TECNOSIL NEWSLETTER

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Ecological footprint: an issue that deserves our attention.

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At any time or place, you are connected to Tecnosil.

Check out our websites, more modern, interactive and easy to navigate. And the best: you can access them from your smartphone, tablet or desktop with the same convenience.

It is a new way for you to get even closer to Tecnosil solutions and rely on the best service, because here you can ask questions, see the products and perform simulations to discover the best product for each application. And all without any complication.

More relevant content.

Also new: soon the Tecnosil website will be renovated to become a true concrete portal, with more content, research, articles, tests and studies on works.

Access, browse, see and enjoy the Tecnosil online channels: stay on top of more news and everything that happens.

Hello, dear reader!

Aware of the challenges of the current economic times we live in, the Tecnosil Group reaffirms once again its commitment to sustainable development, always evaluating the costs involved in creating intelligent solutions.

That's why we keep our work focused on providing high value-added products for the viability of High Performance Concrete (DAC) developing and commercializing a series of products that are transforming the entire concrete chain and stand out due to their durability.

In this issue of the Tecnosil Newsletter, we highlight a number of technical analyses that will show you the potential of using active silica and nanosilica in creating a concrete with exceptional qualities of lifetime, permeability, elasticity and mechanical properties. And, therefore, with an extremely positive impact on our ecological footprint, so prominent on the agenda these days and fundamental to the discussion.

We hope you enjoy reading and deepening your knowledge on the subject that we are so passionate about. If you want to exchange information and tell us about your experiences, please contact us through our websites, which are now even better. We are at your disposal.

Best regards.

ROBERTO B. POMPIANI
Chairman of the Tecnosil Group

The durability of concrete structures with Active Silica.

To talk about the durability of concrete is primarily to talk about the difficulty of penetration of aggressive agents in the pore network of the concrete. Considering this aspect, it is worth defining porosity as a flow which occurs under pressure gradient. At 28 days, we get the following porosity rates:

-15% in conventional concrete;
-10% To 12% in high performance concrete;
-7% to 9% in ultra-high performance concrete.

In general, we can say that the greater the resistance of the paste (water plus cement), the lower its permeability, as the resistance is a function of the relative volume of the gel in the available space.

In high performance concrete (CAD), with the addition of Active Silica, we were able to obtain a less permeable and therefore more resistant concrete. The use of very fine particles of Active Silica densified the cement paste and further reduced the porosity of the concrete, thus prolonging its lifetime and improving its mechanical properties, as shown by a study at the Federal University of Rio Grande do Sul, which proved many advantages of using this microsilica in the microstructure of the cement based materials.

The higher the ability of the cement to resist inclement weather, the higher its durability.

The incorporation of microsilica in Portland cement concretes provided decreased porosity and made the microstructure of the concrete denser and more compact, resulting in a material with superior performance to conventional concrete, better protected against aggressive agents.

(subtitled)
With benefits in the chemical and physical properties of the concrete.

Due to the high silica content and amorphous structure and the high specific surface of the particles (~ 20,000 m2/kg), microsilica has a chemical effect as a pozzolanic material of high reactivity, rapidly reacting with calcium hydroxide formed in the hydration of the cement. The physical effect (microfíler effect) happens due to the smaller size of the particles (~ 0.1 μm), which are inserted between the cement grains and become lodged in the interstices of the paste, reducing the space available for water and acting as nucleation point for the products of hydration, which provides a refinement of the pore structure.

The larger the factors that facilitate the entrance of aggressive substances into the concrete mass, the greater the deterioration of the material. Thus, the Active Silica technology is very welcome because it reduces the porosity and provides improvements to the concrete's ability to withstand the destructive effect of aggressive agents (water, oxygen, carbon dioxide, gaseous chlorides and solutions).

Source:

1 Durability Studies on Concretes and Mortars with Addition of Microsilica. VIEIRA, Fernanda P. Eng. Civil, PhD in Engineering, researcher at NORIE/CPGEC/UFRGS. **KULAKOWSKI, Marlova P.** Eng. Civil, PhD in Engineering, researcher at NORIE/CPGEC/UFRGS. **DAL MOLIN, Denise.** Eng. Civil, Dr. in Engineering, Associate Professor at NORIE/CPGEC/UFRGS.**VILELA, Antônio C. F.** Eng. Metallurgist, Dr. Ing., Associate Professor at LASID/PPGEM/UFRGS.

2 Technical Bulletin Fluid Transport Mechanisms in Concrete with Active Silica, at The Federal University of Rio Grande do Sul, by the Post-Graduate Program in Civil Engineering.

Active Silica and its contributions to sustainability.

When we think of sustainability and alternatives to sustain life on earth without harming the quality of life in the future, Active Silica appears as a great opportunity, thanks to its benefits.

