

**MINIFIBERS, INC.**

MiniFIBERS ADMIXUS<sup>TM</sup> Admixtures  
for  
Cement Containing Applications

July 2016

# The Use of ADMIXUS<sup>TM</sup> Products in Cementitious Applications

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Initial results from a research collaboration between

MiniFIBERS, Inc.

and

Middle Tennessee State University (MTSU)

Concrete Industry Management (CIM) Program

# The Use of MiniFIBERS ADMIXUS™ in Cementitious Applications



Samples prepared  
and tested at MTSU

## Two Grades of Additive

**ADMIXUS™ ES** – ES for “Early Strength”

**ADMIXUS™ LS** – LS for “Low Shrinkage”

# The Use of MiniFIBERS ADMIXUS™ in Concrete

- Experiments at Middle Tennessee State University have confirmed the following:
  - ADMIXUS™ ES gives improvement in early strength and in drying shrinkage, ADMIXUS™ LS gives tremendous improvements in drying shrinkage
  - Addition rate has also been studied. Reducing the addition rate by one half, improvements are still observed
  - Formulations have slightly higher viscosity (lower slump). After adjusting all slumps to the same level as the control by adding water, improvements in drying shrinkage and compression strength are still observed at a slightly reduced level

# The Use of MiniFIBERS ADMIXUS™ in Concrete

- Observations – Drying shrinkage:
  - ADMIXUS™ LS gives outstanding reduction in drying shrinkage (when used at 2#/yd<sup>3</sup> add rate)
    - At a lower add rate of 1#/yd<sup>3</sup>, the improvement is still observed, but reduced
  - ADMIXUS™ ES gives good reductions in drying shrinkage and it seems does better than ADMIXUS™ LS when slump is normalized
  - The combination of ADMIXUS™ ES and ADMIXUS™ LS appears synergistic when slump is normalized

# The Use of MiniFIBERS ADMIXUS™ in Concrete

- Observations – Compression strength:
  - ADMIXUS™ ES gives a strong improvement in early compression strength
    - Observed both in standard concrete and in a formulation for cast concrete which has accelerators and a rheology aid
  - The improvement in strength is maintained (but reduced) if slump is normalized and when the load rate is reduced

# Basic Concrete Data

Mini Fibers Concrete Mix Design			
Material	Specific Gravity	Weight,lbs.	Volume,cu.ft.
Cement	3.15	635	3.228
3/4" Limestone	2.66	1664	10.026
River Sand	2.65	1409	8.524
Water	1	292.16	4.682
Air Content	2%	0	0.54
Total		4000.16	27

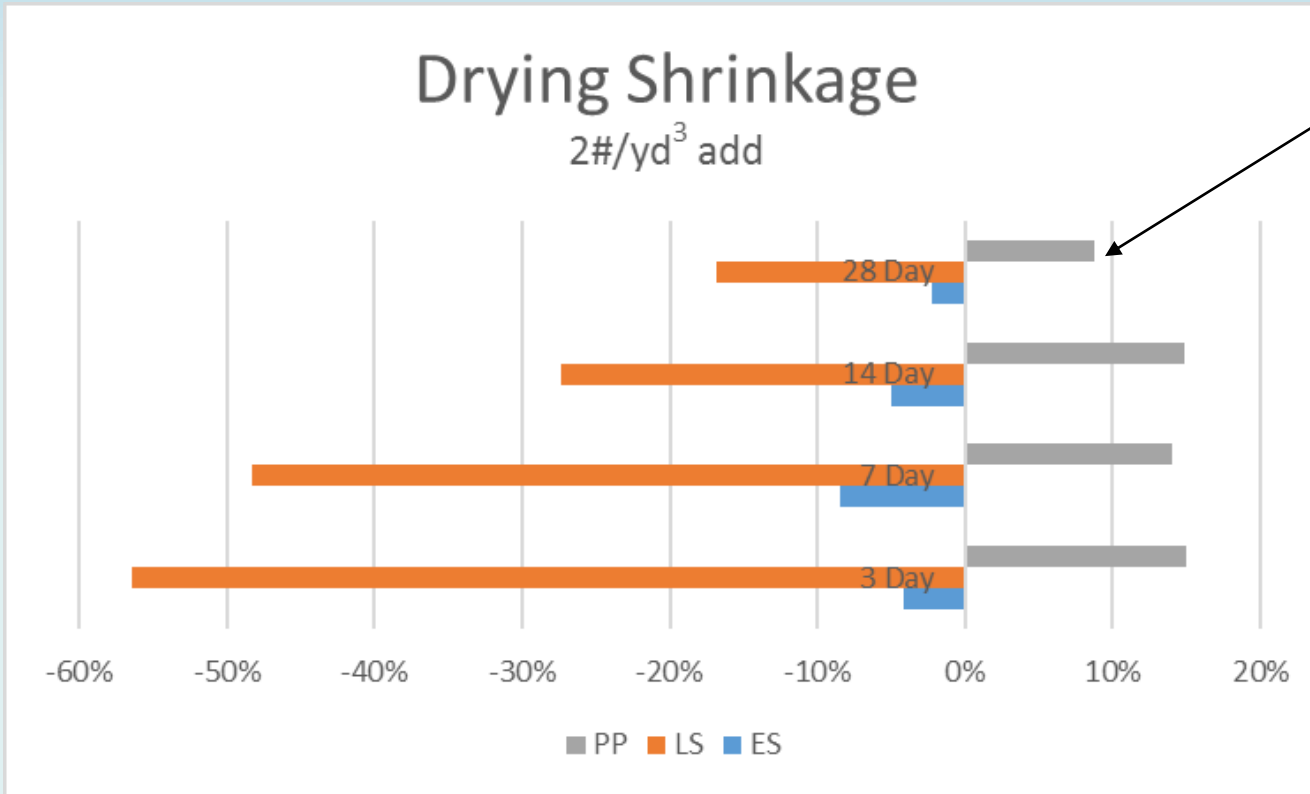


Drying Shrinkage Improvement  
**2#/yd<sup>3</sup> add rate**

# The Use of ADMIXUS™

Drying Shrinkage (2#/yd<sup>3</sup> add rate)

