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Understanding The Rain Screen Principle

Rain Penetration

Problem

Rain penetration is one of the oldest problems building owners (and their design consultants) have to deal with, and yet it still cannot be fully controlled. The contemporary method is to caulk or seal every crack or joint on the exterior surface. This method sometimes works, but only for a short time. A better approach uses the "rain screen" principle. This method uses a drained and vented space behind surface cladding to keep the rain from penetrating the structural wall behind. But for the whole wall assembly to be fully successful, an effective "air barrier" is needed in the "secondary" exterior wall - and the full roof assembly.

The objective of a rain screen wall is to prevent rain penetration. Rain water can penetrate the wall of a building in any one or more of the four following ways:

- Direct entry
- Gravity flow
- Capillary action
- Air pressure difference.

While all four are important factors, the first three have been dealt with extensively by manufacturers in the design of cladding assemblies. The last, air pressure difference, is considered the most significant to a rain screen wall assembly - and the key to solving moisture infiltration from entering the interior.

For wind driven rain to penetrate a wall assembly, three conditions must exist:

- there must be water on the outer surface of the wall,
- there must be an opening through which the water and air can pass; and
- there must be a force (like the wind), to push the water through these small openings.

If any one of these three conditions is eliminated, rain penetration will be significantly reduced or perhaps eliminated. It is practically impossible to prevent rain from ultimately reaching the inside of a building - yet we must endeavor to try.

Most traditional methods of preventing rain penetration have concentrated on eliminating any openings through which the water could pass. However, as water will pass through even the smallest hole or crack, for this type of approach to be successful, the outside of the building wall must be perfectly sealed (sometimes called the "face seal" approach). This is a difficult condition to achieve and virtually impossible to maintain over time. (Example: the face seal approach is exemplified in some EFIS and stucco wall cladding assemblies.)

For a face seal approach, very small pores and cracks may be covered with impermeable or semi-permeable coatings, but these treatments are less likely to be effective for larger pores and cracks nor for a long period of time. Joints between components and materials can be sealed with gaskets or sealants. If they are located where they can be wetted by rain, the seal must be perfect. This is often difficult to achieve because of fabrication or project site inaccuracies or loose tolerances.

Rain Screen Configuration

The rain screen wall works very well because it minimizes the effect of the main dynamic force which actually causes water penetration - the wind. Although it is impossible to prevent wind from blowing on a building, it is possible to counteract the pressure of the wind so that the pressure difference across the exterior cladding of the wall is close to zero. If the pressure difference across the exterior cladding to a protected air space behind is zero, the main force causing rain penetration is eliminated. This is how the rain screen wall works.

The rain screen wall incorporates two wall "layers" separated by an air space or hollow cavity. These component parts are:

- the outer (wall) layer, usually considered as the decorative facade veneer,
- an air space, pressure equalized with the exterior environment, and
- the inner (wall) layer, considered as the structural backup or supporting wall; this layer contains structural load dispersing materials, thermal insulation, an air barrier, and if necessary, a vapor

retarder.

The inner layer of the wall needs to be structurally sound, airtight, and forms the air barrier, while the outer layer (cladding or veneer) is vented (to create pressure equalization) to the outside. In contrast, when the wind blows against a building solid wall, a pressure difference is created between the outside surface and the interior environment. With a rain screen wall, a small amount of air is encouraged to enter the cavity and is trapped by the inner air-tight structural wall layer, causing the pressure in the cavity to increase until it equals the exterior pressure. The time it takes to pressure equalize (taken by actual measurement) is usually less than one second.

The air trapped in the cavity space counteracts the wind blowing on the building and, as a result, the pressure difference across the cladding of the wall (between the exterior air and the air space behind the cladding) is reduced to close to zero. Consequently, as there is no effective force to cause the water on the surface of the wall to move inwards, rain penetration is effectively reduced as being close to zero.

