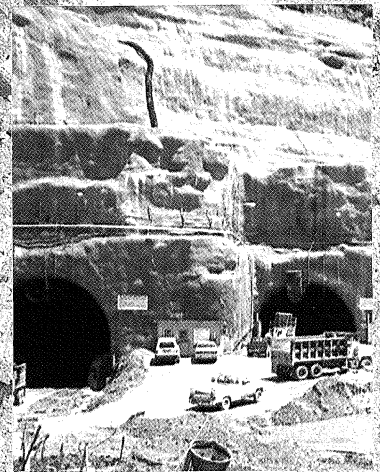


**XOREX™
STEEL FIBER
REINFORCEMENT
MAKES
CONCRETE
TOUGHER AND
MORE DUCTILE.**



NOVOCON
INTERNATIONAL, INC.

NOVOCON International Inc. is not only one of the top steel fiber manufacturers in the world with production facilities in the USA, Canada, Europe, Africa, and South America, but is also the leading expert in design, engineering, consulting and technical support for fiber reinforced concrete technology.



Xorex™ Steel Fiber was the only reinforcement in this water retention pond in Queensland, Australia.

It is these properties; the high tensile strength, good mechanical anchorage, the ease of handling and mixing, and the uniform distribution that produce the superior performance of Xorex™ Steel Fiber Reinforced Concrete and Shotcrete.

MEETING YOUR NEEDS

Xorex™ is manufactured in different sizes and configurations to meet your specific applications. Novocon's dedicated and experienced engineers will assist in every phase of each project, from design to implementation. Their knowledge and expertise will ensure that each design is technically tailored to be structurally efficient and cost effective and to achieve the owner's, the designer's and the contractor's performance and cost objectives.

Xorex™ Steel Fibers in concrete will enhance the static flexural strength, fatigue resistance, punching shear strength, torsional strength, post crack flexural behavior (toughness), ductility and crack and spall resistance of the composite.

Xorex™ Steel Fibers make concrete tougher.

XOREX™ STEEL FIBERS MAKE CONCRETE TOUGHER.

Concrete or shotcrete reinforced with Xorex™ Steel Fiber is handled, mixed, pumped, placed and finished in the same fashion as conventional concrete. No special equipment is required and the time and expense incurred in placing conventional bar or mesh reinforcement is eliminated.

Xorex™ Steel Fibers are compatible with all types of cements and concrete admixtures. There are many successful applications of Steel Fiber Reinforced Concrete that have included silica fume, fly ash, retarders, accelerators, shrinkage compensating cement, or super plasticizers.

SUPERIOR STEEL FIBERS

Xorex™ Steel Fiber is an ASTM A820, Type I fiber, which is considered by many to be the best performing type of fiber available on the market. Xorex™ is made from low carbon, cold drawn, high strength steel wire. The unique geometry of Xorex™ provides exceptional performance in concrete, as well as ease of handling. Xorex™ disperses evenly in concrete, resulting in uniform, homogeneous reinforcement. The deformation or crimping of the Xorex™ Fiber provides enhanced mechanical bonding between the concrete and the fiber.

