Performance Engineered Mixtures

National Concrete Pavement Technology Center

Tech Center

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What do we measure now?

- Slump
- Strength
- Air
- Thickness

How are these related to potential distress?

- ✓And tougher environments
- ✓And new materials
- ✓And new practices

What do we need to assess?

- Materials Quality
- Mixture in place
- For the parameters that matter

A Suggested Process...

- Test properties at design / proportioning stage
- Prove uniformity at delivery
  - ✓Testing
  - ✓3’rd party records

AASHTO Guide Specification

- Based on existing specs
- Add new thinking
- Take out some stuff

Materials

- Cement – M85, M240
- Slag cement – M302
- Fly ash – M295 (ASTM C 1709)
- Admixtures – M154, M194 (others?)

Materials

- Aggregates
  - ✓ M80 for contaminants
  - ✓ PP65 for ASR
  - ✓ ?? For d-cracking

  - ✓ Continue with current individual fraction gradation
  - ✓ Address combined gradation in proportioning

  - ✓ ASTM C 1761 for IC

Prescriptive

Property	Value	AASHTO Test Method	When Test Must be Conducted*
Combined Aggregate Gradation	Within Tarantula Curve	T27	All
	#8 - #30 >15%		
	24% < #30 - #200 < 34%		
Cementitious content	450 lb/yd^3, minimum	Batch records	Mixture design
	658 lb/yd^3, maximum	Batch records	Mixture design
Portland cement content	50% of cementitious, minimum	Batch records	Mixture design
Class C Fly Ash**	30% maximum cement replacement	Batch records	Mixture design
Class F Fly Ash**	25% maximum cement replacement	Batch records	Mixture design
GGBFS**	50% maximum cement replacement	Batch records	Mixture design
w/cm ratio	[0.42] […] maximum	Batch records	All
Entrained air	4% after placement, and	T 152, T 196M/T 196,or T 199	All
	0.2 SAM number	Super-air-meter	All
	2% maximum loss during placement	T 152, T 196M/T 196,or T 199	All

Performance

Property	Value	AASHTO Test Method	When Test Must be Conducted
Electrical Resistivity	[27] […] kΩ-cm minimum at [28] […] days	TP 95	All
Compressive strength	[4000] [3500] […] psi minimum at [28] [90] days	T 22	All
Freeze thaw resistance	RDM > [80] […] %	C666	Mixture design
Shrinkage	Crack free at [14] […] days	ASTM C 1581 Ring	Mixture design
	<0.06 %	ASTM C 157 mod**	Mixture design

