

INSULATED WALL Precast Concrete

Technical Brochure



*Precast Concrete...
Sustainable Structures for Tomorrow!*

Canadian Precast/Prestressed Concrete Institute





Pavilion Desmarais Building • University of Ottawa • Ottawa, ON

The precast panels were designed as non-composite sandwich walls, 290 mm thick, with 90 mm of rigid insulation for a total R value of 21.

Introduction

Precast concrete insulated sandwich wall panels provide a functional and aesthetic wall system. Precast insulated sandwich wall panels consist of two conventionally reinforced or prestressed concrete wythes with a continuous layer of rigid insulation (typically extruded polystyrene) sandwiched between the two wythes. Precast insulated wall panels are available in a wide range of widths, lengths, thicknesses and with many available exterior finishes. Standard modularized panels provide speed and economy, and custom panels can be produced for a variety of special applications. Insulated sandwich wall panels offer many benefits because of their intrinsic construction.

Energy Efficient

Precast insulated panels have superior insulating properties - the type and thickness of rigid insulation contained in sandwich panels can vary with the thermal requirements of the building.

- The thickness of the insulation will be determined by the thermal characteristics of the insulating material and the thermal loads on the structure.
- A minimum insulation thickness of 25 mm is recommended with no limitation on maximum thickness.
- Insulation values are available from R5 (RSI-0.88) to R40 (RSI-7.0) or greater to suit project requirements.
- The insulation is installed under controlled factory conditions and is well protected by the concrete, once cured.
- The panel's excellent thermal mass characteristics are unmatched by any other material.
- Consult CPCI members for standard or custom insulation configurations.



William Osler Health Centre • Brampton, ON
Between the two caulking stages in the joint is an equalization chamber that must be vented and drained to the outside

Long Life

Durable precast concrete construction is available in a variety of pleasing, low maintenance, aesthetic finishes.



- Normal concrete strength is 35 MPa.
- Low maintenance requirements of precast means savings over the entire life of a structure.
- The rigid insulation is protected in the panel and retains its R-value over time. The solid precast sandwich panel exterior and interior wythes prevent settling or shifting that could reduce thermal efficiency.

Family Fitness Super Centre • Toronto, ON
When speed, economy and appearance are important, precast insulated sandwich wall panels are the solution of choice.

Economical

- Panels are plant-produced under factory controlled conditions.
- Panels have attractive exterior surfaces and have hard and optionally smooth interior surfaces (ready for paint).
- Precast insulated panels are a cost effective, energy efficient, durable, strong, and fire resistant cladding system.
- Panels allow for easy removal and reuse in building expansion or adaptation to new uses during the life of a structure.
- Panels can be used in both load bearing and non-load bearing applications.



Strescon Corporate Headquarters ▪ Saint John, NB

Canadian winters provide an ideal example of the advantages of total precast construction.

Fast Construction

Fast erection allows the building shell to be enclosed quickly (in only days) in all seasons – reducing delays due to bad weather, and ensuring early access for sub-trades.

- Early planning and coordination with the precast supplier can result in precast panel erection at rates of up to 120 lineal meters per day on concrete or steel frame buildings.
- Panels are usually designed to span from the foundation wall to the roof framing, reducing the number of joints and pieces to erect.

Attractive Finishes

Designers have the flexibility to select from a wide range of shapes, sizes, colours and finishes.

- Exterior finishes can be smooth, ribbed, textured, sandblasted, etched or incorporate a veneer material.
- Wall panels with a smooth interior finish resist everyday wear and tear damage in all types of occupancies, and provide a clean, durable and mold resistant surface suitable for food processing and other clean occupancies.

Home Depot Store ▪ Fredericton NB

The facade features brick columns with a stone base, a brick soldier course canopy, at the main entrance and brick cladding with limestone banding vertically and horizontally on the remainder of the building.
- all done in precast plant.





Structural Efficiency

Single storey panels can usually be designed to span between the foundation and roof beams without the need for additional intermediate supports.

- Load bearing panels can eliminate the need for beams and columns along exterior walls.
- Precast sandwich panels can accommodate a wide variety of loads, including wind, seismic, equipment, structural loads, and provide blast resistance.

Fire Resistant

Precast concrete has superior fire resistance qualities to many other construction materials.

- Sandwich panels can provide up to 4 hours fire resistance where required.
- Precast wall panels have inherent fire containment characteristics.
- Precast concrete adds safety and security which can improve insurance rates and speed mortgage approvals.
- For the purpose of determining fire resistance (with respect to concrete thickness and temperature rise) the equivalent thickness is generally calculated based on the total thickness of the two concrete wythes.
- Consult CPCI members for specific fire rating resistance.





Acoustics and Vibration Control

High sound-attenuating properties result from the two layers of concrete combined with the insulating core.

- The noise and vibration containment properties of panels keep unwanted noise and vibration from being transmitted through the panels.
- Precast sandwich panels are ideal for residential buildings, schools, colleges, freezer buildings, high-tech labs, clean manufacturing, food processing, research facilities and related specialized environments such as hospitals, high end office spaces and courthouses.
- Consult CPCI members for STC ratings of specific panel design/insulation thickness combinations.