CHART 1 2.0" Xorex™ Steel Fiber Fatigue Design Data

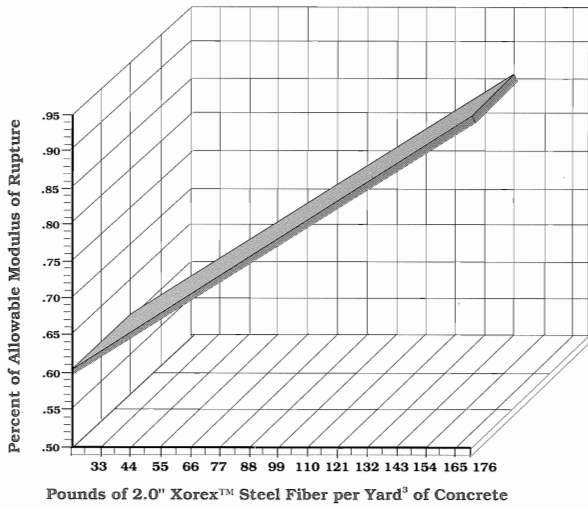
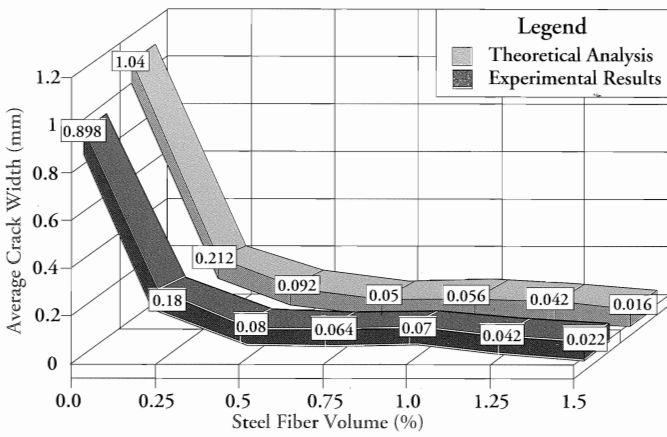
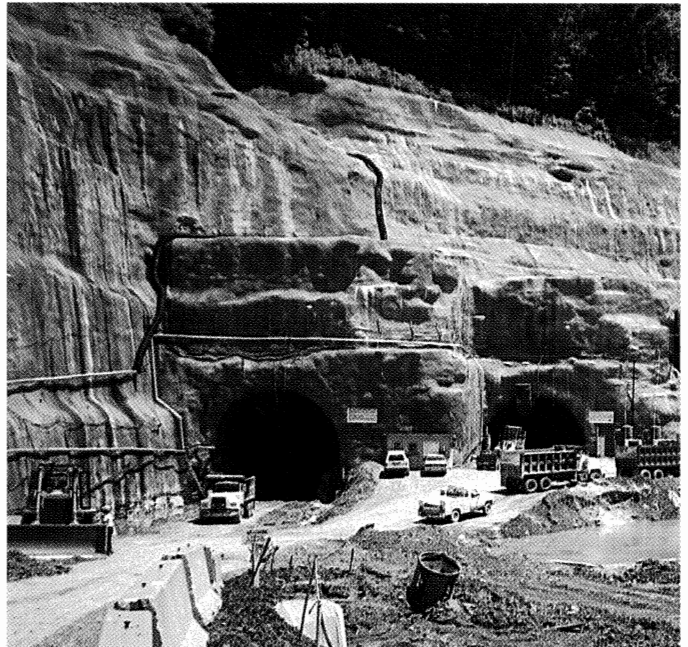


CHART 2 Average Crack Width vs. Steel Fiber Volume (Restrained Shrinkage)



Source: Shrinkage Crack Width vs Steel Fiber Volume, ACI, Mar-Apr '90

**FOR A HEALTHY
BOTTOM LINE,
THINK STEEL FIBER.
XOREX™ STEEL
FIBERS FROM
NOVOCON.**

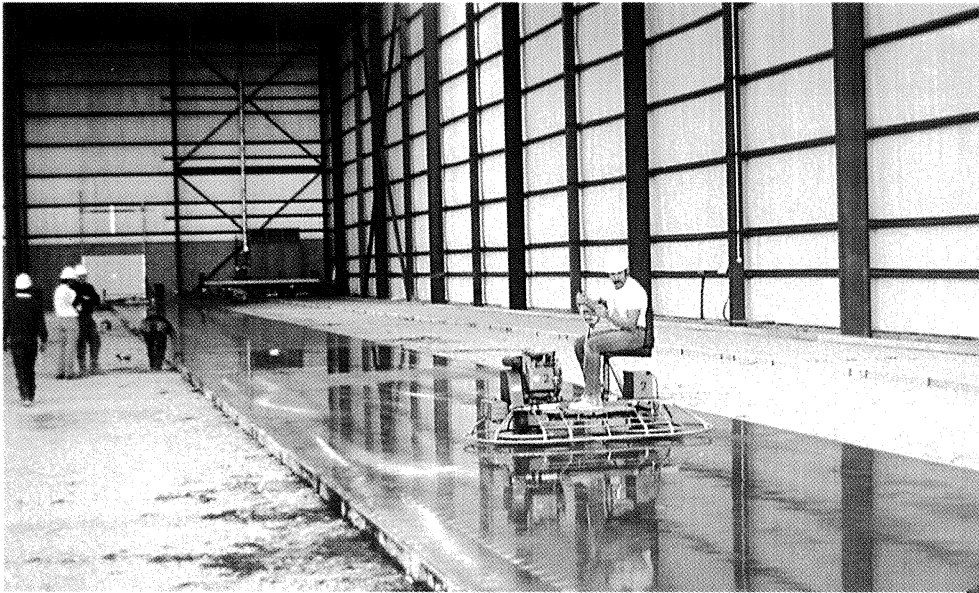


Harlan Gap, Kentucky water diversion tunnels.



Calgary, Alberta, Canada - City street overlaid with 4" of Xorex™ Steel Fiber Reinforced Concrete.

Whatever your concrete application, you can be sure you're getting the RIGHT FIBER with **NOVOCON.**



All types of finishing equipment are compatible with Xorex™ Steel Fiber.

