LAYTON

June 2010
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Table of Contents

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I. Introduction

Layton Consulting was retained by the strata at Harbour Cove, 1470 Pennyfarthing Drive, Vancouver, BC to investigate the existing window system at the same address. Layton Consulting is an engineering consulting firm specializing in glazing and cladding design.

This report was prepared to assess conditions of the original windows and to determine whether or not the existing windows need remediation and/or replacement. An on site meeting and review of the windows was conducted on June 17, 2010. Eric Skytte, AScT of Layton Consulting and the strata council were present at the review. *This report is mostly limited to the structural integrity of the windows only.* Existing water ingress, caulking or sealant issues are not reviewed to a great extent due to the visual only review.

II. Background

The site consists of three high-rise residential buildings constructed in 1985, consisting of 304 strata suites in total. The buildings are of concrete and steel stud construction, clad with brick and large sized windows.

The original and currently installed windows consist of extruded aluminum window frames, black in colour, with mitered corners, approximately 2¾" overall depth with double glazed sealed units (also know as IGU's – insulated glazing units). The windows are a typical aluminum framed product available in the 1980's, likely supplied by National Aluminum Products or Almetco Windows, the primary local suppliers to high-rises at the time of construction.

The strata reported that numerous sealed units are regularly failing* and having to be replaced. (*Note: Failure of a sealed unit generally means that the seals between the glass panes have been compromised, causing fogging of the glass, water ingress, air leakage, etc. These issues are not only problematic from a weather barrier viewpoint, but also visually displeasing). The strata reported that over 350 IGU's have failed and that 80 have been replaced to date. The strata also expressed concern about the safety of the IGU's, in regards to how likely is the glass to come out of the window frames. The windows were also reported to have had some leakage issues, and a previous building envelope investigation was conducted within the last few years in regards to the water damage and state of the windows.

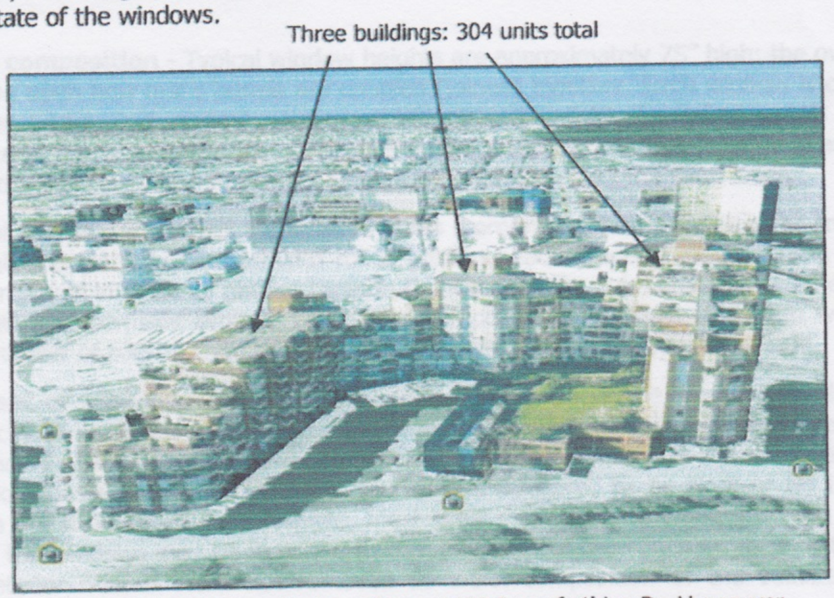

Figure 1 – Site overview, Harbour Cover, 1470 Pennyfarthing Dr, Vancouver

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i) Typical Window Size and Composition

The diagram below, Figure 2, shows a typical window configuration located on the buildings, as viewed from the exterior:

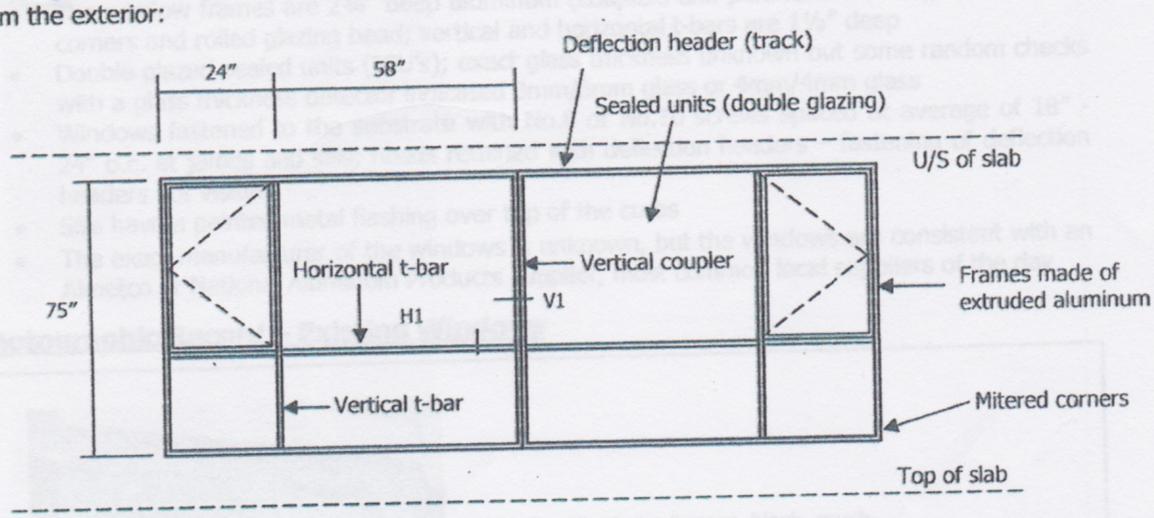

Figure 2 – Typical window elevation

Actual windows:

H1- Horizontal t-bar

V1- Vertical coupler

a) Sizes and composition - Typical window heights are approximately 75" high; the overall widths vary depending upon how many panels are coupled (joined) together. Each window is composed of vertical mullion t-bars, and vertical couplers which connect individual window panels together to form a continuous run of windows. The horizontal mullions support the weight of glass and all of the components together (vertical + horizontal frames and glass) support the wind loads.

The corners of the window frames are mitered joints (corners are joined together at an angle) and the exterior glass is partially secured with rolled glazing beads (angular metal glazing stops). The glass is primarily held in place by glazing tape on the interior side. It is unknown whether or not the window frames are thermally broken, which is a component of modern aluminum windows that reduces the transfer of cold air from the exterior across the window to the interior side.

unbroken according to MH p.14

b) Attachment of windows - The windows are held in place at the jambs and sills by screws fastened directly through the frames into the surrounding substrate. The heads appeared to use deflection header, which is a channel shaped continuous piece that allows the floor slabs above to deflect and not distort the window frame. The screws appeared to be No.8 or No.10 pan head screws, which are fastened to the substrate, most likely steel studs or wood liners on steel studs. The heads of the windows may be fastened to the underside of the concrete slabs or to steel stud bulkheads. Interior finishes were not removed so exact composition of the substrate was not determined.

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ii) Summary of Existing Windows:

- Windows are approximately 25 years old, most with original glass
- The window frames are 2¾" deep aluminum (couplers and perimeter frames), with mitered corners and rolled glazing bead; vertical and horizontal t-bars are 1½" deep
- Double glazed sealed units (IGU's); exact glass thickness unknown but some random checks with a glass thickness detector indicated 3mm/3mm glass or 4mm/4mm glass
- Windows fastened to the substrate with No.8 or No.10 screws spaced at average of 18" - 24" o.c. at jambs and sills; heads retained with deflection headers – fastening of deflection headers not visible
- Sills have a painted metal flashing over top of the curbs
- The exact manufacturer of the windows is unknown, but the windows are consistent with an Almetco or National Aluminum Products supplier, most common local suppliers of the day

III. Photographic Record – Existing Windows

Fig. 3 – Typical window, exterior view

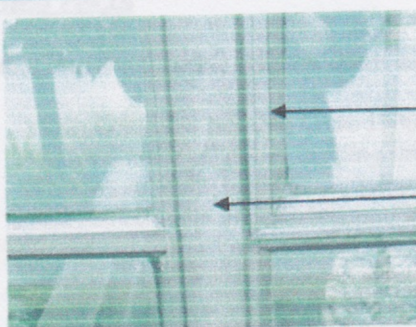

Fig. 4 - Close up of frames and bead

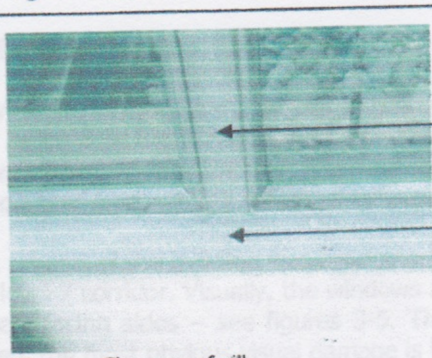

Fig. 5 – Close up of sill

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Fig. 6 – window sill fastening

