Hybrid Rain Screen and Face Seal Enclosures
"The About-Face of Rain Screen Systems"

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ABSTRACT

Confidence in the performance of building envelope systems in the Coastal Climate of British Columbia and elsewhere can only be achieved by applying a sufficient level of protection to guard against the local level of weather exposure. The industry has become reasonably confident in well-built rain screen assemblies and often has reasonable faith in the water management performance of a properly-constructed mass wall of concrete or masonry when certain back-up safe-guards are incorporated. Both are expected to perform if the weather exposure for which they are designed is not exceeded. When hybrids of rain screen and face seal approaches are constructed there is a legitimate concern for the exposure experienced by each of the two enclosure types at the interfaces, where the two assemblies come together.

Exposure has recently been re-defined in quantitative terms in practice guides. Wall assemblies have evolved under the influence of Building Code minimum standards, through experience of failures, and recently, careful risk reviews carried out for third-party warranty firms. When it became obvious that certain levels of exposure were not being adequately addressed by conventional face seal assemblies, rain screen principles and new interface details were introduced to manage water that could not be kept out and tended to accumulate in those assemblies.

Face seal approaches to water-proofing, air-sealing or repairing of walls has almost become synonymous with 'failure'. There are however, lower levels of exposure where appropriate applications of certain robust face seal approaches such as absorptive mass walls can perform adequately. Many proponents of face seal repair approaches to building enclosures eventually lost confidence in non-rainscreen assemblies after repeated and failed attempts to repair poorly-designed walls in a manner in which they would no longer leak and deteriorate.

Absorptive mass walls built of concrete or masonry have generally escaped the need for a comprehensive remediation by virtue of their tolerance to the amounts of water they absorb compared to their capacity, while other less absorptive walls are much more vulnerable to deterioration when water leaks in. In an absorptive mass wall, two independent lines of defense against water entry and a separation between the wall and non-absorptive interior furring wall is usually all it takes to achieve a reasonable (though often not perfect) level of performance to prevent the multi-million dollar remediation requirement. A number of strategies can be employed in mass wall assemblies to enhance their positive attributes such as good air and water infiltration resistance, high water storage capacity and high tolerance to moisture that does enter. These strategies include:

- the application of a closed-cell moisture-cure spray-foam on the interior face to help air seal cracks and improve thermal properties,
- the incorporation of a two-stage seal at each carefully-located control joint so that two independent lines of defense are at work to keep water from entering,
- the application of breathable water repellants on the exterior face to reduce water entry,
- the incorporation of well-sealed interfaces between the concrete and curtain walls, windows, doors and other installed components.

Building enclosures are still being designed, built or remediated in severely exposed locations that are not entirely rain screen-clad assemblies. Many unremediated buildings in this category

have failed to some degree in keeping water out of the structure, putting their long-term performance and durability in doubt.

A great number of West Coast building enclosures are absorptive mass wall – rain screen hybrids, which appear to put them in a more risky and less materials-efficient category than either of the wall-types of which they are composed. The subject of this paper is the challenge faced by the design and construction teams to produce buildings that are a hybrid of architectural concrete or unclad structural brick with in-filled rainscreen panels designed for medium to high exposures. The paper identifies some of the more significant increased efforts required by all parties to the project to produce a successful hybrid enclosure, should this still be the preferred objective after considering the associated extra costs, efforts and risks.

When a rainscreen assembly is utilized in a structure that also incorporates unclad absorptive mass wall or face-seal components, it can be exceedingly difficult to achieve the level of rain penetration resistance and durability required by the design. This is high-lighted in examples of projects where a multitude of factors made it difficult to prevent the highly-trusted pressure-moderated rainscreen system from turning an 'about-face' and not deliver the performance expected of rain screen technology. The case histories uncover the 'about face of the rainscreen' when forced to marry-up with non-rainscreen technology.

There are numerous construction-related pitfalls or hazards in trying to achieve a good hybrid enclosure using rain screen and non-rain-screen assemblies. Our experience did not indicate that successful hybrid enclosures are impossible to build, but rather, that trying to succeed with such a hybrid, requires more resources, special knowledge and skillful cooperation by the designers and builders alike to bring the two types of assemblies together in a manner that they can perform.

