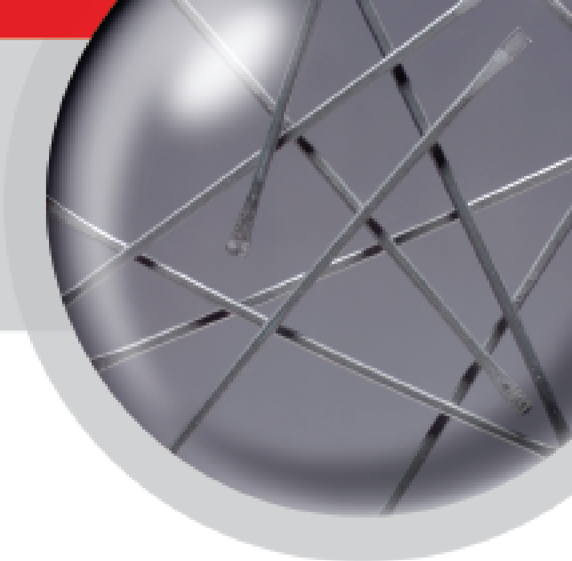
# NOVOCON® 1050

PRODUCT DATA SHEET



## NOVOCON® 1050 STEEL FIBERS

Novocon 1050, formerly Novotex™ 1050, steel fibers are designed specifically for the reinforcement of concrete, mortars and other cementitious mixes. Novocon 1050 is a cold drawn wire fiber, deformed with hooked ends (HE) or flat ends (FE) to provide optimum anchorage within the concrete mix. Novocon 1050 steel fibers are ASTM compliant and specifically designed to meet or exceed the defined performance requirements.

## FEATURES & BENEFITS

- Provides uniform multi-directional concrete reinforcement
- Increases crack resistance, ductility, energy absorption or toughness of concrete
- Improves impact resistance, fatigue endurance and shear strength of concrete
- High tensile strength fiber bridging joints and cracks to provide tighter aggregate interlock resulting in increased load-carrying capacity
- Provides increased ultimate load-bearing capacity which allows possible reduction of concrete section
- Requires less labor to incorporate into concrete than conventional reinforcement
- Offers economical concrete reinforcement solutions with greater project scheduling accuracy
- Ideally suited for hand or vibratory screeds, laser screeds and all conventional finishing equipment

## PRIMARY APPLICATIONS

- Industrial slabs-on-ground
- Airport pavements
- Highway pavements
- Blast-resistant structures
- Equipment foundations

## COMPLIANCE

- Conforms to ASTM A 820 / A 820M - 04, Type 1 cold drawn wire
- Testing shall conform to ASTM C 1116, C 1609 / C 1609M and JCI-SF4

## CHEMICAL AND PHYSICAL PROPERTIES:

| | |
|---|---|
| Fiber Length | 2 in (50 mm) |
| Equivalent Diameter | 0.039 in (1.0 mm) |
| Aspect Ratio | 50 |
| Tensile Strength | 152,000 psi (1050 MPa) |
| Deformation | Flat end (FE), hooked end (HE) |
| Appearance | Bright and clean wire |

### DO SPECIFY NOVOCON 1050 FIBERS:

- For temperature/shrinkage and flexural reinforcement
- Increased crack resistance, ductility, energy absorption or toughness
- Improved impact resistance
- Improved fatigue endurance and shear strength
- Improved durability

### DO NOT SPECIFY NOVOCON 1050 FIBERS:

- Replacing structural levels of steel reinforcement

# NOVOCON® 1050

## PRODUCT USE

MIXING DESIGNS AND PROCEDURES: Novocon® 1050 steel fibers can be added during or after the batching of the concrete but should never be added as the first component. Such devices as conveyor belts and dispensers may be used to add fibers to the mixer at the ready mix plant. After the fibers have been added, the concrete should be mixed for sufficient time (75 rotations at full mixing speed) to ensure uniform distribution of the fibers throughout the concrete. The use of mid- or high-range water reducing admixtures can be advantageous, but is not essential. Novocon 1050 steel fibers can be pumped, shot or placed using conventional equipment.