Fig. 7 – depth of window frame

IV. Assumed Facts

Applicable drawings, codes and standards and relevant information:

- British Columbia Building Code 1980, Vancouver Building By-Law 5583
- Windows installed in the building have been in place since original construction
- Windows manufactured by Almetco or similar manufacturer of the day
- Most sealed units are either 4mm/4mm annealed, or 3mm/3mm annealed
- At least eighty sealed unit have been replaced on the site
- Some water leaks through the windows and substrate were reported to Layton Consulting Ltd, however this topic is beyond the scope of this report
- No review of the building envelope was undertaken

V. Investigation

The on site review was a visual inspection only. No finishes, frames, fasteners, glass or other materials were removed. Windows were largely viewed from the exterior side of the buildings, a few were looked at from the interior side at level 7. Potential water damage and leakage issues were also not explored while on site .

A walk around of the building was conducted and some windows were viewed from the interior side at the level 7 corridor. Visually, the windows appeared very faded in colour, particularly on the south and west facing sides – see figures 3-5. The typical windows did not appear to be deformed or distorted, the most obvious visual damage is the colour degradation of the windows, which is not

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unexpected for a 25 year old window system. When reviewing the windows from the interior and exterior, the following items were noted (also refer to photographs below):

- Window frames were fairly rigid, there was not significant movement to the frames when stressed (pushed on)
- Frames were checked with a level for plumbness and were not found to be out of plane (this check was done on a few windows only at ground level and at corridor on level 7)
- The window panel sizes within each unit are somewhat large as is the span of the horizontal mullions, but fairly typical for windows installed within high-rise buildings at the time of construction - see figure 8
- No water staining or damage was apparent on the inside finishes, however this is not to infer that no water problems exist; *a licensed building envelope specialist should be consulted if conditions warrant (i.e. owners report water within their suites, water damage is visually apparent, water is seen leaking through the window frames, etc.)*
- Fastening of the windows to the substrate was typically as much as 24- 30" apart, which is generally not adequate for high-rise windows of this size
- Some of the sealed units (IGU's) have significant degradations to both the spacer bars (which hold the two glass pieces together) and to the glazing tape, which is bleeding out of the frames in some locations – see figures 9 and 10
- As previously noted, a significant number of sealed units have failed, causing fogging and condensation within the glass – see figure 10
- Frame profiles are smaller than today's typical window wall systems – for example, the windows on Harbour Cover are typically 2¾" deep; a modern window wall system is at least 3½" to 4½" deep – see appendix for assumed profile configurations

i) Investigative findings – photographs:

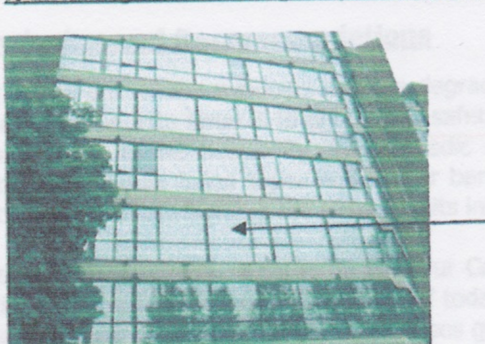

Fig. 8 – typical window sizes and configurations

Fig. 9 – glazing tape degradation

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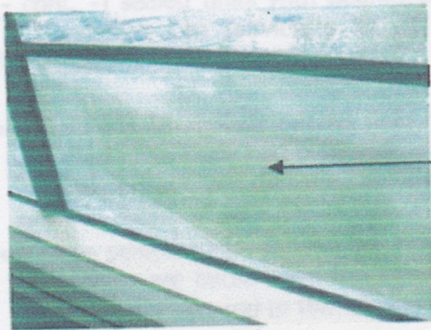

Fig. 10 – sealed unit failure

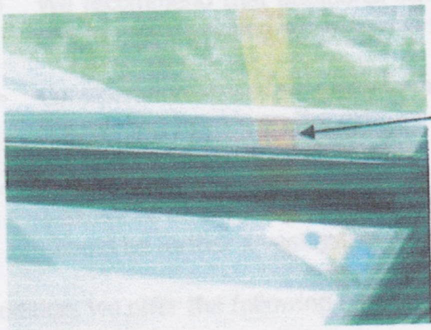

Fig. 11 – spacer bar degradation

VI. Conclusion and Recommendations

Due to the age of the windows and the degradation to the component materials around the glass, the most immediate issue is to ensure the safety of the building occupants and/or the public walking below. There is the possibility that sporadic sealed units could become dislodged during heavy windstorms due to failed tapes and spacer bars. As such, the structural integrity of the tape and spacer bars that are holding the glazing units into the frames must be thoroughly reviewed.