Building system tolerances, project team coordination, and false confidence in the forgiveness of rainscreen technology are examined in the analysis of problems that have to be overcome when the hybrid enclosure project gets derailed by poorly-integrated systems that might normally be accepted as quite functional on their own.

The recommendations stemming from the experience and analysis documented in this paper include:

- Assessing a hybrid enclosure on the basis of its weakest link rather than on the ratings of its predominant cladding system;
- Incorporation of course-of-construction quality control protocol that will (in theory) be capable of constructing a hybrid rainscreen and face seal enclosure;
- Executing a high standard of wall component lay-out accuracy and mock-up review during construction to ensure that the various trades' wall components will have the dimensional compatibility required to fit together;
- Strategies to isolate, yet integrate the two enclosure types to prevent mutual degradation of their individual performances, and to make it clear which wall section was leaking if a problem should occur.

INTRODUCTION

The term "hybrid" is used here to designate a mixture of rain screen and non-rain screen technologies incorporated into a single building enclosure. A hybrid building enclosure typically alternates between rain screen and non-rain screen water management approaches multiple times on each elevation. It is not uncommon, for example to have about 50 transitions or interfaces between absorptive mass walls of concrete or masonry, and rain-screen-clad infill panels of stucco, siding or metal at each level of a building. Since these interfaces or transitions are areas of a significant number of membrane terminations, laps and flashings, they are not as cost-effective or reliable as a continuous, wall.

The objective of this paper is to identify the difficulties and demands presented by attempting to design and construct hybrid enclosures as compared to a continuous rain screen enclosure or a mass wall. The goal is to help facilitate design decisions and construction coordination when hybrid enclosures are incorporated into a project. To illustrate this focus, the paper comments on building enclosure design, risk management and quality control, all of which often appear to be underappreciated or ignored during design and construction to the detriment of the project. The paper's primary goal is to raise the awareness of the importance of planning the design and execution of the hybrid enclosure construction in a manner that often-encountered problems that lead to poor performance expectations can be mitigated or avoided.

Each interface between rain screen and non-rain screen enclosure segments requires special attention to prevent it from becoming the weakest link in the continuous barriers that are relied upon to keep air and water from traversing the enclosure and hence, compromising the function of the envelope as the environmental separator. Furthermore, each interface is a zone where the various envelope trades are becoming more and more aware of the adjacent cladding's potential to leak into their own or vice versa, heightening risk and liability exposure to both parties.

There are significant challenges and concerns faced when designing and constructing building enclosures that interface between rain screen- and absorptive mass wall-type assemblies. Using three case histories as illustrations of these challenges, the following sections highlight:

- The extraordinary concerns and demands of team players involved in producing a hybrid enclosure;
- The increased amount of trade coordination required to build a hybrid enclosure that won't be compromised by the pieces not fitting (dimensional tolerances exceeded);
- The decreased efficiency of materials and labour to construct a performing hybrid enclosure;
- Recommendations to consider when selecting, designing and building hybrid enclosures.

METHODOLOGY

The methodology used to assess the special efforts required and unique risks involved in hybrid enclosure systems is through the examination of the case histories of: remediation, new construction and design of a project that is not yet constructed. Design and construction challenges that confronted the project team to produce a durable enclosure capable of managing wind-driven rain were examined. The extra efforts required to achieve acceptable performance in such hybrid enclosures and the apparent materials inefficiency of the constructed hybrid enclosure assemblies are also identified.

The subject projects include:

1. A pair of 26-year-old 8-storey residential structural brick masonry hi-rise buildings with infill stucco panels that were remediated to correct water ingress problems that had plagued the building since it was constructed in the late 1970's.
2. A new 6-storey institutional building with exposed-concrete frame and rain screen metal panel infill cladding that was recently completed.
3. A new, 6-storey, multi-unit, residential complex still in the design process where decisions to incorporate or eliminate the hybrid enclosures are being worked out by the involved consultants.

In each case an outline of the developmental history of the enclosure is presented. The strategies employed (or that should have been employed) to address the difficulties in achieving proper function are identified. The presentation is concluded by making recommendations that are intended to assist in achieving a functional hybrid enclosure, and further recommendations to avoid a hybrid enclosure approach when it is not the preferred option.

