

## Stucco Failures and Remediation

Roger G. Morse AIA, and Paul E. Haas CSP, CIH

### ABSTRACT

Stucco over a single wythe of concrete block is widely used as wall construction in parts of the country with hot humid environments and heavy rains. Water intrusion has frequently been observed in this type of construction. This paper will identify the sources of water intrusion and describe alternatives for preventing or correcting such intrusion. Observations of water movement into and through wall construction will be described. Wall assemblies that are successful, as well as those with observed defects, will be described. Defects causing water intrusion into the building or damage to the exterior surface will be discussed, including water and insect passage through stucco accessories such as expansion joints, control joints and corner beads; water intrusion where walls sit on solid structures such as concrete bond beams or slabs; corrosion of stucco accessories; and efflorescence at stucco accessories.

**Keywords:** stucco, failures, restoration, water intrusion, moisture, insects, efflorescence, corrosion

### INTRODUCTION

This paper describes observations and measurements, taken over a period of years, of Florida buildings that had exterior walls with stucco applied directly over concrete. Wall construction in these buildings generally consists of a single wythe of lightweight concrete block with a stucco exterior. Typically, the stucco is applied in an effort to create a waterproof membrane, making the wall a barrier-type rather than weather screen-type assembly. Observations in the field found that this construction scheme frequently fails, resulting in various moisture intrusion issues, which in turn results in damage to components of the wall as well as creation of an environment conducive to mold growth and other microbiological problems. It was observed that moisture conditions within these buildings varies from place to place within the building depending upon orientation and external features of the building such as overhangs. It was also found that moisture issues were more severe shortly after completion of construction, before construction moisture dried, than after a year or two.

Exterior walls in Florida buildings are typically simple concrete block walls covered with stucco. In low-rise structures, these will typically be bearing walls built on a concrete slab. Roofs on small buildings such as houses are generally clay or cement tile supported by wooden roof trusses forming an attic over the occupied portion of the building that is usually ventilated with soffit or end wall vents. In high-rise structures, masonry walls with stucco will typically be curtain walls resting on a concrete floor structure and extending to the concrete deck of the floor above. Frequently, stucco is applied to the edges of floor slabs and floors are delineated with

horizontal control joints. On the interior, gypsum board is usually attached to furring which is attached to the inside face of the block. Insulation is frequently installed between the furring strips.

## **MAIN BODY**

### **Florida Climate**

Florida has a hot humid climate, frequent rain showers and high ground water. All of these factors have the potential of causing moisture problems in buildings. Most frequently observed problems include mold growth on the paper faces of drywall panels, rusting, rotting of wood components, swelling, and deterioration of building materials.

Irrigation practices in Florida housing and commercial developments create a hydrological microclimate around buildings. Building sites in Florida are heavily irrigated to maintain lush growth of grass and landscaping. This is accomplished by sprinklers that normally operate during the night, saturating lawns and planting beds. Sometimes these sprinklers become misdirected, causing wetting of the base of walls. In these instances, moisture damage to building interior finishes, particularly drywall, is frequently observed. Water collecting against the wall of a building due to improper sloping of the ground can cause a “rising damp” situation where groundwater rises through masonry to wet the base of walls and cause moisture damage.

### **Moisture Dynamics of Florida Buildings**

In general, moisture enters into buildings and the interstitial spaces of wall cavities and roofs in three forms. In descending order of magnitude these moisture sources are as follows: liquid water, air infiltration, and vapor diffusion.

Liquid water from rain or misdirected sprinklers enters the building envelope by penetrating through the outside face of walls. Moisture migration is typically driven by a moisture gradient, adsorption, and capillary action through stucco and other masonry exterior surfaces, cracks and imperfections in caulk joints and other weatherproofing fixtures such as expansion joints. Less frequently, ground water or water that has ponded against walls rises through the masonry construction of the building causing water damage starting at the base of walls.

Air is a mixture of gases including water vapor. Due to Florida’s high humidity, outdoor air contains a relatively large amount of water vapor. Infiltration of this air into the building and interstitial spaces carries a great deal of water vapor, which may create zones of high relative humidity or condensation upon impacting a surface cooled by air conditioning.

As Florida buildings are universally air conditioned, and thus cooled and dehumidified, a water vapor pressure gradient is created from the hot humid outside toward the cooler drier interior. Water molecules are sufficiently small to be able to readily diffuse through most building materials. The pressure differentials involved are high enough that, under conditions typical of Florida, an appreciable amount of water vapor is driven through building materials such as stucco, concrete masonry units, and drywall panels. Under most circumstances, this water vapor does no damage but instead only becomes a contributor to interior humidity and hence part of the air conditioning load for the building. Sometimes, however, condensation will

occur where water vapor encounters a more vapor-impermeable layer or a cooled surface, and this condensation will cause moisture problems within wall assemblies.

## **Florida Building Construction**

Typical Florida building construction is illustrated in **Drawing 1: Typical Florida Building Wall Section**. As can be seen, a typical low-rise Florida building has no foundation or basement; rather, the building is built on a slab. The slab edges are haunched down to produce a thicker area at the edges of the slab. This provides the foundation for the masonry walls that carry the loads of the roof and second floor, if there is one. A concrete tie beam is poured at the top of the wall, and this tie beam is tied to the slab with reinforced concrete poured in the hollow cores of the block walls, typically on either side of windows and doors, at corners, and at intervals along walls. Roof joists are then anchored to the tie beam with steel strap anchors. This results in a strong reinforced concrete framework that is able to resist the applied forces of a hurricane. The masonry-and-stucco exterior is also able to resist penetration of wind-blown debris during wind events.

**Foundations and Floor.** As there is no frost in Florida and there is high groundwater, buildings are typically built without foundation walls or basements and are instead supported on concrete slabs. This construction is shown in **Drawing 2: Base of Exterior Wall of Typical Florida Building**. To prevent the edges of the slab from becoming undermined and to provide additional structural support, the edges of the slabs are “haunched” down to make the perimeter of the slab thicker than the center. This “haunched” section carries the weight of the masonry exterior walls as well as floor and roof loads transmitted through the masonry walls. The top surfaces of the slabs are stepped down on the perimeter to form a shelf for the installation of concrete block, so that the concrete block in exterior walls starts at about one and one-half to two inches below the inside floor slab elevation. The outside face of the concrete block is installed flush with the edge of the slab. Stucco is applied over the surface of the block and slab edge and extends below grade. No weep holes are installed in the base of the wall, so any water that infiltrates into the wall settles through the hollow block cores to the base of the wall, where it collects, potentially causing wetting of wall components. This source of wetting is ameliorated somewhat by the stepped-down block shelf in the slab, which results in less resistance to passage of liquid water to the outside through the relatively more porous concrete block and stucco than to the interior through the concrete of the slab. As the entire bottom of the wall can become wet due to this configuration, however, the concrete block and slab on the interior behind the drywall can also become wet, causing damage to wood bases, drywall, and floor finishes. Drywall is installed on either wood or metal furring attached to the inside of the concrete block, and is taped and painted to form an interior finish. Depending upon the quality level of construction, the air space between the gypsum panels and concrete block may be filled with insulation. Many types of insulation are used for this purpose; a common form of insulation is a reflective insulation comprised of multiple layers of aluminum foil or aluminized Mylar to create layers of relatively still air.

During construction, water, well beyond that needed for hydration of cement, is added to concrete when slabs are poured, and water is also used in mixing mortar between concrete blocks, for concrete in block cores and tie beam, and for stucco. All of this construction water results in the floor and exterior walls being more moist immediately after construction than they are after several years of occupancy. Moisture at the base of walls can be high enough to

damage wood components such as baseboard and/or gypsum panels used for the interior finish. It is not unusual to find rusted nails in trim and carpet strips at the base of exterior walls or to find mold growth on the base of drywall. For this reason, it is commonly considered good practice to install gypsum panels so that they are not in direct contact with the floor, but are instead about one-quarter inch above the floor.

Observations of moisture conditions in numerous Florida buildings has found that construction moisture evaporates to the relatively dry interior over a period of about two years, eventually reaching a state of equilibrium between water entering the system, as either liquid water, infiltrated air, or diffused water vapor, and water leaving the system. This is evidenced by a cessation of moisture damage, such as mold, rusting, or rot, after a two year period. This means that hygroscopic materials, such as wood and gypsum board on exterior walls, will be wetter immediately after construction, and also that humidity in the building will be higher during the initial phase of this drying period than it is after several years of drying.

