Building Science Corporation

BUILDING ENCLOSURE INVESTIGATION AND ANALYSIS
CENTENNIAL CONDOMINIUMS
ASPEN, CO

Date:

2010.07.22

Prepared For:

Stephen W. Bossart
Project Manager
Capital Asset Department
City of Aspen

Prepared By:

Peter Baker, P.Eng.
Senior Associate
Building Science Corporation

Cathy Gates, AIA
Associate
Building Science Corporation

30 Forest Street | Somerville, MA 02143 | Phone 978.589.5100 | Fax 978.589.5103 | www.buildingscience.com

Contents

List of Figures 3
Introduction 4
Description of Building Complex 4
Reported History 4
Observations 5
Attic/Roof 5
Exterior Walls 6
Crawlspace 11
Analysis 13
Attic/Roof 13
Exterior Walls 13
Wall to Lower Sloped Roof Connection 14
Second Floor Balcony Additions 15
Window Systems 15
Crawlspace 15
Recommendations 16
Attic/Roof 16
Option 1: Increase ventilation and air seal the attic floor 16
Option 2: Modify the attic to be an unvented attic 16
Additional recommended work 16
Exterior Walls 16
Option 1: Patch and repair deteriorated areas 17
Option 2: De-clad and repair walls adjacent to deteriorated areas 17
Option 3: De-clad and repair all walls 17
Window Systems 18
Crawlspace 18

30 Forest Street | Somerville, MA 02143 | Phone 978.589.5100 | Fax 978.589.5103 | www.buildingscience.com

List of Figures

Figure 1: 300 Free Silver Ct Southwest (from west) 4
Figure 2: 200 Teal Ct Northeast (from north) 4
Figure 3: Ventilation Shaft Section 5
Figure 4: Ventilation Shaft 5
Figure 5: Ventilation Shaft and Attic Vents 6
Figure 6: Attic Vent from Interior 6
Figure 7: Attic condensation stains 6
Figure 8: Attic condensation stains at dryer vent 6
Figure 9: Exterior Wall Section 7
Figure 10: SE wall with storage closet 7
Figure 11: Investigation of SE wall 7
Figure 12: Investigation at roof/wall connection 7
Figure 13: Investigation at wall/wall connection 8
Figure 14: Investigation at base of wall 8
Figure 15: SW porch deck 8
Figure 16: SW porch with added "support" 8
Figure 17: Example of deck over storage closet 9
Figure 18: SW porch with added 9
Figure 19: Wing wall built over existing structure 9
Figure 20: Wing wall attachment to building 9
Figure 21: Investigation at NE wall at roof/wall 10
Figure 22: Detail at roof/wall 10
Figure 23: Investigation at NE wall (field) 10
Figure 24: Investigation at SW wall (field) 10
Figure 25: Investigation at window (SE wall) 11
Figure 26: Investigation at window (NE wall) 11
Figure 27: Basement Ventilation Section 11
Figure 28: Exterior Basement Vents 11
Figure 29: Piping in Basement 12
Figure 30: Rim board 12
Figure 31: Foundation wall 12
Figure 32: Foundation wall insulation 12
Figure 33: Poly ground cover at lally column 13
Figure 34: Poly ground cover sealed to wall insulation 13
Figure 35: Rake edge at end wall and eave overhang extension 14
Figure 36: Foundation wall section 15
Figure 37: Base of wall at foundation wall ledge 15

Introduction

Building Science Corporation was retained by the City of Aspen to investigate water intrusion concerns related to the enclosure assemblies at the non-rental unit buildings at Centennial Housing in Aspen, CO. The non-rental buildings are 100 - 400 Free Silver Court and 200 - 400 Teal Court. BSC's investigation consisted of a review of the construction documents and details of the buildings and a site review of the buildings during which isolated intrusive disassembly was performed for investigation purposes.

Description of Building Complex

The complex consists of 7 buildings. Each building consists of a series of blocks or sections which are offset from each adjacent module by either 12 or 18 feet. On the southwest elevation, in each block, the outer wall for each floor steps back from the lower floor and the roof on each floor slopes down towards the façade. The outermost part of the first floor on the southwest elevation consists of a covered porch with a storage closet on one side. (See Figure 1) In some cases, the roof for the covered porch and storage area has been replaced with a 2nd story deck. On the northeast elevation, at each block, the roof slopes to the side with a vertical wall marking the transition to the sloping roof on the southwest. The roof conditions at the ends of the buildings vary (See Figure 2). Thus in general, on the southwest side of the buildings, there are roof/wall connections on the southeast or northwest facing walls whereas on the northeast side of the buildings, the roof/wall connections occur primarily on the northeast walls.

Figure 1: 300 Free Silver Ct Southwest (from west)

Figure 2: 200 Teal Ct Northeast (from north)

Reported History

The buildings were constructed in the 1980's. The buildings are wood-framed with horizontal ship-lap redwood siding on all walls and standing seam metal roofs. There is a continuous crawl space underneath the buildings.

At the time of construction, the second floor decks on the southwest side of the buildings in the original design were deleted from the project. These decks had been designed to extend over the first floor porch and exterior storage closets. Instead, a sloped roof was constructed over these storage closets. A number of second floor homeowners have subsequently added decks to their units.

