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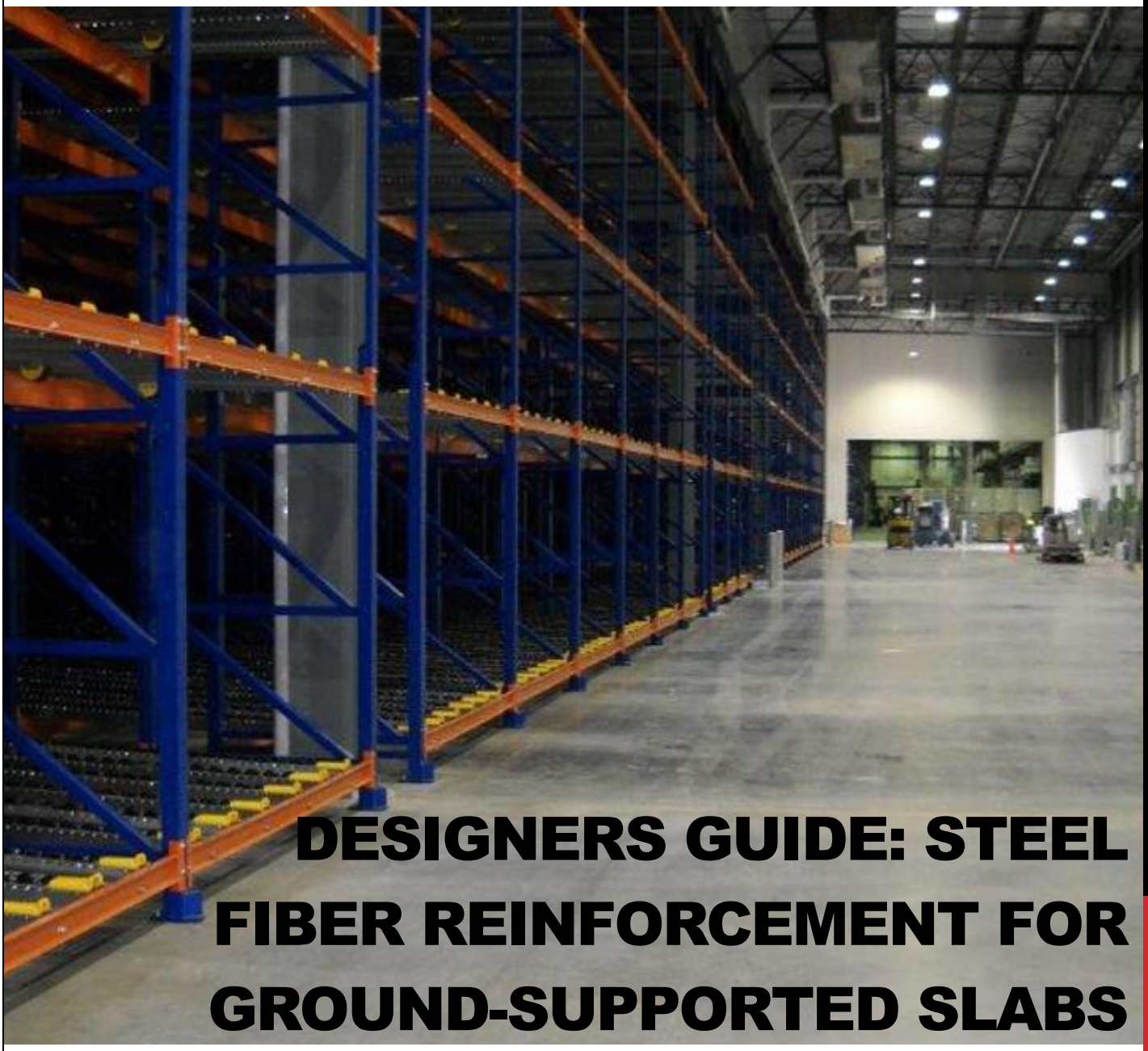

