Description

Image

Caption

1. Close-up of the material. © Granta Design 2. The Basilica of Pisa. © Granta

The material

Marble is the purest form of limestone. It is almost pure calcium carbonate that has been compacted and heated such that it has recrystallized. It is used for ornamental building, statuary, ornamental furniture and for electric power panels. The purest marble (Italian Carrara marble is an example) is very white, delicate in texture and hard. Other marbles are dark green, red, black or gray, allowing their use for decorative patterning like that of the Basilica shown in the picture.

Composition (summary)

Calcium carbonate (CaCO3).

General properties

Density		2.72e3	-	2.85e3	kg/m^3
Price	*	0.41	-	1.04	USD/kg
Date first used		-10000			

Mechanical properties

Young's modulus		50	-	70	GPa
Shear modulus	*	22	-	28	GPa
Bulk modulus	*	26	-	36	GPa
Poisson's ratio		0.14	-	0.22	
Yield strength (elastic limit)		6	-	10	MPa
Tensile strength		6	-	10	MPa
Compressive strength		55	-	105	MPa
Elongation		0			% strain
Hardness - Vickers		16	-	20	HV
Fatigue strength at 10^7 cycles	*	5	-	8	MPa
Fracture toughness		0.6	-	1.2	MPa.m^0.5

Mechanical loss coefficient (tan delta)	* 5e-4	-	0.001	

Thermal properties

Melting point	1.23e3	-	1.34e3	℃
Maximum service temperature	630	-	680	℃
Minimum service temperature	-273	-	-272	℃
Thermal conductor or insulator?	Poor insulator			
Thermal conductivity	5	-	6	W/m.℃
Specific heat capacity	850	-	890	J/kg.℃
Thermal expansion coefficient	3	-	5	µstrain/℃

Electrical properties

Electrical conductor or insulator?	Semiconductor			
Electrical resistivity	* 1e8	-	1e12	µohm.cm
Dielectric constant (relative permittivity)	* 6	-	8	
Dissipation factor (dielectric loss tangent)	* 5e-4	-	0.001	
Dielectric strength (dielectric breakdown)	* 5	-	12	1000000 V/m

Optical properties

Transparency	Translucent

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	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)	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		1.8	-	2.2	MJ/kg
CO2 footprint, primary production		0.118	-	0.13	kg/kg
Water usage	*	3.23	-	3.57	l/kg

Material processing: energy

Grinding energy (per unit wt removed)	*	5.66	-	6.26	MJ/kg

Material processing: CO2 footprint

Grinding CO2 (per unit wt removed)	*	0.425	-	0.469	kg/kg

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

Marble, nearly pure calcium carbonate, is easily cut and carved. Its fine grain size makes it ideal for detailed carving. Marble is hard and dense, and takes a near-perfect polish. It has a wonderful translucency, making it the choice of many sculptors. Like limestone, it weathers well in a clean environment but is attacked by acid, and thus by industrial emissions.

Technical notes

Good marble is expensive. Marblelite is an artificial substitute used for casting statues and small objects. Crushed marble is used as an aggregate in flooring.

Typical uses

Buildings, facings, floors, stairs, statuary and ornamental furniture, electric-power

Tradenames

Carerra marble

Links

Reference

ProcessUniverse

Producers