Several years after construction, some structural damage caused by water intrusion was discovered at one of the windows on the southeast elevation of one of the buildings. In order to better protect the walls from water, metal overhangs were inserted on the ends of the sloped roofs. Kick-out metal flashing was also added at the lower edge of some of the roof/wall intersections.

In August of 2009, a waste pipe broke at the second floor within one of the party walls and caused considerable damage within that wall. While the repairs were being made, the contractor noted that there was significant water damage in the extension of that wall where it becomes an exterior wall. The full length of the wall was repaired and resided.

The most common complaint of water intrusion made by homeowners has been that water gets into the wall of the exterior storage units on the southeast side of the building. It was reported that this situation is at its worst when there is snow on the roof that starts to melt.

Observations

BSC conducted a site review of the buildings on June 30, 2010. The site review was conducted by Peter Baker and Cathy Gates of BSC. Present during the site review were Stephen Kanipe, Scott Miller, Jeff Pendarvis, Lee Cassin, and C.J.Oliver of the City of Aspen, Travis Beard of First Choice Properties, Mike Van Dyke of National Jewish Health, and Arlen Wussow of Rudd Construction.

A survey of the exterior of the buildings was conducted. Several openings were cut to examine the underlying conditions at representative locations. A survey of one attic space (321 Free Silver Ct) and a survey of the southeast end of the crawl space under 300 Free Silver Ct were also conducted.

Attic/Roof

The attic is designed to be ventilated. There is one ventilation chimney/shaft at one end of each block. Each chimney serves as a vent for the two adjacent attics. (See Figure 3 and Figure 4) Attic vents are located in the end walls on the northwest elevation just above the attic floor (see Figure 5) and on the exposed sides (southwest or northeast) on the other side of the building. In Figure 5, the two vents in the foreground (above the windows) are the attic vents. The two higher vents in the background are used for dryer vents. In the surveyed attic, there is a separation wall between the two vents which separates attic space in the block into 2 separate spaces.

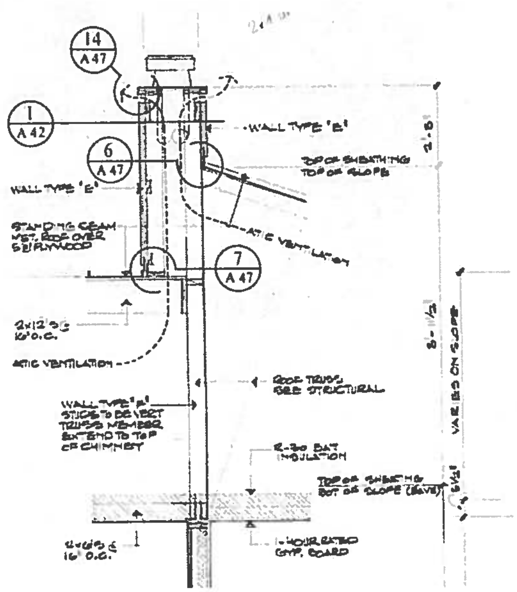

Figure 3: Ventilation Shaft Section

Figure 4: Ventilation Shaft

The surveyed attic was accessed via a pull-down stair. The access hatch was not gasketed; it had been taped shut by the homeowner for air-sealing. In the attic, only one vent was observed (Figure 6). There may have been another similarly sized vent along the side wall on the southwest end of the attic.

There was no observed evidence of water intrusion in the attic. However, there were multiple locations of condensation staining on the framing close to the roof or exterior wall sheathing (See Figure 7). Evidence of condensation was most significant near the dryer vent attachment to the exterior wall (See Figure 8).

