

Ardaman & Associates, Inc.

Geotechnical, Environmental and
Materials Consultants

February 12, 2015
File Number 14-13-0133

PENETRON USA, Inc.
45 Research Way, Suite 203
Setauket, NY 11733

Attention: Jeremy J. Swartzfager, Sales Representative

Subject: ASTM Standard D5084 Permeability Tests on Treated and Untreated Concrete

Gentlemen:

As requested, permeability tests have been completed on two 4-inch diameter by 8-inch long field molded cylindrical concrete samples provided by your firm. The samples were received November 18, 2014 and were labeled: CF-1 AMEC Untreated Plant Test and CF-2 AMEC Treated Field Test. The samples were collected by AMEC from the S150 South Florida Water Management District Culvert replacement project from mixes made on October 24, 2014 (see attached AMEC field sample logs).

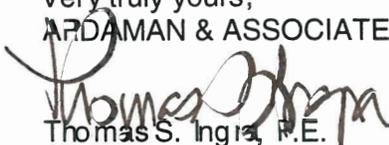
Permeability tests were performed in general accordance with ASTM Standard D5084 "Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter" using both the constant rate of flow test method (Method D) and the constant head test method (Method A). The permeability test results are presented on the attached Hydraulic Conductivity Test Reports with values of hydraulic conductivity shown for selected flow durations. Hydraulic conductivity versus time is plotted on the attached figure.

- Untreated Sample: The untreated concrete sample displayed a hydraulic conductivity at the end of the 14 day test period, corresponding to a sample age of 40 days, of 2.1×10^{-9} cm/sec.
- Treated Sample: The treated concrete sample displayed a hydraulic conductivity at the end of the initial 3 day test period, corresponding to a sample age of 29 days, of 4.5×10^{-11} cm/sec. After an additional 15 days of curing within the permeameter and then one day of permeation, corresponding to a sample age of 45 days, the untreated sample displayed a hydraulic conductivity of 3.1×10^{-11} cm/sec. The measured hydraulic conductivity of the treated sample, at similar ages of 40 to 45 days, was 68 times less than the measured hydraulic conductivity of the untreated sample.

The test samples were reported to be from the client-specified designations herein. The test results are indicative of only the specimens that were actually tested. The test results presented are based upon accepted industry practice as well as the test method(s) listed. Ardaman & Associates, Inc. neither accepts responsibility for, nor makes claims to the final use and purpose of the test results.

Please contact us if you have any questions about the test results or require additional information.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.


Thomas S. Ingraham, P.E.
Laboratory Director
Florida License No. 31987

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY CONCRETE CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: PENETRON USA, Inc. INCOMING LABORATORY SAMPLE NO.: CF-1 AMEC UNTREATED PLANT TEST
 PROJECT: Comparison Testing LABORATORY IDENTIFICATION NO.: 140133/Untreated
 FILE NO.: 14-13-0133 SAMPLE DESCRIPTION: Concrete
 DATE SAMPLE RECEIVED: 11/18/14 SET UP: 11/19/14 DATE POURED: 10/24/14 AGE WHEN TESTED: 26 Days
 DATE REPORTED: 01/19/15 REVISED: 02/12/15

ASTM D5084 TEST METHOD:
 A - Constant Head
 B - Falling Head; Constant Tailwater
 C - Falling Head; Rising Tailwater
 D - Constant Rate of Flow
 F - Constant Volume; Falling Head - Rising Tailwater

PERMEANT: Deaired Tap Water Other _____
 G_s: 2.70 Assumed Measured
 B-factor: 80 % Beginning of Test; End of Test
 Δσ_c (lb/in²): 9

SPECIMEN PREPARATION	
Type	Diameter (inch)
<input type="checkbox"/> Undisturbed Sample	Diameter Trimmed <input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Drive Cylinder	<input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Rock Core	<input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Compacted	<input type="checkbox"/> Tamped Uniform Lifts: No. of Lifts _____
	<input type="checkbox"/> Kneading: No. of Lifts _____ Spring _____ lb.
<input checked="" type="checkbox"/> Other	4" Diameter by 8" Long Field Molded Cylinders

