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570 Rock Road, Unit K
East Dundee, IL 60118

P: 847-836-6002
F: 847-836-6342

Hot Mix Asphalt Longitudinal Joint Construction

Evaluation of Methods in DuPage County

The longitudinal joints in a Hot Mix Asphalt (HMA) pavement are one of the weakest areas of the section. Typically the joints are low in density and thus are highly permeable. They are conduits to water infiltration which leads to freeze/thaw damage and pavement failure.

Since 2013, DuPage County has implemented two innovative approaches in order to combat longitudinal joint failure. The county specifies the use of echelon paving for their four-lane roads, two lanes are paved simultaneously thus eliminating a cold joint between lanes. The county also specifies the use of a joint heater when paving back on the cold center line joint. The heater increases the temperature of the existing cold joint so that it and the new hot mix can unify better during the compaction process.

During the 2016 construction season a new method of longitudinal joint construction was specified, the use of a longitudinal joint sealant (LJS). Prior to paving, this material is sprayed as an 18” wide ribbon directly under the location where the longitudinal joint will occur with the subsequent hot HMA lift. When the HMA is placed and compacted over the LJS, the material is wicked up into the fresh pavement. It will fill voids and ensure the joint is less permeable.

In order to evaluate these three methods of longitudinal joint construction, S.T.A.T.E. Testing proposed to cut a series of cores directly over the longitudinal joints. The cores would then be evaluated by both the Direct Compact Tension Test (DCT) and the Illinois Flexibility Index Test (I-FIT). These test results could help predict the potential crack resistance and durability of each type of joint as well as yield a comparison between the different methods of joint construction. The DCT test was developed to characterize the fracture behavior of an asphalt concrete material at low temperatures, thermal cracking. The testing temperature is 10 °C warmer than the PG low temperature grade of the mixture per ASTM D7313-13. For this reason the testing temperature was -12 °C (10.4 °F). The I-FIT is used to characterize the fracture behavior of an asphalt concrete material at medium temperatures, the temperatures at which reflective and fatigue cracking occur. The testing is performed at 25 °C (77 °F) per ITP-405.

For the HMA mixture type tested, a DCT value of 400 J/m² and an I-FIT value of 8.0 are considered acceptable for pavement. No test values have been established for the pavement joint. For this investigation it is more valuable to look at the comparison results between joint construction types and not focus as much on the actual test result value.

The specimens were prepped and orientated for testing as shown in Figure 1. Since we are testing for strength and durability at the joint interface, the notch was cut in such a way in order to induce cracking at that location.

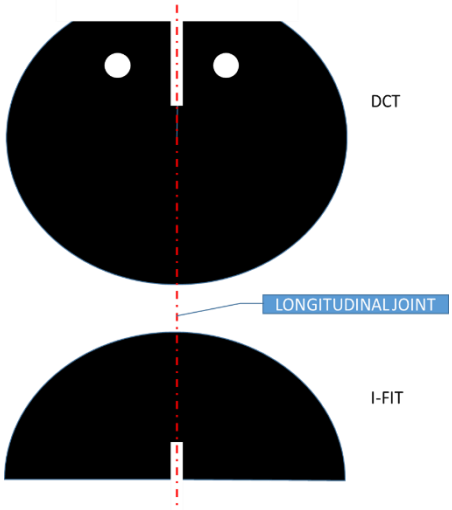

Figure 1

Asphalt Binder Grade testing was also performed on liquid AC extracted from the cores in order to:

1) Confirm that the virgin liquid grade specified was adequate to offset the oxidized recycled asphalt component from the recycled materials in the designs.
2) Investigate the effect that the LJS has on the mixture asphalt binder grade

The two roads that were chosen for testing contained all three methods of joint construction. One road each was chosen from the two contracts that were awarded in 2016. Gary Avenue from the North contract and Hobson road from the South were targeted. While the mixture type was the same on both roads, HMA Surface Mix E N70, the actual HMA designs were different. Each contract was placed by a different paving company /HMA producer.

Twelve 150 mm (5.91 in) diameter cores were taken from each road in the Winter/Spring of 2017. The cores were brought to the lab and saw cut, densities were performed, and the cores were paired and prepped for each type of test. The DCT, I-FIT, and density results are in Tables 1 and 2.

