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INTERIM REPORT ON THE LABORATORY CONSIDERATIONS FOR THE USE OF SYNTHETIC AGGREGATES FOR HOT-MIX ASPHALT PAVEMENTS

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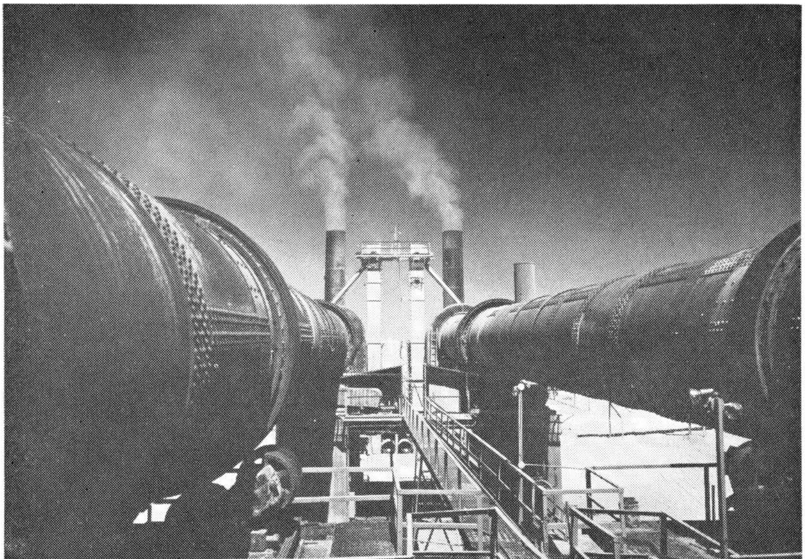

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Interim Report On the Laboratory Considerations for the Use of Synthetic Aggregate for Hot-Mix Asphalt Pavements

by

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Since the introduction of lightweight synthetic aggregate as coverstone for seal coats and surface treatments on Texas highways in 1961, aggregate producers, contractors, highway personnel and even the driving public have watched the performance of this material with a critical eye. Service records for the past six years are now available and these records show conclusively that synthetic aggregate of the proper quality produces a high performance coverstone provided proper procedures are observed in the design and construction of such surfaces.

Records are available on some 2000 miles of primary and secondary Texas highways with traffic volumes from 100 to 8000 vehicles per day to show that this material is serving the driving public safely and economically.

It seems reasonable to expect that this same type of material would serve equally well in hot-mix asphalt paving materials; therefore, the exploratory research reported in this paper was undertaken to verify this hypothesis.

The basic physical characteristics of synthetic aggregates that have a definite influence on the use of these materials in asphaltic concrete are: asphalt affinity, abrasion or wear characteristics, and aggregate durability as determined by freezing and thawing or sodium sulfate soundness.

The research approach for verification of this hypothesis was a complete factoral design including the necessary basic research, laboratory evaluations, and field service trials. The subject study, however, covers only a limited segment of the overall research plan and is therefore incomplete and the conclusions are tentative. It is, nevertheless, clearly evident that synthetic aggregate has a definite potential as a major portion of the aggregate system in flexible pavement structures.

For the materials under study the following results and conclusions are listed. These are tentative since they are based on incomplete laboratory data and limited field trials.

