Fibers-in-Practice

Fiber Reinforced Concrete Association

FIP 2 – Batching Fiber-Reinforced Concrete

Introduction

The proper batching process for fiber-reinforced concrete depends largely on the type, characteristics and dosage of the fiber selected for a particular project as well as the particular mixing system being used to batch the concrete. Therefore, it is important to follow the recommended batching sequence for a particular fiber to minimize clumping or balling in the mix and maximize the three-dimensional uniform distribution of the fiber. The fiber supplier is typically the best source of batching recommendations for their material.

Addition Point

- ***Synthetic and Cellulose Fibers***

Fine filament micro synthetic and cellulose fibers of short length and relatively low dosage should generally be added to the central batch or truck mixing system along with the other concrete materials. Some microfibers are best added as a first or last ingredient, however, the fiber supplier should be consulted for best practice for a particular fiber. Synthetic macrofibers should generally also be added along with the aggregates and other materials to minimize the risk of balling or cement-packing in the nose of the mixing drum. Polyolefin-based synthetic fibers do not absorb water and, therefore, presoaking or adding them first with a portion of the mix water will not aid their distribution. Micro cellulose fibers also do not need to be presoaked prior to batching. Recommendations for absorptive fibers may vary, and the supplier's instructions should be followed closely.

Most synthetic and cellulose fibers are packaged in repulpable paper bags or melt-away bags that disintegrate in concrete, that allow the bags to be added directly to the batch without the need to first open them and empty the fibers into the drum mixer or the aggregate belts. Some fibers are also packaged in pucks or supplied loose in super sacks and added to the batch through a fiber-dispensing system. Fiber bags should be added one, or just a few, at a time while the drum is in motion to help them disperse uniformly throughout the mix. The supplier's recommendations for fiber addition should be followed closely, especially when high fiber dosages are being used, that is, above 3 to 4 pounds per cubic yard (1.8 to 2.4 kg per cubic meter). Caution should be used for small or less-than-full loads to ensure that the fibers or fiber bags do not get stuck to the drum wall, as this will affect fiber distribution and mix uniformity. For small loads, that is, loads less than 50% capacity, the general recommendation is to back the concrete up to the point of discharge, add the fiber or fiber bags directly on top of the concrete, and then wind the concrete back down to commence the mixing cycle.

- ***Steel Fibers***

From a safety in use standpoint, gloves and proper eye protection should always be used when handling and adding steel fibers to batching systems. In general, the optimum concrete slump before adding steel fibers is 5 in. (125 mm) to provide uniform mixing and distribution. Steel fibers should never be added to central batch or truck mixers as a first ingredient, and are generally best added along with the sand and coarse aggregates or to the fresh-mixed concrete. Steel fibers should be added continuously, referencing the fiber supplier's guidelines regarding a maximum fiber weight per minute rate of addition. In general, steel fibers may be added within a range of 5 to 75 pounds (2 to 34 kg) per minute, depending on the fiber characteristics.

Mixing Time and Speed

- ***Synthetic and Cellulose Fibers***

Mixing time and mixing speed for uniform fiber distribution can vary, depending on fiber type and dosage. All fibers can be under-mixed, and some can be over-mixed as well. Generally, normal central batch mixing time is sufficient to distribute synthetic and cellulose fibers uniformly. For ready-mix truck mixing, synthetic and cellulose fibers are generally well mixed and distributed within 4 to 5 minutes at either normal drum mixing-revolution speed or the optimum mixing speed recommended by the truck manufacturer, which is generally noted and mounted on the truck chassis. It is important to note that the slower road-agitation speed is not sufficient to properly distribute the fibers and, therefore, road delivery time should not be counted towards the required fiber mixing time. These fiber additions and mixing recommendations would also apply if the fibers are added to the truck on-site, and proper mixing time should not be shortened regardless of rushed project conditions. Excessive mixer speed can be just as troublesome as a speed too low, as the concrete may not have enough folding action to properly mix and distribute the fibers. Increasing the mixer speed should not be used as an option to decrease the required mixing time.

- ***Steel Fibers***

Mixing time for steel fibers will vary, depending on the shape, length, and configuration of the particular steel fiber being used. In general, one minute or more of actual mixing time per cubic yard or meter of concrete is necessary for complete fiber distribution throughout the mix, and not less than 5 minutes total mixing time once all fibers have been added. Mixer speed should typically be greater than 12 revolutions per minute, though optimum mixing speed depends heavily on the efficiency of the specific mixing system.

Dispenser Systems

A wide variety of transport and dispensing systems are available for steel, synthetic and cellulose fibers, and the fiber supplier should be contacted for specific recommendations. Some methods are simple transfer systems that enable quick and easy transport of pre-weighed fibers or fiber packages from ground level up to upper-story batching and mixing systems, or from the ground up into a ready-mix truck mixer. Other systems involving blowers and/or vibration are also available to actually weigh and move the fibers, generally using a computerized loss-in-weight process. Automatic fiber dispensers should be configured to incorporate the fibers into the concrete mixing system at the optimum point for the particular fiber type being used.

Pre-Project Trials

Due to the wide variety of fiber types and concrete mixing systems, pre-project trials are always recommended to determine the optimum addition point, mixing time and speed, and dosing systems. Based on the particular fiber type and dosage, these trials can save immeasurable time and delays on the actual project, and ensure a smooth fiber batching process and an optimum and uniform fiber distribution.

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References

1. ACI 544.1 R-96 “Report on Fiber Reinforced Concrete”

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