INTRODUCTION

Larson Engineering inspected the exterior masonry cladding on the XYZ Plaza buildings during June and July, 2002. The inspections showed that deterioration of the exterior cladding continues, and with it, the need for repair and maintenance. The majority of the brick and limestone cladding is currently in fair to poor condition.

The root cause of most of the cladding degradation is a failure of the cladding system to resist water infiltration, and more importantly, to properly drain that water which does penetrate into the cladding. To improve the performance of the masonry cladding, Larson Engineering recommends that the brick be tuck-pointed and sealant replaced. We also recommend more extensive renovation of the limestone cladding that includes removal and repair or replacement of the stone panels, installation of flashing, and reinstallation of the stone using new stainless steel anchors.

An estimate of the cost for tuck-pointing the brick is $1 million to $1.3 million, and for renovating the limestone $2.6 million to $2.8 million. The work can be phased and spread over a number of years.

INSPECTIONS

Larson Engineering performed visual inspections, with the aid of binoculars, of all portions of the exterior cladding, from ground level and from surrounding buildings, on June 5, 6 and 11, 2002. We also made visual inspections of the masonry cladding from inside the parking garage on June 11. On July 3, 8, 9, and 10, 2002 close-up inspections from a suspended scaffold were conducted on four areas of the buildings. The close-up inspections from the scaffold revealed only two conditions on the 16th Street elevation of the X Building that were not noted during the ground inspections, and the inspections from the scaffold eliminated more than two questionable conditions. Thus, the inspections from the scaffold showed that the visual inspections from the ground were effective in identifying hazardous conditions.

The inspections were performed with three specific intents:

- Identify specific conditions requiring immediate attention to eliminate safety hazards

- Identify deterioration that has occurred since the previous inspections performed by Halsall Associates
- Generally assess the condition of the cladding in order to make recommendations for repairs and renovation

Larson Engineering did not attempt to catalog the locations of all of the defects noted in previous inspections. The focus of our observations was on deterioration that had occurred since the previous inspection and especially on those conditions that represent a hazard to the public.

FINDINGS

A detailed listing of the findings of the inspections is provided in the "Field Observations" section of the report. Those observations are condensed and analyzed in the following paragraphs.

Immediate Action Items

A number of loose spalls and other conditions that are or could be safety hazards were identified during the inspections. The location of these defects was random relative to the building elevations, but did tend to concentrate near the parapets. A list of "Immediate Action" items was given to Building Management and The Contractor on July 9, 2002 and updated on July 10, 2002. A copy of the list is included in Appendix A. The items on the "Immediate Action" list should be taken care of as soon as possible, and should be completed before autumn when freeze-thaw action begins. In addition, gaps and holes left after the removal of loose spalls should be patched to prevent increasing water penetration behind the cladding.

General Assessment

The major source of problems with the masonry cladding on the XYZ Plaza buildings is a failure to adequately control and drain water that infiltrates into the cladding. With age, the mortar and sealant between the bricks and stone are also deteriorating, further decreasing the resistance of the wall to water infiltration. Even without deterioration, masonry materials such as brick, mortar and limestone are water permeable, and there are minute gaps between the masonry units and the mortar that allow water to penetrate the masonry. Creating a masonry wall completely impermeable to water is not a realistic goal,

thus means must be provided for controlling and draining the water infiltration that does occur.

Compounding the water infiltration problem on the XYZ Plaza buildings, particularly at the limestone panels, is the fact that the anchors that tie the masonry back to the building structure are made of carbon steel and subject to rusting. As they rust and corrode, the steel anchors swell and place additional stresses on the stone and brick.

In the case of the cracked limestone and granite panels on the 13th Avenue elevation of the hotel and adjacent to the X Building, relative movements of the buildings appear to be playing a role in the failure of the stone.

