Learning Outcomes:

☐ Explain the effect of various components of a paving machine on the finished mat.
☐ Select correct patching materials and placement techniques for pavement repair.

Mix Placement

Mix placement and compaction are the two of the most important elements in AC pavement construction and overlay. Mix placement involves any equipment or procedures used to place the delivered AC on the desired surface at the desired thickness. Mix placement can involve complicated asphalt paver operations or simple manual shoveling. This section provides a basic description of AC placement operations.

The basic concept of the asphalt paver has remained relatively unchanged: AC is loaded in the front, carried to the rear by a set of flight feeders (conveyor belts), spread out by a set of augers, then leveled and compacted by a screed. While this process may vary from paver manufacturer to manufacturer, the overall approach is the same. This set of functions can be divided into two main systems: the tractor and the screed.

<table>
<thead>
<tr>
<th>TOOLS AND EQUIPMENT</th>
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<tbody>
<tr>
<td>- The tractor (or material feed system), and</td>
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<tr>
<td>- The screed</td>
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</table>

Describes what tools, equipment and tests are required to complete the job safely and with the highest level of quality.
Tractor (Material Feed System)

The tractor contains the material feed system, which accepts the AC. For most pavers, this is the front of the tractor. Once deposited at the front of the paver, the AC is transported to the rear and spreads it out to the desired width with augers in preparation for screed leveling and compaction. The basic tractor components are:

| **Push Roller and Truck Hitch** | The push roller is the portion of the paver that contacts the transport vehicle and the truck hitch holds the transport vehicle in contact with the paver. They are located on the front of the hopper. Trucks should not be allowed to bump the paver. |
| **Hopper** | The hopper is used as a temporary storage area for AC delivered by the transport vehicle. Therefore, the paver can accept more material than is immediately needed and can use the volume in the hopper to compensate for fluctuating material demands created by such things as paving over irregular grades, utility access openings or irregular intersection shapes. Hopper sides (or “wings”) can be tilted up (or “folded”) to force material to the middle where it is carried to the rear by the conveyor system. Hoppers can also be fitted with inserts to allow them to carry more AC. These inserts are typically used in conjunction with Material Transfer Vehicles. |
| **Material Transfer Vehicle (MTV)** | Material transfer vehicles (MTVs) are used to assist the paver in accepting AC. Most pavers are equipped to receive AC directly from end dump trucks, however in certain situations it can be necessary or advantageous to use an MTV. Paving using bottom dump trucks and windrows requires a windrow elevator MTV, while other MTVs are used to provide additional surge volume, which is advantageous because it allows the paver to operate continuously without stopping, minimizes truck waiting time at the paving site and may minimize aggregate segregation and temperature differentials. |
| **Conveyor** | The conveyor mechanism carries the AC from the hopper, under the chassis and engine, then to the augers. The amount of AC carried back by the conveyors is regulated by either variable speed conveyors and augers or flow gates, which can be raised or lowered by the operator or, more often, by an automatic feed control system. |
| **Auger** | The auger receives AC from the conveyer and spreads it out evenly over the width to be paved. There is one auger for each side of the paver and they can be operated independently. Some pavers allow the augers to be operated in reverse direction so that one can be operated forward and the other in reverse to send all the received AC to one side of the paver. The auger gearbox can either be located in the middle (between the augers) or on the outside edge of each auger. If an inadequate amount of AC is distributed under a middle-located gearbox the result can be a thin longitudinal strip of mat aligned with the gearbox that exhibits lower densities from aggregate segregation and/or temperature differentials. |
The purpose of the paver is to place the hot-mix asphalt to the desired width and thickness and to produce a satisfactory mat texture. The paver consists of two primary parts: the tractor unit and the screed unit. The tractor unit provides the motive power to the paver and transfers the asphalt mixture from the receiving hopper on the front of the machine to the spreading screws at the back of the paver. The tractor unit fulfills all of the functions necessary to receive the asphalt mix from the haul trucks, carry the material back to the spreading screws, and distribute the mix across the width of the screed. It is composed of several major components including the track push rollers, mix-receiving hopper, material flow gates, twin slat conveyors, and a pair of screw conveyors or augers.

