Building and Construction Authority

We shape a **safe**, **high quality**, **sustainable** and **friendly** built environment.

Your Ref. :
Our Ref. : BCA BC 056/41

7 March 2008

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See Distribution

Dear Sir/Madam

PUBLIC CONSULTATION ON PROPOSED REGULATORY MEASURE TO ADDRESS SAFETY CONCERNS OVER USE OF GLASS ON BUILDING FAÇADES

In a modern, densely-built environment like Singapore, glass is used extensively both in the interior and on the exterior of buildings. Tempered glass, because of its high strength property, is often used in parapet walls in the interior, and in claddings and skylight on the exterior of large commercial buildings. In the newer residential buildings, the designs often include full height tempered glass curtain walls to provide panoramic view to homeowners from inside their homes.

2 Since 2006, BCA received reports on about 40 incidents of shattered glass, of which 7 incidents were reported in the past 9 months. Investigations showed that all these incidents involved the use of tempered glass in full-height windows or balcony balustrade. In addition, there were many media reports of incidents of spontaneous shattering of tempered glass used in the interior of buildings.

3 Although the fragments of tempered glass are round-edged, a clump of such fragments could still cause death, if not injury, when falling from height from the glass façade. In addition, the consequence could be dire should a piece of tempered glass panel used in parapet wall or curtain wall spontaneously shatter when a person is leaning on it.

4 In view of the potential dangers posed by glass, BCA is considering introducing some form of performance-based requirements to regulate the use of glass on building façades. BCA would like to seek your comments on one of the two regulatory options proposed in the paper enclosed. Comments/views from individuals are also welcome.

5 We would appreciate it if your comments/views could reach us before **12 April 2008**. You may send your feedback to us in email or snail mail at the following contact:

Email: teo_orh_hai@bca.gov.sg

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Yours faithfully

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Date: 7 March 2008
From: Exterior Features Department, Building and Construction Authority
Purpose: For comments

PROPOSED REGULATORY MEASURE TO ADDRESS SAFETY CONCERNS OVER USE OF GLASS ON BUILDING FAÇADES

Aim

The paper discusses the safety concerns over use of glass on building façades and seeks comments on the proposed regulatory measure to address the concerns.

Background

2 In a modern densely-built environment like Singapore, glass is used extensively both in the interior and on the exterior of buildings.

3 Tempered glass, because of its high strength property, is often used in parapet walls in the interior, and in claddings and skylight on the exterior of large commercial buildings. In the newer residential buildings, the designs often include full height tempered glass curtain walls to provide panoramic view to homeowners from inside their homes.

4 While the tempered glass is able to satisfy the load requirements for the various usages, it could still pose risks to public safety as it could spontaneously shatter. Although the fragments of tempered glass are round-edged, a clump of such fragments could still cause injury, if not death, when falling from a great height. In addition, the consequence could be dire should a piece of tempered glass panel used in parapet wall or curtain wall spontaneously shatter when a person is leaning on it.

Past Incidents of Tempered Glass Spontaneous Shattering

5 Since 2006, BCA has received reports on about 40 incidents of shattered glass, of which 7 incidents were reported in the past 9 months. Investigations showed that all these incidents involved the use of tempered glass in full-height windows or balcony balustrade.

6 In addition, there were many media reports of incidents of spontaneous shattering of tempered glass used in the interior of buildings. The most recent incidents reported in the media occurred at Central Mall on 24 December 2007 and OG Chinatown 18 September 2007.

Current Situation in Singapore

7 To-date, there is no regulation in Singapore that specifies the type of glass to be used for a particular purpose. Where tempered glass is used in place of a concrete

wall/metal railing, all that the professionals need to satisfy is the load requirements for the various usages.

8 In several major public sector projects, the Government, as the project owners, took the initiative to specify the use of laminated glass for safety. These include full height windows in HDB flats, glass panels used in MRT stations and the airport.

9 In addition, the newly launched SS 212 recommends that laminated glass be used in the fixed panels of full height windows.

10 However, as it is today, the use of laminated glass currently depends entirely on the building owners' prerogative in taking upon themselves the duty in ensuring public safety.

Regulations/Practices on Use of Glass in Buildings in Other Countries/Regions

The United States (US)

11 In Florida and New York City, the regulations require glass panels installed at a slope less than 15º from the vertical plane on the exterior of buildings to be designed to resist wind loads. Glass in glazed curtain walls, glazed storefronts and glazed partitions shall meet the seismic requirement of ASCE (American Society of Civil Engineers) 7, Section 9.6.2.10.

12 For glass panel installed at a slope more than 15º from the vertical plane, the regulations allow the use of laminated glass, fully tempered glass or heat strengthened glass.

13 However, in single glazing systems, if heat strengthened glass or fully tempered glass is used, screening must be provided below these glass panels unless the height of the glazing is less than 3m from the walking surface below or the walking surface is permanently protected from the risk of falling glass.