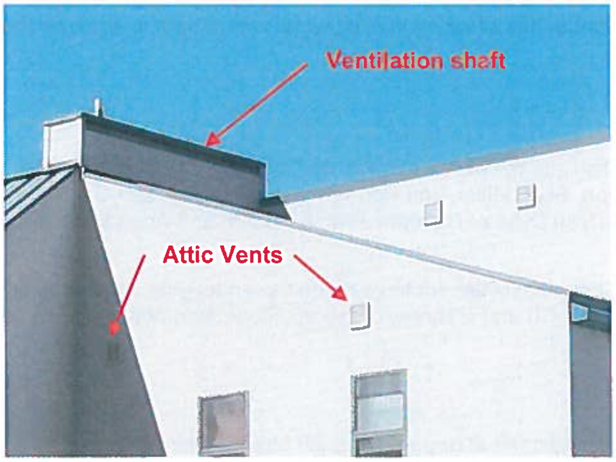

Figure 5: Ventilation Shaft and Attic Vents

Figure 6: Attic Vent from Interior

Figure 7: Attic condensation stains

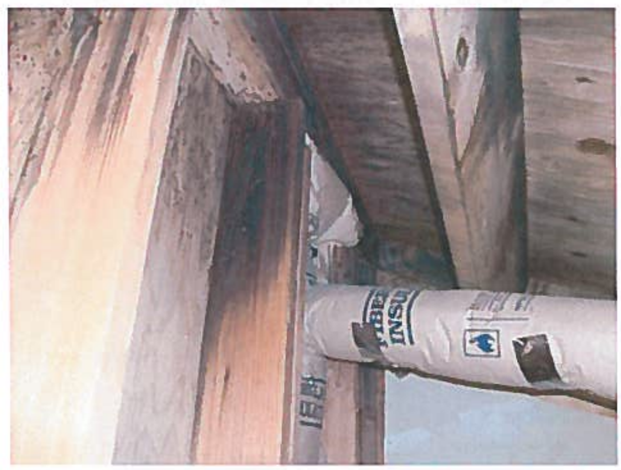

Figure 8: Attic condensation stains at dryer vent

While there was a bathroom with an operating ventilation fan located directly below the attic, there was neither a vent nor a duct for it observed in the attic. It was reported that at the time of construction, the local code did not require that bathroom fans be ducted to the exterior. Therefore, it is assumed that the bathroom fan vented either into an interior second floor wall or into the floor of the attic.

During the exterior wall survey, a cut was made from the exterior into an attic wall for one of the units in 200 Free Silver Court. It was observed that the attic wall was insulated and then covered with a layer of polyethylene. At another location in that building, when the exterior vent cover was removed for one of the lower attic vents, it could be seen that the opening was being used as a duct termination rather than for attic ventilation. These observations suggest that the lower attic vents in some of the units have been blocked by homeowners.

Exterior Walls

The exterior walls of the buildings are constructed with a ½" layer of exterior gypsum board on the exterior side of the plywood wall sheathing as part of a 1-hour fire rated assembly. The shiplap horizontal siding is applied directly over the gypsum board. (Figure 9) There is a layer of polyethylene applied on the interior side of the studs.

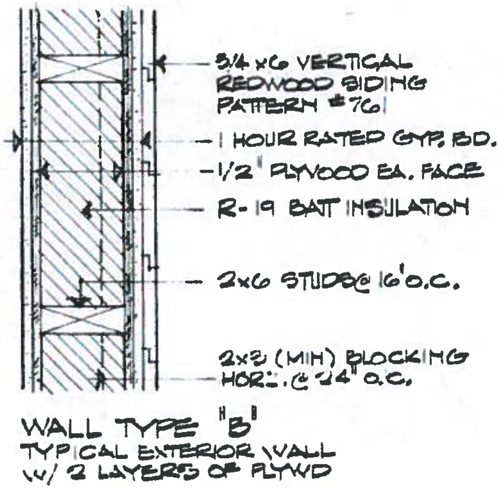

Figure 9: Exterior Wall Section

Figure 10: SE wall with storage closet

Many of the roof/wall intersections, especially on the southwest side of the buildings, showed evidence of peeled paint. Based on homeowner reports of water intrusion at exterior storage closets, a roof/wall intersection at one of the storage closets was selected for further investigation (Figure 11).

Figure 11: Investigation of SE wall

Figure 12: Investigation at roof/wall connection

Upon removal of the siding, it was observed that the exterior gypsum board was water damaged along the sloped intersection of the wall and the roof. The exterior gypsum board was crumbling at the roof/wall connection. For several inches above the connection, the outer paper surface of the gypsum board was peeling away but the gypsum core remained intact. The plywood wall sheathing behind the gypsum board appeared undamaged. The water damage was more extensive towards the outer edge of the roof.

It was observed that the roof underlayment was turned up several inches and sealed to the exterior plywood wall sheathing. The connection between the metal deck and the wall sheathing was covered with a continuous bent sheet metal flashing. The sheet metal flashing was noted to be flashed back to the plywood wall sheathing. This places the flashing behind the exterior gypsum board (See Figure 12).

Figure 13: Investigation at wall/wall connection

Figure 14: Investigation at base of wall

The investigation was continued at this location by removing the siding down along the wall-to-wall connection at the exterior of the storage closet. Here, the exterior gypsum board was water damaged and crumbled. This extended out approximately 12" from the wall-to-wall intersection. Since the plywood sheathing showed water staining, a cut was made in the plywood to investigate the wall structure. No damage to the studs was evident at this location (See Figure 13).

The siding was then removed at the base of this exterior wall. Here extensive damage was observed with both the exterior gypsum board and the plywood crumbling and evidence of rot along the outside edge the wall studs (See Figure 14). Note that at this location, the concrete foundation wall and sill plate is proud of the siding; metal flashing covers the extension.

All of the siding that was removed at this location was in excellent condition. It had originally been primed on all sides and there was no sign of water damage.

It should be noted that the first floor decks on the southwest side of the buildings were originally constructed as cantilevered structures. There was water damage reported in the past at the decks –all the original stairs were removed because of damage – and damage can be seen to the some of the structure underneath. (See Figure 15) In some cases, homeowners have added support underneath suggesting that the original decks may be sagging. (See Figure 16)

Figure 15: SW porch deck

Figure 16: SW porch with added "support"

Some homeowners have added decks at the second floor on the southwest side. By doing so, they replaced the original roof structure at the exterior storage closets below. Figure 17 shows an example of this.

