# DISCUSSION OF SOIL TEMPERATURES

## Field Measurements of Soil Temperatures

Herman H. Miller, Head, Dowflake Technical Service,
The Dow Chemical Company, Midland, Michigan

During the past several years the subject of frost action in soil has been a major topic of discussion with highway engineers of the northern part of the United States and foreign countries. Millions of dollars in damage annually is caused to highways by the action of frost. Buildings in certain areas are also vulnerable. Numerous theories have been advanced as to moisture and frost movement in soils and efforts made to prevent the detrimental damage from such movement. Laboratory and field investigations have definitely proven that soils treated with calcium chloride, either liquid or solid, resisted greatly any frost action which tended to cause heaving or detrimental expansion. Such treatments were usually made without much knowledge of frost penetration. Since the problems of frost action, frost penetration, and moisture movement in soils is common to the installation of underground pipe lines, foundations, and highway construction, it seemed advisable to proceed with a study of soil temperature as one phase of the problem.

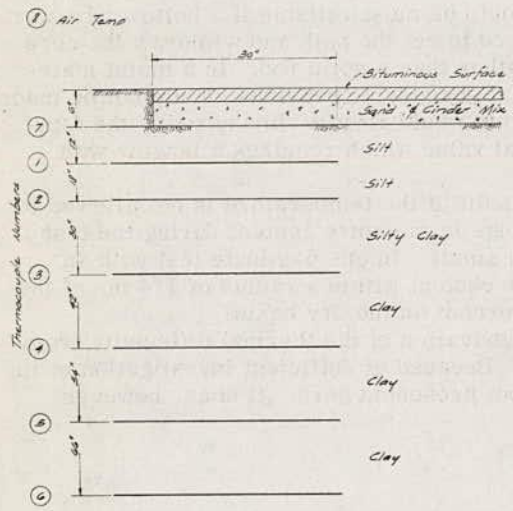


Figure 1. Cross Section of the Pavement. The leads from the thermocouple are attached to an underground cable leading to the recording thermometer.

This progress report covers the results of field measurements of soil temperature made under a 3-in. flexible asphalt carrying an average of 534 vehicles per day. The project began December 4, 1949, and ended December 31, 1950. Thermocouples were installed at 6, 12, 18, 30, 42, 54 and 66 in.

TABLE 1
RAINFALL, INCHES
MIDLAND, MICHIGAN AREA

| | |
|---|---|
| December, 1949 | 3.80 |
| January, 1950 | 3.53 |
| February, 1950 | 3.21 |
| March, 1950 | 2.48 |
| April, 1950 | 2.93 |
| May, 1950 | 1.57 |
| June, 1950 | 2.44 |
| July, 1950 | 5.75 |
| August, 1950 | 1.87 |
| September, 1950 | 5.03 |
| October, 1950 | 1.43 |
| November, 1950 | 1.87 |
| TOTAL | 33.91 |

Average rainfall per year since 1887 is 26.03 inches per year.

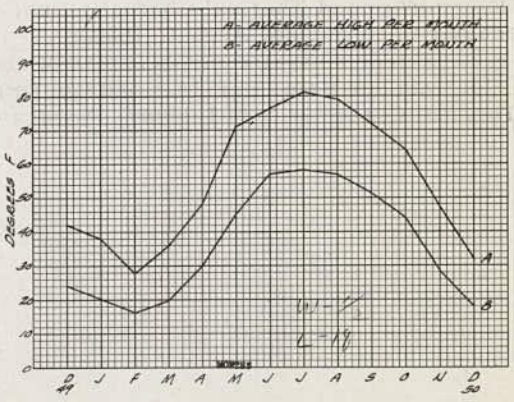


Figure 2. Average High and Low Temperature for Each Month During the Year Plotted From the Extreme Daily Temperatures.

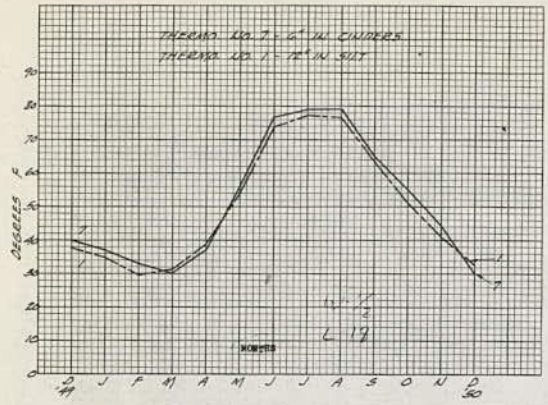


Figure 3. Average Temperature Per Month of Thermocouple 7 at 6 in. and 1 at 12 in.