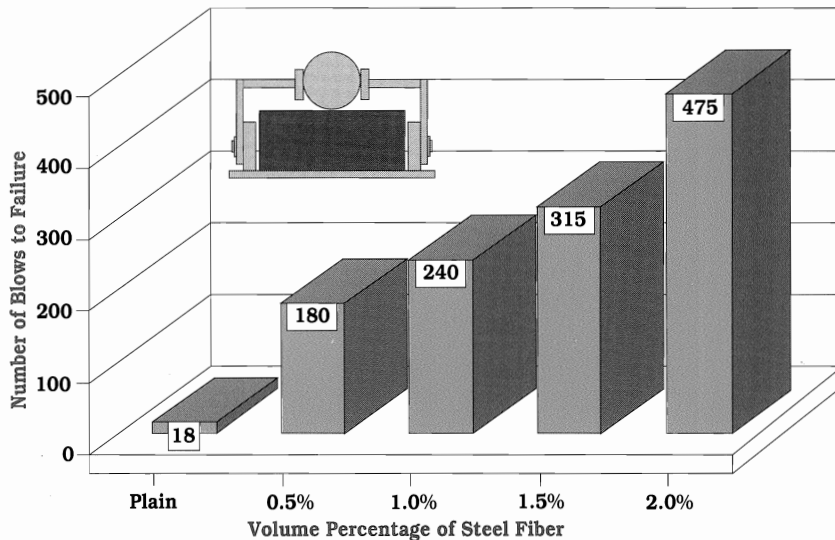
Xorex™ Steel Fiber was used on this superflat application at the Toys R' Us distribution facility in Youngstown, Ohio.



Conventional placing, screeding and finishing techniques are used with Xorex™ to achieve a top quality finish.

CHART 3

Impact Resistance
2.0" Steel Fiber vs Plain Concrete



Source: V. Ramakrishnan, TRB, January 22-25, '89, Washington DC

SLABS ON GRADE AND OVERLAYS

Over one million cubic yards of concrete for slab on grade applications have been reinforced with Xorex™ Steel Fiber. Xorex™ has been used as the primary reinforcement for commercial and industrial slabs on grade, airport runways, roads, weigh scales, overlays, bridge decks and elevated metal deck flooring systems.

Xorex™ Fibers can provide dramatic improvements in the fatigue endurance, flexural ductility, shear strength and impact resistance of concrete. These enhanced properties allow the designer to replace conventional reinforcement with Xorex™ Steel Fiber for slab on grade and metal deck applications. Due to the enhancement of these physical properties, a reduction in slab thickness may also be possible in some applications.

Xorex™ Steel Fibers are either added at the ready mix plant or into the concrete truck at the job site. As Xorex™ Steel Fiber replaces conventional steel reinforcing in these non-structural applications, contractors gain greater flexibility in project scheduling, a reduction in labor costs and an assurance that the reinforcement is properly located. The placing, consolidation and finishing of Xorex™ Steel Fiber Concrete is no different than that of conventionally reinforced

concrete, except that the designer can now have complete confidence in the positive location of the reinforcing steel.

Xorex™ Steel Fiber has a specific gravity that is greater than concrete. With proper placing and finishing techniques, the fiber will behave in a fashion similar to the coarse aggregate, ensuring a smooth, quality finish. Any type of surface treatment is possible, from a burnished superflat floor to a tyned bridge deck overlay. Hardeners and other surface treatments are also compatible.

Xorex™ Steel Fiber Reinforced Concrete can also be poured in very thin sections. This economical solution often means that the overlays can be thinner than with conventional reinforcement, as minimum reinforcement coverage is not a concern. The added durability and strength of Xorex™ Steel Fiber Reinforced Concrete makes it an ideal material for the rehabilitation of existing floors and wearing surfaces.

Novocon customers, who include Ford Motor Company, Toys R Us, Chrysler Corporation, Baxter Healthcare Corp., Price Inc., Pro Coil, General Motors Company and many others have found that both the construction and the life cycle costs have been significantly reduced when Xorex™ Steel Fiber has been specified on their projects.

SHOTCRETE

Xorex™ Steel Fiber Reinforced Shotcrete is a durable, ductile and economical solution for shotcrete applications. The elimination of mesh or rebar reinforcing in slope stabilization, tunnel linings, soil nailing, rehabilitation and restoration, and other specialty applications will reduce unit costs and cut down on rebound, resulting in a better quality shotcrete applied at a significantly higher rate.

