

# RESEARCH ACTIVITIES AND PROGRESS IN INDIANA

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## RESEARCH DEFINED

Research is critical and exhaustive investigation or experimentation to discover new facts and determine their correct interpretation. We can add that research can be used to revise accepted theories, conclusions, and laws. The results of research applied in this manner would be a method of implementation. Keep in mind that implementation is the goal of all researchers.

Now, research comes in at least two flavors. One is theoretical or basic research—probably a laboratory investigation. This type of research is essential to gain a deeper understanding of the fundamental nature and behavior of materials of construction, systems, and processes.

The other flavor is on a little different level—practical or applied research. In our case the term—applied research—is used to denote the evaluation and comparison of materials, systems, methods, and procedures. It is probably a field investigation, but it could be a laboratory study or combination of these two approaches. The results of basic research probably will not be available or lead to implementation right away. On the other hand, the results of applied research might be implemented readily in the form of a written procedure, a new specification, the elimination of a particular feature, the revision of an existing specification, the revision of a construction procedure, or the revision of a test method.

## FIVE LEVELS OF RESEARCH

The total research effort of the Indiana State Highway Commission can be thought of on at least five specific levels. The levels are based on cost, scope, and duration of the study.

### *First Level—Federally Funded Research*

A quick inventory of the current research effort reveals the following: At the first level is a formal program of federally funded research

studies. This group currently includes 22 active studies for departments of the commission who have indicated a need. The range of topics is indicated by a selection of study titles which include:

Treatment of Sanitary Waste

Superior Bluegrasses for Roadside Turf

The Effect of Pore Size On Permeability and Frost

Low Porosity, High Strength Concrete for Bridge Decks

A rough grouping of these 22 projects into specific areas familiar to

Commission employees provides the following breakdown:

Three are related to roadside development.

Five are related to bridge design.

Seven projects are in the area of road design and general design.

Three are related to the work of the Division of Materials and Tests.

Four studies deal with maintenance situations.

This program alone received approximately \$450,000 in fiscal 1979 from the Federal Highway Administration. The Civil Engineering Department of Purdue University through the Joint Highway Research Project and the Research and Training Center of the commission are the agencies primarily responsible for this research.

#### *Second Level—Evaluation of Experimental Construction*

At the second level are studies for the evaluation of experimental features of construction. These are designated as Category II projects and they are monitored and funded in part by the Federal Highway Administration. There are twenty-three active projects in this group. A closer look reveals that one study is related to roadside development, twelve involve bridges—mostly decks, two are in the general area of construction, two are maintenance oriented studies, and six deal with traffic features. Category II studies are longterm evaluations of proprietary items for the most part.

Through these studies various types of joints are being evaluated and compared over a three to five year period of service; bridge deck protection systems such as bituminous membranes, latex modified concrete, other types of modified concrete, and so-called dense concrete are being evaluated over time; reinforcing steel which has been coated or galvanized is being studied; epoxy sealers have been studied at this level for almost ten years. These have proven to be only temporary methods of protecting the bridge deck from the attack of chloride ions. Bridge expansion bearings with teflon surfaces are being evaluated, and expansive cements have been used in a few experimental bridge decks. Prefabricated railroad crossings are being studied. These are crossings

made out of structural foam, timber, and rubber. Reflective sheeting or reflecting sheeting of encapsulated lenses for traffic signs are being evaluated, and so on.

Much of the actual inspection and 90 percent of the reporting is done by the Research and Training Center. However, some divisions and departments do their own evaluating and reporting.

#### *Third Level—JHRP Research*

The third level of the research effort is the work done by Purdue University through the Joint Highway Research Project. This effort includes fifteen active studies which are not funded by the Federal Highway Administration. Study titles indicate a broad range of activities from "Computerized Slope Stability Analysis" to "County Soil Mapping" to "Design Parameters of Asphalt Treated Bases in Rigid and Flexible Pavement Systems." These are relatively short-term studies with a limited scope. Documentation and reporting are still at a high level, but the funding requirements are relatively small.

