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Seibert Experimental Project

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FINAL REPORT

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16. Abstract

Lime shafts and lime till were used to prevent swelling on Interstate 70 in Eastern Colorado. The grading contract for a section of Interstate 70 had been completed in 1964. By spring of 1965 two cut areas had significant swelling. Before the concrete paving began lime shafts were built in one cut and lime till in the other. No swelling has been observed in either section in the eight years of evaluation that have just been completed.

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IMPLEMENTATION

As a result of this study, it is recommended that lime shafts be used in areas of high swell potential. Because of the high cost of this treatment, it is not recommended for other areas. Lime till is an effective method of stabilizing poor soils.

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SEIBERT EXPERIMENTAL PROJECT

INTRODUCTION

In anticipation of reducing subgrade swelling, a section of lime shafts and one of lime till were constructed on Interstate 70 in Eastern Colorado. The grading for the west-bound lanes from Seibert to Vona had been completed in the fall of 1964, the lime treatments were completed in early 1965 and the base course and concrete paving were completed in late 1965.

During the late winter and early spring of 1965, two areas had swelled appreciably. Subgrade investigations indicated that the cut from Station 2239 to 2246 was quite dry with a moisture content of about 7 percent down to at least 20 feet. The grade line from Station 2748 to 2754 was very near the elevation of the original ground line. Just beneath a dry surface layer the subgrade here had a moisture content of 15 percent.

It was decided because of its dry condition that Station 2239 to 2246 (designated as Section 5) would have lime shafts. Station 2748 to 2754 (Section 8) was designed for stabilization with 4 percent hydrated lime mixed into the top foot of subgrade.

This report describes the construction and evaluations of the test areas and compares the results with standard sections.

CONSTRUCTION OF TEST SECTIONS

The lime shafts in Section 5 were done by maintenance forces under a $4,200 Work Order. This was $600/Station for a two lane roadway.

Since the optimum spacing for lime shafts was not known, two different spacings were used. The spacing was five feet longitudinally and six feet transversely from Station 2239+50 to 2242+00 and from 2246+00 to 2246+50 and four feet both directions from Station 2242+00 to 2246+00.

After the 12 inch diameter holes were augered eight feet deep, a slurry of one pound of lime per gallon of water was mixed in the hole. As the water level lowered more water was added until a total of about 75 gallons had been placed in each hole. The following day the holes were backfilled with an open graded sand which had 5 percent passing the No. 200 sieve.

The lime till was done by the surfacing contractor in the summer of 1965. A motor grader bladed some of material to the sides of the roadway and scarified the excavated area down to a depth of one foot beneath the top of the subgrade. Dry lime was spread by hose from the supply trailer, and it was mixed, wetted and compacted. The material windrowed at the sides was then bladed back, and more lime added until the 4 percent amount was reached. Wetting, mixing and compacting completed the operations.

A course of four inches of hydrated lime treated base was placed on the subgrade throughout the project including the test sections. Eight inches of concrete pavement and the shoulder material were placed on the base the same year. See Figure 5 page 8 for partial cross sections of the test and standard sections.

EVALUATIONS

Present Serviceability Indices (PSI), deflections, radii of curvature, flexural stresses, and moisture content of the subgrades were used to compare the sections.

PSI values were determined by using the CHLOE Profilometer which measures the slope variance. Colorado uses the following formula for computing PSI for rigid pavements.

$$PSI = 5.41 - 1.80 \text{ Log } (\overline{SV} - 2) - 0.01\ C + P$$

$\overline{SV}$ = Average slope variance determined by CHLOE
C = Cracking in square feet/1000 square feet
P = Patching in square feet/1000 square feet

These values for all sections are plotted in Figure 1. The downward slopes of the PSI lines would indicate that major maintenance work might be necessary in ten years or so, but it is anticipated that the sections will perform better than that. There is only minor joint faulting at present (0 to 1/4 inch), very little distortion and no random cracking.

The pavement deflections under an 18,000 pound axle load were measured by a Benkelman Beam. These values which are graphed in Figure 2 indicate no significant trend and are quite typical of Portland cement concrete pavements on Colorado highways. The radius of curvature values shown in Figure 3 were measured by a Texas Basin Beam at the same times that deflections were measured. No failures are indicated by these measurements.

The results from the Basin Beam measurements were used to calculate the flexural stresses which are plotted in Figure 4. These are somewhat erratic but do not indicate any serious level or trends.

