

MICHIGAN
STATE HIGHWAY DEPARTMENT
G. Donald Kennedy
State Highway Commissioner

RESEARCH ACTIVITIES
OF
MICHIGAN STATE HIGHWAY DEPARTMENT

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Research Activities of

Someone has defined research as the process of finding out what is to be done when we can no longer continue to do what we are now doing.

Generally speaking, the reason we cannot always continue in the enjoyment of existing conditions is because of the exercise of someones' imagination in the form of research. The effects of research are self-multiplying and help to force development out of the engineering ruts of precedent into which we are accustomed to fall.

Science is built up of facts as a house is built up of stones; but an accumulation of facts is no more a science than a heap of stones is a house. Scientific research is not itself a science, it is still an art or craft; engineering is not itself a science, it is still an art or craft - - but it does seem to be that when results of scientific research are combined with engineering practice the amelioration does bring about a true science.

Research as applied to highway engineering might be divided into two general types, usually classified as fundamental and developmental. The first is directed toward obtaining basic information and the establishing of principles and trends upon which processes and technique may be founded and developed. The second is directed toward the use of this fundamental information so as to produce usable

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techniques and processes which can be evaluated by service behavior. The second phase might be looked upon as the ameliorating process which eventually produces a scientific fact and a resultant science.

Research needs no further justification when the results obtained leads to the improvements and development which we are wont to see, together with this change from art to science, of our engineering practices.

The value of research when placed on a "dollar and cents" basis is best demonstrated in the manner which industrial organizations encourage and finance such activities. Eastman Company, General Motors, General Electric, Western Electric and many others spend millions of dollars yearly for research. From 1912 to the present day, the Eastman Company's budget for research has increased from practically nothing to \$5,000,000 per year. Current research expenditures for this company represent 25 cents for every dollar of earning.

Eastman Company, as many others, has recognized that "research is not like a sausage mill -- you can't put brains in one end and grind out profitable ideas at the other". It is necessary to accumulate small ideas patiently, hoping eventually to fit them together into something big. Five to ten years might elapse before the laboratory produces something really worth while. The methods of research are many and devious. Of this, Dr. Mees, director of research for the Eastman Company, says: "Research opens new frontiers. No one can predict in which direction the new frontiers lie". The thing to do, he says,

"is to let the research man poke his inquisitive nose into some problem that fascinates him, and then follow it from fact to fact, no matter how far off the original track it leads. The man who knows the most about any project is the man doing the job. The man immediately above him knows a little less, the research director considerably less. By the time you get up to a committee of vice presidents, they know precisely nothing". It might be added, however, they do seem to know something about the benefits derived - - or else why the large appropriations?

Briefly, we have defined research, its purpose or aim, we have intimated its value and said something about its methods. Let us now turn to the Michigan State Highway Department and consider the "how, why and wherefor" of its research program as carried on, particularly in the Research Division.

It is fortunate for the people of the state of Michigan that the present administrator of the Michigan State Highway Department, G. Donald Kennedy, does appreciate the value of research and encourages the development of facilities for carrying on such work.

The Michigan State Highway Department, over a period of years, has shown more than average interest in the value of research and has contributed valuable information to the art and science of highway building. However, the efforts have been more or less spasmodic with work directed to the most urgent problems. In some cases, very important and valuable work was initiated, but because no adequate organization

existed which could make long range observations to the end of establishing definite conclusions, the original effort came to practically naught.

Credit must be given to the conscientious workers who made valuable contributions and it is not the intent to belittle their efforts, but rather to point out the necessity of long range programs - programs well planned, with adequate personnel, equipment and funds - to the end that the greatest good may be derived.

In 1939, a Research Division was instituted in the Michigan State Highway Department charged with the responsibility of creating and carrying out a research program best suited to the needs of the highway engineering profession. Special emphasis was to be placed upon the design and construction of concrete pavements from the standpoint of strength, durability and economics.

It was realized that such a program must be a long range plan, the study of which should be made by an adequate staff specially trained in the field of highway research. Also, such an organization should have proper facilities away from the regular routine of highway interoffice business.

