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Original Article

Decoding the Façade: A Practical Workflow for Inspecting Window and Railing Systems in High-Rise Construction

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Abstract *- Balcony edges in coastal high-rise residential buildings are often treated as a finishing detail, even though they combine several critical façade systems: impact-rated windows and sliding glass doors, laminated glass railings, glass dividers, anchorage hardware, grout pockets, and perimeter sealant joints. This paper uses an anonymized Florida condominium in a high-wind coastal zone to show that balcony edges behave as a small but high-risk façade system that must be inspected as one unit. The study draws on a consultant-issued glass and glazing inspection protocol, more than 180 balcony-related inspection reports, an Excel-based tracking log, a laboratory water-resistance test report, and final professional-engineer letters for glazing and railings that supported the Temporary Certificate of Occupancy.*

From this data set, the paper classifies inspection types (mullion clips, perimeter anchorage, perimeter sealant, railing pockets and grout, tie-down and operability, and water testing), maps them to their underlying failure modes, and identifies recurring "pressure points" in the log: clip edge distance and fastener selection, shim control, sealant product compatibility and completeness, railing geometry and gaps at slab edges, broken laminated glass, and sliding-door operability. These findings are then converted into a practical workflow that links an inspection matrix, a structured Excel log, and the use of engineering and manufacturer letters to transform field deviations into documented, safe conditions before handover. The case project demonstrates how systematic balcony-edge inspections can move façade quality control from ad-hoc punch lists to a repeatable, data-backed process aligned with code requirements and Temporary Occupancy certification.

Keywords *- Façade Inspection, Balcony Edge Systems, Impact Windows, Sliding Glass Doors, Laminated Glass Railings, High-Rise Residential Construction, High-Velocity Hurricane Zone (Hvhz), Florida Building Code (Fbc), Quality Assurance And Quality Control (Qa/Qc).*

Note *- This case study is anonymized. Project and company names, locations, permit numbers, and other identifiers have been removed to honor confidentiality and contractual obligations. Images and shop-drawing excerpts are de-identified (logos/serials/stamps/signatures cropped or blurred). These edits do not affect the technical substance, calculations, or conclusions.*

1. Introduction

In coastal hurricane regions, the balcony edge is one of the most stressed pieces of the building envelope [1], [2]. Wind, rain, salt, and occupants all meet at a narrow strip where impact-rated windows, sliding glass doors, glass railings, and divider walls share the same slab edge. In drawings these elements are split by trade and detail number. In reality they behave as a single small façade system: the window and door frames carry wind and impact loads, the railings and dividers provide fall protection, and the sealants and grout at the slab edge keep water away from reinforcement and anchorage [1]-[3]. If any one piece underperforms, the failure shows up at the same location – the balcony edge.

Field experience on coastal high-rise projects shows that this zone fails in very predictable ways. Water finds its way through poorly sealed sliding-door tracks and perimeter joints, staining ceilings and feeding mold inside finished units. At slab edges and railing pockets, small sealant defects allow salt-laden moisture to reach anchor bolts and reinforcement, starting a slow cycle of corrosion and concrete spalling. Guard assemblies suffer from another class of failures: glass panels cut too short, posts set with incorrect spacing, or grout pockets that are never fully filled. These lead to excessive openings in the guard, loosened posts, or broken laminated glass panels at the balcony perimeter [2], [3]. Even when the structure remains safe, the result is the same: emergency repairs, replacement glass on long lead times, disputes over responsibility, and delay in obtaining a Temporary Certificate of Occupancy (TCO).

On paper, the industry already has strong protection against these outcomes. Impact-rated windows and doors are certified through laboratory testing, guardrails are designed for defined loads and opening limits, and manufacturers publish precise anchorage and sealant requirements for their systems [1]-[3], [4]-[6], [9], [10]. The gap is not in codes or product testing; it is in how balcony edges are inspected and documented on real projects. Windows, doors, railings, dividers, and waterproofing are usually awarded to different subcontractors, each with its own shop drawings, schedules, and punch lists. Inspections are often organized by trade rather than by balcony opening. Notes are scattered across PDF reports, emails, and photos in different folders. By the time the building approaches TCO, the project team may have hundreds of comments about balcony edges, but no clear, system-level view of what was checked, what remains open, and what is truly critical for safety and envelope performance.

This paper addresses that gap by treating the balcony edge as a discrete façade system with its own inspection workflow. It uses one coastal residential high-rise as a data source, focusing on the windows, sliding glass doors, glass railings, and dividers at stacked balconies. Over the course of construction, the special inspector issued roughly 180 balcony-related inspection reports and maintained a consolidated Excel log tracking each issue from first observation to final closure. These entries cover anchorage, shimming, sealant, railing geometry, broken glass, door operability, and other recurring problems at the balcony edge.

The central question is straightforward: How can we use one project's 180 balcony inspection reports and Excel log to build a practical, repeatable workflow for windows, doors, and railings up to TCO? The aim is not to re-design façade products, but to decode the inspection logic behind them and translate it into a simple sequence of field checks, documentation steps, and close-out rules that other project teams can adopt. By organizing real defects and resolutions into a balcony-edge workflow, the paper shows how contractors, project engineers, and special inspectors can de-risk this small but critical façade system, reduce last-minute surprises, and support clean engineering letters for glazing and railings at the TCO stage [7], [8].

2. Code and Risk Framework

High-rise balconies on the Florida coast sit inside the High Velocity Hurricane Zone (HVHZ), where the Florida Building Code treats the building envelope as part of the hurricane protection system, not decoration [1]. In this zone, windows, sliding doors and other glazed elements must be tested and approved for large-missile impact and cyclic wind pressure through the TAS 201, 202 and 203 protocols, and then installed exactly in accordance with their approved drawings and instructions [1], [7]. Miami-Dade and the State of Florida keep public databases of these approved systems, together with the pressure ratings, impact test reports and installation details that engineers and inspectors rely on during design and field review [1], [7].

This regulatory framework is backed by wind-speed maps and risk categories that push design pressures in coastal counties to some of the highest values in the continental United States [1], [2]. In practice, this means that a balcony door or railing is not checked only for day-to-day use; it is checked as part of a protective shell that must remain intact during extreme storms. If anchors, clips or glass sizes drift away from the tested configuration, the assembly may no longer meet its certified capacity, even if it "looks fine" on site [1], [7].

Guardrails on these balconies are governed by a slightly different but equally strict logic [1]-[3]. Model codes require guards to be at least about 42 inches high in residential high-rise applications, to resist both a concentrated load in the range of 200 pounds and a uniform line load of about 50 pounds per linear foot along the top rail, while also preventing a 4-inch sphere from passing through any opening in the infill [1]-[3]. These numbers are not arbitrary: they are based on typical adult leaning forces and on child-safety research that shows how quickly a child can slip through or climb a guard if the openings are too generous [3]. For balcony glass, small dimensional deviations immediately translate into measurable loss of safety margin against those load and opening limits [1]-[3].

On top of the prescriptive rules, the Authority Having Jurisdiction (AHJ) uses several layers of evidence to decide whether a particular balcony system is acceptable [1], [8]. First are the model codes and the Florida Building Code, which define the baseline performance [1]-[3]. Second are product-specific approvals such as Miami-Dade Notices of Acceptance (NOAs) or Florida Product Approvals, which document exactly how a given window, door, or railing was tested and how it must be anchored, shimmed and sealed in the field [1], [7]. When actual conditions deviate from those documents – for example, because the anchor cannot be installed at the tested edge distance, or a different sealant is used – the AHJ typically requires a Florida-licensed professional engineer to issue a project-specific letter or signed detail [1], [8]. Those letters effectively "bridge the gap" between the tested configuration and the real installation, by checking capacity and documenting that the modified condition still satisfies code intent [1], [8].

Temporary Certificates of Occupancy (TCOs) link this whole framework directly to people's lives [1], [8]. A TCO allows residents to move in while some non-critical work continues, but it only applies if all life-safety systems – structure, egress, fire protection and critical building envelope elements – are demonstrated to be compliant [1], [8]. Building and life-safety codes are written explicitly to protect human life in buildings and other occupancies, and are coordinated with structural, fire and mechanical standards [1], [3]. For a coastal high-rise, that protection clearly includes balcony guards, impact-rated openings, and watertight edges [1], [3].

