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### **Glass In Furniture**

The purpose of this paper is to give a broad overview of some of the issues involved in the safe use of glass in furniture. The discussion is limited to the use of the so called soda-lime-silica sheet glass or window glass and no attempt has been made to include the extensive range of other glasses available.

#### **GLASS – THE MATERIAL**

Glass is a non crystalline substance made by melting together various metal oxides, commonly sodium oxide (soda 14% approximate proportion), calcium oxide (lime 9%) and silicon oxide (silica 72%) with minor amounts of other oxides such as aluminium, and magnesium. When cooled from the molten state such mixtures do not solidify in the normal sense but show increasing viscosity with reduction in temperature. While they appear to exhibit many of the properties of rigid solids at lower temperatures, they are in fact supercooled liquids having very high but measurable viscosity, normally regarded as a property of a liquid. Some authorities have suggested that glass should be regarded as a fourth state of matter, in addition to solids liquids and gases, because of their unique range of properties.

Glass is a versatile and attractive material which has been widely used for a

very long time in human history. It has considerable mechanical strength - particularly in compression - and rigidity (about 4 times the rigidity of wood, 1/3 that of steel and approximately equivalent to aluminium). It can be relatively easily shaped by a range of methods, is chemically inert with good thermal resistance and its has a wide range of optical properties which make it unique as a constructional and architectural material. These properties make it an obvious choice for furniture applications for items such as doors and windows, for display cupboards, shelves, mirrors and work surfaces, etc.

The serious downside of glass is that it can be very brittle. The normal mode of failure of glass is by the rapid growth of cracks under tensile stress, leading to shattering which may result in the formation of sharp edged shards which are a significant safety hazard as they can cause serious lacerations, contusion and abrasion injuries.

This hazard can be reduced by making the glass more difficult to break for example by using thicker glass or by increasing the strength of the glass, and attempting to reduce the hazardous nature of the shards which form when the glass breaks either by reducing the size of the shards or by restraining the shards so they do not separate when breakage occurs.

The theoretical tensile strength of glass is very high but it is extremely susceptible to the effects of cracks especially those resulting from surface imperfections which may be naturally present or be induced by handling or other accidental causes. Under tensile stress conditions such defects can lead to failure at stress values very much lower than the theoretical tensile stress value.

Glass is highly transparent and while this is normally regarded as a desirable feature, it can be a hazard because large sheets of clean glass may be effectively "invisible" so that people may collide with them simply because they did not see them. When large sheets are used as in doors etc. it is always advisable to fit obvious features such as opaque handles or other features such as opaque stripes or patterns to make them more visible.

## **TYPES OF GLASS**

### **Annealed glass**

Annealed glass is produced by allowing the glass to cool slowly from its softening temperature. This results in a product which is effectively free from internal stresses and in this condition the glass can be readily cut, ground and polished or even drilled. However it is relatively weak in tension and will break by fracturing into potentially dangerous large shards.

### **Toughened glass**

While the properties of glass cannot be changed significantly by heat treatment, it is possible to change the properties of any particular piece of glass by rapidly cooling the surface after heating to close to the softening temperature. In this way the surface layers of the glass will cool and harden more rapidly than the core material. The contraction of the surface layers is easily accommodated by deformation of the still soft core glass. However, when the core material cools and hardens and contracts it effectively places the already hardened outer layers in compression. Glass treated in this way is referred to as heat strengthened, toughened or toughened glass. As fracture of glass almost invariably occurs from the surface due to tensile stresses which cause cracks to open, a considerably greater force is required on a piece of toughened glass to reverse the stresses in the surface layers from compression to tension, consequently, toughened glass will behave as though it has a higher strength than an equivalent piece of annealed glass, typically up to five times higher. Toughening of glass also considerably improves its resistance to thermal shock.

Another feature of toughened glass is that when it does break the release of the imposed residual stresses results in complete fracture of the glass into many small approximately cube shaped pieces sometimes referred to as "dice". While the dice glass has sharp edges and corners the size of individual pieces is such that the risk of serious laceration injuries is significantly reduced. However, any attempt to cut or grind toughened glass is likely to result in its total fracture, therefore it is necessary that all shaping operations be carried out on the glass in the annealed state prior to toughening.