Report

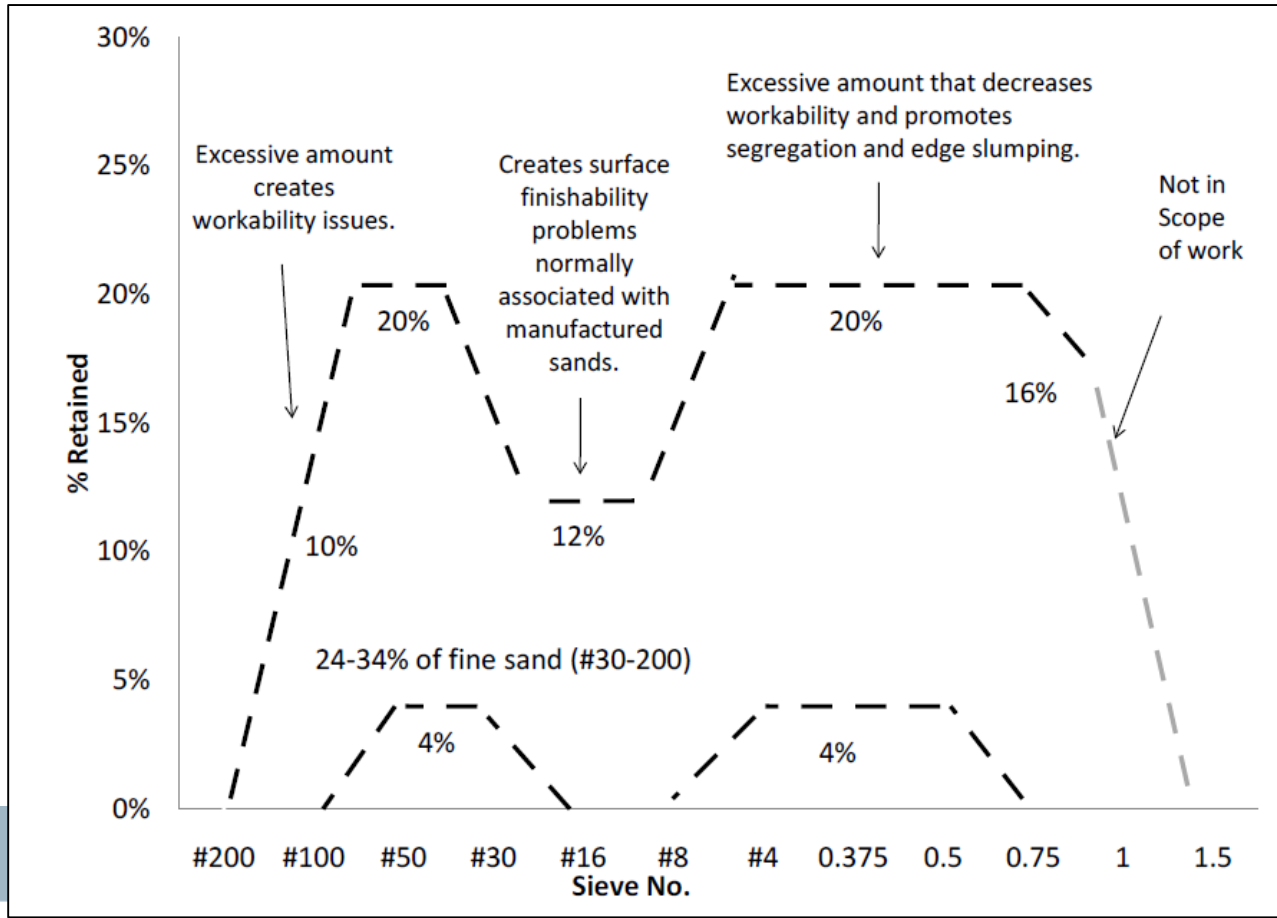
Property	AASHTO Test Method
Modulus of elasticity at 28 days	ASTM C 469
Drying shrinkage	ASTM C 157
Coefficient of thermal expansion	T 336
Rate of strength development to 90 days	T 22
Rate of development of electrical resistivity	TP 95
Unit weight	T 121
Slump	T119

QC

Property	AASHTO Test Method	When Test Must be Condu
Air void system	Foam Drainage	Mixture design
Slump	Within 1” of design mix	T 119M/T 119
Unit weight	Within 3 pcf of design mix	T 121
Calorimetry	Adiacal	Construction
Maturity	ASTM C 1074	Construction
Strength development	T 22	Construction
Resistivity Development	TP 95	Construction