Modular Insulated Sandwich Wall Panels

Panels may be mass-produced in modular widths on long-line casting beds.

- A layer of continuous insulation separates the inner and outer concrete wythes.
- Composite panels have the inner and outer wythes interconnected through the insulation by rigid ties.
- Composite panels are usually longitudinally prestressed.
- With attractive sculptured exterior surfaces and smooth-formed interior finishes, modular panels provide a strong, durable, energy-efficient, fire resistant cladding system. Conversely, the exterior face can also be formed face down and the interior face trowelled.
- Consult CPCI members for modular sizes, exterior finish patterns and colours.



Custom Insulated Sandwich Wall Panels

Custom sandwich panels are usually produced face down in custom forms and are available in a wide variety of exterior finishes and panel sizes.

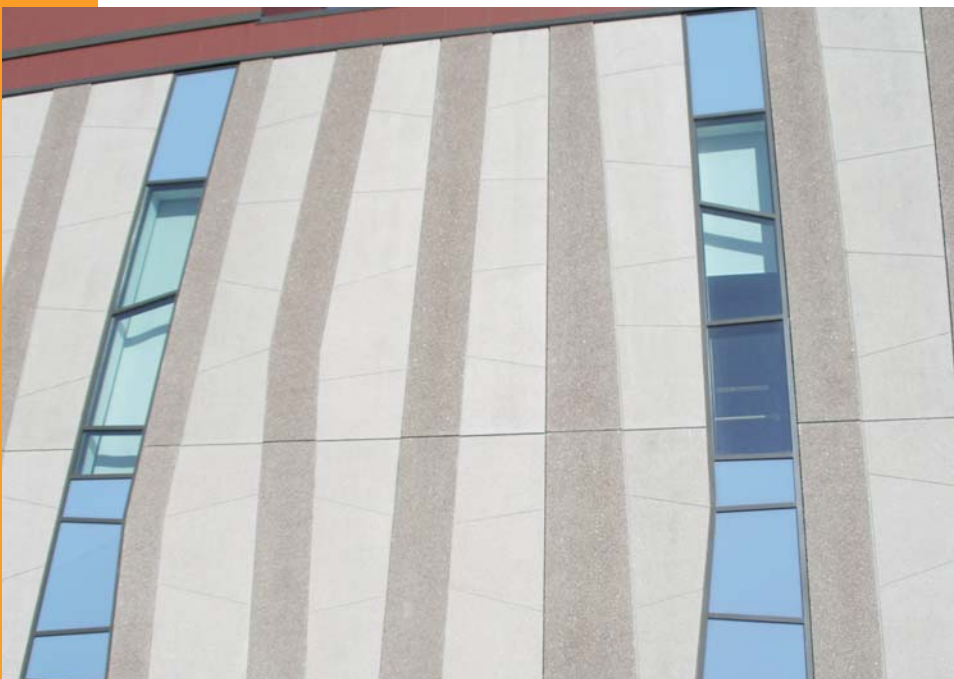


- A layer of continuous insulation separates the inner and outer concrete wythes.
- The interior is usually a smooth steel trowelled finish (suitable for painting).
- Panels are generally designed to be non-composite, in which the inner structural wythe is thicker, supports the exterior wythe and transfers the vertical and lateral loads to the building's structural framework.
- The inner structural wythe supports the loads imposed on the exterior wythe through tension/compression ties and the weight of exterior wythes by way of shear ties or hangers.
- Consult CPCI members for the full range of exterior colours, textures and finish patterns.

Panel Sizes

The size of insulated panels will be determined primarily by architectural design considerations; however precasters capabilities will have to be considered as well.

- The maximum panel dimensions and weight should be determined based on handling, transportation and installation requirements. Consult CPCI members.
- The maximum dimension of composite precast concrete insulated panels will be in the order of $L = 48t$, where L = the maximum panel dimension and t = overall panel thickness, excluding any ribs.
- The maximum dimension of non-composite precast concrete insulated panels will be in the order of $L = 48c$, where L = the maximum panel dimension and c = the concrete thickness ie. the overall panel thickness minus the thickness of the insulation.



- Panel thickness can vary from 170 to 350mm and beyond depending on design considerations and insulation thickness.
- Consult the CPCI Design Manual and CPCI members for specific design information. CPCI members can assist to optimize the building design for maximum economy by using the manufacturer's standard panel widths as much as possible.

Sustainable Design

Precast concrete components can contribute in an integrated design process to achieve sustainable designs. Precast concrete construction can assist architects to achieve as many as 23 to 26 points in the LEED building rating system by the CaGBC.

