



## A PAVING FUNDAMENTAL: Thickness -Yield - Smoothness -- You Can't Have All Three!

Many contractors are faced with a very difficult decision--how to achieve yield, thickness, and smoothness at the same time. Unfortunately, it generally can not be done. The way a typical asphalt paver works has not changed since 1931 when the free-floating screed principle was introduced by the Barber-Greene Company. As everyone knows, the primary purpose of the paver is to level--to place more HMA mix in the low spots on the existing pavement surface and less mix on the high spots. For this reason, the amount of mix needed to resurface a state highway, county road, city street, or parking lot depends on the smoothness of the existing pavement surface.

**Yield:** In most cases the amount of mix needed to resurface a pavement is determined from a calculation of length times width times thickness, converted to a tonnage value. If the pavement is "out of shape", the designer may add 2 to 4 percent more mix to allow for the depressions in the surface. Most pavements, however, require 5 to 15 percent more material so that proper smoothness can be obtained. In order to place a minimum thickness of mix on the high spots in the existing pavement surface, it is necessary to increase the thickness of the mix in the low spots. This situation results in the need for additional mix beyond what is normally calculated based on length, width, and thickness numbers. The contractor must be provided with enough mix to properly construct the pavement. In many instances, the amount of funds available to resurface the pavement is limited and thus the amount of mix included in the contract is also, incorrectly, minimized.

**Thickness:** Suppose the plans call for a surface course mix that is 1-1/2 inches thick. If the inspector on a paving project takes that to be a minimum thickness everywhere, there is going to be a problem with yield. Again, depending on the smoothness of the existing pavement surface, it is going to take "extra" mix to

fill in the low spots. Thus to achieve a minimum thickness on the high spots, the thickness of the mix in the low spots must be greater than the minimum. The thickness shown on the plans thus becomes an average thickness instead of a minimum thickness. If this is not done, the contractor will run out of mix before he runs out of roadway. Either that or his mix tonnage will significantly increase over the amount shown in the plans. This, of course, creates a problem with yield. Smoothness: The amount of smoothness obtained depends on two major factors. The first is the condition or smoothness of the existing pavement surface. The second is the number of layers of HMA mix that is to be placed on top of that existing surface.

Based on the free-floating screed principle, each layer of HMA mix improves the smoothness of the underlying pavement layer by a significant amount. If the present pavement surface is relatively smooth, any new layer placed will be smoother than the original surface since the paver will add more HMA mix in the low spots and thus level that original surface. If the existing pavement surface is rough and uneven, however, the surface of the new layer will be smoother than the original surface, but will still be rough to some extent. This is due to differential compaction.

A layer of dense graded HMA mix will typically compact 1/4 inch per inch of compacted thickness. That means that a layer of mix that is 1 inch thick, when compacted, must be placed 1-1/4 inches thick by the paver in order to allow for the densification that is going to occur under the compactive effort applied by the rollers. A HMA layer that is compacted to a 2 inch thickness needs to be placed 2-1/2 inches thick in order to achieve the proper amount of density.

When mix is placed along a roadway in variable thicknesses, due to the condition of the existing pavement surface, the compacted new surface will still not be completely smooth since the thick areas of mix will compact more than the thinner areas. A second layer of mix will make the surface of that second layer smoother than the original pavement surface. This is because the amount of differential compaction between the thicker and thinner areas will be reduced. The placement of a third layer will make the new surface even smoother. The greater the number of layers constructed, the smoother the final pavement surface. The final smoothness is still dependent, however, on the smoothness of the original pavement surface.

Yield, Thickness, and Smoothness: There are three basic rules in the asphalt paving industry in regard to the resurfacing of an existing pavement surface. First, if yield is the primary consideration, the paver screed operator will have to continually adjust the angle of attack of the screed in order to reduce the amount of mix placed over the present pavement surface. This, of course, will affect both the minimum thickness of the mix over the high spots in the existing

surface and the smoothness of the new pavement layer. The amount of mix set up in the contract must be enough to allow the contractor to properly level the existing pavement surface. Second, if a minimum thickness of mix over the high spots in the existing surface is required, then the amount of mix needed will increase over the quantity shown on the plans. This will result in an increase in the cost to complete the project but will result in a smoother pavement surface. A minimum layer thickness can result in a very rough ride. Last, if smoothness is a primary consideration, several things must happen. First, the number of layers of mix placed must be increased--only one layer will not do the job, even if a "scratch course" of mix is placed. Second, enough quantity of mix must be available to properly level the surface--fill in the low spots and "shave off" the high spots. Third, the paver screed operator must allow the paver to do its job without continually adjusting the angle of attack of the screed. Yield, minimum thickness, and smoothness can not be obtained at the same time unless enough mix and number of pavement layers are set up for the project for the contractor to let the paver screed do its job--fill in the low spots and improve the smoothness of the pavement surface, one layer at a time.

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