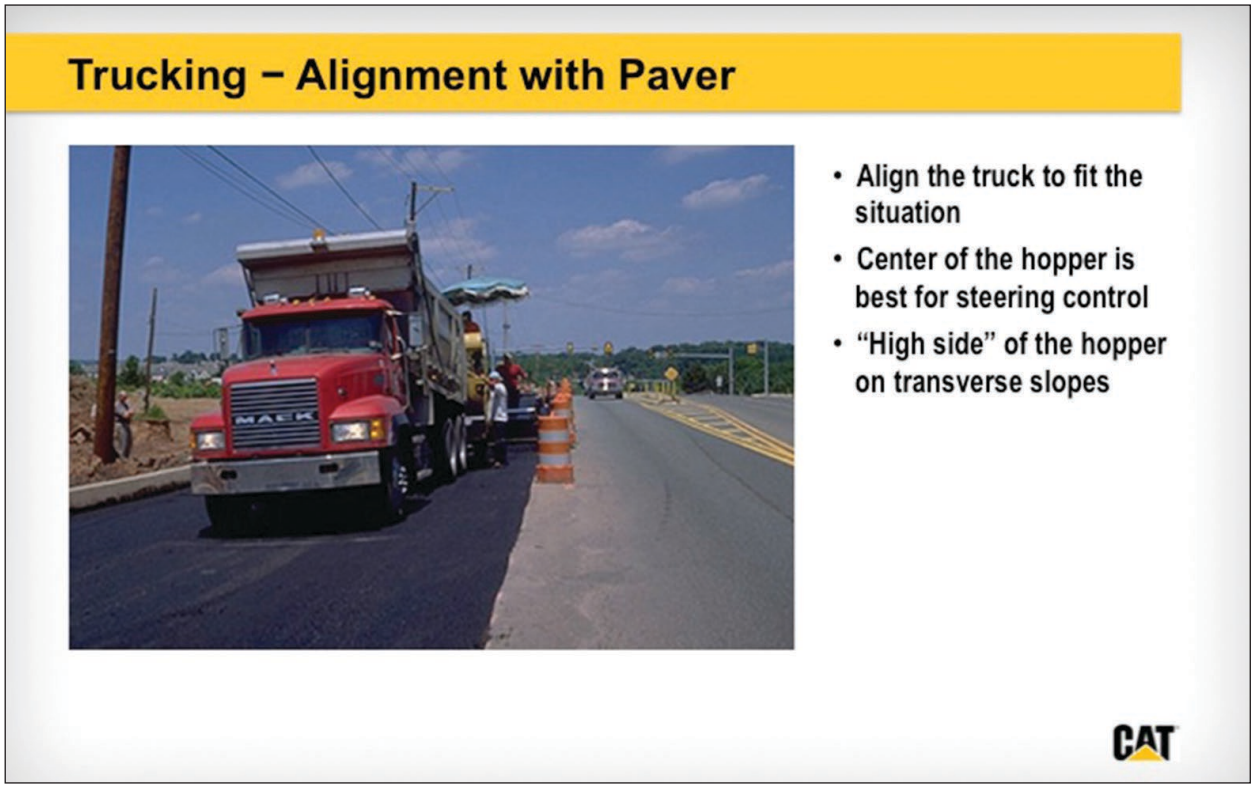
If material is inadvertently dumped or spilled in front of the paver, clean up the spill before the paver gets to it.

Check grade conditions before paving. Best paving practices dictate that high spots are milled off and low spots are patched before the paving operation starts. Likewise, check transverse slope prior to paving and correct slopes whenever possible prior to paving.

II. Trucking

- Mat defects can be caused by paver and truck interface
- Training is key to preventing mat defects related to trucking

Certain mat defects can be introduced by or aggravated by the way that the haul trucks and paver work together. Trucking-related defects are especially of concern when the truck dumps directly into the paver hopper. This procedure means there is contact between the truck and the paver. Training is required to make sure that the truck driver and paver operator know how to handle truck exchanges and how to get the material dumped into the hopper correctly.



The first responsibility of the truck driver is to align the truck in front of the paver as indicated by the paver operator or dump person. As a rule, it is good practice to align the truck in the center of the hopper. Positioning the truck in the center of the hopper helps the paver operator control the paver steering.

However, when the paver is operating on a transverse slope, it is usually advisable to align the truck to the "high side" of the paver. Gravity will tend to pull mix out of the truck bed toward the low side of the hopper. Thus, the low side conveyor will be full of mix when the high side begins to run empty. Likewise, there will be mix in the low side of the truck bed when the high side is empty. When the truck pulls away from the paver, there is likely to be a large spill on the grade in front of the paver if you take the time position the truck where you want.

Trucking – Bumping the Paver

- Common problem - truck backs into paver
- Screed marks mat severely
- Often can't be cleaned up - bump

CAT

One of the most common problems related to trucking is when a driver backs into the paver push rollers instead of stopping short of the paver. The tractor is forced rearward pushing the screed backwards into the finished mat. This action forces the trailing edge of the screed downward into the mat and displaces material rearward. Often, these marks can not be raked out by a laborer and can not be rolled out by the compactor. A bump is produced.

The truck always stops short of the paver's push rollers. A one-foot gap is a good target to shoot for. The dump person (truck guide) or paver operator must have clear communication with the truck driver and be able to signal when the truck should stop.

Trucking – Truck Hitch or Light Brake Pressure

- Truck hitch option provides solid connection between paver and truck, or
- Light brake pressure to prevent roll away

CAT

A truck hitch is an option on Cat Pavers. The truck hitch provides a solid connection between the truck and the paver's push rollers. If there is no truck hitch on the paver, the truck driver must apply light brake pressure, especially on downward slopes, to prevent the truck from rolling away from the paver. The truck driver must be careful not to apply too much brake pressure. Excessive brake pressure may cause the paver to propel erratically or to spin the tires.

Despite the crew's best efforts, sometimes the truck driver makes a mistake and lets the truck roll away from the paver and a huge spill occurs.

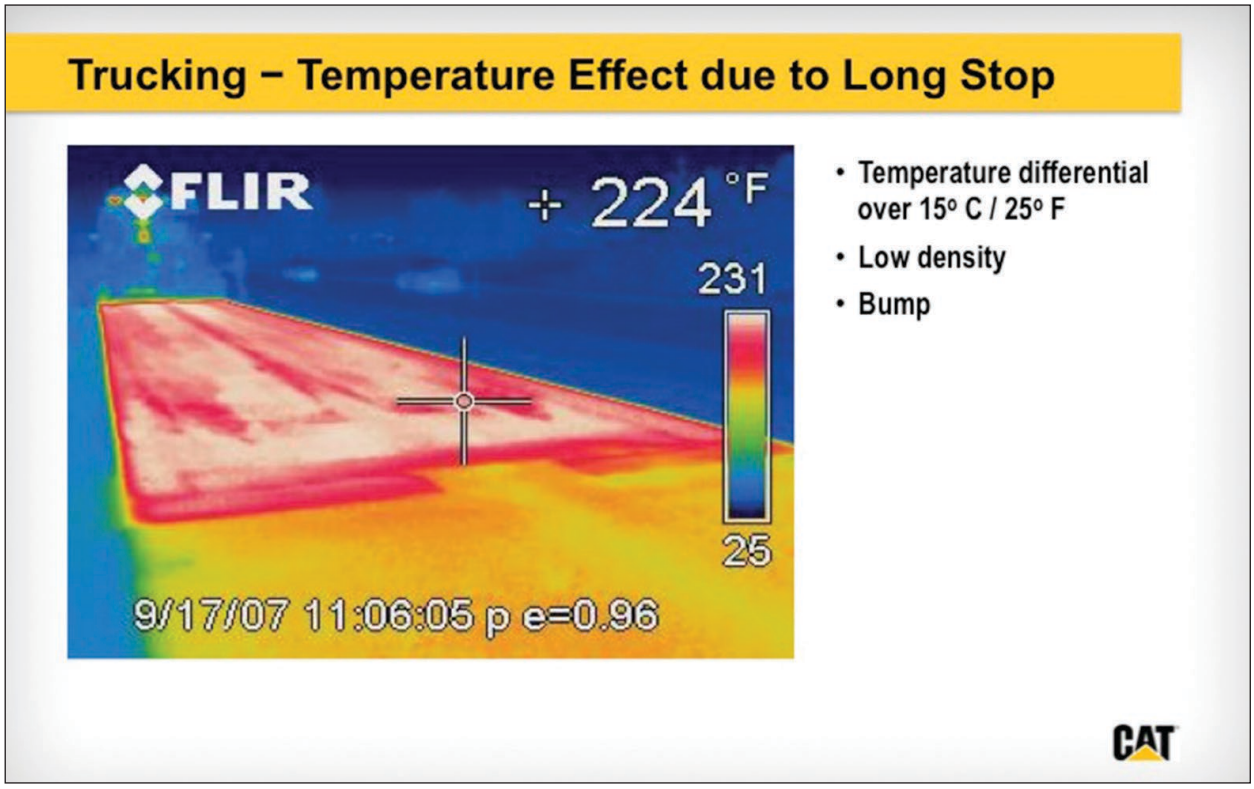
There is no magic cure. But here a few things to concentrate on. Be sure that signals given to truck driver are clear. Reinforce that the driver must apply the brakes to some extent. Don't be afraid to repeat the message. Finally, include truck drivers as much as possible in crew training sessions. Let them know that they are part of the team.

Trucking – Clean Up Tools

- Have skid steers or small loaders on the job
- Try to minimize time stopped
- What is happening to the mat behind the paver while we're cleaning up?

CAT

On most projects, you will have a skid steer or small loader available to help with clean up at the end of a pull. They are also invaluable in cleaning up large spills like this. Try to minimize the time the paver is stopped.



Any stop over five minutes long is likely to create a significant temperature differential in the mat. The mat will be cold directly behind where the screed sat and will be hot where it was confined by the screed. The cold mat will not compact at the same rate as the hot mat. The cold area will have a lower density than the hot area and there will be a bump in that area, too. Events such as large truck spills are considered big mistakes and should be avoided.

Trucking – Screed Settlement due to Long Stop

- Screed settlement during long stop
- Compaction process may clean up mark
- Screed assist can help

CAT

Any stop over five minutes long is also likely to create a significant screed settlement mark in the mat, depending on the stiffness of the mix you are laying down. The settlement mark may or may not roll out completely during the compaction process. If the operator has activated the screed assist system and the screed assist pressure is set correctly, the settlement mark should be minimal.

Note: There will be more discussion of the screed assist system in the section on Ride Quality.

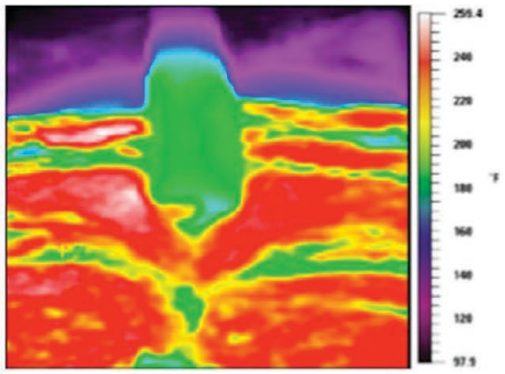
Trucking – Control the Truck Dump

- Release tail gate
- Raise bed to create a surge into the hopper
- Hold bed angle
- Increase angle when more mix is needed
- Driver is watching dump person or paver operator

CAT

When the truck has contact with the push rollers, the driver should raise the truck bed on command from the dump person or the paver operator. With the tailgate released, raise the bed until load "breaks" and begins to discharge into the hopper. Hold the bed at this angle until the level in the hopper is low enough to receive more mix without overfilling the hopper. Alternately, raise and hold the truck bed at the signal of the dump person or paver operator.

Trucking – Dribbling Material out of Truck Bed

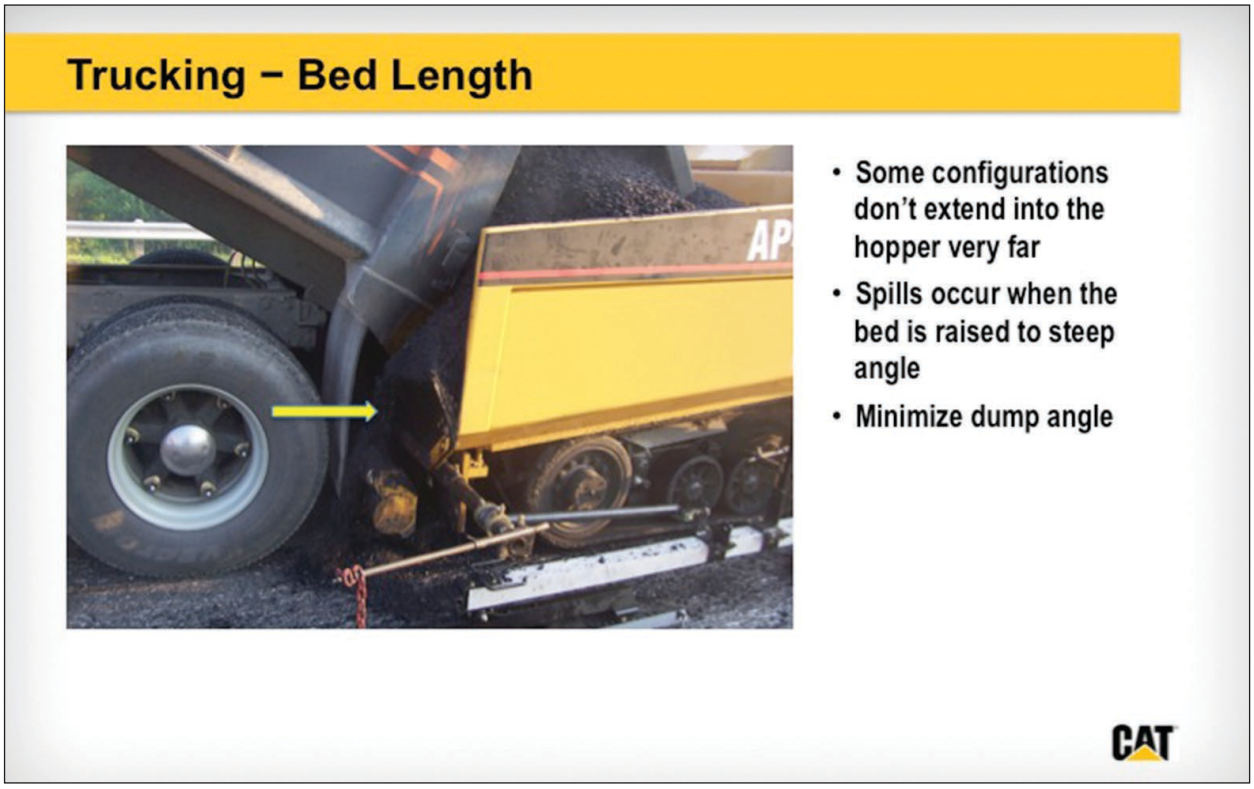


- Dribbling material prone to segregation
- Cooler crust doesn't mix with hot load
- Keep bed up enough to create constant flow

CAT

The paver operator or the dump person and the truck driver have to communicate in order to keep the truck bed raised enough to prevent dribbling material out of the truck into the hopper. Material that dribbles slowly out of the truck is prone to segregation and there may be a tendency for the cooler crust to remain unmixed with the hot core material coming out of the truck.

Have the bed raised so mix is forced against the tail gate before releasing the tail gate. Then, keep the bed raised enough to create a constant surge of mix into the hopper.



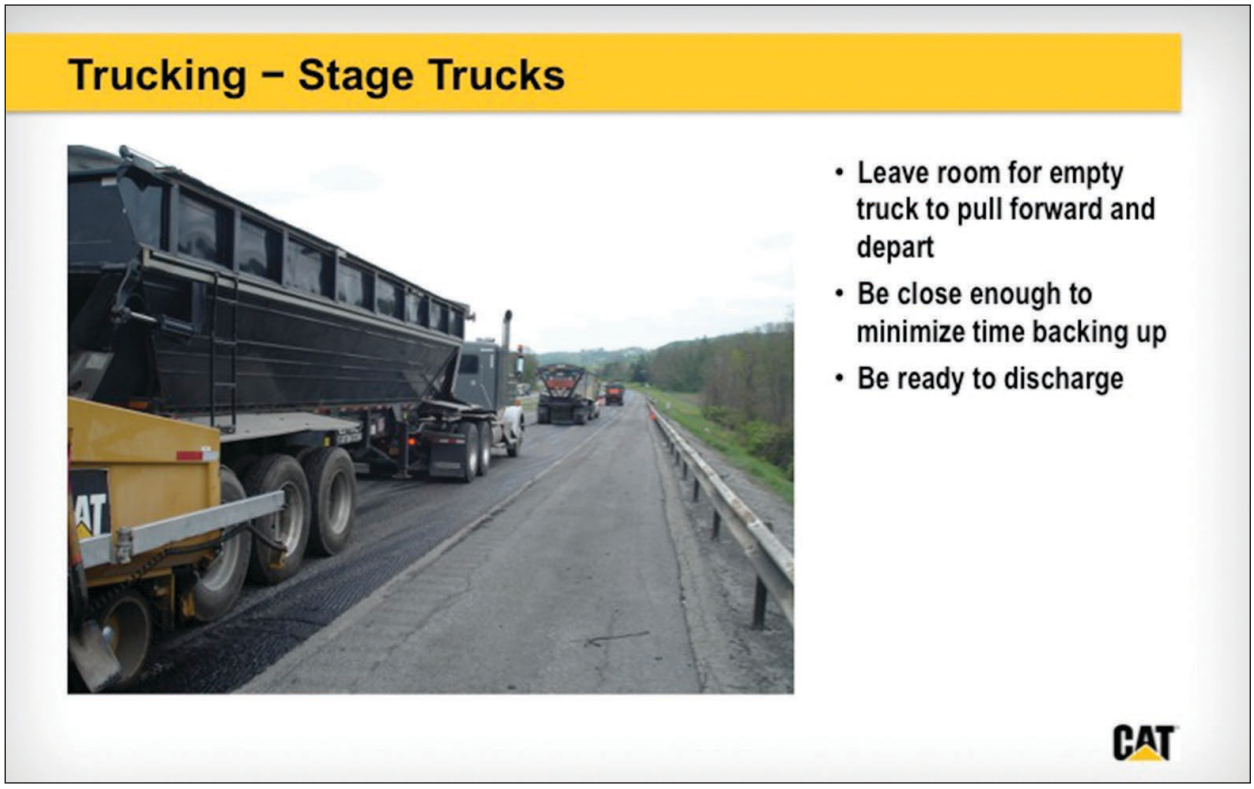
There may be some haul units with bed configurations that do not allow the bed to extend very far into the hopper. As a result you may see mix spilling out of the hopper when the bed is raised to a steep angle. In that case, the dump person or paver operator needs to minimize the bed angle and carefully watch the level in the hopper.

Trucking – Bed Length

- Block mix that is spilling
- Protect the grade that is the reference for grade sensors
- Prevent spills run over by undercarriage
- Identify and eliminate short bed trucks, if possible

CAT

It is a stop-gap measure, but it may be necessary to have a laborer provide a block for the mix that is flowing out of the hopper. Doing this will prevent spills from accumulating on the grade that is being sensed by grade sensors on that side of the paver. And, stopping the spills will prevent piles of mix from being run over the paver undercarriage. Whenever possible, identify those haul units which are not configured properly for dumping asphalt into a paver hopper and eliminate them from your haul unit fleet.



It is common to have one or more trucks waiting to unload on the project. The trucks that are waiting must be far enough in front to allow the truck that has just completed its discharge to move forward to reach the clean-out area or to enter traffic and depart the project. However, those waiting trucks should be close enough so the next in line can quickly back up to the paver. And, those trucks should be ready to discharge: load uncovered, tire flaps retracted and tail gate tripped. Remember, you are trying to minimize the length of time that the paver is stopped between trucks. Short stops – for example, under three minutes - between trucks are not harmful to mat quality.

Trucking – Entering Traffic

- May be heavy traffic in adjacent lane
- Departing trucks have to wait too long to enter traffic
- Paver stops may exceed five minutes
- Need traffic coordinator

CAT

On some projects, there is heavy traffic in the adjacent lane that is to be used by departing haul units. In those situations unless there is some sort of traffic control coordinator, trucks may have to wait too long to safely enter traffic flow. The time that the paver is stopped between trucks may be so long that the mat begins to show significant temperature variations. As a rule, any paver stop that exceeds five minutes is bad for quality. You may have to designate a traffic coordinator to facilitate truck departure.

Depending on local regulations and policies, you may be able to hire law enforcement personnel to act as traffic coordinator on your project. Or, your crew may have a designated safety coordinator or flagger who can assist with traffic control. Or, it may as informal as having a laborer help provide traffic control.

Be sure to conform to all local safety and law enforcement policies.

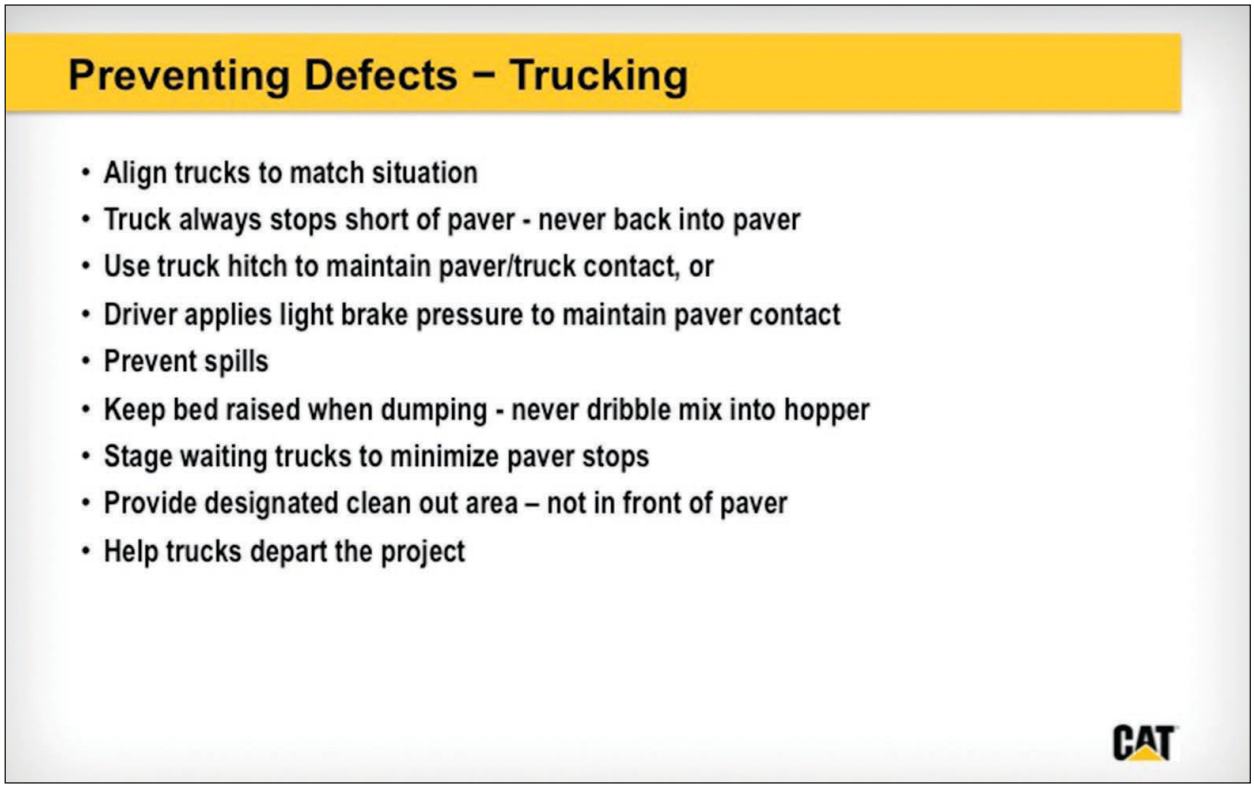
Trucking – Truck Clean-out Area

- Designate a clean-out area
- Prohibit clean-out in front of the paver
- Salvage material left in clean-out areas at end of shift

CAT

Before haul units leave the project, the truck drivers should clean out in an approved area. Clean out in front of the paver should be avoided for two reasons. First, it lengthens the time the paver is stopped between trucks. Second, material on the grade causes mat defects.

Any mix deposited in the clean-out area must be handled in the appropriate manner to prevent contamination.



The prevention of mat defects related to trucking practices is largely a matter of making sure that truck drivers are included in training sessions and are properly directed at the job site.

The paver operator and the dump person need to work with truck drivers to control the following trucking principles.

- Truck never backs in to the paver.
- Use truck hitch to help maintain truck/paver connection.
- Driver applies light brake pressure to maintain paver contact.
- Truck aligns with center of hopper.
- Bed is kept raised high enough to prevent dribbling material.

III. Truck Exchange

- Truck transfer into hopper still a common practice
- Follow an established procedure
- Operator and dump person and truck drivers work together

Depending on the project and the locality, transferring mix from the hauling unit to the paver is often done by dumping directly from the truck to the hopper. Following a good truck exchange procedure is essential to paving efficiently and to producing a high quality mat. Controlling the truck exchange takes coordination between the paver operator and the dump person.

Note: Certain mat defects covered by faulty truck exchange procedures are covered in Section II as well.

The paver operator should follow a four-step routine during the truck exchanges. This is a routine that helps ensure that the hopper is not run low on mix and the head of material in front of the screed remains at the correct level.

