7 Surface Course and Pavement Layers Selection Guide

7.1 General Considerations

The selection of the surface course for a road or highway project should be based on initial cost, annual costs, embankment stability, and other considerations. Variables to consider for initial cost include mobilization, materials, materials availability, and other design and construction costs. Variables for annual costs include maintenance and user costs. Also, consider traffic speed and volume, truck volume, rural versus urban, severity of roughness, embankment stability, expected life, rainfall, temperature, and type of maintenance equipment available. Consult the regional maintenance section when selecting surface courses.

7.2 Unstable Embankments

The thawing of ice-rich permafrost foundation soils is the main cause of embankment instability in Alaska. Consolidation of thick organic soils that have not been adequately surcharged can also cause instability. Because frozen soils consolidate during thawing, thaw settlement instability problems progress at a varying rate from year to year. Sometimes an embankment can take more than 50 years to stabilize. The severity of the consolidation depends on the depth and volume of ice in the soil. Variations in ice content lead to inconsistent consolidation, resulting in differential settlement of the driving surface.

The life of a surface course on unstable embankments should closely match the life of the embankment and foundation. In rural areas, this mays result in the selection of a double-layer asphalt surface treatment or a high-float asphalt surface treatment.

In urban areas, the selection of a surface course depends on traffic volume and speed, severity of the pavement roughness, possibility of vehicle damage due to airborne aggregate, and the possibility that vehicles will be coated with emulsified asphalt. When a hot mix asphalt surface is used in an urban area with unstable soils, the thickness should be 2 inches, the minimum allowable thickness.

If a project has well-defined sections of unstable and stable embankment, consider selecting two types of surface courses, each appropriate to a level of embankment stability. Variables affecting this decision include the length and number of unstable areas, the percentage of the project with unstable embankment, the increased costs of multiple equipment spreads, and the variables discussed above in General Considerations.

7.3 Available Surfacing Types

Asphalt Concrete or Hot Mix Asphalt (HMA): HMA consists of a mixture of asphalt cement and well-graded aggregate. HMA provides the smoothest asphalt surface, the longest life, and contributes to the structural strength of the entire pavement structure. HMA generally requires less maintenance than other surfaces, and it is recommended for use in all stable embankment areas with AADTs greater than 1,000 or significant truck volumes. Consider HMA as an alternate for AADTs less than 1,000, based on the variables given in General Considerations.

Double-Layer Asphalt Surface Treatment (Double-Layer AST): Double-layer ASTs are typically made of two applications of asphalt emulsion and a single-sized aggregate. Double-layer ASTs are usually placed on a granular base. Design the pavement structure, including the base, to provide all the required strength, since the double AST provides no structural strength. The aggregate for a double-layer AST is more expensive than aggregate for a HMA or high-float AST, because more material is wasted making the single-sized aggregate. Double-layer ASTs are a good alternative for unstable foundations and should be considered as an alternative to HMA for projects with AADTs less than 1,000. A double-layer AST is not recommended for high-speed, high-traffic urban areas.

Single-Layer Asphalt Surface Treatment (Seal Coat AST): A seal coat AST is constructed by spraying emulsified asphalt material followed immediately by a thin stone covering. An aggregate seal is typically used to extend the life of pavement. It produces an all-weather surface, renews weathered and cracked pavements, improves skid resistance, seals pavement, and gives no additional strength to pavement. An aggregate seal typically has a longer life in dry climates. An aggregate seal of imported, higher-quality aggregate may be designed for a new pavement if local aggregate wears poorly.

High-Float Asphalt Surface Treatment (High-Float AST): A high-float AST consists of one application of high-float emulsified asphalt followed by a single application of crushed gravel, and it is usually placed on a granular base. A high-float AST provides a less expensive alternative to double-layer AST because it uses a single layer of aggregate with a less restrictive gradation and provides the same design life. Because of the aggregate gradation and properties of the high-float emulsified asphalt, a high-float AST surface is rougher than a double-layer AST—this is especially true for the first few years following construction. As with double-layer ASTs, high-float ASTs are not considered to be structural layers. That is, a high-float AST does not contribute to the load capacity of the pavement structure. High-float ASTs may have a significant P_{200} content, an undesirable trait for use in areas with high rainfall. In wet conditions, it is difficult to keep the P_{200} fraction dry. Wet aggregate clumps in the distributor and makes uniform spreading nearly impossible. High-float AST is a good alternative in areas with unstable foundations.

Sand and Slurry Emulsion Seals: A sand emulsion seal is comprised of sand and emulsified asphalt. A slurry seal is usually comprised of fine, dense-graded aggregate and emulsified asphalt and is placed using specialized slurry seal equipment. Fine-grained seal coats increase skid resistance, seal against water intrusion, and correct minor surface irregularities.