DESIGNERS GUIDE: STEEL FIBER REINFORCEMENT FOR GROUND-SUPPORTED SLABS

CFS 100-2 FIBERS

SUPERIOR CRACK CONTROL – COST SAVING – FASTER INSTALLATION

Meets ASTM A820

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DESIGNERS GUIDE: STEEL FIBER REINFORCEMENT FOR GROUND-SUPPORTED SLABS

CFS 100-2 FIBERS

Steel fibers can help control random cracks in ground-supported concrete floors. In ordinary-jointed floors, steel fibers provide a safety net by limiting the width of any cracks that accidentally occur between the joints. In floors with extended joints, steel fibers take on the primary role in preventing visible cracks while allowing monolithic slabs up to 110' long.

This guide offers information on using steel fibers in both kinds of floors. It does not cover the use of steel fibers in suspended floors, including composite steel deck slabs and pile-supported structural slabs.

Jointed Floors with Steel Fibers

In these floors, closely-spaced sawcut joints form the main defense against random cracks. Most designs space the joints no more than 20 feet apart. ACI 360, *Guide to Design of Slabs-on-Ground,* describes these floors as "slabs reinforced for crack-width control" and categorizes them as Type 2a slabs.

The purpose of the steel fibers is to limit the width of any cracks that occur between the joints and to enhance aggregate interlock at the joints. The steel fibers play a role similar to that of wire mesh or light rebar in other floor designs, but fibers offer two important advantages over those other reinforcing materials. First, steel fibers are always distributed throughout the floor. In contrast, wire mesh and rebar often end up at the wrong elevation. Second, steel fibers don't get in the way when concrete is placed. In contrast, wire mesh and rebar interfere with concrete trucks and screeding machines, and they create a trip hazard.

To use steel fibers in an ordinary-jointed floor, follow these rules:

1. Specify Type II fibers, 1-inch long, continuously deformed, with an aspect ratio of 43, CFS100-2 as manufactured by Concrete Fiber Solutions
2. Specify a fiber dosage of 15-25 lb/yd^3
3. Determine slab thickness and concrete strength as if the slab were unreinforced
4. Determine joint spacing as if the slab were unreinforced
5. Use dowels at construction joints, unless load transfer is not needed
6. Omit dowels at sawcut joints (but see discussion below)

WHY STEEL FIBERS?

Steel fibers are the best means to control shrinkage cracking.

Our CFS 100-2 steel fiber:

- Meets requirements of ASTM A820
- Provides superior crack control
- Is easily placed and finished
- Saves time and money on the job

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7. Saw joints to one fourth the slab depth
8. Consider adding short lengths of rebar at re-entrant corners and other potential crack inducers

Rules 3, 4, and 6 deserve extra discussion.

Rule 3 deals with the floor's basic structural design -- the process of determining what combination of sub-base, slab thickness, and concrete strength is needed to support the intended loads. Steel fibers at 25 lb/yd^3 have practically no effect on concrete's compressive and flexural strengths. For that reason, we at Concrete Fiber Solutions recommend that the fibers not be taken into account in the structural design. Some engineers disagree, recommending designs based on a property called residual strength or flexural toughness. We believe the science behind residual-strength designs has not been proven and may never be proven.

Rule 4 deals with joint spacing -- a complicated, controversial subject, which will not be settled here. We make no recommendation on joint spacing beyond this: If your goal is to minimize visible cracks, do not expect steel fibers at 15-25 lb/yd^3 to allow any increase in joint spacing over what you would feel comfortable specifying for an unreinforced floor. The fibers are there not to prevent cracks, but to limit their width.

Rule 6 deals with load transfer across sawcut joints. Steel fibers improve load transfer and have generally proven adequate in the absence of dowels. The risk exists, however, that some joints will open so wide that they lose the ability to transfer load. If the floor usage demands near-perfect load transfer no matter what, consider adding dowels under the sawcut joints. Alternatively, consider testing the joints later for differential movement and installing mechanical stabilizers where readings exceed 0.010 in. (for vehicles with hard tires) or 0.020 in. (for vehicles with cushion tires).

