AAPA's 14th International Flexible Pavements Conference

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Topic: BULK DENSITY INVESTIGATION IN SOUTH AUSTRALIA

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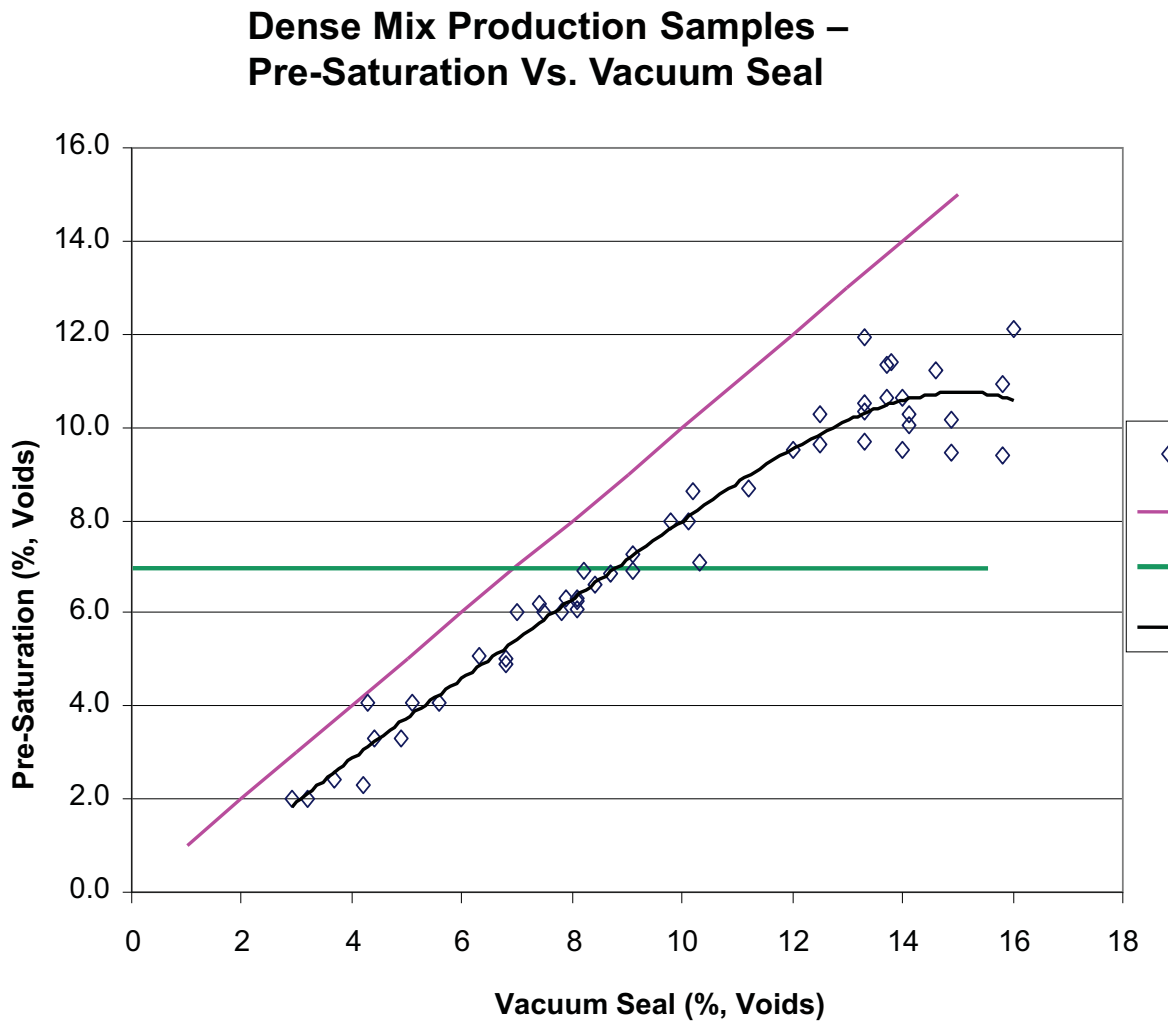
INTRODUCTION

- Three bulk density testing methods:
  - Presaturation (Saturated Surface Dry)
  - Vacuum Seal (Machine & Plastic Bag)
  - Mensuration (By Dimensions)
- Pre-saturation method inaccurate for Stone Mastic Asphalt (SMA) pats/cores.
- Approx 390 samples of DG, SMA & OG were prepared in DTEI lab and some from contractors.
- Aim to introduce the vacuum sealing test into standard laboratory practice.

