1203

FURTHER EVALUATION OF BLACK BASE AND AGGREGATE BASE CONSTRUCTION (M 20 AND M 66)

MICHIGAN DEPARTMENT OF TRANSPORTATION

TESTING AND RESEARCH DIVISION
RESEARCH LABORATORY SECTION

TE 212 M35 1982 c. 3
Further evaluation of black base and aggregate base construction (M-20 and M-66)

FURTHER EVALUATION OF BLACK BASE AND AGGREGATE BASE CONSTRUCTION (M 20 AND M 66)

R. C. Mainfort

Research Laboratory Section
Testing and Research Division
Research Project 75 E-59
Research Report No. R-1203

Lansing, August 1982

Introduction

This report describes further comparison of the performance of a hot mix bituminous stabilized base (represented by an 8-mile section of M 66) and an aggregate base (represented by an 11-mile section of M 20) located such that they have approximately the same traffic volumes, soil conditions, climate, and completion date. The general location of the test sections, constructed in 1974, are shown in Figure 1.

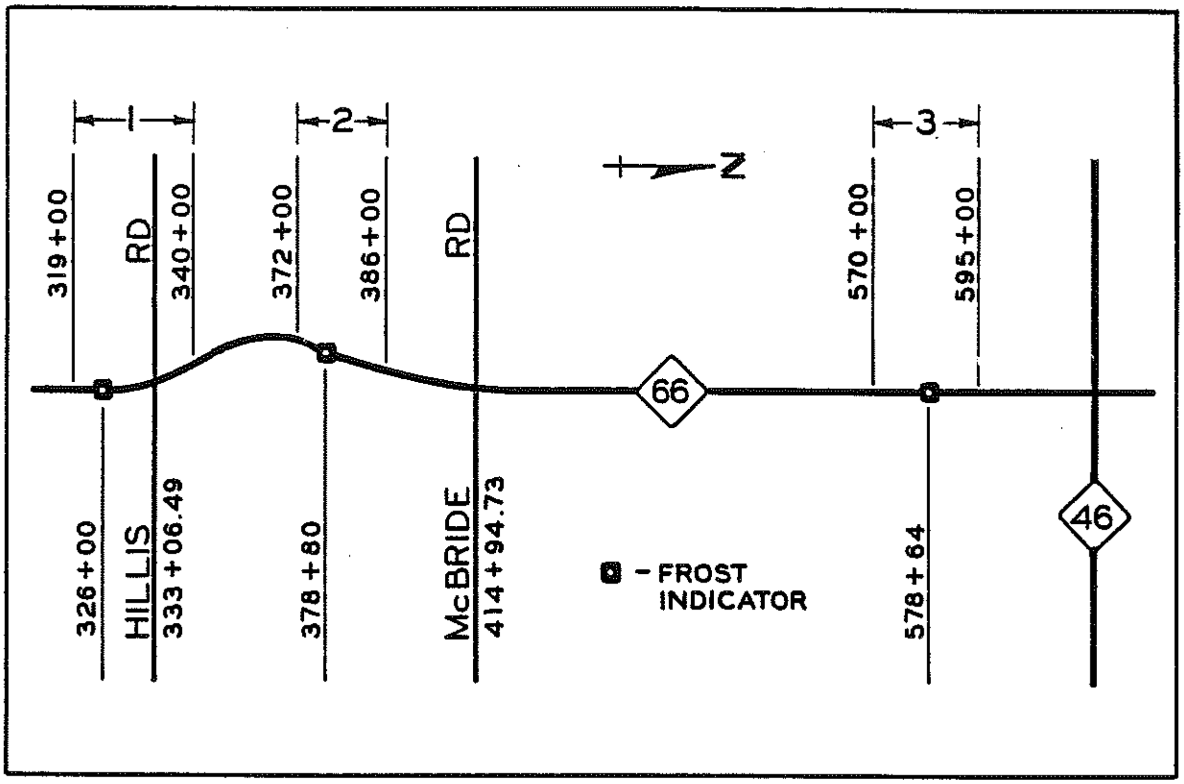
The cross-sections of the bases being compared are shown in Figure 2. The conventional aggregate base section consists of 11-in. of graded aggregate (7 in. + 4 in. of selected subbase), surfaced by 2-3/4 in. of bituminous concrete. The thinner black base section consists of 4 in. of bituminous treated base on 4 in. of selected subbase, surfaced by 2-1/4 in. of bituminous concrete. Both sections are supported by an 18-in. subbase. In effect, 4 in. of black base replaced 7 in. of aggregate base and 1/2 in. of asphalt concrete surfacing.