Because of this combination of extreme environmental demand, strict code language and product-specific approval, balcony-edge issues are treated as essentially zero-tolerance items near TCO [1], [2], [7], [8]. A missing post cap, an over-sized glass gap, a non-approved fastener or an ambiguous sealant substitution is not viewed as a punch-list cosmetic item; it is a potential life-safety or durability non-conformance that can delay occupancy [1], [2], [9], [10]. The rest of this paper treats that regulatory context as fixed and focuses on how one project's inspection reports were used to build a practical workflow that keeps balcony edges within these tight limits all the way to handover.

3. Case Project & Inpsection Program

The case study is an anonymized coastal high-rise condominium in Florida. It is a threshold residential building in the high-wind coastal zone, with roughly seven occupied levels plus a penthouse and about sixty to seventy large units [1]. Each typical unit has two balcony zones: a wide primary balcony facing the water and a smaller secondary balcony on the opposite elevation. The living areas and bedrooms open to these balconies through impact-rated windows and sliding glass doors, with laminated glass railings at the perimeter and glass divider walls between adjoining units. In plan, this creates a continuous band of balcony openings around the tower, all directly exposed to wind-driven rain and salt air.

For this paper, the façade scope is deliberately narrow. Only the balcony edge systems are in focus: impact-rated windows and sliding glass doors at balcony openings, laminated glass railings mounted at the slab or curb edge, glass dividers between neighboring units, and the associated sealant joints, grout pockets, and brake-metal trims at the balcony slab edge. Curtain walls, opaque wall assemblies, roofs, and interior envelope transitions are outside the scope. The balcony opening is treated as a small façade system of its own that must carry wind and guard loads, manage water, and remain operable and safe for residents [1]-[3].

Within that balcony opening, the window and sliding-door system forms the primary weather and impact barrier [1]. Each opening combines aluminum head, jamb and sill members; vertical mullions where large bays are split; and fixed or operable glass units designed for impact resistance. Sliding leaves run on rollers inside threshold and track profiles installed at the slab edge or curb. The frame bears on bucks, shims and grout to transfer load into the structure, while brake-metal flashings and perimeter sealant joints tie the frame back to stucco or CMU [6], [12]. In later sections, inspections of mullion clips, perimeter anchorage, perimeter sealant and door operation all focus on whether these components are installed and performing as intended.

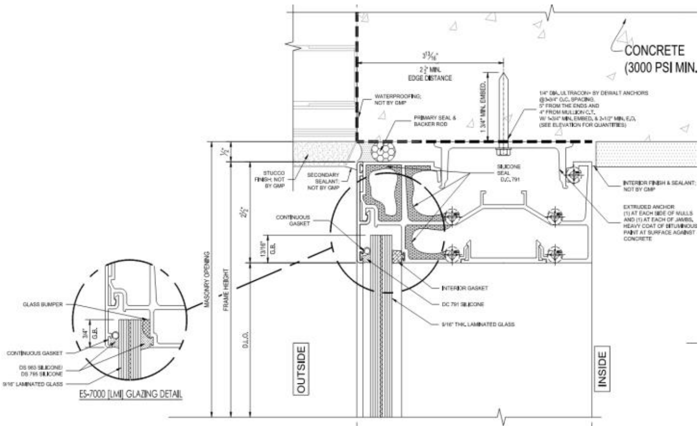


Fig 1: Typical Balcony Sliding Glass Door Head Detail Showing Frame Anchorage and Perimeter Sealing at the Concrete Slab Edge.

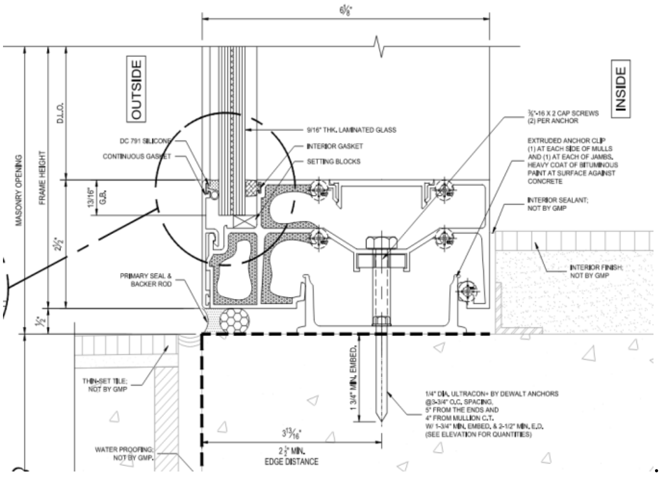


Fig 2: Typical Balcony Sliding Glass Door Sill Detail Showing Frame Support, Anchorage, Shims, and Drainage at the Concrete Slab Edge.

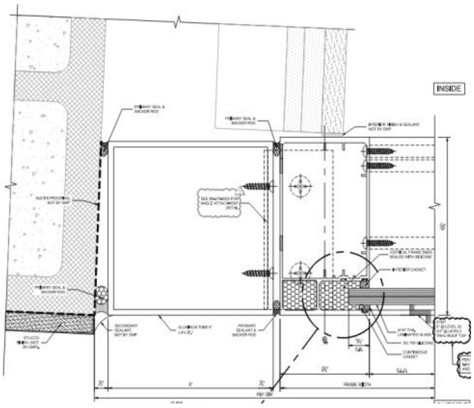


Fig 3: Typical Balcony Sliding Glass Door Corner Detail at Aluminum Tube Showing Frame Anchorage, Sealant Transitions, and Integration with Concrete or CMU and Interior Finishes.

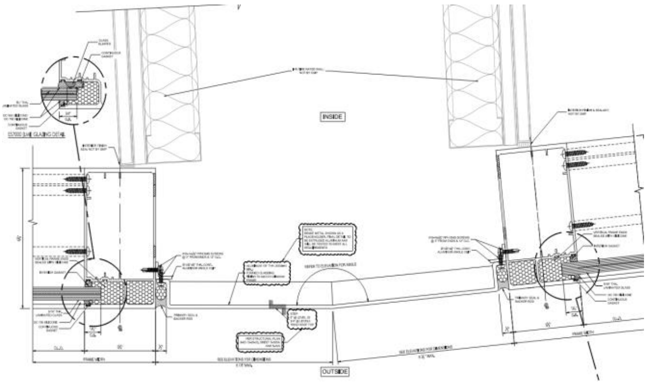


Fig 4: Plan Detail of Brake-Metal Closure between Adjacent Sliding Glass Door / Window Frames at the Balcony.

The balcony railing system provides fall protection at the edge of the slab [1]-[3]. It consists of laminated glass infill panels supported by aluminum posts or base shoes anchored into the slab or curb, usually through grouted pockets or base plates with mechanical anchors. Cover plates close the pockets and protect the grout, and a top rail or edge profile may be used to tie the panel heads together. At the base, sealant joints manage the interface between the curb, grout, and balcony waterproofing. Inspections of railing pockets, post grout, geometry and caps concentrate on this assembly: the quality of anchorage, the length and fit of the glass, the size of gaps at expansion joints and CMU returns, and the presence of post caps that prevent water from entering the hollow sections.

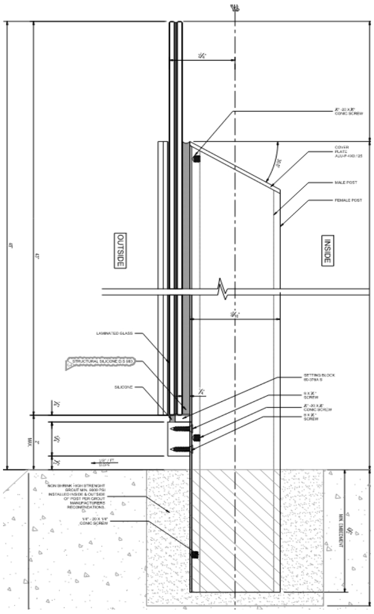


Fig 5: Section Detail of Laminated Glass Balcony Guard Supported on an Aluminum Post Anchored Into The Slab Edge

Glass divider walls separate neighboring units along the balcony line and complete the edge condition between railings and walls. These dividers use laminated glass panels captured in aluminum head and sill profiles, with head anchorage into the overhead slab or beam and sill anchorage into the curb or slab edge. Fasteners, shims, and sealant at these interfaces control both the structural load path and watertightness [6]. Interior sealant and backer rod close the return into interior wall finishes, while exterior perimeter sealant at head, sill and sides protects the glass edge and adjacent envelope. Targeted divider inspections therefore check head and sill anchorage, alignment with balcony finishes, and the completeness of perimeter sealing where the divider ties into the rest of the façade.