AIR VOIDS – ISSUES of PRESATURATION Coarse Mix AC20 (AC28 Interstates)

- Asphalt samples compacted as various gyratory cycles to obtains range of air voids.
- Indication of diverging apart of 2 methods at approx. 7% Pre-saturation air void.



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LITERATURE REVIEW

- ASTM 2726-04 Absorption Check: 3 Masses (m_1, m_2 & m_3) as obtained from Pre-saturation test.

$$ASTM\,2726-04: Water\_Absorbed\_by\_Sample = \frac{(m_3 - m_1)}{(m_3 - m_2)} * 100$$

- If water absorbed by Pats/Cores > 2% for Asphalt Mixes (ASTM D2726-04) => Vacuum Sealing Method.
- Water absorbed by Pats/Cores > 0.4% for SMA and Coarse DG Mixes (WSDOT, 2004) => Vacuum Seal

TESTING METHODS

Loose Asphalt (Mixes: AC10, AC14, SMA10 & OG14) → Gyratory Compaction (80 Cycles @ 150^0C)

→ Asphalt Pats (Approx. 100 mm Diameter x 65 mm Height) → Asphalt Pats & Cores (Approx. 100 mm Diameter x Layer Thickness)

Bulk Density (Pre-saturation): AS2891.9.2

Bulk Density (Mensuration): AS2891.9.3

$$\text{Vacuum Seal (WA 733.2)}: Bulk\_Density = \frac{m_1}{(V_{TS} - V_{Bag})}$$

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TESTING METHOD - VACUUM SEAL

$$\text{Vacuum Seal (WA 733.2)}: Bulk\_Density = \frac{m_1}{(V_{TS} - V_{Bag})}$$

- Vacuum Sealing Bulk Density (t/m^3) = Pat Dry Mass (g) / [Volume of Pat & Plastic Bag (cm^3) - Volume of Plastic Bag (cm^3)]
- Volume of Pat & Plastic Bag V_{TS} (cm^3) = [Dry Mass of Pat (m^3) & Plastic Bag (m^3) – Wet Mass of Pat & Plastic Bag in Water(m^3)] * Water Density
- Volume of Plastic Bag V_{Bag} (cm^3) = Dry Mass of Plastic Bag (m^3) (g) / Plastic Bag Density (g/cm^3)

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VACUUM SEALING METHOD

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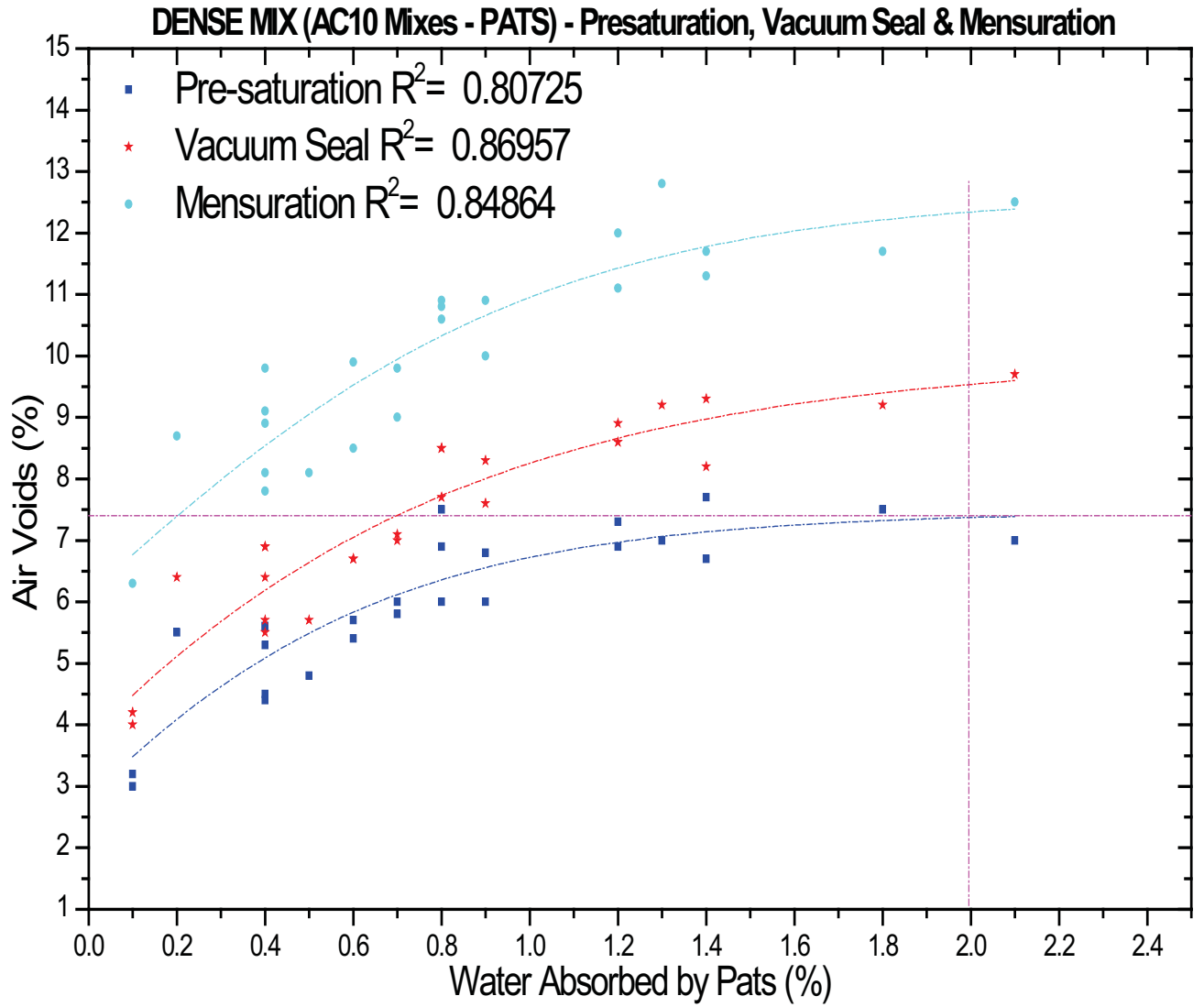
SMA10 PATS

