



McGinnis Chen Associates Inc
ARCHITECTS | ENGINEERS

31 January 2012

Transmitted via E-Mail (Joan.Armstrong@dgs.ca.gov)

Joan M. Armstrong, Office Building Manager III
Department of General Services
450 N Street - Board of Equalization Building
Sacramento, CA 95814

Re: BOE Building 450 N Street (MCA Project No.: 12008.00)
Subj: January 11, 2012 Glass Breakage Report

Dear Ms. Armstrong:

This letter and attached reports from Mr. Tom Schwartz of Simpson Gumperz and Heger (SGH) contain investigation comments and findings for the January 11, 2012 spontaneous glass breakage at the Board of Equalization (BOE) Building (Project) located at 450 N Street in Sacramento. Some of the information from the January 13, 2012 Preliminary Investigation Report is included in this report.

The spandrel glass at the east elevation, 9th floor level, 5th lite from the south end of the corner (Figure 1) was reported to have broken and fallen to the ground at approximately 10:30 am (PST) on January 11, 2012. Climate conditions as reported at a private weather station at 24th and K at 10:35 am (PST) were 50°F, Dew Point of 32°F, 50% RH, skies clear and wind calm. The low temperature overnight was 32°F.

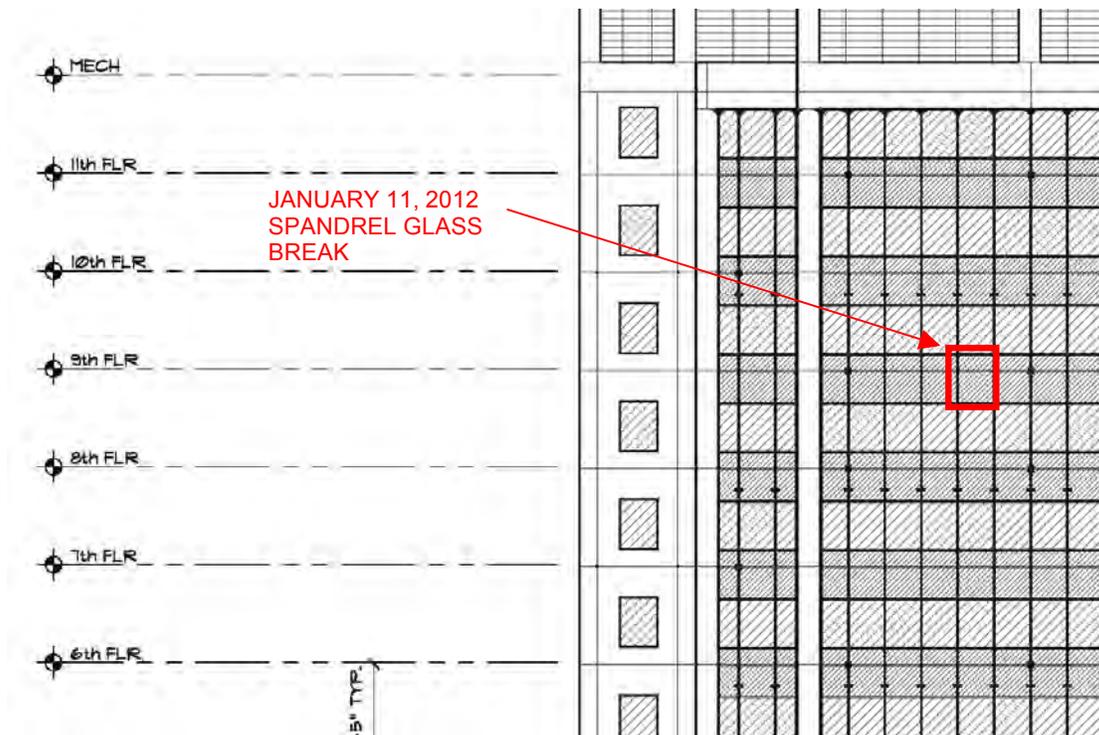


Figure 1 – Partial East Elevation



Ms. Joan Armstrong
450 N Street – Final Report
31 January 2012
Page 2 of 6

MCA arrived at the site at 3:00 pm and was on site until 5:30 pm to perform a preliminary investigation for the cause of the broken spandrel glass. The opening was covered shortly after the preliminary review with plywood to close the opening and secure the remaining glass pieces from falling.