30 Forest Street | Somerville, MA 02143 | Phone 978.589.5100 | Fax 978.589.5103 | www.buildingscience.com

It was reported that there has been water intrusion in the storage closets with modified construction as well as in the original construction. Therefore a disassembly investigation was performed at the wall along one such deck. (See Figure 18) In this case, the original side wall was extended up to form a wing wall for the 2nd floor deck. Siding was removed from the wing wall to check for water damage which can be seen on the exterior gypsum board at several places (Figure 19). A cut was made through the plywood in the building wall at the connection point to see if the water damage extended into the wall. There was dampness felt in the stud space, but no damage to the stud could be seen (Figure 20).

Figure 17: Example of deck over storage closet

Figure 18: SW porch with added

Figure 19: Wing wall built over existing structure

Figure 20: Wing wall attachment to building

The next field disassembly was located at a roof/wall intersection along the northeast side of the building (Figure 21). The siding was removed so the condition of the wall could be examined (Figure 22). There was some water staining on the face of the exterior gypsum board causing peeling of its outer layer but the core was not damaged. The gypsum board was broken off to look at the plywood behind, which was not damaged. The roof/wall flashing detail was similar to that described earlier.

Figure 21: Investigation at NE wall at roof/wall

Figure 22: Detail at roof/wall

Additional investigation openings were made at two locations – in the wall field on a northeast wall and on a southeast wall. At the location on the northeast wall, when the siding was removed, some water stains could be seen on the face of the exterior gypsum board at siding nail penetration and around the windows, but there was no deterioration (See Figure 23). It should be noted that there is no overhang over this wall. On the other hand, along the southwest wall, where there is an overhang, no water staining of the exterior gypsum board was observed (See Figure 24).

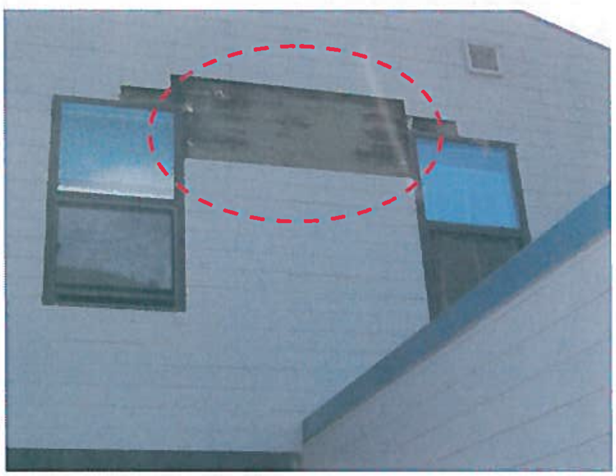

Figure 23: Investigation at NE wall (field)

Figure 24: Investigation at SW wall (field)

The windows from the original construction are still in place. They are double glazed windows and some are reported to be experiencing condensation within the glazing. The siding was removed at a window on the southwest side of the building (on a southeast facing wall) and at a window on the northeast side of the building to check for water damage around the windows (See Figure 25 and Figure 26). In both cases, the windows are on walls for which there is no overhang. There was no flashing observed at the windows. There was some water staining on the exterior gypsum board around both of the windows and on the plywood behind. The plywood was cut at the window on the northeast side to check for damage inside the wall, but none was observed.

Figure 25: Investigation at window (SE wall)

Figure 26: Investigation at window (NE wall)

Crawlspace

The crawlspace is a ventilated, insulated space (See Figure 27). Crawlspace vents were observed along the northeast façade and are also called out in the drawings to be located on the southwest under the first floor porches. The framing and the first floor subfloor are exposed. There is no insulation between the first floor and the crawlspace (See Figure FS-3). Each unit contains its own water heater and heating is provided by electric baseboard. So there is no equipment in the crawlspaces other than plumbing and wiring. During the survey, the crawlspace was not damp nor did it smell musty.

