Distribution Solutions
WireSolutions

ArcelorMittal

Steel fibres
Flooring applications

From the world leader in steel and wire solutions

Who are we?

WireSolutions is the wire drawing division of ArcelorMittal, the world's number one steel and mining company. WireSolutions is one of the world's largest wire drawers, bringing solutions to more than 4,000 customers.

With 14 plants throughout the world, WireSolutions offers a diversified portfolio of low and high carbon wires, steel cord, strands, ropes and corrosion-resistant solutions. Automotive, construction, energy and agriculture are all important segments for WireSolutions.

Staying close with customers and partners, WireSolutions is constantly looking to develop new solutions with the Research and Development centres of ArcelorMittal. Today the company is recognized worldwide for the quality of its corrosion resistant product range.

30 years of experience in steel fibres manufacturing

WireSolutions has been producing steel fibres for over 30 years and is one of the world's leading suppliers of steel fibres. Through a local presence, WireSolutions aims to be closer to its customers to improve its service.

All the fibres manufactured by WireSolutions are made of cold drawn, high tensile steel wire produced using the most modern equipment.

Our policy of continuous investment helps guarantee the durable performance of our products which are manufactured according to ISO 9001, ISO 14001 and OHSAS 18001 standards compliant. All our fibres have CE-marking.

Transforming tomorrow.

Where are our steel fibres produced?

ArcelorMittal Sheffield, United Kingdom

ArcelorMittal Syców, Poland

ArcelorMittal Bissen, Luxembourg

WireSolutions has been producing steel fibres for over 30 years and is one of the world's leading suppliers of steel fibres

Durable solutions for your flooring applications

State-of-the-art floors with steel fibre reinforcement

As the function of buildings varies from manufacturing, storage and distribution to name a few it is important that the design is considered thoroughly and executed to the highest standards with your requirements in mind.

Although some may consider an industrial floor as just another part of the construction process of little importance it should be noted that this thinking ignores the health and safety issues that must be considered if the ultimate limit state of the floor is exceeded.

By contrast, industrial floors are subjected to extensive and heavy use and often onerous wide ranging loading conditions. Well designed and constructed floors impact positively and significantly toward the life cycle costs of a given structure. Such floors provide reduced downtime for operations and maintenance cost contributing toward improved profits for the client.

Over the last 30 years steel fibres have proven their reliability and suitability as a preferred method of reinforcement for floors.

WireSolutions offers several types of industrial floor solutions by design for slab on grade construction (ground supported):

- Floors with saw-cut joints (TAB-Fiber™)
- Jointless floors (TAB-Floor™)
- External areas (TAB-Fiber™)

Some advantages of using steel fibres for flooring solutions for client and contractor are:

- Time savings in construction as compared to mesh solutions
- Improved durability
- Impact resistance
- High ductility
- Crack control
- Easier concrete placement compared to use of traditional reinforcement
- Higher level of health and safety
- Use of Laserscreed possible

In the last three decades steel fibre reinforced concrete has proven to be a reliable and most suitable construction material for typical industrial floors

Applications

Steel fibre solutions for every need

Floors with joints

Possible shrinkage cracking is avoided through weakening the cross section of the slab by saw-cutting joints into the surface of the slab up to a depth of 1/3 of the slab thickness.

Cuts are intended to relieve the shrinkage induced tensile stress. Therefore saw-cuts must be executed in due time after concrete placement (depending of the hardening of the concrete).

The initial width of the saw-cut joint opening is 3-5 mm. Panel size varies between 5 x 5 m² and 12 x 12 m².

- TAB-Fiber™ floors can be used where joints cut into the slab do not disrupt the general use of the floor. The use of the TAB-Fiber™ solution eliminates the handling of reinforcement and simplifies job site operations. This leads to a reduction in construction time and reduces the slab costs.