Significant portions of the glass below the floor level originally fell to the ground (Photo 1).

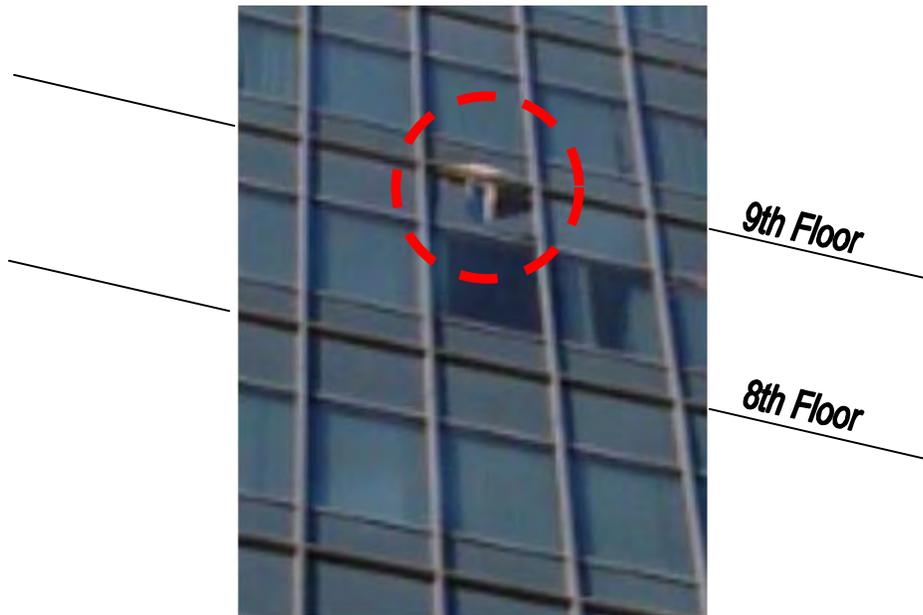


Photo 1 – View of broken spandrel glass shortly after it occurred.

Upon MCA's arrival more glass below the floor line had fallen (Photos 2 and 3) and portions above the floor line had also fallen (Photos 4 and 5).

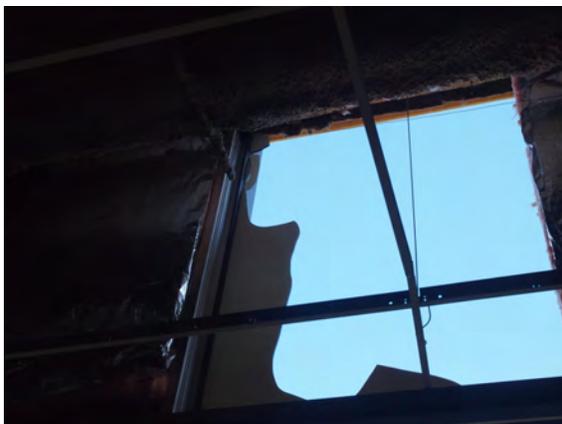


Photo 2 – View from interior of additional glass that had fallen below the floor level.



Photo 3 – View from exterior of additional glass that had fallen below the floor level.



Photo 4 – View from exterior of additional glass that had fallen from above the floor line. Long arching cracks are observed in the glass.



Photo 5 – View from exterior of additional glass that had fallen from above the floor line.