Stone Mastic Asphalt Concrete (SMA): SMA is a coarse-graded HMA mix that resists rutting caused by studded tires. SMAs do not have good fatigue properties and should only be used as a surface layer on top of an HMA. Consider SMA as an alternative for projects with an AADT greater than 10,000.

Stabilized Base Course: Stabilized bases are composed of aggregate and a stabilizing (bonding) material. The aggregates are generally well graded but can be open graded. Bonding materials include asphalt cement, asphalt emulsion, Portland cement, lime, various proprietary chemical products, and even recycled asphalt concrete. Use stabilized bases as required in chapter 2.

Reclaimed Asphalt Pavement (RAP): Create RAP by removing and crushing old asphalt concrete pavement. The RAP often contains a substantial portion of normal base course material picked up during removal of the old pavement surface (sometimes as high as 25% to 30% by weight). RAP can be used as a component in recycled asphalt pavement or as a substitute for base course. A base course can be constructed exclusively from RAP or with a mixture of RAP and virgin crushed aggregate. Always consider the use of RAP in the design of a pavement rehabilitation project.

Recycled Asphalt Pavement: Recycled asphalt pavement is processed from reclaimed asphalt pavement by crushing and mixing it with additional components such as aggregate, asphalt cement, or recycling agents. It is then re-laid and compacted. Hot recycling of pavement is usually processed in a plant, while cold recycling of pavement is usually done in place. Always consider recycling existing asphalt as an alternative on a pavement rehabilitation project.

Gravel Surface: For very low-volume roads, always analyze the cost of grading and replacing gravel versus the cost and maintenance of any other surface. Consider the continual loss of the crushed gravel surface (through maintenance operations and wind erosion) in the cost analysis. Calcium chloride or other dust palliatives may be used, especially for higher traffic volumes. These usually last only a year or two. Also consider the cost of future applications in the maintenance costs. Gravel surface courses require a higher P_{200} content than base courses for hot mix asphalt surfaces (10 to 15% versus less than 6% for HMA). If a road is to be paved in the future, the surface course will need to be replaced.

Portland Cement Concrete (PCC): Because of the high cost of PCC and the necessity of a thick, non-frost-susceptible base, PCC is rarely used in Alaska. PCC pavement sections have seen limited use at some Alaska airports. Consider PCC as an alternative to HMA. Local conditions may result in PCC being cost-effective. However, this manual does not cover PCC design.

An NHI course is available for anyone interested in developing expertise in PCC design. See basic reference materials in reference.[22]

7.4 Stabilized Layers

Use the following in conjunction with policies detailed in Chapter 2.

7.4.1 Stabilized Base

Stabilized base is a typical granular base course material that has been stabilized with a binder component. No minimum amount of additive is required, although stabilized base material must (1) achieve a M_R value ≥ 80,000 psi, and (2) exhibit some other form of improvement that is directly applicable to improving the structural design of the pavement, e.g., reduced frost susceptibility. The modulus value improvement and/or other improvement(s) gained through the addition of the binder must be documented or otherwise verified by regional or statewide materials personnel with pavement design expertise. Acceptable documentation will cite previous experience with similar materials or will be based on test data using current test method(s).

Stabilized bases are normally defined as standard base course materials containing one or more of the following components:

- Emulsion
- Asphalt cement
- Foamed asphalt cement
- Lime
- Portland cement
- Recycled asphalt concrete pavement *
- A mixture of recycled asphalt concrete pavement and base course material *

** These stabilized base materials, incorporating recycled asphalt concrete, are usually created through an unheated, mechanical mixing process. Such mixtures may require a significant period of time after construction (perhaps a year or more) before the expected stabilization effect is fully achieved.*

A stabilized base is considered a lightly bound material. Therefore, use the Per Ullidtz equation as the failure criterion for stabilized base material (see Section 4.3.2).

7.4.2 Asphalt-Treated Base

Asphalt-treated base (ATB) is defined as a typical granular base course material that has been stabilized with a minimum of 4% asphalt cement (residual asphalt cement) binder additive. The minimum amount of asphalt cement additive required is that necessary to achieve an M_R value ≥ 150,000 psi. The modulus value used for mechanistic design must be justifiably based on experience or on M_R current test method(s). Achievement of the 150,000-psi minimum modulus value, whether by test or presumption, must be documented or otherwise verified by regional or statewide materials personnel with pavement design expertise. Acceptable documentation will cite previous experience with similar materials or will be based on test data using current test method(s).

Asphalt-treated base is considered a heavily bound material. Therefore, use The Asphalt Institute (TAI) fatigue equation as the failure criterion for asphalt-treated base material (see Section 4.3.2).

7.4.3 Alaska Renewable Pavement

Alaska Renewable Pavement (ARP) is a pavement layering system that provides an acceptable alternative to stabilized base or can be used to amplify the benefits of a stabilized base. ARP can also be combined with a stabilized base or asphalt-treated base to satisfy requirements for pavement designs involving high ESALs. The ARP system is similar to normal asphalt concrete pavement except that it is thicker and is composed of two sub-layers. Figure 7-1 illustrates ARP layering and examples of applications both with and without a stabilized base course.