**Exterior Walls.** Exterior walls of recently built Florida buildings are typically constructed of concrete masonry units, which are comprised of crushed coral aggregate with Portland cement binder. Crushed coral is soft and porous and, as such, blocks made with this aggregate readily absorbs water and water readily passes through the block. Stucco is applied directly to the outside face of the concrete masonry units to provide a weather surface. The intent of this installation is to provide a barrier-type waterproof coating. In reality, the moisture performance observed in Florida building walls is much more complicated.

Stucco as used in Florida building construction is a composite of Portland cement with sand, aggregate, and lime (SBBC 2010; SDPBC 2010). Bags of ready mixed stucco are typically used, and these bags frequently contain admixtures intended to make the stucco more water-resistant. Observations of stucco applied to concrete block substrates generally finds microcracking, which makes the stucco relatively porous. This is expected, as the prevailing mode of stress relief is when the shrinkage of the stucco during curing is restricted by its bond to a fixed substrate such as concrete block. As a result, stucco is normally regarded as “providing a durable fire-resistant covering,” but, “shall not, however be considered to be waterproof” (ASTM 2006). Field observations of many installations have found that this porous nature allows liquid water to pass through the stucco and into, and through, the concrete block substrate. Control joints are installed at sufficient intervals to prevent the development of shrinkage stresses large enough to cause macrocracking. Stucco accessories, however, such as control joints and corner beads, are open at the back, providing a ready path for water to impact directly upon the porous concrete block beneath the stucco. Water that penetrates through the stucco wets the concrete block underneath and, when the block becomes saturated, runs down the hollow cores of the block and collects in the bottom of the wall.

When walls are warmed by the sun, moisture in wet materials will be driven by temperature differentials from the sunny exterior side toward the cooler interior of the building. At night, the process will be slowed or even reversed. This results in an equilibrium moisture content in the wall components, including the drywall panels, that changes with time of day and time of year. This moisture equilibrium will also be affected by rain events and winds.

**Window Construction.** Windows in a typical Florida building consist of a manufactured aluminum or vinyl window unit set into a masonry opening with no sill, head or jamb flashing at all. This construction scheme allows liquid water to penetrate into the wall assembly. Despite this water penetration, walls with this type of window installation succeed in most instances, due to the moisture storage capacity of the masonry wall and the concrete slab. In terms of moisture

control, however, this renders the situation fragile, as the wall operates at a moisture balance closer to failure, a situation that can easily lead to moisture problems. **Drawing 3: Window in Typical Florida Building**, illustrates window installation in a typical Florida building. First a masonry opening is prepared. This is accomplished by installation of jamb blocks with square ends on both sides of the opening supporting a precast concrete lintel. A precast concrete sill is installed in the bottom of the opening. Typically, this sill ends at each jamb, so there is a vertical joint at this location. There is no through-wall flashing at either the head or sill to direct water out of the interstitial spaces of the wall. Blocking is installed to accept a manufactured window unit. The head, jambs and sill are all covered with stucco and the joint between the stucco and window is caulked.

### **Stucco as Waterproofing**

It is common practice in Florida to apply stucco over a concrete block wall in the hope that it will provide a waterproof layer, making the wall weather-tight. This is accomplished by applying stucco directly to the surface of concrete block without reinforcing or supporting lath. Typical requirements are for 5/8 in. to 3/4 in. thick coatings of stucco, but layers as thin as 1/4 in. or less are commonly observed, particularly on low budget projects. Observations of many installations have found that water is frequently able to pass through the stucco into the wall assembly. It was observed that as stucco, as well as applied coatings and sealants, aged, the amount of water intrusion increased both in magnitude and frequency. Close inspections of the stucco found not only the micro-cracking normal for stucco, but also cracks and other defects in many locations that allowed water to seep through the stucco layer and into the concrete block substrate.

Stucco shrinks as it cures. When bonded to a fixed substrate such as concrete block, stresses due to this shrinkage are expected to be relieved by microcracking. Normal practice is to install expansion joints, both horizontally and vertically, at relatively frequent intervals to divide the stucco surface into areas small enough so that shrinkage stresses do not grow beyond the point at which these stresses can be relieved by microcracking. Observations of many installations found, however, that, while this is largely successful, cracking beyond microcracking is inevitable and occurred on a widespread basis throughout the stucco installations observed. Cracks were observed in the form of map cracking, larger shrinkage cracks at areas of stress concentration such as the corners of window openings, and separation of stucco from accessories. In a number of instances, evidence of water passage through stucco into wall assemblies was evidenced by moisture damage and efflorescence. **Photograph 1: Efflorescence Due to Water Seeping Through Stucco** illustrates efflorescence where water that seeped through stucco had leached out to both the interior and exterior surfaces of the building in areas where the wall cavity was blocked by a floor slab. Leak testing of walls documenting leakage through stucco into wall cavities is discussed below.

Typically, stucco is painted in an effort to improve its water resistance. Paint observed in many installations, however, was found to have defects such as cracking, particularly after several years of service and particularly on orientations with direct sun exposure. In these locations, paint and sealants develop defects such as cracks and checks. Paint was also observed to have cracked as the stucco beneath the paint developed cracks, thus making the paint ineffective in preventing water intrusion.

## Observations During Leak Testing of Stucco Walls

Observations made during leak tests performed as part of window acceptance testing in accordance with applicable ASTM testing methods (ASTM 2000; ASTM 2001; ASTM 2006) were frequently confounded by leaks through stucco. Observations during these tests found that interruptions to the plane of stucco, such as at control joints, corner beads, and openings for windows and doors, were major locations for leaks. In leak tests of walls with blanked off windows, it was found that water first entered the building through defects in the stucco and sealant at the corners of the sill, and then around the perimeter of the window. The magnitude of such leaks typically masked leaks through the stucco itself. Leak tests of blank runs of stuccoed concrete block walls in locations without accessories or openings still found leaks, although at a slower rate than at accessories and openings.

## Stucco Accessories

Application of stucco typically starts with the installation of accessories, such as corner beads and control joints, which define transitions and divide a wall area into smaller segments to control cracking. **Drawing 4** shows a typical arrangement of control joints. Stucco accessories also provide grounds used to determine stucco thickness. These accessories are made of zinc, galvanized steel, or plastic. In coastal areas of Florida, zinc or plastic is preferred to resist corrosion due to chloride contamination from sea water.

Some stucco accessories, such as control joints and outside corners, incorporate a void space behind the accessory as shown in **Drawing 5: Control Joint Cross Section**. This void provides a pathway for water and insect travel. In several instances, moisture transport through stucco accessories has been observed to have resulted in water intrusion into block cavities, and even through the block into the building interior.

Control joints are frequently installed to break a large wall into a pattern of squares or rectangles, resulting in vertical and horizontal joints with the inevitable intersections. Intersections can be made as mitered or coped joints. The least troublesome arrangement is for a vertical accessory to continue uninterrupted until it reaches a weather-tight termination at the top. This prevents water from entering the void behind the accessory at the top and running down the surface and into concrete block. In this instance, the horizontal runs are coped to but not cut into the vertical. It is not uncommon, however, for joints to be formed by mitering all four pieces at the intersection, as shown in **Drawing 6: Mitered Control Joint**. This arrangement not only opens the top of the vertical accessory to the weather, but also allows water collected by the horizontal accessory to drain into the open top of the vertical accessory. Typically, a sealant is daubed over the intersection, but observations of many installations have found that this is largely unsuccessful at preventing water intrusion, particularly after sealants have aged for several years. As a general observation, it was found that water penetrates behind accessories in most situations where miter joints were used between horizontal and vertical accessory runs, such as at window and door openings. Presumably, the top of the vertical accessory could be filled with sealant to prevent water entry, but this has not been observed in practice.

Control joints extending to, or even below, grade allow water entry into walls and provides a path for insects. In such instances, it is not unusual to find ant activity between vertical and horizontal runs and ant nests in the voids behind horizontal runs.

J-beads are intended to be used to terminate stucco where it comes to the end of a wall or meets an obstruction. However, sometimes it is used to form an accent by boxing in areas or forming horizontal accent bands. In this configuration, the horizontal top of the lower J-bead collects water and allows the water to penetrate directly into the block substrate.