Older window systems, such as on Harbour Cove, utilize window frames that are smaller and less rigid than current 'window wall' systems of today. As such, older windows can be more prone to flex under large wind loads. This flexibility causes greater stress of the seals, leading to potential air and water leaks, creating a shorter life expectancy of the windows as compared to an engineered system of today. Also note that in the 1980's, there was no requirement for the engineering of the window system as is required today. As such, a contractor would select the windows based upon the project specifications, but no structural review was required.

Due to the on going problem of sealed unit failures and the issues with existing seals and glazing tapes at the glass, we therefore offer the following recommendations:

i) <u>Short term actions</u> (within one year or less):

- All windows on each building should be reviewed from the interior **and** exterior to check the integrity of the glazing tape and spacer bars; the spacer bars should be visually reviewed for cracks, warping, deformation, etc, (i.e. as shown in Figures 9, 11); the glazing tapes should be checked for bleed out and detachment from the window frames and glass; any of the

What was done?

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(- cont. -) sealed units with degraded spacer bars and/or tapes should be replaced. Layton Consulting can provide a list of recommended companies to perform this review and replacement.

- Continue to replace sealed units that have failed and are fogging up, leaking, etc. The sealed units likely had a 10 year warranty and the need to replace many of these units is to be expected given that they are already 25 years old.
- New sealed units should be installed with a modern double sided glazing tape; these products are better than the tapes provided in the 1980's and will help ensure the glass is adequately secured to the window frame.
- We recommend that additional screws be added to the existing windows at the jambs and sills to provide added securing and stiffness to frames.
- Consideration should be given to installing new rolled glazing beads and perhaps re-painting the existing frames on the exterior (these items can be priced out to see if cost effective).
- The buildings should be regularly monitored and checked for potential water damage and leakage at or around the windows; if any leaks or damage are continually found, this issue should be further investigated – see third bullet point in mid-term actions section below

In addition, we offer the following recommendations over longer terms:

ii) <u>Mid term actions and considerations</u> (1 to 3 years)

- Consideration should be given to ultimately replacing all the windows on the building as the sealed units are nearing, or are at the end of, their intended life span. Mitered windows are known throughout the industry to leak at the corners, modern windows do not use mitered joints. Furthermore, failed sealed units will become cloudy, obscuring the visibility through the glass
- Aluminum window systems have a limited life span. Repairs at this stage to existing windows are only a stop gap approach. Costs associated with sealed unit replacements (including labour, materials, swing stages, etc.) could have been used towards a full window replacement
- Consideration should be given to immediately hire a "moisture specialist" to verify the integrity of each suite. Extra care should be taken to look at all locations, i.e. joints, discontinuities, etc. where water may "wick" into the structure. This review will give the strata a comfort level in preparation for future restorative work
- Considering increasing the structural integrity of the existing frames by adding aluminum or steel tubes to the back of the frames. This reinforcing helps reduce the flex of the window frames under high wind loads, thus lessening the stress on seals, tapes and caulkings. However, such an endeavour can be labour intensive and not significantly cheaper than a full window replacement

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iii) Long term actions (5+ years)

- Full replacement of window will be required at some point due to limited life spans of the frames and glass. As the age of the windows increase, the likelihood of original sealed units failing will continue to increase at a higher rate. It is recommended a contingency fund for window replacement be set up

- Note that in the event that heavy water damage, water leakage, etc, is found around the windows at any time within the next five years, consideration should be given to replacing the windows as soon as possible

If desired, we can provide a timeline and detailed summary list of actions of the preceding items to assist in your planning,

Sincerely,

Layton Consulting Ltd.

Eric Skytte, AScT

July 26, 2010

Disclaimer: This report was a visual assessment of the existing window system only, no review of the building envelope was conducted. This report is intended to assess the windows only and is not intended as a building envelope investigation.

Who was on council at this time?