Corners and edges of sheet glass are obviously more prone to damage due to bumping and chipping during handling etc and such damage to toughened glass may result in the total shattering of the items so it is important that the edges be protected where possible.

Toughened glass is referred to as tempered glass in some countries but the term is not widely used in the Australian glass industry

### **Laminated glass**

Another method of controlling the fracture characteristics of sheet glass is to layer two or more sheets of annealed or toughened glass in plies using an organic interlayer, commonly polyvinyl butyral (pvb). When fracture of such glass occurs the shards are held together by the interlayer and not so likely to cause injury. One downside of such glasses is that the interlayer material is soluble in water and so edges must be protected if water exposure is likely. This is probably not an issue as the edges of laminated glass cannot be machined as neatly as annealed glass.

### **Other glasses**

Various other means are employed to address the problems with annealed glass, such as chemically hardened glass and film coatings.

### **SAFETY OF GLASS IN FURNITURE**

While there are no Australian Standards relating specifically to the use of glass in furniture, the general product safety requirements of the Trade Practices Act 1974, which require that suppliers of furniture - take reasonable steps to ensure that their products are safe, will also apply to items incorporating glass. The responsibility for ensuring that products are safe lies entirely with the supplier, which includes the manufacturer, wholesaler and retailer. Demonstration of safety of products is not a pre-requisite for sale under the act, but

the cost of failure in this regard by way of penalties and suits for damages by injured customers due to the supply of unsafe goods is likely to be far greater than the cost of pre-sales testing and assessment and the setting up of effective systems to ensure the ongoing safety of products.

Standards Australia is currently considering the development of a Standard which will specifically cover this matter but it may be some time before this eventuates. In the interim a reasonable approach by manufacturers to demonstrate reasonable safety of furniture items incorporating glass would be by establishing compliance with the more appropriate of two British Standards:

- BS 7376:1990 Specification for inclusion of glass in the construction of tables or trolleys; (At the time of writing this standard is listed as current but is under review by BSI), and
- BS 7449:1991 Specification for inclusion of glass in the construction of furniture, other than tables or trolleys, including cabinets, shelving systems and wall hung or free standing mirrors.

These two British Standards will in all probability form the basis for the proposed Australian Standard. However, there are some differences in the classification rules for flat glass products between the United Kingdom and Australia and these need to be taken into account when applying these British Standards to flat glass products purchased in Australia.

Both British Standards referred to above have as their primary objective the reduction of the risk of injury which is associated with various applications of glass. They define rules for selection of glass type and minimum thickness for various panel sizes and loads, requirements for edge treatment and for support systems as well as marking requirements, including warnings.

Where glass is used for shelving there is a requirement to indicate the maximum safe load.

### **ACTIONS TO ENSURE COMPLIANCE**

#### **For manufacturers of furniture which incorporates glass:-**

- Become familiar with the requirements of the relevant British Standards covering the use of glass in furniture which relate to the products being manufactured as well as the equivalence of rating systems for glass used in Australia and the United Kingdom.
- Ensure that glass is ordered and supplied to specifications which will meet the requirements for type and thickness which is appropriate for the size of the application as specified in BS 7376 or BS 7449.
- Require as part of purchase contracts that the glass is supplied with appropriate certification or evidence of compliance.
- Take all steps to ensure that the glass is handled appropriately into and out of storage and while in storage.
- Inspect glass components prior to assembly for possible defects which would impair the performance of the glass during service. Refer to AS 1199: 2003 for further information on attribute sampling systems.
- Ensure that the glass is installed in the furniture in a manner which meets the requirement for type and size of panels as defined in the appropriate Standard.
- Carry out any testing of the assembled items required by the relevant Standards, either in house or by an accredited testing laboratory.
- Attach appropriate labels and all necessary warnings to the final products as defined in the appropriate Standards.
- Ensure that the packaging systems used will provide adequate protection of the glass components during shipping and handling.
- Submit all sections of the production operations which involve the use or handling of glass components to regular and independent safety audit.
- Keep records of all design calculations, inspections, test and audit results, and copies of certificates supplied with the incoming glass components.
- Be prepared to supply appropriate certification to distributors of the finished products.

