Technical Design Guide: 07 42 00

# DESIGN CONSIDERATIONS

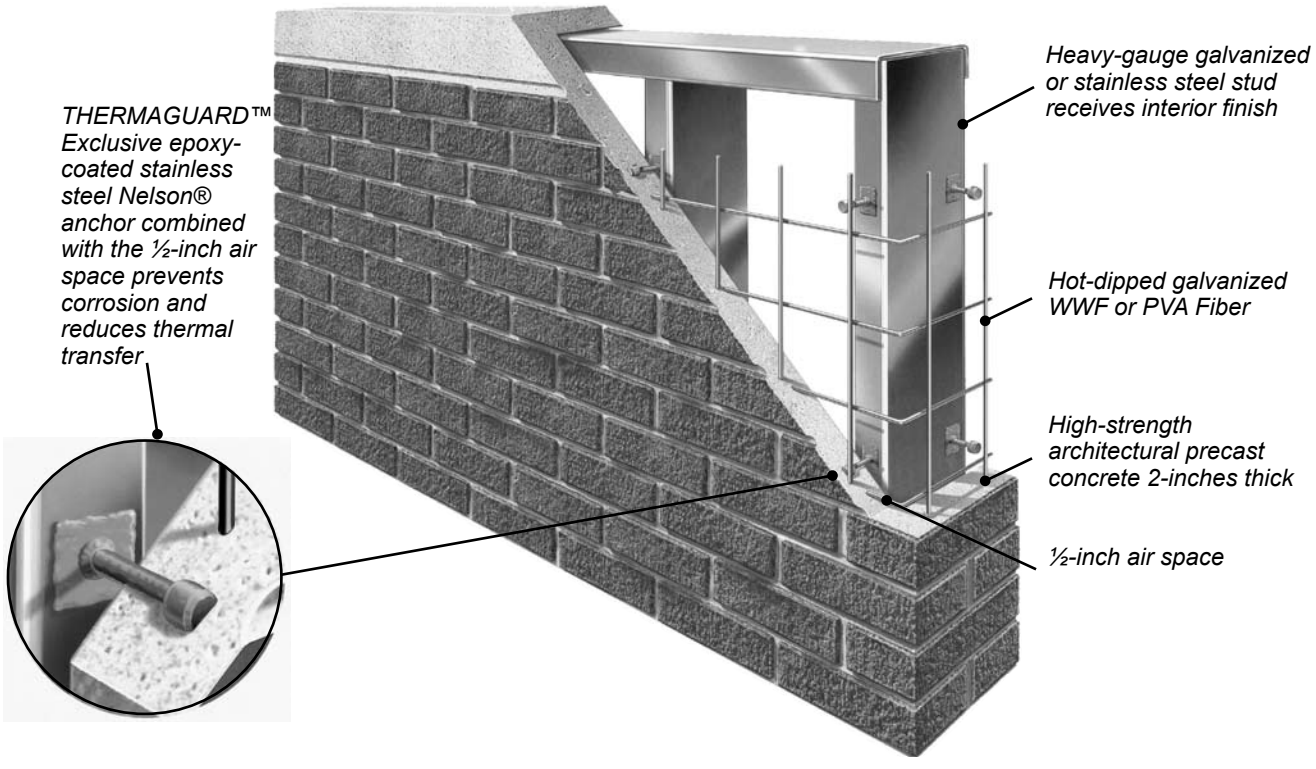
## General Design Approach

EASI-SET® designers use state-of-the-art design and detailing techniques to provide the most economical and aesthetically-pleasing exterior wall system available. *SLENDERWALL®* designs are in compliance with IBC, ACI, AISC, PCI Design Handbook, CRSI Manual of Standard Practice, and applicable state and local building codes. EASI-SET®'s engineers consider a range of load cases when designing the wall systems including handling loads, wind, seismic, panel weight, thermal expansion as well as other applied loads specified on the contract documents. Additionally, EASI-SET® has completed numerous, independent, full-scale mock-up tests to account for wind, water, thermal and sound transmission. Various test data can be found in SECTION 4 of this Architectural Portfolio/ Technical Design Guide. For additional information, please contact your EASI-SET® sales representative at 540-439-8911 or 800-547-4045, or visit our websites at www.easiset.com and www slenderwall.com.