1. Research findings reveal that economical hot-mix designs can be produced by blending synthetic coarse aggregate (½-

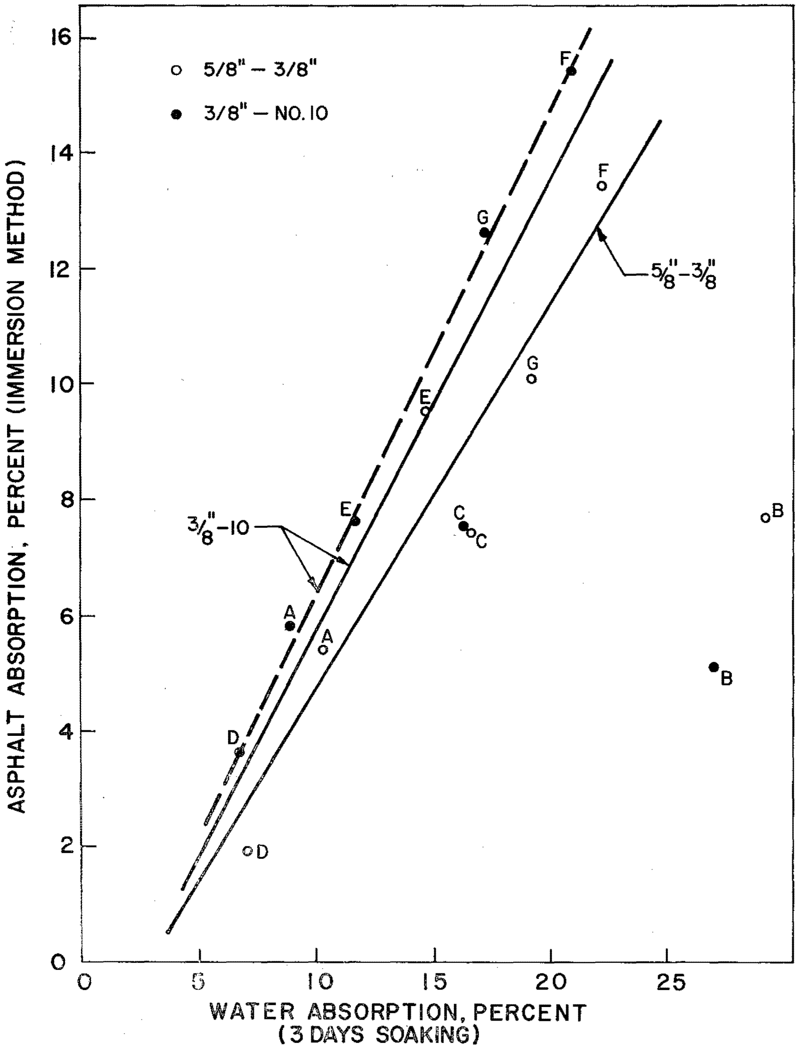

Figure 1. Correlation of asphalt and water absorption.

inch to No. 10) with locally available fine aggregates such as crusher fines and field sand, or both. Where field sand alone is used as the fine material, the coarser gradings produce more economical mixes.

Designs meeting the specification requirements of the Texas Highway Department's Item 340, Hot-mix Asphaltic Concrete Pavement, Class A, Type D, were easily obtained with the materials under study. Proof of service performance for the various producers' products has not been obtained.

2. Laboratory compaction degradation was found to be a minor problem even for designs containing 100 percent synthetic aggregate. The Texas gyratory shear compactor was used in the study; so, it is not known what results would be obtained with, say, the Marshall impact hammer or the California kneading compactor. A high Hveem stability is a common characteristic of designs containing aggregate with a rough surface texture and it is probably for this reason that the hot-mix designs that were investigated produced stabilities in the range of 40 to 50. Large changes in asphalt content had little effect on measured stabilities. This capacity for a wide range of asphalt contents has an economic potential; however, the possible improvement in service is much more important. Table I shows the effect of different levels of laboratory compaction energy for a single source of material and a given combination of coarse and fine aggregate.

TABLE I
Effect of Compactive Effort on Compaction Degradation
(Aggregate A, Combination No. 6, 6.5% Asphalt)

U. S. Sieve Size	Aggregate Gradation Percent Passing (by Weight)			
		Recovered		
	Original	THD Manual Press	THD Motorized Press	
		100 psi End Point	50 psi End Point	150 psi End Point
⅜ inch	100.0	100.0	100.0	100.0
No. 4	83.6	83.7	83.3	82.8
No. 8	43.9	50.4	50.2	48.9
No. 16	36.3	37.8	37.3	37.4
No. 30	36.1	36.7	36.0	36.1
No. 50	26.5	30.1	30.1	29.4
No. 100	9.9	10.6	10.5	10.5
No. 200	4.2	4.2	4.6	4.2

TABLE II
Asphalt Absorption for Lightweight Aggregate
(Rice's Method)

Aggregate Source	Absorption, % by Weight of Lightweight Aggregate in Mix	
	⅜ inch — No. 10	
	Curing No. 1*	Curing No. 2**
A	3.1	2.4
B	0.8	2.2
C	2.6	2.2
D	0.4	0.1
E	2.8	2.6
F	2.8	2.0
G	2.8	3.2

*Curing No. 1—3 hours at 250°F.
**Curing No. 2—1 hour at 250°F. and 20 hours at 140°F.