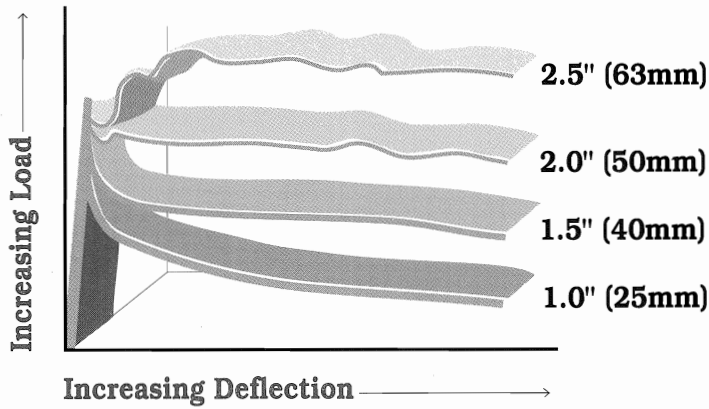
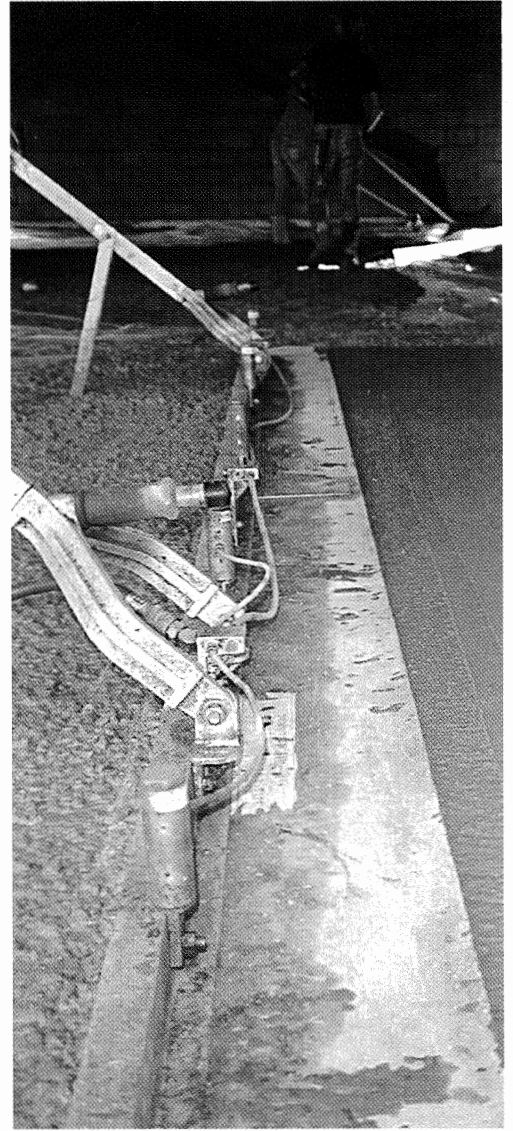
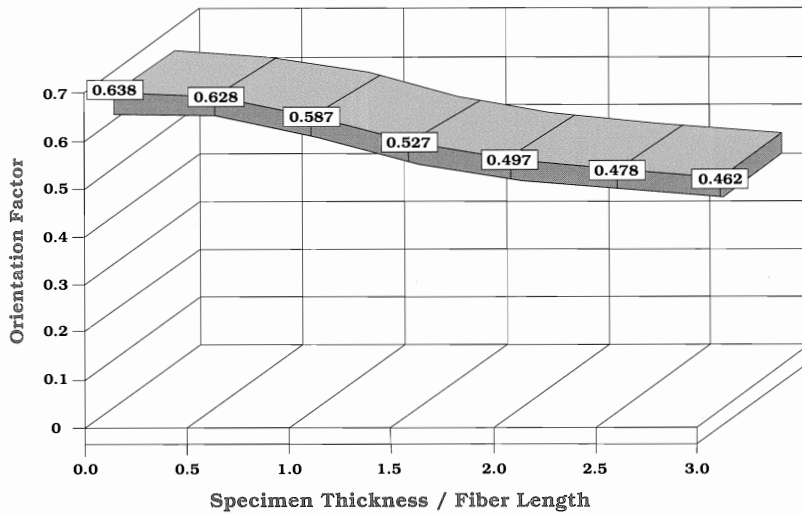
Xorex™ Reinforced Shotcrete has gained wide acceptance as the material of choice in major highway and hydraulic tunnels in the USA, Canada and the rest of the world. The use of Xorex™ Reinforced Shotcrete has been chosen by major contractors and designers on projects such as the Super Collider, the Harlan Gap Tunnels and the Hanging Lake Tunnels for the cost/benefit performance and ease of handling. Novocon field representatives have helped these clients ensure smooth and profitable shotcrete operations. Xorex™ is the best all-around product for any shotcrete job, in both wet and dry mix applications.



Xorex™ Steel Fiber Reinforced Concrete has been used to achieve many superflat (F_{min} -100) floors.

