SYMPOSIUM ON EXCHANGE PHENOMENA IN SOILS

SUMMARY

By Edmund F. Preece[1]

In engineering as in other technical fields the development of a new area usually extends over a considerable period of time. When that period of development is viewed in retrospect, however, some one part or event stands out from the general background as a milestone marking the end of one developmental phase and the beginning of another. The 1936 conference at Harvard University, for example, marked the coming of age of contemporary soil mechanics. It is not unlikely that when time shall have provided the proper perspective this year of 1952 will stand out in a similar manner with respect to the engineering application of soil physicochemistry. In the light of this thought this symposium is a most significant contribution.

The problems associated with the use of soil as an engineering material may be divided into two general categories, those relating to the coarse-grained and those relating to the fine-grained soils. The characteristics and behavior of the first group are adequately defined by mechanics and hydraulics. These disciplines have not provided suitable solutions, however, for the fine-grained types.

Fine-grained soils are distinguished by their tremendous surface area per unit volume. In addition to physical condition and mechanical characteristics, mass behavior reflects also the mineralogical nature and surface chemistry of the soil constituents. The relative importance of these variables in any particular set of conditions is as yet but partially understood. For that understanding we must turn to applied science.

Vannevar Bush, president of the Carnegie Institute, recently discussed the relative functions of the applied-scientist and the engineer, and his remarks appear to be particularly significant to this symposium. He pointed out that engineering is becoming both more diversified and more complex. It becomes increasingly essential, therefore, to draw upon the fundamental sciences.

Generally, the engineer is more concerned with the practical application of methods than with their development, which is the field of the applied scientist. It may be said, then, that the applied scientist reaches back into the fundamental sciences to develop methods and that the engineer, starting where the applied-scientist leaves off, translates those methods into practical use. The two functions are complementary. The boundary between them, however, is not sharply defined and one may extend into the area of the other. Maintenance of a logical balance depends upon the engineer preparing himself to assume his share of the task at the relay zone.

This symposium represents a cooperative undertaking on the part of the applied-scientist and the engineer. As time passes it will be interesting to see what

[1] Principal Engineer, Washington District Corps of Engineers, Washington, D. C.

manner of man will take the lead in the field of soil physico-chemistry as applied to engineering problems. Will it be the applied-scientist or the engineer? It would seem a more complete solution if it is the applied-scientist with an adequate background of engineering or the engineer with an adequate background of applied science. We must look forward to training men for this broad, fundamental and practical approach to the problem.

Grim has presented an interesting discussion of the fundamentals of ion exchange which contains a number of thoughts to which special emphasis should be given. First, he has pointed out that an understanding of the ion exchange reaction is essential to an understanding of the nature of the properties of soils. This is important because it is the mechanism of ion exchange which presents the most practicable means of modifying the characteristics of soils. Electroosmosis, for example, causes water to move through soil under the influence of an emf, but this movement of water is certainly not the only or even the most important reaction. It appears that the ion exchange induced by the electro-osmotic phenomenon is of much more significance than the simple removal of a portion of the water.

Attention is called to the fact that no single, generally acceptable mathematical expression has as yet been devised for the exchange reaction. It is not to be expected that Subcommittee R-6 will fill the void out-of-hand, but the statement does serve to emphasize the desirability of adopting a common datum within the subcommittee even if that datum is admittedly a temporary one.

The example given concerning the relative exchangeability of calcium and sodium ions with respect to the degree of saturation is particularly interesting when considered against the background of some of the papers appearing from time to time in which the effects of adding calcium chloride and lime to soil are discussed and in which the only soil properties considered are gradation and Atterberg limits. One of the most encouraging aspects of this symposium is the fact that ionic exchange has been presented in its proper physico-chemical environment without twisting the relationships to conform to the concepts of mechanics.

Davidson and Sheeler have presented a very interesting study which, for convenience, will be considered under two categories, first, methodology and, second, ion exchange-engineering properties relationships.

At this stage it is quite important that the methods and procedures used be clearly defined, and these authors have satisfied this requirement completely. Discussion here of the individual procedures would of necessity be too superficial to serve a good purpose. This should be undertaken by the subcommittee. In this connection it seems timely to emphasize the desirability of considering each test procedure in detail regardless of how well established the present generally accepted specification may be. The authors have presented a program of twenty procedures of which some thirteen or more are widely used. It is not suggested that generally accepted procedures are unsatisfactory, but it is possible that it may be desirable to define some features of the procedures more closely than they are presently stated. In mechanical analysis, for example, there is the question of the method of dispersion. Again, what fraction of the soil should be used for the determination of exchange capacity and exactly how should limit samples be prepared? Questions such as these should be considered as well as those relating to the presently unspecified procedures such as differential thermal analysis.

The data presented showing a relationship between ionic exchange capacity and engineering properties are particularly valuable. Before we can expect the sort of general interest that encourages wider study and experimental application, it will be necessary first to show that there is a reasonable possibility of practicable use. The data are a significant contribution to this end.

The paper by Goldberg and Klein is as thought provoking as it is comprehensive. Too often papers such as this are received in polite silence and then interred in print without even an obituary. Dr. Lambe's challenging discussion will serve, it is hoped, to keep interest in this important contribution alive.

"Job Experience with Exchange Phenomena Involving Inorganic and Organic Ions" and "Surface-Chemical Properties of Clay Minerals and Soils" by Hans F. Winterkorn are in keeping with the contributions which we have come to expect of this prolific writer. The listing of the Holy Scriptures as a reference is a unique addition to soil literature.

Taken as a group the papers presented here represent a tremendous volume of thoughtful work. They will not satisfy their fullest purpose, however, if the Symposium serves simply as a show window It is hoped that the papers will be studied and discussed in detail, for it is only by constructive discussion that progress will be accelerated and certainly acceleration is due.