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ANALYSIS OF BUILDING ENVELOPE AND PREVIOUS REPORTS

By
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Submitted to Roger Taylor
for
Owners of Strata Plan VIS #2720

Subject Properties: Hampton Court located at 545 Manchester and Churchill Place located at 520 Dunedin

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Introduction

In accordance the strata's instructions I have now completed the review of Levelton Engineering Ltd.'s reports on the building envelope, the waterproof membrane and the specification for parking garage roof waterproofing. I have visited the site to review the construction and investigate water infiltration in both, a) areas known to have problems and b) other areas as well. I have directed Downs Construction Ltd.'s removal of flashings and claddings. I have documented this removal and the findings. The areas opened have been temporarily shielded with sheet metal. When a more permanent repair is required Downs Construction Ltd. will attend to it upon notification from the Strata or myself.

The focus of this report is specifically water infiltration concerns of both buildings. I have not attempted to detail every source of water ingress nor duplicated the work done by Levelton Engineering Ltd.. This report is designed to identify the cause of the water infiltration, attempt to quantify the extent of the infiltration, and provide a solution to the problem.

I have structured my report in three parts followed with a conclusion. I have begun with some construction background information and education. I find when dealing with construction issues it is important to know some of the basics. This helps to understand the problem and the solution properly. With out some education it is hard to comprehend what is being advised and compare it to other options or opinions. Secondly, I have given the results of our exploratory investigation, my opinion as to the problem with the construction, and a solution. Thirdly, I have briefly critiqued the Levelton reports with the added information now available from our removal of the cladding.

Construction Information

The two buildings are built with a design or technology commonly referred to as "face sealed". This type of construction relies on the exterior surface of the building to shed water and to be sealed against water penetration. Stucco cladding has never been considered watertight and works in conjunction with a tar paper membrane designed to shed water getting through or past the stucco to form a water barrier.

This type of construction has been used for decades. Previous building designs where often more simple, with fewer details, large overhangs, and thicker stucco. Still older buildings with face seal design did and are experiencing water infiltration problems. Signs of this water can be seen with removal of the exterior cladding. This wall system (face sealed) has changed significantly over the years. New products, heavier vapour barriers, more insulation, and sealants have almost completely sealed the wall system from the inside. This has in effect reduced any drying of the structure due to air movement through the wall and interior heat leaking out. Moisture is now trapped in the wall system for extended periods of time. Evan the moisture from rain during construction can become a problem with the walls so well sealed. In essence the wetting cycle (water getting past the face seal) is no longer off set by drying cycles or heat loss from the building. Modern buildings with water infiltration are not drying before getting wet again. The result is a building with considerably less tolerance to water infiltration. This technology should not be recommended for our climate.

New buildings are also designed to look more attractive, incorporating decks, roof gardens, offset and terraced balconies and other details that must be attended to in both the construction and maintenance. Flashings, joints, connections, expansion strips, windows, membranes and every other item referred to as the building's "details" are potential entry points for water infiltration. New designs and architectural details are often difficult for competent trades to get right. No one is capable of perfect work and often the low bid is won with less expensive and less competent workmanship and materials. This results in some of the details being completed improperly and failing. Even a one to ten percent failure of these details in buildings sensitive to water infiltration can have horrendous effects.

Water infiltration requires a combination of three factors

1. a source of water
2. a force to propel or draw the water in
3. a place for the water to enter

The source of water is obvious, rain (can also be sprinklers and hoses). Exposure is a key factor. With limited or no overhangs buildings are more exposed than ever. Walls exposed to the prevailing winds have more problems than sheltered walls.

The force is gravity, wind, pressure, and capillary action. A building with a negative pressure inside due to ventilation, heating, and cooling systems can actually contribute to water infiltration by drawing the water in. The wind exerting pressure on the building can cause the building to have a negative pressure and drive the water in. Gravity is a constant factor pulling water along the easiest path. Capillary action allows water to run in where a path of water exists. It may take hours to create the path however once the path is made a surprising amount of water is able to flow.

The entry point is most commonly found in the "detail" area of the building. Usually one can find some detail work that was incorrectly installed, damaged, or not maintained. Holes, cracks, and water saturating the cladding also allow a point of entry.

The face seal system combined with the other elements of modern construction is the wrong technology for our climate. The "rain screen" system or the "drain screen" system is a far better system to be used for building envelope protection. The rain screen technology is not new. It does increase costs of building. The added cost and the assumption that the face seal system worked is likely the main reason that the rain screen technology was not utilized more.

