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The sustainability impact of steel fibers in precast elements

Sustainable construction increasingly involves precast concrete in its design. Precasters around the world want to simultaneously solve their productivity challenges and answer the sustainability needs of their customers: buildings and structures should be built to last and use sustainable materials. Steel fiber reinforcement is an efficient and sustainable concrete reinforcement solution for both civil engineering precast applications (pipes, utility vaults and electric cabins) and building applications (modular housing, facade elements and sandwich panels).

The technology of steel fiber reinforcement in precast elements

Working with rebar and mesh involves the extremely time consuming and labor-intensive activity of placement, tying, cutting and bending of the reinforcement.

In contrast, Dramix® steel fibers are added directly to the concrete, guaranteeing a fast and safe solution on the construction site.

Further, Dramix steel fibers reinforce every part of the concrete structure, because unlike steel mesh, the fibers are distributed in every part of the concrete. They are bundled together using a water-soluble glue, which prevents the fibers from balling during mixing and ensures a homogenous distribution of the fibers throughout the concrete mix. The result?

- Better crack control
- Three-dimensional reinforcement
- A more efficient mixing process
- A homogeneous steel fiber mix
- High ductility

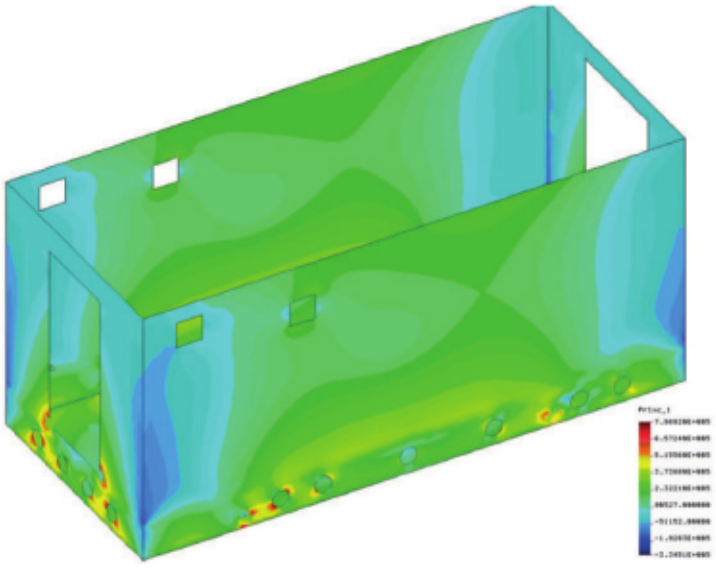
Finally, galvanized steel fibers are guaranteed rust-free over their long lifetime. This means no performance degradation over time due to rusting. Moreover, there is no unattractive discoloration of the final precast element, which means no compromise of the aesthetic aspect of precast elements.

Sustainability impact of steel fiber solutions

Steel fiber reinforcement allows for significant concrete and steel savings, which has a significant impact on the carbon footprint of the precast concrete structure.

We obtained multiple Environmental Product Declarations for Dramix, which allows builders to compare concrete reinforcement products and see the impact they have on the environment. This objective tool demonstrates how much CO_2 can be saved using Dramix steel fibers, compared to the traditional reinforcement solutions.

Example of precast eletric cabins



3D Model for stress in concrete electric cabin

This is just one of the first steps of our decarbonization roadmap. By 2030, we aim for a 40% cut of all carbon emissions, and by 2050, we are committed to reach net-zero emission, backed by science-based targets. That is why we have applied and have been accepted to join other leaders to support the Business Ambition for 1.5°C campaign.

In the following case study, we demonstrate the significant sustainability savings of using a Dramix solution in comparison with traditional reinforcement.

Case study: Carbon footprint of Rebar vs. Dramix reinforcement in electric cabins

In 2018, the Nation Technical Norms (N.T.C.) admitted steel fiber reinforced concrete (SFRC) for structural use. Italian precasters and designers have since been attracted to SFRC and started implementing Dramix steel fibers to solve problems related to the construction process of electric cabins, such as:

- Reducing congestions of rebar and meshes
- Reduce the thickness of the concrete for walls, roofs and slabs
- Reducing labor costs

…which in turns makes optimizing the design easier and the solution more affordable.

A study was set up in 2018 together with University of Brescia prof. G. Plizzari and a precaster, the design adopting a concrete C32-40 MPa plus Dramix 3D.

