22/07/15

Submission to Senate Inquiry into non-conforming Building Products

Title: "Sub-Standard Glass in Windows".

The Senate inquiry into non-conforming building products has come to our attention and as individuals involved in various segments of the Australian Glass Industry we thought it important to make a submission concerning the Australian Standard on "Selection and Installation of Glass in Buildings" (AS 1288 – 2006) and on the process that was involved in its preparation and publication.

1. The end result is a standard which allows thinner glass to be installed in Australia than permitted by glass standards in other countries for the same design conditions and window sizes. For example, prior to the 2006 revision of AS 1288 the 'limiting' design stress for 4 mm thick glass was 25.05 MPa, whereas in the current Standard the ULS design stress is 38.99 MPa. In other parts of the World, for instance in Europe the ULS design stress is 25 MPa which is consistent with the 1994 version of AS 1288 for ≤ 6 mm glass. This means that in Australia 4 mm thick glass, whether made in Australia or imported, is currently deemed to be around 56% stronger that in the rest of the World.

2. In regard to the Terms of Reference of the Senate inquiry into non-confirming building products referred to the Senate Economics References Committee on 23 June 2015 our submission specifically relates to the following Items:

   - b.iv the overall quality of Australian buildings and
   - d. any other related matters.

3. It concerns the failure (and active complicity) of Standards Australia in allowing the Australian Standard on the installation of glass in buildings published by them, to be technically incorrect and consequently not ensure the provision of a safe environment for the Australian community.

4. Having regard to the above, it appears that Standards Australia has failed to perform as an effective independent body with a charter to develop technically correct and safe standards for use in Australia. Instead, an unsafe and incorrect standard for the selection and installation of glass in buildings was published in 2006. The facts indicate that Standards Australia has allowed itself to be manipulated by the Australian Building Code Board and commercial interests, being those of influential members of the glass and glazing industry.

Background

6. This submission details how the finalisation and adoption of the 2006 version of AS1288 was manipulated by various parties with the apparent support and connivance of Officers of Standards Australia. This submission illustrates some of the technical errors that are incorporated in the current version of the standard. Standards Australia, failed to prevent an unsafe and technically incorrect standard from being published, and indeed actively facilitated irregular processes which led to this outcome.

7. As is normal practice, any revision to a Standard must be sent out for public comment. On receipt of all the public comments the committee discusses these comments and then revises the draft in accordance with suggestions accepted by the Committee prior to a ballot by all the committee members before the document is sent to the editorial department for finalisation and publication.

8. The public review of the draft revision of AS 1288 in 2003 did not raise any comments in relation to the adequacy of the new design charts proposed at that time specifically in relation to glass strength. Consequently, the design protocol that was in the public draft document ought to have been incorporated and issued in the new version of the standard. This did not happen. The 2006 version of the standard prescribes much higher ULS design stresses that:

    - are technically incorrect and unsubstantiated
    - can and will lead to unsafe glass being installed in buildings
    - are the result of pressure from external influences to compromise the design and selection of glass for commercial reasons

9 The explanation provided by the Chairman for the adoption of higher design stresses and variable glass strength as a function of thickness is based on the adoption of work on glass strength presented by Mr Masashi Kikuta et al at the Glass Processing Days 2003 Conference. The Chairman did not recognise that the research undertaken and presented by Kikuta et al was the result of:

a. testing small ring on ring samples
b. using a three parameter Weibull distribution (probability plot)

Because of the inherent brittle nature of glass which results in a wide distribution of breakage stresses from sample to sample, the three parameter Weibull distribution is not appropriate for glass design. The three parameter Weibull distribution assumes that at some stress level glass will not fracture. This is not practical for glass design. However, the two parameter Weibull distribution (generally used in the glass

industry) better accommodates the brittle nature of glass and the variability in its strength. See graph 1 & 2 below.