The rain or drain screen system on a basic level simply creates an air space between the building exterior wall and the cladding. The wall is protected with a water shedding membrane and then strapped. The cladding is installed to pressure treated strapping keeping it away from the building and providing an air space. The most obvious benefit is that water infiltrating the cladding is able to run down between the cladding and the building. This creates a secondary drainage (the primary being the exterior of the cladding).

The system and technology are not that simple. Two of the main factors at work are:

- The air space if ventilated helps to equalize the pressure so that less water will actually infiltrate through the same size opening and in the same conditions as in the face seal system.
- The air space provides a dryer cavity and greatly increases removal of moisture through drying. The drying surface is very large allowing for good drying through capillary action, evaporation, and diffusion.

The results of this technology when applied correctly are as outlined below:

- Less water will infiltrate given the same circumstances.
- The secondary drainage system behind the cladding will allow the water that infiltrates to freely drain.
- The air space and the additional surface area create a dying area for removing excess moisture.
- The exterior of the sheeting has a more consistent watertight membrane with considerably fewer perforations. Water that does not drain off must get past the air space, find a breech in the membrane, and enter with considerably less pressure or forces assisting it. Water infiltration is reduced to a bare minimum.

Although the above is a quick and simple explanation of the two types of technology the benefits of the rain screen system is clear. The City of Vancouver has taken steps to see that the rain screen system is incorporated into all new construction. They are working to create a new professional that will be a building envelope specialist and will be required to monitor the construction of the building independently of the City. My belief is that the work the City of Vancouver is doing will become the standard building practice in our area and probably part of the building code requirements.

In light of the above I would be remiss if I did not bring this to your attention and recommend it as the best solution to your problem. In fact, to change the technology is the only solution that will permanently resolve the problem. This of course is an expensive proposition and as such not the most economically attractive. I will suggest an alternative that would be more economical and buy some time for the owners. The alternative however is not a permanent solution.

Investigation Results

An exploratory investigation to the exterior of the building was completed and documented on video. The investigation was completed near the end of a very long wet winter season with many harsh storms and high winds. The video captures the removal of cladding and flashing as required to assess the building paper and sheeting below. In most cases the building paper showed signs of water having infiltrated but was not overly wet. The sheeting under the paper was moist with moisture content levels ranging from zero to twenty eight percent. The video compliments this report and further information is provided in the narrative.

Specific Deficiencies

During the exploratory investigation I was able to confirm that the majority of the water infiltration and the leaks documented to date are related to several details that have not been attended to well. Outlined below is a list of problems encountered.

- Building Paper: The building paper is poorly installed and incorrectly lapped in some areas. The edge was not caulked or taped to the window frame allowing water entering around the window to get under the paper.
- Windows: The windows themselves showed no indication of leaking. The slider style of window is not the best for this application and has problems inherent to it. Water is entering in some cases around the window due to stucco and flashing details. This is documented on the video (south wall of Hampton court) where we found moisture content readings of twenty eight percent by the window frame around the center of the window edge flange. We were able to rule out other sources of ingress.
- Window Flashing: The window flashing appeared to be installed correctly in the areas exposed. Some flashing is sloped back to the building. This can contribute to the water infiltration and is likely caused by building shrinkage and movement.
- Stucco: The stucco is cracked in many areas. This is common and related to building movement and shrinkage. : The fire wall has some sever cracks in the stucco and one area that was not flashed properly allowing water in since day one. This is documented on the video. The stucco is divided with vinyl and metal expansion channels. Some of these particularly on the first level are installed for appearance only. Stucco is used to clad the decorative bands around both buildings and corner posts on the balconies. I have found problems in both areas.
- Expansion joints: The expansion joints are a definite source of water ingress. At the corners there are open joints with no caulking. Butt joints are not sealed. These details also channel water into windows and other areas where they terminate allowing water to in some areas to flow behind the stucco.
- Decorative band flashing: The decorative bands are positioned close to the bottom of the windows. For the flashing to be installed easily it was cut differently at the windows. When the flashing was installed it was simply over lapped at all of the joints. Each window provided two lap joints, as the flashing under it was a different profile. These joints rely on caulking that has failed in several areas due to poor installation and building movement. This is documented on the video. The video shows an area on the south side of Hampton Court where this flashing was pulled up showing the water beneath it.