CHART 4

Effect of Fiber Length on Load Deflection Behavior

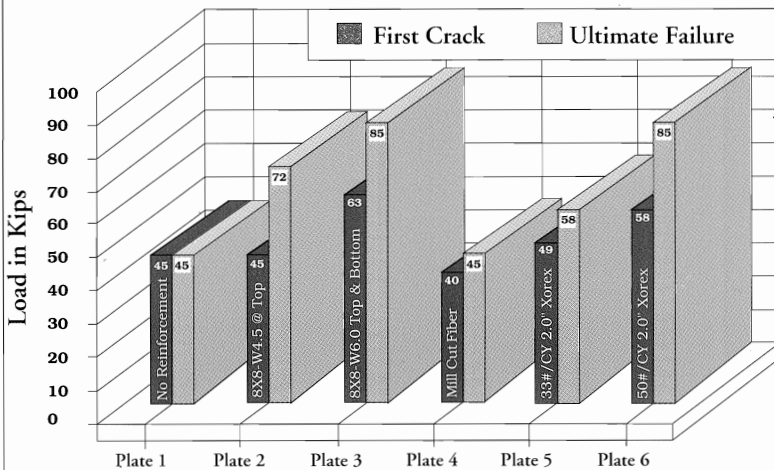
**CHART 5**Effect of Slab Thickness on Orientation Factor
in Cases with Two Boundaries

Xorex™ Fiber Reinforced Concrete is handled in the same way as conventional concrete.

CHART 6

Comparative Slab Tests


Load at First Crack and Failure



The bi-axial stress response is critical to the overall performance of a slab on grade. To better study the response of steel fibers in comparison to other methods of reinforcement, a program was undertaken at Thames Polytechnic Institute in the United Kingdom. Slabs were cast on ground and center loaded from a hydraulic jack. The slabs measured 10' x 10' (300 cm x 300 cm) and were 6" (150 mm) thick. The loading jack base plate measured 4" x 4" (100 mm x 100 mm). Results of this test show that Xorex™ Steel Fiber provides the same static load capacity as two layers of continuous reinforcing.

METAL DECK SYSTEMS

Xorex™ Steel Fiber is ideal for the reinforcement of concrete slabs on metal deck systems. The concrete can be pumped into place with the fiber already added, eliminating the difficulty of placing and working around wire mesh. The elimination of wire mesh, not only reduces costs, but also provides a safer environment for the concrete crews to work in. Xorex™ Steel Fiber will significantly reduce cracking in the overlay, ensuring monolithic behavior. This monolithic behavior is necessary when the deck acts as a building diaphragm.

Xorex™ Fiber is currently the only steel fiber with a  fire rating. The high tensile strength of Xorex™ Fiber and the mechanical deformation along the length of the fiber reinforces the concrete, controlling cracking and eliminating the need for other temperature steel.

OTHER APPLICATIONS

Precast Products

Xorex™ Steel Fiber is used in security vaults, steps, breakwall units, pipes, manholes, pile tips, tilt up panels, mine cribbing and refractory castables. Elimination of mesh or other reinforcement speeds up the pre-casting operation and can reduce the thickness of panels.

Seismic Applications

Xorex™ Steel Fiber is an ideal addition to conventional reinforcement for concrete used in beams, slab column connections and suspended slabs. The fiber provides additional shear and spall resistance under seismic loading, resulting in a safer, more durable structure. Recent research indicates that Steel Fiber Reinforced Concrete in conjunction with stirrups, outperforms conventionally reinforced concrete under seismic loading.

Hydraulic Structures

Xorex™ Steel Fiber Reinforced Concrete used in hydraulic structures has significantly reduced cavitation and wearing in high water volume and

abrasive conditions. Xorex™ Fibers have been successfully used in spillways, diversion tunnels and channelizations.

Refractory

Xorex™ Steel Fibers in high temperature applications prevent cracking and thermal spalling. The fibers help dissipate the heat more evenly, preventing the effects of thermal shock. Xorex™ is also available in a stainless steel for extremely high temperature applications.

Blast Resistant Structures

Xorex™ Steel Fibers have been used in high concentrations in conjunction with conventional reinforcement for Military and Civilian Blast Resistant Structures. The energy absorption properties of Xorex™ concrete prevent the spalling and shattering of the concrete, enabling the structure to better withstand blast forces.

