Rolling Patterns To Achieve Density And Production

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Midwest Contractor

Provided By: Volvo Construction Equipment Shippensburg, Pa.

During most paving operations, at the end of each production day or night, someone from the contractor's management team asks the paving crew how many tons were placed. Often, the real question is how many tons were laid for which full payment and incentive, if available, has been earned. Productivity seems to drive the behavior of most paving contractors.

A productive paving project is well choreographed. The four primary elements of plant output, transportation, laydown, and compaction are carefully balanced to achieve best results. When any one of these items is out of balance, productivity drops.

Most paving contractors know precisely how many tons of mix the asphalt plant is capable of producing on an hourly basis. The contractors know the storage capacity of the silos. Contractors determine whether the plant will be providing mix for only one project or for multiple projects at the same time. If the contractor does not own a plant and must purchase mix from another producer, the number of tons of mix to be purchased is usually a contract item and of predictable supply.

Contractors also know the size and capacity of the transport trucks used to deliver hot mix asphalt (HMA) to the project. From experience, contractors estimate the round-trip transportation time from plant to job site and determine how many loads each truck can deliver per unit of time.

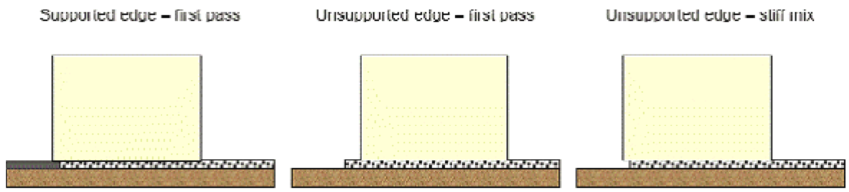
When it comes to laydown and compaction, predictions on productivity are less certain. Especially for compaction, the variables of how much HMA is produced and when it is delivered influence the temperature of the asphalt when compacted. Mix temperature is the most critical element in compaction. Keeping compactors in the proper rolling zone to achieve target density requires the right rolling patterns.

Best Practices of Compaction

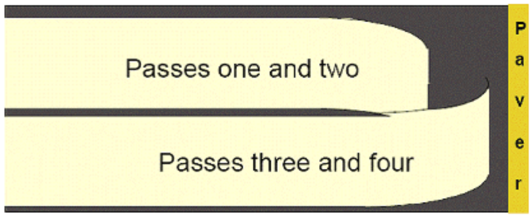
There are several procedures that compactor manufacturers teach operators to increase productivity. Since nearly all breakdown rolling today utilizes vibratory double-drum compactors, the following best practices concentrate on operating of this type of compactor.

Make the first pass toward the paver with vibration on.

The first pass achieves the most air void reduction because the mix viscosity is low and the ability to rearrange aggregate particles into closer orientation is high. If the edge of the pavement is supported against lateral movement, the operator should slightly overlap the joint between cold and hot panels. The more skilled the operator, the narrower the overlap of the joint needed. Most operators need only 3 inches to 4 inches of overlap. If the edge of the pavement is unsupported, the operator should make this first pass 6 inches to 8 inches away from the edge to reduce lateral shoving of the mat. Stiffer mixes may not require this precaution. Figure 1 shows the proper drum orientation to the pavement on the first pass. Stop forward motion of the compactor, rolling in a slight arc toward the center of the panel, a safe distance behind the paver and crew.

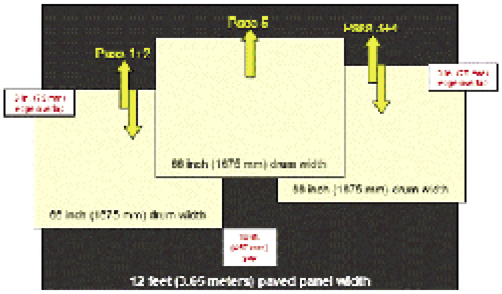


The reason for stopping on an angle is to facilitate rolling out drum depressions on the next pass. This helps prevent formation of bumps on the pavement. Figure 2 shows the technique. The pass on the left side of the panel stops in an arc and the compactor returns on the same path. The next forward pass is on the right side of the panel, passing the previous forward pass, with an arc toward the center of the panel. This technique permits the compactor to achieve more uniform density by staying in the same range of temperature with each side-by-side pass. Roll the end of each subsequent pass beyond the end of the adjacent and previous pass.