Step one is releasing the truck as soon as the truck bed is empty. The operator signals the truck driver to begin lowering the bed and preparing to exit from the front of the paver. The paver continues to lay down mix at the same paving speed.

Truck Exchange – Continue Paving

- Step two - continue paving as truck pulls away
- Pave until level of mix permits cycling hopper wings without spillage– *if allowed*
- Next truck getting position

CAT

As the empty truck pulls away, the paver operator continues to pave at the same speed and checks the level of material in the hopper. Assuming that the hopper is full, the operator paves until the level has gone down to the point where the hopper can be cycled without spilling mix out of the front of the hopper.

At this point the next truck should be getting ready to position in front of the paver.

Truck Exchange – Cycle Hopper

- Step three - continue paving at normal speed
- Slowly fold hopper wings combining mix from sides with mix in middle

The operator continues to pave at the normal speed. When the level in the hopper is low enough to allow folding the hopper wings without spilling out the front of the hopper, the operator should slowly bring up the wings to combine the cooler mix with the hotter mix in the center of the hopper.

Truck Exchange – Cycling Hopper Prohibited

- Cycling hopper wings may be prohibited when laying large stone mixes
- Large stone rolls to sides of hopper
- Folding wings contributes to end-of-load segregation
- Shovel out sides of hopper periodically

CAT

There may be times when the operator is told to not cycle the hopper wings. Usually, when laying down a mix with aggregates that are 19 mm (3/4”) or larger, it is advisable to not cycle the hopper wings. Large aggregates will accumulate at the sides of the hopper when transferred from the truck directly into the hopper. When the wings are folded, the large aggregates tend to pass through the paver as a mass and show up as patches of segregation.

When the hopper is not folded, mix will accumulate at the sides of the hopper. These large piles of mix can interfere with the tail gate opening of subsequent trucks. Therefore, you will need to shovel out the sides of the hopper periodically.

Truck Exchange – Stop Paver

- Step four - stop paver and lower hopper wings
- Level in hopper covers deck and conveyors
- Mix in hopper will be covered by next load

When the level of the mix in the hopper is still covering the deck and the conveyors are still full of mix, the operator should stop the paver and lower the hopper wings.. The level of mix in the hopper should be even and still covering the deck and tunnels completely. The mix left in the hopper will be covered by fresh hot mix as soon as the next truck is in position to raise its bed and dump into the hopper.

Poor Truck Exchange

- Paved too long without cycling hopper wings
- Conveyors low on material
- Jeopardize head of material in front of screed

CAT

This image shows an example of a poor truck exchange. The operator continued paving between trucks, but did not cycle the hopper wings while paving. Both the left and right conveyors are low on material. There will be a gap in the delivery of mix to the auger chamber and the head of material in front of the screed may get too low causing the screed to drop.

Poor Truck Exchange

- Folding hopper wings and apron while stopped
- Cooler mix dumped into empty conveyors
- Segregated mix dumped into empty conveyors

CAT

The paver is now stopped and the operator has started to fold the hopper wings and the optional folding front apron. This action moves cooler and possibly segregated mix directly into the almost empty conveyors.

Poor Truck Exchange

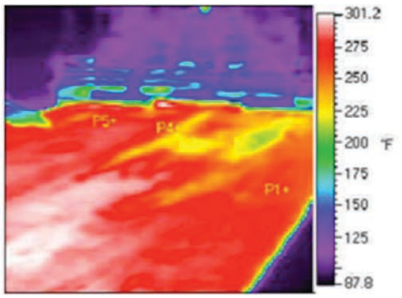
- Crew use feeder system override to refill auger chamber
- Cool, segregated mix flows back to auger chamber

CAT

Usually, the paver operator or the screed operator(s) will use the feeder system manual override to refill the auger chamber at this point. This action will transfer cool, segregated mix back to the auger chamber and under the screed when paving resumes.

Poor Truck Exchange

Point	Temp
P1	261° F
P2	213° F
P3	223° F
P4	243° F
P5	278° F



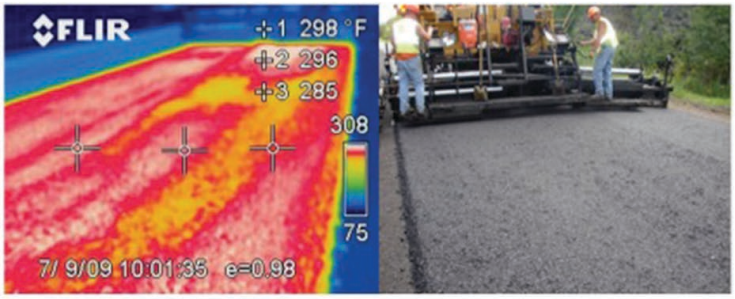
- Large temperature variation appears
- Patch segregation appears
- Affects density and smoothness
- Operator training required

CAT

When paving resumes, a large patch of segregated aggregates appears in the mat. The infrared image shows that the temperature variation is about 65 degrees F in the area around the segregated material. This degree of temperature variation is likely to result in variations in density. The cold mix will not compact at the same rate as the hotter mix. Rideability will be affected as well as density.

This problem can be, and should be, cured with proper operator training.

Typical Truck Exchange



- Acceptable variations occur during truck exchanges
- Quick exchanges reduce variation
- Exchanges should take 1-2 minutes
- Screed marks should roll out

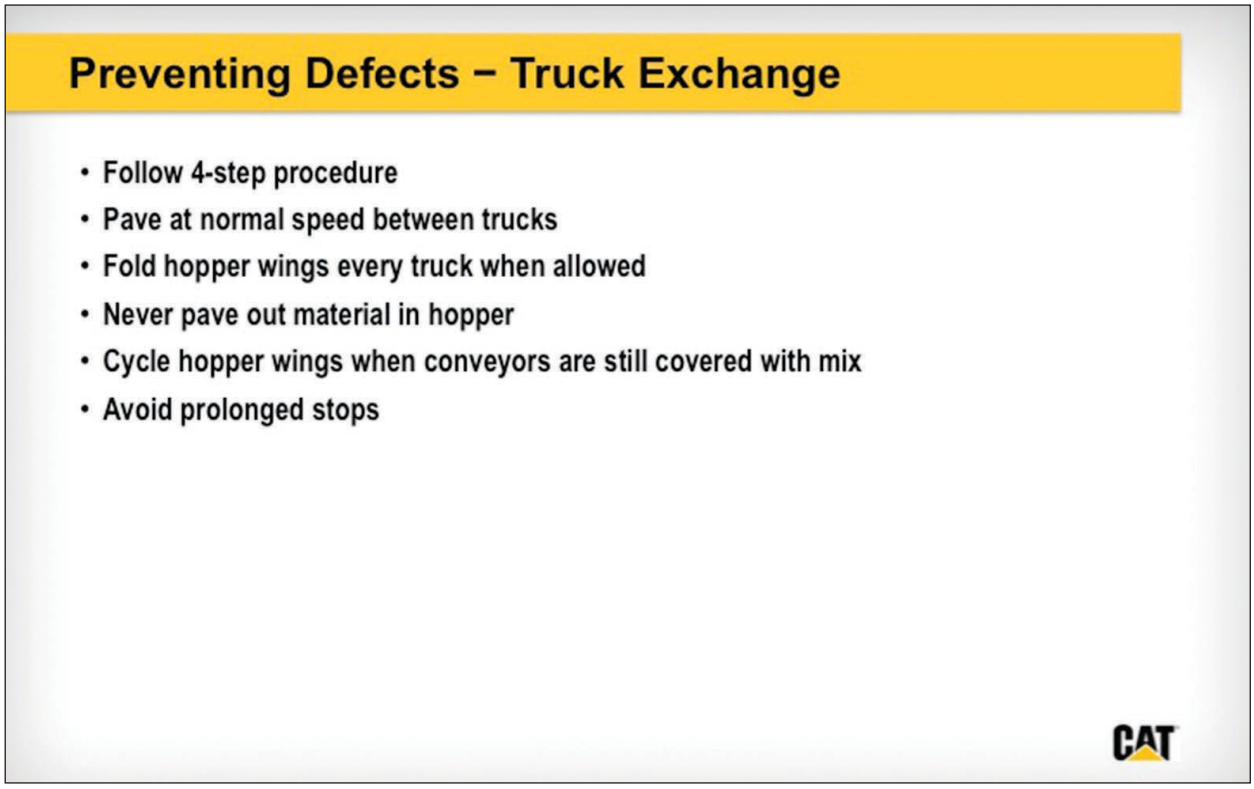
Point	Temperature
P1	298° F
P2	296° F
P3	285° F
P4	308° F

CAT

During the end dumping process, some temperature variations are normal. But, the amount of variation can be minimized if the crew is efficient at getting trucks in and out and the proper procedures are followed. Most truck exchanges can be accomplished in one to two minutes.

When the paver is stopped, the surface begins to lose heat immediately. The core temperature of the mat will begin to drop, too, but less rapidly, depending on the thickness of the mat and the grade temperature. The screed may also leave a mark in the fresh mat during stops. On most projects, the marks will roll out if the paver stop is not prolonged. The paver stops should not create bumps or variations in density.

In this example, not only did the crew get the truck exchanges done quickly, the paver operator took care to stop the paver before running the hopper low on mix.



Good truck exchanges help prevent mat defects and require training and practice. Always follow a set procedure that is known by the operator, the dump person and the truck drivers. The key points in good truck exchanges are:

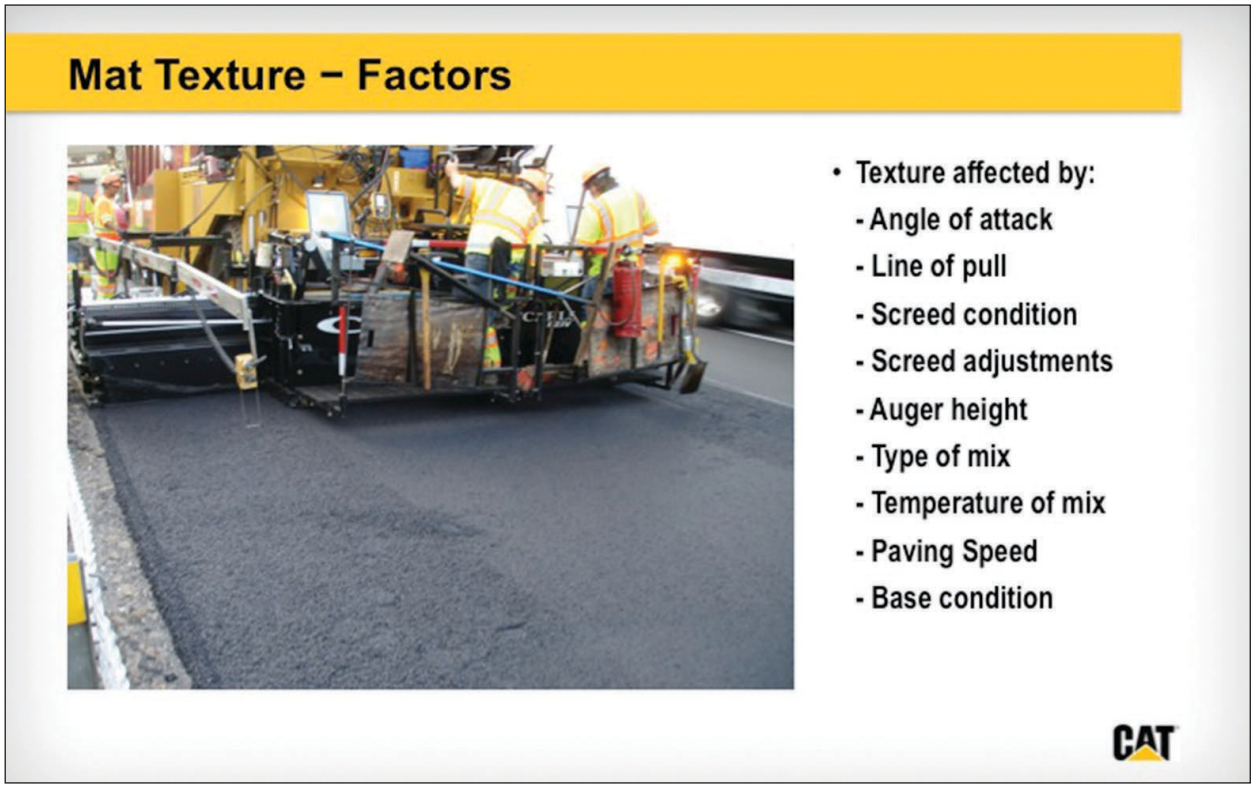
- Never pave out the material in the hopper.
- Pave at normal speed between trucks
- Fold hopper wings every truck when folding the wings is allowed
- Never run low on mix in the hopper, especially the conveyors
- Cycle hopper wings when the conveyors are still covered.
- Avoid prolonged stops.

IV. Mat Texture

- Visual appearance of the surface
- Not the same as aggregate segregation
- Affected by many factors
- Goal is uniformity from edge to edge

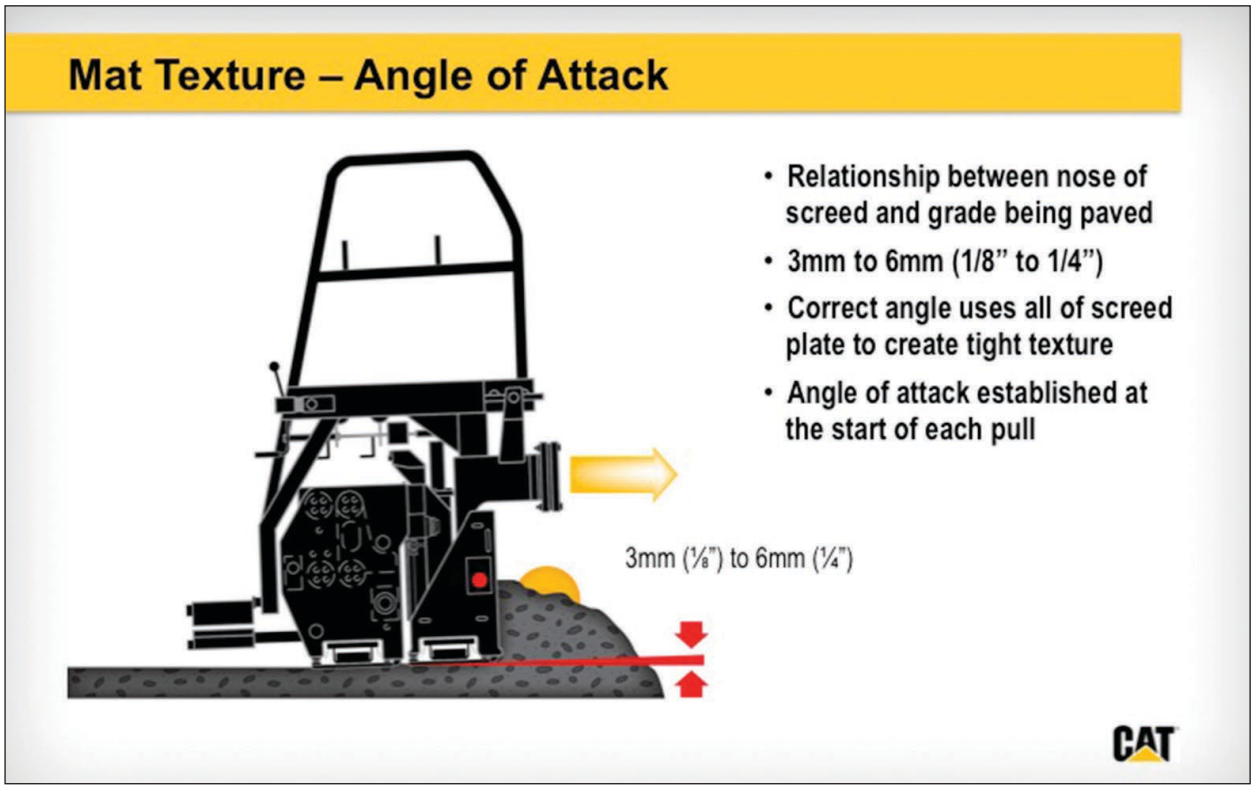
Mat texture is defined as the visual appearance of the surface of the asphalt layer. Texture is often confused with segregation of aggregates. It is true that a mat with segregation will have an open-texture appearance in those areas where segregation is present. But, the causes of aggregate segregation are usually much different than the causes of texture variation. Segregation will be covered in the next unit of this presentation.

Texture is influenced by many factors and there can be several contributing to poor, or non-uniform, texture at the same time. Troubleshot texture problems in a methodical manner, the same way you would approach any quality issue. Your goal should always be to lay down a mat that has an acceptable texture that is uniform from edge to edge.



The texture of the asphalt layer can be affected by a range of factors. Some have more influence on the appearance of the mat than others. And some are inter-related. The factors covered in this unit are:

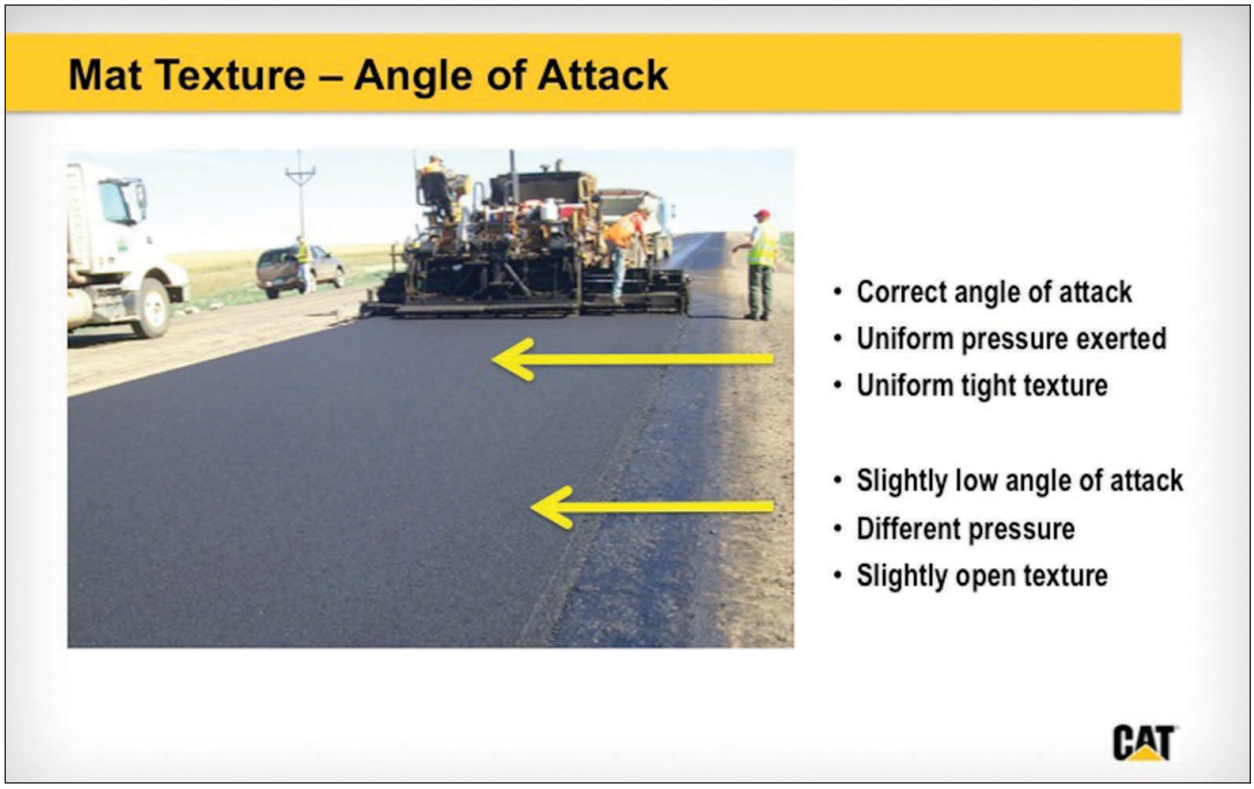
- Angle of attack of the main screed and the screed extensions
- Line of pull
- Screed condition
- Screed adjustments
- Auger height
- Type of mix
- Temperature of the mix
- Paving speed
- Base condition



A major influence on the texture of the mat is the screed angle of attack. Most screeds are designed to run with a slight nose-up attitude. The correct angle of attack is no less than 3 mm / 1/8" and 6 mm / 1/4". At that angle of attack, most of the screed plate is in contact with the surface of the mat and, for many types of mix, a tight texture is created. The leading edge of the screed plate and nose bar, if equipped, are slightly raised above the surface of the mat.

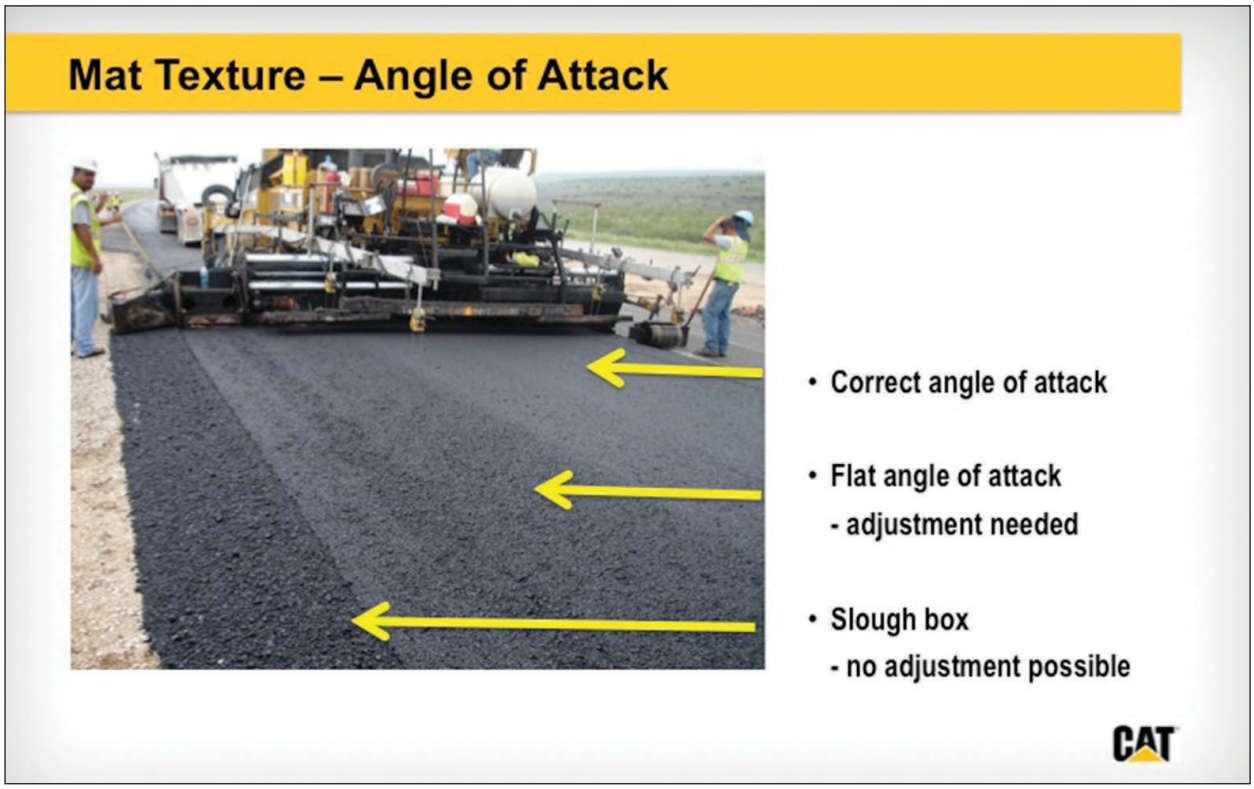
The crew establishes the main screed angle of attack while preparing to pave at the start of each pull. During the length of that pull, the screed will always try to maintain the original angle of attack.

Note: See "Paving by the Numbers" for complete instructions for preparing the screed at the start of paving.



When the screed runs with the correct angle of attack and exerts uniform pressure on the mat, the texture of the surface is relatively tight and uniform. In this example, the texture behind the main screed and the hydraulic screed extensions is uniform. Uniform texture indicates equal angle of attack across the width of the main screed and the extensions.

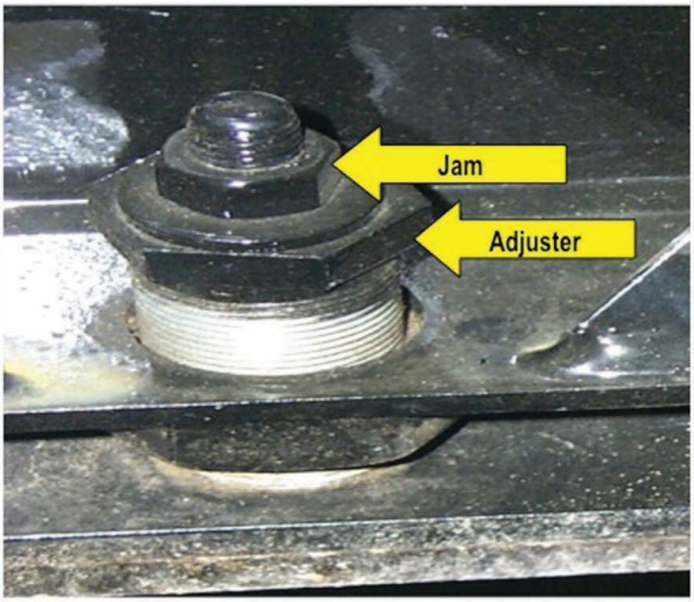
The crew installed two feet (60 cm) of bolt-on screed extension to the right hydraulic screed extension. The angle of attack of the bolt-on screed extension is slightly less than the rest of the screed. Consequently, the pressure exert by that screed plate is different and the surface texture is slightly different at the extreme right edge. This minor texture difference would generally be considered acceptable and no screed adjustment is necessary.



