



A Fiber Floor Philosophy - Extending Joint Spacing

Dan Biddle, FORTA Corporation

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Concrete is strong, durable, and easily formable, making it a popular choice for many applications.

Residential Patio

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Concrete table-top

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**Concrete umbrella
weight**



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Polished office floor

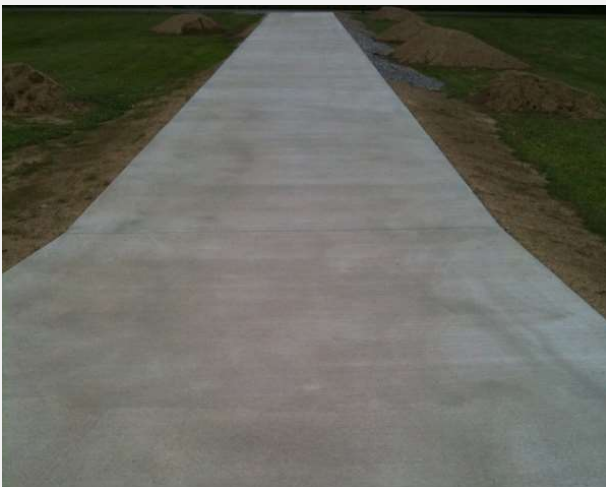


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**Impact-resistant
concrete mailbox**

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**Concrete driveway with unique
joint-practice 155'x10'x5"**

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Cracks vs. Joints:

Owners don't like either,
and are the driving force to minimize both.

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SHRINKAGE

Concrete shrinks as it dries and cures.
Shrinkage must be acknowledged, respected,
and then accommodated.

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While wet, the concrete slab
“sponge” lays flat.

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As the slab cures, the top dries
quicker than the bottom; the result
is cracking and curling.

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Owners report
joint-related
problems far
more than any
other floor issue.

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To address this joint dilemma requires a
fundamental change in floor construction
philosophy...

One that focuses on shrinkage
rather than strength.



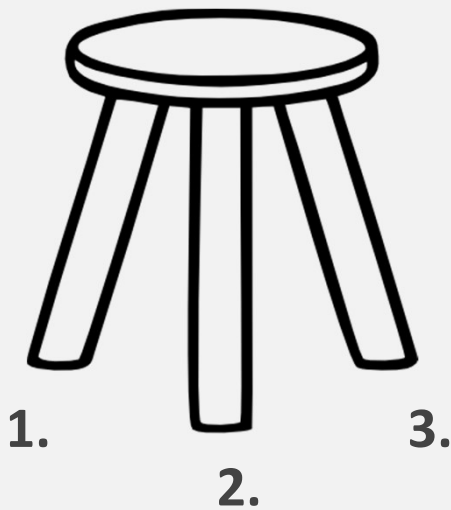
- Owner
- Architect
- Engineer
- General Contractor
- Concrete Contractor
- Subgrade Contractor
- Concrete Producer

All involved construction parties must buy in to the shrinkage-related focus and regimen.



Macro-synthetic fibers act as “reinforcement vitamins”, and they are a critical part of a shrinkage reducing diet.

But they can’t do it alone!



A reduced-joint objective
requires attention to a
F-C-P formula:

1. **Fiber**
2. **Concrete**
3. **Practice**



Fiber Characteristics

Fiber Characteristic Formula: 4C's

C – CONFIGURATION

- Fiber shape and configuration affect both performance and mixability

C – CHEMISTRY

- Fiber make-up determines strength and long-term durability

C – CONTENTS

- Dosage affects performance and user friendliness

C – CORRECT LENGTH

- Fiber length affects performance, mixability, and friendliness



Level 1: Micro Synthetic Monofilament

Purpose: reduce plastic shrinkage cracking; used in addition to steel; conventional joint-spacing

C – Configuration

- very fine mono- or single-filament fiber collated in unconnected clips

C – Chemistry

- polypropylene, nylon, polyester, cellulose, fiberglass

C – Contents

- 1.0 pound per cubic yard

C – Correct Length

- 3/4"



Level 2: Micro Synthetic Fibrillated

Purpose: reduce plastic shrinkage and temperature-related cracking; some light steel replacement and conventional joint spacing

C – Configuration

- fibrillated or net-shaped fiber collated in interconnected clips

C – Chemistry

- polypropylene

C – Contents

- 1.5 to 3.0 pounds per cubic yard

C – Correct Length

- 3/4" to 1-1/2"