Jointless floors

Joints are the weakest point in every slab. In order to improve the technical properties of the floor, especially for heavy traffic and high static loads, ArcelorMittal has developed the jointless TAB-Floor™ concept.

- TAB-Floor™ allows the casting of bays up to 2500 m² without any saw-cut joints. It is necessary to maintain a maximum length to width ratio of 1:1,5. By doing this significant maintenance costs normally associated with joints are reduced or avoided. Through the use of suitable construction joints, the durable shear load transfer can be guaranteed and optimised, while allowing for free shrinkage in all directions.
- With TAB-Floor™ one can reduce slab thickness compared to that of traditional solutions with improved crack control and ductile behaviour. The joint edges are protected by a steel profile thus reducing the spalling effect under heavy traffic.
  The use of steel fibres improves the impact resistance of the floor as there is no unreinforced concrete cover. Due to the high number of fibres within the concrete the width of shrinkage cracks is limited. However it is not possible to avoid cracking completely. TAB-Floor™ jointless slabs should only be constructed by specialized flooring contractors.

External areas

Steel Fibre Reinforced Concrete (SFRC) is also suitable for external areas. The construction of external slabs is similar to saw cut joint floors.

However there are some differences. In addition to heavy statical and dynamical loading, there is also the significant impact of weather conditions. It is necessary in these cases to use air entrained concrete with slightly higher dosage rates of fibres.

Due to weather conditions, in particular moisture, small points of rust on top of the slab may be visible. This is caused by corrosion of steel fibres lying close to the surface. This is only an aesthetic problem and does not affect on the load bearing capacity of the concrete slab.

- External SFRC slabs are used for parking areas, roads, container storage, transit warehouses and more.

Planning

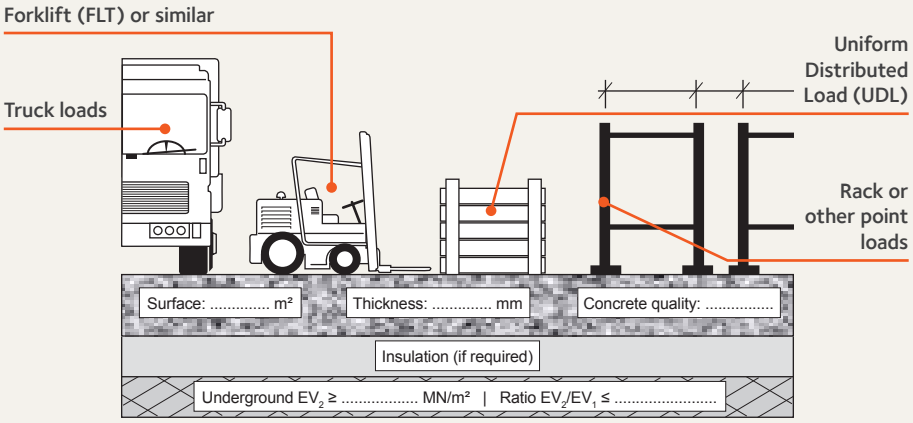
Design note

ArcelorMittal floors are designed for the ultimate limit state as well as for the serviceability limit state.
The methods of analysis used differ from country to country, from linear elastic analysis (e.g. France) to plastic analysis (e.g. United Kingdom, Germany, Scandinavia). By applying linear elastic analysis the real load bearing effect of Steel Fibre Reinforced Concrete (SFRC) will not be utilised, thus plastic analysis is used whenever possible.

In the ultimate limit state, SFRC floors are designed according to yield line theory, based on the British recommendation "TR 34" using design approaches of Meyerhof & Losberg. Bending as well as punching shear are verified. Alternative approaches according to German "Stahl-faserrichtlinie", Austrian "Richtlinie Faserbeton" or Dutch "CUR 36 & CUR 111" are possible.
In the serviceability limit state, the slab should remain macro-crack free at small deflections. Design approaches and safety concepts used (according to "DTU 13.3" for France and "TR 34" elsewhere) assure that the flexural tensile resistance of SFRC is not exceeded. The combined effects of loading, shrinkage and thermal effects are considered in our design method.