No adjustment for slump



PP increased shrinkage

←  
Reduced Drying Shrinkage  
All compared to control

Compression Strength Improvement  
**2#/yd<sup>3</sup> add rate**

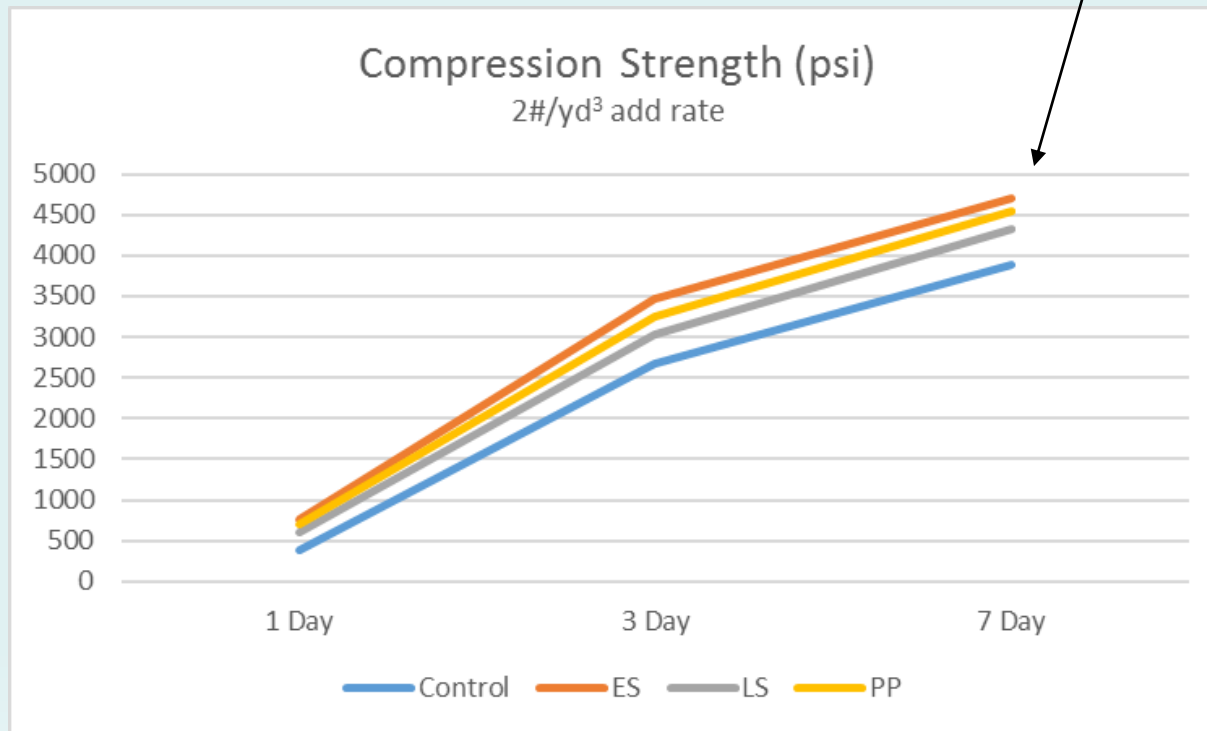
# The Use of ADMIXUS™

## Compressive Strength (2#/yd<sup>3</sup> add rate)

No adjustment for slump

	1 Day	3 Day	7 Day	28 Day
Control	393	2667	3883	6990
ES	757	3460	4707	7020
LS	597	3040	4320	6720
PP	697	3243	4547	7013

ADMIXUS™ ES  
is best for early  
strength!



Drying Shrinkage Improvement  
with slump equalization  
**2#/yd<sup>3</sup> add rate**

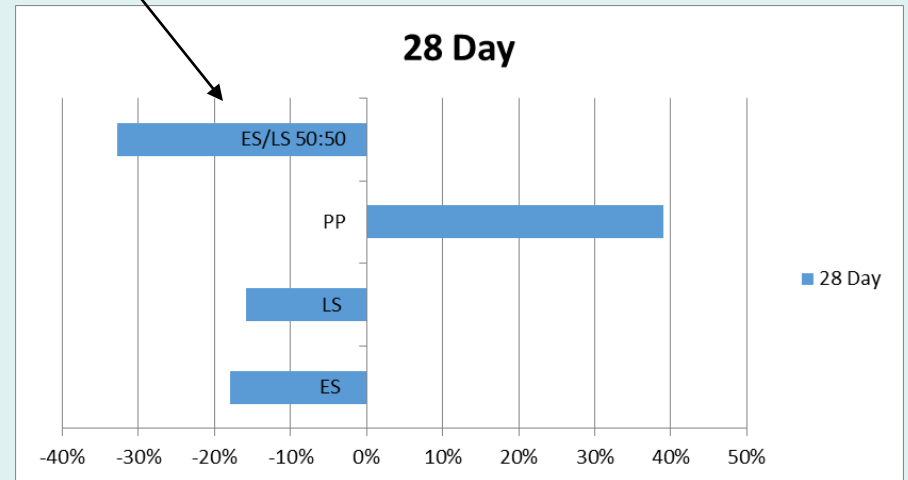
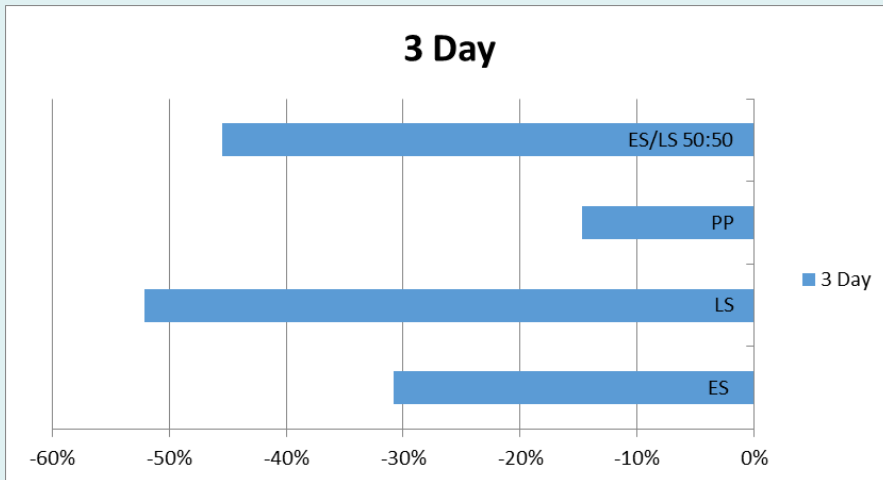
# The Use of ADMIXUS™

## Drying Shrinkage (2#/yd<sup>3</sup> add rate)

Adjusted for slump

	Initial Slump (in.)	Final Slump (in.)	Water added (lbs.)	Final W/C Ratio 2
Control	4.25	n/a	0	0.5
ES	2.750	4.250	1.305	0.528
LS	1.250	4.250	2.010	0.543
PP	3.000	4.250	1.180	0.525
50:50 ES/LS	2.500	4.250	1.515	0.532