>Reduced consumption of energy and CO_2

Among the materials used in construction, concrete has the least impact on the environment, compared with ceramics, steel, wood and others. By analyzing the energy consumption and CO_2 emissions of the constituent materials of concrete with or without the addition of silica activates, it is possible to clearly see the advantages of Active Silica, with values ranging from 25% to 35% for concrete of the same class of resistance, simply by reducing the consumption of binder.

>Use of natural resources.

In addition to greater resistance, another significant advantage that Active Silica provides to us is a reduction in the volumes of concrete and steel used. Just look at the example below, considering the central pillar of a building, with a load of 800 tf. There is a 34% reduction in energy consumption and 43% reduction in CO_2 emissions, simply due to the reduction in the consumption of materials: 44% less concrete and 42% less steel, which translates into significant savings in natural resources.

>Increased lifetime.

Several studies show that during the functional, economic and technical lifetime of a building, 40% of energy consumption occurs during in its construction phase and the other 60% over its 50 years of life. Active Silica contributes deeply to reducing this percentage and to increasing the durability of concrete structures, allowing the creation of less permeable concretes, which are therefore more resistant to many chemical attacks, carbonation, corrosion of reinforcement, alkali-aggregate reaction, etc.

With the most efficient use of natural resources, creating technologies and solutions for reinforced concrete structures that pollute less during their construction and that have a long life cycle, of more than 100 or 200 years instead of the usual 30 to 50 years, we will contribute greatly to sustainable development. And more: generates excellent business, with estimated gains of about 10% to 20% on the final cost of a structure designed within this concept.

What is Active Silica?

It is a fine powder made as a byproduct of the manufacturing process of silicon metal or ferrosilicon. Its particles are spherical, vitreous and have an average diameter of less than 1 µm, with a very high specific surface and a low specific density mass. The high SiO_2 content in the amorphous format, combined with a high fineness, provides high reactivity with the products due to the cement hydration, giving a better performance in concrete and mortar.

It is in this footprint that construction progresses.

Among the current challenges for society, one that draws our attention is that of sustainable development. How to meet our requirements for quality of life and well-being without compromising future generations?

(txt that can be free in the article, with some image to illustrate)
Economic activity, the environment and society's well-being are the bases of sustainable development.

Any and all sustainable development strategies must consider the harmony between humans and nature. And there is an intrinsic relationship with an economic, political, social and technological system that ensures the participation of citizens in the decision-making process.

In this sense, it is impossible to address the issue of durability of concrete without mentioning these three basic points: preserving the quality of the environment for restoration, increased social equity and increased economic efficiency.

(subtitled)
The dimensions of Sustainable Development.

When calculating the environmental impact of a functional unit (house or highway) on the environment, from its conception to its complete disappearance, we need to consider all the materials and energy used, and all gas or water emissions.

These impacts form a set of data and can be expressed differently according to the objectives sought and the methods used. But it is necessary to relativize the direct impact of the concrete by the function it exercises and the gains from further impacts that it generates. A construction requiring regular and important maintenance can, in fact, completely reverse the life-cycle analysis of the whole set.

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"The main problem with the concrete is the use of energy resources rather than non-renewable energy. Its main quality, however, is its durability, which provides a very long life cycle and therefore limits the impact of its use." (A. Capmas, 2014)

That is why the role of building materials is significant, and concrete is at the center of these discussions, since it represents 90% of the construction market.

Concrete is a durable material and in most cases does not need specific protection or maintenance. The best way to ensure its durability is to pay attention to its design and implementation to avoid wasting time and resources as much as possible.

Have you already realized the footprints you leave?

Understand the definition of Ecological Footprint.

The way we live leaves marks on the environment, "traces", "footprints", which may be higher or lower, depending on how we relate to nature around us. The Ecological Footprint is an environmental accounting methodology that measures the pressure of the consumption of human populations on natural resources.

Expressed in global hectares (gha), it allows you to compare different consumption standards to ensure that they are within the planet's ecological capacity, reflecting the extent of territory that one person or an entire society "uses" on average to sustain itself.

A global hectare means one hectare of average global productivity for land and productive waters in one year.

The concept of an Ecological Footprint allows us to account for renewable biological resources, where each type of consumption is converted into an area measured in hectares. In addition, it must include the areas used to receive the generated waste and residues and to reserve an amount of land and water for nature, ensuring the maintenance of biodiversity.

Learn about its components:

Carbon: extent of forest land able to sequester CO_2 derived from burning fossil fuels, excluding the portion absorbed by the oceans which leads to acidification.

Growing areas: extent of crops used for the production of food and fiber for human consumption as well as for the production of feed for livestock, oil and rubber.

Pastures: extent of pasture used for the creation of dairy and beef cattle and for the production of leather and wool products.

Forests: extent of forest areas needed for the supply of wood products, pulp and firewood.

Built-up areas: Extent of areas covered by human infrastructure, including transport, housing, industrial structures and reservoirs for hydroelectric power generation.