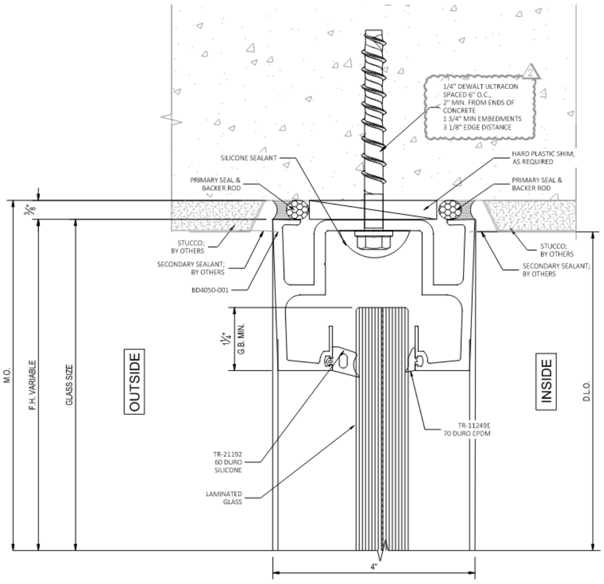


Fig 6: Head detail of laminated glass balcony divider panel anchored at the slab edge.

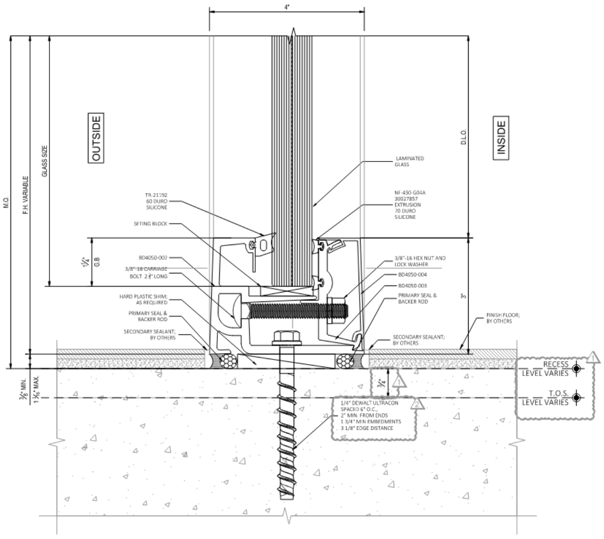


Fig 7: Sill Detail of Balcony Glass Divider Panel Showing Base Shoe, Anchor into Concrete, Shims, and Perimeter Sealant at the Slab Edge.

A dedicated façade consultant was engaged as special inspector for glazing and railings under the project's threshold-building inspection plan [1], [8]. Early in construction, this consultant issued a written glass and glazing inspection protocol that defined what would be inspected at balcony openings, how each inspection had to be requested and documented, and how deficiencies would be closed. In practice, balcony-edge inspections were organized around recurring types: mullion and clip anchorage, perimeter anchorage of frames and bucks, perimeter sealant and weatherproofing, railing pockets and post grout, tie-down and operability checks for windows and sliding doors, and focused checks on divider anchorage and sealant. Separate field water-resistance tests were carried out on selected sliding glass doors by a certified laboratory, following the AAMA 502 procedure with the ASTM E1105 method, to confirm that representative openings met the specified water-test pressure once installed [4], [5].

Logistics for these inspections were also formalized. Each inspection type had to be requested at least twenty-four hours in advance, with clear identification of the floors, units, and elevations to be checked. After each site visit, the special inspector issued a numbered PDF report, typically within a day, summarizing the inspection type, locations visited, observed deficiencies and illustrative photographs. Defects that could be corrected by straightforward rework, such as missing anchors, incomplete grout, or unfinished sealant, were tagged for re-inspection. Conditions that deviated from standard details, such as unusual shim heights, edge distances or non-standard products, were flagged as requiring a signed and sealed engineering disposition from the façade engineer or a formal approval letter from the product manufacturer [1], [7], [8]. The same protocol applied across balcony windows, doors, railings, and dividers so that all balcony-edge findings could be handled within one consistent workflow.

All analysis in this paper is based on project documents generated from that inspection program. The primary data source is an Excel inspection log maintained jointly by the contractor and façade consultant, which consolidates more than 180 balcony-related inspection entries across the construction period. Each row links an inspection report ID, date, inspection type, building location, description of the condition, suggested corrective action, whether re-inspection was required, and whether any engineering or manufacturer letters were received. The log is cross-checked against the underlying consultant reports and their photo sets, the field water-test report for the sliding glass doors, and the final professional-engineer letters for glazing and railings that supported the Temporary Certificate of Occupancy. In the remainder of this paper, this building is referred to simply as the case project, and these documents are treated as a single integrated data set for decoding a practical balcony-edge inspection workflow.

4. Inspection method

On this project, the balcony edge was not inspected “by feel” or with ad-hoc punch lists. The team used a small set of repeatable inspection methods, each linked to a specific set of drawings, approvals, and failure modes. For every balcony, inspectors asked the same questions: what is actually installed, how does it compare to the approved detail or NOA, and which risk does this check control (loss of load path, leakage, fall risk, or inoperable egress) [1]-[3], [7].

This section describes each inspection type in practical terms: what the inspector looks at or measures on site, which documents they use as reference, and what problem each method is designed to prevent.

4.1. Mullion and clip anchorage

Mullion / clip inspections focus on the hidden connections that tie aluminum frames back to the structure [1], [2], [6], [7]. The inspector begins by exposing the anchorage where possible: removing snap covers, pulling back gaskets, or asking the installer to open a small portion of the finished frame. They visually confirm that:

- the correct type of angle or clip is used at the jamb and sill.
- fastener diameter and type match the approved anchor schedule.
- fasteners are installed into the intended substrate (concrete, structural buck, or tube) and not into non-structural material.
- the clip bears properly on the tube or frame, without visible distortion, bending, or over-tightening [6], [7].

Edge distance and spacing are then checked against the approved shop drawings and NOA details for that system [2], [7]. The critical dimension is the distance from the fastener centerline to the edge of the aluminum tube or plate; too small a distance risks tear-out, and too large a distance may indicate the clip is not engaging the tube as designed [2]. Where necessary, the inspector measures these distances and compares them to the engineered limit.

The purpose of this method is to verify the basic load path: that wind suction, impact forces, and guard loads are transferred safely from the mullion into the structure through clips that are installed exactly where the engineer assumed they would be [1]-[3]. If this check fails, the weakness is not cosmetic; it is in the core structural connection of the façade at the balcony edge.

4.2. Perimeter anchorage at frames, railings, and dividers

Perimeter anchorage inspections extend the same logic to all components sitting on the slab edge: window and door frames, railing shoes, and divider channels. Here the inspector is concerned with three main questions:

- Are the anchors installed in the right place?
- Are they embedded deep enough into sound substrate?
- Is the support beneath the frame or shoe continuous and solid?

On site, this means confirming that anchor locations match the spacing and pattern on the NOA or delegated engineer’s detail, that anchors are driven into concrete or structural members (not into weak toppings or patch material), and that embedment meets the minimum required depth [1], [2], [6], [7]. Where accessible, the inspector checks that base plates or shoes are fully supported, without voids or excessive packing. Missing or crushed shims, hollow spots under a sill, or incomplete grout under railing shoes are treated as risks to the load path.

For dividers and end conditions, anchorage at the top, bottom, and side jambs is checked together. The intent is to verify that each balcony guard or divider can actually deliver the guard loads and wind loads defined by code into the slab and adjacent structure, not only while the building is new but over its full-service life [1]-[3].

4.3. Perimeter Sealant

Perimeter sealant inspections are about water and long-term durability rather than immediate structural failure. Inspectors walk each balcony line and examine the joints where frames, rails, and dividers meet stucco, concrete, or other cladding. They look for:

- continuous sealant beads around the full perimeter of the window or door
- correct joint geometry (width and depth suitable for movement, not a thin smear)
- evidence of proper joint backing (backer rod or bond-breaker tape, not three-sided adhesion)
- clean, dry, and sound substrates, without dust, release agents, or loose stucco
- product identification that matches the approved sealant or an accepted alternate [1], [3], [6], [9], [10], [12].

If a different sealant has been used, the inspector checks that there is written confirmation from the manufacturer and that field adhesion tests (simple hand-pulls or cut-and-pull samples) have been performed at representative locations [6], [9], [10], [12]. Where sealant is missing, poorly tooled, or smeared over dirty surfaces, the joint is marked for removal and proper reinstallation rather than just a touch-up.