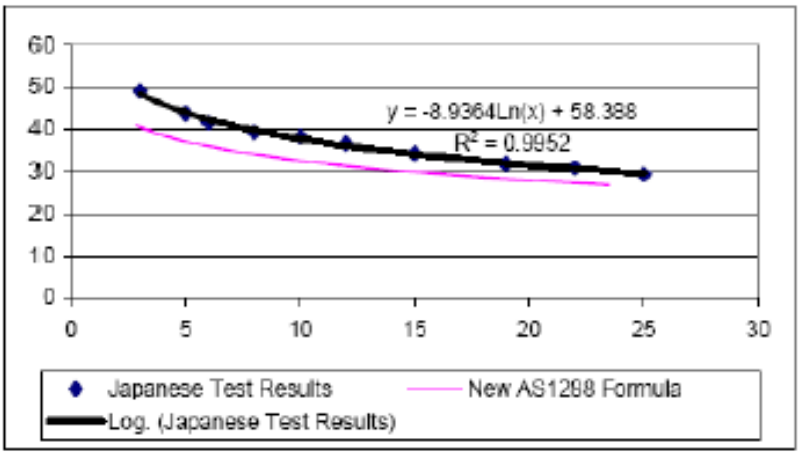

Figure 1. Kikuta stress values (3 parameter Weibull) and AS 1288 – 2006 ULS design stress

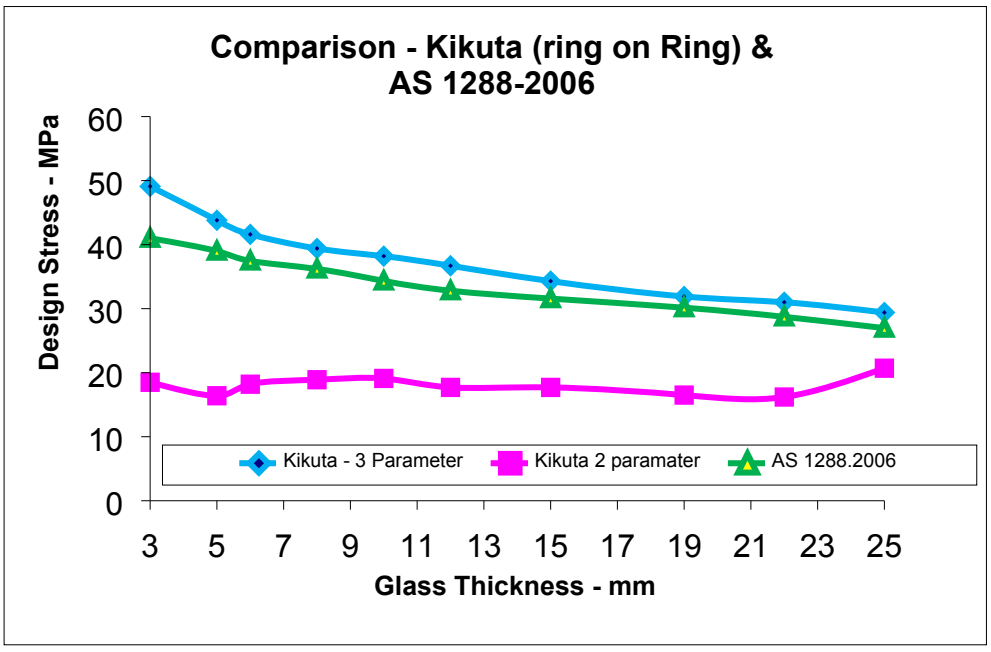

Figure 2. Comparison – 2 & 3 Parameter Weibull – Kikuta ring on ring testing and AS 1288 – 2006.

The two parameter Weibull distribution does not show any variability in breakage strength versus glass thickness.

In addition, testing undertaken in Australia using 3 mm and 6 mm thick glass samples showed virtually no difference in the breakage stress not reflecting the design values in table B 1. See figure 3 below.