Initial Conditions				Test Conditions				Final Conditions				Hydraulic Conductivity										
H (cm)	D (cm)	V _o (cm ³)	WDS (grams)	w _c (%)	Y _d (lb/ft ³)	S (%)	Date Permeation Started	Test Method	Cell	Inflow	Outflow	i _{avg} (cm ³)	ΣQ (cm ³)	Σt _r (hours)	H (cm)	ΔV/V _o (%)	w _c (%)	Y _d (lb/ft ³)	S (%)	k ₂₀ (cm/sec)		
17.33	10.27	1,436.2	3,084.6	7.4	134.1	78	11/25/14	A	190	169.5	150.0	80	3.5	28.6							4.1x10 ⁻⁹	
									190	168.9	150.0	77	7.1	94.6								2.9x10 ⁻⁹
									190	170.7	150.0	84	9.4	143.3								2.3x10 ⁻⁹
							12/01/14	D	190	169.0	148.2	84	10.3	161.0								2.2x10 ⁻⁹
							12/03/14	A	190	161.5	144.2	70	11.0	185.4								1.7x10 ⁻⁹
									190	169.2	148.2	85	11.1	188.0	17.33	0.0	9.0	134.1	94			2.1x10 ⁻⁹

COMMENTS: Sample maintained at as-received diameter. Ends trimmed square and to length. Back-pressure saturation was started on the sample 26 days after it had been molded, permeation was started 6 days later (32 days) and terminated after 8 days of flow (40 days).

The test data and all associated project information presented hereon shall be held in confidence and disclosed to other parties only with the authorization of the Client. Physical and electronic records of each project are kept for a minimum of 7 years. Test samples are kept in storage for at least 10 working days after mailing of the test report, prior to being discarded, unless a longer storage period is requested in writing and accepted by Ardaman & Associates, Inc.

Where: H = Specimen height; D = Specimen diameter; V_o = Initial volume; WDS = Dry mass; w_c = Water content (ASTM D2216); Y_d = Dry density; S = Saturation; i_{avg} = Average hydraulic gradient; ΣQ = Cumulative flow volume; Σt_r = Cumulative flow duration; ΔV/V_o = Volume change ("- " denotes consolidation, "+" denotes swelling); k₂₀ = Saturated hydraulic conductivity at 20°C; and G_s = Specific gravity.

Checked By: TM Date: 02/12/15

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY CONCRETE CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: PENETRON USA, Inc.
 PROJECT: Comparison Testing
 FILE NO.: 14-13-0133
 DATE SAMPLE RECEIVED: 11/18/14 SET UP: 11/19/14
 DATE REPORTED: 01/19/15 REVISED: 02/12/15

INCOMING LABORATORY SAMPLE NO.: CF-2 AMEC TREATED FIELD TEST
 LABORATORY IDENTIFICATION NO.: 140133/Treated
 SAMPLE DESCRIPTION: Concrete
 DATE POURED: 10/24/14 AGE WHEN TESTED: 26 Days

ASTM D5084 TEST METHOD:
 A - Constant Head
 B - Falling Head; Constant Tailwater
 C - Falling Head; Rising Tailwater
 D - Constant Rate of Flow
 F - Constant Volume; Falling Head - Rising Tailwater

PERMEANT: Deaired Tap Water Other _____
 G_s: 2.70 Assumed Measured
 B-factor: 90 % Beginning of Test; End of Test
 $\Delta\sigma_c$ (lb/in²): 9

SPECIMEN PREPARATION

Type	Diameter (inch)	Diameter Trimmed
<input type="checkbox"/> Undisturbed Sample		<input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Drive Cylinder		<input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Rock Core		<input type="checkbox"/> Yes <input type="checkbox"/> No