- Balcony flashing: The flashing to the balcony is a difficult installation by design. There are several areas that are allowing water ingress despite the fact that it appears that the sheet metal trades people tried hard to make it work. This is evident on the video as well as on the balcony of units #208 and #410 of Churchill Place.
- Balcony membranes: The balcony membrane is a thinner material than I would recommend. There are individual problems such as in unit #410 of Churchill Place. These can be addressed on an individual basis. It is the nature of these balconies to have ponding or poor drainage. This is more of a nuisance than a problem provided the water does not exceed the height of the membrane upstand edge or the bottom of the patio door. In unit #409 of Churchill Place the drain is installed near the exterior wall of the building on a cantilevered deck. Cantilevered decks are known to settle with the unsupported corner becoming lower that the connection at the walls. The ideal location for the drain would be in the unsupported corner. The style of drain utilized can also be a source of problems and should be monitored and maintained. Water infiltration above the membrane from the railing and flashing details can get behind the membrane. This could cause the membrane to fail creating a further problem. An example of this can be seen on the video of unit #208 of Churchill Place.
- Balcony railings: The balcony aluminum railings are secured to the building with screws and other fasteners that go through the flashings and stucco into the structure. Several where found to be lacking any caulking or sealant to prevent water ingress through the holes made by the fasteners. This is evident on the video and on the balcony of units # 208 and #409 of Churchill Place.
- Roofing: The roof membrane has been moved and shifted with the building settlement and torn open in some areas. This is dealt with more extensively later in this report.
- Plumbing vents: The building settlement has dropped the metal storm collars by as much as one and one half inches. These collars stop water from entering between the vent pipe and the roof flashing. They where originally installed over tape to seal them to the pipe. The tape band is now above the collar leaving it loose and unable to stop the water entering. The leak to the left of the door to Hampton Court is likely a result of an internal plumbing leak. To properly assess this situation we will require some scaffolding be erected over the awning or to open the wall space from the inside.

The above is a good indication of the amount of problems found. This is far from a complete list as it was not the intention of this review to try to identify every source of water infiltration. Three things became evident:

1. The majority of the problems are related to flashings on the balconies and decorative bands.
2. Many of the other problems can be identified and temporarily corrected with caulking or simple maintenance.
3. There is no certain method to seal this building and stop one hundred percent of the water ingress with out removal of all of the exterior cladding.

Some facts to Consider

- During construction anything beyond 19 percent should be dried prior to closing in.
- In wood zero to sixteen percent moisture is acceptable and does not allow for rot or decay.
- Seventeen to nineteen percent moisture is borderline and twenty percent or higher is problematic.
- Wood with twenty percent or higher moisture content over a significant amount of time lends itself to rot and decay.
- Moisture meters utilized to collect this data can vary according to species and temperature. This variance cannot easily be compensated for under the circumstances of our investigation and the product we are testing.

The tests indicated that the more exposed areas of the buildings had higher readings of twenty plus percent. The less exposed or sheltered areas had lower readings between fifteen and seventeen with the occasional nineteen percent. The sheeting I exposed showed no signs of rot, decay, or microbiological contaminates. It should be noted that no testing was preformed for microbiological contaminates. I cannot recommend any testing to be done at this time.

There were indications of swelling and delaminating of the OSB sheeting in its earliest stages. It is obvious that this problem is in its early stages and will likely take years to reach the degree required to do structural damage. This is based on the observation of areas exposed. There is a chance that there are presently areas of rot going unnoticed. Efforts where taken to get test areas that are representative of both buildings. Odds favor some undetected problems existing at this time.

The severity of these undetected problems can only be guessed at. Usually the type of problems that cause structural damage show symptoms of water infiltration into the building long before the damage is done. These symptoms are often temporarily repaired, caulked and or ignored for years allowing the damage to take place.

I cut test holes in areas of the building that did not exhibit signs of water infiltration as a control measure. The moisture reading in these areas where similar to all of the other data collected.

In my opinion this building is experiencing problems that should be expected. The problems are inherent to the design and construction. Test results indicate that this is the first stage of deterioration and it has been identified before major structural damage has taken place. This is partly due to a diligent Strata Council and a building managers that have not ignored the problem or attempted temporary measures allowing it to persist for the time required to cause the structural damage. As the problem is in its early stages it allows the option of maintaining it until a time when it becomes necessary or the funds are available to correct it with the rain screen system. My feeling is that if left as is without any actions taken it would take another four to five years before significant structural damage occurred. With maintenance and some corrective measures taken now this could easily be extended to ten to fifteen years. The key is to keep on top of it, not to ignore even the smallest concerns of individual owners, and to complete annual or biennial reviews.