In this example, surface texture is significantly different across the width of the mat. The texture is good behind the right screed extension and behind most of the main screed. The texture behind the left hydraulic screed extension is too open, indicating that the left screed extension is running flat or nose down. The texture is even more open behind the two-foot (60 cm) bolt-on extension, indicating that the bolt-on extension is running flat or nose down. At the extreme left end of the screed, to meet project specifications, the crew has installed a two-foot (60 cm) slough box, which is simply a strike-off without screed plate. The open appearance of the mat behind the strike-off is unavoidable as no adjustment is possible for the strike-off.

To change the angle of attack of the screed extensions for this type of screed, turn the adjusters on the trailing edge of the screed. Turn the adjusters clockwise to push down the trailing edge of the screed plate and increase the angle of attack. Whenever possible, make the adjustment while paving to verify that the adjustments are correct.

Mat Texture – Angle of Attack Adjustment

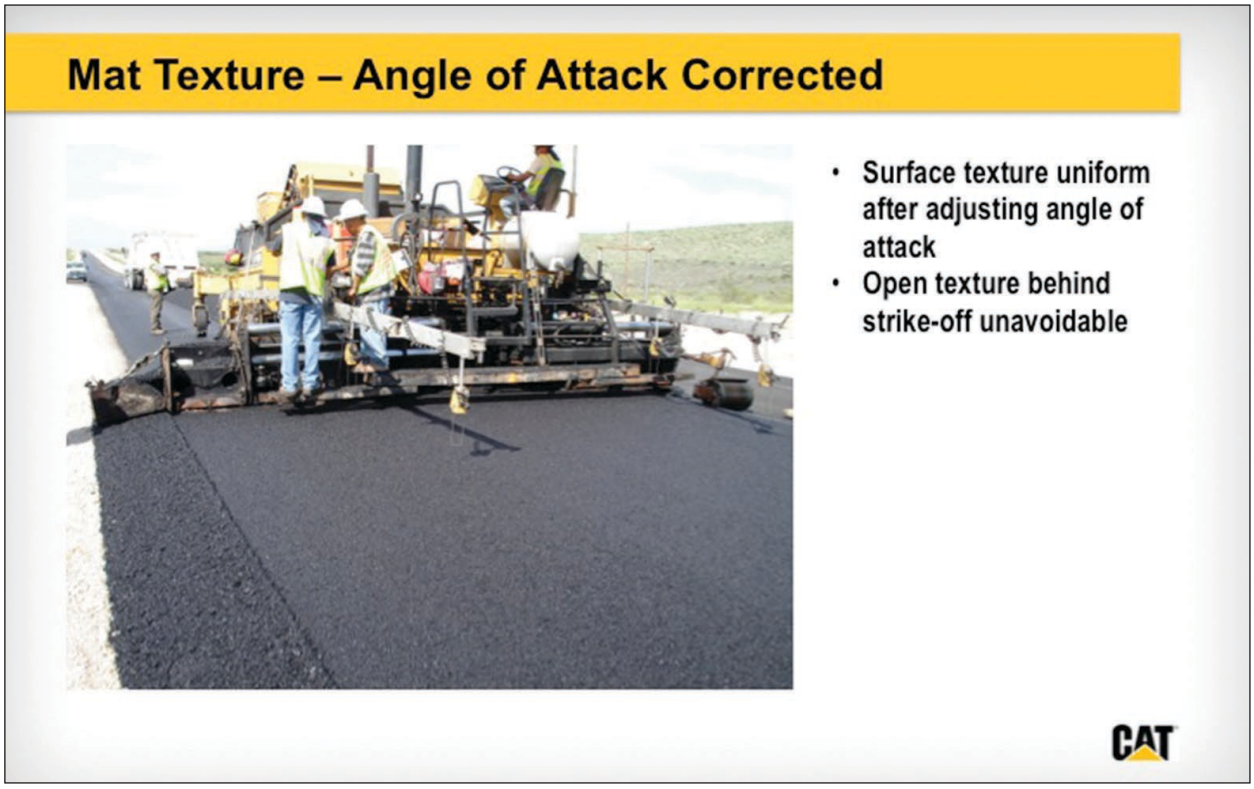


- To increase angle of attack, turn adjusters clockwise
- To decrease angle of attack, turn adjusters counter-clockwise
- Turn each adjuster nut the same amount
- Make adjustments until mat is uniform full width

CAT

Many screeds have adjusters on the trailing edge of the screed extensions. To increase the angle of attack, loosen the jam nut and turn the adjuster clockwise. To decrease the angle of attack, loosen the jam nut and turn the adjuster counterclockwise. Then, re- lock the jam nut. Turn each adjuster the same amount across the trailing edge. Repeat these steps until the mat is uniform across the full paving width.

On other screeds, the method of adjusting the angle of attack for the screed extensions may be different. Consult the Operation and Maintenance Manual for the screed you are using.



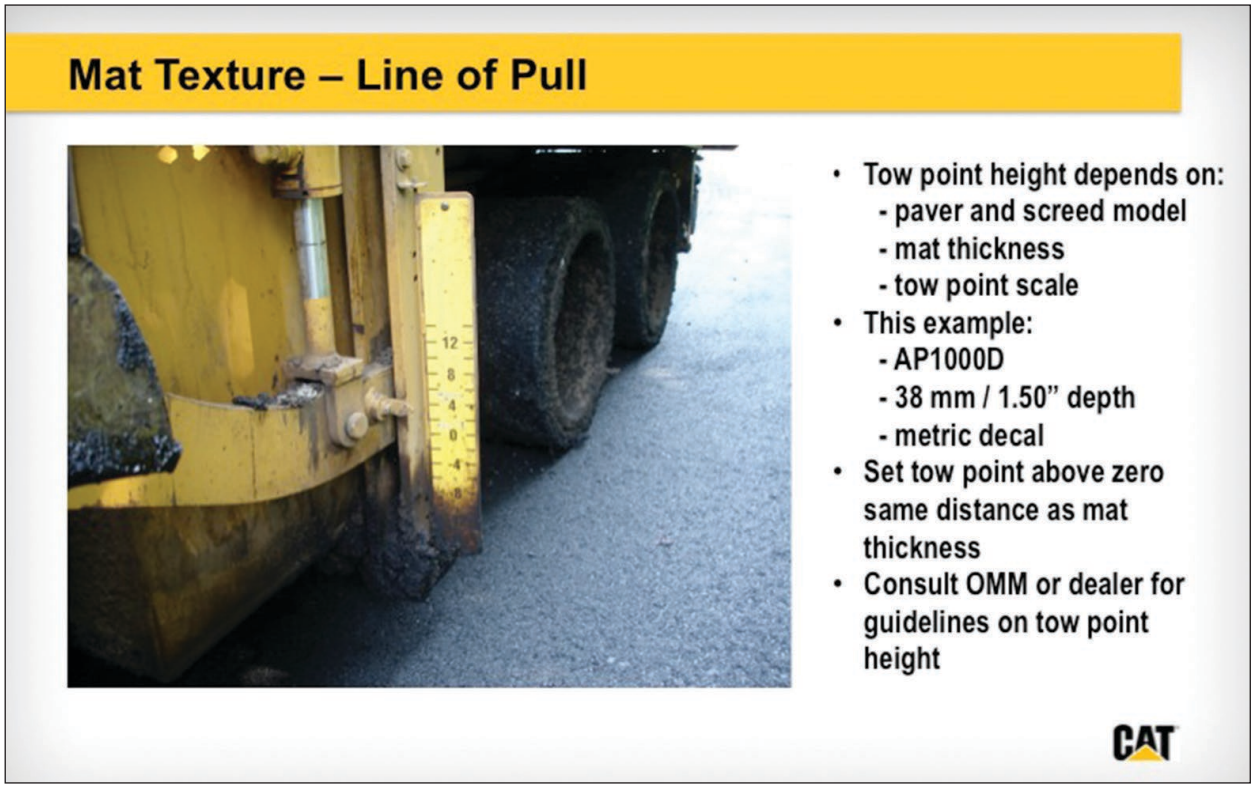
After adjusting the angle of attack on the left hydraulic extension and the two-foot bolt-on screed extension, the surface texture of the mat is uniformly tight across the width of the mat. Only the area behind the strike-off remains open and that condition is unavoidable.

Mat Texture – Line of Pull

- Relationship between tow point height and screed pivot point height
- Same height above grade creates parallel line of pull
- Slightly upward line of pull acceptable
- Helps screed maintain stable floating condition

CAT

Line of pull also can have an effect on mat texture. Line of pull is defined as the relationship between the height of the tow point and the height of the screed pivot point. The correct relationship occurs when these two points are at the same height above the grade being paved to create a parallel line of pull. It is also acceptable for the tow point to be slightly higher than the screed pivot point to create a slightly upward line of pull. When the line of pull is parallel or slightly upward, the screed can maintain a stable, nose-up floating condition.



The correct tow point height for any pull depends on the thickness of mat being laid down, the model of the paver and screed, and the decal that shows tow point height. In the example shown, the paver is a Cat AP1000D. The uncompacted depth specification is 38 mm (1.50”). For this paver model, the tow point should be set above the zero mark a distance equal to the thickness of the mat. Therefore, the tow point has been set just under the 4 cm (40 mm) mark on the tow point height scale.

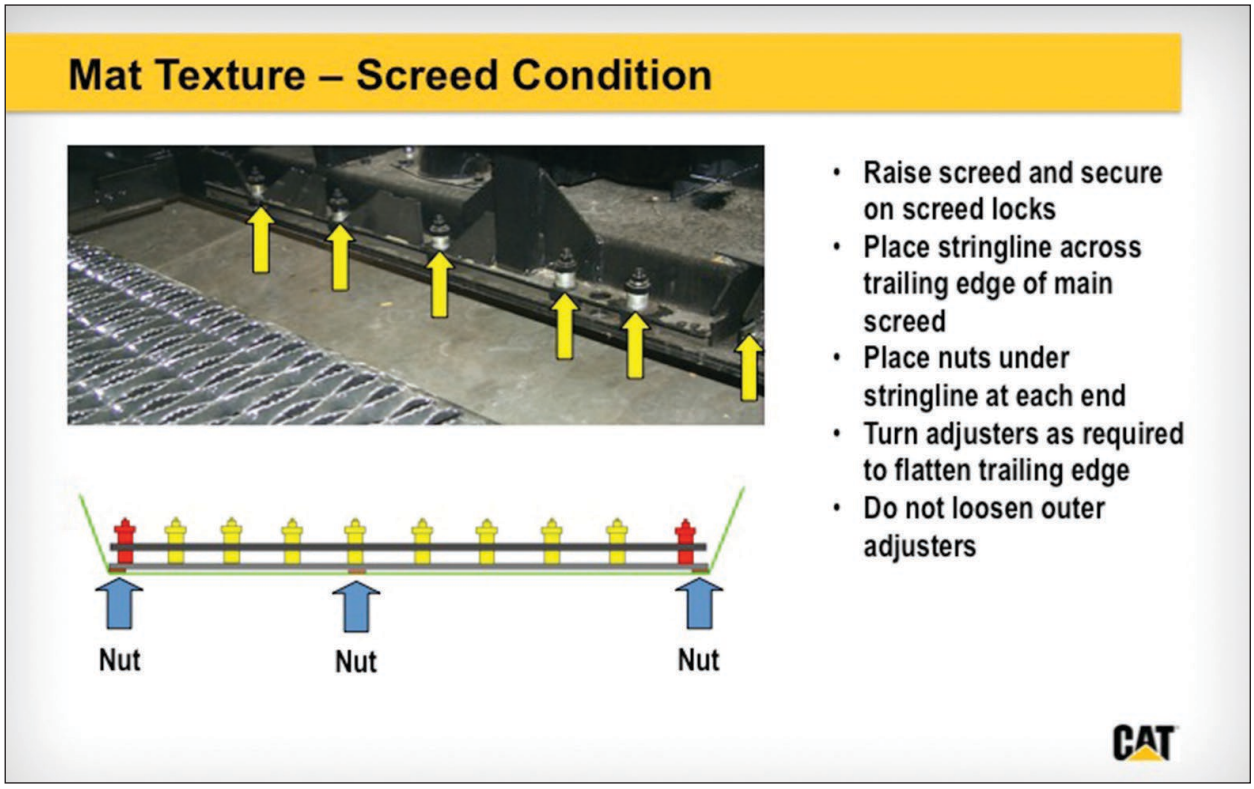
Consult the Operations and Maintenance Manual for the paver and screed you are using. Or, consult with your Cat Dealer for recommendations on tow point height.

Mat Texture – Screed Condition

- Condition of screed affects mat texture
- Texture striping indicates non-uniform pressure
- Check screed flatness

CAT

The condition of the main screed plate affects mat texture. When there is texture striping behind the main screed, that means the screed plate is exerting non-uniform pressure on the mat. You should check the flatness of the main screed and adjust, if necessary.



With screed raised on the resting on the screed locks, run a stringline across the trailing edge of the main screed plate. Place 13 mm (1/2”) nuts between the stringline and the screed plate at each end of the screed plate. Using another 13 mm (1/2”) nut, verify that the trailing edge off the main screed is flat. Do not touch the two outer adjusters.

Mat Texture – Screed Condition

- Verify that texture is uniform
- Try to duplicate conditions:
  - paving speed
  - mix type
  - mix temperature
  - base conditions

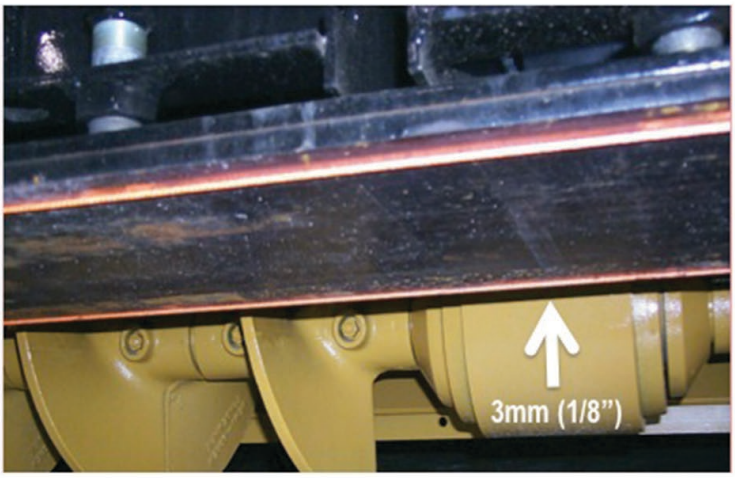
CAT

After adjusting the flatness of the trailing edge of the main screed, verify that texture is uniform and no longer open. To make the comparison realistic, try to duplicate all the conditions that existed when texture stripes were noted. Pave at the same speed, using the same mix design and the same mix temperature. If possible, make sure that grade conditions have no influence on the condition of mat.

Note: On this project, the texture striping disappeared after the trailing edge was flattened.

A texture stripe in the center of the mat can be caused by several things. One, it may indicate a need for lead crown in the main screed. Two, if the reversing augers or kicker paddles are worn or missing, there may a centerline stripe. Finally, the reversing augers or kicker paddles may be installed incorrectly for the application.

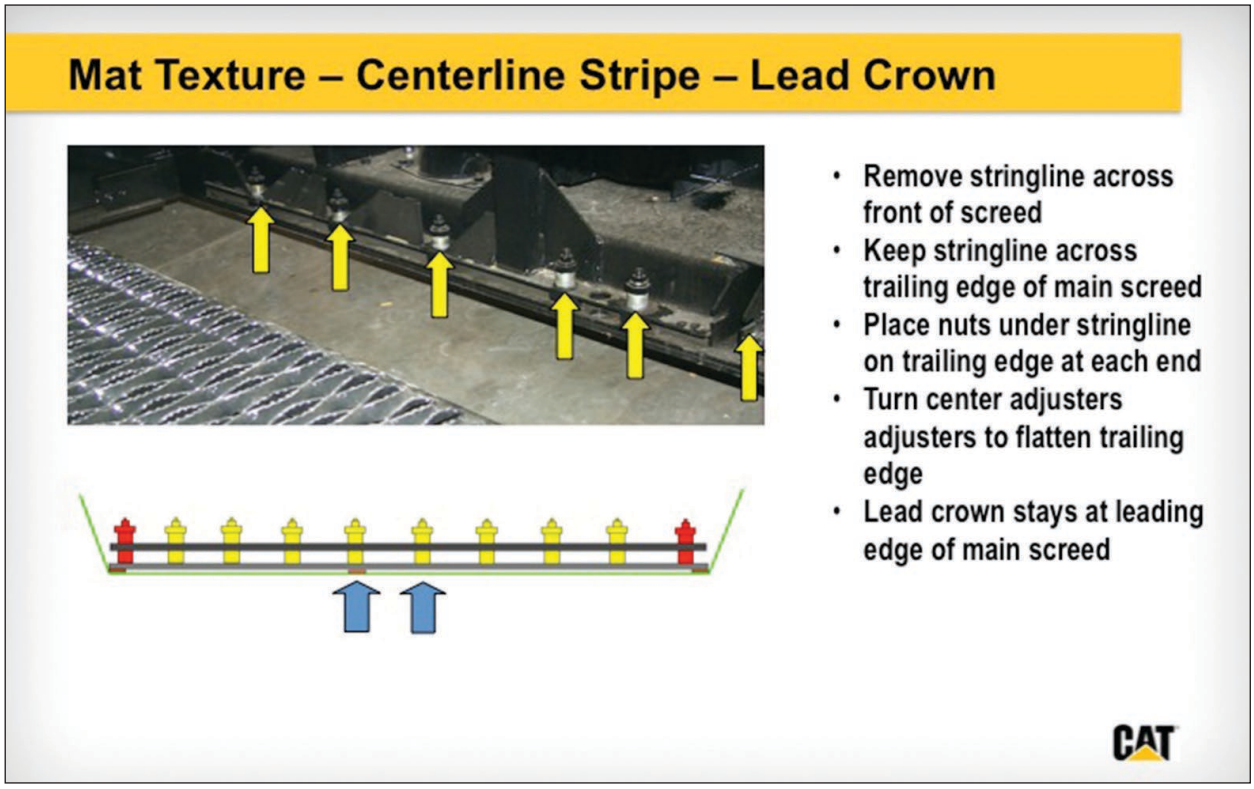
Mat Texture − Centerline Stripe – Lead Crown



- Place stringline on front and rear of main screed.
- Adjust main screed crown until 3mm (1/8") gap is present in center of main screed
- Helps large aggregate tuck under center of screed plate

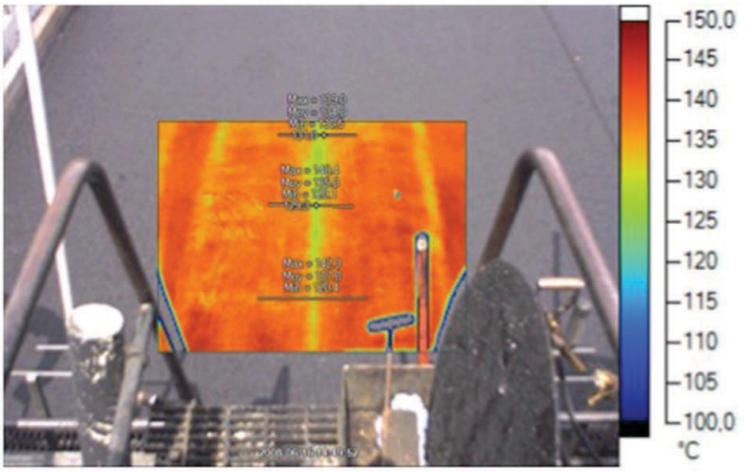
CAT

To install lead crown, place a stringline across the front and rear of the main screed. Using the power crown switch or manual crown adjuster, put in positive crown until a 1/8" gap is present in center of the main screed at the front and rear.



With screed raised on the resting on the screed locks, remove the stringline in the front. Keep stringline across the trailing edge of the main screed plate. Place 13 mm (1/2”) nuts between the stringline and the screed plate at each end of the screed plate. Using another 13 mm (1/2”) nut, adjust the center two adjusters until the center of the trailing edge is flat. The lead crown will remain at the front of the main screed plate.

Mat Texture – Centerline Stripe – Temperature Variation

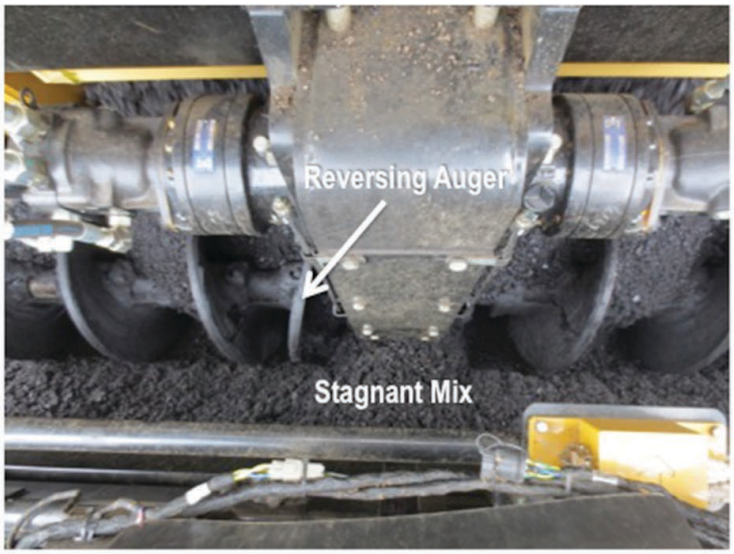


- Infrared image shows continuous cool centerline stripe
- Digital image does not show stripe
- Indicates “dead” area in center of auger chamber
- Inspect reversing or kicker paddles

CAT

Some Public Works Departments require that the temperature of the surface of the mat be measured and recorded. There is often a specification concerning the maximum temperature differential that is allowed. In this example, the infrared camera detects the much cooler centerline stripe that is not visible to the human eye. When continuous cold stripes are detected, it means there is stagnant material in this area. If material in this area is stagnant, examine the reversing augers or kicker paddles on the inner ends of the auger shafts.

