

Pervious Concrete- 2016 State of the Practice

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ASTM Standards for Pervious

- ❖ C-1688 – Fresh Unit Weight
- ❖ C-1701 – Hardened Infiltration
- ❖ C-1747 – Raveling Potential
- ❖ C-1754 - Hardened Density and Voids

ASTM C 1688

- ❖ Closest thing to a 'slump test' for pervious – used to check the ready mix producer's consistency
- ❖ Also provides important information to the installer and the testing lab or owner
- ❖ Current range of +/- 5 pounds per cubic foot may be too broad (my opinion)
- ❖ Voids and density will vary based on local materials, application requirements and installer's method of placement.

ASTM C-1701

- ❖ Used to check infiltration rates of hardened pervious
- ❖ May now be used for acceptance – specify as a minimum
- ❖ Results for individual test vary – look at averages.
- ❖ Useful for determining loss of infiltration rate over time – if test is run immediately after placement and before service to set a baseline
- ❖ Use to determine when cleaning or other maintenance is needed



ASTM C-1747

- ❖ More important than compressive strength for pervious (my opinion...)
- ❖ Samples are molded per the standard and then tumbled (LA Abrasion) 500 cycles (no steel shot)
- ❖ Mass loss is measured – lower loss should mean tougher, more durable pervious.
- ❖ Results under 40% mass loss appear to represent good pervious mixes.
- ❖ Not intended for use with cores

ASTM C-1754

- ❖ For HARDENED density and voids
- ❖ Requires coring – tests are run on cores taken from field installation
- ❖ Two drying methods are allowed in the standard – they will produce different results. Can't compare results between the two drying methods.

ACI 522.1-13

- ❖ Reference Specification for Pervious Concrete
- ❖ Specifiers may add additional requirements – suggest inclusion of the following:
 - ❖ Baseline infiltration testing using C-1701
 - ❖ Determination of hardened density to use C-1754
 - ❖ Consider use of C-1747 for mix design submittals
- ❖ ENFORCE requirements for certified installers AND testing personnel

Modern Pervious Placement

- ❖ REQUIRE certified installers, per ACI 522.1-13
- ❖ Most pervious today placed with single roller screeds and should produce good, consistent results.
- ❖ Better techniques are being developed to increase compaction without sealing the pavement
 - ❖ BUT they require skilled installers and good mix designs!

Contractor Certification

- ❖ Pervious Concrete Installer Certification developed by the National Ready Mixed Concrete Association
- ❖ Three levels of certification:
 - ❖ Technician – pass written exam. Required for field testing technicians. NOT sufficient for Installer personnel
 - ❖ Installer – pass written and performance exam, plus meet minimum experience qualifications. Three Installers required on every pervious placement to meet ACI 522.1-13
 - ❖ Craftsman – All of the above, plus 1500 hours of direct pervious experience. (Still very rare – about 45 in US)





Modern Pervious Mixes

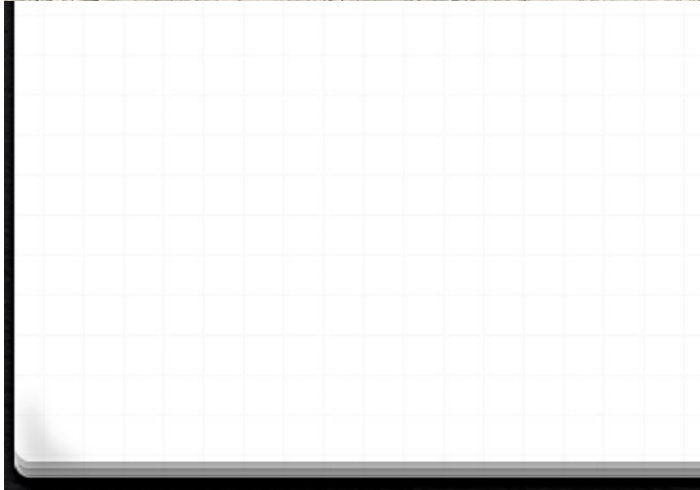
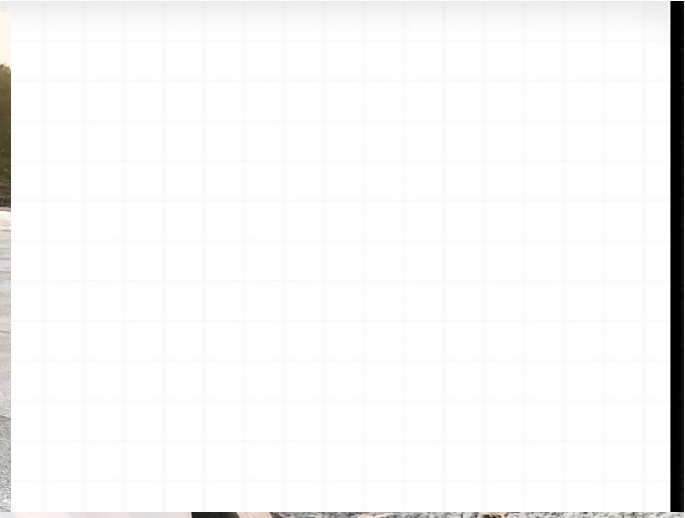
- ❖ Easier to place and harder to mess up
 - ❖ CAUTION: Still a lot of “old” mix designs floating around
- ❖ Cementitious contents are trending lower and w/c ratios are trending higher – both good things!
- ❖ NEVER specify cement content or require minimum cement contents!
- ❖ ALWAYS require ready mix producer to submit C 1688 information (density and voids) and consider C 1747 test results

