

NEW GENERATION HIGH-TECH MATERIAL FOR CONSTRUCTION

# geopolymer cement

géocement – new environment friendly cement, based on geopolymer technology

*Geopolymers are the new inorganic materials with a polymer structure of molecules. They possess high strength and a range of specific properties. They have received their name - geopolymers since the raw materials used for their production are mainly minerals of geological origin.*



## History

The first to use the term geopolymer was a French chemist Joseph Davidovits in 1978. The term geobeton was suggested by Russian engineers of Renca Rus as a particular case for construction materials based on geopolymer binders.

The use of geobeton in construction is widely spread in Australia, Ireland, USA and others. For instance, in 2014 for the first time an entire airport in Brisbane was constructed with a concrete based on geopolymer binders. Moreover, metropolitan tubings and elements of the load bearing structures are produced. Back in the 80-s of the 20th century in USA they used special high strength geopolymer concretes for the airfield and road repair.

In Russia the development of similar materials started in 1950s. The research works were made by the Kiev Institution of Civil Engineering guided by Glukhovskiy V.D. Various objects were built including civil and industrial constructions (residential house in Lipetsk, a part of the railroad with concrete ties in Moscow region, a motorway in Magnitogorsk, surface of the tank training battlefield near Chelyabinsk and others).

# Technology

Technology of geopolymer concrete is based on idea of applying inorganic mineral substances the production of which does not require the additional use of natural resources and does not lead to CO<sub>2</sub> emissions into the atmosphere (byproducts of metallurgical, electrometallurgical industries and power plants).

Geobeton is chemically inert to a range of aggressive substances, it is sturdy both to high temperatures and severe climates. Thanks to excellent physical-chemical properties geobeton can be widely used in construction. In comparison with traditional concrete production technology based on portlandcement, geobeton has better results in strength, durability, freeze-thaw resistance, fire resistance, heat insulation, corrosion and aggressive substance resistance including some types of acids.

As a result, the use of geobeton improves general ecological situation by reducing CO<sub>2</sub> emissions by up to 90% and recycling industrial byproducts. Their properties enable their implementation in the spheres with specific requirements towards concrete.



## Main Properties

*Geobeton exceeds the properties of natural stone*

### Chemical Resistance



High resistance to various acids and aggressive substances, and high sulphur resistance due to the absence of calcium compounds in the structure.

### Superior Waterproof Properties



Excellent waterproof properties are achieved thanks to mesoporous structure of the material, big molecules like water can't enter in the geopolymer matrix even if they are pushed using external forces.

### Thermal Resistance



Geopolymer concrete is resistant both to high temperatures over 1000 C and to low temperatures due to high level of freeze-thaw resistance.



### Fire Resistance

Unlike ordinary portland cement based concretes, water in geopolymer concrete is present on molecular level in not bound form and if heated it easily evaporates and does not explode the concrete from inside.



### Thermal Insulation Properties

By using high quality aggregates and geobeton one can create thermal insulation materials and plasters.



### Fast Strength Development

Geopolymer concrete develops about 50% of its strength in the first three days, this increases the construction speed.



# Advantages

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## Sustainability

In the process of geopolymer cement production the CO2 emissions are reduced by 90%.



## Utilisation of by-products

Possibility of utilizing wastes and byproducts of existing industries.



## High efficiency

High level of physical-mechanical properties and durability, higher compressive strength and axial tension strength, freeze-thaw resistance, water impermeability and resistance to abrasion.



## Cost effectiveness

To achieve special properties no additives or modifiers are needed, due to fast strength development the speed of the project implementation increases.



## Technical Specifications

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*Geopolymer nano-structure and a high level of mesoporosity let the air pass through the material and this gives the following properties to the concrete:*

✓ **Insulation**

✓ **High Level of Freeze-thaw resistance**

✓ **Thixotropy**

✓ **Adjustable Setting Time**

from 0 to 180 minutes

✓ **Resistance to Corrosion**

✓ **Resistance to Thermal Shock**

✓ **Fire Resistance**

✓ **Flowability**

✓ **Constantly High Strength**

Compressive strength over 100 MPa, flexural strength over 13 MPa

✓ **Resistance to alkalies, salts and acids**



## Ecological Aspects

*Geocement - eco-friendly, green product,  
which reduces CO2 emission into the atmosphere by 90%*

## Environmental Impact

The traditional portland cement industry is the second largest producer of CO2 globally.

With the population growth and corresponding increasing demand in concretes and cements, ecological aspects become a major concern of the generation.

Introduction of the geopolimer technology in the production of concrete and cement gives the following environmental benefits in comparison with traditional portland cement production:

- reducing CO2 emissions up to 90% in production process;
- a minimum 60% less impact on the environment as a result of the extraction of raw materials;
- use of wastes and by-products of the existing industries.



## Sustainability

Geocement is a material of the future that reduces the global warming impact by reducing CO2 emissions into the atmosphere due to eco-friendly production process and the use of various industrial wastes. This makes Geocement a sustainable green product.