Limestone

The limestone panels that make up the column covers, fascias and parapets of the XYZ Plaza buildings are in good to poor condition with the majority being in fair to poor condition. The panels in worst condition occur at the column covers at the parking garage levels, on the 13th Avenue elevation of the hotel and at the fascias and parapets all around the buildings. The amount of deterioration of the stone relative to the stone's location on the building is generally proportional

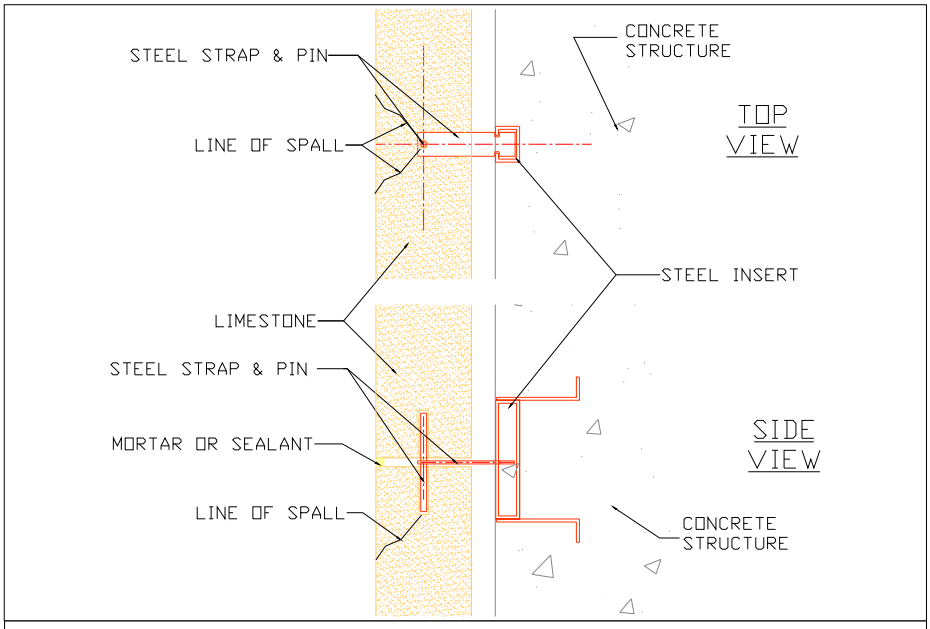

Figure 1. Existing Anchor Detail

to the stone's exposure to water infiltration.

The most common type of failure of the limestone is spalling or cracking of the stone along the top and bottom edges of the stone where the anchors are located. The anchors that tie the stones back to the building consist of a steel pin inserted into the stone and through a steel "dove-tail" strap that slips into slotted inserts in the structure behind the stone. See Figure 1.

Water that gets behind the stone causes the pin to rust, and with the rusting comes an increase in the volume of the pin that exerts pressure on the stone, eventually causing the stone to crack and spall. In addition to the swelling of the anchor, the water that causes the rusting may itself be freezing and expanding, placing additional stress on the stones.

The large crack in the stone column cover on the 13th Avenue elevation of the hotel and immediately adjacent the X Building that runs from the granite base course up into the first 8 or so courses of limestone appears to be due to relative movements between the two buildings. If these stones are replaced, expansion joints of adequate size must be installed in the correct location to allow for those movements.

A number of the patches previously made to the limestone have failed, most noticeably at the very large spall on the 13th Avenue elevation of the Hotel, column line H, level 12. Appropriate materials and procedures must be used to patch the stone.

Brick

The condition of the individual brick units is good overall, with few instances of cracked or broken bricks being noted. The condition of the mortar between the bricks varies from fair to poor depending upon the location on the building. In most locations, the brick mortar is beginning to soften and lose cohesion such that it will "dust off" when rubbed with a fingertip. In some locations, particularly the courtyard elevation of the Y Building and the Hotel courtyard elevation, the mortar is cracking and coming loose from the joints.

