CASE STUDY

The Putman Family YWCA

Total Precast Concrete - Passive House (TPC-PH)

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Introduction

The Putman Family YWCA Housing Project is the first mid-rise, Total Precast Concrete - Passive House (TPC-PH) building in Canada (**Figure 1**). Construction began in late 2019 and was completed in November of 2021. The building has a gross floor area of 5,017 m^2 (54,000 ft^2) including fifty affordable units and two levels dedicated to community centre space.

Figure 1 :The Putman Family YWCA Passive House, in Hamilton, ON, is the first mid-rise total precast concrete passive house. (TPCPH) project in Canada (Photo Source: Kearns Mancini Architects Inc.)

For a building to meet Passive House (PH) standards, seven general principles are followed as shown in **Figure 2**. Among others they include an airtight building envelope with high R-value insulation and high-performance windows, as well as the elimination of thermal bridges.

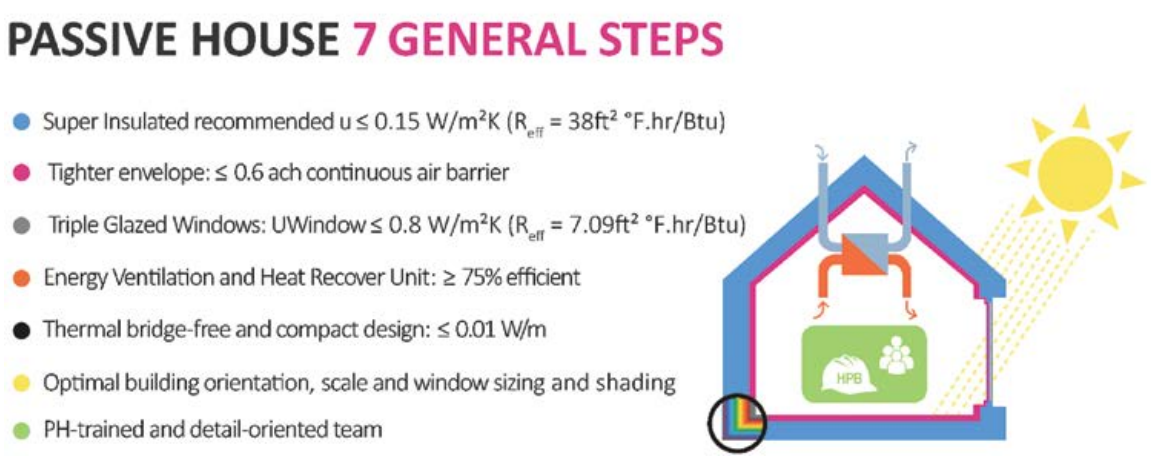

Figure 2 : To achieve Passive House design standards requires seven key principles (Image Source: Procuring Passive House Projects, 2018, Sab Mag - https://sabmagazine.com/procuring-passive-house-projects/

IIn the TPC-PH solution, double-wythe insulated precast concrete wall panels offer an affordable solution that achieves airtightness, moisture protection and continuous insulation in one assembly. This eliminates the need for multiple trades, and significantly reduces construction time on site. Additionally, manufacturing most of the major building components off-site allows for a higher degree of quality control resulting in, among other things, durable products with consistent architectural finishes.

As with any prefabricated solution, TPC-PH designs have specific details that need attention during the preliminary planning stages. Planning is the key to the success of any PH project and a high level of coordination and involvement from all team members is required from project inception. The client needs to also reconsider procurement processes so that the selected contractors and suppliers are hired and engaged to work with the design teams from the start.

Next, a cost-benefit analysis during the early design stage will ensure that well-thought-out buildings are delivered to the client. Finally, continuous coordination between the design and manufacturing teams will prevent costly re-design and re-working of details.

The Client and the Design Team

The client, YWCA, wanted a building constructed of concrete in order to meet three main criteria:

1. Their intentions to “buy locally”,
2. A building that was representative of the manufacturing town in which it is located, and
3. A building with a robust, durable, and secure material (the latter having mostly a psychological effect on the YWCA and the people they represent and accommodate).

Kearns Mancini Architects Inc. (KMAI) considered ‘PH Certified’ precast concrete wall components from Europe and had also investigated local precast manufacturing capabilities. Coreslab Structures Inc., based in Hamilton, Ontario was approached and was eventually selected as the supplier for the project. Coreslab Structures Inc. (Coreslab) is a certified precast plant under the Canadian Precast Concrete Quality Assurance (CPCQA) certification program (**https://www.precastcertification.ca/en/**). The CPCQA qualification was an important factor in KMAI’s decision to select Coreslab as the supplier.

"No matter the material, factory-built assemblies like precast concrete systems are the future of building sustainably. The methods and rigour in manufacturing are especially relevant to PH durability." – KMAI

The original schematic design had assumed a cast-in-place structure as the basis of design. What started as a discussion about a wall panel solution quickly became a conversation about a TPC-PH structure, which required a paradigm shift in the design team's previous design and rationale. Pivoting to total precast concrete meant that more input was needed from the precast concrete manufacturer with the KMAI design team.

Carbon Emissions

The combination of a precast concrete structure and envelope, as well as a local supplier, helped to lower the carbon footprint of the building compared to the original proposed cast-in-place concrete design. Wood construction was considered as well, but it was not selected as the best option for this project for the following reasons:

1. Apart from the client's request to build with concrete, a basement was needed to satisfy the YWCA program requirements;
2. The additional excavation for the basement required large footings and unique shoring (due to the poor soil conditions and restricted site);
3. The structural constraints required a significant amount of concrete if a cast-in-place or hybrid wood & concrete structure were to be used. A total precast construction allowed for material and time savings, which reduced the carbon emissions compared to other construction methods.

KMAI conducted a life cycle assessment to compare the carbon emissions of precast concrete, cast-in-place concrete, and hybrid wood structures. The results demonstrated that regardless of the construction method, more than 40% of the whole building's carbon emissions were produced during the building's use. This further substantiates that passive house design is the key to reducing the overall carbon footprint of new buildings.

Procurement – Design Considerations – Design Team Point of View

Precast concrete is an obvious choice for Passive House. Building a Passive House in a controlled environment like a precast concrete manufacturing plant significantly reduces the risks of non-compliance that are typically inherent with on-site construction. The quality of the product is significantly increased in a clean and dry facility where there are no inclement weather conditions and fewer human errors. Precast concrete also has reduced embodied carbon emissions compared to traditional cast-in-place concrete due to less material waste and a highly optimized construction schedule.

While the team at KMAI are proponents of factory-built assemblies, the firm also recognizes the need to adjust its processes to take full advantage of the benefits of precast concrete, such as:

- Reduced waste and better use of raw materials;
- Consistent quality in design and constructed products;
- Reduction in number of trades required on-site;
- Reduced time on-site;
- Shorter construction schedule;
- Mostly unaffected by inclement weather;
- Reduced site coordination for materials, trucks, and people;

- Reduced embodied carbon of the entire build;
- Increased level of safety on-site;
- Increased durability and building resiliency;
- Reduced traffic congestion and site emissions;
- Reduced noise complaints, air pollution and environmental impacts;
- Significant cost savings; and
- Better capital investment durability.

In addition to the efficiencies gained during manufacturing and construction, the cost benefits continue throughout the life of the building. Quality control in a plant environment is far superior to any on-site quality control. This increases the life span of the structure and reduces the maintenance cost, resulting in a better long-term investment for the owner (lower total cost of ownership).

