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IRC 11089-MB10-165CR December 23, 2010

St. David and St. Patrick Anglican Church
520 Speedvale Road East
Guelph, Ontario
N1E 1P6

Attention: **Mr. David Kupp**

RE: Flat Roof Retrofit Feasibility Study
St. David and St. Patrick Anglican Church

Dear Mr. Kupp,

1. Terms of Reference

IRC Building Sciences Group Inc. (IRC) was authorized by Mr. David Kupp of the St. David and St. Patrick Anglican Church to perform a Flat Roof Retrofit Feasibility Study at the above noted site. The purpose of this study was to review and evaluate the options for replacing the existing flat roof with a new flat roof assembly or a sloped roof assembly.

2. Scope of Work

As noted in IRC proposal 4938P, the scope of work is as follows:

1. Review all available documentation made available to IRC. This would include drawings and building condition surveys. To determine the as built configuration of the roofs. It has been assumed that the existing building structural information will be obtained from the drawings. No destructive openings have been included to determine the as built structure.
2. The existing roofing systems at two roof areas will be visually inspected. As per our discussions, external access to the roofs is required. Core cuts will be made at both roof areas to confirm the roof composition.
3. During the course of this inspection, pictures are taken of the general roof area, as well as all anomalies which are pertinent to the determination of the roof condition and configuration.
4. Following the site work, a structural review will be performed to determine if the building has sufficient capacity to allow for the installation of a sloped roof assembly.
5. Upon completion of the investigation work a written report will be prepared outlining the following:
    1. Options for retrofit and recommendations directly relating to the determined condition,
    2. Budgetary costing to carry out the prescribed recommendations,
    3. Prioritization of the recommendations into a strategic multi-year rehabilitation plan.

3. Background Information

The following information was provided for IRC to review:

- Roof replacement quote prepared by Wm. Green Roofing dated April 15, 2009
- Roof truss quote prepared by Roof Trusses and Components Ltd. dated March 16, 2009
- Estimate for supply and installation of roof trusses and sheathing prepared by Framing Futures Inc. dated March 30, 2009.

- Structural Roof Report by Tacoma Engineers dated January 30, 2009.

Some architectural building plans were provided to IRC for review, drawings 1, 2, 2A, 3, 4, and 5 prepared by D.B. McIntyre Architect dated October 12, 1966. No structural drawings or timber frame drawings were available.

4. Building Description

The building was constructed in the late 1960s. The main building structure for the main hall section of the building is a concrete block foundation supporting glulam wood timber frames. Tongue and groove wood decking spans between the frames at the sloped mansard side walls and flat roof deck. According to the drawings, the roof deck is 4" thick. The end walls of main hall section are concrete block, with a stone veneer at the south elevation. At the rear of the building, there is a lower section of the building that houses the entrance foyer and a study area. This area utilizes concrete block walls supporting a segmental precast concrete plank roof deck.

It has been assumed that the elevation of the building facing Speedvale Avenue is facing south.

5. Existing Roof Review

The existing roofing systems are as follows:

1. The main hall roof system is a multiple ply, felt and asphalt, built up roof membrane assembly with pea gravel surfacing (Photograph 1). According to the cut test, there is a 1.5" thick layer of fibreglass insulation (Photograph 2). This roof has an approximate R-value of 7. At the core sample, the membrane felts were noted to be deteriorated. It appears that repairs have been completed recently at the south perimeter of the roof area (Photograph 3). This corresponds with comments made by Mr. Kupp, that there have been ongoing leaks at over the alter area at the south end of the main hall. The roof area is drained by 3 perimeter scupper; one at the southeast corner, one at the northwest corner and one at the mid point of the north side (Photograph 4). Deflection of the roof structure has resulted in ponding water in the centre of the roof area. This roof is at or near the end of its useful service life.
2. The roof system at the bump out on the east elevation of the main hall (Sacristy/Choir Area) has the same roof assembly as the main roof (Photographs 5 and 6). This roof is drained by a single scupper that drains down over the metal tile system at the mansard wall below, no downspout has been provided. This roof is at or near the end of its useful service life.
3. At the lower roof area over the foyer/study area at the rear of the building, the roof membrane system is a 2 ply modified bitumen membrane system (Photograph 7). The core test indicates that the roof assembly below the membrane includes a ½" layer of fibreboard over 3" of polyisocyanurate insulation, over a 2 ply asphalt and felt vapour retarder. This roof has an approximate R-value of 20. The roof is drained by 2 scuppers along the north side. The roof generally appeared to be in fair condition. According to information supplied to IRC, this roof was completed at the same time as the mansard roofs, approximately 13 years ago. The roof does not appear to drain very well. It appears that repairs have been completed in the form of hot pour asphalt at the perimeter flashing (Photograph 8). This roof has approximately 3 to 5 years of service life remaining.

6. Options for Roof Retrofit

Two main options for retrofit of the flat roof over the main hall of the church (including the sacristy/choir area) are presented;

1. Replacement with a new flat (low slope) roof assembly and
2. Retrofitting with a sloped roof utilizing wood trusses and a metal tile roof system.

