MATERIALS AND MIX DESIGNS FOR RESURFACING PAVEMENTS AND MAINTAINING BRIDGE DECKS

Jon A. Epps and Bob M. Gallaway, Texas Transportation Institute,
Texas A&M University

Abridgment

A large portion of highway maintenance funds are allocated for seal coats and asphalt concrete (AC) overlays to extend the life of the highway pavement and to repair bridge decks. The engineer can make selections from several types of materials and combine these to produce a mixture that will provide the desired engineering function. Because synthetic aggregates are one of the many materials the engineer must consider, it is necessary that definitive information on the properties and performance of such materials be developed. This paper presents results that add to this body of knowledge and reports the behavior of mixtures made with synthetic aggregates in several pilot and full-scale studies.

SYNTHETIC AGGREGATES FOR SEAL COATS AND SURFACE TREATMENTS

Windshield Damage

Newly constructed seal coats and surface treatments utilizing cover aggregates of an appreciable size have caused damage to the glass and finish of vehicles using the roadway. In order to reduce or eliminate flying stones, synthetic aggregates have been utilized (1).

Design of Synthetic Aggregate Seal Coats

Methods of seal coat and surface treatment design developed for normal-weight aggregates can be used when synthetic aggregates are used (2, 3, 4). However, certain modifications including amount of binder, viscosity of binder, rate of cover-stone application, traffic volume, and construction techniques appear to be warranted based on field experience. These modifications are summarized as follows: (a) Asphalt content determined by standard design methods should be increased by as much as 10 percent; (b) only high-viscosity asphalt cements should be used; (c) the quantity of cover stone normally obtained by present methods should be reduced approximately 15 percent; (d) traffic volumes should be less than 10,000 to 15,000 vehicles per day for rural roads; (e) seal coats should not be used in urban areas where turning movements of vehicles are involved; and (f) light pneumatic compaction equipment should be utilized together with synthetic aggregates that have low moisture contents.

Sponsored by Committee on Pavement Maintenance.

Performance of Synthetic Aggregate Seal Coats

Experience gained with more than 4,000 miles of seal coats and surface treatments in Texas has indicated that not all synthetic aggregates are suitable for cover stone. Specific properties that render some of the aggregates unsuitable include crushing resistance and freeze-thaw resistance. However, the reduction in paint and windshield damage together with the ability of the aggregate to provide a high friction value suggests that the use of synthetic aggregates for seal coats and surface treatments is beneficial.

SYNTHETIC AGGREGATES FOR HOT-MIXED AC OVERLAYS

Skid-resistance measurements performed on synthetic aggregate seal coasts indicate that high friction values can be obtained. Therefore, research into the utilization of synthetic aggregates in hot-mixed AC overlays was initiated to provide a high friction surface that would withstand high traffic volumes. In addition, AC mixtures offered an opportunity for using synthetic aggregates that possessed low crushing resistance because the fine aggregate-asphalt matrix (utilizing local available sands) acts as a cushion for the coarse synthetic aggregate.

Skid Resistance

The establishment of adequate skid resistance in a new road surface normally presents only limited problems. However, the establishment of prolonged skid resistance is often difficult to obtain.

Synthetic aggregates, because of their vesicular nature, provide a material with a renewable surface texture and thus prolonged skid resistance. Hot-mixed AC overlays made with these synthetic aggregates as the coarse aggregate skeleton have been in service in Texas since 1963. Skid measurements made on one of these facilities are shown in Figure 1. It should be noted that the inital values of friction are greater than the minimum requirement of 0.37 suggested by the Federal Highway Administration; and, furthermore, the friction values have steadily increased under high volumes of traffic. Friction values obtained on pavements constructed in Alabama (5), Louisiana (6), Virginia (3), and Wyoming (7) also show high initial and prolonged friction values.

Concurrent with several of the jobs just described, the Texas Transportation Institute in cooperation with the Texas Highway Department built an experimental section in which lightweight aggregates in mixtures with open gradations were used. The objective of using open gradation was to provide a mixture containing 15 to 20 percent air voids. Extensive skid tests and observations have shown that the pavement is performing essentially as planned. The free-draining properties of this mixture practically eliminate the probability of hydroplaning (Fig. 2).

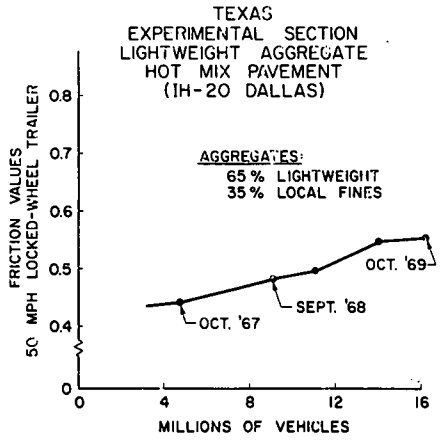

Figure 1. Locked wheel friction versus vehicle passages and time.