Level 3: Macro Synthetic Blend

Purpose: reduce plastic shrinkage, add toughness, and increase post-crack behavior; higher level of steel replacement and potential increased joint spacing

C – Configuration

- heavy-duty macro filaments blended with small amount of fibrillated, collated in unconnected twisted bundles

C – Chemistry

- polypropylene and co-polymer blend

C – Contents

- 3.0, 5.0, 7.5 lbs. per cubic yard and higher

C – Correct Length

- 1-1/2" – 2-1/4"



Chicago Shrinkage & Curling Floor Study

Sponsor: Concrete Construction Magazine

Application: 60,000 sq. ft. warehouse floor, 6" thick

Location: Bartlett, IL

Project Date: February 2009

Concrete Contractor: Scurto Cement Construction Ltd. Elgin, IL

Ready Mix Supplier: Elmhurst-Chicago Stone, Elmhurst, IL

Fiber: FORTA-FERRO® Macro synthetic 2-1/4" long, 3.0 & 7.5 lb. / cu. yd. dosage





Project Steering Committee

Jerry Holland, Wayne Walker, Pat Harrison – *Structural Services*
 Greg Scurto – *Scurto Cement*
 Allen Face – *Allen Face Companies*
 Howard Kanare – *Portland Cement Association CTL*

Project Study Goals

Compare shrinkage and curling
 Two-year study
 Run floor-flatness scans

Project Variables

Mix Design
 Aggregate size/proportions
 Chloride/non-chloride accelerators
 Rheology admixtures
 Finishing methods
 Synthetic fibers



Chicago Fiber Variables

	<u>1.</u> (20,000 sq. ft.)	<u>2.</u> (30,000 sq. ft.)	<u>3.</u> (10,000 sq. ft.)
<u>C - Configuration</u>	Microfibrillated	Macro synthetic	Macro synthetic
<u>C - Chemistry</u>	Polypropylene	Polypropylene/Copolymer	Polypropylene/Copolymer
<u>C - Contents</u>	1.5 lb./cu. yd.	3.0 lb./cu. yd.	7.5 lb./cu. yd.
<u>C - Correct Length</u>	3/4"	2-1/4"	2-1/4"

[No steel reinforcement used]



Chicago Project: Mix and Strength Details

Base Mix Proportions

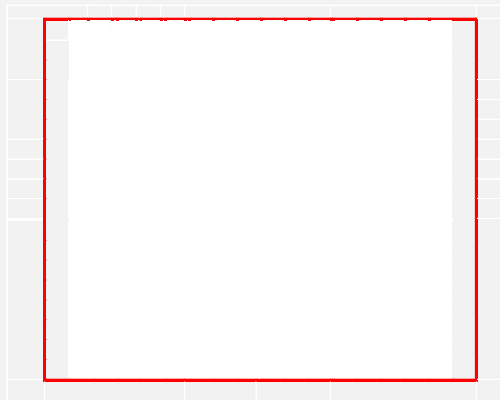
Coarse Aggregate	1740 lbs
Fine Aggregate	1550 lbs
Cement	517 lbs
Water	274 lbs
Air	None
Mid-range	6 oz

Compressive Strength (30 days)

1.5 lb Micro-fiber	4805 psi ave
3.0 lb Macro-fiber	5370 psi ave
7.5 lb Macro-fiber	6400 psi ave



Chicago Project: Joint Layout 60,000 total square feet



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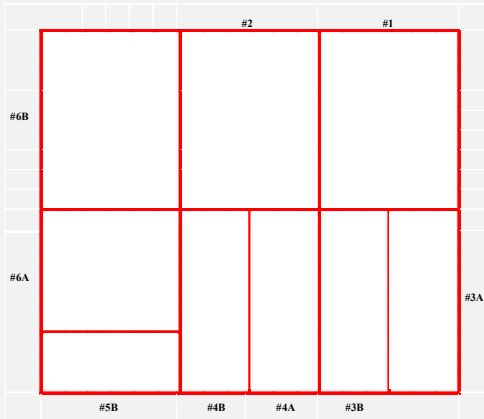
Chicago Project: Joint Layout

60,000 total square feet

#1, 2 = 1.5 lbs. micro

#3A, 3B, 4A, 4B, 5B, 6A = 3.0 lbs. macro

#6B = 7.5 lbs. macro



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Chicago Project: Joint Layout