The high level of efficiency, however, demands that the design team is open to a shift in their thinking, and to work within the requirements of the off-site precast plant manufacturer. Problems encountered during front-end manufacturing design must be addressed quickly to avoid cost-overruns and design errors. The following can put potential efficiencies and cost savings of factory-built assemblies at risk if they are not addressed at the outset:

- The architectural design intent – does it match the manufacturers' capabilities;
- Panelization limitations on architectural design intent;
- The structural framing, sub-structure, and grid design;
- Site level and structure depths tie ins with existing services – Site levels already restricted (drive aisle/hydro truck, road level connections/beam depth);
- Floor levels, finishes, barrier-free requirements, and sanitary installations (Floor topping, camber, barrier-free shower tie in);
- Thermal bridge free design;
- The design process – is true integration possible;
- The design tools and level of detail shared – coordination in 2D, 3D and 4D;
- Logistical and site constraints that impact building design – example: cranage requirements that alter building structure and basement shoring;
- The mechanical servicing strategy – duct runs, service shafts and chases;
- The procurement process – how will the designer and builder be hired; and
- The procurement timeline – when will the builder and manufacturer be hired?

The longer it takes the manufacturer (and the General Contractor) to be part of the design process, the less impact they have on cost savings and design efficiencies. The rigour required in manufacturing a building is aligned with the rigour required for Passive House design. On a project such as this, having a building that is more structurally massive than traditional cast-in- place buildings can lead to potential thermal bridges that could transport heat from the structure to the façade. Lack of early coordination could affect detailing, and potentially force designers to overcompensate thermal bridge areas. These problems can be avoided through early consultation with the manufacturer and the design team during the conceptual planning and design stage, as illustrated in **Figure 3**.

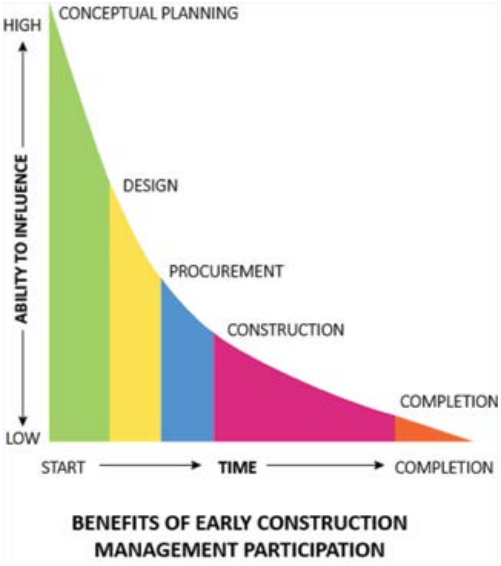

Figure 3 : Early consultation at the conceptual stage provides the greatest opportunity to influence the final completed building. The graph above shows the benefits of early and timely participation and the ability to influence success. (Photo Source: Kearns Mancini Architects Inc.)

Regulations and Engaging the Authorities

To minimize disruptions to the approvals process, it is just as important to engage the local authorities. Passive House requirements are not always in line with Canadian codes and standards. For example, due to the airtightness of Passive Houses, PH ventilation rates are much lower than the ASHRAE requirements (note: the Ontario Building Code references ASHRAE). Using this design approach will need special approval from the City. Fortunately, for the YWCA project, the City of Hamilton was willing to accept Passive House requirements after the team presented the rationale.

The different standards between European and Canadian products also require special consideration. A Passive House certified project requires the use of certain components (most notably windows and energy recovery ventilators (ERVs) that are verified, tested, and certified by the Passive House Institute in Germany. Europe follows the Industry European Norm (IEN) requirements, while Canada follows the Canadian Standards Association (CSA). Currently, the North American market is limited in the components it offers and many are imported from Europe. In order to use these products in Canada, the manufacturer needs to provide testing under Canadian standards, or an engineer needs to review, sign and validate the products.

Double Wythe Insulated Precast Concrete Wall Panels – How the Final Design was Conceived - and the Precast Manufacturer's Involvement

After deciding to pursue a complete precast building, KMAI and the local precast manufacturer designed the exterior envelope together. After some deliberation on whether the inner or outer wythe should be load-bearing, it was decided to manufacture the wall panels similar to existing Coreslab product designs, and to have the inner wythe load-bearing; this resulted in reduced risk and costs.

To meet PH requirements, the encapsulated insulation was upgraded to a higher thermal rating. Interior wall shear ties were changed to have an optimum tensile strength in relation to the lowest possible thermal transmittance. The resulting panel, (see **Figure 4**), was a 400 mm double wythe insulated precast concrete wall panel with 120 mm phenolic insulation encapsulated between the two concrete wythes. The outer and inner wythe of the insulated wall panels is tied together by fibre-reinforced plastic (FRP) wall ties. A dual bead caulking arrangement with weephole (also known as a two-stage joint) is applied at vertical panel joints to fully drain rainwater to the exterior.

This assembly, including the wall ties, achieves a U-value of 0.167 W/m 2 K (R_{eff} of 34 ft 2 F.hr/Btu) based on the lowest-performing panel on the building (short wall near a junction). The design team chose to proceed with the lower R_{eff} value because the holistic building design met the PH requirements without using the recommended U-value for walls. This reduced the size of the wall panel and costs.

The intent of using the insulated precast concrete wall panels is to comply with all structural, weather, thermal, fire, code, and PH requirements in one assembly. The insulated wall panel system still met all of these requirements even after they were connected.

It was easy to comply with PH requirements for individual panels, but it was much more complex to comply with the PH requirements for the whole building assembly. Many changes were made to KMAI's design process and to Coreslab's manufacturing and erection process to comply with all PH building criteria.