## Physical Properties

The *SLENDERWALL®* system is a composite, lightweight wall system that takes advantage of the unique properties of steel and concrete to achieve a durable and aesthetically-pleasing façade system. Its exterior surface is 2-inches of reinforced traditional architectural precast concrete. The panel's interior surface is 16-gauge, 6-inch galvanized or stainless-steel studs on 2-foot centers. The composite section of steel studs and high-strength architectural precast concrete provide the system with strength and stiffness to allow the system to resist hurricane level winds and seismic movement.

Securing the 2-inch concrete facing to the steel frame are a series of proprietary THERMAGUARD™ connectors, which are insulated, epoxy-coated stainless-steel Nelson® anchors. These connectors not only securely anchor the concrete facing to the steel frame, but also provide the means to allow the concrete to respond independently to thermal gradients with a 1/2-inch air space between the precast concrete and the stud frame. This reduces thermal transfer from the exterior to the interior of the building by as much as 25%.



In addition to the thermal transfer reduction, another proprietary technology, DURAFLEX 360°™, is utilized. This technology allows isolation of the exterior precast concrete skin from the structural stresses associated with wind loading, structural steel movement, expansion and contraction, and seismic movement. DURAFLEX 360°™ is the only 2-inch wall connection that meets the AAMA 501.4-2000, Interstory Differential Movement, Vertical and Horizontal Displacement Test.

The exterior 2-inch-thick architectural precast concrete face can be finished with a variety of textures, colors, shapes, applied products, or finishes. *SLENDERWALL®* utilizes 5,000 psi concrete with either galvanized wire mesh and/or PVA fibers.

***DURAFLEX 360°™***

## *Panelization Options*

Optimizing the precast system includes reducing the production cost and increasing the speed of erection. The examples shown in drawing details P-1 through P-4 in SECTION 3.01 of this Technical Design Guide illustrate the several different ways panels can be combined or split up to achieve a desired result. Depending on panel sizes, shipping limitations, erection considerations and/or connection concepts, any one of these solutions may be the one best suited for your particular project. As shown in drawing details P-2 and P-3 in SECTION 3.01 of this Technical Design Guide, it is desirable to maintain a minimum section of 18-inches concrete around all openings and block-outs. Also, rough-opening-window-widths should be limited to 7-feet-0-inches unless special designs are implemented. Consult your EASI-SET® sales or technical representative for assistance in providing optimal panelization options for your particular project.

In general, the economics of the design are driven by two key factors:

1. Size of panel
2. Form utilization (repetition of same form)

Because erection cost is typically considered on a fixed "per piece basis," it is generally advantageous to find ways to reduce the number of erected pieces by making panels as large as possible. Note, however, that panel size is often constrained by fabrication and shipping considerations. Panel sizes can also be affected by the hauling conditions particular to the project in question and/or site conditions that may result in weight or crane reach limitations. Site access must also be considered when determining maximum panel sizes. Generally, the maximum economical size to produce is 10-feet by 35-feet. The largest panel size that can be produced is 13-feet by 40-feet, but there could be significant additional shipping costs to consider.

The second consideration in panelizing the building is form utilization, or the number of form set-ups. The more times the same form can be used, the lower the fabrication cost per piece will be. Therefore, it is extremely useful to look for ways to make maximum use of the same forms by building repetition into the shapes and sizes. This is especially important for buildings with brick finishes. Drawing Details A-9 and A-10 contained in SECTION 3.01 of this Technical Design Guide show guidelines for laying out brick patterns that reduce cost.

Your EASI-SET® representative can assist you in making the most economical choices for your particular project.

## *Connections*

*SLENDERWALL®* connections are designed to allow panels to be erected as quickly as possible, thereby shortening the overall project schedule.

The most efficient connections are those that allow erectors to attach any welded-on material well before the start of erection. When possible, bolted connections can be utilized to allow the precast to be set faster as well as to allow for greater panel adjustment. Final adjustments can then be made at a later time. Coordination between

the various trades must allow connections to properly interface with other building materials. Included in this Guide are a number of typical connections that provide the designer with a solid basis for cost-effective and highly-efficient designs. Consult your EASI-SET® representative for your particular project to help optimize the connections and provide overall economy of materials.