MIX: AC10M (AC14 Interstate)

- Three tests against Absorption
- Difference between three methods as expected
- 7% air voids limit for Pre-saturation



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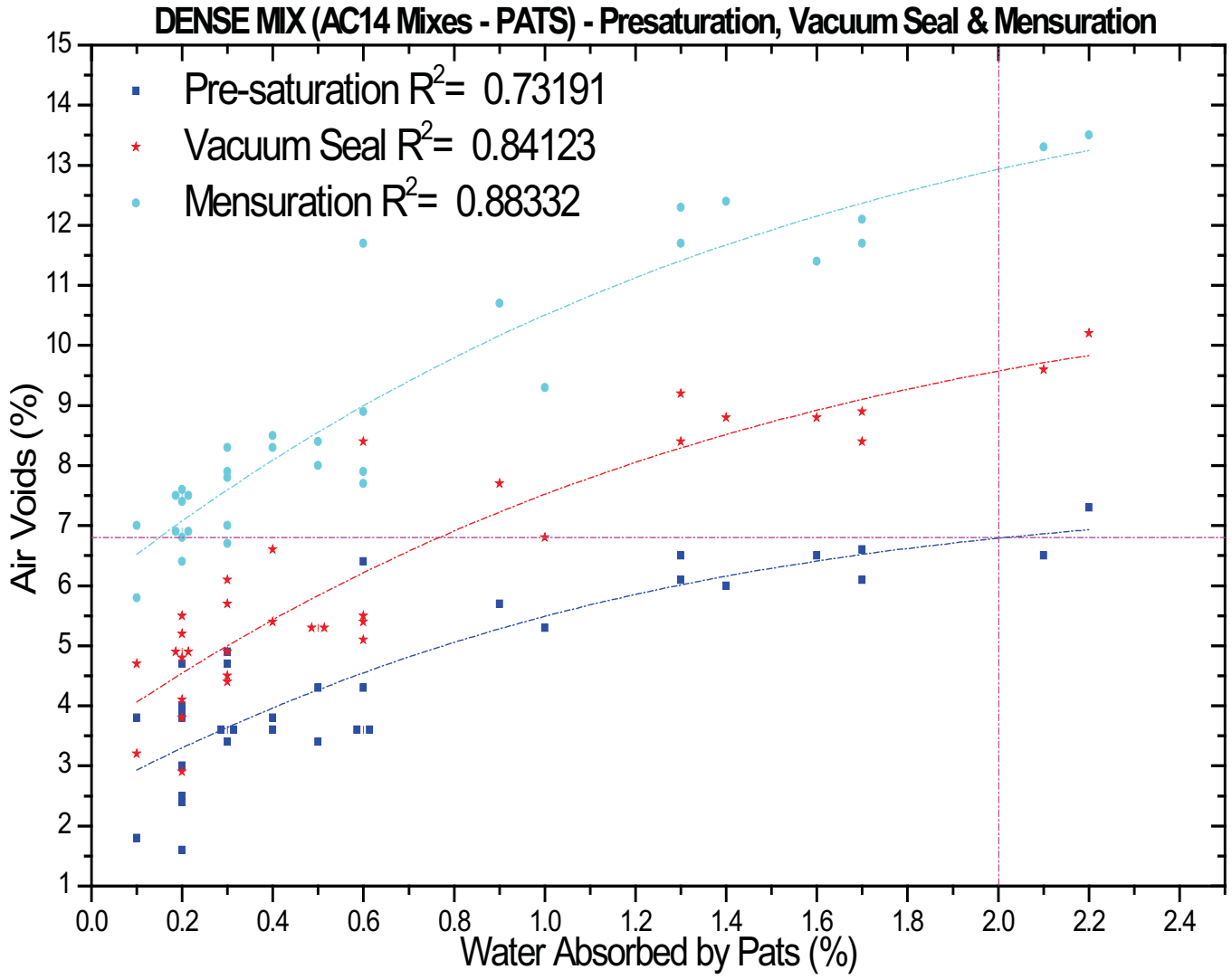
MIX: AC14M (AC20 Interstate)