Water that seeps into and through stucco, as described above, contains dissolved minerals from the stucco. Horizontal accessories, such as expansion joints or J-beads, act as collectors for this water, and either concentrate water flow at joints in the accessory or dump the water down intersecting vertical accessories. **Photograph 2: Efflorescence at an Accessory Joint** illustrates the result of such a condition.

Decorative elements, such as cornices, moldings, window headers, etc. are often molded from foam plastic. These decorative elements are applied to the surface and covered with a thin layer of stucco. Many instances have been observed where water penetrates into these decorative elements and becomes trapped between the foam and wall. These situations are frequently discovered as a result of insect traffic in and out of the element.

## **Moisture Control in Florida Building Construction**

The moisture content of materials in wall assemblies in a Florida building will vary by location and time of the year, as well as with age of the building. The overall movement of water in a typical Florida building is illustrated in **Drawing 7: Moisture Pathways in Typical Florida Building**. Water enters the building as liquid water through the outside walls, particularly at windows. This liquid water tends to descend due to gravity and collect at the bottom of walls. Air infiltration enters the wall assemblies through cracks in stucco and defects in caulking, as well as through cracks such as window joints. Water vapor diffuses through the materials comprising the exterior walls and the ceilings. The exact moisture content at any point in an envelope assembly will be the equilibrium that results from moisture added by these sources and the counteracting drying forces.

Notable characteristics of moisture in Florida houses include:

- Components of the outside wall, such as wood trim and gypsum board, will have higher moisture content immediately after construction due to construction moisture. Construction moisture will dry after several years, resulting in drier overall conditions.
- Relative humidity in a building will be higher immediately after construction due to evaporation of construction moisture.
- Rain during construction could increase the quantity of construction moisture and could lead to differences in moisture conditions between buildings, which could lead to differences in moisture damage.
- Due to gravity flow of liquid water entering wall assemblies, the bases of walls were observed to be wetter than other locations in the building. This is particularly true immediately after construction, when water infiltration and construction moisture are combined.
- As the envelope assemblies in Florida buildings generally do not have a vapor retarder, water vapor is able to diffuse through the exterior walls and ceiling to become part of the air conditioning load of the building. This may result in localized variations in the equilibrium moisture content within wall assemblies depending upon adjacent construction. For example, conditions at sections of the exterior wall with hollow concrete block cores may differ from locations with concrete filled cores.

- Windows leak more water than the general run of walls, making the base of walls under windows likely to be a wetter location than other places in the building.
- Stucco is not waterproof. Rain water is able to penetrate through stucco and cause moisture problems within wall assemblies and within the building, particularly at the base of walls. This water penetration can be reduced by proper maintenance of coatings and sealants.
- Stucco accessories, unless properly designed and installed, can provide water pathways and concentration points leading to water intrusion.

## DISCUSSION

Observations of many installations over a number of years found that stucco provides a rugged fire-resistant finish able to resist damage from hurricane force winds and wind blown debris. Furthermore, stucco, particularly when applied over concrete block masonry, was also found to provide an effective air barrier. Stucco did not, however, provide an effective water/moisture barrier. Many instances were observed in which water entry through stucco/masonry walls supported indoor air quality issues, such as mold, bacteria, and insect infestation, and caused water damage to materials, such as rotting, corrosion, delamination, and swelling.

Buildings with stucco over masonry rely on the moisture storage capacity of the concrete block in the wall assembly and the concrete slab to safely store water that enters through the stucco. This results in a fragile situation. If the rate of moisture entry exceeds the storage ability of the block and slab, moisture problems occur. Observations in buildings with no complaints of moisture-related problems typically found the moisture content of the concrete slab and concrete block, particularly at the base of walls, to be near levels that would result in moisture damage or indoor air quality problems. Even slight amounts of added moisture, such as from a window leak, misdirected lawn sprinkler, sealant defect, or even heavy rain, could tip the moisture balance and result in moisture problems. This fragility results in the high incidence of moisture damage observed in buildings that rely only on stucco over masonry without additional moisture management.

For new construction, there are a number of moisture management features that can be implemented to improve the situation. Ideally, stucco would be installed as a rain screen over a drainage layer configured to allow free drainage of water to the exterior surface of the building. In the absence of this, additional moisture management features should be added to the construction, including:

- Addition of weep holes at the base of walls to allow moisture to escape from wall cavities to the exterior.
- Use of less moisture-sensitive interior materials at the base of walls, such as mold/moisture resistant drywall, pressure treated wood, non-corroding metals such as aluminum and stainless steel materials, synthetic carpet, or tile.
- Addition of water-resistive coatings on the inside of walls, particularly at the base of the wall.
- Monitoring of the moisture content of slabs and masonry to insure they are sufficiently dry before installation of drywall, insulation, and interior finishes, particularly finishes such as ceramic tile, that restrict drying.

## Stucco Remediation

The best solution to water intrusion through stucco into a wall assembly is to retrofit a new properly drained surface. As an example, addition of a drainage plane material, such as W. R. Grace Bituthene®, over the existing stucco, and then stucco on self furring lath spaced from the surface, effectively prevents water entry into the wall assembly. In addition, use of a drainage screed at the bottom of wall, and weep holes or drainage screed at obstacles such as window and door openings is recommended to direct water from the drainage plane to the face of the wall. As this prevents the entry of water into the wall system it has a high probability of success.

Where retrofit of the stucco is not possible, it may be possible to tip the moisture balance in the wall back to the point where the moisture storage capacity of the concrete block and concrete slab can safely store the incoming moisture. Reduction of water intrusion through stucco can generally be achieved with one or more of the methods listed below. It should be pointed out that this is more an amelioration than a correction, and that moisture problems can re-occur if the rate of water intake increases by a mechanism such as additional cracking or aging of sealants. As normal aging of materials can increase water intake, an effective operations and maintenance program for the stucco and sealants is essential in order to have a reasonable chance of preventing future problems. As the goal is to slow, but not necessarily stop, water intrusion, it is difficult to predict how well these methods will succeed in correcting moisture problems. Methods for reducing the rate of water intrusion through stucco over masonry include:

- Patching of missing or loose stucco
- Repair of cracks
- Restoration and/or installation of sealants
- Restoration and/or installation of coatings
- Remediation of accessories
- Retrofitting of weep holes.

Patching of missing or loose stucco is typically accomplished by applying a bonding agent, adding a scratch coat, then bringing to full thickness with one or more coats of stucco. Sometimes fiber-reinforced stucco is used to reduce cracking and shrinkage. The surface is finished to match the original stucco and the repair is painted. Performed properly, patching can effectively restore stucco, as long as the cause of the original failure has been corrected. Unfortunately there is always a risk of shrinkage cracking between the patch and original stucco. As such, the repair should be evaluated after about a year of service and additional repairs made as necessary.

Repair of fine cracks, such as map cracking, is usually accomplished by application of a brush-grade sealant into the crack. Larger cracks are normally repaired by raking out the crack and packing it with a knife-grade sealant. Movable cracks are normally raked out and repaired with backer rod and gunned sealant. Following crack repair, the surface is painted to provide a uniform surface. Observations of many such crack repairs has found that initially this repair will slow water penetration sufficiently to greatly ameliorate water intrusion problems, but that problems will reoccur as the sealants and paint age.

Virtually all stucco repairs include restoration and/or installation of sealants to prevent water entry into accessories and at joints. In some instances the void in the back of an accessory is filled with a low viscosity sealant to prevent water entry. Sealants in this application are believed to have a long life as they are protected from sunlight.

Coatings are frequently used to reduce water transmission through stucco. Observations of such installations have found that, while coatings initially reduce water infiltration, coatings become progressively less effective as they age. In many instances, paint has been observed to be rendered ineffective as a moisture barrier by continued deterioration and cracking of the stucco. The tensile strength and elasticity of coatings are insufficient to prevent cracks in the stucco from extending through the coating. Elastomeric coatings perform better in this regard, but are still not able to resist damage from cracking of the underlying stucco, and, in addition, are more difficult to repair.

Water intrusion due to damaged or improperly configured stucco accessories can be considerably ameliorated, but usually not permanently corrected, by remediation of the accessories.