The Brick Industry Association estimates the life expectancy of mortar at 25 years or more. Given the approximately 40-year age of the XYZ Plaza buildings, the buildings are probably due for tuck-pointing, even if they have been tuck-pointed before. To Larson Engineering's

knowledge, the buildings have never been tuck-pointed except for whatever renovation work was done on the X building.

On the Blue Street elevation over the entrance, the brick has spalled and come loose from the wall. Stains indicative of water being behind the brick are visible in the areas of the failures and above.

At the elevator penthouse on the hotel building, a cracked mortar joint "steps" through the thickness of the parapet wall to the left when viewed from the courtyard. Please refer to Figure 2. The location of the crack is at approximately the level of the penthouse roof, and is indicative of a failure due to water from the roof entering the brick wall and freezing. It should be verified that the roof of the penthouse is properly flashed and drained to prevent water entering through the back of the penthouse wall.

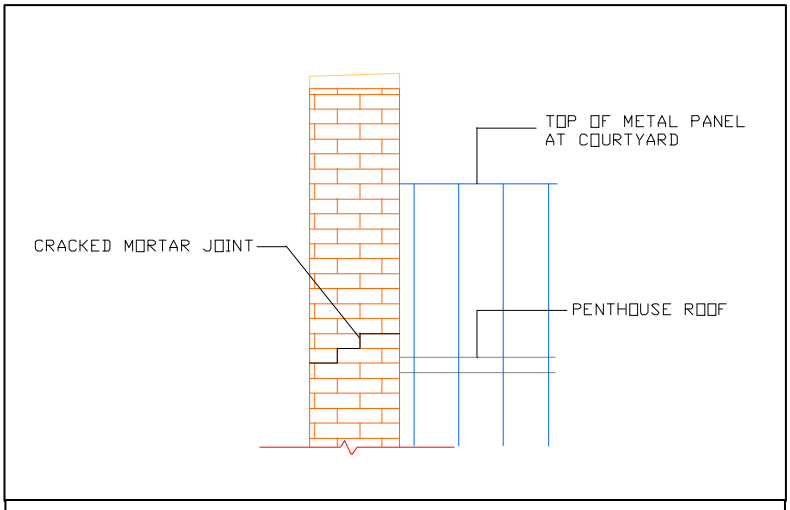

Figure 2. Crack at Penthouse Parapet

Sealant

Sealant (caulk) joints on the building are in generally poor condition showing cracking, tearing and loss of adhesion. The sealant appears to be a polyurethane sealant, a type often used in masonry applications, and it has probably reached its expected life of about 10 years. Where used in joints that take movement or are too wide for mortar, the existing sealant should be removed and replaced. In some instances, sealant has been applied over the top of a mortar joint; we do not recommend this practice because it tends to trap water inside the masonry wall.

RENOVATION AND REMEDIES

Immediate Action Items

The “immediate action items” consist of loose spalls and old patches in the limestone panels that need to be removed before they come loose and fall from the building. If, in the process of removing the loose pieces of stone, holes are created in the façade that would allow water infiltration behind the stone, those holes should be patched.

Many of the patches previously applied to the stone have deteriorated and failed. If the patches applied to the stone are intended to be permanent, and not just a stopgap measure until more intensive repairs are made, then the material used to make the repairs must be carefully selected. The material must be appropriate for the size and type of repair being made, and must be properly applied. We have had positive results on a previous project using Jahn Masonry Restoration products, and would recommend those products. Other products may also be appropriate.

Brick

Larson Engineering recommends that the brick façade be tuck-pointed and that sealant be removed and replaced in order to increase the façade’s resistance to water infiltration. Tuck-pointing entails removing the existing mortar using a power grinder or a toothing chisel to the greater depth of three-quarters of an inch or until sound mortar is reached, cleaning all dust and debris from the mortar joint, and installing new mortar. The work should be done in accordance with the Brick Industry Association standard *Technical Notes on Brick Construction 7F*. As the tuck-pointing work progresses, broken and heavily spalled bricks should be replaced using accepted brick industry methods.