The underlying question is simple: will this joint still keep water out after many years of thermal movement, wind cycling, and minor differential movement in the slab edge [1], [3], [6], [12]. Failed sealant at balcony edges does not just create stains; it allows water to reach anchors, shims, and reinforcing steel, leading to hidden corrosion and future structural repairs [1], [3], [6].

4.4. Railing Post, Pockets, Grout & Geometry

Railing inspections combine anchorage checks with geometric checks because both matter for safety. At the slab interface, inspectors verify that post pockets or shoe channels are properly filled with grout or approved anchoring material, that there are no large voids, and that the grout is bonded to both the steel/aluminum and the concrete. Where posts are surface-mounted, the fastener type, diameter, and embedment are checked against the NOA or engineer's detail [1]-[3], [7].

At the same time, the inspector measures railing geometry:

- the clear distance between glass or pickets, and between the last glass panel and any CMU wall or return
- the height of the guard relative to finished floor.
- the distance between the sliding glass door frame and the first line of railing glass.

Openings are checked against the 4-inch-sphere rule described in Section 2 [1]-[3]. If a gauge of that size can pass through any gap between glass panels, at expansion joints, or at the interface with walls and dividers, the guard does not satisfy basic child-safety intent [1]-[3]. Where the railing runs in front of a sliding glass door, the inspector also reviews the shop detail and door hardware information to confirm that travel stops or bumpers limit the door movement before the glass edge can be struck.

For glass dividers and end conditions, the inspection confirms that the panels are anchored at all designed points and that there are no excessive gaps that could become a passage or pinch hazard. The aim is to verify both the strength of the anchorage and the effectiveness of the guard geometry in preventing falls and protecting glass edges at the balcony perimeter [1]-[3].

4.5. Tie Down & Operating Force Checks

Tie-down and operating force inspections examine two related questions: does the door or window stay anchored under load, and can a normal user still operate it safely.

For tie-downs, the inspector uses a simple pull gauge or scale to apply a controlled horizontal load at the sliding glass door or balcony door, in line with the project protocol. A 40 lb. pull is used as the practical acceptance threshold [1], [3], [6]. While the load is applied, the inspector checks for visible movement at tie-down straps, anchorage points, or frame-to-structure connections. Any significant deflection, uplift, or loss of engagement is flagged for correction.

For operating force, the same gauge is used at the door handle to measure the force required to start the door moving and to keep it in motion. The door is cycled open and closed several times. During this process the inspector observes whether the panel binds in the track, rubs against the head or jamb, or shows signs of racking. Hardware function is also checked: latches and locks must engage fully without excessive effort, and the door should not jump out of its track or ride on debris [1], [3].

This method turns subjective comments like "door feels heavy" or "hard to open" into a measurable criterion. A door that fails the operating-force check is treated as both a comfort and safety issue, because difficult operation may hide misalignment or stress that can later translate into cracked glass, damaged hardware, or compromised egress in an emergency [1], [3].

4.6. Water-resistance testing

Water-resistance testing is the most intensive method in the program, used on a sample of fully installed sliding glass doors to verify that the system performs close to its laboratory rating under field conditions. The project followed AAMA 502 and ASTM E1105 procedures, with an independent test agency conducting the work [4], [5].

At each selected location, a temporary chamber is built at the interior face of the sliding door. The exterior side of the assembly is sprayed uniformly with water while a static pressure differential is applied across the door [4], [5]. The laboratory qualification for the SGDs used on the project is higher, but for field verification the test pressure is intentionally set at approximately two-thirds of that value [5]. In this case, the field test pressure was 8.1 psf [4], [5].

Once the chamber reaches the specified pressure, the spray is maintained continuously for 15 minutes at that pressure level [4], [5]. During the test, the inspector and test technician stand on the interior side and visually monitor all frame joints, corners, and sill components for leakage [4], [5]. The sill is allowed to collect water up to a shallow depth consistent with the system's drainage design. In this project, that depth was roughly 1½ inches in the test chamber before water reached the overflow threshold.

Adjacent joints and non-tested interfaces are masked or temporarily sealed so that any leakage observed during the test can be attributed to the tested sliding door assembly and not to unrelated cracks or penetrations [4], [5]. At the end of the 15-minute period, the interior surfaces are inspected again for dampness, staining, or active water flow.

A test is considered a pass if no uncontrolled water penetrates beyond the interior plane of the frame or bypasses the intended drainage path [4], [5]. Any measurable leakage into the occupied side is treated as a failure and triggers a root-cause investigation of glazing gaskets, frame joints, anchor penetrations, or sealant terminations.

The purpose of this method is to validate, under controlled but realistic conditions, that at least a sample of balcony sliding glass doors can resist wind-driven rain close to their design pressure without leaking into the unit. It ties laboratory performance directly to actual installation quality and becomes a strong reference point for accepting the remaining openings built to the same details [4], [5].

Fig 8: Specimen Being Tested for Water Resistance- Interior View

Fig 9: Specimen Being Tested for Water Resistance- Exterior View.

Fig 10: Water Intrusion at Sliding Glass Door Sill, with Leakage Migrating Beyond the Interior Plane of the Frame (Failure Condition).

5. Data Source & Excel

To make hundreds of balcony inspections usable, the project team treated the Excel file not as a defect list, but as a life-cycle tracker. Each row in the log represents a specific façade inspection event or issue tied to a consultant’s report, a physical location, and a clear path from first observation to final closure. In other words, the log captures the full story of each balcony-edge issue: when it was found, where it occurred, what was wrong, what response was required, and when it was finally closed.

Across the project, this log holds on the order of 180 balcony-related inspection entries for windows, sliding glass doors, railings, and dividers. Some entries cover many openings in one run; others capture a single high-risk condition. For analysis, the columns can be understood in four functional groups: identification, location and scope, technical content, and closure / quality-control fields.

5.1. Report Identification

The first group of fields anchors each line of the log in time and documentation. Inspection Date records the day the consultant actually visited the site and performed the inspection. This allows the team to align findings with construction progress, water tests, and city inspections.

Report ID is the unique identifier of the consultant’s written report (for example, a glazing inspection report or shoe-railing report number). This ID is the handle that links the Excel row back to the full PDF report, its photo set, and any later closing report.

Together, these two fields answer basic traceability questions: when was this inspected, and which formal report does this line belong to.

5.2. Location & Inspection Scope

The next group of fields describes where the issue lives on the building and what kind of inspection generated it:

- Inspection Performed specifies the inspection type for that entry, such as mullion / clip anchorage, perimeter anchorage, perimeter sealant, railing pockets, railing post grout, or tie-down / operability. This connects each row directly to the inspection matrix defined earlier in the paper.
- Building Section identifies which portion of the building is involved (for example, a particular wing, elevation, or tower designation used internally).
- Floor / Level pins the finding to its vertical location so patterns can be seen, such as recurring issues on a typical level.
- Status of Report (open or closed) records whether the overall inspection report that generated this entry is still active or has been fully resolved.
- Sheets lists the drawing sheet numbers on which the inspector highlighted the affected openings or railing runs. This creates a bridge from the Excel row to the inspection report and then to the exact mark-ups on the façade drawings.
- In combination, these fields allow the team to answer “what did we inspect, and exactly where” in a way that can be traced both on paper and on site.

5.3. Description, Occurences and Engineering Response

Once inspection type and location are clear, the log records what was actually found and how it is expected to be handled.

Description is a short technical narrative of the observed condition, for example “insufficient clip embedment at head mullion,” “perimeter sealant missing at top jamb,” or “railing post grout incomplete at pocket.” Occurrences indicates whether the issue is local or repeated: a single opening, several openings on the same level, or a pattern across many units within that report. This distinction matters because one line can represent either a one-off mistake or a systematic problem.

Suggested Solution captures the consultant’s recommended response. In practice, entries tend to fall into two main categories:

- straightforward field correction for simple site issues (install missing anchors, complete grout, re-seal perimeter joints, adjust rollers and hardware, and similar work), and
- formal engineering response for conditions that deviate from standard details, such as excessive shimming, non-standard edge distances, or modified openings. In these cases, the log explicitly notes that a signed and sealed engineering letter or calculation package is required to justify the as-built condition.

This block effectively turns each row into a small action plan: it states what is wrong, where it happens, and what level of response is expected from the contractor, the façade engineer, or the manufacturer [1], [3], [7], [8].

