Description

Image

Caption

1. Close-up of the material. © Granta Design 2. Red Sandstone, University of Sydney, New South Wales, Australia © Granta Design

The material

Sandstone is consolidated sand particles (quartz), bonded by a cementing agent: feldspars, limes, silica or clays. The size of the sand particles, the porosity and the strength vary greatly in different sandstones. The colors derive from iron or manganese impurities and give sandstones their character.

Composition (summary)

Silica (SiO_2) particles bonded with lime (CaO), calcium carbonate ($CaCO_3$) or clays (alumino-silicates).

General properties

Density		140	-	165	lb/ft^3
Price	*	0.186	-	0.281	USD/lb
Date first used		-10000			

Mechanical properties

Young's modulus		2.03	-	3.63	10^6 psi
Shear modulus	*	0.812	-	1.45	10^6 psi
Bulk modulus	*	1.6	-	2.9	10^6 psi
Poisson's ratio		0.22	-	0.29	
Yield strength (elastic limit)		0.58	-	3.19	ksi
Tensile strength		0.58	-	3.19	ksi
Compressive strength		7.25	-	22.5	ksi
Elongation		0			% strain
Hardness - Vickers		7	-	38	HV
Fatigue strength at 10^7 cycles	*	0.45	-	1.74	ksi
Fracture toughness	*	0.637	-	1	ksi.in^0.5

Mechanical loss coefficient (tan delta)	* 0.0019	-	0.0057	

Thermal properties

Melting point	* 2.19e3	-	2.55e3	°F
Maximum service temperature	* 752	-	1.11e3	°F
Minimum service temperature	-459			°F
Thermal conductor or insulator?	Poor insulator			
Thermal conductivity	0.52	-	2.89	BTU.ft/h.ft^2.F
Specific heat capacity	* 0.201	-	0.22	BTU/lb.°F
Thermal expansion coefficient	* 4.44	-	11.1	µstrain/°F

Electrical properties

Electrical conductor or insulator?	Good insulator			
Electrical resistivity	1e10	-	1e14	µohm.cm
Dielectric constant (relative permittivity)	* 6	-	9	
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	3	-	4

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%)	Acceptable
Acetic acid (glacial)	Limited use
Citric acid (10%)	Acceptable
Hydrochloric acid (10%)	Limited use
Hydrochloric acid (36%)	Unacceptable
Hydrofluoric acid (40%)	Unacceptable
Nitric acid (10%)	Limited use

Nitric acid (70%)	Unacceptable
Phosphoric acid (10%)	Acceptable
Phosphoric acid (85%)	Unacceptable
Sulfuric acid (10%)	Limited use
Sulfuric acid (70%)	Unacceptable

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	Acceptable
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)	Limited use
Fluorine (gas)	Limited use
O2 (oxygen gas)	Excellent
Sulfur dioxide (gas)	Limited use

Durability: built environments

Industrial atmosphere	Acceptable
Rural atmosphere	Excellent
Marine atmosphere	Acceptable
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)	Unacceptable
Tolerance above 850 C (1562 F)	Unacceptable

Primary material production: energy, CO2 and water

Embodied energy, primary production		43.3	-	65	kcal/lb
CO2 footprint, primary production		0.0269	-	0.0297	lb/lb
Water usage	*	0.387	-	0.428	gal(US)/lb

Material processing: energy

Grinding energy (per unit wt removed)	*	795	-	879	kcal/lb

Material processing: CO2 footprint

Grinding CO2 (per unit wt removed)	*	0.551	-	0.608	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

Sandstone is easily cut and carved. Marble has a wonderful translucency, making it the choice of many sculptors. It weathers in a benign attractive way, but the surface traps dirt in an urban or industrial environment, requiring periodic cleaning.

Technical notes

Sandstones consist of particles of quartz, feldspar and mica bonded by a natural cement. The cement determines the strength, durability and color. Calcareous sandstones are bonded with calcium carbonate; they are called "freestone" because they are easily worked but they weather badly. Siliceous sandstones are bonded with alumino-silicates; they are acid resistant and durable but harder to work. Bluestone, much used in New York state, is noted for its even grain and high strength. It is about 70% silica bonded with clay. Ferruginous sandstones contain oxides of iron, giving lovely browns, reds and yellows.

Typical uses

Buildings and facing, table tops, bench tops and chemical equipment to resist acids and

Tradenames

York stone; Bluestone

Links

Reference

ProcessUniverse

Producers