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Flooring in fibre-reinforced concrete for the scrap yard **Acciai Speciali of Terni**

Solution in fibre-reinforced concrete for the floorings of the outer service areas used as scrap yard of the steelworks Acciai Speciali of Terni.

Thanks to the use of steel fibers FIBRAG® STEEL it was possible to realize a high-strength flooring, optimizing the duration of the work.

The realization of the concrete floorings for the scrap yard of the steelworks **Acciai Speciali of Terni** is spread over a total area of 40,000 m² and was realized by **Eng. Antonio Totino** of **MASCIO ENGINEERING SPA** of Terni. This project aims to store scrap iron temporarily in order to obtain new material to be re-inserted in the production process.

Innovative solutions have been adopted for the project, like the addition of steel fibers in the concrete mix-design. Given the complexity of the project and the need to realize a flooring subject to high loads, the solution of the fibre-reinforced concrete has been identified as the best both in design and performance terms. This type has indeed allowed to optimize the thickness of the flooring and thus guarantee a reinforcement of the whole height of the section, in addition to a reduction of the duration of the realization of the work too. Thanks to the use of fibre-reinforced concrete it was possible to realize the flooring sparing about 30 days of work and therefore deliver the area in a very tight timeframe, a fundamental and necessary requirement in order not to interrupt the continuous and complex production cycle of the customer.

The Interview

Are you satisfied with the work?

"I am very satisfied with the work both from an economic and operational point of view. Thanks to the technical solutions adopted we have obtained noteworthy benefits in performance and we have considerably anticipated the closure of the construction site, without jeopardizing the ordinary productivity of the steelworks".

Eng. Massimo Calderini
Plant Manager
Acciai Speciali Terni



Intervention area

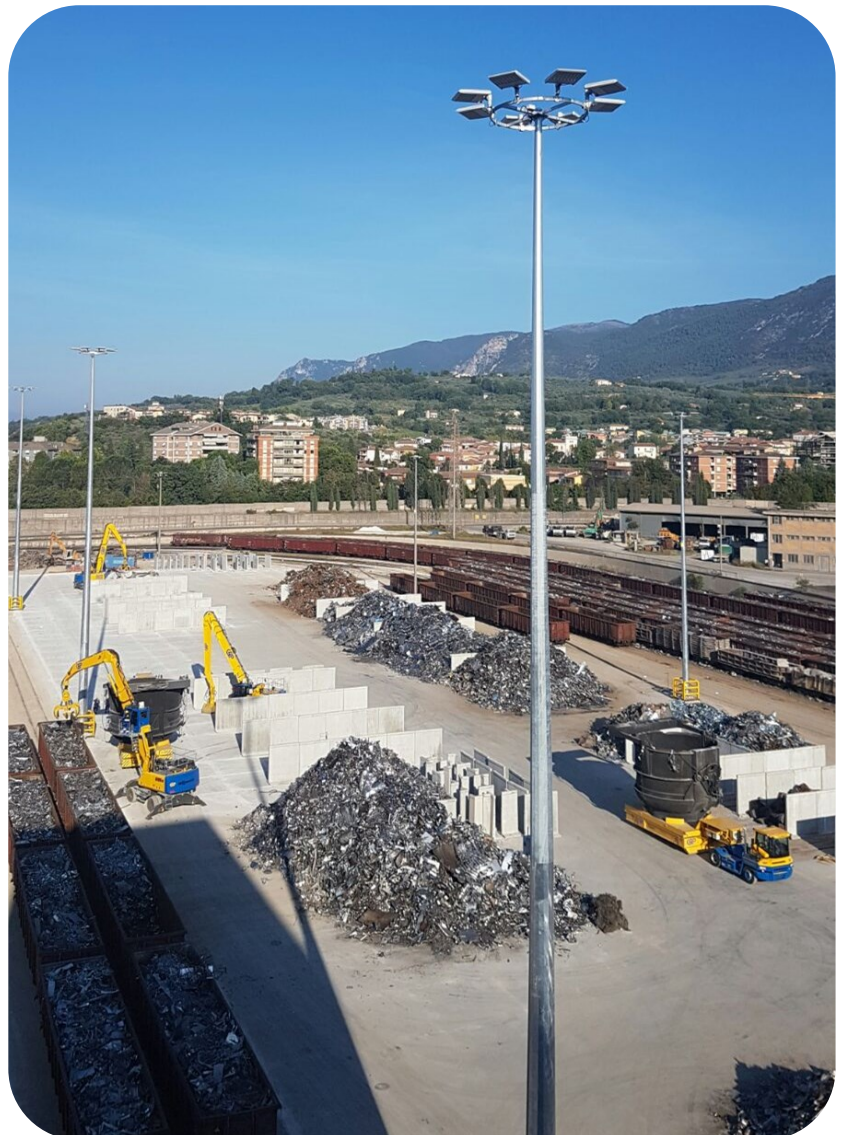


The numbers

The complexity of the work has engaged more than 50 workers, 30 construction vehicles for a total of 35 consecutive days of work.

