GEOPOLYMER CEMENT

"GeoCement"

Technical Datasheet

Last edited: October 2025

All data vary depending on formulations, equipment, raw materials, and process.

DESCRIPTION

Geopolymers are an inorganic polymer binder or polysialate derived from the natural geological materials silica and alumina. The name "geopolymer" comes from its chemical and structural similarities to the molecules that bind natural rock. It was the cement used in antiquity before the invention of ordinary Portland cement 150 years ago. Various formulations find applications as a paint, coating, ceramic, grout, fiber composite materials, and long-lasting, high-quality, sustainable, recyclable cement.

Note: Geopolymers and alkali-activated materials (AAMs) are often confused, but they differ in terms of chemistry and performance. At GPI, we produce aluminum silicate-based materials for a variety of applications. We are committed to advancing materials with enhanced functionality, resilience, and sustainability, while prioritizing safety and cost-effectiveness.

PRIMARY APPLICATIONS

- All-purpose cement and mortar
- High-strength structural concrete, including steel, basalt, or fiber-reinforced concrete
- Precast and prestressed construction
- Repair for Portland and geopolymer cement, including for runways and highways, tanks, beams, columns, and walls
- Toxic and nuclear waste-containment
- Agglomerated stone, perfect for exterior and interior decoration and attractive tileUse in marine and strong acid environments.
- Pipes and tunnels

FEATURES / BENEFITS

- High compressive and flexural/tensile strength (three times that of Portland cement)
- Reaches 80% of strength within hours of hardening
- Can incorporate most mineral and many non-mineral aggregates or fillers, including Portland rubble, some inorganic wastes, plant materials, and industrial by-products
- Can be produced and cleaned with salt or wastewater
- No need to re-equip your factory
- Bears similar features to natural rock like granite or andesite
- As durable as natural rock (thousands of years) compared to 70 years for Portland.
- Water-based system free of solvent or vapor
- Hardens in seawater within two hours
- Adjustable setting time
- Lower heat of hydration
- Reduced drying shrinkage
- Low energy consumption
- Heat resistance; does not explode in fire
- Freeze-thaw and wet-dry resistant
- Superior waterproofing properties
- Excellent thermal insulating properties, including a passive cooling effect for buildings
- No cracking once hardened since there is no alkali-aggregate reaction and a very low shrinkage rate
- Resistant to corrosion, salts, acid, and sulfate
- Chemically inert for a range of aggressive substances and sturdy in severe climates
- 80% lower embodied CO_2 than Portland
- Geopolymer concrete is recyclable as an aggregate into a fresh slurry of geopolymer cement

TECHNICAL INFORMATION

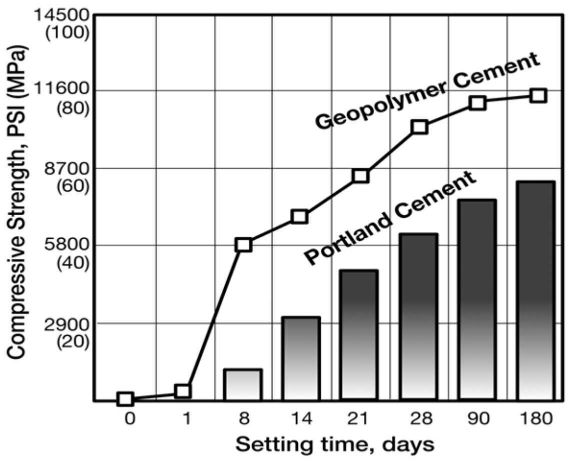

Figure 1: Comparison of early strength between geopolymer and ordinary Portland cement, set at room temperature.

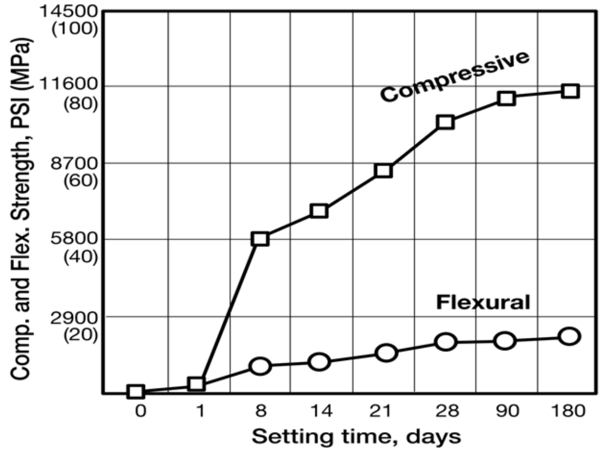

Figure 2: Average geopolymer cement compressive and flexural strengths, set at room temperature.

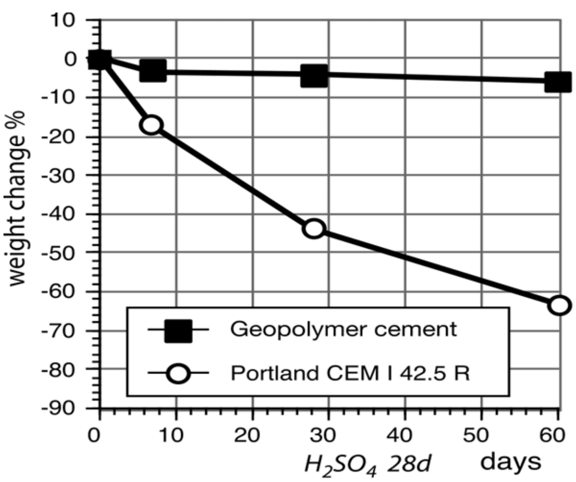

Figure 3: Comparison of resistance to corrosion between geopolymer and Portland cement. After 28 days' standard setting, samples were put into 5% sulfuric acid solution and the weight loss was measured.

