SMA Technical Meeting:

Performance Impact of Various Fiber Additions in ASTM C-926 Plaster Basecoat

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Presentation Outline

- Project Goal &Test Methodology
- Test Details
- Discussion and Questions

Project Goal

Determine the significance that variations in fiber dosage, composition, and length have upon ASTM C-926 basecoat plaster

Will fibers increase strength?
Will fibers improve shrinkage?
Will fibers prevent cracking?
Do fibers increase water retention?

Project Outline

C 926 – 06

TABLE 3 Base-Coat Proportions,[A] Parts by Volume[B]

Plaster Mix Symbols	Cementitious Materials					Volume of Aggregate per Sum of Separate Volumes of Cementitious Materials	
	Portland Cement or Blended Cement	Plastic Cement	Masonry Cement		Lime		
			N	M or S		1st Coat	2nd[C] Coat
C	1	...	...	...	0–¾	2½ –4	3–5
CL	1	...	...	...	¾ –1½	2½ –4	3–5
M	...	...	1	...	...	2½ –4	3–5
CM	1	...	1	...	...	2½ –4	3–5
MS	...	...	...	1	...	2½ –4	3–5
P	...	1	...	...	...	2½ –4	3–5
CP	1	1	...	...	...	2½ –4	3–5

[A] The mix proportions for plaster scratch and brown coats to receive ceramic tile shall be in accordance with the applicable requirements of ANSI A108.1 series applicable to specified method of setting time.

[B] Variations in lime, sand, and perlite contents are allowed due to variation in local sands and insulation and weight requirements. A higher lime content will generally support a higher aggregate content without loss of workability. The workability of the plaster mix will govern the amounts of lime, sand, or perlite.

[C] The same or greater sand proportion shall be used in the second coat than is used in the first coat.

Materials

- Cement: Plastic Cement
  - Conforming to ASTM C-1328 from local producer.
- Sand: “ASTM C-897”/ “ASTM C-144”
  - Meets composition requirement
  - Meets fineness modulus – 2.85
  - Non-conforming gradation – Allowed in ASTM C-926 based on “demonstrated” performance
- Water
  - Deionized

Materials: Sand

	ASTM C-144 (% Retained)		ASTM C-897 (% Retained)		
U.S. Standard Sieve	Natural	Manufactured	Natural	Manufactured	Trial Sand
No. 4	0	0	0	0	0.00
No. 8	0-5	0-5	0-10	0-10	8.20
No. 16	0-30	0-30	10-40	10-40	25.90
No. 30	25-60	25-60	30-65	30-65	64.20
No. 50	65-90	60-80	70-90	60-80	69.20
No. 100	85-98	75-90	95-100	75-90	97.60
No. 200	95-100	90-100	97-100	90-100	99.50

4.4 *Aggregates*:

4.4.1 *Sand for Base Coats*—Specification C 897. Aggregate failing to meet gradation limits in Specification C 897 shall be permitted to be used, provided the plaster made with this sand has an acceptable demonstrated performance record in similar construction and climate conditions.

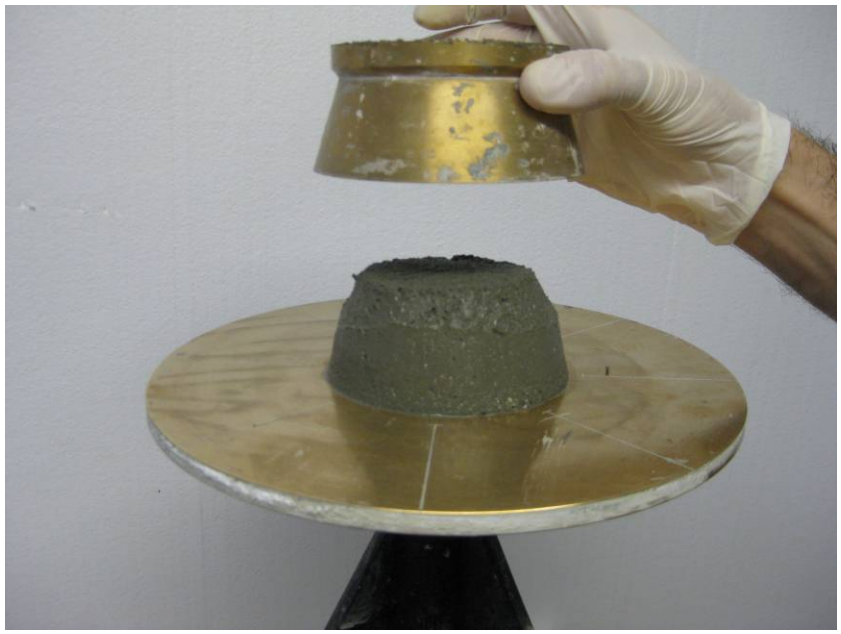
Materials: Fibers

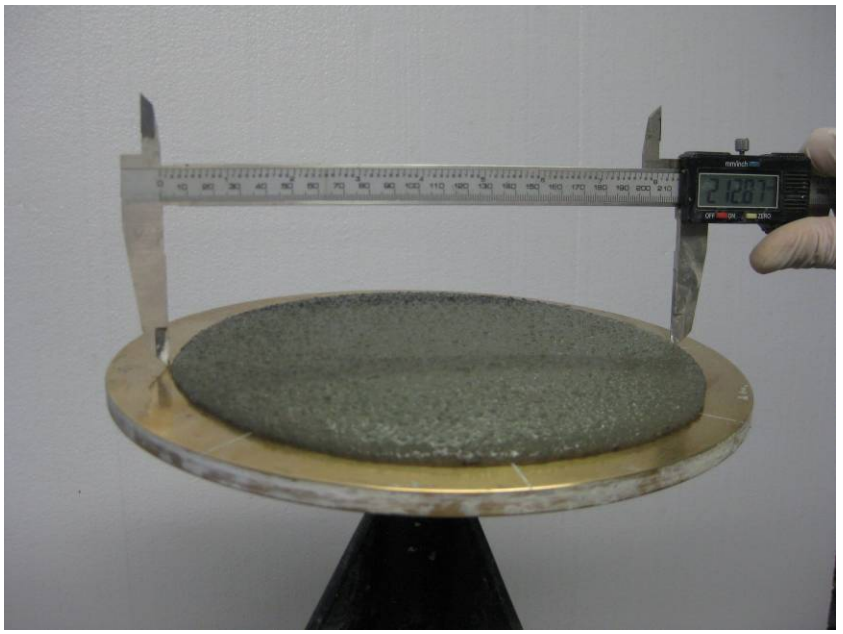
Trial	Composition	Length	Comments
	Control		No Fiber
FB1	AR Glass	1/4"	Water dispersible
FB2	AR Glass	1/2"	Water dispersible
FB3	AR Glass	1/2"	Standard Chopped
FB4	AR Glass	1/4"	Water dispersible
FB5	AR Glass	1/2"	Water dispersible
FB6	Polypropylene	3/16"	
FB7	Polyester	1/2"	Uncrimped, staplecut
FB8	Polypropylene	3/8"	
FB9	Cellulose	400uM	
FB10	Polyethylene	15uM	Hydrophillic PE

Basic Recipe

Plastic Cement	**500**	**500**
Sand	**1500**	**1500**
Glass Fibers	**2 or 6**	
Organic Fibers (all others)		**1 or 3**
Water	**Adjusted to 110% Flow**	

Trials





We use the flow table to benchmark workability/flow in the lab

All mixes adjusted to 110% +/- 5% Flow

Curing Conditions

- AC – Air Cure
  - 24 Hours Molded 75F, Covered
  - 27 Days 75F, 50% R.H.
- MC – Moist Cure
  - 24 Hours Molded 75F, Covered
  - 6 Days 75F, 95% R.H
  - 21 Days 75F, 50% R.H.

Real World vs. Lab

- There is **NO** substitute for Real World data
- …but Real World data is:
  - difficult to collect
  - difficult to interpret do to uncontrollable field variations across trials
  - difficult to conduct due to testing limitations
  - expensive

Real World vs. Lab

- Lab data provides results under controlled conditions that can reveal trends and properties that can help explain field results and/or focus field testing into something manageable
- Lab data is only part of the story!

Testing

- Dispersion – Wet and Dry
- Wet Density
- Compressive Strength
- Tensile Strength
- Flexural (Bending) Strength
- Shrinkage
- Check Cracking

Dry Dispersion

Concerns for processing:

- **Tangles**
- **Bundles**
- **Matting**
- **Longer fibers matt**
- **Shorter fibers bundle**
- **Flexibility makes it worse**
- **Higher dosage makes it worse**
- **FB1, FB2, FB7, FB8, FB10**
- **FB6 is marginal**

Dry Dispersion

Dispersed and Uniform:

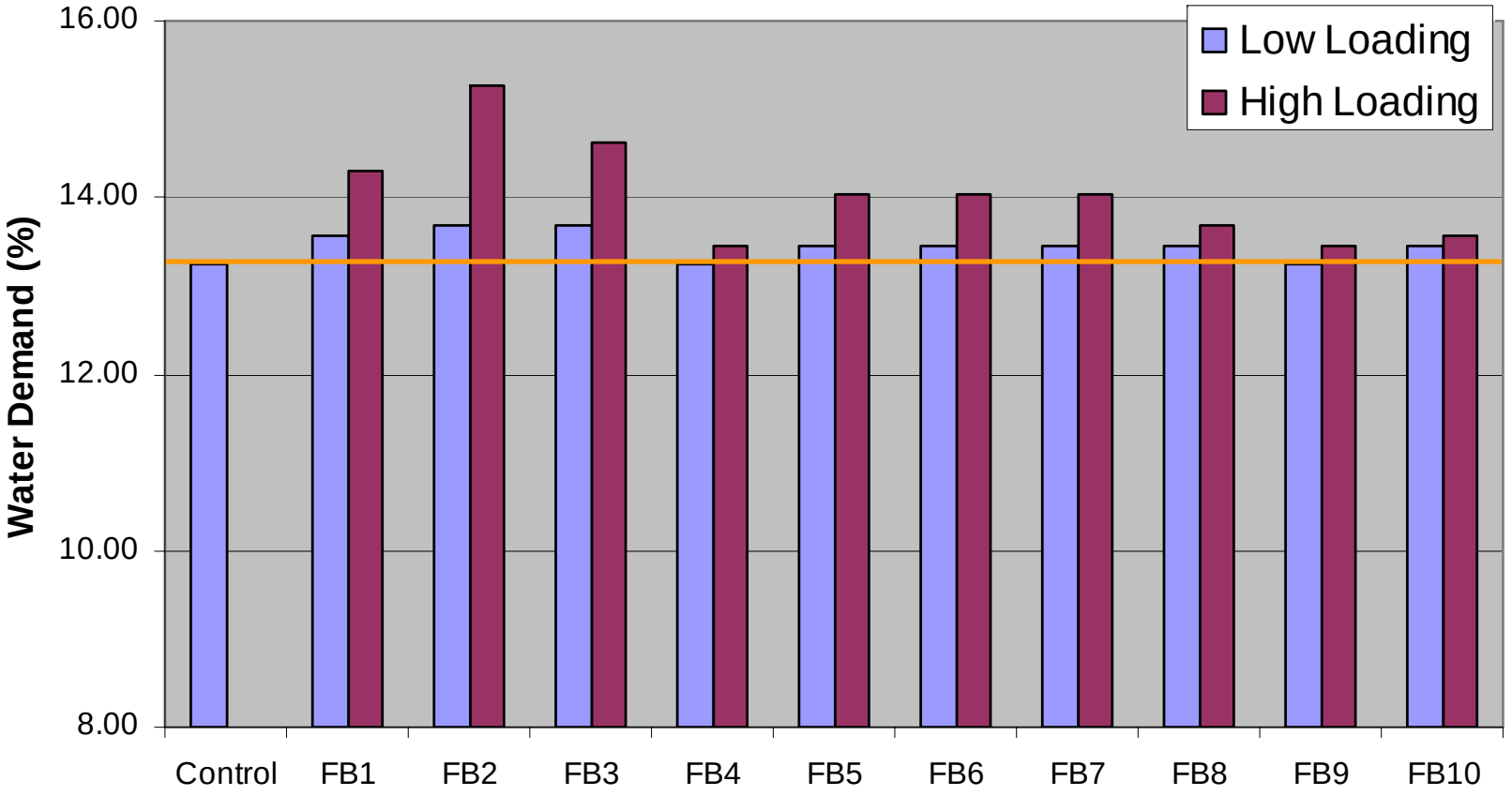
- **Harder/firmer fibers**
- **Less clinging and wrapping with smaller fibers**
- **FB3, FB4, FB5, FB9**

Wet Dispersion

Concerns for Application:

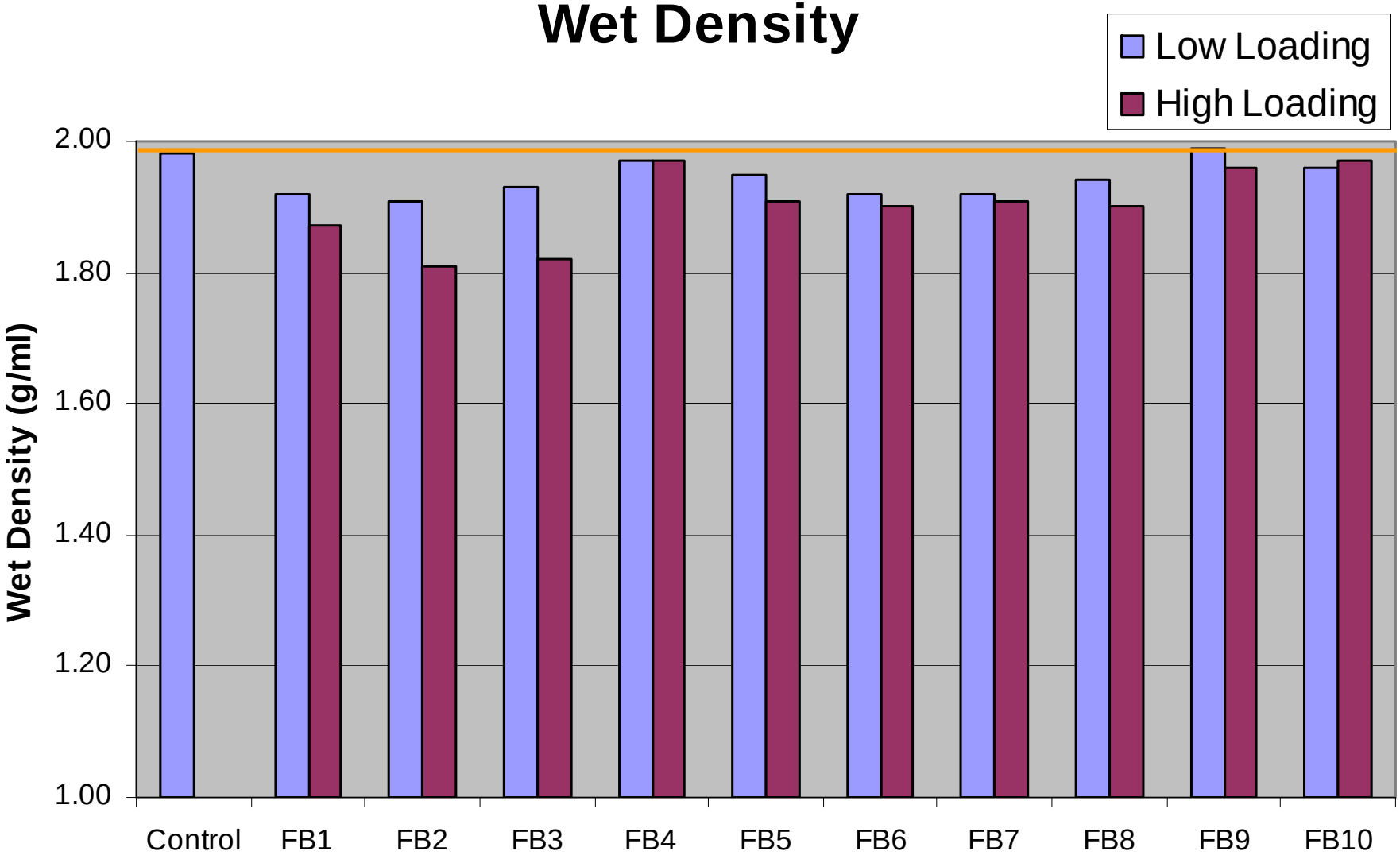
- **Sprayability – Clogged nozzles**
- **Clumping**
- **Dispersion => Efficiency**
- **High dosages can be problematic for all grades**
- **Longer flexible fibers more problematic**
- **FB3 does not break up**
- **FB7 tangles and bridges**

Water Demand @ 110% Flow



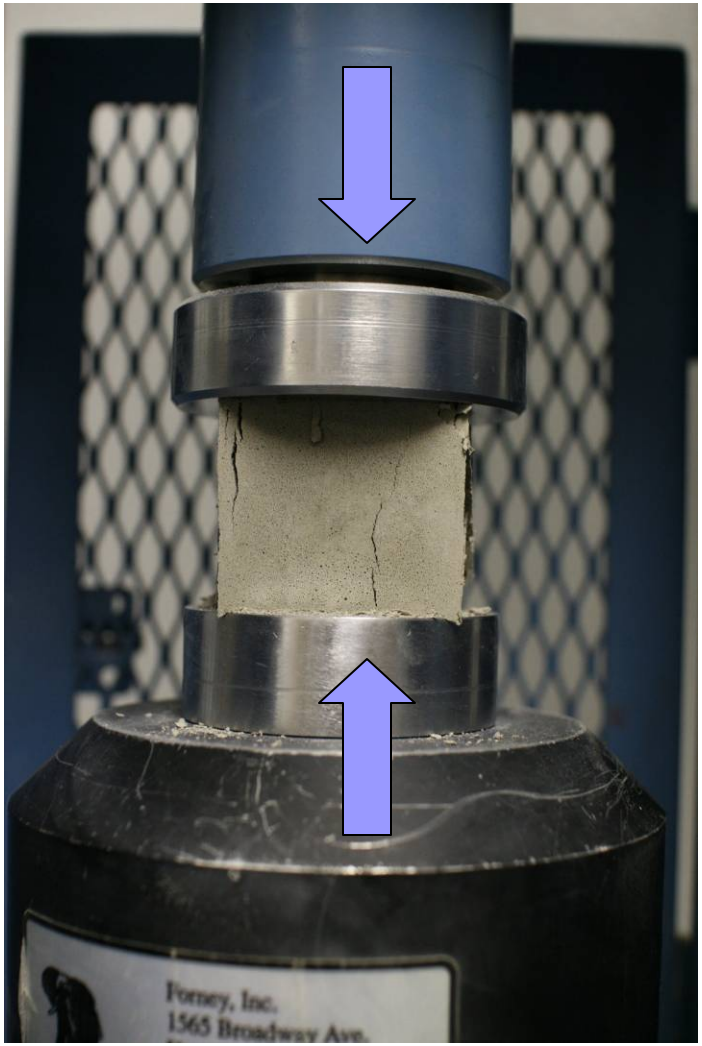
Most fibers increased water demand
1% on the graph = 4lbs water per sack of cement