More than 10,000 mc of fibre-reinforced concrete were poured.

Thanks to the great versatility of fibre-reinforced concrete the work was delivered in record time, managing to follow the timescale set during the design stage.



Intended use

The project provided for the realization of the flooring in fibre-reinforced concrete for the scrap yard of the steelworks Acciai Speciali of Terni, the intervention area is of 40,000 mq, realized by an ATI specifically created for this project, consisting of: **IMPRESA NUOVA TONELLI SRL, GRUPPO PALLOTTA SPA, IMPRESA CASTELLANI & GELOSI e IMPRESA PICONE COSTRUZIONI SRL.**

The necessity to realize the flooring in fibre-reinforced concrete was prompted by the high loads, both static and dynamic, on the flooring. In close collaboration with the designer, **Eng. Antonio Totino**, the **FIBROCEV** technical office has studied and verified a solution in high-performance fibre-reinforced concrete, that satisfies the onerous intended use of the flooring.

The loads

In the flooring project the following loads have been considered:

- STATIC LOADS

Ferrous materials	24 ton/m ²
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- DYNAMIC LOADS

Materials mover	10 ton/wheel
Lorry 6 Axes	7,5 ton/wheel
Merger basket	45 ton/wheel

The concrete

For the flooring project particular attention was paid to the concrete mix-design, in order to guarantee the correct integrity to the flooring both during the first few hours of concrete curing and to preserve its useful life in relation to the agent loads.

Specifically, a type of concrete explained as follows was used:

Concrete	C28/35
Exposition class	XD1
Rapport a/c	0,55
Consistency class	S4

Structural type

In order to guarantee the required performance, the concrete was mixed with structural steel fibers **FIBRAG® STEEL: F-DUE 44/45 MT**: thanks to the high degree of contact, interaction and uniform distribution inside the cement matrix, they supply an excellent three-dimensional reinforcement to the section, increasing the concrete residual tensile strength.

The unique geometry of the fibers **FIBRAG®** has ensured a great miscibility in the cement matrix, without generating neither “balling” effects nor outcrop of the fibers on the surface of the flooring.

- STATIC LOADS



Ferrous materials piled up

- DYNAMIC LOADS



Lorry and Materials mover



Merger basket

The fibers

FIBRAG® STEEL: F-DUE 44/45 MT



Group	II (cut sheet)
Length	44 mm
Equivalent Diameter (D)	0,98 mm
Aspect Ratio (L/D)	45
Tensile strength	1100 N/mm ²
Numerosity	3.860 fibers/kg

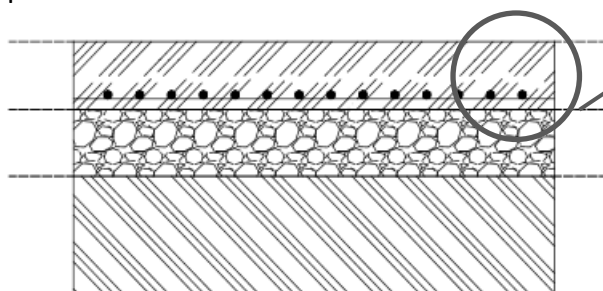
The flooring project

For the evaluation, the flooring has been schematized like a plate on continuous support. The ground has been modelled like a set of independent elastic elements (Winkler). The stratigraphy of the flooring realized is explained below:

Piastra in calcestruzzo
fibrorinforzato

Massicciata

Terreno naturale
compattato



CHECKING THE SERVICEABILITY LIMIT STATES

Three tests have been performed for the serviceability limit states:

- Deformability test
- Cracking test
- Operating voltage test

CHECKING THE ULTIMATE LIMITE STATES

The concrete flooring ultimate limit states test plus integration with traditional reinforcement can be performed in view of the fact that the fibre-reinforced resistant contribution adds up to that of the reinforcement.

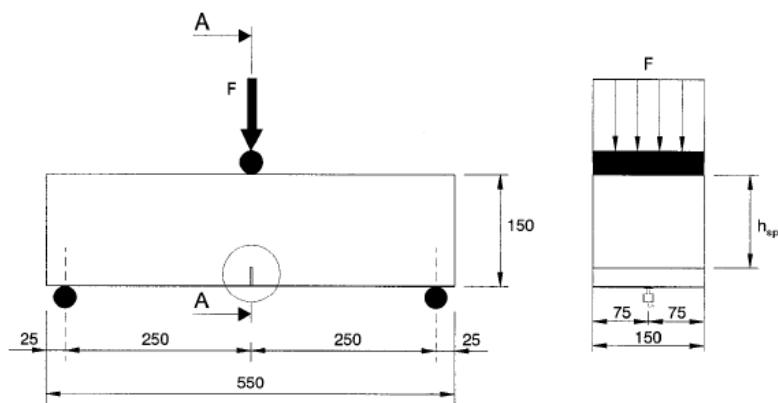
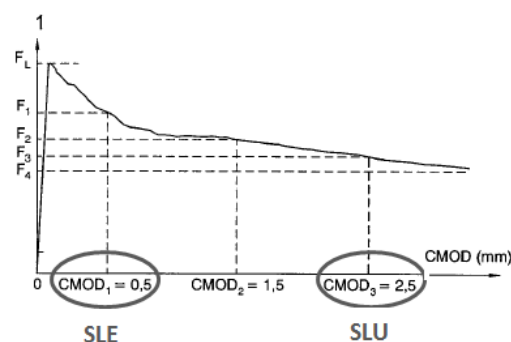
The test has been performed on the comparison between the design value of the stimulating actions and the corresponding values of the fibre-reinforced concrete residual resistance.