The first progress report, prepared by F. T. Hsia (1), described the construction of the projects and their condition after one year of service. The project performance was determined by the Minnesota method using a system of Benkelman beam deflection measurements. The one-year results indicated that the black base sections were slightly superior to comparable aggregate base sections from the standpoint of reduced deflections and corresponding higher allowable springtime axle load capacities. The differences were considered minor, however, and both type pavements were in excellent condition. Also, the Minnesota method appeared to be suitable for comparing the pavements. Deflection measurements were made in the outer wheel tracks of the northbound lane of M 66 and the eastbound lane of M 20.

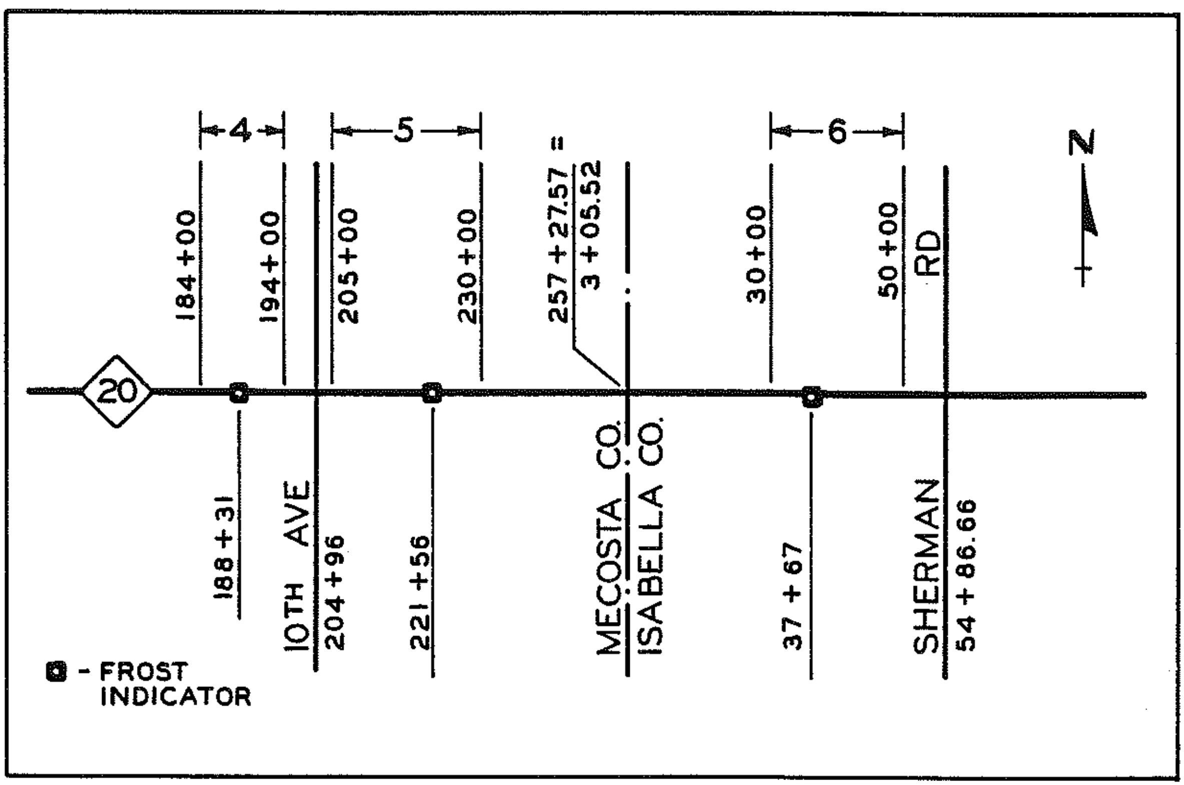
The present report describes evaluation of the test sections after three years (1978) and six years (1981). The largest part of the evaluation was made using the three-year data for which several methods of analysis were used.

Third Year Evaluation (1978)

For the sake of continuity and simplicity of testing, the Minnesota method was again used for evaluating pavement performances. As described in Ref. (1), this method permits prediction of springtime deflection values from deflection measurements measured at any frost-free time of the year. Although empirical in nature, the method has proven satisfactory in other studies by the Department (1, 2) and seems well suited to relative



(A) Black base sites (M 66, C/S 59051, J/N 01770A).



(B) Aggregate base sites (M 20, C/S 54022 and 37021, J/N 00519A and 05101A).

Figure 1. Site layout.

