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FIELD TRIAL OF FOAMED ASPHALT STABILIZATION
FINAL REPORT

MICHIGAN DEPARTMENT OF TRANSPORTATION

MATERIALS and TECHNOLOGY DIVISION

FIELD TRIAL OF FOAMED ASPHALT STABILIZATION
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Category 2 Experimental Features Project
Work Plan No. 81R

Research Laboratory Section
Materials and Technology Division
Research Project 81 D-41
Research Report R-1251R

Lansing, March 1986

SUMMARY

In August 1981, the shoulders of two highways were reconstructed using an in-place foamed asphalt stabilization process. The Research Laboratory conducted an evaluation of the stabilized base material in accordance with Category 2 Experimental Work Plan No. 81R in cooperation with the Federal Highway Administration. Construction operations were monitored on both projects, I 96BL in Muskegon County and US 131 in Antrim and Charlevoix Counties. Samples of the stablized material from US 131 were obtained during construction and tested in the laboratory for tensile strength, stiffness modulus, and Poisson's ratio. Strength tests were performed after various time intervals to determine the curing rate of the foamed asphalt mixtures.

INTRODUCTION

Hot asphalt cements (330 F) have been used by the Michigan Department of Transportation for in-place recycling and stabilization since 1977. Previous attempts at using emulsified asphalts were not successful and the use of cutback asphalts was phased out because of air quality restrictions. The foaming process has been used to aid in the dispersion of the asphalt cement and to aid in compaction. Foamed asphalt mixtures can be compacted immediately after mixing, in constrast to emulsions and cutbacks which require extensive aeration between mixing and compaction.

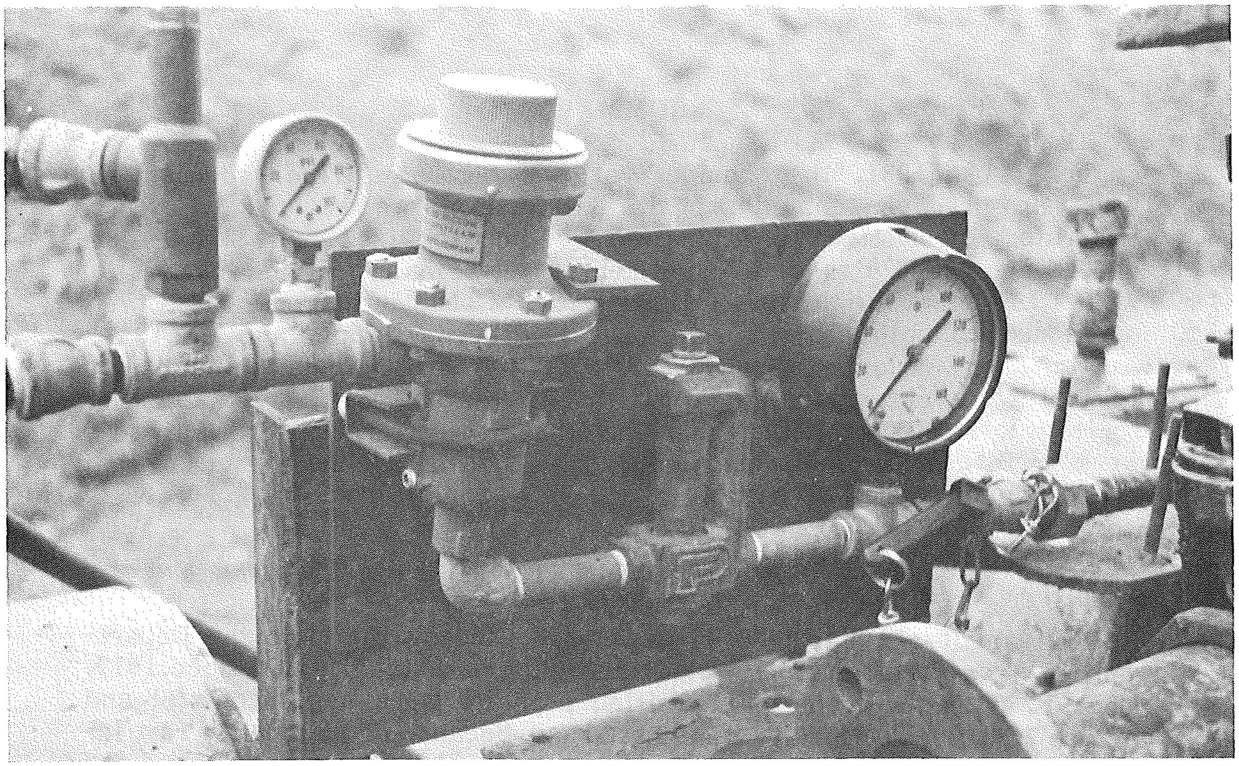
The experimental test sections used existing shoulders with sandy granular base materials. Existing shoulder material was stabilized to a depth of approximately 5 in. using foamed asphalt cement, 120/150 penetration grade, as the stabilizing agent. Foaming was accomplished by adding water in metered and controlled proportions to the hot asphalt cement (330 F) through a special mixing system (Fig. 1). After water was added at the rate of 1.4 percent of the asphalt cement, the mixed liquids were blended with the base aggregate to achieve an asphalt content of about 3 percent. Shoulder stabilization operations are shown in Figure 2. Work was performed under contract in accordance with Section 4.07, 1979 Standard specifications for Construction, MDOT. The stabilized base was surfaced with 1-1/2 in. of hot mix wearing course.