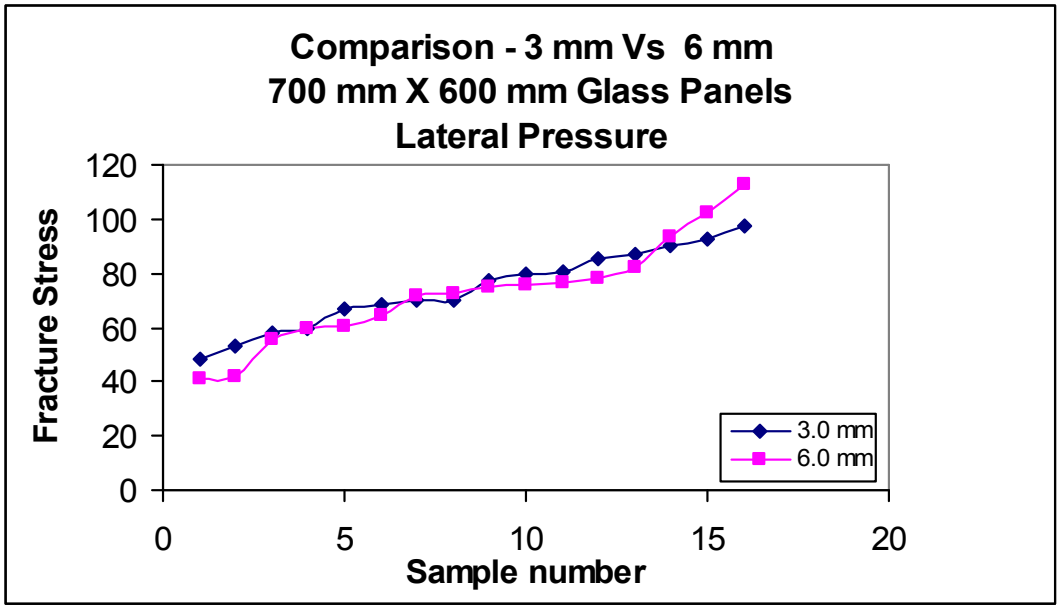

Figure 3. Comparison between 3 and 6 mm glass to breakage

(Note: Both sets of samples show a considerable variability in strength from sample to sample but no difference in the overall spread of results).

10. Two technically qualified Australian committee members, Dr Leon Jacob, past BD 7 Committee Chairman and Dr Nathan Munz representing the Australian Industry Group voted negatively on the pre-publication 2006 draft. Also two New Zealand committee members reportedly voted negatively to the prepublication of the draft Standard in 2005.

11. The two negative votes from Australia were never resolved in accordance with the protocols for the preparation and publication of any Australian Standard. It was stated that Standards Australia had made an executive decision to publish. Furthermore, the changes to the public review draft were profoundly significant and according to Australian Standards rules should have been circulated for another public review prior to publication.

12. In regard to the publication of the supplement to the Standard, Dr. Munz was subject to strident criticism by the AGGA President and State President of the Australian Industry Group (AIG) which is the body represented by Dr Munz. We understand from Dr Munz that he was verbally threatened with being denominated by AIG, and Standards Australia improperly accepted a positive vote from an AIG employee, rather than the 'valid" negative vote from its technical expert duly appointed to Committee BD7 of Standards Australia.

Post AS1288 2006 publication activities

13. After the publication of the standard in January 2006, Dr. Leon Jacob, one of the negative votes again re-iterated serious concerns as to the adequacy and correctness of the published standard especially in regards to glass strength. (This was necessary because no discussions as to resolving the negative votes were undertaken by Standards Australia). The committee then agreed for Dr. Jacob to make a presentation to the committee in relation to his concerns on the inadequacy of the Standard. This was undertaken at the next committee meeting held in Melbourne in July 2006. After the presentation the members of the committee in attendance requested a technical paper be prepared for review by the committee. This was done and sent to the committee secretary. This document was not immediately distributed to the committee. Subsequently Dr. Jacob issued the document on his own.

14. The document was only officially distributed some 9 months later after the BD 7 Chairman had prepared a response to the document. None of the technical issues raised in the Jacob document was adequately addressed, responded to or negated by the purported "response".

15. The chairman maintained the position that 'he was satisfied with the published Standard'.

16. A sub-committee was then formed, under the chairmanship of Dr. Nathan Munz, to further consider the unresolved issues of glass strength. Two meetings later, the position from the Chairman changed from

    - "the Standard being technically correct" to
    - the glass strength charts having been 'calibrated' to the previous Standard (1996), which is now claimed to be, adequate and safe (see comments below from Dr Calderone regarding his earlier views).

17. This is a contradiction to the above criteria (point 15.0) in a statement made by the Chairman in an email sent to Mr. Alan Hickey (from G James) on the 24th June 2004, where he stated:

    "You seem to have completely missed the point that the design charts in the current standard are not technically correct. Therefore in some cases they allow thicknesses to be used with dangerously high stresses at the design pressures. Therefore, there is a need for new design charts, which will undoubtedly reduce the glass breakage that is currently occurring during wind storms. Your comparisons simply serve to demonstrate how un-conservative the current AS 1288 charts are."