The United Kingdom (UK)

14 The UK Approved Document N states that glazing in critical locations should break safely if it breaks, be robust or in small panes or be permanently protected.

15 The critical locations refer mainly to places where the glass panels are used as a barrier to prevent falling off and where horizontal impact is possible.

Australia

16 The Australian Standard, AS 1288, requires overhead glazing to be laminated glass. Those overhead glazing which are less than 3m above the finished floor may be tempered glass.

17 In addition, AS 1288 clearly provides detailed guidelines on the types of glass, the minimum thickness and maximum span of glass, the design of supporting frames, etc, for the various usage of glass in buildings.

China (including Hong Kong SAR)

18 In 2003, China developed the Code on Application of Architectural Glass (CAAG). For glass used in parapet walls/balcony balustrades, tempered glass or laminated tempered glass of not less than 12mm thick is required.

19 Safety glass (i.e. tempered glass or laminated glass) must be used for skylight or glass roof. If the glass is installed at a height exceeding 5m, only laminated glass may be used.

20 In Hong Kong SAR, although the use of laminated glass is not mandated, it is recommended in the Practice Notes issued by the Building Department to minimise the use of tempered glass given the possibility of spontaneous breakage. Glass of suitable type, thickness and size should be selected to provide an appropriate degree of safety, taking into account the intended use and the possibility of catastrophic consequences in the event of breakage.

India

21 In India, a similar code is also available to regulate use of glass in buildings. For instance, laminated glass is required for curtain walls and balconies, where there is no safety barricade, or there is risk of falling through height of more than 1.5m.

Thailand

22 For Thailand, the external wall glass for high rise buildings (23m and above), big buildings (floor area of more than 2,000m^2, or the building height of more than 15m and the floor area of more than 1,000m^2 but no larger than 2,000m^2) and extra big buildings (floor area of more than 10,000m^2) must be laminated glass.

Comments and Recommendations

Comments on Requirements in the US and the UK

23 The requirements of the US and the UK on the use of glass in buildings are performance-based. Although they have not specifically mandated the use of laminated glass, it appears that only laminated glass can satisfy the performance-based requirements in certain circumstances.

24 In the US, for overhead glazing, if laminated glass is not used, one would have to provide additional protection such as screening below the glazing for the users below. However, the provision of screening may not be aesthetically pleasing. Thus, laminated glass would be the only solution here.

25 In the UK, glazing in critical locations should break safely if it breaks, be robust or in small panes or be permanently protected. The type of glass that can meet this requirement in all circumstances is laminated glass. Whether tempered glass also meets this standard is arguable. Although the fragments of tempered glass are bead-like, they may still be considered unsafe if the fragments can fall from height.

Recommendations

26 Given Singapore's densely built environment and more buildings being built with glass façades, it is prudent to have some form of regulations on the use of glass on building façades. Keeping status quo would not be a tenable option as public safety will continue to be subject to the building owners' prerogative in taking up their social responsibility.

27 In view of the potential public hazards posed by glass, BCA is exploring the feasibility to implement one of the following two options:

a) Option A

Introducing prescriptive regulations to require all new glass facades above the first storey be glazed with laminated glass.

b) Option B

Introducing performance-based regulations on use of glass focussing on critical locations, such as skylight, curtain walls and balcony, where the glass could be subject to impact/load under normal operation.

The regulations aim to protect passers-by from falling fragments, and occupiers from falling through height resulting from shattered or broken glass balustrade. As an acceptable solution, laminated glass is preferred at these critical locations.

Annex A

PAST INCIDENTS OF SPONTANEOUS SHATTERING OF TEMPERED GLASS ON INTERIOR OF BUILDINGS

Spontaneous Shattering of Shower Screens in HDB Flats

In 2002, The New Paper quoted the then SPS Khoo Tsai Kee that 58 cases of breakage had been reported since May 2000. SPS also mentioned that for new HDB contracts, laminated safety glass would be used for the shower screens.

In a recent check with HDB, it has stopped providing shower screen since 2004. HDB also avoids glass shelters and canopies in its projects.

Shattered Glass Door at McDonald's Restaurant

In 2004, the Straits Times reported on a lawsuit against McDonald's for the injury sustained by a 7-year old boy when a glass door at one of the McDonald's restaurants shattered spontaneously. The boy had to undergo several operations to remove the fragments embedded in the various parts of his body.

Shattered Glass Panel in Parapet Wall at Isetan Scotts

In 2005, a member of public wrote to ST Forum on a spontaneous shattering incident at Isetan Scotts. The member of public saw a glass panel along the parapet wall on the 2nd level shattered into pieces. She raised a concern over such unpredictable incident, especially that glass panels are fitted both inside and outside of many shopping centres and the human traffic is high at these places.

Shattered Glass Panel in Parapet Wall at Plaza Singapura

In 2006, an incident of a spontaneously shattered glass panel along a parapet wall in Plaza Singapura was reported in the various newspapers. A member of public suffered

multiple cuts on his head, back and hands as the fragments fell onto him from a higher level.