Samples of the stabilized material were obtained during construction for laboratory testing to determine rate of curing, tensile strength, stiffness, and uniformity of mixing.

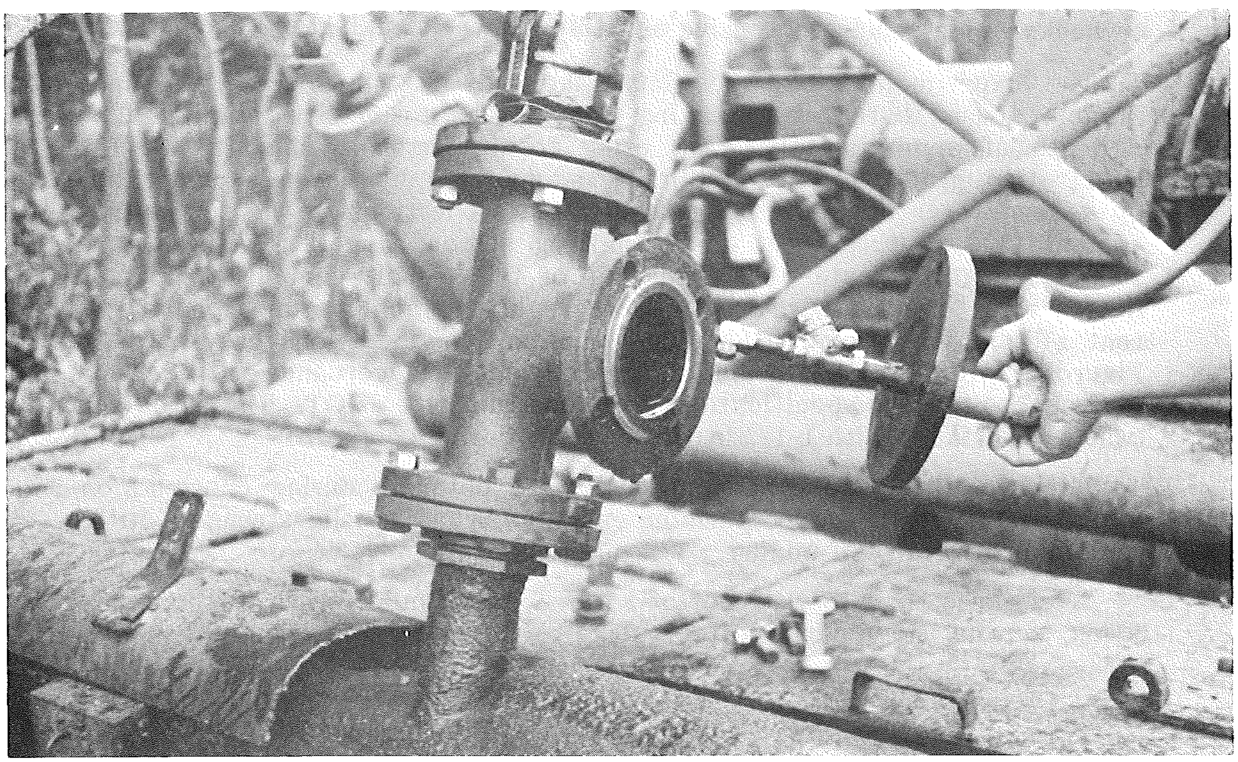
After more than three years of service, the shoulders are in good condition showing no adverse effects due to loads or environmental conditions.