5.4. Follow-Up, Documentation & Site Correction

The next fields exist to prevent a common failure in complex projects: issues being noticed and discussed, but never fully closed. They record whether the issue is moving through the workflow or stuck at some step.

Reinspection Required (yes or no) indicates whether the consultant must return specifically to verify the correction in the field. Minor items can sometimes be closed on the basis of clear photographic evidence; others, such as critical anchorage corrections, demand a second physical visit.

Follow-up Required with Subcontractor PM (yes or no) flags issues that need management-level attention, for example recurring workmanship problems that require a change in crew practices rather than a one-time fix or a signed and sealed engineering letter or calculation package.

Remedial Documents Received (yes or no) applies where a formal calculation or engineering letter is needed, such as for alternate anchors, revised shim limits, or acceptance of non-standard conditions [1], [7], [8].

Description of the Provided Documents briefly records what has been submitted, for example “PE letter confirming alternate anchor spacing at balcony sliders” or “manufacturer letter approving sealant substitution at perimeter joints.”

On the site-work side, the log also includes Deficiency Corrected on Site (yes or no), confirming whether the physical work linked to that line item has actually been corrected in the field. This field is used primarily for installation-related deficiencies such as missing grout, incomplete sealant, misaligned doors, or missing caps.

Together, these fields answer whether someone has acted on the issue, whether all required paperwork has been received, and whether another inspection visit is still outstanding. Without this group, the log would be a static list; with it, the file becomes a dynamic control tool.

5.5. Closure & Final Reports

The final pair of fields marks where the life cycle of each issue ends.

Closing Report ID records the identifier of the follow-up inspection report that confirms the item has been resolved. This ties the original finding directly to the report that signs it off.

Closing Report Date captures the date on which that closing report was issued and the deficiency was officially moved to “closed” status.

These two fields do more than stamp a date. They allow the project team and the engineer preparing the glazing and railing certification letters to see exactly when each balcony-edge issue left the risk column and entered the closed column. If a building official or owner later asks “when was this balcony door leak resolved, and under which report,” the answer is available in one row [1], [8].

5.6. Roll of the log in Overall Workflow

In summary, the Excel inspection log ties together three layers of information:

- Field reality, in the form of dated observations at specific elevations, floors, and openings.
- Design and engineering, via references to drawings, calculations, and remedial letters; and
- Quality control and certification, through status fields, closing reports, and dates that feed directly into the engineer’s final letters for TCO [1], [3], [8].

Because inspection type, description, occurrence, and engineering response are all coded in structured fields, the dataset can later be filtered and grouped by inspection type, by recurring issue, or by issues that required formal engineering disposition. This makes it possible to see patterns across the 180 entries rather than treating each one as an isolated event.

By structuring the log in this way, the project team treats balcony façade inspections not as scattered punch-list notes but as a managed workflow with traceable accountability. Each micro-issue at the balcony edge – an anchor, a shim, a sealant bead, a grout pocket, a broken glass panel, or a heavy sliding door – is tracked from first observation to final sign-off. That level of structure is exactly what is required on a coastal high-rise, where the margin for error at balcony edges is small and the consequences of missing one detail can be very large [1]-[3].

6. Field Findings from 180 Balcony Inspection Reports

This study uses an Excel log made by GC covering approximately 180 balcony-edge façade inspection reports prepared by the special inspector during construction of a coastal high-rise. Each report corresponds to one site visit focused on a specific inspection type (mullion clips, perimeter anchorage, perimeter sealant, railing pockets, grout, tie-downs, etc.) and typically covers many openings in a single run. Only a small subset of those openings in each report actually had deficiencies; those specific locations were marked as requiring re-inspection.

The distribution of reports across inspection types is not uniform. The log records about 52 perimeter anchorage reports, 43 perimeter sealant reports, 33 railing pocket and geometry reports, 22 railing post grout reports, 17 mullion-clip anchorage reports, 9 window/door tie-down and operability reports, and 4 railing tie-down reports. This pattern already indicates the “pressure points” of balcony construction: most attention is pulled toward anchorage, sealant, railing geometry, and the final tie-down and operation of doors and guards.

The purpose of this section is to describe, in a factual way, what the inspector actually found in each category: where problems clustered, what they looked like on site, and how they were recorded in the log.

6.1. Overall pattern in the log

Across the ~180 reports, most entries fall into a handful of recurring categories: perimeter anchorage, perimeter sealant, railing pockets and geometry, railing post grout, mullion clips, and tie-down/operability checks for railings and windows. Within those categories, the same issue types appear again and again: clip edge distance, wrong fasteners, excessive or missing shims, sealant completeness and product choice, railing gaps around balcony edges, broken glass, missing caps, and doors that are visually installed but not operating within the target force limits.

Rather than hundreds of unique problems, the log reveals a small family of repeating failure modes that show up across different floors and elevations. The subsections below summarize those modes, grouped by inspection type.

6.2. Mullion-clip inspections (17 reports)

Seventeen reports are dedicated to mullion and clip anchorage. Each of these visits samples the hidden connections that tie aluminum mullions and frame segments back to structural tubes or concrete.

Two recurring technical issues dominate this category. The first is insufficient clip engagement or edge distance. In a typical entry, the inspector notes that “insufficient clip engagement was observed at one opening” and refers to the shop-drawing limit of 1-3/16 in from the clip fastener to the edge of the aluminum tube. The accompanying photo shows a tape reading closer to about 1-9/16 in from tube edge to screw, so the as-built condition sits outside the tested geometry even though the frame looks finished. This pattern appears in several reports and becomes the most common mullion-related finding in the log.

Clip engagement distance of up to 1 9/16".

Fig 11: Mullion Clip Edge-Distance Out of Tolerance, with Measured Clip Fastener-to-Tube Edge Distance of Approximately 1-9/16 In.

The second recurring issue is wrong fastener type or size. Some clips were installed with screws that do not match the approved diameter or embedment. For example, the log and photos record 2¼ in screws where the schedule called for fasteners providing roughly 3¼ in embedment into concrete, and occasional use of different diameters than the ¼ in anchors specified on the detail. These deviations are logged as “wrong fastener type and size” across several openings.

A third theme in the mullion-clip reports is “mullion not installed / incomplete opening.” In those cases, hoists, scaffolding, or other trades blocked installation at the time of the visit. The log still records these openings under mullion-clip inspections, but clearly as incomplete work or sequencing items rather than workmanship defects.

Mullion observed not installed.

Fig 12: Incomplete Opening at Time of Inspection: Mullion not installed Due to Ongoing Work and access Constraints (Sequencing Item, Not a Workmanship Defect).

6.3. Perimeter anchorage inspections (52 reports)

Perimeter anchorage is the largest single category in the log, with 52 reports focused on how frames, shoes, and bucks are tied into the slab edge and surrounding structure.

The dominant issue in this group is shimming. Multiple entries describe “excessive shimming” at balcony sills and railing shoes, including one case where shim stacks under a sill approached about 1 in in total height. Other photos show shoes sitting on a visible stack of plastic shims rather than a thin, uniform bearing layer. At the opposite end, some openings are recorded as having “no shims at shoe,” with a clear gap visible between the aluminum extrusion and the concrete support.

Excessive shimming up to 1" at sill.

Fig 13: Excessive Sill Shimming Observed at a Balcony Opening, with Shim Stack Height Approaching 1 In.

From the inspector's perspective, these findings are important because shims form part of the load path between aluminum and concrete. Tall stacks or missing pieces are treated as structural observations, not cosmetic notes, and the log reflects this by giving them their own descriptive entries.

A second set of entries in this category simply notes "opening not installed at time of inspection." These lines document inspection attempts that encountered incomplete work, where frames or shoes were not yet in place. They are carried forward in the log so those locations can be revisited, but they represent progress and sequencing rather than non-compliance.

Not installed. Buck hoist.

Fig 14: Opening Not Installed at Time of Inspection Due to Buck/Hoist Staging; Noted as Sequencing (Not A Workmanship Defect)

6.4. Perimeter sealant inspections (43 reports)

Perimeter sealant inspections account for 43 reports. Here the focus shifts from anchors and shims to the weather-resistive joint around balcony windows and sliding glass doors.

Two patterns appear repeatedly. The first is sealant product substitution. In several reports, the inspector observes that DOWSIL 790 weather seal silicone was installed at joints where the planned submittals had identified DOWSIL 795 [9], [10]. Visually, the sealant beads look neat and continuous; the issue flagged in the log is that the installed product is not the one expected by the design team and protocol. These entries are written as "wrong sealant type" and held in the log until a formal judgement is provided by the manufacturer and engineer.