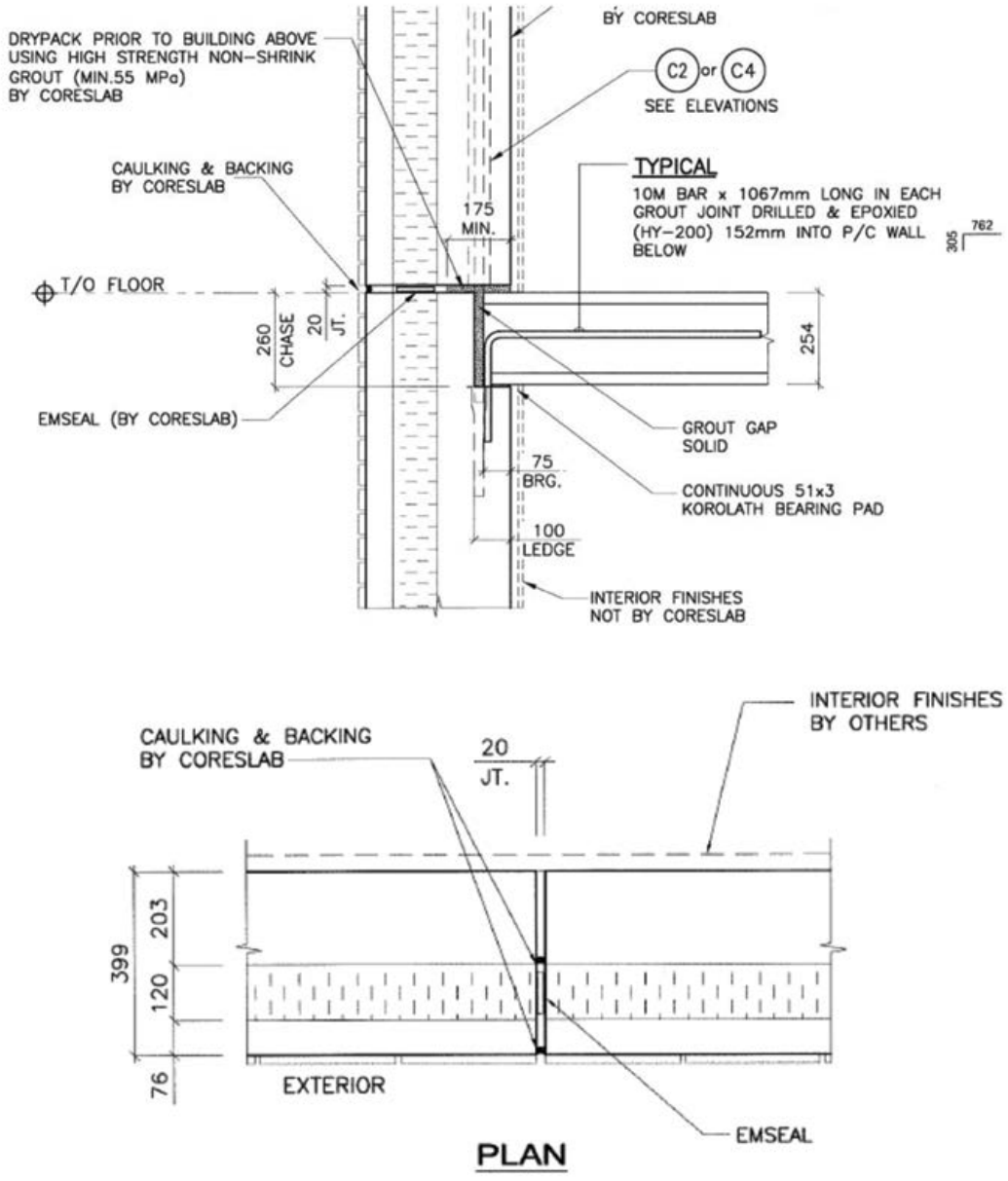

Figure 4 : Panel detail displaying the double wythe insulated (sandwich) precast concrete wall panels that were used in the final design and build of the YWCA. All dimensions are in mm unless otherwise noted. [Note the use of Emseal at all horizontal and vertical joint locations].

KMAI and the Precast Concrete Partner Point of View - Workflow and the Integrated Design Process

As large-scale PH buildings are relatively new in Canada, manufacturers of wall assemblies and high-performance building components are still learning the standards and level of coordination required to achieve the performance criteria. Passive House typically requires a massive, thermally broken, airtight building envelope that is above the typical standard in the industry. One particular area that requires extensive consultation is the thermal bridges at junctions of structural beams and columns. In addition, the weight and size need extra attention in assemblies where extra structure may be required.

PH treats a building holistically; The same is also true for total precast concrete structures. Decisions made by the Architect and Structural Engineer without consultation with the precast concrete manufacturer can negatively impact the design and potentially cause non-compliance with PH requirements. PH Designers often like to say "it is all about the envelope," however the building must also meet the PH heating and cooling requirements. How the HVAC system is coordinated will affect energy usage. Mechanical serviceability will depend on which ducts and penetrations are permitted by the manufacturer. Unlike other building materials, precast concrete structures are less forgiving when holes need to be cut on site. Certain service shaft locations may not be possible depending on the span direction. PH designers should pre-locate and define every service penetration and thermal bridge in the building prior to construction. If the services could not be routed as planned, it could result in extra cost and reduced energy efficiency.

On this PH project, the precast manufacturer was not able to provide design assistance until after Site Plan Approval (SPA) from the municipality and by then, the height and shape of the building was already defined. The structural engineers put off locking in their grid and the method of constructing the basement/foundation for as long as possible. Unfortunately, as the design progressed, the team had no choice but to reconfigure spaces and reclaim the required service height from the interior.

Despite Coreslab's later than desired involvement during the project, the integrated approach with the PH design meant that the team was able to quickly incorporate the design input from Coreslab. Weekly CAD uploads were reviewed in coordination with the architectural 3D model. 'Clash detection' in the 3D model was completed to check for interference among building components. Detail such as the walls, roofs, floors, stairs, elevator shafts, junctions, openings, parapets, penthouses and sub-structure connections were collectively resolved with the precaster.

Building Information Modelling (BIM) allowed easy coordination between all stakeholders (**Figure 5**). This coordination was done in line with the project development so that design changes were flagged and incorporated into the manufacturer's 3D model on a day-to-day basis. Not every proposed design is buildable, so constant communication was needed to ensure the design intent could be met by the manufactured components.

As the design team became familiar with the structural and manufacturing constraints of the system, better solutions were proposed. This reduced the amount of reconfiguration work needed by Coreslab to meet the objectives.

Many hours were spent discussing, designing, and re-configuring precast concrete components to satisfy all building requirements, and some concessions were made to maintain the overall design intent. This was followed by weekly drawing and design reviews in order to cover most issues that could not be foreseen in the meeting sessions.

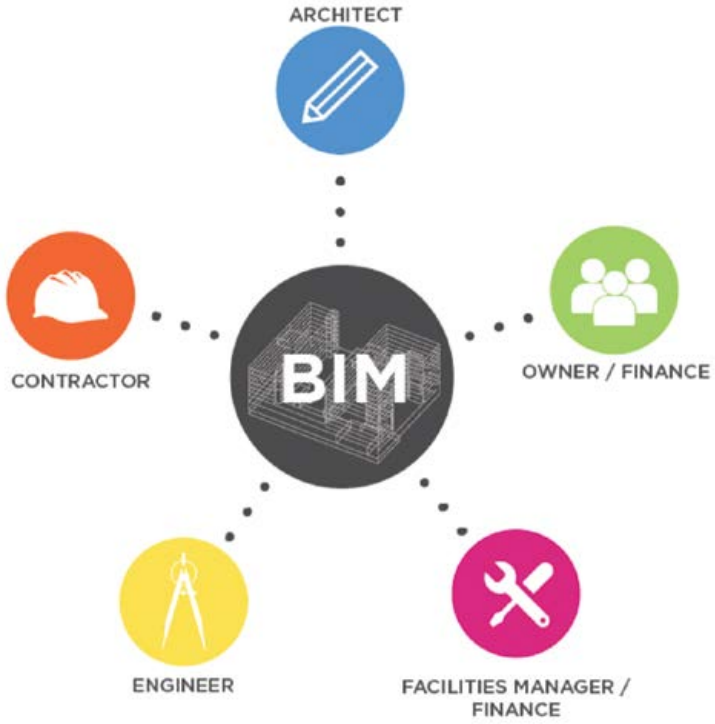

Figure 5 : Building Information Modeling (BIM) disciplines that helped coordinate project development and construction for the Putnam Family YWCA TPC-PH project. (Photo Source: Kearns Mancini Architects Inc.)

Site and Design Challenges

To ensure project success, an understanding of the precast concrete design limitations was needed, specifically:

- Proper connection between the precast concrete members and the poured foundation; and
- Penetrations had to be spaced further apart and away from the underside of the ceiling, limiting the ability to keep services high and compact, so distribution routes became cluttered resulting in lowered head rooms.

Ceiling areas were reworked to accommodate mechanical services. Routing required extensive trade coordination during the review of precast shop drawings to ensure all penetrations were properly cast in the precast manufacturing plant.

The building height and its size was also restricted, so resolving precast-related structural requirements needed to be done from inside the building. This resulted in services needing readjustments in the floor slabs and building envelope. One such location was the drive aisle: space restrictions on site made it challenging to locate structural columns to support the four floors above the drive aisle. Limitations on the number of columns that could be used for this purpose made it necessary to increase structural precast beams & depths, constraining the minimum headroom clearances required in this area. In this case, the design team was left with only 50 mm to wrap the large structural beams with insulation to maintain the integrity of the envelope and provide minimum height clearance for the hydro truck. A high-grade metal insulated panel removed the thermal bridge and provided an exterior façade finish and moisture barrier. Figure 6 shows the drive aisle junction detail and the corresponding thermal model. This junction turned out to be the weakest thermal junction in the building, but it still demonstrated high thermal performance.

Site space restrictions also made it challenging to find a mobile crane with the necessary capacity to hoist the precast concrete components across the entire building's width. An appropriate crane was found but ground conditions made it necessary to have crane mats brought in to evenly distribute the crane's weight and achieve an acceptable ground bearing pressure.

