

Macro-Synthetic Fiber Reinforcement

Mix Proportioning, Dispensing, Mixing, Placing and Finishing

Macro-synthetic fiber reinforcement imparts toughness, impact and fatigue resistance to concrete while also reducing plastic shrinkage cracking. Typical macro-synthetic fiber reinforced concrete (FRC) applications include commercial and industrial flooring and elevated composite decks. Slight mix design, dispensing, placement and finishing modifications may be required when incorporating macro-synthetic fibers into a concrete mixture, particularly at higher dosage rates. Batching, mixing, delivery and sampling of macro-synthetic FRC should be done in accordance with ACI 304R-00 (**Guide for Measuring, Mixing, Transporting, and Placing Concrete**), ASTM C1116 (**Fiber-Reinforced Concrete and Shotcrete**) and ACI 544.3R-08 (**Guide for Specifying, Proportioning, and Production of Fiber-Reinforced Concrete**). Consult with your local GCP Applied Technologies sales representative for additional usage and application information for GCP’s macro-synthetic fibers, STRUX® 90/40 and STRUX BT50.

Mix Proportioning

Minor adjustments to typical slab on ground mix designs may be required when utilizing macro-synthetic fibers to assure ease of use during the batching, mixing, placement and finishing processes. These adjustments may become more critical as macro-synthetic fiber dosage rates increase.

1. Due to their surface area, macro-synthetic fibers will consume some percentage of the mortar fraction, thereby reducing the workability and creaminess of the mix. As detailed in ACI 544.3R-08, it is recommended mix designs be modified to contain **maximum** 55% by volume coarse aggregate content by total volume of aggregates (coarse and fine aggregate). Slight increases in cementitious contents [up to 50 lbs/yd³ (30 kg/m³)] may also be required to achieve required mortar fraction.
2. Some level of slump reduction can be expected when macro-synthetic fibers are incorporated into a mix (see Table 1 below) It is strongly recommended that this loss of workability be restored through the use of a high range or mid range water reducer (instead of water). GCP’s polycarboxylate based ADVA® high range and MIRA® mid range water reducer product lines have a field proven track record of imparting cohesive properties to macro-synthetic FRC.

Table 1 — Approximate Slump Reduction (in.) (mm) as a function of fiber type and dosage rate

Dosage Rate — lbs/yd ³ (kg/m ³)	3 lbs/yd ³ (1.8 kg/m ³)	7 lbs/yd ³ (4.5 kg/m ³)	15 lbs/yd ³ (9.0 kg/m ³)
STRUX 90/40	2 in. (50 mm)	4 in. (100 mm)	
STRUX BT50		2 in. (50 mm)	4 in. (100 mm)

Dispensing

Macro-synthetic fibers are engineered to have superior dispersion properties when dispensed into concrete in both dry batch and central mix concrete plants. The following guidelines should be followed to assure complete dispersion without fiber balling is achieved. It is also recommended that full load size trial batches be conducted prior to job start up.

- **(Best)** Dispense upfront into empty drum.
- **(Good)** Tail end addition on concrete in drum revolving at charge speed.
- **(Good)** Broadcast on aggregate moving up conveyor belt.

Mixing

Macro-synthetic FRC mixing procedure should, at a minimum, follow ACI 304R-00 4.5.2 guidelines. ACI 304R-00 recommends 70 to 100 revolutions at charge speed initially in plant yard, followed by an additional 30 revolutions at job site prior to discharge to ensure uniformity. Higher macro-synthetic fiber dosage rates may require up to 50% additional mixing at charge speed.

Placement

Macro-synthetic FRC concrete can be placed using conventional placement techniques including chutes, buckets, buggies, conveying and pumping. Placement of macro-synthetic FRC concrete should be conducted in accordance with ACI 304R-00—section 5.4 with a couple slight modifications. Macro-synthetic FRC concrete may appear to be stiffer and want to “hang together” more than conventional concrete, particularly at higher dosage rates. It is recommended the use of vibratory screeds, laser screeds and/or hand vibrators be used to ease placement and assure adequate consolidation is achieved. Refer to ACI 544.3R-08 **Chapter 7 – Placing and Finishing** for additional recommendations for placing and finishing macro-synthetic FRC.

When screeding and bullfloating macro-synthetic FRC concrete, a substantial number of fibers may remain exposed on the surface. This is expected as a majority of macro-synthetic fibers disappear during the power float and trowel processes. The use of magnesium, rather than wood, bullfloats is recommended. The use of jitterbugs (grade tamper) and/or rollerbugs may help embed exposed macro-synthetic fibers beneath the surface prior to trowelling.

Finishing

(Broom) It is expected that broom finished macro-synthetic FRC will have some exposed fibers visible on the surface. While brooming, the brooms should be held at a small angle to the horizontal surface and should be pulled in one direction only.

(Trowel) The floating and trowelling process provides the best opportunity to work towards achieving a fiber free or near fiber free macro synthetic FRC surface. Field experiences show excellent quality near flawless fiber free macro-synthetic FRC surfaces can be achieved by following the methodologies below.

- Final finishing operations should be conducted as late as possible (footprints are barely perceived on surface).
- Power float, followed by power trowel finishing technique should be utilized, with more, rather than less, passes made.
- Float blades and finish blades should be kept as FLAT as possible, particularly during initial passes.

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