Synergy of ES/LS blend



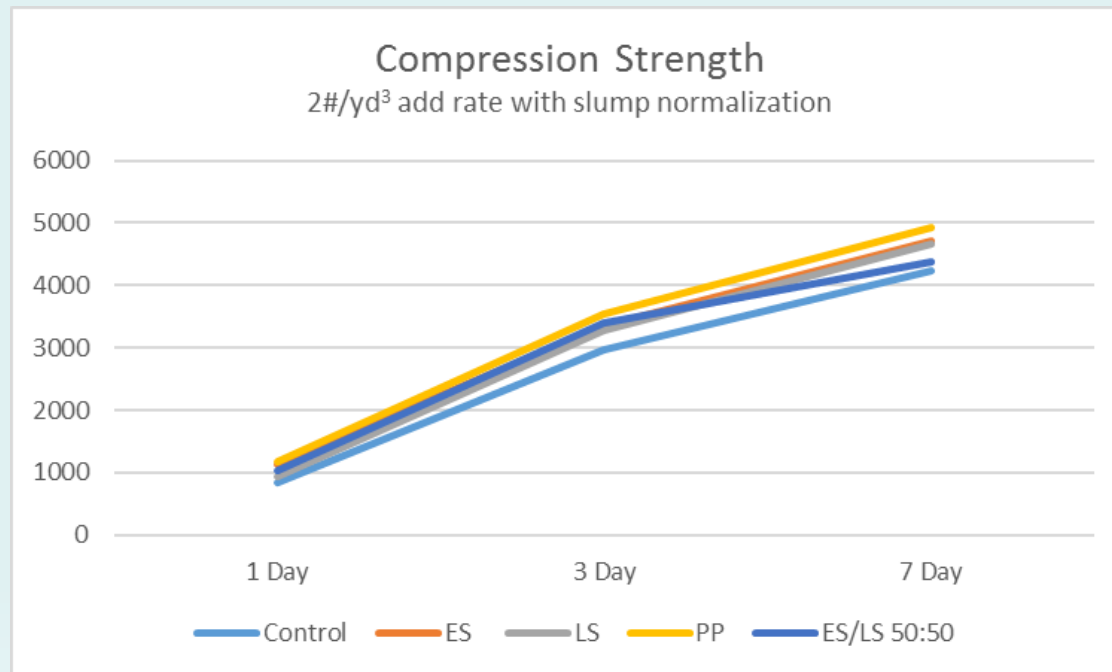
Compression Strength Improvement  
with slump equalization  
**2#/yd<sup>3</sup> add rate**

# The Use of ADMIXUS™

## Compressive Strength (2#/yd<sup>3</sup> add rate)

Adjusted for slump

	1 Day	3 Day	7 Day
Control	843	2963	4240
ES	1133	3340	4700
LS	943	3280	4670
PP	1167	3546	4920
ES/LS 50:50	1043	3400	4380



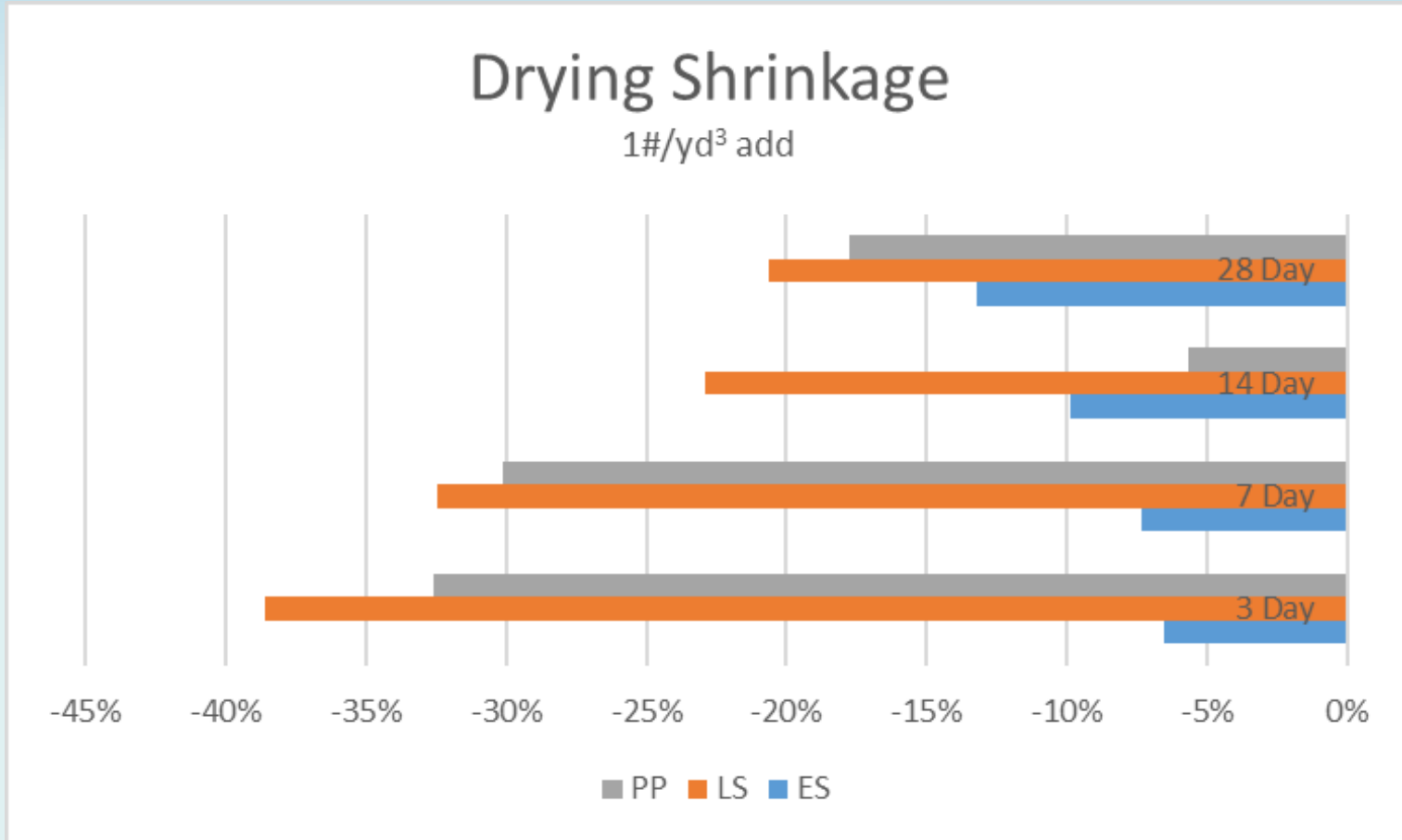


Effect of Lower Use Rate  
Drying Shrinkage Improvement  
**1#/yd<sup>3</sup> add rate**

# The Use of ADMIXUS™

Drying Shrinkage (1#/yd<sup>3</sup> add rate)