**Drawings 8a, 8b, and 8c** illustrate such a remediation of the control joints in a building. Prior to the remediation, water that seeped through the stucco was collected in the void in the horizontal control joints in sufficient quantity to drain into the vertical joints, filling the joints, and then seeping into the building. Due to programming and fiscal constraints, it was not possible to correct this by replacing the stucco; therefore, the accessories were modified to sufficiently reduce water entry to resolve the water intrusion. Horizontal joints were retrofitted with a water stop and drip edge, and weep holes were installed to relieve collected water. Vertical joints were isolated from horizontal joints, and void areas were filled with low viscosity silicone sealant to prevent water entry. Another alternative would be to chop out the accessories, and install new, properly configured accessories, and then patch the stucco. While this would resolve the accessories issue, it would raise a new series of issues regarding cracking at the joint of the patch and original stucco. With this alternative, any such repair would require a follow-up evaluation and would probably require additional repair after some time in service.

In severe instances, water from leaking stucco and accessories may collect at the bottom of walls in sufficient volume to saturate the bottom of the wall. It may be possible to ameliorate this situation by installation of weep holes to allow bulk water to escape to the outside of the building. This improves the situation, but does not convert the wall to a proper cavity wall or drained wall system (NIBS 2010), as there is no drainage plane or through-wall flashing. In instances, however, where the downward flow of water inside the hollow block cavities is obstructed by a water-resistant structure, such as a floor, lintel, or beam, weep holes can relieve the collected water to the outside. Combined with a waterproof coating on the inside face of the masonry at the base of the wall, this scheme can ameliorate, but not completely correct, the situation where a more permanent correction is infeasible for some reason. In some instances, an impressive gusher of water has resulted when holes are initially drilled. **Drawing 9: Retrofit of Weep** illustrates installation of a weep hole in the base of a wall. Ideally such a weep will be installed at the bottom of the wall in a vertical mortar joint (head joint) below open block cells. However, with square end block, it may be necessary to cut the weep hole into a hollow cell of the block. In either case, it is necessary to clear out mortar droppings enough to allow water passage to the weep. A weep hole accessory that prevents insect entry should be used for the weep hole. Use of an accessory designed for brick masonry that is 3/8 in. wide and 2 1/4 in. high usually provides sufficient clearance to clear mortar droppings from the water path.

All of these remediation techniques rely on sealants and coatings that will, in time, age and fail. Any such remediation therefore requires that the building owner become an active participant in maintaining the building envelope in a leak-tight condition. This can be accomplished by developing a preventive maintenance program to repair and replace sealants and coatings on a regular basis prior to failure.

## **CONCLUSIONS**

Construction in Florida that relies on stucco over concrete block masonry is failure-prone, and its water control capabilities could be greatly improved by substitution of a drainage plane-type of construction that incorporates a waterproof barrier with proper drainage, flashing, and weep holes. Retrofit of a similar assembly over existing problematic stucco installations has a high probability of success. If economic or other considerations prevent the installation of a retrofitted drainage plane wall finish, remediation of existing stucco, accessories, and sealants can ameliorate the rate of water intrusion. If the rate of water intrusion is sufficiently reduced, it may be possible to achieve a moisture equilibrium in the wall at a level that can be safely stored by the concrete block and slab.

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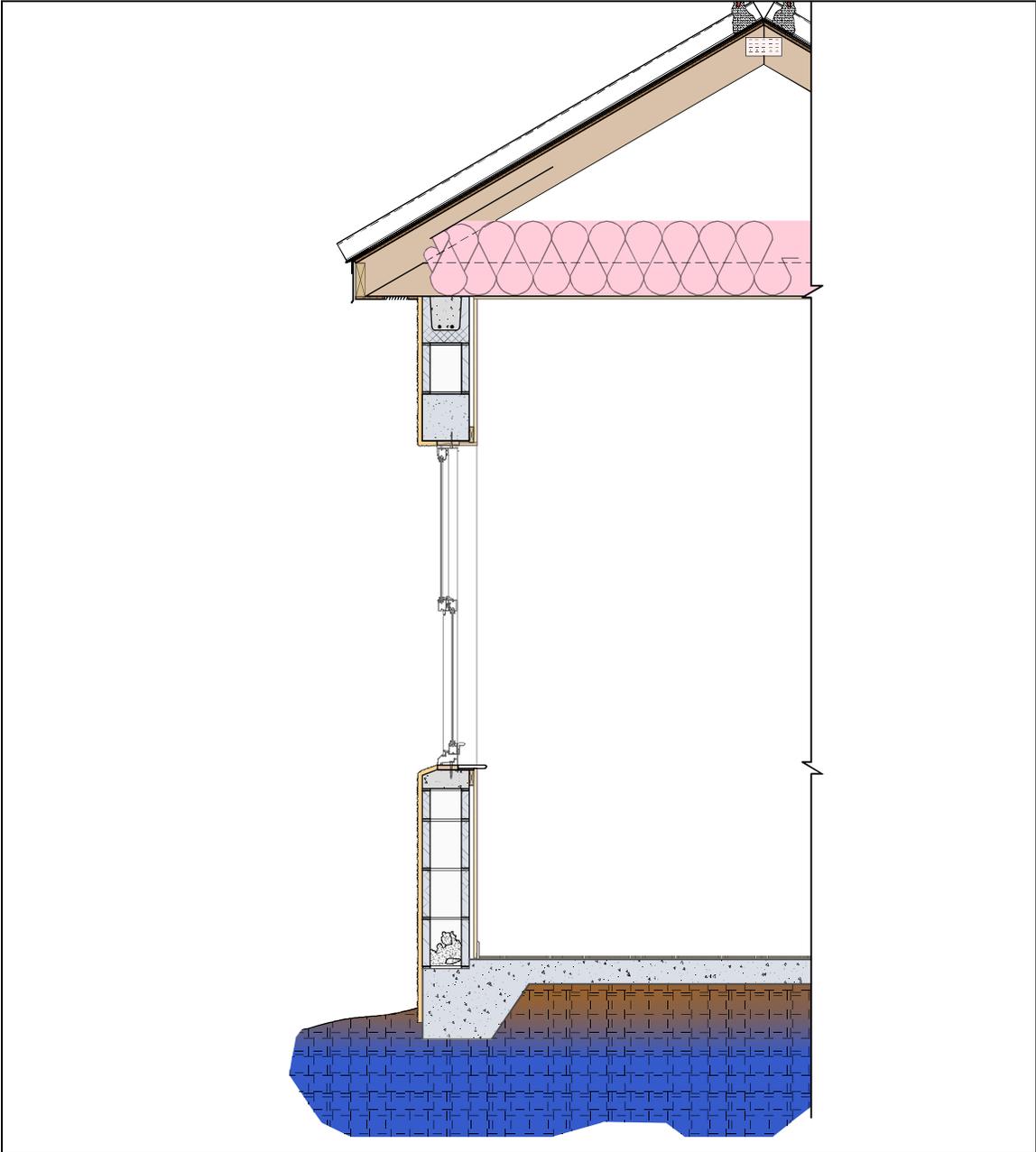
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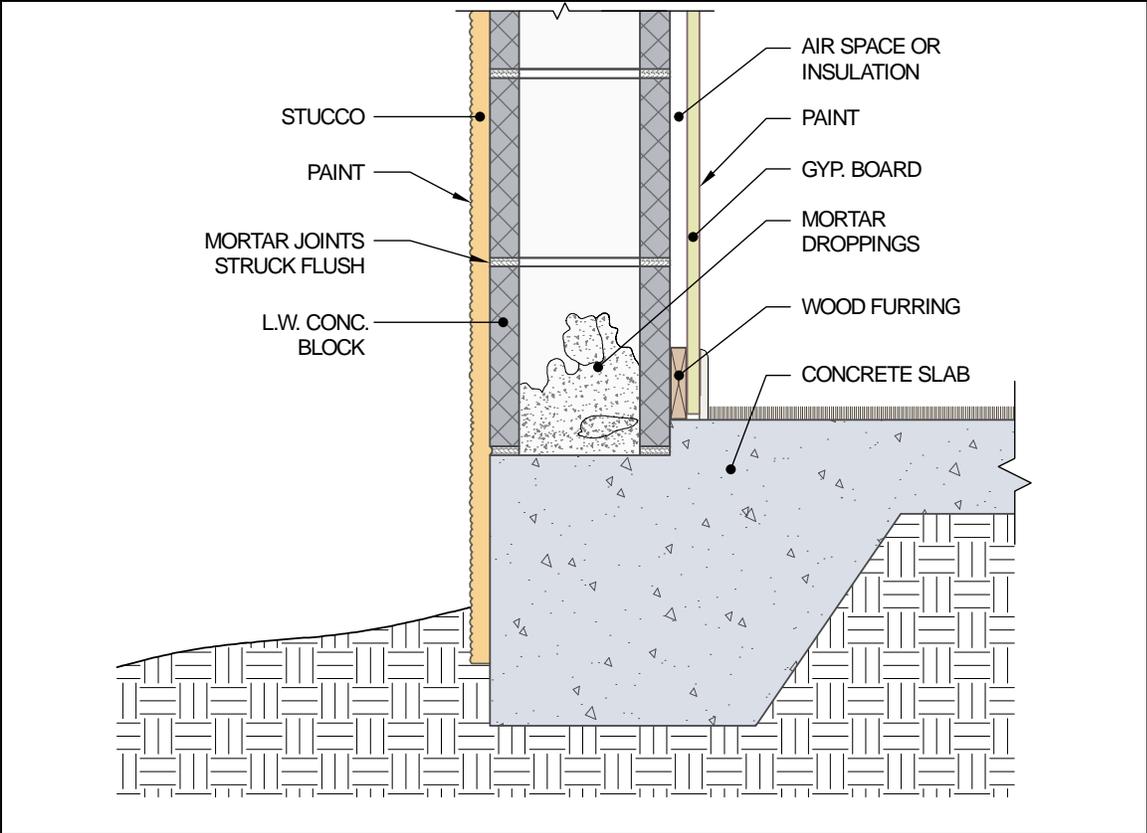
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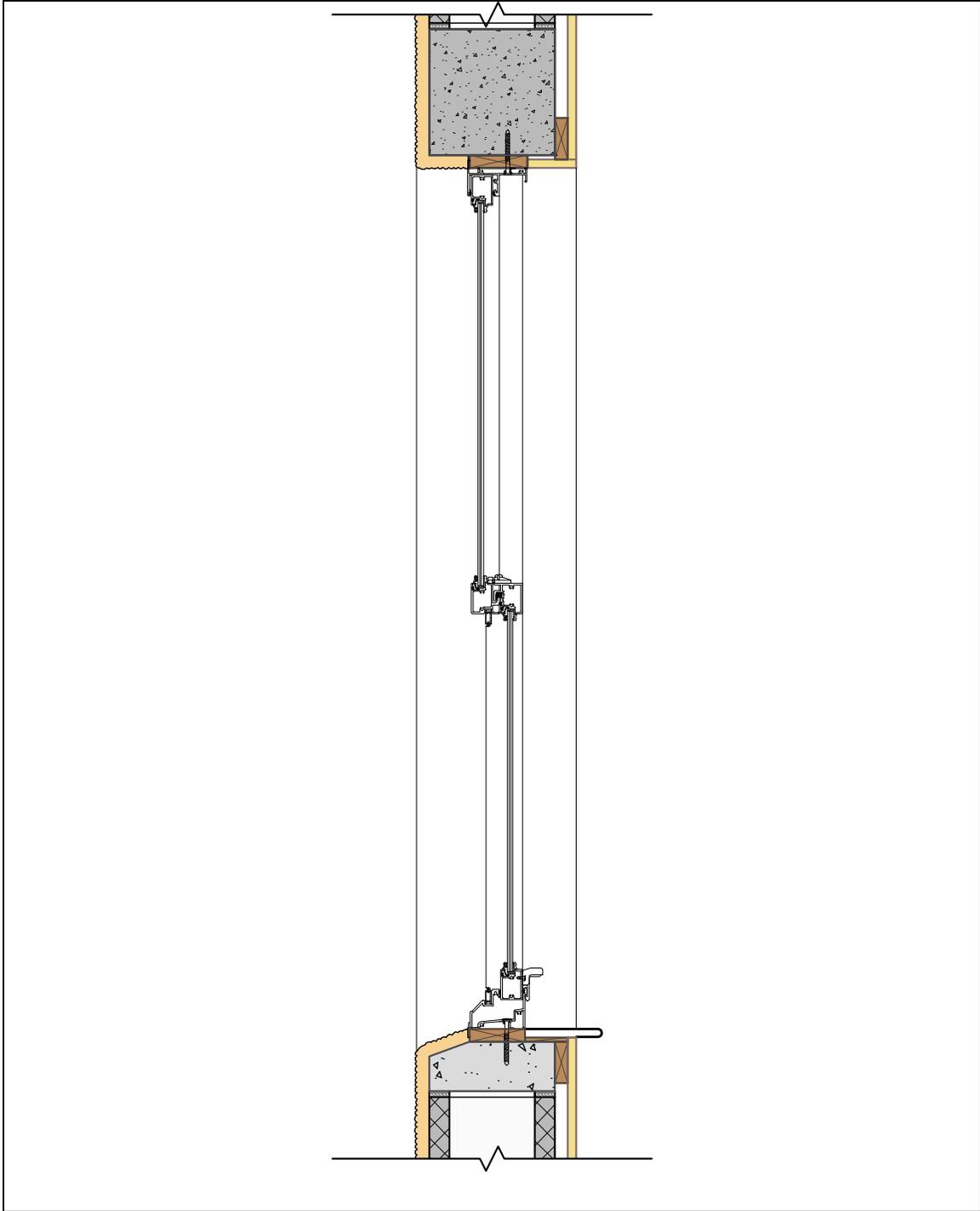
**DRAWINGS AND PHOTOGRAPHS**



