PROCEEDINGS OF THE FIFTEENTH ANNUAL HIGHWAY GEOLOGY SYMPOSIUM

Held
March 19, 1964
at the
Missouri Geological Survey
and
Water Resources
Rolla, Missouri

STATE OF MISSOURI
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GEOLOGICAL SURVEY
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ACKNOWLEDGMENTS

The generous assistance of fellow staff members at the Missouri Geological Survey did much to make the Fifteenth Annual Highway Geology Symposium a success. Dr. William C. Hayes handled the greater part of the logistics and Mr. Jerry Vineyard, in addition to reading Mr. Migliacciao's paper, gave a slide-illustrated talk on Missouri's caves at the banquet. Mr. John W. Koenig guided the manuscripts and plates through the processes necessary to produce this publication. Those who presented papers made the Symposium a successful one, and their cooperation, promptness, and adherence to schedule is hereby acknowledged. The attendance and the geographical distribution of those attending was especially gratifying to the host and demonstrates that these symposia have established themselves as permanent and useful meetings.

Thomas R. Beveridge
Local Chairman

THE DUTIES AND TRAINING OF A GEOLOGIST IN THE OKLAHOMA STATE HIGHWAY DEPARTMENT

by

R. A. Helmer

The schooling of a civil engineer is to a certain extent directed toward highway work. Yet, a graduate engineer starting to work for a highway department has to become proficient in many new fields of study.

The duties of a geologist working for a highway department vary greatly from state to state. However, any highway geologist must also supplement his professional training with additional study.

In the Oklahoma Highway Department most of the geologists are in the Research Branch. Research requires knowledge in areas that are not usually covered in the training of either the geologist or the engineer. So, regardless of a man's formal education, it requires a rather long period of training and study to become a research scientist in the field of highway research.

To become indoctrinated with both highway work and research in highways is a rather large assignment. But, this kind of training is well worth the time and effort because it will greatly increase the value of a geologist not only in research but in all branches of highway work.

Our geologists make investigations and recommendations for the usual highway problems such as landslides, ground water, foundations, and material sources. These problems are closely related to geology. In the investigation of landslides we sometimes make geological surveys of new alignment to locate and avoid areas of potential slides. This involves a study of aerial photographs, investigation of the character and attitude of the rock strata, and a close

study of the colluvial material, recognizing the possibility of this material sliding at the rock interface. We frequently investigate slides which have occurred on older highways to determine the cause. We then recommend a remedy. Since we find that ground water is almost always a contributing factor, the determination of the source of the water is necessary. We drill some test holes, but they are held to a minimum because of the difficulty of drilling in these sliding areas and the possibility that moving a dry hole just a few feet might have found the water. We supply the usual remedies of retaining walls, toewalls, and benching, but most of our effort is directed toward intercepting the water entering the slide area. We use subdrains and horizontal drilling for this purpose.

We have had excellent success with these horizontal drains. In the southeastern part of our state the division engineer said he had solved about 90 percent of his landslide problems with horizontal drains.

Two inch perforated pipe is placed in 4-inch drilled holes. No backfill material is placed in the holes. This method has been used for many years in California, and I should give them credit for its development.

To the highway engineer, all material which reduces to a soil-like material under normal construction operations is considered to be soil. This includes many geological materials such as the softer shales and sandstones. Gravels and sands are also soils to the highway engineer.

Through the years engineers have developed many methods to classify and evaluate these so-called soil materials. All of these methods require testing of each material classified.

The development of so many methods is an indication that none of them has been found entirely satisfactory, probably because this kind of classification

requires many tests which takes much time and is expensive. Some of the more common soils are encountered many times, and each classification requires new tests.

The principal tests we use in Oklahoma to classify soil material are the liquid limit, plasticity index, percent passing the No. 200 sieve, and the California bearing ratio is used to indicate the strength of a soil. We have developed an index number by means of which we can estimate the California bearing ratio from the plastic limit, liquid limit, and the percent passing the No. 200 sieve.

To hold the volume of testing to a minimum we have adopted a system of filing our test data for soil under the soil series name used by the Soil Conservation Service and the tests of the underlying geology under the geological name. The soil scientist and the geologist have accumulated much other information of value to the engineer. This system brings together in our files the information of the geologist, the soil scientist, and the engineer. When we know the name of a material, our records of previous tests can be used to evaluate it for highway purposes.