Wet Density

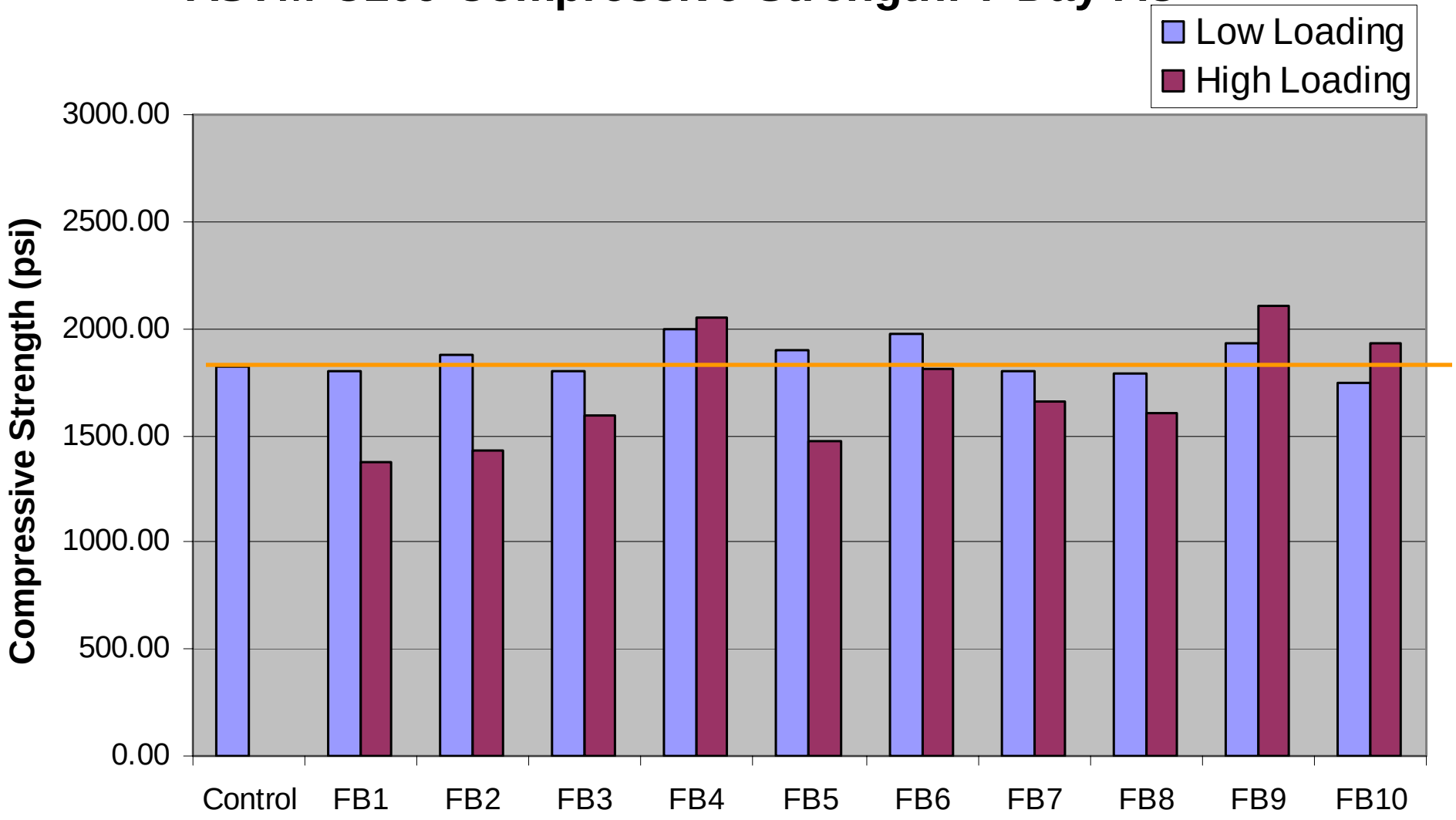


A decrease in density can be attributed to higher water, and higher air
Keep this in mind as we look at strength numbers in following slides

Testing: Compressive Strength

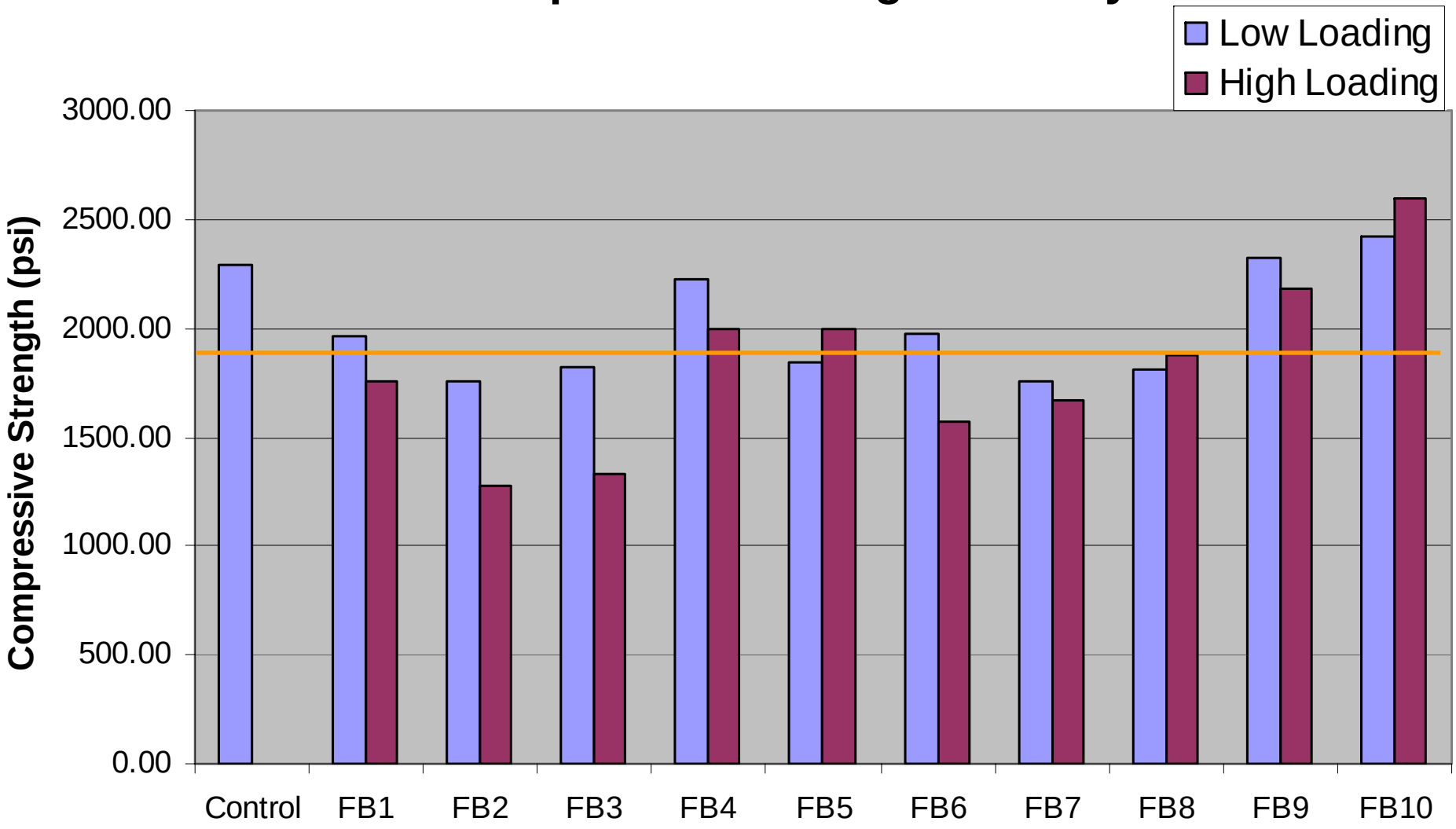


ASTM C109 Compressive Strength: 7 Day AC



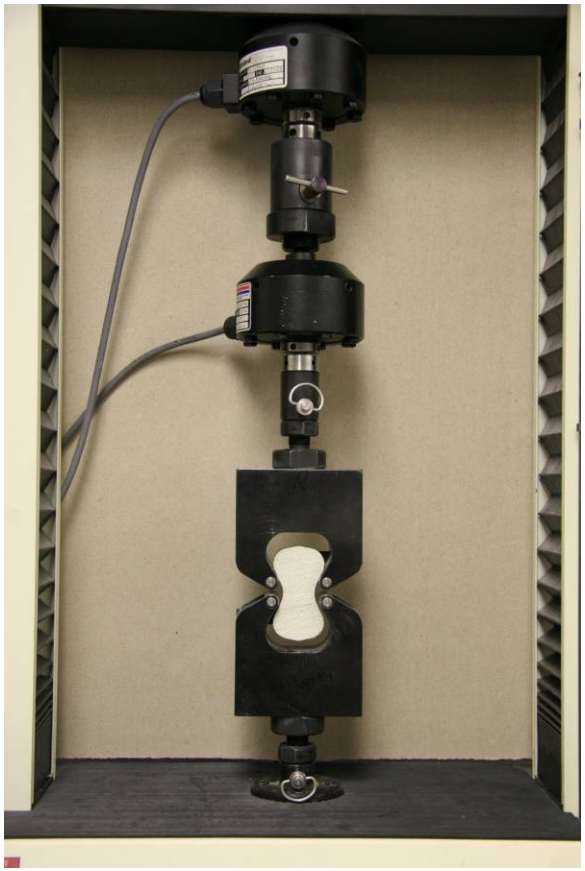
We believe the loss in strength is primarily due to added water for workability

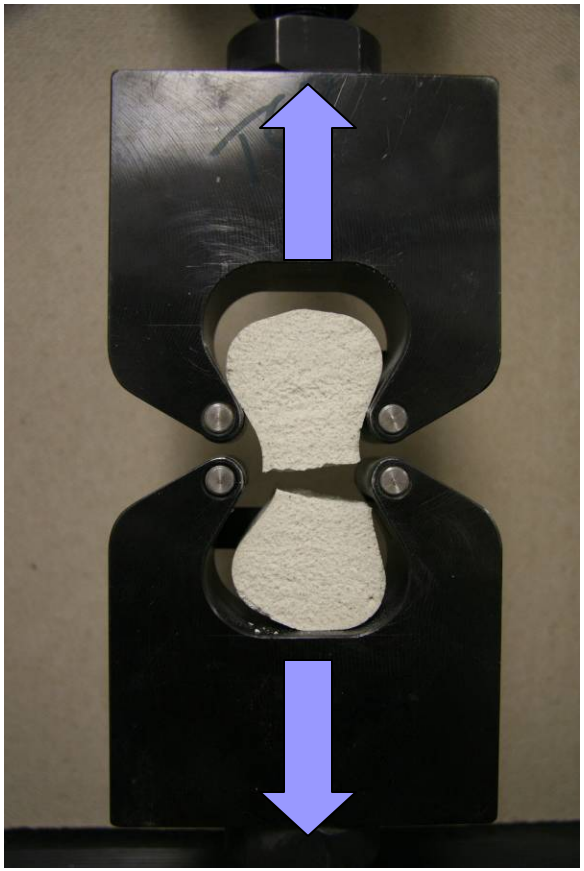
ASTM C109 Compressive Strength: 28 Day AC