#### *Fourth Level—R & T Research*

At the fourth level are the in-house studies of the Research and Training Center. For the most part these are routine evaluations of pavements and highway structures. Specifically, various activities of the Center include the following:

*Laboratory Testing of Soil Samples*—This work consists of laboratory tests of samples obtained by Soil Conservation Service field crews. Specific information obtained includes establishing the density/moisture relationship, determination of atterberg limits, grain size distribution, and classification of the individual samples. This information is reported back to the SCS as the testing of the set samples for a county is completed.

*The Dynaflect Study*—This is an investigation of the factors which affect the response of the dynaflect. The dynaflect is a device used to determine the structural adequacy of pavement and its base. Specific factors being studied include temperature—both air and surface, pavement type, pavement structure, and sub-base condition.

One the degree and influence of these factors is known, understood, and quantified it will be possible to utilize the Dynaflect at any time of the year, on any pavement type, at any time of the day to determine structural adequacy and performance of the pavement, accurately and with confidence.

*Nuclear Gauge Application Study*—Nuclear gauge application is an on-going in-house effort. Use of a portable gauge to monitor construction and maintenance activities has come a long way in the last ten or twelve years. The gauge was strictly a research tool ten years ago in Indiana. The Highway Commission owned three gauges when the center opened. These gauges were used in a research study to determine the variability of soil density and moisture content. Today the center is responsible for more than 40 gauges. The main use now is to monitor the density of bituminous courses. Last year the center developed a procedure to monitor the density of modified concrete overlays for bridge deck repair. Work was also done last year by the Division of Materials and Tests to see if the gauge could be used to determine the degree and uniformity of compaction of thin bituminous overlays. It was found that they can. Other applications are being studied.

*Pavement Smoothness*—Research using the PCA Roadmeter to measure pavement smoothness also continues from year to year. Each fall the roadmeter is used to determine the smoothest pavement constructed during the year in three categories. The Smoothness Awards presented annually at Road School are the results of that effort. The roadmeter is also used to correlate pavement smoothness with pavement age, and the center is attempting to determine if seasonal variations produce a major change in pavement smoothness.

*Skid Inventory*—Except for the bridge effort, the skid inventory would have to rank as the major in-house effort of the Research and Training Center.

Development of the skid inventory has brought together a lot of information about the 11,300 miles of the primary and secondary highway system in Indiana. Just in the past three years, skid inventory has been developed to such a degree that pavement type, age, and traffic volume, in addition to skid resistance are known for virtually any location around the state. Every complete and formative weekly, monthly, and annual reports are available of the information obtained and consolidated by the skid inventory investigation of the center.

So much information is available now that computers have to be utilized for analysis, compilation, and all of the information available. By next year, all districts, divisions, and departments will be able to call skid data from the state computer and have it displayed on a screen at their own terminal.

*Evaluation of Coated Pipe*—A relatively new in-house study is the evaluation and comparison of the resistance of various types of coated

pipe to corrosive effluent. This study is a combination field inspection of selected pipe installations, and a laboratory effort where in sections of pipe with various types of coatings are soaked in an acid bath to determine rate. This study grew out of a cooperative effort with the New Products Committee of the Division of Materials and Tests.

*Pothole Research*—The evaluation of pothole repairs has already begun. Eight sets of repairs are being evaluated. The sets are based on the combination of three major variables: (1) Material condition—cold, directly out of the stockpile or heated; (2) degree of hole preparation—minimal or extensive to the point of reconstructing the base, cutting vertical faces and using tack and prime; and (3) method of compaction from wheel rolling to a mechanical tamper. All in all, there are 288 patches (36 repairs in each of eight categories) which require eight inspections, each according to the plan of study. It is hoped that information learned here will lead to more suitable pothole repairs.

Included in this group are investigations by various other divisions within the commission which are not accounted for in the formal and funded program or the Category II evaluations. Most of the work is by the Division of Materials and Tests.

#### *Fifth Level—Informal Research*

At the fifth and final level are the informal studies by others within the commission. The term informal means that a plan of study is not required, that minimal documentation, if any, is required, that there is a limited scope, in other words this is probably an isolated situation, and that the effort is a simple experiment requiring simple analysis of the data. The informal studies are sometimes needed to get some quick answers. This preliminary discussion should provide some idea of the total research effort which is in progress within the commission.