We frequently work from highway plans, and reading plans is a part of a geologist's training. For the engineering classification of materials, it is necessary to know the engineering tests, how they are interpreted, and how they enter into the specifications. Since our geologists classify both the geology and the soils, it is necessary for him to have a good working knowledge of all three methods of classification. Also, he should be able to identify by name the geology and the soil series in the field.

Basic to the study of pedological soils is the concept that all soils are the product of five soil forming factors. These factors are parent material,

topography, biological life, climate, and time. Material, topography, and climate are major factors in the performance of highways.

A geologist must know what geological formations produce aggregate suitable for road building purposes. He must understand not only how the geology is reflected in topography, but how the topography is related to highway problems.

In the design of a highway pavement the principal governing factors are the material from which the pavement is to be constructed, the strength of the subgrade upon which it is to be placed, the traffic and wheel load it will carry, and a regional or environmental factor which is the combined effect of geology, soils, and climate.

The traffic data are available, but it is necessary to evaluate both the regional factor and the subgrade soils. This regional factor is very important and could change the required thickness of a pavement by as much as 100 percent.

The freezing and thawing and shrinkage and swell of engineering soils can rapidly destroy a pavement. The solving of this environmental problem has two parts; the identification of soils that are susceptible to damage by frost and study of the climatic records of the area to evaluate the degree days or frequency of temperatures that produce freezing conditions.

For our state the shrinkage and swell of plastic soils cause more damage to pavements than freeze and thaw. Here again it is a combination of soil type and wet and dry cycles of weather.

Our geologists spend a large part of their time doing research work. In fact, they are classified as research scientists.

Our research is of two general kinds. We investigate problems encountered by other departments, and we also carry on some rather large research projects

in cooperation with the Bureau of Public Roads. We have had projects lasting several years and have investigated such things as flexible pavement, portland cement pavement, geologic materials, maintenance costs, and nuclear testing of moisture and density.

The collecting of data and the evaluation and analysis of the data are very difficult fields of study.

We use electronic computers in many of our projects, and an understanding of the equipment, preparation of data, statistical mathematics and methods is a part of a geologist's training in our organization.

In our research we use the performance of the pavement as the dependent variable and relate all the other factors to pavement performance.

The service of a pavement is determined by making a detailed field condition survey and noting all defects. Since this is a question of judgment, a man must be able to estimate the importance of the things he can observe in the field. Experience is required to become proficient in making these surveys, but we have geologists who can do an excellent job of making a condition survey.

Although it is rather unusual for a research department to design the thickness of pavement, this task is assigned to our research branch, and we have geologists who can make these designs.

Our geologists teach such subjects as soils, ground water, landslides, and geology in our training schools.

My purpose in giving this paper is not to paint a picture of the kind of a job a geologist will have if he works for a highway department, but to indicate the large variety of talents needed by the highway industry and to indicate the many areas in which the geologist can adapt himself to work.

I think there is a very narrow view held by both engineers and geologists of the place a geologist could occupy in the field of highways. For the good of the engineer and geologist, I want to correct this error.

Prospecting for and locating highway materials are similar to prospecting for oil and gas, and this is the first thing an engineer thinks of when considering the need of geological assistance.

It is true that materials are rapidly becoming depleted in many areas. Finding suitable materials is a major problem, but I have tried to indicate some of the many areas in which geology, supplemented by other knowledge, can be valuable.

There is work for the geologist in the planning, construction, and maintenance of highways. The larger a business gets the greater the variety of talent needed.

I recently heard an official of General Motors say that they had done extensive research on the shape of borrow ditches along highways. This research in the field of highway design was undertaken because cars are going to run off the road, and they felt that inasfar as possible cars should be designed to run into borrow ditches safely.

Highways are a multibillion dollars business. The highway problem covers an amazing number of areas commonly considered as functions of the doctor, lawyer, chemist, meteorologist, physicist, and many other professions.

The reasons for drivers going to sleep, the effect of an expressway on the abutting property values, the weight of a truckload of groceries, the origin and destination of a man going to work are all a part of the highway business. Most of these things enter into the highway problem in the form of observed data.

The geologist is trained in observation and the systematic recording of data, and this ability together with his training in the basic sciences such as mathematics, chemistry, physics, soils, and surveying gives him a good back-

ground for highway work.

I think those who are responsible for the teaching of geologists would do well to shape the education of these students a little less toward the production of oil and more toward the expanding field of furnishing the highways which are necessary to consume so much of the gas and lubricants which are products of the oil industry.

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