The second pattern is incomplete or missing sealant at the time of the visit. Many reports document that sealant was not yet installed at one jamb, at head corners, or at pockets, even though other parts of the same perimeter had been caulked. Typical wording is "sealant not complete at perimeter" or "sealant missing at head/jamb of specified opening." These items are timing-related but still logged in detail, with photos, because perimeter joints are a critical part of the balcony water path and must be continuous before any final certification.

6.5. Railing pockets and geometry (33 reports)

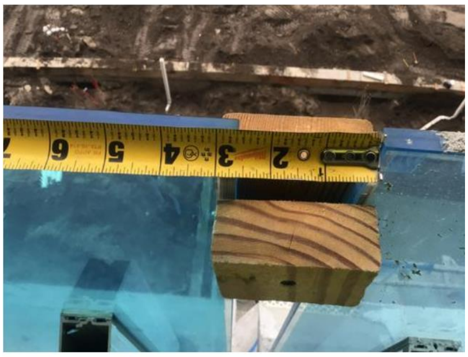
The log contains 33 reports for railing pocket and geometry inspections. These reports cover both the anchorage zone at the slab edge and the spatial relationship between glass, posts, sliding doors, and adjacent walls.

Three recurring issues stand out. The first is railing distance to sliding glass doors. Several entries state that the "railing distance to SGD not adequate to protect glass integrity." Inspection photos show a tape measure from the sliding glass door frame to the first railing glass panel or post, with a relatively small clearance. The concern recorded in the log is that door operation or furniture movement could bring impact too close to the glass edge.

Railing distance to opening not adequate.

Fig 15: Insufficient Clearance between the Sliding Glass Door Frame and the Adjacent Railing Glass/Post, Creating an Impact Risk During Door Operation.

The second is excessive gap at expansion joints between railing runs. In one documented case, the gap between two adjacent railing panels measures up to about 2⅝ in where the shop drawings limited that joint to 2 in. The photo shows a timber spacer and tape measure illustrating the gap. While still below the 4 in clear-opening limit used in many guardrail codes, this difference is large enough to be treated as an out-of-tolerance condition at a critical location [1]-[3].



Excessive gap between railings up to 2-5/8".

Fig 16: Expansion-Joint Gap between Adjacent Railing Glass Panels Measured at Approximately 2-5/8 In., Exceeding the 2 in. Shop-Drawing Limit.

The third issue is excessive gap between railing glass and CMU walls. A series of reports note that the “distance to CMU not adequate. Max 2½ in per shop drawings.” Tapes in the photos show measured clearances beyond that limit where the last piece of railing glass terminates at a shear wall. These entries highlight end conditions where as-built geometry does not match the intended closure to the wall and pushes the assembly closer to the guard opening limit.

Distance to CMU not adequate. Max 2-1/2" Shop drawings.

Fig 17: End-Condition Clearance between Railing Glass and Adjacent CMU Wall Exceeds the 2-1/2 In. Maximum Shown in the Shop Drawings.

Taken together, these 33 reports show that guard geometry around balcony edges is a frequent source of comments, particularly where railings interface with sliding doors, expansion joints, and structural walls.

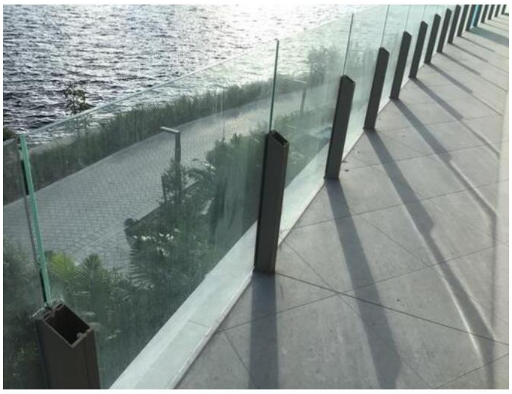
6.6. Railing post grout and caps (22 reports)

Twenty-two reports focus specifically on railing post grout, with some overlap to observations on post caps. These reports document the condition of the grout filling around railing posts in pockets or base shoes along the balcony edge.

The most common note is simple: grout not yet completed at the time of inspection. Entries describe “grout incomplete in some pockets” or “posts installed, grout pending,” often with photos showing hollow pockets or partially filled bases. Although these are straightforward to address, they are recorded systematically because the posts do not yet have the designed embedment and bearing until grout is fully placed and cured.

In the same area, inspectors also log missing railing post caps. Photos show finished balcony edges where several posts are still open at the top, with comments that caps are missing or not installed. Even when these are treated as punch-list items, the log text emphasises that open posts create a path for water and debris into the tube and are therefore relevant for long-term durability.

This group of 22 reports therefore captures an intermediate state of the railing system: posts in place but grout and caps not fully completed, requiring follow-up before the guard can be considered finished.



Missing caps.

Fig 18: Missing Railing Post Caps Observed Along Completed Glass Guard Line, Leaving Hollow Post Tubes Open to Water and Debris Ingress

6.7. Railing tie-down and broken glass (4 reports)

Railing tie-down inspections generate only four reports, but they track one of the most disruptive balcony-edge issues on the project: broken railing glass and related safety items.

By the time close-out is reached, the log counts approximately 72 broken laminated balcony glass panels. The causes are varied and usually recorded qualitatively: damage during railing installation, accidental impact during balcony stone or tile work, and incidental contact from other trades moving tools and materials near the railing line. Each broken panel is noted with its location, report number, and a brief description.

Railing glass observed broken.

Fig 19: Broken Laminated Glass Panel Observed at Balcony Railing, Recorded for Replacement and Tracked in Inspection Log

These same reports also revisit missing post caps along completed railing runs. The inspector records caps that are still absent even after the primary railing installation is done, reinforcing that they are not merely decorative covers but part of protecting the anchorage zone from water ingress.

Even though this category has the smallest number of reports, it concentrates a large amount of replacement work and schedule risk, because each broken panel represents a custom-fabricated glass unit that must be reordered and reinstalled.

6.8. Window tie-down and operability (9 reports):

Nine reports fall under window and sliding glass door tie-down and operability inspections. These visits combine checks on anchoring hardware, door and window operation, and visible condition of glazed units at balcony openings.

The log records several distinct issue types in this category:

- Broken window glass: about 20 individual window lites are noted as cracked or shattered across the project, usually with photos identifying the specific opening.
- Damaged frame: one notable case of a deformed or dented aluminum frame is recorded, flagged for further attention.
- Missing threshold: a single opening is logged with a missing threshold element, described as incomplete at the sill.
- Inoperable or hard-to-operate sliding doors: roughly 14 balcony sliding doors fail the pull test used by the inspector. The log notes that measured operating force exceeded the 40 lb criterion adopted for this project, with comments such as “door requires excessive force to operate” or “door fails pull test” tied to specific units.

Inoperable SGD.

Fig 20 :Sliding Glass Door Operability Pull Test Using a Handheld Force Gauge, Showing an Opening Force of About 41.00 Lb. (Above the 40 Lb. Acceptance Criterion)

- Missing corner bead at stucco return: at least one entry notes that a stucco corner bead is missing at a window return, raising the risk that the future stucco edge will not terminate cleanly or be sealed properly around the mullion.
- Missing hardware and weatherstripping: isolated cases of missing handles, locks, or weatherstripping are recorded, typically as “handle missing,” “threshold piece missing,” or “weatherstrip incomplete” at individual doors.

These findings show that a balcony façade can appear visually complete while still having functional and durability issues that only become visible when doors are operated, forces are measured, and terminations are examined closely [6].

6.9. Patterns emerging from the findings:

Looking across all 180 inspection reports and their logged observations, a consistent pattern emerges. Most balcony-edge issues cluster around a limited set of failure modes:

- geometry and edge distances at hidden mullion clips and anchors,
- shim height and bearing conditions at sills and shoes,
- perimeter sealant completeness and product choice,
- railing gaps at expansion joints and CMU walls,
- completeness of grout and caps at railing posts, and
- broken glass and sliding door operability near the TCO stage.

The Excel log helps reduce hundreds of balcony openings and dozens of visits into this short list of concentrated problem types. Later sections of the paper build on these findings by analyzing why these failure modes recur, how they were closed in the field, and how an inspection workflow can be structured to catch and manage them well before final certification.