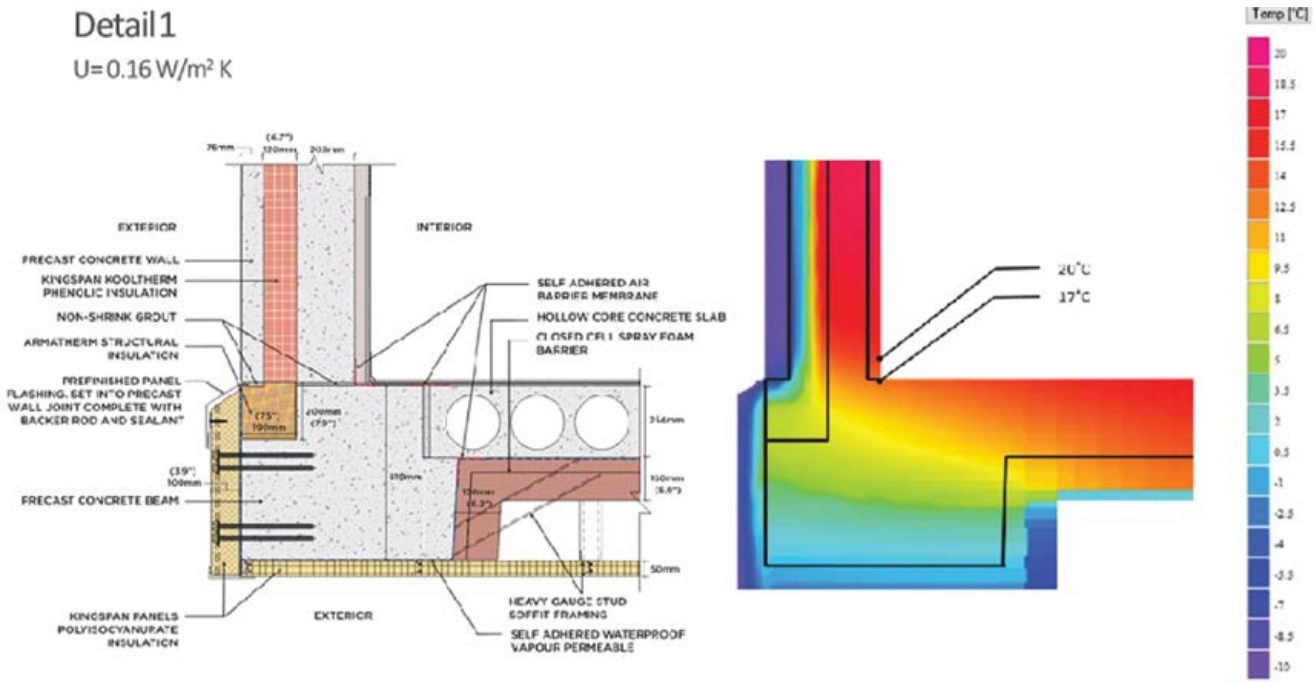

Figure 6 : Drive Aisle Detail illustrating the 'weakest' thermal junction in the building, and the corresponding thermal model that demonstrates there are no thermal comfort or hygiene issues at this junction of the building. [Source: Kearns Mancini Architects Inc.]

Solutions – KMAI & Precast Concrete Partner Point of View - Final Design Selection and Justification

From a PH perspective, the intent of using the insulated wall panel is to maintain insulation and airtightness throughout the building. The PH insulation requirement of R38 would require infeasibly thick panels if typical rigid wall insulations are used. Typical rigid insulation used in wall panels only gave a rating of R5 per inch, therefore 8 inches (203mm) of insulation would be needed to meet PH targets. This would result in a wall assembly with an overall thickness of 483 mm (19 inches). To avoid unnecessary thickness, Kingspan Kooltherm K20 insulation was used. This material has significantly better thermal performance and only 120 mm (4.75 inches) of insulation was needed.

The length of panels varies considerably, from one to nine metres. Both the horizontal and vertical junctions are consistent at 20 mm wide. The panel-to-panel junction used high-strength non-shrink grout finished with caulking and backing. In the middle of the junction, an Emseal backer foam is placed to ensure insulation continuity (**Figures 4** and **7**).

All structural junctions are taped on the interior to maintain an air seal. Floors are also taped above and below. Siga Fentrim IS 20 tape was used. To ensure proper adhesion of the tape the interior face of the precast panels had to be relatively smooth and consistent (**Figure 7**).

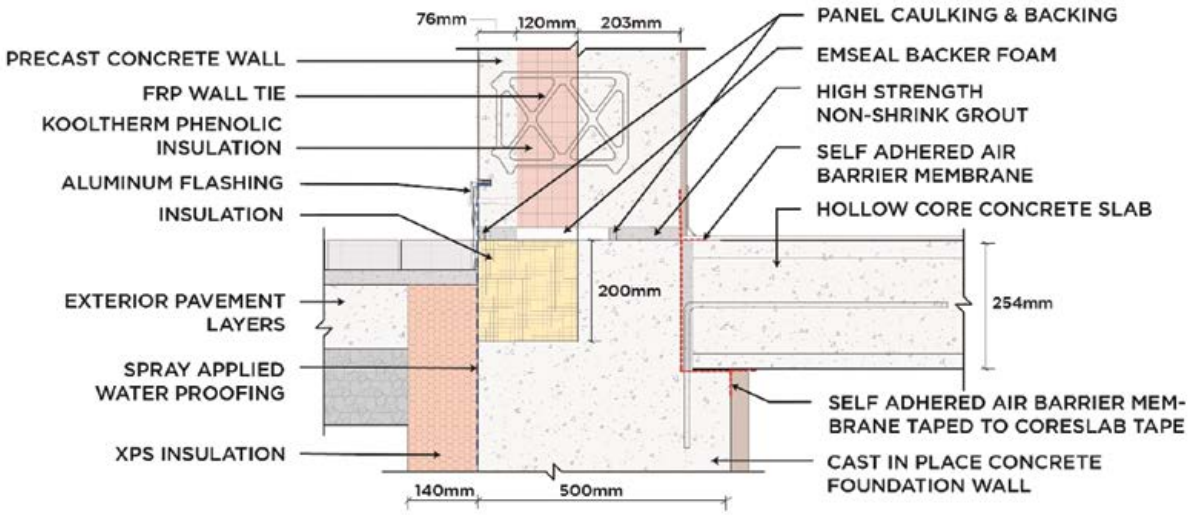

Figure 7 : Typical Floor Slab to Exterior Wall Detail showing the insulated wall panel design that was used in the YWCA. All structural junctions are taped with a self adhered membrane and continuity of insulation is maintained at all joints with Emseal backer foam.