- Precast concrete walls used with integral insulation can provide energy benefits that exceed the benefits of mass or insulation used alone in most climates.
- Precast concrete sandwich wall panels used as an interior surface can save materials by eliminating the need for interior framing and drywall.
- The raw materials used in precast concrete manufacturing are generally sourced locally. Precast panels are usually shipped locally as well.
- Precast concrete walls can be designed to be disassembled, saving materials and extending the service life of the panels.
- Precast concrete's durability creates a long life-cycle with low maintenance, reducing the need for replacement and maintenance during a building's life.
- Precast concrete is manufactured in plants under tight quality controls. Precast concrete eliminates construction waste and minimizes transportation and disposal costs.
- Using plant-manufactured precast concrete components with just-in-time delivery reduces site disturbance and material storage requirements.
- Precast concrete contains recycled steel content and may contain recycled supplementary cementitious materials (fly ash, slag or silica fume).



Pavillion Desmarais Building ▪ University of Ottawa ▪ Ottawa, ON
Moriyama & Teshima Architects

Benefits of High Thermal Mass

One of precast concrete's key benefits is its high thermal mass, a property that allows concrete to gradually store and release heat to help moderate daily temperature swings. Recent studies by the U.S. Department of Energy (DOE), have demonstrated that the thermal mass of exterior walls reduces annual energy costs in buildings. Thermal mass interacts with the environment, both internal and external, to delay the effect of changes in the internal or external thermal loads.

The Environmental Council of Concrete Organizations (ECCO) reports: "The guiding principle for all thermal-mass standards has been performance. These standards have successfully translated the behavior of thermal mass into understandable and easy-to-use terms. The result is that thermal mass has become a feasible element of building design."

Visit www.sustainableprecast.ca for more information.

Precast Helps Projects Attain LEED Certification

Precast concrete's local manufacturing, energy efficiency, recyclability and minimal waste are key factors in meeting environmental standards.

Many owners are constructing sustainable buildings. Attention has been spurred by the Leadership in Energy & Environmental Design (LEED) standards specified by the Canadian Green Building Council (CaGBC). With attention to climate change and a desire to lower the consumption of energy and materials, the use of precast concrete construction can assist designers with "green" advantages.

Durability

Buildings constructed using robust materials can withstand the elements and occupant use for an extended building life. Precast concrete building structures with precast cladding can have life expectancies of over a hundred years.

Precast Concrete Sandwich Wall Panels

Precast concrete sandwich wall panels can help achieve LEED certification in a variety of ways; their ability to be recycled, being locally manufactured, having high thermal mass and incorporating integral insulation. These attributes reduce the expended energy needed to manufacture, transport and erect precast concrete panels, key LEED requirements.

Minimum Energy Use

Precast concrete sandwich wall panels can be constructed with high R values that will lower HVAC demands. Large precast concrete panels have fewer, sealed joints, reducing uncontrolled air infiltration. These attributes can help a project earn many of the LEED credits in the Optimize Energy Performance category.



Le Vistal ■ Montreal, QC ■ Jean-Pierre Bart Architects



M-Tech Headquarters ■ Calgary, AB ■ McKinley Dang Burkart Design Group

Eagle Ridge Apartments ■ Fort McMurray, AB ■ Gibbs Gage Architects ■ Calgary, AB



Leon's Retail Store ■ Edmonton, AB ■ Murphy Hilgers Architects

Indoor Air Quality

Mold:

Mold and a lack of air circulation can cause considerable damage to a building. The proper design of building envelopes built with the correct construction materials is a key way to reduce the presence and potential damage from mold.

The concrete, foam insulation and steel in concrete wall systems are not food sources for mold growth. However, organic materials such as floor decking, paper faced drywall and carpet used inside buildings can provide a food source for mold growth and should be treated accordingly.



Woodmont High School ▪ Piedmont, SC ▪ Perkins & Will, Design Architect, Craig Gaulden Davis, Architect of Record

Increased energy costs and a limited supply of fuel have forced the construction of more energy efficient buildings. Past construction practices allowed moisture from occupant activities to readily escape, along with conditioned air. Sealing a building envelope against air loss is critical in achieving superior energy performance. Problems can arise when moisture and humidity levels are uncontrolled.

Controlled Production:

Precast concrete is produced in a controlled and protected environment in a process that resists moisture intrusion. Precast concrete is made of 35 MPa concrete that is virtually impermeable to moisture migration.

Quicker Close-in:

The speed of construction allows a precast concrete structure to be completed faster, leaving the interior exposed to humidity and moisture for a shorter time. This is particularly vital for the installation of the heating, ventilation, and air-conditioning (HVAC) system that is a common location for mold formation.

Fewer Entry Points:

Because of their panelized construction and 2 stage joint seals, fewer points of potential moisture penetration exist with precast concrete cladding panels. Maintenance requirements are also minimal.

CPCI Precast Concrete Certification Program for Architectural and Structural Precast Concrete Products and Systems



CPCI has reintroduced an updated audit based process certification program to ensure conformance to CSA A23.4 and related standards. This program reintroduces strict, measurable, nationwide standards for precast certification. CPCI Certification is a superior program at no additional cost.