Gravity connections are typically spaced at 4-feet-0-inches o.c. with tie-backs located at 6-feet-0-inches o.c. Based on actual panel size and loading conditions, these spacing guidelines may differ. This is why it is always best to involve an EASI-SET® technical representative early on in the design process. This Guide also contains numerous connection concepts for various construction and/or building types. See Drawing Details S-1 through S-20 in SECTION 3.01 of this Technical Design Guide.

Rotational movement of the structural support system and/or edge angles by imposed panel live and dead loads is the responsibility of the Engineer of Record to analyze for both temporary landing gravity/torsional loads and permanent gravity/torsional loads.

The Engineer of Record is also responsible for verifying the strength and stiffness of the supporting structure. Because *SLENDERWALL®* panels utilize gravity supports at a 4-foot-0-inches o.c. spacing, consideration must be given to limit possible adverse effects from torsional rotation, or vertical deflection of the supporting structure. At no time should excessive torsional rotation of the supporting structure occur. The Engineer of Record must ensure that adequate bracing, stiffeners, and edge angles have been provided to allow for the optimum performance of the façade system.

Three basic types of deflection need to be considered and limited. These limitations will help ensure proper panel alignment and maintain adequate joint size. Each of these deflection limits should be noted on the Contract Documents and considered in the design of the supporting structure.

- Deflection Type 1 – Deflection of the Supporting Structure Prior to Placement of the Panels: Prior to the placement of the precast panels, and under application of the construction dead loads, the structure will undergo a certain amount of deflection. The EOR should ensure that these deflections are within code limits. This information should also be provided to EASI-SET® and coordinated with the engineer during the early design phase so that appropriate connection designs can be developed. The effects of camber should also be included in this deflection limitation.

- Deflection Type 2 – Additional Deflection of the Supporting Structure after Erection of the Precast Panels: Once the panels are loaded onto the structure, the supporting structure could undergo an additional amount of deflection. It is extremely important to limit the amount of deflection at this critical phase as much as possible in order to allow the erector minimal need for costly post-erection alignments. Therefore, it is recommended that this type of deflection be limited to 1/8-inch (preferred), with a maximum deflection of less than 1/4-inch.

- Deflection Type 3 – Additional Long-Term Deflection of the Supporting Structure Due to the Effects of Superimposed Dead Load Plus Live Load: After the panels have been erected, the supporting structure may undergo further deflection due to the application of additional dead and live loads. These deflections should be limited to reduce the possibility of long-term degradation of the panel joints and to ensure optimal performance of the façade system.

It cannot be over-emphasized that these deflections must be noted on the Contract Documents in addition to coordinating this with EASI-SET® during the design phase. EASI-SET® utilizes this information in the design and detailing of the panels and their connections.

## Panel Erection

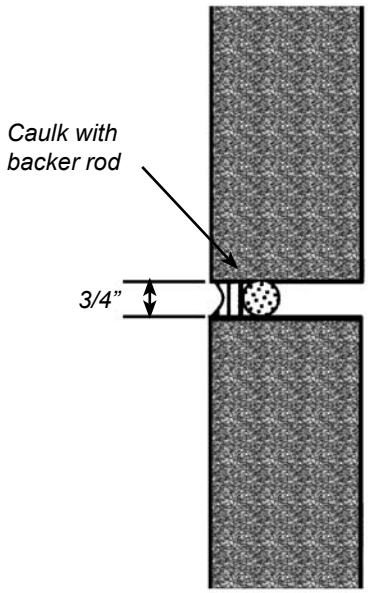
EASI-SET® uses a proprietary erection method—Lift-and-Release™ – that effectively speeds up panel installation. With the Lift-and-Release™ system, *SLENDERWALL®* panels can be plumbed and aligned after the crane has unhooked and moved on using a turn-of-nut connection. See Drawing Details E-1 through E-4 contained in SECTION 3.01 of this Technical Design Guide for more information on this system.

EASI-SET®'s choice of experienced erection companies must be PCI-qualified erectors, or have a minimum of five years experience installing *SLENDERWALL®* architectural precast concrete panels. They place safety first as they set panels according to required delivery sequences and schedules. They also carefully coordinate site access and storage priorities with the general contractor to maximize the number of panels set per day, minimizing the overall erection time frame. Field crews carefully execute the connection details according to the approved engineering design.

