Bonding of Layers is Critical to Good Performance

Building asphalt pavements in layers provides a number of advantages, since each layer can be engineered to have specific characteristics and properties. For example, surface layers may be designed to provide high levels of friction, be porous to drain water and eliminate hydroplaning, and optimized to provide a low levels of tire-pavement noise. Intermediate layers can be designed to be highly crack resistant if placed over an existing pavement with joints and/or cracks, or they can be designed as high-modulus layers to provide structural stiffness to the pavement to minimize tensile strains that lead to fatigue cracking and limit high compressive strains that lead to permanent deformation in lower unbound layers. Asphalt base layers can be designed to be highly strain tolerant to eliminate fatigue cracking.

Building asphalt pavements in multiple layers is also an advantage for stage construction, whereby an initial thickness is designed for a predicted amount of traffic over a period of time shorter than the typical design period, and a structural overlay is planned to be added later. This is a great advantage when there is significant uncertainty about future traffic growth. Rather than guessing at traffic 20 or 30 years into the future, it can be more prudent to design for a shorter period of time, such as 15 years. At that point, traffic demand can then be reassessed to set the thickness of the structural overlay.

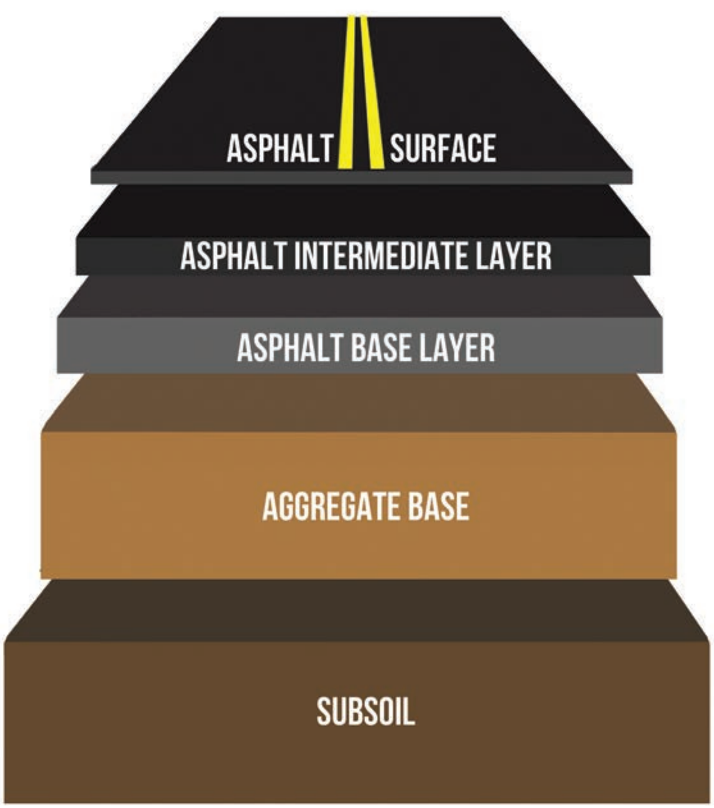


Figure 1: A typical asphalt pavement is comprised of multiple layers.

Finally, layered asphalt structures are an advantage for future rehabilitation work where existing surface layers can be milled-off quickly to restore smoothness and remove surface distresses so that a new surface can be placed. This type of rehabilitation work is quick and with milling depths commonly less than two inches, traffic can maneuver safely across milled and unmilled lanes, thereby minimizing long lane closures. However, if the layers are not bonded together, the interface between layers becomes the weak link in the system and the pavement will not perform as intended. Although we can design, construct, and rehabilitate each layer independently, the layers must be bonded together for the pavement to respond to loads as intended. That is the purpose of tack coats.

A great deal more attention has been given to tack coats in the last few years. New tack coat products have come into the market. Some agencies are specifying spray pavers that apply tack coats right in front of the screed for certain mix types. Several major research studies have examined how to determine the optimum application rates for a variety of tack coat products as well as for different types and conditions of the underlying surfaces. A few states have also implemented bond strength testing on cores taken from projects to verify the adequacy of the tack coats. Workshops and webinars are now available to share information on the best practices for selecting and applying tack coats. All training courses for paving crews and roadway construction inspectors should emphasize the importance of tack coats and instructions on do's and don'ts for their application.

Common distresses associated with poor bonding of layers include slippage cracks, delamination, and alligator cracking, examples of which are shown in Figure 2 on page 11. Alligator cracking may be perceived as a bottom-up fatigue distress when in fact the damage may have initiated at the poorly bonded interface. Highway agencies should routinely core pavements in need of rehabilitation to determine if poor bonding is contributing to pavement deterioration.

In the past 10 years, forensic investigations of a few test sections on the NCAT Test Track revealed bond failures that led to rapid structural deterioration of the pavements. As illustrated in Figure 3, an engineering analysis of a pavement with and without one of the layers bonded will substantially increase the tensile stresses beneath the load. Cracking will initiate when a layer is unable to withstand the strains applied. Although tack coats are a small cost item in the overall cost of building and rehabilitating pavements, bonding of asphalt layers is critical to good performance.