Before constructing an industrial floor, it is important to have a prepared design note based on static and dynamic load information.

Load cases and design basics



The design note will allow for the determination of the concrete grade, fibre type and fibre dosage rate. For certain loads it is extremely important to considers various aspects such as:

- Base plate size and distance for point loads e.g. [150 x 150] x [1'100 x 300 x 1'100] (mm)
- Gangway width and pallet storage widths for UDL
- Precise load description and drawing for UDL ≥ 70 kN/m²
- Tire contact pressure specified in N/mm² for a FLT
- Soil date can give as CBR – value also of subgrade reaction k (N/mm³) or modulus of deformation EV_2 and EV_1 (MN/m²), both determined from a plate loading test, preferably with a plate diameter of 750 mm.

Sub-base
Even more important is to have a well prepared sub-base, in order to achieve a professional industrial floor. The sub-base supports the entire floor. Thus it is crucial to have uniform soil parameters. Performance of the slab depends on flatness and levelness of sub-base as well.

Insulation
The use of insulation under the slab reduces the soil bearing capacity. This leads to higher stresses in the slab.

Heating system
Our systems also work for slabs with an integrated flooring heating system.

Prior to design

Load cases

Soil parameters

Subgrade
Gravel with 1× polythene sheet = TAB-Fiber™
Gravel with 2× polythene sheet = TAB-Floor™

- Soil
  - EV_2 = 100 MN/mm²
  - EV_2/EV_1 = 2,2
    k = 0,083 N/mm³

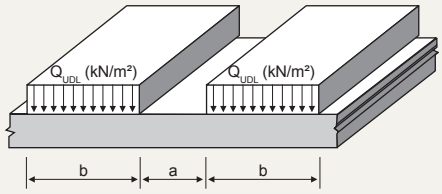
Slab characteristics

- TAB-Fiber™ (slab with saw-cut joints)
  - Concrete class C25/30
  - Distance between cutting joints 6 m
- TAB-Floor™ (slab without saw-cut joints)
  - Concrete class C25/30
  - Distance between day joints 30 m

The use of a premium fibre or a jointless solution increases the efficiency of the solution

Uniformly distributed load

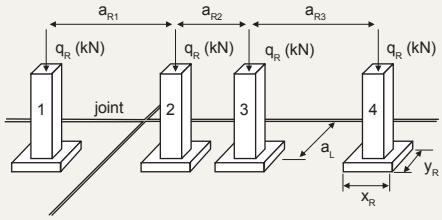
- Two loaded surfaces with gangway



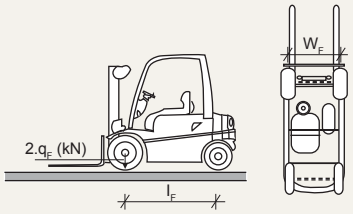
a = 1,30 m
b = 2,60 m
QUDL = 80 kN/m²

Point load

- Point load combinaison with forklift truck



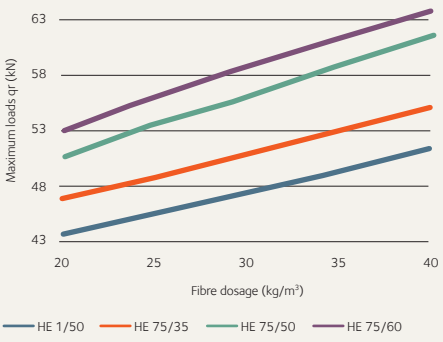
$a_{R1} = a_{R3}$ = 1 m ; a_{R2} = 0,3 m
a_L = 0,075 m → TAB-Fiber™
a_L = 0,3 m → TAB-Floor™
$x_R = y_R$ = 0,15 m