Solutions Considered/ Design Charrette

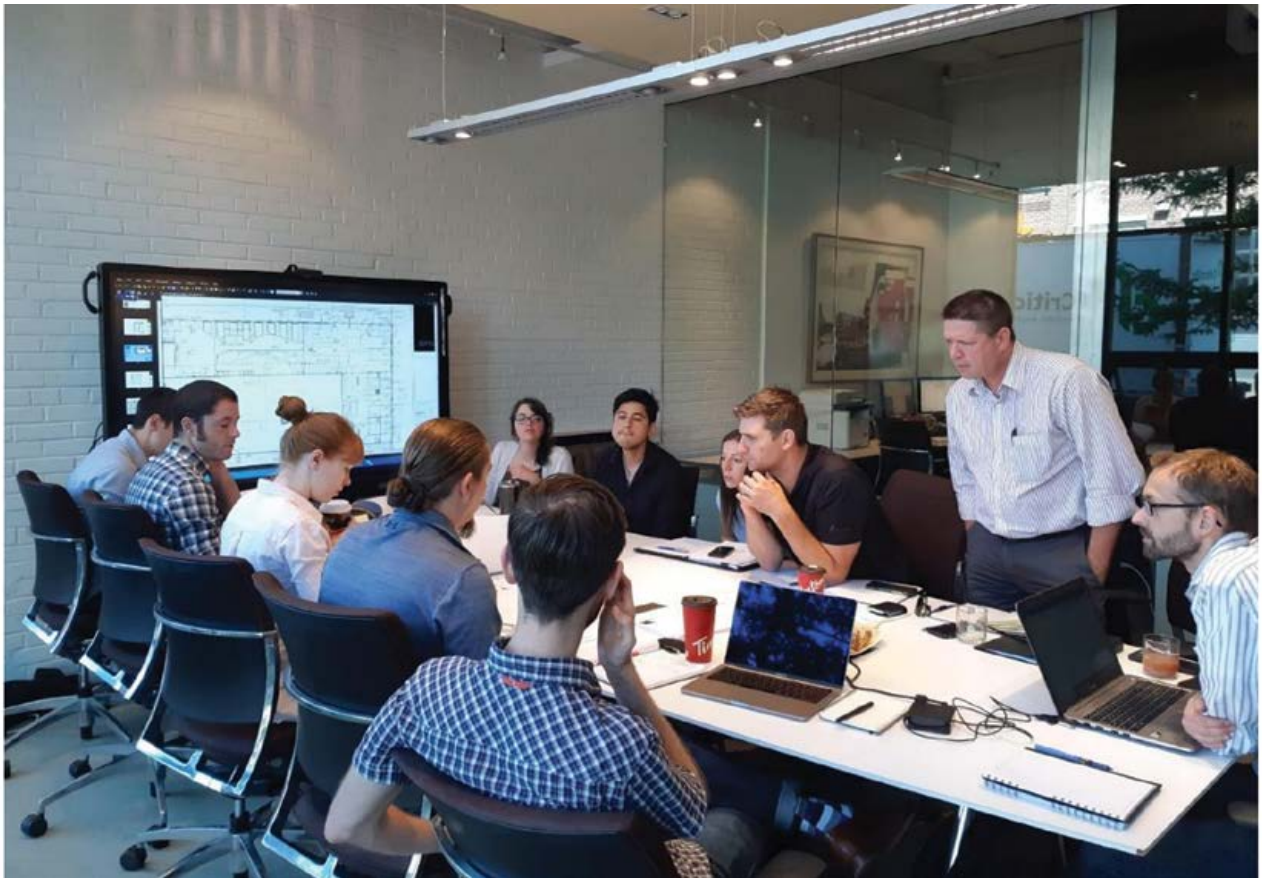

Figure 8 : PH Services Coordination Meeting were critical to success of the project and included people representing all aspects of the design: architecture, electrical, mechanical, construction, building services, modelling, certification, and manufacturing

[Source: Kearns Mancini Architects Inc.]

The KMAI team conducted two full-day service coordination meetings (**Figure 8**) to virtually 'walk' every service in and out of the building so that the locations were final and to ensure that the manufactured assembly would not need to be cored on-site. These meetings were essential in identifying potential issues. An example of this is the prevention of an issuance of an expensive change order on day one of site mobilization due to the need of a tower crane which would have required retro-modification to the PH envelope below grade.

During the virtual walk to inspect mechanical ducting around the building, some height restrictions were identified which caused 'pinch points' in the drive aisle. Coreslab was able to correct the issue. Earlier coordination of mechanical detail with Coreslab could have prevented this issue, but the walk was successful in catching these issues. **Figure 9** shows an example of a detail that could have been better resolved had the coordination of the superstructure design and shape been done with the manufacturer at the beginning. **Figure 10** highlights improvements made to the total precast solution during a virtual walk through; the red pencil line highlights how the inner wythe would have been previously built.

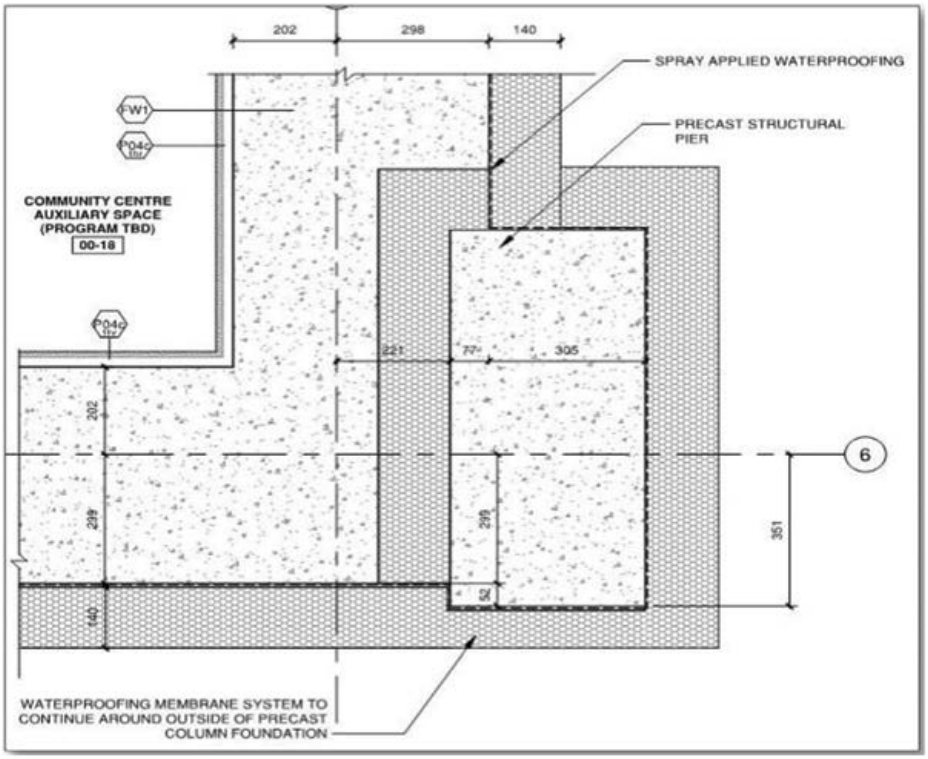

Figure 9: Driveway column plan showing an example of a detail that could have been better resolved had the coordination of the superstructure design and shape been done with the manufacturer at the beginning. All dimensions are in millimetres unless otherwise noted.

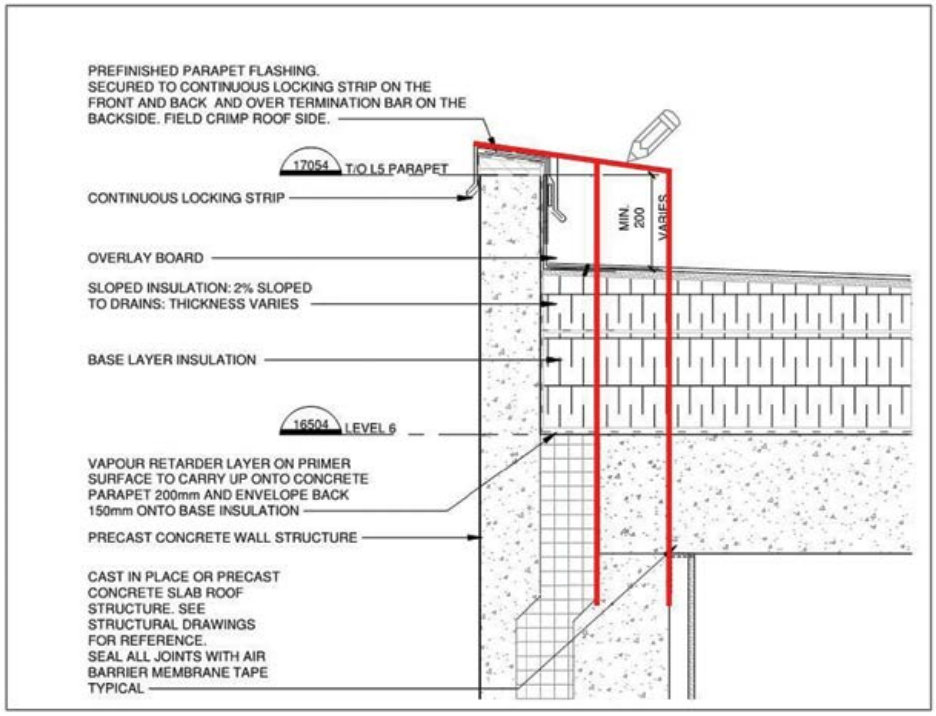

Figure 10: Parapet detail showing how the virtual walk through identified an improvement to the original design. The pencil line shown is the previous design which was optimized. All dimensions are in millimetres unless otherwise noted.