TESTING PROGRAM

Evaluation of the material stabilized with foamed asphalt involved field sampling and testing during construction followed by laboratory



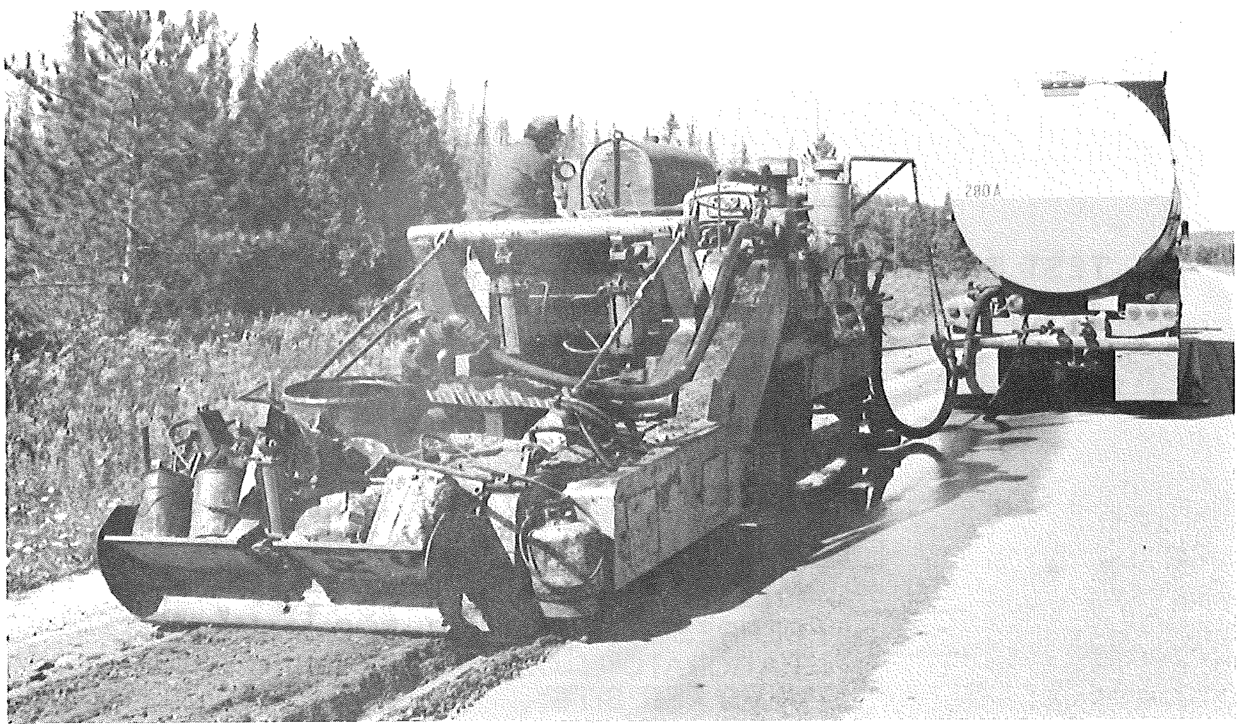
Water metering and control system.



Water nozzle removed from foaming chamber.

Figure 1. Apparatus used for foaming asphalt cement.

Stabilization of median shoulders along I 96BL in Muskegon County. Operations include asphalt tanker (pulled by tractor), single-pass stabilizer adding and mixing foamed asphalt, and pneumatic roller.



Stabilization of shoulders along US 131 in Charlevoix County, single-pass stabilizer adding and mixing foamed asphalt following asphalt tanker.

Figure 2. Shoulder stabilization with foamed asphalt cement.