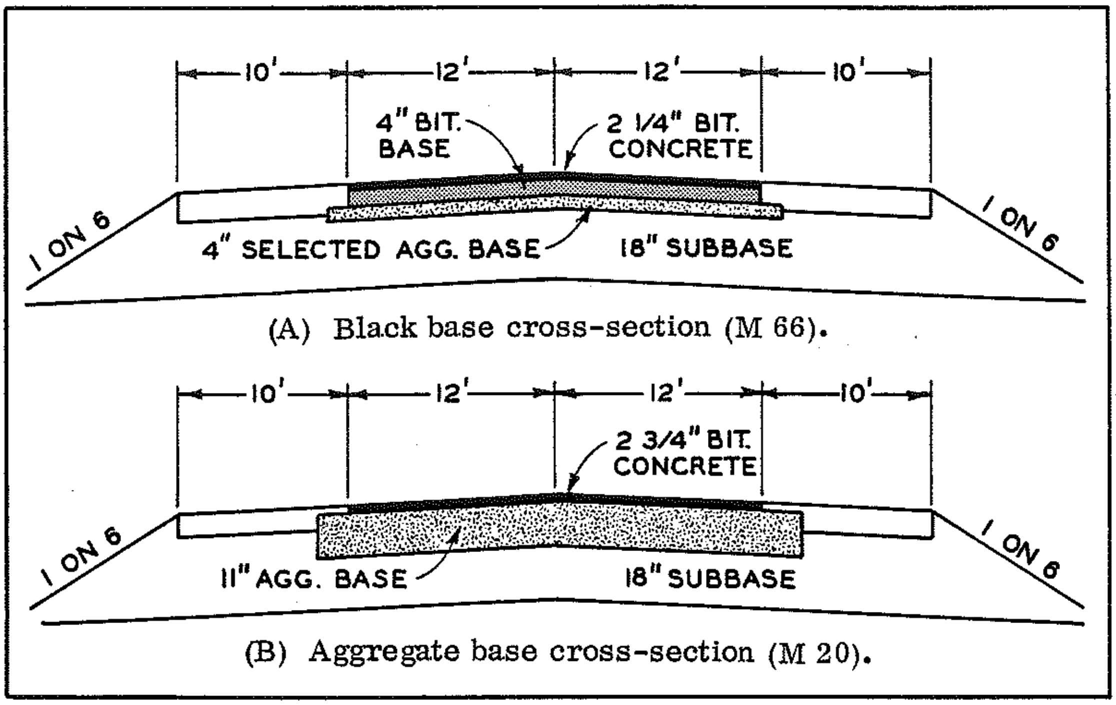


Figure 2. Cross-sections of the two bases.

comparison of different pavement conditions in proximate areas. Deflections were measured by Benkelman beams using a system developed for the method as described in Ref. (1).

Figure 3 shows the predicted springtime allowable load carrying capacity of the sections as predicted by the Minnesota method for both the original 1976 tests and for the 1978 testing, showing the range and mean values based on deflection measurements made at various periods of the years. Mean values compare quite closely for the two years and show a slightly higher load supporting ability for the black base.

Figure 4 summarizes results of different phases of the 1976 and 1978 testing used to obtain allowable springtime load values for the two pavement types. Figure 4A shows the average of the deflections measured periodically during the years, corrected to a temperature of 80 F, plus two standard deviations.

Figure 4B shows the mean allowable load at the time of test and Figure 4C summarizes, in bar graph form, the mean allowable springtime load capacity for the two pavement types. The 1978 data favor the black base over the aggregate base. The 1976 data had shown the summertime strength to be about the same for both aggregate and black bases (Figs. 4A and 4B).