Important benefits:

1. Easy identification of plants committed to fulfill the highest level of certification available in North America.
2. Assurance that precast manufacturers have demonstrated their ability to manufacture quality products and have an ongoing quality system in place.
3. Certified manufacturers have a confirmed capability to produce superior products and systems.
4. Get the job done right the first time by qualified manufacturers - saving time, money and headaches.
5. Quality products will help speed installation and reduce construction time.
6. Deal with established precast manufacturers who have earned a reputation for superior, reliable workmanship.
7. No additional cost to you – CPCI Certified Manufacturers pay the certification fees.
8. Assurance that CPCI Certified Manufacturers will furnish products ideally suited for each project.



Program requirements

The manufacturing of precast concrete products must conform to the requirements of:

- CSA Standard A23.4 Precast Concrete — Materials and Construction
- PCI Quality Control Manual; MNL-116 - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products
- PCI Quality Control Manual, MNL-117 - Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products.

The more stringent requirements of these specifications are the governing criteria.

Eligibility

Any qualified manufacturer located in Canada or the United States that produces structural and architectural precast concrete products and complies with the requirements of the CPCI Certification Program is eligible for participation.

How is precast certification a requirement of Canadian building codes?

National Building Code of Canada – Division B:
Clause 4.3.3.1.(1) - Buildings and their structural members made of plain, reinforced and prestressed concrete shall conform to CSA A23.3, Design of Concrete Structures.

Clause A-4.3.3.1(1) - Precast Concrete- CSA A23.3, Design of Concrete Structures, requires precast concrete members to conform to CAN/CSA-A23.4, Precast Concrete – Materials and Construction

CSA A23.3 – Design of Concrete Structures:
CSA-A23.3 - Clause 16.2.1 – All precast concrete elements covered by this standard shall be manufactured and erected in accordance with CSA A23.4.

CSA A23.4 – Precast concrete
– Materials and construction:
CSA-A23.4 - Clause 4.2 – Precast concrete elements produced and erected in accordance with this standard shall be produced by certified manufacturers, with certification demonstrating the capability of a manufacturer to fabricate precast concrete elements to the requirements of this Standard.



Audits

Quality Audits are the heart of the precast certification program. Audits ensure manufacturers have a quality system in place that is consistently adhered to. Audits ensure conformance to standards A23.4, MNL-116 and MNL-117. Audits evaluate and identify areas requiring upgrading or corrective action (continual improvement).

There are a minimum of two regular audits in each full calendar year.

- The audits determine the conformity of the manufacturer's quality system and compare the finished products with the specified requirements.
- The audits determine the effectiveness of the implemented quality system and confirm that the manufacturer meets the regulatory requirements.
- The audits provide manufacturers with the opportunity to improve their quality system.
- A detailed audit determines the grade for each division of the audit manual together with a grade for each product group to determine the overall plant performance.

Auditor

Adherence to the certification program is monitored by an independent certification organization responsible to conduct quality audits in a fair and objective manner with equal treatment of all manufacturers.

The auditors are professional engineers, trained and knowledgeable in the evaluation of precast concrete manufacturing plants and procedures.

Quality Assurance Council

A multidisciplinary body oversees the certification program with representation by an independent architect, engineer and building official to oversee the certification program.



How to specify CPCI Certification?

The Construction Specifications Canada (CSC) TEK-AID for 03 45 00 Architectural Precast Concrete and 03 41 00 Structural Precast/Prestressed Concrete contains the following Clause 1.8 Quality Assurance:

- .2 Manufacturer: certified to Canadian Precast/Prestressed Concrete Institute (CPCI) Certification Program.
- .1 Manufacturer must meet requirements of CSA A23.4, including Appendices A and B, together with PCI MNL-116 and 117 and CPCI certification requirements.

See www.precastcertification.ca for a listing of certified plants.



Maintenance and Cleaning

Precast concrete units require little maintenance to preserve their original appearance. By following a simple program of inspection and maintenance, precast concrete can easily achieve the design service life of a building. To ensure proper performance or appearance, it is recommended that visual inspections be carried out yearly. Attention should be given to the caulked joints, surface appearance, and connections, if visible.

CPCI recommends that façade inspections be carried out by building owners or their professional representative at a minimum frequency level and extent as indicated by ASTM E 2270 Standard Practice for Periodic Inspection of Building Facades for Unsafe Conditions

There are specific items that require periodic attention:

1. Window cleaning — clean every 90 to 180 days (based on dirt accumulation effects of the environmental pollution).
2. Dirt removal — the precast concrete facade may be power-washed as necessary (based on the effects of the environmental pollution). Buildup of dirt is usually a gradual process, and a periodic flushing with plain water may be an adequate maintenance program.
3. Joint sealants — check all joint sealants for deterioration and repair, as required. Typical maintenance issues are water leakage through the joint, visible separation of the sealant from the concrete, and cracking or tearing of the sealant. Inspections of sealants generally detect sealant deterioration before joints have failed and let water into the building. Building owners should keep accurate records of when their exterior sealants were installed and the average useful service life of the sealant. Once the sealant has reached 75 percent of its useful life, periodic review of the sealants should be conducted. In most cases, the initial evaluation could be done from the ground and the roof. Once the sealants have reached the average useful service life, a more extensive evaluation should be performed, including the use of a swing stage to adequately observe the building sealant joints.
4. Sealer—if methyl methacrylate sealer was applied, it should be re-applied every 4 to 5 years or as specified by the manufacturer; if penetrating silane or siloxane sealer was applied, it may not be necessary to recoat. If desired to recoat, the minimum time would be 7 to 10 years

Precautions should be taken to avoid damaging or staining precast concrete units by:

1. Ensuring access equipment does not scratch or chip precast concrete surfaces.
2. Ensuring window cleaning solution (run-off) is cleaned from precast concrete units to prevent staining.