At this point Larson Engineering does not see the need to recommend the installation of flashing on top of the ledger angles that support the brick because the ledger angles and brick are in relatively good condition. However, if deteriorated ledger angles that need replacement are found, then flashing should be installed when the angle is replaced.

In any case, the ledger angles will tend to act as flashing, collecting moisture behind the brick and pushing it towards the exterior. To

facilitate drainage of this moisture, weep holes or wicks should be installed between the bricks on top of all ledger angles. Wicks should be installed at a maximum of 16 inches on center and weeps at a maximum of 24 inches on center per the Brick Industry Association standard *Technical Notes on Brick Construction 7*. (These weeps or wicks should be installed whether or not the ledger angle is replaced.)

At sealant joints, all the existing sealant should be cut out and the surfaces that the sealant adheres to should be cleaned. A joint of the correct depth should be created by installing a non-absorbent, non-gassing foam backer rod. In the case of shallow joints, no backer rod is required, but a bond breaker tape should be applied to the back of the joint to prevent three-sided adhesion. Installation and tooling of new sealant completes the work. To avoid staining of the masonry and to maintain compatibility with the existing sealant, which practically cannot be completely removed, Larson Engineering recommends using a polyurethane sealant such as Tremco Dymeric 511 sealant that offers movement capabilities equivalent to silicone sealants (plus/minus 50 percent of joint dimension). The expected life span of polyurethane sealants is about 10 years.

The cost of tuck-pointing the brick and replacing sealant is estimated to be $8 to $10 per square foot. With an approximate 129,622 square feet of brick cladding on the buildings, the total cost is expected to range from $1,036,978 to $1,296,222. The cost estimates for the tuck-pointing and the limestone renovation were provided by W.R. Weis Company, a Chicago masonry contractor, based on the information in this report and on prevailing wage data for Hennepin County. The square footage was calculated using elevation drawings that Larson Engineering drew based on the original architectural drawings, and extrapolated to include the areas over the Federal Building and the mechanical penthouses. The estimates of the cost for both the tuck-pointing and the limestone renovation must therefore be regarded as "ballpark" figures. Our calculation of the cost estimate is in Appendix C.

The tuck-pointing work could be done in phases with one elevation of a building being done at a time. If phased, Larson Engineering recommends beginning the work at the courtyard elevations, as that is where the brick is in the worst condition.

Limestone

Given the ongoing deterioration of the limestone cladding, the safety risks it presents, and the costs of inspecting and maintaining a deteriorating cladding system, Larson Engineering strongly recommends that the owner consider a major renovation of the limestone cladding on the XYZ buildings. This would entail:

- Removing the existing limestone panels and repairing or replacing damaged stones. Patching must be done using materials and techniques that assure safe, long-lasting repairs.
- Replacing the steel ledger angles as needed with galvanized steel angles
- Repairing, replacing or installing (if none exists) the waterproofing on the concrete structure behind the stone
- Installing new stainless steel flashing over the ledger angles
- Reinstalling the limestone panels using new *stainless steel* anchors
- Installing weeps that drain moisture to the exterior
- Sealing the joints between the stones with a polyurethane sealant following procedures as described above

Figure 3 presents a detail of the limestone cladding renovated in this manner. The combination of non-corrosive anchors and a properly flashed and drained wall cavity should greatly reduce the cracking and spalling of the stone with a commensurate reduction in maintenance costs and risks.

At the column on the 13th Avenue elevation of the hotel adjacent the X Building where several stones are cracked, the location of the joint between the buildings needs to be determined, and new stone installed with a joint between the buildings of adequate size and in the correct location to accommodate building movements. This is in addition to the steps outlined above.