For the rain screen to function effectively, it is important that the inner wall be air-tight. If there are leakage points or openings in the inner layer, the pressure in the cavity will not equalize with the exterior air pressure and subsequent rain penetration can easily occur. However, it is easier to permanently seal this inner layer than it is to seal the outside veneer surface. The inner seal will last longer, because the inner wall layer is not exposed to the harsh exterior surface environment. Any rain water that does penetrate the outer layer via vent openings because of gravity forces or capillarity action or direct wind driven rain, should drain back to the exterior side of the veneer. Consequently flashing details in the cavity that drain water back to the exterior, are very important.

It is also important that the cavity space not be continuous around the sides and rear of the building. When wind blows on the face of the building, it creates a positive pressure on that face alone. However, a negative (suction) pressure is created on the sides, roof and rear of the building. If the cavity space between the two layers (the outer cladding and the inner layer) is continuous around the corner of the building, air will move quickly through the cavity space to the sides of the building to where negative pressure exists - and pressure equalization will not occur. This could force rain into the cavity and water leakage could easily occur. A similar action will occur if the cavity is open at the top of the wall and air movement is permitted to enter the roof area where a suction (negative) force exists.

To make a rain screen function, the cavity air space must be divided into "compartments" in the adjacent orientation planes. Each of these compartments must be airtight at the building corners to allow pressure equalization to occur naturally in each plane (see Figure B). The formation of these compartments at corners also eliminates the cooling effect of wind washing onto the insulation.

Although the rain screen wall may sound like a new concept, it has been used for many years in wood siding and brick veneer construction, where the air space behind the siding or face brick is vented to the exterior and drained at the bottom. A vented and drained cavity space is not a true rain screen wall until it is compartmentalized and the inner structural wall is made airtight. It is easy to adapt this concept to conventional construction, to create a true rain screen wall.

Masonry cavity walls are an application of the rain screen concept, and are used extensively used in Europe and North America where they have been developed as a means of obtaining protection from penetration of rain through walls. In recent years in North America, many significant buildings with differing cladding types have been constructed with cavity (rain screen) walls.

Figure B illustrates the compartmenting concept for rain screen design used in common rain-screen applications such as: frame construction with a siding to siding compartment, and siding to brick veneer compartment, at the corners of a simple frame building including a house.

Rain Penetration and its Control

Rain penetration of building walls occurs all too frequently despite advances in building technology and new materials with improved properties. Through-wall or complete penetration of moisture may damage building contents as well as cause stains and deterioration of interior finishes. Uncontrolled partial penetration, which is less frequently recognized as such, can permit undesirable quantities of water within the wall assembly. This will result in deterioration and degradation of wall assembly materials, with mold, mildew and ice forming.

Water, in excess, is a key factor in most instances of deterioration of walls or wall materials - the primary source of this water is rain. Although a number of traditional wall systems have had a measure of success, it is only somewhat recently (in the last several decades) that scientific studies have been undertaken to explain the mechanisms of rain penetration. Through better understanding of these mechanisms, it should be possible to design and construct walls from which the water penetration problem can be virtually eliminated. The proper construction criteria for this structural inner wall is a subject for another paper - suffice it to suggest that this inner wall assembly must be air and water tight.

Examples of Common Rain Screen Walls

There are many current examples of rain screen walls, even though we do not always perceive them to be such:

- Wood, aluminum, or plastic siding as cladding on a home, where the siding is applied over wood strapping (that creates a pressure equalized air space between the strapping).
- Face brick veneer with a masonry or metal stud supporting wall; the air space in the cavity between the masonry wythes is pressure equalized.
- Marble or granite exterior veneer supported by a structural backup wall; the air space in the cavity between the veneer and the supporting inner wall is pressure equalized.

- Fluted metal siding (air space created by the flutes) or flat panel siding placed over metal subgirts (with an air space between the siding skin and the insulated structural backing); both created with a pressure equalized air space.
- Glazed curtain wall comprised of structural metal tube frame, glass and metal panel infill; the pressure equalized air space is carefully created within the components of the assembly, with water drainage back to the exterior.