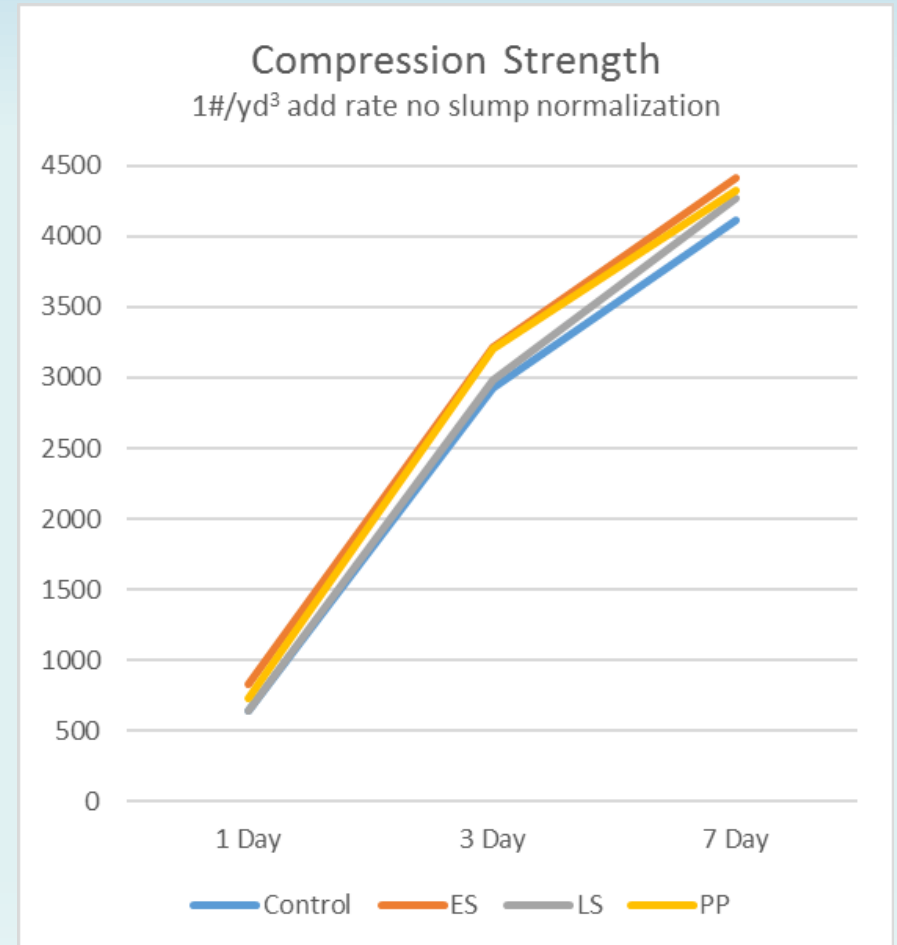
No slump adjustment



# The Use of ADMIXUS™

## Compressive Strength (1#/yd<sup>3</sup> add rate)

Set 3 0.6 kg/m <sup>3</sup>	1 Day	3 Day	7 Day
Control	641	2930	4110
ES	827	3210	4410
LS	643	2980	4270
PP	729	3200	4320

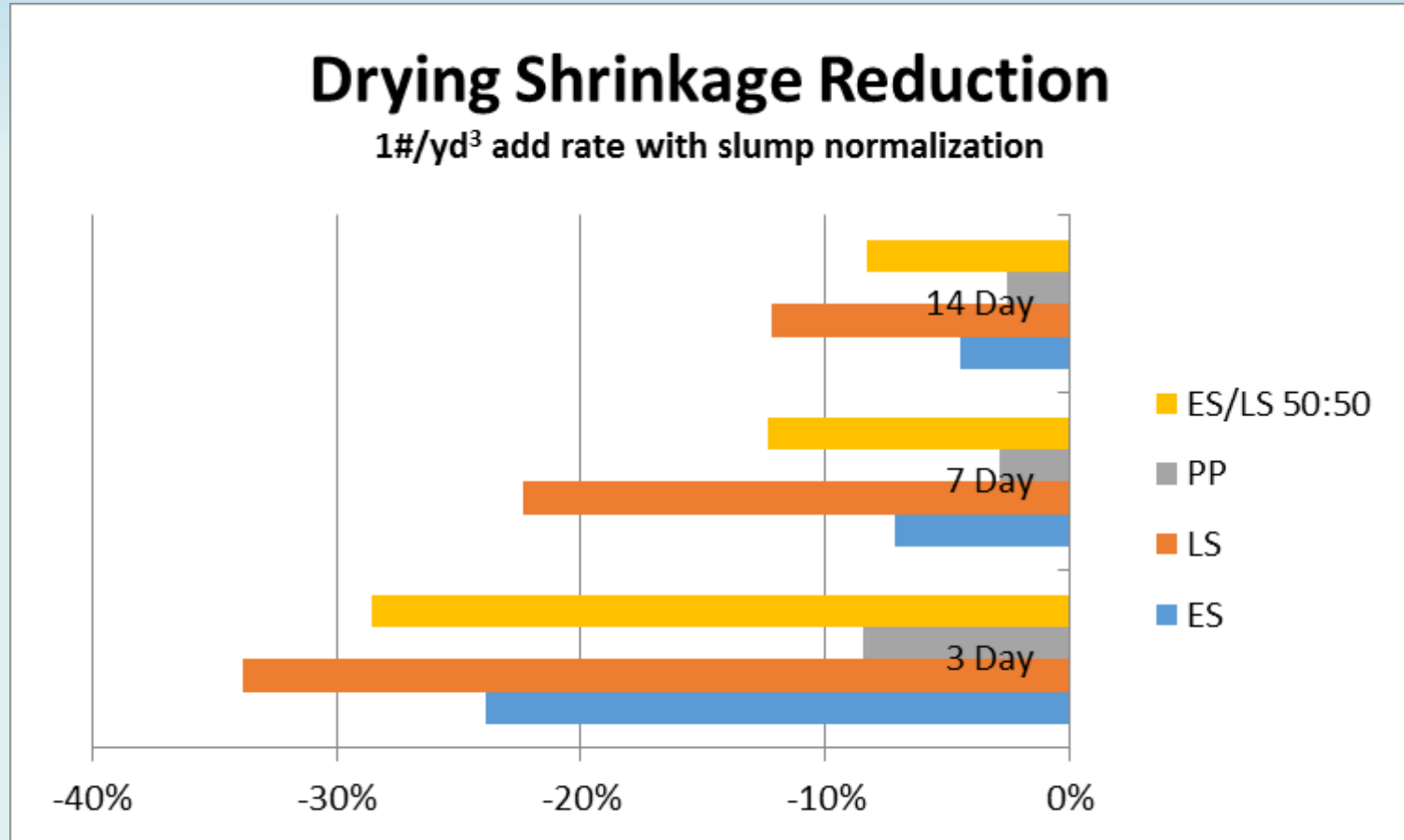


Drying Shrinkage Improvement  
with slump equalization  
**1#/yd<sup>3</sup> add rate**