PHYSICAL PROPERTIES OF XOREX™ CONCRETE

The addition of Xorex™ improves the behavior of concrete and shotcrete. Concrete is inherently a brittle material. Xorex™ Steel Fibers - in a properly designed matrix and in a concentration designed for the application - can make the concrete composite more durable and can increase the fatigue endurance, the shear strength, the flexural ductility, the ultimate flexural strength, the impact resistance, the crack and spall resistance and the tensile strength of the composite. With an engineered mix design and an adequate concentration of Xorex™ Steel Fiber, the Modulus of Rupture of concrete can be increased significantly (see Chart I). The same applies to the shear and torsional strength. Xorex™ Steel Fiber Reinforced Concrete can also have ten to fifteen times the energy absorption capability of plain concrete. Flexural fatigue strength can be increased 60 to 80%. These enhancements will depend on the matrix design and the size and concentration of Xorex™. Consult a Novocon Engineer for a full analysis and recommendation for your project requirements.

Xorex™ Steel Fiber Reinforced Concrete and Shotcrete can also enhance the concrete matrix's corrosion behavior by eliminating the continuous reinforcing steel. Numerous tests and practical applications, including bridge deck overlays, which are subjected to heavy de-icing salts, sea walls in the North Atlantic and breakwaters in California, have proven the superior performance of Xorex™ in highly corrosive environments compared to conventional reinforcement. The fibers decrease the permeability created by cracking and are discontinuous, thus eliminating the battery-like effect caused by chloride penetration to the continuous steel reinforcing.

DESIGN AND SERVICE

Novocon's engineers and field personnel are among the most experienced and knowledgeable in the world. Not only are they experts in Steel Fiber Reinforced Concrete design and implementation, but they are concrete experts as well. They can assist owners, designers and contractors to achieve the most economical and functional concrete design.

All projects are important to Novocon and our engineers will analyze the conditions and make recommendations for any type of application, large or small. Novocon will also ensure that, where possible, a trained technician is present for technical presentations, design meetings, pre-construction meetings and for the first pour of each job. Novocon will also work with contractors to ensure a smooth, orderly and quality application. Novocon is a dynamic and innovative manufacturer of steel fibers, whose aim is to excel in design, implementation and application. Novocon offers a professional design service structured to assist Engineers, Contractors and Owners in designing and specifying Xorex™ Steel Fiber Reinforced Concrete and Shotcrete.

Xorex™ Fiber can either be added at the batch plant or directly into the ready mix truck at the site.



SUPPLY AND DISTRIBUTION

Novocon maintains stock of all sizes of Xorex™ Steel Fiber in warehouses around North America to quickly meet the customer's needs. Novocon's warehouses are located in Chicago, IL, Columbus, OH, North Charleston, SC, City of Industry, CA, Montreal and Toronto, Canada. Novocon's distributors also keep stock in Taiwan, South Korea, Singapore, Australia, Italy, Venezuela and Mexico.

Novocon will attend to all the customer's needs and oversee projects in which Xorex™ Steel Fibers are specified or applied, from the design stage through to implementation. Our staff of professional engineers and technical representatives are ready to respond to your needs anywhere in the world.

NOVOCON

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Toll Free in the U.S. and Canada: 1-800-424-3340

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SLABS ON GRADE

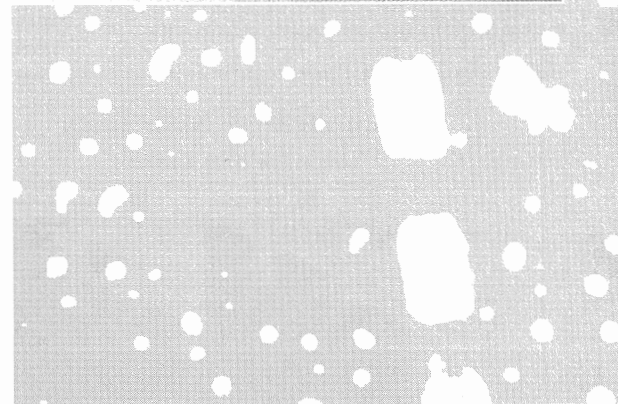
XOREX™ STEEL FIBER
REINFORCEMENT
FOR CONCRETE
SLABS ON GRADE



Concrete slabs on grade are one of the most important components of any industrial or commercial building.

They are generally subjected to severe conditions and must perform under a variety of loading conditions such as:

- Dynamic Wheel Loads (i.e. vehicular traffic, lift truck)
- Static Rack Loads (storage)
- Uniformly Distributed Live Loads



SLABS ON GRADE

TECHNICAL ADVANTAGES OF XOREX™ STEEL FIBER IN CONCRETE FLOORS

The advantages of XOREX™ Steel Fibers in concrete floors vs. plain or conventional reinforcement are as follows:

- Three Dimensional Homogeneous Reinforcement
- Crack Arrest and Shrinkage Control Mechanisms
- Increased Impact Resistance
- Increased Flexural Strength
- Ductility and Energy Absorption Capability
- Increased Fatigue Resistance