The results are summarized in the table

Table 1: electric cabin designs

	REBAR STANDARD SOLUTION	**DRAMIX® DESIGN**
Rebar incidence walls	70 kg/mc	**25 kg/mc**
Rebar incidence roof and slab	90 kg/mc	**40 kg/mc**
Wall thickness	9 cm	**7 cm**
Slab Thickness	10 cm	**9 cm**

A1 – A3 Product stage
- **A1** Raw material extraction
- **A2** Transport to manufacturing site
- **A3** Manufacturing

A4 – A5 Construction stage
- **A4** Transport to construction site
- **A5** Installation / Assembly

B1 – B5 Use stage
- **B1** Use
- **B2** Maintenance
- **B3** Repair
- **B4** Replacement
- **B5** Refurbishment
- **B6** Operational energy use
- **B7** Operational water use

C1 – C4 End of life stage
- **C1** Deconstruction & demolition
- **C2** Transport
- **C3** Waste processing
- **C4** Disposal

D – Benefits and loads beyond system boundary

Reuse, recovery and/or recycling potentials, expressed as net impacts and benefits

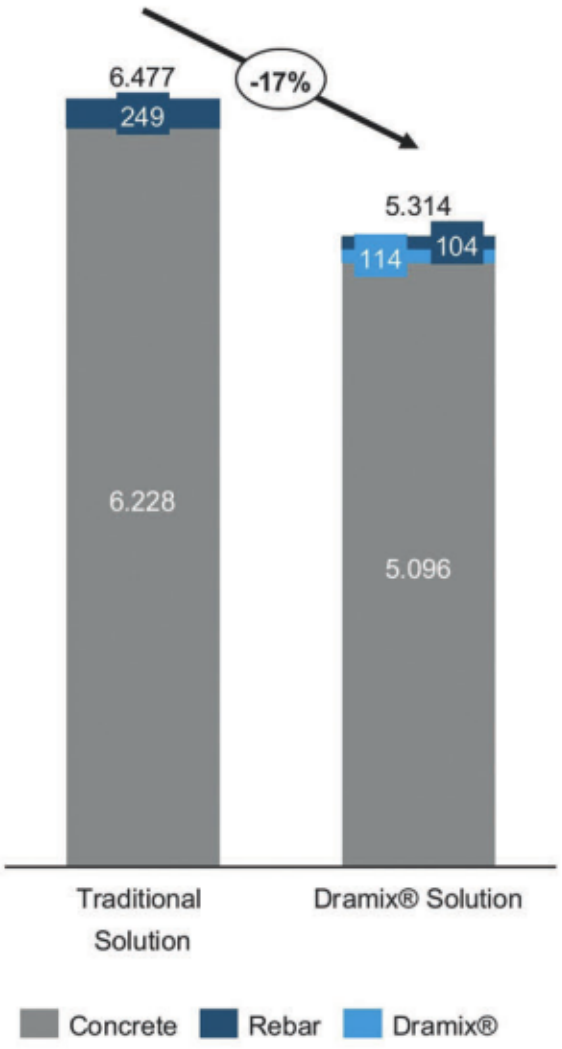
LCA assestment stage according with EN-15978. Source: One Click LCA

Adopting Dramix solutions not only gave technical and economic benefits, but more importantly, it significantly reduced the carbon emissions. These results have been obtained through a life cycle assessment (LCA) using One Click LCA calculations tools in accordance with the current EN-15978 standard. Input data for concrete mix design, rebars come from real customers' experiences and Dramix steel fibers are covered by a specific EPD certificate issued by an external notified body.

The assessment has been done by comparing traditional reinforcement with Dramix steel fiber reinforcement. The impact on Global Warming Potentials of both solutions is calculated at product and process level from cradle to construction (stages A1-A4 as shown in the graph below).

As shown, a great reduction in terms of embodied carbon related to raw materials (A1-A3 stage) is close to 18% of reduction and is widely recognized that this stage is the most relevant for the whole process.

The graph shows the specific amount of CO_2 emissions (kg CO_2e) for both solutions, as you can see majority of emission comes from concrete, followed by reinforcement. In contrast to a traditional solution, the Dramix solution allows a reduction of 17% GWP. How did Dramix achieve this? By both reducing the amount of reinforcement and the thickness of the concrete. These benefits are relevant considering that 96% of GWP of raw material comes from concrete.



The results of Table 1 indicate a 55% reduction of rebar by moving from a double to a single layer mesh. This in turn leads to an increase of production speed and a reduction of weight of precast elements. Conducing a LCA is not just useful to precasters, but also to designers. An LCA allows advantages for sustainability certifications for buildings like LEED and BREEAM and many others.

At the end of lifecycle of precast element, up to 95% of Dramix can be recovered by separating from concrete using heavy crusher and magnetic separator. The recovered material can be used in new steel production and some can be reused.

In conclusion, Dramix steel fibers reinforced precast concrete have a net positive impact on reaching the sustainability targets of your project. Steel fiber designs are optimized in accordance with norms and standards by an expert team to maximize total savings. These contributions position steel fibers as an important constituent for a sustainable future for precast concrete elements. ■

FURTHER INFORMATION

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