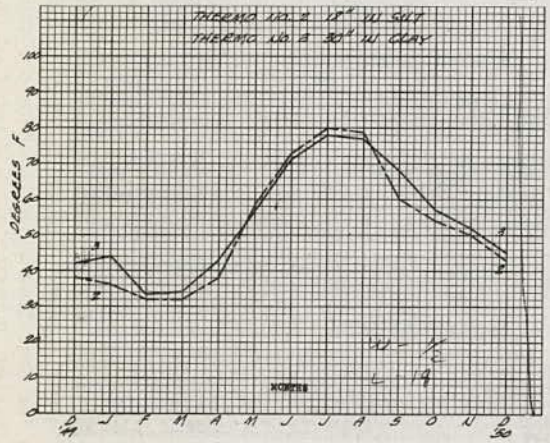


Figure 4. Average Temperature Per Month of Thermocouple 2 at 18 in. and 3 at 30 in.

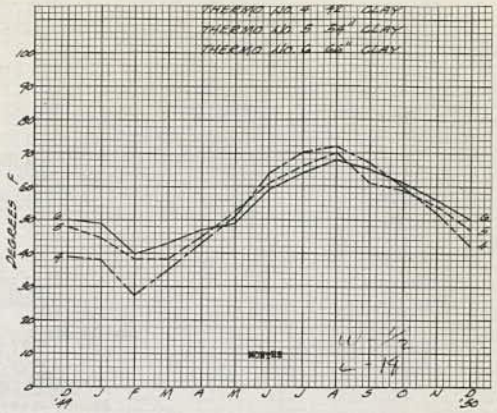


Figure 5. Average Temperature Per Month of Thermocouple 4 at 42 in., 5 at 54 in., and 6 at 66 in.

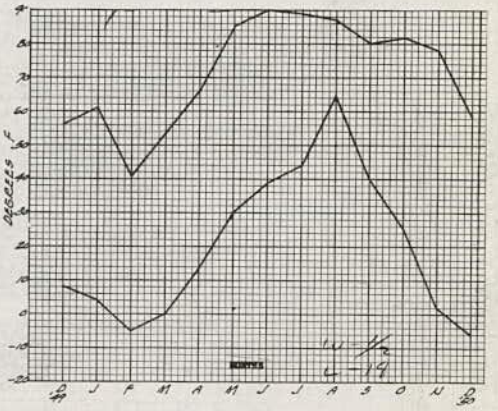


Figure 6. Extreme Temperature Reached During the Year.

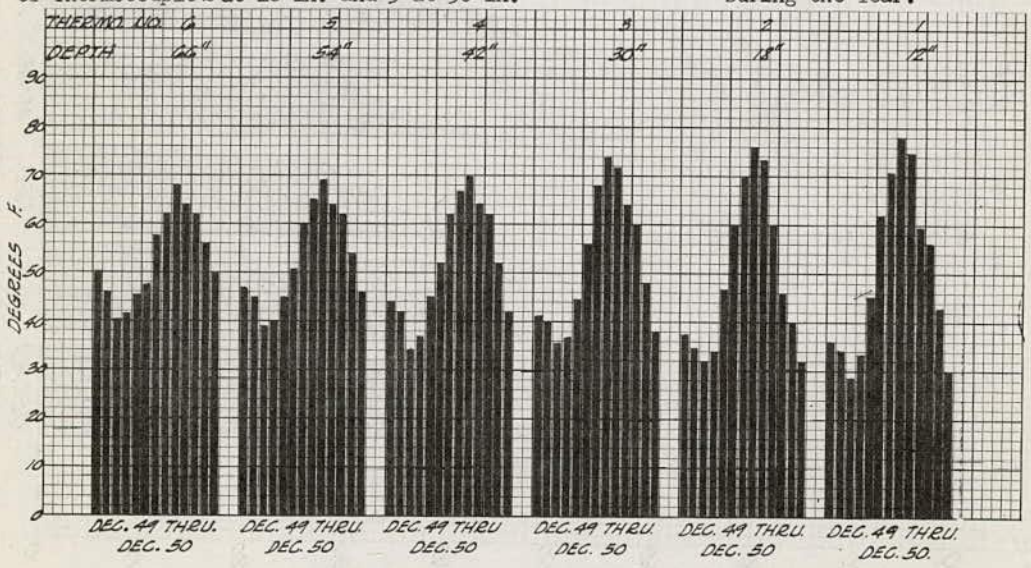


Figure 7. Average Monthly Temperature for Thermocouples 1-6.

