M.I.S.T.

Moisture Induced Sensitivity Testing

Application Brief

InstroTek, Inc.

Introduction:

The M.I.S.T.

The InstroTek, Inc. MIST (Moisture Induced Sensitivity Test) is designed to evaluate the resistance of an asphalt mix to stripping and moisture damage. It is designed to be an accelerated test simulating the action of traffic on wet pavement. When a tire rolls over wet pavement, the water caught between the tire and the pavement is subjected to high pressure. This forces the water into the accessible pores. When the tire rolls away from that region, the pressure is reduced and the water drains or is pulled from the pores back to the surface of the asphalt.

The System:

The InstroTek MIST replicates this condition by cyclically applying and removing high pressure from unsaturated compacted samples of hot mix asphalt (HMA). To further accelerate the potential damage to the core from this action, the test is performed at elevated temperatures, 60 °C. There are four basic components to the MIST, the hydraulic pump system, the pressure transfer system, the sample tank, and the control electronics module. The hydraulic system is capable of using standard automatic transmission fluid available from any automobile supply store. It incorporates a 5 gallon reservoir and the pump is driven by a 1 HP 115 VAC single phase motor and delivers up to 300 psi. The pressure transfer system consists of a double acting hydraulic cylinder coupled to a pneumatic cylinder each with a 6 inch stroke. A solenoid valve determines the direction of flow for the hydraulic fluid and whether the hydraulic piston is extending or retracting. The output of the pneumatic cylinder is coupled to a bladder inside the sample tank and is the pressure transfer system. The sample is placed into a cylindrical tank and rests on a platform above the bladder. A restraining plate is bolted against the top of the cylinder to keep the sample from moving during testing. An o-ring in the top rim of the tank produces a seal once the lid is bolted on. The tank is filled with water and the lid attached. Using a ball valve in the top of the lid, the water level in the tank is topped off. The system incorporates a heater in the tank which can raise the water temperature to 144 degrees Fahrenheit. Electronics and software are designed to control the system and allow the user to select the temperature, the pressure, and the number of cycles the process will take.

Description of Process:

A cylindrical asphalt sample with approximate dimensions of 6” diameter by 4” thick (150mm X 100 mm) and approximate air void percentage of 7% is prepared using a laboratory compactor. The bulk specific gravity of the sample is measured using ASTM D2726 or AASHTO T166. The pressure is set to 40 psi. The sample is placed into the testing tank of the MIST and securely fastened . The tank is filled with water; the lid is placed on the tank and heated to 60°C. The sample in the tank is stabilized to 144 °F. The total heating and stailization time is 3.5 hours. Once temperature equilibrium is achieved, the unit begins pressurizing and depressurizing the sample inside the testing tank. This is achieved by the hydraulic cylinder driving the pneumatic cylinder alternately compressing and decompressing the air contained in the cylinder and bladder.

As the pressure cycles between 0 and 40 psi, the sample voids are pressurized and depressurized. The elevated temperature of the water washing in and out of the pores not only produces a scouring action similar to that which would occur as tires pass over wet pavement, but accelerates the rate at which the action causes a compromise in the integrity of the sample and the bond between the binder and the aggregates. The application of high pressure forces the water to work its way between the asphalt and the aggregate to accelerate stripping. One of the most visible signs that the process is inducing a change in the integrity of the asphalt sample is the change in bulk specific gravity. The bulk specific gravity change shows a dependence on the number of cycles for constant temperature and maximum pressure. A "Good Mix" is shown below, note that the MTSR (MIST TSR) is the same as the AASHTO T283.

"Good Mix"

MIST Sample	Break Pressure (N)	Tensile Strength Ratio	%AV Before	%AV After	Diff %	Visual Inspection
1	27,900	91.1	7.0	7.2	0.2	None
2	28,500	99.9	7.0	7.0	0.0	None
3	28,000	98.1	7.0	7.0	0.0	None

AASHTO T283	9.5 mm surface mix	
	Conditioned Strength	26,000 N
	Unconditioned Strength (DRY)	28,530 N
	TSR	91.1
	Visual Inspection	None

The samples shown below are from a mix that within 3 weeks failed in the field, but indicated a passing TSR. When the same samples were subjected to conditioning in the MIST, it is notable that the samples show a range of values in the MSTR and changes in specific gravity. However, there were two cases of the same mix that showed a significant decrease in the density. In addition, all four samples showed severe stripping when visually inspected. AASHTO T-283 however indicated that the mix was good and resistant to moisture damage.

Mix failed after 3 weeks

MIST Sample	Break Pressure (N)	Tensile Strength Ratio	%AV Before	%AV After	Diff %	Visual Inspection
1	15,600	84.3	6.6	9.8	3.2	Severe
2	14,500	78.3	6.6	8.5	1.9	Severe
3	17,200	93.0	5.8	6.2	0.4	Severe
4	17,250	93.2	4.8	5.3	0.5	Severe

AASHTO T283	9.5 mm surface mix	
	Conditioned Strength	17,900 N
	Unconditioned Strength (DRY)	18,500 N
	TSR	96.8
	Visual Inspection	Moderate

Conclusion:

Results so far indicate that InstroTek MIST appears to apply a conditioning to the asphalt samples that is more representative of the conditioning occurring in the field. An indicator of the failure of an asphalt mix is the change in specific gravity of the samples after conditioning. This change in specific gravity (opening of weak samples and creating larger volume determination) along with the MTSR will lead to a better predictor of whether a mix design will be susceptible to moisture damage and stripping in the field

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