Pervious Wet Voids



Modern Pervious Mix





It's NOT 1-size Fits All...



Results From the Field

Murfreesboro Ready Mix Plant Installation

- Preliminary Results
- Infiltration Results

Murfreesboro (TN) 2016 Field Study

49 Test Loads	UW Hard	Hard Void		C1688	NONE!	C1747	C1701
	C1754	C1754		Unit Weight	PSI	Mass R	Infiltration
			min	115.16	1155.50	58.00	469.82
			max	134.37	3314.50	86.00	2839.64
			range	19.21	2159.00	28.00	2369.82
(7 Tests)	113.7953541	27.49	mean	124.53	2056.69	72.28	1583.95
			median	123.39	1959.25	71.50	1594.25
			std. dev.	4.24	479.27	5.75	578.01
			%std. dev.	3.4%	23.3%	8.0%	36.5%

Adding 20# of OPC

<u>Formula</u>	<u>comp. strength</u>	<u>28d abrasion mass kept</u>	<u>infiltration</u>
A2	2724	86	
C10 (+20 OPC)	2712.5	76	1573
C11 (+20 OPC)	2302	72	2258
C12 (+20 OPC)	2256.5	70	1697
C13 (+20 OPC)	2680.5	67	N/T
C17 (+20 OPC)	2966.5	74	N/T
Averages	2584	72	1843

Adding 125# Sand

<u>Formula</u>	<u>comp. strength</u>	<u>28d abrasion mass kept</u>	<u>infiltration</u>
A2	2724	86	
C14 (+125 sand)	2551.5	80	2116
C15 (+125 sand)	2902	72	2840
C16 (+125 sand)	2376.5	81	N/T
C18 (+125 sand)	2261	67	N/T
Averages	2523	75	2478

Does it Need Maintenance?



Absolutely!



Can it be Cleaned?



Absolutely!





NRMCA Maintenance & Operations Guide



First Steps

- ❖ Designs should be checked to see if they are maintenance-friendly
- ❖ Assure/Verify a quality installation, including soil characteristics, gravel layer, and pervious
- ❖ Require certified installers and REQUIRE initial infiltration testing (C1701)
- ❖ Provide owner with Maintenance/Operations Guide

Next (Three) Steps

Step One: Routine Maintenance

- ❖ Periodic Visual Inspection
- ❖ Leaf blower or similar as needed
- ❖ Sweeping (for entire lot) as needed
- ❖ Spot maintenance – more intensive as needed to prevent more severe clogging



Next (Three) Steps

Step Two: Periodic Maintenance

- ◆ Often PRIOR to onset of winter, always when routine maintenance isn't enough
- ◆ Should start with sweeping or dry vacuum process – get all loose material off. Measure (weigh) if possible.
- ◆ May require pressure wash and vacuum at same time

Next (Three) Steps

Step Three: Deep Cleaning

- ◆ When infiltration rate drops by more than 25%, or under 100 inches per hour.
- ◆ Will require simultaneous application of pressurized water and significant vacuum – specialized equipment.





Results From the Field

- 0 Franklin Eastern Flank Infiltration Testing
- 0 Pervious Field Inspection Report

Franklin (TN) Parking Lot

Estimated Pounds Removed:	843
Primary Filter Bag	169
Dry Vacuum Removal:	280
Total Pounds Removed:	1292

Over $\frac{1}{4}$ # of sediment per SF

Franklin (TN) Parking Lot

Average Infiltration Before:	18	Inches/HR
Average Infiltration After:	196	Inches/HR

Winter Time Notes

- ❖ 1st winter is more critical – same as for conventional concrete
- ❖ De-icing chemicals NOT recommended. Research ongoing for admixtures to impart better chemical resistance
- ❖ Calcium treated sand (after 1st winter) or plain COARSE sand may be used – pavement must be vacuumed at end of winter
- ❖ Plow with caution

Questions?



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