Table 1

2016 DuPage North - Gary Avenue					
Mix Type	Vir AC	Section Type	DCT (J/m^2)	I-FIT (FI)	Ave Density
N70E	SBS PG70-28	J-Band	675.5	41.0	98.9[1]
N70E	SBS PG70-28	Echelon	485.5	14.7	94.1
N70E	SBS PG70-28	Joint Heater	418.5	12.3	90.4
1 - Gmm calculated from cores					

Table 2

2016 DuPage South - Hobson Road					
Mix Type	Vir AC	Section Type	DCT (J/m^2)	I-FIT (FI)	Ave Density
N70E	SBS PG70-28	J-Band	395.5	48.5	95.7[1]
N70E	SBS PG70-28	Echelon	418.5	10.7	93.3
N70E	SBS PG70-28	Joint Heater	340.0	11.0	92.8
1 - Gmm calculated from cores					

From Gary Avenue, Table 1, the longitudinal joint built with the LJS (J-Band) yields the best results for both the DCT and I-FIT tests. The elevated DCT value from the joint containing a LJS is typical of what we've seen from past joint testing comparisons. While from Hobson Road, Table 2, the I-FIT value for the LJS (J-Band) is the highest but Echelon Paving produced the highest DCT result. The voids are better filled and compaction is higher on the LJS joints as indicated by the higher density at both placement locations. The joint heater method of constructing longitudinal joints yielded the lowest values on all testing.

After the DCT and I-FIT were performed, the test specimens were used for asphalt binder grading. The LJS (J-Band) cores were separated from the non-LJS cores and placed in an oven set at 275 °F until they became pliable. 3000 g of each core material, in two batches, were placed into an *InfraTest* Asphalt Analyzer in order to recover the asphalt binder. The recovered binder was then performance graded. Results are in Tables 3 and 4.

Table 3

2016 DuPage North - Gary Avenue				
Joint Type	Design AC Grade	Continuous Grade (Tested)	AASHTO M320 Grade (Tested)	Plan AC Grade
J Band	PG 70-28 SBS	PG 71.9-30.5	PG 70-28	PG 76-22
Non - J Band	PG 70-28 SBS	PG 76.7 - 27.8	PG 76-22	PG 76-22

Table 4

2016 DuPage South - Hobson Avenue				
Joint Type	Design AC Grade	Continuous Grade (Tested)	AASHTO M320 Grade (Tested)	Plan AC Grade
J Band	PG 70-28 SBS	PG 78.9-26.8	PG 76-22	PG 76-22
Non - J Band	PG 70-28 SBS	PG 85.7-24.2	PG 82-22	PG 76-22

The HMA designs that were used to construct the two roads were the same type of surface, N70 E, but the recycled components of each were very different. This is reflected in the resultant performance grading. Gary Avenue was paved with an N70E surface design that contained approximately 20% Asphalt Binder Replacement (ABR). It contained only a Fractionalized Recycled Asphalt Pavement (FRAP) ABR contribution. Hobson Road was also paved with an N70E surface but the design contained almost 30% ABR. This 30% ABR contained both a FRAP and a Recycled Asphalt Shingle (RAS) component. The ABR difference between the two mixes is reflected in the mixture performance grade results. The mixture used on Hobson Road, because of the increased ABR including RAS, was stiffer than the mixture used on Gary Avenue (PG 82-22 vs PG 76-22). This increase in mixture stiffness correlates with the lower DCT values from the Hobson Road cores.

The testing data suggests that the addition of the J-Band material within the core has minimal effect on the end result performance grade of the asphalt, a grade change is not the mechanism for joint durability containing LJS. A more likely conclusion could be made that the addition of the J-Band contributes to a more durable joint by partially filling the joint and adjacent mat air voids. The joint will be much less permeable and less likely to allow water infiltration.

The testing data suggests that out of the three methods of longitudinal joint construction, the joint heater method will not produce a joint that is as durable and as long lasting as LJS or echelon paving. We recommend, on future overlays, that the joint heater method of constructing longitudinal joints be eliminated and replaced by a LJS. We further recommend that echelon paving continue to be utilized whenever feasible and whenever it's not, to use the LJS in its place.