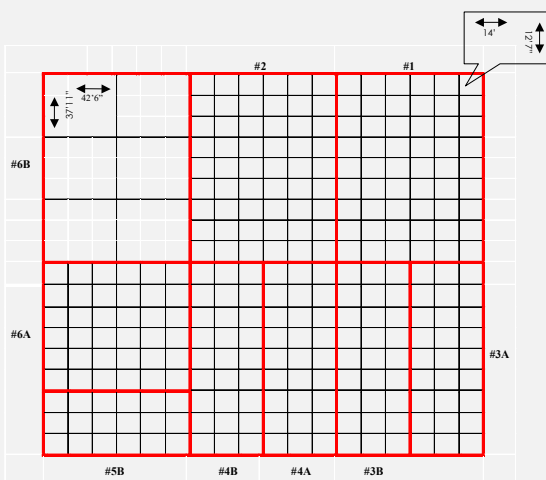
60,000 total square feet

#1, 2 = 1.5 lbs. micro

#3A, 3B, 4A, 4B, 5B, 6A = 3.0 lbs. macro

#6B = 7.5 lbs. macro

80% reduction in saw cuts





Chicago Project: Trial Study, Bartlett, IL – February 2009

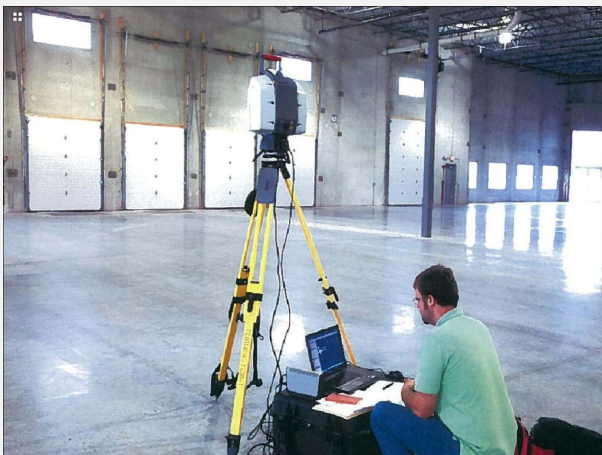


Small 14' x 13' micro-fiber panels

Large 38' x 42.5' layout saved almost 1,000 ft of saw cuts/10,000 sq ft



Chicago Project: Floor Profiles



3-D Laser Scans

D-meter runs scans at:

- 24 hours
- 30 days
- 6 months
- 1 year



Chicago Project: 12-Month Flatness Results

<u>Mix #</u>	<u>Fiber</u>	<u>Curling Radii (ft.)</u>	<u>Corner Lift (in.)</u>
2	1.5 lb. micro	2636'	.184"
1	1.5 lb. micro	3660'	.133"
4A	3.0 lb. macro	4491'	.108"
6A	3.0 lb. macro	5369'	.091"
3B	3.0 lb. macro	6034'	.081"
4B	3.0 lb. macro	7255'	.067"
6B	7.5 lb. macro	-14751'	-.033"

7.5 lb. macro-fiber (#6B) showed by far the least
amount of slab-edge change



- Conventional/historic ACI joint-space practice =
2x to 2 ½ x thickness in inches/feet
Example: 6" slab = 12' to 15' spacing
- Chicago (6" slab):

Low fiber	14' x 13'	2.2x factor
High fiber	38' x 42.5'	6.7x factor



Chicago Experience

“Warehouse maintenance issues start along control joints because forklift traffic causes crumbling and cracking – where curling is the highest and the least support for a panel exists. So high-volume macro fiber slabs offer the possibility of flatter slabs with less maintenance over time.”

Editor Joe Nasvik, CONCRETE CONSTRUCTION, March 2010



Chicago Highlights

- Independent sponsor, reporter, participants, and testing
- Confirmed macro fiber's user-friendliness – mixing, workability, and finishing
- No steel
- Less joints – 80% less – 2x vs. 7x spacing factor
- No mid-panel cracking
- No curling in high-fiber sections
- Validation of FORTA® research, 10-year practice, and performance

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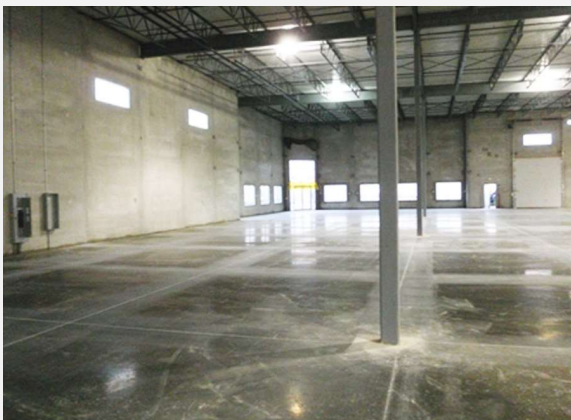


The combination of reduced shrinkage and slab relaxation led FORTA® and others to begin reconsidering conventional joint-spacing practices for slabs-on-ground.