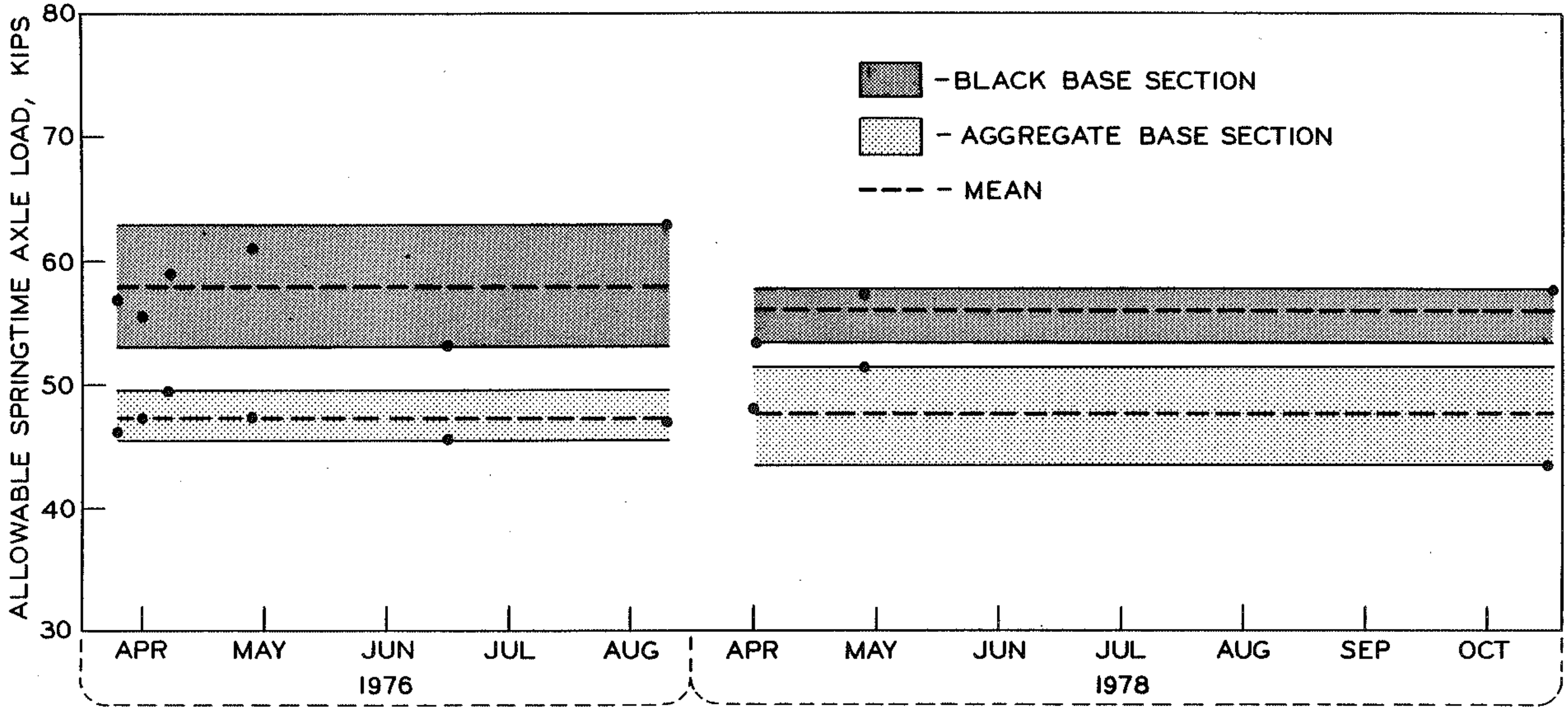


Figure 3. Allowable springtime load carrying capacity of the test sections as predicted by the Minnesota method from deflections measured at time indicated.