Removing stains from old concrete sometimes leaves the area much lighter in color than the surrounding concrete because surface dirt has been removed along with the stain or because the surface may have become slightly bleached. If at all possible, cleaning of the precast concrete should be done when the temperature and humidity allow rapid drying. Slow drying increases the possibility of efflorescence and discoloration. There is no single prescription for the cleaning and/or restoration of architectural precast concrete as each building is exposed to a unique set of ambient conditions.

Because efflorescence often occurs during or immediately following construction, the first impulse is to immediately wash it off with water or an acid cleaning solution.

This is not advisable, particularly in cool or damp weather when the primary result of such action will be to introduce more water into the concrete. The water will wash some of the alkali salts from the surface but will also dissolve and carry the salts back into the concrete, thus causing a reoccurrence of the efflorescence. If it is possible to wait one to two years before attempting to remove the efflorescence, most of the time, the efflorescing salts will work themselves to the surface and the problem may solve itself by normal weathering. The water-soluble alkali salts will gradually weather away. Heavy calcium carbonate efflorescence, although less common, is extremely difficult to remove as it forms a hard, white crust. After weathering to calcium hydrogen carbonate, it may be easily removed; otherwise acidic cleaners may be necessary. It is often helpful to determine the type of efflorescent salt, dirt, or stain so that a cleaning solution can be found that readily dissolves it without adversely affecting the surface finish.

Before cleaning the complete precast concrete building or affected area, a small and inconspicuous area; at least 0.9 x 0.9 m (3 x 3 ft), should be cleaned and checked to be certain there are no adverse effects on the concrete surface finish or adjacent corrodible materials such as glass, metal, or wood. Cleaning can consist of a sprayed-on application, stripped off with stiff bristle, stainless steel, or bronze wire brushes, a mild soap powder or detergent, and clean water using low or high pressure depending on stone type, if necessary. Acid or other strong chemicals that might damage or stain the stone veneer should not be used. Information should be obtained from stone suppliers on methods of removing oil, rust, and dirt stains from the stone. Mortar stains may be removed from brick-faced panels by thoroughly wetting the panel and scrubbing with a stiff bristle brush and a masonry cleaning solution.

A prepared cleaning compound is recommended; however, on red brick, a weak solution of muriatic acid and water (not to exceed a 10% muriatic acid solution) may be used. Acid should be flushed off the panel with large amounts of clean water (using a pressure washer) within 5 to 10 minutes of application. Brick should be cleaned in accordance with the brick manufacturer's recommendations, possibly using proprietary cleaners rather than acid to prevent green or yellow vanadium stains and brown manganese stains.

Following the application of the cleaning solution, the panel should be rinsed thoroughly with clean water. Low pressure using a 0.2 to 0.3 MPa (30 to 50 psi) washer or high-pressure water cleaning techniques may also be used to remove mortar stains except on sand finished brick. Unglazed tile or terra cotta surfaces should be cleaned with a 5% solution of sulfamic acid for gray or white joints, and a more dilute (2%) solution for colored joints. The surface should be thoroughly rinsed with clean water both before and after cleaning. Glazed tile manufacturers generally do not recommend the use of acid or abrasive powders for cleaning purposes.

For information on removing specific stains from concrete, reference as follows;

Removing Stains And Cleaning Concrete Surfaces, IS 214, published by the Portland Cement Association, Skokie, IL.

For more information on design & detailing also reference;
Architectural Precast Concrete: Walls and Structures (Best Practice Guide) published by Canadian Mortgage and Housing Corporation.