Case History #1: Envelope Remediation of Masonry Mass Walls with Infill Stucco Panels

A pair of 26-year-old unclad reinforced hollow clay masonry towers with face-seal stucco had been leaking since they were constructed in the late 1970's. The suites had experienced leaks through the roof as well as the structural masonry and infill stucco wall sections. The engineer's preferred recommendation to over-clad the buildings entirely was rejected by both the Owners and the City, leaving a hybrid rain screen and absorptive mass wall system as the only permissible repair solution.

Perhaps ironically, the absorption characteristics of 'modern' masonry walls were described in "Rain Penetration and Masonry Wall Systems", an NRC publication released in 1979, (the same year that these buildings were built), as not being as favourable as historic, more massive brick walls that were much thicker and '*acted like a sponge holding the water until evaporated during drying weather'*. [2.] The subject walls were a nominal eight-inch single-wythe, clay brick showing obvious signs of not holding the moisture until they could dry.

In the "OAA Rain Penetration Control Practice Guide" [6] describes the varying storage capacity of examples of absorbent mass walls. Full utilization of the storage capacity presumes that the voids are small enough to maintain capillary retention of the water, which in the case of this building was compromised by not all of the large hollow cells of the masonry units being filled above the 6th floor level, which was permitted in the design. In such a case the masonry is actually an unwanted transport mechanism rather than the desired and presumed storage provision.

Most designers appear to agree that the exterior-insulated, pressure-moderated, rain screen wall assembly that replaced the face seal infill stucco panels on this building is the preferred system for exposed conditions. The confidence in such a rain screen wall upgrade can be put in jeopardy however when a non-rain-screen assembly is to be connected with a highly-trusted (and perhaps warranted) assembly with only a membrane separating them. In addition, the concrete floor slab was regarded as an untrustworthy potential bridge or conduit that could introduce water to the warranted pressure-moderated rain screen walls to which they are intimately connected.

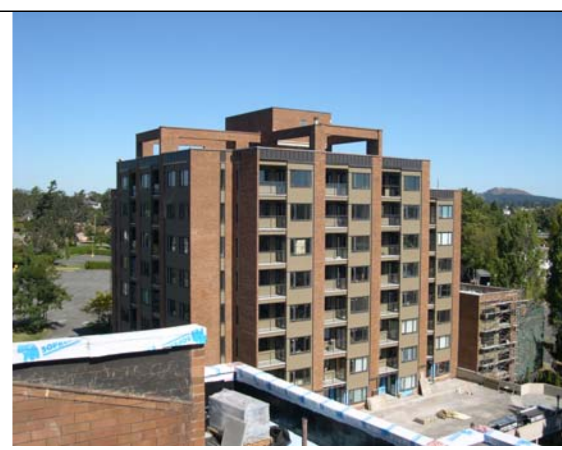

Figure # 1: Elevation view of unclad reinforced clay masonry wall and infill stucco façade. The photo at left has the original face seal stucco panels and the photo at right has rain screen stucco with flashing over-cladding around the perimeter of the stucco panels. The masonry was re-pointed and sealed but remained unclad. There were typically more than a dozen interfaces on each level of each façade.

Accepting responsibility for performance or future repair work in leaking strata-titled buildings is not an attractive proposition to most owners, designers, builders or water-ingress warranty companies, particularly if there is any doubt about its future performance. There is a great reluctance to accept responsibility for various parts of the remediation work by involved parties. It was apparent in this case that if there was any potential risk of water ingress involved in the project, each player wanted to be indemnified from any possible claims that might arise due to deficiencies beyond their own control. This desire is understandable, but very difficult to fulfill in a hybrid situation. Despite the difficulty, two layers of separation were put in place to isolate the adjacent wall types for this reason.

The three-part wall-upgrade objective of the project was to replace the face seal stucco panels (that had leaked since the original construction), thoroughly re-point and seal the structural face seal masonry which had also leaked, and finally to provide a reliable interface between the two parts of this hybrid enclosure. The buildings were also re-roofed.

The non-permitted appearance change requirement brought forward by the city and the owners, conflicted with those of the consultant, contractor and warranty provider, which made the process of repairing and upgrading the buildings more complex, adding to cost and schedule time. The following statements illustrate the conflicting requirements by the parties involved in the remediation process that are exacerbated in hybrid enclosures due to the focus at the cladding interfaces.

- The city and the owners were contractually bound in a land-use-contract which made it exceedingly problematic to change the appearance of the buildings. The permit application drawings therefore minimized changes in the overall appearance; particularly at the interfaces between face seal and rain screen exteriors.

