MATES

MICHIGAN DEPARTMENT OF TRANSPORTATION

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FLEXIBLE PAVEMENT DISTRESS - PART I

TRANSVERSE AND ALLIGATOR CRACKING: WHAT CAUSES IT?

You may already be aware that highway agencies all over the world are spending more and more time and money determining the condition of their pavements. This work stems from the widening gap between funds available and funds needed to keep pavements in satisfactory condition; forcing highway agencies to apply available funds to only the higher priority needs. How is this being accomplished? The usual first step is to conduct surveys to establish the system's overall condition and locate the worst areas; that is, candidates for repair. For many highway agencies, the only purpose of these surveys is to establish the condition of the pavement surface. The surveys that MDOT's District personnel conduct, however, have a number of different purposes, one of which is to determine the causes of surface distress.

Through investigations conducted by the M&T Division, it has been found that the form, extent, and severity of flexible pavement surface distress is related to properties in the various layers of the pavement system—subgrade, sand subbase, aggregate base course, or surface course. Based upon this research, it is now possible to simply look at a pavement and determine why it is failing; to find out which layer or layers are responsible for the distress. By considering pavement age, it is possible to determine specific material deficiencies as well. Such recognition may then be used to determine the kind of repairs to be made, and to bring about changes in material specifications necessary to eliminate such causes of deterioration in future construction. Improving material performance characteristics will bring about longer pavement life, and longer pavement life is a most effective way to make available funds go farther.

In establishing causes of pavement deterioration on the basis of surface distress, it is necessary to remember that the evaluation is macroscopic (that is, large enough to be seen with the naked eye). Thus, while there may be many subtle factors acting to produce distress forms, we look for those of the most significant influence. For many pavements, only one classical distress form such as transverse cracking will be present; however, there are often many distress forms on the same surface occurring as the result of more than one type of problem. This can make interpreting such a pavement more difficult but also more interesting. This article deals with patterns of certain types of transverse and alligator cracking (a closely spaced cross-hatch crack pattern resembling the back of an alligator) that occur in flexible pavements and how such patterns can tell highway engineers a great deal about the pavement structure and its constituent materials.

Remember that we are dealing only with flexible (bituminous) pavements, not with bituminous overlaying concrete. Cracking of bituminous pavement is usually related to either the asphalt mixture or the base, or to a combination of the two. Asphalt mixture deficiencies are indicated by transverse cracking, and base problems by alligator-type cracking that develops from, and is associated with, transverse and longitudinal cracking. These basic distress forms are illustrated in Figure 1.

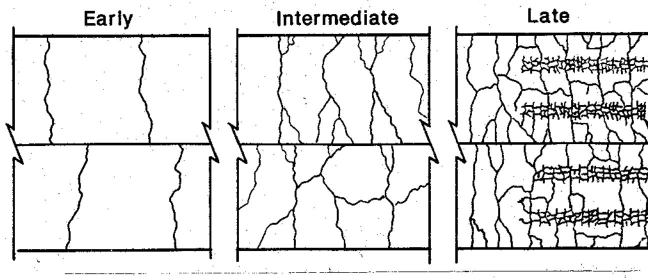

Figure 1. Stages of failure due to cracking.

<u>Transverse Cracking</u>

Transverse cracking has been the historical primary cause of premature flexible pavement deterioration. Its occurrence signals the beginning of the end of the pavement, for it indicates that the bituminous concrete's tensile strength is too low for existing conditions. The earlier in the life of the pavement that transverse cracks occur, the more serious the deficiency. Pavements that crack within the first few years continue to propagate transverse cracks at a faster rate than those that first crack when they are much older. The rate at which transverse cracking occurs is directly related to the tensile strength of the asphalt concrete and the temperature susceptibility of the asphaltic cement. Tensile strength is primarily a function of the thickness of the asphalt cement coating on the aggregate particles. Sufficient asphalt content is not indicated merely by its percent in the total mix. For example, a sandy mix and a stoney mix may both have the same asphalt content by percent of mix; however, the sandy aggregate, because of its much larger surface area, will have a thinner coating of asphalt on each particle than a stoney mix and will be more subject to premature cracking.