**Drive System**

The tractor unit is powered by its own engine and provides the required propulsion energy to move the machine forward, either on rubber tires or crawler tracks.

**Rubber Tire**

If the paver is moved regularly under its own power between paving locations, the rubber tire machine is normally used because its travel speed is much greater than that of the crawler track paver.
Track
The crawler tracks could be all steel, steel equipped with rubber pads, or flexible bands with steel shoes and rubber pads. If the paver is used on top of a yielding surface, the crawler track system will provide an increased area over which to spread and support the weight of the paver.

Screed Vibration Shaft with Weights
The applied amplitude is determined by the location of the eccentric weights on the shaft. The position of the weights can be altered to increase or decrease the amount of compactive effort applied to the mix by the screed. Typically the amplitude setting selected is related to the thickness of the mat being placed - low amplitude for thinner lifts and higher amplitude for thicker lifts.
Hopper

The paver hopper is used to receive and temporarily hold the asphalt mix from the haul vehicle or the pickup machine.

Shape, Capacity, Wings

The hopper must be wide enough to allow the body of the haul truck to fit inside of it. In addition, particularly for smaller pavers, the hopper must be low enough to permit the truck bed to be raised without the bed placing excessive weight on the front of the hopper.

Some Contractors weld a diagonal wedge into the back corners of the hoppers to redirect the mix into the center of the hopper.
Chapter 4 | Mix Placement

**Conveyor (Slat Conveyor)**

At the bottom of the paver hopper is a set of slat conveyors. Their purpose is to carry the asphalt mix from the hopper through the tunnel on the paver and back to the spreading screws. The slat conveyors are on either side of the paver, operating independently of each other. This allows the paver operator to control the amount of material fed to each side of the paver in order to pave ramps, mailbox turnouts, or tapers.

**Conveyor Flow Gates (Hopper Gates)**

At the back of the paver hopper is a set of flow gates, one over each of the two slat conveyors. These are used to regulate the amount of mix that can be delivered by the conveyors to the augers. The gates move vertically, either by manual manipulation or mechanically. The flow gates should be adjusted to provide a uniform head of material (at a level of or just above the center of the auger shaft) in front of the screed.
Augers

Keep the amount of mix carried in the auger chamber as constant as possible. The proper depth of material on the augers should be at the center of the auger shaft. The level of material carried in front of the screed should not be so little as to expose the lower half of the screw conveyor flights. Further, the level of mix delivered to the screed should never be so great as to cover the upper portion of the auger, as shown in this same figure.

The mix that is carried to the back of the tractor unit by the slat conveyors is deposited in front of the screw conveyors or augers. Just as the two slat conveyors operate independently of each other, the augers on each side of the paver are run separately from one another.

The mix placed in the auger chamber from the slat conveyors is distributed across the width of the paver screed by the movement of the augers. At the junction of the two augers in the center of the paver, adjacent to the auger gear box, there typically is a different-shaped auger (reverse auger or paddle) to tuck mix under the gear box and assure that the mix placement at this location is the same as that across the rest of the width of the mix being laid. It is important that the augers carry a consistent amount of mix across the front of the screed so that the pressure (head of material) on the screed is kept as consistent as possible.
Material Feed System

If the feed system is set and operating properly, the slat conveyor and augers on each side of the paver will rarely shut off. This continuous action of the conveyors and augers is accomplished by setting the proper position for the hopper flow gates and determining the correct speed setting for the slat and screw conveyors.

The primary key to the placement of a smooth pavement layer is the use of the material feed system to keep the head (level) of material in front of the screed constant, primarily by keeping the slat conveyor and augers running as close to 100 percent of the time as possible.
Operation of the tractor, and specifically the material feed system, can have significant effects on overall construction quality and thus long-term pavement performance. Although there are many detailed operational concerns, the two broad statements below encompass most of the detailed concerns:

1. **AC must be delivered to maintain a relatively constant head of material in front of the screed.** This involves maintaining a minimum amount of AC in the hopper, regulating AC feed rate by controlling conveyor/auger speed and flow gate openings (if present), and maintaining a constant paving speed. As the next section will discuss, a fluctuating AC head in front of the screed will affect the screed angle of attack and produce bumps and waves in the finished mat.