Mix Design

Standard methods of mix design based on stability measurements and density requirements have been used in Texas for these synthetic aggregate mixtures. Usually 70 to 100 percent of the ½-in. to No. 10 fraction of these mixtures are lightweight aggregate, and thus the lightweight fraction will normally constitute about 50 percent by weight of the total aggregate.

A stability test performed on these synthetic aggregate mixtures indicates that high stabilities will occur at relatively high asphalt contents.

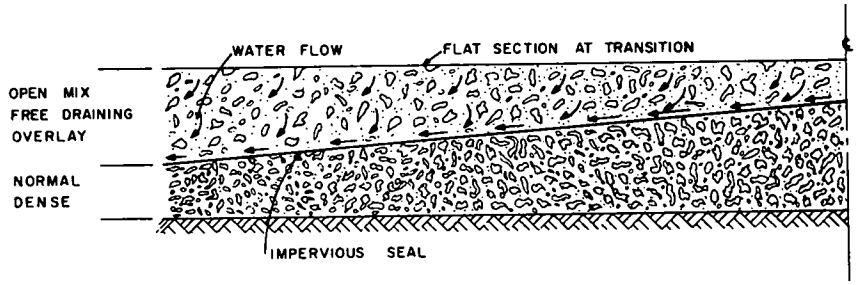

Figure 2. Pavement cross section at transition from tangent to superelevated curve (flat section, no surface cross slope).

Asphalt content on a weight basis is usually 3 to 4 percentage points above that of normal weight aggregates. However, on a volume basis the mixtures will have nearly the same asphalt content. Thus little increase in asphalt is needed to pave a given facility.

BRIDGE DECK OVERLAYS

Maintenance of bridge decks has become one of the major problems facing the state maintenance forces. Because of their proven high coefficients of friction obtained when used on seal coats and overlays and because of their tolerance of high asphalt contents while maintaining stability, synthetic aggregate have been considered and used by the Texas Highway Department on more than 400 bridge decks in the Dallas-Fort Worth area in the past 2 years.

The procedure used for the repair of these decks calls for removal of the delaminated area and repair with an epoxy cement or speedcrete. The entire bridge deck is then covered with a 120 to 150 penetration asphalt cement at a rate of 0.3 gal/sq yd. A lightweight aggregate graded to a typical seal coat gradation is applied. Within 3 days or less, a hot-mixed overlay consisting of synthetic lightweight aggregates, crushed limestone, field sand, asphalt, rubber, and asbestos is applied. The asphalt contains 3 percent latex rubber solids, and asbestos fibers are used in certain mixtures.

Observations made during construction and service suggest that the mixtures containing both rubber and asbestos have performed better than the mixture containing only rubber. All mixes investigated have provided crack-free surfaces while maintaining adequate skid resistance.

CONCLUSIONS

Synthetic aggregate manufacturing procedures and paving mixture design concepts for seal coats, surface treatments, and AC mixtures are available to the engineer. Performance data collected on pilot and full-scale field sections indicate that synthetic aggregates offer advantages in several applications

Seal Coats and Surface Treatments

Windshield and paint finish damage due to flying cover stone can be reduced by the use of synthetic aggregates. In addition, these aggregates produce a surface that has prolonged high skid resistance.

Hot-Mixed AC Overlays

High and prolonged high coefficients of friction can be obtained with AC mixtures containing synthetic aggregates as the major portion of the coarse aggregate fraction. Furthermore, these mixtures will possess sufficient stability at relatively high asphalt

contents to ensure that these overlays will be impermeable and flexible for extended periods of time.

Bridge Deck Overlays

Bridge deck overlays utilizing synthetic aggregates have been constructed successfully. These mixtures contained rubber and asbestos additives that improved the viscoelastic behavior of the mixtures. The synthetic aggregates help maintain relatively high coefficients of friction and proper stability at the high asphalt contents necessary to adequately seal the bridge decks.

REFERENCES

1. Gallaway, B. M., and Harper, W. J. Laboratory and Field Evaluation of Lightweight Aggregates as Coverstone for Seal Coats and Surface Treatments. Highway Research Record 150, 1966, pp. 25-81.
2. Asphalt Surface Treatments and Asphalt Penetration Macadam, 2nd Ed. The Asphalt Institute, Manual Series 13, Nov. 1969.
3. Dillard, J. H. Summation of Practices of Virginia Department of Highways in Providing Skid Resistant Roads. Paper presented to ASTM Subcommittee 3f of Committee D-4, Atlantic City.
4. Benson, F. J., and Gallaway, B. M. Retention of Cover Stone by Asphalt Surface Treatments. Eng. Exp. Station, Agricultural and Mechanical College of Texas, Bull. 133, Sept. 1953.
5. Eiland, E. Skid Resistance of Alabama's Pavements. Alabama State Highway Department, 1969.
6. Arena, P. J. Expanded Clay Hot Mix Study. Louisiana Department of Highways, Research Rept. 37, April 1969.
7. Mills, J. A. A Skid Resistance Study in Four Western States. HRB Spec. Rept. 101, 1969, pp. 3-17.