The degree of the improvement of these properties and the performance of XOREX™ Steel Fiber reinforced floors are a function of:

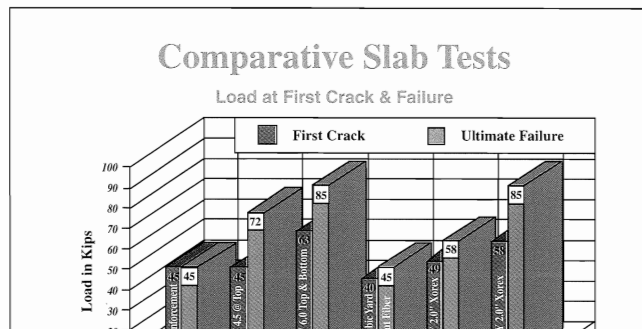
- Matrix Strength and Mix Design
- XOREX™ Steel Fiber Concentration
- Subgrade Condition
- Proper Control
- Joints Spacing
- Good Concreting Practice
- Proper Curing

DESIGN OF SLABS ON GRADE WITH XOREX™ STEEL FIBERS

In designing XOREX™ Fiber reinforced slabs on grade, the following parameters should be considered:

- Type and Magnitude of Loading
- Contact Area
- Modulus of Subgrade Reaction, K
- Concrete Mix Design

In analyzing the stresses generated within the



slab, the Westergaard theory for pavement design is used for point loads, and Hetenyi's equation is used for uniformly distributed loads. (PCA guideline for U.D.L. may also be used.)

Novocon's professional engineers will provide recommendations based on analyses using state-of-the-art computerized software, proven testing, and their extensive experience in design and implementation of numerous XOREX™ Steel Fiber Concrete floors.

In the design of XOREX™ SFRC floors, the following document may be consulted A.C.I. 544.4R "Design Considerations for Steel Fiber Reinforced Concrete."

MIXING, PLACING, FINISHING AND CURING

XOREX™ Steel Fibers can be added to the concrete either on site or at the batch plant. The fibers will disperse evenly in the concrete with 5 minutes of maximum drum rotation.

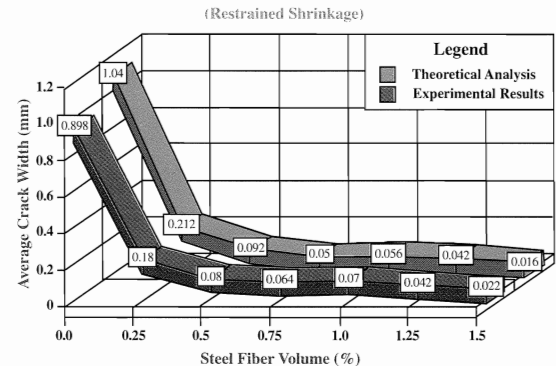
The placing and finishing techniques of XOREX™ Reinforced Concrete are the same as with plain concrete. At higher concentrations, the use of a superplasticizer may be required to aid in workability. Consult your Novocon Representative.

Shovels should be used, as rakes may disturb the uniformly distributed fibers. Vibratory screeds will produce the best finish. Internal vibration is recommended around construction joints, bulkheads, and dowels. Bull floating with a strong rocking motion will ensure a fiber free surface.

Broom finishes, power trowel or other texturing is suitable for XOREX™ concrete. Good finishing techniques will ensure a quality floor. The Laser Guided Screed™ and XOREX™ Steel Fiber are an excellent combination.

All curing methods and compounds are compatible with XOREX™ Steel Fiber

Average Crack Width vs Steel Fiber Volume



Source: Shrinkage Crack Width VS Steel Fiber Volume, ACI, Mar-Apr '90

CONTROL JOINTS

Joint spacing is determined by design considerations. Often, spacing can be increased by using XOREX™ Steel Fibers, but each application should be analyzed by a Novocon Representative. The control joints should be made to a depth of 25 - 33% of the slab thickness. This depth is necessary as XOREX™ will actually inhibit the crack's formation.

THE ECONOMIC ADVANTAGES OF XOREX™

XOREX™ Steel Fibers are manufactured in the U.S.A., Brazil, Italy, Poland, Canada and Australia by Novocon. This allows Novocon to offer a high quality, Type I (ASTM A820) cold drawn steel fiber for a very competitive price. The high quality of XOREX™ Fiber and local production combine to give owners the highest cost/benefit of any steel fiber.