Although we do not always think of these examples of exterior wall constructions as rain screen walls, they are such. More recent examples include an outer cladding of spandrel glass, metal panels, and specially manufactured colored ceramic panels.

Mechanisms Of Rain Penetration

Rain Water Accumulation

Water blown against a windward wall and cast by air currents and turbulence onto side walls, produces an accumulation of water at the building exterior. Extending roof overhangs, although successful in minimizing rain wetting of low buildings, are usually incapable of keeping walls dry on tall buildings or of giving protection during rain storms accompanied by high winds and wind gusts.

Some designs for solar shading (placed outward beyond the veneer or cladding) can be effective in minimizing wetting, but there is little likelihood that a building can be designed so that walls will never be wet. Openings that permit the passage of water are quite numerous on the face of a building in the form of pores, cracks, poorly bonded interfaces and bad joints between components or materials.

Depending upon the absorptivity and moisture storage capacity for surface materials and recognizing the rate of rainfall, a substantial film of water can form and flow on and about the veneer face. Surfaces of low absorptivity and low moisture storage capacity readily become covered with a film of water that increases in thickness or volume flow, toward the lower levels of multi-storey buildings. The flow of this water film is influenced by surface texture (smoothness) of the cladding, gravity, and air movement along a wall face. Normally, the net result is a lateral migration of water, with downward flow, concentrated at vertical irregularities in the wall cladding surface.

Experiments have shown that the water flow in narrow vertical depressions (mortar joints for instance) in a wall face, can be many times greater that the average over the remaining veneer surface.

Water Movement Through a Wall

Even more difficult is the maintenance of a perfect joint over a reasonable period of time, because of natural aging of a sealant. Also, differential movement between components constantly flex and stress the joint material. Skilled application and the use of new sealing materials can be exercised but it is seldom possible to guarantee that no openings will develop that will restrict the passage of water. Even when water is present and an opening exists, leakage will not occur unless a force or combination of forces is available to move the water through an opening.

The forces contributing to rain water penetration are the:

- kinetic energy of the rain drop,
- capillary suction,
- gravity and
- air pressure differences.

Under the influence of wind, rain drops may contact wall cladding with considerable velocity so that their momentum or kinetic energy carries them through openings. If an opening is small, the rain drop will be shattered upon impact, but small droplets will continue inwards. If there is no through path however, water cannot pass freely into the wall by this means alone. Battens, splines, or baffles can be used to advantage at joints to control rain penetration from this kinetic energy.

Capillary suction acts only to draw or hold water in a space, bound by wet-able surfaces. When a material approaches saturation, the capillary suction approaches zero but the water it holds will have no tendency to exude from it unless an external differential force is introduced. Gravity or an air pressure difference can cause a certain amount of water to flow through or out of this saturated material at a rate limited by the size by the size of the capillaries. Fine capillaries of less than 0.01 millimeter (normal hard-fired clay brick or cast concrete) can draw and hold a small volume of water with such high suction that they seldom contribute to rain penetration.

If the two faces of a cladding material are connected by capillary passages, severe wetting at the interior may occur because of capillary action alone, but only after the moisture storage capacity of the materials of the material has been filled. Partial water penetration can be controlled by introducing a discontinuity or air gap in the joint.

Other Forces Acting to Move Water

Gravity acting on water on the wall surface or in large capillaries can pull it through any passages that lead downwards and inwards. Water running down the sides of vertical cracks or joints can also be diverted inwards by surface irregularities. Rain penetration as a result of gravity alone seldom occurs through intentional openings. Cracks or other openings that develop after the construction process however, often allow water to enter.

An air space or discontinuity in the joint or wall immediately behind the wetted face will prevent further flow of water inwards. Water reaching this space will cling to the surface and will flow downwards so that it can be led out of the wall by flashings at suitable locations. A relatively low velocity air flow can carry fine water droplets or snow into the air space to create the same problem. Water can be raised a considerable distance and caused to flow into a wall when an air pressure difference is added to capillary suction. An even more serious situation can occur when, as a result of a large amount of water at the surface, openings up to 3/8 inch (9 mm) or more are bridged with water, which is readily forced through the passage by even small differences in air pressure.