After a little over two years, the Research Division has put under way a comprehensive program including the study of primary problems pertaining to higher quality concrete and bituminous pavements as well as subgrade characteristics and soils stabilization. In regard to concrete pavements special importance is being placed upon such subjects as scaling, curing, design, including slab thickness, spacing of joints,

joint design and concrete mix design. The changes in characteristics of binding medium and consequent development of specifications for binding material are being considered under bituminous pavements. Subgrade and soil studies include measurements of subgrade modulus, relation of characteristics of subgrade soil to supporting value and methods of soil stabilization.

Of these various phases of work, I wish to discuss or outline briefly, some of our work in connection with the design and durability of concrete pavements.

In connection with design, we have three panels depicting our work. One, the construction of a concrete road as a large field laboratory in the study of dimensional factors in design; another, showing laboratory studies of load transfer devices at joints in concrete pavements; and the other, outlining a study of "subgrade modulus", an important factor in pavement design.

Under the subject of durability, one panel covers the construction of a concrete road adjacent to the design project for determining certain factors relating to durability of concrete, particularly scaling, another showing laboratory studies in scaling and third, the development of a method for determining the "breakdown of concrete" in freezing and thawing by electrical methods.

The set-up of the two panels describing the design and durability road project will be briefly outlined and is completely described in the bulletin on the Michigan Test Road. I believe the movie which

we have prepared will give a more comprehensive idea of its scope and purpose. Now, for the time being, let us give more detailed attention to the four other projects shown in our panels.

The subject of joints and load transfer at joints has been a controversial issue for a number of years. We are trying in our study of this problem to better understand the value of mutual support at the end of discontinuous sections of concrete pavement slabs, to determine the strength characteristics of methods and devices proposed for mutual support and, lastly, to develop a fundamental theory of design based upon these characteristics in relation to the allowable stresses which may be imposed upon a pavement slab.

In considering the design of an elastic "flexible or rigid" slab upon a subgrade it is necessary to know something about the relation of the "subgrade supporting value" to the design of the slab as well as some method of measuring it. Valuable work on the relationship of the slab design to subgrade support has been carried on by other investigators, although not complete. For the present, we are confining our efforts to developing a method for measuring this property of the subgrade, as a factor in concrete pavement design.

The design of a concrete pavement for structural adequacy is very important, but if the materials from which we built it will not remain structurally intact over the estimated life -- and serious maintenance costs are involved -- then our problem has not been completely solved. The movie will show you some phases of our work

in studying methods for improving durability but I believe you will be equally interested in some of our laboratory work in this connection.

We have known for some time that when "calcium chloride" and sodium chloride is used for ice removal on concrete pavements scaling of the slab surface is accelerated. In order to determine the best method for curbing this deterioration, it is first necessary to study the various factors pertaining to scaling. It has been shown by field survey that approximately 10 percent of the surface of concrete slabs have scaled in Michigan. Scaling in most cases has not been serious to the point of influencing the structural efficiency of the slab, but there is reason to believe that heavy scaling over a period of time would affect it.

The preliminary studies and conclusions are well shown by the panel which we will discuss briefly.

In connection with the laboratory studies on the durability of concrete and its relation to tendency to scale -- valuable use of the "sonic" apparatus has been made to determine changes in modulus of elasticity in relation to the number of freezing and thawing cycles and thus establishing a relative index of resistance.

MOVIE

Conclusion

"If in some things I dissent from others, whose wit, industry, diligence and judgment, I look up at and admire, let me not therefore

hear presently of ingratitude and rashness. For I thank those that have taught me, and ever will; but yet dare not think the scope of their labour and inquiry was to envy their posterity what they also could add and find out If I err, pardon me: "No art is discovered at once and absolutely I do not desire to be equal to those that went before; but to have my reason examined with theirs If I have anything right, defend it as "Truth's, not mine, save as it conduceth to a common good Stand for truth and 'tis enough".

Ben Johnson, "Discoveries Made on Men and Matter", (1641)

"If the truth were admitted, it would probably reveal that many of the worlds great scientific discoveries as well as a majority of the lesser developments in the various branches of engineering originated with somebody trying an experiment "just for fun". The idea of some genius marshalling a test tube and slide rule offensive against some obstacle to human progress is a pretty picture, but it is largely imaginative art painted after the fact" - - Engineering News Record Editorial, November 6, 1941, in commenting on a thin steel plate clinic building recently built by the Chicago Bridge and Iron Company for the employees of the Company.