7. Issue Significance and Resolution

7.1. Anchorage details – protecting the load path:

The repeated findings on clips, anchors, and shims described in Section 6 all point to one core question: can balcony windows, doors, and railings actually transfer wind and guard loads into the structure the way the tested system assumes [1], [2]. Slightly excessive clip edge distances, undersized or shallow fasteners, and improvised shim stacks might look minor in a photo, but each one weakens the only load path between the aluminum and the concrete.

On this project, those “looks wrong” conditions were not left to opinion. Where clip fasteners sat further from the tube edge than the original shop detail allowed, the façade engineer issued a signed and sealed sketch and calculation package that re-defined the minimum acceptable geometry for the specific tube and screw combination. If a clip and its fasteners fell inside that engineered envelope, the condition was accepted as compliant; if not, the crew had to shift clips or add new ones. The same logic applied to wrong fastener type or embedment: non-conforming screws were removed and replaced with the specified diameter and minimum embedment, then re-inspected with photos and measurements.

Shim issues followed a similar pattern. Where sill or shoe shims were stacked too high or missing altogether, the engineer’s detail set a strict limit on shim material, thickness, and total height, plus anchor spacing and embedment. Installers then checked each opening against that envelope, resetting only the outliers instead of tearing everything out. Incomplete mullions and openings blocked by hoists or other trades were treated differently: they were logged as “not yet installed” rather than as defects and were brought back into the inspection loop once access was available.

In effect, anchorage findings were converted either into engineered conditions with explicit geometric limits, or into physical corrections that restored the original design intent. The result was a balcony load path that could be defended on paper and in the field, instead of relying on subjective judgement [1], [2].

7.2. Sealant choices – controlling water and long-term durability:

Perimeter sealant findings mattered for a different reason: they controlled the water path, not the load path. The recurring issues were straightforward to describe – crews had installed a different DOWSIL product than originally specified at some metal-to-metal joints, and many joints were simply incomplete at the time of inspection [9], [10] – but the consequences were long-term. If the wrong sealant is used, or if beads are missing at corners and jambs, wind-driven rain can reach anchors, shims, post pockets, and slab edges, quietly corroding hardware and reinforcing steel over years.

Rather than ordering automatic removal of all substituted sealant, the team asked the manufacturer for a formal opinion. The resulting letter confirmed that the installed sealant is acceptable for the specific metal-to-metal perimeter joints around these openings, provided correct surface preparation, primer selection, and adhesion tests are carried out [9], [10]. That letter, combined with field adhesion checks, turned “wrong product” into “approved alternate under defined conditions.” Incomplete runs were handled more simply: missing beads were installed and tooled, corners were finished properly, and the consultant closed each item after visual confirmation or a quick return visit.

Here, documentation was as important as the bead itself. Manufacturer letters and adhesion tests ensured that the joint is not just neatly tooled, but compatible and durable in a salt-laden balcony environment [9], [10].

7.2. Railing geometry and caps – life safety, not cosmetics:

Railing pocket and geometry findings were about where people stand and lean, not about appearance. Small dimension changes at expansion joints and CMU returns – a gap that grows from 2 inches on the drawing to about 2⅝ inches on site, or a glass edge that sits further from a wall than intended – directly affect the guard opening. When those gaps creep toward or past the 4-inch limit used in most guard requirements, they reduce the safety margin that prevents a child’s body or head from passing through [1], [3].

The inspection log shows two distinct ways these issues were closed. Where the concern was railing distance to a sliding glass door, the subcontractor responded with the approved details and hardware data instead of a hammer. The drawings fixed a clear offset between door and railing line, and the door hardware included a bumper or stop that limits panel travel before it can reach the railing. Once the inspector saw that the installed condition matched the detail and that the door physically cannot swing or slide into the glass edge, the comment was closed as “meets design intent” with no field change.

Where the concern was excessive gaps at expansion joints or CMU walls, the only acceptable fix was physical. Glass panels were reordered at correct lengths, pockets or post locations were adjusted [1], [3]. At the same time, missing post caps – which seem cosmetic at first glance – were treated as mandatory. Without caps, water runs directly into hollow posts and sits above base plates and anchors, accelerating hidden corrosion exactly where the guard is supposed to resist load. Installing proper caps was therefore logged and tracked as part of the safety and durability package, not as optional punch-list decoration.

7.3. Operability and hardware – making "looks finished" actually work:

Findings around operability and hardware showed how easily a balcony can look complete while still failing basic performance tests. Doors that required more than the 40-lb pull threshold, misaligned frames, missing thresholds, absent handles or locks, gaps in weatherstripping, and missing corner beads at stucco returns all appeared in the log. None of these defects change the skyline silhouette, but all of them affect how safely a resident can use the opening day to day [1], [3], [6].

Corrective actions followed a simple but disciplined sequence. Tracks were cleaned of construction debris, frames were re-squared where they had racked under temporary loads, and rollers with flat spots or damage were replaced. Doors were then re-tested with the gauge until they passed the operating-force limit consistently. Hardware and thresholds were installed or corrected so that doors latched properly, sealed against wind-driven rain, and met the expected clear opening width to the balcony. Missing stucco corner beads at window returns were installed before plastering, so that the stucco termination could be properly sealed and would not bridge directly onto mullions or anchors.

The key point is that these are not cosmetic upgrades. A heavy or sticking sliding door is an early signal that something is wrong with alignment or support; a missing threshold or weatherstrip is a path for water and air; a missing bead can turn into a leak path behind the finish. By treating each of these as façade performance items, the inspection program tied "looks finished" to "actually works" in a measurable way [1].

7.4. Broken glass – the long-lead risk that must be managed early:

Broken balcony glass and window lites emerged as one of the most disruptive patterns in the log, even though each individual crack or shatter could be blamed on day-to-day construction traffic. Railing panels were chipped during installation, struck by tools or materials during balcony stone and tile work, or damaged as other trades finished ceilings and lighting. Window lites were also broken at scattered locations. In an active high-rise interior, these events are almost inevitable, even with careful crews.

What made them critical was not just safety but time. Each laminated railing panel and impact window lite had to be custom fabricated, laminated, packaged, shipped, cleared through customs, and delivered to site. A realistic cycle for railing glass was on the order of six weeks for fabrication and another ten to fifteen days for shipping and port handling, with additional uncertainty for customs and local logistics. The authority would not accept a TCO while broken railing glass remained at balcony edges, so these were not issues that could be left for the last punch walk.

The project responded by treating broken glass as a long-lead risk within the inspection workflow. Months before the planned TCO date – roughly six to eight months in advance – the team began systematically walking balconies, logging every broken or cracked panel and batching replacement orders so that there was always glass "in the pipeline." Installation of replacement panels was then sequenced around other trades to avoid repeating the same damage path. By the time the engineer prepared the glazing and railing letters, the log confirmed that all broken pieces had been addressed and that no balcony edge relied on temporary barriers [1].

7.5. How the log converts defects into safe conditions:

Across all these categories, the Excel log acted as the bridge between field observations and a façade that could be certified as safe. Each line in the log represented a decision point: will this condition be corrected physically, or will it be justified and bounded by engineering or manufacturer documentation.

Wrong fasteners and excessive shim stacks were resolved by replacing hardware and resetting supports within a sealed design envelope. Edge-distance concerns at clips were turned into explicit geometric criteria through calculations and details. Sealant substitutions moved from "non-compliant" to "approved alternate" only after manufacturer letters and adhesion tests were on file. Railing gaps, missing caps, broken glass, and operability failures followed the same pattern: they were logged, assigned a clear corrective path, and only moved to "closed" once there was evidence – photos, re-inspection notes, or formal letters – that the risk had been removed.

By the time the project approached TCO, the balcony edge was not just a set of installed components, but a system whose weaknesses had been systematically found, evaluated, and either engineered or repaired. The log made that journey visible. It tied each micro-defect to a closing report and gave the special inspector enough confidence to sign glazing and railing letters that the building official could rely on. In practical terms, Section 7 is where the raw findings from Section 6 stop being statistics and become a story about how disciplined inspection and documentation turn a high-risk façade zone into a condition that is acceptably safe for people to live behind.