#### **Distributors and importers and retailers:-**

- Become familiar with the requirements of the relevant British Standards covering the use of glass in furniture which relate to the products being handled as well as the equivalence of rating systems for glass used in Australia and the United Kingdom.
- Ensure that sales staff are also familiar with these requirements.
- Require as part of purchase contracts that all furniture which incorporates glass is supplied with appropriate certification or evidence of compliance
- Inspect the products received for defects in the glass which might affect its performance.
- Ensure that all stock is adequately stored to prevent damage to glass components. This may require separate storage of the glass components.
- Closely inspect any glass components of showroom stock before disposal and be prepared to replace any items which appear damaged in any way,



even if the item is being sold as a showroom "special".

- Provide competent advice to all purchasers of furniture which includes glass about the hazards of glass in furniture and requirements for safe use of such furniture.
- Be prepared to supply copies of appropriate certification to distributors of the products.

***Furntech-AFRDI would like to acknowledge the input of Noel Stokes (Manager-National Accounts and Government Relations) Pilkington Australia in the preparation of this article.***



## **Furntech-AFRDI Now Testing to 5459.2 2000**

There has been a demand for chairs to have specified SWL's (Safe Working Loads) and especially so for heavy people. SWL's are not defined in AS/NZS 4438.

ISO (the International Standards Organisation) have prepared a new swivel chair draft standard, ISO/WD 21015. At some time this will be considered for adoption in part, or in full in Australia and the current Australian Standard AS/NZS 4438 will no doubt come under review by the Standards Australia committee working on commercial furniture standards (CS-088). The ISO draft is more specific than AS/NZS 4438 in relating the weights of chair users to the testing used to prove the strength and durability of a chair. It is also flexible – suggesting loads and numbers of cycles for any combination of user weight and durability that a chair manufacturer may wish to test to. It also offers similar flexibility to purchasers in writing specifications which define their requirements for chairs.

In the meantime, AFRDI has tested chairs to BS 5459.2:2000 at the request of clients and has decided to advertise that we are now including this on our testing regime. This facility is available for any client. BS 5459.2.2000 is a chair

standard specifically tailored for people up to 150 kg, for use 24 hours per day, seven days a week.

Due to the broader range of tests and greater cycles and loads required by BS 5459.2, testing will put considerably more stress on a chair and its components and will take longer than AS/NZS 4438.

BS 5459.2 does not specify any ergonomic requirements, nor does it rely on pre-qualification of components although it defines tests for what is referred to as *type approval* of components. One advantage of type approval is that if a chair is assembled with a full suite of type approved components some testing concessions are granted (for the assembled chair). However, testing requirements for type approval are very stringent and extensive, involving multiple identical samples – 12 for seat mechanisms, bases and back stems and 20 for gas struts – and will consequently be expensive and rarely, if ever, undertaken. Until there is a more practical component prequalification/type approval standard (along the lines of AFRDI 109) we do not see the possibility of the flexible interchange of components as currently exists under AS/NZS 4438. As a consequence at this

stage only chairs incorporating the same components as fitted to the actual chair when tested will be covered by our certification. Furntech-AFRDI is considering developing its own pre-qualification standard as a substitute for that incorporated in BS 5459.2 but this exercise will hinge on there being sufficient demand and funds to undertake the research effort necessary to underpin the standard.

(100,000 cycles), durability of seat height adjustment mechanism (10,000 cycles), footrest fatigue - if fitted - (200,000 cycles), static tests of control levers and knobs, and locking device fatigue (500,000 cycles).

A comparison of the relative severity of testing between AS/NZS 4438 and BS 5459.2:2000 is given in the following table. It should be emphasised that

	AS/NZS 4438:1997				BS 5459.2:2000
	Level 3	Level 4	Level 5	Level 6	Level N/A
<b>Durability Ratio<sup>1</sup></b>	<b>1</b>	<b>2</b>	<b>4</b>	<b>4</b>	<b>&gt; 4<sup>2</sup></b>
<b>Safe Working Load<sup>3</sup></b>	<b>95 kg</b>	<b>95 kg</b>	<b>95 kg</b>	<b>120 kg</b>	<b>150 kg</b>

If any client has an interest in having chairs tested to BS 5459.2 you are invited to discuss your specific needs with us. As the risk of failure is increased (due to the higher stresses and cycles) Furntech-AFRDI is prepared to offer the option of **staged testing payments** under our policy of Payment In Advance for all testing. We also recognise that this work may involve product development and clients can be assured that all your discussions and test results will be treated confidentially.

the table is presented to give *guidance only* and is not a definitive statement on the matter of safe working loads or relativities between standards.