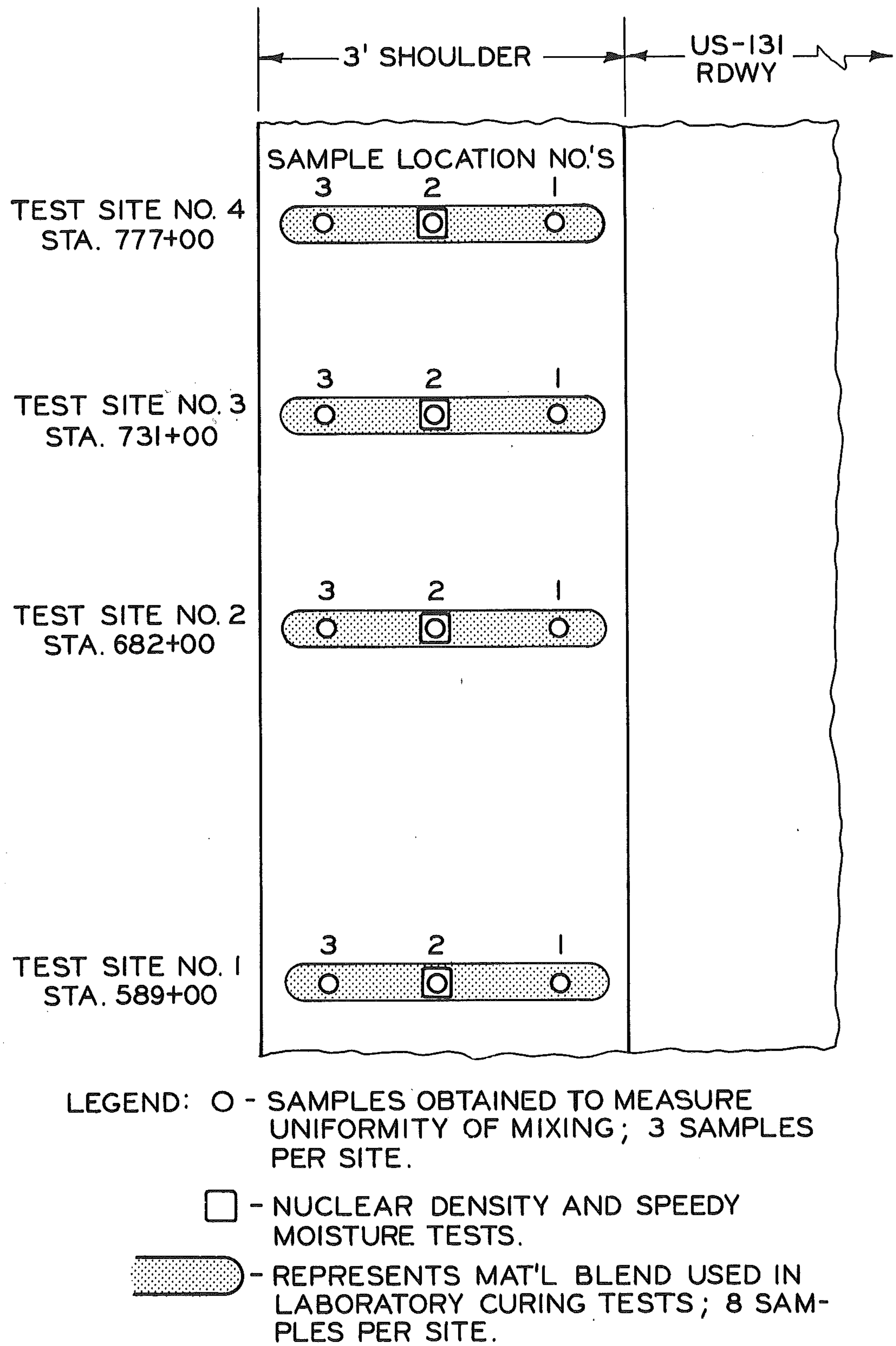


Figure 3. Sampling and test locations on foamed asphalt shoulder project.

testing after construction. Locations of sampling and testing sites are shown schematically in Figure 3. In-place density and moisture contents were measured where shown, using nuclear density gages and Speedy moisture meters.

Eight Marshall specimens were molded at each section using freshly mixed stabilized material sampled immediately prior to compaction. Each of the eight samples was cured in an unsealed plastic bag in the laboratory. After the scheduled curing periods, ranging from 1 to 104 weeks, the eight samples were subjected to indirect tensile testing. Stabilized material was sampled from across the width of the shoulder and blended to represent the mix at each site. Three additional Marshall specimens were also molded at each site using material sampled from near the edge of the pavement, at the center of the shoulder and near the outer edge of the shoulder, located as shown in Figure 3. These specimens were sampled at sites selected to indicate the uniformity in the lateral mixing of the asphalt with the granular base material.

