8.60 RUMBLE STRIPS IN HMA PAVEMENTS

8.61 MILLED SHOULDER RUMBLE STRIPS

Milling has become the standard method for installing rumble strips in HMA shoulders. The process utilizes a milling machine to produce shallow concave depressions in the HMA shoulder surface. The milled surface is then sealed with asphalt emulsion to prevent intrusion of water into the HMA shoulder. Milling provides the benefits of a more consistent pattern and depth, while increasing the "rumbling" warning to errant motorists. Milling allows for better compaction of the HMA shoulder, and eliminates the problem of tearing and raveling associated with other methods of producing shoulder rumble strips. While this technique overcomes many of the previous problems with rumble strip construction, there are other issues requiring the attention of both contractor and inspector in order to achieve the desired results.

Standard Road Plan PV-12 shows configurations and details for milled shoulder rumble strips on two-lane roadways, interstates and expressways. The grinding pattern itself is the same for all three situations, utilizing a standard width, depth, and spacing. Similarly, the offset distance from the painted edgeline is the same for the three applications. Difference lies in the "skip" pattern specified for two-lane roadways and the outside shoulder of expressways versus the continuous pattern for interstates. Alignment tolerances and other requirements are contained in *Specification 2548.* Grinding dimensions and alignment of the pattern should be randomly checked and adjusted, if necessary. Rumble strips are typically placed on mainline HMA shoulders only, with the pattern omitted near entrances, intersections and ramps & loops as shown on *Standard Road Plan PV-12*.

Milling equipment variations can result in differences in the rumble strip construction operation. The cutting head must be capable of providing a smooth cut, without tearing or snagging the HMA pavement. Multiple cutting heads and electronic controls can speed the process and eliminate variability in milling depth and pattern, especially at the beginning of each set of strips on shoulders of two-lane roadways and the outside shoulder of expressways.

All loose material resulting from the milling operation must be removed from the shoulder on a daily basis. Some milling machines are equipped with a vacuum system to assist in this effort. Millings may be used as fillet material adjacent to the paved shoulder or may become property of the contractor and properly disposed of off the project. Specific plans may require the millings to be taken to a designated location.

Bituminous Fog Seal, Asphalt Emulsion for Fog Seal (Shoulders), meeting the requirements of *Specification 2308*, is used to coat the rumble strips and thereby reduce premature deterioration of the milled surface. Undiluted asphalt emulsion is typically placed on the milled rumble strips only, unless the contract documents call for its use in sealing the entire shoulder.

8.62 MILLED CENTERLINE RUMBLE STRIPS

Milled centerline rumble strips are transverse concave depressions that are ground into the pavement surface, along the centerline of an undivided roadway. These devices can be installed on new or existing HMA or PCC pavements, utilizing similar milling equipment as for shoulder rumble strips. Using noise and vibrations, centerline rumble strips alert drivers whose vehicle is crossing the centerline that corrective action is

needed. Centerline rumble strips have demonstrated the ability to reduce multi-vehicle crossed centerline (MVCC) and single-vehicle run-off-road left (SVROR Left) crashes.

A unique gapped milling pattern, consisting of skipping every third centerline cut, is used to provide a noticeable difference between the rumbling warnings of milled centerline rumble strips and milled shoulder rumble strips. Differentiating between the two is intended to break the conditioning of a driver to always veer left when traveling over rumble strips which, in the case of centerline rumble strips, would be the opposite of the desired effect.

Standard Road Plan PV-13 shows configurations and details for milled centerline rumble strips. Alignment tolerances and other requirements are contained in *Specification 2548*. Grinding dimensions and alignment of the pattern should be randomly checked and adjusted, if necessary. Centerline rumble strips are gapped at intersections and bridge approaches as shown on *Standard Road Plan PV-13*.

As with shoulder rumble strips, milling equipment variations can result in differences in the centerline rumble strip construction operation. The cutting head must be capable of providing a smooth cut, without tearing or snagging the HMA pavement. Multiple cutting heads and electronic controls can speed the process and eliminate variability in milling depth and pattern. Similarly, all loose material resulting from the milling operation must be removed from the pavement surface and either used as fillet material adjacent to the pavement edge or properly disposed of off the project.

Unless specified otherwise in the contract documents, centerline rumble strips are not sealed with Bituminous Fog Seal. Since centerline paint markings are subsequently placed through milled areas, there are concerns that the fog seal will prevent adequate bonding of the paint to the pavement surface.