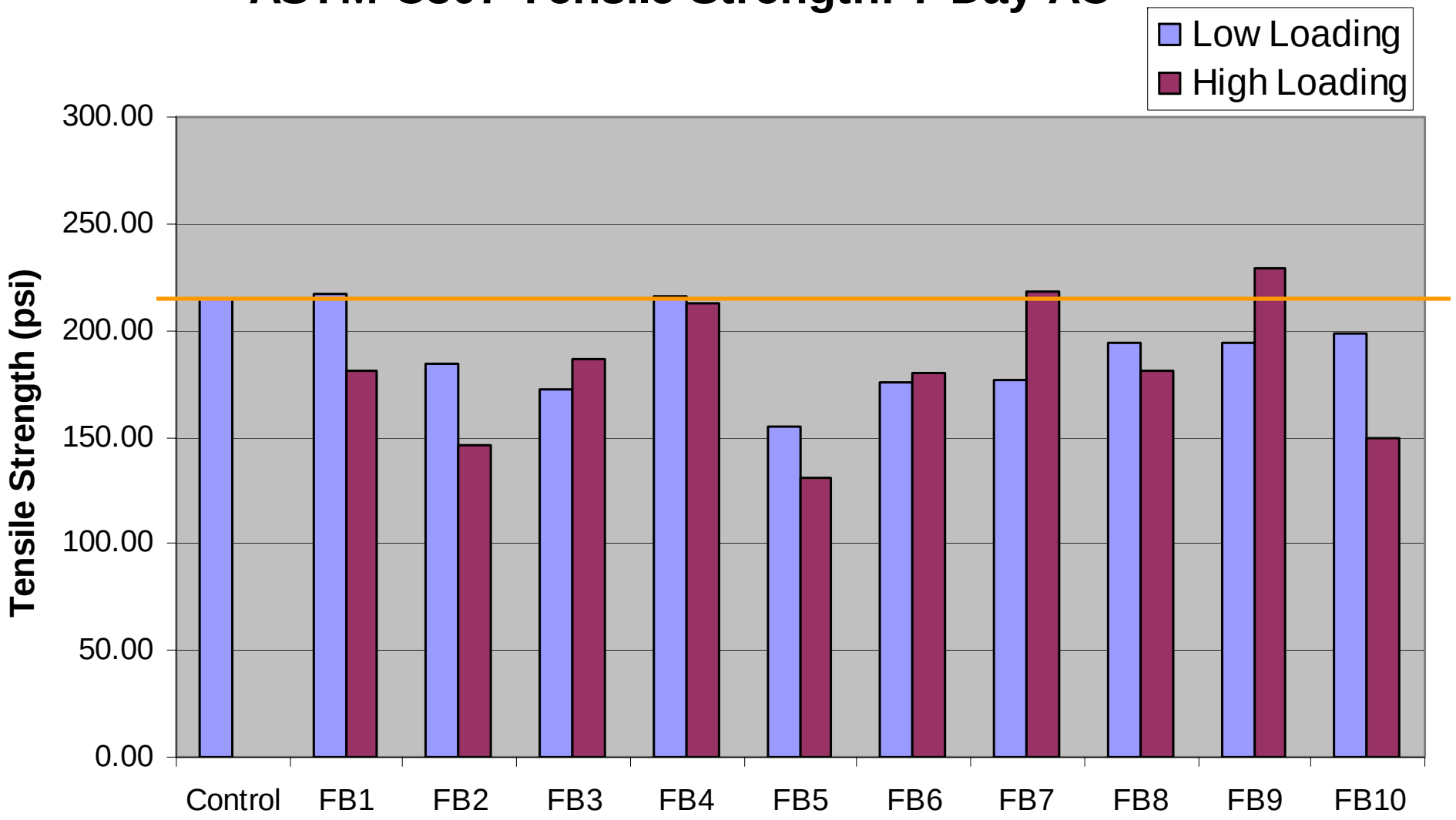
We believe the loss in strength is primarily due to added water for workability

