

STRUX® 90/40 Macro Synthetic Fiber for Composite Steel Floor Deck Applications

Frequently Asked Questions

List of questions from the engineer, contractor and ready mix supplier point of view.

Which “FIBERMESH®” product are you referring to?

STRUX® 90/40, a macro synthetic fiber from Grace. FIBERMESH® is a brand of fibers that is often used generically to describe synthetic fibers used in concrete. There are two types of fibers in the market; micro type and macro type fibers and both have different purposes.

What is the difference between “Micro” and “Macro” fiber?

“Micro” type fibers are typically polypropylene, cellulose or nylon monofilament (see Figure 1) or fibrillated (see Figure 2) fibers with diameters less than .004 in. (0.22 mm), length ranging from 0.5–0.75 in. (12.7 mm–19 mm), with addition rates between 0.5 lbs/yd³–1.5 lbs/yd³ (0.30 kg/m³–0.88 kg/m³) and specifically designed to control/reduce **plastic shrinkage cracks** that occur within the first 24 hours. Grace offers the following micro type fibers: Grace MicroFibers™ (monofilament), Grace Fibers™ (fibrillated) and Gilco® Fibers (monofilament).

“Macro” type fibers (see Figure 3) are typically monofilament with a diameter between .012 in.–.05 in., lengths ranging from 1.5 in.–2.5 in. (38 mm–64 mm) and made with polyolefin or steel. The typical synthetic macro fiber addition rate is between 3 lbs/yd³–10 lbs/yd³ (1.8 kg/m³–7.0 kg/m³)

while steel macro fibers have an addition rate between 25 lbs/yd³–100 lbs/yd³ (15 kg/m³–60 kg/m³). The primary benefit of “Macro” type fibers is post crack control and/or to meet temperature/shrinkage reinforcement similar to welded wire fabric when properly positioned. In other words it can substitute the crack control steel required in slabs on ground, precast and composite deck applications.



Figure 1: Monofilament fibers (Grace MicroFibers shown)



Figure 2: Fibrillated fibers (Grace Fibers shown)

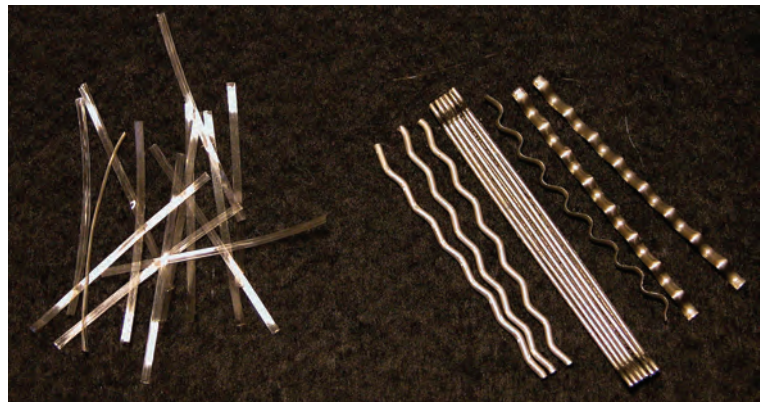
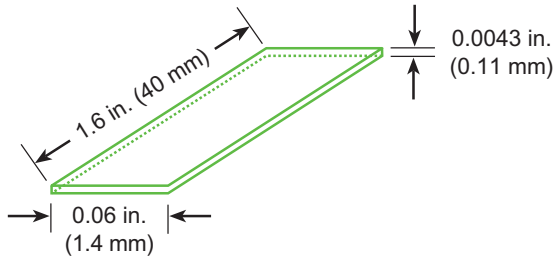


Figure 3: “Macro” fibers (STRUX 90/40 left, steel fiber right)

What are the primary properties of STRUX 90/40?

STRUX 90/40 is a polyolefin (blend of polypropylene and polyethylene) product with the following dimensions and physical properties:



Tensile strength	90 ksi (620 MPa)
Modulus of elasticity	1,378 ksi (9.5 GPa)
Alkali, acid & salt resistance	High
Absorption	None
Specific gravity	0.92
Melting point	320°F (160°C)
Ignition point	1,094°F (590°C)

Can STRUX 90/40 be used for composite steel floor deck applications?

