

An Overview of Current Research of the Indiana State Highway Commission's Research and Training Center

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INTRODUCTION

The Indiana State Highway Commission has long realized the benefits and cost effectiveness of research. To fulfill this realization the Research and Training Center was conceived in 1966 to assist the commission in areas of research and training. Since its inception the center was targeted to be a prime mover in providing data to highway management for proper decision-making in today's changing transportation arena. Within the commission the center is under the administration of the Research and Engineering Services and under the directorship of Paul L. Owens.

RESEARCH AREA

Originally our primary research function was to coordinate, monitor, and supervise any and all construction research projects for the commission. However, because the needs of the highway system are changing, the direction of our research is also changing to include work concerning maintenance, traffic, and the like. From the completed research, we make recommendations that meet or answer the ever-changing technological needs in these areas.

Our research can be divided into three major areas. One group of projects is initiated by the commission, managed by the Research and Training Center, and conducted with the help and cooperation of other departments and divisions within the highway commission. These are listed as "Category II—Experimental Features of Construction" and currently 25 projects are under this heading. There are also 22 major, long-term studies funded by FHWA and investigated in cooperation with members of Purdue Civil Engineering Department, through the Joint Highway Research Project. The Research and Training Center is

the state's agent for these combined studies. Also a considerable number of in-house research projects cover a wide range of topics.

From this sizable research effort in progress at the center, the areas of research which we have decided to highlight in this discussion are: bridge studies, pipe coatings, pavement marking and mowing, recycling, and pavement performance.

BRIDGE STUDIES

The research spectrum for bridge studies currently consists of five federally-funded research programs related to bridge design and 12 partially-federally-funded Category II studies. Through the Category II studies various types of joints and bridge deck protection systems are being evaluated over a specified period of service. Bridge expansion bearings with teflon surfaces are also being evaluated, as well as expansive cements which have been used in a few experimental bridge decks.

In particular, the areas of bridge deck deterioration and bridge deck protection systems have received high priority in the state as well as on the national level due to their frequency and high cost for rehabilitation. It has been estimated one-third of all highway bridge decks are seriously deteriorated due to the corrosion of the reinforcing steel, and conservative estimates place the funds required to undertake replacement or repair of these bridges at \$12.4 billion on the federal-aid system and \$10.6 billion for the off-system bridges.

The bridge deck deterioration problem stems from a combination of the large amount of steel in the bridge deck and the application of deicing salts. As the salts penetrate the bridge deck, corrosion of the reinforcing steel can begin under adequate conditions of moisture, oxygen, and salt concentration levels.

The Research and Training Center has evaluated various bridge deck protection systems such as bituminous membranes, epoxy coated and galvanized reinforcing steel, and epoxy sealers. Currently the center is investigating the performance of various latex modified concretes, low-slump dense concretes, and corrosion inhibitors such as calcium nitrite. Performance is relegated to resistance to chloride ion penetration, corrosion potentials, construction problems, bonding with the parent concrete, and surface characteristics.

Among the protection systems tested, chloride ion levels have generally increased by year at the various levels tested. The amount of increase in chloride ion concentration depends on the type of protection system tested with some systems reportedly protecting the reinforcing steel from corrosion chloride levels 10 to 15 years.

Accelerated laboratory testing and field sampling is continuing on

the protection systems previously noted to define the performance of each system in comparison to each other and the conditions whereby a particular protection system becomes more desirable.

PIPE COATINGS

Caustic discharge and acidic runoff have resulted in a significant reduction in the service life of pipes in the northern and southern portions of Indiana. To extend this service life pipe manufacturers are proposing a variety of methods, the most common method being pipe coatings.

In the summer of 1979 the ISHC New Products Committee and the Research and Training Center initiated a study to evaluate the ability of various pipe coatings toward inhibiting pipe corrosion in an acidic environment. Pipe coatings tested included: asbestos bonded-bituminous coated pipe, plain bituminous coated pipe, bituminous coated-polymeric coated pipe, epoxy coated pipe, aluminized pipe, aluminum pipe, polymeric coated pipe, galvanized pipe, vitrified clay pipe, and concrete pipe.

The pipes were subjected to a constant 2 pH sulfuric acid solution and were periodically inspected. Various defects appeared in several coatings such as blistering, disbondment of the coating, rusting, and pitting.

