Illinois' Efforts to Reduce HMA Permeability

Reducing HMA Permeability

- What is Permeability?
- How is it measured?
- Why are we concerned about Permeability?
- Problem Areas
- Illinois' Efforts to reduce Permeability

What is Permeability?

- Permeability is the measure of flow of a liquid or gas through a porous medium.

- Function of:
  - In-Place Density
  - Aggregate Size
  - Thickness

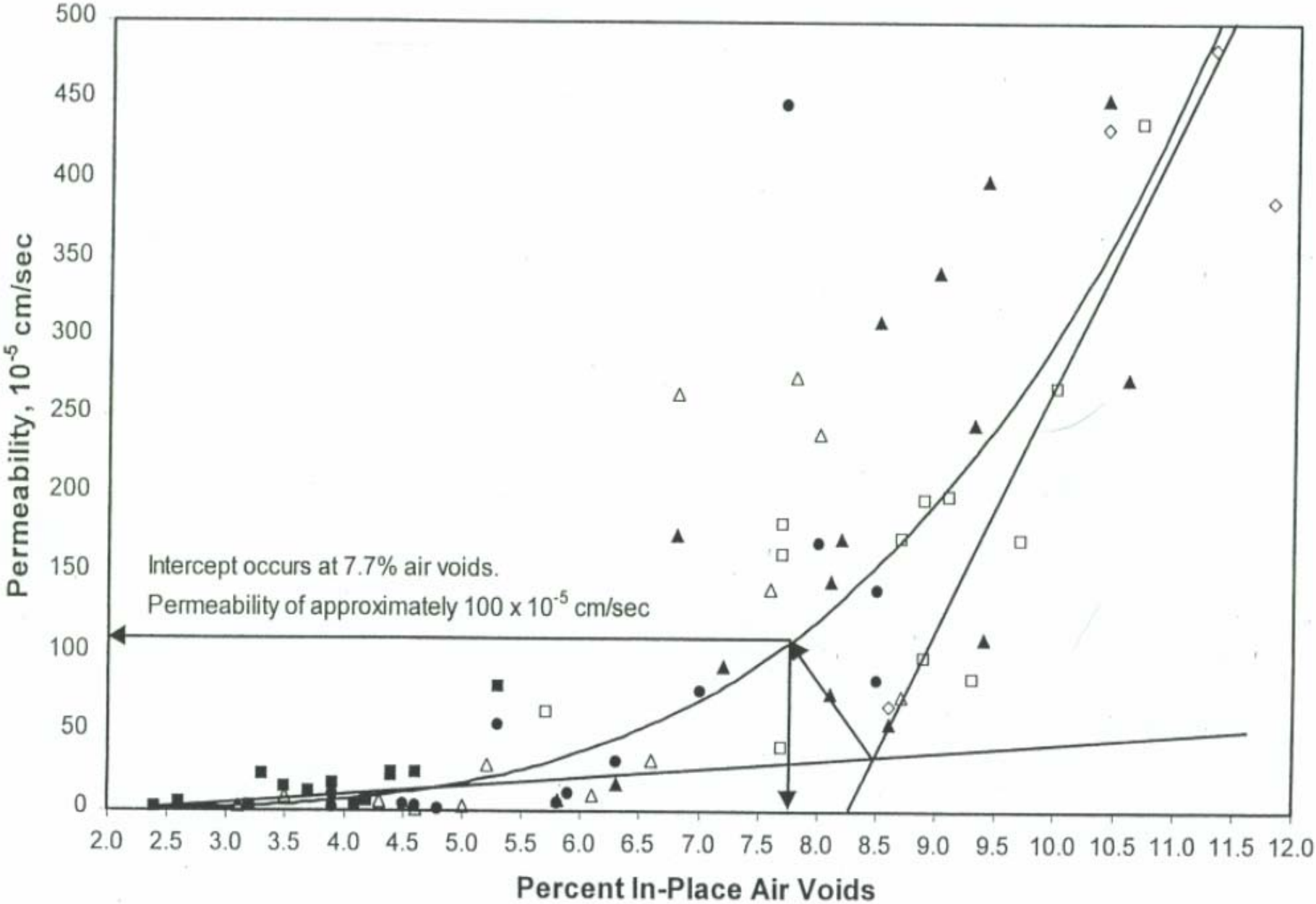
How is Permeability of HMA Measured?