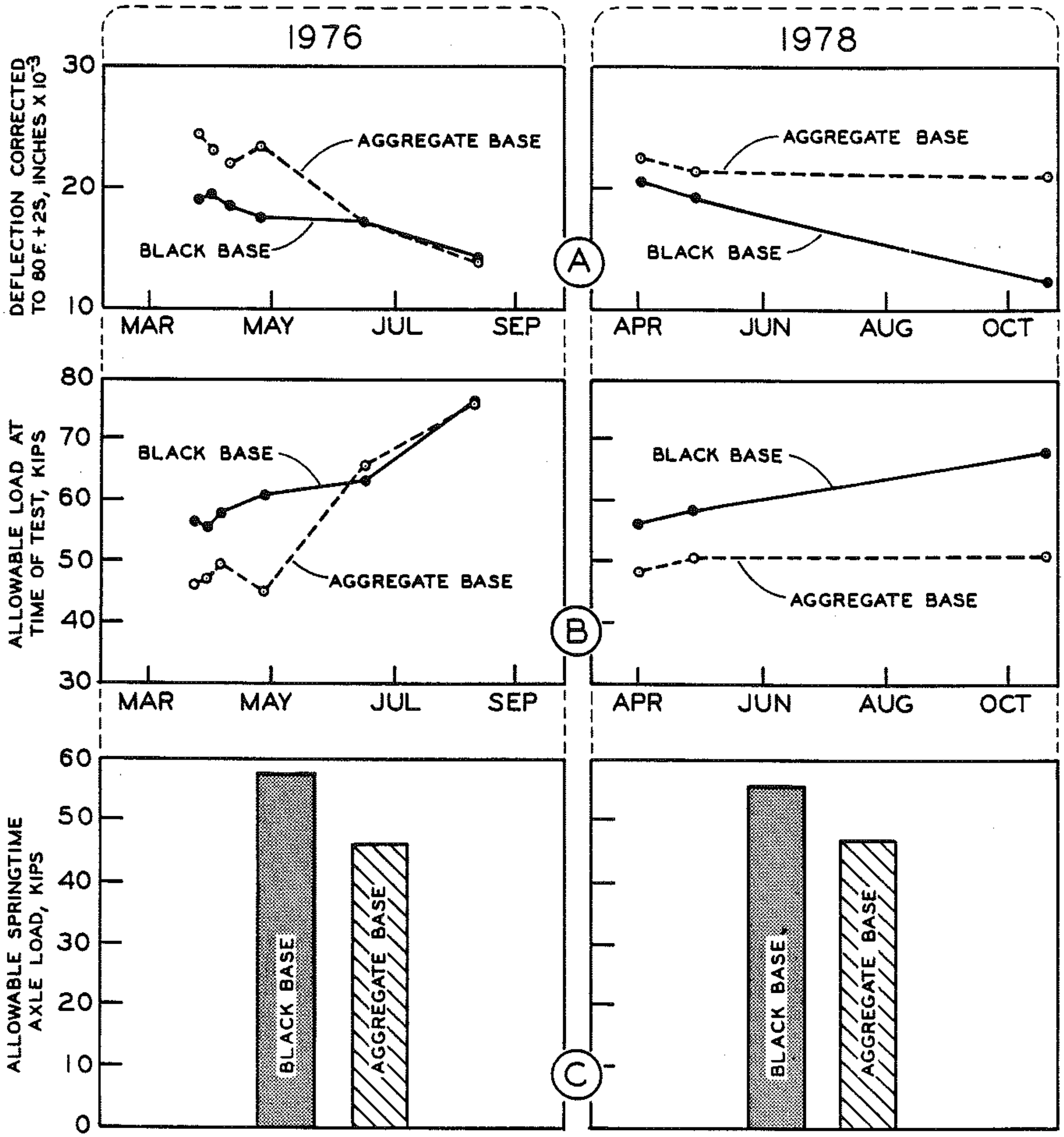


Figure 4. Summary of 1976 and 1978 test results based on average values for the two test sections—Minnesota method.

