

**Proceedings of the
Seventh Annual Symposium on**

**"GEOLOGY
AS APPLIED TO
HIGHWAY ENGINEERING"**

February 24, 1956

Sponsored by

N. C. STATE HIGHWAY AND PUBLIC WORKS COMMISSION

Conducted by

N. C. STATE COLLEGE

RALEIGH

Foreword

The Annual Symposia are informal meetings at which subjects of mutual interest to geologists and highway engineers are presented and discussed. The value of geological sciences and procedures to the planning and construction of highways has become recognized in many areas but the fullest efficiency of their use has not been developed. The exchange of ideas always aids in more rapid advancement and the avoidance of errors and it is to this end that the symposia were originated by Mr. W. T. Parrott, Geologist for the Virginia Department of Highways. The first Symposium was held in the Highway Department's Auditorium in Richmond, Va., in 1950.

Extreme latitude is given the Sponsors as to the arrangements and every effort is made to keep the Symposia simple to arrange and conduct. Central themes are avoided and diversity of subjects encouraged. Practical aspects are considered highly important and involved scientific treatises have no place in the Symposia. It is felt that these aims have been accomplished in all of the Symposia held thus far and the continued interest and attendance recommends that even greater efforts to advertise them are justified in the future.

COMMITTEE PERSONNEL

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- Allen Lee, Research Engineer of the Maryland State Roads
Commission, Baltimore, 3, Maryland.
- Harry Marshall, Geologist, Ohio Department of Highways,
State Office Building, Columbus, Ohio.
- J. L. Stuckey, State Geologist for North Carolina and
Professor, North Carolina State College, Raleigh
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- A. C. Dodson, Chief Geologist, N. C. State Highway and
Public Works Commission.
- R. E. Fadum, Head, Department of Civil Engineering,
N. C. State College.
- D. B. Stansel, Assistant Director, College Extension
Division, N. C. State College.
- J. L. Stuckey, State Geologist, N. C. State Department
of Conservation and Development.

SYMPOSIUM ON GEOLOGY AS APPLIED TO HIGHWAY ENGINEERING

RALEIGH, N. C.

FEBRUARY 24, 1956

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1956 Program Arrangements

The Symposia have always been held in a one-day programs that leave very little time for the personal contacts and development of acquaintanceships which, frequently, form the most profitable part of the conference or meeting. With this in mind there was an innovation at the Seventh Annual Symposium on Geology as Applied to Highway Engineering in the form of a Smoker the evening before the formal program to which all who registered were invited.

The refreshments were provided by the Superior Stone Company, Raleigh, N. C., and the Becker County Sand and Gravel Company, Cheraw, S. C. A large number of those who attended the Symposium were on hand, and most of the Speakers, thus making it possible for the Speakers to feel more at ease in their approach to their subjects and to fit the expressed interests of their prospective listeners at the next day's sessions. All declared the social hour to be a definite success. It was held at the Sir Walter Hotel in downtown Raleigh whereas the program was held in the Riddick Engineering Building on the North Carolina State College Campus.

The Welcome to State College was given by Chancellor Carey H. Bostian who was introduced by Dean J. H. Lampe, School of Engineering. The Response was made by Chairman A. H. Graham, North Carolina State Highway and Publics Works Commission.

Presiding over the morning session was Dr. Ralph E. Fadum, Head, Department of Civil Engineering, N. C. State College, and at the afternoon session the presiding officer was Dr. Jasper L. Stuckey, North Carolina State Geologist.

Between the morning and afternoon sessions lunch was served in the College Dining Room following which there was a color motion picture shown, "Relocation of U. S. 70 Between Ridgecrest and Old Fort, N. C." The film was produced by J. P. (Pete) Bourke, Roadway Photographer for the State Highway Commission and showed the construction of the spectacular highway across the mountain from clearing to final surfacing.

The Staff and facilities of the College Extention Division of North Carolina State College who performed the details of printing, publicity, registration and many other essential chores are hereby acknowledged with the thanks of the Sponsoring Committee.

Landslides and the Engineer

by
Robert F. Baker

INTRODUCTION

The role of the engineer in the solution of landslide problems has never been well defined. For many years, railroad and highway administrators have charged him with responsibility for their proper treatment, but have frequently relied upon a geologist or an engineering geologist for guidance in the solution of large-scale mass movements. Unfortunately, the theory for scientific treatment was very sketchy and investigators were forced to rely almost completely upon experience.

Geology produced excellent qualitative data, but a correspondingly accurate quantitative approach was not available. Since engineering is founded upon analyses that relate driving and resisting forces, it was natural for engineers to devote more and more attention to the development of a reasonably rational procedure based upon the fundamentals of engineering mechanics. Furthermore, the advent of large earth moving equipment, bringing with it a more favorable price for excavation, made slope stability a more frequent consideration.

With the increasing number of slope stability problems, the highway engineer was faced with a choice between a qualitative or empirical method and the highly theoretical mechanics approach. Almost without exception, assistance from the geologic viewpoint was requested. The degree of success was varied. When help came from the engineering-geology field, progress was generally good. However, for the academic or purely scientific geologist, the transition to the requirements for a practical solution came with considerable difficulty. In some instances, this latter condition led to the selection of engineers with a soil mechanics background. Within the soil engineering field, interest in slope stability was great, and numerous engineers became interested from a fundamental viewpoint.

With both geologists and engineers active in the studies of landslides, it has been increasingly more common to encounter uncertainty as to the most desirable organization for problems related to the two sciences. It is the purpose of this paper to discuss possible interrelationships, and to cite a typical landslide study by way of example.

RELATION BETWEEN GEOLOGIC AND ENGINEERING PRINCIPLES

In order to clarify the discussion that follows, certain

terminology needs clarification. A landslide* is defined as "downward and outward movement of slope-forming materials composed of natural rock, soils, artificial fills or combinations thereof". Falls, slides, and flows, are the three principal types of landslides, and can be differentiated simply on the basis of the forces and resistance to movements*. Falls are masses that move down the slope in leaps and bounds, largely under the direct force of gravity. Slides are those movements for which a significant shearing resistance exists at the slip-surface, and flows are landslides for which little or no shearing resistance is available along the surface of separation.

A landslide problem will be used in a rather specific sense to differentiate between an academic or pure science approach and a specific set of conditions that require a practical solution. Geologic principles are defined as those data that describe, in a qualitative fashion, the history of the area, the development of the landslide, and the causes and contributing factors to movement. Engineering principles will refer to those factors that produce, in a fairly direct manner, quantitative values that delineate resisting and motivating forces as well as the economics that are involved.

It is quite obvious that geology and engineering will overlap, particularly in practice. The borderline situations involve very argumentative factors. However, since precise delineation is not important for the purposes of this paper, no detailed differentiation will be attempted.

One perspective of the relative position of geologic and engineering principles in a landslide study is contained in Table I. The steps in the investigation were outlined, and the use of basic principles from the two sciences were considered. An effort was made to delineate between the degree of importance of basic principles at various stages in a study. Rather arbitrarily a "major" or "minor" status was assigned. There is very little real significance to Table I, although two conclusions might be drawn: one, geologic principles are extremely important in the investigational and analytic phases, while engineering principles are particularly necessary in the analytical and solution stage; and, two, neither of the two sciences should be ignored during any phase of the study.

* Definitions from "Landslides and Engineering Practice" a forthcoming book prepared by the Committee on Landslides Investigations of the Highway Research Board.

