PORTABLE EQUIPMENT TO MEASURE THE EFFECTIVENESS OF MAINTENANCE TREATMENTS

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BACKGROUND

A major part of Strategic Highway Research Program's (SHRP's) Highway Operations Research is concerned with preventive maintenance. For many years, I was a Maintenance Manager in the U.K. with responsibility for the maintenance of highway networks ranging from heavily trafficked national roads to lightly trafficked farm to market roads. I know, like others before and since, from practical experience that a stitch in time does indeed save nine and that preventive maintenance treatments, such as chip seals, thin overlays or slurry seals, if applied at the opportune time, can prolong the life of pavements.

INTERVENTION

The question is, what is the opportune time? I've known Engineers who have maintained that a sealcoat should be laid two years after a surfacing has been laid. I've known other Engineers who have said, with equal conviction, that preventive maintenance is most effective if applied after the first micro-crack has appeared. The general practice seems to be to wait until there is noticeable deterioration, although I'm sure there are many other ideas.

SHRP Project H-101 is aimed at providing a definitive answer - the optimum time to intervene with a preventive maintenance treatment to maximize maintenance cost-effectiveness. The optimum time will be related to a stage in the deterioration of the pavement structure, for which a condition, such as surface cracking, may be symptomatic.

CONDITION MEASUREMENT

Project H-101 will define the condition that should trigger preventive maintenance action. Project H-104 is concerned with the development of devices to measure that condition. When we started on this road, our panel of experts agreed that preventive maintenance was likely to be most effective when carried out at a very early stage in the deterioration of a pavement. From that opinion, we concluded that we probably needed to be able to measure small symptoms of distress.

Our preliminary research showed that at present there isn't equipment that can do that, and indicated that we might well need to be able to measure hidden conditions, such as changes in base moisture content that could increase the flexure of the pavement and thus the incidence of fatigue cracking.

The sort of conditions that we became interested in measuring were:

- Moisture in the foundation layers beneath a flexible surface
- Moisture under rigid pavement joints
- Moisture within an asphalt layer
- Fine cracking
- Subsurface problems
- Voids or loss of support under rigid pavement joints
- Overlay delamination
- Asphalt Aging

The preliminary research confirmed that there were technologies that could be used to detect and measure those conditions so we advertised for proposals and were able to select two proposals that in consort offered the prospect of both problem detection and diagnosis.

OBJECTIVES

The objectives of Project H-104 are straightforward. They are to help the Maintenance Engineer to determine:

- the need for preventive maintenance treatment,
- where it should be carried out,
- the effectiveness of preventive maintenance treatments, and
- the status of the preventive maintenance experiments.

NETWORK LEVEL

On April 1, 1990 a research contract was awarded to Geophysical Survey Systems, Inc. to develop equipment utilizing ground penetrating radar (GPR) technology that could be used to survey a whole highway network.

The concept is an advanced form of radar mounted on a vehicle or in a trailer which, travelling at highway speed, would detect and measure:

- Moisture in the foundation layers beneath a flexible surface
- Moisture under rigid pavement joints
- Voids or loss of support under rigid pavement joints
- Overlay delamination
- Moisture within an asphalt layer (stripping)
- Subsurface problems

PROJECT LEVEL

At the same time, a research contract was awarded to the University of Texas at El Paso to develop equipment using seismic technology that could be used at a project level. The Seismic Pavement Analyzer utilizes wave propagation technology to perform detailed diagnosis of pavement conditions.

The conditions to be diagnosed include:

- Moisture in the foundation layers beneath a flexible surface
- Moisture under rigid pavement joints
- Voids or loss of support under rigid pavement joints
- Overlay delamination
- Fine Cracking
- Asphalt Aging

NETWORK VS. PROJECT LEVEL

As an example of the different level of information to be provided by the two types of equipment, whereas a ground penetrating radar survey of a highway network might provide the location of overlay delamination, the Seismic Pavement Analyzer will convey the difference in pavement performance at specific locations through the change in pavement modulus. The radar equipment can be used for rapid problem detection over a roadway network. The pavement analyzer is a stationary device that provides on the spot detailed diagnosis and thus the two devices are complementary.

CRITERIA FOR EQUIPMENT

The intention is that in both cases the equipment should be operable by maintenance technicians from a district office. Consequently, it has to be serviceable and user friendly.

When we were drawing up our shopping list of wants, our panel of experts, made up mostly of maintenance engineers from state DOT's, leavened by specialist technical expertise, advised that the equipment should be:

- Portable e.g., mobile and easily moved
- Reasonable cost
- Easy to use and interpret results - A current drawback of this type of technology is that it requires expert interpretation.
- Easy to calibrate
- Reliable and reasonably quick to use
- Rugged

PROGRESS

So, how are we doing? We are now in the third year of development and the research contractors are designing and building second generation (near commercial) prototypes. It should be recognized that we're trying to do something that hasn't been done previously. Even the definition of what we're looking for is vague and requires more research to tie down the cause and effect, such as, for example, the ingress of moisture through fine cracks in the pavement surface and the consequent softening of the base. We're also working, in advance of the findings of the preventive maintenance experiments, on the conditions that should trigger preventive maintenance treatment.

We spent a year on the feasibility stage, trying to determine the criticality of condition measurements to establish targets for the devices, clarifying the measurement concepts for the specific devices and verifying the concepts at the laboratory level.

In the next year, the contractors built and tested first generation prototype devices. They need to be tested and calibrated for specific condition states. However, pavement conditions can vary widely, and the true situation can prove very difficult to establish. Consequently, a full scale outdoor test facility with built-in defects of known dimensions was constructed at the University of Texas at El-Paso to allow controlled testing.

At the moment, we're hoping that all the problems that we found in the second year field testing will be overcome by the improved second generation devices, and by January 1993, we shall know that reliable, readily understood information can be produced from the pavement measurements.

DEMONSTRATIONS

Of course it's no good building a better mouse trap if nobody knows about it! So, as well as the states in which the proof testing will be taking place later this year, we shall, from January to March next year, take the equipment around the country and demonstrate its operation to State DOT'S. There will be the opportunity for hands on experience and feed back from the potential users on the usefulness of the equipment.