Tech Brief

Joint Movement Estimator for Designing Transverse Joint Seal Installations

Introduction

Sealing of concrete pavements began approximately a century ago when full-depth gaps were left between slabs to allow for expansion and to control cracking[1]. The gaps were commonly filled with asphalt, tar, pitch, or boards.

Shortly after WW I, expansion failures or blow ups were becoming more common place and this led to the use of contraction joints with their earliest use at the bottom of the slab. Shortly after 1920, the contraction joint had evolved into grooving at the top of the pavement surface[1].

During the 1930s and 40s, agencies were concerned with pumping at joints as a result of infiltration of water through joints and bases. This led to considerable investigation of the best materials for sealing joints. By the 1950s, however, it was still common practice to reseal pavements annually to ensure an effective seal.

In the late 1960s, considerable research ensued resulting in the development of the shape factor concept by Ton[2], which is the basis for all modern day joint designs.

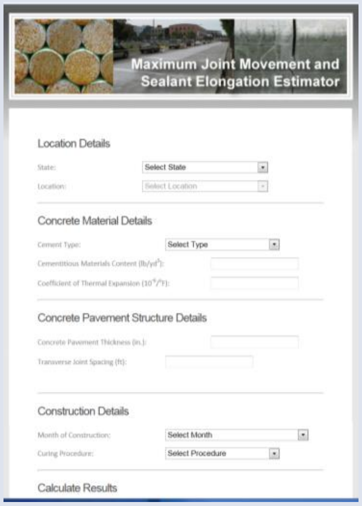

Figure 1 ACPA Joint Movement Estimator Tool

The shape factor is based on the concept that there is a preferred sealant width to depth ratio which will provide the longest sealant performance for formed in-place sealants.

The desired shape factor is a function of both the material properties and the amount of expected joint opening and closing movement. The required shape factor then determines the actual joint reservoir design for the expected environmental, pavement design, and traffic conditions.

When first implemented, it was necessary to calculate the expected joint opening movement for a particular design installation. This requires knowledge regarding the: (1) expected change in slab length, (2) subbase/slab friction resistance restraint factor, (3) slab length, (4) Concrete Coefficient of

Thermal Expansion (COTE), (5) maximum expected placement temperature minus the minimum ambient temperature, and (6) the shrinkage factor.

As evident from the six calculation inputs required above, determining the shape factor was a bit laborious. Agencies soon adopted standards based on their particular designs and conditions and standard joint designs became common place so that pavement designers did not have to conduct this evaluation for each individual project. This was beneficial because some of these inputs could only be estimated at the design stage.

Impact of the Mechanistic Empirical Design Guide on Estimating Joint Movement

With the development of the AASHTO Mechanistic Empirical Design Guide, it became possible to more accurately estimate the expected joint movement for each project design. In fact, many of the same inputs required for the pavement design can be used to estimate expected joint movement. This ties the actual pavement design to the estimated joint movement, which was not commonly done previously.

Introduction of the ACPA Joint Movement Estimator Web Tool

To capitalize on the features of the MEPDG, the ACPA developed a web based tool that enables designers to estimate transverse joint movement for a given pavement design. Figure 1 is a view of the tool which is available at http://apps.acpa.org/apps/. The tool has been developed to allow actual design and material properties as direct inputs or alternatively the user can select common properties and evaluate different possibilities. This allows a designer to effectively evaluate the maximum movements to ensure the selected sealant design will be adequate for the intended application.

Applications of the Web Based Joint Movement Estimator Tool

- To accurately estimate the expected joint movement to ensure that joint reservoir designs and selected material types can accommodate joint movements throughout the planned performance period --for both formed-in-place and compression seals.
- To evaluate the impact of high friction subbases that sometimes result in every third to fourth joint opening wider than the other joints. If this condition occurs, it may be beneficial to use an alternative joint geometry and/or sealant approach.
- To conduct forensic investigations to evaluate historical field performance so that planned performance can be compared to observed performance. This allows the efficacy of historical designs and specifications to be validated.
- To evaluate the current agency standards/material selections to see if they are consistent with the estimated movements.
- To conduct research on joint seal specifications and performance.

References:

1. K.T. Hall, et al., “Effectiveness of Sealing Transverse Contraction Joints in Concrete Pavement, FHWA, August 2008
2. Ton, E., “Factors in Joint Seal Design, “Highway Research Record No. 80, Highway Research Board, National Research Council, 1965