- Similar to AC10M
- Pre-sat. line tends to horizontal after 7% void
- Higher water absorbed by Pats @ same air voids due to surface texture



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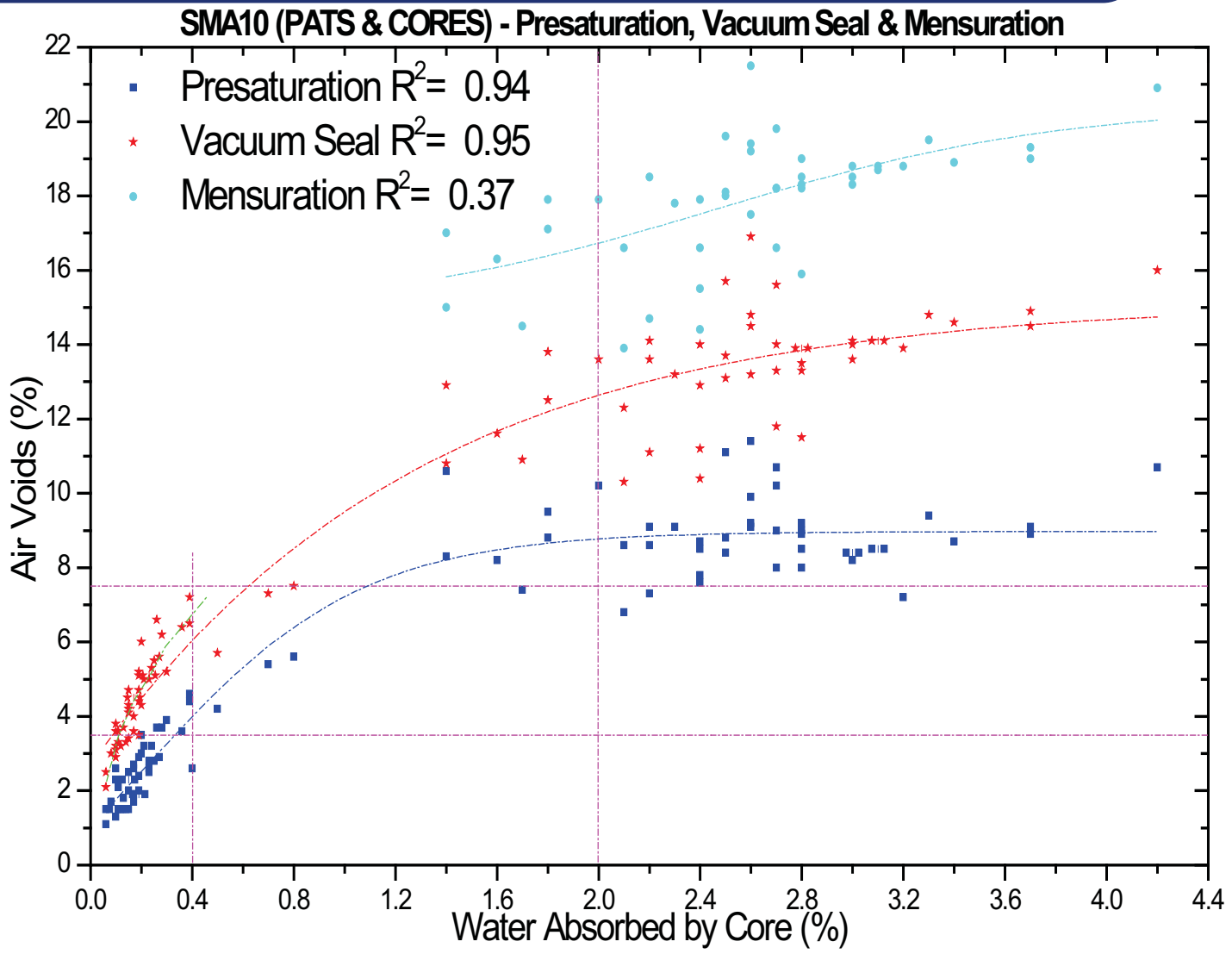
MIX: SMA10 (SMA14 Interstate)