For the new roof assembly option, IRC would recommend a 2 ply modified bitumen membrane system with a 10 to 20 year manufacturer's warranty. It is recommended that the insulation level in the roof be increased to R20. The new roof should incorporate a tapered insulation system to provide positive drainage to the perimeter scuppers and eliminate the standing was currently present. The installation of additional scuppers is recommended to minimize the requirements for tapered insulation.

This system would provide a 20 to 25 year service life. If the system is maintained regularly, at the end of its service life, the existing cap sheet membrane can be primed and an additional ply of modified bitumen cap sheet installed. This retrofit would provide an additional 10 to 15 years of service life at approximately 15 to 20 percent of the replacement cost. This process can be completed several times before complete replacement of the system down to the structural deck is required.

The other benefit of this system, is that it is lighter than the existing built up roofing system (approximately 4 psf (pounds per square foot) vs 8 psf), so the potential for further roof deflection would be reduced.

The sloped roof retrofit option would include the removal of the existing roofing system, reinforcing of the existing structure, installation of a new sloped roof structure and roof sheathing, metal tile roofing, and insulation and vapour retarder within the new attic space.

Based on the information supplied on the Roof Trusses and Components Ltd truss layout, the anticipated roof loading would be 40 psf live load (snow and rain) and 5 psf. The 40 psf live load corresponds with the live loading assumed in the Tacoma report and what would be expected for Guelph based on the requirements of the Ontario Building Code (OBC). The 5 psf dead load for the new sloped roof assembly is less than the weight of the existing built up roof assembly. Additional structure will be required along the roof edges at the truss bearing points to transfer the loads back to the glulam frames. This structure must be adequately anchored to the glulam frame to resist the wind uplift forces.

The additional wind load to be applied to the structure is undefined at this time and would depend on the slope of the roof selected. In addition, the lack of original structural drawings does not allow us to determine what the lateral load capacity of the glulam frames. Further analysis of the frames during or prior to the design process would be required to determine their capacity. If lateral reinforcement for wind loading is required, how the frames are reinforced would be a difficult decision given the exposed nature of the frames and their impact on the aesthetics of the interior of the church.

As the new sloped roof system will create an attic space, ventilation of the attic spec to meet the O.B.C. is required. This will necessitate ventilation at both the ridge and the eaves. The venting at the ridge is easy to accommodate with either a continuous ridge vent or a number of individual vents spaced near the ridge. Venting at the eaves would necessitate an overhang along the roof edges to provide a sheltered space for venting. This may have a significant impact on the aesthetics of the building, as there would not be a smooth transition from the sloped roof to the mansard.

There are 2 options for control of rain water; allow the water to just drain down off the sloped roof onto the mansard, or install gutters and downspouts. With either option, there would likely be icing issues in the winter. Falling ice may cause damage to the mansard metal roof tiles. With the no gutter option, deflectors would be required above the window dormers to limit water flow over the dormers to reduce the potential for water penetration. These deflectors could cause additional icing issues. Long term, the drainage of water over the mansard roof tiles may shorten the service life of the tile coating. The installation of gutters would better control the rain water and limit the effects on the mansard below.

7. Opinion of Probable Cost

The cost of retrofit options is based upon the existing conditions present at the time of the investigation, costs obtained by the Client and average unit prices obtained from our experience on similar projects in Southern Ontario. It is important to realize that the prices are not based on tendered specifications, but instead on general approaches and assumed quantities. The actual costs will depend on the prices received at the time of tendering and/or the actual quantities removed during the repair contract. Please note that the listed prices do not include HST.

Table 7.1 Initial Costs

Item	Description	Estimated Cost
1.0	**Roof Replacement Option**	
1.1	Roof Replacement – IRC	$50,000 to $55,000
1.2	Roof Replacement based on the Wm. Green Quotation for a similar system as described above	$40,000
1.3	Engineering costs for preparation of details, tender documents, tendering, construction review and contract administration	$5,000 to 10,000
1.4	**SUMMARY of Initial Costs for Roof Replacement Option**	**$45,000 to $65,000**
2.0	**Sloped Roof Retrofit Option**	
2.1	Removal and disposal of the existing roof system	$2,500 to $5,000
2.2	Supply and installation of roof trusses and roof sheathing	$25,000
2.3	Supply and installation of metal tile roof system and flashings	$15,000 to 20,000
2.4	Supply and installation of building structure reinforcement *****	$5,000 to $10,000
2.5	Engineering costs for design and preparation tender documents required for Building Permit, construction review and contract administration	$10,000 to $15,000
2.6	**SUMMARY of Initial Costs for Sloped Roof Retrofit Option**	**$57,500 to $75,000**

***** This cost is based on an assumed approach not a final design

Table 7.2 Long Term Costs

Item	Description	Initial Long Term Work After:	Repeating Every:	Estimated Cost (2010 Dollars)
1.0	**Roof Replacement Option**			
1.1	Installation of a new cap sheet membrane	Starting after 20 to 25 years	10 to 15 years	$10,000
1.2	Replacement	After 40 to 50 years		$50,000 to $60,000
2.0	**Sloped Roof Retrofit Option**			
2.1	Recoating metal roof tiles	Starting after 25 to 30 years	10 years	$7,500
2.2	Replacement of metal roof tiles	After 50 to 60 years – potentially longer with regular re-coating and maintenance		$25,000 to $35,000

It should be noted that over the long term, after 50 to 60, there will likely be other requirements that govern the replacement, such as building modification, changes for energy conservation or improved roofing technology.

