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NYSDOT Waterproof HMA Mix Verification

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16. Abstract

The New York State Department of Transportation (NYSDOT) is currently using Waterproofing Hot Mix Asphalt (HMA) to overlay their concrete bridge deck systems. The waterproofing characteristics of the mix provide a protective coating on the concrete bridge deck to protect it from future exposure to environmental conditions, along with de-icing chemicals. However, due to the movements associated with the bridge deck, this thin layer is highly susceptible to fatigue cracking.

In an effort to ensure the NYSDOT is "getting what they are paying for", the NYSDOT's Waterproof HMA specification includes performance testing to verify the HMA mixture is indeed fatigue cracking resistant and waterproof. To verify for fatigue cracking, the mixture is evaluated using the Flexural Beam Fatigue test (AASHTO T321). Meanwhile, waterproof verification is done by testing compacted samples in the flexible-wall permeameter (ASTM D5084).

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Introduction

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In an effort to ensure the NYSDOT is "getting what they are paying for", the NYSDOT's Waterproof HMA specification includes performance testing to verify the HMA mixture is indeed fatigue cracking resistant and waterproof. To verify for fatigue cracking, the mixture is evaluated using the Flexural Beam Fatigue test (AASHTO T321). Meanwhile, waterproof verification is done by testing compacted samples in the flexible-wall permeameter (ASTM D5084).

Flexural Beam Fatigue Test Results

Flexural Beam Fatigue samples were tested at a test temperature of 20^{o}C. The test specimens were tested until the specimen's flexural strength reached approximately 50% of its initial flexural stiffness. The methodology outlined in AASHTO T321 was used to determine the number of loading cycles to fatigue failure (N_f). A loading frequency of 10 Hz was used at a tensile strain level of 750 micro-strains, as specified in the NYSDOT Waterproof HMA specification, found in the Appendix of this report.

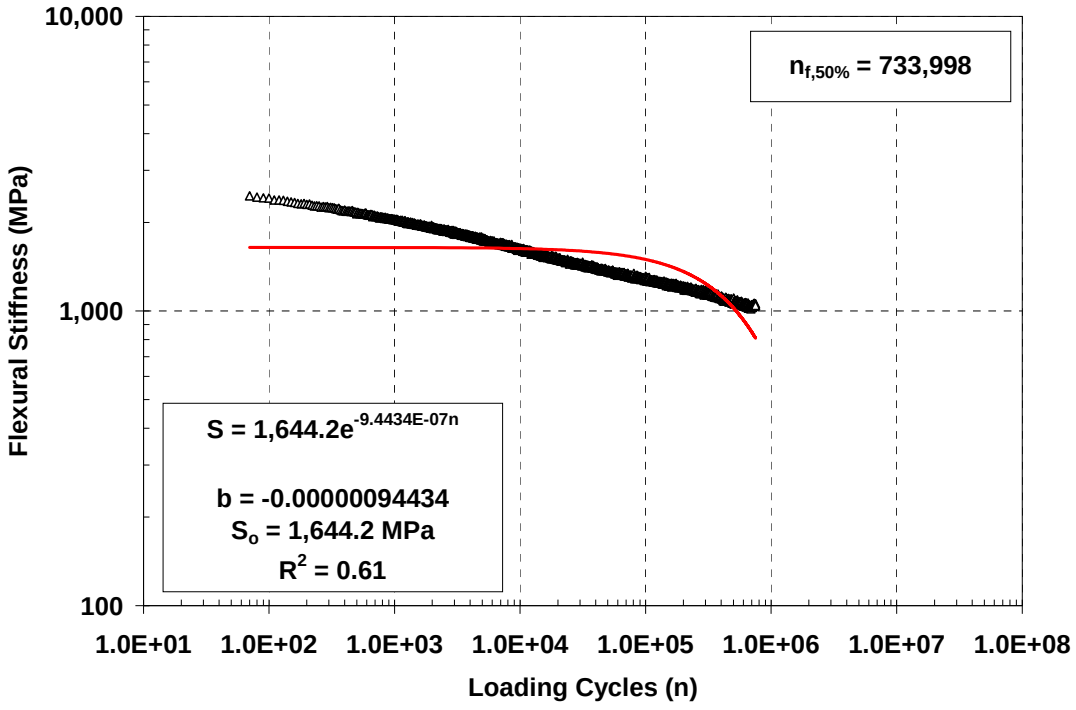
Throughout the test, the flexural stiffness of the samples was calculated and recorded. The stiffness of the beams was plotted against the load cycles and the resulting data was fitted to an exponential function as follows (AASHTO T321):