Copies of BS5459.2:2000 can be purchased from Standards Australia.

Significant features of the testing defined for chairs include stability, seat and back impact, drop test, a fore and aft loading safety test (in which significant offset seat loads are applied for and aft of the axis of rotation of the chair and for which any failure in the first 120,000 cycles is final, but in the following 380,000 cycles breakage may be accepted if it does not create a safety threat to the chair user. It also involves an alternating side to side seat loading safety test of 250,000 cycles, arm loading and impact test, durability testing of swivel action

<sup>1</sup> Expressed as multiples of level 3 i.e. level 4 is 2x as durable as level 3, level 5 4x etc.

<sup>2</sup> BS 5459.2:2000 uses different methodology making precise comparison difficult. It is, however, clear that conformance to it demonstrates a higher level of durability than AS/NZS 4438 level 6.

<sup>3</sup> The Safe Working Loads shown for AS/NZS 4438 are indicative values only based on the loads and number of cycles used in fatigue tests defined in this Standard and should not be read as absolute values. The Standard itself makes no statement associating test levels with Safe Working Loads.

## **New Furntech-AFRDI Members**

We would like to welcome the following new members :-

Emanate Design Pty Ltd  
Hartman Pacific Pty Ltd  
Harvey Norman  
Ke-Zu Pty Ltd  
Redfurn Commercial Furniture

In addition we would like to thank those members who have recently renewed their membership.

**The Annual General Meeting of the Australasian Furnishing Research & Development Institute/Furntech will be held in Sydney on:**

**Date:** Thursday 14 October 2004  
**Time:** 3 pm  
**Where:** Sebel Furniture Limited  
96 Canterbury Road, Bankstown, NSW

## **Standards Update**

The following new or revised or draft standards have recently been issued:

AS 2001.4.A04-2004	Methods of test for Textiles
AS 2001.4.A05-2004	Methods of test for Textiles
AS 2001.2.20-2004	Methods of test for Textiles
AS 4608-2004	Dispute Management Systems
COER 001-2004	Best Practice Report – Issue No 1
HB 251-2004	Customer Focused Culture
	Customer Satisfaction Measurement
DR 04344	Prams and Strollers – Safety Requirements
DR 04393CP	Amendment to AS/NZ 2272.1996
	Plywood – Marine
DR 04394/5	Structural Laminated Veneer Lumber
DR 04396/7	Textiles for Health Care Facilities and Institutions

Copies of these standards may be purchased through the Institute.

## PDF Certificates on the Web

Furntech has adopted a practice of placing PDF format copies of our Blue and Orange Tick Certificates of Compliance for all certified products on our Web site ([www.furntech.org.au](http://www.furntech.org.au)). These may be viewed and downloaded by any interested party, but the original form of the certificates cannot be modified. We feel that this is a secure and convenient way to make the certificates available to anyone who might require copies at any time. This will only occur as new certificates are issued or existing certificates are renewed. We do not intend any catch up of older existing certificates.

If, for any reason owners of products for which Blue or Orange Tick Certificates will be issued, do not wish their certificates to be available from our website in this way, should mark the box on our Request for Test form indicating non PDF listing of Certificates when submitting products for testing or assessment.

### What is Furntech-AFRDI Blue Tick?

Blue Tick is an undertaking where manufacturers or suppliers of furniture or components submit their products for testing and quality certification to recognised Standards. Companies whose products meet these requirements are listed on the Furntech-AFRDI website ([www.furntech.org.au](http://www.furntech.org.au)) which is used by many specifiers, manufacturers, buyers and sellers of furniture. Further details on Blue Tick may be found on our website or by contacting the Institute.



Blue Tick  
Product  
Certification



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Standards, Testing and Product Certification for Commercial, Domestic and Nursery Furniture in Australia and New Zealand