2. **The hopper should never be allowed to empty during paving.** This results in the leftover cold, large aggregate in the hopper sliding onto the conveyor in a concentrated mass and then being placed on the mat without mixing with any hot or fine aggregate. This can produce aggregate segregation or temperature differentials, which will cause isolated low mat densities. If there are no transport vehicles immediately available to refill the hopper it is better to stop the paving machine than to continue operating and empty the hopper (TRB, 2000).
Screed

The most critical feature of the paver is the self-leveling screed unit, which determines the profile of the AC being placed (Roberts et al., 1996). The screed takes the head of AC from the material delivery system, strikes it off at the correct thickness and provides initial mat compaction.

<table>
<thead>
<tr>
<th>DEFINITION</th>
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<tr>
<td>Screed Terminology</td>
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<td>The following is a list of basic screed components and terms:</td>
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<tr>
<td>Screed plate</td>
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<td>Screed angle (angle of attack)</td>
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<tr>
<td>Strike-off plate</td>
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<td>Screed arms</td>
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<tr>
<td>Tow point</td>
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<tr>
<td>Depth crank</td>
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<td>Screed heater</td>
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<td>Screed vibrator</td>
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<tr>
<td>Screed extensions</td>
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</table>
Sensor Types and Location

For the automatic feed control system to function properly, the feed sensor control arm should be located as close to the outside end of the augers as possible. If rigid paver screed extensions are used, as discussed later, the control arm should be mounted beyond the end of the augers, just inside the end gate on the paver screed.

Material Feed Sensor

For this system, a feed control sensor (a type of limit switch) is used to determine the amount of mix in the auger chamber. If the volume of mix available in front of the screed falls below the desired amount, the feed control sensor will move enough to engage the slat conveyor and auger system, pulling more mix back to the screed area. As the material is distributed in front of the screed, the feed control sensor will rise and disengage the feed system.

This action will maintain the pre-selected head of material in front of the screed. This sequence repeats itself, continuously maintaining consistent head of mix as long as material is available in the hopper. On some pavers, a variable-speed (potentiometer-type) feed system is used to control the amount of material in front of the screed. Instead of an on-off system, the speed of the delivery system is increased when more mix is needed and the speed of the slat conveyor and auger system (on each side of the paver) is decreased when the head of material in front of the screed is too great.
In addition to these limit switch-type and variable-speed systems, both ultrasound and infrared sensing devices can be used to determine the amount of mix in the auger chamber. These two types of systems operate on the same basis as the limit switch system; measuring the amount of mix in front of the screed and controlling the slat conveyor and auger feed system to maintain a constant head of mix at the screed.

**Tow Points**

The screed unit is attached to the tractor at only one point on each side of the paver. This point is called the tow point or the pull point by the different paver manufacturers. The tow point is really a pin-type connection that allows the leveling arms (also called side arms or pull arms) of the screed to rotate or pivot around the point. This pin connection reduces the transmission of movement between the tractor unit and the screed unit.
Screed Unit (Review of Equipment and Function)

Paver Screed

The second unit consists of the paver screed. This leveling device is attached to the tractor unit at only one point on each side of the paver and is able to “float” on the asphalt mix and provide initial texture and compaction to that material as it passes out from under the screed.

The screed unit, which is towed by the tractor unit, establishes the thickness of the asphalt layer and provides the initial texture to the new surface. In addition, the screed imparts some level of density to the material being placed through the vibratory or combination tamping and vibratory action of the screed. The principle of the free-floating paver screed was developed in the early 1930’s. That concept allows the paver screed which is attached to the tractor unit at only one point on each side of the machine (the tow or pull point), to average out changes in grade that are experienced by the wheelbase (rubber tires or crawler tracks) of the tractor unit. The floating-screed principle is employed on all of the modern asphalt pavers in use today.