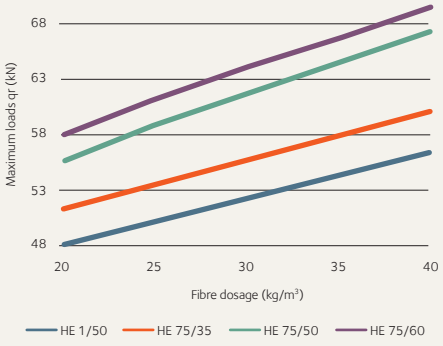
Single wheel
contact pressure: 6 N/mm²
q_F = 22,5 kN

Solution examples

- TAB-Fiber™ H = 15 cm



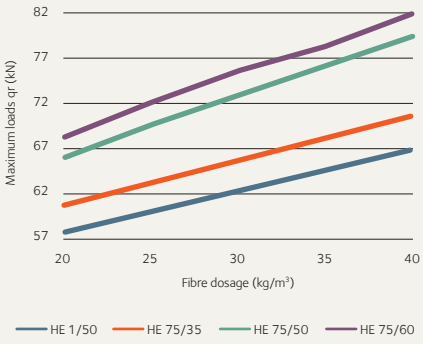
- TAB-Fiber™ H = 16 cm



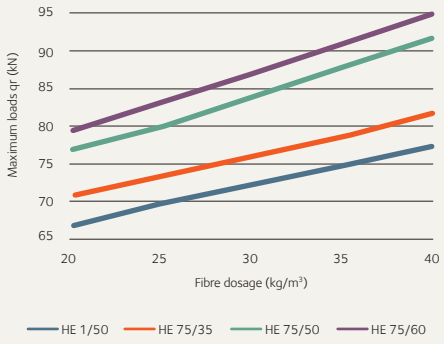
Prior to design

Solution examples

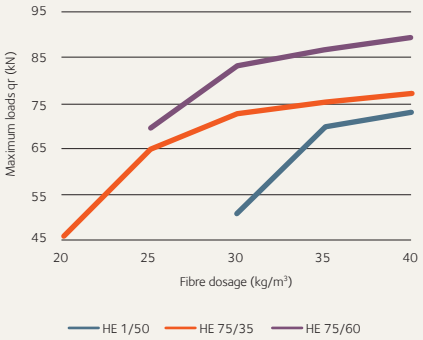
TAB-Fiber™ H = 18 cm



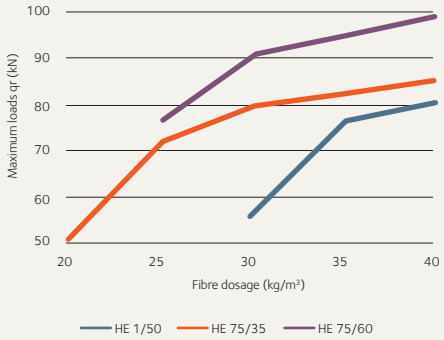
TAB-Fiber™ H = 20 cm



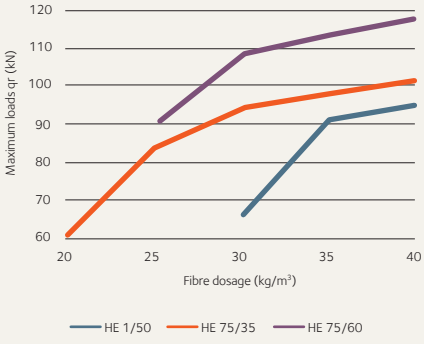
TAB-Floor™ H = 15 cm



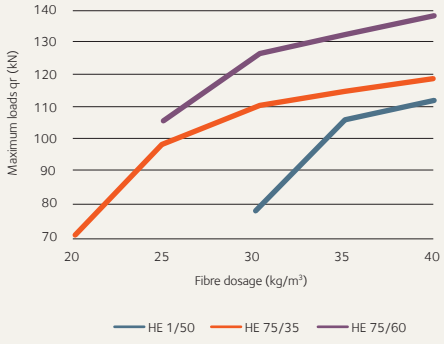
TAB-Floor™ H = 16 cm



TAB-Floor™ H = 18 cm



TAB-Floor™ H = 20 cm

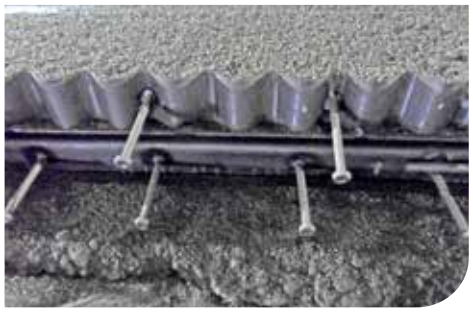


N.B. Generally, we recommend to limit the foot loads at 80 kN for HE 75/35 fibre type

Jobsite preparation

Our recommendations

- Foremost, it is necessary to control and maintain the current status of the soil. Plate-tests are required in order to provide control and ensure that the assumed or requested design values have been reached (CBR or EV_2/EV_1 or k-value).
- Control of the top surface flatness of the sub-base is critical in helping to control early-age shrinkage cracking of the slab as well as avoiding a reduction of the load carrying capacity of the slab to an unacceptable extent.
- The control of the finished floor level is essential to ensure the required thickness of the concrete floor as per the design requirements.
- In-situ control of all additional reinforcement and profiles according to design requirements is essential.
- Ensure that the building is "dried in", such that the floor is protected against rainwater, wind and other climatic conditions. This will help to eliminate cracking at an early stage prior to the concrete developing its final strength.
- The optimum conditions for dosing the steel fibres is in the ready-mix batch plant. It is normal and customary to use a conveyor belt either static or mobile for the dosing the steel fibres into the ready-mix truck or into the plant mixer.