$$S = S_O e^{bN} \qquad (1)$$

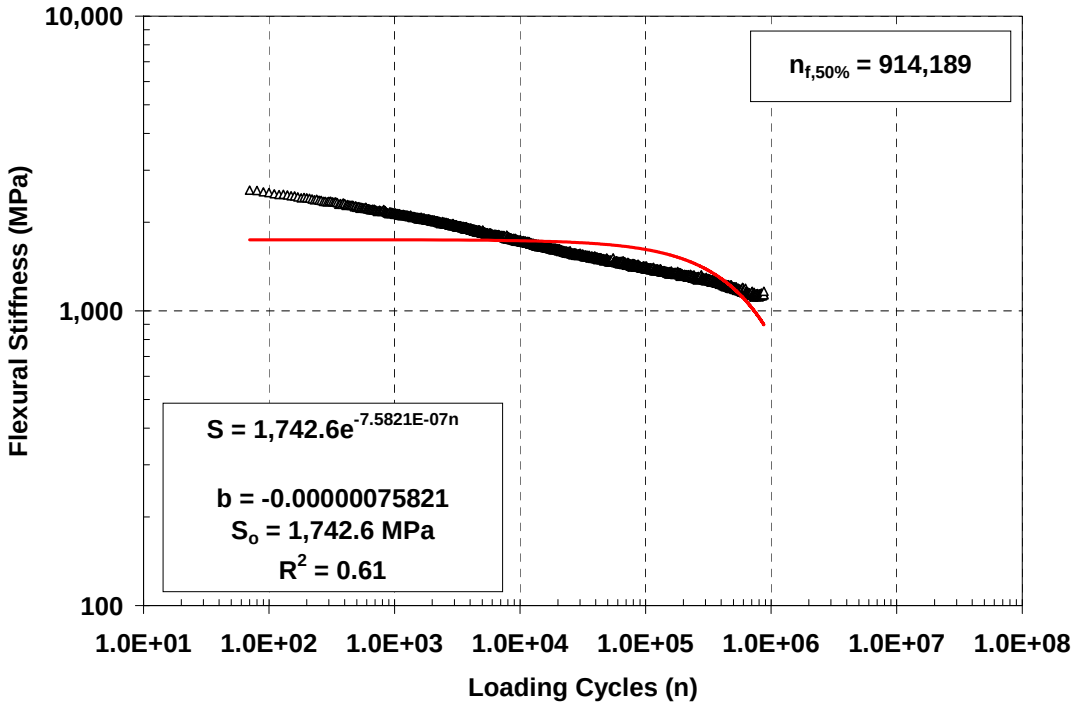
where,

S = flexural stiffness after the n load cycles;
S_O= initial flexural stiffness;
e = natural algorithm to the base e
b = constant from regression analysis
N = number of load cycles

The test results of the Flexural Beam Fatigue testing are shown in Figures 1 a) and b). The test results show hot mix asphalt mixture supplied by Willets Point Asphalt surpasses the NYSDOT required fatigue life of 250,000 cycles.



(a)



(b)

Figures 2a and b – Flexural Beam Fatigue Test Results for NYSDOT Waterproofing HMA Design Submitted by Willets Point Asphalt

Flexible-Wall Permeability Testing (ASTM D5084)

Flexible-wall permeability testing (ASTM D5084) was conducted on laboratory compacted and cored test specimens to evaluate the permeability of the asphalt mixture meet the requirements of the NYSDOT Waterproof HMA specifications (< 10^{-7} m/sec). The test data and results of the flexible-wall permeability testing are shown in Figure 2. The test results clearly show that the volumetrics (air voids, asphalt content) of the asphalt mixture provides a final HMA mixture with a permeability of 2.54 x 10^{-9} m/sec.

Hydraulic Conductivity Test - Flexi-wall
ASTM D5084

Project: NYSDOT Waterproofing HMA Client: Willets Point Asphalt

Sample Identification: Willets Point Waterproof HMA #1
Sample Description (Visual): Laboratory Compacted HMA Sample

Test Method: ASTM D5084 Constant Head
Permeant Type: Distilled Water
Special Conditions: Vaseline applied on sides of sample to limit side-wall leakage

Sample Dimensions	
Length (cm)	7.70
Diameter (cm)	6.78
Compacted AV (%)	3.4

Test Parameters

Cell Pressure (psi):	102.3	Sat. Back Pressure (psi):	79.8	Hydraulic Gradient:	21.01
Influent Pressure (psi):	74.5	Effluent Pressure (psi):	72.2	Degree of Saturation:	N.A.

Final Hydraulic Conductivity (corrected to 20°C)
5.24E-07 cm/sec
5.24E-09 m/sec

Figure 2 – Results of Flexible Wall Permeability Test (ASTM D5084)

APPENDIX A – NYSDOT Waterproof HMA Mixture Performance Requirements

Table 1 – Waterproofing HMA Design Gradations

Standard Sieves (mm)	Percent Passing Criteria	
	Maximum	Minimum
12.5		100
9.5	100	80
4.75	76	50
2.36	54	37
1.18	40	26
0.600	29	17
0.300	21	10
0.150	16	5
0.075	8	2

Table 2 – Waterproofing HMA Volumetric Design Criteria

% Air Voids at N_{design}	% Voids in the Mineral Aggregate, minimum
≤ 1.5	15.5

Table 3 – Waterproofing HMA Design Number of Gyrations

Compactive Effort	N_{design}
Number of Gyrations*	50

* - Aggregate Consensus Properties must still meet the requirements based on project ESAL level as outlined in Materials Method 5.16. The project ESAL level will be specified in the contract documents.

Table 4 – Waterproofing HMA Production Gradation Tolerances

Sieve Size (mm)	12.5	9.5	4.75	2.36	1.18	0.600	0.300	0.150	0.075
Tolerance	---	± 6	± 6	± 5	± 4	± 4	± 3	± 2	± 1.5

Table 5 – Waterproofing HMA Additional Mixture Design Criteria

Permeability (ASTM D5084) 4.0% ± 1.0% Air Voids	10^{-7} m/s minimum
Flexural Beam Fatigue (AASHTO T321) @ 750 microstrains, 10 Hz, 4.0% ± 1.0% Air Voids	250,000 cycles minimum (average of two samples)