Yes. The new ANSI/SDI C-1.0 Standard for Composite Steel Floor Deck allows “macro” synthetic fibers as a suitable alternative to replace temperature and shrinkage steel specified by deck manufactures/Engineers. Please consult with a Grace Engineering Service Group representative or Grace sales representative to obtain the correct addition rate for this specific application or refer to Engineering Bulletin for Composite Steel Floor Deck at www.graceconstruction.com/strux.

Where can I access the ANSI/SDI C-1.0 Standard for Composite Steel Floor Decks?

A copy is available at the Steel Deck Institute web site (www.sdi.org) or from a Grace representative. Section 6, titled Reinforcement permits the use of either steel or macro synthetic fiber to replace temperature and shrinkage reinforcement with prescribed addition rates and fiber characteristics.

What is ANSI/SDI?

ANSI/SDI is the American National Standard Institute and SDI is the Steel Deck Institute. “ANSI facilitates the development of American National Standard (ANS) by accrediting the procedures of standards developing organizations (SDOs). These groups work

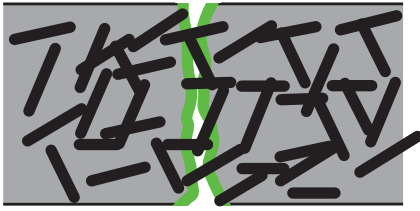
cooperatively to develop voluntary national consensus standards. Accreditation by ANSI signifies that the procedures used by the standards body in connection with the development of American National Standards meet the Institute’s essential requirements for openness, balance, consensus and due process.” (www.ansi.org).

Steel Deck Institute is an organization of steel manufacturers, consultants, professors and associate members that have a common interest in providing guidance, recommendations, documentation and standards to various organizations involved with steel construction (www.sdi.org).

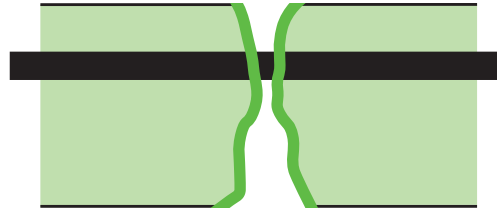
Why is WWF specified for use in composite decks?

WWF is specified in composite decks to provide control of temperature and shrinkage cracking. In limited instances engineers may also rely on the WWF to provide some structural capacity (i.e. in negative moment regions or for instances of elevated diaphragm shear transfer through the composite deck). Often in these instances and in order to avoid uneconomical designs, rather than increasing the size of the mesh throughout the slab engineers will call for additional reinforcing steel added locally as needed.

Figure 4



Uniform Crack Width
with STRUX 90/40
(Synthetic Macro Fiber)



Wider Cracks Away
from WWM/Rebar

What are the advantages of STRUX 90/40 vs. WWF?

Macro type fibers are uniformly dispersed throughout the concrete matrix to minimize the potential for cracks.

Macro synthetic fibers offer post-crack performance at all depths of the concrete no matter where the crack is developed. Cracks in concrete with WWF must propagate to the steel before it is controlled. Because there is only one layer of WWF running through the concrete, cracks can propagate and widen above and below this reinforcement layer, weakening the concrete (see Figure 4).

The fiber count per unit volume of macro synthetic fibers, by contrast, provides uniform reinforcement throughout the concrete, from sub grade to surface.

