

## 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.

### Compositional summary

Calcium carbonate ( $\text{CaCO}_3$ ).

## General properties

Density	170	-	178	lb/ft <sup>3</sup>
Price	* 0.186	-	0.472	USD/lb
Date first used	-10000			

## Mechanical properties

Young's modulus	7.25	-	10.2	10 <sup>6</sup> psi
Shear modulus	* 3.19	-	4.06	10 <sup>6</sup> psi
Bulk modulus	* 3.77	-	5.22	10 <sup>6</sup> psi
Poisson's ratio	0.14	-	0.22	
Yield strength (elastic limit)	0.87	-	1.45	ksi
Tensile strength	0.87	-	1.45	ksi
Compressive strength	7.98	-	15.2	ksi
Elongation	0			% strain
Hardness - Vickers	16	-	20	HV
Fatigue strength at 10 <sup>7</sup> cycles	* 0.725	-	1.16	ksi
Fracture toughness	0.546	-	1.09	ksi.in <sup>0.5</sup>

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

Melting point	2.25e3	-	2.44e3	°F
Maximum service temperature	1.17e3	-	1.26e3	°F
Minimum service temperature	-459	-	-458	°F
Thermal conductor or insulator?	Poor insulator			
Thermal conductivity	2.89	-	3.47	BTU.ft/h.ft^2.F
Specific heat capacity	0.203	-	0.213	BTU/lb.°F
Thermal expansion coefficient	1.67	-	2.78	μstrain/°F

### 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)	* 127	-	305	V/mil

### Optical properties

Transparency	Translucent			
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### Processability

Machinability	3	-	4
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### 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
O <sub>2</sub> (oxygen gas)	Excellent
Sulfur dioxide (gas)	Unacceptable

### **Durability: built environments**

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

### Durability: flammability

Flammability	Non-flammable
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### 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	195	-	238	kcal/lb
CO2 footprint, primary production	0.118	-	0.13	lb/lb
Water usage	* 0.387	-	0.428	gal(US)/lb

### Material processing: energy

Grinding energy (per unit wt removed)	* 613	-	678	kcal/lb
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### Material processing: CO2 footprint

Grinding CO2 (per unit wt removed)	* 0.425	-	0.469	lb/lb
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### 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.

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**Technical notes**

Good marble is expensive. Marbleite 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

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