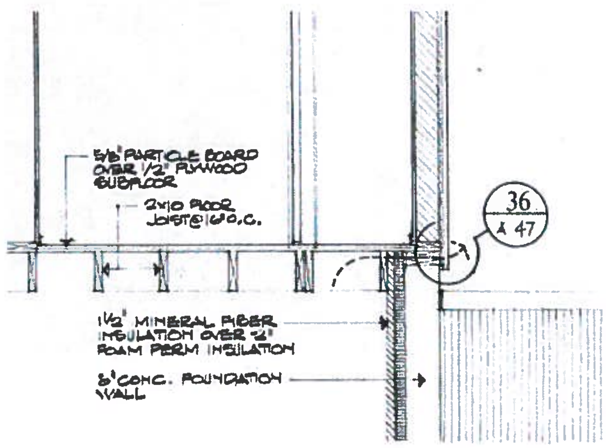

Figure 27: Basement Ventilation Section

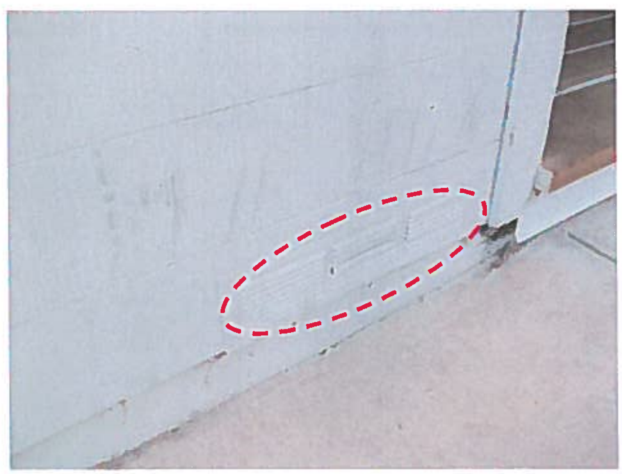

Figure 28: Exterior Basement Vents

In general, the subfloor and framing was clean and free of water staining. However, there was occasional evidence of condensation. This can be seen on the blocking above plumbing pipes in Figure 29. There was also evidence of condensation along the rim joist (See Figure 30). No structural water damage was observed on the floor framing or on any portions of the rim board that were examined.

Figure 29: Piping in Basement

Figure 30: Rim board

The walls of the crawlspace are insulated with a layer of XPS against the concrete foundation wall which is covered with a blanket of fiberglass insulation. The crawlspace floor has a continuous ground cover of polyethylene. The ground cover is sealed to the footing at the interior columns (Figure 33) and is sealed to the XPS at the walls (Figure 34).

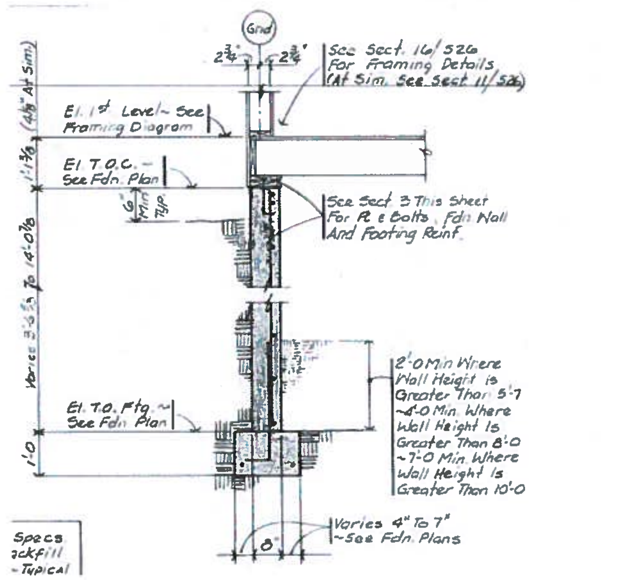

Figure 31: Foundation wall

Figure 32: Foundation wall insulation

Figure 33: Poly ground cover at lally column

Figure 34: Poly ground cover sealed to wall insulation

Analysis

The problems identified in these buildings are caused primarily by water intrusion at certain locations in the exterior wall assemblies. Some secondary concerns were noted that related to condensation accumulation.

Attic/Roof

The design of the buildings specifies ventilated attics. In cold climates, the primary purpose of attic ventilation is to maintain a cold roof temperature to control ice dams and to vent moisture that moves from the conditioned space to the attic. Attic ventilation is primarily driven by stack effect, and therefore requires both lower openings as well as higher openings to allow for flow. The amount of flow is a function of the size of the openings and the vertical distance between them.

In terms of moisture control, in order for the attic ventilation to be effective, the rate of moisture removal from the attic must exceed the rate of moisture leakage into the attic.

Each attic space is designed to have two wall attic vents and a venting chimney with a 1-hour rated attic floor system separating the unit below from the attic. The area of lower wall vents is insufficient to provide for adequate ventilation of the attic. In addition, the design of the ceiling leaves a large potential for air leakage from the conditioned space into the attic. A clearly observed and significant gap is around the non-gasketed pull down attic access hatch. However, there are likely other pathways as well such as around light and electrical fixtures, at the top plates of partition and exterior framed walls. In addition to the air leakage from the interior space, there is concern relating to moisture loading of the attic from bathroom fans and dryer exhaust (as was observed in the unit investigated).

The resulting moisture load is greater than can be managed by the ventilation scheme. As a result, condensation accumulates at various places on sheathing and framing at the exterior surfaces.

Exterior Walls

Overall the exterior wall assemblies are performing moderately well from a water management perspective. The horizontal shiplap siding provides an effective shingle lapped siding interface. The weakness of the system concentrates at interfaces with other building elements (roofs, balcony walls, windows, vents, etc) or at ends of the cladding boards.

Water damage of building elements is a function of moisture balance. The rate of wetting must exceed the rate of drying in order for accumulation to occur, and the amount of accumulation must exceed the safe storage capacity of the material in order for damage to occur. Therefore, while pathways for water infiltration into the exterior wall assemblies do exist on the buildings, damage will only occur provided that sufficient water volume is able to penetrate into the system and provided the water cannot be drained to the exterior or dried out effectively.

The spot removal of cladding demonstrated little to no deterioration or even signs of water staining on the exterior gypsum board for walls that were protected by the addition of the eave overhang extensions.

End walls that do not have an overhang were noted to have increased wear on the system due to the exposure. Water infiltration behind the cladding has lead to staining and minor deterioration of the paper facing on the exterior gypsum sheathing. It was noted however that in these locations, the core of the gypsum was still solid and undamaged as well as the plywood sheathing behind it.