Drawing 1: Typical Florida Building Wall Section



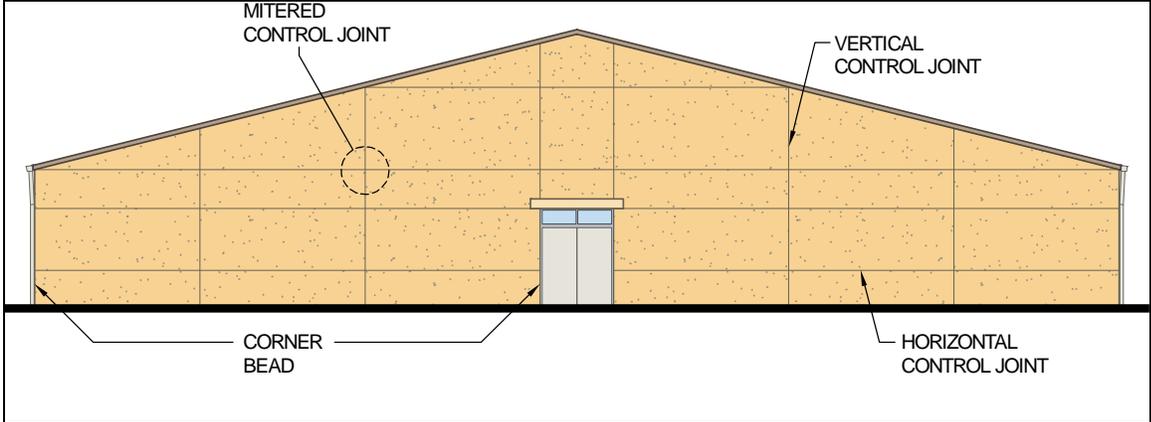
Drawing 2: Base of Exterior Wall of Typical Florida Building



