

## Studies of Frost Problems in a Northern State

MILES S. KERSTEN, *Professor of Civil Engineering,  
University of Minnesota*

The paper reviewed the history in one state, namely Minnesota, of frost studies on highways, design of highways for frost conditions, and research studies which have been made at a university. The intent of the presentation was thus to give examples of attacks which are being made on frost problems without trying to cover the very broad subject of frost studies in the entire country. The information and most of the slides used were drawn from papers previously published.

The paper reviewed information on the winter climate in the United States and the manner of making soil surveys and designs for frost treatments in Minnesota (*Ref. 1*). The findings of the Highway Research Board Committee on Load-Carrying Capacity of Roads as Affected by Frost Action concerning the loss of strength during the frost melt period were described, and the design thickness of flexible pavements in Minnesota was shown to indicate requirements in a frost area (*Ref. 2*).

The laboratory studies for determination of thermal properties of soils made in Minnesota were described in some detail (*Ref. 3*). Methods for calculating frost penetration in highways (*Ref. 4*) and field measurements for comparison with calculations made in Minnesota, were presented. (*Refs. 5, 6*).

It was the intent of the paper to present short description of several phases of frost problems, and thus to suggest a variety of questions in the discussion. This was accomplished at the two seminars at which the paper and slides were presented.

### REFERENCES

1. Braun, R. P. "Correlations of Soil Test Data to Design Relating to Highways and Airfields." Conference on Soil Mechanics and Foundations. University of Minnesota. 1959.
2. Meskal, G. A. "Final Report on Load-Carrying Capacity of Roads as Affected by Frost Action." HRB Bulletin No. 207. 1959 (also previous reports by same committee).
3. Minnesota Department of Highways. "Approved Flexible Pavement Design Standards." 1954.
4. University of Minnesota, Bulletin 128. "Thermal Properties of Soils."
5. Kersten, M. S. "Frost Penetration: Relationship to Air Temperature and Other Factors." HRB Bulletin No. 225. 1959.
6. Kersten, M. S. and Johnson, R. W. "Frost Penetration Under Bituminous Pavements." HRB Bulletin No. 111. 1955.

## Soil Stabilization

T. WILLIAM LAMBE, *Professor of Soil Engineering,  
Massachusetts Institute of Technology*

At the seminars at Moscow and at Kiev, the writer gave a short description of some of the recent research conducted at the Massachusetts Institute of Technology on additives to improve the properties of soil. Presented were the results of work on additives to modify the frost susceptibility of soils and on additives to increase the effec-

tiveness of portland cement as a primary stabilizer.

On the basis of laboratory tests the most promising additives for the modification of the frost heaving characteristics of soils were ferric chloride (an aggregant) and the polyphosphates (dispersants). A group of 11 dirty gravels were treated with 0.3 per