What is HENDIX™ Solutions?

This is a complex of reliable and cost-effective SFRC solutions for construction industry.
Steel fibre reinforced concrete (sfrc) is a state-of-the-art composite material which provides users certain advantages in comparison with traditional reinforcement. Its strength and load bearing capacity can be as good as with traditional solutions, but in contrast to conventional reinforcement steel fibre modifies the brittle concrete into a ductile material. Cracks can be controlled much more efficiently in this three dimensionally reinforced concrete. The special load bearing properties of steel fibre reinforced concrete ensure a wide variety of applications through the replacement or reduction of traditional reinforcement. The use of steel fibre reinforced concrete generally provides significant cost-saving effects.

**Advantages of sfrc in industrial floors:**
- Easy to install, easy to handle on a jobsite
- Generally no pump needed – concrete can be installed directly from the truck-mixer
- Laser screeds can be used to achieve high accuracy in levelling the floor
- No complicated installation of reinforcement
- No mistakes in reinforcement placement
- Reduced planning time
- Reduced construction time
- Reduced costs for the floor
- Effective crack control
- High resistance against abrasion
- High resistance against curling damage
- High impact resistance
- Improved impact-resistance on joint edges
- Reduced maintenance costs
Flooring Solutions

Industrial floors are flooring solutions which can be either ground supported with an ideal elastic assumed subgrade and a load bearing unbounded or cement bounded layer of gravels or macadam. In case of a missing load bearing capacity of the subbase it can be supported by piles. Industrial floors carry the traffic loads like racks, forklifts, trucks, single loads from mezzanine or machine-loads. Very often they are exposed to high chemical, abrasion or thermal impacts.1

Industrial floors are divided into three basic types:

Industrial floors with saw cut joints
Elastically ground supported floor which is divided into sectors by saw cuts. Normally used in industry and warehouses. It is the standard option for external floors.

Jointless floors
This is the state-of-the-art solution for industrial floors. The floor is divided into sections (daily fields) with dimensions of approximately up to 2500m². The lack of joints within these sections provides the user with some practical and economic advantages.

Pile supported floors
In the event of an insufficient load bearing capacity of the subbase or expected big or differential settlement, jointless floors can be supported by deep piles in a grid of 2m x 2m up to 5m x 5m. In this case the soil is regarded as not load bearing and the piles are considered to be the only supporting structure of the slab.

1 - Generally they are separate of the building itself, columns and walls. The building itself is normally supported by single- or strip-foundations beneath the slab. In case of rafts or foundation floors please refer to the “housing” brochure.
Industrial Floors with Saw Cut Joints

This type of industrial flooring is used in producing industrial units and warehouses. It is the ideal solution for external floors or floors with high demands on crack width limitation. It can be used for any floor with traditional requirements for durability and sustainability. These floors are elastically supported by the soil and a load bearing layer of cement-bound or unbound gravel or macadam.

The strategy in this solution is to avoid shrinkage cracks in the slab by adding fibres to control the cracking process at a very early stage and by cutting apparent joints with a depth of 1/3rd of the floor thickness. Usually the joint spacing is between 5m x 5m and 8m x 8m. These cut joints act as a predetermined break line. The floor sections can move freely on a slip membrane, installed between the concrete floor and the subbase. So once the cut joints have opened the slab releases from the tension due to shrinkage effects.
All vertical building elements like walls or columns must be separated from the floor by soft joint inlays and cut joints to avoid forced tension.

The loadbearing capacity of the structure is derived from a combination of the subbase and the concrete floor.

The subbase improves the loadbearing capacity of the soil. It can be made of unbound gravel or macadam. In some cases, when high loadbearing capacities are required, the subbase can also be made with hydraulically bound gravel or macadam.

The loadbearing capacity of the soil including subbase can be checked by the load-plate test according to DIN 18134. The result is a modulus of elasticity $E_{v2}$ in [MN/m²]. The relation of $E_{v2}$ in 2nd load to $E_{v1}$ in 1st load must not exceed 2.5.

The behavior of the soil can also be described by the subgrade modulus $k_s$ in [MN/m³]. Both variants $E_{v2}$ and $k_s$ are suitable for the design of an industrial floor structure.

A double layer of polyethylene sheets between the subbase and the concrete floor reduces the friction between these two layers. The stresses in the concrete floor will be limited so that no further cracks will occur apart from the cut joints. All crack openings will be concentrated in the predetermined break line which can be filled with elastic material.

Additional rebars in reentering corners control stress peaks and cracks in these areas.
Jointless industrial floors are an efficient alternative to industrial floors with saw cut joints. This type of industrial flooring is recommended for all indoor applications. The floor is divided into sections (daily fields) with an area of up to 2500m². Within these sections no saw cuts are needed as they are vulnerable to deterioration. So the maintenance needs are minimised for the user. The sections are separated by shear transmissioning steel profiles. Loads at the edges of the sections can be transmitted and the abrasion at the edges is eliminated. Horizontal movement at the edges of the sections is controlled by the specific structure of the joint profiles.

Inside the sections the strategy to avoid substantial cracking is to induce many very small and harmless microcracks instead of one large crack. Therefore the friction between the subbase of gravel or macadam and the concrete floor will be considerable and no slip membrane is installed to increase the friction between these two layers. So the span between two microcracks is minimised and they can be efficiently controlled by the fibres in the concrete.

Generally the floor can be designed with a thinner thickness because the critical design case load at the edge can be disregarded. This Severstal-metiz flooring system provides excellent properties with increased resistance against typical impacts on industrial floors.
The use of joint profiles allows horizontal movement and openings in the joints of the sections. Full vertical shear transmission is guaranteed.