Compacted Tamped Uniform Lifts: No. of Lifts _____
 Kneading: No. of Lifts _____ Spring _____ lb.
 Other 4" Diameter by 8" Long Field Molded Cylinders

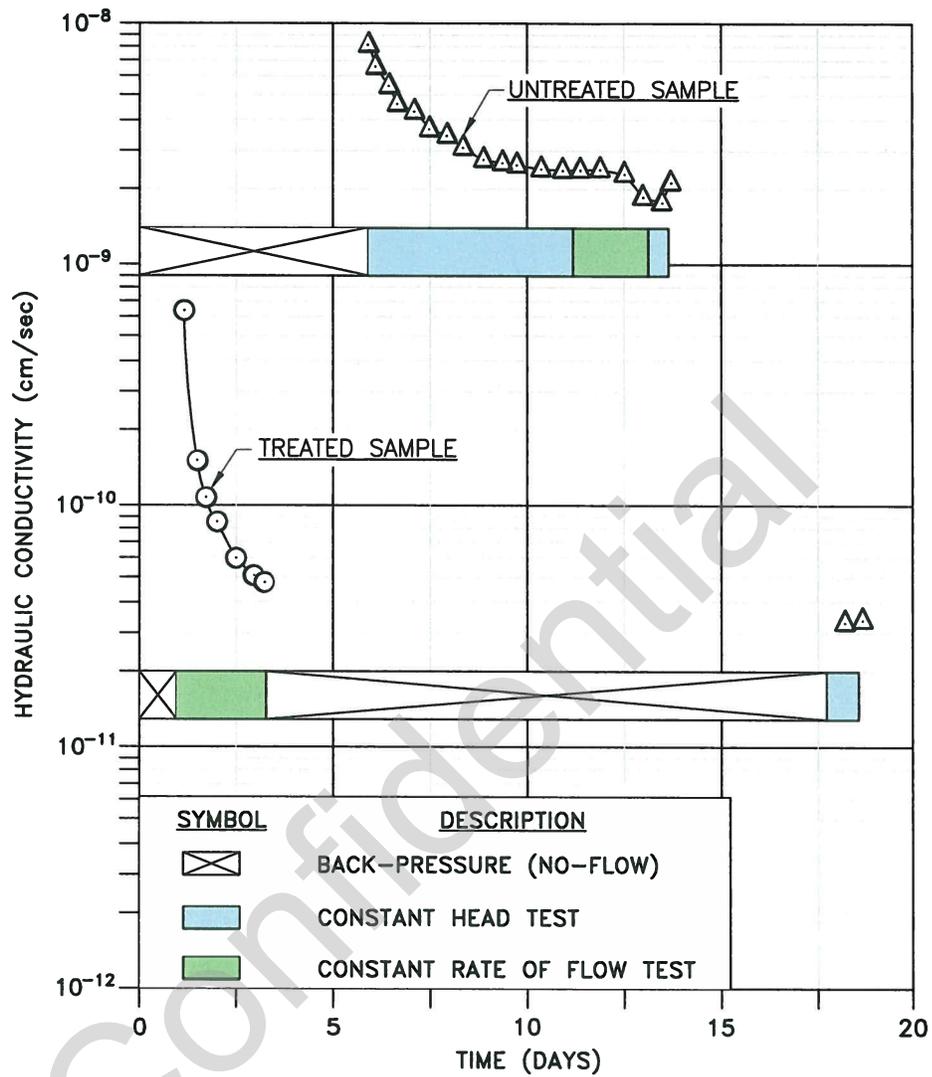
Initial Conditions				Test Conditions				Final Conditions				Hydraulic Conductivity k ₂₀ (cm/sec)										
H (cm)	D (cm)	V ₀ (cm ³)	WDS (grams)	w _c (%)	Y _d (lb/ft ³)	S (%)	Date Permeation Started	Test Method	Cell	Inflow	Outflow		i _{avg} (cm ³)	ΣQ (cm ³)	Σt _t (hours)	H (cm)	ΔV/V ₀ (%)	w _c (%)	Y _d (lb/ft ³)	S (%)		
17.32	10.27	1,434.7	3,016.8	9.2	131.3	87	11/20/14	D	600	568.0	275.9	1,186	0.71	23.7							8.6x10-11	
									600	593.4	33.7	2,273	1.71	56.9								4.5x10-11
							12/07/14	A	190	171.0	99.0	292	1.76	78.3	17.32	0.0	9.7	131.3	93		3.1x10-11	

