

# Concrete in Practice

What, why & how?



## CIP 24 - Synthetic Fibers for Concrete

### WHAT are Synthetic Fibers?

Synthetic fibers specifically engineered for concrete are manufactured from man-made materials that can withstand the long-term alkaline environment of concrete. Synthetic fibers are added to concrete before or during the mixing operation. The use of synthetic fibers at typical addition rates does not require any mix design changes.

### WHY Use Synthetic Fibers ?

Synthetic fibers benefit the concrete in both the plastic and hardened state. Some of the benefits include:

- reduced plastic settlement cracks
- reduced plastic shrinkage cracks
- lowered permeability
- increased impact and abrasion resistance
- providing shatter resistance

Some synthetic fibers may be used as secondary reinforcement. (Hardened Concrete Performance Documentation Required.)

### HOW do Synthetic Fibers Work in Early Age Concrete?

Early age volume changes in concrete cause weakened planes and cracks to form because a stress exists which exceeds the strength of the concrete at a specific time. The growth of these micro shrinkage cracks is inhibited by mechanical blocking action of the synthetic fibers. The internal support system of the synthetic fibers inhibits the formation of plastic settlement cracks. The uniform distribution of fibers throughout the concrete discourages the development of large capillaries caused by bleed water migration to the surface. Synthetic fibers lower permeability through the combination of plastic crack reduction and

reduced bleeding characteristics.

### HOW do Synthetic Fibers Work in Hardened Concrete?

The early age concrete benefits of using synthetic fibers continue to contribute to the hardened concrete. Hardened concrete attributes provided by synthetic fibers are lowered permeability and the resistance to shattering, abrasion, and impact forces.

The ability to resist shattering forces is greatly enhanced with the introduction of synthetic fibers to the concrete. When plain concrete is compressed, it will shatter and fail at first crack. Synthetic fibers manufactured specifically for concrete prevent the effect of shattering forces by tightly holding the concrete together.

Abrasion resistance is provided when synthetic fibers are used because the water-cement ratio at the surface is not lowered by variable bleed water. The water-cement ratio is more constant at the concrete surface. This improvement is assisted by the internal settlement support value of the synthetic fibers contributing to uniform bleeding.

Synthetic fibers reduce the amount of plastic cracking of the concrete. This improves the impact resistance of concrete. The relatively low modulus of the synthetic fibers provides shock absorption characteristics.

Synthetic fibers help the concrete develop its optimum long-term integrity by the reduction of plastic settlement and shrinkage crack formation, lowered permeability, and increased resistance to abrading, shattering, and impact forces. Synthetic fibers are compatible with all admixtures, silica fumes, and cement chemistries.

## HOW are Synthetic Fibers Used as Secondary Reinforcement?

Synthetic fibers which meet certain hardened concrete criteria can be used as nonstructural temperature or secondary reinforcement. These fibers should have documentation confirming their ability to hold concrete together after cracking.

The uniform distribution of synthetic fibers throughout the concrete ensures the critical positioning of secondary reinforcement.

### References

1. ASTM C 1116 Standard Specification Fiber Reinforced Concrete and Shotcrete.
2. ASTM C 1018 Standard Test Method for Flexural Toughness and First-Crack Strength of Fiber Reinforced Concrete (Using Beam with Third-Point Loading).
3. ASTM C 78 Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
4. Non-structural Cracks in Concrete, Concrete Society Technical Report No. 22.
5. ICBO Evaluation Service, Inc., Acceptance Criteria for Concrete with Synthetic Fibers, January 1993.

### APPLICATION GUIDELINES

#### ***Do Use Synthetic Fibers For:***

- The reduction of concrete cracking as a result of plastic shrinkage.
- An alternate system of nonstructural secondary and/or temperature reinforcement.
- Greater impact, abrasion, and shatter resistance in concrete.
- Internal support and cohesiveness; the concrete for steep inclines, shotcrete, and slipformed placements.
- The reduction of concrete cracking as a result of plastic settlement.
- To help lower the permeability of concrete.
- Placements where nonmetallic materials are required.
- Areas requiring materials that are both alkali proof and chemical resistant.

#### ***Do Not Use Synthetic Fibers For:***

- The control of cracking as a result of external forces.
- Higher structural strength development.
- Replacement of any moment-resisting or structural steel reinforcement.
- Decreasing the thickness of slabs on grade.
- The elimination or reduction of curling and/or creep.
- Increasing of ACI or PCA control joint guidelines.
- The justification for a reduction in the size of the support columns.
- The thinning out of bonded or unbonded overlay sections.