Screed Plate

The screed plate is a formed piece of steel that bolts to the bottom of the screed. The screed plate is the only portion of the screed that develops the initial texture of the mat and can be adjusted. The center of the leading edge of a rigid screed has grooves cut into it to allow the screed to be flexed or warped.
Strike-Off (Pre-Strike Off)

The screed may be equipped with a device on its front edge that is called a strike-off by some manufacturers and a prestrike-off by others. The purpose of this device is to control the feed of the asphalt mix under the paver screed, thereby regulating the amount of mix that reaches the nose of the screed plate. Further, the strike-off or prestrike-off is used to reduce the wear on the leading edge of the screed. When the strike-off is attached to the front of the screed, its position becomes important relative to the ability of the screed to handle the asphalt mix properly. If the strike-off is set too high, extra material will be fed under the screed. This action will cause the screed to rise. The resulting increase in the mat thickness will be overcome by manually reducing the angle of attack of the screed, using the thickness-control cranks. This, in turn, will cause the screed to pivot around its hinge point and ride on its nose. Rapid wear of the nose plate will result. In addition, the screed will settle when the paver is stopped between truckloads of mix because the weight of the screed is carried only on the front part of the screed.

When the strike-off is set too low, the thickness of the lift will be reduced because of the lack of mix being fed under the screed. In order to maintain the proper thickness, the angle of attack of the screed must be altered, causing the screed to ride on its tail. This increases the wear on the back of the screed and also causes the screed to settle whenever the paver is stopped because of the concentration of weight of the screed on a smaller surface area.
Crown Control

The screed on the paver can be angled at its center to provide for positive or negative crown. The amount of crown that can be introduced into the screed varies. The adjustment of the crown is typically done using a turnbuckle device to flex the bottom of the screed and impart the desired degree of crown. Normally the lead crown setting is 1/32 to 3/16 inch greater than the tail crown position, with 1/8 inch being the average difference in the crown settings.
Screed Extensions and End Plates

Hydraulically Extendible

Most paver manufacturers have developed hydraulically extendable paver screeds that trail the primary or basic screed on the paver. One make of pavers, however, is equipped with a power extendable screed that places the extendable portion of the screed in front of the main screed. For all hydraulically extendable screeds, it is very important that the angle of attack for the extendable screeds is the same as the basic screed. If the extensions on the extendable portion of the screed are not properly aligned with the main screed, a longitudinal mark or ridge will occur in the surface of the mix at the junction between the two screeds. In addition to the longitudinal mark, a mismatch in the elevation between the two screeds can also result in a possible difference in surface texture in the mix. Finally, the lack of proper alignment between the two screeds can cause a difference in the degree of compaction that is obtained in the mix under the extendable screed. In addition, proper placement of the material feed sensor is important to avoid segregation problems.
Rigid Screed Extension

When the basic width of the paver screed (8 feet for small pavers and 10 feet for the larger machines) needs to be changed to accommodate increased paving widths, rigid screed extensions can be employed. These extensions come in several widths, usually 6 in., 1 ft., 2 ft., 3 ft., and 5 ft. sections. Further, it is very important that the extension be set at the same elevation and angle as the basic screed to prevent the presence of a transition line or ridge at the intersection of the main screed and the extension or between different sections of extension. Whenever a rigid screed extension is employed on the basic paver screed, auger extensions and the accompanying auger tunnel extensions should also be added. The length of all the auger and tunnel extensions should, in general, be the same length as the added screed extensions to allow room between the end of the auger and the end plate of the screed. Typically the distance between the end of the auger extension and the end plate should be about 18 inches.

Hydraulic Strike-Off

The hydraulic strike off is an option for most screeds and allows the screed to be extended for brief periods to form turnouts, ramps, etc. Either a strike off or mini screed approximately 6 inches is available to impart initial texture and compaction to the mix that passes under it. However, this texture and compactive effort are normally different from that which develops under the screed. In addition, the mix will need to be left higher than the screed placed mix. The use of hydraulic strike-offs to place mainline paving instead of adding rigid extensions is not considered best practice.
End Plate (End Gate)

An end plate (or end gate or edger plate) is attached to the end of the screed to restrict the outward movement of the mix around the end of the screed. In typical operating mode, however, the end plate is positioned tight to the surface being paved to retain the mix and control the width of material being placed.

Cut-Off Shoes

Cut-off shoes can be used, if necessary, to reduce the width of mix placed to a width that is less than the basic main screed width. Typically the cutoff shoes come in widths of 1 - 2 feet, and are adjustable in increments of 1½ - 3 inches, depending on the manufacturer.