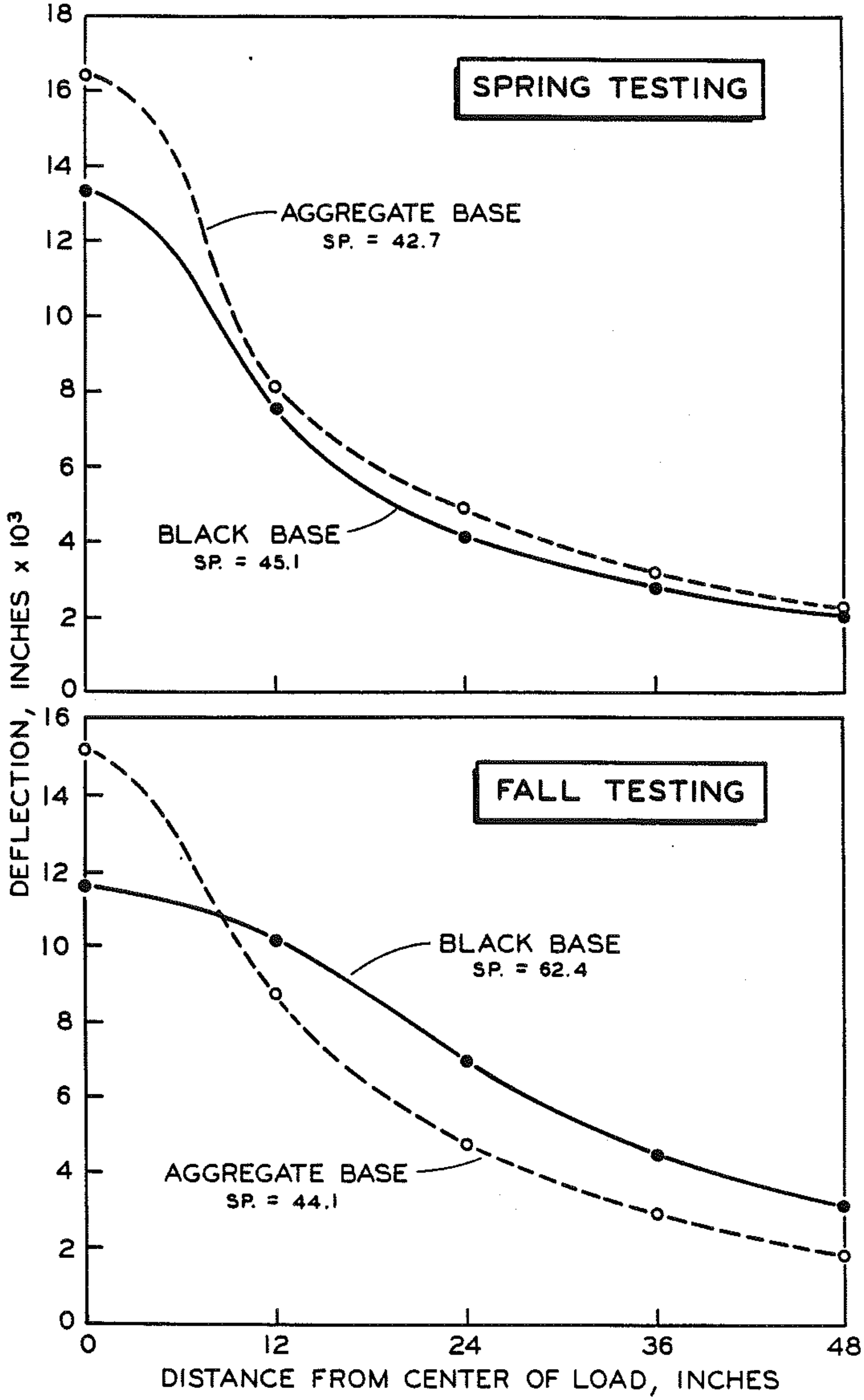


Figure 5. Average deflection basins for the aggregate and black base test sections—spring and fall tests, 1978.

In addition to the Minnesota method of test, other procedures were used for the 1978 evaluation. These were conducted under the direction of S. S. Kuo, prior to his leaving the Research Laboratory, who also developed some of the methods employed. These included a rational method for determining the springtime allowable axle load and the use of the entire deflection basin under a load rather than only the maximum value. Values obtained from the deflection basin, designated "spreadability" values, are expressed as a percentage (3). For the spreadability tests, deflection measurements were made at the maximum deflection point under the wheel load and at 12, 24, 36, and 48 in. from the center of loading, longitudinally along the wheelpath being tested. All deflections were corrected to 70 F by use of a correction factor developed by Kingham (4).

The spreadability value is defined as the average deflection at all five measurement locations expressed as a percentage of the maximum deflection, or

$$\text{Spreadability} = \frac{d_0 + d_{12} + d_{24} + d_{36} + d_{48}}{5d_0} \times 100$$

where d_0 is the maximum deflection and d_{12} through d_{48} are the deflections at 12 through 48 in. from the maximum wheel load position. The higher the spreadability values the more effective will be the load distribution and consequently the less strain on the subgrade.

Typical deflection basins obtained by this method are shown in Figure 5, in which average values obtained for the black base and aggregate base during spring conditions (weakest) and fall conditions (strongest) are compared. These values show the black base to be somewhat superior to the aggregate base during both spring and fall. The data indicate, however, that the black base is more sensitive to seasonal variation than is the aggregate base.

Evaluation of Individual Test Sections (Third Year)

Each of the test areas (aggregate and black base) were tested by evaluating three individually selected areas within an overall area. In order to check variations within a test area and to obtain a better indication of the sensitivity of the various test methods used, values obtained from each section were plotted individually. These are summarized in Figure 6 for springtime, or weakest conditions. In addition to the tests already discussed, these data also include results of a rational method used to obtain allowable springtime axle loads. The development and discussion of this method is beyond the scope and purpose of this report but has been described by S. S. Kuo (5, 6). In this method, the black base was considered