8. Engineer's TCO Letters for Windows and Railings – Closing the Loop

By the time a high-rise façade reaches the Temporary Certificate of Occupancy stage, almost all physical work at the balcony edge is complete. What the city still needs is not more construction, but a formal assurance that the windows, sliding doors, and balcony railings have been inspected properly and are safe for people to live behind. In Florida and similar jurisdictions, this assurance comes as a short, signed letter from a licensed Professional Engineer or special inspector, submitted under the threshold-building inspection plan. That letter is the formal bridge between months of field inspections and the authority having jurisdiction's decision to release TCO for the façade scope [1], [8].

In the case project, the glazing TCO letter covers windows and sliding glass doors over several residential levels. Structurally, it is simple: it is addressed to the building official, identifies the project and the glazing permit numbers, and states that the engineer has been engaged as the special inspector for "glazing windows and doors" on those levels. The body of the letter ties its conclusion to a defined set of field work by referencing a numbered range of inspection reports, for example "Field Inspection Reports 001 through 035 for glazing," covering mullion clips, perimeter anchorage, sealant, and tie-down checks. Based on those reports, the engineer certifies that, in their professional judgment, the installed glazing is in general compliance with the permitted drawings, the approved product approvals, and the applicable building code requirements [1], [7]. The letter is digitally signed and sealed, with license information and contact details, turning what might look like a short memo into a formal engineering certification the city can rely on.

A companion letter addresses the balcony shoe railings. Its structure mirrors the glazing letter but with the guard scope clearly defined, for example "shoe railings, Level 1." It identifies the same project and references the specific permit covering guardrails, then states that the signer is the special inspector for the railing system under the threshold-building inspection plan. The letter again links its conclusions to a discrete set of field inspections, such as "Shoe Railing Reports 001 through 003," covering railing pockets, post grout, geometry checks, and related observations. On that basis, the engineer certifies that the installed railings are in general compliance with the permitted shop drawings, approved NOA details, and the guard requirements described earlier in the paper, and confirms that all deficiencies noted in those reports have been corrected [1], [7]. As with glazing, the signature and seal signal that a licensed professional is taking responsibility for the life-safety behavior of the guard system, not just its appearance.

Behind both letters sits the inspection log described in Section 5. The same report numbers cited in the glazing and railing TCO letters correspond to entries in the Excel log, where each observation has a location, description, and closure path. If an issue remains open in the log, there is no basis for the engineer to sign a clean TCO letter, because the chain from observed defect to corrective action is incomplete. The workflow on the case project was deliberately built the other way around: every missing shim, gap, sealant substitution, broken lite, and operability failure was recorded, resolved in the field or covered by an engineering or manufacturer letter, and then marked closed, so that by the time the façade was visually complete the log and the letters told the same story.

In that sense, the engineer's TCO letters for windows and railings are not side paperwork. They are the visible tip of an inspection and logging system that connects the as-built balcony edge back to the permitted drawings, the product approvals, and the special inspection plan filed at the start of the job. For threshold buildings, authorities often will not issue TCO until these letters are on file for glazing and guards; once they are received, the building official can confidently treat balcony-edge life-safety items as complete, even if minor cosmetic work continues [1], [8]. Practically, this turns the balcony-edge workflow into a closed loop: field inspections feed the log, the closed log empowers the engineer to sign, and the signed letter allows the city to open the building safely to residents.

9. Workflow Lessons

9.1. Treating the balcony edge as one system:

The first lesson from this project is conceptual: the balcony edge must be managed as a single façade system, not as three separate trades. Impact windows, sliding glass doors, laminated-glass railings, and divider walls share the same load paths and water paths at the slab edge. A change in one element (for example, a shim stack at a sill) can easily show up later as a broken railing panel or a leaking door track. The inspection and tracking process only became effective once the project team stopped thinking in terms of "window issues" and "railing issues" and instead treated the entire balcony opening as one critical assembly that must remain safe, dry, and operable for the life of the building.

9.2. From defect list to inspection workflow:

The second lesson is organizational: balcony inspection needs a fixed matrix and a structured log from the very beginning, not a pile of ad-hoc punch lists at the end. On this project, six inspection types were defined and repeated across all balcony levels: mullion / clip anchorage, perimeter anchorage, perimeter sealant, railing pockets and post grout, tie-down and operability, and targeted water-resistance tests. Every consultant report, regardless of level or elevation, was coded against this matrix and entered into a single Excel log.

That log was built as a life-cycle tracker rather than a simple defect list. Each line tied a finding to an inspection date, report ID, elevation, floor, inspection type, concise description, suggested action, re-inspection status, engineering or manufacturer responses, and the closing report and date. In practice, this transformed the process from "we have many issues" into "we know exactly which clips, shims, sealant joints, gaps, and doors are still open, and what must happen next to close them." It is this structure, more than any individual correction, that allowed the team to manage around 180 balcony inspection reports without losing control.

9.3. Focusing early on high-risk and long-lead items:

The inspection data also showed that not all findings carry the same risk. A handful of recurring categories caused most of the serious concern: clip edge distance and wrong fasteners at mullions; excessive or missing shims under sills and shoes; sealant product selection and incomplete perimeter beads; railing geometry at expansion joints and CMU walls; broken balcony glass; and sliding doors that failed the operating-force test. Once these patterns were visible in the log, the project team could treat them as "pressure points" and plan their work around them instead of reacting unit by unit.

Broken glass, in particular, emerged as a long-lead risk rather than a cosmetic annoyance. By the time the building approached TCO, the log recorded dozens of broken railing panels and several broken window lites. Each replacement required custom fabrication, shipping, and customs clearance, with a lead time measured in weeks. The only workable strategy was to begin systematic broken glass tracking six to eight months before the planned TCO date, batch replacement orders, and coordinate installation windows so that no balcony edge carried visible broken glass when the authority inspected the building. The same forward planning applied to missing railing caps and other small items that, if left late, would have kept posts open to water and delayed close-out.

9.4. Turning deviations into documented, safe conditions:

Another clear lesson is that a practical workflow must distinguish between simple defects and acceptable deviations. Many balcony findings were resolved by straightforward field work: swapping non-compliant screws for the specified anchors, resetting shoes with proper shims, completing missing sealant joints, re-grouting pockets, or cleaning and adjusting sliding doors until they passed the pull test. In these cases, the Excel log moved entries from "open" to "corrected on site" once photo evidence or a re-inspection confirmed the fix.

Other conditions could not be solved with a screwdriver. Excessive shim stacks, clip edge distances beyond original details, sealant substitutions, or modified glass dimensions required formal evaluation. Here the workflow relied on signed and sealed engineering details and manufacturer letters. These documents defined new geometric limits, confirmed alternate materials, or justified as-built conditions against project loads. Once such a letter was received and logged, the issue changed status from "defect to fix" to "engineered condition," with a clear paper trail. In this way, the combination of inspection matrix, structured log, and targeted engineering responses converted every deviation into either a physical correction or a documented safe condition, with nothing left in a grey zone.

9.5. From code requirements to TCO: closing the chain:

All of these steps sit in a larger chain that runs from abstract code requirements to a Temporary Certificate of Occupancy. Section 2 of the paper outlines the regulatory framework: Florida Building Code provisions for impact-rated glazing in the HVHZ, guard and railing criteria for height, openings, and loads, and the role of Notices of Acceptance and product approvals [1], [2], [3], [7]. Sections 3 through 7 then translate those rules into balcony-level inspection practice and a data-driven understanding of where real risks appear on a live project.

Section 8 shows how, at the end of construction, the same inspection reports and Excel log become the backbone of the engineer's glazing and railing letters that the authority requires before issuing TCO [1], [8]. Those letters do not stand alone; they are only possible because every balcony-edge issue in the log has a recorded closure path, whether by rework or by engineered disposition. In effect, the workflow connects code → product approvals → inspection protocol → structured log → PE letter → TCO in a single, traceable line.

10. Conclusion

This case study demonstrates that balcony façade performance in a coastal high-rise is not only a matter of product choice or individual installer skill. It is largely a function of how systematically the project team inspects, records, and closes hundreds of small decisions at the balcony edge. By treating windows, sliding doors, railings, and dividers as one system; using a fixed inspection matrix and a structured log from early stages; focusing early on high-risk categories such as clips, shims, sealant, railing gaps, broken glass and operability; and using engineering and manufacturer letters to turn deviations into documented conditions, the project converted a long list of potential defects into a repeatable QA/QC workflow.

The broader lesson is that detailed inspection data is not just a record of problems. When organized correctly, it becomes a practical template that other coastal projects can adapt to manage balcony façades: a way to see patterns early, act on them in time, support honest engineering certification, and hand over balcony edges that are safe, dry, and usable on day one and resilient through many storm seasons.

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