Thickness Control Screws

The thickness-control mechanism, usually either a crank or a handle, allows the screed to be moved or rotated around the pivot point. As the mix passes under the screed plate, the screed floats on the mix, determining the mat thickness and the texture of the material as well as providing the initial compaction of the asphalt mix. For a constant position of the tow point (the tractor unit running on a level surface and without automatic screed controls), altering the setting of the thickness-control devices changes the attitude (angle of attack) of the screed and changes the forces acting on the screed. This, in turn, causes the screed to move up to, or down to, a new elevation as the paver moves forward, and thus alters the thickness of the mat being placed. The reaction of the screed to changes in position of the thickness-control settings, however, is not instantaneous.
Screed Arm (Tow Arm)

The screed is attached to the leveling or tow arms on each side of the paver through a hinge or pivot point. The pivot point is located at the center of the wheelbase of the tractor. This allows the screed to use the tractor as a leveling device, much like a ski.
Pre-Compaction Systems

Early pavers were equipped with tamper bars that were located on the leading edge of the paver screed. These tamper bars were used to tuck the asphalt mix under the screed and to provide some degree of initial compaction to the mix as it passed under the screed. The tamper bar system was replaced by the more efficient vibratory screed system.

Two factors within the screed itself also contribute to the degree of compaction. The first is the frequency of vibration and the second is the amplitude of the compactive effort. The frequency of vibration is controlled by the rotary speed of the vibrator shaft. Increasing the revolutions per minute of the shaft will increase the frequency of the vibration. The applied amplitude is determined by the location of the eccentric weights that are located on the shaft. The position of the eccentric weights can be altered to increase or decrease the amount of compactive effort applied to the mix by the screed. In general, the vibrators should be used near the maximum possible frequency. On screeds where it is possible to change the amplitude of the applied vibrational force, the amplitude setting selected is related to the thickness of the mat being placed; lower amplitude for thinner lifts and higher amplitude for thicker lifts.

The amount of density obtained by the paver screed is also a function of the speed of the paver. The faster the paver moves, the less time the screed sits over any particular point in the new mat, and, thus, the amount of compactive effort applied by the screed decreases. For asphalt concrete mixes, it can be expected that approximately 70 to 80 percent of the theoretical maximum density of the mix will be realized in the mix when it passes out from under the paver screed. A few of the most recent pavers (and many pavers used in other countries) are equipped with combination screeds—both tamper bars and a vibratory screed.
Heating Systems

The screed is equipped with heaters or burners, the primary purpose of which is to increase the temperature of a cold bottom screed plate to approximately 300°F. It is necessary for the screed to be at the same temperature as the asphalt material passing under it in order to assure that the mix does not stick to the screed plate and tear, providing a rough texture to the mat. A properly heated screed, particularly at the start of the day’s paving operations or after any extended shutdown of the laydown process, provides for a more uniform mat surface texture.

The screed heaters cannot be used to increase the temperature of the mix being placed because the amount of time that the mix is actually under the screed is much too short to accomplish any temperature rise in the mix.
**Screed Forces**

There are six basic forces acting on the screed that determine its position and angle (Roberts et al., 1996):

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<table>
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<tbody>
<tr>
<td><strong>1. Towing force.</strong></td>
<td>This is provided by the tractor and exerted at the tow point. Thus, towing force is controlled by paver speed.</td>
</tr>
<tr>
<td><strong>2. Force from the AC head resisting the towing force.</strong></td>
<td>This is provided by the AC in front of the screed and is controlled by the material feed rate and AC characteristics.</td>
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<tr>
<td><strong>3. Weight of the screed acting vertically downward.</strong></td>
<td>This is obviously controlled by screed weight.</td>
</tr>
<tr>
<td><strong>4. Resistive upward vertical force from the material being compacted under the screed.</strong></td>
<td>This is also a function of AC characteristics and screed weight.</td>
</tr>
<tr>
<td><strong>5. Additional downward force applied by the screed’s tamping bars or vibrators.</strong></td>
<td>This is controlled by vibratory amplitude and frequency or tamping bar force.</td>
</tr>
<tr>
<td><strong>6. Frictional force between the screed and the AC under the screed.</strong></td>
<td>This is controlled by AC and screed characteristics.</td>
</tr>
</tbody>
</table>
Factors Affecting Mat Thickness and Smoothness

Since the screed is free floating it will slide across the AC at an angle and height that will place these six forces in equilibrium. When any one of these forces is changed, the screed angle and elevation will change (which will change the mat thickness) to bring these forces back into equilibrium. Therefore, changing anything on the paver that affects these forces (such as paver speed, material feed rate or screed tow point) will affect mat thickness.