Testing: Tensile Strength

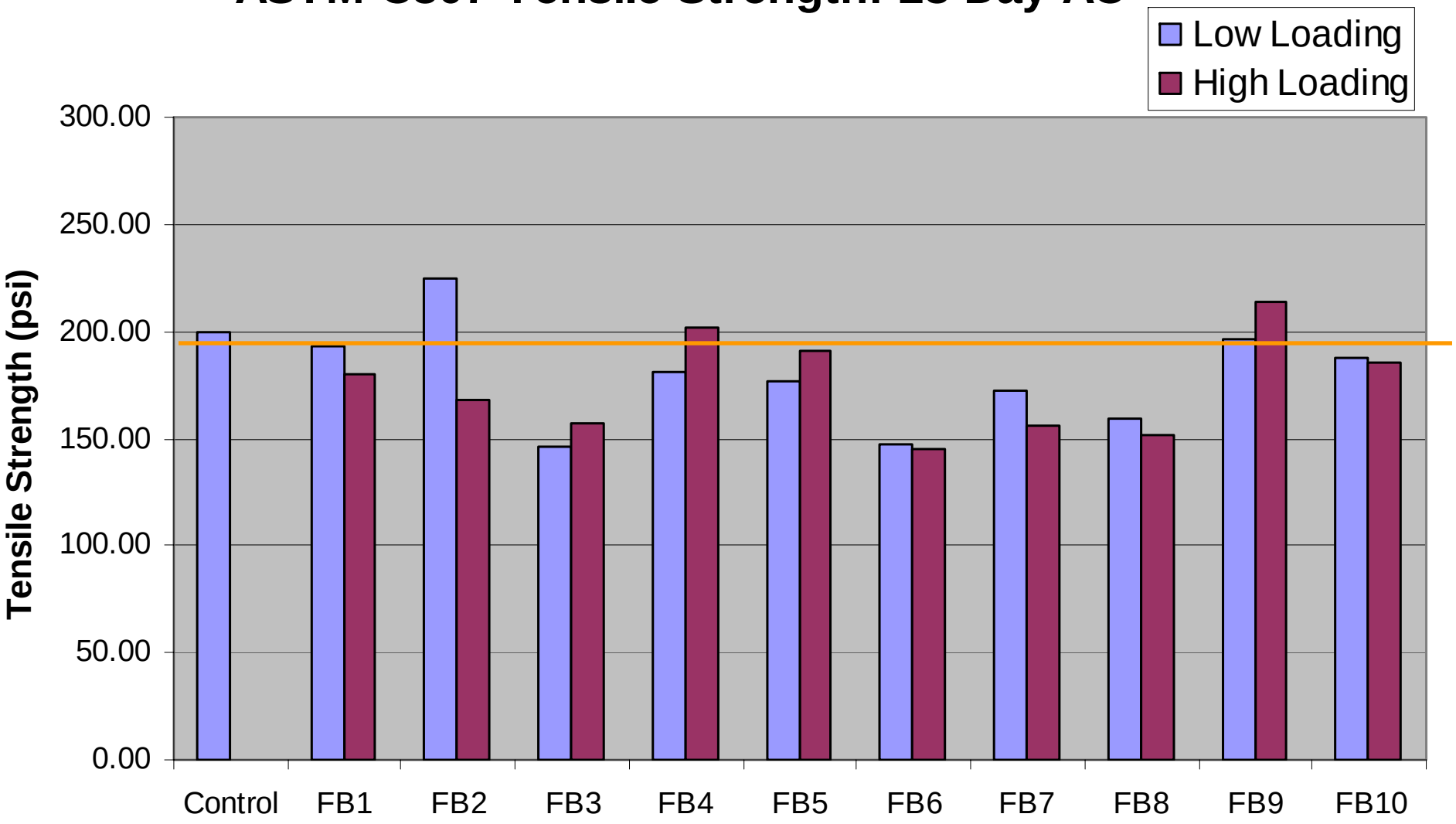




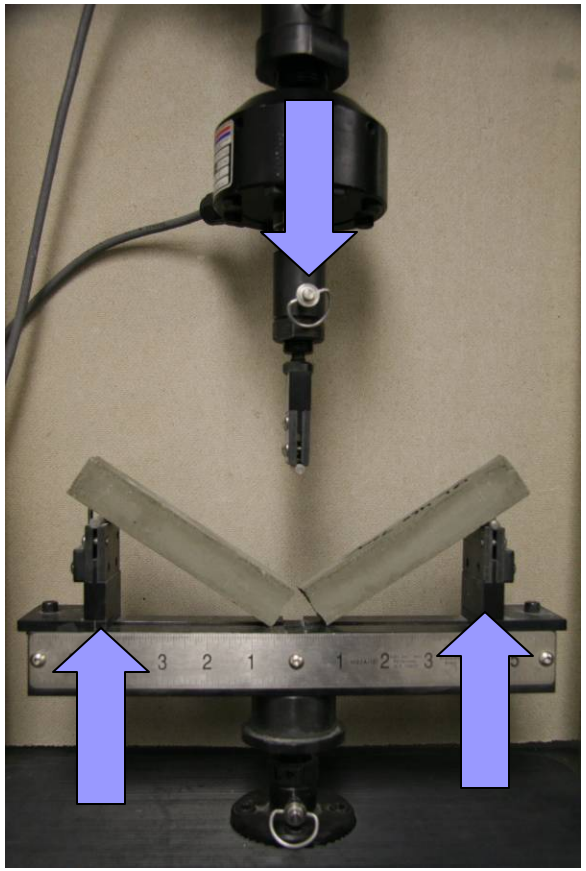
ASTM C307 Tensile Strength: 7 Day AC



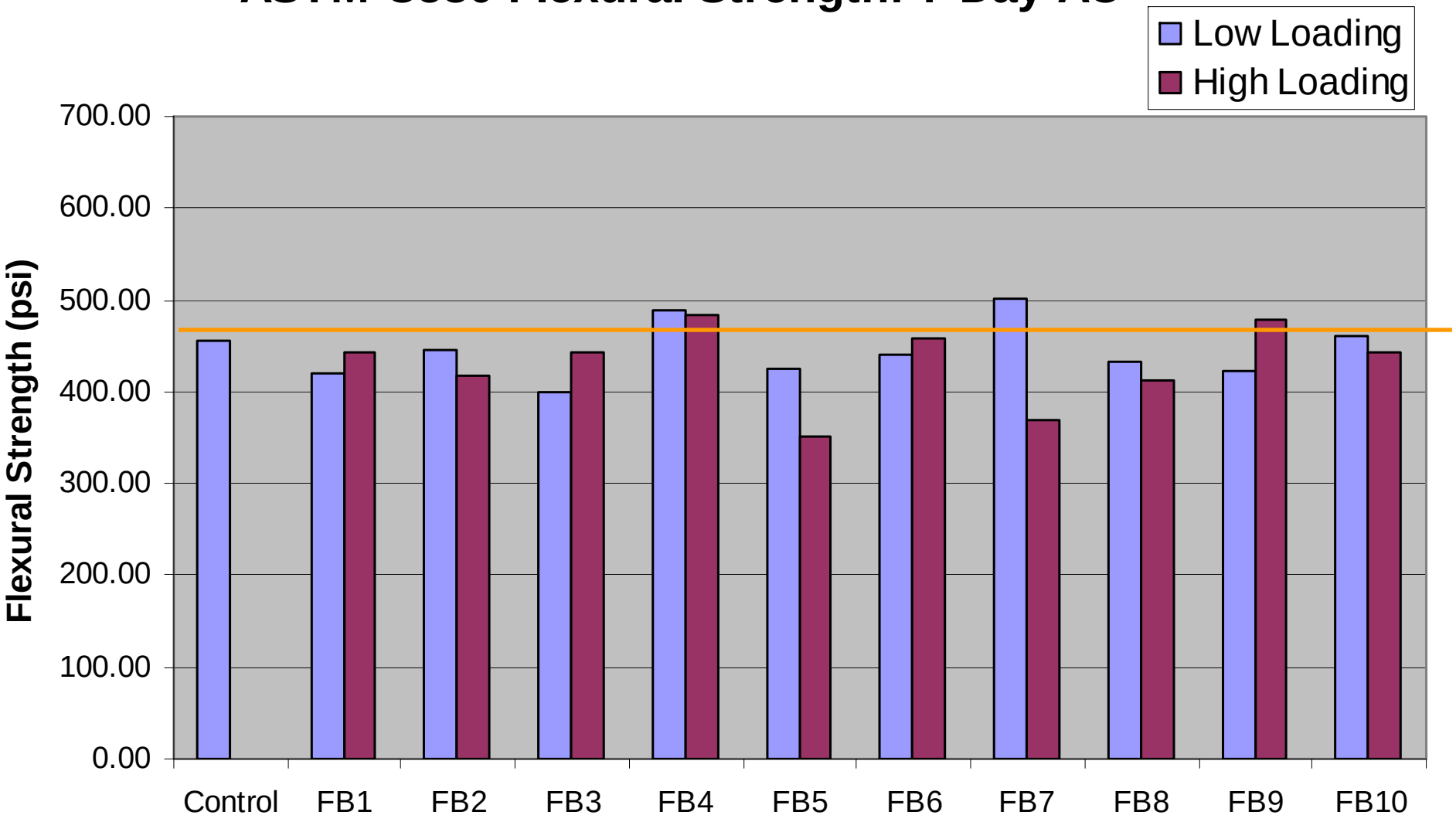
ASTM C307 Tensile Strength: 28 Day AC



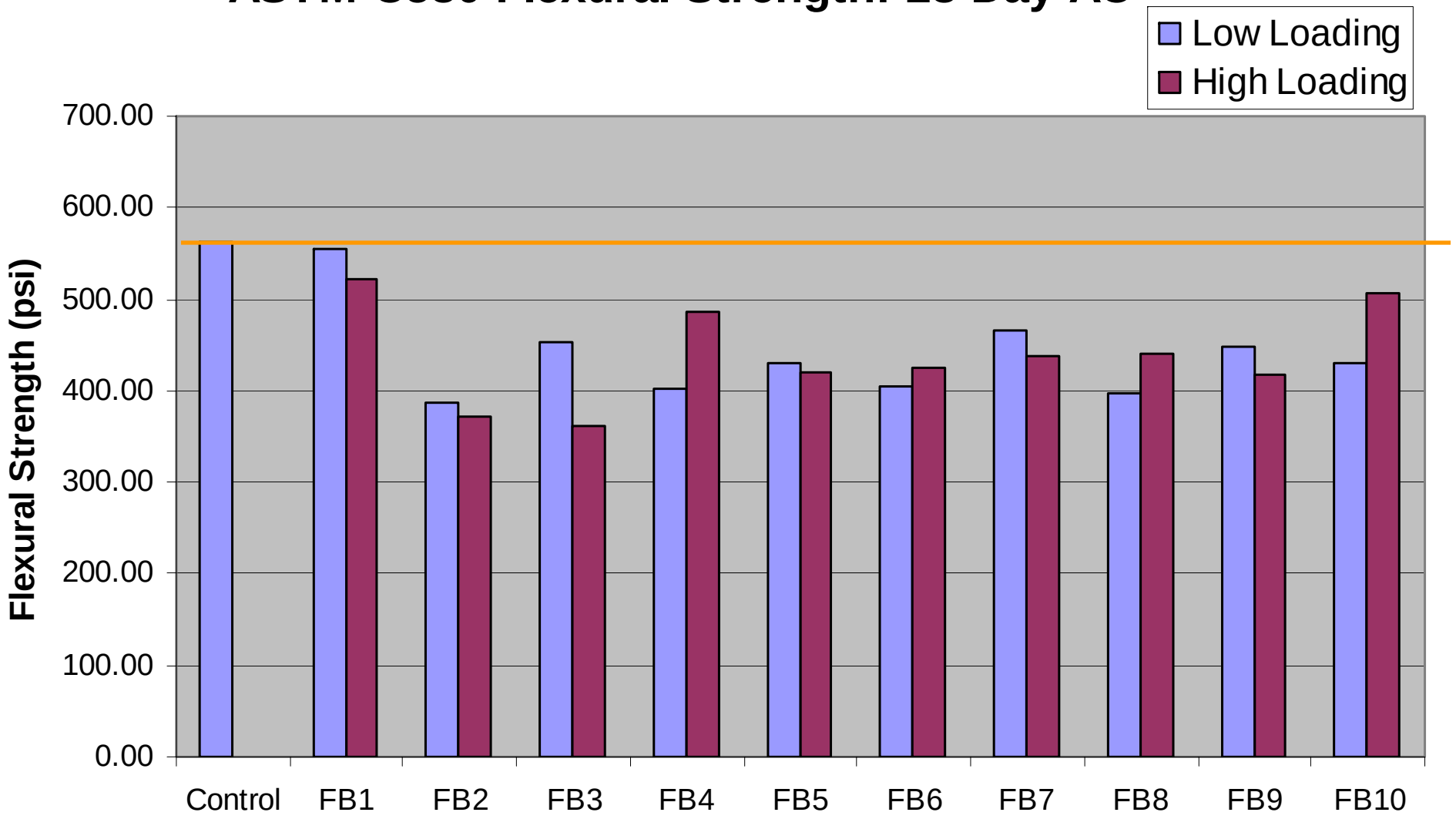
Testing: Flexural Strength



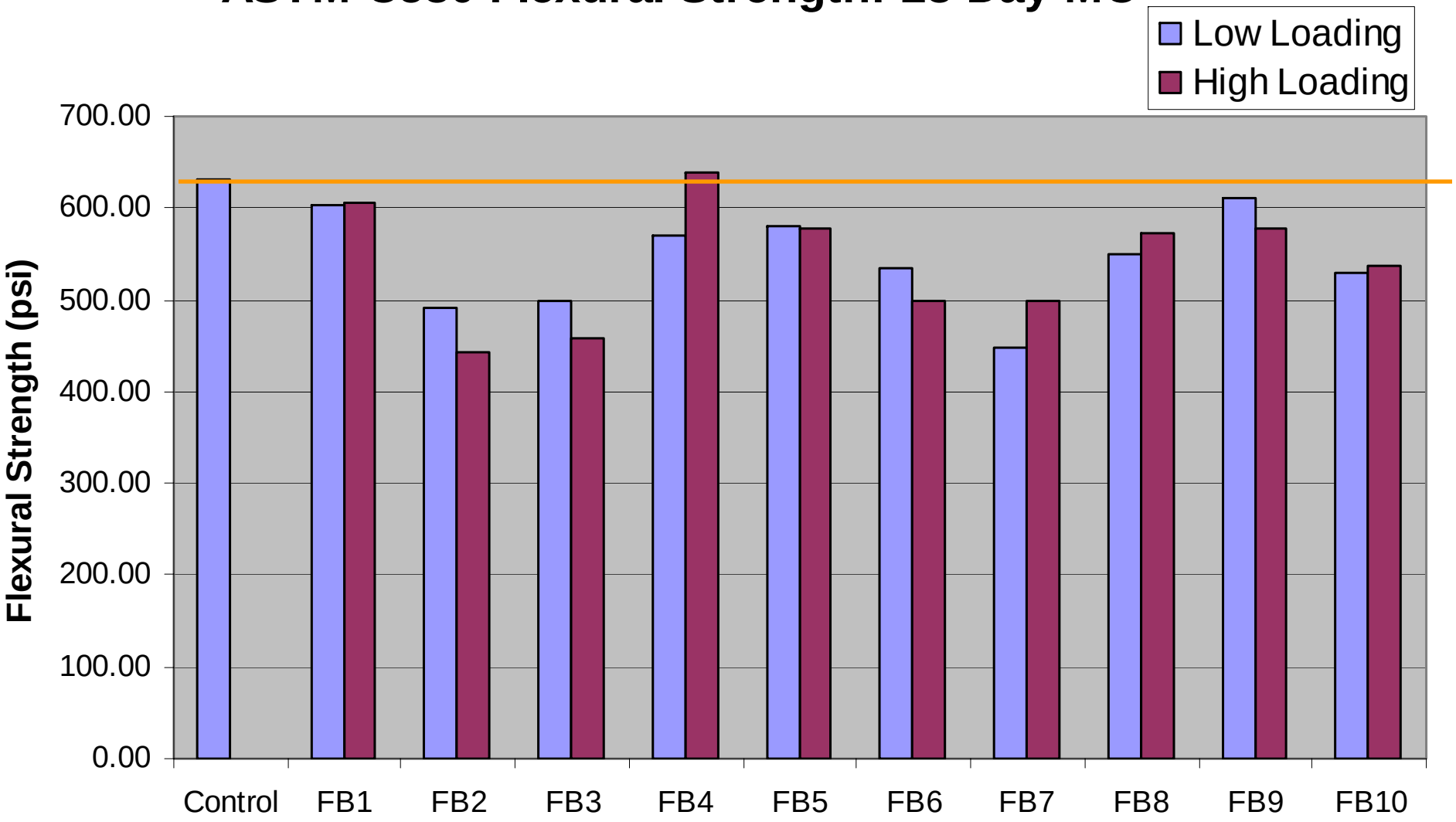
ASTM C580 Flexural Strength: 7 Day AC



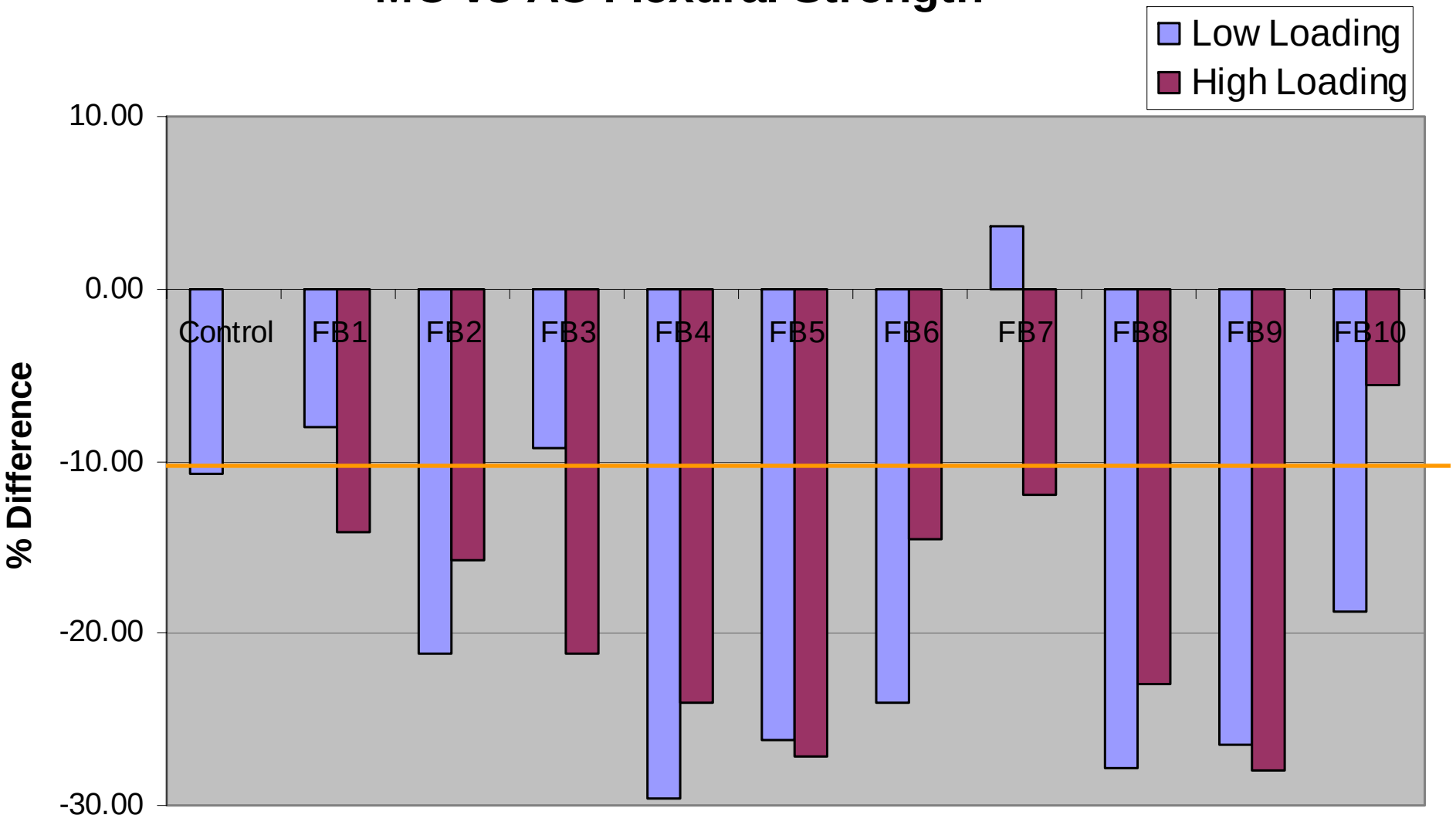
ASTM C580 Flexural Strength: 28 Day AC



ASTM C580 Flexural Strength: 28 Day MC

