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TEXAS TRANSPORTATION INSTITUTE

In cooperation with
Texas Department of Transportation
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Summary Report

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CEMENT COATING MARGINAL AGGREGATES FOR USE IN ASPHALT PAVEMENTS

PROBLEM STATEMENT

To meet the quality requirements of asphalt-pavement mixtures, districts often cannot use locally available aggregate. Thus higher quality aggregate must often be hauled long distances. For example, in East and Northwest Texas, and along the Gulf Coast, local aggregate supplies are siliceous river gravels, sands, and field sands. Mixes containing high percentages of these aggregates are not recommended for use in construction of asphalt concrete pavements, particularly on high volume roadways, because they contribute to a number of shortcomings—permanent deformation, moisture damage, insufficient skid resistance in wet weather, and poor fatigue resistance to heavy loads.

Recent laboratory research done in Kuwait and Saudi Arabia developed a promising cement-coating process for upgrading marginal aggregates. The basic principle of the aggregate-upgrading process is to create a rough-textured surface on the aggregate particles. A paste of Portland cement and water precoats the aggregate particle surface with a cement film that is allowed to cure completely. The newly coated granular material can then be used in bituminous concrete mixtures as usual. This promotes adhesion between the asphalt binder and the aggregate particles, significantly increasing the interparticle friction and improving the shear strength of the mix. The concept is to increase the shear strength and thus load bearing capacity of the aggregate-binder mix, which should provide a longer lasting pavement.

Successfully applying this process could make normally unsuitable aggregates from many local sources qualify for use in hot mixed asphalt concrete (HMAC). This would conserve higher quality aggregates, reduce transportation costs of hauling quality aggregates long distances, and ultimately save substantial public funds.

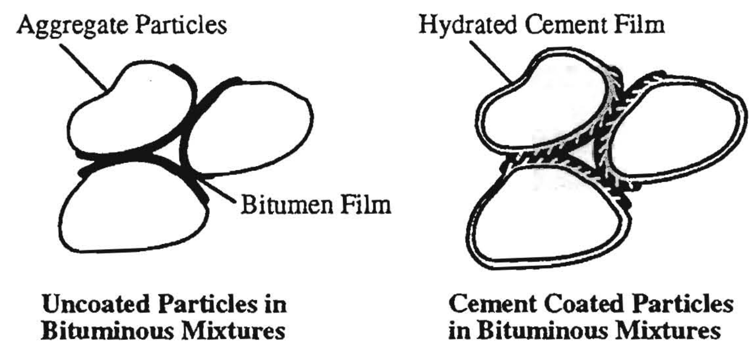
OBJECTIVES

The Texas Transportation Institute (TTI) conducted study 1253, *Upgrading Marginal Aggregate for Use in Asphalt Concrete*, for the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA) to examine the effects of applying a coating of Portland cement paste to marginal aggregates prior to use in HMAC. Both laboratory and field tests were conducted with the ultimate goal of establishing practical field operations for the aggregate-coating process. The study also examined the economic feasibility of the overall process.

An experimental plan was developed to test four different aggregates—all of marginal quality and not normally suitable under current TxDOT specifications—from four different locations and geological sources. Aggregates ranging in size from fine sand to one-inch rock were separately coated with cement, cured, and then blended to produce the desired mixture. Laboratory and field evaluations were performed using the process to coat the aggregate with Portland cement prior to use in HMAC. The hot mix asphalt concrete mixtures were designed and specimens were prepared according to standard TxDOT procedures.

FINDINGS

To evaluate the mixture's resistance to permanent deformation and moisture damage, researchers examined the mechanical properties of the uncoated and coated mixtures through standard laboratory tests such as Hveem and Marshall stability, resilient modulus as a function of temperature, indirect tension, moisture susceptibility, creep, and permanent deformation.



CEMENT COATING CONCEPT

The study showed that asphalt mixture design can be performed successfully with cement-coated aggregates using the standard TxDOT method. In the laboratory or in the field, aggregate coated with cement paste in accordance with the guidelines provided in the report will exhibit a uniform, rough-textured surface and will not form permanent clusters of aggregate which might negatively affect the design gradation of hot mixed asphalt concrete.

Unfortunately, electron microscopy revealed nearly 50-75% of the mixture wore off in laboratory mixing, and 95% of the cement coating came off following the mixing phase of the field tests. Evidently, this was caused by the highly kinetic mixing and compaction process. *So if an aggregate is unsuitable for use in a pavement surface course because of potentially poor surface friction, the cement-coating process cannot effectively be used in the field to upgrade the aggregate.*

Laboratory evaluation did, however, give some promising results. While the resilient modulus tests at different temperatures revealed no appreciable or consistent differences in stiffness (which determines susceptibility to cracking) between the uncoated and coated specimens, Hveem stability tests showed an increased resistance to permanent deformation when cement-coated aggregate was used in the asphalt mixtures. Although Marshall stability varied significantly between the different mixtures, there was no significant difference in Marshall flow attributable to the cement coating. Neither is tensile strength of asphalt mixtures consistently affected by cement coating the aggregate. Cement coating improved moisture resistance for three of the five mixtures; and creep tests on asphalt concrete specimens *did indicate* that cement-coated aggregate will show *improved shear strength*, thus providing better resistance to pavement rutting than similar uncoated materials.

CONCLUSIONS

A coating process for upgrading marginal aggregate for use in HMAC does have tremendous potential at the national level. The cost difference between coated local aggregate and high-quality aggregate hauled long distances will continue to increase as transportation costs increase. When comparing the cost of high-quality aggregate with that of HMAC containing cement-coated local aggregate, an estimated maximum savings approaching 10 percent can be realized when the haul distance for the high-quality aggregate is the maximum required in Texas. However, this study observed a problem with the lack of toughness or abrasion resistance of the cement coating.

Although resistance to permanent deformation improved with the cement coating, in both the laboratory-prepared mixtures and particularly in the field-prepared mixtures, most of the cement coating was worn away during the mixing process and during routine handling in the field. At the present state-of- the-art, researchers do not recommend implementation of the cement-coating process to upgrade marginal aggregate in HMAC on high-traffic roads.

However, a series of tests on mixtures in which the Portland cement is added dry as a filler would reveal a relative measurement of how much the mixture properties are altered by coating the aggregate with cement, and how much they are altered by the mere presence of the cement in the mix. In short, more research is needed to develop an abrasion resistant yet cost-effective method of upgrading marginal aggregates.

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The contents of this summary are reported in detail in TTI Research Report 1253-1F, "Cement Coating Marginal Aggregates for Use in Asphalt Pavements," Joe W. Button and Vidyasagar Jagadam, November 1992. This summary does not necessarily reflect the official views of the FHWA or TxDOT.