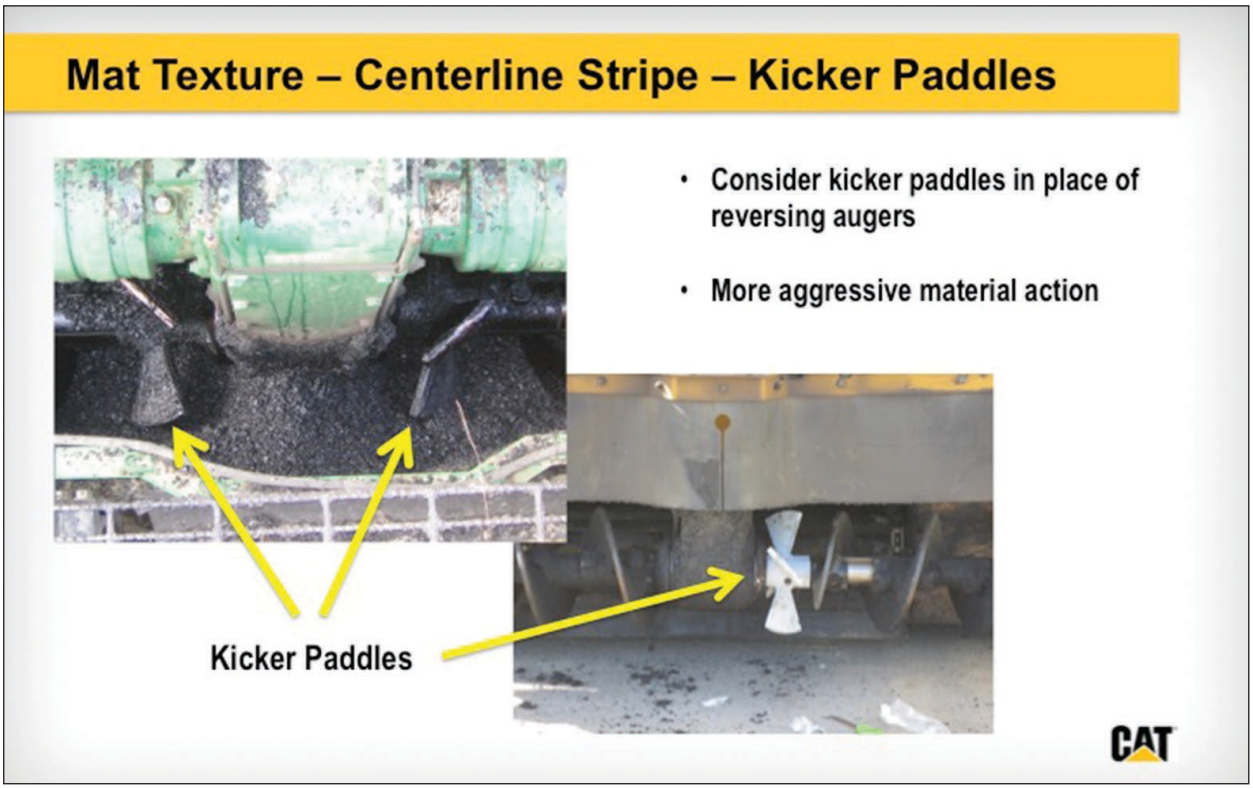
Mat Texture – Centerline Stripe – Reversing Augers



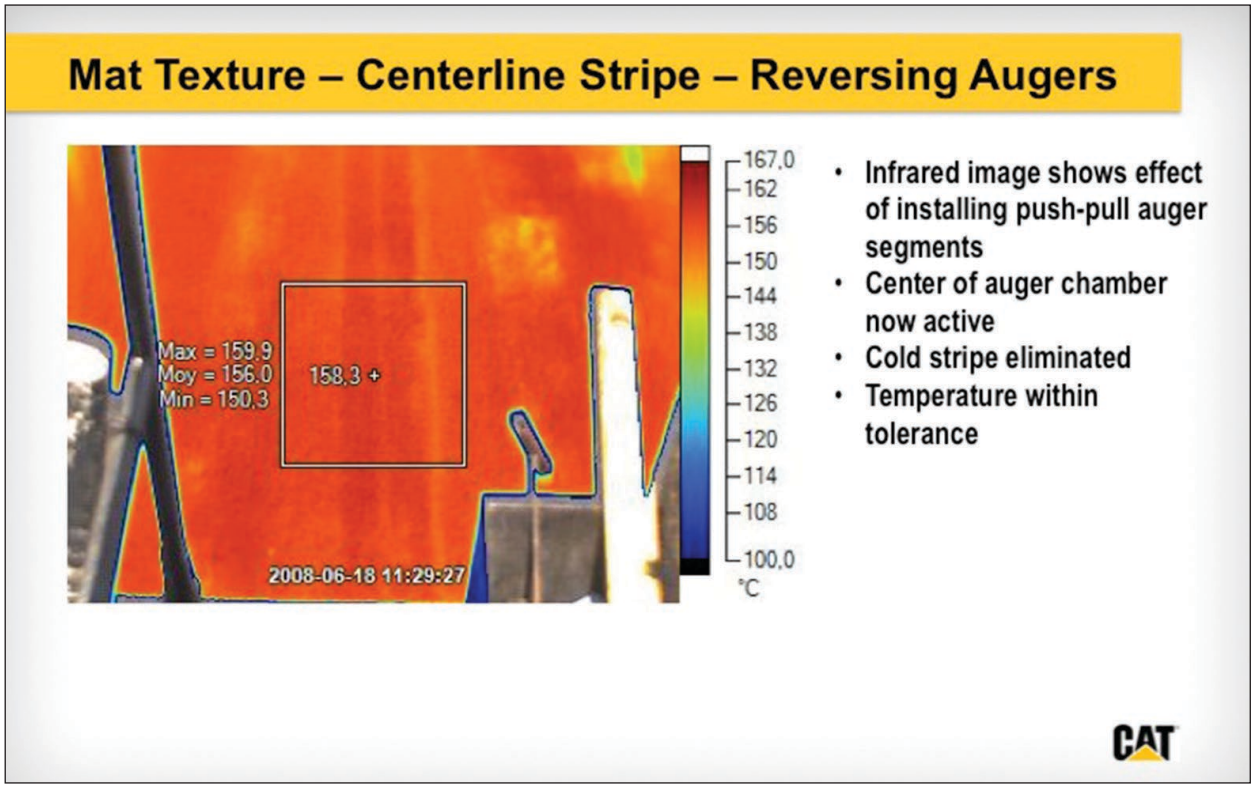
- Check condition of reversing augers
- Consider installing one "pull-type" reversing auger
- One auger segment pushing mix and one pulling mix will eliminate stagnant area

CAT

Verify that the reversing augers are not extremely worn, broken or missing. If both reversing auger segments are pushing mix toward the center under the chain case, install a "pulling-type" auger segment on the inner end of one auger shaft. Having one push-type and one pull-type auger segment will make the mix directly under and behind the center chain case more active.



There are other options available to help move material through the center of the auger chamber. Consult with your Cat Dealer about the availability of kicker paddles. Kicker paddles provide more action.



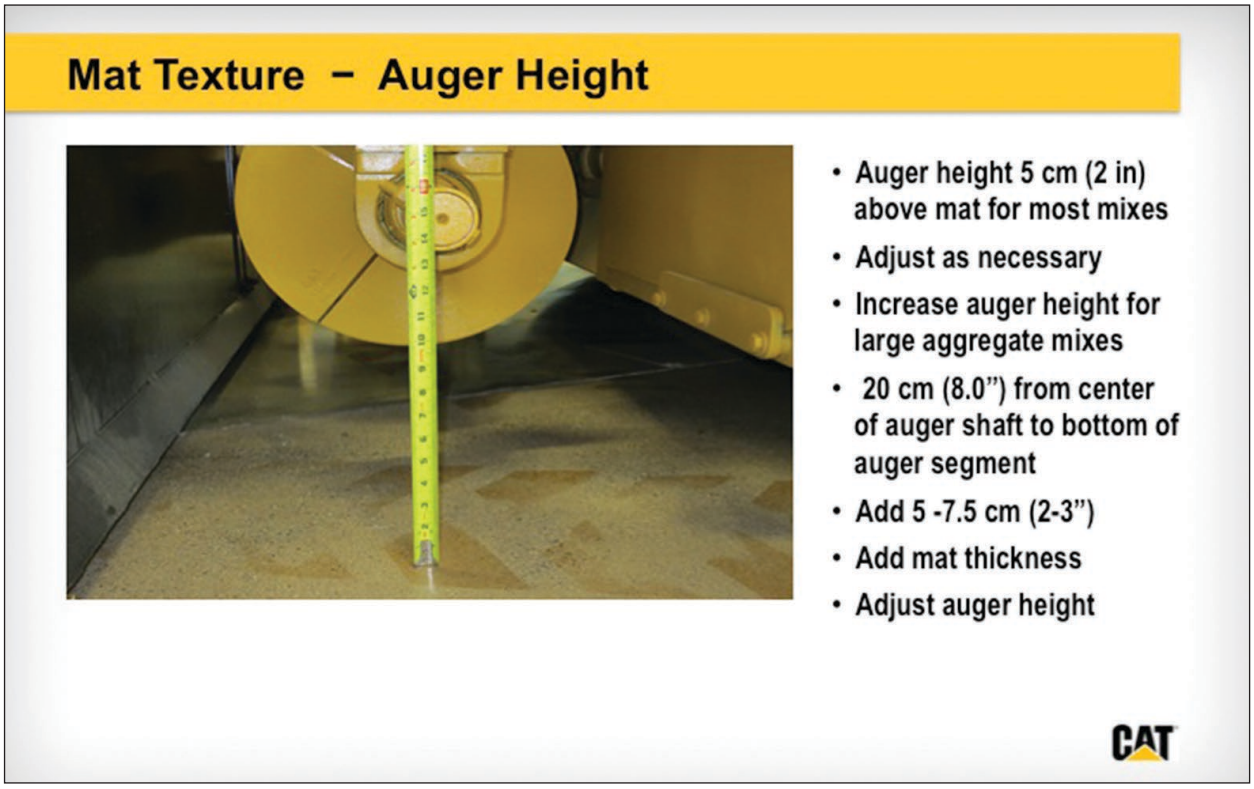
This infrared image shows the effect of installing one push-type reversing auger segment and one pull-type auger segment on the ends of the auger shafts. Now, with mix moving across the center of the auger chamber, the surface temperature of the mat in the center is hot and uniform with the rest of mat.

Mat Texture – Auger Shadows

- Texture stripes appear directly behind the augers
- Especially common when mix has large aggregates
- Raise augers until mat is tight and uniform

When the auger height is too low, it is common to see two texture stripes in the mat directly behind the right and left augers. This is particularly true when paving with a base course mix that usually has large aggregates. As the augers are turning, large aggregates may be left near the surface of the mat if the augers are too low.

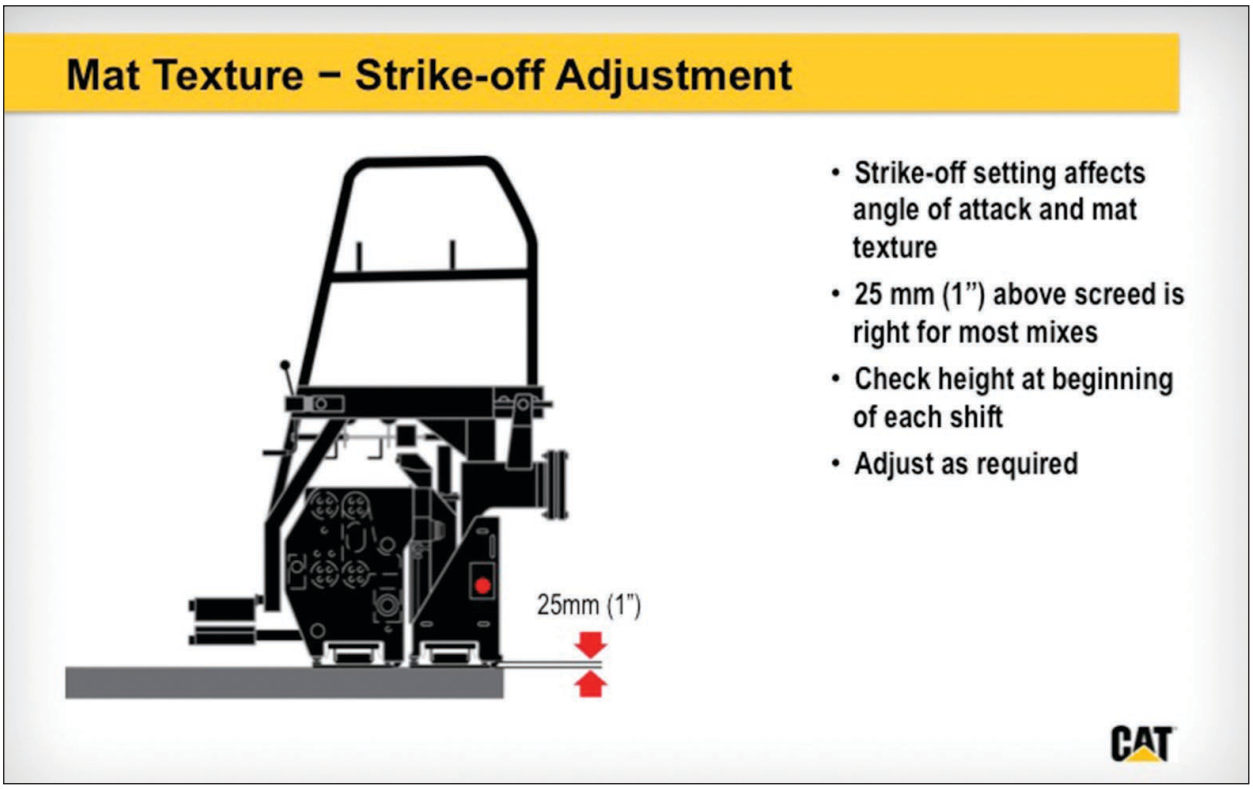
To tighten up the mat surface, raise the augers in small increments until the surface of the mat is tight and uniform in appearance.



At the start of paving, set the auger height so the augers are about 5 cm (2.0”) above the surface of the uncompacted mat if the mix has aggregates up to 12.5 mm (1/2”). Increase auger height when paving with mixes that have aggregates that are 19 mm (3/4”) or larger.

From the bottom of the auger to the center of the auger shaft is 203 mm (8”). Now add 50 mm (2”) to that. Then add the thickness of mat to be paved. The total is the distance from the centerline of the auger shaft to the grade. Adjust the auger up or down until the dimension is reached.

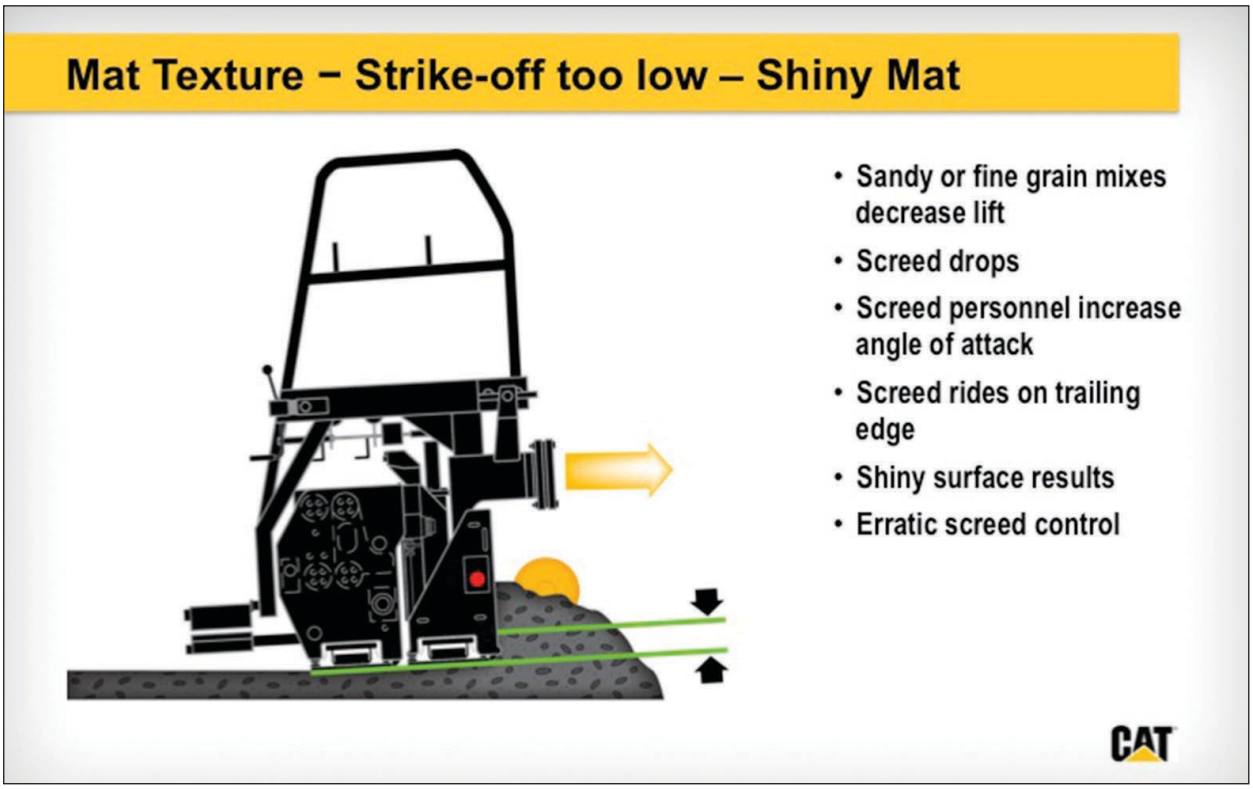
Fine tune the auger height after paving starts if the mix is very coarse or very tender.



The position of the strike-off that is located in front of the main screed plate on some screeds affects the angle of attack and consequently the texture of the mat. The strike-off is adjustable and, for most mix designs, a setting that is 25 mm (1”) above the screed plates works well. Check the height of the screed at the beginning of each paving shift and make adjustments depending on the texture of the mat being placed.

Large stone mixes tend to create more lift under the screed and the screed rides up. In an effort to compensate for the added lift, screed personnel have to decrease the angle of attack, either manually through depth cranks or automatically through tow point control. In other words, they force the screed to ride on its nose. The open texture is created because only a portion of the screed plate is finishing the mat surface.

To overcome the added lift, the correct procedure is to lower the strike-off. With less of the nose bar exposed, lift is reduced and the screed should run at the correct angle of attack and maintain mat thickness and texture.



If the strike-off is set too low for a particular mix design, not enough lift is created. Sandy or fine grain mixes which don't support the weight of the screed may create this condition. To compensate for lack of lift, screed personnel increase the angle of attack and the screed runs on the trailing edge. You may see a tight, shiny surface and the screed may act erratically. You may also observe excessive wear on the trailing edge of the screed.

The correct procedure is to raise the strike-off to allow more mix to pass under the nose bar. With added lift, the screed will run at the proper angle of attack and the mat surface will improve.

Mat Texture – Cold Screed

- Mix sticks to cold screed plate
- Creates very open texture
- Screed drops
- Pick up, heat screed and re-start OR
- Repair low spot while screed rests on hot mat to warm up.

CAT

When any portion of the screed plate is significantly colder than the mix passing under the screed, mix will adhere to the screed plate and you will see areas of the surface that are very open. Also, the screed will begin to go down and mat thickness will be too thin.

Stop paving when you observe this condition. You may have to pick up the screed and re-start after the screed has reached the proper operating temperature. Or, you can repair the low spots on the mat while the screed rests of the mix in order to heat the screed plate to the point where mix no longer sticks.

Mat Texture – Separation Marks – Extension High

- Continuous lines mean height mismatch between main screed and extension
- Lined up with outer edge of main screed, extension too high
- Lower extension to erase line

CAT

There may be continuous lines in the mat that are caused by a height mismatch between the main screed plate and one or both of the extension screed plates. If the line is in alignment with the outer edge of the main screed, then the extension is too high. Using the extension height switch, lower the extension until the line disappears.

If the line is in alignment with the outer edge of the main screed, then the extension is too high. Using the extension height switch, lower the extension until the line disappears. If the line re-appears behind the outer edge of the main screed, there may be incorrect slope in the extension. Use the slope extension switch to remove the line. At the first opportunity, check to position of the extension slope stop to prevent continuous problems with slope height.

Mat Texture – Cold Sticky Mix

- Mixes with modified AC pull apart at low temperature
- Can occur end of load between trucks, OR
- Long hauls cold ambient, OR
- Plant output temperature too low
- Increase plant out temperature, if possible

CAT

Mix designs that contain asphalt cement that is heavily modified with polymers or latex are stiff even at high temperatures. These "sticky" mixes tend to adhere to all parts of the paver that transfer or form the mix. When the mix cools below its optimum laydown temperature, you may see torn, open spots show up randomly in the surface of the mat. In the example shown, the mat temperature was 270 degrees F. Normally, the mix passed under the screed around 290 degrees F. During truck exchanges the operator let the mix in the hopper run too low. Also remember that on cold days, there may be a lot of heat loss in the haul units. An increase in the plant output temperature may be the best alternative when heat loss is contributing to mat defects. Certainly don't allow the hopper to run low between trucks.

By the same token, mix designs that contain asphalt cement that is heavily modified with polymers or latex are prone to tearing, or pulling apart, at high paving speeds. These sticky mixes may need more time under the compressive force of the screed to keep a tight surface. Even though it means lowering production somewhat, you'll need to slow the paving speed gradually until the texture of the may is acceptable. Increasing the frequency of the screed vibrator brings fines to the surface and helps close up the surface texture. Screed heat may help in some situations – particularly during short stops between truck exchanges.

In this instance, the crew was laying down a very sticky wear course mix to a depth of 32 mm (1.25") while paving 15 m (50') per minute.

Mat Texture – Sticky Mix – Paving Speed Lowered

- Paving speed lowered by 30%
- Open texture eliminated
- Lower speed better matched production rate
- Better density as well

CAT

The crew reduced the paving speed gradually from 15 m (50’) per minute until the appearance of the mat was acceptable. There was a 30% reduction in paving speed down to 11 m (35’) per minute. In reality the lower paving speed was more in line with the production rate on this project. Plus, the lower speed made it easier for the breakdown compactor to stay close to the paver and, consequently, density improved.

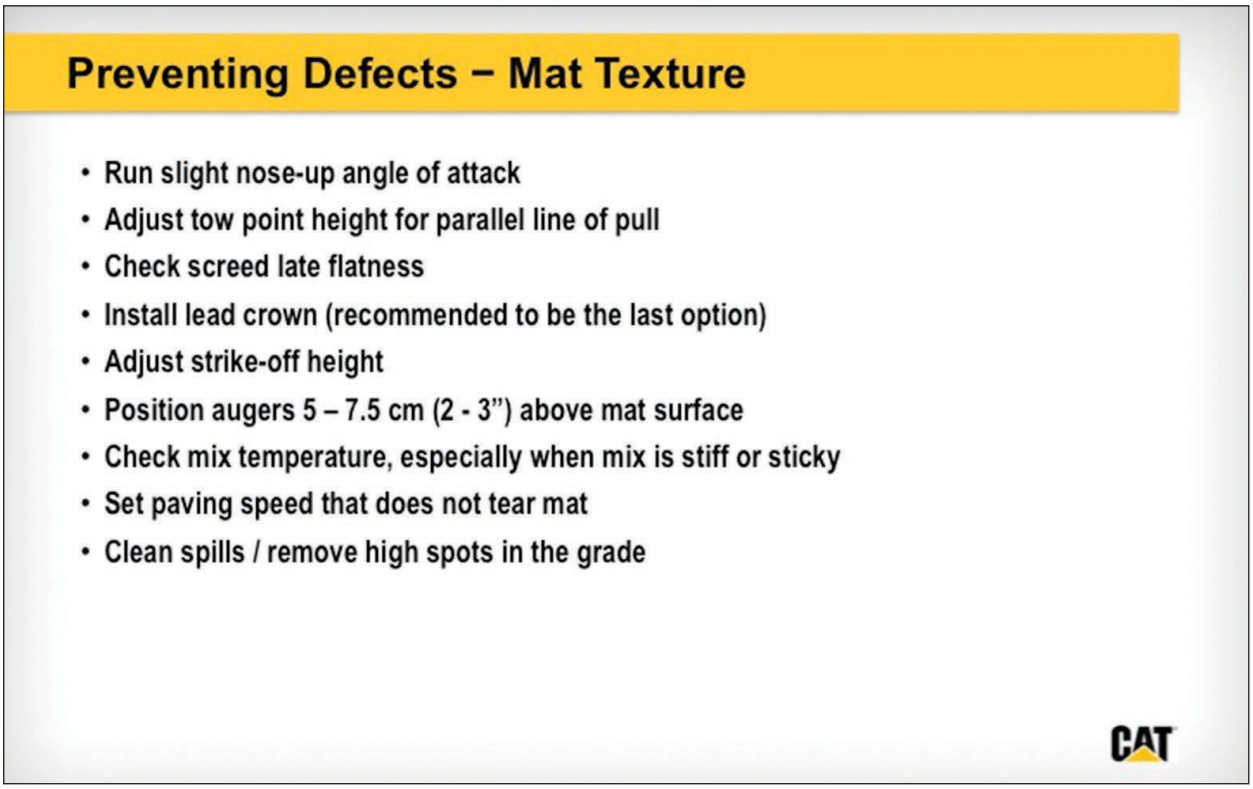
Mat Texture – High Spots & Spills

Spills on grade

Drag Marks

- Mix spilled on grade acts like high spot
- Screed drags cold mix
- Texture opens
- Smoothness & density suffer
- Clean all spills!

CAT



In summary, there are many factors that can cause defects in mat texture. Troubleshoot mat texture issues by checking and adjusting:

- Angle of attack
- Tow point height
- Screed condition
- Lead crown
- Strike-off height
- Auger height
- Mix temperature
- Paving speed
- Base conditions

"Segregation" as a term used in the asphalt paving industry is often defined as the lack of uniformity of the main constituents of hot mix or warm mix asphalt – aggregates, asphalt cement and air voids. The presence of segregation indicates that there will be a high possibility of accelerated pavement distress.

In general, there are three types of segregation:

- Patch segregation that occurs in a repetitive fashion
- Stripe segregation that is continuous
- Patch or stripe segregation that occurs randomly
-

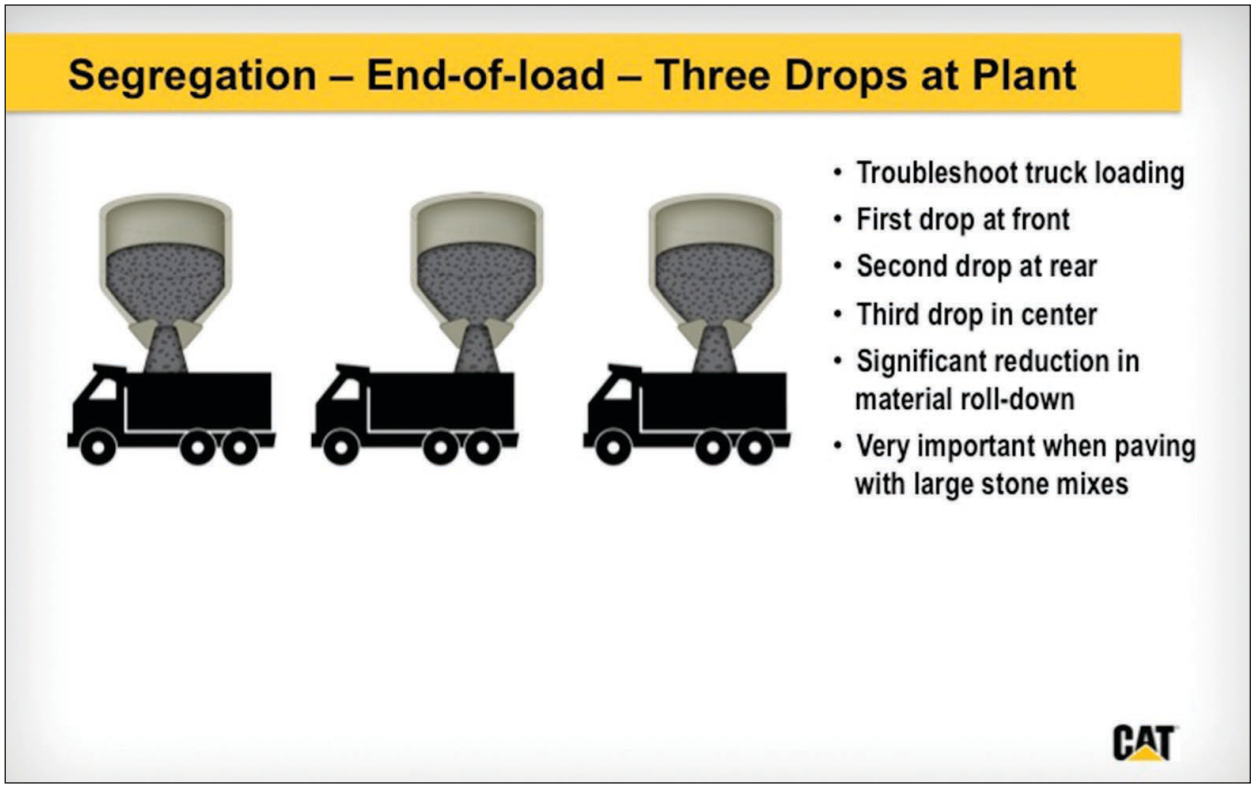
Aggregate segregation may also include what is commonly referred to as temperature differential, which simply means that the segregated areas of the in-place material have lower temperatures that contribute to density problems.