- The concrete mix should be checked prior to commencing work on site to ensure the correct composition and consistency.



Concrete mix requirements

Planning, mixing and placing

The intended concrete mix must achieve the required compressive strength. It should also optimize the anchorage of the fibres while providing good workability. In addition to the concrete grade intended steel fibre reinforced concrete is characterised by its residual flexural or equivalent flexural strength.

Typically C25/30 Concrete is used although C30/37 and C35/45 concrete are used where required. The slump should be Class S4 or S3 with mechanical placement methods are implemented. The concrete at any slump should be stable with no segregation of materials.

Pure Portland cement, composite cements with moderate additives of limestone ore slag are useful. Material with high slag content (CEM III) requires special consideration. The cement should produce a moderate hardening with requisite early strength.

The minimum cement content should be between 310 to 340 kg/m³.
Water-cement ratio should be between 0.50 and 0.55.

The concrete mix design should show a stable gradual curve with a maximum aggregate size of 16 or 22 mm in some areas.

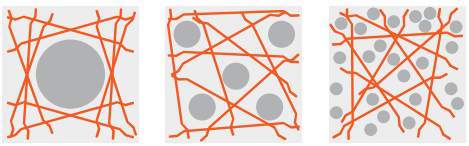
The maximum aggregate size in any case is 32 mm for fibre dosage rates. The maximum aggregate size used should in any case be smaller than the average distance between fibres. Using aggregates larger than the average distance between fibres increases the risk of balling.

The mix should have enough fines to allow for easy integration of the fibres and promote stability of the mix.
The concrete must be cured immediately after the final finishing process is completed. The means and methods of curing are many and vary according to the type of concrete used, the use of the floor and the final finish that is to be applied if any.
The best method of curing concrete is through the use of water. This is not always practical as the water must be kept continually on the entire slab area.