In the numerical analysis carried out the use of a post-cracking tensile constitutive link was considered, which was determined on the basis of experimental tests on the material performed in accordance with the EN14651 legislation. This legislation provides for the performance of experimental bending tests on three loading points, performed on carved planks of size 600 x 150 x 150 mm, by which it is possible to determine the two post-tracking resistances: the former, typical for the **SLE** operational conditions, is the residual strength (fr_1), which is reached in correspondence of an opening at the base of the carving CMOD equal to 0,5 mm; the latter, typical for the **SLU** ultimate limite state, is the residual strength (fr_3), found in correspondence of a CMOD equal to 2,5 mm.

The section

In relation to the agent loads, a fibre-reinforced concrete section with traditional reinforcement of a height of **30 cm** has been designed, reinforced with **27 kg/m³** steel fibers **FIBRAG® STEEL F-DUE 44/45 MT**. The traditional reinforcement used consists of a electrowelded mesh $\phi 8 - 15 \times 15$ cm, spaced of 4 cm from the concrete plate laying surface.

Typical curve $F - CMOD$ determined by a UNI EN 14651 bending test on a fibre-reinforced concrete specimen.



section A-A

The steps of the casting

The casting and the realization of the flooring have been accomplished through pumping of concrete provided by two plants for a total of about 11,000 mc.

The supply of concrete was given to **CALCESTRUZZI CIPICCIA SPA** of Narni (TR), **C.S.C. CALCESTRUZZI SABATINI & CRISANTI S.R.L.** of Terni and **CALCESTRUZZI TERNI SRL** of San Gemini (TR).

The casting and the realization of the flooring in fibre-reinforced concrete lasted 30 consecutive days.



Concrete curing



Advantages with the use of steel fibers FIBROCEV

FIBRAG® STEEL F-DUE 44/45 MT

- ✓ Superior electrowelded mesh **completely removed**
- ✓ **Reduction** of concrete installation time
- ✓ **Higher residual strength** of concrete
- ✓ **Contrast** the **shrinkage** of concrete
- ✓ **Higher resistance** to dynamic and static loads
- ✓ **Higher resistance** to impact and fall of materials
- ✓ **Higher durability** of the flooring
- ✓ **Higher resistance** to abrupt flooring temperature changes
- ✓ **Homogeneity** of the **performance** in the whole height of the section



The use of the flooring



First scraps storage



The flooring

In addition to bearing static and dynamic loads, the flooring also has to bear the accidental fall of ferrous materials. Thanks to a reinforcement diffused in the whole height of the flooring, ensured by the presence of metallic fibers **FIBRAG® STEEL F-DUE 44/45 MT**, there is a great increase in strength of the section, that allows to satisfy the onerous loading conditions, allowing to increase the useful life of the flooring too.

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Subdivision of scraps according to chemical characteristics

General data of the work

CUSTOMER

AST – Steelworks Acciai Speciali Terni
Eng. Costantino Di Pietro – Manager of the Technical Area



STRUCTURAL DESIGN AND WORKS SUPERVISION

MASCIO ENGINEERING SPA
Eng. Antonio Totino

MASCIO ENGINEERING

SOLUZIONI INNOVATIVE
PER L'INGEGNERIA INDUSTRIALE
AERONAUTICA E CIVILE

EXECUTING COMPANY - ATI

IMPRESA NUOVA TONELLI SRL



GRUPPO PALLOTTA SPA

IMPRESA CASTELLANI & GELOSI



IMPRESA PICONE COSTRUZIONI SRL.

FLOORING EXECUTING COMPANY

PAVICEM SRL



CONCRETE

CIPICCIA CALCESTRUZZI SPA



CALCESTRUZZI CIPICCIA S.p.A.



C.S.C. CALCESTRUZZI SABATINI & CRISANTI S.R.L.

CALCESTRUZZI TERNI SRL



FLOORING

Area	40.000 mq
Thickness	30 cm
Concrete	C28/35
Consistency class	S4
Fiber reinforcement	FIBRAG® STEEL: F-DUE 44/45 MT