Details and Construction Photos – Comparison

The following section shows a comparison between construction photos and projected details. The integration of the precast concrete design elements into the final Passive House changed over time to best suit the construction needs.

The following issues were noted:

1. The building was very close to the street with a combination of large footings, poor soil and a considerable building weight. Shoring was required which was wrapped in continuous insulation to avoid a thermal bridge (**Figures 11** and **12**). In this case, the detail was able to be constructed as planned (**Figure 13**).

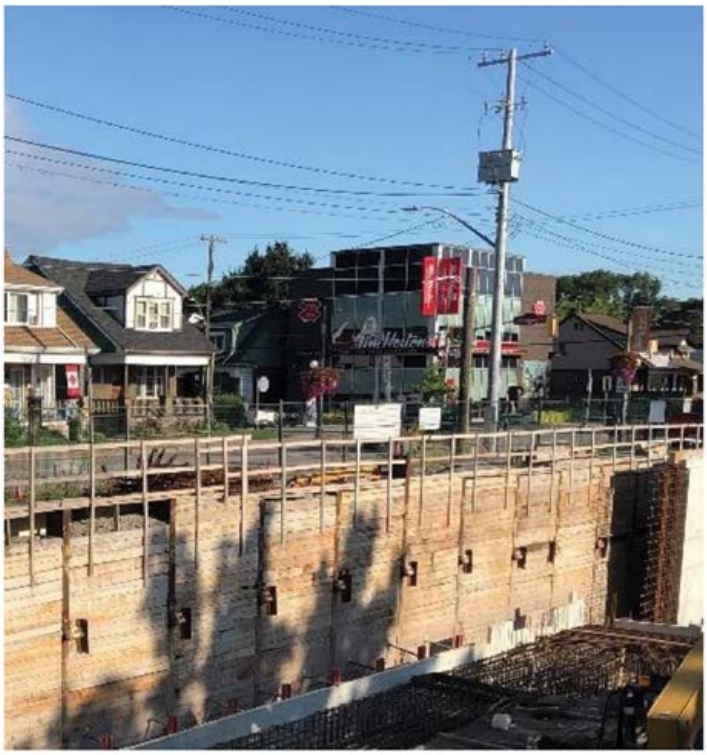

Figure 11: Shoring Detail Photo [1]

Figure 12: Shoring Detail Photo [2]

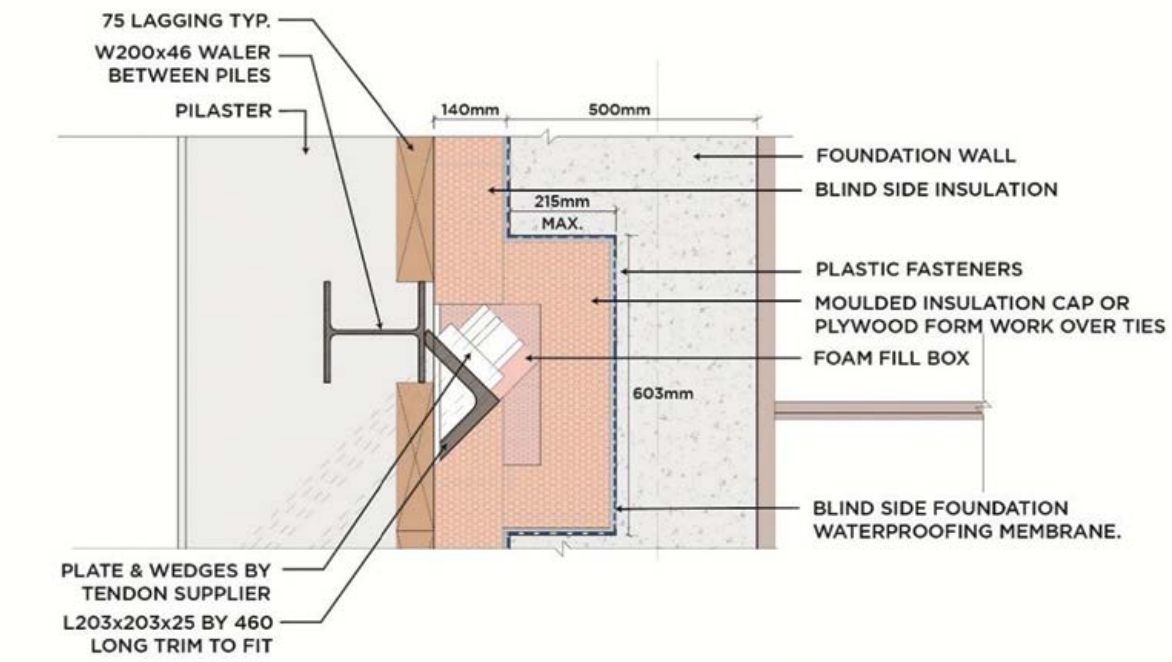

Figure 13: Shoring detail showing the continuous insulation that was required to eliminate thermal bridging. All dimensions are in millimetres unless otherwise noted.

2. Airtightness is one of the most important elements of a Passive House. Since the taping method was new to the trade, mock-ups were done before construction to determine the best method to tape the joints of the elements (**Figure 14**). During construction, smaller sections of the building were tested to confirm all the building elements were sealed properly. When the final whole building air test was done (**Figure 15**), the results were impressive, receiving a final air change rate of 0.37 ACH. In the original detail (**Figure 16**), taping between the side of the floor slab and the foundation wall was shown but during the air testing, it was discovered that this was not necessary.

Figure 14: Airtightness mock-up to determine the best method to tape the joints of the elements

Figure 15: A full-scale air test was performed on-site

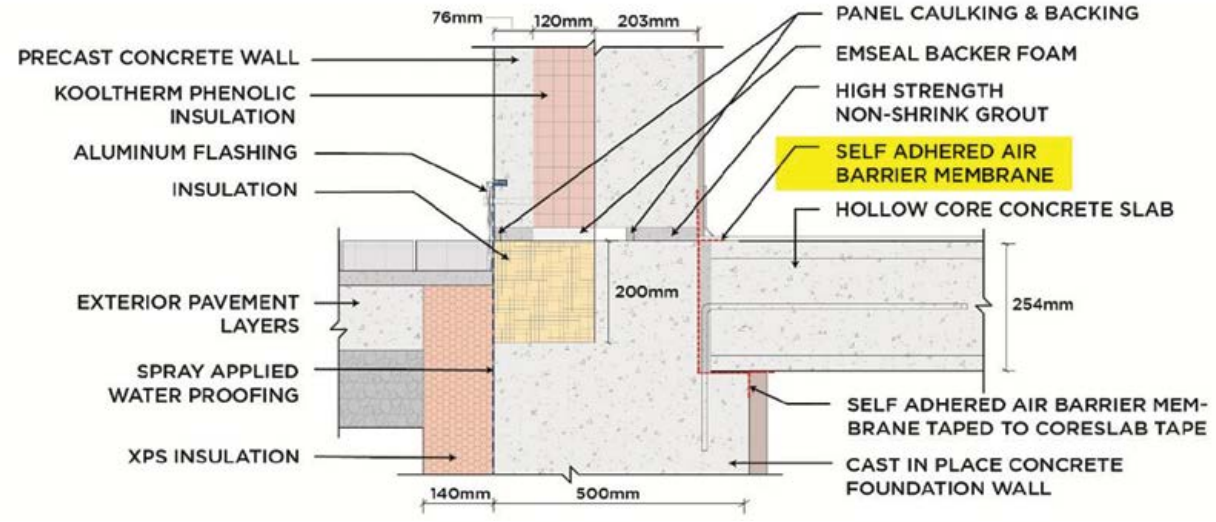

Figure 16: The original exterior wall to floor detail included an adhesive air barrier (highlighted above) between the floor slab and the foundation wall but the air testing showed this was not required. All dimensions are in millimetres unless otherwise noted.