COMMENTS: Sample maintained at as-received diameter. Ends trimmed square and to length. Back-pressure saturation was started on the sample 26 days after it had been molded, permeation was started 1 day later (27 days) and terminated after about 2 days of flow (29 days). The sample was maintained in the permeameter under backpressure for 15 days, and the hydraulic conductivity measured again using the constant head test method over a period of 1 day (45 days).

The test data and all associated project information presented hereon shall be held in confidence and disclosed to other parties only with the authorization of the Client. Physical and electronic records of each project are kept for a minimum of 7 years. Test samples are kept in storage for at least 10 working days after mailing of the test report, prior to being discarded, unless a longer storage period is requested in writing and accepted by Ardaman & Associates, Inc.

Where: H = Specimen height; D = Specimen diameter; V₀ = Initial volume; WDS = Dry mass; w_c = Water content (ASTM D2216); Y_d = Dry density; S = Saturation; i_{avg} = Average hydraulic gradient; ΣQ = Cumulative flow volume; Σt_t = Cumulative flow duration; ΔV/V₀ = Volume change ("+" denotes consolidation, "-" denotes swelling); k₂₀ = Saturated hydraulic conductivity at 20°C; and G_s = Specific gravity.

Checked By: M Date: 02/12/15



HYDRAULIC CONDUCTIVITY VS. TIME ON TREATED AND UNTREATED CONCRETE



CLIENT: _____
 PROJECT: _____
 CONTRACTOR: _____

PROJ. NUMBER: _____
 LAB. NUMBER: 104017
 MIX STRENGTH: _____ DESIGN STRENGTH: 5000

GENERAL INFORMATION AND SAMPLING DATA

DATE SAMPLED: 10/24/14
 SAMPLED BY: Humberto Noranjo
 NO. OF CYLINDERS MOLDED: 3(4 X 8)
 DATE CYLINDERS RECEIVED: _____
 EXTRA WATER ADDED AT JOB SITE? YES ___ NO ___
 IF YES, _____ GALLONS TO _____ C. Y.
 EXTRA WATER AUTHORIZED BY: _____
 DELIVERY TICKET NUMBER: 5
 APPROVED MIX: YES ___ NO ___
 DRUM ROTATIONS: _____
 SAMPLED FROM: CHUTE _____ HOPPER _____

SPEC. MIN. COMP. STRENGTH _____ PSI @ DAYS
 MIX IDENTIFICATION NO: _____
 MIX DESCRIPTION: 5000 Red 3B WC-505g NRWR
 MIX TYPE: NORMAL WT. X LIGHTWEIGHT _____
 CONCRETE SUPPLIER: Supermix
 TIME CONCRETE BATCHED: _____
 TIME SAMPLED: _____
 SIZE OF LOAD:/SAMPLED AT: _____ C. Y.
 TRUCK ARRIVAL TIME: _____ FINISH TIME: _____
 TRUCK NUMBER: 3461
 DISCHARGE HOSE _____ OTHER _____

DESCRIPTION AND LOCATION OF CONCRETE PLACEMENT: _____

100-6/08

D 5043 UNTREATED

FIELD AND LABORATORY TEST DATA

PROPERTIES OF FRESH CONCRETE					CURING SCHEDULE FOR STRENGTH SPECIMENS		
M&TE EQUIP.	PARAMETER	TEST METHOD	FIELD DATA	SPEC. REQ.	CURING METHOD	INITIAL 18-24 Hrs.	FINAL
	Air Temp (F)	C1067/	<u>74</u>		ASTM C 31/ Field Conditions: Other: (see remarks)	_____	_____
	Concrete Temp (F)	C1067/	<u>81</u>			_____	_____
	Slump (in.)	C143/	<u>8"</u>			_____	_____
	Air Content (%)-Vol	C173/				_____	_____
	Air Content (%)-Pres	C231/				_____	_____
	Plastic Unit Wt. (pcf)	C138/				_____	_____

