ASPHALT COMPACTION

ROLLING PATTERNS

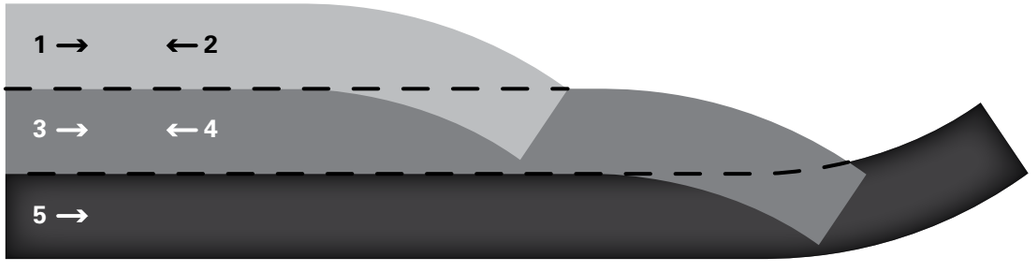
A rolling pattern is a series of movements made by a compactor or compactors on a freshly-laid, uncompacted asphalt layer. The rolling pattern is intended to be consistently repeated in order to produce uniform density in the asphalt layer.

The rolling pattern covers a certain area of square meters (feet) defined by the length and width of the pattern. It is assumed that the thickness of the asphalt layer is relatively consistent from one edge of the mat to the other within the pattern. The temperature of the asphalt mix within the rolling pattern will also be reasonably consistent as long as the area covered by the pattern is always in the same relationship to the paver as the paver moves forward. Therefore, a rolling pattern with a consistent number of passes, a consistent working speed and consistent compaction forces should produce uniform density.

Note: In this manual, the term "pass" shall mean the movement of the compactor in one direction. In other words, when the compactor begins a pattern by moving forward from a starting point to a point closer to the paver, that movement is considered one pass. When the compactor reverses to return to the starting point of the pattern, that movement is considered another pass.

Once a rolling pattern has been established, it should not be altered unless there are changes in the paving process in front of the compactor, changes in the mix formula or changes in climate conditions.

REVERSING



BASIC ROLLING PATTERN

There are certain techniques that are common to any rolling pattern. One technique is stopping and reversing a tandem drum roller at the end of a pass.

In the drawing shown above, it is assumed that the mat has two unconfined edges or that there is no adjacent cold mat to roll onto. The compactor operator must stop and reverse on the hot mat.

Notice that the first two passes are along one edge of the mat. At the end of Pass One, the operator turns toward the center of the mat and stops slowly with both drums turned at least 30° leaving the stop mark at an angle to the direction of compaction. The operator reverses in the same path for Pass Two.

Pass Three is down the center of the mat with some overlap on the coverage of Passes One and Two. Pass Three is longer than Pass One in order to keep up with the paver and to clean up the stop mark left at the end of Pass One.

Two initial phase compactors reversing direction behind a paver. Note angled stop.

At the end of Pass Three, the operator turns toward the uncompacted edge, being careful to not push out the edge of the mat. Again, the stop mark is left at an angle to the direction of compaction. The operator reverses in the same path for Pass Four.

Pass Five is along the other unconfined edge with some overlap on the coverage of Passes Three and Four. Pass Five continues through the stop mark left at the end of Pass Three. At the end of Pass Five, the operator turns toward the center of the mat leaving an angled stop mark where the next pattern will clean it up. The operator reverses in the same path for Pass Six.

Pass Seven will reposition the compactor to start another pattern. This is called a seven-pass pattern.

This pattern results when it takes three overlapping passes to cover the width of the mat and it takes two passes per coverage to create the required density.

Initial phase compactors are always stopping to reverse in proximity to the rear of the paver. There are no absolute rules that dictate how far behind the paver the compactor should stop. Workplace safety should be the primary consideration. A reasonable guideline would be for the compactor(s) to stop at least 5 m (16') behind the paver. Remember, there may be laborers or screed operators working on the mat behind the paver.

User Tip: *When stopping a steel drum roller to reverse direction, whether on a hot mat or a cold adjacent mat, always shut off the vibratory system as soon as you begin to slow down. Remember, it is important to maintain drum impact spacing. As the machine speed decreases, the impacts may be too close together. You can manually deactivate the vibratory system or you can select the "AutoVibe" feature that will automatically stop and start the vibratory system when the working speed reaches programmed levels.*

Pneumatic compactors are allowed to stop straight on the mat.