Furthermore, since mat thickness needs to be closely controlled, pavers have controls to manually set screed angle rather than rely on a natural equilibrium to determine mat thickness. In typical paving operations, the screed angle is adjusted to control mat thickness.

In order to understand how a manually controlled screed angle affects mat thickness, a brief discussion of how the paver parameters of speed, material feed rate and tow point elevation affect screed angle, screed height and therefore mat thickness is provided.

1. Speed

   Paver speed affects mat thickness by changing the screed angle. If a paver speeds up and all other forces on the screed remain constant, the screed angle decreases to restore equilibrium, which decreases mat thickness. Similarly, as paver speed decreases, screed angle increases, which increases mat thickness.

2. Material Feed Rate

   The amount of AC in front of the screed (the material “head”) can also affect screed angle and thus mat thickness. If the material head increases (either due to an increase in material feed rate or a reduction in paver speed), screed angle will increase to restore equilibrium, which increases mat thickness. Similarly, if the material head decreases (either due to a decrease in material feed rate or an increase in paver speed), screed angle will decrease to restore equilibrium, which decreases mat thickness (TRB, 2000).
Therefore, in order to maintain a constant mat thickness for a change in paver speed or material head in front of the screed, the natural equilibrium of forces on the screed cannot be relied upon and the screed angle must be manually adjusted using a thickness control screw or depth crank. Screed angle adjustments do not immediately change mat thickness but rather require a finite amount of time and tow distance to take effect. It typically takes five tow lengths (the length between the tow point and the screed) after a desired level is input for a screed to arrive at the new level.

Because of this screed reaction time, a screed operator who constantly adjusts screed level to produce a desired mat thickness will actually produce an excessively wavy, unsmooth pavement.

3. **Tow Point Elevation**

Finally, tow point elevation will affect screed angle and thus mat thickness. As a rule-of-thumb, a 1-inch movement in tow point elevation translates to about a 0.125 inch movement in the screed’s leading edge. Without automatic screed control, tow point elevation will change as tractor elevation changes. Tractor elevation typically changes due to roughness in the surface over which it drives. As the tow point rises in elevation, the screed angle increases, resulting in a thicker mat. Similarly, as the tow point lowers in elevation, the screed angle decreases, resulting in a thinner mat. Locating the screed tow point near the middle of the tractor significantly reduces the
transmission of small elevation changes in the front and rear of the tractor to the screed. Moreover, because the screed elevation responds slowly to changes in screed angle, the paver naturally places a thinner mat over high points in the existing surface and a thicker mat over low points in the existing surface (TRB, 2000).

The interaction of paver speed, material feed rate and tow point elevation determine the screed position without the need for direct manual input. This is why screeds are sometimes referred to as "floating" screeds.

**INSPECTION AND MEASUREMENTS**

- Verify head of material at the auger – should be maintained at center of auger shaft for consistent mat thickness
- Augers should be turning slowly and consistently approximately 100% of the time
- Verifying material thickness behind screed by sticking the mat
- Placement of straightedge behind screed, parallel to the screed to verify correct cross-slope
- Minimizing folding of hopper wings to every third or fourth load
- Uniform mat appearance behind the screed to minimize streaking

*Describes inspection, Quality Assurance and/or Quality Control practices.*
Automatic Screed Control

As discussed previously, the screed angle can be manipulated manually to control mat thickness. However, tow point elevation is not practical to manually control. Therefore, pavers usually operate using an automatic screed control, which controls tow point elevation using a reference other than the tractor body. Since these references assist in controlling AC pavement grade, they are called “grade reference systems” and are listed below (Roberts et al., 1996):

- **Erected stringline.** This consists of stringline erected to specified elevations that are independent of existing ground elevation. Most often this is done using a survey crew and a detailed elevation/grade plan. Although the stringline method provides the correct elevation (to within surveying and erecting tolerances), stringlines are fragile and easily broken, knocked over or inadvertently misaligned. Lasers can be used to overcome the difficulties associated with stringlines because they do not require any fragile material near the pavement construction area. Lasers can establish multiple elevation or grade planes even in dusty or high-electronic and light-noise areas and are therefore sometimes used to construct near-constant elevation airport runways. The laser method becomes quite complicated, however, when frequent pavement grade changes are required.