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JOINT-FREE
BARTLETT, IL



CHICAGO FLOOR STUDY

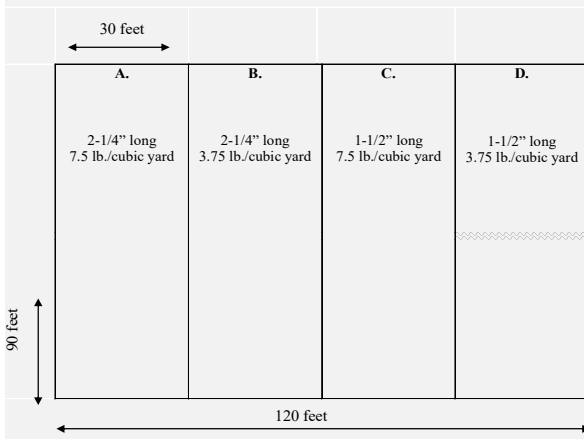
FORTA-FERRO®

- 60,000 sq ft warehouse floor, 6" thick
- FORTA-FERRO® 2-1/4"
- 3.0 & 7.5 lb/cu yd dosage
- Small 14'x13' micro-fiber panels and large 38' x 42.5' macro-fiber panels

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PROJECT PROFILE:
SLAB-ON-GROUND
NEW WILMINGTON, PA



GILLIAND PALLET CO.

FORTA-FERRO®

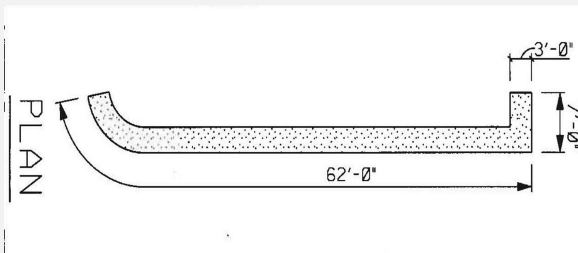
- Heavy-duty manufacturing floor
- Contractor delay precipitated joint-free design
- Fiber variables: dosage and length
- Only cracked slab used 1/2 dosage and shortest length



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PROJECT PROFILE:
JOINT-FREE
ATLANTA, GA



RESIDENTIAL SIDEWALK

FORTA-FERRO®

- Owner, Jerry Holland, Structural Services, world-renowned floor expert
- 2-¼" length
- 7.5 lb/cu yd
- Crack-Free after 15 years
- Won the 2004 Georgia ACI "Outstanding Achievement Award"

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Project

JOINT-FREE
MARIETTA, GA



SPARKLES ROLLER RINK

FORTA-FERRO®

- Won the 2004 Georgia ACI "Award of Excellence"
- Polypropylene/Copolymer
- 2-¼" length
- 7.5 lb/cu yd

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Over a one-year period, scores of successful reduced-joint projects were placed all across the United States.

- August 2007, Morrison Custom Welding Wooster, OH
- 60' x125' x6" joint-free
- 7.5 lbs. / cu. yd.
- August 2007, Attaway Waste Services, Greensboro, GA
- 75' x80' x10" joint free
- 7.5 lbs. / cu. yd.
- May 2008, North-South Highway Bridge Deck, Oahi, HI
- 1,000 cu. yd. of 5" deck joint free
- 7.5 lbs. / cu. yd.



Two ways to use macro-synthetic fibers in floors:

- Simple alternate to conventional temperature steel; maintain conventional joint-spacing and panel size.
- Alternate to steel; AND consider reduction of control joints and larger panel sizes when sufficient fiber dosages are used.



Macro-synthetic fibers are only a part – albeit an important one – of a complete recipe to control shrinkage and curling in slabs-on-ground.

The additional F-C-P facets should be carefully considered when embarking on a reduced-joint or joint-free path.

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- The installation, filling, and maintenance of floor joints represent a huge burden to the owner
- Along with shrinkage-reducing practices, macro synthetic fibers represents a viable and cost-effective solution.

FORTA®
CONCRETE FIBER
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Thank You!!