The upper layer of the ARP, called the *wearing course*, consists of asphalt concrete containing components that: maximize resistance to abrasion wear (addresses tire-stud rutting), minimize surface roughness (addresses ride quality), minimize plastic deformation (addresses displacement rutting), and minimize permeability (addresses premature weathering and aging of the asphalt concrete).

The lower layer of the ARP, called the *binder course*, consists of asphalt concrete containing components that maximize fatigue resistance (addresses fatigue cracking) and minimize plastic deformation (addresses displacement rutting).

The ARP design provides for a minimum 30-year service life because the ARP concept anticipates periodic replacement of the upper ARP layer by mill-and-fill construction methods. Periodic mill-and-fill reconditioning can be done without ever penetrating the lower ARP layer. Therefore, vehicle traffic will never be subjected to an unpaved surface during future reconditioning events. Because of these objectives, apply an extended design life (30 years minimum) when considering an ARP pavement system.

Details regarding selection of materials and mix design requirements for ARP wearing and binder layers are outside the scope of this manual. However, the following points generally apply:

- The design procedure and mix design class may vary for upper and lower layers.
- Aggregate gradation type need not be the same for both layers.
- Minimum thickness for wearing course is 2 inches.
- Minimum thickness for binder course is 2 inches (if stabilized base is used) and 3 inches (if stabilized base is not used).

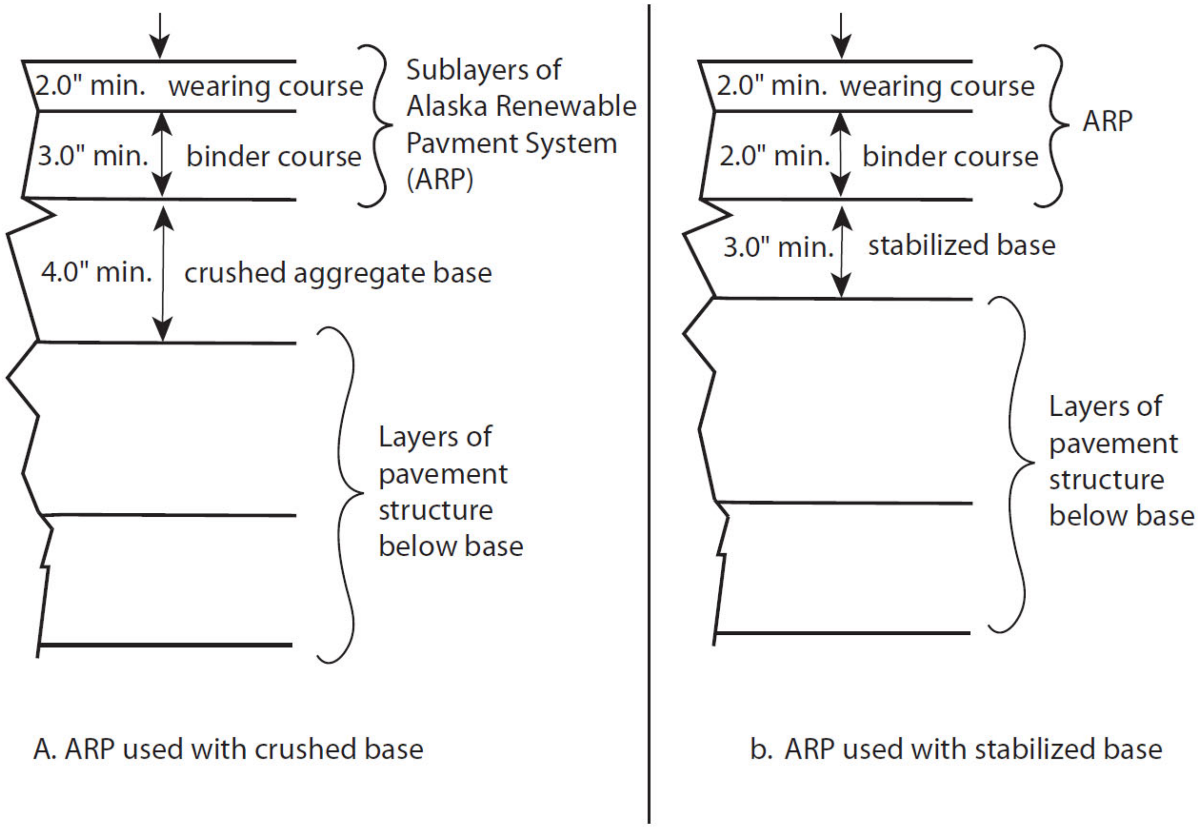

Figure 7-1 Pavement Structures Showing ARP Layers