Unlike steel drums, the rubber tires on pneumatic compactors should not be turned when bringing the compactor to a stop. Aggressive turns with pneumatic compactors will tear the mat. The pneumatic compactor should stop slowly without turning. There will be a slight stop mark in the mat, but usually the finish roller will clean up those marks completely.

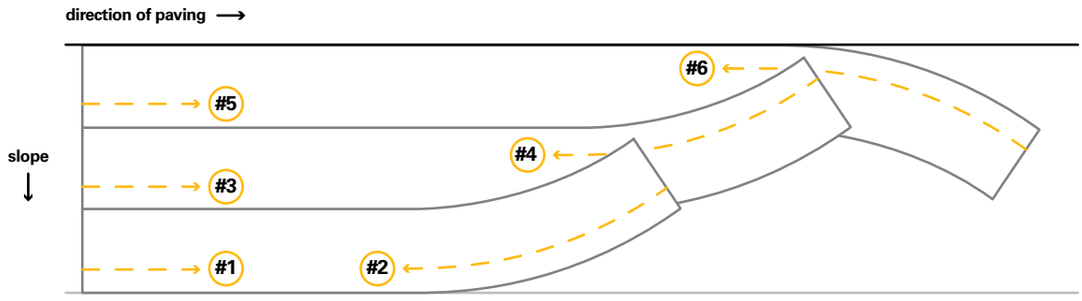
PATTERN FOR TWO UNCONFINED EDGES

In this example, assume that the mat has two unconfined edges, that the left edge is the centerline of the structure and that there is a 2% slope from the centerline to the right unconfined edge.

When the structure to be compacted has two unconfined edges and a sloped surface, Caterpillar recommends making the first passes along the lower edge of the structure. The next series should be in the center of the mat. The final passes should be along the upper unconfined edge. Compaction from the low side to the high side tends to build strength in the mat and reduce the amount of mat deformation.

In general, the First Pass along any unconfined edge should be made with the drum edge at least 15 cm (6") away from the edge. The Second Pass, typically the return pass in the same coverage area as the first pass, should be made with the drum slightly overlapping the edge. This sequence also helps minimize mat distortion.

TWO UNCONFINED EDGES



When compacting unconfined edges, watch for cracks in the mat along the drum edge when the drum edge is set back from the unconfined edge. Some mixes with large aggregates and low asphalt cement content will show deep cracks if the edge is not overlapped during the first pass.

When cracks appear, immediately change the rolling pattern to overlap the unconfined edge with every pass along the edge of the mat.

Pneumatic compactors should not overlap unconfined edges. The rubber tires should be at least 15 cm (6") away from the unconfined edge to avoid rolling over or distorting the edge of the mat.

Crack in the mat along drum edge set back from the unconfined edge.

Pneumatic compactors always stay al least 15 cm (6") from unconfined edges.

PATTERN FOR ONE CONFINED EDGE

In this example, assume that the left edge of the mat is matching an adjacent mat along the centerline of the structure. The adjacent mat is compacted and is cold. Traffic cones are set adjacent to the centerline edge on the cold mat and traffic is present on the cold mat. A 2% slope runs from the centerline down to the unconfined edge. You have two acceptable rolling patterns for this application.

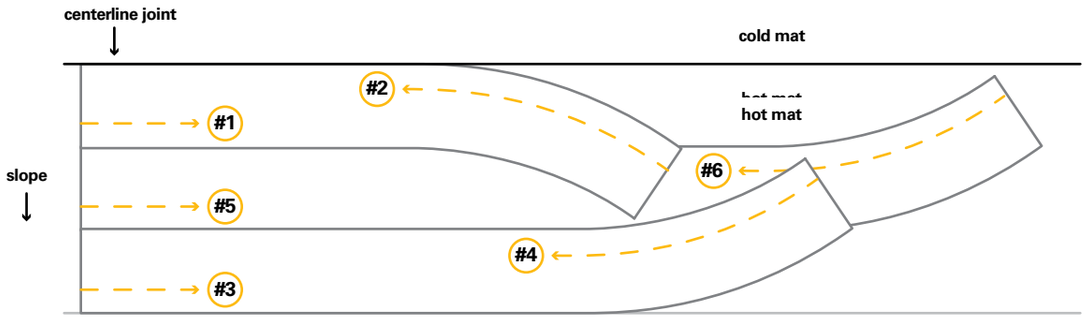
If there is a joint density specification on the project, then the first pass should be along the left edge of the mat to take advantage of the highest mat temperature resulting in the highest joint density. Both drums should be completely on the hot mat about 15-30 cm (6-12") away from the cold mat. During Pass Two, the return pass along the left edge, the drums should be positioned to overlap the hot / cold joint by about 15 cm (6"). The overlap will begin the process of sealing the longitudinal centerline joint.