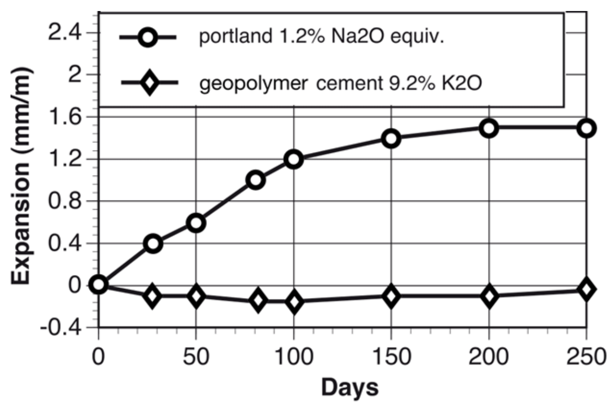

Figure 4: No alkali-aggregate reaction. Geopolymer cements even with alkali contents as high as 9.2% or higher do not generate any dangerous alkali-aggregate reaction. But in Portland cement, even alkali contents as low as 1.2% are dangerous.

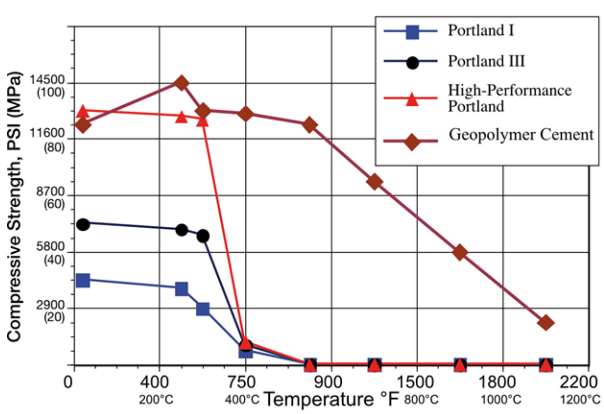

Figure 5: Comparison of strength of geopolymer cement-based concrete with high performance Portland and ordinary Portland cement-based concrete (type I and III) under high temperature.

The geopolymer cement-based concrete was kept at a temperature of 1800°F for three hours and retained a compressive strength of approximately 4400 PSI. Portland cement-based concretes exploded and deteriorated at 570°F.

Technical Data

(Potassium-Sodium, Calcium)-Poly(sialate-siloxo) / (K-Na,Ca)-(Si-O-Al-O-Si-O-), Si:Al=2:1
These data are only applicable to a standard geopolymer binder and may vary by up to 25% depending on the binder quality, fillers, process, and manufacturing conditions of your sample.

Tested on standard sand mortar prisms:
- Setting time: 20 hours at -5°F to 90 minutes at +70°F (adjustable)
- Shrinkage during setting: <0.05%, not measurable
- Compressive strength (uniaxial): > 11000 PSI in 28 days
- Flexural strength: 1600-2200 PSI in 28 days
- Young Modulus: > 290 kPSI
- Freeze-thaw: mass loss < 0.1% (ASTM 4842) and strength loss < 5% after 180 cycles
- Wet-dry: mass loss < 0.1% (ASTM 4843)
- pH: crushed and powdered, 11 to 11.5 after 5 minutes in deionized water (compared to Portland cement: 12 to 12.5, and granite: 11)
- Leaching in water (after 180 days): K_2O < 0.015%
- Water absorption: < 3%, not related to permeability
- Hydraulic permeability: 10-10 m/s
- Sulfuric acid (10%) resistance: mass loss 0.1% per day
- Chloride acid (5%) resistance: mass loss 1% per day
- KOH (50%) resistance: mass loss 0.02% per day
- Ammoniac resistance: no mass loss
- Sulfate resistance: shrinkage 0.02% at 28 days
- Alkali-aggregate reaction: no expansion after 250 days, -0.01% (compared to Portland Cement with 1% Na_2O, +1.5%)
- Linear expansion: < 5.10-6/K
- Heat conductivity: 0.2 to 0.4 W/m.K
- Specific heat: 0.7 to 1.0 kJ/kg
- Electrical conductivity: strongly dependent on humidity, geopolymer binder is microporous
- Thermal stability: mass loss < 5% up to 1800°F, strength loss < 20% at 1100°F, < 60% at 1800°F

Other values:
- Density of binder with 1:1 fine sand aggregate: 1,802g/L
- D.T.A.: endothermic at 480°F (zeolitic water)
- MAS-NMR spectroscopy:
  - 29Si: SiQ4, major resonance at -94.5 ± 3ppm
  - 27Al: AlQ(4Si), major narrow resonance at 55 ± 3 ppm
- Energy consumption: SEC for cement 1230-1310 MJ/ton (compared to Portland clinker 3500 MJ/ton)
- CO_2 emission during manufacture: 0.2 t/ton of cement (compared to Portland clinker 1.0 t/ton); for geopolymer concrete end including aggregates: 220 kg/m^3 CO_2 eq

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