### NOW—MAINTENANCE OVER CONSTRUCTION

As for research *and* progress; well, progress got us to this point. As you well know, the big construction effort has peaked. Not too long ago we saw the end of a 20-year cycle—construction of the interstate system. Today, the big dirt and paving contract is the exception, not the rule. Now, we have a tremendous investment in our highway system. The emphasis has shifted because to protect this investment requires a maintenance effort. The key words now are maintenance, safety, environmental considerations, the energy crunch, and rising costs of materials and labor. All these factors are influencing a shift of the activities of the Indiana State Highway Commission.

So, what are we really doing at the Research and Training Center these days? Basically, we're spending a lot of time evaluating the product of design and construction efforts. Actually, we've done this for some time; in fact, to the point where we have amassed a sizeable data base, which can be used to evaluate pavement surfaces. We spend almost the rest of our time on bridge decks because the restoration of bridge decks has been a major activity statewide.

#### *Techniques to Protect Concrete Bridge Decks*

Many methods have been tried to protect the concrete decks against the intrusion of chloride ions which leads to the deterioration of the concrete. From linseed oil to coal tar, from penetrating sealers to membranes with bituminous wearing surfaces, and from low slump concrete to latex modified concrete every conceivable method and available product has been tried. The question which must be answered are obvious. Which ones provide protection from the intrusion of salt? Which ones are durable and retain serviceability? Which ones maintain bond with the parent bridge deck? Which ones retain a desirable surface texture? Which methods are easy to apply? This reconstruction is maintenance, but it is also research because we need to know which ones are the best. The same can be said for pavements, whether we restore them, resurface them, or reconstruct them, they require the results of research to determine when, how, which, to what extent, and in what order. All of these items must be considered if economy, efficiency, and effectiveness are important.

#### *Pavement Studies and Ratings*

Along these lines the commission currently uses efficiency ratings to determine needs and establish pavement maintenance priorities. This system uses subjective, numerical values assigned by individuals. This system is time-consuming and subject to the bias of human judgment. A study was just completed in the level one group which was a joint venture between Purdue University and the Research and Training Center to improve the existing procedure by establishing a method of rating pavement performance objectively using the skid system, the PCA Roadmeter and the Dynaflect.

### FUTURE RESEARCH AT THE R & T CENTER

The question is, what's coming down the road? The items that come to mind readily are:

#### *Modified Bituminous Surfaces and Open Graded Surfaces*

Indiana State Highway Commission has been experimenting with these already for some time with a number of things in mind: safety,

high skid resistance, constant skid number independent of speed, reduced possibility of hydro-planing by letting the water go down and out laterally, and durability. These experimental surfaces look good initially, but what about five years later?

#### *End Result Specifications*

The results of statistical quality control studies and nuclear gauge research has led the commission to develop specifications and procedures for trial application on selected contracts. This method of controlling construction operations requires more work on the contractor's part and makes the contractor more responsible. He is producing a material within the framework of reasonable specifications which take into account the variability of the material and the state must determine if the end result is or is not acceptable.

#### *Thin Concrete Overlays for Pavements*

A level one project finished last May has probed this possibility. The effort showed promise and, hopefully, the recommendations from the study will lead to a trial application. Resurfacing an existing pavement with a thin layer of portland cement concrete is a very new idea for Indiana. This will require some changes in traditional thinking.

#### *Recycling*

This activity is coming on strong. Both hot and cold recycling are being considered and studied. A partial or total effort on portland cement concrete and bituminous concrete pavements is a real possibility. Again, the questions—restore? resurface? or reconstruct? Material costs, labor costs, and environmental conditions are forcing this issue on the highway commission, and the commission has already done something very positive in this area.

The cold recycling of a portion of SR-32 was completed last fall, and a report was presented at one of the general sessions of this meeting describing the efforts, activities, and findings of a level one study of some of the aspects of recycling bituminous pavement.

#### *Bridge Decks*

A new effort has been proposed which deals with the evaluation of calcium nitrite as an admixture in bridge deck concrete to inhibit corrosion of the reinforcement. This study will begin this coming construction season.

## CONCLUSION

What does this all boil down to? The research effort in Indiana is extensive. It includes both basic and applied investigations of materials,

methods, and procedures. The desire, the aim of the people involved, is to be able to implement the results and findings of these efforts as soon as possible. We feel that the Research and Training Center can provide technical assistance to districts, departments and divisions. We feel research is progress.