Scope of Services

Effect of Joint Sealant Condition on Moisture Infiltration and Erosion Potential

Even though joints in concrete pavement systems are commonly sawcut at given widths and intervals to accommodate cracking tendencies inherent according to the paving conditions and configuration they tend to create points of moisture infiltration. Consequently, joint sealing is used to:

- Repel infiltration and buildup of roadway debris in the joint which may disrupt normal movement of the joint,
- Minimize infiltration of moisture flow into the pavement sublayers which subsequently resupplies the water that transports loosened solids under the action of slab pumping

A concern for almost as many years as it has been employed in paving construction has been the capability of joint sealing to inhibit the supply of moisture at the interfaces of the pavement substructure. In order for erosion to occur, a combination of mechanical wearing of the subbase surface and slab pumping in the presence of moisture must take place. Certainly, hydraulic energy expressions can be adopted to explain the tendency for free water to flow under pressure induced by a passing wheel load through a joint based on the width of the joint opening and the magnitude of the hydraulic head. Representing the mechanics of the hydraulic process can become complicated in the presence of joint sealing particularly if the sealing is allowed to deteriorate, develop open cracks, or debond from the face of the joint well. For this reason, the flow of moisture through a joint during a rainfall event is not always predicable for a given depth of surface flow and joint opening.

Pavement Test Track

A pavement drainage test track constructed at the Riverside Campus of Texas A&M University was configured in short drainage segments to accommodate a variety of pavement types and drainage studies. One of the pavement types included in the test track is a 6 inch jointed concrete pavement. Other types of concrete pavements are pervious jointed concrete and CRC pavement.

Each pavement segment (Figure 1) was constructed with unstabilized subbase materials consisting of two different gradations to create two levels of permeability. The top of the subgrade was compacted and graded longitudinally to slope the drainage to the longitudinal center of each pavement segment to a transverse outflow drainage pipe in which to collect the subdrainage moisture. From there, the collected moisture is conveyed to the pavement edge where a tipping bucket can be used to monitor the amount of moisture being discharged from the pavement structure. The surface moisture also flows transversely across the pavement section (different sections are isolated one from another via impermeable barriers) into an adjacent curb and gutter along the longitudinal edge to transport the water to the longitudinal center of the pavement segment where it is laterally discharged into another tipping bucket designated to monitor the net surface flow.

Water can be applied to the pavement surface through the use of a simulated rainfall machine or via nature rainfall. The rainfall machine consists of several spray nozzles arranged on an overhead framework to support the application of droplets of water to the pavement surface below. The framework is approximately 10 feet wide and 20 feet long and will only apply rain to a given length of a pavement segment and selected pavement sections.

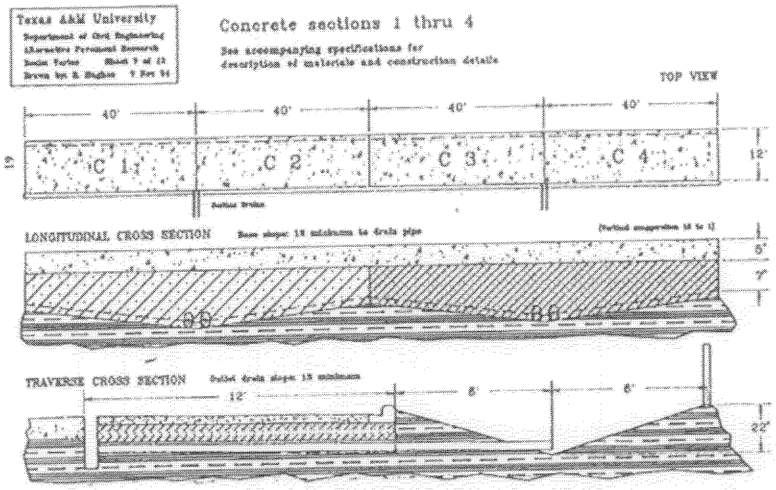

Figure 1 Concrete Pavement Drainage Test Section.

Test Program

The testing program is detailed below in 6 tasks. Much of the testing will be conducted at the Riverside Campus of Texas A&M University, in College Station, Texas.

Task 1: Review Relevant Literature on Subsurface Pavement Drainage

Over the past 25 years certain drainage or drainage related studies may have been conducted which may provide valuable information on the characteristics of water flow off a pavement surface and provide some insight into the amounts moisture that may penetrate the joints and cracks in making its way to the subbase and subgrade layers. Some of these studies were funded by NCHRP and by the FHWA. Other information may also be obtained such as joint opening and the degree of sealing involved as well as information of the effect of climatic conditions and annual rainfall amounts on the incidence of water reaching the layer interfaces. All sources of information in this regard should be assembled and synthesized to the extent possible reduce the tendency to repeat work carried out in prior studies. The review carried out under this task should also seek information of methods of testing joint sealants relevant to moisture infiltration through a sealed joint which would be utilized under Task 2. It is anticipate this task would be completed in 2 to 3 months.