- The engineering design of the hybrid enclosure absolutely required a number of visible upgrades that: thickened walls, flashed joints that were previously not flashed or over-clad. The upgrade design requirements challenged the city's and owners' requirements to conserve the appearance.

- The province has a mandatory water ingress warranty requirement that is provided by firms who engage peer professionals to complete risk reviews. In a hybrid enclosure, the warranty on the remedial work only pertains to the rain screen walls, not to the absorptive mass wall. The warranty provider's risk reviewer required low-risk zones to create a safer separation between the warranted wall and the adjacent unwarranted wall. [5] This was achieved by over-cladding a strip of the exposed masonry wall and therefore resulted in a significant change in appearance to the façade.

Discussions between the design engineer and the warranty provider's risk review engineer concluded that it was a fact of life that; while the municipal government disallowed appearance changes, the provincial legislation forced changes that could not avoid resulting in appearance changes. Once the project was well underway, it was presumed that the increased protection provided by adding more flashing and over-cladding strips to satisfy the provincially-mandated warranty would probably not be forcefully removed by the municipal government's requirements to preserve the appearance.

The function of the warranty provider's risk review engineer provided additional motivation to introduce as much back-up protection at the hybrid wall's interfaces as was practical. While this was debated for cost reasons to some extent, the net result was more protection from wind-driven rain which was a benefit to all concerned.

In addition to the natural conflicts between the requirements and desires of various parties, there were a number of challenges and inefficiencies associated with detailing hybrid wall interfaces that are worth noting.

1. The complex three-dimensional angular geometry of the hybrid walls and decks presented numerous and complex three-dimensional intersections of membranes, all of which had to be compatible from a materials-point-of view. Design details of the desired assembly typically required more than a dozen three-dimension sequential steps to be drawn to communicate the intended layering and lapping of each interface between rain screen and face seal assemblies. Numerous details were drawn and since the building's existing construction was not completely known prior to demolition, there were a number of change orders required to tackle all of the conditions exposed once the old stucco was removed. If we had not produced a hybrid design but completely over-clad the buildings with a rain screen façade, much less detail direction would have been needed to direct the contractor on how to water proof and clad the buildings.

