

GLASS PHYSICAL PROPERTIES

General physical characteristics of soda, lime silica glass for building purposes:

Density	2,500 kg/m ³
Specific gravity	(21°) Approximately 2,50
	Glass used for building purposes has a specific gravity compared with that of aluminium which is approximately 2.60
Coefficient of Linear thermal Expansion	8x 10 ⁻⁷ /deg.C. Glass has a much lower coefficient of linear thermal expansion than metals.
Thermal Conductivity	(K value) 1.05 W/m°C. The difference between various types of flat glass is small enough to be negligible.
Thermal endurance	6 mm glass heated to a higher temperature and plunged into water at 21°C will rupture at approximately 55°C differential.
Softening point	Approximately 730°C.
Modulus of elasticity	Young's modulus 69 GPa (69 x10 ⁹ Pa). The modulus of elasticity for glass is similar to aluminium.
Poisson's ratio	Float glass .22 to .23. Glass conforms to the elastic theory to the point of fracture.
Compressive strength	25mm cube: 248mPa (248 x10 ⁶ Pa).
Tensile strength	For sustained loading 19.3 to 28.4 Mpa. Determined as modulus of rupture.
Impact strength	See mechanical strength below
Hardness scale	Moh's scale, diamond 10, sapphire 9, glass 5.5 to 6.5, gypsum 2, talc 1. Knoop hardness (Kg/sq mm) : Diamond 5,500 to 6,950, glass 575, gypsum 32.
Dielectric constant	6mm glass at 21°C temperature. 1,000,000,000 cycles per sec 6.0 10,000,000 cycles per sec 6.5 1,000 cycles per sec 7.4 10 cycles per sec 30.0
Refractive index	1.52 - Refractive index varies for light of different wavelengths.
Reflection loss	Approximately 8 to 10% per light (no absorption) normal incidence. Light is always reflected when it passes from a medium of one refractive index to a medium of another refractive index. The loss is a function of both the refractive indices of the media and the angle of incidence of the light.

Thermal transmittance (U Value) 5.8 W/m²°C for summer – 6.2 W/m²°C for winter. This U Value is for single glass and is based on standard ASHRAE conditions. However, for most purposes a U Value of 6 is used.

Visible light transmission Ordinary glazing glass has the property of being relatively transparent to short wave infra-red rays, but opaque to the longer wavelengths. This is the reason why horticultural glass houses accumulate heat from the sun's rays- radiation of short wavelength from the sun is passed by the glass, and is absorbed by plants, benches, walls, etc; inside the house; these become hot and in turn re-radiate heat but of longer wavelength which cannot pass through the glass and is reflected back into the interior

Ultra-violet transmission Ordinary glass transmits a very small proportion of the sun's rays. At 315 nm less than 1%, at 340 nm 41%.

Chemical resistance Glass will resist most acids except hydrofluoric and, at high temperature, phosphoric. Alkalis, however, attack the surface of the glass. When glazed into concrete framing, alkalis released from the concrete by rain may be leached onto the glass causing staining, or etching of the glass surface. Self-weathering steels can deposit soluble sulphates, which may be difficult to remove from the glass. It is important therefore, that the glazing be such that rundown cannot wash onto the glass surfaces. Should this occur any deposits should be removed as soon as possible.

Surface tensile strength It has been mentioned that glass is weak in tension. The fact is that glass never breaks until the critical tensile stress is developed in some part of its surface, and when the tensile strength is spoken of, it is the surface tensile strength that is indicated. It is probably more true to say that the real intrinsic tensile strength of glass is relatively high and quite unknown.

This is because it appears impossible to cause mechanical breakdown of a piece of glass by engendering tensile stresses which do not reach its surface at some point, as, for instance, by certain kinds of thermal effect.

It is interesting to note that the strength of a good homogeneous glass does not seem to depend fundamentally on its composition.

Glasses of quite widely varying composition show no significant differences in strength. Strength is much affected by lack of homogeneity, and the opaque glasses, whose lack of transparency is due to the presence of microscopic crystals in the matrix of glass, are appreciably weaker than the clear glasses.

Mechanical strength The two important mechanical qualities of glass are that it is completely brittle material, and that there is a wide variability in the strength exhibited by samples of uniform manufacture.

Glass is weak in tension, is elastic up to its breaking point, and has no ductility. It obeys Hooke's law with considerable accuracy, and cannot be permanently deformed by an applied load. Thus it is unable to give any warning of impending failure by showing a permanent 'set' after application of an excessive load. Another characteristic is that the greatest load which can be carried if it is very quickly applied and removed is approximately twice as much as the static load which can be withstood indefinitely.

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The variability is an inherent characteristic with important consequences which are best allowed for by abandoning the engineer's usual method of determining safe stresses by dividing known breaking strength by a factor of safety. We recommend employment of a method based on statistical principles, which take account of the wide range of breaking strength.

The two important mechanical qualities of glass are that it is completely brittle material, and that by taking a sufficiently large number of samples and submitting these to test the variability can be reliably computed. The variability having been thus determined and the average breaking strength being known, it is possible to calculate the risk of fracture involved in loading to any particular working stress.

Complete safety is assured in all ordinary uses of glass by choosing a working stress corresponding to a risk of failure of 0.8%, so long as that working stress represents the heaviest loading conditions which can ever come upon the glass. In practice, such loading usually results from a combination of causes and these are so seldom realised simultaneously that the risk virtually vanishes. The 'Percentage Risk' method of choosing allowable stress is useful because it enables one to work at whatever risk may be appropriate.

In cases where special safety is desirable, such as applications involving personal safety, it shows how much to reduce the working stress in order to eliminate risk entirely: and in cases where some special result cannot be attained without running a risk it gives a quantitative estimate of that risk. Appropriate design stresses may be obtained from AS1288-1989.

Wired glass Wired glass is often spoken of as 'reinforced', which implies that the wire strengthens the glass.

This cannot be so as the wire mesh is in the middle of the thickness, so it cannot help by occupying a tension zone in the concrete. The wire itself breaks the continuity of substance of the glass and entails some minor residual stresses due to differential thermal contraction during cooling. Its merit lies entirely in the way the wire holds the glass together after fracture, and therein lies its value for fire resistance, roof glazing and shower screens.

Toughened glass TENSILE STRENGTH: The modulus of rupture is 175Mpa for sustained loading.

THERMAL ENDURANCE: 6mm toughened glass heated to a higher temperature when plunged into water at 21°C. will rupture at approximately 250°C. differential.