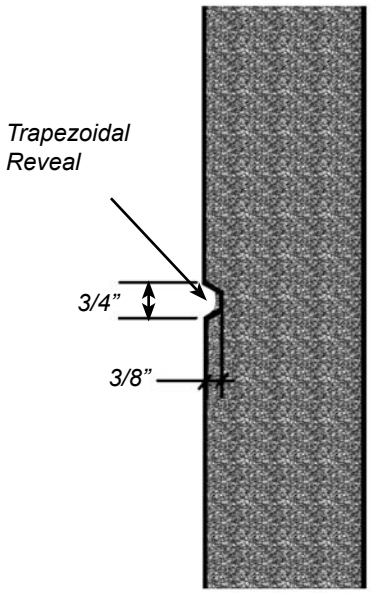
## Joints and Reveals

The size of the joint chosen on your project should be carefully considered. EASI-SET® recommends a minimum nominal joint size of 3/4-inch, to account for production and erection tolerances and to help ensure a long lasting, watertight panel joint. Joints detailed less than 3/4-inch can, in some instances, result in actual panel joints smaller than caulk sub-contractors cover under warranty. It's important to maintain a 3/4-inch joint between the precast and the window system for the very same reason. Also, it is strongly recommended that the caulk joints be inspected at regular intervals over time to ensure that degradation of the caulk has not occurred. Your EASI-SET® sales team will provide specific maintenance guidelines to help assist you.

When selecting accent reveals or rustication lines, it's important to tie them in to the chosen joint size. Triangular reveals are not to be used because they are difficult to affix to the forms. Instead, a trapezoidal reveal will provide a flat nailing surface for the form builders and help minimize possible nail-hole irregularities. When choosing a reveal, limit the depth to 3/8-inch. This is to maintain a minimum effective concrete thickness of 1-5/8-inches at all locations. See also Drawing Details A-1 and A-6 in SECTION 3.01 of this Technical Design Guide for more information relating to joints and reveals.



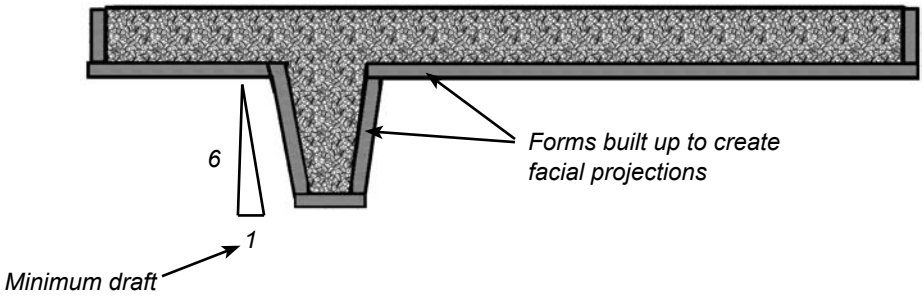
Panel Joint



Reveal

## Facial Projections

Facial projections can add a unique accent to your building project. Because these features are cast to the panels "bottom in form," a minimum draft dimension is necessary in order to be able to strip the panels out of the forms. Without proper draft, suction forces generated between the concrete and the form may cause the panels to bind up during stripping and possibly damage the panel and/or forms. To ensure this does not occur, EASI-SET® recommends a minimum draft of 1:6 on facial projections, as noted in the sketch below. See Drawing Details on A-7 in SECTION 3.01 of this Design Guide for more specific dimensional limitations. It should also be kept in mind that facial projections tend to increase production costs, since forms need to be built up to accommodate the feature.




## Panel Finishes, Architectural Brick — Second Nature™ Architectural Precast Concrete Brick (APCB)

Whenever possible, utilizing local aggregates and materials will help minimize cost. Your EASI-SET® sales representative will help guide you through the available ranges of materials, finishes, color combinations and applied materials to help give you that one-of-a-kind look. Choosing from a sandblast finish, acid etch, exposed aggregate, Thin Brick, granite facing, or many other finishes will provide the unique building accent that best emulates your design intent. Available exclusively with the *SLENDERWALL®* system is a proprietary finish of precast concrete architectural brick cast integrally into the panel. This finish—Second Nature™ Architectural Precast Concrete Brick (APCB)—is the only Class "A" precast concrete brick on the market with the level of quality necessary for Class "A" commercial projects.

Drawing Details A-9 and A-10 contained in SECTION 3.01 of this Technical Design Guide provide excellent guidelines for maximizing form utilization and optimizing the aesthetic quality of the façade.