Segregation – End-of-Load

- Usually appears as equally spaced pattern
- Often has chevron shape
- Most common when aggregates are 19 mm (3/4”) or larger

CAT

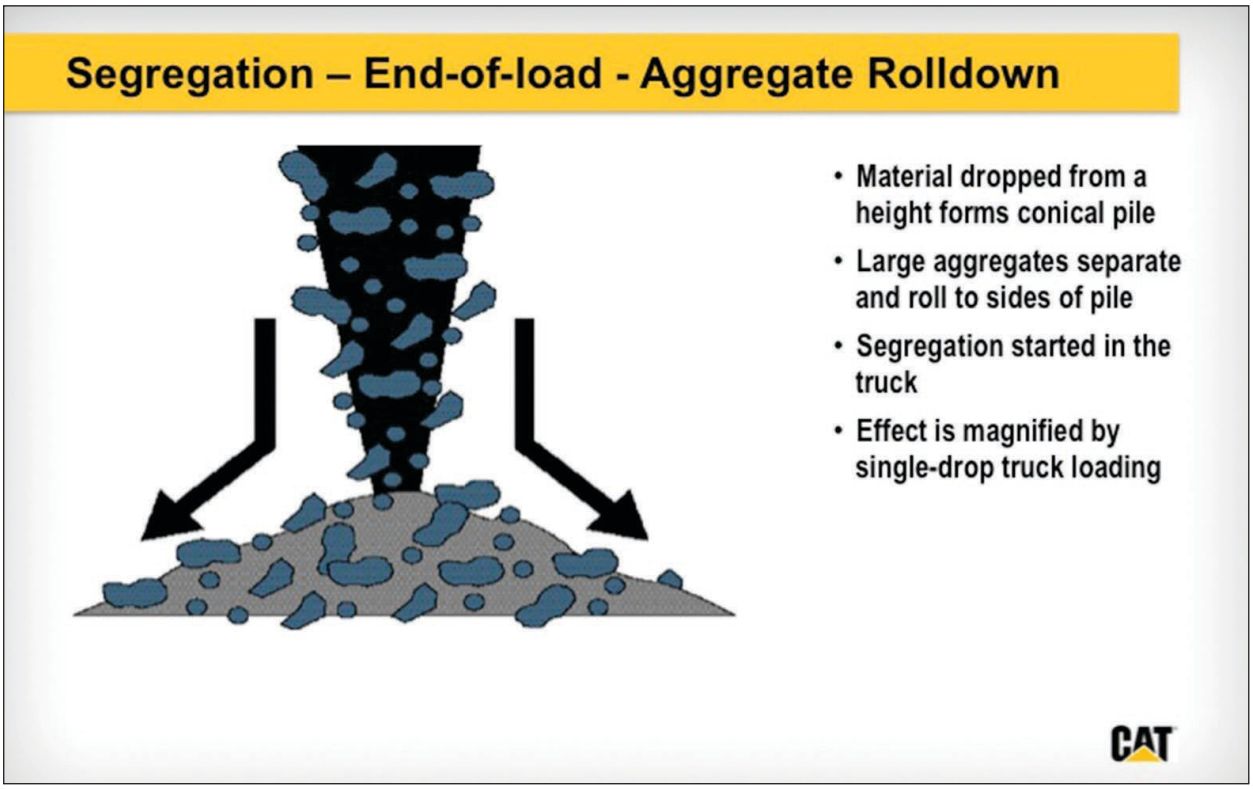
What is commonly called end-of-load segregation usually appears as a pattern of chevron-shaped patches. The length of the pattern is the distance that one truckload of material will pave. The patch is normally confined to the area of the mat where a truck exchange has occurred. Although you may see end-of-load segregation when using any type of mix, it is most common with large stone mixes that have aggregates 19 mm (3/4”) or larger.



One way to reduce end-of-load segregation is to make sure that trucks are loaded by a three-drop method at the plant. For the first drop, the truck should be positioned so mix fills the front of the truck bed. The front wall of the bed helps confine the mix so a conical pile is not formed. For the second drop, pull the truck ahead so the mix falls into the rear of the bed. Now, the tailgate is the vertical barrier that prevents the conical pile. Finally, move the truck back slightly so the third drop is in the center of the bed. The first and second drops help confine the third drop and there will be much less roll-down of large aggregates.

The three-drop procedure is especially important for mix designs that have a large amount of aggregates 19 mm (3/4") and larger. Fine mixes are less prone to segregation, but the three-drop method is still recommended.

If segregation is not occurring during the truck loading process, continue to troubleshoot.



When asphalt is discharged continuously from a considerable height into any container (like a truck bed), it forms a conical pile. The larger aggregates in the mix tend to roll faster and farther down the sides of the pile than the smaller aggregates and fines. The large aggregates will accumulate in pockets at the sides, the front and the back of the container. When the container is dumped, these pockets of large aggregate will show up as segregation patches. The accumulation of large aggregates at the sides of the load is magnified when single-drop truck loading is used.

Segregation – End-of-load – Truck Bed

- Pockets of large aggregates at ends and sides of truck beds
- Keep bed raised to minimize additional rolldown

CAT

When mix starts to come out of the truck bed, you will notice that larger aggregates have accumulated as pockets at the ends and sides of the truck bed. By keeping the bed raised at a fairly steep angle, you can minimize the tendency of the larger aggregates to break free (more segregation) and form pockets in the paver's hopper. In other words, try to keep a surge of mix out of the truck bed and prevent the hopper from running low on mix.

Segregation – End-of-load – Segregation in Hopper

- Large aggregate accumulates at sides of hopper
- Prohibit folding hopper wings
- Keep conveyors full during truck exchange
- Shovel out hopper sides occasionally

CAT

Whenever you see pockets of large aggregates at the sides of the paver's hopper, stop folding the hopper wings during truck exchanges. Keep the conveyors full of mix during truck exchanges. If you run the conveyors empty, or even low, you run the risk of transferring segregated mix from the truck bed directly into the empty conveyors. Then, the segregation will move directly back to the auger chamber without the chance to blend with some existing mix in the hopper. To help open the tailgates of trucks during exchanges, you will have to shovel out some of the mix at the front of the hopper periodically.

Segregation – End-of-load – MTV Remixing

- Some MTVs have remixing capability
- Surge capacity with mixing augers or paddles
- Blend segregated mix prior to discharge into hopper or insert
- Specified on some projects

CAT

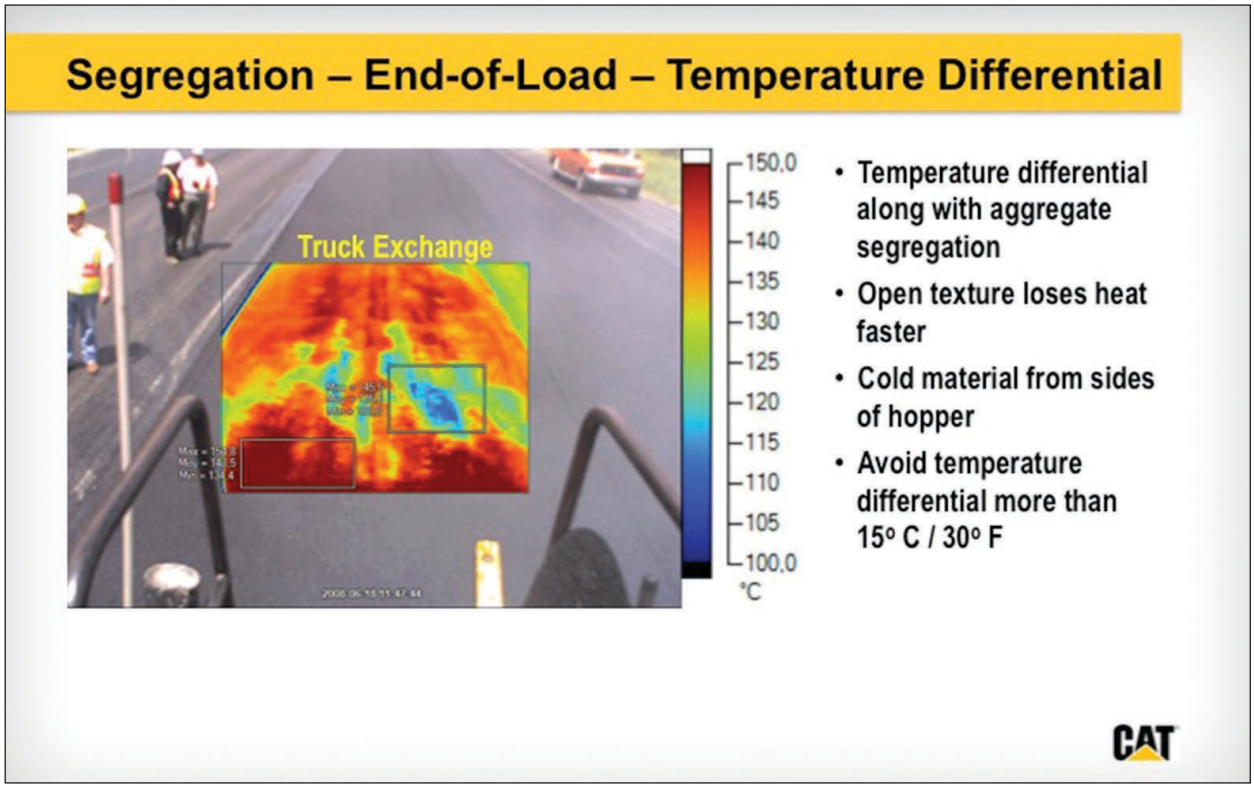
Another proven way to reduce end-of-load segregation is the use of Material Transfer Vehicle (MTVs) with remixing capability. Many MTVs have mix storage capacity that includes remixing augers and paddles. Even if the mix is segregated in the truck bed, it is likely that a remixing MTV will combine the segregated mix to a certain degree before discharge into the paver hopper or hopper insert. Some public works departments specify the use of MTVs on certain types of projects. Always refer to project specifications when choosing the equipment for a project.

Segregation – End-of-Load – MTV Blending

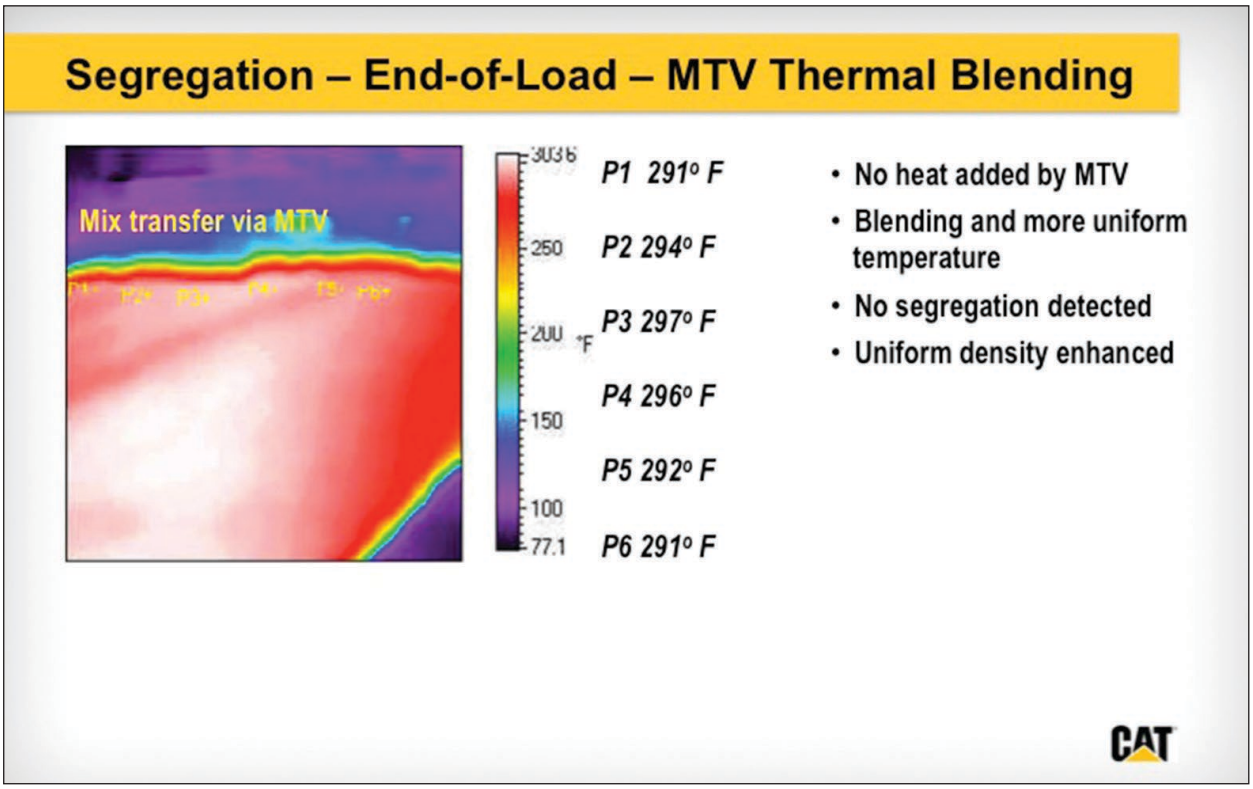
- Pattern segregation minimized
- Highly recommended for large stone mixes and SMA

CAT

The use of MTVs with remixing capability helps minimize end-of-load, pattern segregation. Their use is highly recommended when paving with large stone mixes and Stone Matrix Asphalt (SMA). This view shows a large portion of an SMA wear course laid down using an MTV with remixing capability. Note lack of segregation at any point.



End-of-load segregation is often accompanied by large temperature differentials (temperature differential) in the surface of the mat. Heat loss is more rapid due to the open texture of the segregated area plus the segregated material comes from the sides of the hopper where there is more heat loss. Some public works departments now have specifications regarding temperature differential. In general, for uniformity of density, agencies like to see the temperature differential less than 15 degrees C, or 30 degrees F.



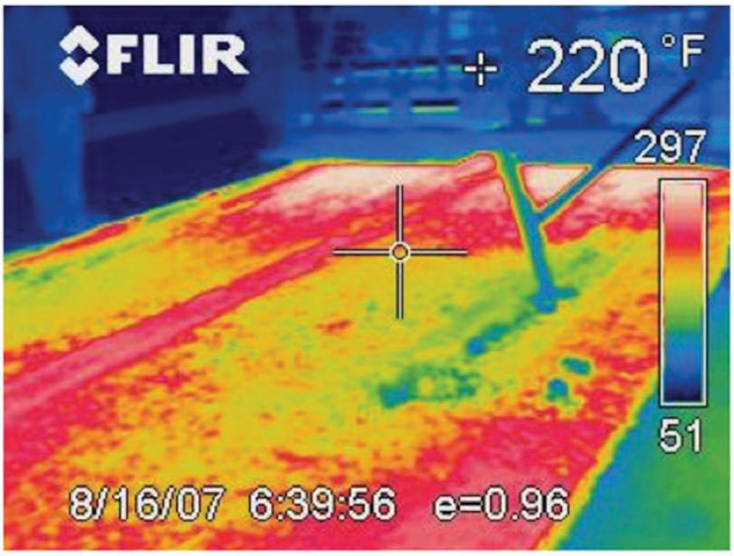
MTVs do not add heat to the mix as it is being transferred, but most MTVs do provide blending for more uniform heat and, consequently, a better opportunity for uniform density during the compaction process. Notice in this example, there is very little temperature differential from edge to edge and there is no patch or stripe segregation detected by the infrared camera. Uniform temperature in the asphalt layer is one of the big advantages to the use of MTVs.

Segregation – End-of-Load – Cold Chunks

- Cold weather and long hauls may cause cold chunks
- MTV will re-mix and break up chunks
- Lower flow gates, if equipped
- Cover loads
- Insulated beds

When the ambient temperature is low and haul units have to travel a long distance to the job site, you may see agglomerations of hot mix (cold chunks) as part of the load. Without the use of an MTV with remixing capability, there is little that the crew can do to prevent these chunks from passing through the paver feeder system. If the paver is equipped with flow gates at the rear of the hopper, lower the flow gates to help break up chunks or prevent them from entering the auger chamber. Make sure that loads are covered. You can also ensure that haul units have insulated beds to help prevent chunks from forming.

Segregation – End-of-Load – Cold Chunks



- Chunks dragged by screed
- Large cold areas
- Low density
- Poor ride quality
- Chunks likely to 'pop out'

CAT

Cold chunks will normally be dragged by the screed and create large areas of open texture and cold mix. These large temperature differentials lead to low density and poor ride quality.

Segregation – End-of-Load – Cold Chunks

- Lots of hand work to remove chunks and repair the mat
- Consider putting laborers at each end of the auger chamber
- May be able to shovel out chunks before going under screed

CAT

There will be substantial amounts of hand work required to remove chunks and repair the mat. Continuing to pave when cold chunks are passing through the paver may seem like the only answer, but you may be able to remove the majority of the chunks from the auger chamber before they pass under the screed. To do so, position a laborer in front of each screed extension, lower the paving speed and allow the laborer to shovel out chunks that are detected.

Segregation – Random Patch

- Appears in the mat without pattern
- Comes and goes
- Difficult to pin down
- Usually paver operation related and with large aggregate mixes

CAT

Random patch segregation appears, as the name implies, without pattern in the asphalt layer. Because this type segregation comes and goes, it can be difficult to troubleshoot. Random segregation can be associated with the loading of trucks at the plant, but usually you'll need to do most of your investigation on the paver itself.

Segregation – Random Patch – Hopper / Insert Level

- Check level of mix in hopper or insert
- Large aggregates roll to the sides when dropped form conveyor
- Keep insert at least half full when paving with large stone mixes

CAT

A good place to start is looking at the level of mix in the hopper, or especially in hopper insert, if you are loading the paving with an MTV. Remember, when you discharge mix from the conveyor into the hopper insert, larger aggregates will roll to the sides of the insert of the hopper. You want to keep the insert at least half full if you're paving with 19 mm (3/4") or larger aggregates.

Segregation – Random Patch – Insert Low

- Large aggregates accumulate on sides as level drops
- Center empties first
- Segregated, large aggregates empty last
- Stop paving
- Wait for more mix
- Do not empty hopper / insert
- Do not empty MTV

CAT

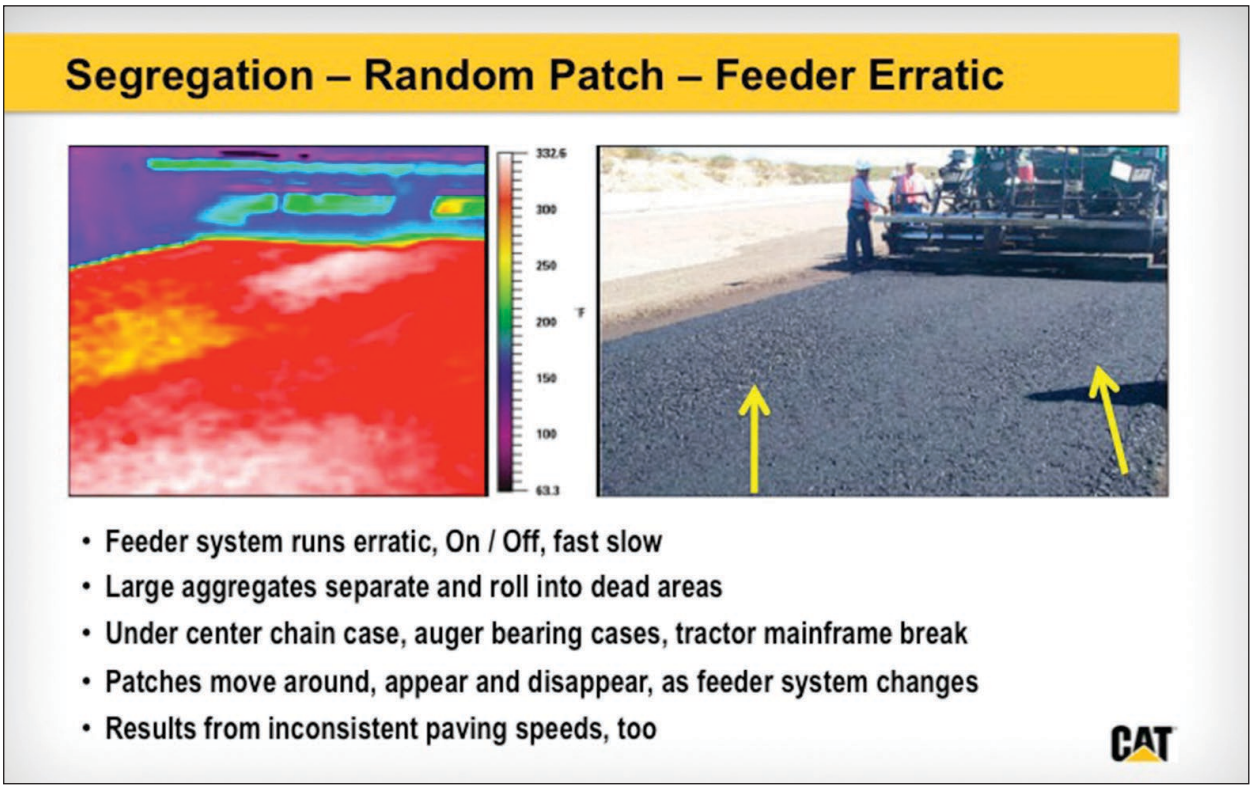
As the level in the hopper insert drops, more and more large aggregate accumulates. The center of the insert with blended mix empties first. The large aggregates on the sides are the last items out of the insert. You are better off stopping and waiting for more mix than continuing to pave out all the mix on the insert. Also, you should not pave out the surge capacity in the MTV when paving with large aggregate mixes. The last portion out of the MTV will also be segregated. For example, if you are required to empty an MTV prior to crossing a bridge or overpass, discharge the last of the mix into a truck and salvage that mix later. Don't run the last of the mix from the MTV through the paver.

Segregation – Random Patch – Drop Height

- Discharge into hopper or insert from low height
- Low height means less velocity
- Aggregates do not roll as much
- Segregation reduced

CAT

As you load the hopper or insert from any type material transfer device, keep the drop height as low as possible. By reducing drop height, you reduce the velocity of mix entering the insert or hopper and the aggregates do not roll as easily. Segregation in the insert is therefore reduced.



When the feeder system runs erratically, fast and slow or On and Off, random patches of segregated mix are likely to show up in the mat. The feeder system should run consistently at the same speed. If the augers turn erratically, large aggregates tend to separate from the mix and roll into dead areas such as under the center chain case, or under the auger bearing cases or around the break of the tractor mainframe. Depending on the speed of auger rotation and the feeder system irregularity, the patches of segregated mix move around and appear at random.

Erratic feeder system operation can simply mean that the feeder controls are not adjusted properly. But, don't forget the effect of paving speed on the feeder system. If the paver operator changes paving speed frequently, the screed operators will have to adjust the feeder system. Failing to do so will result in random segregation.

Segregation – Random Patch – Sensor Position

- Important troubleshooting step
- Re-aim sonic feeder sensor
- Major factor in feeder system problems

CAT

If you are having a hard time adjusting the feeder system controls to make the augers run smoothly, try re-aiming the sonic feeder sensors. If the sonic sensor is not aimed properly, some of the sound pulses may not echo back to the sensor and the feeder system will run erratically. Re-aiming the sonic feeder sensors should be your first step in troubleshooting erratic operation.

Segregation – Random Patch – Sensor Position

- Place 45 cm (18”) rule adjacent to sensor
- Move sensor until rule is touching mix coming off the front of the auger
- Adjust mix height dial to control height of mix
- Adjust conveyor speed to control auger RPM

CAT

The feeder sensor should be aimed at the active, moving head of material coming off the front side of the augers. Use a folding rule or tape measure to help you aim the sensor. Extend the rule out 45 cm (18”) and place it adjacent to the sensor. Loosen the sensor and move the sensor until the end of the rule is touching the mix that is coming off the front of the auger shaft. Then, adjust the mix height dial (sensitivity dial) until you have the head of material at the height you want. Check to make sure that the augers turn steadily in the range of 20 to 40 rpm. Have the operator adjust conveyor speed if needed to get the augers to turn at the correct speed.

A continuous segregation stripe is easy to confuse with a texture stripe. Both blemishes have an open texture. However, close examination should reveal a preponderance of large aggregates to differentiate segregation stripes from texture stripes. Segregation stripes are almost always caused by feeder system operation or techniques associated with paving widths.