Detailing Layer by Layer

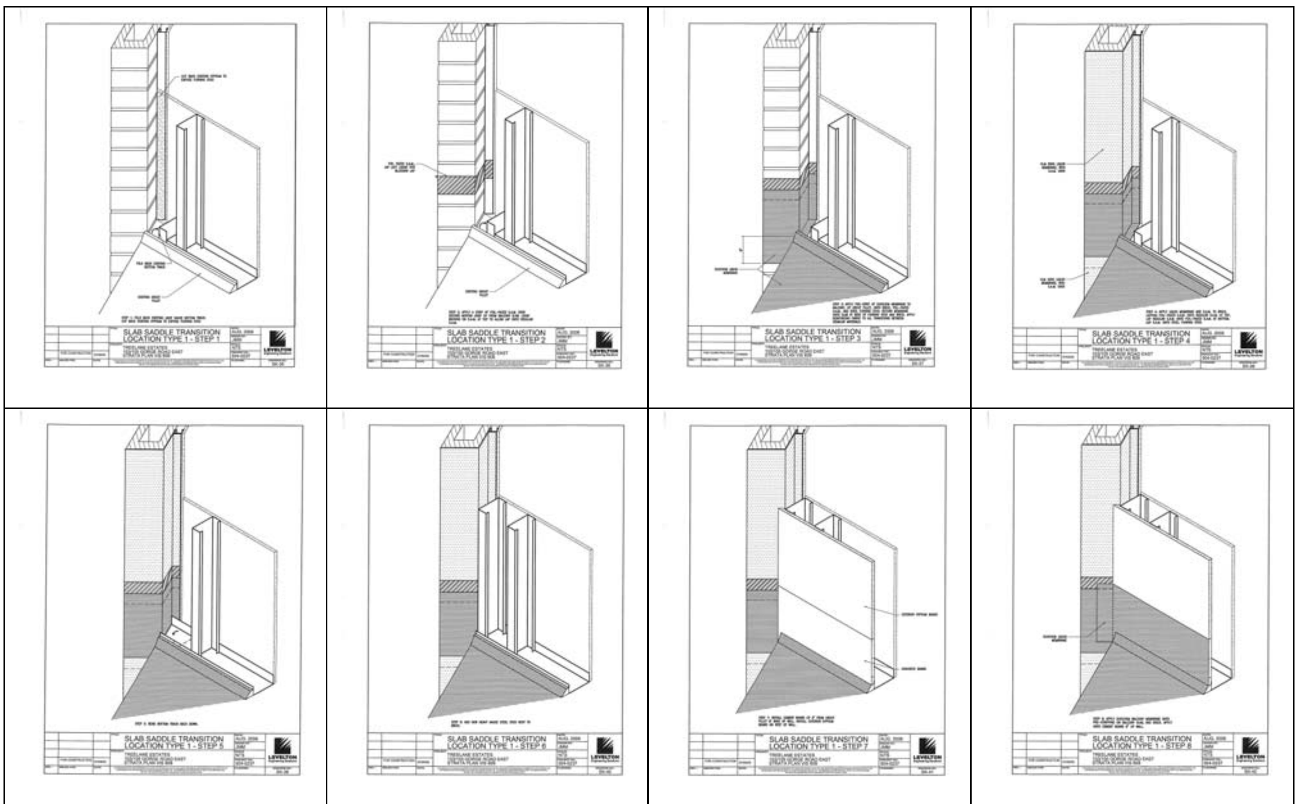

Figure # 2: 8 of 16 three-dimensional sequenced details to direct the installation of only one of many types of interfaces between the face seal brick structure and the rain screen steel stud and stucco infill wall. The complexity of the geometry, materials compatibility issues, potential for error are always present when complex details such as these are being constructed. Also implied in the many layers of application is the amount of overlap and hence low coverage efficiency of the membranes used at the hybrid interfaces.

2. Terminating the self-adhered air/vapour barrier membrane from the rain screen wall onto the unclad structural brick wall and its accompanying interior furring wall involved applying a reinforced liquid-applied membrane to ensure long-term water resistance from the brick that might otherwise have compromised the adhesion of the self adhered membrane.

3. The interface membrane had to extend much further into the interior space than would be required to keep the rain out of the building, in order to clearly delineate the source of a potential leak (from brick or stucco wall) should it occur. (*It was communicated to the owners that the face-sealed brick re-pointing would not ensure that there was no water ingress in the brick, while the rain screen stucco wall was under warranty*). The motivation to provide a complete separation between connected walls just to separate the water ingress responsibility between trades (*or warranted and non-warranted walls*) doesn't exist in non-hybrid enclosures. The function of this type of separation doesn't provide much of an environmental separator from inside to out, which should be the main reason one builds an enclosure. The implication is that some funds are spent just separating liability exposure of the adjacent walls' constructors and warranty provider. This cost does not exist when completely over-cladding a building.
4. The stucco panels were exterior-insulated, while the masonry wall was insulated its interior face between the gypsum furring studs. This presented a technical difficulty and physical compromise in insulation continuity at the interfaces. It also compromised the insulation efficiency of the wall as a whole, since special effort had to be made to provide insulation at the interfaces to avoid thermal bridging where each transition from interior to exterior insulation occurred.
5. Since the unclad masonry was presumed to be a wet sponge that could not be made waterproof, the concrete floor slabs to which they were connected were perceived as a continuation of the water diffusion or capillary bridge. It was believed that if the concrete slab could get wet from the damp brick, the slab could deposit moisture into the rain screen stucco walls which were also connected to the slab. In other words, the concrete slab which connected the rain screen stucco walls and non-rain screen masonry was believed to represent a potential 'conduit' for transporting water into the warranted walls which were to be risk free. A reinforced liquid membrane was applied into reglets cut deep into the top, front and bottom faces of the slab to mitigate water transport by this mechanism. Cutting completely through the slab to isolate the slab sections from stucco and brick sides of the hybrid enclosure completely would have been preferred, but this was not possible due to structural concerns.