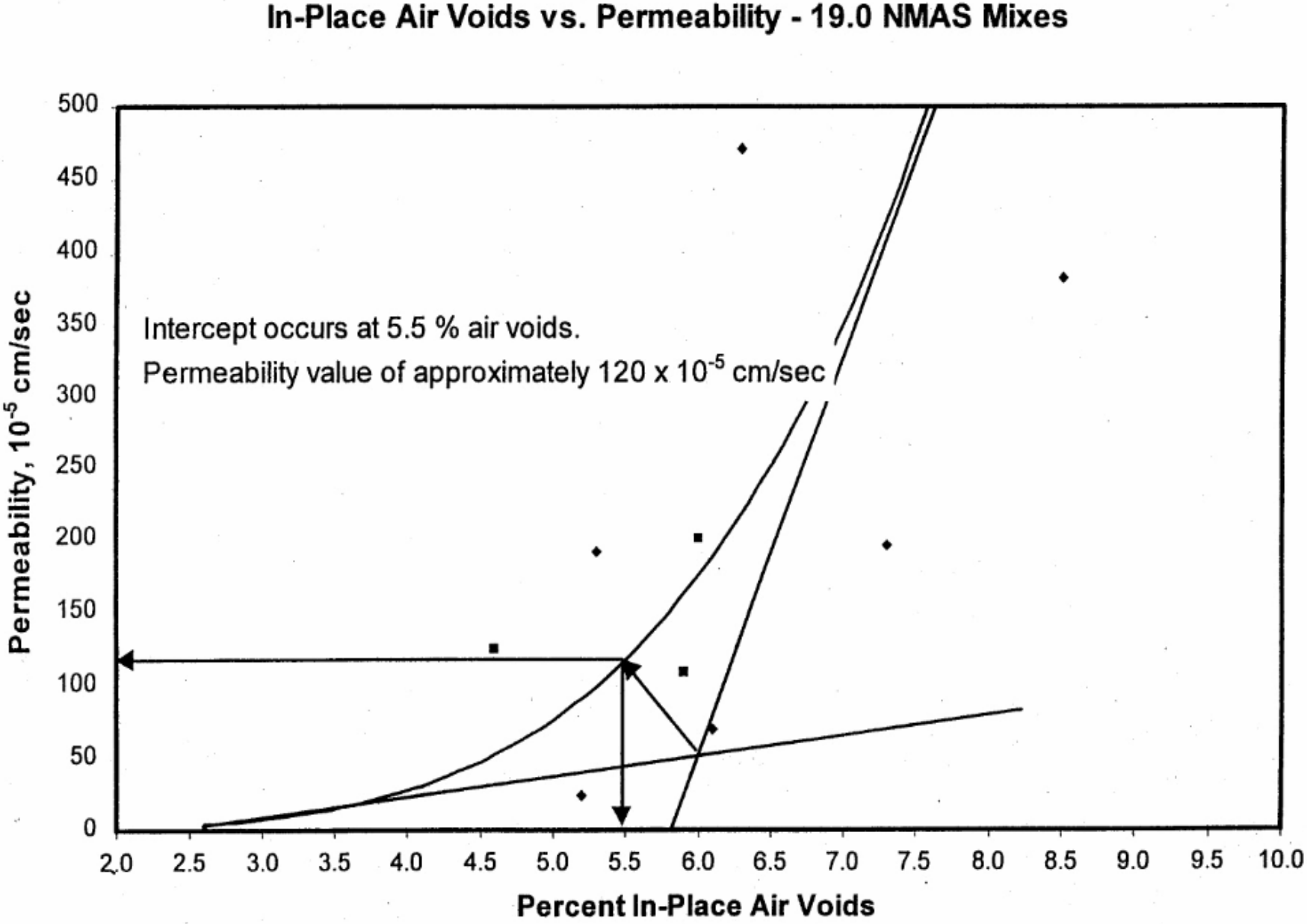
- Lab Permeameter
  - Used to measure the flow of water vertically through a 6” core or lab compacted specimen.

How is Permeability of HMA Measured?

- Field Permeameter
  - Measures the flow of water through HMA pavement

What is Considered High Permeability?