TABLE 1
PROPERTIES OF GRANULAR BASE STABILIZED WITH FOAMED ASPHALT CEMENT

Section	Initial Moisture Content Percent	Initial Base Temperature F	Temperature of Blended Mixture, F	Extracted Asphalt Content Percent	Moisture Content After Mixing Percent	Compacted Dry Unit Weight, lb	Compaction Percent of 50-Blow Marshall
1	5.5	80	88	2.6	6.5	130.6	99.2
2	4.6	60	80	3.4	5.7	129.8	99.3
3	7.6	80	90	3.6	9.1	125.5	95.2
4	7.4	65	85	3.4	7.8	125.4	94.1
Average	6.3	71	86	3.3	7.3	127.8	97.0

RESULTS

As Constructed Properties

Tests and measurements made during construction included moisture content, density, and temperature of the base mixture. Subsequent laboratory analyses of samples obtained during construction also provided apshalt content and uniformity, and gradation of the stabilized mixture. Results of these tests, given in Table 1, show that, on the average, 3.3 percent asphalt was added along with an additional 1 percent water; the stabilized mix was then compacted to 127.8 lb/cu ft density corresponding to 97 percent of 50-blow Marshall compactive effort.

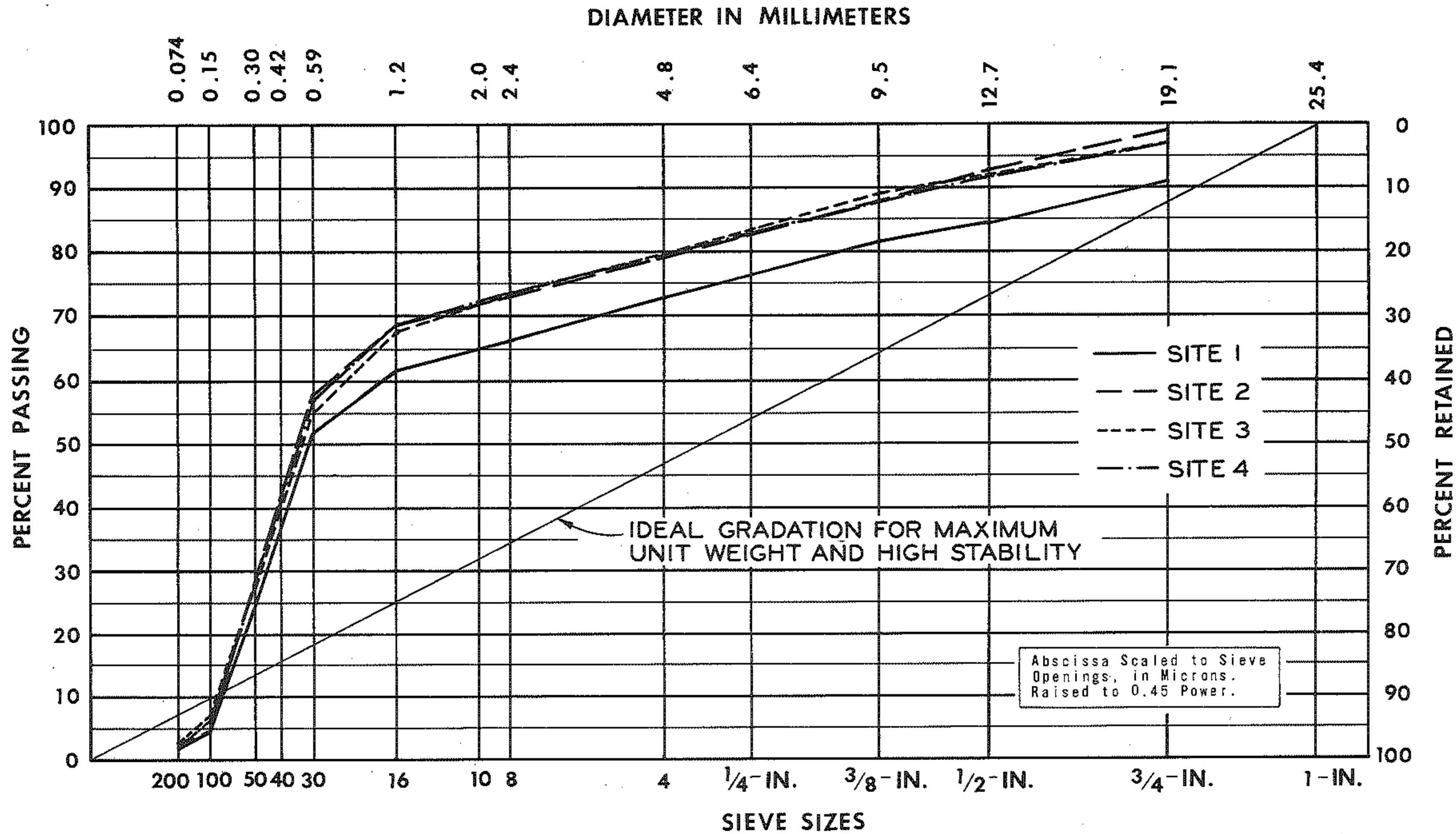


Figure 4. Gradation of granular base material stabilized with foamed asphalt.