FINISHING: Hand or vibratory screeds and laser screeds can be used with Novocon 1050 steel fibers. Conventional finishing techniques and equipment can be used when finishing Novocon 1050 steel fiber concrete. In some cases an extra bull float process is advised and lowering the angle of the power float blades will help to minimize fiber exposure on the surface.

APPLICATION RATE: The fiber dosage will vary depending on the type of application, concrete mix design and the performance/toughness requirements of each particular project. Typically, steel fiber dosage will be in the range of 25 lbs to 75 lbs per cubic yard (15 kgs to 45 kgs per cubic meter). Propex Concrete Systems technical staff can offer advice on dosage requirements once performance requirements have been established by the project designer/engineer.

## SAFETY

It is recommended that gloves and eye protection be used when handling or adding Novocon 1050 steel fibers to concrete.

## COMPATIBILITY

Novocon 1050 steel fibers are compatible with all curing compounds, superplasticizers, water reducers, hardeners and coatings.

## PACKAGING & STORAGE

Novocon 1050 HE and 1050 FE fibers are available in 55 lb boxes. The pallets should be protected against rain and snow. Do NOT stack pallets on top of each other.

## TECHNICAL SERVICES

Propex Concrete Systems is backed by our team of reinforced concrete specialists who can carefully analyze each project and provide fiber reinforced concrete design solutions to ensure maximum project performance and cost efficiency.

## REFERENCES

- ASTM A 820 Standard Specification for Steel Fibers for Fiber-Reinforced Concrete.
- ASTM C 94 Standard Specification for Ready-Mixed Concrete Uniformity Requirements.
- ASTM C 1399 Average Residual Strength of Fiber Reinforced Concrete.
- ASTM C 1436 Standard Specification for Materials for Shotcrete.
- ASTM C 1609 / C 1609M Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading). Replaces ASTM C 1018.
- ASTM C 1116 Standard Specification for Fiber-Reinforced Concrete And Shotcrete.
- ASTM C 1550 Standard Test Method for Flexural Toughness of Fiber Reinforced Concrete (Using Centrally Loaded Round Panel).
- JCI-SF4 Method of Test for Flexural Strength and Flexural Toughness of Fiber Reinforced Concrete.
- ACI 304 Guide for Measuring, Mixing, Transporting and Placing Concrete.
- ACI 506 Guide for Shotcrete.
- ACI 544-3R Guide for Specifying, Proportioning, Mixing, Placing and Finishing Steel Fiber Reinforced Concrete.
- UL® Approvals for use as an alternate or in addition to welded wire fabric used in floor-ceiling D700, D800 and D900 series designs.

## SPECIFICATION CLAUSE

Fibers for concrete shall be Novocon 1050 HE (hooked end) or FE (flat end) steel fibers conforming to ASTM A 820 Type I and manufactured from cold drawn wire with a minimum tensile strength of 152,000 psi. Unless otherwise stated, Novocon 1050 steel fibers should be added to the concrete at a rate of .........lbs/yd³ and mixed for sufficient time (75 rotations at a full mixing speed) to ensure uniform distribution of the fibers throughout the concrete. Fiber reinforced concrete shall be manufactured by Propex Concrete Systems, 6025 Lee Highway, Suite 425, PO Box 22788, Chattanooga, TN, 37422, USA, tel: 423 892 8080, fax: 423 892 0157, web site: fibermesh.com.

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Fiber Reinforced Concrete

# Design for Ground-Supported Slabs

The design of reinforced concrete slabs on ground has typically taken one of two different forms: 1) slabs designed as plain concrete (reinforced for serviceability) or, 2) slabs designed with the primary reinforcing for load-capacity mechanism.

Whichever the case, slab thickness, moment capacity, shear transfer and joint spacing are always key to the design process and the long-term performance of the slab.