The Problem:

The problem is simple. The buildings where constructed with a poor or faulty technology for our climate. This technology leaves the buildings very susceptible to water infiltration. The design, workmanship, and exposure guarantee water infiltration.

The Solution:

The solution is simple. Change the technology to one that is better for our climate. This would mean removal of the exterior cladding, redesign of the building exterior to allow for the rain screen technology, and the installation of a new exterior cladding utilizing the rain or drain screen technology. Roughly estimated at two and one half to three million dollars to complete both buildings.

The Alternative:

The alternative is not so simple. The alternative is to understand the problem, correct the most obvious deficiencies and areas of water infiltration, and monitor the situation. The object is to limit the water infiltration as best possible and maintain the buildings knowing full well that the problem exists and that it will require more maintenance and higher repair budgets. It is simply a way to live with what you have. What must be remembered is that each detail in the building has a potential to allow water in. No work is perfect, and there fore no repair that does not change the technology can correct the problem or could be considered a permanent repair. I can guarantee that water will, whether noticed or not, infiltrate the face seal on these buildings and cause more problems in the future if not corrected. I also believe that with competent management and maintenance focussed on this problem it can be maintained in such a way as to not cause major structural damage, hamper quality of living, or have a significant negative impact on the building. Having said that it should be noted that there would likely be areas with damage possibly even structural in the future. The strata would be taking a risk that the initial repairs, the additional maintenance, and any future repairs related to this would be less costly than putting up all of the money now to correct the problem.

Review of the Levelton Reports

I will take this opportunity to discuss the reports, my impression of them and any suggestions I have.

Waterproofing Membrane Review

The Levelton report suggests that the membrane is attached well on the horizontal surfaces and is failing in approximately three areas. They are:

1. The perimeter upstand wall where it has become unbonded or delaminated.
2. The patios around the drains and where new drains have been installed
3. The electrical and irrigation system penetration through the slab.

They also mention the possibility of other perforations.

I agree with their findings. The repair specifications outlined leave me with a few reservations. I feel that it would be wise to attempt to solve this problem as outlined below rather than the extensive work outlined in the report. I also have some concern as to the design for repair and would suggest getting a second opinion if going this route.

I was not engaged to do further investigation into this problem. I was however asked to address a suggestion I had. Roger Taylor had shown me the water infiltration and the delamination of the membrane from the exterior walls above grade. It is possible that the majority of the water infiltration is a result of this delamination.

The correct detail would be to curf the wall above the membrane and installed a flashing to protect the top edge of the membrane. This is sited in Levelton's repair specification. The water infiltration through the concrete is more of a nuisance than an immediate problem. The structural damage that would result takes years of exposure. My recommendation would be to clear the landscaping around the perimeter of the building as required to expose the top of the membrane. Inspect the membrane, repairing and fastening it to the wall as required. Do not be concerned at this time with the area below grade or the water now trapped under the membrane. Curf the wall above the membrane and install the flashing above it.

This may result in most of the problems being resolved. Other problems that persist may be able to be pinpointed and repaired without addressing the entire membrane. If this does little of nothing to solve the problem and replacement is required the work done to install the flashing can still be utilized. Only a portion of the costs will be duplicated.

Due to the nature of this water infiltration and the time it takes to do any significant structural damage there is very little risk in approaching the problem from this direction. On the other hand there is a real potential for this to save the strata from having to carry out the expensive repairs outlined in Levelton's report.

Building Envelope Review (Levelton Engineering Ltd. November 1998)

In general I agree with the findings of this review. I will discuss each section briefly.

Building Exterior

- I agree with Mr. Knight's review of the windows, balconies and building exterior.
- I agree with the areas of concern that where identified in the report.
- I disagree with the repairs outlined.
- I feel that Mr. Knight has missed the main focus of the review. All of the problems and deficiencies reported can be corrected however the building will still have a problem with water infiltration. The areas repaired will also have some percentage of failure. To report that the building's problems can be corrected with the repairs outlined in Levelton's report is misleading. Those repairs will stop a significant amount of water infiltration however the measures outlined could not be completed in a way that would safe guard the buildings from all water infiltration.