Task 2: Develop an Infiltration Test to Qualify Joint Seal Condition

A test procedure and apparatus is needed to assess the degree or quality of sealing present along a given joint. This qualification will be carried out relative to the rate of measured infiltration that takes place under a given head of hydraulic pressure. The procedure should be sufficiently adaptable to allow measurements to be made at multiple locations in a relatively short period of time noting that the degree of sealing along a joint can be variable as a function of debonding and other forms of deterioration. In this manner, it should be possible to represent various stage of seal deterioration as it may be reflected in the resulting infiltration rates. We'll also use GPR to detect moisture levels below the slab during testing.

As a means of validating the test apparatus, 3 different qualities of joint sealing (sealed, partially sealed, and unsealed) will be established at the pavement test track previously noted in which to make measurements on using the testing apparatus. The values measured will be verified by measurement of flows due to simulated rainfall application to the test area. Flow through the joints will be monitored by tipping buckets and data loggers several minutes after application of a given rate of rainfall has been made. The test program will consist of 3 different factors: degree of sealing (i.e. sealed, partially sealed, and unsealed), level of rainfall application, and the opening of the joint. In this manner, a 2^3 factorial design can be carried out in terms of these 3 main. The complete factorial would constitute 8 combinations for monitoring. It is anticipated that 4 to 6 months would be needed to carry out the procedure development monitoring of the test combinations. A weather station will also be positioned at the test track during the monitoring.

In each case of monitoring, flows rates will be monitored through the transverse and longitudinal shoulder joints against the total rate of application for each rainfall level and sealant condition tested. Validation will come through developing test data for flow through each established joint sealant condition and in developing a relationship between rainfall intensity and pavement infiltration as a function of the sealant condition and rate of infiltration. As noted, GPR work will also be conducted to examine the correlation of dielectric readings with the amount of infiltration that has taken place for a given sealant condition. This relationship can also be used in the field conducted under Task 3.

The outcome of this task will be flow rate data through each type of joint tested and the intensity/time of application as a function of the degree of sealing. We should also have a better understanding of the utility of using GPR data to interpret moisture levels under concrete pavements.

Task 3: Visit LTPP Test Sites and Assessment of Sealant Condition

Work under this task will be carried out if funding is available but would endeavor to identify selected LTPP test sites which potentially can be visited to determine representative joint sealant conditions using the test procedure developed under Task 2. The selection of sites will consider subbase type, traffic and performance level, and climatic type in order to collect data over a range of conditions. It should be possible to correlate the joint condition data gathered from infiltration measurements taken at these selected sites to the observed performance in terms of the wet days contributing to the accumulated erosion. The number of wet days is a parameter included in models for erosion that should depend upon the climatic conditions and would be back calculated from the observed performance data included in the LTPP database. Correlations studies will be undertaken to examine trends in the back-calculated # of wet days and the factors previously mentioned. The challenge associated with this part of the project will be getting access to the travelled lane long enough to conduct the infiltration test which most likely will require lane closure while testing is carried out. The field investigation will also include use of the GPR to collect pavement dielectric data. This task may take 4 to 6 months to complete.

Task 4: Assess Performance Factors Affected by Joint Sealing Effectiveness

A key part of this research will be the analysis of the test data and the assessment of the effectiveness of the joint sealant materials to resist moisture infiltration. It is anticipated that the LTPP database will be sufficient to facilitate data analysis however, the base erodibility (although ideally determined from actual field cores of the subbase layer) may need to be extrapolated from laboratory test data of representative subbase samples prepared in the laboratory. The validity of the data trends will depend upon the relationship between the noted performance and the back-calculated # of wet days. Nonetheless, the sealing effectiveness will be represented by the capability of the joint seal to shed water and prevent or minimize infiltration. This task can be completed in 30 days.

Task 5: Establish the Effectiveness of Joint Seals

Based on the parameters included in the erosion model, joint seal effectiveness can be described in terms of traffic levels, climatic conditions, joint seal condition, and erodibility of the subbase layer. Analysis of the above data should provide a tie between the condition of the joint seal and the resulting performance. This task can be completed in 30 days.

Task 6: Summary Report

The research work and data will be summarized in a report detailing the pertinent data collected and analyzed during the work effort. Relevant conclusions will be drawn based on the measured data and the analysis of key trends and relationships. This task can be completed in 30 days.