Concealed Condensation Within an Inner Wall

In nearly all instances of a vented cavity space, moisture problems may arise from:

- direct rain penetration into the air space (as it should), or
- humid indoor air, exfiltrating into the cavity space as water vapor and condensing into liquid, or
- all potential occurrences happening together.

Condensation caused by air leakage (exfiltration) through the inner structural wall can be a major contributor. It occurs more often in the upper storeys of a building where more air exfiltration takes place because of the stack effect (increased air pressure due to warm air rising, especially prone with multiple floor levels). That is warm air, which is lighter, pushing upwards somewhat like hot air rising in a chimney. The result is an increase of an air pressure difference with the exterior environment.

> The amount of concealed condensation occurring because of air exfiltration in a wall depends on the relative humidity of the inside air, the temperature difference measured across the inner wall assembly, and the amount of air (and moisture) moving through the wall. Total

exfiltration depends on the difference of air pressure between inside and outside (measured on either side of the inside wall layer).

Severe concealed condensation problems are more likely to occur in areas subject to sustained cold temperatures and extended winter seasons. Windy regions will promote exfiltration at the leeward side of a building where the air pressure is negative - which causes an increase in pressure difference with the building interior. Air leakage through and within the constructed inner wall assembly can cause serious and expensive-to-fix problems.

consider A Pressure Equalized Air Space

Air Space Creation

Introduction of an air space in the wall must encourage equal air pressure to that on the outside wall face. This is accomplished by providing sufficient free area of opening through the exterior cladding layer to allow the wind pressure to maintain equalization. When the air pressures both outside and inside a wetted plane are equal, there is no air pressure difference to move the water.

It is important to note that the air barrier of a building enclosure must be located inward of this air space. The air barrier, regardless of its exact position in the structural wall assembly, is the point at which the air pressure difference between outside and inside the building occurs - and it must resist wind load pressures. Provided the air barrier does not get wet or subject to degradation, very minor air leakage through it will not be accompanied by rain penetration.

It has been shown that through-wall penetration of rain can be prevented by incorporating an air chamber in the joint or wall where the air pressure is always equal to that on the outside. In essence the outer layer is then an "open rain screen" that prevents wetting of the actual (real) wall or air barrier of the building.

The success of traditional walls is explained by this principle. Partial rain penetration or the wetting of rain screen materials can be minimized by reducing the surface porosity and absorptivity or by control of the forces necessary to produce it. It should be emphasized that the open rain screen principle of rain penetration control can be employed for any situation where rain penetration of walls and wall components can occur, especially at joints between components.

Cavity Wall as a Rain Screen

A cavity wall is a real world application of the rain screen principle. The term "cavity wall" is applied to a type of wall construction in which a continuous air space or cavity is provided within a complete exterior wall assembly. The air space is usually placed close to or directly behind the exterior cladding/face. A cavity wall is actually two "walls" separated by an air space, but joined by means of metal anchors for structural rigidity of the outer veneer or skin.

The most important advantage of cavity walls (with a pressure equalized space behind the outer veneer) over solid walls, however, is the positive protection against rain penetration which cavity walls can provide. In many buildings, solid masonry or concrete walls have been used under severe conditions of exposure to wind driven rain. Frequently under these conditions, the result has been penetration of moisture through the wall to the interior, producing damp wall problems. Cavity walls, on the other hand, do not permit rain penetration of the inner wall.

By their design, water cannot reach the inside surface of the wall assembly. When rain contacts a cavity wall, it will penetrate the outer cladding, but the water then trickles down the inner surface of the outer veneer and cannot easily traverse the cavity. The base of the wall is provided with flashings that direct water that has entered the cavity, outward through openings (weep holes) provided for the purpose.