Global warming and environmental protection has become a major concern for the world which is due to carbon dioxide (CO2) emissions into the atmosphere by human activities.

The environment must be protected by preventing dumping of waste and by-product materials in uncontrolled manners and by significantly decreasing Carbon dioxide (CO2) emissions. Interest towards green and sustainable building has grown in Russia in recent years.

There is a special certification system in Europe in the sphere of green and sustainable construction (LEED certification or «carbon credits»).

Application of Geocement in construction completely corresponds to this certification system and gives an ability to gain additional points. Buildings constructed with Geocement produced by Geobeton company would earn additional LEED points compared to conventional construction materials.

Green Building

Green building brings together a vast array of practices, techniques, and skills to reduce and ultimately eliminate the impacts of buildings on the environment and human health. It often emphasizes taking advantage of renewable resources, e.g., using sunlight through passive solar, active solar, and photovoltaic equipment, and using plants and trees through green roofs, rain gardens, and reduction of rainwater run-off. Many other techniques are used, such as using low-impact building materials or using packed gravel or permeable concrete instead of conventional concrete or asphalt to enhance replenishment of ground water.

A green building is one which uses less water, optimizes energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building. Considering the tremendous benefits that it offers, green building concept is gaining major importance in the world. By adopting Green methodologies we would be able to reduce the carbon footprint and would be helping the environment.

Construction industry is one of the major consumers of natural resources such as cement, sand, rocks, clays and other fossils. The ever increasing unit cost of usual ingredients of concrete have forced the construction engineers to think of ways and means of reducing the unit cost of its production. At the same time, increased industrial activity in the core sectors like energy, steel and transportation has been responsible for the production of large amounts of by-products such as fly-ash, blast furnace slag, silica fume and quarry dust with consequent disposal problem.

*Geopolymer technology completely corresponds to the concept of green building by optimizing energy efficiency of the buildings, preserving natural resources and at the same time utilizing the by-products of other industries, thus decreasing the CO<sub>2</sub> emissions by up to 90%.*

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## Application

Geocement can be applied as a component for various products with a wide range of applications in different industries.

Examples of industries where products based on geopolymer cement can be applied:

- General construction



- Earth quake proof construction and buildings
- Concrete Blocks
- Road construction
- Concrete pavements
- Eco-friendly green building
- Concrete floors
- High-strength fiber-concretes
- Containers and tanks for various liquids
- Pre-cast concrete
- Bridge constructions
- Railroad slippers
- Modular houses
- 3D-printing
- Sewer systems
- Various infrastructural projects
- Fire-proof systems
- Radioactive substances containment / encapsulation systems
- Marine structures
- Piles, foundations and other sub-terrain structures
- Petrochemical constructions
- Architectural constructions
- Design, architecture and decoration
- Countertops, panels and other concrete goods
- Thermal insulation materials

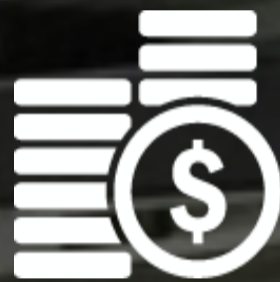
# 3D géobéton

*Together with the introduction of 3D-printing technology in construction, geopolymers and geobeton on their base make a new step in development. And already widely used in this technology of buildings construction.*



## Fast

*About 100 m2 accommodation in 24 hours.*



## Cost Effective

*No waste, faster construction period.*



## Sustainable

*Due to the use of industrial by-products CO2 emissions are reduced by up to 90% in comparison with traditional technology.*

# Future is Now

In Irkutsk for the first time in Russia successful tests of géobeton (geopolymer concrete) were made in printing constructions on the mobile 3D-printer. A Russian-Italian company Renca Rus, LLC has elaborated and tested various compositions of geobeton based on geopolymer binder for the technology of 3D-printing on mobile construction printer of the company Apis Cor.

This experience is unique. Both technologies are at the start of conquering the construction market, but the representatives of both companies believe that the future is in fast and eco-friendly construction.

The tests have shown a high efficiency of geobeton. Due to its specific composition an ideal for 3D printing consistency of the mixture was reached. This shortens the time of construction: the houses can be built within hours.

The elaborated formula of geobeton is the most suitable for the technology of 3D printing due to a higher thixotropy, fluidity and an ability to adjust the setting time, with a constantly high mechanical strength (compressive strength reaches 100 MPa and more). Moreover geobeton is cost-efficient eco-friendly material thanks to the use of industrial byproducts.

Engineers of the company Renca Rus plan to modify compositions of the mixtures to adjust them both for the hot climate and severely cold temperatures, as well as to create the mixtures on the base of various local raw materials in the regions of Russia and worldwide to optimise the cost and properties of geobeton and to enable its efficient implementation with the mobile construction 3D printer of Apis Cor.



 **геобетон**  
архитектурный бетон

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