Balconies

- I agree with the deficiencies noted.
- I agree with the recommendations for repairs. I do have concerns as to how that work could be done properly given the current design. The current design makes it almost impossible to install metal flashings where all the joints are standing seem or S locked style. I recommend changing the design of the balcony railings to minimize flashing and detail work.
- The balconies should be addressed once a decision has been made on the building exterior repairs. Some design changes would make the balconies more practical and cut down the repair costs. Removal of the stucco corners and installing a continuous aluminum railing would reduce a lot of the problem areas for the sheet metal and stucco work.

The Roofs

- The roofs have some areas of concern.
- These areas represent the typical problems that should be addressed as buildings shrink, settle, and age.
- I do not agree with Mr. Knight that the "workmanship of the original installation appears to have been poor". As in all aspects of construction we rely on people and no job is perfect. People make mistakes and things can go wrong. That is precisely the reason we have warranties. The company utilized for the roofing is one of Victoria's better companies for this type of work. They do good work and warrantee their work well. Perhaps one must see some examples of really poor installations before condemning this roof.
- I agree with most of the deficiencies noted and the repairs suggested. I found the roofing to be fairly straight with a high percentage of the workmanship to be good. Most of the deficiencies can be related to building shrinkage, settlement, and movement.
- I find no evidence of problems that would require $18,0000 to repair as estimated in the report.

In my opinion the roof is in need of some maintenance now however I find no indications that it will not perform properly to its normal life expectancy if properly maintained.

General

I found Levelton's report to be very good at describing the building particulars, and type of construction. They have also detailed some of the application problems and deficiencies with the building very well. Problems and deficiencies of this nature are common to all buildings. Causes of these problems including building settlement, shrinkage, movement, poor construction and a lack of supervision. Further and more in-depth investigations and reports will bring more of these problem details to light. It is not necessary to identify all water ingress to report on the problem the building is faced with and the solution.

In my opinion Levelton Engineering Ltd. has missed the big picture. The technology leaves the buildings vulnerable to water infiltration. No competent contractor could build or repair this building and "face seal" it to the extent that there would be no water infiltration. The solution then is to change the buildings to a technology that is not vulnerable to water infiltration. The alternative is to maintain and live with buildings that leak and expect greater maintenance costs. An analogy would be a very old cedar shake roof on a building. You know that the roof requires replacing however for economical reasons you choose to repair and maintain the roof running the risks that the roof will not leak badly enough to cause serious problems. To recommend repairing and maintaining this roof without telling the customer they need a new roof is doing them a disservice even if in the end they choose to only repair and maintain.

Conclusion

The face seal technology utilized in the construction of these buildings is extremely difficult if not impossible to make work and maintain. This is the wrong technology to utilize in our climate and should not have been attempted. The rain or drain screen technology is far superior and in my opinion the correct method to have been used for these buildings. The water infiltration problems can either be corrected or maintained. The obvious and likely best correction for the problem would be to change to the rain screen technology. This would require the removal of the entire exterior cladding (stucco) and starting from the sheeting. There is a further advantage of exposing all damaged areas of the building and allowing for treatment of any microbiological contamination. This is the best and the most expensive option outlined in this report. The costs though may be prohibitive. The only other option that I can recommend is to understand the problem, reduce the water infiltration at the obvious and worst areas, repair known damage, and live with the problem increasing maintenance and inspections to prevent and repair problem areas as they become apparent. This option does not repair the problem, address hidden damage, or allow the treatment of microbiological contamination. It is risky and should be implemented with a special maintenance fund.

Another fund to raise money to change to the rain screen system in the distant future would be desirable. Thus when maintenance and repairs have taken their toll on the buildings and their appearance and condition is lacking the funds would be available to change to the better system. My recommendation if you go in this direction is to complete the work in one area of one building so that any surprises, and or difficulties that change the work can be addressed prior to tendering the entire project.

Following I have listed as a guide the next steps the Strata may wish to entertain.

- Decide which option or direction that is best suited to the owners as an avenue to proceed. I recommend to either implement a rain screen system or to work with the existing system to reduce and prolong the negative effects of water infiltration.
- Complete the design work required to carry out the option chosen.
- Write up a complete specification for the work.
- Identify the areas of the buildings to be worked on if not completed in its entirety.
- Choose one area and complete the work there first as a test area.
- Upon completion of the work to the test area revise the design and specifications if required.
- Place the project for tender and complete the work.

I trust this report has accomplished what the Strata was looking for. I am available to clarify or explain any of the report or details if required. If there is anything else I can do to assist you with this or any other construction matters please feel free to contact me at 380-6396 or alternatively at 384-1390.

Yours truly,

D. A. Downs
Per DougLes Consulting Services Inc.