Edges in the joints are protected by the joint profile so traffic loads like forklifts do not harm the corners. Longterm maintenance costs are reduced.

Advantages of jointless industrial floors:
- Reduced thickness of the floor
- Bays of up to 2.500m²
- No need for saw cut joints, vulnerable to deterioration
- Joint edges are protected by steel profiles
- Shear transmission in the joints
- Improved load transmission into the ground at the edge of the floor
- Excellent impact resistance
- Improved high ductile behavior
- Improved effective crack control
- Reduced curling
- Reduced maintenance costs due to the absence of saw cut joints

Significant cost saving effects:
- no need for reinforcement placement
- no concrete covering
- reduced maintenance needs
- reduced thickness
In case of weak and non load-bearing ground or big expected plastic settlements and/or differential settlements the concrete floor can be supported by a grid of piles which transfer the loads down to stable and reliably supporting ground levels. It is recommended to install the piles in a square-grid with 3x3m – 5x5m spacing in each direction. The pile supported flooring system from Severstal-metiz uses steel fibres to reinforce the concrete. Jointless floors with a typical span to depth ratio of 20 can resist loads of up to 100kN/m².
The concrete floor is poured directly on the ground. In this design the ground is regarded as not load bearing so the floor is bearing from pile to pile. Therefore a minimum thickness of 18cm is required. The span to depth ratio should not exceed 20 and a regular square grid of piles is recommended.

Pileheads can improve the loadbearing capacity of the floor regarding shearforces and bending moments. Pileheads can be of different types with round or square heads. In practice they can be precast on the pile or poured together with the slab.

At the edge a ground beam is needed which can also be realised with additional rebars in the floor. In general there is no need for a slip membrane except if the soil is water absorbing. In such cases a membrane is recommended to protect the fresh concrete.

**Recommendations for construction:**
- Adequate preparation of the sub-base (level, sand layer)
- Maximum bays of 2500m² with a joint distance of 50m
- No slip membrane except absorbing sub-base
- Local reinforcement of critical zones (openings)
- Use of day joint profiles compatible with the application (Omega, Delta,...)
- Curing is extremely important
- Building should be enclosed
- Steel fibre dosage 40-70 kg/m³ of Hendix Prime/Ultra 75/52

**Advantages of pile supported industrial floors:**
- Concrete poured onto ground but designed as free bearing from pile to pile
- No steel reinforcement needed except in local singular points
- Easy installation
- Generally no pumping needed
- Bays of up to 2.500m²
- Applicable for wire guided forklifts without problems
- Floor with high crack control
- Excellent impact and abrasion resistance
- Joint edges are protected by steel profiles
- Shear transmission in the joints
- Considerable time savings
- Considerable material savings
HENDIX™ Steel Fibre

HENDIX™ steel fibre has probably the best known fibre shape in the world and the best anchorage mechanism (hooked end anchors).

HENDIX is optimal in shape and material properties
- high performance in concrete
- very good operability
- pumpability in all dosages
- uniformly distributed in concrete
- can be dosed into a plant mixer or a truck mixer on site

HENDIX™ steel fibre is made of cold-drawn wire with a high tensile strength.

Available in 3 strength grades:
- **HENDIX** (1150 N/mm²)
- **HENDIX Prime** (1500 N/mm²)
- **HENDIX Ultra** (1800 N/mm²)

Available in 3 shape types:
- **HENDIX 1/50**
  l=50mm, d=1mm for standard applications
- **HENDIX 75/52**
  l=52mm, d=0,75mm for high performance applications
- **HENDRIX 60/32**
  l=32mm, d=0,60mm for shotcrete and thin structures
Fibre is supplied in:
- cardboard boxes 25kg each, fibres aligned in the box for easy manual dosing
- big bags 1000kg for automatic dosing systems.
The use of steel fibre as the sole means of reinforcement or as well as combination with traditional or prestressed reinforcement has been developed within the last two decades. Severstal-metz and its engineers have done a lot of work in this field in recent years.

Today the total replacement of traditional reinforcement is completely routine for most structural applications.

The vast experience of Severstal-metz engineers guarantees reliable and solid solutions for the customers thus enabling design engineers, construction companies and investors to profit out from long-term cooperation with our company. Our collaboration with well-known research institutes and participation in several European standardization committees for steel fibre reinforced concrete proves that Severstal-metz design methods have a serious scientific foundation.
Our long practical experience and an ambitious R&D programme with numerous tests with small and 1:1-scale specimens allowed us to explore the behavior of steel fibre reinforced concrete in structures in details. Today we make this knowledge open to you through our technical support.

Service provided by Severstal-metiz:

- Technical design and documentation
- Support in the choice of a suitable concrete design
- Research and development
- Implementation of new applications and solutions in the market
- Support and consultancy on a jobsite
- Consultancy at a very early project stage
- Implementation of most recent R&D-results in our solutions
- Tailor-made solutions
- Fast response to your request and preparation of your project-related solution
Achieve more together

Our contacts:

JSC Severstal-metiz
2/3 Klara-Tsetkin str., Moscow,
127299 Russian Federation

Commercial Department

Dipl.-Ing. Jürgen Mandl
Head of fiber group + R&D

Tel.: +7 (495) 540 77 66 (ex.6547)
mobile: +7 (925) 011 46 69
e-mail: j.mandl@severstalgroup.com

www.severstalmetiz.com