Wide Slab Floors with Steel Fibers

In these floors, steel fibers form the main defense against random cracks. Slabs are cast up to 110-feet long and 110-feet wide without intermediate joints. The purpose of the steel fibers is to prevent visible cracks by stopping microcracks from growing. While no design method or material can guarantee the total elimination of all visible cracks, steel fibers in high doses have proven highly effective at crack prevention.

Steel fibers are not the only way to achieve an extended-joint floor, but they offer one big advantage over the alternatives of shrinkage-compensating concrete, post-tensioning, and heavy continuous reinforcement. All those alternatives require that substantial amounts of steel be installed ahead of the concrete pour. In contrast, with a steel fiber design, all the reinforcement comes down the chute of the concrete truck.

To use steel fibers in an extended-joint floor, follow these rules:

1. Specify Type II fibers, 1-inch long, continuously deformed, with an aspect ratio of 43. CFS100-2 as manufactured by Concrete Fiber Solutions.
2. Specify a fiber dosage of 65 lb/yd^3.
3. Specify concrete with 28-day drying shrinkage of no more than 0.035%, when tested to ASTM C157 (air-storage method).
4. Determine slab thickness and concrete strength as if the slab were unreinforced.
5. Divide the floor into slabs no more than 110 feet by 110 feet.
6. Make the slabs square or rectangular, with an aspect ratio not to exceed 1.5.
7. Avoid changes in slab thickness within any slab.
8. Install a polyethylene slipsheet directly beneath the slabs.

9. Carefully isolate the slabs from columns, walls, and all other building elements with 1 inch of soft, compressible foam.
10. Do not tie the slabs to any other building elements.
11. Avoid re-entrant corners.
12. Make no sawcuts or other induced joints within the slabs.
13. Use dowels at the construction joints between slabs.
14. Expect the construction joints to open wider than in an ordinary-jointed floor. Consider armoring the joints or filling them late in the construction schedule.

Answering Questions and Objections

Anyone proposing a floor design that includes steel fibers can expect certain questions.

Q: *Will fibers show at the floor surface?*

A: The short answer is yes. You must expect to see at least a few fibers in any floor that contains fibers. The long answer is that the fibers recommended here -- Type II, 1-inch long, with continuous deformations -- almost never appear at the surface in numbers large enough to cause trouble. To be sure, there are horror stories of slabs that bristled like porcupines, but they involved much longer fibers, often with hooked ends.

Q: *Does the floor need a dry-shake hardener to cover the fibers?*

A: No. The fibers recommended here are used regularly without any dry shake.

Q: *Will the concrete be hard to place and finish?*

A: No. If you use the fibers recommended here, and if the concrete mix is designed so that it would have good workability without fibers, you should expect no unusual difficulties in placing and finishing.

Q: *Can I substitute another kind of steel fiber?*

A: Not without risk. The design recommendations in this paper are based on the use of CFS Type 2 fibers, 1-inch long. Other steel fiber types and lengths could be less effective in controlling and preventing cracks. Other types could also make the concrete harder to place and finish and might result in more visible fibers at the floor surface.

Q: *Can I substitute synthetic (plastic) fibers?*

A: No. Because steel fibers differ fundamentally from synthetic fibers, they cannot be considered equivalent. This is true whether the fibers being proposed are microsynthetic or macrosynthetic. While it may be possible to build a good floor with synthetic fibers, you cannot substitute them for steel fibers and expect the same performance.

Why Specify CFS 100-2 Fibers

COST

Time is money in construction. In the time it takes to set the mesh or rebar, concrete with steel fibers could have been placed and finished. And with a steel-fiber-reinforced slab, the required number of sawcuts is greatly reduced, saving even more time and expense.

SAFETY

One of the leading tripping hazards on a jobsite is the mesh or rebar. This hazard is completely eliminated with the use of steel fibers. And we know that the elimination of potential injuries means a more productive work force as well as no costly insurance claims.

When designing or constructing your next slab-on-grade project, specify Concrete Fiber Solutions CFS 100-2 steel fibers for the best results.

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