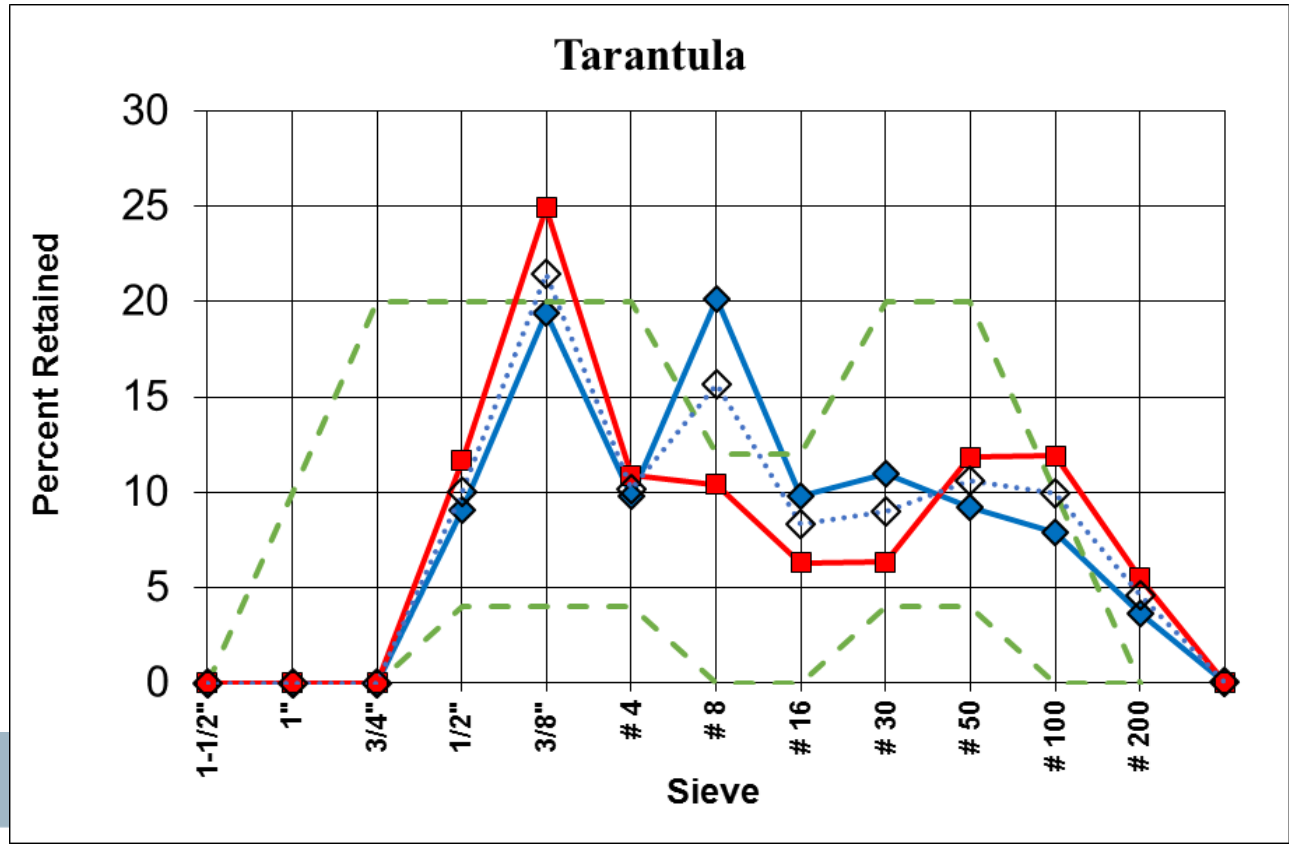
Proportioning

- Choose Aggregate System
  - ✓ Tarantula Curve (Ley)
  - ✓ Measure voids



Aggregate System

- 2 aggs – void ratio 23.2%
- 3 aggs – void ratio 19.8%
- 3 aggs (T) – void ratio 20.4%



