forced efforts to produce more economical asphalt treated bases.

From a review of the component cost of hot mix, it appears as if significant savings can be effected by reducing materials cost by some 50 percent, if the total cost of hot mix production can be attributed to asphalt and aggregates. Substitute binders such as sulphur-asphalt and the use of marginal aggregates are areas requiring further study if the price of black base is to be significantly reduced.

SUMMARY

The performance of black base pavements based on ten years experience in Texas is favorable. Only minor amounts of traffic load associated distress has been noted. The "block" cracking pattern typical of West Texas flexible base pavements can be reduced by the use of black base pavements. The effect of swelling clays on pavement roughness cannot be solved by the use of black bases. Reflection cracking from lime treated subbases can be expected to propagate through the asphalt treated base and asphalt surface course. As several district representatives have said, "We like black bases".

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PERFORMANCE OF COARSE AGGREGATE, HOT SAND AND ASPHALTIC CONCRETE BASES IN OKLAHOMA

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During the late 1940's and early 1950's Oklahoma experienced considerable success with road mix sand asphalt bases. This success encouraged the trial and subsequent use of hot mix sand asphalt bases with the advent of the interstate system. This paper depicts the experience in Oklahoma of not only the sand asphalt bases but also the coarse aggregate and asphaltic concrete bases which have been in service since the late 1950's.

This is not intended as a formal paper but rather as a dissertation on the experience in Oklahoma of the various type bituminous bases.

In order to understand some of the philosophy behind the acceptance of fine aggregate bituminous bases (FABB), formerly referred to as hot sand asphalt, I should explain that we have constructed several hundreds of miles of low-type secondary roads and some primary using a road mix soil asphalt composed of fine sands and medium curing cut-back asphalts.

With the advent of the interstate construction program, it became apparent that our normal aggregate sources would not be able to supply the quantities of materials necessary to sustain the accelerated construction; therefore, it became necessary to innovate. Experiences in South Carolina indicated that medium-fine to coarse sands could be used for a high-type pavement base when mixed with asphaltic cements. A group of our paving engineers visited South Carolina to better understand the type of material and the construction procedures necessary to accomplish satisfactory bases. The techniques observed were then adapted to the Oklahoma environment.

The materials used in fine aggregate bituminous base are sands which have 100 percent passing the one-inch sieve and have five to twenty percent passing the 200 sieve. These sands are combined with asphalt percents ranging from three to eight percent. The mixes are designed to have a minimum Hveem stability of twenty.

The soil materials suitable for construction of the fine aggregate bases are generally found in the western two-thirds of the state; however, it is sometimes necessary to blend the natural sands with crusher screenings or fine chips in order to achieve the stability requirement.

Approximately 500 two-lane miles of this type base have been constructed since 1957. The majority of this is on the interstate system. The performance has been exceptional. Structural failures are almost nonexistent. Some sections of highway with fine aggregate bituminous base have experienced distress, but the cause has not been failure of the base material.

The mixtures, although having approximately 18 percent air voids, are extremely impervious to water. A two-and-one-half to three-inch course of material is adequate to protect the underlying grade from water. The asphaltic materials in most instances retain their ductility and penetration much better than the other type bases.

In general, the fine aggregate bituminous base is covered with two to four-and-one-half inches of asphaltic concrete. A few projects have been constructed with a double bituminous wearing course. As the thickness of the overlying material decreases, the stability requirement in the top half of the base is increased.

Another type base, coarse aggregate bituminous base (CABB), has been used but not so extensively. This base is designed very similarly to asphaltic concrete with the exception that gradation band on the aggregates is opened somewhat. These aggregates all pass the one-and-one-half-inch sieve and have from two to ten percent passing the number 200. The asphalt percentage ranges from three to six percent.

This material is not so impervious to water and we have experienced some difficulty during construction with the subgrade becoming wet. This type base also is susceptible to water while in service as evidenced by some failures caused by stripping of the asphalt.

The original intent of the specification for the coarse aggregate base was to utilize natural gravel deposits; however, satisfactory stabilities could not generally be obtained, and additional crushed material had to be added. This put the aggregates of the base in very close competition with the aggregates required for the asphaltic concrete surfaces.

In recent years experimental sections have been constructed using asphaltic concrete as a base material. Because the strength of the various materials varies, we have determined that one inch of asphaltic concrete can be substituted for one-and-one-half inches of fine aggregate bituminous base or one-and-one-quarter inch of coarse aggregate bituminous base. Using these equivalency ratios it seems apparent that the asphaltic concrete base is the most economical. However, the availability of crushed aggregates varies depending on the area of the state. Suitable aggregate sources may be as far as a 150-mile distance.

The performance of the asphaltic concrete bases to date seems very satisfactory.

Satisfactory performance has been experienced with all three types of bases. Very possibly the moisture susceptibility and permeability of the coarse aggregate base could be reduced if the material were placed in lifts of six inches or more in thickness. The extreme nonpermeability of the fine aggregate base renders it a very valuable and desirable material from the construction standpoint. The asphaltic concrete bases, depending on the area of the state, are in a very favorable position economically.

In all probability we will begin using more asphaltic concrete bases and fewer coarse aggregate bases in our construction.