3. Taping around the window and curtain wall openings was similarly designed. Air testing confirmed the final construction was exactly as designed (**Figures 17** and **18**).

Figure 17: Curtain wall sealing was as designed in figure 18 with no changes after the full-scale air testing

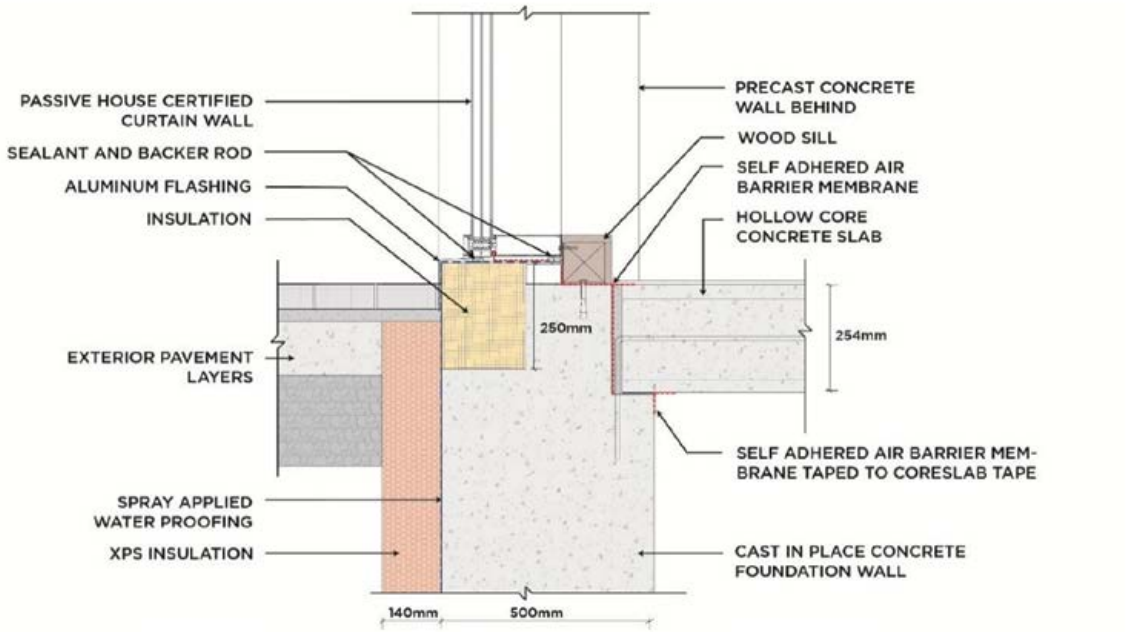

Figure 18: Curtain wall detail – note the self-adhered air barrier membrane. All dimensions are in millimetres unless otherwise noted.

4. As part of the design, a rooftop area was proposed including guardrails with posts. The posts required a penetration into the roof insulation. To minimize the thermal bridge, thermal break insulation was used between the roof slab and the guard post; The posts were also highly insulated. **Figures 19** to **22** shows the post insulation process, which followed the details shown in **Figure 23**.

Figure 19: Roof top area guard rail and post insulation process (1)

Figure 20: Roof top area guard rail and post insulation process (2)

Figure 21: Roof top area guard rail and post insulation process (3)

Figure 22: Roof top area guard rail and post insulation process (4)

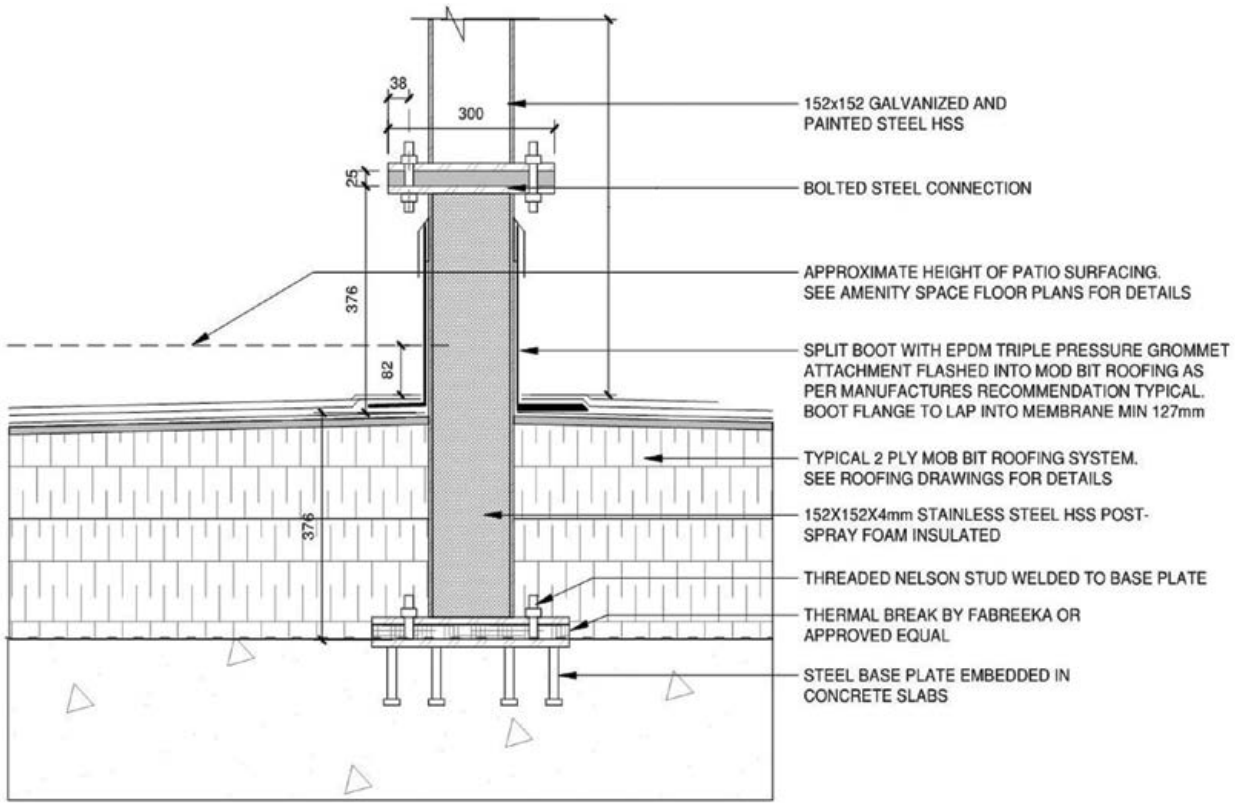

Figure 23: Guard post details. All dimensions are in millimetres unless otherwise noted.

5. The exterior wall connection to the foundation wall was a critical detail. The insulation was not aligned and a bridge element was required to connect them. After discussions with the precaster, it was agreed that rigid insulation could be placed below the outer wythe of the exterior wall to connect to the foundation wall as shown in **Figure 24**. The connection required additional attention during construction to maintain integrity of the exterior panels. The end result is shown in **Figures 25** and **26**. The detail is shown in **Figure 27**.