Applications



Cinema



Residential

Applications



Restaurant



Schools



Industrial Park



Bus Transit Headquarters

Applications



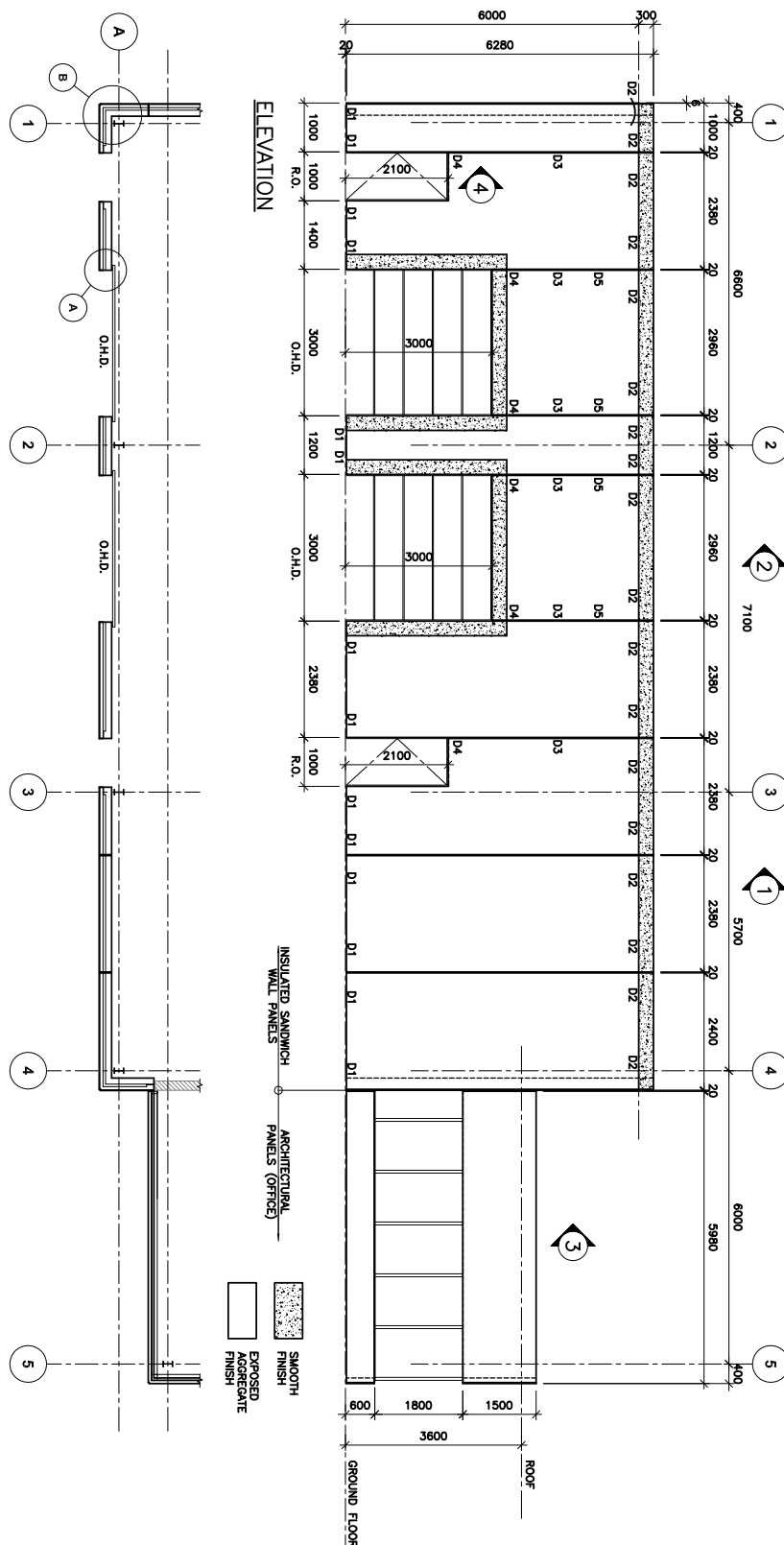
Warehouse Complex



Retail Centre

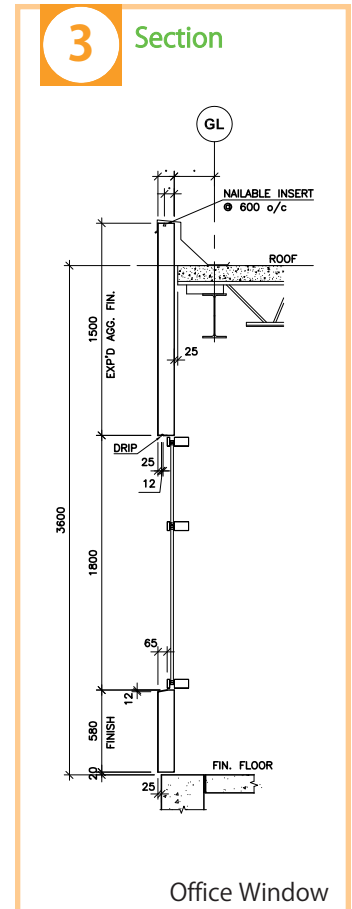
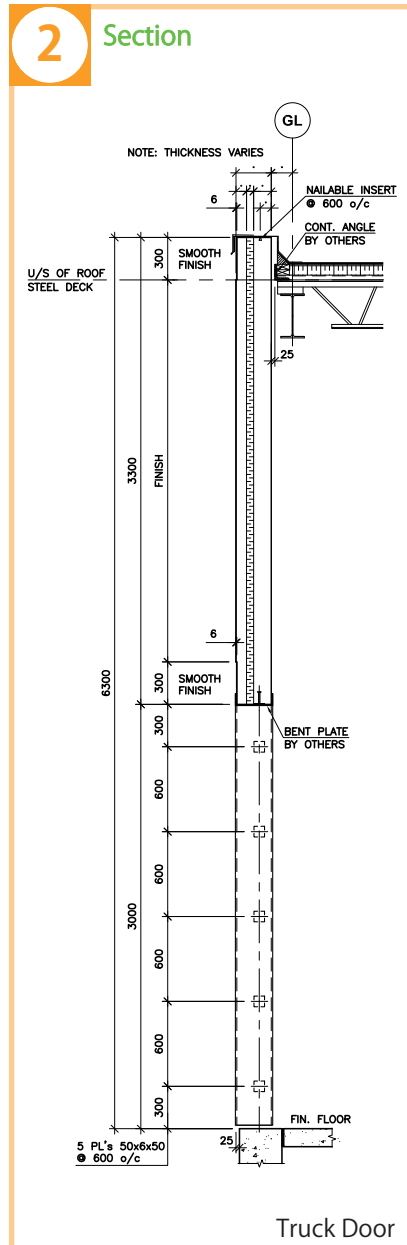
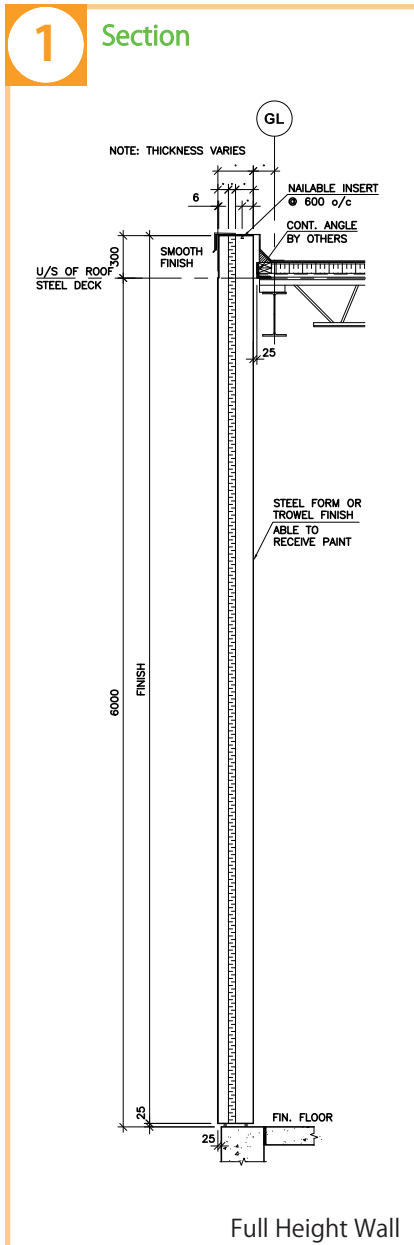
Typical Wall Sections

Plan



Note: Dimensions indicated are for illustrative purposes only.
Consult your local CPCI members for specific dimensions.

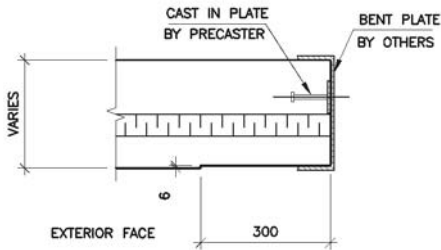
Typical Wall Sections



Note:
Insulation and panel
thickness varies
as required to meet
wall thermal
performance criteria.