- **Mobile reference.** This consists of a reference system that travels with the paver such as a long beam or tube attached to the paver (called a "contact" device since it actually touches the road) or an ultrasonic device (called a "non-contact" device since it relies on ultrasonic pulses and not physical contact to determine road elevation). The mobile reference system averages the effect of deviations in the existing pavement surface over a distance greater than the wheelbase of the tractor unit. Minimum ski length for a contact device is normally about 25 ft. with a typical ski lengths being on the order of 40 to 60ft. (Asphalt Institute, 2001).

- **Joint matching shoe.** This usually consists of a small shoe or ski attached to the paver that slides on an existing surface (such as a curb) near the paver. Ultra sonic sensors accomplish the same task without touching the existing surface by using sound pulses to determine elevation. This type of grade control results in the paver duplicating the reference surface on which the shoe or ski is placed or ultra sonic sensor is aimed.

In addition to grade control, the screed can also be set to control pavement slope and/or crown. A slope controller uses a slope sensor mounted on a transverse beam attached to the screed to determine
screed slope, then adjusts screed slope to the desired amount. Generally, one side of the screed is set up to control grade and the opposite side is set up to control slope based on that grade. The usual practice is to run grade control on the side of the screed nearest the pavement centerline and run slope control on the screed side nearest the pavement edge because it is easier to match the centerline joint if grade control is used on that side of the paver (TRB, 2000).

Screed crown (the elevation of the middle in relation to the edges) can also be controlled. Typically screeds offer separate front and rear crown controls. If crown control is used, the front control is usually set to a slightly more severe crown than the rear control to allow for easier passage of AC under the screed.

**Screed Operation Summary**

The floating screeds used by today’s pavers are acted upon by six basic forces, which when left undisturbed result in an equilibrium screed angle and elevation that determines mat thickness. Adjusting paver speed, material feed rate or tow point elevation will change these forces and result in a new equilibrium screed angle and elevation and eventually a new mat thickness.

**BEST PRACTICE**

In order to achieve the most consistent thickness and smoothest possible surface, pavers attempt to maintain a constant speed, use automatic feed controls to maintain a consistent head of material in front of the paver, and use automatic screed control to maintain a consistent tow point.

*Deskripsi a best practice to be utilized when possible.*

Although the screed angle can be adjusted manually to change mat thickness, excessive adjustments will result in a wavy, unsmooth mat. In addition to grade, screeds can also control mat slope and crown to provide almost complete control over mat elevation at any location.
Chapter Four Knowledge Check

1. The paver consists of two primary parts: the tractor unit and the screed unit.
   a. True
   b. False

2. The proper depth of material on the augers should be at the
   _fill mark on the auger shaft_.
   a. Fill mark on the auger shaft.
   b. Top of the auger shaft
   c. Two inch mark of the auger shaft.
   d. Center of the auger shaft.

3. The primary key to the placement of a smooth pavement layer is the use of a material feed system to keep a constant head (level) of material in front of the screed.
   a. True
   b. False

4. The screed unit is attached to the tractor at:
   a. One point on each side of the paver.
   b. Two points on each side of the paver.
   c. Three points on each side of the paver.

5. The amount of density obtained by the paver screed is also a function of the speed of the paver.
   a. True
   b. False

6. The primary purpose of the heater or burner on the screed is to assist in reheating the asphalt mix to make up for heat loss during transit.
   a. True
   b. False

7. When changing the thickness control screws or tow point position, it takes ________ before an adjustment is completed.
   a. 15 minutes
   b. One tow length of the paver
   c. Five tow lengths of the paver

8. When changing trucks during paving, it is best if the transfer is accomplished without slowing down or stopping the paver.
   a. True
   b. False

9. Auger operation and conveyor operation should be adjusted to keep them running as close to _________ percent of the time as possible.
   a. 80
   b. 90
   c. 95
   d. 100