Worldwide, for the last 25 years, fiber reinforcing has been used to reinforce both types of slabs, whether for serviceability or for primary load-capacity. Slabs reinforced for serviceability only, have typically been reinforced with fibers quantities ranging from 0.2 to 0.4% by volume, while slabs reinforced for primary load-capacity have typically been reinforced with quantities ranging from 0.3% to 0.8% by volume.

For much of this time, the 'macro' fiber reinforcing used in primary reinforcing applications was a steel fiber (ranging in size from 0.5 to 1.2-mm diameter and 25 to 60-mm in length). In the last decade, however, a 'macro' synthetic fiber (with similar dimensions) has also evolved to serve in similar primary reinforcing applications.

Whether steel or synthetic, the load-capacity mechanism of 'macro' fiber reinforced concrete is measured by its' toughness or 'post-crack' load-carrying capacity. Industry standards like ASTM C1018, C1550 and JCI SF4 are all used to measure this post-crack load-capacity by means of the load vs. deflection relationship that the fiber reinforced concrete provides. This relationship is defined by the fiber reinforced concrete's equivalent flexural ratio. The standard unit of this measure is the Re value or Re,3 value that defines this relationship to a deflection of 3.0-mm and the frc's load-capacity after cracking, similar to continuous reinforcing.

Load-deflection curves generated by ASTM C1018 or JCI SF4 can be used to generate this Re value by measuring the total area under the load-deflection curve out to the given deflection (typically 3.0-mm).

Propex Concrete Systems' Slab Design is a computer generated program that has made easy the process of determining the proper design for the slab on grade. Combined with proper engineering judgment, Propex Slab Design can aid the engineer in addressing all facets of the slab on ground design - from thickness, to joint spacing, to reinforcing quantities, acceptable stress levels and proper safety factors.

## APPLICATION OF $R_{e,3}$ TO ANALYSIS: Yield Line Analysis Based on Meyerhof Thickness Design Approach

Propex Slab Design utilizes the thickness design approach for ground supported slabs as provided by the Meyerhof Design Method indicated in Appendix F of TR 34. This design method is intended for ground supported design conditions only, and it utilizes the strength of the SFRC, by means of the equivalent flexural strength as represented by $R_{e,3}$, to effectively redistribute moment and shear forces and maintain the integrity of the concrete slab under loaded conditions. The Meyerhof approach analyzes three separate possible loading conditions - interior, edge and corner - as the slab's ability to handle stresses at these locations vary.

### LOAD CONDITIONS

**Interior Load**

$P_o = 6[1+2a/L]M_o$: A central load located more than 20 inches from a free edge.

**Edge Load**

$P_o = 3.5[1+3a/L]M_o$: An edge load located within 20 inches from a free edge, and contains no shear load transfer mechanism.

**Corner Load**

$P_o = 2[1+4a/L]M_o$: A corner load located within 20 inches of intersecting joints containing no shear-load transfer mechanism.

For interior and edge loading conditions, the limiting moment of resistance calculation is provided as follows:

$M_o = [1 + R_{e,3} / 100]\, f_{ct}\, bh^2 / 6$

Where:

a = contact radius of load

$P_o$ = ultimate load

L = radius of relative stiffness of slab

$M_o$ = limit moment of resistance of slab

$f_{ct}$ = ultimate flexural strength

b and h = width and depth of slab

The $[1 + R_{e,3} /100]$ enhancement is the factor that accounts for the redistribution of the ultimate moments of the steel fiber reinforced concrete. This enhancement resulting in increased ultimate load capacity is dependent upon the fiber type, geometry and quantity. SI Slab Design takes this enhancement factor into account and can accommodate concentrated loading and distributed loading alike, broken down into four major categories: Fork Truck loading, Rack Post loads, Dual and Dual Tandem Vehicle loading and Uniform Distributed Live loads as illustrated on the back page.