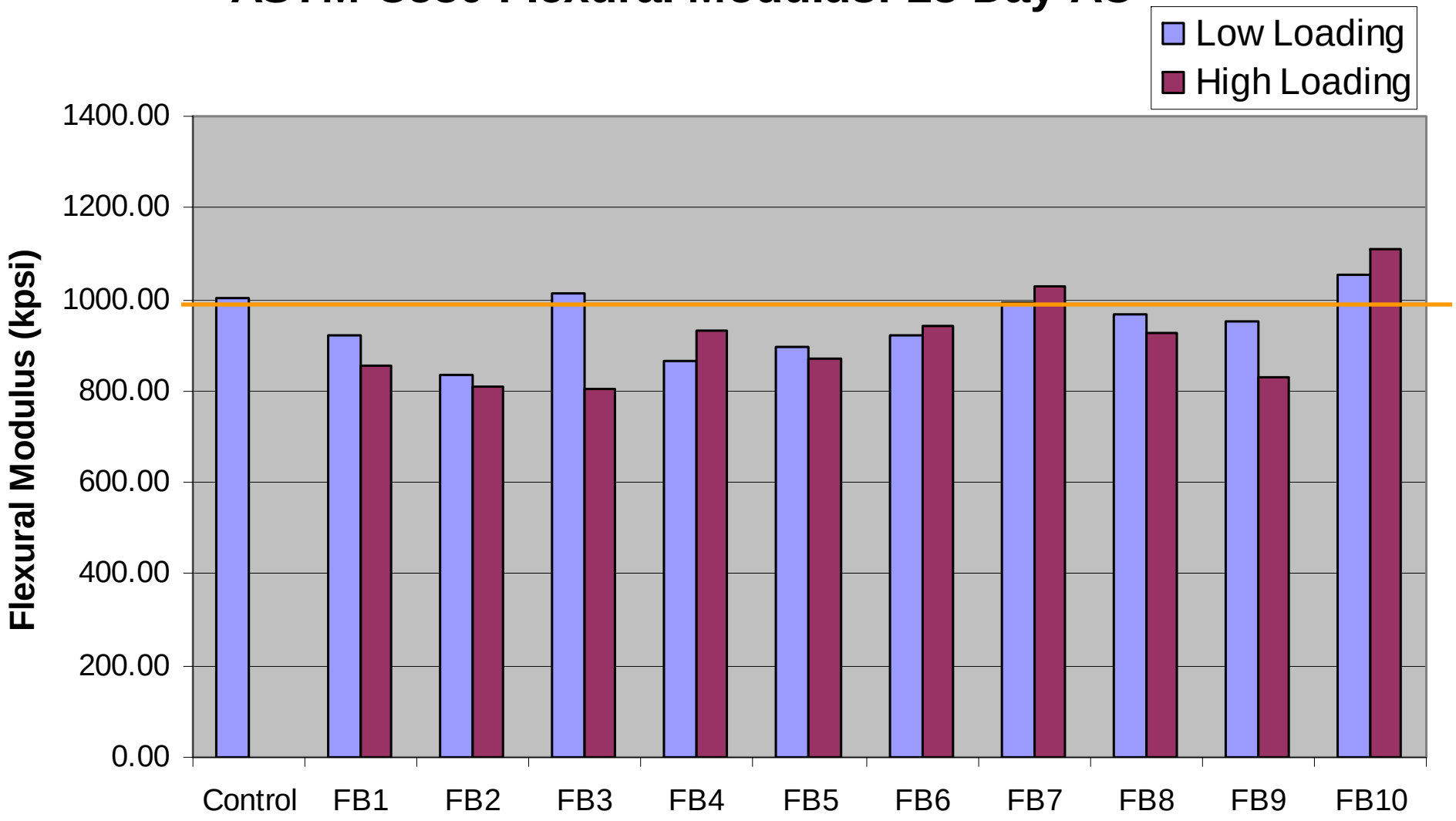


MC vs AC Flexural Strength

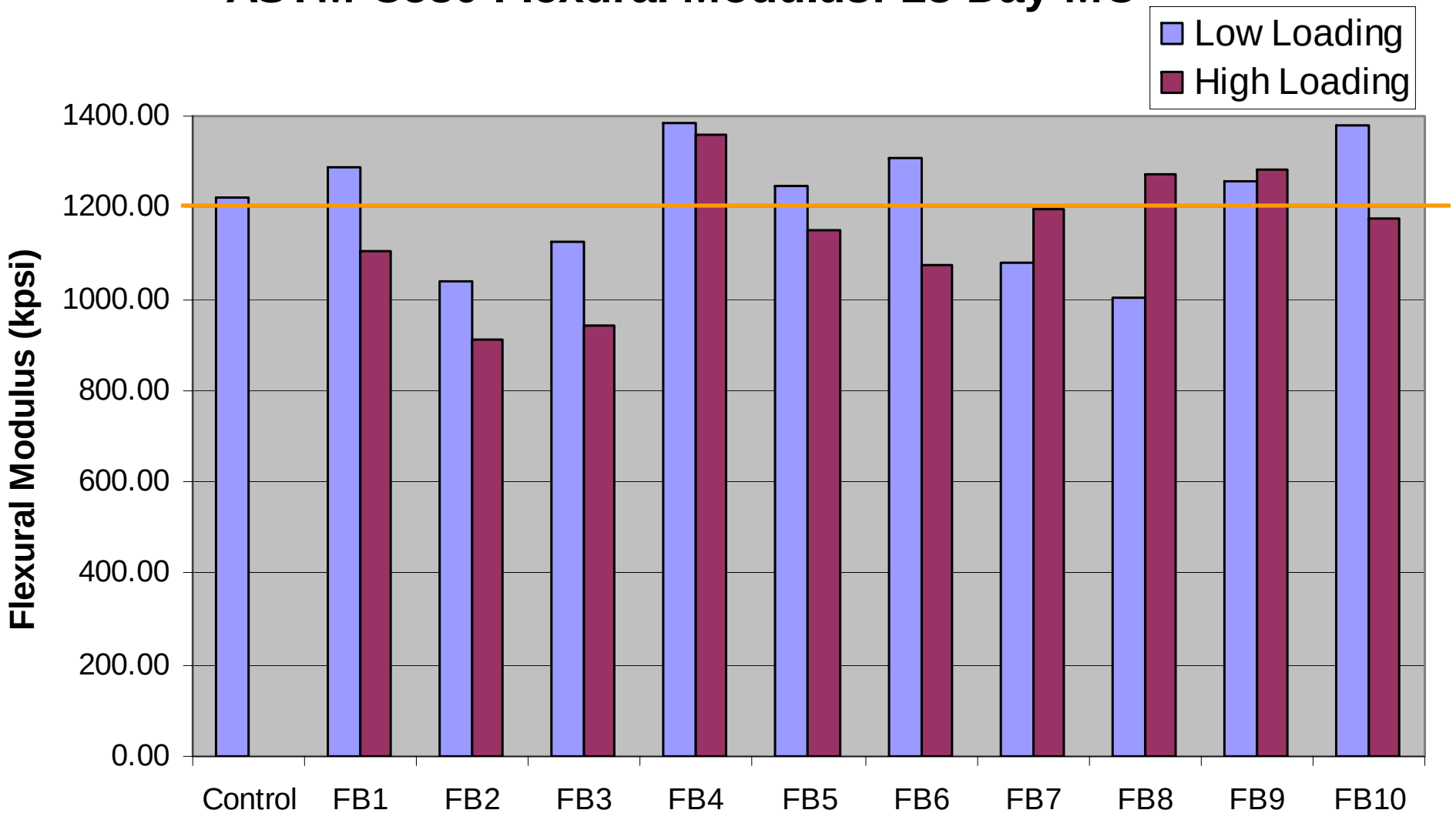


If fibers gave water retention, we would expect less difference between AC/MC

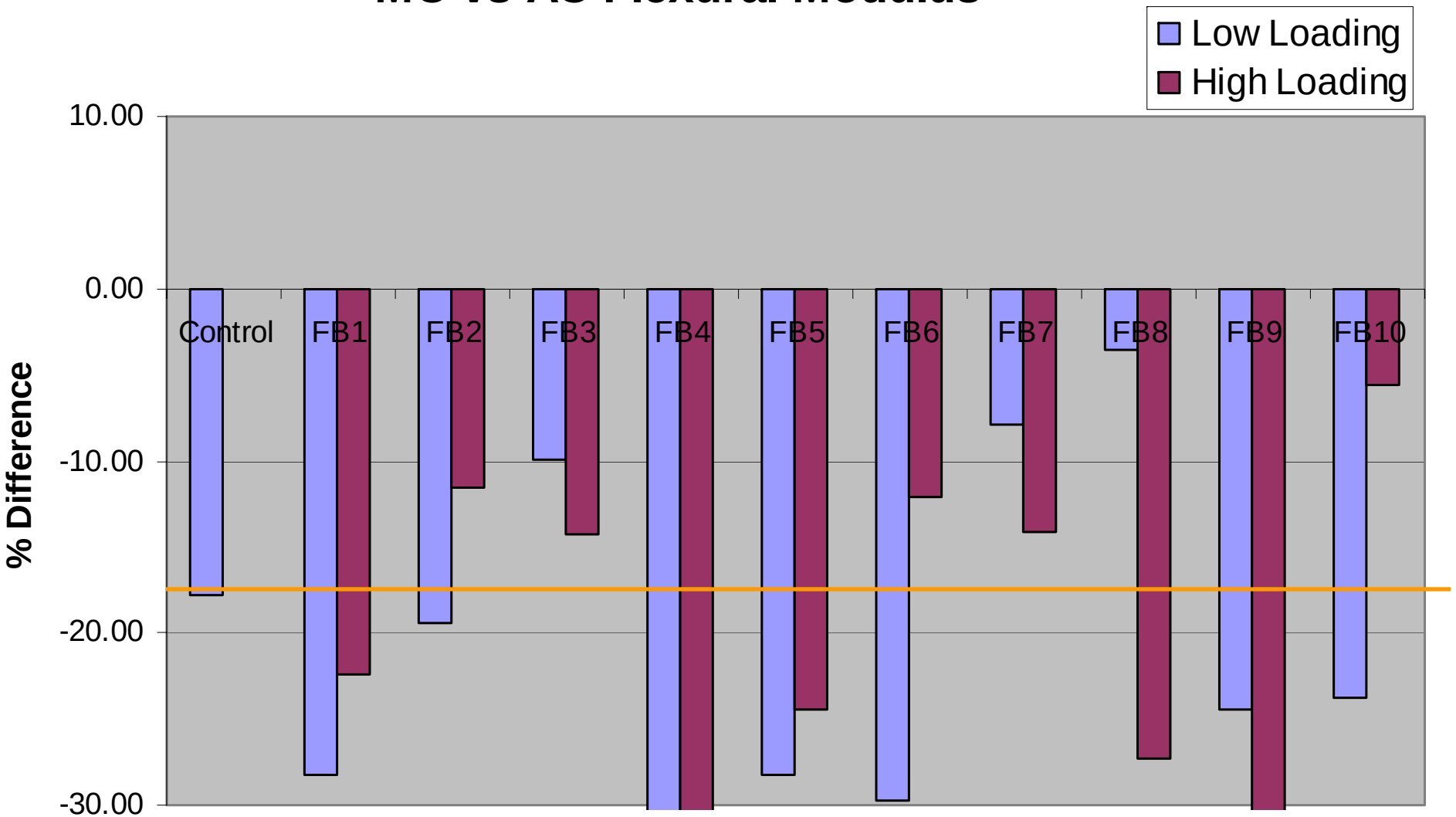
ASTM C580 Flexural Modulus: 28 Day AC



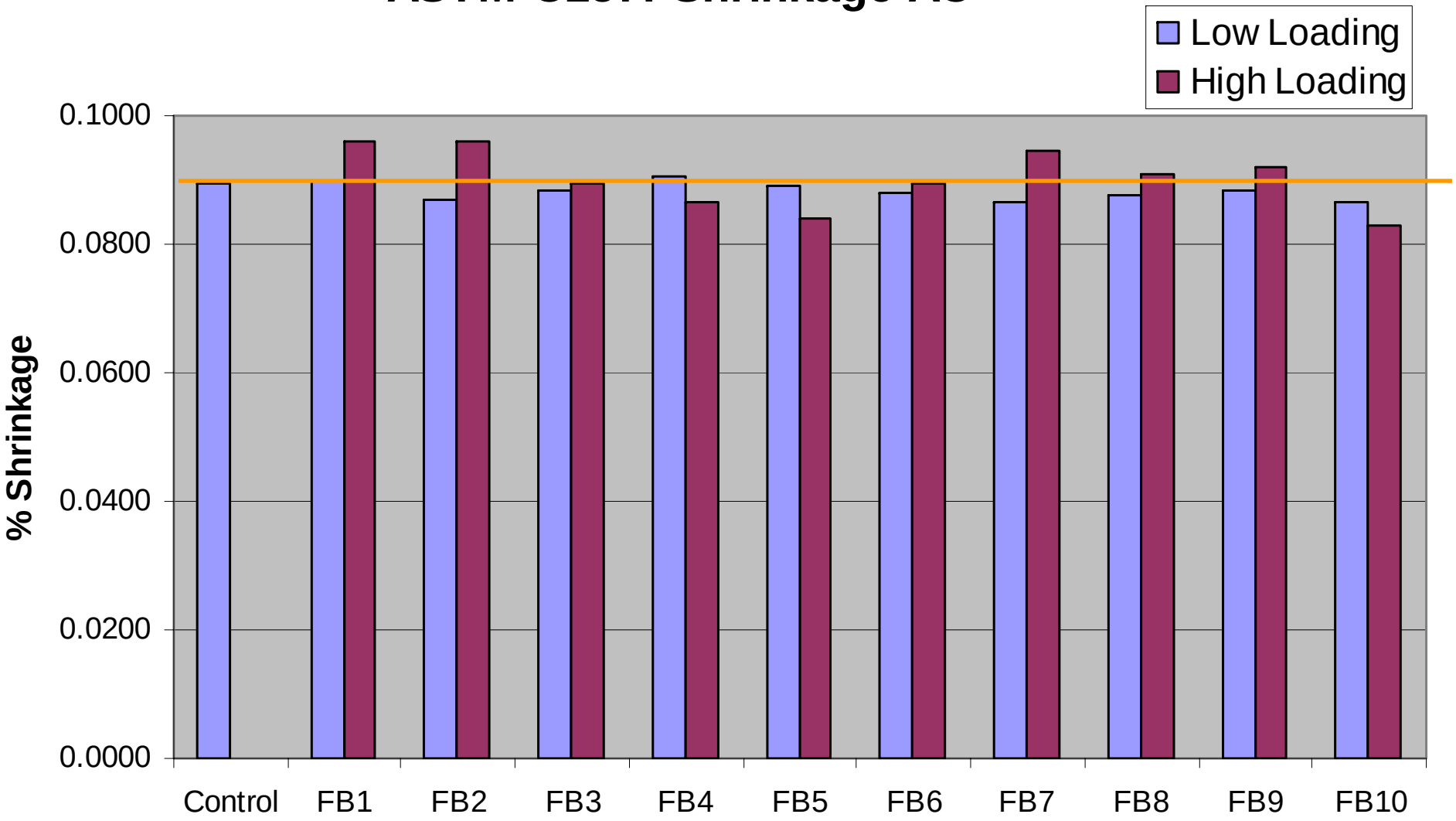
ASTM C580 Flexural Modulus: 28 Day MC

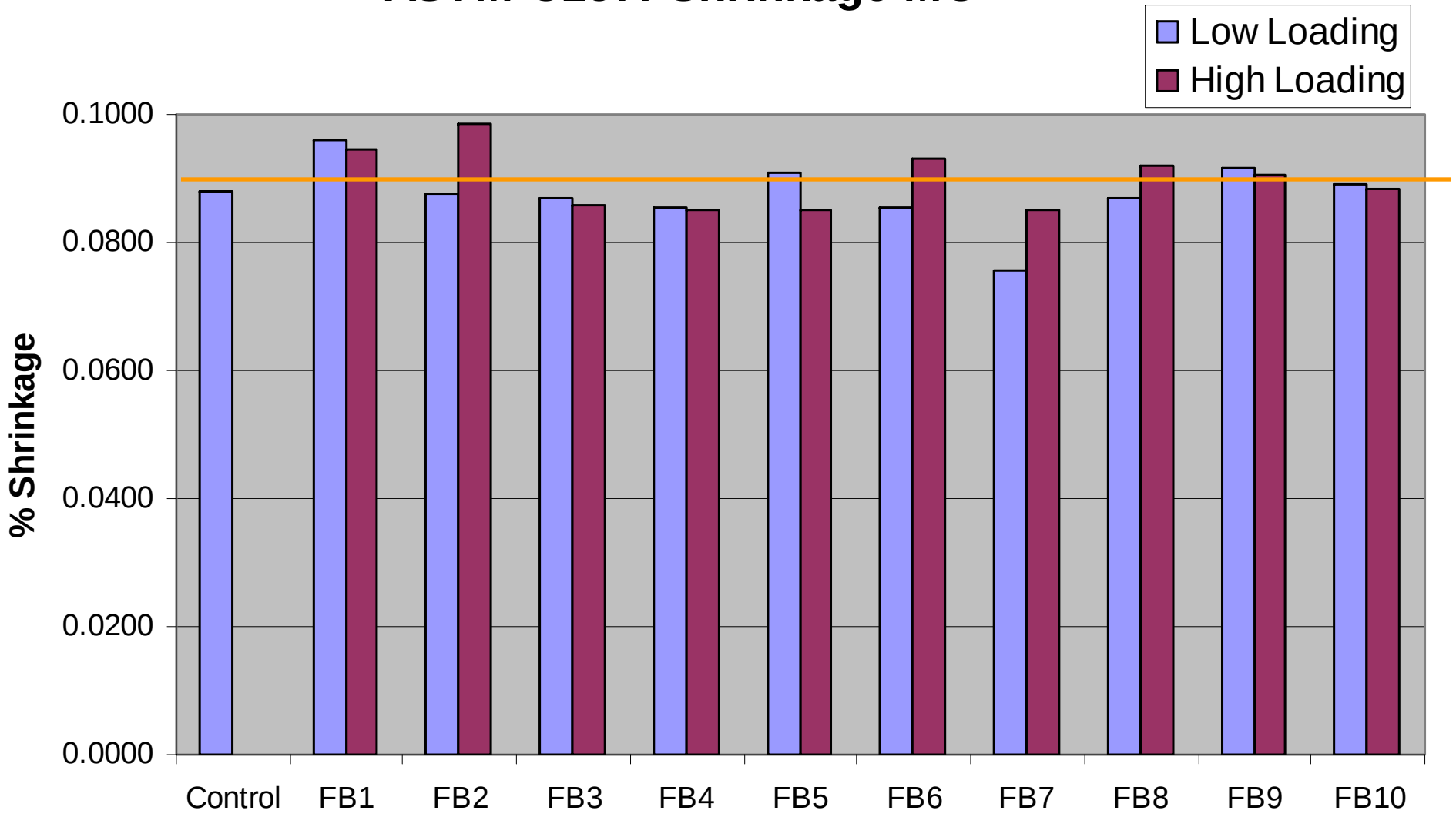


MC vs AC Flexural Modulus



ASTM C157: Shrinkage AC



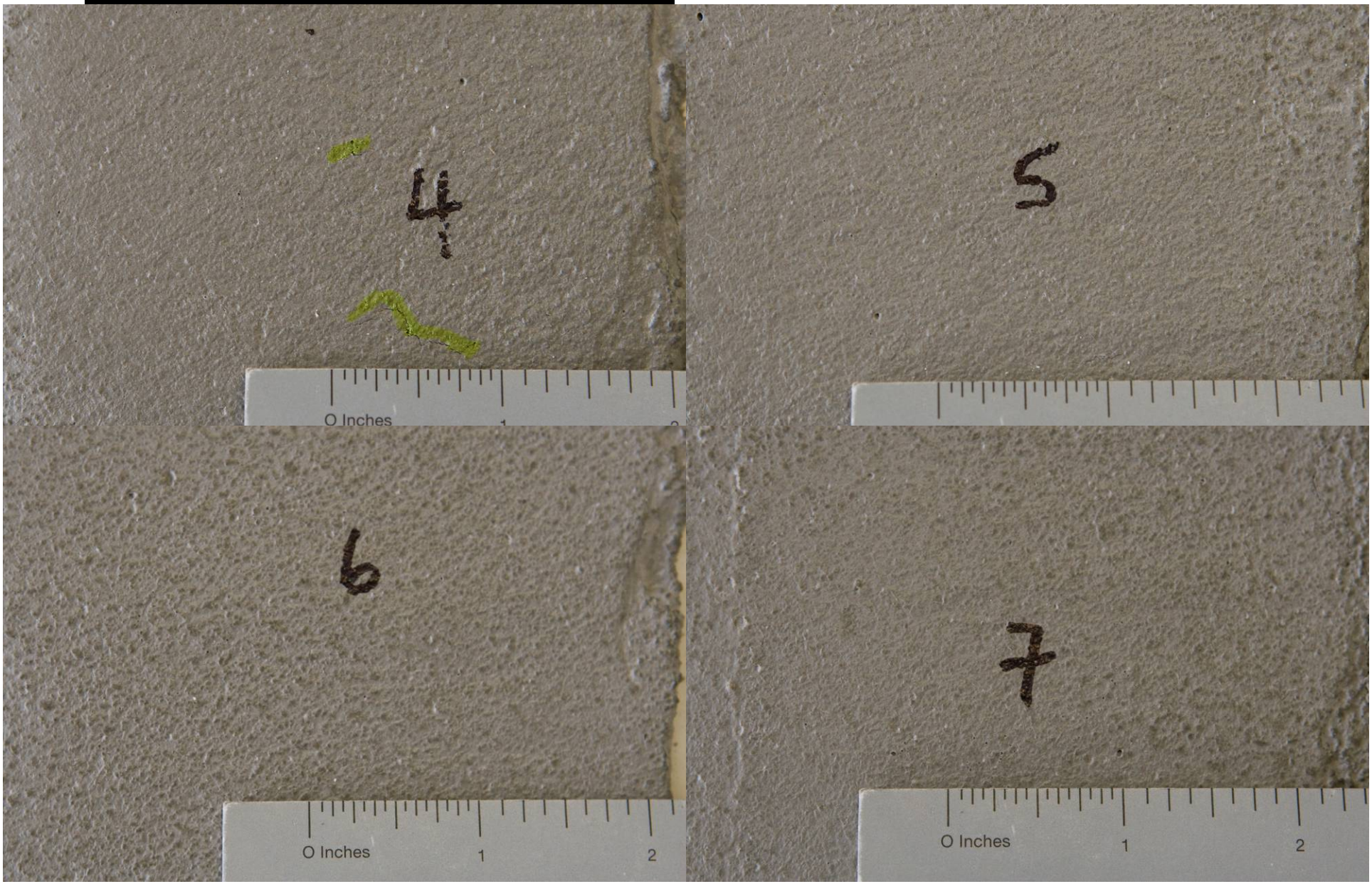

ASTM C157: Shrinkage MC
Low Loading