Construction of Rain Screen Walls

Rain screen walls do not require special materials except an ability to withstand wetting and drying cycles without deterioration. The outer part of a rain screen wall can be brick masonry, plastic siding, metal cladding, precast concrete, marble, granite, structurally supported glass, or ceramic tile. The inner wall layer may be of brick, CMU, wood or metal stud with gypsum board cladding, or other substantial construction - provided it is structurally sufficient and capable of being an air barrier (and vapor retarder when necessary) and capable of resisting dynamic wind loads and wind gusts.

When a rain screen wall is constructed on a foundation, it is essential that a properly designed water-shed gutter be installed between the foundation and the wall. The flashing which forms the gutter is placed beneath the outer part of the wall cladding, and is shaped so that it turns up the outer face of the inner wall, and is carried into a joint of the inner wall.

Masonry Veneer: The gutter collects water that moves down the rain screen and must be drained. During construction of a cavity masonry wall, the inner and outer wythes are anchored by metal ties, laid in the horizontal mortar joints. They are arranged in a definite pattern. It is essential that the air space be kept continuous and not bridged by mortar or other material that will allow water to pass across the cavity.

Glazed Ceramic Panel Cladding: Another form of rain screen wall is to place an outer layer of ceramic panels with spaced joints, held in place by steel anchors to the backup structural wall. The air space created by the tile cladding and the small space between the tile panel units provides an ability to pressure equalize the cavity space - and successfully achieve a rain screen wall. Due consideration must be made for draining the space at the bottom of the cavity and for damming the air space at the building corners.

Door and Window Openings

Where a door or window is fitted into a rain screen wall, the continuity of the air space can be broken, care must be taken to prevent water from passing along the door or window frame to the interior. If a window is installed immediately beneath a shelf angle or attached to a spandrel beam, the normal flashing details for the shelf support are sufficient to preserve the water-tightness of the wall along the top of the window head.

If wall openings are made elsewhere, a separate support needs to be provided and a proper flashing must be installed to collect water moving down the cavity, with weep holes provided for drainage. The profiles of door and window frames must be designed so that water cannot travel along them to the interior. Diverter strips that project from the sides of the door or window frame into the cavity, are usually provided for this purpose.

Cavity Insulation

In recent years, special loose fill insulating materials have been developed for filling the air space of rain screen walls in order to improve the thermal insulation value of the wall. Since the main advantage of rain screen walls is to provide resistance to rain penetration which in turn, depends on keeping the air space free of anything that might form a "water bridge", it might be expected that filling the cavity space would destroy its resistance to rain penetration. Laboratory tests have indicated however, that this is not the case if specially prepared insulating materials, treated to be water repellent, are used.

Condensation

In North America, the performance of rain screen walls has been studied for about four decades. No special vapor retarder was installed in the buildings to control movement of water vapor from the inside to the outside, and there appeared to be no harmful effects of condensation in the walls. When high relative humidity is maintained in a building however, and the outside air temperature is very low, as may be the case in many areas of the country in the winter, there is danger of condensation of water vapor within the inner wall and of frost action. Under these conditions it is prudent to provide continuous vapor retarder protection to the inside (warm side) of rain screen walls, particularly if the cavity contains a special loose fill water repellant insulating material.

wind Pressures On Buildings

Wind

Wind is one of the significant forces of nature that must be considered in the design of buildings. Structural loads imposed by high winds are readily appreciated, even if the method of determining them is not so easily understood. Other effects that can be caused even by moderate breezes are commonly overlooked however, because quite often there is no obvious link between wind and the performance behavior of a building.

Interior structural wall, as part of a rain screen wall assembly, can be displaced or degraded by ice (under freeze/thaw conditions) accumulating within the wall as a result of moisture-laden air drawn out of a building under the action of wind suction. Rain leakage around flashings and through joints in curtain walls may be due to a pressure gradient across the wall, and the functioning of ventilating and heating systems may be affected by pressure distributions where ducts and openings are located.

