

Effects of Size, Surface Texture, and Shape of Aggregate Particles on the Properties of Bituminous Mixtures

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•THE THREE basic strength properties of bituminous concrete consist of the cohesive strength of the bituminous material, the frictional resistance between the aggregate particles, and the interlocking resistance that is introduced in the compacted structure of the aggregate combination. Two of the basic strength properties, not including cohesive strength, are profoundly affected by the size, surface texture, and shape of the aggregate particles that are used in the bituminous mixture. The following brief commentary relates the effects of size, surface texture, and shape of aggregate particles to the properties of bituminous mixtures.

SIZE OF PARTICLES

The term "size of particles" must be qualified for a discussion of the effects of particle size on the properties of bituminous mixtures. Bituminous mixtures are actually affected by the maximum size of particles, minimum size of particles, and the gradation of the particle sizes within the size limits. Therefore, particle size must be discussed in terms of size limits as well as in terms of the gradation of the various sizes included in the bituminous mixture. Particle size discussed in terms of gradation and gradation limits affects the amount of asphalt required for the mix, workability, density, stability, and the performance characteristics of the pavement. A large percentage of coarse particles will produce a harsh mix that complicates laydown or construction operations. Aggregate combinations that are poorly graded (skip-graded) have a high voids ratio, require a large percentage of asphalt, and normally produce low stability mixes. Fine-grained mixes are workable, but they lack the stability that is developed in a well-graded aggregate combination. The large surface area of particles that is present in fine-grained mixes may present a problem of selective absorption of the asphalt. This condition may lead to early hardening or aging of the pavement.

SURFACE TEXTURE

The frictional resistance that is developed between aggregate particles depends on the surface texture of the particles. Therefore, surface texture has a profound effect on the stability of the bituminous mixture. This property of the aggregate is reflected in the angle of internal friction. Laboratory tests conducted by the author indicate that frictional resistance is responsible for about 50 percent of the shearing resistance that is developed in a dense-graded bituminous mixture. Bituminous mixes containing friction-textured aggregates reflect a significant decrease in workability and an increase in stability.

SHAPE OF PARTICLES

The shape of the aggregate particles affects the interlocking resistance that is developed in the bituminous mixture. However, the aggregate particles must be well graded in order to develop a keying action between individual particles. Laboratory tests conducted by the author indicate that about 25 percent of the shearing resistance in a dense-graded mix is developed in the form of interlocking resistance. The shape of the aggregate particles may also affect voids and workability.

SUMMARY

The two basic strength properties that reflect significant effects of the size, surface texture, and shape of aggregate particles are frictional resistance and interlocking resistance. These two basic strength properties hold promise for the development of additional shearing resistance (or stability). The effects of size, surface texture, and shape of aggregate particles are not reflected in the cohesive strength of a bituminous mixture. It is the author's opinion that the inherent material properties of asphaltic binders preclude the development of major increases in shearing resistance in the form of cohesion. In fact, the strength component developed in the form of cohesion is subject to deterioration or a strength loss because of aging and the thermoplastic properties of the asphalt binder.