Figure 35: Rake edge at end wall and eave overhang extension

While the overall wall assembly appears to functioning moderately well, there were three primary locations where the system had noted problems.

- Wall to lower sloped roof connections
- Second floor balcony additions
- Window systems

Wall to Lower Sloped Roof Connection

The most severe area of damage noted during the investigation was related to the wall to lower roof interfaces that terminate in the field of the wall. The main problem stems from the roof to wall flashing being installed behind the exterior gypsum layer and the lack of kick out flashings at the termination of the sloped roof in the field of the walls.

Water management of the enclosure in the Aspen environment requires a system that not only addresses rainwater penetration but also handles potential for water accumulation created by the formation of ice dams.

Because the flashing was installed behind the exterior gypsum board layer it created a hole at the roof edge termination in the field of the wall. This hole funneled water that was draining down along the flashing in between the gypsum and plywood sheathing. The location was particularly susceptible to water infiltration due to ice dams. The ice dams created a situation that allowed the water to back up above the height of the lower flashing leg and subsequently drain into the wall assembly. This analysis was corroborated with the reported history of the building that identified problems occurring more often during times of ice damming.

The problem appeared to be more severe on the Southeast elevations than the Northwest elevations. It was theorized that this may be due to the solar exposure of the South East roofs leading to more solar heating and subsequent cyclical melting and freezing of water at the ice dam formations. The Northwest elevations are more shaded reducing the melting potential of the roofs.

The leakage at the roof to wall connections is resulting in damage of the first floor structure where the wood frame structure is connected to the concrete foundation. The buildings are designed with the framing set back from the exterior edge of the foundation wall (Figure 36). This created a ledge for the water to accumulate at the base of the wall assembly. Removal of the siding material at the base of the southeast facing wall during the field investigation revealed that the framing had deteriorated (Figure 37).

30 Forest Street | Somerville, MA 02143 | Phone 978.589.5100 | Fax 978.589.5103 | www.buildingscience.com

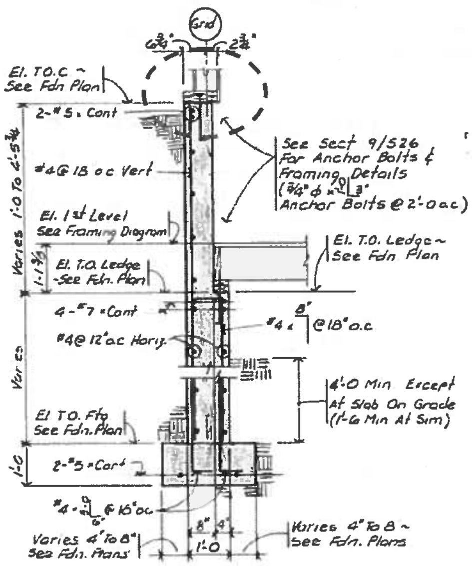

Figure 36: Foundation wall section

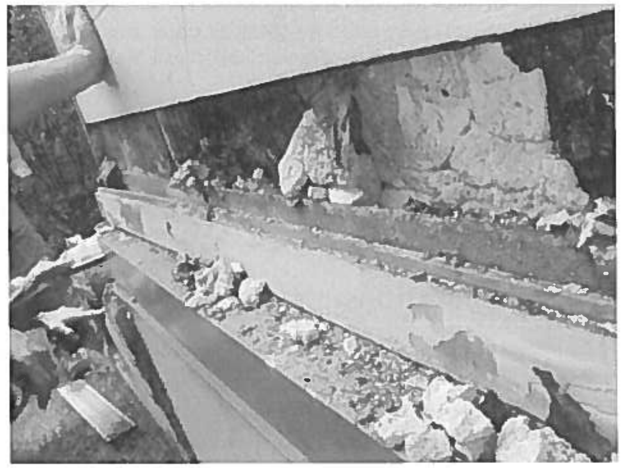

Figure 37: Base of wall at foundation wall ledge

Second Floor Balcony Additions

The addition of the exterior second floor decks was reported to have been done over several years with no specific details used for the construction. It was stated that the design and construction was typically left up to the contractor performing the work. This creates a situation where the actual construction could be variable at each location.

At the deck interface that was reviewed, no saddle flashings or other water proofing was installed at the wall to wing wall interface or below the wood trim.

Without water proofing or flashing installed at the balcony wing walls, water is able to penetrate directly into the structure below. The removal of the wood siding at the wing wall to structural wall interface revealed a concentration of deteriorated material at the interface.

Window Systems

Since the windows are original to the building and no flashing was applied when they were installed, there is potential for water intrusion at each the windows. Based on the observed water staining of the exterior gypsum board around the windows, some water is getting behind the cladding at the windows; however the observed damage was not extensive around the openings.

The current condition of the windows in the rough openings is a function of the amount of water reaching the windows. The windows on walls that have overhangs are less likely to show water intrusion than those that are on walls without overhangs or those that are exposed to additional water from nearby roof drainage.

