Description

Image

Caption

1. Close-up of the material. © John Fernandez 2. Granite Butts Mehre Heritage Hall, University of Georgia. © John Fernandez

The material

Granite is one of the most durable of materials. The pyramid of Giza (2980 BC) was built of limestone cased in granite. It is a coarse grained igneous rock, very hard and compact. It takes a fine polish, showing the beauty of its crystals. It is the most important stone in building - whole cities are built of it (Edinburgh, in Scotland UK, is an example). It is used for work-surfaces because of its durability, resistance to acids and alkalis, and its decorative appearance. Granites, because of the lack of porosity, do not weather or crack as more porous stones do.

Composition (summary)

Granite is made up of quartz (SiO2) and feldspars and micas (both complex alumino-silicates).

General properties

Density	164	-	200	lb/ft^3
Price	* 0.472	-	2.82	USD/lb
Date first used	-10000			

Mechanical properties

Young's modulus	7.25	-	10.2	10^6 psi
Shear modulus	3.05	-	4.21	10^6 psi
Bulk modulus	* 4.35	-	6.53	10^6 psi
Poisson's ratio	0.15	-	0.26	
Yield strength (elastic limit)	1.16	-	3.34	ksi
Tensile strength	1.16	-	3.34	ksi
Compressive strength	16	-	37	ksi
Elongation	0			% strain
Hardness - Vickers	27	-	45	HV
Fatigue strength at 10^7 cycles	* 0.58	-	2.32	ksi

Fracture toughness		0.819	-	2	ksi.in^0.5
Mechanical loss coefficient (tan delta)	*	0.01	-	0.03	

Thermal properties

Melting point	*	2.19e3	-	2.91e3	°F
Maximum service temperature	*	1.11e3	-	1.29e3	°F
Minimum service temperature		-459	-	-458	°F
Thermal conductor or insulator?		Poor insulator			
Thermal conductivity		1.44	-	1.62	BTU.ft/h.ft^2.F
Specific heat capacity		0.185	-	0.201	BTU/lb.°F
Thermal expansion coefficient		5.56	-	6.67	µstrain/°F

Electrical properties

Electrical conductor or insulator?		Good insulator			
Electrical resistivity	*	1e13	-	1e14	µohm.cm
Dielectric constant (relative permittivity)		14	-	18	
Dissipation factor (dielectric loss tangent)	*	0.001	-	0.01	
Dielectric strength (dielectric breakdown)	*	127	-	305	V/mil

Optical properties

Transparency		Opaque			

Critical Materials Risk

High critical material risk?		No			

Processability

Machinability		2	-	3	

Durability: water and aqueous solutions

Water (fresh)		Excellent			
Water (salt)		Excellent			
Soils, acidic (peat)		Excellent			
Soils, alkaline (clay)		Excellent			
Wine		Excellent			

Durability: acids

Acetic acid (10%)		Excellent			
Acetic acid (glacial)		Excellent			
Citric acid (10%)		Excellent			
Hydrochloric acid (10%)		Excellent			
Hydrochloric acid (36%)		Excellent			
Hydrofluoric acid (40%)		Unacceptable			

Nitric acid (10%)	Excellent
Nitric acid (70%)	Excellent
Phosphoric acid (10%)	Excellent
Phosphoric acid (85%)	Excellent
Sulfuric acid (10%)	Excellent
Sulfuric acid (70%)	Excellent

Durability: alkalis

Sodium hydroxide (10%)	Excellent
Sodium hydroxide (60%)	Excellent

Durability: fuels, oils and solvents

Amyl acetate	Excellent
Benzene	Excellent
Carbon tetrachloride	Excellent
Chloroform	Excellent
Crude oil	Excellent
Diesel oil	Excellent
Lubricating oil	Excellent
Paraffin oil (kerosene)	Excellent
Petrol (gasoline)	Excellent
Silicone fluids	Excellent
Toluene	Excellent
Turpentine	Excellent
Vegetable oils (general)	Excellent
White spirit	Excellent

Durability: alcohols, aldehydes, ketones

Acetaldehyde	Excellent
Acetone	Excellent
Ethyl alcohol (ethanol)	Excellent
Ethylene glycol	Excellent
Formaldehyde (40%)	Excellent
Glycerol	Excellent
Methyl alcohol (methanol)	Excellent

Durability: halogens and gases

Chlorine gas (dry)	Excellent
Fluorine (gas)	Excellent
O2 (oxygen gas)	Excellent
Sulfur dioxide (gas)	Excellent

Durability: built environments

Industrial atmosphere	Excellent
Rural atmosphere	Excellent
Marine atmosphere	Excellent
UV radiation (sunlight)	Excellent

Durability: flammability

Flammability	Non-flammable

Durability: thermal environments

Tolerance to cryogenic temperatures	Excellent
Tolerance up to 150 C (302 F)	Excellent
Tolerance up to 250 C (482 F)	Excellent
Tolerance up to 450 C (842 F)	Excellent
Tolerance up to 850 C (1562 F)	Acceptable
Tolerance above 850 C (1562 F)	Unacceptable

Primary material production: energy, CO2 and water

Embodied energy, primary production		596	-	693	kcal/lb
CO2 footprint, primary production		0.303	-	0.335	lb/lb
Water usage	*	0.387	-	0.428	gal(US)/lb

Material processing: energy

Grinding energy (per unit wt removed)	*	1.24e3	-	1.37e3	kcal/lb

Material processing: CO2 footprint

Grinding CO2 (per unit wt removed)	*	0.858	-	0.949	lb/lb

Material recycling: energy, CO2 and recycle fraction

Recycle	✗			
Recycle fraction in current supply	1	-	2	%
Downcycle	✓			
Combust for energy recovery	✗			
Landfill	✓			
Biodegrade	✗			
Toxicity rating	Non-toxic			
A renewable resource?	✗			

Supporting information

Design guidelines

Granite is exceptionally hard, making it expensive to quarry and work, but it is exceptionally durable and wear resistant, and can be polished to a mirror-like finish. Its great chemical stability gives resistance to aqueous and organic fluids, acids and alkalis. Granite is used in optical tables; streets paved with granite cobbles looked today as they did when they were laid. Stone weathers in a benign attractive way, unlike concrete; and its association with the great structures of the past makes it attractive for imposing buildings of today.

Technical notes

Granites are made up of crystals of feldspar, dull white to deep red in color, with small grains of gray quartz and crystals of mica that give the stone its sparkle.

Typical uses

Granites are used for building and facing, floors and work surfaces, stable supports for machine tools, optical tables and supports for other precision instruments. Much is now used in ornamental ways.

Links

Reference

ProcessUniverse

Producers