PERVIOUS CONCRETE
Making the Impossible Possible

Construction of the I-81 Exit 140 Park-n-Ride in Salem, VA
Exit 140 Park-n-Ride location
The Impossible

- Existing Exit 140 Park-n-Ride surrounded by two secondaries, a primary and the interstate
- Already over crowded
- <100 parking spaces
- No room for expansion
The Possible

- **Exit 140 Park-n-Ride**
  - Pervious Concrete
    - Approx. 250 spaces
    - Approx. 2.5 acres
- **Exit 118 Park-n-Ride**
  - Conventional Asphalt
    - Approx. 250 spaces
    - Approx. 4 acres
Why Pervious Concrete?
Pervious Concrete Acceptance Criteria

- Infiltration Rate (ASTM C 1701)
  - Greater than 100 inches per hour (industry minimum)
- Hardened Density and Void Content (ASTM C 1754)
  - Density: +/- 5 pcf of Approved Mix Design
  - Voids: +/- 4% of Approved Mix Design
- Core Length (ASTM C 174)
  - -3/8 in. to + 1.5 in. of Design Thickness
- Average Compressive Strength at 28 days (ASTM C 39)
  - Greater than 2,000 psi
Infiltration Rate Test

- ASTM C 1747
- Infiltration Rate was never a problem as the minimum 100 in./hr. established for the project was easily attained and may have actually been too high on occasion as some measured values exceeded 1,000 in./hr.
Evaluation of Cores for Strength, Hardened Density and Voids

- Cores were taken to evaluate the strength, in-place density, void content and thickness of the pervious concrete.
- In-place density and voids were a challenge throughout the project. There was a slight variation between the density and voids measured using ASTM C 1754 Method A versus Method B. Method A (slow drying) was generally used for the project as the ASTM recognizes that Method B (fast drying) may produce lower density and higher void content.
- Strength (min. 2,000 psi) was generally achieved on average after 28-days of field curing. Cores checked for density and voids by use of Method A (slow drying) can be used for strength testing; however, we found 30% reduction in strength for oven dried cores vs. field cured.
Test Slab

• Forms on No. 57 Stone
• 14 ft x 19 ft w/ joint to test joint rolling, resulting in 12.5 ft x 19 ft slab for shrinkage crack evaluation
• Tried three variations of cross-rolling
  • No Weight
  • One Plate Weight – 35 lbs
  • Two Plate ‘Weights – 70 lbs
Test Slab

- Concrete Placement
- Motorized Screed
- Cross-Rollers
Test Slab

- “Pizza Cutter” for Joints
- 0.5-inch strips were placed on forms for initial screed pass and then removed for weighted rolling
- Variations in weight of cross-roller did not make an impact on density
Test Slab Results

- **Fresh Density and Void Content (ASTM C 1688)**
  - Density: 128.4 pcf : 125 pcf to 140 pcf  **PASS**
  - Voids: 19.6% : 15% to 25%  **PASS**

- **Infiltration Rate (ASTM C 1701)**
  - Average = 343 in/hr. : Greater than 100 inches per hour  **PASS**

- **Hardened Density and Void Content (ASTM C 1754)**
  - Density: 121.4 pcf : +/- 5 pcf of Approved Mix Design (122.8 – 132.8 pcf)  **FAIL**
  - Voids: 25.6% : +/- 4% of Approved Mix Design (16 – 24%)  **FAIL**

- **Core Length (ASTM C 174)**
  - Average Length = 6.07 in. : -3/8 in. to + 1.5 in. of Design Thickness  **PASS**

- **Average Compressive Strength at 28 days (ASTM C 39)**
  - 7-day Average = 1,067 psi : Greater than 2,000 psi  **FAIL**
  - 28-day Average = 2,590 psi : Greater than 2,000 psi  **PASS**
Exit 140 Park-n-Ride Typical Section
Preparations for Production Slabs

- **Underdrain System**
  - 12” PVC Underdrain (UD)
  - 26 - 12” PVC UD Cleanouts
  - 6” Lateral UD
  - 5 – 6” Corner UD Cleanouts
Work Order #3 – 12” Cleanout Redesign

- 12” UD Cleanouts – as designed 1.5’ above top of pervious
- 14 Total Redesigned 12” Cleanouts
  - End of Mainline 12” Cleanouts
  - Along Mainline 12” Cleanouts
  - Increased Lateral 6” Cleanouts from 5 to 52 Total
- 3 days of delays
Exit 140 Park-n-Ride Typical Section

SLOPE VARIES, 2-3% TYP

5' PERVERIOUS CONCRETE SECTION, SEE DETAIL SHEET 2A

OPEN GRADED RESERVOIR OF *57 STONE, DEPTH VARIES
STONE SHALL BE WASHED AND FREE OF FINES

6" DIA. UD-1 PERFORATED UNDERDRAIN PIPE @ 0.5% SLOPE, TYP
(NOTE: UD PIPE SHALL BE 6" DIA SMOOTH WALL PVC PER ASTM F758
WITH 3/8" DIA PERFORATIONS SPACED 6" O.C. MAXIMUM

3" DEPTH NO. 8 STONE CHOKER LAYER
SUBGRADE STABILIZATION FABRIC AROUND BOTTOM AND SIDES OF RESERVOIR
EXIST SUBGRADE SOIL, (NOT TO BE COMPACTED)

STONE RESERVOIR TYPICAL SECTION
N.T.S.
Preparations for Production Slabs

- Forms are set and No. 57 Aggregate has been graded.
Due to lack of density on Test Slab, cross-rollers were replaced with “heavy roller”

On the test slab 0.5-inch strips were used for initial motorized screed pass; however, due to difficulty with getting the concrete to compact down and fear of slab to slab roughness, contractor switched to 0.375-inch strips.
First Production Slabs / Test Slab No. 2

- Telebelt conveyor was used to distribute concrete from the trucks to the forms.
- Despite concerns of pervious concrete being exposed to air too long, the telebelt conveyor proved to be a valuable tool to distribute concrete quickly and without segregation.
First Production Slabs / Test Slab No. 2

- Procon had a lot of workers ready to go and kept a very tight operation with concrete being covered with plastic in 10 – 15 minutes after discharge.
The Goal

Strength, Durability and Permeability
Designed BMP Upgrades
BMP Upgrade Issues

- Existing 48” CM Pipe upstream of structure 5-3 was crushed and bottom rusted out
- Additional 103’ of 48” Storm Sewer Pipe required
BMP Upgrade Issues

- **Work Order – Differing Site Condition**
  - Unsuitable Material unknown due to lack of boring logs
  - Material up to 1’ above 48” Storm Sewer Pipe included in the cost of the pipe
  - Roughly 3400 CY of Unsuitable Material removed and disposed of – Dump Fees
Completed BMP Upgrade
QUESTIONS?