## BEYOND THICKNESS

In addition to load analysis and stress determination, Propex Slab Design evaluates the necessary amount of steel fiber reinforcing for temperature and shrinkage crack control, and for shear-load transfer at control joints.

**Joint Design:**

Proper control joint spacing and joint detailing are essential elements of Propex Slab Design in providing the necessary cross-sectional area of steel for crack control and shear-load transfer mechanism. Meeting the requirements for these design elements plays a big role in determining the proper steel fiber design, as does meeting the required levels of toughness or post-peak equivalent strength.

**Joint Spacing:**

Propex Slab Design optimizes the quantity of steel fiber reinforcing based on the requirements for control joint spacing. The program offers varied steel fiber quantities depending upon the project specifications and the tolerance for risk. As with conventional reinforcing, increased quantities of steel fiber may be recommended to allow for increased joint spacing; however, this theory alone does not fully address the effect that increased joint spacing has on the integrity of the slab.

Research over the last decade indicates that extended joint spacing can significantly increase the curling potential and the long-term performance of the slab. Coupled with the fact that the majority of owners and contractors have a low tolerance for random cracking, Propex Concrete Systems recommends a conservative joint spacing to reduce the risk of interpanel cracking, slab curling and potential loss of shear-load transfer at the control joints. Propex Slab Design can accommodate the approach for extended control joint spacing as long as varying design parameters are met.

**Joint Stability:**

Control joints are an induced weak point, a place of prescribed cracking where the continuity of the concrete to distribute stress is lost.

Because of the shrinkage inherent in concrete and the economics associated with jointing, counting on aggregate interlock for shear-load transfer is not a viable solution for the positive shear-load transfer required under today's harsh loading conditions created by constant wheeled traffic and stress distribution across joints.

For lightly to moderately loaded slabs, steel fibers can provide the necessary shear-load transfer mechanism in the absence of other mechanical devises, such as dowels, at control joints. The Propex Concrete Systems design philosophy evaluates the severity of the loads – type, magnitude, and repetitions – and the control joint spacing to determine the effectiveness of the steel fiber design solution to provide adequate shear-load transfer.

For heavy loading conditions, conventional mechanical load transfer systems may be required to meet the extreme requirements for shear-load transfer and to provide the most economical solution.

## FACTORS OF SAFETY

The final component of Propex Slab Design is evaluating the resulting stresses, the service design life, and the fatigue endurance limits to determine the minimum safety factors for the SFRC design. While engineers vary in their requirements for safety factors, Propex Concrete Systems generally recommends a minimum factor of safety of 1.5 for static load cases, and a factor of safety of 2.0 for dynamic load cases to allow for unlimited load repetitions. Many factors can influence these safety ratios and it is recommended that the factors of safety be evaluated for each individual project.

## REFERENCES

1 - Beckett, D., "Comparative Tests on Plain, Fabric Reinforced and Steel Fibre Reinforced Concrete Ground Slabs", Concrete, March 1990.

2 - Faulkner, H. and Teutsch, M., "Comparative Investigations of Unreinforced and Steel Fibre Reinforced Industrial Flooring," Technical University of Brunswick, Germany, 1993

3 - Technical Report 34, "Concrete Industrial Ground Floors - A Guide to their Design and Construction," The Concrete Society, Slough, U.K., 1994.

4 - Meyerhof, G.G., "Load Carrying Capacity of Concrete Pavements," Journal of the Soil Mechanics and Foundation Division, Proceedings, ASCE, June 1962.

5 - "JCI Standards for Test Methods of Fiber Reinforced Concrete," JCI-SF, Japan Concrete Institute, Tokyo, 1987

6 - JCI SF-4, "Method of Test for Flexural Strength and Flexural Toughness of Fiber Reinforced Concrete," JCI-SF, Japan Concrete Institute, Tokyo, 1987.

7 - ACI Committee 360, "Design of Slabs on Grade," (ACI 360R-92), American Concrete Institute, Farmington Hills, 1992.