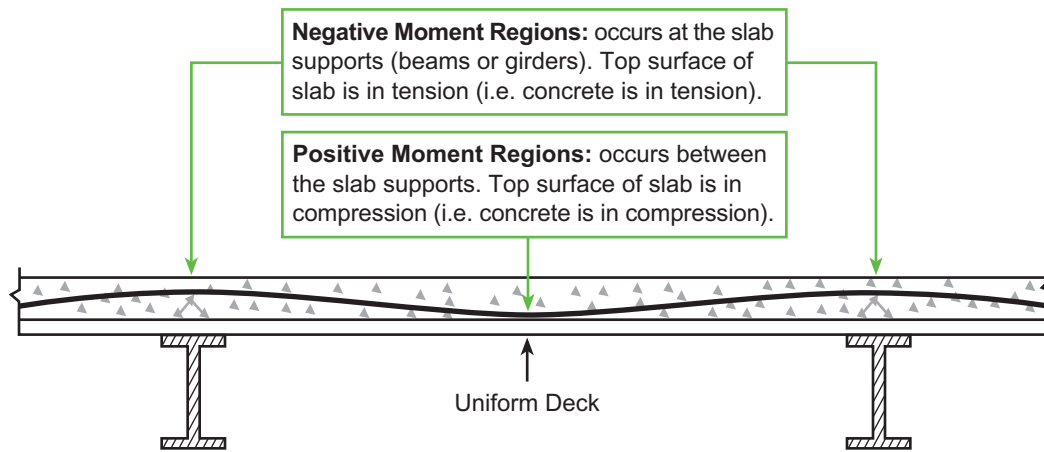
What are the advantages of STRUX 90/40 vs. steel fibers?

The main advantage of STRUX 90/40 versus steel fibers is the ease of mixing, handling, placing and finishing. The key lies in the macro synthetic fiber count per unit volume.

Pound for pound, macro synthetic fiber offers reinforcing performance that is superior to steel. At equal volumes in the mix, macro synthetic fiber provide 5 to 15 times more individual fibers in the concrete than steel fibers—up to 530,000 macro synthetic fibers versus about 35,000 steel fibers. [Note that the new ANSI/SDI standard calls for steel fibers to be specified at a minimum addition rate of 25 lbs/yd³ (14.7 kg/m³) vs. macro synthetic fiber at a minimum addition rate of just 4 lbs/yd³ (2.4 kg/m³)]. This far greater fiber count per unit volume results in superior post-crack performance, because there are many more fibers available to intercept a micro crack and keep it from expanding.

Added to the mix at the batch plant, steel fibers are hard on equipment, including drums and ready mix trucks, shortening their lifespan. At the plant and at the job site, steel fibers are difficult to dispense and exposed steel fibers continue to present a hazard, especially on surfaces handling foot or vehicular traffic. Exposure of steel fibers can also result in unsightly staining due to corrosion.

Figure 5



Will STRUX 90/40 impact the vertical load capacity of the composite steel deck?

No. STRUX 90/40 will not impact the vertical load capacity of composite steel decks in comparison to WWF when used to control temperature and shrinkage cracking. An independent loading test on composite steel decks with vertical point loads indicated that STRUX 90/40 performed equivalent to WWF.

For instances where the engineer increases the WWF size beyond what is necessary for temperature and shrinkage reinforcing in order to improve the negative moment capacity (refer to Figure 5), STRUX 90/40 can still be used as a replacement to WWF with localized reinforcing steel being added in negative moment regions as needed. Generally, the combination of STRUX 90/40 with localized rebar, will provide a more economical design then increasing the size of the WWF throughout the deck (see more on the economics of STRUX 90/40 vs. WWF in proceeding FAQ's).

Will STRUX 90/40 provide shear capacity when considering diaphragm design criteria?

No. Further testing needs to be conducted to confirm these capabilities. Concerns about diaphragm shear transfer within a deck are most relevant in multi-story buildings located in zones with high seismic or wind loads. Often in these cases heavy re-bar is needed to provide the necessary capacity. STRUX 90/40 or any other macro synthetic fiber alone will be insufficient at practical dosage levels.

Can STRUX 90/40 be specified for non-composite deck applications?

Yes and No. Typically, non-composite deck requires a primary reinforcement and not a temperature and shrinkage requirement, hence why STRUX 90/40 cannot be used. When primary reinforcing is utilized, temperature and shrinkage reinforcing is sometimes used. When this is the case, STRUX 90/40 may be substituted for this steel.

Does STRUX 90/40 have UL approval?

Yes. STRUX 90/40 has a 1 hr, 1.5 hr and 2 hr rating for Floor Designs D700, D800 and D900 with a maximum addition rate of 5 lbs/yd³.

Does STRUX 90/40 have ULC (Canada) approval?