Moisture content of the base and subgrade was determined periodically in an attempt to correlate with performances. Figure 5 shows the first and last complete moisture profiles recorded for the test sections. The water content in the subgrade of Section 5 is quite high because the lime that was added in the shafts attracts and holds the moisture. The 1968 moisture profile was probably sampled at a location slightly further from the lime shaft than the 1972 profile. The subgrades of the standard sections have dried since 1969 except for the 36 inch and lower depths in Section 9 which have gained in moisture content. The moisture samples were removed from an area just outside of the concrete pavement.

Soil data as determined prior to surfacing operations are listed below.

Section Number	Classification	Liquid Limit	Plastic Index	% Passing #200 Sieve	Optimum Moisture
4	A-6(14)	38	20	75	20%
5	A-7-6(23)	48	30	79	21%
8	A-6(11)	32	12	95	19%
9	A-4(4)	29	7	77	15%

Sections 4 and 9 are standard. Section 5 has lime shafts and Section 8 has lime till.

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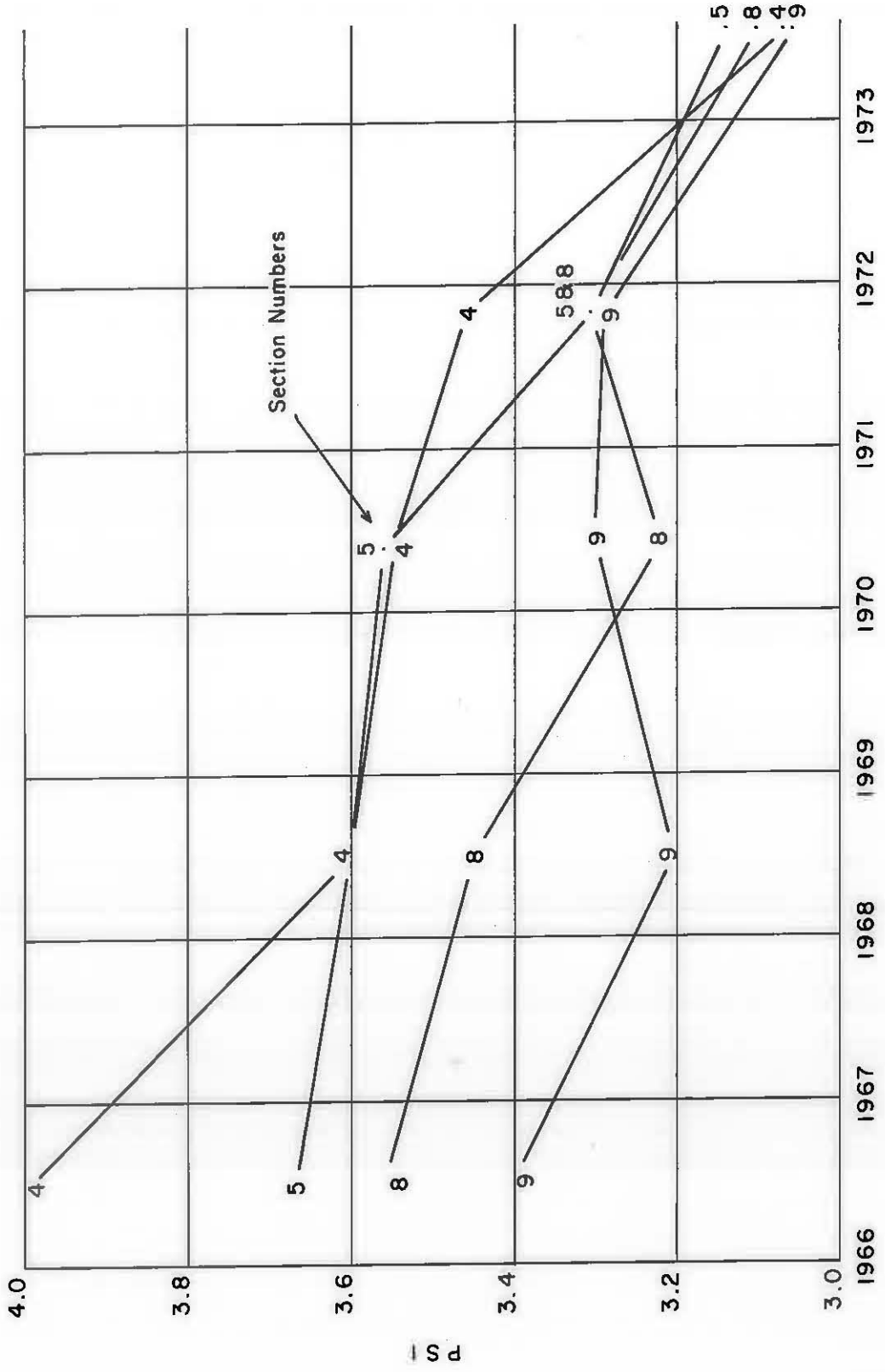