Critical In-Place Air Voids and Permeability ~ 9.5 and 12.5 mm NMAS Mixes
Permeability, 10^{-5} cm/sec
500
450
400
350
300
250
200
150
100
50
0
Intercept occurs at 7.7% air voids.
Permeability of approximately 100 x 10^{-5} cm/sec
2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0 10.5 11.0 11.5 12.0
Percent In-Place Air Voids


In-Place Air Voids vs. Permeability - 19.0 NMAS Mixes
Intercept occurs at 5.5 % air voids.
Permeability value of approximately 120 x 10-5 cm/sec
Permeability, 10-5 cm/sec
Percent In-Place Air Voids
500
450
400
350
300
250
200
150
100
50
0
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0

High Permeability When:

- Surface Mixes > 100 x 10^{-5} cm/sec
- Binder Mixes > 120 x 10^{-5} cm/sec

Why are we concerned about Permeability?

- Permeability allows air and water to penetrate the pavement structure causing:
  - Oxidation
    - Cracking & Raveling
  - Stripping
    - Rutting, Shoving & Raveling

Where do we have Permeability Problems?

- Segregated Areas
- Mainline Binder
- Longitudinal Joints
- Level Binder

Segregated Areas

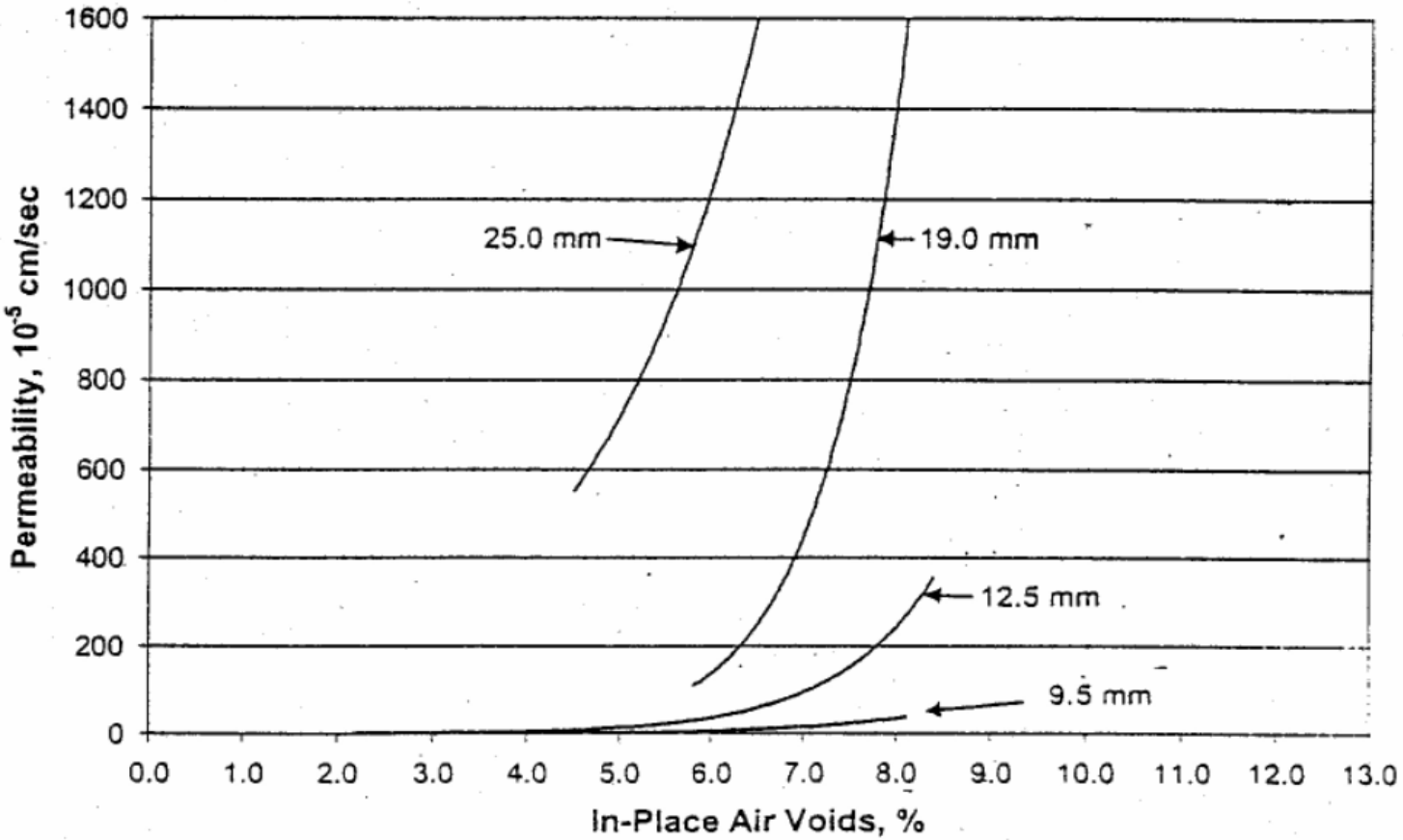
Illinois' Efforts to Minimize Segregation