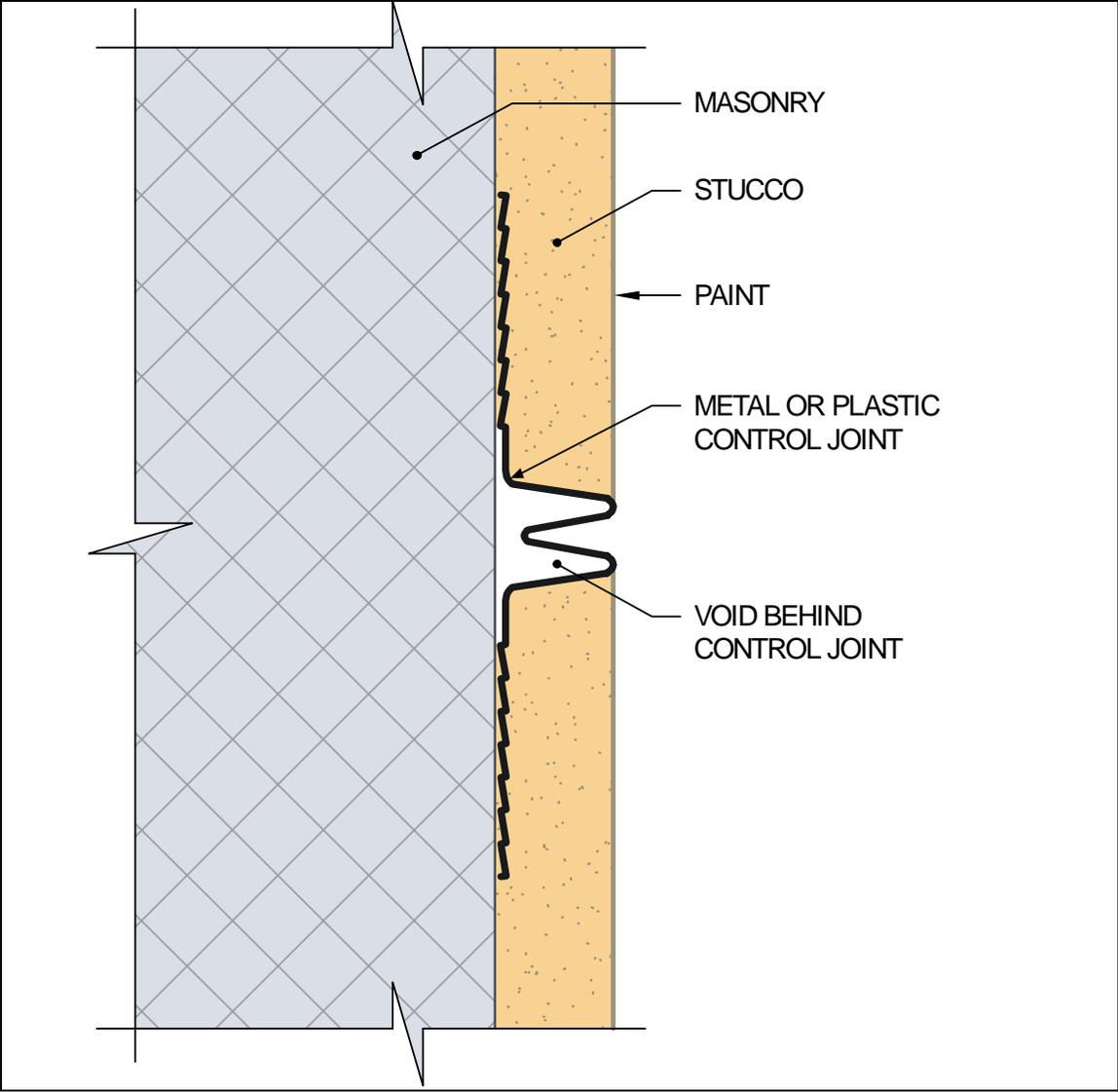
Drawing 3: Window in Typical Florida Building



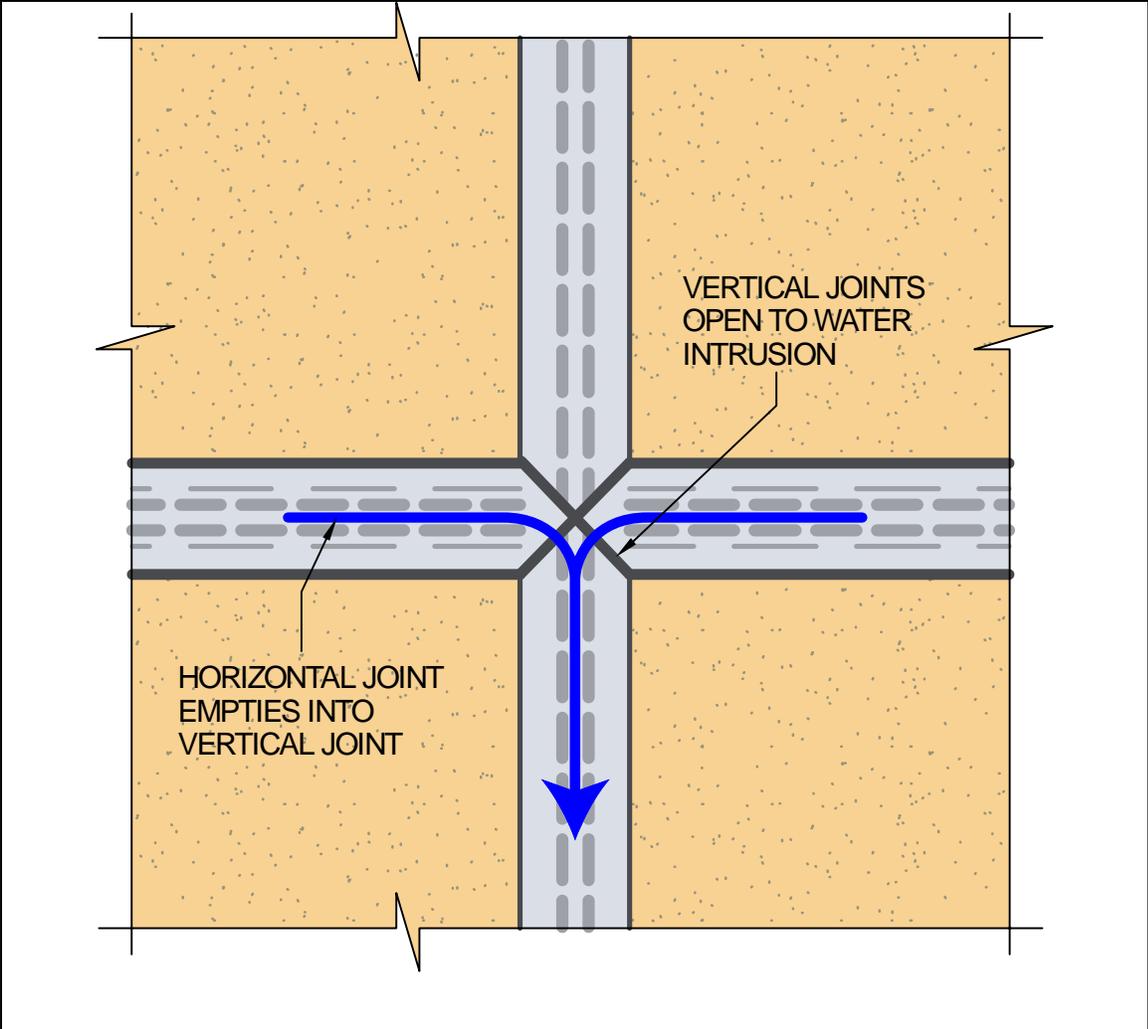
Photograph 1: Efflorescence Due to Water Seeping Through Stucco