Thus it is not only the structural engineer who must consider wind action but the architect and mechanical engineer as well. The architect and engineers are often concerned with average or day-to-day pressures, whereas the structural engineer is chiefly concerned with the maximum pressures that can reasonably be expected to occur during the useful life of the structure.

Interaction of Wind and Structures

The distribution of pressures and suctions over a building depends largely on how it disturbs the air flow. The datum from which all pressures and suctions are measured is the ambient pressure in the undisturbed air flow. When wind strikes a simple structure such as a rain screen wall, the air itself (due to pressures within the wall) is forced to deviate and pass around the building edges. The direction and magnitude of the original wind velocity are altered by the encounter and cause changes in pressure. Stagnation pressure is produced near the centre of the wall, but there is an increasingly steep pressure gradient towards the edges where the air flow, diverted by the wall, regains its velocity in a direction parallel instead of perpendicular to it as before.

Behind the wall, a different situation prevails. The streamlines of air flow are unable to come together immediately, because of the inertia of the air. A wake is left where they are separated from the wall. Air from the wake region is captured by the fast-moving flow lines, thus reducing the pressure below the ambient pressure of the undisturbed flow and creating suction. These are the pressure coefficients (sometimes called shape factors) that relate the pressure and suction on a structure to the basic design velocity pressure or stagnation pressure. Negative values indicate suction.

Pressure is not usually constant over a wall or roof surface; but to simplify design procedures, an average coefficient is specified for a given surface; when multiplied by the area and the basic pressure it gives the total force on the surface. The net force on the free standing wall would of course be the result of both the pressure on the windward side and the suction on the leeward side. Correspondingly, for an exterior wall of a building, the net pressure on the wall would be the difference in pressures outside and inside the building, the inside pressure being a function of openings and the affect of their seals.

Recognize that with a pressure equalized air space, wind generated air pressure on a wall is actually acting on the internal wall, not the cladding or veneer. That is why the internal wall must be structurally sufficient to resist the imposed wind/suction loads, as well as other loads.

Functions of a Wall

It is important, at the outset, to recognize that the over-all function of an exterior wall, in conjunction with floors and roofs, is to provide a barrier between indoor and outdoor environments, so that the indoor environment can be adjusted and maintained within acceptable human limits. The requirements for a wall must then relate to its ability to remain in place and to be durable for an anticipated length of time, while providing the necessary barrier or filter to wind, rain, solar radiation, heat, noise, fire, particulate matter, insects, animals and even humans.

The wall (openings) may be required to transmit light (windows), while imposing a barrier to other factors, must not itself be a hazard to life or property; but must contribute suitably to the form and aesthetics of the building generally. It must also satisfy a number of lesser requirements such as color, texture and porosity. All of this must be achieved as far as possible at acceptable cost, including both initial and longer term maintenance costs.

A complete list of all possible requirements could be a very long one. Fortunately it is seldom necessary to consider all of them in any given case. Further, many may be omitted from direct consideration as they will usually be satisfied automatically when other criteria are met.

Principal Requirements of a Wall

The following listing describes properties and attributes of a typical wall assembly.

- Control heat flow,
- Control air flow,
- Control water vapour flow,
- Control rain penetration,
- Control light, solar and other radiation,
- Control noise,
- Control fire,

- Provide strength and rigidity,
- Be durable,
- Be aesthetically pleasing,
- Be economical.

Any such list is a compromise of sequence and coverage and has, inevitably, strong interrelationships between properties so that it is always necessary to consider several of these requirements simultaneously.

Exterior Wall as a Barrier

Of the listing above, the first seven of the requirements relate to the expectations required of a wall as a selective separator between indoor and outdoor environments. An actual or potential flow of matter or energy is involved. The greater the differences between the inside and outside environments, the greater the stress or duty imposed on a wall assembly to resist undesirable matter or energy movement or affect.