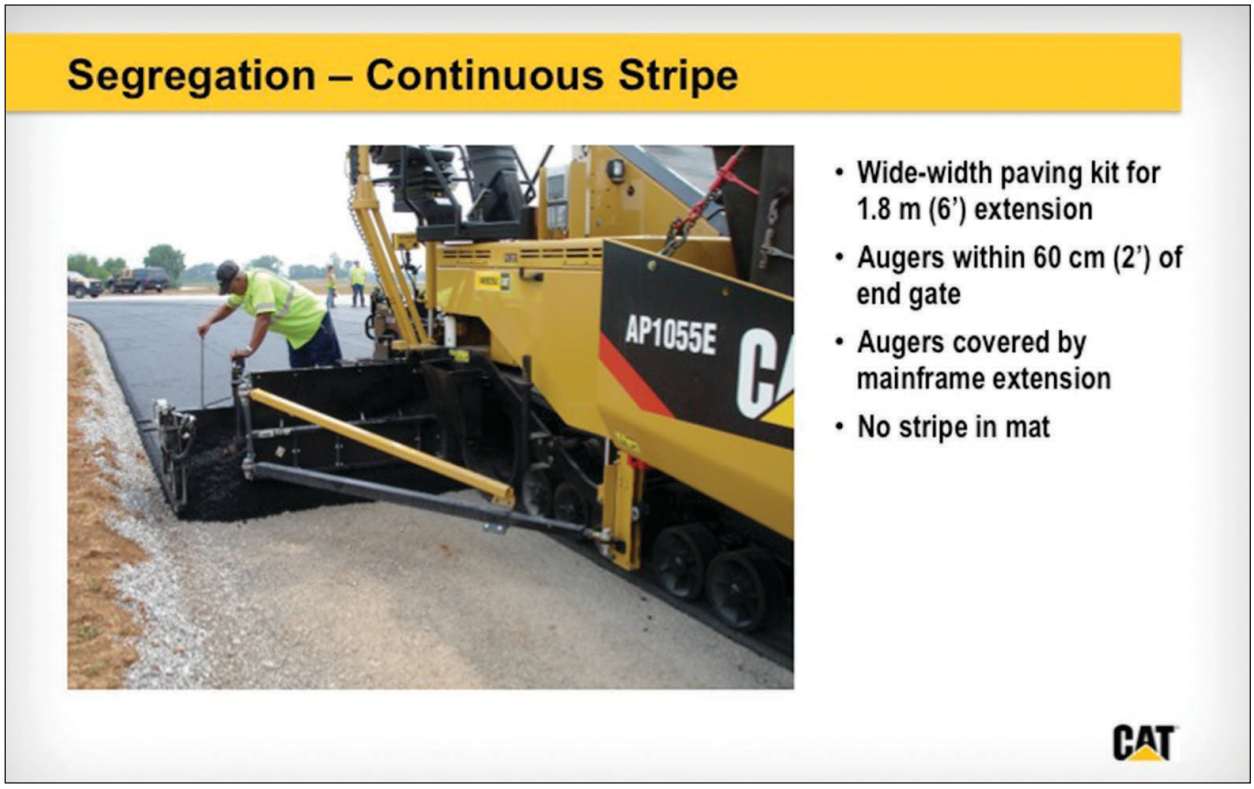
To troubleshoot stripe segregation, follow the stripe to its source at the paver.

Segregation – Continuous Stripe

- Place 45 cm (18") rule adjacent to sensor
- Move sensor until rule is touching mix coming off the front of the auger
- Adjust mix height dial to control height of mix
- Adjust conveyor speed to control auger RPM

CAT

In this example, the stripe in the right side of the mat aligns with the right edge of the tractor mainframe that forms the front of the auger chamber. The right screed extension has been moved out almost 1.80 meters (6'). Two auger segments have been added – not nearly enough for this paving width. No mainframe extensions have been added. There are two major mistakes. One, there should be at least one meter (3') of auger extension added for this paving width. Two, the auger extensions must be covered in the front by mainframe extensions. Lack of augers and no mainframe extension causes the crew to overload the area in front of the right extension. Mix rolls forward continuously around the mainframe because it's not contained. The big aggregate separates as it rolls around the break. That's causing the stripe in the mat.



Here is another example of a paver set up to pave with the right extension pulled out 1.80 meters (6”). The crew has installed the correct wide-width paving kit. The augers extend out to within 60 cm (2’) of the end gate and the augers are completely covered by mainframe extensions. The mat behind the right side of the paver shows no striping.

Segregation – Continuous Stripe

- Place 45 cm (18") rule adjacent to sensor
- Move sensor until rule is touching mix coming off the front of the auger
- Adjust mix height dial to control height of mix
- Adjust conveyor speed to control auger RPM

CAT

A closer view of the end of the right extension illustrates how the proper set-up has helped the crew and enhanced may quality. Note that the head of material is exactly one-half auger at the end of the auger shaft. Note that the sonic feeder sensor is aimed perfectly at the moving head of material coming off the front of the auger shaft. Consequently, there is no mix rolling forward around the end of the mainframe extension and there is no segregation.

Segregation – Continuous Stripe

- Left extension out 60 cm (2')
- Mix rolling around mainframe break
- Left extension was retracted from wider width
- Mix trapped between end gate and main screed
- Need to shovel out "dead" area

CAT

Even at narrower paving widths, you may sometimes see a segregation stripe aligned with edge of the tractor mainframe. In this instance, the left screed extension is only out about 60 cm (2'). But, there is still large aggregate rolling forward at the mainframe break. The cause of the rolling aggregate is the trapped mix between the end gate and the side plate of the main screed. Mix was trapped in this location when the left extension was brought in to a narrower paving width. To make this area "live" and let mix flow normally out to the end gate, it is necessary to shovel out the trapped mix.

Segregation – Continuous Stripe

- Centerline stripe
  - conveyor speed too high
  - auger speed too low
  - anti-segregation kit missing

CAT

Centerline segregation can have several causes. First, the speed of the conveyors may be too high. High conveyor speed often means that large aggregate is pulled away from the mix as it rubs the side guards along the conveyors. Second, high conveyor speed usually means low auger speed and the large aggregates roll into the dead area under the center chain case. Finally, there are guards and deflectors at the ends of the left and right conveyors. This anti-segregation kit should be inspected frequently to make sure it has not been damaged or is badly worn.

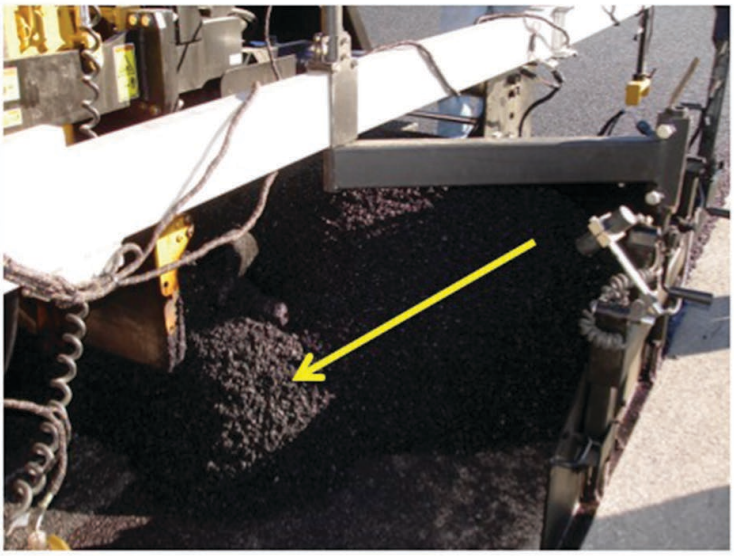
Segregation – Intermittent Stripe

- Intermittent stripes traced to feeder system
- Left auger erratic
- Head of material erratic
- Left side feeder system running at maximum speed
- Throwing aggregate to create stripe
- Sensor too far from target

CAT

Like random patch segregation, stripes that come and go are usually associated with the feeder system operation and set-up. In this example, the left auger is running alternately fast and slow with significant variation in the head of material in front of the left extension. Note that mix is being thrown aggressively in front of the auger and around the end of the mainframe extension. This causes a segregation stripe in line with the end of the mainframe extension. Also, note the large distance between the feeder sensor and the sensor target. Remember, when the sensor is 75 cm (30”) away from its target the feeder system runs at maximum speed. Maximum speed is the condition of the feeder system at this point.

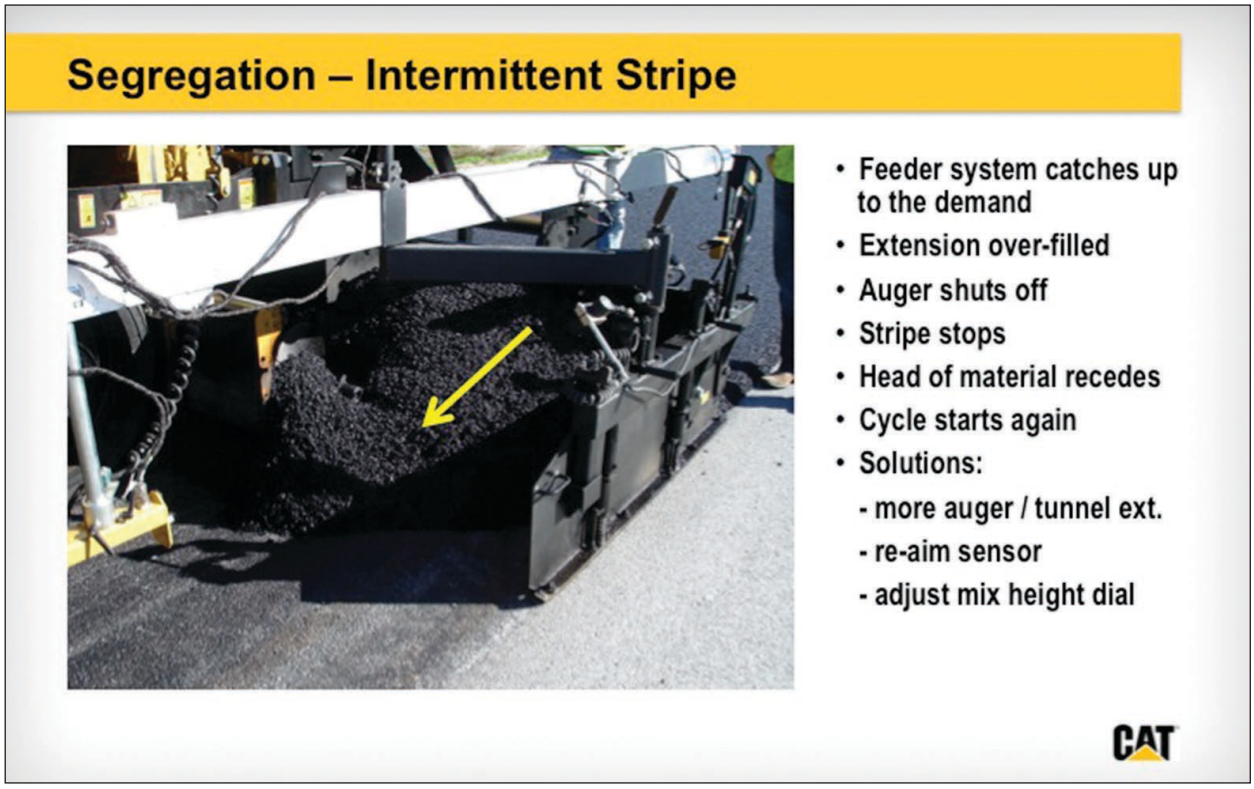
Segregation – Intermittent Stripe



- Head of material moving toward end gate
- Still rolling forward around mainframe extension
- Stripe moving toward edge of mat
- Sensor still too far away from target

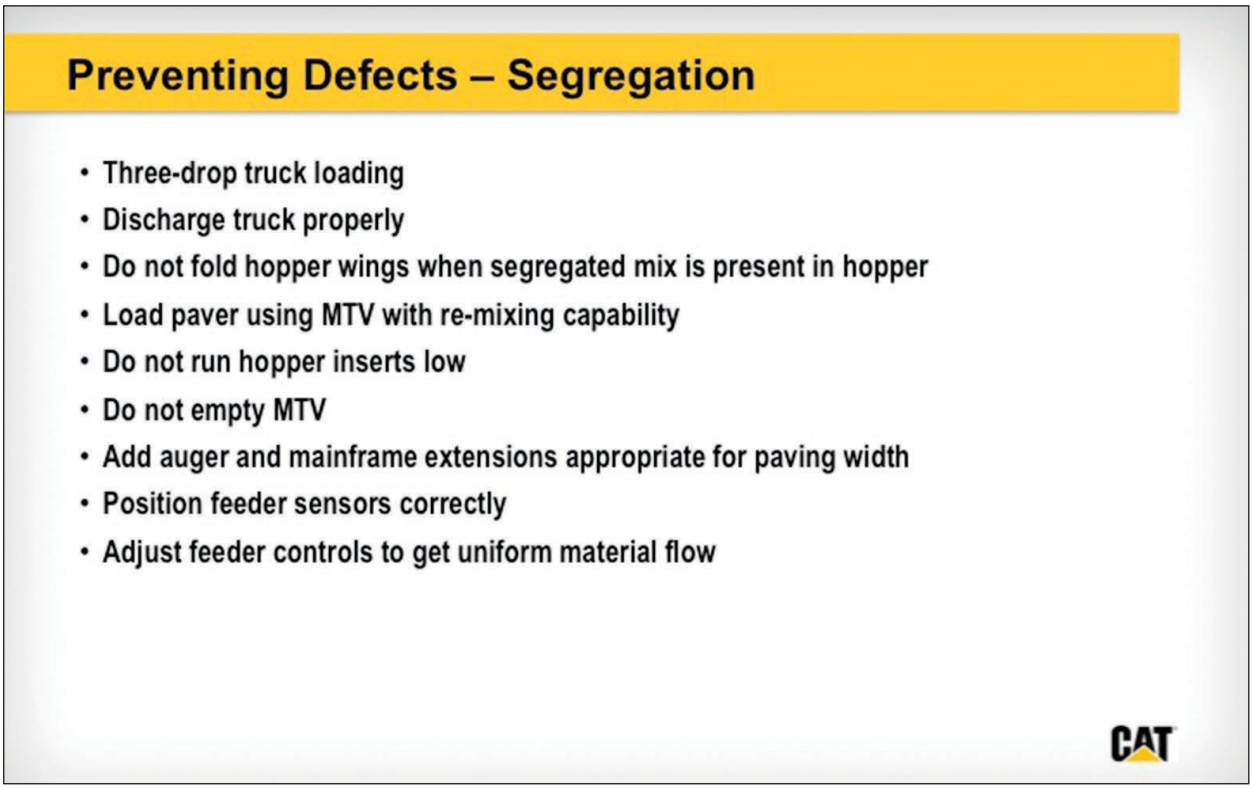
CAT

The head of material has moved farther out but mix is still running forward around the mainframe and the stripe continues. The distance from the sensor to the target is closing but is still too great. The feeder system continues to run close to maximum speed.



Finally, the left side feeder system has caught up to the demand for mix. The head of material has moved far enough out to be in range of the feeder sensor. The left side feeder slows. The stripe goes away because the mix has stopped rolling. The head of material begins to recede and the cycle of starving and over-feeding begins again. The stripe will re-start.

There are obvious solutions. First, if available, the crew should add additional auger and mainframe extensions to get closer to the end gate. Second, the crew should re-aim the sonic feeder sensor to a closer target and then adjust the mix height dial to develop consistent feeder operation on the left side.



In summary, there are many factors that can cause segregation. Troubleshoot the appearance of segregation by checking:

- Truck loading at the plant
- Truck discharge into hopper
- Procedure to fold hopper wings
- Use of MTVs with remixing capability
- Hopper or insert level
- MTV surge level
- Auger and mainframe extensions
- Positioning feeder sensors
- Feeder controls adjustment
- Paving speed
- Base conditions

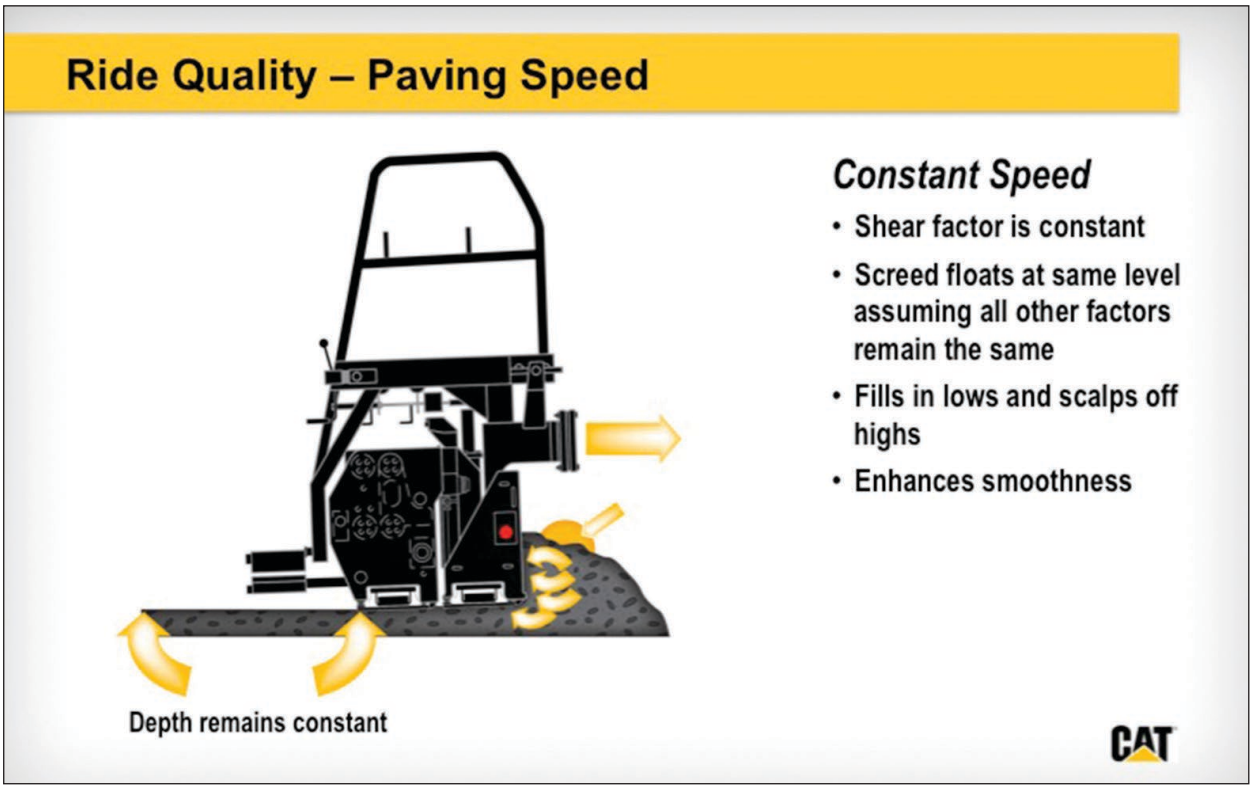
VI. Ride Quality

- Ride quality important on most projects
- May have pay factors tied to smoothness / roughness
- Ride quality influenced by many factors

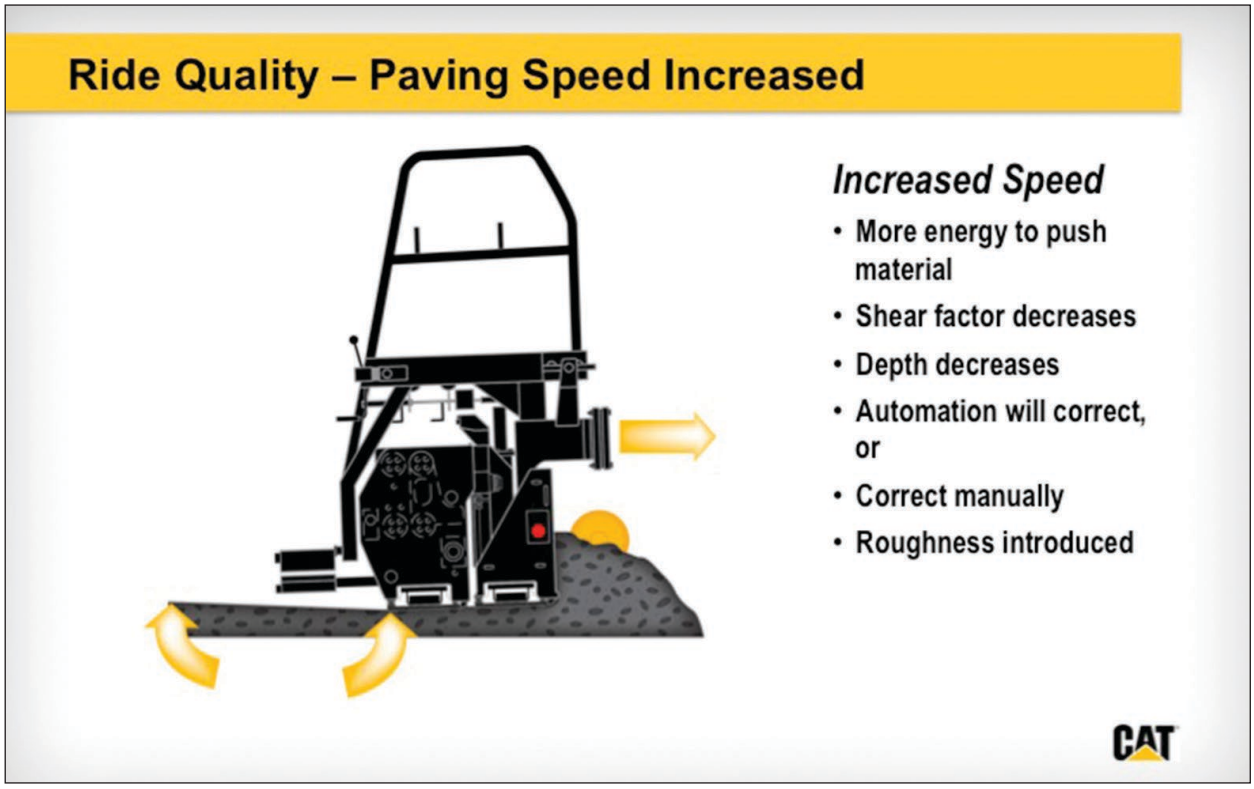
CAT

Ride quality, or smoothness, is a very important issue on any asphalt paving project. In fact, on many road and highway projects, there is a pay factor associated with ride quality. It may be possible to earn an incentive by having exceptional ride quality. Likewise, it may be possible to have a negative pay factor when there is a high degree of roughness or isolated large bumps.

Like the other issues covered in this presentation, ride quality can be affected by a variety of factors.



The speed of the paver is one of the most important factors when it comes to ride quality. When the paving speed remains the same, the shear factor that allows the screed to float on a certain amount of mix while pushing the rest in front in the auger chamber will remain the same. The screed will tend to fill in low spots and scalp off high spots in the grade. Therefore, the screed can make a significant improvement in smoothness when the speed is constant.



When the paver operator increases the paving speed, the screed has more energy to push the head of material in the auger chamber. The shear factor decreases and less material passes under the screed. The thickness of the mat will decrease. If automatic grade and slope control is in use, you will see the tow points move up and the screed will rise back to the desired height. If the crew is paving manually, then the screed operators will use the depth screws to increase the mat thickness. Either way, some roughness is introduced.

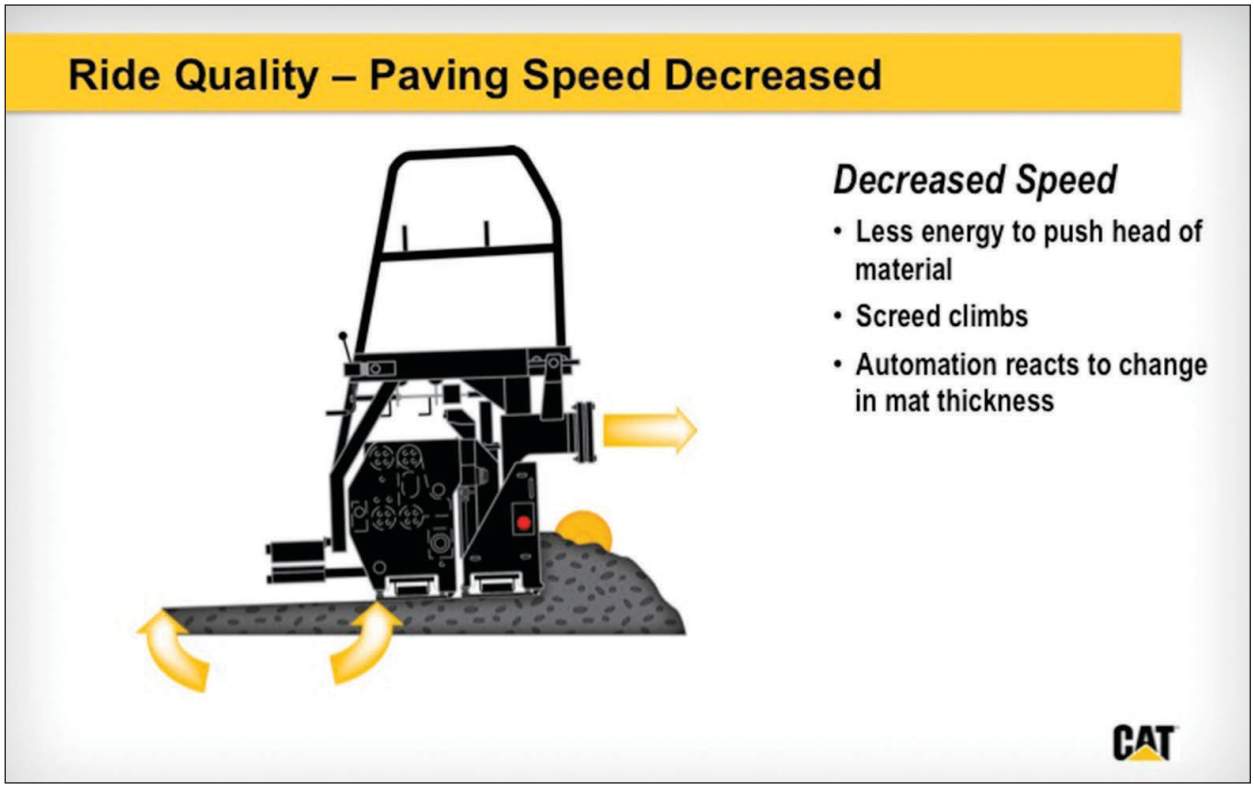
Ride Quality – Paving Speed Increased

- Increased speed reacting to trucks lined up
- Not really more productive
- Harmful to quality
- Harmful to compaction
- Want more production? – Order more trucks

CAT

A common reason for increasing paving speed is reaction to a line of haul units on the project waiting to unload. It seems to make sense to get the trucks unloaded and sent back to the plant, but it is really no more productive than paving at a slower speed. High speed paving can be counter to quality paving because mistakes happen quickly.. Plus, paving at high speed probably means that the compactors working behind the paver are unable to keep up with the high paving speed.