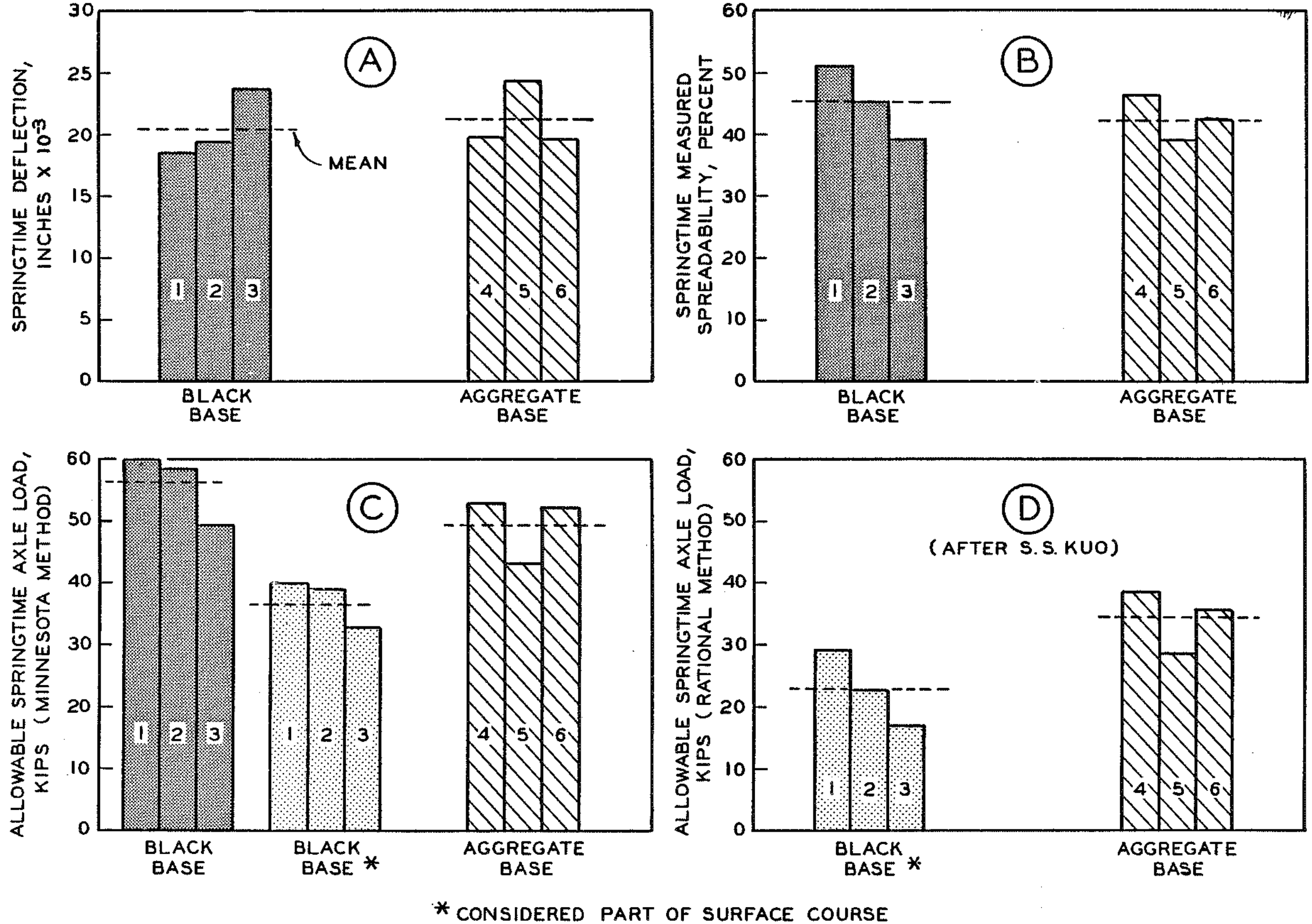


Figure 6. Performance of individual test sites within the two test sections as based on different evaluation methods—1978 data.

to be a part of the surface course rather than of the base, a condition which reduces the allowable load carrying capacity compared with that obtained when the black base is considered as a base. In the original evaluation, however, it was felt that the black base would be more appropriately considered as a base and the load carrying capacity evaluated on that basis. The Minnesota method, in the present study, reduces the carrying capacity by about one-third if the black base were considered part of the surface and, for comparison, these values are included in Figure 6C.

Figure 6 shows that there is as much, or more, variation within a test section than there is between the two different treatments. In fact, except for the controversial case where the black base is considered as part of the surface, all of the tests indicate that there is very little difference between the springtime performance of the black and aggregate bases. This has been supported by visual inspection, rutting surveys, and crack counts of the areas. It should also be noted from Figure 6 that the same trend of relative values is obtained in all the test methods. That is, the strongest, weakest, and intermediate values are the same within each of the two basic test sections no matter which method of test is used. This indicates that a simple springtime maximum deflection measurement would suffice for at least obtaining relative evaluation of the two test areas.

Sixth Year Evaluation (1981)

The sixth year evaluation consisted of measuring deflections during the fall of the year and conducting rut depth measurements of the test sections. These data are summarized in Figure 7. Here again, the results slightly favor the black base sections. No highly significant differences are noted however, and the general appearance and riding quality of both test areas continued to be excellent. Very little cracking was found in either area.

Conclusions

Based on deflection measurements, rut depth measurements, and visual inspection during a six-year life span of the test sections, the following conclusions have been reached.

1) The thinner black base section has performed as well or slightly better than the conventional aggregate base.

2) Both test areas (and the surrounding roadway of which they are a part) are in excellent condition from a rutting, cracking, and riding standpoint and deflection values are well within allowable limits for all weather load carrying capacities.