8. Conclusions and Recommendations

Based site review performed, the existing roof membrane over the main hall of the church is near or at the end of its useful service life and requires replacement. The primary issue with the current built up roofing membrane system, is the presence of ponding water on the membrane. Ponding water on the membrane presents several problems; i) long term – water will penetrate the felts and cause deterioration, ii) any defect in the membrane results in a leak due to constant water presence, and iii) in the winter, the ponding water freeze/thaw cycling places addition stress on the membrane.

The roof replacement option with a 2 ply modified bitumen membrane incorporating tapered insulation resolves the main problems affecting the current membrane. The modified bitumen membrane is a more robust and durable membrane when compared to the built up membrane. It is also generally unaffected by standing water. The tapered insulation will drain water from the roof so there is less chance of water entering the roofing system at a defect because it is constantly being drained away.

The sloped retrofit option will introduce a roofing system that is generally more redundant and less prone to water penetration than a flat (or low slope) assembly. A flat roof is more prone to water entry at a breach in the membrane, while a sloped roof can rely on the overlapping materials and greater slope to prevent water penetration even in the presence of a breach. Ultimately, installation and workmanship is less critical on a sloping roof rather than a flat roof.

In this situation, the sloped retrofit option does contain more unknowns than the flat roof option. There are a number of issues that are unknown at this time, including the requirements for lateral building reinforcement, the inclusion of an attic space in the building and the icing effects at the edge of sloped roof. With the roof replacement option there are no significant potential unknowns.

The installation of a sloped roof on the church will be a significant aesthetic change to the church with the sloped roof rising above the walls and the eave venting detail. A building permit and possibly planning department approval will be required for the sloped retrofit option. A building permit is typically not required for a roof replacement with a similar material/system.

Long term, the maintenance/retrofit costs are similar although depending on the coating performance, the

recoating work may be considered an aesthetic upgrade. For the flat roofing system, the installation of a new ply of cap sheet is a necessity.

Ultimately, both systems, properly designed and installed, will provide a high level of waterproofing performance for the church. The initial and long term costs for both systems are projected to be similar, with the roof replacement option slightly less expensive initially and the sloped roof system slightly less expensive over the long term.

IRC's recommendation would be the roof replacement option, with our long term experience with properly designed flat roofing project. We are involved with facilities where IRC was the consultant for the roof replacement 18 to 20 years ago where similar 2 ply modified bitumen membrane systems were installed. These membrane systems are still functioning as designed after minimal maintenance today.

9. Limitations

IRC prepared this report solely for the client named. The responsibilities of IRC are as described in the Terms of Reference and the Scope of Work. The material in this report reflects the opinion of IRC at the time of preparation and within the terms of reference as agreed. Any use, which a Third Party makes of this report, or any reliance on decisions based on it, are the responsibility of such Third Parties.

IRC does not warrant the accuracy of the identified information provided by others at the time of the report preparation. Unless provided in writing, but not limited to, mistakes, contacts, insufficient information or certification of such information is not the responsibility of IRC.

Only the specific information or locations noted in the report have been reviewed. Although every reasonable effort was taken to identify defects, latent and hidden defects may affect the accuracy of this report. No physical or destructive testing and no design calculations have been performed unless indicated elsewhere in this report.

The assessment provided is based on visually observed defects at a limited number of locations and our experience with similar types of buildings. Deficiencies may exist at other areas not referenced in this report or that are not visually apparent given the level of evaluation. No responsibility is therefore assumed concerning these matters, or for failure to carry out technical or engineering techniques which would be required to discover any inherent or hidden conditions of the property since such an investigation was not included in the scope of work.

We trust that the above is satisfactory for your purposes. If you have any questions regarding the enclosed, please contact the undersigned at your convenience.

Yours very truly,
IRC Building Sciences Group Inc.

Mark Bechthold, P.Eng.
Manager Building Sciences

APPENDIX A: PHOTOGRAPHS

Photograph 1: View of the main roof area. The dark areas in the gravel surfacing indicate areas of ponding water.

Photograph 2: View of the core cut at the main roof area.

Photograph 3: Scouring at the corner of the roof area, exposing the membrane.

Photograph 4: View of a typical scupper drain.

Photographs 5 and 6: View of the sacristy/choir area roof.

Photograph 7: View of the low roof area over the entrance foyer.

Photograph 8: View of the hot pour asphalt repairs at the low roof area.