<u>Alligator Cracking from Pavement Surface Problems</u>

When transverse cracking reaches the severe stage (average spacing of 15 to 20 ft) in about 10 years or less, it usually is a warning that traffic loading will soon cause alligator cracking in the wheel paths. Alligator cracking in the wheel paths can also be fatigue cracking that is induced only by traffic loading, but in such cases transverse cracking will not be present. Alligator cracking in the wheel paths indicates total structural failure of the bituminous concrete, although it may continue to provide a satisfactory ride for a short time.

<u>Transverse Tears</u>

Sometimes flexible pavements with sufficient bitumen content will crack transversely anyway due to asphalt cement that is too temperature sensitive. This type of distress is indicated by short transverse cracks or tears that begin at the pavement edge, but do not extend completely across the wheel path. When a combination of these tears and the transverse cracks described above occurs, it indicates the asphalt cement is temperature-sensitive and the asphalt content is inadequate. Several methods exist for avoiding transverse cracking problems. The most common is to use softer asphalts and mixtures with less sandy aggregate gradations.

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Tents, Faults, Depressions

Transverse cracks often 'tent' or fault, or sometimes a depression is formed at a crack (Fig. 2 shows stages of roughness developing from a transverse crack). The tenting problem is seasonal, occurring during freezing weather. It occurs when deicing saltwater saturates a densely graded base. Since the saltwater zone has a lower freezing point than the rest of the base, it freezes last and, essentially, from the bottom up. This problem is particularly bothersome to motorists because of the excessively rough ride that it creates. With a poorly draining base, transverse cracks can result in a loss of fine material from the base due to a pumping action as traffic passes over the crack. This results in loss of support and a depression at the crack. With good permeability, a base will drain rather than pump and good riding quality will persist long after cracking occurs.

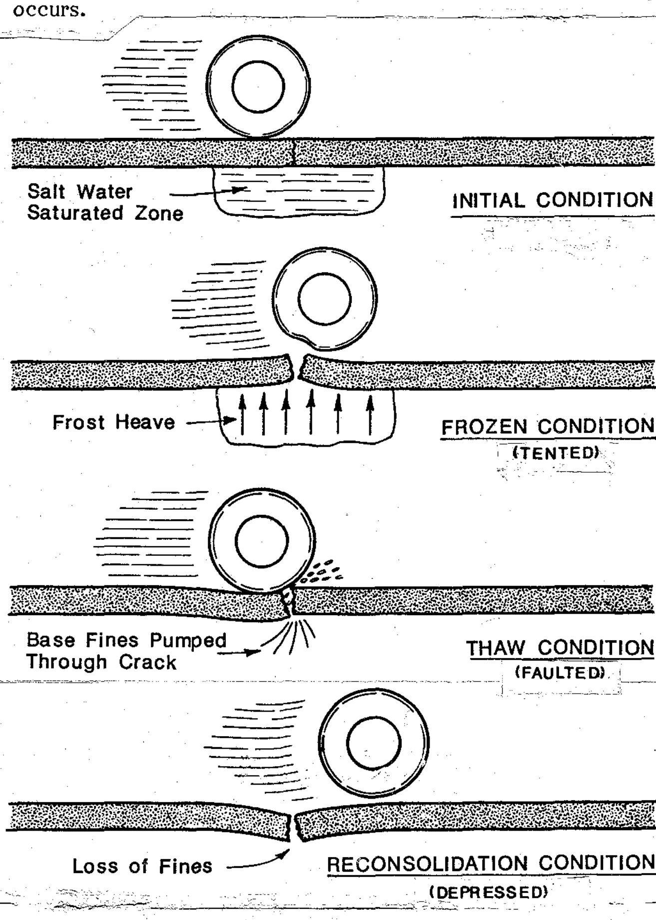

Figure 2. Pavement roughness developing from a transverse crack.