Curing blankets and membranes work well. The chosen method of curing should be discussed and decided on prior to concrete placement. If curing compounds are used it is important that the contractor verifies the curing agent does not interfere with the final floor finish. It is mandatory that freshly placed concrete slabs are cured in order to prevent early age, plastic shrinkage cracking. The purpose of curing is that the rate of evaporation of water within the concrete needs to be slowed in order to allow the hydration process to occur without causing cracks.

$$d_m = \frac{122 \times d}{\sqrt{V_f}}$$

d_m = average fibre distance (mm)
d = fibre diameter (mm)
V_f = fibre content (kg/m³)



WireSolutions' steel fibres

High performance solutions

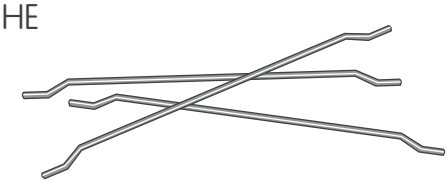
The selection of the steel fibre is related to the required performance and workability.

In all cases fibres should be CE marked in accordance with EN 14889-1.

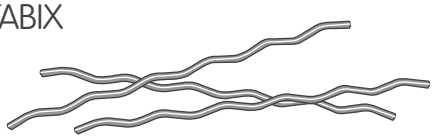
The performance of the fibre depends on:

- Aspect ratio
  = higher performance obtained but workability may be reduced
- Tensile strength of wire
  = higher performance with higher concrete grade

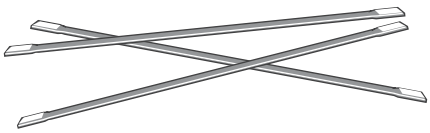
HE



TABIX



FE



Technical data

Fibre type	Diameter	Length	Performance	Workability	Dosing recommendations
TABIX 1/50	1,00 mm	50 mm	**	*	Blast machine
TABIX 90/35	0,90 mm	35 mm	*	***	Manually or conveyor belt
HE 1/50	1,00 mm	50 mm	*	***	Manually or conveyor belt
HE 1/60	1,00 mm	60 mm	**	**	Manually or conveyor belt
HE 90/60	0,90 mm	60 mm	***	**	Manually or conveyor belt
HE 75/35	0,75 mm	35 mm	**	***	Manually or conveyor belt
HE 75/50	0,75 mm	50 mm	***	*	Blast machine
HE 75/60	0,75 mm	60 mm	***	*	Blast machine
HE+ 1/60	1,00 mm	60 mm	***	**	Manually or conveyor belt
FE 60/36	0,60 mm	36 mm	*	***	Manually or conveyor belt

* Normal ** Good *** Excellent

Suitable steel fibre per application

Fibre type	Saw cutted joints	Common jointless floor	Jointless floors with high loads	Jointless floors with big joint distances
TABIX 1/50	**	**	**	**
TABIX 90/35	***	**	-	**
HE 1/50	**	*	*	*
HE 1/60	*	*	**	*
HE 90/60	*	**	**	*
HE 75/35	*	**	-	***
HE 75/50	*	*	***	**
HE 75/60	*	*	***	**
HE+ 1/60	*	*	**	*
FE 60/36	*	(1)	(1)	(1)

* Normal ** Good *** Excellent - Not recommended
(1) In combination with other fibres for improving impact resistance

Product storage and packaging

The fibres have to be stored in a dry area.
Pallets and big-bags are additionally wrapped in a plastic film.

10*/20*/25 kg boxes
on 1.2/1.5 ton pallets

Big-bags
from 500 to 1100 kg

* On demand

Case studies

TAB-Fiber™

Industrial floor for production halls and warehouses

TAB-Fiber™ for heavy duty uniform distributed loads

Parking area

TAB-Floor™

TAB-Floor™ system with heavy traffic
(forklift, truck)

TAB-Floor™ system with panels up to 50 x 50 m

TAB-Floor™ for unique applications: aircraft
maintenance

External areas

Container terminal
with very heavy container point load

External area in front of logistics warehouse with high
traffic loads and frost/thaw resistance

Parking garage roof
with large panels and moderate loads

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