## Glazing-Interface

The glass, glazing, curtain-wall systems interface with the *SLENDERWALL®* system in a similar fashion as with the 6-inch-thick architectural precast concrete systems. The most economical design is a flush-faced design where the window system is in alignment with the exterior face of the *SLENDERWALL®* system (*see Drawing A-2 in SECTION 3.01 of this Technical Design Guide*). This allows the window frame to overlap the 2-inch-thick *SLENDERWALL®* precast. An optional upgrade allows glazing to be set back from the face of the *SLENDERWALL®* precast (*see Drawing A-2 in SECTION 3.01 of this Technical Design Guide*). A precast return is introduced to produce the desired set-back. The maximum standard return is 4-1⁄2-inches from the face of the panel. Wood blocking is then field-applied to frame around the window opening to support the glazing system.

It is important to note that the weight of the glazing system cannot bear on the precast in the system. All glazing loads must be transferred onto the steel-stud back-up frame. Refer to Drawing Detail A-2 in SECTION 3.01 of this Technical Design Guide for details of the window head, jambs, and sill.

## Fire Stop

In many cases the building must be designed with a fire-rated floor system. This typically means that the cavity between the edge of the floor slab and the back of precast within the *SLENDERWALL®* system needs to incorporate a fire-stop or other fire safety design. This cavity is filled with a mineral-wool fireproof material. A pour-able smoke seal material may or may not be used on top of the fire-stop material.

There are several UL rated assemblies utilizing proprietary fire safety material that can be used to provide the required fire safety design. Refer to Drawing Detail A-3 in SECTION 3.01 of this Technical Design Guide for typical Fire Stop detail at slab edges.

## Fire Rating

The standard *SLENDERWALL®* system with one 5/8-inch layer of Type X drywall meets a one-hour fire rating. A two-hour rating may be achieved by adding fire-resistant materials to the back of the steel-stud frame.

## Penetrations

Penetrations through the precast that may be required for wall hydrants, pipe penetrations and light fixtures can be cast into the panels provided the coordination for location and size is done early enough in the shop drawing development. Ideally, the location and size of these penetrations should be provided to EASI-SET® designers about 8 weeks prior to fabrication. This is to ensure that the information can be incorporated into the shop drawings and fabrication drawings in adequate time. For openings less than 10-inches square, it is recommended that the penetrations be field cut. However, in no instance should the heavy-gauge stud frame be cut.

## Interior-Finish Applications

The *SLENDERWALL®* system is designed to accept numerous types of interior finishes. These finishes can be applied directly to the heavy-gauge stud framing. When detailing the interior finish applied directly to the back of the stud frame, a note should be made in the plans and specifications indicating that there is a difference in allowable tolerances between production and installation of the *SLENDERWALL®* system and the metal-stud-frame system. This means that there may be differences in the stud frame on the back of the *SLENDERWALL®* panels that will need to be accommodated by the interior-finishing contractor. They should also be made aware that the standard *SLENDERWALL®* frame incorporates 16-gauge vertical studs and a 14-gauge top and bottom track.

In some cases— for example, where four (4) *SLENDERWALL®* panels intersect, or with a long uninterrupted exterior corridor— the designer may elect to introduce a horizontal furring strip of 5/8-inch or 1-inch. This is used to "true up" the wall system before the interior finish is applied.

## Slab-Edge/Column-Face Locations

The slab-edge/column-face location should be clearly defined on the Contract Documents. A 1-inch dimension is required between the edge of slab or column face and the back of the *SLENDERWALL®* steel-stud back-up frame to account for tolerances both in the slab and column as well as the precast. Particular attention must be paid to slab-edge/column-face conditions along skewed or curved building edges as these areas are often the areas that cause the most difficulty during layout.