18. In December 2006, Dr Nathan Munz and Dr Leon Jacob made a written submission to the CEO of Standards Australia requesting an investigation as to the conduct of Standards Australia in allowing or being a party to the subversion of the Standards development process which led to the publication of an incorrect and dangerous Standard. The only response received was an abusive phone call from a Standards Australia senior executive, ([redacted]) to Dr. Nathan Munz that an appropriate response would be forthcoming. No response was ever received.

19. The points made in all the correspondence and reports are still unresolved and Standards Australia has made no attempt to do so.

Critical non-conformance of the design methodology to fundamental engineering principles

20. There are two fundamental issues with the design protocol prescribed in the AS 1288 – 2006 Standard.

    1. The ULS design stress levels prescribed in the Standard, which vary in value dependent on glass thickness (as discussed above), with thin glass giving the highest design stresses and
    2. The methodology (see item B 1.4 below) applied in the design charts (graphs) and tables for glass selection in the Standard which was based on an incorrect assumption for the glass support condition in framed windows. See discussion below:

21. Appendix B in AS 1288 – 2006 provides the technical basis for the development of the design graphs provided in AS 1288 – 2006.

22. Item B 1.4 Edge supports states:

    "Edge supports used in the analysis provided out-of-plane restrain ony. No in-plane membrane action was directly resisted by the edge supports. Although the edges might be supported at their sight line by the frames, the analysis was based on the restraint being at the edge of the glass. Thus, the stresses that can occur at the glass edge under these restraint conditions were taken into account in the development of the design charts".
    (underline – our emphasis)

23. This methodology is not consistent with how window glass is supported in buildings. In our opinion it is currently impossible for a glass panel to be fixed in a window frame using this edge support condition. It theoretically permits the lower 'at edge' stress (see table B1) to be used. The design charts (graphs and tables) in the

Standard for 4 edge supported windows (framed) are based on the glass strength 'at edge' which are assumed to be restrained at the edge and not along the site line (neglecting the support of the frame along the surface of the captured glass edges).

24. Finite element analysis has demonstrated that in the case of fully framed windows the stress on the glass does not go to the edge. So it is logical that a qualified engineer using finite element analysis to determine glass thickness would use the (higher) 'away from edge' stresses prescribed in Table B 1 of As 1288 – 2006 to determine the required glass thickness rather than using the AS 1288 – 2006 design charts. The unwitting consequences of such logical and commercial use of the 'away from edge' stresses provided in Table B 1 of As 1288 – 2006 are:

    - reduction of glass thicknesses required compared to the glass thicknesses determined from the use of AS 1288 – 2006 design charts, and
    - increased risk of glass breakage resulting in possible injury to building occupants or passers-by.

    For example see table below. This table illustrates the glass thickness permitted by AS 1288 – 2006 and the glass thickness based on the correct design protocol (without manipulation using at edge stress etc.) of 25 MPa as applicable in Europe and the previous Australian Standards. In every case the required glass thickness is thicker than that currently prescribed by AS 1288 – 2006. (The glass panel sizes are typical for windows in homes – these sizes were provided by the Australian Window Association).

Design Data – ULS Pressures		Typical Window Panel Size	AS 1288-2006. Permitted Glass Thickness	ULS Design Stress (25 MPa) Permitted Glass Thickness
AS:4055	Pressure Pa.	mm x mm	mm	mm
N1	700	1800 x 1500	3	4
N2	1000	1800 x 1500	4	5
N2	1000	1800 x 1300	3	4
N3	1500	1800 x 1300	4	5
N3	1500	1800 x 1500	4	5
N4	2300	1400 x 1500	5	6
N5	3300	1800 x 1500	8	10
N5	3300	1400 x 1500	6	8
N6	4500	1400 x 1300	6	10
N6	4500	1800 x 1500	8	10
N6	4500	1700 x 1500	8	12

Table 1. Comparison of permitted glass thickness based on AS 1288-2006 with that permitted by ULS design stress of 25MPa. (LJ private comm. March 2003).

Recommendation

25. It is recommended that AS 1288 2006 be immediately withdrawn and replaced with the original design charts that went through the public review stage in 2005.

27. This submission contains statements which are in the authors' opinions based on proper material made available to us or which we are aware of.

Signed by:

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Glass Processor

Date: 31st July 2015.