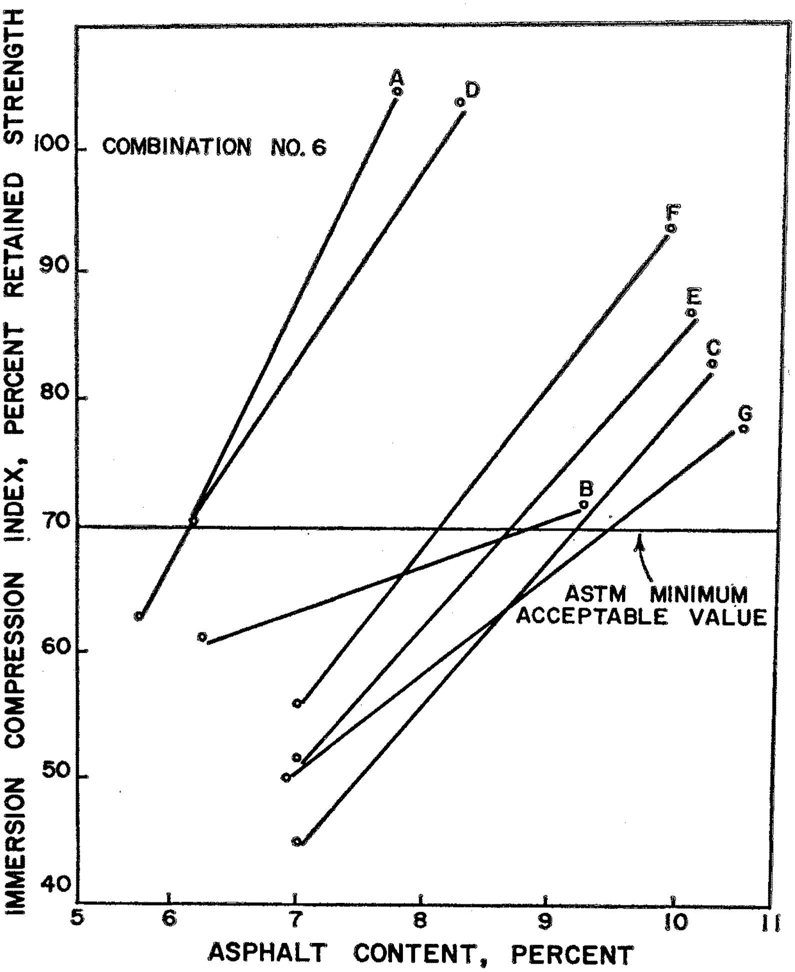

Figure 2. Immersion compression index versus asphalt content.

3. Asphalt absorption of the synthetic aggregate under study was essentially constant at 2 to 3 percent for the various producers' products when the available asphalt was limited; however, when an unlimited supply of hot asphalt cement was made available to the different materials under study, considerable difference was noted in the absorption capacity. Depending on particle size distribution and source of material, the absorption varied from 2.0 to 15.4 percent by weight. Under plant and field construction conditions, asphalt absorption of the synthetic aggregate fraction would normally be in the range of 2 to 3 percent by weight. Microscopic examinations indicate this absorption to be nonselective. Design asphalt contents of 7 to 10

percent by weight of mix are common. Corrected to a volume or film thickness basis, these compare favorably with THD Class A, Type D, hot-mix, dense aggregate designs in use today. It will be noticed from Figure 1 that the asphalt absorption is related to the water absorption if the aggregate is immersed in hot asphalt cement; however, for normal asphaltic concrete designs the asphalt absorption of the aggregate system is rather low. See Table II.

4. Hot-mix designs examined for water susceptibility included field sands so the results obtained are not clear, and the method used to make the evaluations is not absolute. However, at reasonable asphalt contents most of the designs were acceptable from the viewpoint of water susceptibility. Figure 2 shows the Immersion-Compression Index at different asphalt contents for the various aggregates.

5. The synthetic aggregates included in this study exhibited negligible expansion pressure and the swell as measured by Test Method Tex-209-F was in the range of 0.004 inch or less, compared to an allowable of 0.03 inch. It is therefore apparent that the qualities measured by these tests are quite high.

6. Air permeability measurements were made on a single design using aggregates from all seven sources. As has been found in the past, a general decrease in air permeability is associated with an increase in asphalt content; however, a coefficient of determination of 0.43 was obtained when air permeability was related to air voids in the compacted laboratory specimens. Results in the field are likely to be even more variable. Permeability to water instead of air should be measured.