Historical Summary of Glass Breaking at 450 N Street:

In September of 1999 a spandrel glass broke at this elevation. It occurred at the floor below this occurrence (curtain wall frame expansion joints are located at this level). The south elevation has had five (5) previous spandrel glass panels break; all were located at curtain wall frame expansion joint locations. The west elevation had a spandrel glass break in August of 2001; it was not located at an expansion joint location. Only one of the previous six (6) reported breaks has occurred in January (January 2005 - South elevation at 8th floor level (above the 7th floor vision glass)).

Visual Observations - January 11, 2012:

- The location of the broken spandrel glass at this floor level does not coincide with the curtain wall framing expansion joints.
- The glass is wet sealed at the exterior perimeter. A review of the glass perimeter indicates the glass has not shifted or moved since its re-installation during the exterior remediation project. The sealant is in good condition.
- The framing is not deformed or distorted. No indications that the glass became disengaged from the framing were observed.
- 20% of the glass edge along the north side below floor level was carefully checked for contact with the framing. No contact with framing was observed.
- The insulation assembly at the back side of the spandrel glass was reviewed for wear marks (frit (ceramic coating at the back side of the glass) residue from the spandrel glass) indicating vibration contact with the glass. No indications of frit residue were observed.
- No staining was observed on the exterior glass surfaces indicating long-term glass breakage.
- Both long cracks with large glass pieces and localized concentrated small breakage patterns were observed in the glass (Photos 4, 6 and 7). The localized concentrated small breakage is in the areas of more constrained edges (corner and at the horizontal bar at the floor line).



Ms. Joan Armstrong
450 N Street – Final Report
31 January 2012
Page 4 of 6



Photo 6 – View of upper right corner of the broken glass with concentrated small breaks.



Photo 7 – View of the right side of the broken glass at the floor line with concentrated small breaks that terminate to a focal point (Photo 9).

- The adjacent spandrel glass to the south of the broken lite was checked for cracks and to insure that it was secure. No cracks, or distortion in the glass was observed and the lite was secure.

MCA was provided with a small piece of the spandrel glass for further testing. One corner of the specimen contains a circular pattern (Photo 8). The original location of this sample prior to the break is unknown.

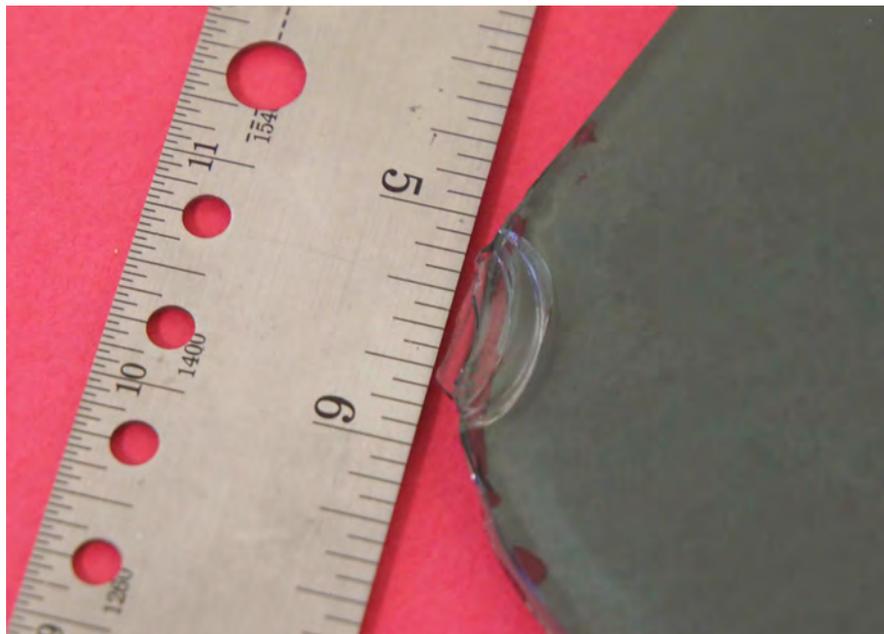


Photo 8 – View of circular pattern at the corner of a piece of the spandrel glass.