Fish stocks: calculated from the estimated primary production required to sustain fish and shellfish caught, based on capture data relating to marine and freshwater species.

Overall, highly industrialized societies have higher footprints than less industrialized societies. By using more resources, they affect increasingly distant locations, causing major impacts due to the generation of waste.

Therefore, evaluating to what extent our impact has exceeded the limit or not is essential because only then can we know if we are respecting the "capacity" of the planet and living sustainably.

Source: http://www.wwf.org.br/natureza_brasileira/especiais/pegada_ecologica/o_que_e_pegada_ecologica

The joint action of nanosilica and active silica.

In line with these concepts of sustainable development and in order to reduce the environmental impact in the construction sector, the Tecnosil Group is betting on and investing in creating solutions for more durable infrastructure that requires fewer repairs, without sacrificing any quality of materials.

The Active Silica and nanosilica that Tecnosil markets have identical chemical compositions, SiO_2, but nevertheless provide different properties both in efficiency and in operation time when added separately because they have very different particle sizes.

When used together in the production of concrete of any type, they provide significant gains in the mechanical-elastic properties and durability in various harsh environments.

Joining forces.

The explanation for this synergism is found in the subsequent or additional refinement of the microstructure of the concrete, mortar or cement paste which is produced during hydration of a portion of Portland cement. This is due to the fast reaction with $Ca(OH)^2$ released, leading to an initial network of CSH gel of excellent quality in the dissolution which, after all, is integrated into particles of anhydrous cement, creating bridges of hydrated calcium silicates between them.

As the nanosilica is exhausted after the initial hours and the hydration of the Portland cement fraction continues, you can observe:

The usual products of hydration of the Portland cement are gradually segmented and grow in the spaces on the original CSH gel network from the nanosilica source, which generates a higher densification of the microstructure. At the same time, the refinement of the microstructure also starts due to the pozzolanic activity of the Active Silica, which generates greater amounts of CSH gel by reaction with $Ca(OH)^2$ of better properties in the absence of the initial network of nanosilica origin.

In the case of reinforced concrete, this process leads to a material whose microstructure can be described as highly durable in accordance with different criteria, which are:

Physical type : Due to the high density of the resulting microstructure, which produces a very low porosity of the material, with a smaller pore size and high mechanical resistance both to compression and to traction, and a higher elastic modulus. Therefore, it is a very durable concrete, which prevents the penetration of foreign fluids, whether liquids or gases.

Chemical type: Due to the reduced size of the crystalline products and the balanced Ca/Si ratio of the CSH gel that makes the concrete less leachable by water, volumetrically much more stable and more resistant to aggressive attacks, especially to carbonation.

Actual results.

The combined addition of Active Silica and nanosilica in Portland cement to produce concrete of all types, normal or high resistance, is a viable and very economical option that enables the replacement of a certain amount of cement, keeping the same properties and even improving them. Check out the advantages:

-Reduced water consumption (decrease of the a/c ratio).

-Increased resistance to separation and surface exudation, which also gives the surface a better finish.

Better cohesion and workability (in relation to time and quality of mixing, that is, homogeneity of the concrete paste), even in hot climates.

-Increased resistance (compressive, tensile and flexion and traction) at the start and end with equal or even lower Portland cement content.

-Increased elastic modulus of the hardened material.

-An extremely reduced permeability of the concrete and high resistance to transport by diffusion of ionic species.

Tecnosil group: synergy translated into results.

The Tecnosil Group actively participates in the development of sustainable products to increase the lifetime of concrete structures. Today, you can highlight its new generation of additives based on stabilized nanosilica for concrete, **Silicon**, and a version with more benefits with regard to handling and dosage of Active Silica powder, but with the same quality and performance, **AdSil**.

In addition to the actual results of the permanent action (Active Silica + Nanosilica) with **Silicon** additives, which give better cohesion and impermeability, the silica that is a big hit at the moment is **AdSil**, an aqueous dispersion of Active Silica that simultaneously incorporates the benefits of using this product with the advantages of handling a liquid additive, facilitating its use.

See the benefits of **AdSil,** active silica in Tecnosil suspension, both fresh and hardened:

- Better performance, inhibiting chemical attack and penetration of chloride ions, RAA;
- Low permeability, porosity and absorptivity;
- Better paste adherence/reinforcement and paste/aggregates;
- High resistance to harsh environments;
- Thicker application in planned concrete;
- Increases cohesion and decreases exudation;
- Better performance against abrasion and erosion;
- More durability of concrete structures;
- High increase in initial and final mechanical resistance;
- Liquid product ready to use and free of chlorides;
- High productivity of the work, with simple and safe handling.

To learn more about Tecnosil solutions for the construction industry, visit our websites: WWW.silicon.com.br or WWW.tecnosil.com.br.