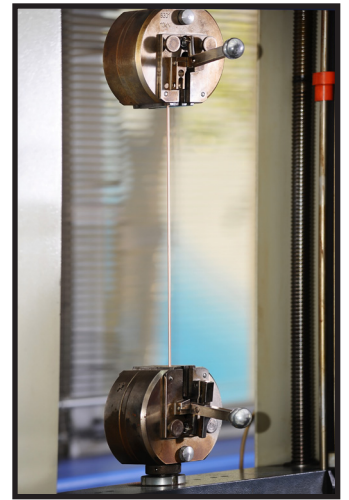


## Guide to Tensile Strength

What is tensile strength? In layman's terms, it is the measurement of the force required to stretch a material until it breaks. The test is done to see how much pulling force a material can withstand before it reaches the breaking point. This is extremely important in many fields such as mechanical engineering, material science, and perhaps the most important, structural engineering.

There are three different ways tensile strength is measured: the yield strength, the ultimate strength, and the breaking strength.

The yield strength is the amount of stress that you can put on a material without it breaking and deforming. The yield point is the point at which the material will no longer return to its original form and become permanently deformed. The ultimate strength is the maximum amount of stress that a material can withstand while being stretched or pulled. The breaking strength refers to the point on the stress-strain curve where the material can no longer withstand the stress of the tension and it breaks.



Below is a guide to the tensile strengths of several common materials.

Material	Yield strength (MPa)	Ultimate strength (MPa)	Density (g/cm <sup>3</sup> )
Structural steel ASTM A36 steel	250	400	7.8
Steel, API 5L X65 (Fikret Mert Veral)	448	531	7.8
Steel, high strength alloy ASTM A514	690	760	7.8
Steel, high tensile	1650	1860	7.8
Steel Wire			7.8
Steel, Piano wire	c. 2000		7.8
High density polyethylene (HDPE)	26-33	37	0.95
Polypropylene	12-43	19.7-80	0.91
Stainless steel AISI 302 - Cold-rolled	520	860	8.03;
Cast iron 4.5% C, ASTM A-48	130 (??)	200	7.3;
Titanium Alloy (6% Al, 4% V)	830	900	4.51
Aluminum Alloy 2014-T6	400	455	2.7
Copper 99.9% Cu	70	220	8.92
Cupronickel 10% Ni, 1.6% Fe, 1% Mn, balance Cu	130	350	8.94
Brass		250	
Tungsten		1510	19.25
Glass (St Gobain "R")	4400 (3600 in composite)		2.53
Bamboo	142	265	.4
Marble	N/A	15	
Concrete	N/A	3	
Carbon Fiber	N/A	5650	1.75
Spider silk	1150 (??)	1200	
Silkworm silk	500		
Kevlar	3620		1.44
Vectran		2850-3340	
Pine Wood (parallel to grain)		40	
Bone (limb)		130	
Nylon, type 6/6	45	75	1.15
Rubber	-	15	
Boron	N/A	3100	2.46
Silicon, monocrystalline (m-Si)	N/A	7000	2.33
Sapphire (Al <sub>2</sub> O <sub>3</sub> )	N/A	1900	3.9-4.1
Carbon nanotube (see note below)	N/A	62000	1.34

Note: Multiwalled carbon nanotubes have the highest tensile strength of any material yet measured, with labs producing them at a tensile strength of 63 GPa, still well below their theoretical limit of 300 GPa. However as of 2004, no macroscopic object constructed of carbon nanotubes has had a tensile strength remotely approaching this figure, or substantially exceeding that of high-strength materials like Kevlar.