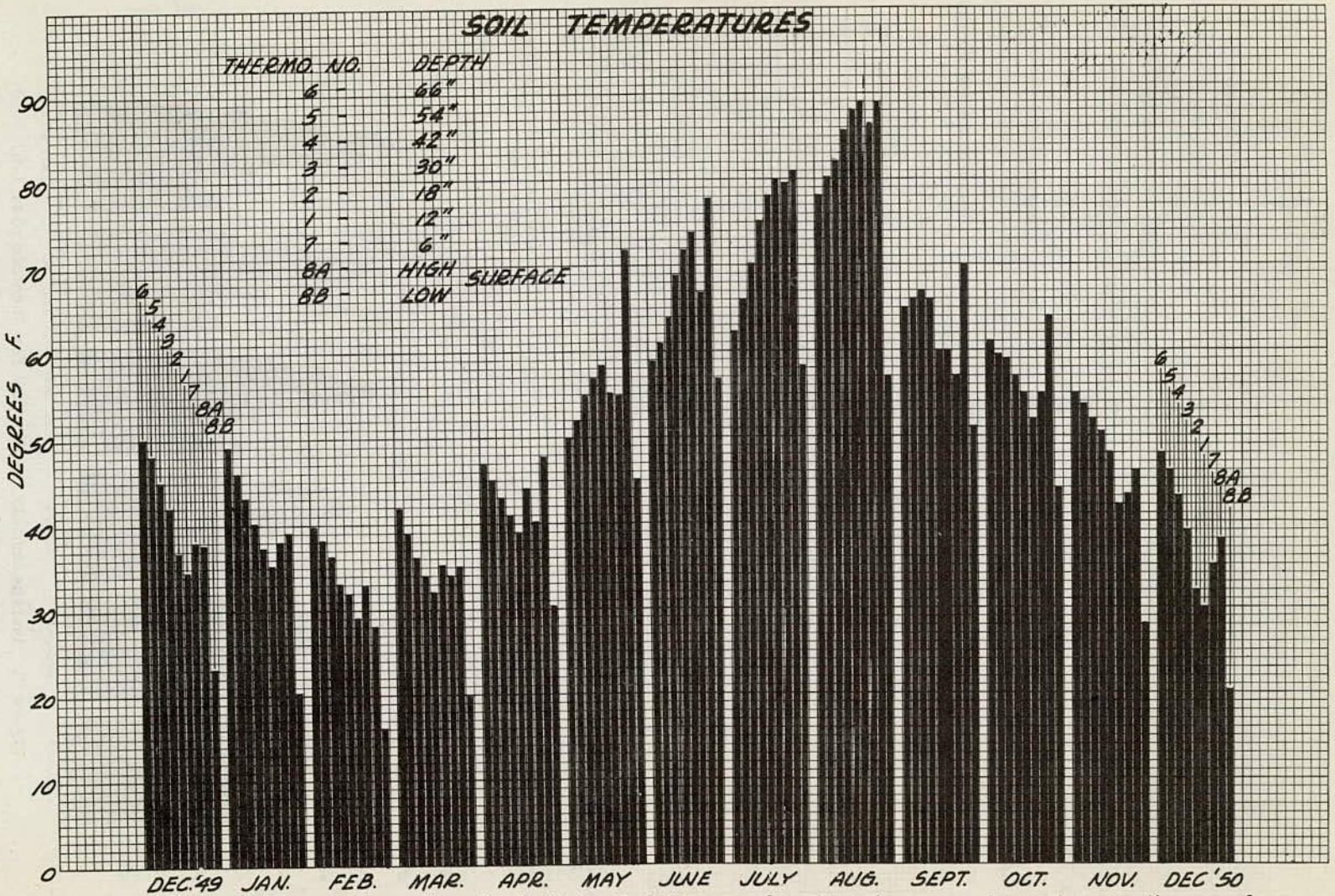


Figure 8. Average Temperature Per Month Per Each Thermocouple. Here the average temperature per thermocouple below 12 in. varied approximately 2 F. per foot depth.

below the surface of the pavement and one at atmospheric exposure. These thermocouples were attached to an automatic Leeds and Northrup 8-point recording thermometer placed in a heated room of a building about 40 feet from the road. The chart's ranges were from -25 F. to 125 F., 40 yards long, recording 8 times per hour, changed at 35-day intervals. In this study no consideration was given to ground water or moisture content of the soil. However, a precipitation record was kept.

The results to date seem to verify the findings reported at the 1951 meeting of the Highway Research Board by Mr. R. F. Legget, National Research Council, Ottawa, Canada, and Professor L. D. Yoder, Purdue University. No definite conclusion has been drawn as it is indicated that this study should continue for several months before concise conclusions can be drawn.