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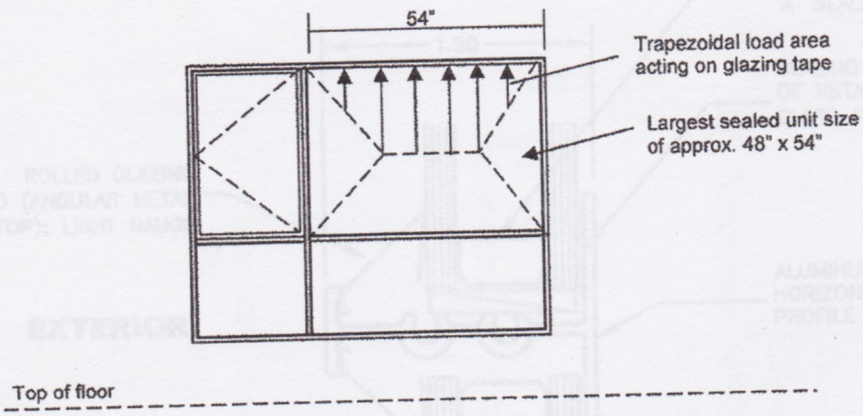
APPENDIX

I. FASTENING CALCULATIONS – GLAZING TAPE

1. CALCULATE BITE WIDTH REQUIRED FOR TAPE:



Calculation of width of the adhesive bond is calculated by the trapezoidal load distribution theory. Flat plate glass distributes the loads to the tape and the mullions in a trapezoidal load area as shown by the diagram above. Typical bonding design stress of glazing tape is 12 psi, an industry accepted standard which includes an appropriate margin of safety

Assuming the highest wind load design used on this high-rise was approx. 30 psf under earlier building codes, we can check to see the required width of the tape to adequately secure the glass to the window frames, based on the following formula:

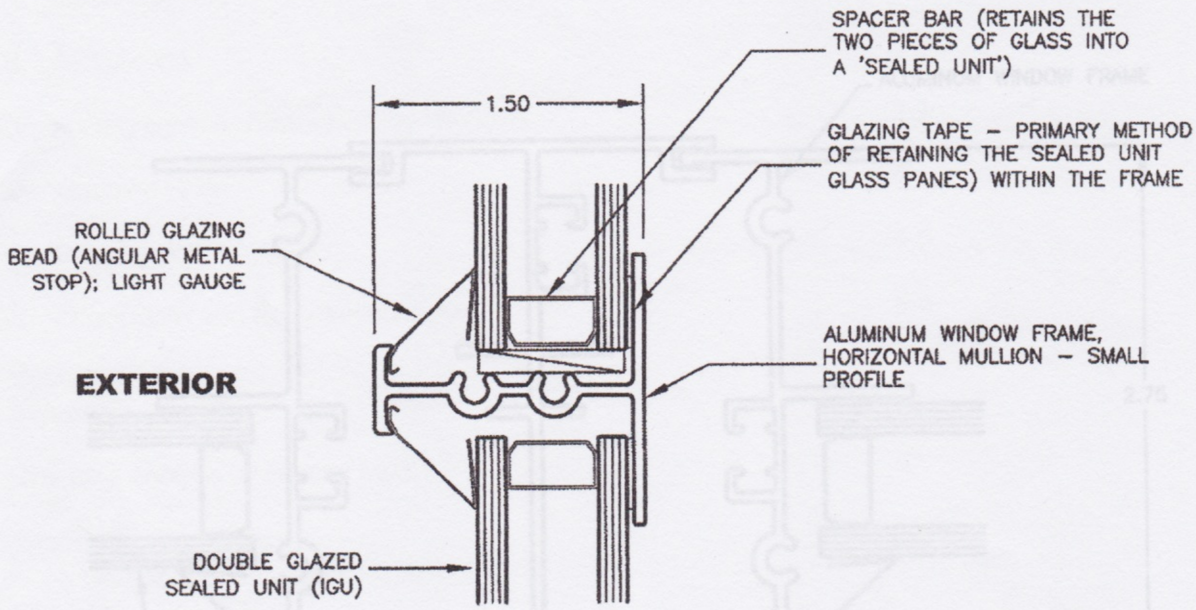
$$\textbf{Structural bite width} = \frac{\tfrac{1}{2} \times L \times \text{design wind pressure (psf)}}{\text{Glazing tape bonding stress} \times 12 \text{ in/ft}}$$

A typical window lite on the building is approx. 54" x 48" high, therefore L= 4.0 ft

Stress (ULS) wind load;	p_{net} = **30.00** psf;
Longest dimension of sealed unit;	L = **54.00** in;
Bonding material design stress of glazing tape;	s = **12.0** psi; *(Older tapes may be less)*
Structural bite width;	$B_w = (0.50 * L * p_{net}) / (s * 12 \text{ in/ft}) =$ **0.47** in;