In the study a field investigation was also initiated along with cost comparisons. An attempt was also made to rank the various coatings and pipe by their performance in an acidic environment, availability in various diameter and lengths, and cost.

PAVEMENT MARKING AND MOWING

The Research and Training Center was directed by the chief highway engineer to initiate a study to develop recommendations and guidelines to assist in the determination of the advantages of contract versus in-house placement of painted pavement markings. The study concentrated on comparing the cost of applying various types of traffic striping on the centerline and on the edgeline. Other aims of the study were to make recommendations concerning: scheduling and planning, administration and control of work, coordination of striping activities with other highway maintenance activities, quality of work, materials, and specifications.

Randomly selected field sections were also evaluated for field performance of the pavement marking materials. Conclusions from this cost comparison study are being drawn from the data with specific recommendations toward making the pavement marking operation

even more efficient. This type of comparison analysis has also been proposed for comparing mowing operations performed by in-house forces versus contract forces.

RECYCLING

Within the past decade the emphasis of transportation agencies has shifted from one of the new facility construction to one of maintaining and upgrading existing highway facilities. Recycling is believed to be one method that can be used to facilitate this shift in emphasis.

The Research and Training Center is participating with the Purdue Civil Engineering Department in a Joint Highway Research Project (JHRP) to determine the most effective methods and materials for recycling. Both hot and cold recycling are being considered and studied. The study will also evaluate the in-place service of the recycled pavements.

Considerable preliminary work has already been performed on evaluating the behavior of various types and quantities of bituminous rejuvenators for use in recycling. The findings of this work and the above mentioned study will be used to prepare special provisions for a hot recycling project on US-41 near Terre Haute, Indiana, and a cold recycling project on SR-16 near Rensselaer, Indiana. Both of these projects are planned for 1981.

PAVEMENT PERFORMANCE

Pavement management is another major area that the Research and Training Center is addressing. By definition pavement management is the process of coordinating and controlling all activities related to pavements to best utilize public funds for providing and maintaining pavements in a serviceable condition on an ongoing basis. It involves using feedback information on pavement performance and pavement rehabilitation activities and costs.

The ISHC has already established a Pavement Management Committee to implement pavement management programs which will relate design, pavement performance, cost evaluations, and will even project future funding needs.

In pavement management, it is desirable to measure pavement performance on a statewide basis. The areas of pavement performance normally investigated are: rideability, safety, and strength.

These performance features are collectively referred to as serviceability and, if expressed quantitatively at some point in the pavement life, then as the pavement serviceability index or PSI.

To measure rideability the Research Training Center has used, since 1973, a PCA Roadmeter* (Figure 1).

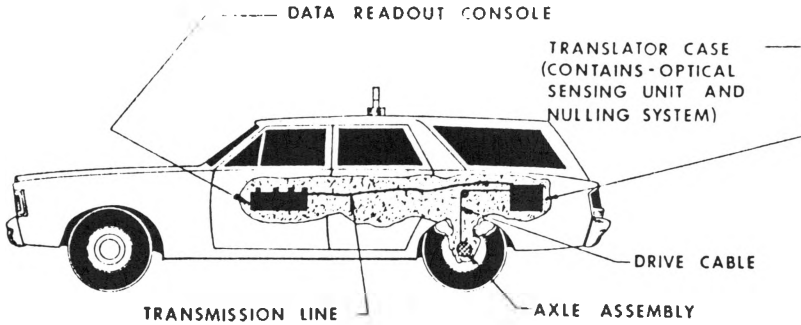


Figure 1. PCA Roadmeter

The PCA Roadmeter measures the total number of 1/8 -in. deflections of a car body while traveling at a speed of 50 mph. This provides a realistic approximation of the rideability of the road in terms of the user. This rideability information coupled with a recently completed JHRP study concerning pavement evaluation methods has resulted in a relationship between PSI and road roughness. The results of this relationship is that the PSI of a pavement can be established through the annual roadmeter inventory the center performs on Indiana's roads, provided that background information for a pavement section is known, such as pavement age, traffic volume, and percent of truck traffic. With the initial roughness of the pavement known and with expressions for PSI and minimum PSI, the expected service life of a pavement can be calculated based on rideability.