Addressing the above challenges as described appeared to work well, however it resulted in a number of inefficiencies that would not be required if this was not a hybrid wall. The unavoidable inefficiencies encountered in providing reliable interfaces in the hybrid system included but were not limited to:

- A large number of different materials to satisfy chemical compatibility of wall and deck membranes. Typically, three or more membranes and flashings covered most locations of the interface. This burden could only be lessened by avoiding a hybrid enclosure by over-cladding the buildings entirely.
- The remedial work required a high level of engineering detail to clearly communicate the complex interfaces. (Figure 2 shows a small sample). This situation could be improved by undertaking a reasonably large scale pilot project in cases such as this when the underlying structure and connection details are not known. This would provide a superior basis for detailing and experimentation with solution alternatives that could also be communicated and reviewed by the risk reviewer. In summary: it appears that remediation of hybrid enclosures should involve a pilot project prior to preparing the final remediation contract documents. The high level of detailing would be developed during the pilot project.
- The required detail refinements during construction impacted the schedule (productivity). This would also be addressed with a pilot project.
- The interior insulation behind the brick would need to be extended past the location where the exterior insulation starts to prevent potential thermal bridging. This overlap should be detailed into the repair design, but comes at a cost premium as compared to completely over cladding the wall.

Case History #2: Construction of 6-Storey Exposed Concrete with Rain Screen Metal Panels

We were retained to perform field reviews for the owner of a new, 6-storey, institutional building with a hybrid building enclosure. We had not taken part in design. The building enclosure was exposed concrete with an infill metal panel cladding system applied over z-girts and rigid insulation over a self-adhered membrane on gypsum sheathing and steel stud substrate. The building also incorporated a high-quality curtain wall system.

The exposed concrete was intended to behave as a mass wall, face-sealed but able to accommodate and mitigate water entry between wind-driven rain periods. The CMHC Poured-in-Place Concrete for Residential Construction [3] describes the concrete's sealed face and the absorbent mass as two separate lines of defense against water intrusion. The metal panel system was designed to behave as a classical rain screen system, with the airtight back-up wall membrane separated from the outer water-shedding plane of the metal panel, with a layer of insulation and a capillary break (air space). Both systems were appropriately intended to have two lines of defense against water intrusion.

The system was designed with the metal panels to be perfectly in-plane with the concrete face. The concrete conditions at the perimeter of the rain screen panels relied on this to provide the detailed interface between the air-tight back of the panel system and the edge of the concrete to which it was sealed.

Fundamentally, for rain screen designs to function, they are to maintain a capillary separation between a relatively dry protected air seal and the wet front water shedding surface. Shedding rain on a plane outboard of the water-shedding surface was established as fundamentally preferred practice in 1963 by Kirby Garden of the NRC's Division of Building Research. [1.]

This fundamental part of the rain screen concept was not realized in some locations however, since much of the metal panel perimeter was significantly out-of-plane with the surrounding concrete such that, there was little or no concrete edge to which the air barrier membrane could be attached. Thus the metal edge of the panel was left open to the weather. This created two risky conditions: poor basis for air/vapour membrane termination and poor flashing geometry to protect the membrane at the same locations.

In the recent CMHC Study of Poured in Place Concrete Assemblies [3] and subsequent bulletin published by BC's Homeowner Protection Office [4], the author states two facts: a) that "*poured-in-place concrete walls are cost effective since they combine functions of a structural element and an exterior wall assembly*"; and b) that "*today's poured-in-place buildings are more complex in terms of building form and interface details*". Both of these statements are relevant to this discussion of hybrid enclosures.

The cost-effectiveness presumed by using poured-in-place concrete to form the exterior of the enclosure, rapidly succumbs to the cost of providing numerous interfaces with repeated infill panels that rely on a different water management strategy.

As illustrated below, increased cost is not the only additional burden in building hybrid enclosures. The burdens of increased quality control, increased inter-trade communication and coordination and increased schedule duration are only 3 additional project burdens when dealing with hybrid face seal / rain screen enclosures.

The Importance of Coordinating Hybrid Enclosure Construction

	
Figure # 3: Photo of Metal Panel Wall on Steel Stud and Gypsum Sheathing Infill Wall Properly Aligned Flush with Face Seal Concrete Surrounding Wall.	**Figure # 4:** Photo of Metal Panel Wall on Steel Stud and Gypsum Sheathing Infill Wall Improperly Aligned with Exposed Perimeter.

The misalignment of the two adjacent exterior surfaces provided openings that permitted water to enter around much of the panel perimeter. This meant that water could run down the face of the air barrier membrane behind the insulation, making the membrane a water-shedding surface as well as an air barrier, and thereby undermining the basic rain screen principle on which assembly was designed, and relied upon to perform.