Ms. Joan Armstrong
450 N Street – Final Report
31 January 2012
Page 5 of 6

On January 13, the sample piece provided was taken to MCA's San Francisco office to perform a strength analysis and further review of the sample piece circular pattern at the corner (Photo 8). The compressive strength was determined to be 7,500 psi using a GASP device. This result conforms to the glass type and is consistent with previous tests performed (reference attached 27 March letter.pdf).

Photos and the preliminary report were forwarded to Mr. Tom Schwartz (SGH) for further discussion and course of action to determine the cause/source of the break. The circular pattern at the corner of the glass sample was further reviewed and determined to be most likely a result of impact damage from falling. The focal point of the glass breakage pattern in Photos 7 and 9 was of interest and would be further reviewed along with edge conditions of the remaining glass during replacement of the broken glass on January 16th.

On January 16, Architectural Glass and Aluminum (AGA) removed the remaining glass pieces and installed a replacement spandrel glass (glass was taken from replacement spares kept in the building's mechanical penthouse). MCA was on site during the removal phase to investigate edge conditions not previously checked due to the glass remaining in place. The glass edges were verified not to be in contact with any metal framing pieces. The setting blocks were observed to be properly positioned. The back side of the brass bar was reviewed and no wear or burnish marks were observed indicating that something had been wedged between the brass bar and window. The glass break pattern that terminated to a focal point was photographed in place (Photo 9) and removed for further review and testing.



Photo 9 – January 16 view of focal point of glass break with the horizontal brass bar removed.

The glass closest to the focal point was forwarded to Mr. Schwartz for analysis and subsequent final report (attached 001TASchwartz-L-060230.00meh.pdf).



Ms. Joan Armstrong
450 N Street – Final Report
31 January 2012
Page 6 of 6

Findings:

As stated in Mr. Schwartz's report, a definitive cause of the failure cannot be determined, but that with the information known a nickel-sulfide (NiS) fracture is the most likely cause.

Discussion:

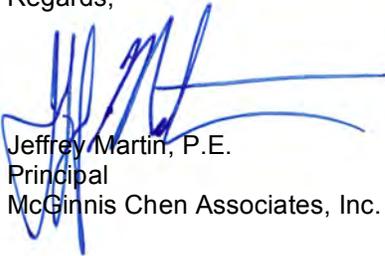
There are no existing feasible procedures for determining this condition for glass that is already installed on buildings. The statistical proportion of NiS failures is slightly less than 2% of the total number of the heat strengthened windows (the spandrel glass) and the failure rate significantly falls off after 12 years but failures can occur up to 20 years after manufacture (attached AIS -13 A, Review of Nickel Sulphide Induced Fracture in Tempered Glass).

Recommendations:

The possibility of a future spontaneous fracture, though very limited, cannot be 100% ruled out. Consideration of applying a safety film (attached data sheet SH-4 CLARXL.pdf) to keep possible future glass breaks from falling or replacement with glass not considered to contain this element are the only options for greater assurance against falling glass. MCA did contact a contractor regarding applying a safety film and was given a budget of \$100,000 per elevation (\$400,000 for the building) to perform the work. MCA recommends additional contractors be contacted to firm up this budget, but believes the number provided to be, on order of magnitude, correct.

Please call me if you have any questions regarding the above information.

Regards,



Jeffrey Martin, P.E.
Principal
McGinnis Chen Associates, Inc.

Attachments: 001TASchwartz-L-060230.00meh.pdf
27 March letter.pdf
AIS-13 A, Review of Nickel Sulphide Induced Fracture in Tempered Glass.pdf
SH-4 CLARXL.pdf

Copy to: Jeff Chen (McGinnis Chen Associates, Inc.)