Yes. STRUX 90/40 has a 1 hr, 1.5 hr and 2 hr rating for Floor Designs D700, F700, D800, F800 and F900 all except F909 with a maximum addition rate of 3 kg/m³.

What is the significance of the fire rating and why does STRUX 90/40 not have a 3-hour UL rating?

The hourly rating is driven by code (occupancy/building size, etc.) and not by material capability. Macro fibers (synthetic or steel) only replaces temperature and shrinkage reinforcement and are not a structural component of a composite steel floor deck. The goal of the UL testing is to prove that the fibers being tested do not adversely affect the transfer of heat on the top of the slab during a fire, which is not any different if there was no minimum reinforcement, or with WWF. Therefore fibers **do not enhance fire characteristics**. Grace's objective at UL was to test STRUX 90/40 to **ONLY** achieve the most common 2 hour rating found on 90% of the composite steel floor deck projects versus 3 hour ratings only specified for approximately 10% of the composite steel floor deck projects.

Why should a "macro" type fiber be specified vs. WWF on composite steel floor deck?

By using STRUX 90/40, there are many steps involving installation of WWF properly on composite steel floor decks that can be eliminated.

- 1) Prior to WWF placement, estimating/scheduling/ordering.
- 2) Locating storage space at the job site.
- 3) Crane time/cost required to haul the WWF onto each elevated floor.
- 4) Setting chairs and tying-off the WWF.
- 5) At minimum a 15% overlap of WWF sheets is required by the structural engineer thus resulting in material waste. (15% is an overlap of one square but it can be as much as 2 squares which is over 30% overlap).

After WWF placement:

- 1) Concrete pump lines can get caught on or tangled in the WWF, making the job more difficult and dangerous.
- 2) WWF presents other safety risks such as tripping and falling which may result in injury.

Other items to consider:

- 1) On average it takes 2 to 3 men one day to install 10,000 ft² of WWF on a composite deck. Eliminating WWF from the equation results in a fast track concrete construction schedule.
- 2) Safety issues, insurances and workers compensation from trips/falls and other injuries associated with WWF will be minimized.
- 3) Finally performance of STRUX 90/40 will hold cracks together tightly throughout the slab thickness and is equal or superior to WWF.

Figure 6

Height of concrete above flutes (in.)	Recommended WWF to meet minimum area of steel per ANSI/SDI C-1.0	Equivalent STRUX 90/40 addition rate lbs/yd ³	
		Light weight	Normal weight
2.0	6 x 6 W1.4 x W1.4	5	4.5
2.5	6 x 6 W1.4 x W1.4	4	4
3.0	6 x 6 W1.4 x W1.4	4	4
3.5	6 x 6 W2.1 x W2.1	4	4
4.0	6 x 6 W2.1 x W2.1	4	4
4.5	6 x 6 W2.1 x W2.1	4	4
5.0	6 x 6 W2.9 x W2.9	4	4
5.5	6 x 6 W2.9 x W2.9	4	4
6.0	6 x 6 W2.9 x W2.9	4	4

What is the required addition rate for STRUX 90/40 on composite steel floor decks?

Figure 6 is an addition rate table for Composite Steel Floor Decks. For more information go to: www.graceconstruction.com/strux and review Engineering Bulletin for Composite Steel Floor Deck.

What is the typical savings using STRUX 90/40 vs. WWF for composite steel floor deck applications?

The typical addition of STRUX 90/40 will vary between 4 lbs/yd³ (2.4 kg/m³) to 5 lbs/yd³ (3.0 kg/m³) but in most cases it will be 4 lbs/yd³ (2.4 kg/m³). On average the savings for STRUX 90/40 vs. WWF can be as much as 25% on just material and labor alone depending on regional markets. On actual job applications, contractors have indicated that just the result of faster construction and safety over WWF is worth exploring STRUX 90/40 as an alternative to WWF. Please consult with your local ready mix supplier for local pricing.

Can STRUX 90/40 be specified for slab on grade applications?