A secondary concern was noted with the window systems. The evidence of sealed unit failure as noted by the condensation accumulation between the two lites of the insulating glass units is an indication of the insulating glass units sitting for prolonged periods of time in water. This is an indication that water is getting past the exterior seals and being held in the glazing pocket. This creates a concern of water leakage occurring through the window frame itself and not just at the window to wall interface. Without a pan flashing installed below the window there is a risk of water infiltration into the building.

Crawlspace

The design of the crawlspace of the buildings is for a ventilated but insulated space with no insulation in the first floors of the living space. The polyethylene ground cover is sealed to the wall insulation and around the discontinuities at the support columns. The space appears to have functioned well with only a slight evidence of condensation.

Ventilation of this crawlspace is unnecessary and creates a discontinuity in the thermal enclosure of the buildings. In addition, the ventilation and any other air gaps that exist along the top of the wall may be the source of the moisture. In the winter, any air brought in by the ventilation will make the basement cooler than the space above. In the summer, outdoor air brought in will tend to be more humid.

There was very little evidence of past liquid water intrusion into the crawl space. The polyethylene ground cover is turned up and sealed it to the interior face of the rigid wall insulation. In this configuration, any water infiltration though the foundation wall would be directed under the polyethylene ground cover. Therefore any water that was able to get on top of the polyethylene ground cover would likely have had to come from the wood framed walls above, and would not be considered a crawlspace issue..

Recommendations

The following is a list of potential strategies that may be employed to address the concerns identified with the performance and durability of the building enclosure assemblies.

Attic/Roof

There are two proposed strategies that could be employed to reduce the potential for condensation from occurring in the attic spaces:

Option 1: Increase ventilation and air seal the attic floor

This strategy would try to increase the ventilation rate for the attic as well as reduce the infiltration of conditioned air into the attic from the living space below. The following is an outline scope of work:

1. Add additional lower vent openings, including soffit vents at the eave overhang extensions.
2. Replace pull down ladder access hatched with gasketed and sealed hatches (a secondary hatch cover should also be considered given the high potential for infiltration through the attic hatch).
3. Air seal gypsum ceiling at all partition walls, electrical and mechanical penetrations, and exterior framed wall.

Additional strategy options:

1. Mechanically induce attic ventilation through the use of fan. The fan should be positioned to blow exterior air into the attic space. DO NOT exhaust air from the attic space as this may result in an increase of infiltration of conditioned air into the attic.

Option 2: Modify the attic to be an unvented attic

This strategy would add air impermeable insulation to the underside of the roof sheathing as well as the end walls bringing the attic within the thermal and air tightness boundary of the units. The following is an outline scope of work:

1. Close and seal all vent openings to the exterior
2. Close and block the vent shaft and re-flash the top to prevent wind blown rain from being able to infiltrate into the vent shaft.
3. Install a layer of closed cell spray polyurethane foam to the underside of the roof deck (Minimum thickness to meet R-30 based on *Table R806.4 Insulation for Condensation Control* of the 2009 IRC)
4. Install a layer of closed cell spray polyurethane foam to the end walls
5. If required cover the foam with an approved thermal or ignition barrier.

Additional recommended work

The following additional work is recommended independent of either option chosen:

1. Ensure all dryer exhaust ducts are properly ducted to the exterior. Seal around all connections to prevent leakage of dryer exhaust into the attic space.
2. Duct all bathroom exhaust fans properly to the exterior.

Exterior Walls

To correct the concerns relating to water intrusion, the damage areas need to be repaired and the details leading to the water intrusion problems should be modified to prevent future infiltration. Several levels of repair can be implemented. Each subsequent level from the base minimum recommendations would improve the overall performance of the building and reduce the risk of future damage and deterioration from occurring.

30 Forest Street | Somerville, MA 02143 | Phone 978.589.5100 | Fax 978.589.5103 | www.buildingscience.com

Option 1: Patch and repair deteriorated areas

This strategy targets known problem areas and removes material systematically to the point where no more damaged material is found. Uncovered damaged material is replaced and the assembly is reconstructed. The intent is not to remove more material from the wall than is necessary to complete the targeted repairs of the building. This strategy does not make any significant improvements on the performance of the building as only areas where material is removed is modified.

The locations for the targeted repairs would be as follows (in order of priority):

1. Sloped roof termination in the field of the wall on the Southeast and Northwest elevations on the Southwest side of the buildings
2. Second floor balcony additions attachment locations
3. Sloped roof termination in the field of the wall on the Northeast elevation on the Northeast side of the building.
4. Windows

The following is an outline scope of work:

1. Remove the exterior siding in order to expose the extent of the deteriorated material. Store for re-use.
2. Remove deteriorated material and replace with new as needed. Match existing wood materials (plywood and framing lumber), all replaced gypsum should be non-paper faced (DensGlass Gold or equivalent)
3. Modify building connection details to include appropriate membrane waterproofing and flashing.
4. Reinstall the original siding
5. Paint as necessary

The extent of the cladding removal may approach a complete de-clad of the some of the wall areas.

Option 2: De-clad and repair walls adjacent to deteriorated areas

This strategy expands on the scope of Option 1 by completely removing the siding on walls that have known or have expected deterioration. Similar scope of work applies to uncovering and repairing damaged material as needed; however, by de-cladding the entire wall area, the build back can make provisions to improve on the details of the entire system.