COMPRESSIVE STRENGTH RESULTS C39/ M&TE: _____
 END PREPARATION: Sulfur Caps _____ Pad Caps _____ (Durometer _____) Plain _____ CURING METHOD: Tank _____ Moisture Rm _____

Specimen No.	Test Date	Age (days)	Diameter (in.)	Area (in ²)	Maximum Load (lbs.)	Compressive Strength (psi.)	Fracture Type	Tester	Reviewer

REMARKS

REC'D

NOV 18 2014

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ORLANDO



CLIENT: _____ PROJ. NUMBER: _____
 PROJECT: _____ LAB. NUMBER: 104017
 CONTRACTOR: _____ MIX STRENGTH: _____ DESIGN STRENGTH: 5000

GENERAL INFORMATION AND SAMPLING DATA

DATE SAMPLED: 10/24/14 SPEC. MIN. COMP. STRENGTH _____ PSI @ DAYS _____
 SAMPLED BY: Humberto Naranjo MIX IDENTIFICATION NO: _____
 NO. OF CYLINDERS MOLDED: 3 (4 x 8") MIX DESCRIPTION: 5000 Pcc 3B WC-50Sg NRM
 DATE CYLINDERS RECEIVED: _____ MIX TYPE: NORMAL WT. X LIGHTWEIGHT _____
 EXTRA WATER ADDED AT JOB SITE? YES ___ NO ___ CONCRETE SUPPLIER: Supermix
 IF YES, _____ GALLONS TO _____ C. Y. TIME CONCRETE BATCHED: 7:10
 EXTRA WATER AUTHORIZED BY: _____ TIME SAMPLED: 7:30
 DELIVERY TICKET NUMBER: 5 SIZE OF LOAD: /SAMPLED AT: 10/3 C. Y. _____
 APPROVED MIX: YES X NO _____ TRUCK ARRIVAL TIME: 7:25 FINISH TIME: 8:20
 DRUM ROTATIONS: 186 TRUCK NUMBER: 3461
 SAMPLED FROM: CHUTE X HOPPER _____ DISCHARGE HOSE _____ OTHER _____
 DESCRIPTION AND LOCATION OF CONCRETE PLACEMENT: _____

100-6/08

D 5048 TREATED

FIELD AND LABORATORY TEST DATA

PROPERTIES OF FRESH CONCRETE					CURING SCHEDULE FOR STRENGTH SPECIMENS		
M&TE EQUIP.	PARAMETER	TEST METHOD	FIELD DATA	SPEC. REQ.	CURING METHOD	INITIAL 18-24 Hrs.	FINAL
	Air Temp (F)	C1067/	<u>75</u>		ASTM C 31/		
	Concrete Temp (F)	C1067/	<u>82</u>				
	Slump (in.)	C143/	<u>7"</u>		Field Conditions:		
	Air Content (%)-Vol	C173/			Other: (see remarks)		
	Air Content (%)-Pres	C231/					
	Plastic Unit Wt. (pcf)	C138/					

END PREPARATION: Sulfur Caps _____ Pad Caps _____ (Durometer _____) Plain _____ CURING METHOD: Tank _____ Moisture Rm _____
 COMPRESSIVE STRENGTH RESULTS C39/ M&TE: _____

Specimen No.	Test Date	Age (days)	Diameter (in.)	Area (in ²)	Maximum Load (lbs.)	Compressive Strength (psi.)	Fracture Type	Tester	Reviewer

REMARKS

REC'D
NOV 18 2014
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