This work could also be done in phases. The areas where repairs are most needed are on the 13th Avenue elevation, and the 17th Street elevation, particularly at the parking garage levels. The cost per square foot for this work is estimated to be $70 to $75 if the old stone is replaced with new. With an approximate 37,374 square feet of

limestone cladding on the buildings (X Building not included), the total cost is estimated to be $2,616,198 to $2,803,069. These prices include a $10 per square foot cost for demolition. If the existing stone is saved for re-use, the cost for demolition increases to about $25 per square foot. Thus the cost of repairing the old stone would need to be $15 per square foot less than the cost of new stone. This may or may not be the case.

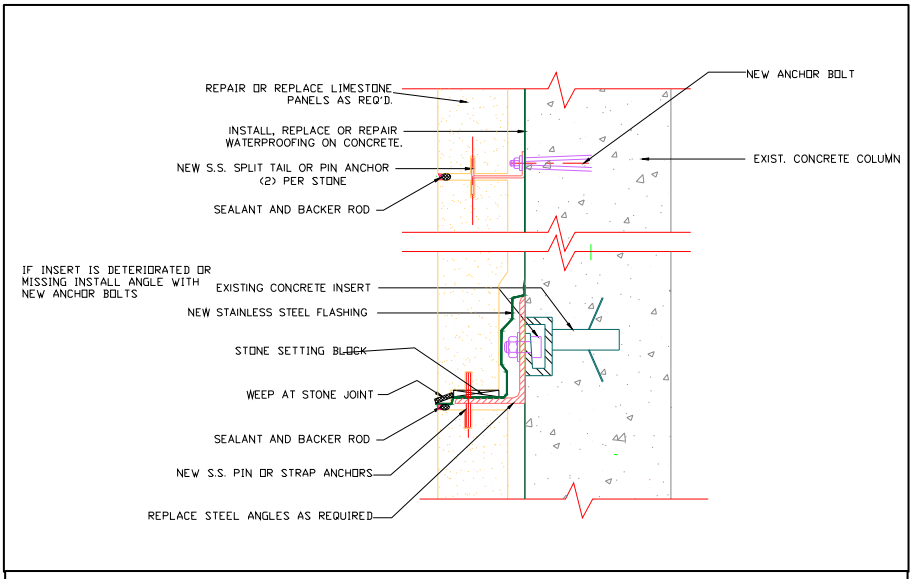

Figure 3. Limestone Remedial Detail

On the X Building, failure of the stones is concentrated at the parapets and related to the corrosion of carbon steel anchors. Given the limited façade area on this building, it is probably more cost effective at this time to continue to monitor and repair the wall as required. Repairs intended to be long term should, depending on the situation, include removal of the old corroded anchors, re-anchoring the stone with a non-corrosive stainless steel anchor and patching the stone using materials and techniques that assure longevity. The details of such repairs would depend on the location, the stone and its condition, and the structure behind the stone. Any roofing or flashing leaks that occur in this area should be promptly repaired to prevent large amounts of water from getting behind the stone façade.

ALTERNATIVES

For comparison purposes, an alternative to repairing the existing façade is to replace it with a new cladding system. An all-new glass and aluminum curtain wall that would replace the limestone, brick, panels, grates, and windows would cost around $70 per square foot for a standard system, or a total of $18,408,845 for the approximately 262,983 square feet of total wall area. An all-new cladding system would allow for changes to the aesthetics of the building if desired. Other options such as replacing the limestone with another material are also possible.

It should be noted that if the deficiencies to the existing cladding are not corrected, the owner will need to consider the installation of an all-new cladding system sooner rather than later.

CONCLUSION

Without taking steps to improve the ability of the masonry cladding on the XYZ Plaza to resist and drain water penetration, the need for maintenance and the risk of failure will continue and likely increase. Tuck-pointing the brick and renovating the limestone cladding will improve the performance of the exterior wall and reduce maintenance costs and safety risks.

If the owner decides to proceed with a renovation program, Larson Engineering offers its assistance in that endeavor. In any case, we appreciate having had the opportunity to participate in this project, and look forward to being of service to Building Management in the future.