This is also shown in Figure 2. Following the forward motion of the paver keeps the breakdown compactor in the same relative temperature range of the mat as the paver. Limiting the length of the breakdown rolling zone helps the front compactor keep up with the paver. There is no more important technique in compaction, especially for stone mastic asphalt (SMA) and Superpave mixes.

Complete breakdown rolling before the mix cools below a temperature consistent with achieving target density.



This technique accomplishes two objectives. For the majority of mixes, it permits the highest production to be achieved. For those mixes that exhibit tenderness, this permits density to be reached before the mix begins toexhibit instability.

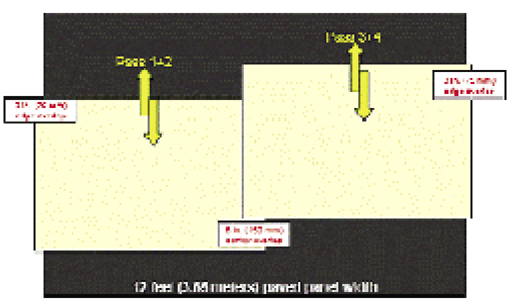
Compact the joint for uniform density.

One of the more common deficiencies found in HMA pavements is low joint density. Low density at the joint is caused by poor paving technique, excessive luting and raking, poor rolling practice, or a combination of these. Poor rolling practice can be overcome by proper training of compactor operators and through experience. The Ingersoll Rand Road Institute offers a number of courses that teach compaction techniques to paving crews.

Select a compactor based on effective rolling width.

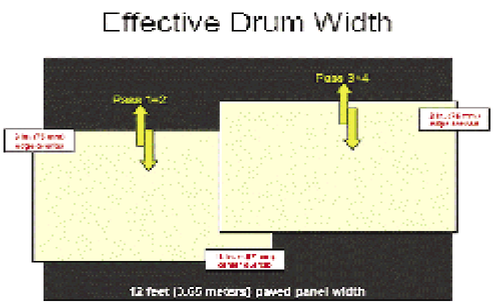
The length of the compactor drum is not the true measure of the productive capacity of the compactor. Rather,effective drum width (EDW) is the important metric. The difference between EDW and drum length can be significant. Generally, these two dimensions are within 10 percent. Several examples in Figure 3 (click to enlarge) shows this relationship.

The width of the paved panel in Figure 3 requires three side-by-side passes of the compactor to provide complete coverage. Unfortunately, even the best operator will fail to achieve uniform pavement density when making a rolling pattern like the one shown, since the compaction forces are not evenly applied across the width of the panel. The fifth pass overlaps the pavement surfaces compacted during the first four passes, but gives only a single pass over the middle 18 inches of the panel. This means density will be lowest in the center, slightly higher at the outer quarters of the panel, and highest in the sections where three drum passes were made. This does not meet the necessary requirements. The narrow rolling width also interferes with the ability of the operator to keep up with the paver.



Notice in Figure 4 (click to enlarge) that only two side-by-side passes are needed to completely cover the same panel width from Figure 3. This is due to a compactor with a wider EDW. The well-trained operator on a compactor with 78-inch drums is able to compact the panel with uniform coverage except in the exact center where the side-by-side passes overlap slightly. Using this breakdown rolling technique will achieve uniform density across the panel and help achieve requirements.

It is also possible to have drums that are too wide for the panel. In Figure 5 (click to enlarge), the compactor drums are 84 inches wide.



The center of the panel is receiving twice as much compaction force as the outer sections. Because a compactor with drums too wide for the pavement was used, breakdown rolling results will fail to achieve requirements. In addition, the larger compactor has higher ownership and operating costs, so there is reduced payback to the contractor on the investment.

This is the reason nearly all manufacturers produce highway-class compactors with drums in three basic widths: 66 inches, 78 inches and 84 inches.