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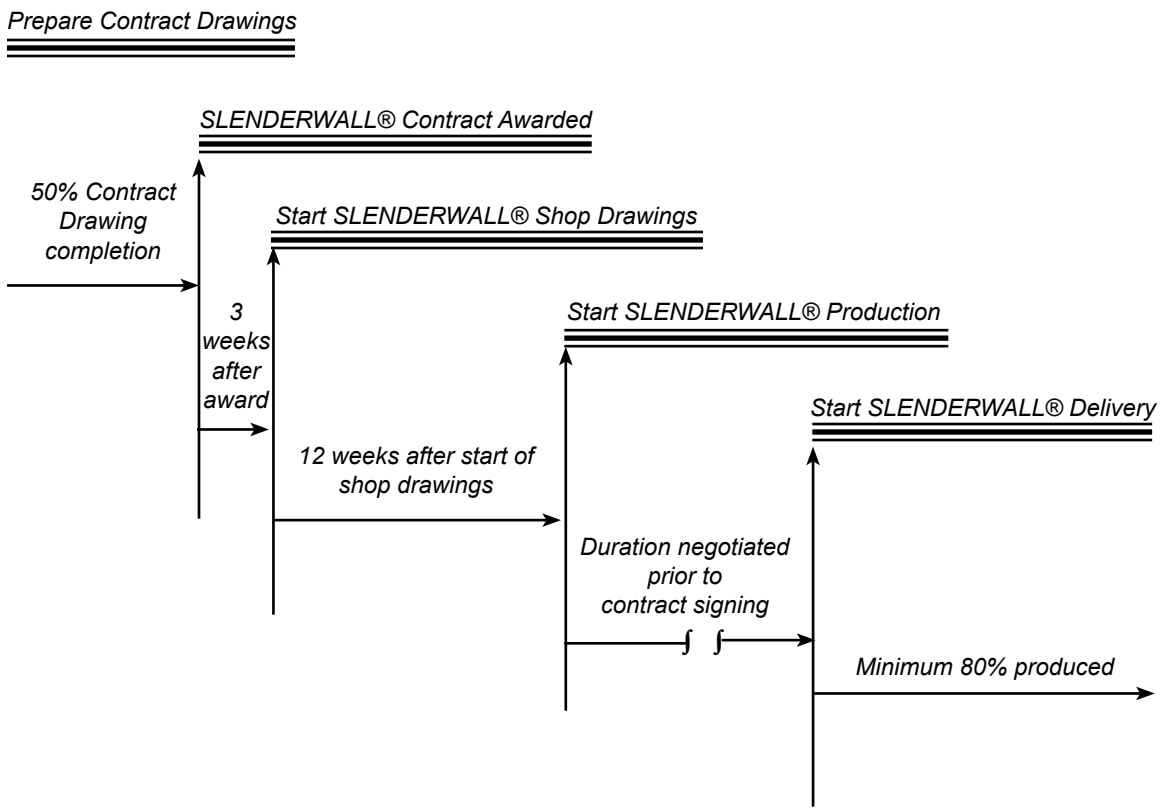
## Project Timeline

In order to optimize the *SLENDERWALL®* system, it is highly recommended that EASI-SET® be involved in the coordination of details, connections and panelization options early during the design development phase. Because plant availability may vary, it is best to award the *SLENDERWALL®* façade contract prior to other trades. This will also facilitate incorporation of *SLENDERWALL®* connections into the Contract Documents. The timeline below represents a typical project schedule, incorporating *SLENDERWALL®* into the subcontract. Note that the timeline below depicts representative durations to achieve maximum economy. Depending upon project complexity, these durations may vary. Allowing for optimal lead times and production rates will help keep costs low and quality high. EASI-SET® can assist you in preparing a more detailed schedule for each project to integrate into the overall project timeline.

### Optimal SLENDERWALL® Project Schedule




## Thermal Performance

*SLENDERWALL®* delivers the precast industry's only 100% thermal-break plus air-barrier panel connection system. This proprietary connection, THERMAGUARD™, is an epoxy-coated stainless-steel Nelson® anchor with 1/2-inch of air space between the concrete panel and stud, which prevents corrosion and reduces thermal transfer by as much as 25%. (See illustration on page 3 of this Design Considerations Section.)

*SLENDERWALL®* also offers a foamed-in-place urethane continuous-insulation method which acts as an insulation, water and air barrier.