The elements of a wall must be selected so that they impart the necessary resistance to keep heat, moisture, air and other flows within acceptable limits. The way they are arranged is also very important. This will determine the variations in conditions throughout the wall. These factors influence the environment in which the various parts of a wall must continue to function. Interactions between the various factors involved may produce conditions within the wall that require special attention. Some understanding of the phenomena involved is necessary so that they can be judged quantitatively and resultant wall design evaluated.

The latter four items of the above list may be regarded as general or over-all requirements, each must be satisfied as a wall fulfills its basic function - as a protector of an interior environment. They may apply to individual elements of a wall as well as to a wall assembly itself, and even to the complete building, of which a wall is only a part.

Aesthetic quality can also become a major factor in cost, although this is not always so. Form, color, texture, and pattern can usually be varied over a wide range without affecting other requirements. But insistence upon a particular aesthetic feature or quality may make it difficult to satisfy the service requirements or may force unsatisfactory solutions.

There are, in addition, loads arising from wind that must be borne by the exterior wall and its component parts. These must be transferred together with the dead load of the wall, through suitable structural connections with the building structural frame. This kind of structural analysis and design has been well established for many years and need not be discussed further. There is, however, one kind of loading arising out of dimensional changes in materials that deserves far more attention, particularly in the design of exterior walls and building frames, than it has yet received. That is induced loading - a subject for some other paper.

The Inner Wall

One of the most important of the above requirements, "strength and rigidity", is a functional requirement that has important inter-relationships with other requirements. There is a further complication with inner walls because they may interact with the structural frame to contribute to its strength and rigidity.

This inter-relationship may vary widely at the designer's choice, from curtain walls supported on the building frame to designs in which walls contribute racking strength and rigidity or assist in carrying vertical loads. The extent of this inter-dependence must be considered in the structural design of both building frame and its wall.

Examples of the construction of an inner wall can be:

- structural studs (wood or metal), insulation fill in the void spaces, gypsum board finish at the interior surface, water-resistant gypsum sheathing at the outer surface, the outer-surface of the sheathing may also include a liquid or sheet waterproofing membrane bonded to it.
- concrete masonry units, the inner surface may be exposed and painted (with a filler and enamel paint to form an air barrier), the outer surface may include rigid insulation set in a tacky-surfaced bitumen/compound coating.
- a shop or field cast reinforced concrete panel, finished on either side as for the masonry units described above.

All inner wall construction will require some form of thru-wall or surface fit flashings to divert moisture out of the wall assembly to the exterior.

summary

Rain screen walls provide an important advantage over single solid walls in that they can afford complete protection against rain penetration even when exposed to conditions of severe wetting by wind driven rain. Under similar conditions, rain leakage through solid walls as a destructive force is not uncommon. There are several essential requirements for rain screen wall construction:

- The two primary parts of a rain screen wall (the cladding/veneer and the inner wall) must be anchored together with structural metal ties that are corrosion resistant and sufficiently strong to resist imposed loads.
- The inner wall must be structurally sufficient to resist positive and negative loads imposed by the wind, in addition to creating an effective air barrier and perhaps a vapor retarder for containing the interior environment.
- The cladding/veneer material must have air vents or spaced joints to encourage air pressure equalization of the formed air space.
- The created air space/cavity must be free of mortar or other non-essential material. These may form a water bridge across the space or impede water drainage back to the exterior by means of a gutter or flashing at its base to collect leakage water, to drain water back to the outside.

Rain screen walls have been used in many countries over a long period of time and have established their excellent performance record under widely varying conditions using very dissimilar products.

The differences in the properties of inside and outside atmospheres to be separated by a wall, dictate the requirements of that wall. In combination with the properties of the materials to be used, these differences determine the environments within which each element must perform. The service life of a material is determined by the properties of the material and the conditions of the environment to which it is subjected.

Durable and well functioning walls can be achieved by judicious selection of materials to suit the environment, by redirecting the environment to suit the materials being used, or by a combination of both. Such manipulation, however, requires an understanding of the pertinent properties of materials and the phenomena that operate within exterior walls.