The better option is to pave out the trucks at a calculated speed that consumes the mix as it is delivered to the project. If there is a need to increase production, order more trucks. Do not pave fast and then stop to wait for trucks.



When the paver operator slows the paver, the screed has less energy to push material in front and the shear factor increases. The screed will ride up on the head of material in the auger chamber. The movement of the screed will cause a reaction in the grade and slope system. Roughness will be introduced.

Ride Quality – Paving Speed Decreased

- Slowing between trucks is common practice
- Better to pave a constant speed
- Stop when level in hopper is sufficient to maintain head of material
- Never expose slats or conveyor tunnels

CAT

Some operators have been trained to slow the paving speed during truck exchanges in order to minimize the time stopped waiting for the net truck or to avoid stopping completely. In Unit Three, "Truck Exchanges", we learned that the paver should maintain the paving speed until the level of mix in the hopper requires stopping to wait for the next truck. By paving at a constant speed and maintaining the head of material during truck exchanges, smoothness is enhanced.

Before you start paving on any project with reasonably long pulls, you should calculate the paving speed. Having a calculated and enforced paving speed let's you verify that you have suitable equipment for the project. Calculating the paving speed is simple to do. Use the Caterpillar Paving Production Calculator to calculate paving speed based on estimated hourly tonnage, mat thickness, paving width and weight of material. Then, communicate the paving speed to the crew. Stick to that speed unless there is a change that requires a new calculation.

Ride Quality – Continuous Paving Speed

- Best ride quality with non-stop paving at one speed
- Only possible with material transfer device
- Expect 10% to 15% better ride quality through continuous paving

CAT

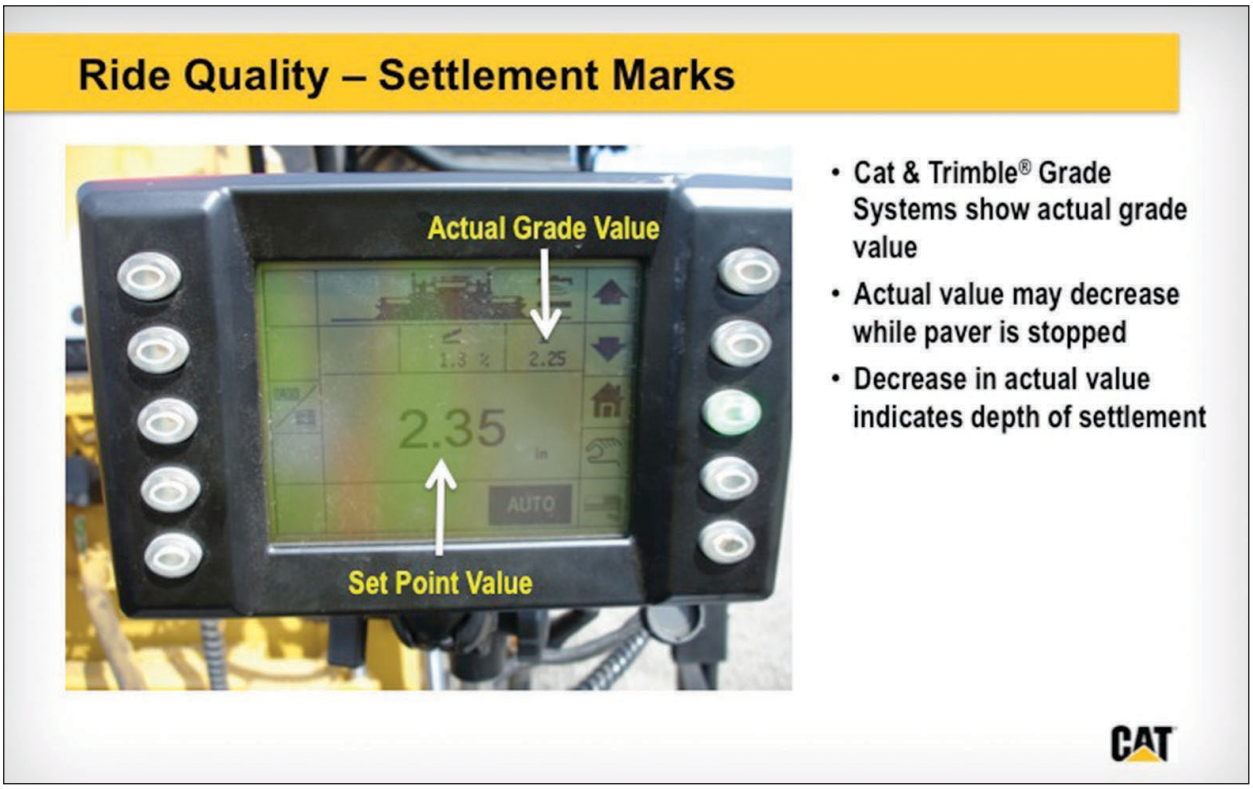
All other factors being equal, the best ride quality results when the paver lays down the asphalt at a consistent speed with no stops. Continuous paving at one speed is only possible when a material transfer device is between the paver and the haul units. The transfer device can be a self-propelled MTV or a device like a windrow elevator that is attached to the front of the paver. The Caterpillar Production Calculator will give you a speed that let's you be 100% efficient based on the use of a material transfer device. You should be able to rely on 10% to 15% better ride quality when you employ continuous paving compared to truck exchange, stop-and-go paving.

Ride Quality – Settlement Marks

- 1-2 minute stops unavoidable during truck exchanges
- Mat will dent to some extent
- Normally shallow enough to roll out

CAT

Short paver stops, 1-2 minutes long, are unavoidable during truck exchanges. Depending on the type of mix and the length of the stop, the mat will be dented to some extent by the weight of the screed. The depth of the mark in the mat is normally small enough that the breakdown roller is able to roll out the mark completely. Therefore, the screed stop mark will be detected minimally by traffic or the smoothness measurement device.



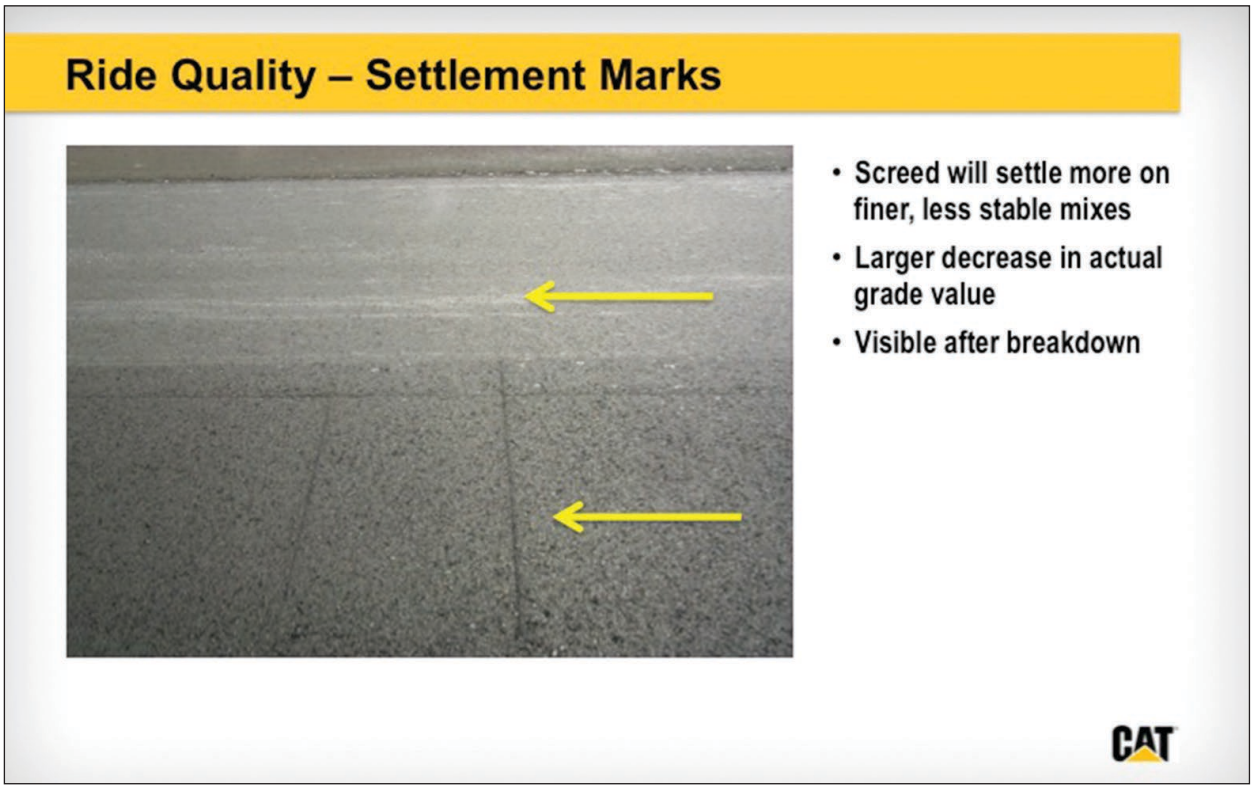
If the paver that you are using is equipped with Caterpillar or Trimble® Grade and Slope Control, you will be able to judge the amount of screed settlement during a paver stop. The grade display screen shows the set point value for grade control and also shows the actual grade measurement. The actual measurement value will decrease during the stop as the screed settles. If you note the actual value at the time of the stop, you will be able to determine fairly accurately how much the screed has settled by the end of the stop. Small settlement marks, such as the 0.10” value shown in this example, will roll out without a problem.

Ride Quality – Settlement Marks

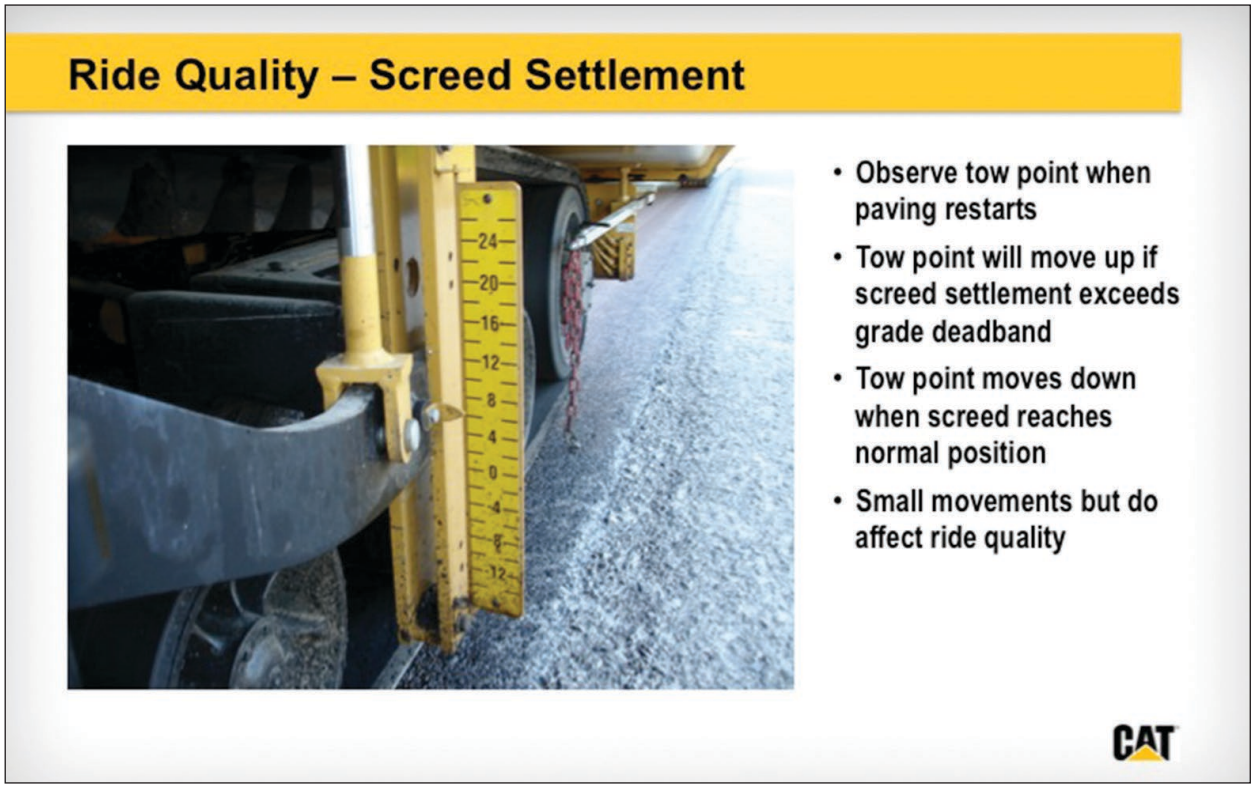
- Observe settlement marks during breakdown compaction
- If marks disappear, no issue with ride quality due to normal paver stops

CAT

To determine if the screed settlement marks are being rolled out adequately, observe the mat after the breakdown roller has made its passes. If the mark is completely gone, there is no issue related to the screed settlement marks in the mat



Some fine mixes that contain mostly small aggregates and fines and unmodified asphalt cement compact more under the weight of the stopped screed. Also, excessively high mix temperatures behind the screed are less able to support the weight of the screed because the asphalt cement is at a lower viscosity (more fluid) at higher temperatures. You may detect a larger decrease in the actual grade value on the Cat grade display and you may see that the settlement mark is deeper. In these cases, the mark may be visible after compaction and the mark will be felt by traffic and the smoothness measurement device, if any is used.



To help determine the effect of paver stops and screed settlement on ride quality, you can also observe the tow points when paving resumes. If the screed has settled more than the grade control deadband, usually 3 mm (1/8”), then you will see the tow point move up shortly after the paver propel lever is taken out of the Neutral position. Then, as the screed resumes its normal floating position, the tow point will move back down. These are small tow point movements and small screed movements, but they all add up and they do affect the ride quality. This is one of the main reasons why continuous paving improves ride quality compared to stop-and-go paving.

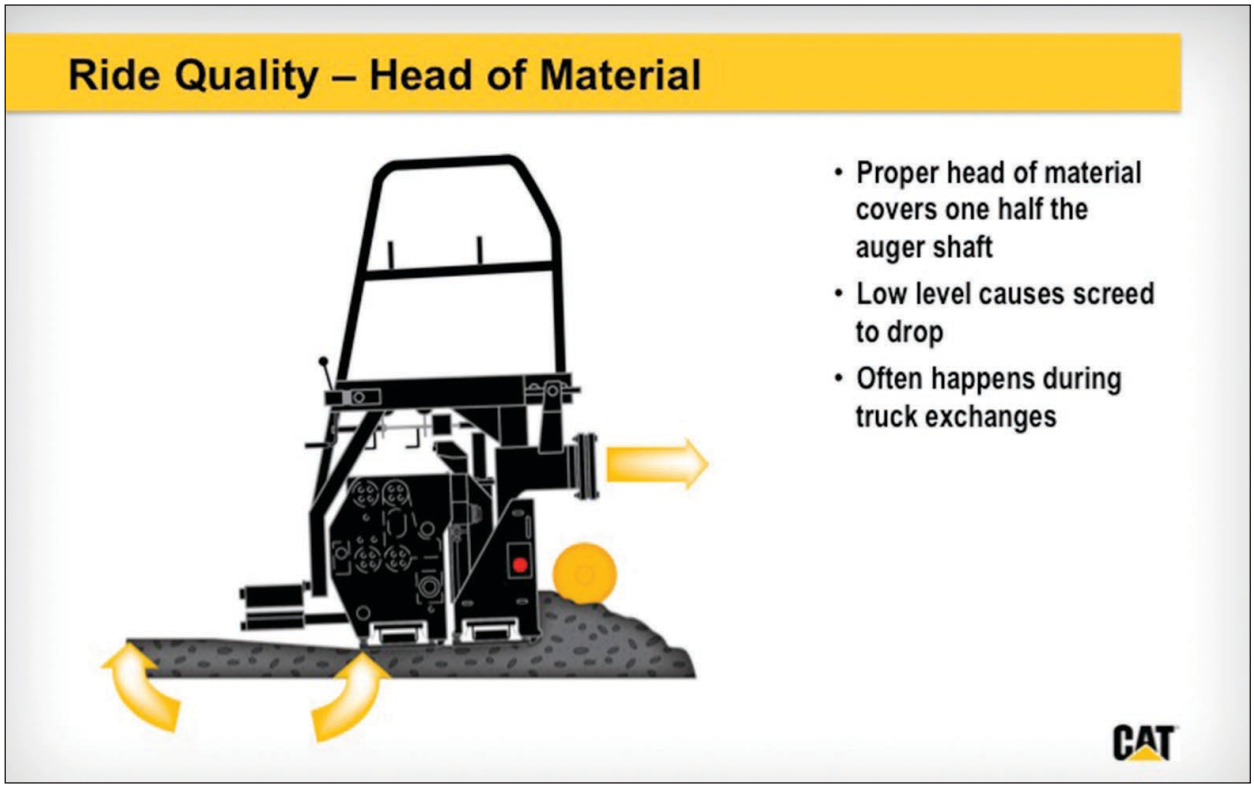
Ride Quality – Screed Assist

- Screed assist reduces weight of screed
- Reduces settlement marks during stops
- Commonly used on tender mixes
- Check pressure before activating

CAT

To help overcome the negative effects of stop-and-go paving, many pavers are equipped with screed assist, sometimes referred to as screed counterbalance. When the screed assist system is activated, a small amount of hydraulic pressure is sent to the screed lift cylinders. This small upward pressure reduces the weight of the screed to reduce the depth of screed settlement during stops and ride quality can be improved.

Always check the pressure in the system before activating. Too much upward pressure in the screed lift cylinders can result in an uncontrollable screed. Consult the Operation and Maintenance for the paver and screed you are using to determine the range of allowable screed assist pressure.



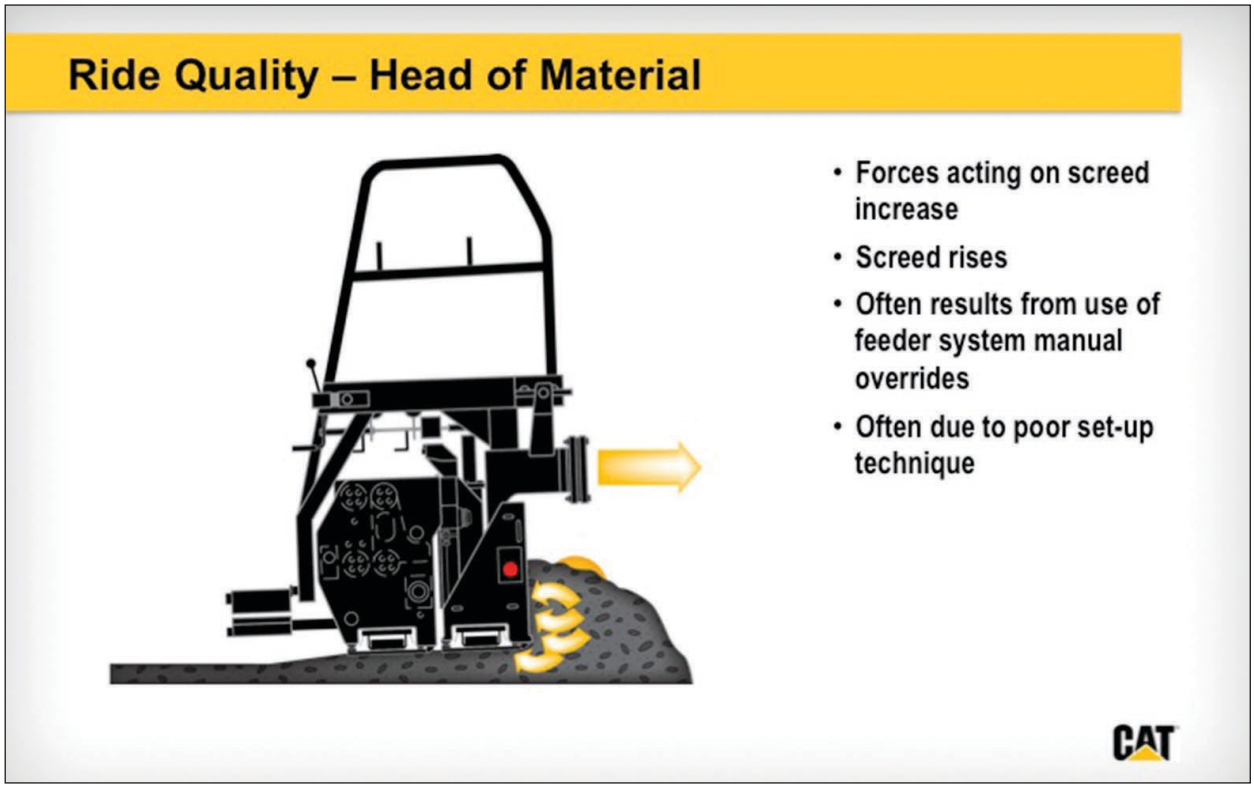
The correct head of material is achieved when the mix in the auger chamber covers one half of the augers. This level should be maintained from the center of the auger shaft out to the end of the auger shaft. When the head of material is too low, the forces acting on the screed are reduced and the screed will fall. As mat thickness decreases, a depression is created and smoothness will suffer.

This condition often occurs during truck exchanges when the operator continues to pave and consumes all the mix in the hopper. As the conveyors run empty, the head of material drops and the screed settles.

Ride Quality – Head of Material Low

- Screed drops
- Voids may appear
- Open texture and drag marks
- Lots of handwork to repair
- High roughness

When the head of material in the auger chamber drops, the screed also drops. If the head of material runs extremely low, then you will see voids appear in the mat as in this example. You are likely to see open texture and drag marks because the mat has lost the correct ratio of layer thickness to aggregate size. There will be considerable hand work in this area with lots of roughness as a result.



When the head of material is too high, the forces acting against the face of the screed will increase. As there is increased resistance, the screed will rise with resultant increase in mat thickness. The crew will sometimes experience this situation during the truck exchange sequence. In reaction to a low head of material, the crew will use feeder system manual overrides to fill the auger chamber. As they try to fill the area in front of the extensions, too much mix is delivered.

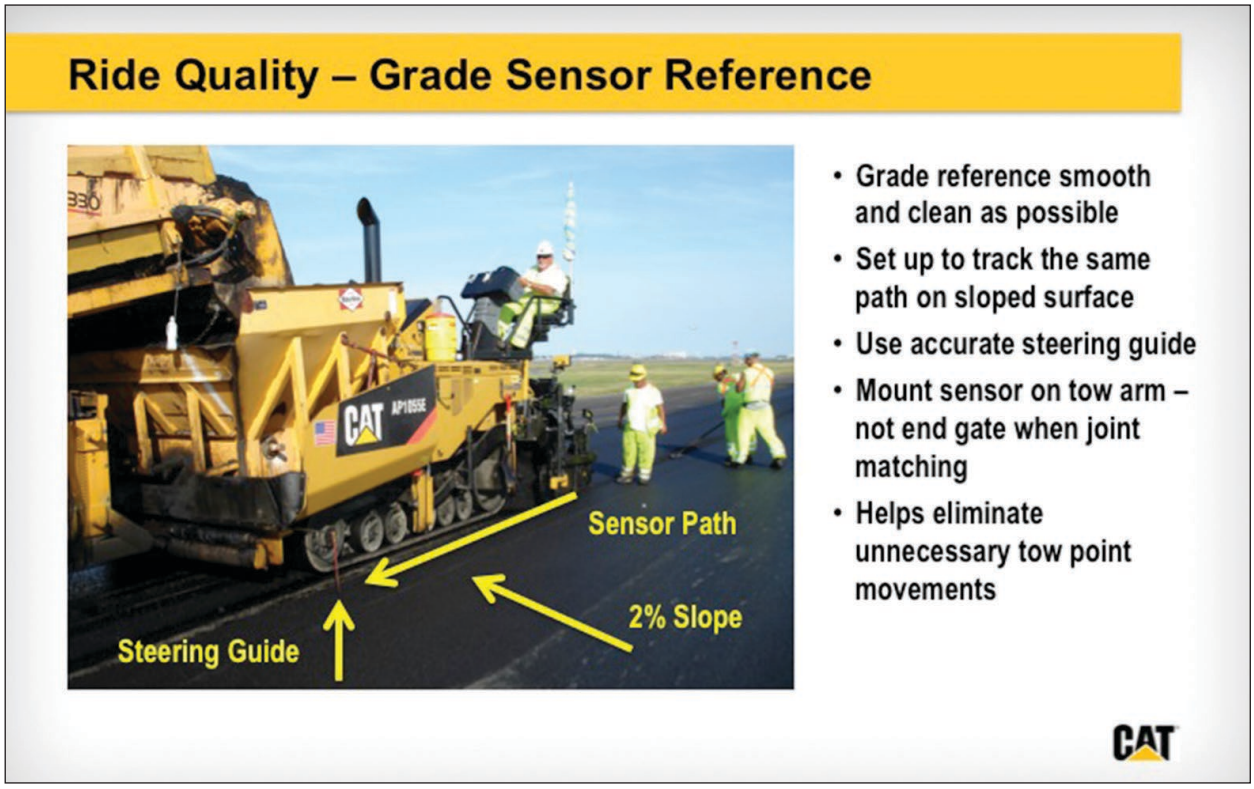
An excessive head of material often results from poor set-up techniques, too.