High Loading
% Shrinkage
0.1000
0.0800
0.0600
0.0400
0.0200
0.0000
Control
FB1
FB2
FB3
FB4
FB5
FB6
FB7
FB8
FB9
FB10

Check Cracking

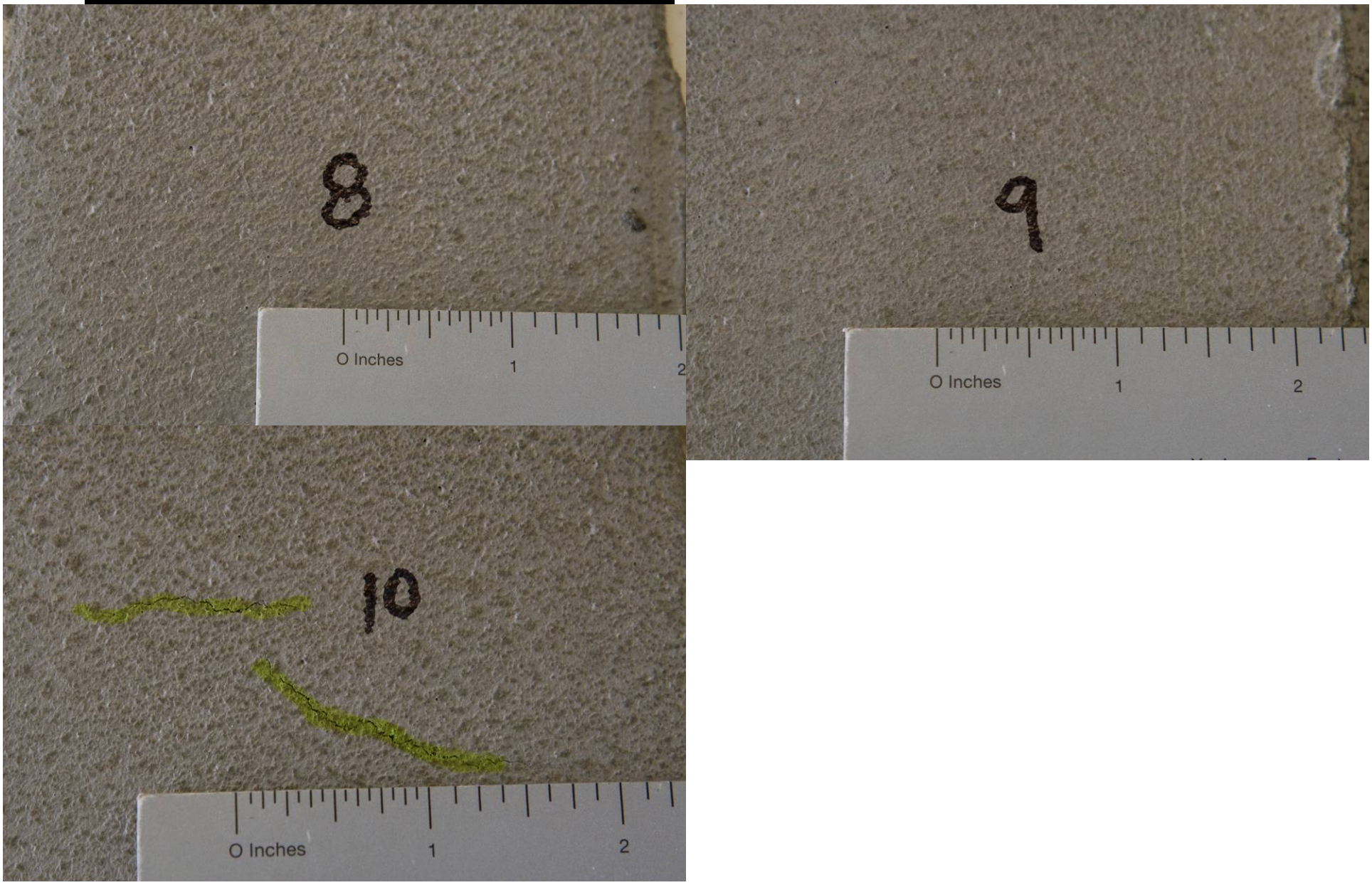
- Test formula would not check crack in lab
- Check cracking formula
  - 1:2 Plastic Cement:Sand
  - w/c = 0.55
  - low fiber dosage
  - ½ application over wallboard
  - oven cure at 120F – 2 hours

Check Cracking

Check Cracking



Check Cracking



Summary

- Water retention
  - Data does not support late water retention
  - Early water retention may be present to help with check cracking – plastic properties
  - Followup work on water retention will be conducted
- Dosage
  - Can vary water demand – effecting strengths
  - Ladder study needed to find optimum dosage
- Composition
  - No general trend visible in this data
- Length
  - May vary results by manufacturer product
  - No general trend across all fiber
  - Caution: Longer flexible fibers may be problematic for processing and application

X 4

Give Matt a hand for doing all of the hard work in the lab!