- Presaturation line tends to horizontal after 7% void
- Presaturation & Vacuum Seal Data diverge @ approx 0.4% Absorption



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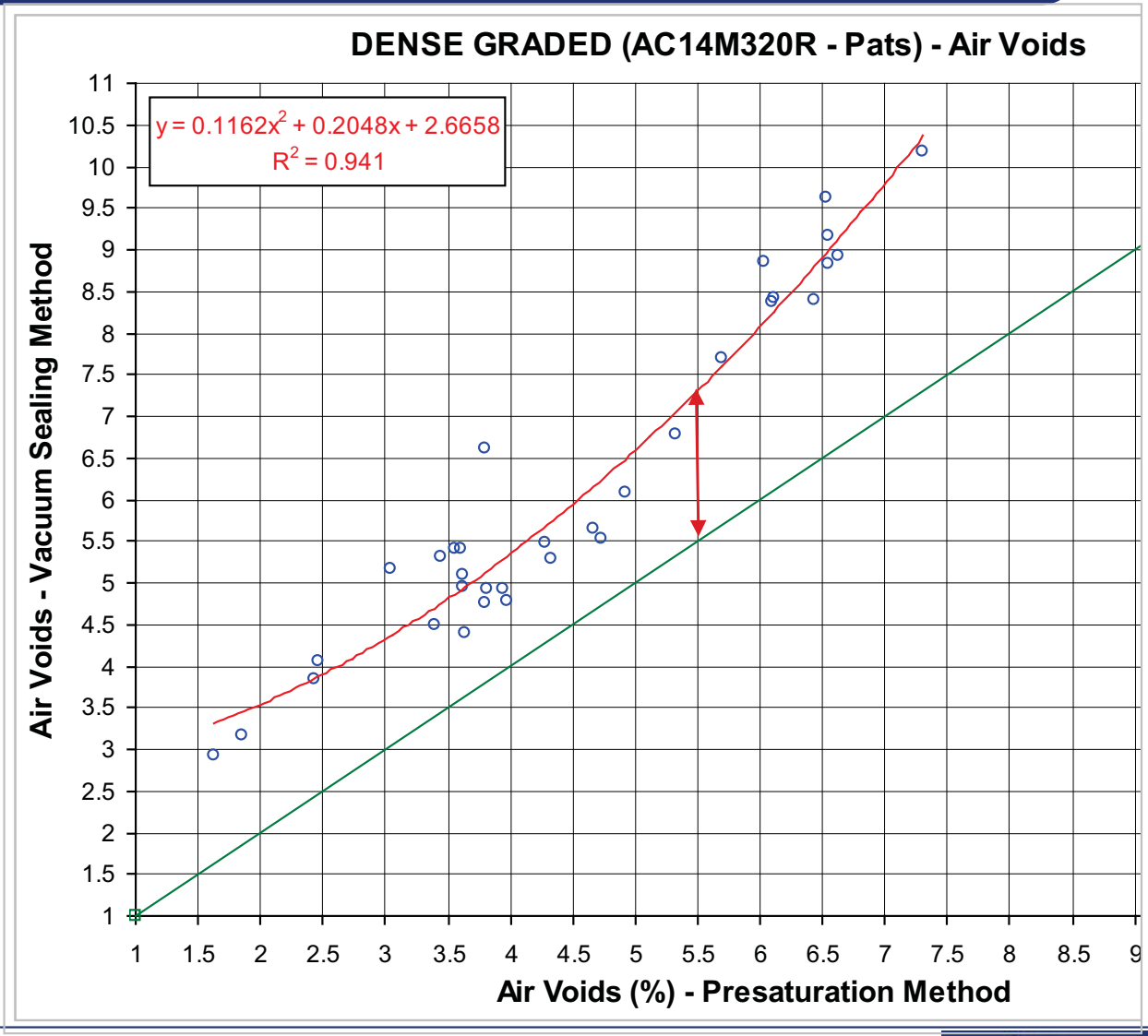
MIX: AC14M320R (AC20 Interstate)

- A slightly coarse dense mix
- Difference increases as voids increase, R^2=0.94
- Step change at 5.5% pre-sat method @1.8% air voids difference