The major contribution of the compactor to the paving train is the ability to achieve density. Selecting a compactor size is sometimes based on what is in a contractor's fleet. Since keeping up with the paver is as important as achieving uniform density, attention to compactor selection and rolling patterns yields benefits, especially in the success of achieving specifications.

Editor's Note: AB Volvo purchased the road development business unit of Ingersoll Rand earlier this year. The Volvo equipment shown in the pictures are still displaying Ingersoll Rand designations.

1.1 Balancing HMA Production And Placement

By Dale Starry
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Texas Contractor
Understanding the role of vibratory compactors in asphalt laydown.

Provided By Volvo Construction Equipment, Shippensburg, Pa.

To achieve the best results and most profitable operation on a paving project, contractors must balance a complex series of events and equipment choices during hot mix asphalt (HMA) production and especially in the critical compaction phase.

Production

The size of the project determines whether a contractor will rely on a top-end stationary drum mix facility that produces up to 700 tons per hour of HMA or a portable drum/batch plant that produces 30 tons to about 100 tons per hour of HMA.

Delivery

Transport vehicles, some designed specifically to haul HMA, play a critical role in temperature control and segregation. The longer a mix is stored in a silo and the longer the delivery time to the paver, the greater the temperature loss. Once the type and capacity of the haul vehicles is matched to the paver's capacity, the delivery of HMA from the plant to the paving project requires consistency timed with the speed of the paving train so that the mix is placed at uniform temperature.

Placement: Laydown

Placement of HMA is a two-part process. Laydown speed depends upon the paver operator's skill in three primary areas. The first focuses the operator's attention forward to the amount of HMA being delivered to the paver. The second focuses downward at the width and thickness of the pavement panel being laid. The third focus is behind, to see if the compactor train is keeping up with the paver.

This delicate balance in production and placement must be maintained throughout paving. If the delivery of mix to the paver is interrupted, the paver must slow down or at worst, stop. If the paver outruns the compactor train, the entire operation is at risk of failing to achieve target density and/or pavement smoothness.

Placement: Compaction

The second step, compaction, must be completed within a finite time period, an interval referred to as time available for compaction (TAC) and varies based on the environment, mix properties and mix temperature. By the time the breakdown compactor begins the compaction process, the mix may have cooled 10 percent to 15 percent from the point of production.

Most compactor manufacturers provide charts to show the expected TAC on a pavement panel placed at a certain temperature over a base of a certain temperature and measured thickness. The TAC varies from less than 10 minutes to greater than 20 minutes based only on the difference in temperature of the base. Obviously, it is more difficult to achieve specified density in 10 minutes than in 20, with all other factors remaining constant.

Compaction speed must match paving speed for optimum project efficiency. If a vibratory compactor is utilized for breakdown, the rolling speed is controlled by the need to achieve pavement surface smoothness. A vibratory compactor drum impacts the surface of the pavement each time an unbalanced weight inside the drum spins one complete revolution. Vibratory compactor drums must make between 10 to 14 drum impacts for each foot of travel.

Vibration frequency of the compactor is measured using a vibrating reed tachometer or similar tool. Dividing vibration frequency by the required drum impacts per length of travel determines the rolling speed of the compactor with vibration. For example, a vibratory compactor with 2,500 vibrations per minute frequency that delivers 12 drum impacts per foot spacing means the compactor can roll at a maximum speed of 208 feet per minute or 2.4 miles per hour. This vibratory compactor cannot increase rolling speed if it fails to keep pace with the paver. To do so would change impact spacing and risk failure to achieve smoothness.

This is why vibratory compactor manufacturers like Ingersoll Rand have developed high-frequency vibrating compactors. These units have a vibration frequency of 4,000 vibrations per minute or greater. With the same drum impact spacing of 12 impacts per foot, a vibratory compactor with 4,000 vibrations per minute can increase rolling speed to 330 feet per minute or 3.8 miles per hour and still achieve pavement surface smoothness. The higher vibration frequency provides a 50-percent faster speed to keep up with faster, more productive pavers.

Balance

The best paving projects find balance between placement and production, between mix delivery and production, and careful control of the paving speed and compaction of the mix at consistent temperatures.