# The Use of ADMIXUS™

Drying Shrinkage (1#/yd<sup>3</sup> add rate)

With slump adjustment



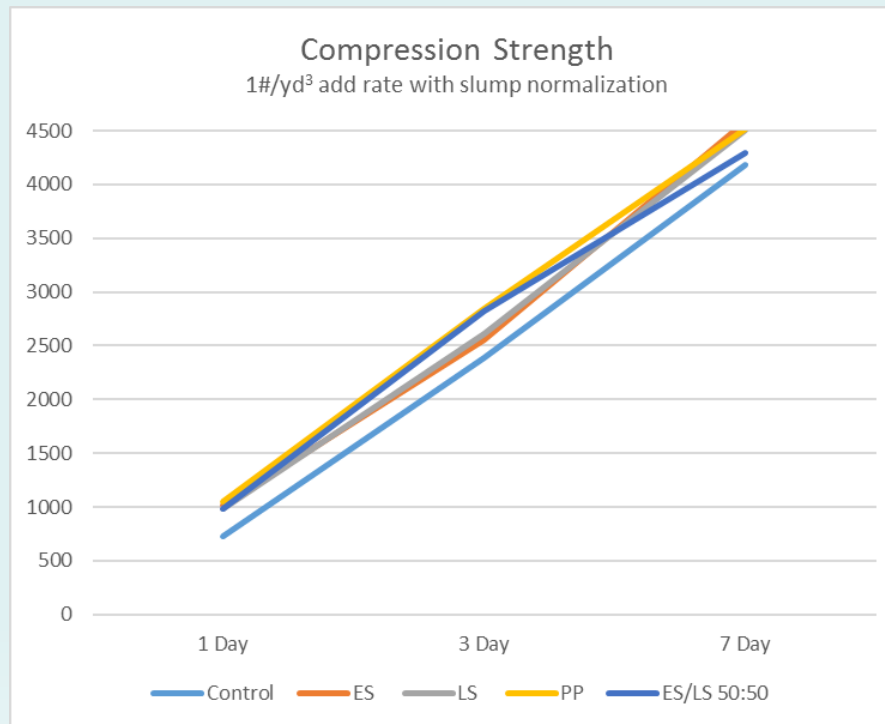
Compression Strength Improvement  
with slump equalization  
**1#/yd<sup>3</sup> add rate**

# The Use of ADMIXUS™

## Compressive Strength (1#/yd<sup>3</sup> add rate)

With slump adjustment

Set 4 0.6 kg/m <sup>3</sup> with slump norm	1 Day	3 Day	7 Day
Control	721	2383	4180
ES	1013	2557	4580
LS	983	2607	4510
PP	1047	2847	4520
ES/LS 50:50	987	2820	4300



# Compression Strength Improvement Cast Concrete Formulation

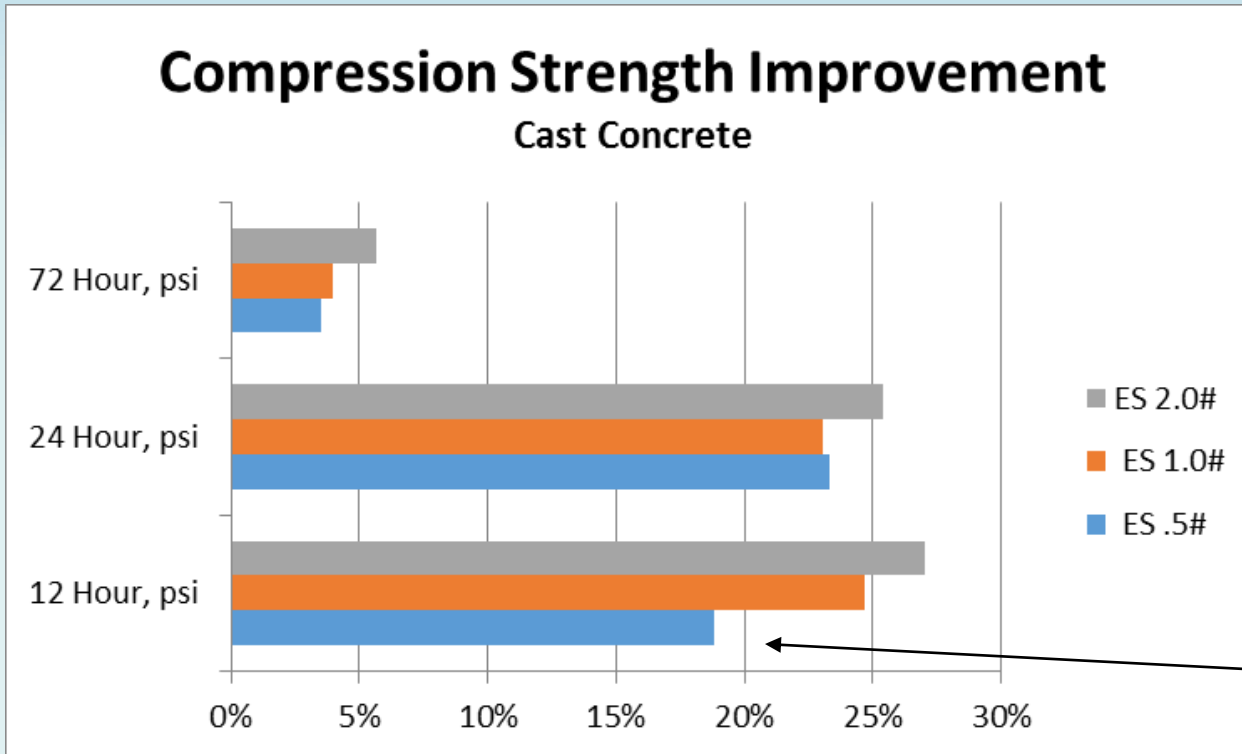


# Cast Formulation

Mix Design				
Material	lbs/yd <sup>3</sup>			
Type III Cement	900			
River Sand	898			
1/2" Limestone	1888			
Water	316.5			
Entrapped Air	2%			
Unit Weight	148.3 lbs/ft <sup>3</sup>			
w/c ration	0.352			
*Full Dosage of Glenium 7500 Water Reducer = 8 fl oz. per cwt				
*Full Dosage of MasterSet AC 534 = 40 fl oz. per cwt				

