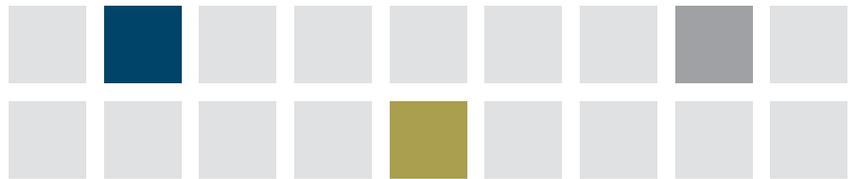


FIBER REINFORCEMENT BEST PRACTICES

TECH NOTES



FIBER TYPES

ASTM C1116, "Standard Specification for Fiber-Reinforced Concrete," outlines four fiber classifications:

Type I – Steel fiber-reinforced concrete (ASTM A820)

Type II – Glass fiber-reinforced concrete (ASTM C1666)

Type III – Synthetic fiber-reinforced concrete (ASTM D7508)

Type IV – Natural fiber-reinforced concrete or shotcrete (ASTM D7357)

Microfibers have a diameter less than 0.3 millimeters and are typically used for plastic shrinkage control. Microfibers are not structural fibers and should never be used for steel reinforcement replacement.

Macrofibers are greater than 0.3 millimeters in diameter and can be considered as a replacement for structural steel, where codes or project specifications allow.

Fiber reinforcement suppliers can work with concrete producers to design a blend of both micro and macrofibers in one mix.

MIX DESIGN CONSIDERATIONS

Adding fibers into concrete can reduce slump (or spread) and can result in a loss of workability. A rough estimate is to expect about an inch of slump loss for every three pounds of fiber per cubic yard of concrete. The use of super-plasticizers or mid-range water reducers will assist in preserving slump and workability without altering the w/c of the mix.

In addition, it's important to resist adding water to enhance workability when slump or spread is reduced. Fresh concrete tests are static tests. Concrete, when placed in the formwork, may still flow adequately even if slump or spread is lower. Refer to the NPCA Fibers White Paper for additional means of modifying mix designs to accommodate fibers.

BATCHING, MIXING AND SEQUENCING

When adding fibers, a concrete batch should be mixed at high speed for at least 3-5 minutes (or for at least 70 revolutions if using a mixer truck). This is a general guideline only. Any specification or contract requirements should always be followed, if applicable. Experience with your equipment, sequencing and fibers will help perfect your concrete batch.

Fibers are rarely added at the beginning of batch sequencing. Instead, fibers are sometimes added with aggregates or added near the end of the batching cycle. Special precautions need to be taken when adding degradable bags, since most manufacturers advise to not add them the same time as cement. Bags can sometimes be opened prior to batching to aid in dispersing the fibers and bag disintegration. Always consult your fiber supplier to address any batching, mixing or sequencing issues with any type of fiber.

FIBER ADDITION METHODS

Fibers can be added to the mix in different ways:

Pre-weighed degradable bags – Bags will degrade when mixed but opening the bag prior to batching can assist with dispersion. Please consult with manufacturers prior to opening the bags. Be aware that some manufacturers advise not to add bags with cement.

Pucks – Fibers are aligned with a water-soluble wrap. The pucks are placed on the aggregate belt, skip hoist or in the mixer and will break apart during mixing. The puck may be loose in a box or packaged inside of pre-weighed degradable bags. The puck system can lessen the chance of balling.

FIBER BATCHING SYSTEMS

Blower – Several types of fiber blower delivery systems are available to dispense fibers into mixers. These systems typically pneumatically transfer fibers through a hose into the mixer. Controlled fiber flow into the mixer can provide superior dispersion and uniformity. Some blower delivery systems are integrated with the concrete plant's batch automation.

Fluid (similar to an admixture) – Fiber fluid delivery systems are available with some fibers. These automated dispensing systems provide accurate and recordable dosage of fibers in an easy, efficient and safe manner. Producers should consult with fiber fluid dispenser manufacturers to determine fiber dosage (pounds/cy) per fluid ounce or gallon.

HOW TO AVOID BALLING

All fiber types have the potential to ball up in concrete. This phenomenon is usually caused by adding fibers into concrete mixes that are too dry or into mixtures that do not have enough fine particles (cement, sand, supplemental materials, etc.) to coat the fibers. This can result in the mix stiffening.

Loose fibers in an empty mixer or drum may clump together, which is why some suppliers advise against adding fibers at the beginning of batch sequencing. Fiber types that are too long or have varying geometries may also cause problems. When using longer fibers, it helps when they are collated or glued together. The glue holds the fibers together long enough to prevent tangling and then the glue dissolves. This helps reduce balling but can add to the cost and complexity.

Steel fibers may also ball up when they are not added at a consistent rate, which makes ribbon feeding an ideal method of fiber addition.

As always, a test trial should be performed to ensure the mixture will support the fiber type and dosage and that the batching sequence will not cause any problems. If necessary, make modifications to mix design to maintain the desired slump for placement or sequence to address inconsistent dispersion issues with your mix.



NPCA

Precast ... The Concrete Solution

CONSOLIDATION

Manual, vibratory or laser screeds can be used during the strike-off operation. Laser guided screed and vibratory screeds ensure surface vibration, which brings paste to the surface and limits the possibility of exposed fibers. Be careful not to over vibrate fiber-reinforced concrete as this can cause fibers to sink to the bottom of the structure.

BLEEDING

Fiber-reinforced concrete bleeds more evenly than plain concrete and is less prone to large amounts of bleed water. The even bleeding rate can give the impression of initial set, so finishing operations may need to be delayed to accommodate the uniform bleeding characteristic.

FLOATS

Magnesium floats are recommended for use with fiber-reinforced concrete to create a smooth, level surface and to close any tears or open areas in the concrete surface that may occur around the fibers during the strike-off operations. As with any concrete, care should be taken not to overfinish the concrete which can bring excessive fines to the surface and cause crazing. This may also result in pulling up fibers to the surface.

TROWELING

Premature troweling can pull fibers to the surface since the cement paste can be removed to expose the fibers. In general, do not over-trowel stiffened concrete. If fibers appear on the surface during troweling, cease troweling operations for fifteen minutes. Trowel blades should be kept as flat as possible for as long as possible before increasing the trowel angle to obtain the desired finish.

FINISHING

Burlap drags should be avoided for fiber-reinforced concrete as they may catch fibers, lift them up and tear the curing concrete surface. When textured finishes are needed, pulling a broom or rake in one direction only is the preferred method.

STAINLESS OR GALVANIZED STEEL FIBERS AT SURFACE OF HARDENED CONCRETE

When using galvanized or stainless steel fibers, they may become exposed at the surface of the structure and, after some time, start to show signs of corrosion. This is typically exhibited by small reddish spots on the surface.

While this is not aesthetically pleasing, it poses no risk to the structure's durability and capacity. Steel fiber-reinforced concrete will not support galvanic corrosion like conventional reinforced concrete. The fibers are noncontinuous and discrete, providing no mechanism for propagation of corrosion activity.

Steel fibers at the surface will corrode to the depth of the surface carbonation and will cause staining. Interior fibers below are protected.

This publication is designed to provide accurate and authoritative information, however the National Precast Concrete Association does not guarantee the validity or accuracy of any data, claim or opinion appearing in this publication. If engineering, legal or other professional services are required, the services of a competent professional should be obtained. The National Precast Concrete Association does not assume and hereby disclaims liability to any person for any loss or damage caused by errors or omissions in this publication, regardless of whether such errors result from negligence, accident or any other cause whatsoever.