Description

Image

Caption

1. Close-up of the material. © John Fernandez 2. Georgia State Capitol. © John

The material

Limestone is formed of petrified sea-creatures. In its pure form it is chalk (when porous) or marble (when fully dense). Most limestone is not pure but contains sand (silicate) and other minerals. The most interesting limestones contain visible shells and other fossils of the creatures from which they derived. It is easy to cut; where it is available it is widely used as a building stone.

Composition (summary)

Calcium carbonate (CaCO3) plus silicate impurities.

General properties

Density		159	-	162	lb/ft^3
Price	*	0.186	-	0.472	USD/lb
Date first used		-10000			

Mechanical properties

Young's modulus		5.08	-	7.98	10^6 psi
Shear modulus	*	2.03	-	3.19	10^6 psi
Bulk modulus	*	3.34	-	5.08	10^6 psi
Poisson's ratio		0.2	-	0.26	
Yield strength (elastic limit)		1.16	-	3.19	ksi
Tensile strength		1.16	-	3.19	ksi
Compressive strength		4.35	-	29	ksi
Elongation		0			% strain
Hardness - Vickers		3	-	18	HV
Fatigue strength at 10^7 cycles	*	0.58	-	2.32	ksi
Fracture toughness		0.546	-	0.91	ksi.in^0.5

Mechanical loss coefficient (tan delta)	0.0011	-	0.0054	

Thermal properties

Melting point	2.25e3	-	2.46e3	℉
Maximum service temperature	* 626	-	716	℉
Minimum service temperature	-459	-	-458	℉
Thermal conductor or insulator?	Poor insulator			
Thermal conductivity	0.532	-	1.24	BTU.ft/h.ft^2.F
Specific heat capacity	0.193	-	0.22	BTU/lb.℉
Thermal expansion coefficient	2.06	-	3.5	µstrain/℉

Electrical properties

Electrical conductor or insulator?	Poor insulator			
Electrical resistivity	* 1e8	-	1e12	µohm.cm
Dielectric constant (relative permittivity)	10	-	15	
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	Limited use

Durability: acids

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

Nitric acid (70%)	Unacceptable
Phosphoric acid (10%)	Limited use
Phosphoric acid (85%)	Unacceptable
Sulfuric acid (10%)	Unacceptable
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)	Unacceptable
Fluorine (gas)	Unacceptable
O2 (oxygen gas)	Excellent
Sulfur dioxide (gas)	Unacceptable

Durability: built environments

Industrial atmosphere	Limited use
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)	Unacceptable
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		26	-	37.9	kcal/lb
CO2 footprint, primary production		0.0147	-	0.0163	lb/lb
Water usage	*	1.56	-	1.73	gal(US)/lb
Eco-indicator 99		2.63			millipoints/kg

Material processing: energy

Grinding energy (per unit wt removed)	*	671	-	741	kcal/lb

Material processing: CO2 footprint

Grinding CO2 (per unit wt removed)	*	0.464	-	0.513	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

Limestones vary widely in composition and porosity and their strength and weather resistance reflect this. The softer ones can be sawn and carved by hand, and so are widely used for sculpture and decorative moldings. They weather in a benign attractive way; the carbonic acid in rain dissolves a very thin surface film over time, making the surface self-cleaning.

Technical notes

Limestone consists mainly of calcite, $CaCO_3$, with sand (SiO_2) and, in some cases magnesium carbonate, $MgCO_3$, (Dolomitic limestone). Limestones vary greatly in hardness and are generally easier to work than sandstones.

Typical uses

Limestone is widely used for building and sculpture. It is calcined in large quantities to make lime (CaO) for cement and as a flux in the smelting of iron.

Tradenames

Portland stone; Bath stone

Links

Reference

ProcessUniverse

Producers