Yes. STRUX 90/40 has been utilized for slabs on grade for over 5 years for residential, commercial, manufacturing, distribution, institutional, agricultural and other applications. Grace’s STRUX 90/40 SDS Software is also available to assist with all particular slab on ground designs from wheels loads, post loads to racking systems from edge loading to center loading cases. The result is a 25-page report showing the most cost-effective design using Yield Line theory backing up the calculations. Please contact your local Grace Engineer Service Group to get a copy or assistance with your designs. Also refer to STRUX 90/40 FAQ for Slab on Ground Applications for more detailed information.

Where can customers purchase STRUX 90/40?

Your local ready mix producer can purchase STRUX 90/40 anytime and shipment will be received within standard lead times of 3 to 5 days.

What is the packaging for STRUX 90/40?

STRUX 90/40 is packaged in 1 and 5 lb concrete ready bags that are added to the concrete mixer. Handling is much easier than steel fibers (usually 25–50 lb bags) or WWF on site. STRUX 90/40 for Composite Steel Floor Deck applications is in 5 lb (2.3 kg) bags (330 lbs/pallet). STRUX 90/40 is also packaged in 1 lb (0.45 kg) bags in a box of 24 bags/box, 18 boxes/pallet.

Can STRUX 90/40 be stored at the job site?

No. STRUX 90/40 is purchased by the ready mix supplier and added at the plant for proper mixing.

How is STRUX 90/40 mixed in the ready mix truck?

STRUX 90/40 is packaged in concrete ready bags that break down during mixing. Typically in a dry batch plant STRUX 90/40 bags are added to the concrete truck prior to batching. In a central batch facility STRUX 90/40 bags can be added in three different ways:

- 1) Mixed directly into the central mixer,
- 2) Added to the truck prior to the concrete being dumped from the central mixer or
- 3) Added after the concrete has been dumped in the ready mix truck. Please consult with your Grace sales representative for proper batching procedures.

Are there any mix design requirements needed when utilizing STRUX 90/40?

Yes. Only a slight mix adjustment from the ready mix supplier is required due to slump loss of approximately 1 in. per 3 lbs/yd³ (25 mm per 1.8 kg/m³) addition rate. The addition of a mid-range or superplasticizer is recommended to stay within the water/cement ratio specified. It has been noted based upon actual job applications that pumping is easier with the addition of STRUX 90/40 in light weight concrete.

What type of finish should I expect when using fibers?

Proper finishing procedures are required to achieve a fiber free surface finish. The most effective way to screed the concrete is with either a laser screed (BEST), vibratory screed (Very Good) or handed screeded (Good). Follow normal power troweling methods for proper finish. A broom or course finish will reveal fibers at the surface.

Does STRUX 90/40 make pumping concrete difficult?

No. For normal weight concrete STRUX 90/40 does not increase the pressure needed to pump the concrete mix or cause any other issues. It is recommended that if a “fiber ball” appears it is best to remove it before being pumped. For light weight concrete, experience has shown that STRUX 90/40 makes it easier to pump with minimal slump loss at the end of the hose.

Can STRUX 90/40 provide plastic shrinkage crack reduction benefit?

Yes. Grace laboratory tests demonstrated 3 lbs/yd³ (1.8 kg/m³) of STRUX 90/40 reduced the amount of plastic shrinkage cracking by 85%, which exceeds the ICBO AC32, Annex A acceptance criteria, which require that the synthetic fibers reduce the plastic shrinkage cracking of concrete by at least 40%. Some other synthetic fibers and steel fibers do not provide this benefit. Micro type fibers have to be used in addition to meet this requirement.

What other applications besides typical slabs on ground can STRUX 90/40 be specified?

STRUX 90/40 has been utilized in a multitude of applications such as precast, shotcrete, thin-overlays (concrete less than 4 in. (100 mm) thick), whitetoppings, concrete curbs, slabs with two mats of rebar (eliminating the temp/shrinkage layer) and used in combination with Eclipse® Floor to extend joint spacing for distribution/warehouse projects. For more details on each of these applications please contact your local Grace representative.

www.graceconstruction.com/strux

North American Customer Service: 1-877-4AD-MIX1 (1-877-423-6491)

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STRUX-59 Printed in U.S.A. 1/08

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