# The Use of ADMIXUS™

## Compression Strength Increase at Various Addition Rates



Even at 0.5#/yd3 add rate significant improvement

Even at 0.5#/yd3 add rate significant improvement

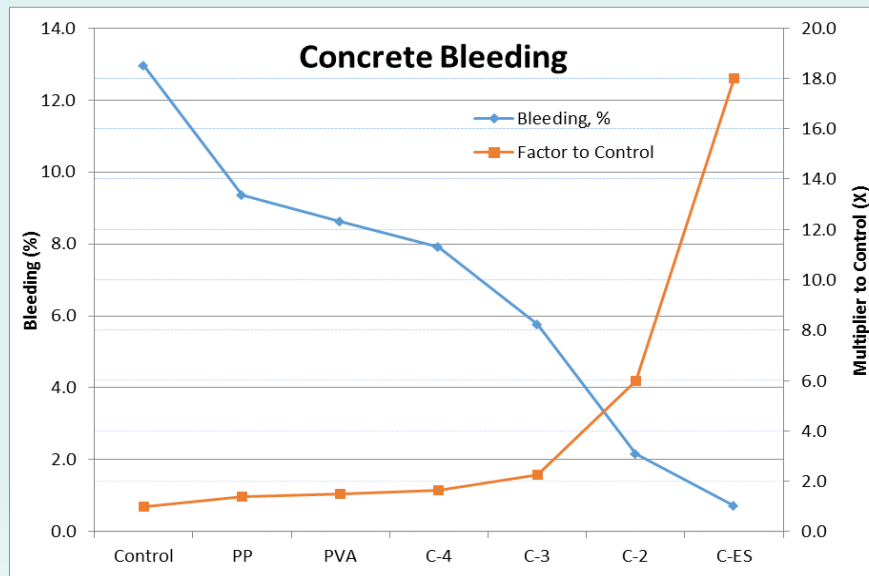
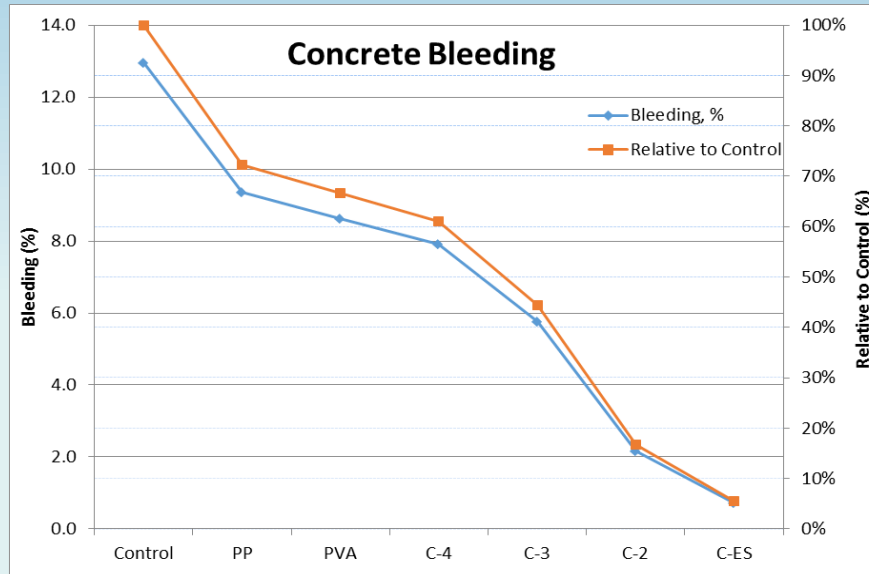
# Bleed Testing Result

ASTM C232

Measures amount of water bleed from fresh  
concrete mix

# The Use of ADMIXUS™

## Bleeding



# Other Tests Conducted

- Tests on plastic shrinkage (ASTM 1579) have been done
  - Tests were done @ 2#/yd<sup>3</sup> addition rate and at 1#/yd<sup>3</sup> add rate and also at both addition rates with slump adjustment with water addition
- Tests on restrained shrinkage (ASTM C1581) have also been conducted

# Plastic Shrinkage Tests (ASTM 1579)

>40% crack reduction ratio to pass

**Addition rate of 2#/yd<sup>3</sup> no slump adjustment**

ASTM C 1579 Plastic Shrinkage Cracking, Set 1	
	Crack Reduction Ratio, %
ES	42.9
LS	44.7
PP	69.8

**Addition rate of 2#/yd<sup>3</sup> with slump adjustment**

ASTM C 1579 Plastic Shrinkage Cracking, Set 2	
	Crack Reduction Ratio, %
ES	29.6
LS	26.3
PP	59.4
ES/LS 50:50	27.2

**Addition rate of 1#/yd<sup>3</sup> no slump adjustment**

ASTM C 1579 Plastic Shrinkage Cracking, Set 3	
	Crack Reduction Ratio, %
ES	31.5
LS	33.1
PP	54.3

**Addition rate of 1#/yd<sup>3</sup> with slump adjustment**

ASTM C 1579 Plastic Shrinkage Cracking, Set 4	
	Crack Reduction Ratio, %
ES	32.4
LS	29.2
PP	57.1
ES/LS 50:50	30.3

# Restrained Shrinkage Test (ASTM C1581)

>28 days to rate at “low potential for cracking”

ASTM C 1581 Restrained Shrinkage, Spring		
	Time of Cracking, Days	Potential for Cracking
PP	>28 Days	Low
PVA	>28 Days	Low
C-1	25.4 Days	Moderate-Low
C-2	20.97 Days	Moderate-Low
ES	26.3 Days	Moderate-Low
C-3	20.2 Days	Moderate-Low