Passes Three and Four will be along the unconfined edge to build strength and minimize mat deformation at the unconfined edge.

Passes Five and Six are made in the center of the mat. This portion of the mat will be the coolest by this time, but the center portion of the mat will have, in effect, two confined edges to aid in compaction.

If there is no joint density specification, then Passes One and Two can be along the right edge on the low side of the sloped mat as shown in the illustration for two unconfined edges. The center of the mat is compacted by Passes Three and Four. Finally, the centerline joint is compacted with Pass Five slightly off the joint and Pass Six overlapping the joint.

ONE UNCONFINED EDGE



Pneumatic compactors in the intermediate phase are effective at sealing hot / cold longitudinal joints.

There are no drum stop marks in the fresh mat when the compactor is able to roll onto a cold, compacted mat.

All other compactors during intermediate or finish phases may overlap the longitudinal joint. The rubber tires of pneumatic compactors are particularly efficient at "pinching" joints. The pneumatic compactor operator should try to straddle the joint with one of the tires.

On some projects, the edge of the mat that is matching a joint will be adjacent to a cold, compacted mat. Whenever possible, compactor operators should roll off the hot mat and onto the cold mat to stop and reverse direction. By reversing direction on the cold mat, there will be no stop marks left on the hot asphalt layer and smoothness will be improved.

The compactor operator must be aware of several safety issues when rolling off the hot mat to stop and reverse. First, there may be traffic using the adjacent lane. Pilot vehicles may be leading traffic through the work zone. The operator should never pull onto the adjacent mat if there is traffic present.

Second, there may be workers around the paver. In particular, laborers may be raking the joint behind the paver. Be sure to pull off the mat far enough behind the paver if there are workers present.

PATTERN USING EMERGENCY LANE FOR REVERSING

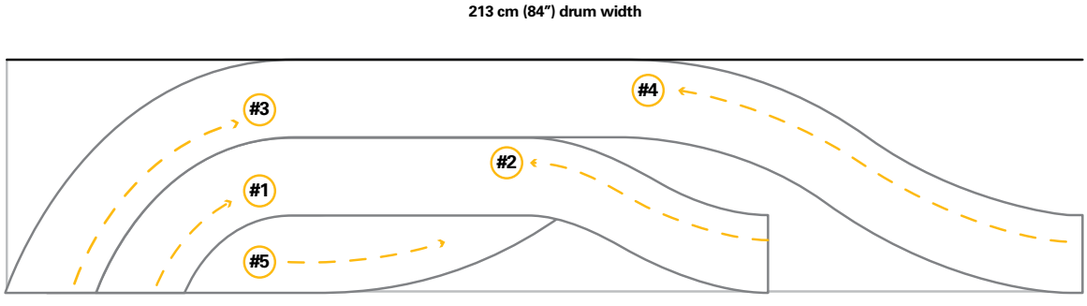
On some projects, the plan calls for the paving width to include an emergency lane (also referred to as a shoulder or breakdown lane) along with one driving lane. Normally, if the emergency lane is less than 1.5 m (5') wide, it will be included in the conventional pattern used by the initial phase compactor. Or, if the emergency lane has a separate slope, sometimes the emergency lane will be compacted by a utility compactor and will not be included in the pattern with the driving lane.

However, if the emergency lane is at least 1.5 m (5') wide, the emergency lane can be included in the initial phase pattern and can be used for all compactor stopping and reversing.

The rolling pattern will resemble a series of half circles. After each pass, forward and backward, the compactor operator will arc slowly across the driving lane and straighten out on the emergency lane with both drums on the emergency lane. The compactor operator will stop straight. Stopping straight is generally permitted on emergency lanes since there is no smoothness specification for emergency lanes.

If a pneumatic compactor is part of the compaction train, the pneumatic compactor will continue to stop straight on the driving lane and will not turn off onto the emergency lane. The finish compactor should use the emergency lane for stopping and reversing, too.