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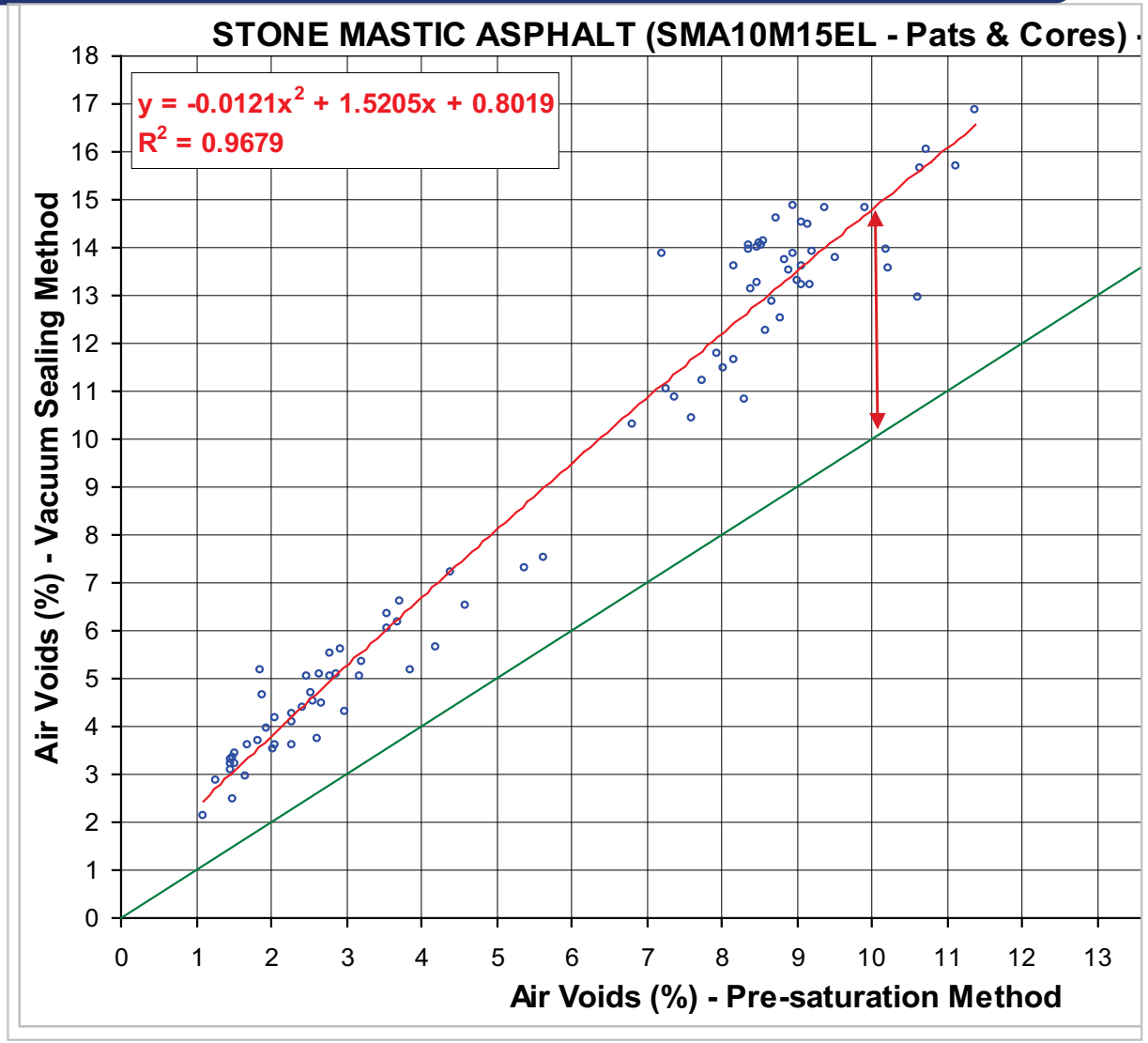
MIX: SMA10 (SMA14 Interstate)

