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GEOPOLYMER CEMENT

The purpose of this research is to study the physical, chemical and mechanical properties of geopolymer cement, its advantages, specifications, and environmental impact.

Geopolymers are inorganic materials with a polymer structure of molecules. They possess high strength and a range of specific properties. They are called "geopolymers" because the raw materials used for their production are mainly minerals of geological origin.

Technology

The technology of geopolymer concrete is based on the idea of applying inorganic mineral substances, the production of which does not require the additional use of natural resources, and does not lead to CO2 emissions into the atmosphere (byproducts of metallurgical, electrometallurgical industries and power plants).

Geopolymer concrete is chemically inert to a range of aggressive substances and remains sturdy in severe climates. In comparison to traditional concrete production technology based on portland cement, geopolymer concrete has been shown to possess superior results in strength, durability, freeze-thaw resistance, fire resistance, heat insulation, corrosion, and aggressive substance resistance including some types of acids. Besides, the use of geopolymer cement reduces CO2 emissions by up to 90% compared to portland cement production. Geopolymer cement can be formulated to re-use and recycle industrial byproducts.

Main properties:

1) chemical resistance

Geopolymer concrete is highly resistant to various acids and aggressive substances, as well as highly sulfur resistant due to the absence of calcium compounds in its structure.

2) superior waterproof properties

Excellent waterproof properties are achieved thanks to its inherent mesoporous structure. Big molecules like water can't enter the geopolymer matrix even if they are pushed using external forces.

3) thermal resistance

Geopolymer concrete is resistant both to high temperatures over 1000 °C (1832 °F) and to low temperatures due to a high level of freeze-thaw resistance.

4) fire resistance

Unlike ordinary portland cement-based concretes, water in geopolymer concretes easily evaporates (not bound on a molecular level) and does not explode the concrete from inside.

5) thermal insulation properties

Materials and plasters using high-quality aggregates and geopolymer cement have superior thermal insulation.

6) fast strength development

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

Advantages:

1) ecological safety

Geopolymer cement production reduces CO2 emissions by 90% in comparison to traditional production.

2) utilisation of by-products

Utilizes waste and byproducts of existing industries.

3) high efficiency

Geopolymer concrete possesses higher-level compressive strength and axial tension strength, freeze-thaw resistance, water impermeability and resistance to abrasion.

4) cost effectiveness

Speed of the project implementation increases due to fast strength development. No additives or modifiers are needed.

Technical specifications.

Geopolymer concrete nanostructure and a high level of mesoporosity allow air to pass through the material, giving it the following properties: insulation, resistance to thermal shock, high level of freeze-thaw resistance, fire resistance, thixotropy, flowability, adjustable setting time from 0 to 180 minutes, constantly high strength, compressive strength over 100 MPa (14500 psi), flexural strength over 13 MPa (1885 psi), resistance to corrosion, resistance to alkalis, salts, and acids.

Environmental impact.

With population growth and the corresponding increasing demand in concretes and cements, ecological aspects of building have become a major concern of our generation. The portland cement industry is the second largest producer of CO2 globally. Introduction of the geopolymer 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 the production process;
- a minimum 60% less impact on the environment by reducing the need to extract raw materials;
- recycle and reuse of wastes and by-products of the existing industries.

Geocement is a material of the future. It has a far more eco-friendly production process. Buildings constructed with geocement earn additional points compared to conventional construction materials.

Application.

Geocement can be used in a wide range of different industries.

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

- General construction
- Earthquake-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 subterranean structures
- Petrochemical constructions
- Architectural constructions
- Architectural design and decoration
- Countertops, panels and other concrete goods
- Thermal insulation material

REFERENCES

1. Bakka MT, Sivko V.Y. Extraction and transportation of construction rocks. manual, - Zhytomyr: RVV ZhSTU 2003. - 249p.

2. Terentyev OM Engineering and technology of overlapping of building rocks [Text]: textbook. tools. / OM Terentyev, VG Kravets. –K .: NTUU “KPI”, 2013. - 220 p.

3. Khmara LA Crushing and sorting tip and finish: textbook. tools. / L. A. Khmara, OS S. Shipilov, O. G. Onishchenko. - D. - Poltava: PoltNTU, 2009. - 209 p.

4. Bedran NG Translation and quality of minerals. / N.G. Bedran, LM Skorobogatova - Kiev: Donetsk: High School. Main edition, 1984. - 189 p.

5. https://www.geocement.ru