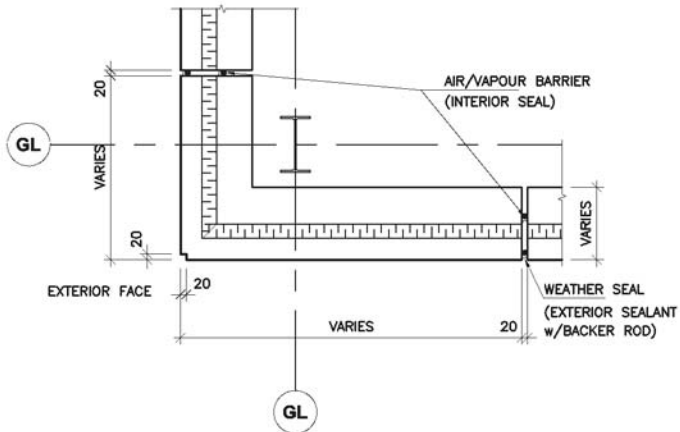
Typical Wall Sections

A Plan Detail



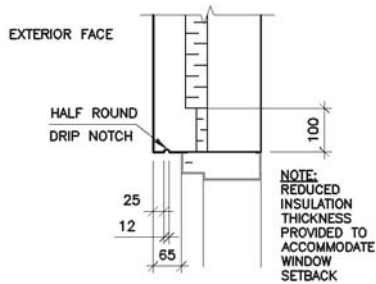
Jamb Detail at Overhead Door

B Plan Detail



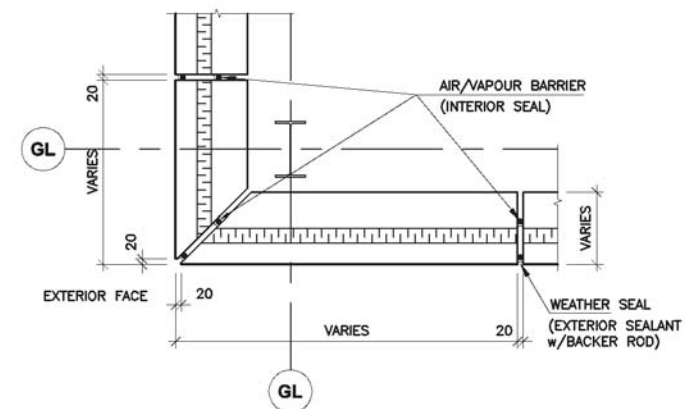
Returned Corner

4 Section 4



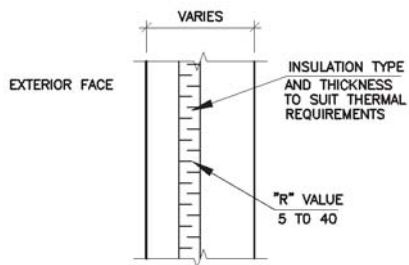
Head Detail at Man Door

B Additional Plan Detail



Mitred Corner

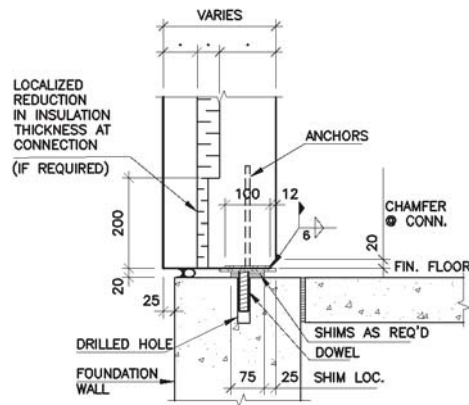
Typical Wall Section



Note:
Insulation and panel thickness varies
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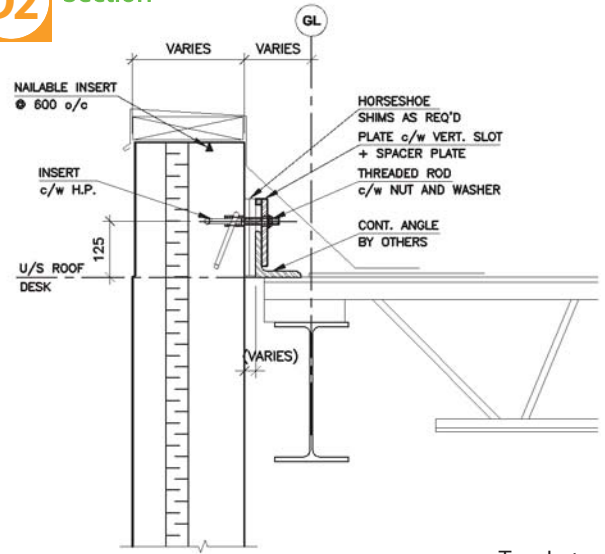
Typical Wall Sections

D1 Section



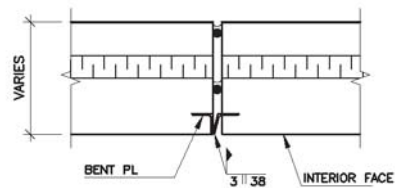
Bottom Lateral

D2 Section



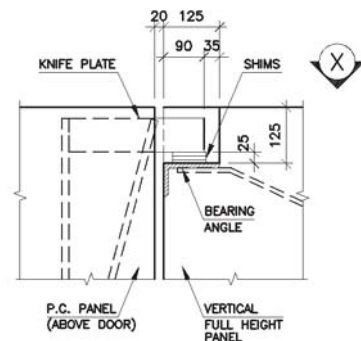
Top Lateral

D3 Plan Detail



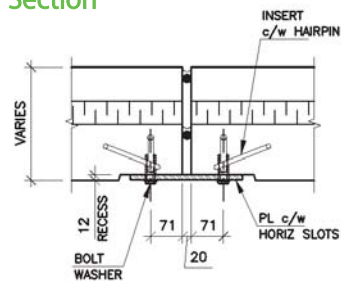
Concealed Mid-Height Lateral

D5 Back Elevation



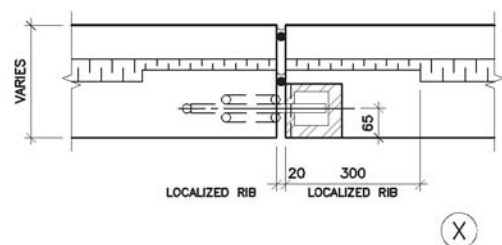
Load Bearing at Overhead Door

D4 Section



Exposed Panel to Panel Mid-Height Lateral

D5 Plan Detail



Load Bearing at Overhead Door

Note: All connections shown are for concept design only.



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196 Bronson Avenue, Suite 100, Ottawa, Ontario K1R 6H4

Telephone (613) 232-2619 Fax: (613) 232-5139

Toll Free: 1-877-YES-CPCI (1-877-937-2724)

E-mail: info@cpci.ca Web: www.cpci.ca

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