Ride Quality – Head of Material High

- Screed climbs on excessive material
- Grade control reacts
- Head of material fluctuates
- Grade control reacts
- Wavy mat results
- *Poor planning and set-up*

CAT

The excessive head of material in front of the screed will cause it to constantly try to climb up on the pile. In reaction, the grade control system will be constantly trying to force the screed down. The situation will be further aggravated by fluctuations in the head of material that will result from this poor set-up technique. A wavy mat will be the result of the struggle between the feeder system, the screed and the grade control system.



The grade reference for the sonic grade sensor affects ride quality in several ways. Obviously, you should try as often as possible to have a clean, fairly smooth grade to reference. Here's the point to remember. Most of the time, the grade reference will have some degree of transverse slope. Therefore, you should should try to keep the grade sensor above the same transverse grade path to avoid measuring height differences that are being created by the sloped surface. For example, if the transverse profile contains a 2% slope, then the height of the grade will change by 6 mm (1/4") for every 30 cm (12') of transverse distance and the grade sensor will detect that difference.

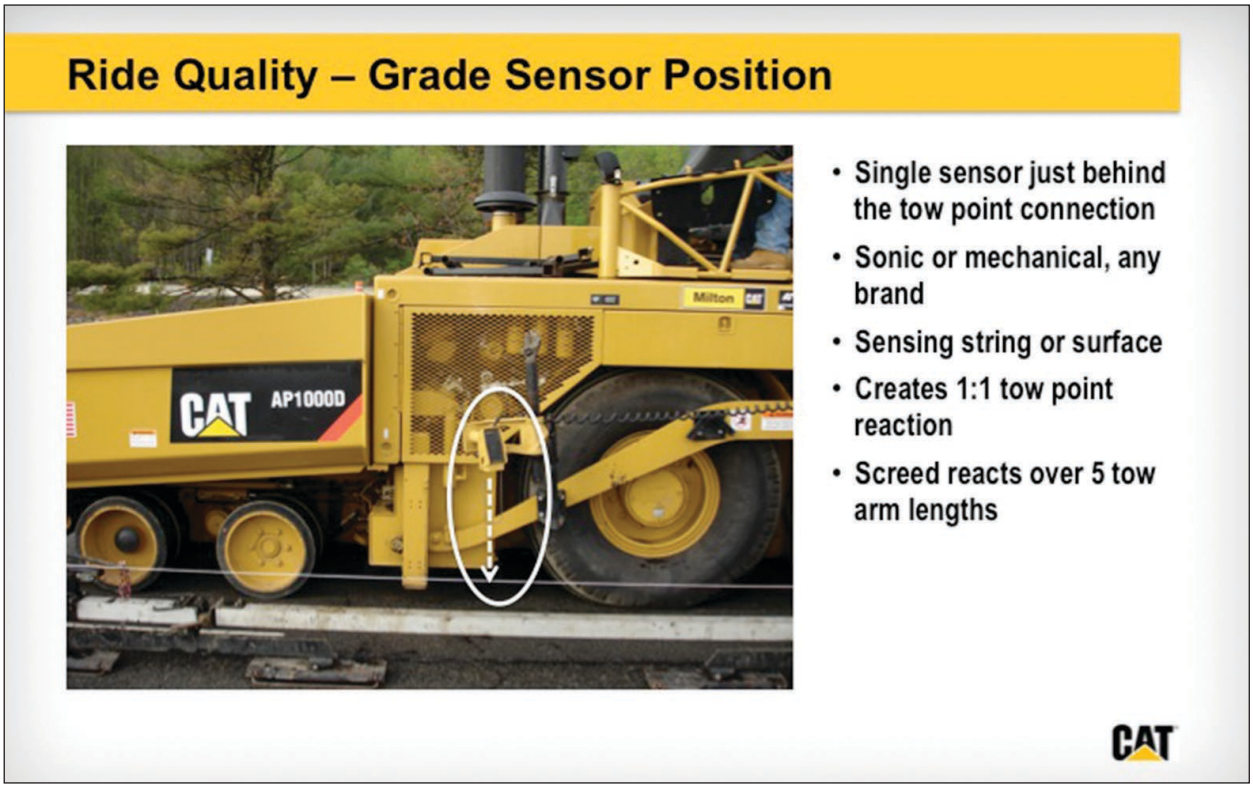
In order to keep the grade sensor in the same position relative to transverse profile, provide the paver operator with an easy-to-see steering reference that helps the operator steer a straight line. If you are joint matching, install the sensor mounting hardware on the tow arm and not on the screed end gate. Attaching the grade sensor to the tow arm will keep in the sensor in the same position to read the grade. If the sensor is mounted off the end gate, the sensor position will change every time the end gate is moved in or our for joint matching accuracy.

Ride Quality – Grade Sensor Reference

- Keep sensor(s) away from spills
- Clean up all spills
- Choose new grade reference

CAT

It is imperative to keep the grade reference clean and free of spills or any objects that will interfere with accurate grade sensor measurements. In this view, it is obvious that there are spills from the right side of the hopper. With the grade sensor installed inside the paving width, it is being affected by these spills. In this particular application, there is a better grade reference outside the paving width away from any possible spills. The crew should re-position the grade sensor over the clean reference.



Any time you are using a single grade sensor and you want to make the most improvement in ride quality, position the grade sensor so it is just the behind the connection of the tow point cylinder and the tow arm. This rule applies whether you are using a sonic sensor or a mechanical sensor and regardless of the brand of grade control system. It applies whether you are sensing a string on a ski, an erected stringline, or a grade surface itself. With the grade sensor just behind the tow point connection, any deviation detected by the grade sensor will cause the tow point to adjust the same distance. In other words, if the detected grade deviation is 6 mm (1/4”), the tow point will 6 mm (1/4”). The small tow point movement causes a small change in the main screed angle of attack and the screed will react slowly to the grade change. The change in elevation will be spread out over five tow arm lengths for the best smoothness.

Ride Quality – Slope Control

- Slope negatively affects ride quality
- Slope only base or binder
- Auto slope control drives large tow point movements
- Screed reacts quickly

CAT

The use of slope control on one side of the paver usually has a negative effect on ride quality. Caterpillar recommends the use of slope control only when paving base or binder lifts and not when laying down wear courses.

However, on some projects, there may be a specification that requires the use of automatic slope control under certain conditions. Or, you may simply need to correct transverse profile by using slope control. Remember, paving with automatic slope control causes the tow point to make large movements and the screed will react quickly to any changes. Significant improvements in ride quality will not be made if there are numerous large slope corrections during any paving length.

Prior to using automatic slope control, check the slope of the grade at various points throughout the paving length. If there are only minor slope corrections to be made, say less than 0.5%, then you can be reasonably confident that automatic slope control will not cause large tow point movements and large mat thickness deviations over short distances. However, if there are large slope corrections required, you should consider making the slope corrections manually. If you correct slope using screed depth cranks, you can control the rate of change and lessen the impact on smoothness.

Ride Quality – Manual Slope Control

- Actual slope displayed on control box
- Required slopes on grade stakes
- Using depth cranks to slowly create required slopes
- Least effect on smoothness

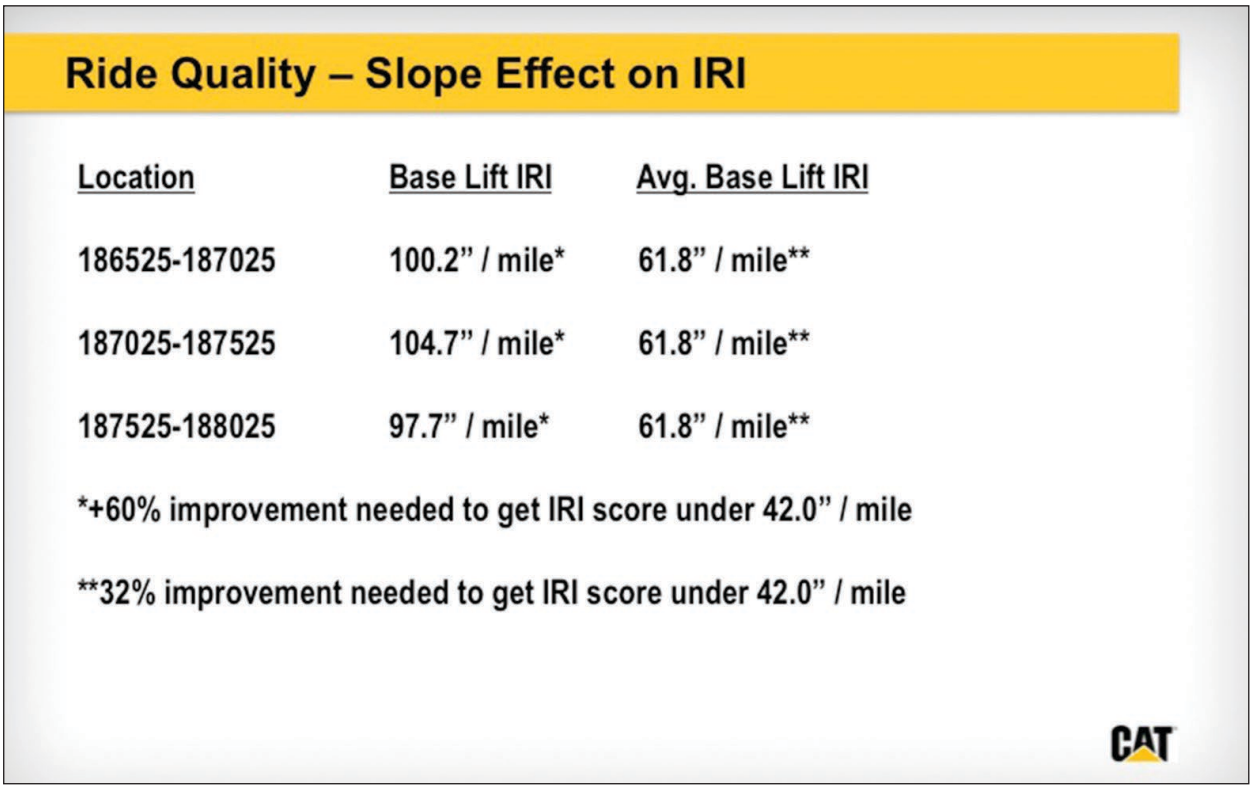
CAT

In this example, the crew is paving through a super-elevation. The slopes have been marked on grade stakes throughout the curve. The actual slopes in the granular base are incorrect. The screed operator has elected to make slope corrections manually using the screed depth cranks. The grade / slope display boxes are being used to show the actual slopes. As the screed operator turns the depth cranks, he watches the slope display in the control box. He is able to slowly create the correct slopes with the least effect on ride quality.

Ride Quality – Auto Slope – Dragging Screed

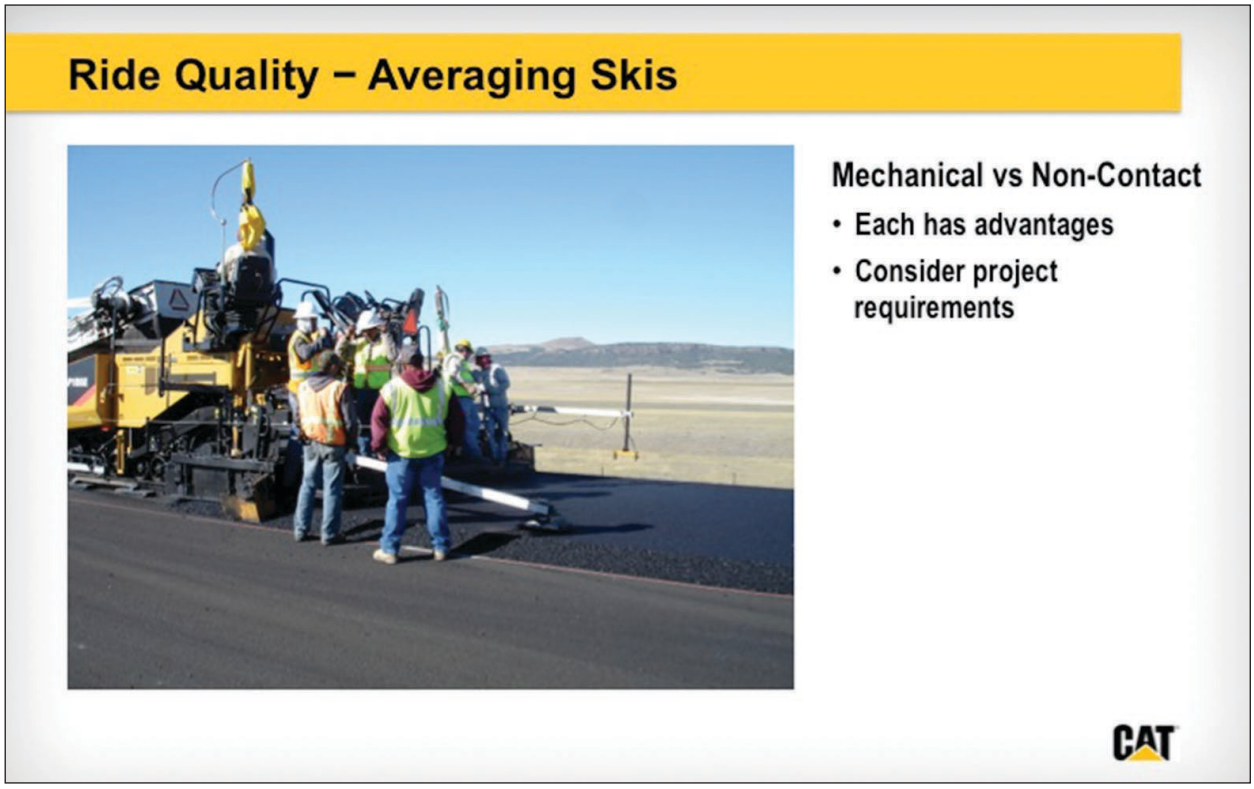
- Slope control only considers profile
- No regard for thickness or smoothness
- Can drag screed when correcting slope of the grade
- Yield and smoothness affected

When automatic slope control is selected, the system considers only the slope of the surface of the mat. There is no consideration for mat thickness or smoothness. If the slope of the existing grade is too low and automatic slope control is attempting to create more slope, there is high likelihood that the screed will begin to drag aggregates due to lack of depth as shown in this example. Not only was the yield affected in this area, but ride quality was, too.



The mat in this example was affected by the screed dragging in three consecutive segments of smoothness measurement. The International Roughness Index (IRI) score for those three segments is shown in the middle column. Each affected segment had an IRI of around 100 inches per mile. Compare these scores to the average for the rest of the segments paved during that shift. The average score for the base lift laid on granular base was 61.8 inches per mile.

With the wearing course remaining, there would have to be more than 60% smoothness improvement to get the IRI score 42 inches per mile, which is the target on this project. The other segments would need on average only 32% improvement to reach the target for smoothness.



In recent years there has been a tendency for crews to use non-contact averaging skis rather than mechanical ("drag") averaging skis. Each type ski has its own advantages. Caterpillar recommends that you consider the requirements of each project before deciding which type ski to acquire or to install on your paver.

Ride Quality – Mechanical Skis – Advantages

- Superior averaging
- Reduce deviations by a factor of 8
- Use when the grade has extreme roughness
- Use for difficult smoothness specifications
- Ideal for long pulls
- Can be set up outside or inside paving width

CAT

Mechanical skis provide superior averaging capability. Under optimum conditions, they reduce grade deviations by a factor of eight. That is to say, they convert a 25 mm (1.0”) grade deviation to a 3 mm (1/8”) deviation at the center of the ski where the grade sensor is positioned. Mechanical skis should be selected whenever there is significant roughness in the grade to be paved or when there are strict smoothness specifications. Mechanical skis are ideal for long pulls where there is little or no requirement to re-position the paver for another pull. Mechanical skis can be installed on a paver to sense grade outside the paving width (as shown) or inside the paving width (previous image).

Mechanical skis may take more time to install than non-contact skis. Since they contact the grade, they can pick up tack and often require more maintenance than non-contact skis. They can be cumbersome to use on projects where there are obstacles such as catch basins or utility boxes located in the path of the ski. They may be suitable on projects with multiple pulls or night shifts when time to install skis is limited by restricted time to pave.

Ride Quality – Non-contact Skis – Advantages

- Easier to install
- Stay on the paver when moving around job site
- Ideal for multiple pulls
- Not affected by obstacles
- Maintenance free
- Suited for grade reference with moderate to low roughness
- Set up inside or outside paving width

CAT

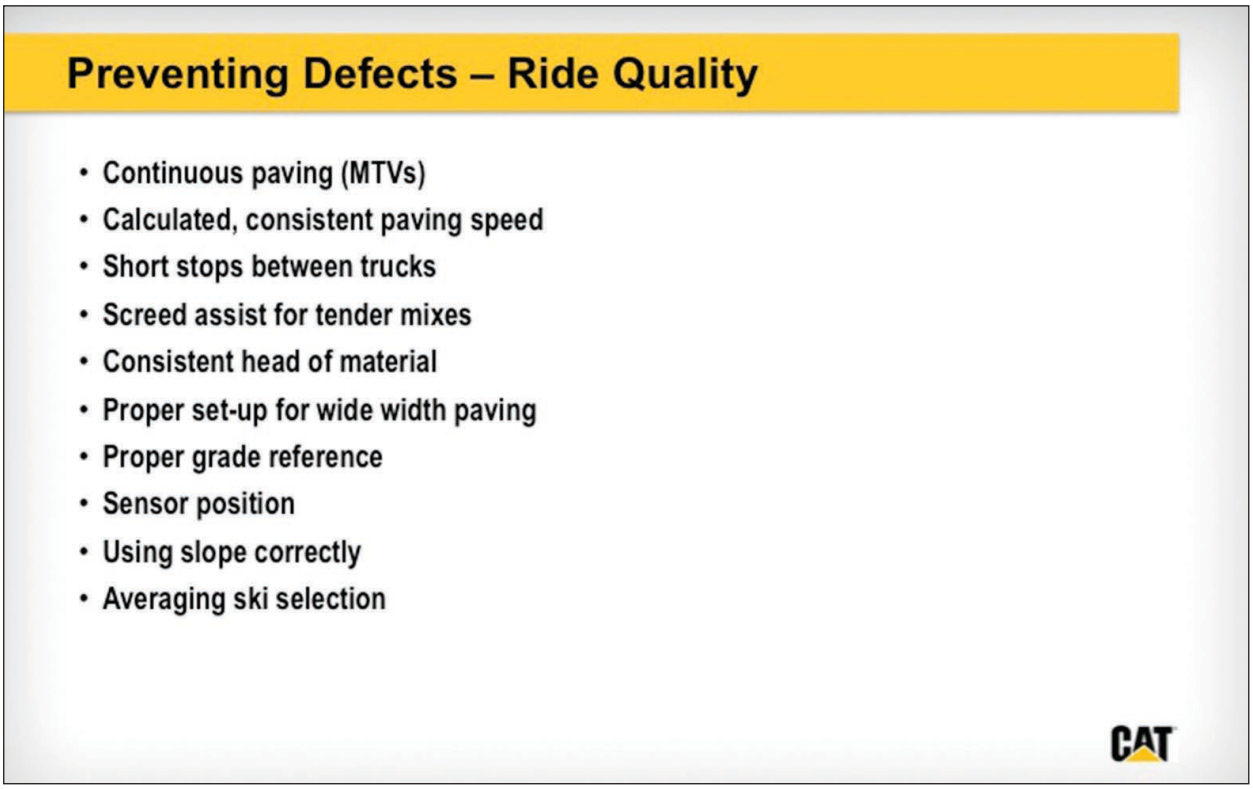
Non-contact, or electronic, averaging skis are usually easier to install and can be left on the paver when the paver is moved around the job site. Therefore, non-contact skis are better suited to projects with multiple pulls or time constraints like night shifts. Non-contact skis are not affected by obstacles. They are virtually maintenance free. They provide adequate averaging when the grade reference has low to moderate roughness. They can be installed on the paver to reference grade inside the paving width or outside the paving width.

Ride Quality – Non-Contact Skis – Disadvantages

- Less averaging capability
- Less suited for rough granular bases
- Less suited for cracked / jointed rigid surfaces
- Affected more by spills or debris in the sensor path

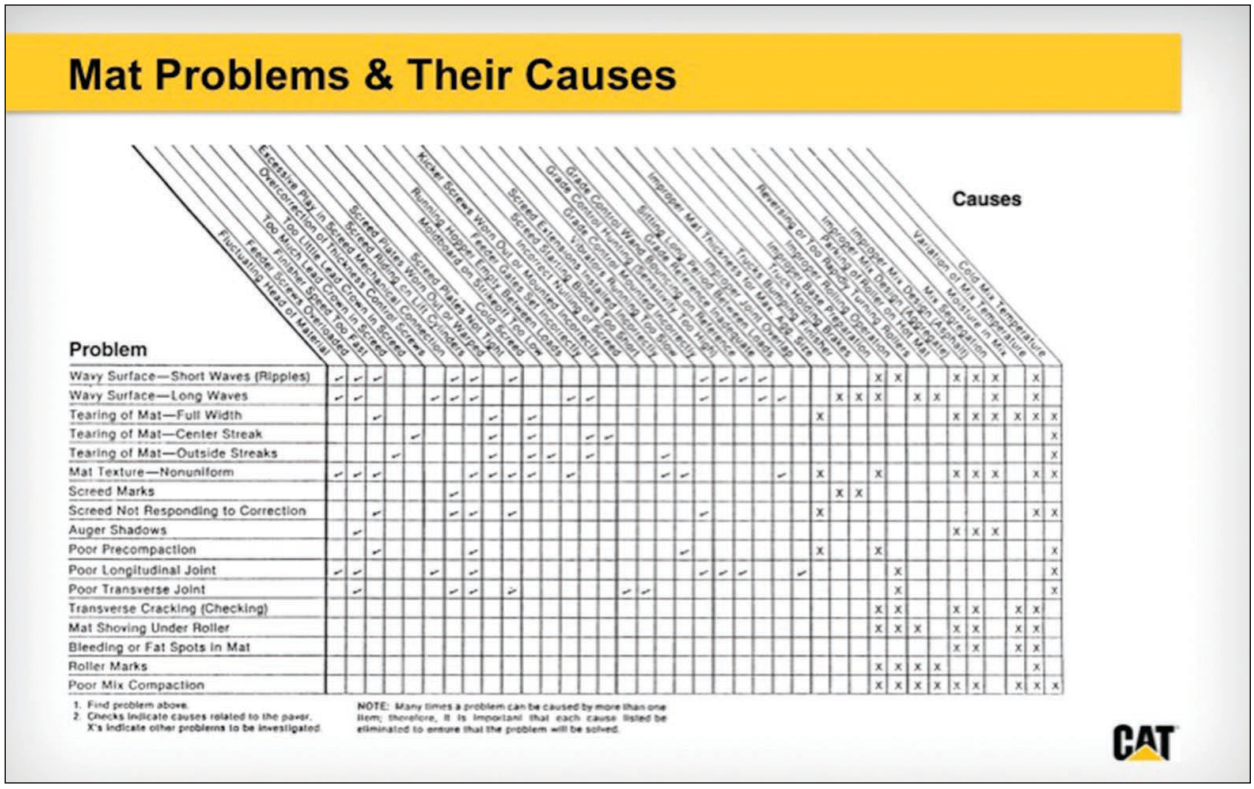
CAT

The averaging capability of a multi-sensor, non-contact ski is not quite as high as the averaging capability of a 9-meter (30-foot) mechanical ski. The do not provide the smoothness often required when paving over rough granular base or rigid surfaces with cracks or joints. They are more affected by spills or any kind of debris in the path of the sensors.



Ride quality, or smoothness, can be affected by many factors. Many of these factors are associated with fundamentals of asphalt paving and have been covered several times in this presentation Smoothness is really the culmination of "best practices" observed by the crew. We can summarize the steps to smoothness by focusing on:

- Continuous paving
- Paving at a calculated, consistent speed
- Limiting time stopped during truck exchanges
- Using screed assist when required
- Maintaining a consistent head of material
- Adding auger and mainframe extensions when required
- Selecting the proper grade reference
- Protecting the grade
- Positioning grade sensors correctly
- Understanding slope control
- Selecting the appropriate averaging skis



This troubleshooting chart was developed by Barber-Greene Company.

Notes

Notes

Notes

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