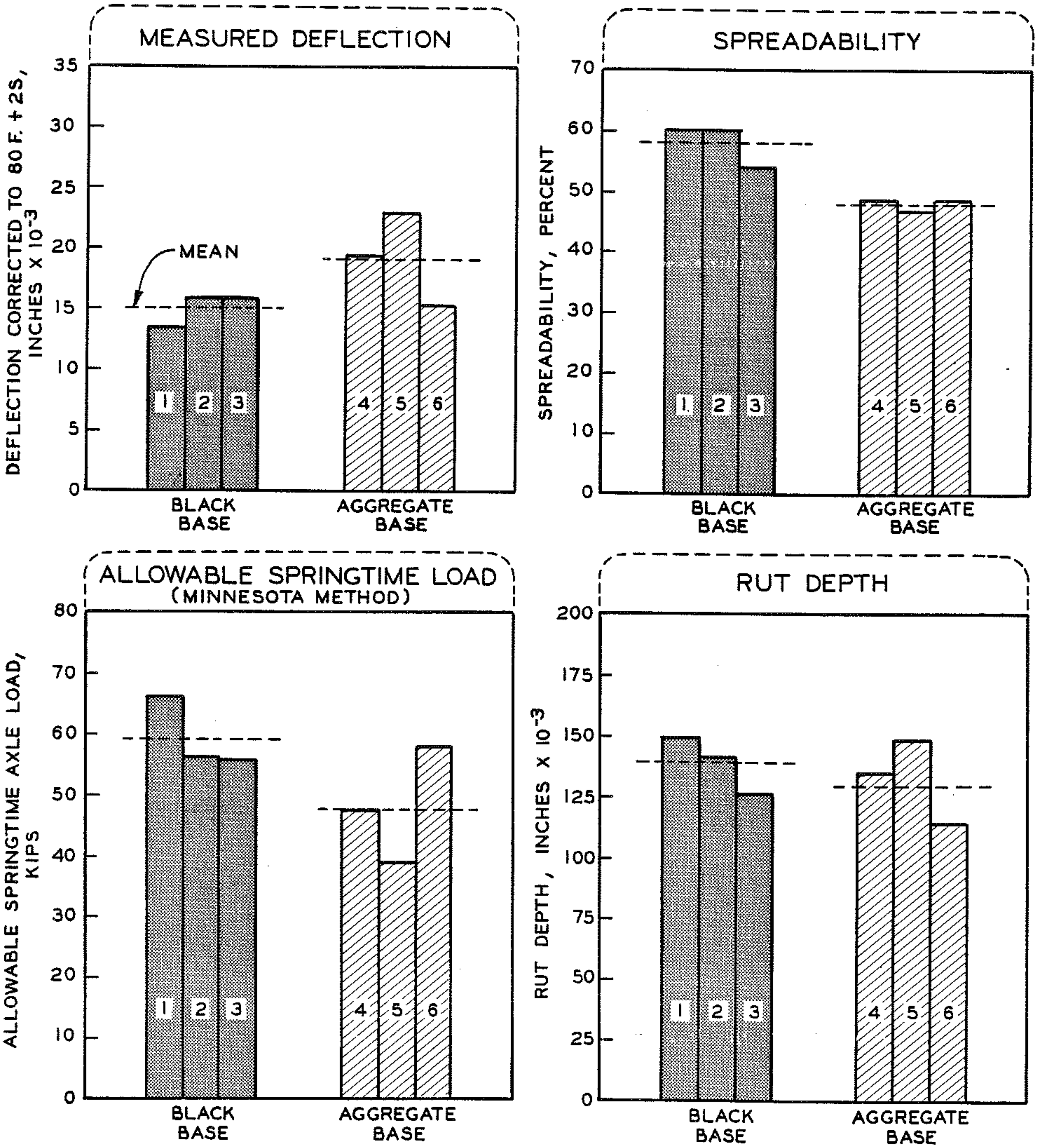


Figure 7. Results obtained from 1981 fall measurements.

3) The weakest individual area found was the middle test section of the aggregate base area. Long-term observation of the performance of this section relative to the others might be of value for checking the suitability of the testing methods used in this study.

4) In general, test results show greater differences within individual areas of a given test section than was the difference between the two basic test areas.

5) Although the objective of this project has been met, it is suggested that long-term observations of the test sections be made to determine if any eventual change in performance of individual subsections can be correlated with that to be expected from test results obtained in this study.

REFERENCES

1. Hsia, F. T., "Comparison Study on the Performance of Bituminous Stabilized Bases (M 66 and M 20)," MDOT Research Report R-1046, February 1977.

2. Mainfort, R. C., "A Study of Seasonal Variation in Pavement Conditions by Means of Benkelman Beam Deflection and Frost Depth Measurements," MDOT Research Report R-1178, August 1981.

3. Rufford, P. G., "A Pavement Analysis and Structural Design Procedures Based on Deflection," Proceedings, Fourth International Conference on the Structural Design of Asphalt Pavements, 1977.

4. Kingham, R. I., "A New Temperature Correction Procedure for Benkelman Beam Rebound Deflections," The Asphalt Institute, Research Report 69-1, 1969.

5. Kuo, S. S., "Development of Base Layer Thickness Equivalency," MDOT Research Report R-1119, June 1979.

6. Kuo, S. S., Unpublished data prepared at the Research Laboratory, Michigan Department of Transportation.