Conclusion – The typical glazing tape should have a width of at least 0.47" (1/2"). however with the bleed out at many of the units, the actual bonding width of the tape still inside the frame is less than this amount. The seals may already be in the process of rupturing at these locations and will continue to do so, leading to further water ingress

HORIZONTAL T-BAR MULLION PROFILE OF EXISTING WINDOWS



ASSUMED CROSS SECTION
(Exact profile may differ)

Material: Aluminum   Deflection limit = L/175
(As per codes and standards)

Note: all dimensions are in inches. Frame is assumed to be composed of 6063–T5 aluminum, a common alloy used for window extrusions

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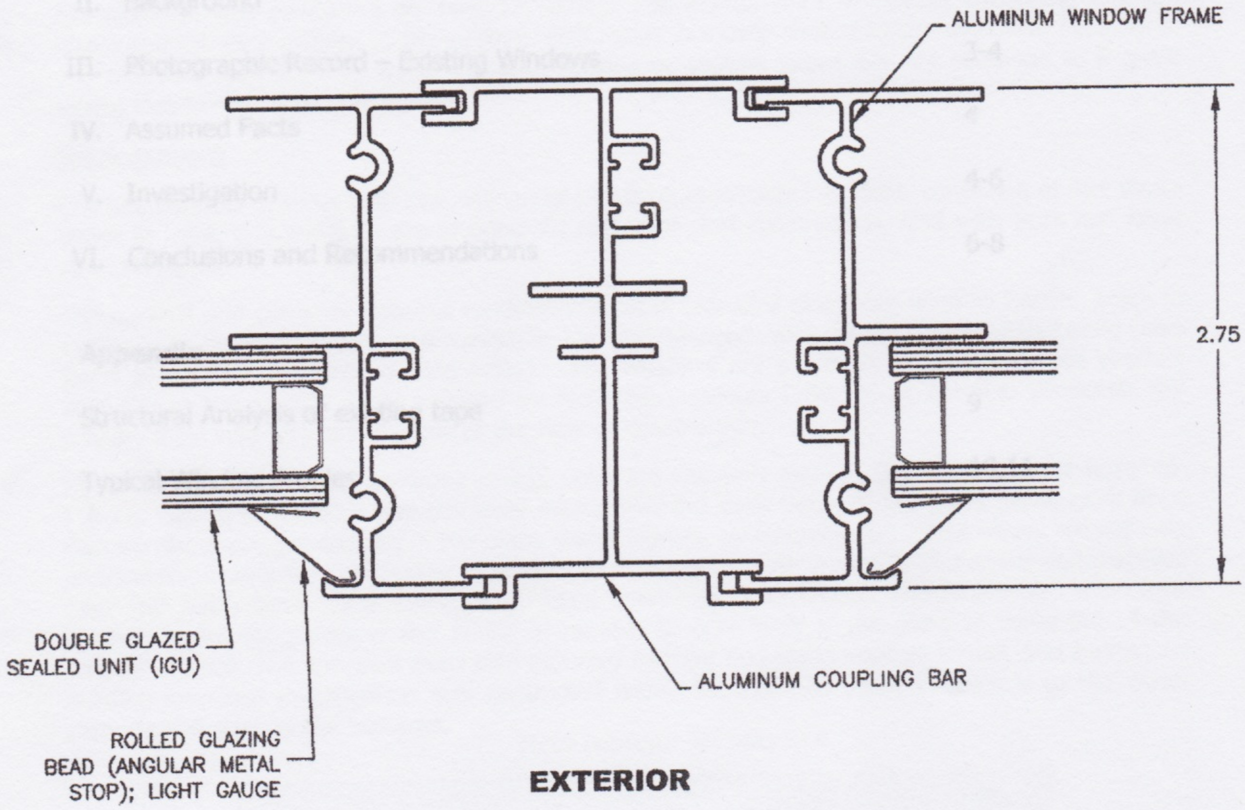
WINDOW SERIES: **TYP. 1980'S HIGH-RISE ALUMINUM WINDOW**	SCALE: FULL SIZE	DATE: JUL 2010	DWG. NO: **H1**

VERTICAL COUPLING MULLION OF EXISTING WINDOWS



ASSUMED CROSS SECTION IN PLAN VIEW
(Exact profile may differ)

Material: Aluminum **Deflection limit = L/175**
(As per codes and standards)

Note: all dimensions are in inches. Frame is assumed to be composed of 6063–T5 aluminum, a common alloy used for window extrusions

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