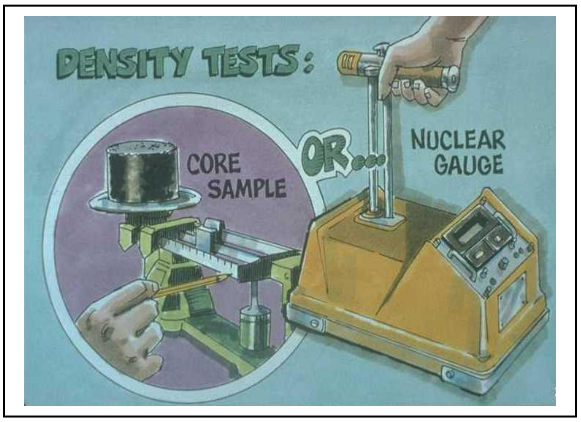
II. Mix Properties

Stability

Stability of a hot mix asphalt pavement is the ability to resist shoving and rutting under traffic. A stable pavement maintains its shape and smoothness under repeated loading. Stability requirements should be high enough to handle traffic, but not so high as to result in a stiff pavement that is less durable. The stability of a mixture depends on both internal friction between aggregate particles and cohesion. Internal friction relates to the shape and surface texture of the aggregate particles. Cohesion results from the bonding ability of the asphalt. Cohesion relates to asphalt binder content up to a point. Increasing the asphalt binder content beyond the critical point will reduce internal friction by creating too thick a film on the aggregate particles. The primary sources of pavement instability are excess asphalt binder in the mix, excess medium sized sand in the mix, or rounded aggregate with little or no crushed surfaces.

Density

The density of the compacted mix is its unit weight, or the weight of a specific volume of mix. For compacted HMA, this is approximately 145 pounds per cubic foot. Density is particularly important because high density of the finished pavement is essential for long term pavement performance.



Laboratory density of a specific mix is essentially the maximum density for the mix, and is the standard by which field compaction is measured. Field densities and specification limits are expressed as a percent of laboratory density.

Workability

Workability describes the ease with which a paving mixture can be placed and compacted. "Harsh" mixes contain a high percentage of coarse aggregate, have a tendency to segregate with handling, and may be difficult to compact. "Tender" mixes are too easily worked or shoved, and may be too unstable to place and properly compact. Tender mixes may be caused by a shortage of mineral filler, too much medium sized sand, smooth or rounded aggregate particles, too much moisture in the mix, and/or too high of mix temperature.

Flexibility

Flexibility is the ability of a hot mix asphalt pavement to adjust to gradual settlements and movements in the subgrade without cracking. Since virtually all subgrades either settle (under loading) or rise (from soil expansion), flexibility is a desirable characteristic for all hot mix asphalt pavements. An open-graded mix or one with higher asphalt binder content is generally more flexible than a dense-graded mix or one with lower asphalt binder content. Sometimes the need for flexibility conflicts with the need for stability, so that trade-offs must be made in selecting the optimum asphalt binder content.

Durability

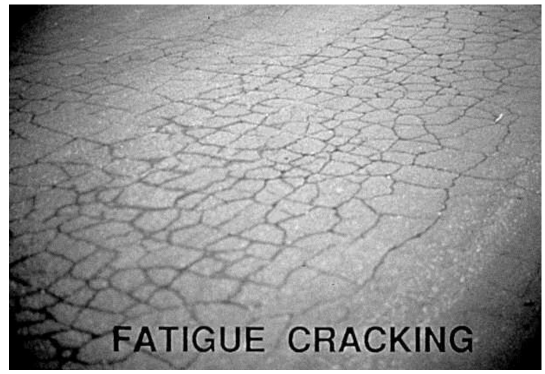
The durability of a hot mix asphalt pavement is its ability to resist disintegration by weathering and traffic. A lack of durability can result in aging or oxidation of the asphalt binder, disintegration of the aggregate, and stripping of the asphalt film from the aggregate. Thick asphalt films provide durability benefits in that they do not harden and age as thin films do, and tend to seal the pavement better so as not to allow large volumes of air and water to penetrate the mat. A dense gradation of sound, tough, strip-resistant aggregate contributes to pavement durability by creating better particle interlock and minimizes disintegration and raveling of the pavement.

Impermeability

Impermeability prevents the passage of air and water into or through the asphalt pavement. This characteristic is directly related to the void content of the compacted mixture. Even though void content is an indication of the potential for passage of air and water through a pavement, the character of the voids is more important than the number of voids. The size of the voids, whether or not they are interconnected, and the access of the voids to the pavement surface, all determine the degree of impermeability.