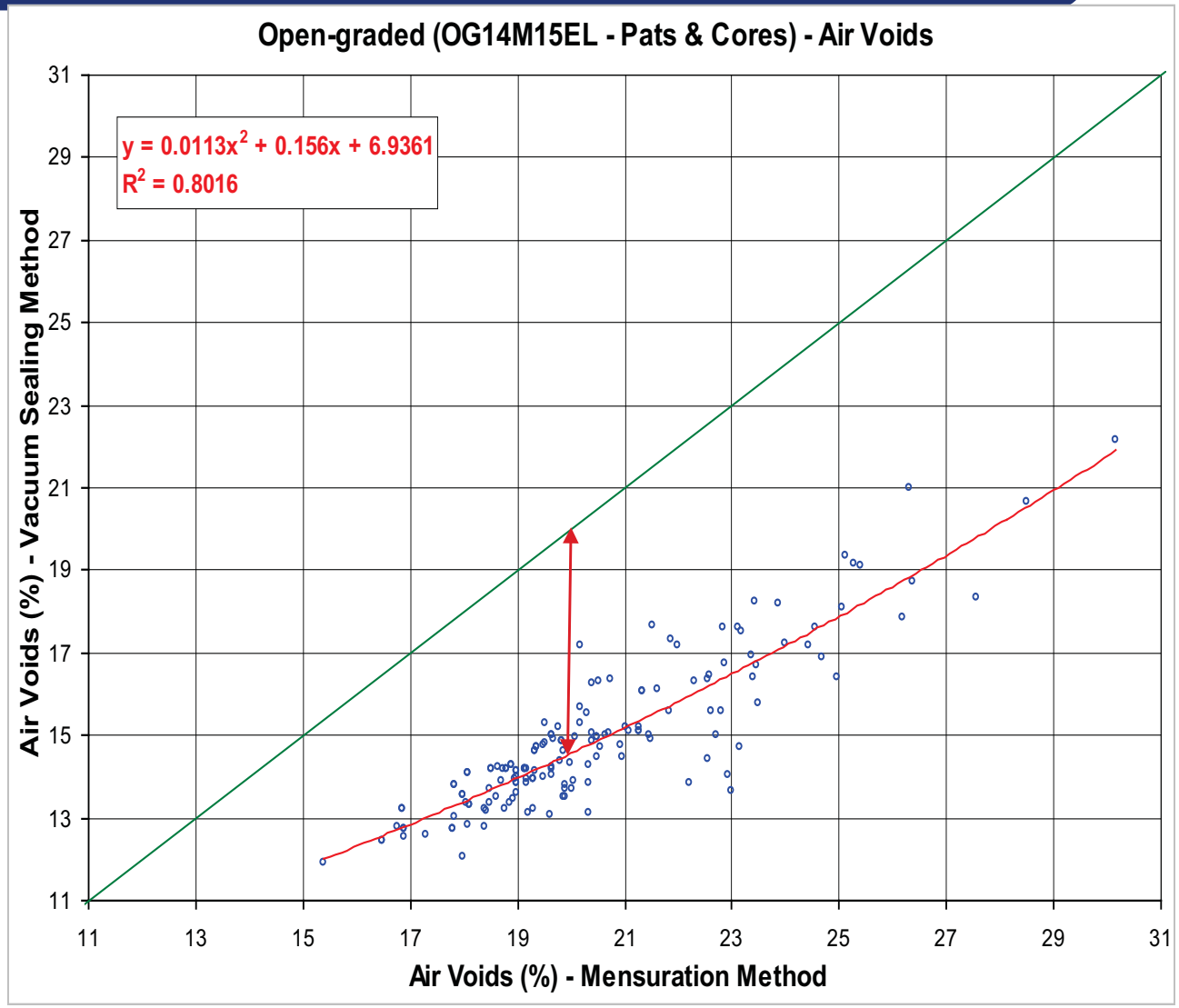
- SMA is a coarse gap graded mix, has very high surface texture.
- Step change at 10% pre-sat method @15% air voids difference



MIX: OG14 (OG20 Interstate)