REVERSING ON EMERGENCY LANE

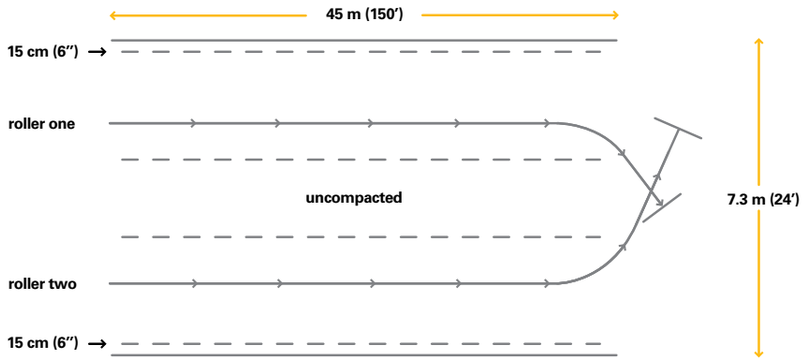


ECHELON COMPACTION PATTERNS

On some projects, two or more compactors may operate in the initial compaction position directly behind the paver. For the following reasons, an echelon pattern should be selected.

- **Wide width paving.** When the paving width exceeds 6 m (20'), it is unlikely that one compactor will be able to cover the paving width in three or fewer passes. Therefore, in general, one initial compactor will not be able to match the paver production.
- **Stiff mix requiring many passes.** Some mix designs, especially those including modified asphalt cement, are very stiff and require many passes to bring density up to required levels. In that situation, the pattern needed for one compactor will cause that compactor to fall behind the paver.
- **Limited time for initial compaction.** The time available for initial compaction may be limited by the thickness of the mat, ambient temperature, or the appearance of a tender zone in the mat. Sometimes, more than one initial compactor is needed to cope with rapid temperature loss and a short opportunity to get initial density.

INITIAL PHASE — PASS ONE

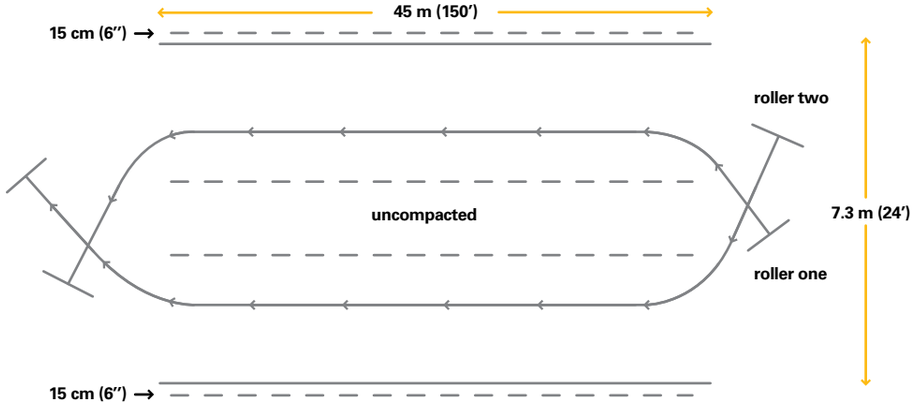


In the first example, assume that the paver is laying down 275 tonnes per hour (300 tons per hour) at a width of 7.3 m (24') and at a depth of 50 mm (2"). The effective paving speed is 6 meters per minute (20 feet per minute). There are two 200 cm (79") wide tandem drum rollers available for initial compaction. It takes two passes to bring density to the compaction target of the initial phase.

Roller One starts first along the left edge with the outer drum edge about 15 cm (6") away from the unconfined edge. Roller Two begins just after Roller One and operates along the right edge, also staying away from the unconfined edge. Roller One comes to a slow stop at an angle in the center of the mat and reverses. Roller Two moves slightly past the Roller One stop and also turns toward the center and reverses.

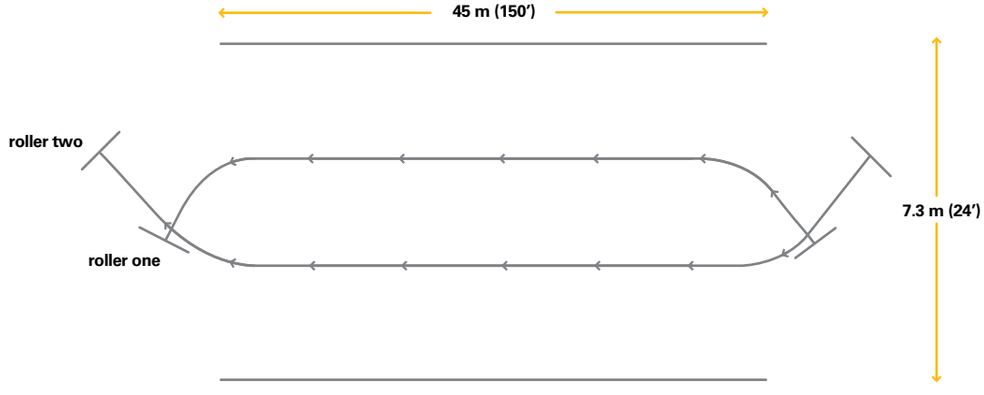
User Tip: *When employing an echelon pattern, the lead roller should be far enough in front of the second roller that the operator can complete the stop and reverse maneuver before the second roller starts to turn and reverse.*