Fatigue Resistance

Fatigue resistance is the pavement's resistance to repeated bending under wheel loads (traffic). Air voids and asphalt binder viscosity has a significant effect on fatigue resistance. As air voids in the pavement increase, either by design or lack of compaction, fatigue resistance is reduced. Likewise, a pavement containing asphalt that has aged and hardened significantly has reduced resistance to fatigue. The thickness and strength characteristics of the pavement and the support of the subgrade also play a role in determining pavement life and preventing load-associated cracking.



Skid Resistance

Skid resistance is the ability of a hot mix asphalt pavement surface to minimize skidding or slipping of vehicle tires, particularly when wet. The best skid resistance is obtained by a rough-textured aggregate in a relatively open-graded mixture. Aggregates that tend to "polish" smooth under traffic have poor skid resistance. Flushing or bleeding of excess asphalt binder in the mix to the pavement surface can create serious skid resistance problems.

Smoothness

Smoothness of the finished riding surface is considered the most important pavement property to the travelling public. The smoothness of primary and interstate pavements contributes to travelers' overall perception of the state.

Smooth pavements are generally safer, last longer, and cause less wear and tear to the vehicles they carry.

HMA pavement smoothness is adversely affected by a number of factors, including variations in paver speed and general lack of uniformity in the paving operation, improper aggregate gradations, improper operation of trucks, poor joint construction practices, and poor grade controls.

Since contractors may receive smoothness incentive payments (or price reductions) based on the relative smoothness of the pavement, it is in their own best interests to control their operations in a manner that produces pavements that are as smooth as possible.

Asphalt Binder Content

The asphalt binder content in the mixture is critical and must be accurately determined in the laboratory and precisely controlled on the job. It is usually expressed as a percentage, by weight, of asphalt binder in the mix. For our purposes, it is the amount of asphalt binder that effectively forms a bonding film on the aggregate surfaces.

The optimum asphalt binder content of a mix is highly dependent on aggregate gradation and absorption. A finer mix gradation has a larger total surface area, thus requiring a greater amount of asphalt binder to effectively coat the particles. Conversely, coarser mixes have less total aggregate surface area and demand less asphalt binder to coat particles. Highly absorptive aggregates increase the quantity of asphalt binder required to satisfy mix demands.

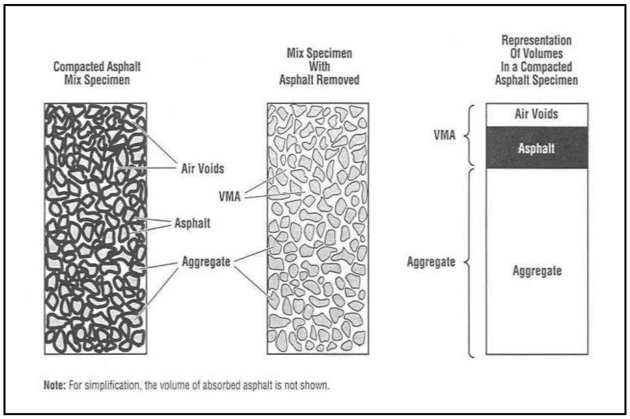
Air Voids

Air voids are small pockets of air between the coated aggregate particles in the final compacted mix. The durability of a hot mix asphalt pavement is a function of the air void content. An air void content that is too high provides passageways for the entrance of damaging water and air into the mat. An air void content that is too low can lead to "flushing" under compaction by traffic. Flushing is a condition in which excess asphalt binder squeezes out of the mix onto the pavement surface, since there are not enough voids in the pavement to accept the displaced asphalt binder. A mix that is too low in air voids can also be prone to rutting under traffic and temperature extremes.

Density and air void content are directly related (inversely):

Higher Density → Lower Air Voids
Lower Density → Higher Air Voids

Voids in the Mineral Aggregate (VMA)



Voids in the Mineral Aggregate (VMA) are the void spaces that exist between the aggregate particles in the compacted mix, including spaces filled with asphalt binder.

VMA represents the space available to accommodate the effective volume of asphalt binder and air voids in the mix. The Effective Volume of Asphalt (binder) is the total volume of asphalt binder in the mix minus the volume of asphalt binder absorbed into the aggregate. The higher the VMA in the dry aggregate, the more space is available for asphalt film. In general, the thicker the asphalt film on the aggregate particles, the more durable is the mix.