- OG is a gap graded mix, has high surface texture and is porous

- Step change at 20% Mensuration method @15% air voids difference



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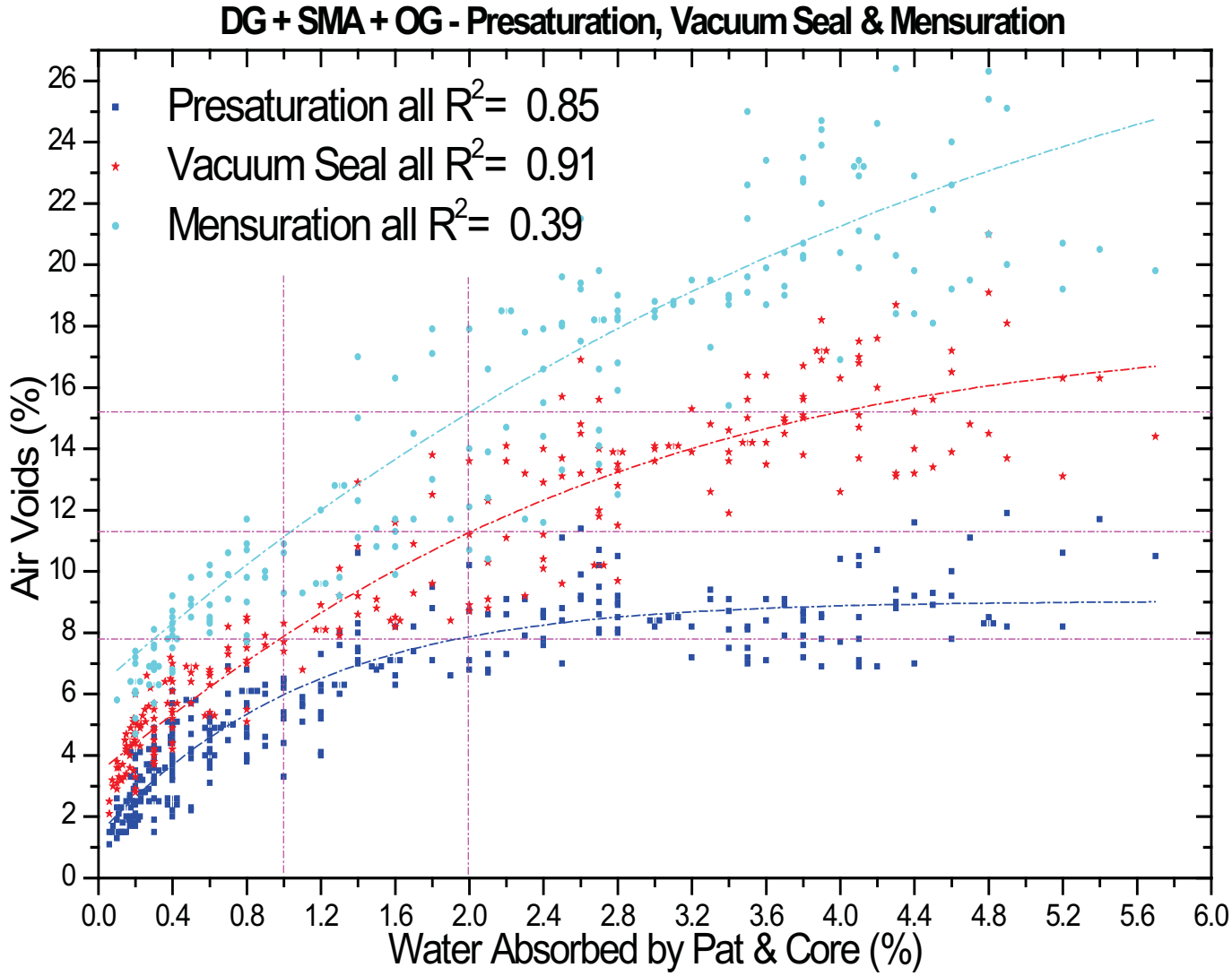
EFFECTS OF TEXTURES & ABSORPTION

- SMA10: 80 Cycles Gyropac Pat (Left) & 350 Cycles (Right)

- 80 cycles Pat: Less compacted => High texture & voids => High absorption

SUMMARY: ALL ASPHALT MIXES (DENSE GRADED, SMA10 & OG14)

- Presaturation method drops off at 2.0% absorption & 7.5% air voids.
- Vacuum seal method increases over full air voids range.



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CONCLUSION - 1 to 3

- *1)* Presaturation, Vacuum Seal and Mensuration bulk density tests provide different void results for the range of samples tested.

- 2) Pre-saturation test has serious limitations for asphalt samples with high void levels, with inaccuracy encountered at approx. 7% air voids above.

- 3) The “Absorption” check on Pre-saturation provides a useful check on the test’s suitability, and should be incorporated into the appropriate Australian Standard.

CONCLUSION - 4 to 6

- 4) When Pre-saturation is outside its range of suitability, Vacuum Seal could be used, but a step change exists between the two methods making this option a little impractical.
- 5) The absorption limits of 2% DG & 0.4% SMA for each mix type need to be calibrated to Australian practice and asphalt mixes.
- 6) Vacuum Seal is a bulk density test that could be used on all asphalt mix types to create a seamless voids comparison but is considered not to be economical for regular Dense Grade production use.

CONCLUSION - 7 to 10

- 7) The vacuum seal method is considered to be suitable for Stone Mastic Asphalt, especially for in-situ cores, but also mix design and production samples.
- 8) The Open-graded air voids of 20% (Mensuration) is equivalent to Stone Mastic (Pre-saturation) air voids of 10%.
- 9) The vacuum sealing method should be introduced into Australian Standard
- 10) The vacuum sealing method has the potential to be used as the dispute resolution method.

FUTURE RESEARCH

- Continued testing investigation of the vacuum sealing method to determine step change value at 2% absorption for each asphalt company DG mix e.g. AC20 mixes.

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Further information.

AAPA 2011 Conference Proceeding Paper of "**Bulk Density Investigations in South Australia**"

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