## Newest Data – Tourney Consulting Group

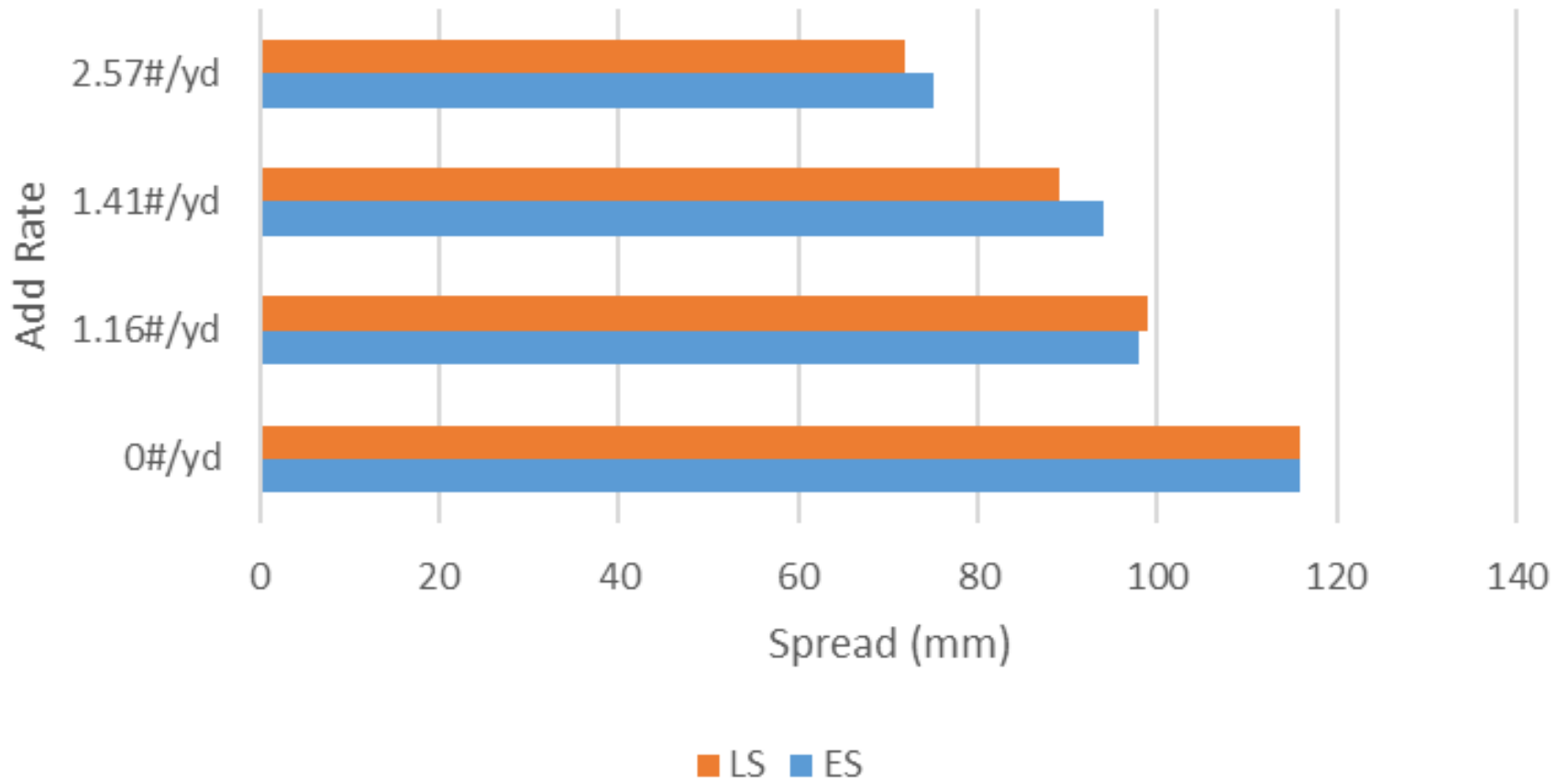
- Tourney Consulting is a concrete engineering firm with a certified laboratory
- This initial work was done to confirm the data gathered at MTSU with new formulations
  - The formulation tested included entrained air (used for freeze-thaw resistance)
  - The formulations also contained fly ash (from coal burning used to reduce cost)



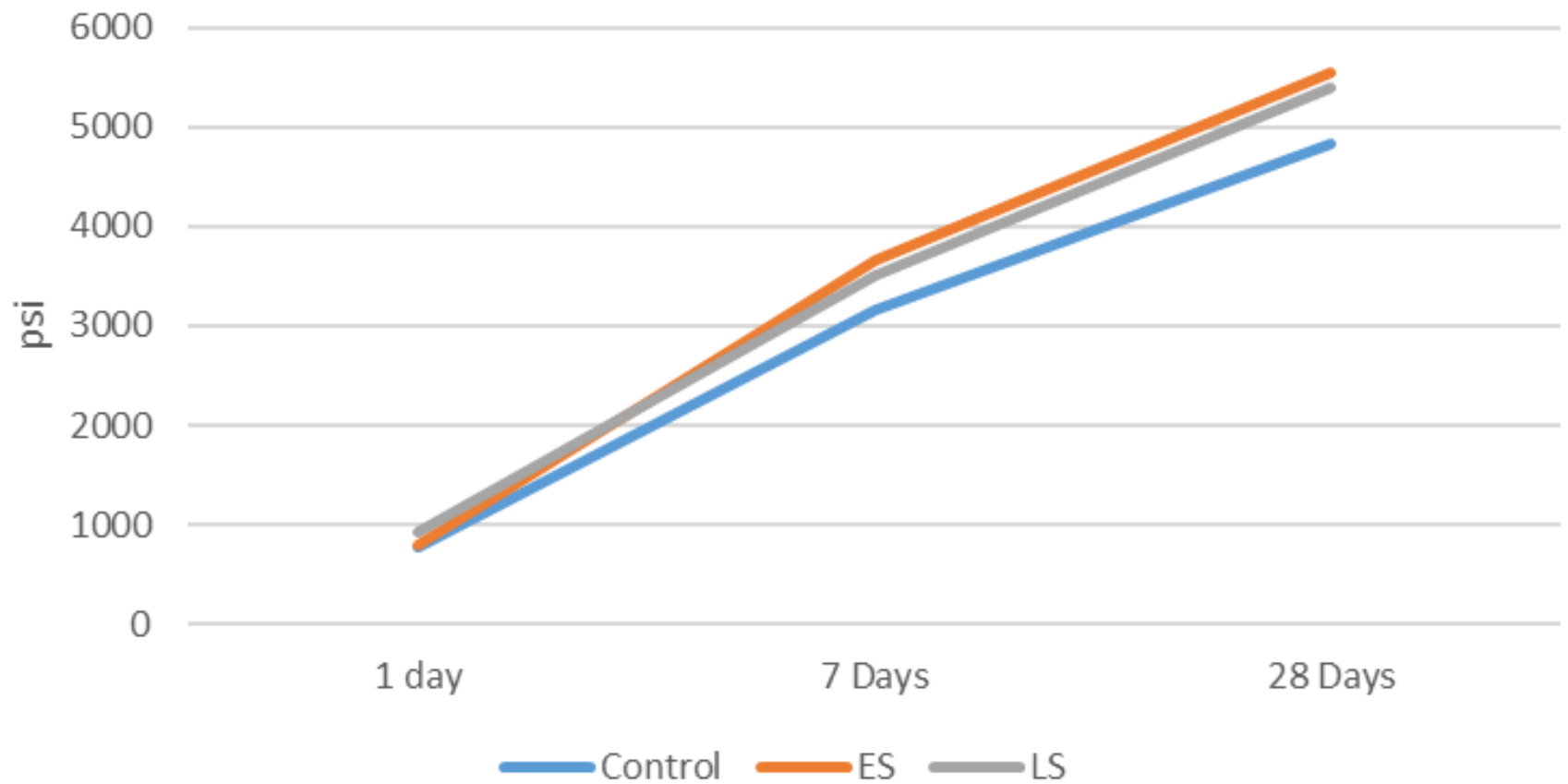
# Formulations - Mortar

Batch Size	Lb/yd3		Lb/yd3	Lb/yd3
Lafarge Type I Alpena 11-6-15	648		648	648
Class C Fly Ash Atl. GA 9/21/15	162		162	162
Consumers Dry Mason Sand	2228		2228	2228
Water	324		324	324
Designed Air Content %	15.0%		15.0%	15.0%
	oz/cwt		oz/cwt	oz/cwt
BASF Master Air-100 (AEA)	0.34		0.34	0.34
BASF Delvo (Ret)	1		1	1
BASF Glenium 7500 (Super)	21.50		23.5	23.5
<b>ES</b>	-		<b>2.57</b>	-
<b>LS</b>	-			<b>2.57</b>