- Provided Laydown training to Contractors
- Developed Segregation Spec
- Began Requiring M.T.D.'s

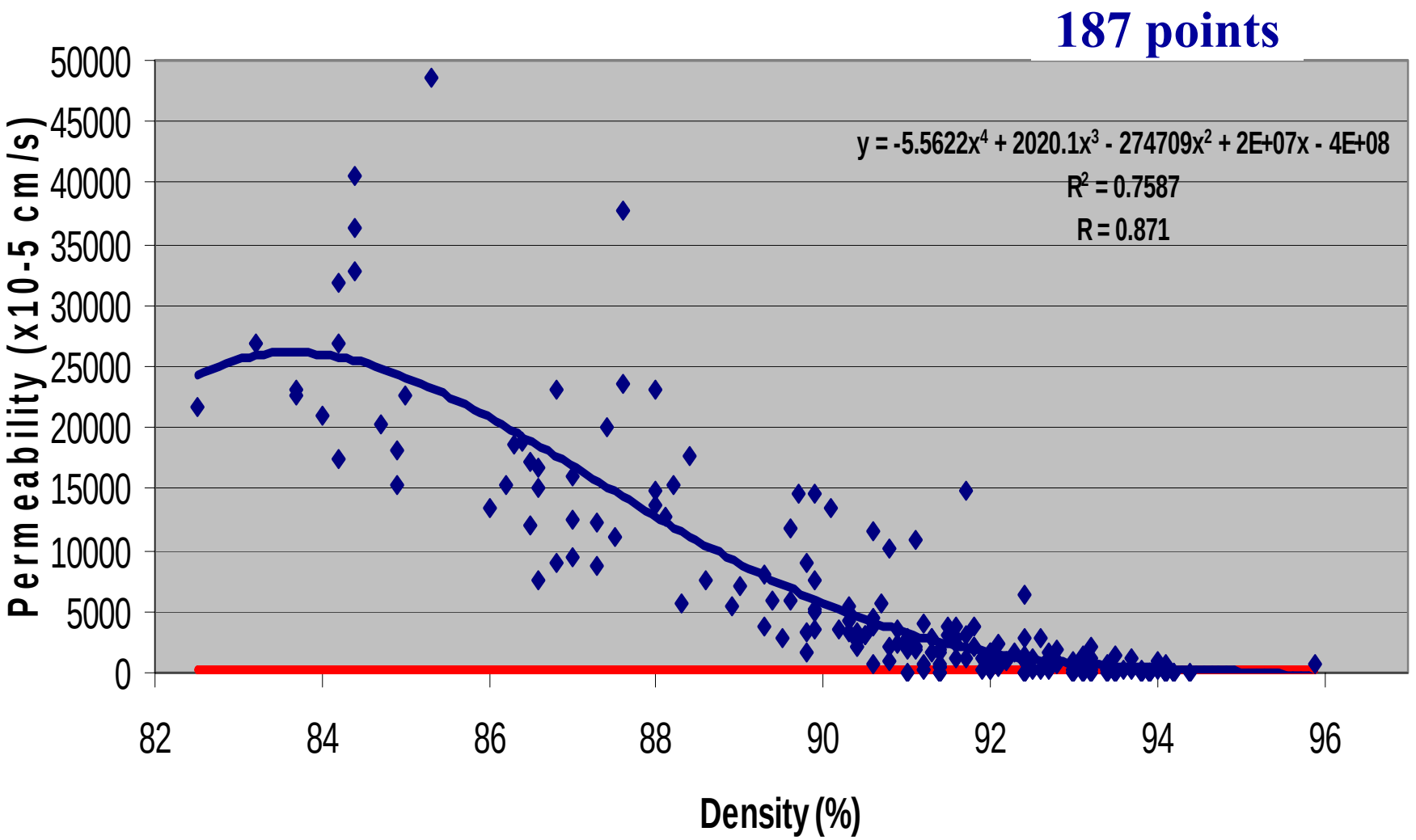
Mainline Binder

- Very Permeable when:
  - placed 1-3/4 inch thick &
  - placed at 92.0% density