FIGURE 1

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DEFLECTIONS

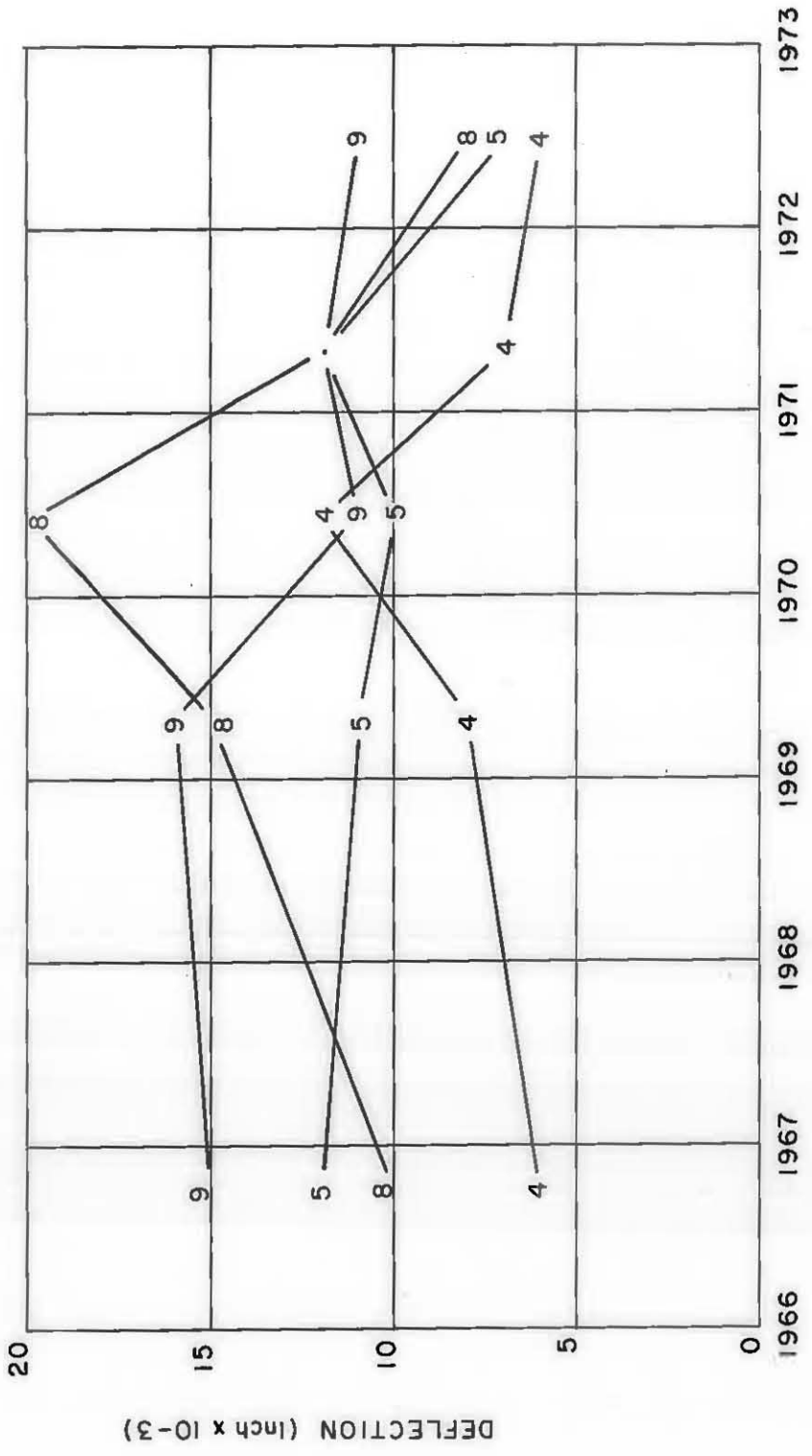

FIGURE 2

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RADIUS OF CURVATURE

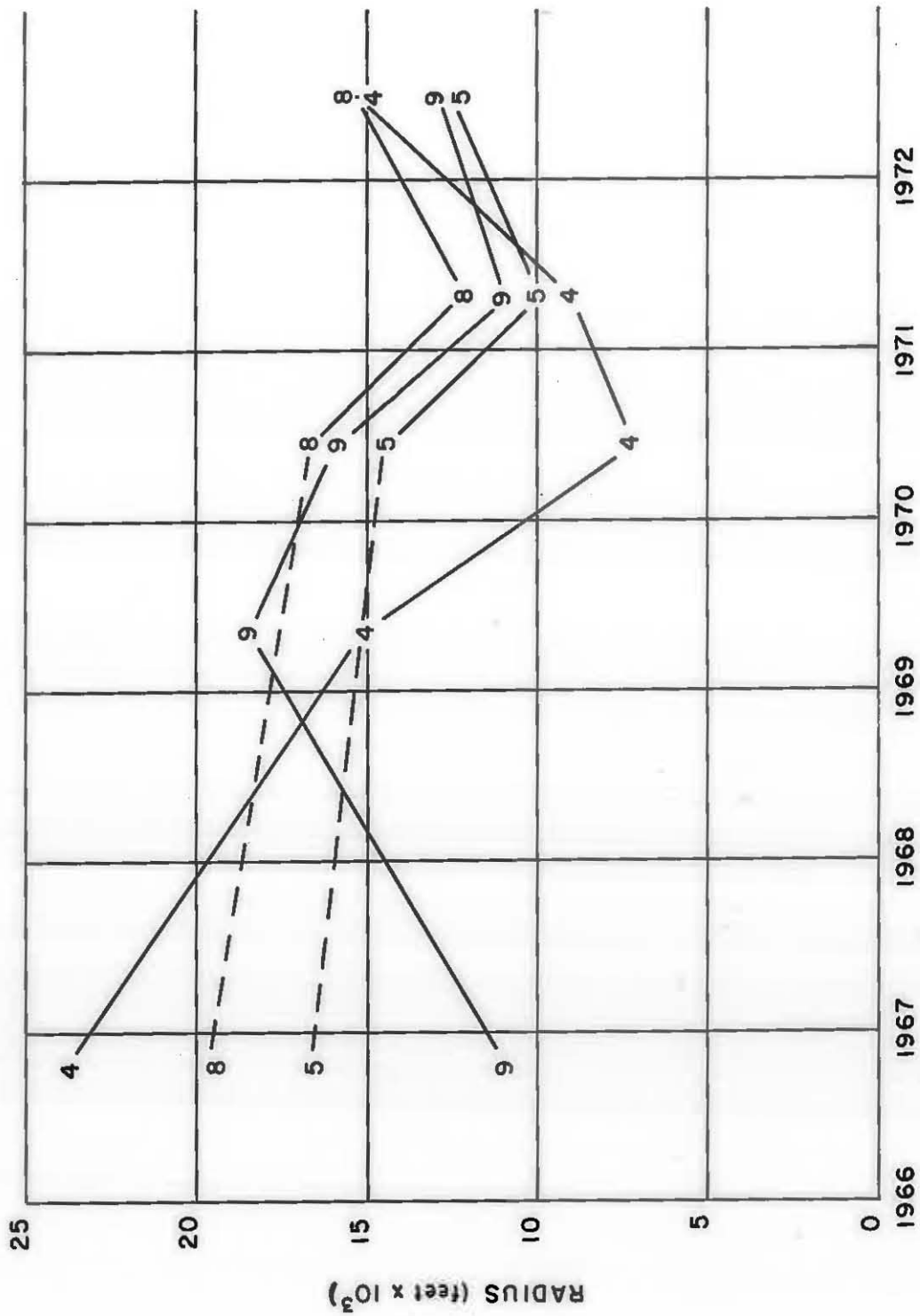

FIGURE 3

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FLEXURAL STRESS

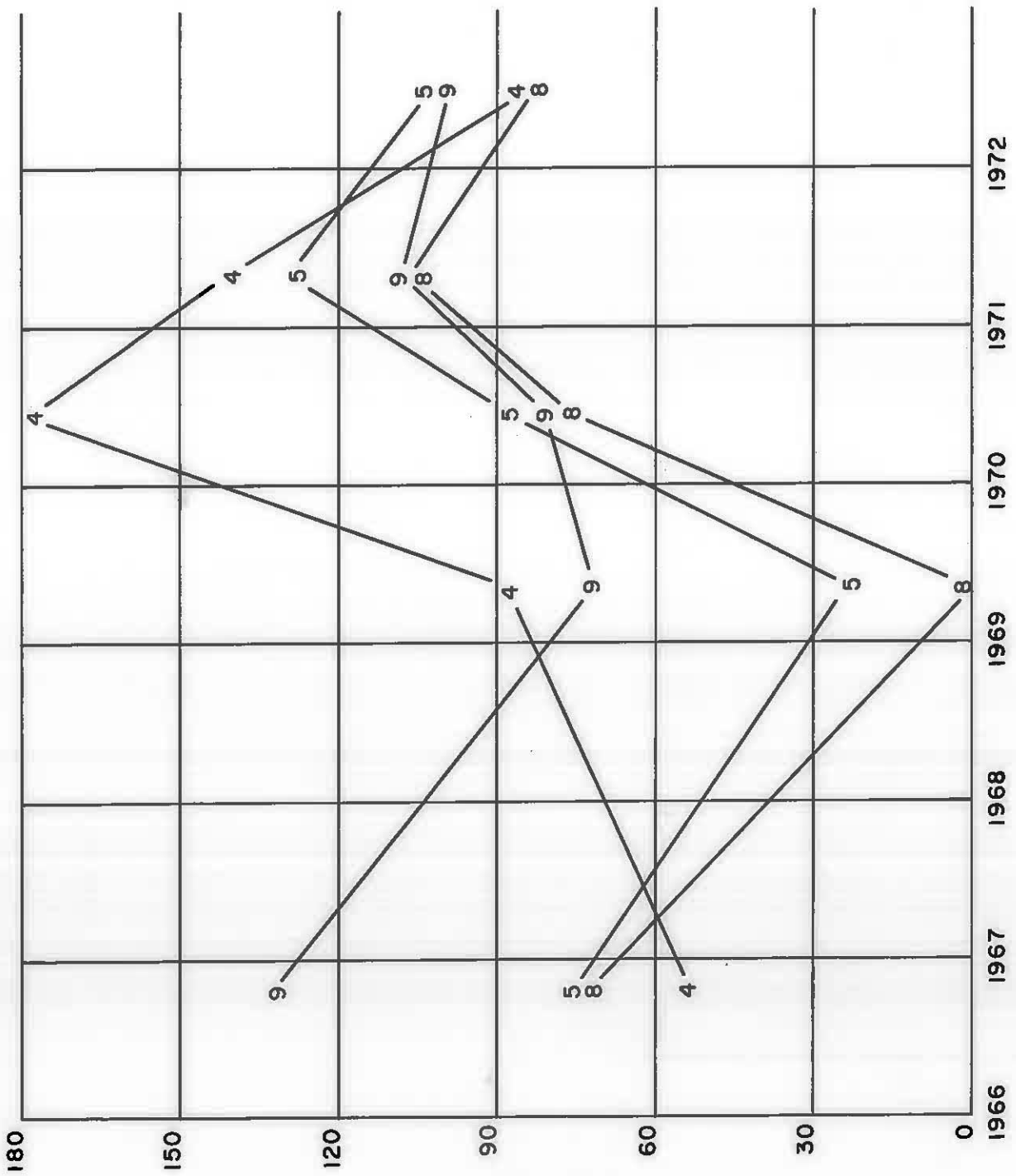

FIGURE 4

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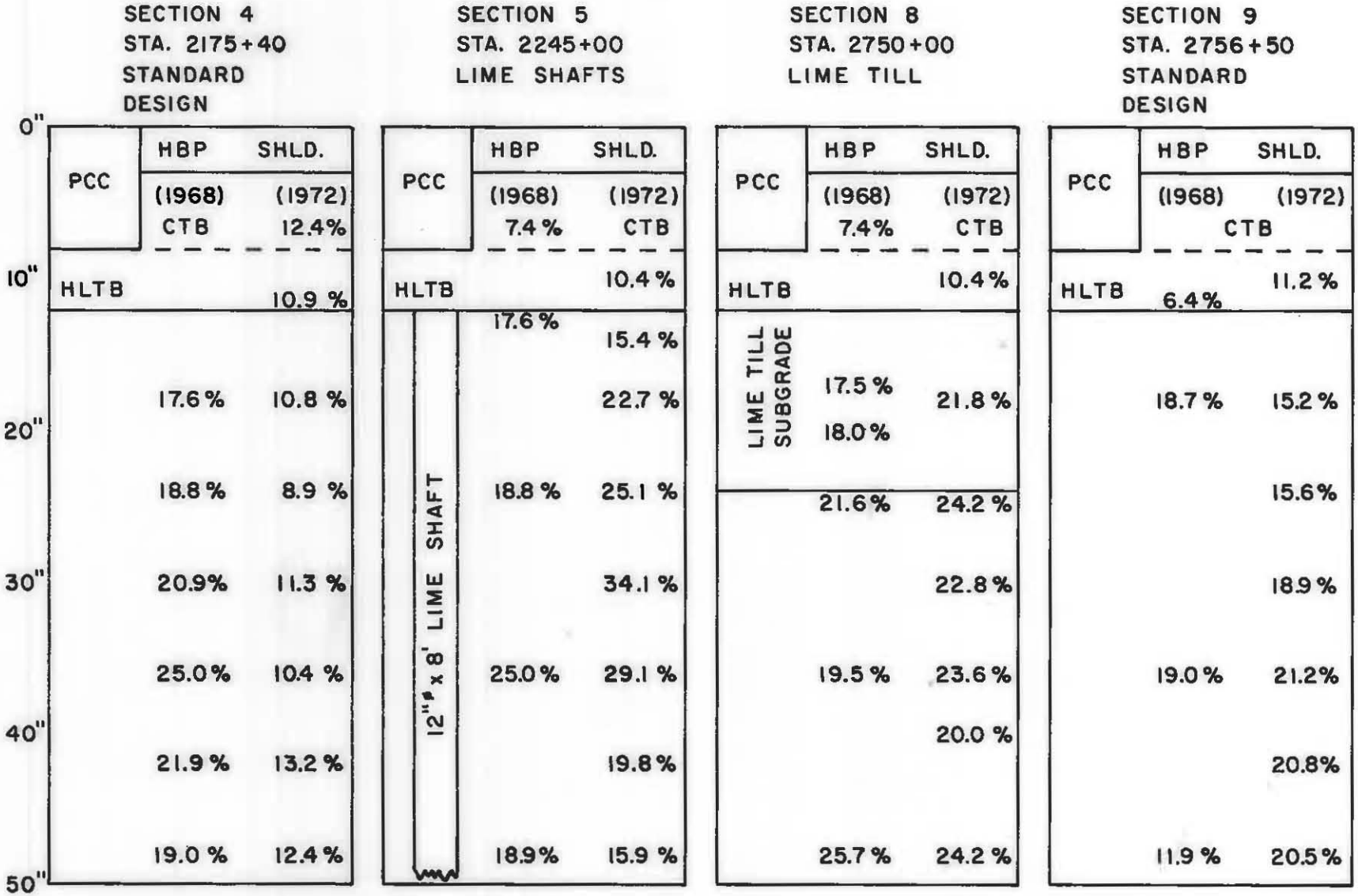
MOISTURE PROFILE



PCC — PORTLAND CEMENT CONCRETE
HBP — HOT BITUMINOUS PAVEMENT
HLTB — HYDRATED LIME TREATED BASE