When the contractors responsible for the face-seal concrete and the rain screen panels were confronted with this unacceptable condition, some commented that the leaked-in water could drain out and that since this was a ‘rain screen’, there was nothing to worry about. In reality, the system they had constructed was not truly a rain screen system and would not become one until measures were put in place to prevent the air barrier membrane from being a water-shedding surface.

This is an “about-face” of the intended rain screen system. In other words, the compromised edge conditions of a reliable system significantly change its performance. An assembly that was presumed to offer the reliability and durability of the rain screen system was not about to deliver these benefits due to significant compromises at its interfaces with the surrounding face seal portions of the wall. Since water could get past the intended water-shedding surface in significant quantities while the wind pressure was present, the self-adhered membrane was being tested at a level typically only face seal surfaces experience. Any imperfection, flaw, poor adhesion, unsealed fastener or damage in the wetted zones of the self-adhered membrane would potentially result in water entering into the perimeter of the back-up wall.

There was considerable difficulty in retro-fitting the poorly-aligned concrete-to-panel interfaces and the proposed solutions were less-than-ideal. In the discussions surrounding the problem on this project and similar projects, it was clearly established that the following factors contributed to the problem. (Solutions are also suggested):

- The designed exposed concrete and metal panel detail is one that would require very tight quality control of the concrete placement which evidently wasn’t in place. One solution would be to design the panels to be inboard of the concrete face by at least the amount of expected variation in the concrete. Tolerances should be specified to be commensurate with this requirement. Another proactive solution to preventing the interface alignment problem would be to require the contractor to provide evidence of monitoring and checking his layout for dimensional compatibility during the project in the contract documents, followed up by a field review focus on this item.

- The need for a high-level of quality control of the concrete placement appeared not to have been realized by the contractor until too late in the project. The solution to this problem is for the contractor to recognize this need and provide the quality control and monitoring, whether explicitly required by the contract documents or not. Quality control at all stages of concrete and cladding construction are especially important in hybrid enclosures involving metal panel systems.

- When the panel-to-concrete alignment problem was first realized, the steel stud infill walls that were to hold the panels should have been located sufficiently inward to preclude the panel protrusion past the concrete faces. (The wall appeared to have been located in a manner to maintain the exact design size of the room interior, irrespective of the wall alignment difficulties that would arise from this.) It is strongly recommended that the location of the infill panels of a hybrid wall should be dictated by the interface design to align and water proof the perimeter of the paneled area to the face seal concrete.

- The Z-girts used to fasten the metal panels to the back-up stud wall were not adjustable to facilitate localized attempts at alignment with the irregular concrete face. The last possible adjustment to improving the alignment of the hybrid's two enclosure elements is to have adjustable z-girts. The metal panel installer can then attempt to provide a flat face and better alignment despite undulations in the studs, sheathing or concrete. Since the required adjustments will be both inward and outward, there must be careful planning of the overall depth or thickness of the wall. For this to be achieved it is crucial that the studs are set sufficiently inward.

Recommendations to Avoid Compromising the Hybrid Enclosure's Performance:

The contractor's frustrations on this project suggest that the following design and construction execution considerations are absolutely necessary to prevent an 'about face' of the hybrid rain screen panel system that is set into an unclad concrete wall frame:

At the design Stage:

1. Allowance could be made in the design for the panels and frame to be out-of-plane by a certain amount. This could be partly facilitated by setting the panels back, behind the plane of the concrete face.
2. The architectural concrete component of this façade should be placed with very low tolerance for deviation in its monolithic face. If this is impractical to achieve, then the option of using pre-cast elements fastened over water-proofed concrete frame should be considered to achieve the desired appearance.

During Construction:

3. The steel back-up wall studs should be located so as to fully accommodate the full thickness of the panel system within the accidental concrete irregularities.
4. The z-girts fastening system for support of the metal panels should be adjustable to mitigate the out-of-plane effects. This should be on the shop drawing review checklist.
5. The trades involved should be more aware of the strict requirements on their installations and fabrications to permit the construction of a successful functional rain screen cladding

system. The term "rain screen" should not be understood as the savior and forgiver of all mistakes.