Figure 24: Foundation wall to exterior wall insulation installation

Figure 25: Foundation wall to exterior wall insulation - end result (1)

Figure 26: Foundation wall to exterior wall insulation - end result (2)

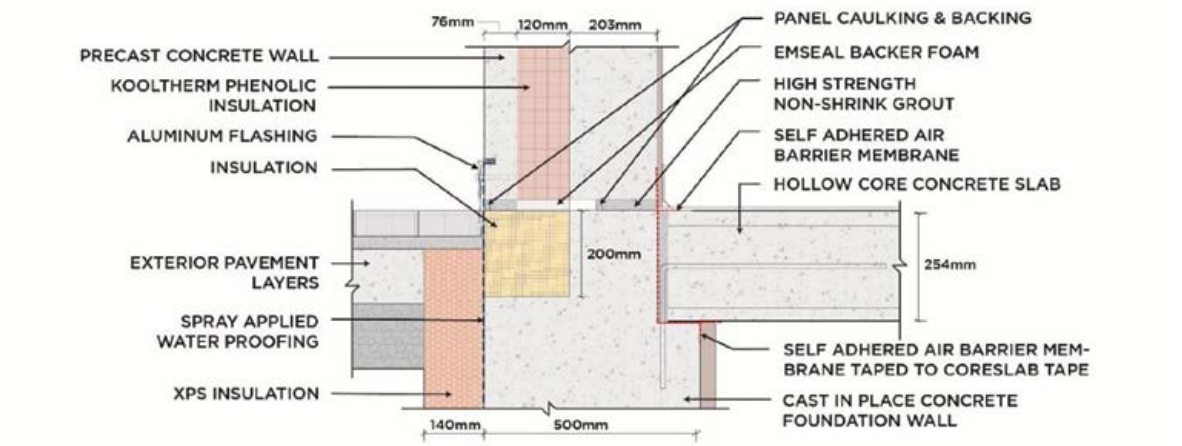

Figure 27: Foundation wall to exterior wall insulation detail. All dimensions are in mm unless otherwise noted.

6. The drive aisle required special attention during the design process to accommodate height restrictions and structural integrity while avoiding pinch points. **Figures 28** and **29** show the installation process of the thermal break insulation and the special insulated precast wall panels around the drive aisle. **Figure 30** shows the result. Figure 31 shows the detail as designed.

Figure 28: Drive aisle during construction

Figure 29: Drive aisle soffit and column

Figure 30: Drive aisle finished result

Conclusions and Lessons Learned

The success of high-performance Passive House building projects like the Putman Family YWCA is attributed to the shared commitment to the desired design outcome, and the constant open communication between all team members from the client, designers, engineers, builders and manufacturers. The secrets to success are the 3Cs: Communicate, Coordinate and Check!

Overview of the KMAI Team and the Precast Concrete Partners

Kearns Mancini Architects Inc.

Kearns Mancini Architects Inc. (KMAI) is a Toronto based architectural practice pursuing projects that improve the way we live through intelligent change. Since 1984, KMAI has developed a reputation for leveraging leading-edge methodologies to create architectural solutions for their clients—whom they consider partners—to build for a better future. The firm remains informed on leading-edge sustainable technology— both passive and active—to keep their work effective diverse and innovative. KMAI has been utilizing the Passive House Standards since 2009, putting the company at the very forefront of leaders of sustainable design in Canada.

Coreslab Structures (ONT) Inc.

Coreslab began in 1975 in Burlington, Ontario as a hollowcore manufacture rand installer. The company's business model, product, and service proved to be successful in the construction industry and in 1988 the company began to expand into the United States. Today Coreslab has 17 locations across North America making it one of the largest precast concrete manufacturers on the continent. Each location offers its own set of precast concrete products to best service their market. At Coreslab Ontario, hollowcore is still the main component of the business and forms an integral part of their Total Precast structures which also includes structural walls with exterior finishes, beams, columns, and balconies.

Canadian Precast/Prestressed Concrete Institute (CPCI)

CPCI is the leading source of technical resources (Body of Knowledge (BOK)) for the precast concrete industry in Canada. From this BOK, Building Codes, Design Guides, Educational Programs, Certification, Sustainability Programs, Accelerated Building Construction and new research ideas are derived. CPCI's initiatives on behalf of the industry ensure continuous development of the BOK necessary for resilient structures.

Acknowledgements

Kearns Mancini Architects Inc, along with Coreslab Structures and CPCI recognize that the land and waterways we congregate on today is the traditional land of the Huron-Wendat, the Seneca, and most recently, the Mississaugas of the Credit River. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land. We would also like to acknowledge the traditional territories of the many nations' land and we respectfully share across the continent.

Appendix: Glossary of Terms

Airtightness – an impermeable or nearly-impermeable seal to air leakage.

Building envelope – all building components that separate the indoors from the outdoors, including exterior walls, foundations, roof, windows, and doors.

Cast-in-place – a construction technique that uses temporary forms to shape liquid concrete until it hardens.

Clash detection – the Building Information Modeling (BIM) technique of identifying if and how building elements (plumbing, walls, etc.) interfere with one another by taking up the same space.

CPCQA Certification – The Canadian Precast Concrete Quality Assurance Certification program is a third-party and independent formal auditing process for precast concrete manufacturing facilities. **(www.precastcertification.ca)**

Distribution routes – Path of travel for the mechanical and electrical elements of a building.

Drive aisle – a vehicle passageway or maneuvering space where vehicles enter and depart parking stalls.

Emseal backer foam – an expanding foam sealant that provides watertight secondary sealing. **(https://www.emseal.com/)**

Energy Recovery Ventilation Unit – a ventilation device that replaces stale indoor air with fresh outdoor air while recovering heat from the exhaust air in the process. Heat Recovery Ventilation Units transfer heat while an Energy Recovery Ventilation Unit transfers both heat and moisture.

Hollowcore slabs - precast prestressed concrete floor and roof slabs with tubular voids extending the full length of the slab, making them lighter and faster to assemble.

Panelization – a construction method where housing components are prefabricated in a facility and then shipped to the construction site to be assembled.

Passive House – a highly efficient building standard that is designed to maintain a comfortable interior climate without active heating and cooling systems. A typical passive house is a well-insulated and highly air-tight building, with stringent design and construction standards. It is primarily heated by passive solar and other internal heat gains and equipped with an energy recovery ventilator for a constant and balanced fresh air supply.

Parapet – a low protective wall on the edge of a roof, bridge, or balcony.

Penetrations – Locations where external elements like pipes, conduits, clips, etc. enter the building envelope and the insulation layer.

Phenolic insulation – a rigid foam insulation product that is high-performing due to low thermal conductivity.

Precast concrete – a construction product produced by casting concrete in a reusable form that is cured in a controlled facility before it is shipped to the construction site.

Precast system – a system of precast concrete elements that is shipped from a facility and assembled on site.

Procurement – the act of securing all goods or services needed to bring the construction project to a successful completion.

R-value – an R-value signifies how well a type of insulation can thermally insulate. A higher R-value means greater insulation performance. Typically expressed as R##, where '##' is the number rating.

R_{eff} – Signifies the final R-value of a building assembly once its constructed.

Schematic design – a rough construction drawing that shows a general overview of a project's basic features and construction cost estimates. In a project design, it is used to refer to the early stages of the process.

Site – an area of ground on which a building is constructed.

Site Plan Approval – is a required process that you must follow for most developments before applying for building permit and construction. The purpose is to review site design features, building exterior design and the impact of the proposal on the surrounding land.

Sub-structure – the underlying or supporting part of a structure.

Superstructure – a building or part of a building built above the foundation.

Thermal bridge – an area of a building construction that has a significantly higher heat transfer than the surrounding materials, most often caused by gaps in insulation.

Thermal model – a process that a building is represented in a computer simulation program to show how it will function thermally.

Wythe – a vertical section of a construction component that is one unit of thickness.

CASE STUDY

The Putman Family YWCA

Total Precast Concrete - Passive House (TPC-PH)

CANADIAN PRECAST/PRESTRESSED CONCRETE INSTITUTE
INSTITUT CANADIEN DU BÉTON PRÉFABRIQUÉ ET PRÉCONTRAINT

KEARNS MANCINI ARCHITECTS

67 Mowat Ave suite 432, Toronto, ON M6K 3E3