The locations for the de-cladding and repairing would be as follows (in order of priority):

1. Walls on the Southeast and Northwest elevations on the Southwest side of the buildings
2. Walls with second floor balcony additions attachment locations
3. Walls on the Northeast elevation on the Northeast side of the building.
4. All remaining walls (optional)

The following is an outline scope of work:

1. Remove all the exterior siding. If careful, it may be possible to re-use the siding. Store for re-use or discard if replacing.
2. Remove deteriorated material and replace with new as needed. Match existing for all wood materials (plywood and framing lumber), all replaced gypsum should be non-paper faced (DensGlass Gold or equivalent)
3. Modify building connection details to include appropriate membrane waterproofing and flashing
4. Install a building wrap over the exposed wall
5. Install a 1/4" vertical spacer strip to provide for a drainage gap behind the siding (recommended option)
6. Reinstall the original siding or install new siding
7. Paint as necessary

This approach has a more reliable cost associated with it due to a fairly known extent of scope. This approach provides an easier method to maintain the aesthetic appearance as there are definite termination lines for the siding. By targeting the known walls that are experiencing problems the majority of the issues will be resolved; however, there is still some risk associated with this approach since certain portions of the exterior walls may not be addressed.

Option 3: De-clad and repair all walls

Option 3 expands the scope of option 2 to include all walls regardless of potential damage. This approach provides the most reliable repair due to all of the walls being exposed for inspection. In addition it provides the opportunity to integrate some building wide improvements to the current design.

The locations for the de-cladding and repairing would be as follows:

1. All walls (project can be phased following priority list set out in Option 2)

The following is an outline scope of work:

1. Remove all the exterior siding. If careful, it may be possible to re-use the siding. Store for re-use or discard if replacing.
2. Remove deteriorated material and replace with new as needed. Match existing for all wood materials (plywood and framing lumber), all replaced gypsum should be non-paper faced (DensGlass Gold or equivalent)
3. Modify building connection details to include appropriate membrane waterproofing and flashing
4. Install a building wrap over the exposed wall
5. Install a 1/4" vertical spacer strip to provide for a drainage gap behind the siding (recommended option)
6. Reinstall the original siding or install new siding
7. Paint as necessary.

Given the estimated scope of work, we would recommend at minimum Option 2 with a possible phased approach to complete the repair to the extent outlined in Option 3.

Window Systems

As a subset to the wall recommendations, there are several options to consider in regards to the window systems

Option 1: Leave as is - The areas where reviewed did not indicate a severe problem related to the water management performance of the window systems, however some deterioration was noted. It may be possible to leave the existing windows as they are; however, we feel that this approach brings with it a high risk, particularly if other elements of the exterior wall assemblies are being repaired. This approach should only be considered in conjunction with Wall Option 1 or with areas that are not addressed in Wall Option 2.

Option 2: Leave in place and seal flanges with membrane flashing – This approach will minimize the risk of water infiltration at the window to wall interface; however, it does not address the identified concern of water infiltration through the window assemblies themselves. This approach could be implemented with any wall option strategy.

1. On areas where a new building wrap is being installed, the membrane flashing would be integrated with the buildingwrap.
2. On areas where no repair to the wall is being completed, we would recommend cutting an area of the cladding out from around the window equal to the width of new trim. This will allow for the membrane flashing to seal the window flanges to the gypsum sheathing. New window trim should be installed to cover the joint.

Option 3: Remove, install a pan flashing, and reinstall the window – This approach addresses both the potential leakage at the window to wall interface as well as window leakage through the unit itself. The scope is the same as option 2, with the additional steps of removing the window frame, installing a pan flashing in the window rough opening, and re-installing the window frame prior to the application of the membrane flashing seals at the flanges.

Option 4: Remove and replace the windows – This approach is identical in scope to option 3; however the original windows are discarded and replaced with new windows

We do not recommend Option 1. In our opinion the potential of continued water infiltration and future deterioration creates too much of a risk given that other repairs to the water management of the building are being completed.

While Option 2 would significantly decrease the risk of potential ongoing water leakage concerns, we feel that the cost difference between Option 2 and Option 3 would be minimal enough to justify Option 3.

We do recommend Option3 as a means to reduce the risk of water infiltration concerns in the building. This option does not improve the thermal performance and it does not address the aesthetic issue of the condensation within the sealed insulating glass units.

Option 4 would be recommended as the best approach to address all concerns related to window performance.

Crawlspace

There were only minor concerns identified with the crawlspace. We would recommend that the existing vents be sealed and the space operated as a conditioned crawlspace. In order to mitigate the potential for air infiltration from the crawlspace into the living spaces above, a strategy would be to install a fan to exhaust air from the crawlspace to the exterior. This will depressurize the crawlspace with respect to the living spaces above. The benefit of the net air flow being from the conditioned space into the crawl will be prevention of pollutants from migrating into the living spaces from the crawlspace as well as some heat transfer to the crawlspace to help protect against freezing of the pipes.

30 Forest Street | Somerville, MA 02143 | Phone 978.589.5100 | Fax 978.589.5103 | www.buildingscience.com