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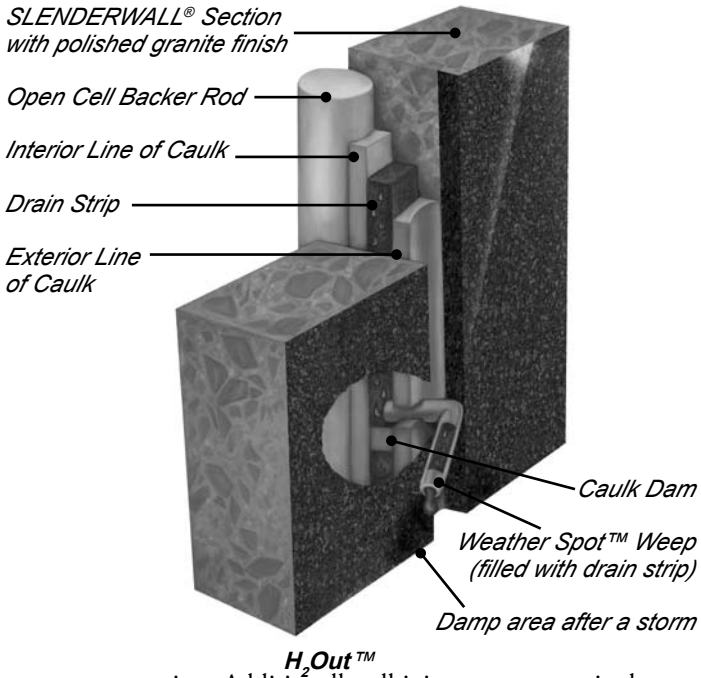
## Moisture, Dew Point

*SLENDERWALL®* uses a face-seal double-caulking method and offers an optional *proprietary* secondary water drainage system, $H_2$Out™.




**Water Penetration:** There are four forces that move water through walls—gravity, capillary action, kinetic energy and air pressure differences. Gravity will move water through an opening that slopes downward; capillary action draws water into small cracks or pores in building materials; kinetic energy refers to water leakage through walls due to the force of wind-driven droplets impinging on openings in the wall; and differences in air pressure will move water from a high pressure area to a low pressure area in search of equilibrium.

*SLENDERWALL®* resists water penetration by use of the face-seal method. This is accomplished by completely sealing the exposed face. The concrete mix is designed to a higher density (minimum 5,000 psi) and incorporates an integral concrete admixture, which has proven to significantly reduce water penetration. Additionally, all joints may use a single layer—or in extreme cases, a double layer—of sealant applied from the exterior. A secondary water drainage system exclusive to *SLENDERWALL®* is $H_2$Out™, which also can be utilized if so designed. Dow Corning and other major manufacturers have warrantied the use of their sealants in $H_2$Out™ applications. (Copies of approval letters are available upon request.)

**Water Vapor Penetration:** Water in its gaseous state (vapor) exists in practically all air. It is expressed as the percent of humidity. The higher the air temperature and percent humidity are, the higher its density and, thus, the higher its pressure. For instance, if the outside air is 90-degrees Fahrenheit and 75% humidity and the inside air is 75-degrees Fahrenheit and 20% humidity, then the outside air is higher pressure than the inside air and it flows toward the lower pressure area. Designing a true pressure-equalized wall system is cumbersome and expensive. The alternative is to recognize pressure differences and construct a vapor barrier in the wall system.

In hot, humid seasons, the vapor tends to migrate from the exterior to the interior. If the climatic conditions exist where this is a concern, then a closed-cell polyurethane insulation is put on the interior side of the 2-inch concrete skin of *SLENDERWALL®*. (See Material and Component Section for Dow Corning).

In cold seasons, vapor tends to migrate from the interior to the exterior. In conditions where this is a concern, a layer of plastic is field-installed by others over the light-gauge steel studs on the interior before the drywall is attached.

**Dew Point:** A common concern when discussing vapor transmission is the dew point— that point in a wall assembly where a temperature change through the wall causes the vapor to condense. Since a vapor barrier for vapor moving in either direction can be applied with *SLENDERWALL®*, the dew point is not a concern.

## LEED® (Leadership in Energy and Environmental Design)

The LEED® Green Building Rating System™ is a voluntary, consensus-based program for developing high-performance sustainable buildings. Based on well-founded scientific standards, LEED® emphasizes state-of-the-art strategies for sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality. It is becoming an increasingly important component of the building design. The *SLENDERWALL®* system can assist the designer in obtaining LEED® Certification for the building. The number of points gained toward Certification depends upon various design factors, such as the mix used and the finish. For example, more points may be obtained if a light-colored mix is utilized, or if a Thin Brick or Architectural Precast Concrete Brick (APCB) finish is utilized. Contact an EASI-SET® representative (540-439-8911 or 800-547-4045) for more specific details.