Distribution of the asphalt stabilizer was checked for uniformity by extracting the asphalt from samples obtained at three locations across the width of the shoulder at each of the four test sections. Results of these measurements are summarized in Table 2 and show about 1 percent more asphalt adjacent to the driving lane (inside edge) than across the remainder of the shoulder; this lack of uniformity is intentional and agrees with the current Departmental practice of incorporating more asphalt next to the pavement in order to reduce the longitudinal cracking of the shoulder surface layer, a frequent problem in Michigan.

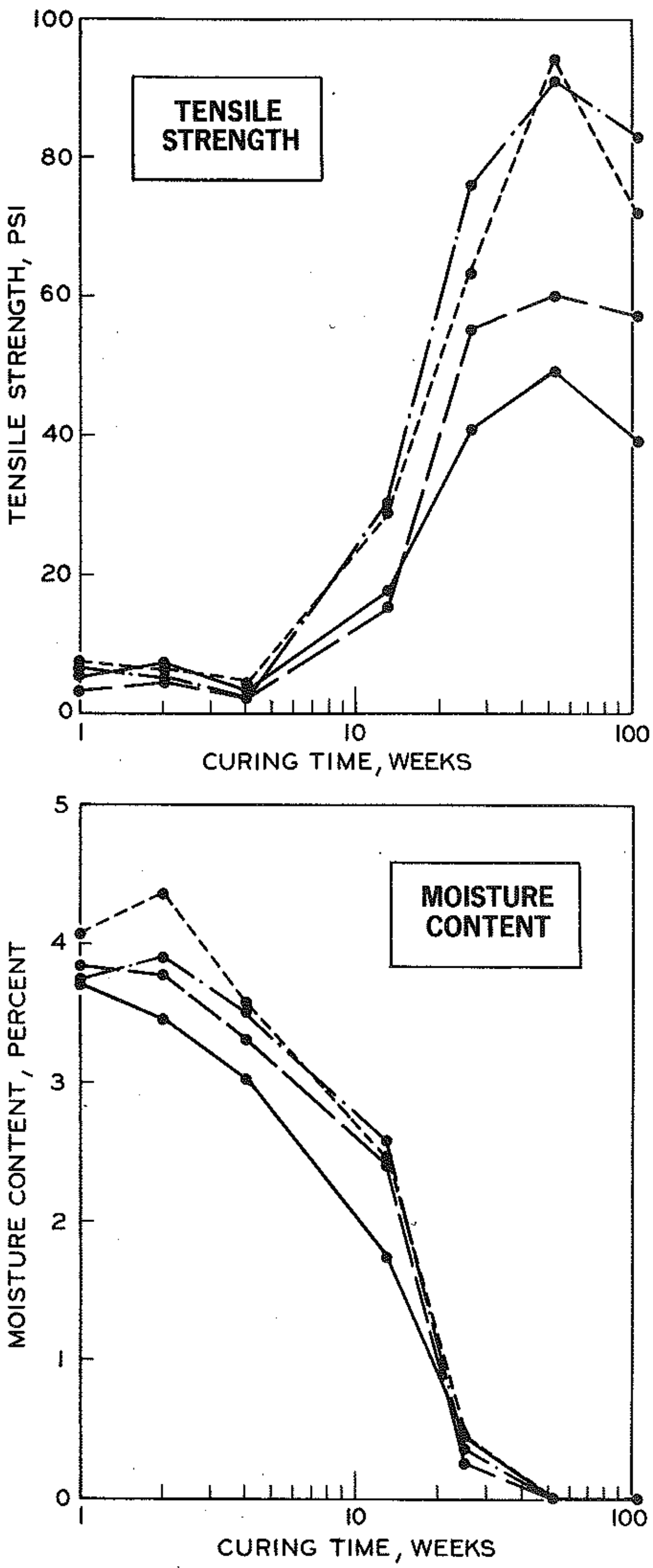
TABLE 2
VARIATION IN ASPHALT CONTENT, PERCENT

