GLASS AS A MATERIAL FOR BODY JEWELRY

STRENGTH AND BREAKABILITY OF GLASS

In truth glass is a strong material, used in sky scrapers and car windshields. But everyone knows glass can break. Glass is a paradox in many ways. The properties of glass should not be compared to those of metal. For instance, shear strength means a great deal with metals, but has little or no significance in glass. Hardness of glass must be measured in terms that rarely apply to ductile materials. These are some of the mechanical properties of glass and how they are measured.

Strength: The intrinsic or theoretical strength of glasses is considerably higher than is normally measured, but stress concentrations caused by surface imperfections resulting from manufacturing or handling limit the ultimate strength to around 10,000 p.s.i. Laboratory tests have shown glass fibers with tensile strengths of up to one million p.s.i. The practical tensile strength of glass however, is about 5000 p.s.i. Between 70 and 80% of the failures occur in commercial glass near this value. To preserve a safety factor, a prolonged working stress of 1000 p.s.i. is the maximum that should be used. Rate of loading is also important. Glass fatigues under constant load and the faster the loading rate, the higher the apparent strength.
These values can be used for current commercial glasses since the composition of glass has little practical effect on its strength. Most borosilicate glasses, though, tend to resist scratching and therefore usually give better mechanical service.

Ductility: Glass does not plastically deform before failure and therefore breaks in a brittle fashion. In practice, it can be considered to break only from tensile stresses. Failure due to pure shear or compressible stresses is rare. Glass is a nearly perfect elastic material, meaning that it can bend, but will automatically return to its original shape. The strength of glass is measured by various methods.

Young's Modulus (Modulus of Elasticity): Young's Modulus is the ratio between stress and strain, and is determined by measuring the sonic or ultrasonic frequencies of a simple beam at room temperature. Most commercial glasses have values between 9 and 10 million p.s.i. By comparison, steel is 30 million, copper 17 and aluminum 10.

Poisson's Ratio: The longitudinal stretching of any elastic material is accompanied by a lateral contraction, and the ratio of the contraction to the proportional stretching is known as Poisson's Ratio. It is measured by a similar method of that used to measure Young's Modulus. A Poisson's Ratio of 0.20 is usually given for glass since the actual value is very seldom less than 0.18 or greater than 0.22.

Hardness and Impact Abrasion Resistance: Glass hardness cannot be measured by the methods and scales (Brinnel or Rockwell) used for metals. One of the three other scales is usually used.

MOHS: Scratch hardness. Glasses lie between apatite (5) and quartz (7). On this scale glasses are softer than (i.e., can be scratched by) sand, hard steel, agate, emery; and are harder than mica, aluminum and copper.

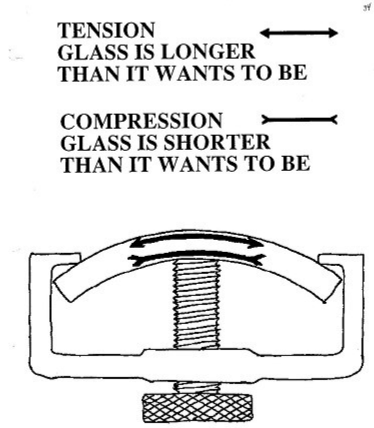
Knoop (and Vickers): Penetration hardness. Typical values for commercial glasses range from 300-366Kg/mm (Knoop Scale) when a load of 50 grams is used.

ZEISS: Grinding or impact abrasion. Impact abrasion resistance is evaluated by measuring the glass resistance to sandblasting under standard conditions. All values are relative. Unity is assigned to soda lime plate (standard window glass) and all other values are assigned relative to this standard.

Density: Density is defined as the mass per unit volume. For glass, density depends upon its composition (primarily) and its thermal treatment (density for a particular glass composition will be greatest when the glass gas has been stabilized at the lowest practical temperatures). It is measured by one of several buoyancy methods, usually a hydrostatic weighing procedure.

	Density	Youngs Modulus (10*8 PSI)	Poisson's Ratio	Impact Abrasion Resistance
SODA-LIME	2.47	10	0.24	1.2
BOROSILICATE	2.23	9.1	0.21	3 to 4
QUARTZ	2.2	10.5	0.17	
LEAD	3.04	8.6	0.22	.6 to .8

Mechanical Properties



FLAWS AND BREAKABILITY
Glass breaks the way it does due to its lack of ductility, and also because flaws concentrate stress increasing its breakability. Flawed glass under tension will fracture, but glass will not fail without both factors (flaw + tension = fracture). Glass breaks only under tension, very rarely from compressive or shear forces.

The reason glass breaks more easily when dropped on a porcelain floor rather than a wooden one is because the hard porcelain will scratch or ding the surface of the glass, while the softer wood will not. It is the resulting damage to the surface of the glass that creates the crack initiation site. It is advised to remove glass jewelry before showering or bathing because the glass may not survive a drop on a porcelain surface.

Advise customers to take care of their glass jewelry. Glass jewelry is often most vulnerable when it is not being worn, and should be stored in a safe, dry place.