Proportioning

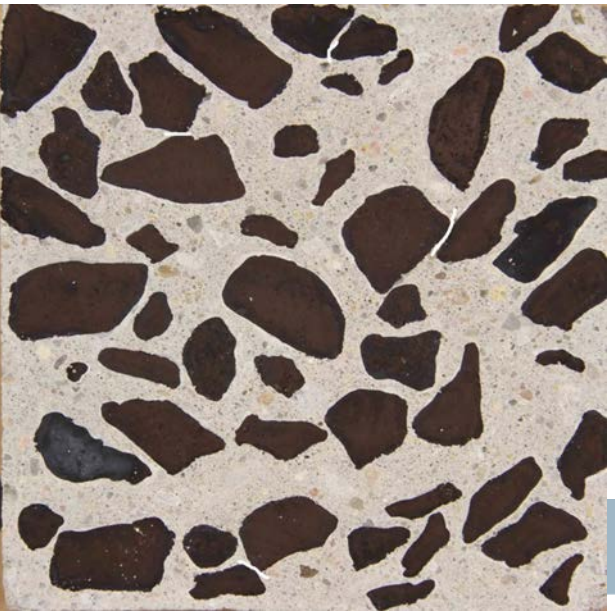
Choose a Paste System for Performance

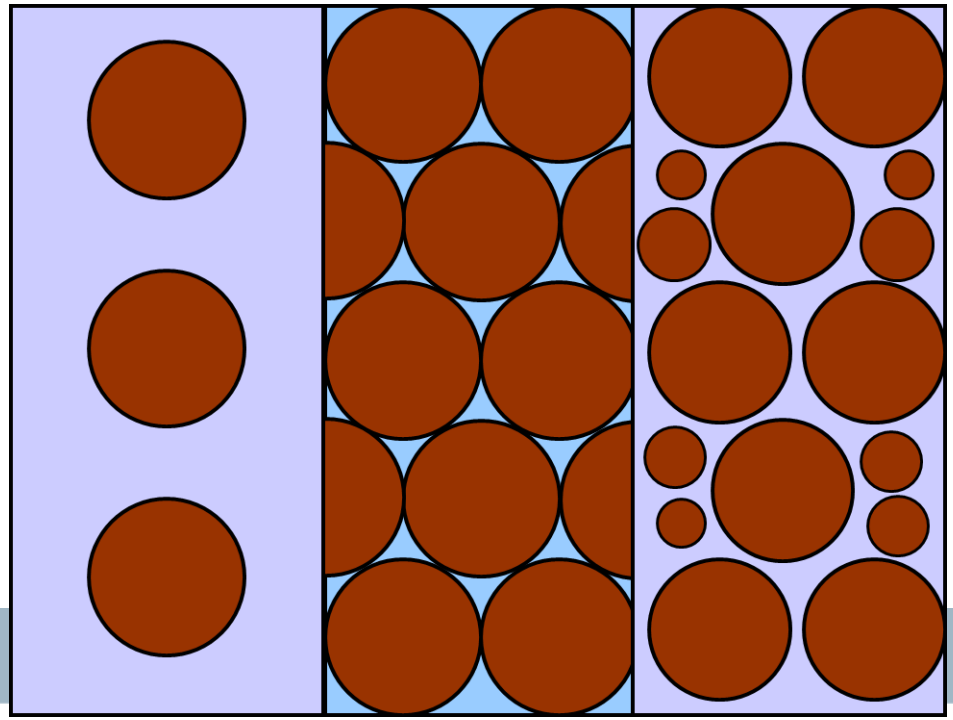
- Cementitious blend
- W/Cm
- Air content
- Chemical admixtures

Proportioning

Choose Paste Volume

- All voids must be filled with paste
- And a bit more to coat the particles for workability