Figure 2: Common distresses associated with poor bonding of layers include slippage cracks, delamination, and alligator cracking, as shown in 2a, 2b, and 2c, respectively.

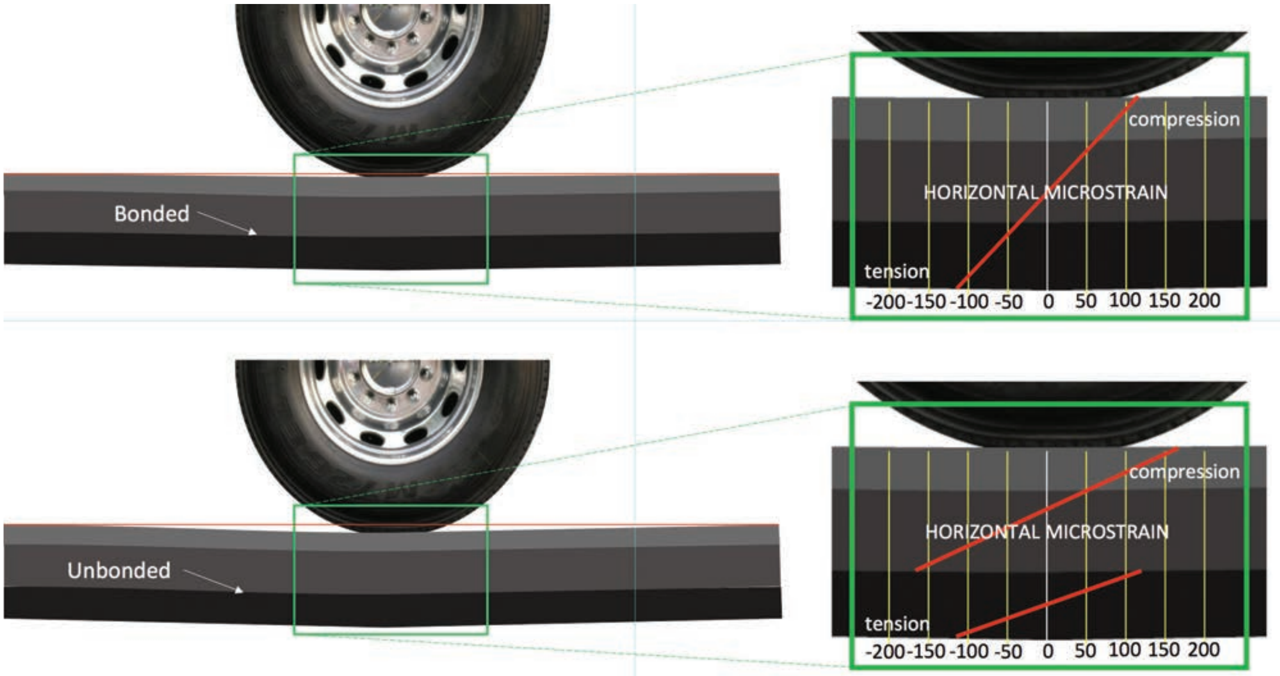
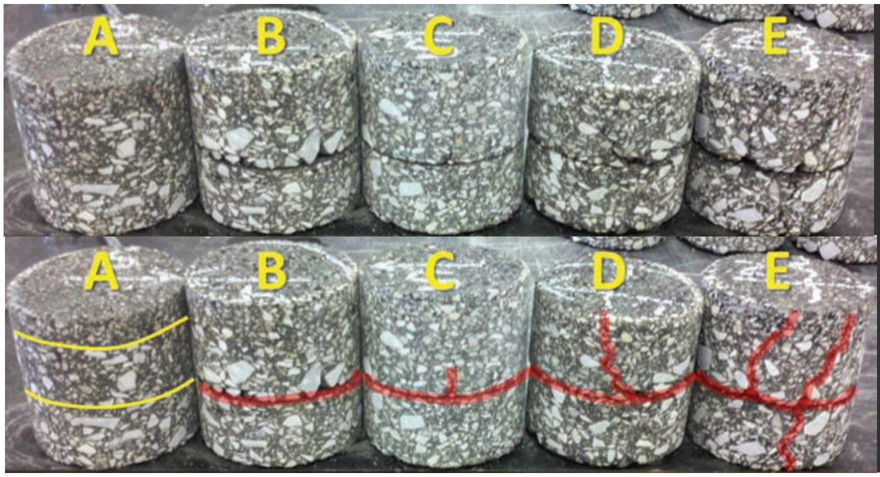


Figure 3: An engineering analysis of a flexible pavement with and without one of the layers bonded.



These cores were taken at several test section locations during a forensic investigation at the NCAT Test Track to assess crack progression. In core A, the interface between the intermediate and base lift is visible, but intact. No surface cracking was evident at this location. In core B, debonding along the same interface can be seen. In core C, a middle-up crack has originated and is propagating towards the surface. The crack has reached the surface in core D and in core E there are cracks throughout the entire core.

Figure 4: Core samples taken from NCAT's Test Track to assess crack progression (cracks are highlighted in second image).