Segregation occurs when the fine and coarse aggregates become separated from each other during the hauling or paving operation. Segregated course feature locations where there are primarily coarse aggregate particles with no fines. The appearance is similar to an open graded mixture. There will be other locations within a segregated course where there are few, if any, pieces of coarse aggregate and mainly consists of asphalt coated fines. The appearance is similar to a sand surface. Common causes of segregation include improper loading of trucks, faulty paver auger operation, and situations where a paver is forced to stop because the hopper runs out of mixture. To avoid the paver having to stop, many paving trains include a material transfer device sometimes referred to as an MTD or a "shuttle buggy". Shuttle buggies essentially provide a larger hopper capacity for the paver and permit the paving operation to progress as long as a sufficient number of trucks hauling mixture are available.

Flushed pavements have locations where liquid asphalt collects on the surface of the course. This may result from excess tack coat being brought up through the course, improper mixing of the materials, or too much PG binder in the mixture.

The remedy for segregated courses usually requires removal of the affected areas and replacement with suitable material. Minor areas of segregation can be repaired using a sand seal coat. Larger and more significant flushed pavement areas shall require removal and replacement, diamond grinding, or other fine milling to remove the excess asphalt. Mark all segregated or flushed areas for correction by the Contractor prior to the course being covered by another lift of material or opened to traffic. Corrective action should be in accordance with the Contractor's QCP. If the QCP does not address the repair of segregated or flushed pavements and an agreement on a solution cannot be reached with the Contractor, contact the AE. The M&T, CM, and the Department's Highway and Pavement Design section are all available resources for determining the scope of the required repair.

Another common defect in a newly placed course is pulling or tearing. The course can be torn or pulled by:

- a paver that is traveling too fast
- a paver with a worn screed, or a screed that is not heated properly
- compacted by a roller that is traveling too fast or rolling a mix that is too tender.

Mark all torn areas so they can be repaired by the Contractor prior to the course being covered by another lift of material or opened to traffic. All torn areas must be repaired in accordance with the QCP. If the QCP does not address the repair of tears in the course, contact the AE if no agreement on an appropriate repair can be reached with the Contractor.

13.16 COMPACTION AND DENSITY *(Rev. 03-01-22)*

For 402 mixtures, compaction is performed in accordance with 402.15. Since cores are not taken to verify in-place density, the PEMS must verify that the Contractor is performing the rolling operation in accordance with the SS requirements.

For 401 QC/QA mixtures, density is one of the properties included in the QA Adjustment calculation. In most situations, it is necessary to take cores to determine the density pay

factor. However, there are exceptions to core density control related to overlays placed on shoulders. The PEMS should refer to 401.16 to help determine whether cores are required for these situations. When cores are not required, the density is assumed to be 94% MSG and the pay factor for that sublot is assumed to be 1.00.

In general, there are three compaction phases:

- Breakdown or Initial Rolling.
- Intermediate Rolling.
- Finish Rolling.

Breakdown rolling provides the initial compaction of the mix beyond the small amount of compaction provided by the paver's vibratory screed. This initial rolling process helps seat the mix and introduces aggregate interlock. The intermediate rolling process helps further compact and seal the newly placed mixture. Finish rolling is necessary to remove roller marks and other imperfections present in the new course.

There are many aspects of the rolling operation that affect density in the course. Roller speed is one such factor and maximum roller speed requirements for situations where density is not controlled by cores are included in 401.15. Be aware that there are different maximum speeds for static and dynamic rollers.

Density of the newly placed mixture is affected by the way the Contractor rolls the course. Information related to acceptable compaction is included in 402.15. The finish rolling operation should be performed while the mixture is still sufficiently warm to compact. There is no set rule for the timing and spacing of rollers. Mixture properties and atmospheric conditions affect the compaction of the course. During the rolling operation, roller passes should be differing lengths so that the roller is not always reversing direction at the same location. Achieving the highest course density possible is the objective of the rolling operation.

The Contractor must be performing QC testing in conjunction with their rolling operation to maximize the course density while minimizing the rolling effort. Periodically, the Contractor may need to adjust the number of roller passes, as well as the amplitude and frequency of the vibratory rollers, to achieve density requirements. There should be no roller marks, creases, or other surface defects in a course when the rolling operation has been completed. The approved QCP should include information regarding corrective action for situations where the rolling operation has not achieved satisfactory density results.

Areas that cannot be compacted by a roller must be thoroughly tamped with mechanical tamps or vibrators. Tampers should be operated to achieve a thoroughly and uniformly compacted surface over the entire course. Often the areas requiring tamping methods of compaction are at critical locations. Care must be exercised to avoid over-tamping the mix and creating low spots which allow water to pond.

During the rolling operation surface distresses may develop. Common distresses include

waviness, surface cracks, honeycombed texture, shoving, and roller chatter in the surface. Similar to the spreading operation, these distresses may be due to one or more of the following causes:

- Rolling too soon.
- Rolling too fast.
- Excessive rolling which crushes coarse aggregate.
- Turning the roller too abruptly.
- Too much slack in the roller drives.
- Reversing the roller too abruptly.
- Allowing the roller to stand on fresh surface.
- Insufficient rolling.
- Roller too light.
- Mixture temperature.
- Mixture composition.
- Incorrect vibratory roller frequency or amplitude.

Upon completion of the rolling operation, the course must be protected from vehicular traffic until it has sufficiently cooled (approximately 175˚F) to prevent damage from the traffic. The required cooling time varies due to atmospheric conditions.

Urban construction often requires compaction practices that differ from rural paving operations. It is essential to have a good joint seal between the new course and the adjacent curb or curb and gutter. Thorough compaction adjacent to the curb, at intersections, and adjacent to castings is essential to produce quality construction. In addition to the compaction requirements, the finished surface course must match or be slightly higher than the grades of adjacent gutters and castings to ensure proper drainage. In many situations, an improper matching of grades between a pavement surface and an adjacent gutter line or inlet casting can cause water to pond over a significant area. The PEMS or HT must verify that the roller operator does not allow the roller to bridge the mixture placed adjacent to a combined curb and gutter by allowing the roller drum to ride on the gutter pan instead of the mixture.

The SS contain the same density requirements for urban and rural contracts. Achieving the proper density is as important on an urban street as it is on a rural roadway. In many situations, the Contractor will request density requirements be waived when vibratory rollers are turned off due to potential damage to adjacent property or underlying utility facilities. In many situations, proper density can be achieved if the Contractor adjusts the amplitude and frequency associated with the vibratory rollers. However, some Contractors are reluctant to take the time required to determine the appropriate amplitude and frequency combination. Do not waive density requirements without the Department's Pavement Design or DCM approval.

13.17 SMOOTHNESS *(Rev. 04-04-23)*

For 402 mixtures, the PEMS must verify the longitudinal profile of the newly constructed course in all mainline lanes and shoulders by using a 16 ft straightedge. Verify smoothness transverse to the direction of traffic on the mainline by using a 10 ft straightedge. The 10