Drawing 4: Typical Arrangement of Control Joints



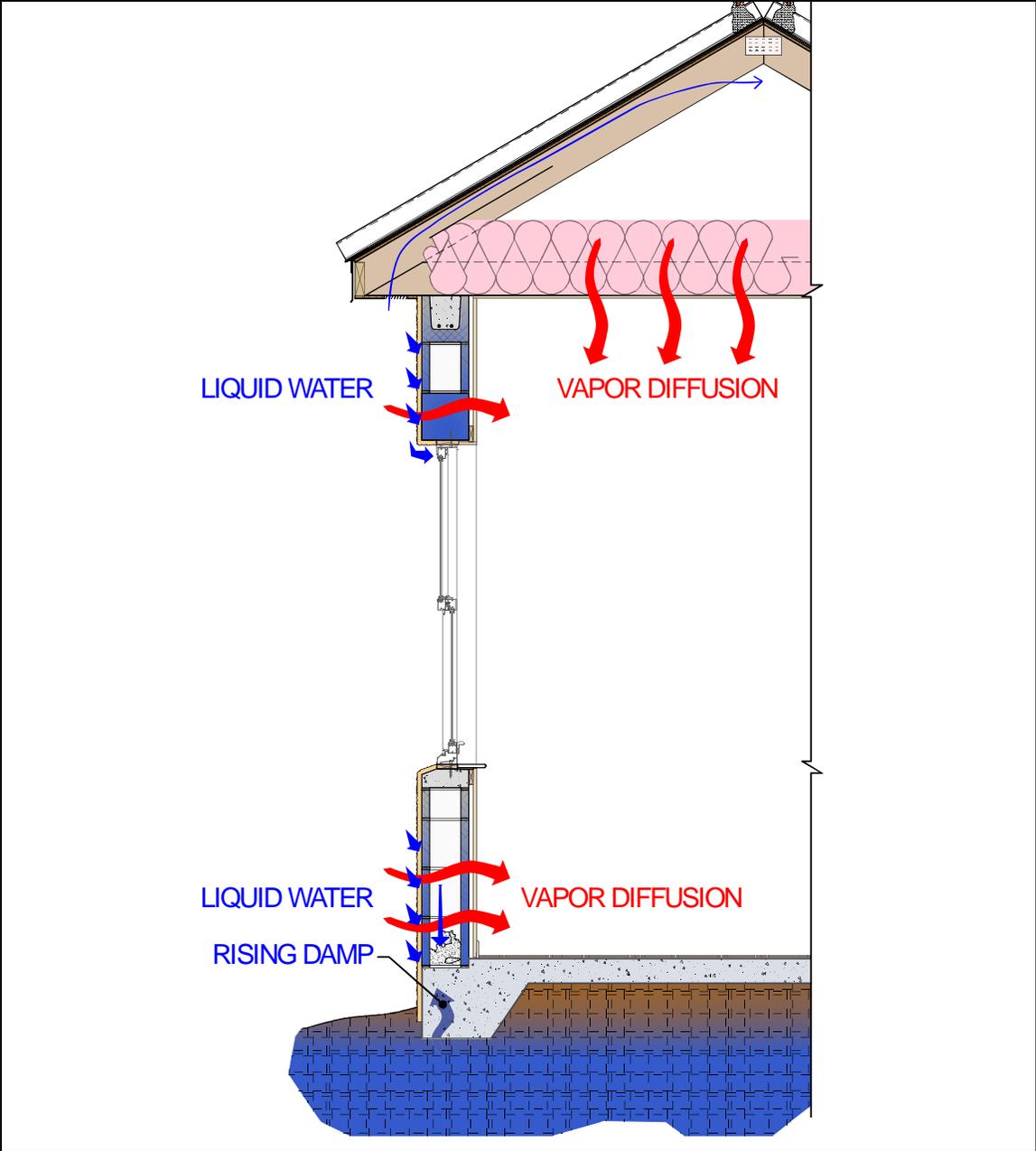
Drawing 5: Control Joint Cross Section



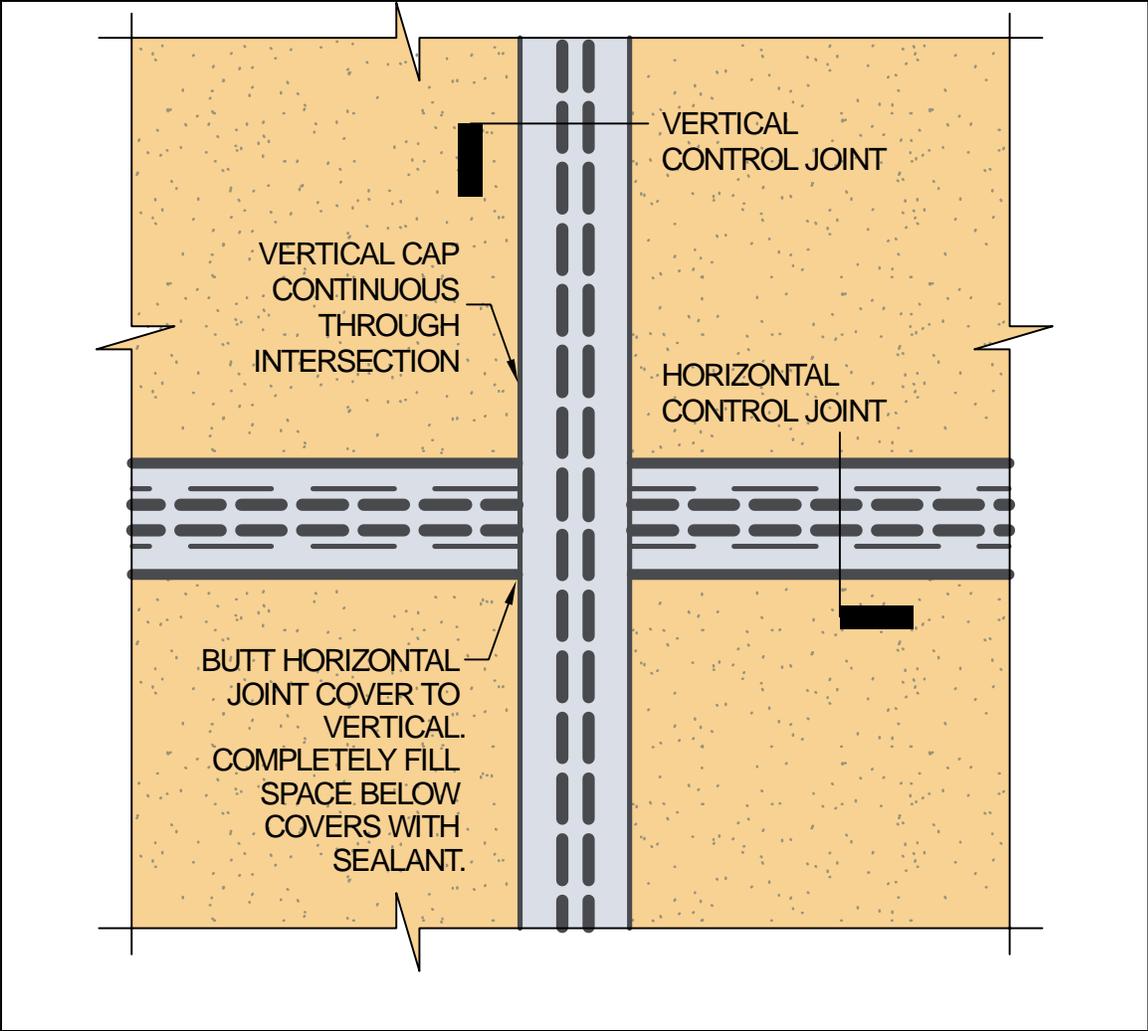
Drawing 6: Mitered Control Joint



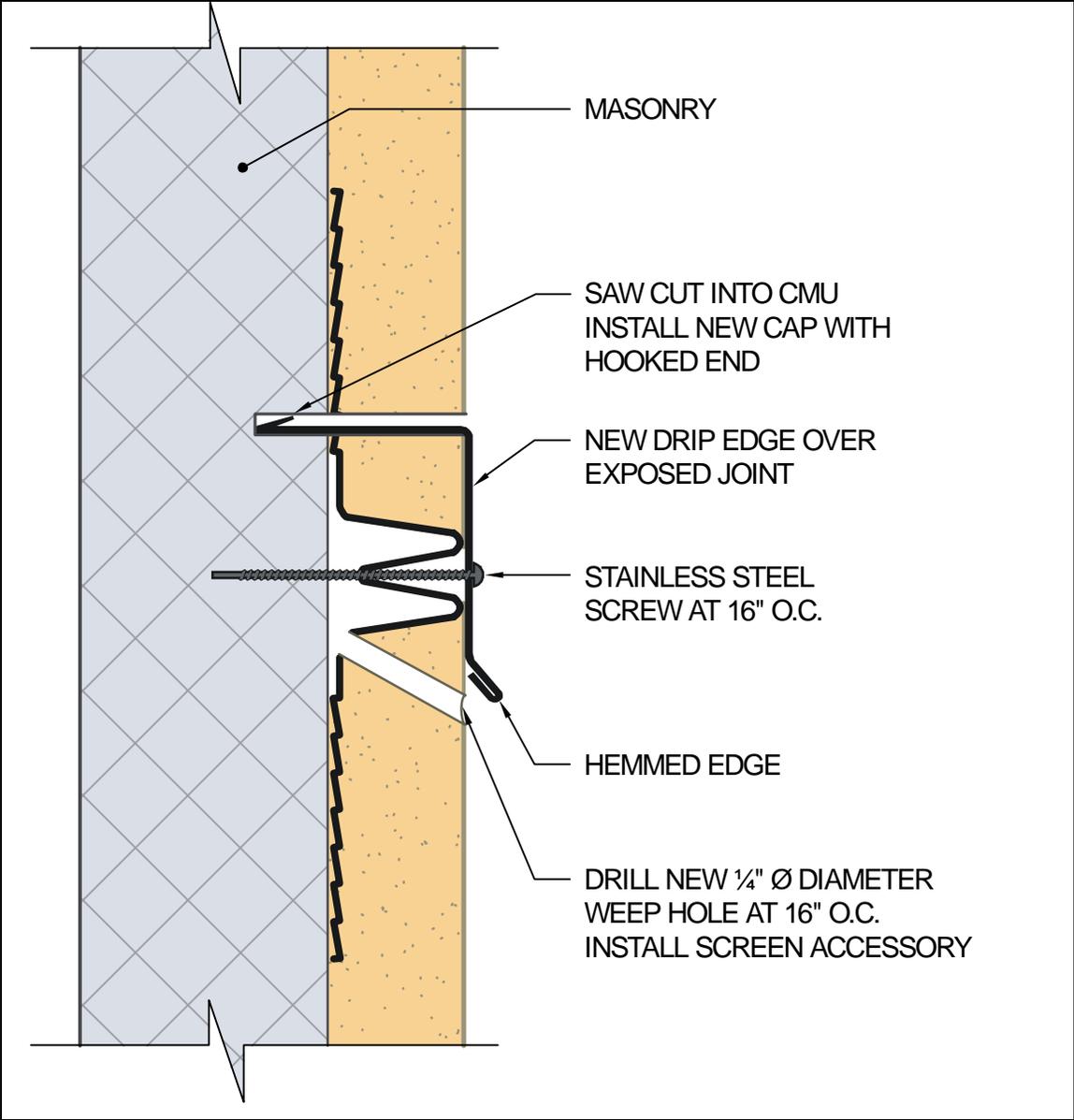
Photograph 2: Efflorescence at Accessory Joint