The center evaluates safety, another component of PSI, by determining the level of frictional resistance to skidding that the pavement provides. This determination is made with an ASTM standard skid system (Figure 2) which measures the coefficient of wet sliding friction between the pavement surface and a standard test tire. This coefficient multiplied by 100 gives the friction number for the pavement.

*Recently the Research and Training Center has also acquired a May's Ridemeter.

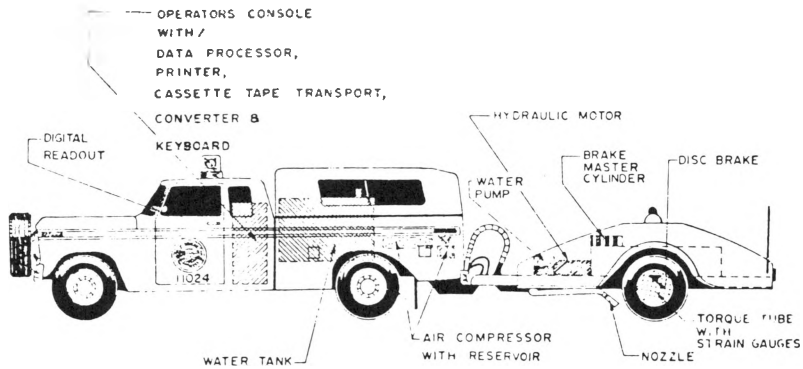


Figure 2. Skid Test System

From the skid inventory data base, obtained from the periodic testing of approximately 11,300 miles of the primary and secondary system in Indiana, the relationship between the level of friction of a pavement during its service life can, hopefully, be predicted. Similarly, the remaining service life can be predicted if a terminal friction number is assumed. From the relationships between friction number and service life another expression for PSI can then be obtained.

However, when considering friction numbers, seasonal variations need to be taken into account. This cyclic variation in pavement friction is noted for most pavement surfaces with higher frictional levels typically recorded in the winter and early spring seasons and lower levels in the summer season. The factors contributing to this fluctuating effect on pavement friction levels are being investigated in a related study.

Another expression for PSI in terms of the strength of the pavement system is being investigated. To measure the strength of this pavement system the center uses a device called the Dynaflect (Figure 3). The dynaflect subjects the pavement to a cyclic load and measures the amount and type of deflection of the pavement system.

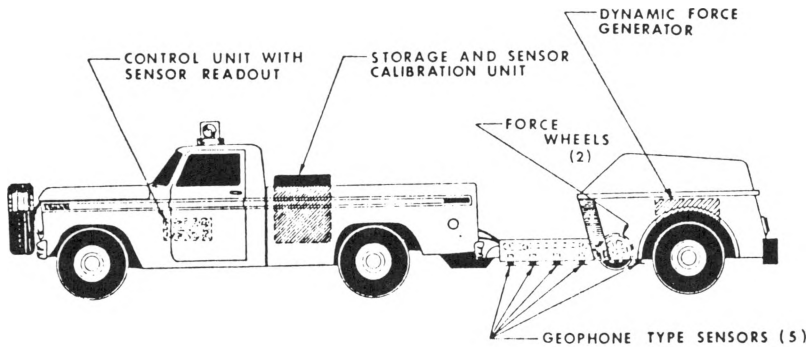


Figure 3. The Dynaflect System

A JHRP study currently underway is attempting to correlate dynaflect measurements with the structural life or service life of the pavement. Eventually the relationship for PSI in terms of strength will be examined.

Finally, PSI will be expressed by the variables: rideability, safety, and strength. These variables will be measured by inventory and special testing with the center's PCA roadmeter or May's ridemeter, skid systems, and dynaflect system respectively. Problem pavements could then be identified and the type of rehabilitation strategy most suitable for the existing conditions could be suggested.

CONCLUSION

In this discussion we could only glimpse five areas of research the Research and Training Center is involved with. However, the total research effort performed by the ISHC, in particular the Research and Training Center, is extensive. A wide range of topics is included in this effort and considers both basic and applied investigations of materials, methods, and procedures. Furthermore, the ISHC understands the basic concept, that research will provide valuable milestones in its desire to provide a safe, well-built, and properly maintained highway system that Indiana taxpayers deserve.