FOREWORD

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The Symposium on Frost Heave and Frost Action in Soil is devoted to presentation and discussion of papers dealing with a variety of subject matter. Because of the wide diversity and the large number of papers, the symposium committee was divided into sub-units, each administered by a sub-committee as follows: Climate and Distribution of Soil, L. E. Gregg, chairman; Soil Temperature and Thermal Properties of Soils, R. F. Legget, chairman; Soil Moisture and Moisture Movements, Miles S. Kersten, chairman; Basic Data Pertaining to Frost Action, George W. McAlpin, Jr., chairman; Frost Action and Spring Break-up, J. H. Swanberg, chairman; Remedies and Treatments, T. E. Shelburne, chairman; and Needed Research, F. R. Olmstead, chairman. Each paper was reviewed by the sub-committees before they were accepted by the entire committee. The papers were prepared by well-known authorities. The cooperation of Harold Allen, chairman of the Department of Soils, and the entire staff of the Highway Research Board, particularly Fred Burggraf, A. W. Johnson, and the late R. W. Crum, deserves special mention.

In April 1944 the Highway Research Board appointed a small committee to study the use of calcium chloride in minimizing frost action in highway subgrades and bases. This committee, under the chairmanship of F. C. Lang had meetings in Columbus, Detroit, Chicago, and Washington. Other members included A. G. Cochran, J. E. Lawrence, A. E. Matthews, Frank R. Olmstead, and K. B. Woods.

In 1945, after the untimely death of F. C. Lang, K. B. Woods was made acting chairman of the committee. Meetings were held in Oklahoma City in 1945, Washington in 1946, and Swampscott, Massachusetts in 1947. At this latter meeting the committee was reorganized and the scope was changed to include Frost Heave and Frost Action in Soil. The membership in the committee was increased considerably with 19 members being listed at the present time.

The committee has had annual meetings at Ely, Minnesota in 1948; Gaylord, Michigan in 1949; and Albany, New York in 1950. In addition the committee meets at the time of the annual meeting of the Highway Research Board.

At the Ely meeting it became apparent that a bibliography and a review of the existing literature was essential for the proper functioning of the committee. With recommendation of the committee and the Department of Soils, the Highway Research Board assigned the engineer of soils and foundations, A. W. Johnson, part time to the project. An annotated bibliography was prepared by Johnson and published as Highway Research Board Bibliography No. 3, Frost Action in Soils, Annotated 1948.

After the release of this bibliography, Johnson continued his work with the development of a comprehensive review of the litereature on frost heave and frost action in soil. This manuscript will be an outstanding contribution of special interest to practicing highway engineers and those interested in developing research projects covering frost action in soil. This manuscript is being published and should be released about the same time as this symposium.

The Sub-committee on Climate and Distribution of Soil submitted three papers. The paper relating soil profiles to climate makes brief mention of the five soil-forming factors, but the authors have concentrated their efforts in discussing the climatic variable. The paper on climatic aspects of frost heave discusses climatic and other environmental factors affecting ground-heat loss. The author discusses climatic and geographical data from the standpoint of distribution of frost heave elements in predicting the timing and severity of frost heave forces.

The group of papers on Soil Temperature and Thermal Properties of Soils, appropriately enough, is initiated by a review of the literature on soil temperatures which includes an excellent bibliography. The paper on field measurements of soil temperatures in Indiana reports data collected under asphaltic pavements covering the period

1938-1950. The paper on thermal conductivity and diffusivity of soils presents a method which can be used for measuring these thermal properties while the paper on thermal conductivity probe presents a different technique.

The importance of soil moisture and moisture movement with respect to frost heave and frost action in soil is illustrated by the large group of important papers developed by the sub-committee on Soil Moisture and Moisture Movements. Several of these papers deal with methods of measuring moisture content and include discussions of plaster-of-paris electrical-resistance method, the nylon electrical-resistance method, and the measurement of soil moisture density by neutron and gamma-ray scattering. One paper discusses soil moisture and temperature measurements by means of a heat-diffusion moisture cell. Three papers in this section are devoted to the actual measurement of moisture content of airport and highway subgrades including both rigid and flexible pavements, while one paper discusses capillary moisture.

The Sub-committee on Basic Data Pertaining to Frost Action presented a group of eight papers covering a wide range of subject matter. The paper on heat transfer and temperature distribution in soils covers a laboratory study of transient heat, while the paper on thermal properties of soils is directed toward a discussion of the several variables, including temperatures, density, soil moisture content, texture, mineral composition, and soil structure. The paper on clay-mineral composition analyzes the data and concepts that have come out of recent clay-mineral researches pertinent to frost action and frost heaving. Two papers are included in this group on solifluction, slump, and instability of slopes; and one paper deals with a method of calculating the depth of thaw in frozen ground. The laboratory study of frost action in soils includes data from tests being performed for the purpose of improving design and evaluation criteria for roads and highway and airfield pavements constructed on soils subject to seasonal freezing and thawing. One paper on permafrost includes identification of various types by means of aerial photographs.

The papers on Frost Action and Spring Break-up include a great deal of information on extent of frost-heave damage to roads and airfields. The paper covering damage to New Hampshire highways is a sampling from the New England states, while the northern Middle West is covered by a paper on the frost problem in Michigan. The paper from Colorado covers information of interest to those in the northern plains and in the Colorado plateaus. One paper is included on frost damage to roads in Great Britain. Two papers are included on load-carrying capacity, one on roads and one on airfields. One laboratory study of frost action in soils from New Jersey is included.

An important addition to the symposium is the group of papers on Remedies and Treatments. The subject of calcium chloride treatment of subgrades and bases was covered in one review paper, while the design practice for controlling the effects of frost action is covered in a paper from Michigan. A paper on remedies and treatments for the frost problem in Nebraska includes detailed data on soil characteristics, moisture content, and design practices for that state. Similarly, the design practices for the Connecticut Highway Department are included in the paper from the New England states. The problem of frost action in New York is discussed in another paper which covers a description of types of problems encountered in that area. This group also includes a discussion of frost heaving as a problem of the Norwegian railways. The Sub-committee on Remedies and Treatments sent out questionnaires to secure pertinent information concerning the frost action problem throughout the country. The results of this questionnaire are included as a separate paper.

Two papers are included in this group on Needed Research. The committee sent out a questionnaire, and an analysis of the data collected is included in one paper. The second paper covers an analysis of needed research pertaining to frost action and related phenomena.

The Committee on Frost Heave and Frost Action in Soil has set out to collect data pertaining to the problem. It is felt that this endpoint has been achieved through the publication on a review of the literature by A. W. Johnson and this Symposium on Frost Heave and Frost Action in Soil. The next task of the committee will include the collection of ideas for research projects and the soliciting of papers for presentation at annual meetings.