6. The trades require strict layout coordination and monitoring at each step to provide properly-aligned framework to which the panels could be fastened flush with the concrete.
7. As an alternative to considering the above attempts to build a hybrid enclosure, serious consideration should be given to cladding the whole building over a continuous membrane and insulation. Pre-cast concrete elements on the column and beam lines would change the enclosure to a full rain screen approach and make near-perfect surface alignment between the metal panels and concrete face achievable.

Case History #3: Design of 6-Storey Concrete Building with Rain Screen Stucco and Siding

The following case history is short, since the project was put on hold while re-design was being contemplated. The project was in the design development stage. The cladding systems, windows, doors, deck assemblies and roofs were still being formally selected and detailed. The building was to be partially-exposed concrete with a rain screen cladding on most of its exterior. Only certain areas were to remain as exposed concrete to obtain the desired appearance. The building envelope consultant met with the prime consultant and the structural engineer to discuss the location and water-stopping of the exposed construction joints. These were concrete wall junctions that would be expected to leak if not properly detailed in a manner that could accommodate movement while maintaining two lines of defense against water ingress. In the concrete construction control joint locations this would be a serviceable seal in an appropriately-crafted reglet for continuity of the water-shedding plane and the absorptive capacity of the concrete wall as discussed in the referenced CMHC document [3] and the Homeowner Protection Office "Moisture Management Strategies" [4] document.

Water stops introduced in the concrete placement and sealed construction joint reveals were one proposed method of creating a double line of defense against water entering the building. During these discussions, which identified a number of secondary processes to create the dual-sealed approach, it became apparent that perhaps it would be more cost effective and time-efficient to abandon exposed poured-in-place concrete as a finish on the exposed regions of the structure.

It was agreed that a dual seal would be appropriate to guard against high exposures. It appeared that, in view of the rain screen system being employed on most of the wall surface, two lines of defense could be most reliably provided by making the rain screen system continuous over the entire wall. A dual seal built into the construction control joints in a hybrid face seal rain screen wall would not address the potential for cracks and subsequent leaks in the field area of the concrete panels, should they occur.

Similar to the first two scenarios, the insulation location in this hybrid enclosure would also alternate from the interior side of the wall to the exterior at each interface. This would require an overlap of the two insulation planes, making continuity of insulation costly and inefficient. Since only a small fraction of concrete façade is desired, it would be appropriate to design both the detailed hybrid interface with all its complexity and inefficiency as well as the alternative pre-cast concrete continuation of the rain screen and perform a cost analysis on both. This would permit the owner and designers to make an informed decision. In the writer's opinion, the continuous rain screen option should be selected if there is not a large discrepancy in cost.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS FOR HYBRID-RAIN SCREEN / FACE SEAL ENCLOSURES

CONCLUSIONS	RECOMMENDATIONS
Hybrid enclosures can be designed for reasonable performance and durability with sufficient effort and cost of the multitude of layered interfaces.	A hybrid enclosure should only be considered after the efforts, costs and risks are known to the owner and the design team. Selection of the hybrid enclosure approach should shift considerable focus of the design and review to the interfaces.
In a hybrid enclosure, there is an additional concern by the stakeholders in guarding against water ingress into the rain screen portion from the adjacent non-rain screen portion.	The individual risk mitigation objectives of the designer, builder and warranty provider should be considered from all points-of-view when a hybrid enclosure is selected and designed. Envelope assembly strategy meetings should be required with all involved attending.
The term 'rain-screen' is still not well understood by project team members and does not describe the wall type if the air barrier on the back up wall is actually a water shedding surface for water that systematically enters behind the cladding due to compromised interfaces.	Water must be diverted away from the back-up wall air-barrier for an assembly to perform as a rain screen system. Myths of the forgiveness of rain screen should be dispelled early in the project by demanding a continuous water-shedding surface. Educate all involved about the rain screen principals as they relate to building enclosure.
The new construction of a hybrid enclosure involves extra-ordinary focus on quality control, layout and trade coordination that, if not addressed can compromise its performance, durability as well as cost.	Provide strict quality control and built-in cladding plane adjustment to permit alignment of metal panels with their perimeter boundary conditions and hence permit a proper interface with the surrounding face seal concrete structure.
The decision to design a hybrid building enclosure should not be made without comparing the cost and benefit involved of a fully-clad structure.	Perform a cost and benefit analysis of a hybrid enclosure approach with preliminary details and components in place that provide a level of risk mitigation acceptable to the project team (including warranty provider) and owner.

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