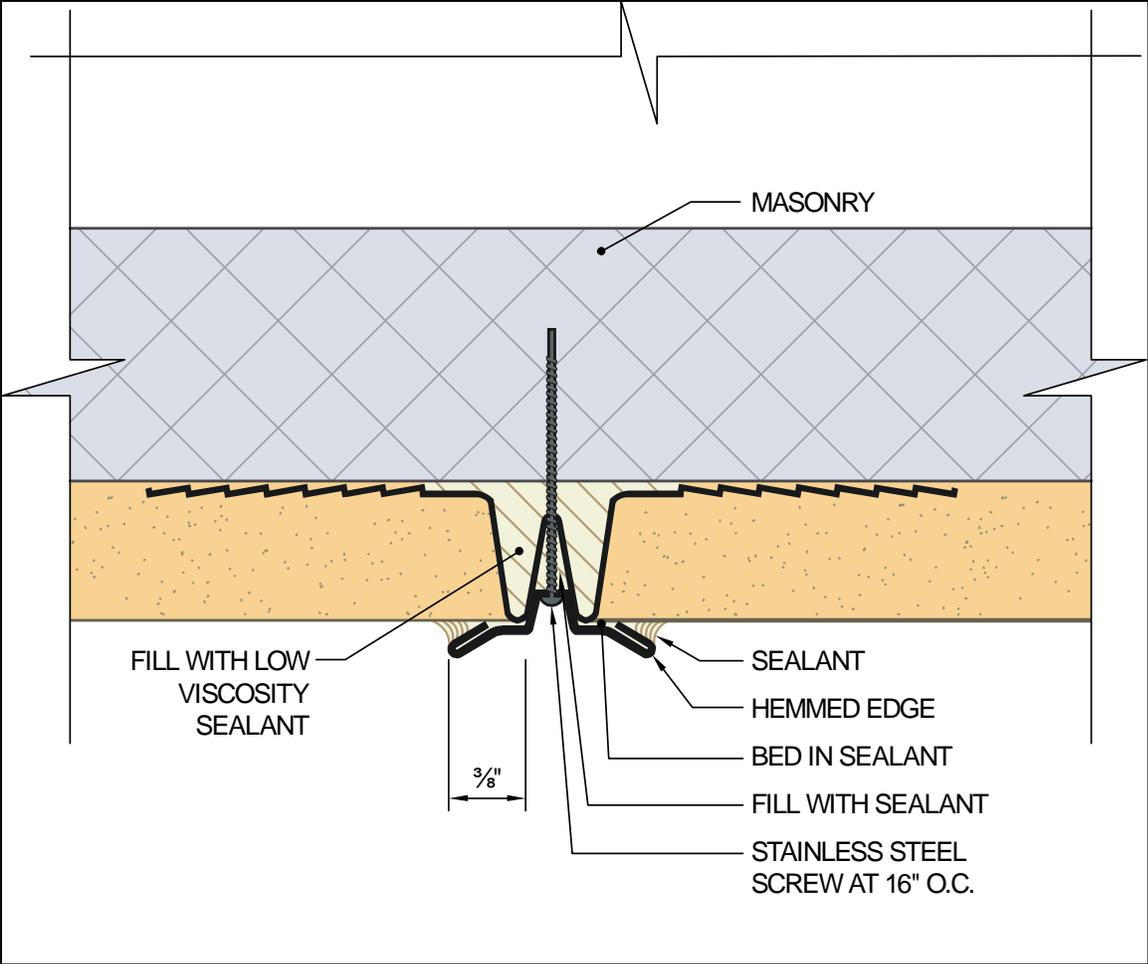
Drawing 7: Moisture Pathways in Typical Florida Building



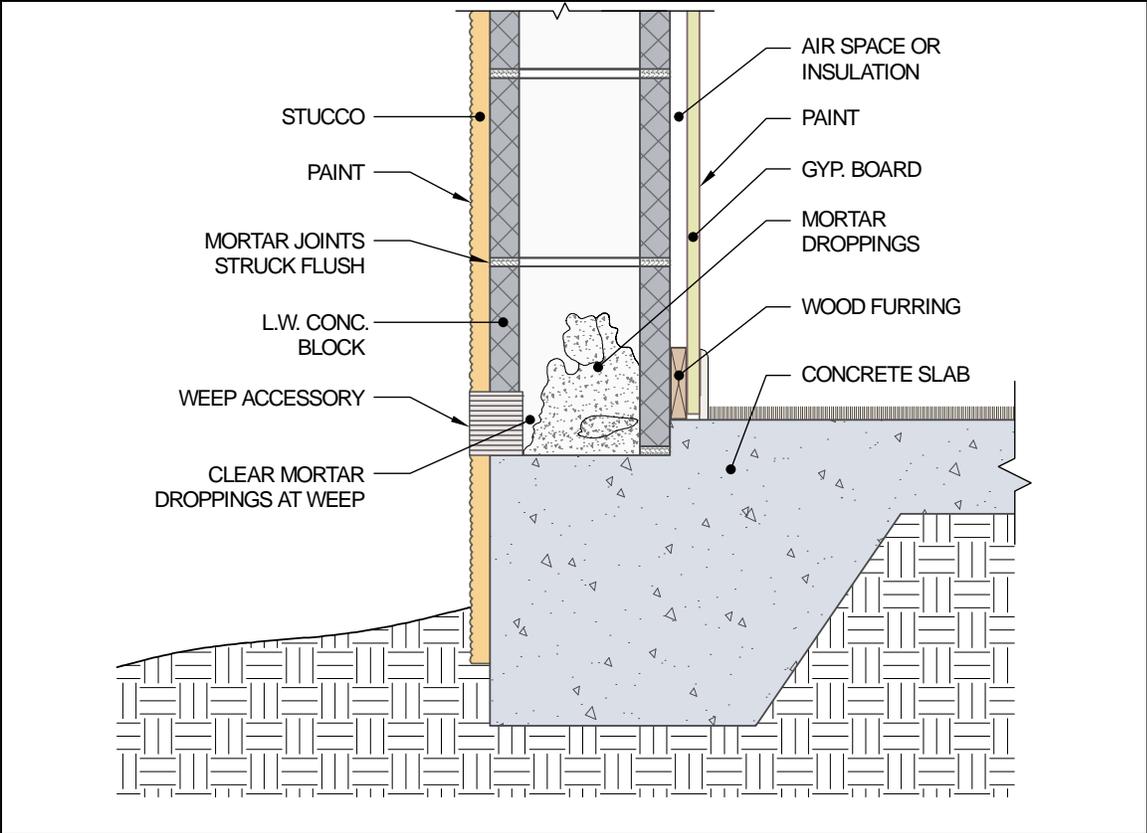
Drawing 8A: Remediation of Mitered Control Joint



Drawing 8B: Remediation of Horizontal Control Joint



Drawing 8C: Remediation of Vertical Control Joint



Drawing 9: Retrofit of Weep