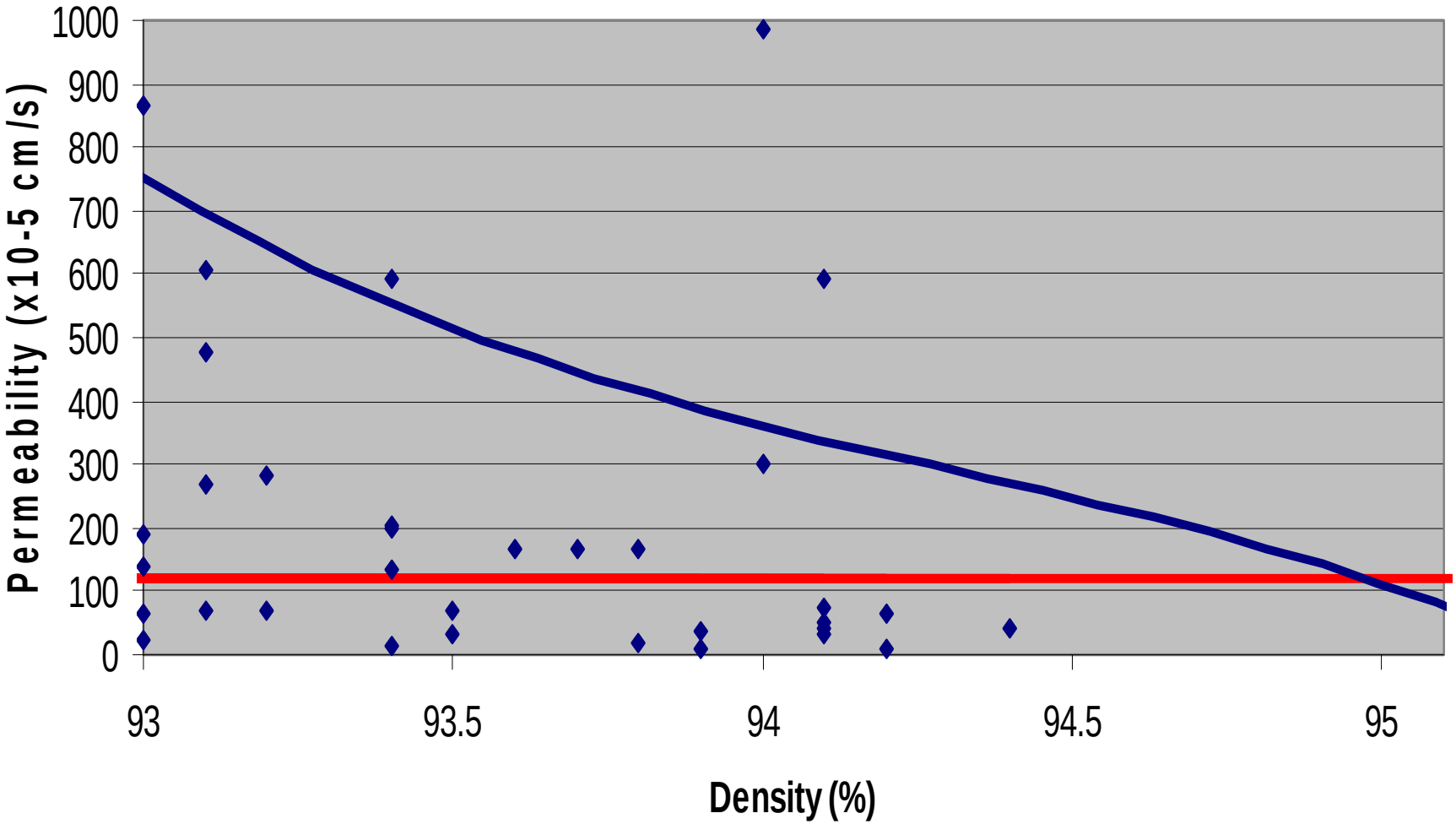
Mainline Binder



Mainline Binder



Mainline Binder - Close-up



Efforts to Reduce Permeability in Mainline Binder Mixes

- Increased Binder Thickness from 1-3/4 in. to 2-1/4 in.
- Increased Minimum Density for 19.0 mm mixes to 93.0%