Section	Inside Edge	Center	Outside Edge	Average
1	3.50	2.41	2.04	2.65
2	3.76	3.15	3.22	3.38
3	4.26	2.42	4.00	3.56
4	3.90	3.73	2.71	3.45
Average	3.86	2.93	2.99	

Grain size analysis of the granular material, presented in Figure 4, shows the material to be about 70 percent sand with almost no material coarser than 3/4 in. Because of this predominance of sand, the unstabilized material would neither be very dense nor very stable as compared with a dense graded material with the same top size; represented by the straight line gradation also shown in Figure 4.

Laboratory Measurements of Strength and Curing Rates

Samples from each test section were cured in the laboratory and tested for tensile strength, stiffness modulus and moisture content after curing periods of 1, 2, 4, 13, 26, 52 and 104 weeks. Results of these tests are shown in Figure 5. These tests show a continual gain in strength and stiffness through the first year along with a decrease in moisture content. Lower values measured at two years (104 weeks) are probably due to the samples having zero moisture content, a condition which would probably never be achieved under field service conditions.



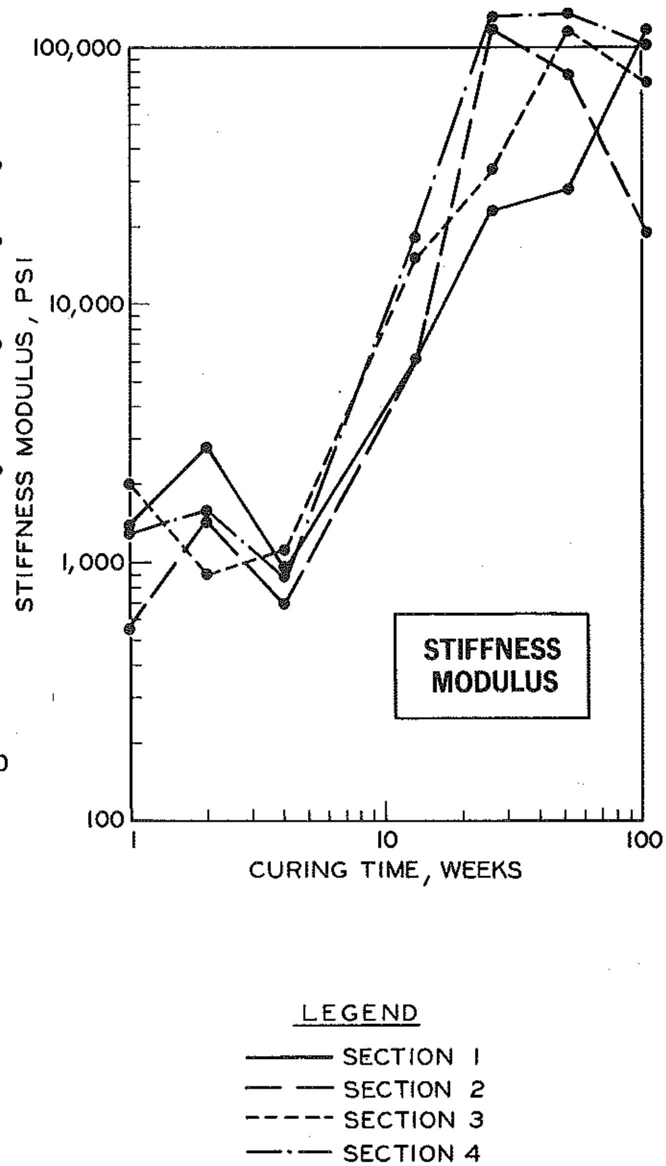


Figure 5. Relationship between strength, stiffness and moisture content throughout 24 month curing period.

CONCLUSIONS

Results of this evaluation show that the asphalt foaming process can be effectively used along with mix-in-place stabilization of granular base materials.

An advantage of the foaming process is the dual role of the added water. The moisture added through foaming not only aids in the dispersion of the asphalt but also is beneficial to the compaction process, especially for materials high in sand content.

Foaming equipment can readily be added to stabilizing machines normally used for in-place recycling and should provide an economical means of achieving well blended, stabilized base mixtures.