XOREX™ Steel Fiber is an economical alternative to conventionally reinforced slabs on grade as it provides superior performance as well as:

- Elimination of conventional reinforcement that is rarely placed where it is supposed to be
- In some cases reducing the slab thickness
- Reduction in labor costs
- Lower life cycle costs
- Faster placement of slab on grade
- Competitive pricing
- Fewer cracks and spalling at joints

CURVE LITE GLASS FACILITY

PROJECT REPORT



NOVOCON

PROJECT:

CURVE LITE GLASS
500 PARK DR.
OWATONNA, MN 55060

General Contractor:

A.B. Systems, Inc.
Steve Knode
209 Woodlake Dr., S.E.
Rochester, MN 55904

Concrete Contractor:

Jesco Inc.
Tom Lerrick
7175 Cahill Rd.
Edina, MN 55437

Steel Fibers:

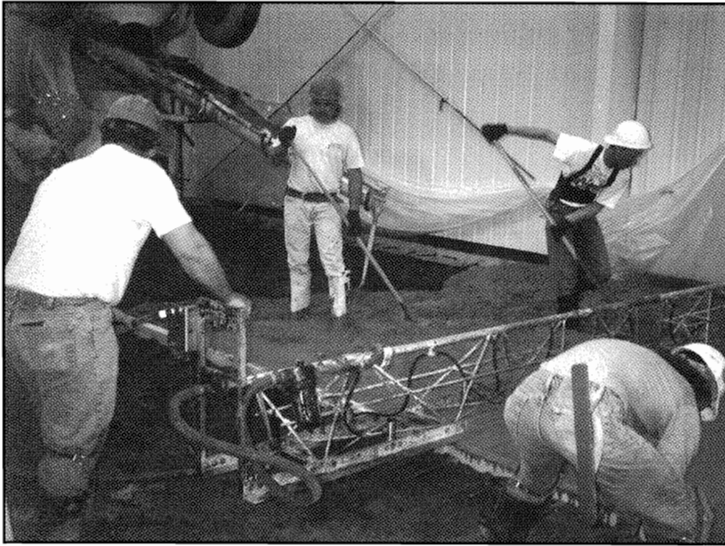
Novocon International Inc.
Ron Meskis, P.E.
520 Business Center Dr.
Mt. Prospect, IL 60056

A superflat floor was recently placed in Owatonna, MN for the Curve Lite Glass Distribution Facility. The project consisted of 93,500 square feet of superflat floor and 51,533 square feet of random traffic or low tolerance floor.

The superflat floor was 7" thick, constructed with 4000 psi concrete reinforced with 60 pounds per cubic yard of Xorex™ 2.0" Steel Fibers. The loading conditions used in the design of the superflat floor slab were a 22,600 pound post load with a 16,500 pound gross vehicle weight turret truck.

The slab-on-grade concrete for the superflat area was placed in 15' wide by 500' long strips in order to meet the $F_{min}75$ Flatness tolerance. The total superflat area was poured in five consecutive days and consisted of 2,010 cubic yards of concrete. The floor slabs were measured using a rolling profileograph that simulates the action of a lift truck as it propels itself down the defined aisle. Though the flatness specification was $F_{min}75$, the flooring contractor, Jesco Inc., achieved flatness tolerances averaging between $F_{min}100$ and $F_{min}150$.

The use of steel fiber reinforced concrete allowed the project schedule to be shortened. Two alternating strips were



*Superflat slab placement and consolidation
Curve Lite Glass*



*Floating, highway straight-edging and troweling of superflat slab
Curve Lite Glass*

RELATED STEEL FIBER PROJECTS

Owner	Location	Area(sf)	Dosage	Contractor
Baxter Healthcare Distribution	Montgomery, NY	1,300,000	50 lb/cy	Baker Concrete Construction
Nestle Distribution	McDonough, GA	220,000	42 lb/cy	Ace Avant Enterprises
Amway Corp. Distribution	Grand Rapids, MI	640,000	50 lb/cy	Van Laan Concrete
Toys 'R' Us Distribution	Frederick, MD	500,000	40 lb/cy	Jesco Inc.
Toys 'R' Us Distribution	Flanders, NJ	500,000	40 lb/cy	Fricks Floor Systems
Toys 'R' Us Distribution	Orlando, FL	500,000	40 lb/cy	Fricks Floor Systems
Toys 'R' Us Distribution	Lee's Summit, MO	500,000	40 lb/cy	Jesco Inc.
Toys 'R' Us Distribution	Youngstown, OH	200,000	50 lb/cy	Fricks Floor Systems
Chrysler Manufacturing/Distribution	Belvedere, IL	200,000	50 lb/cy	Colasanti Corporation
Honda Distribution	Quebec	270,000	50 lb/cy	Divco
Home Depot (Aikenhead's)	Woodbridge, Ontario	140,000	40 lb/cy	United Floor Systems
Price Costco	Mississauga, Ontario	130,000	40 lb/cy	Tricon