Longitudinal Joints

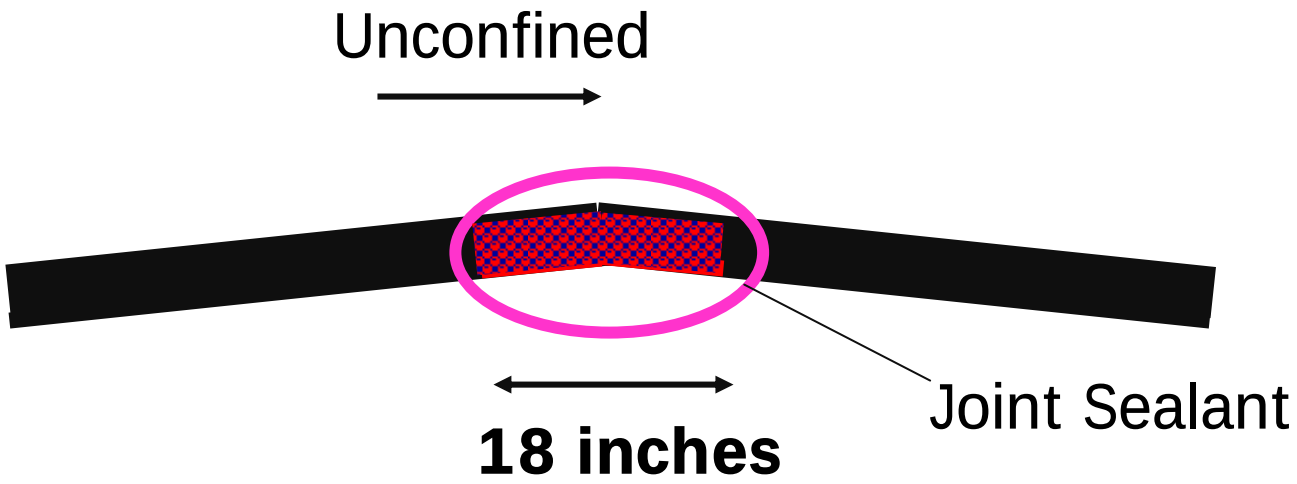
- Unconfined Edge
- Lack of Rolling due to Density not being Measured
- Densities typically 84 to 88% for binders, & 86 to 90% for surfaces
- Permeabilities typically 13,000 to 26,000 for binders, & 1,500 to 7,000 for surfaces

Efforts to Minimize Permeability along Longitudinal Joints

- Longitudinal Joint Sealants
  - IDOT working w/ Two companies to develop a Longitudinal Joint Sealant
  - Here is How it Works

Joint Sealant Concept

- **Band melts up into the joint thus:**
  - **Increasing density**
  - **Decreasing permeability**
  - **Increasing joint life**




Melt & Migrate

Level Binder

- 9.5 mm C.G. mix placed 3/4 inch thick
- No Density Requirement
- Lack of Compactive Effort because of No Density Requirement
- Densities typically 85 to 92%
- Permeabilities typically 300 to 10,000 (2250)

Efforts to Minimize Permeability in Level Binders

- IL-4.75 mm Mix
  - Mix made up of mostly Man. Sand & High AC
  - 3/4 inch thick = 3 X N.M.A.S => 94% Min. Density Requirement
  - 2003 Demo Projects (Dists. 2,3,4,&5)
    - Density Ranged from 90 to 97
    - Permeability Ranged from 0 to 200 (20)

Benefits of using IL-4.75mm

- In-Place Density & Better Stability
- Helps Retard Reflective Cracking
- Waterproof

Typical Mix Design

Aggregate:

FMM-20	64%	Stone Sand
FMM-02	30%	Natural Sand
Mineral Filler	6%	Manufactured

Asphalt Cement:

SBS PG 76-28	8%

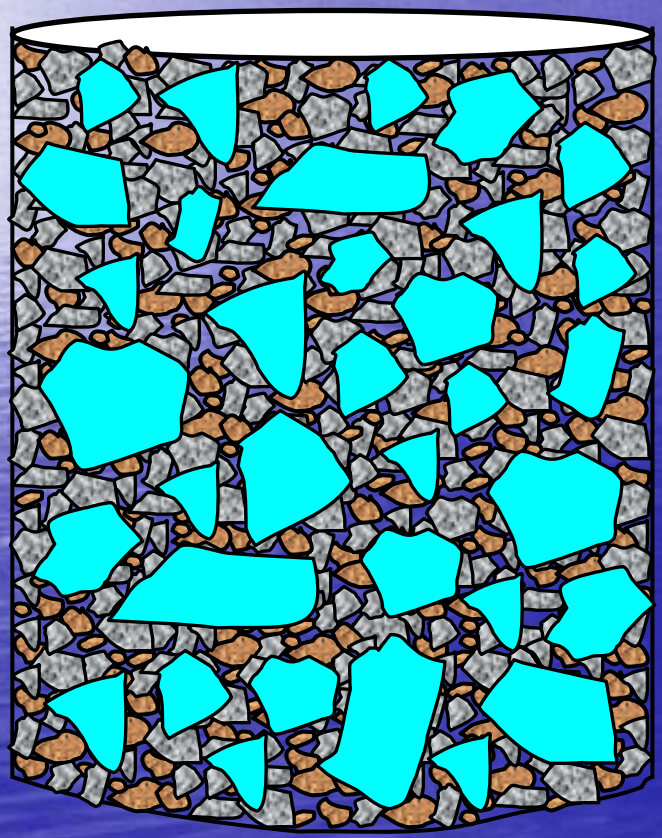
Air Voids: 2.5% @ N50 (VMA ≥ 19.0%)


MACK
4282
4282

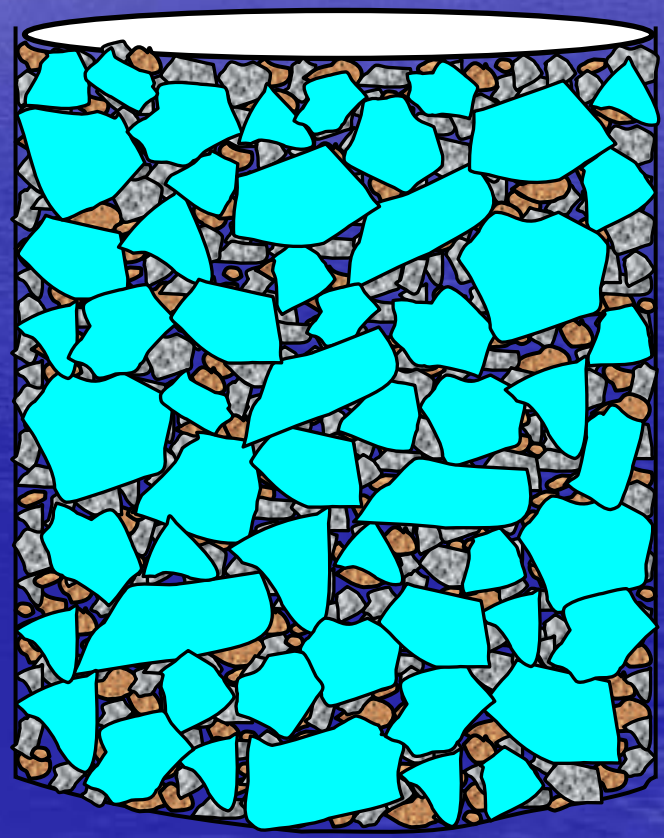
Cheaper Alternative?

- Fine Graded 9.5 mm
  - Little or no CA particle contact
  - Fine aggregate carries most of the load
  - Gradations typically plot above Max density line of 0.45 Power Curve

Fine Graded



Coarse Graded



Fine Graded Mixes

- Anticipated benefits:
  - Higher achievable density at ¾ inch than conventional level binder
  - Density spec ≥ 91.0 %
  - Lower permeability than conventional level binder
  - Cheaper than IL-4.75

Questions?