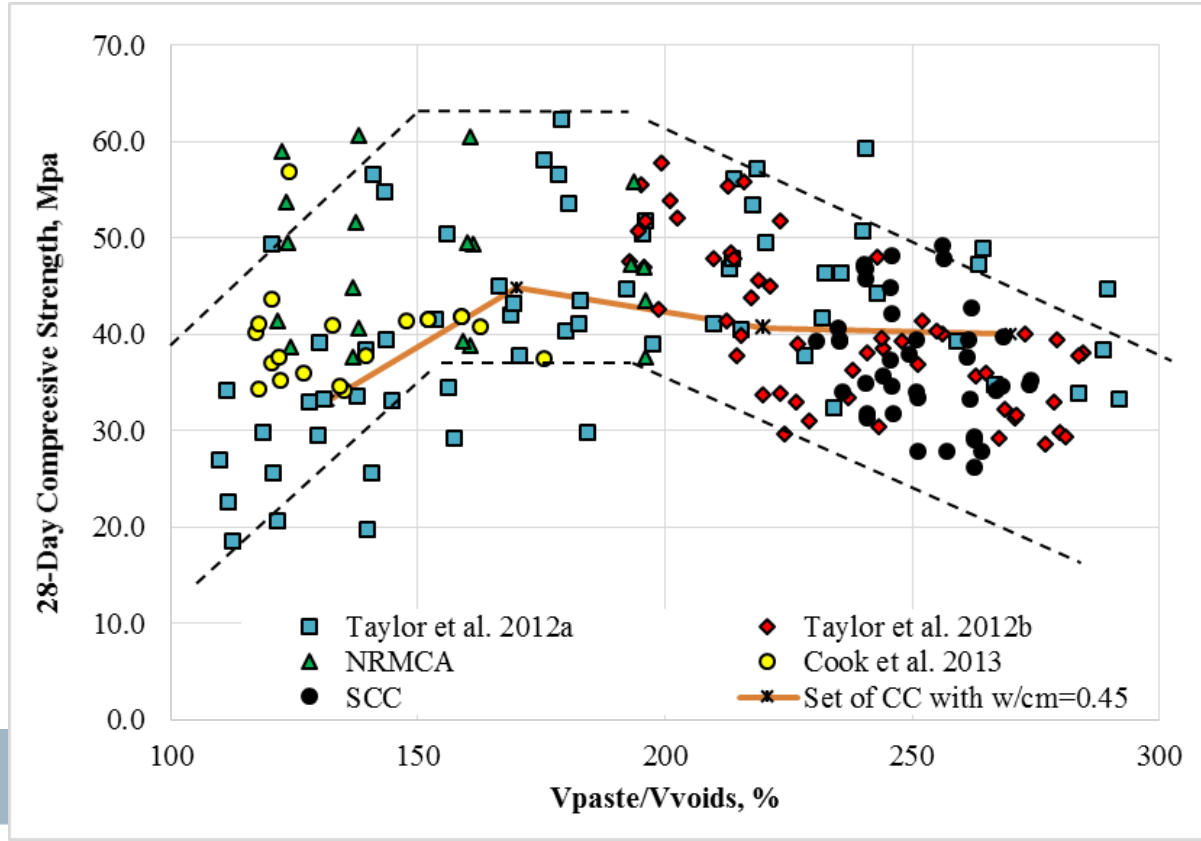




Proportioning

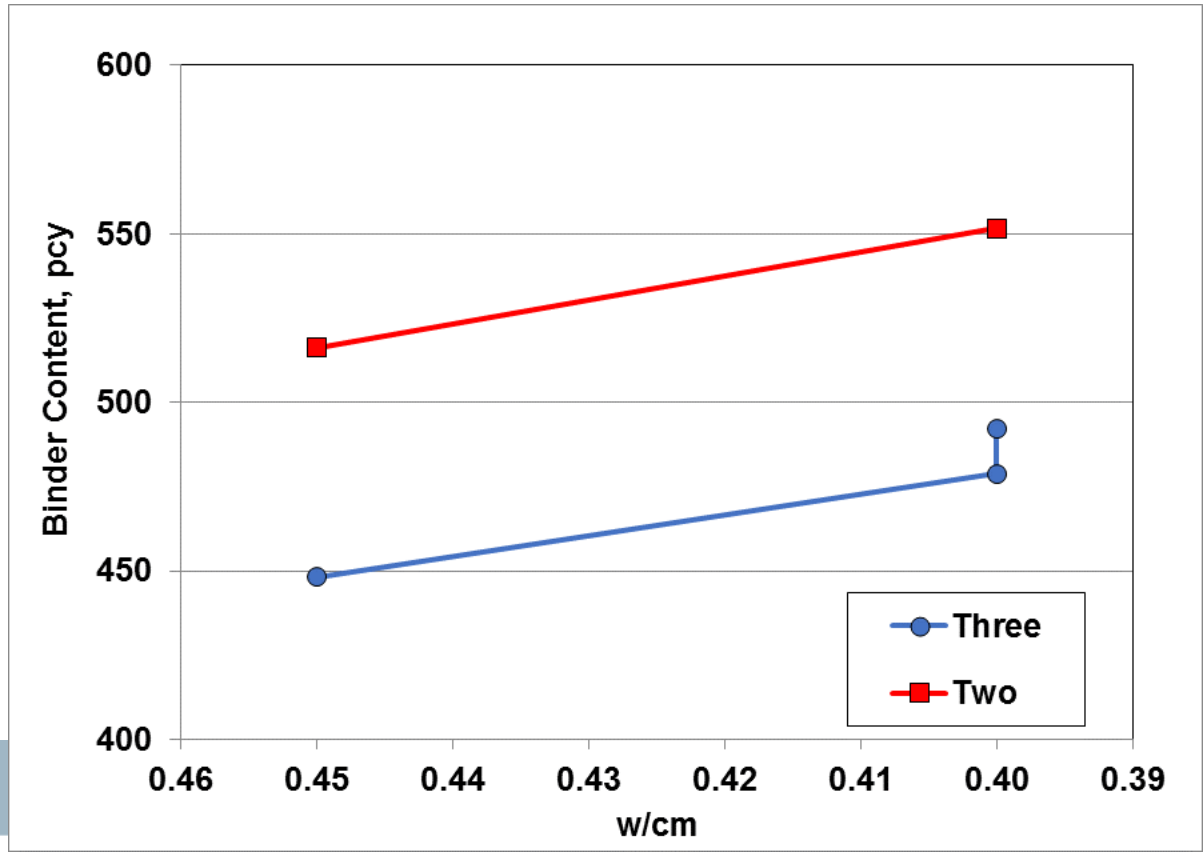
Choose Paste Volume

- Need enough paste for mechanical properties ~175% of voids



Proportioning

- Put it all together
- Test
- Iterate



What else?

- Commentary needed to guide users in choosing limits
- Education has go with it
- Still need test methods:
  - ✓Rapid freeze thaw
- Pooled Fund!