## Effect of Additive on Spread of Mortar



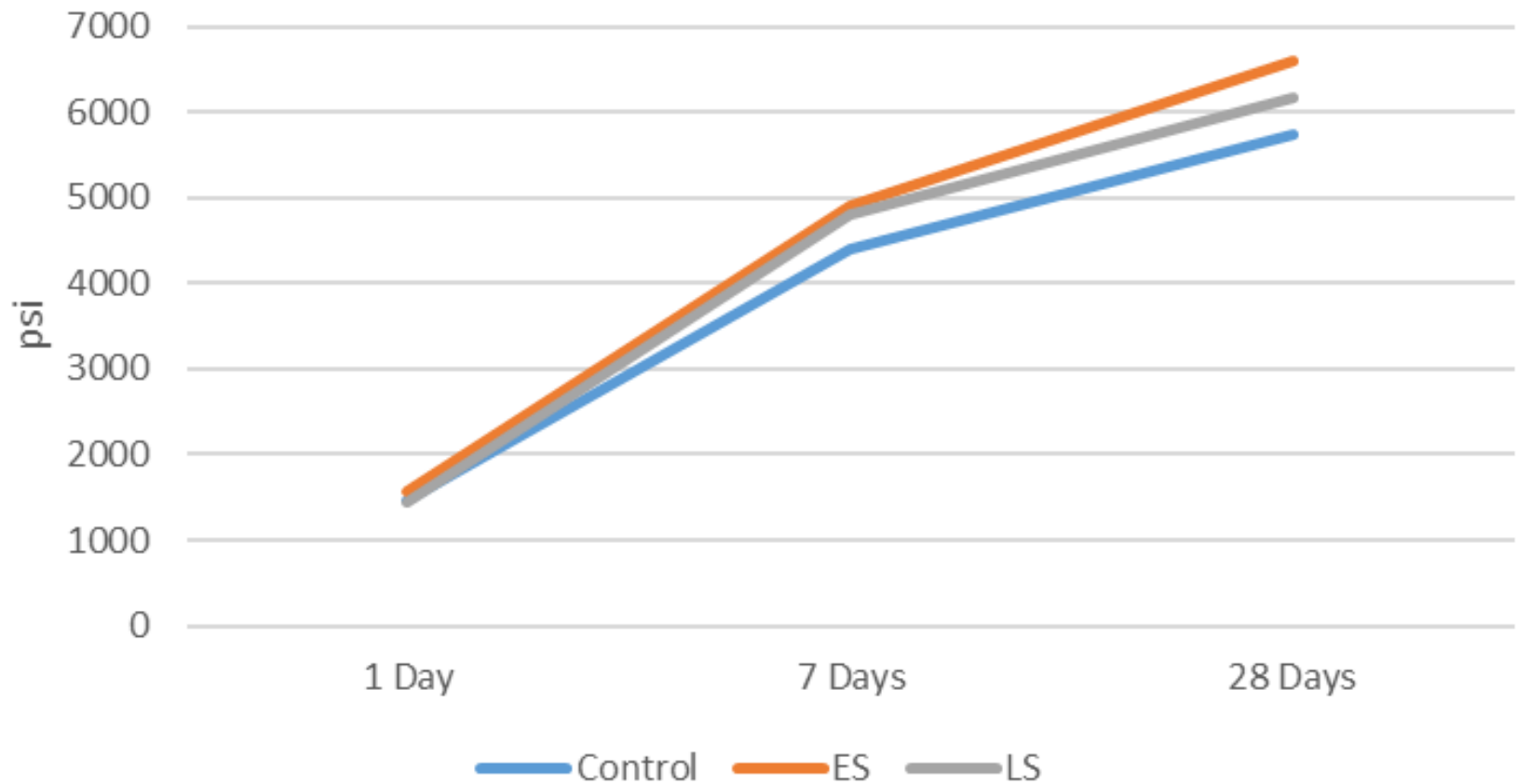
## Compression Strength Mortar



# Formulations for Concrete

	<u>Control</u>		<u>ES</u>		<u>LS</u>
Batch Size	Lb/yd3		Lb/yd3		Lb/yd3
Lafarge Type I Alpena 11/6/16	480		480		480
Class C Fly Ash Atl. GA 9/21/15	120		120		120
Agg resources Midway Nat. Sand	1325		1325		1325
Bay Agg. Cedarville 3/4" Limestone	1800		1800		1800
Water	240		240		240
Designed Air Content %	6.0%		6.0%		6.0%
Designed W/C Ratio	0.40		0.40		0.40
<u>Admixtures</u>	oz/cwt		oz/cwt		oz/cwt
BASF Master Air-100 (AEA)	0.65		0.65		0.65
BASF Delvo (Retarder)	1		1		1
BASF Glenium 7500 (Super)	2		2		2
Mini Fibers ADMIXUS™ ES lbs/ yd3	NO		1.5		NO
Mini Fibers ADMIXUS™ LS lbs/ yd3	NO		NO		1.5

## Compression Strength - Concrete



# Summary

- **ADMIXUS™ ES** improves drying shrinkage and early strength
- **ADMIXUS™ ES** is best for early strength
- **ADMIXUS™ LS** is best for drying shrinkage improvement
- Mixtures of these grades appear to be synergistic for drying shrinkage reduction when slump is adjusted
- **ADMIXUS™ ES** keeps water in the mix (reduced bleed) which we believe is part of its mode of action in these mixes
- **ADMIXUS™ ES** also reduces plastic shrinkage, passes ASTM test at 2#/yd<sup>3</sup> addition rate
- **ADMIXUS™ ES** nearly meets 28 day limit on restrained shrinkage at 2#/yd<sup>3</sup> addition rate
- Latest data at the certified laboratory show both additives increase long term strength when used with fly ash and entrained air

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