INITIAL PHASE — PASS TWO



During Pass Two, the return to the starting point, Roller One is in the lead with Roller Two slightly behind. During Pass Two, the outer drums slightly overlap the unconfined edges. Again, both compactors turn toward the center of the mat to make the stop and reverse. At this point, the outside edges of the mat have been compacted twice. There is a strip in the center of the mat that is about 3.5 m (11.5') wide.

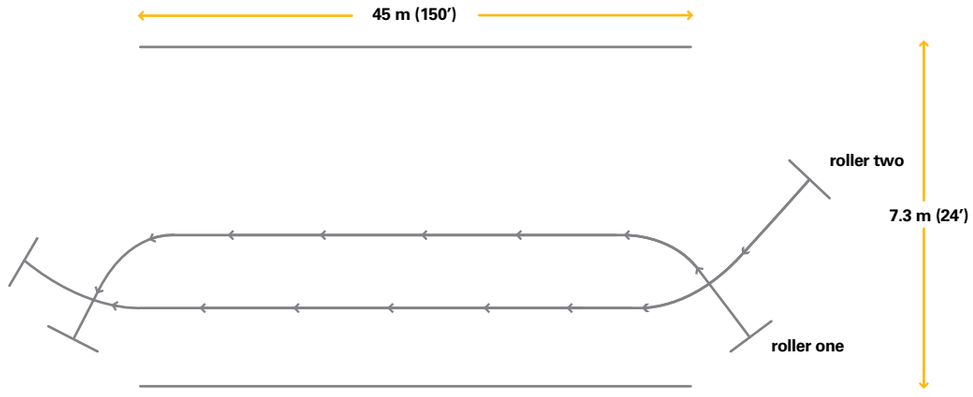
INITIAL PHASE — PASS THREE



For Pass Three, Roller One goes first and operates on the left center of the mat with a slight overlap of the left drum edge onto the area covered in the first two passes. Roller One will pass straight over the drum stop mark left by Roller Two, moving forward about 8 m (25') past the stop mark before turning toward the right edge to stop and reverse.

Roller Two is slightly behind and operates on the right center portion of the mat with the right drum edge slightly overlapping onto the area covered in the first two passes. Roller Two will clean up the first stop mark left by Roller One, continue forward another 8 m (25') past the stop mark and turn toward the left edge to stop and reverse.

INITIAL PHASE — PASS FOUR



During Pass Four, the two compactors return in the same area back to the starting point with Roller One slightly ahead of Roller Two. It is recommended that they roll straight through the stop marks they left at the end of Pass Two before stopping and reversing.

Stopping to reverse repeatedly in the same area will overwork the fresh asphalt.

User Tip: *Whenever possible, use a pattern that cleans up compactor stop marks. Do not stop and reverse in the same area. Stopping and reversing in the same area can distort the mat and create bumps that cannot be cleaned up. While it is most important to avoid stopping in the same area when the compactors move forward and reverse on the hot mat behind the paver, it is also a good practice to stagger the stop marks at the end of the return passes.*

Pass Five will be a static pass moving forward toward the paver. Both compactor operators should position their machines along the edges of the fresh mat and start the vibrator systems when the compactors enter the uncompacted zones. There should be a new pattern area about 36 m (120') long in front of the old pattern.

User Tip: *If the new pattern is too short, in other words, the paver has not moved far enough forward, the compactor operators should reduce their working speeds during Pass Five. Pass Five is done in the static mode so there is no concern about drum impact spacing. Reduce the compactor speed, but never park on the fresh mat.*

User Tip: *Sometimes the area left uncompacted in the center of the mat is relatively narrow. In that situation, there will be a large overlap between the drums of the two compactors in the center of the mat. Because a lot of the drum surface will be vibrating on an already dense mat, there is likelihood that the drums will bounce. The operators should be ready to reduce the amount of force being delivered by operating with one drum vibrating and one drum static.*