FIGURE 5

CONCLUSIONS

All sections appear to be equal in strength and serviceability at this time. Because the lime shafts are located in the worse soil, it is believed that this treatment has prevented deformations from swelling. The area that has the greater spacing between lime shafts has performed as well as the one with less spacing. A spacing of five feet longitudinally and six feet transversely is adequate, at least for this location. Previous research indicated that the lime migrates only an inch or so, but it helps the water to migrate about 30 inches. Also, the shafts allow the clay to swell laterally instead of vertically.

Since lime shafts are estimated to cost $3,310 per 100 feet of a four lane highway, they are recommended only for areas of high swell potential. Lime till apparently prevented further swelling in this test section. No swelling was observed after the treatment. Four percent lime mixed into the top foot of subgrade is estimated to cost $1,660 per 100 feet of four lane highway.

APPENDIX

Photographs of Section 5

Photograph No. 1 is from the middle of the Section looking west, and Photograph No. 2 is of the east half of the Section. The change of spacing in the lime shafts is at the hammer on the shoulder. No difference was noted in the conditions of the halves of the section. Note the separation of the asphaltic shoulder from the concrete and that there is no cracking and very little faulting in the concrete pavement. The terrain is similar to that of the other test sections.

Photograph No. 1

Photograph No. 2

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REFERENCES

Lime Shaft and Lime Till Stabilization of Subgrades on Colorado Highways 1967