Alligator Cracks from Base Problems

Many flexible pavements are constructed on densely graded bases. The belief is that maximum possible stability is necessary to provide adequate pavement support. Unfortunately, such bases are susceptible to softening when wet, and their thickness may expand by 5 to 10 percent when a wet base freezes. This causes weak base areas to develop in the vicinity of surface cracks and leads to alligator-type cracking parallel to, and spreading from, transverse or longitudinal cracks. Therefore, the appearance of this type of alligator cracking if developed from transverse or longitudinal cracking indicates the presence of a dense graded base that is subject to softening when wet. Similar alligator cracking can occur along the edge of pavements and may indicate comparable base deficiencies.

From this brief article, the reader should begin to see that the visible distress on flexible pavement surfaces provides clues to the cause(s) of that distress. Such knowledge is of great value in the decision process related to rehabilitating distressed flexible pavements.

In a future MATES article on flexible pavement distress, we will deal with rutting and other problems. Moreover, articles will appear relating rigid and composite pavement distress forms to their causes in later issues.

-Ed Novak

NEW PERSONNEL AT M&T

It's always difficult to lose those who occupy key positions in the Division. Besides missing them as friends and valued colleagues, the problem arises of finding replacements who can continue to maintain the performance quality that's long been expected of M&T. This is no easy task; competition for employees with the specialized expertise necessary to do these jobs is keen, and the process of locating and interviewing them takes time. Therefore, we are very pleased to announce the appointment of four new employees to our staff; Eileen Chapman, Douglas Coleman, Robert Nordlund, and Cheryl Stanfield.

Over recent years, Michigan has taken the lead in the development of bridge coating materials and methods, and in training painting contractors in the new techniques involved. **Eileen Chapman**, our new paint and coating specialist in the Research Laboratory, brings the expertise to the Division necessary for continuing these important programs. Eileen comes to us from the Iowa DOT, where she was the Engineer in Charge of Protective Coatings and Traffic Markings. Prior to her experience with Iowa DOT she was a process engineer in the chemical industry, dealing with organic pigments. Her background in painting materials, specifications, and training, will enable us to continue, and improve, our coatings programs...**Douglas Coleman**, who is now Acting Bituminous Engineer in the Testing Laboratory Section, is an 'in-house' man. Doug has been with MDOT for 18 years, working in bridge design, road design, and route location. Prior to his employment at MDOT, Doug was involved in military construction while spending five years in Vietnam and the Republic of China with the Navy Seabees. Doug's variety of experience and strong MDOT background will ensure that MDOT continues to be among the national leaders in bituminous technology ...**Robert Nordlund** has joined us as the assistant head of our Spectroscopy and Photometry Unit in the Research Laboratory. Bob was manager of the inorganic laboratory of the Michigan Department of Natural Resources' Environmental Lab and, prior to that, was the supervisor of their air quality laboratory. He was also employed in the Industrial Health and Air Pollution Control Lab of the Michigan Department of Public Health. Bob possesses a comprehensive knowledge of State and Federal environmental laws and regulations, air and water quality monitoring experience, and years of expertise in laboratory management. He will play a key role in M&T's service to the Department in the environmental quality area...**Cheryl Stanfield** is a new geologist in our District Support Section. Cheryl brings with her considerable experience in geologic mapping which she gained from her employment with an oil exploration firm. Cheryl has assumed the duties of conducting geologic and hydrogeologic investigations, performing resistivity surveys, and investigating various environmental compliance issues that relate to surface water and ground water contamination. As new laws require more MDOT activity in the environmental areas, M&T continues to strengthen its staff to provide pollution prevention and control measures. We're pleased to have this group of talented people join us, and know that they will help us continue the tradition of service to the Department and the highway industry that this Division has established.

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