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CANADA

SOUND ISOLATION IN MASS TIMBER

How to Avoid Load Path Oversights
Keys to Firestopping Specifications
A Guide to Commercial Roof Sealants



The official magazine of Construction Specifications Canada

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Sound Isolation in Mass Timber Construction

From Systems to Details

By Sarah Mackel,
B.A.Sc., P.Eng., and
Kiyoshi Kuroiwa,
B.A.Sc., P.Eng.

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KASIAN ARCHITECTURE

The first article in this series explored the acoustical challenges associated with mass timber construction as building codes continue to enable more ambitious timber buildings across Canada.

This article builds on that, discussing the construction details and processes that can determine whether a mass timber building meets its sound isolation targets, and why each one has an outsized effect on building performance and the user experience.

The question facing project teams is no longer whether mass timber buildings can achieve good acoustic performance. Several projects across North America have demonstrated this. But that success is not universal. The next challenge is understanding how that success is achieved and replicating the process across all projects. Whether a residential tower, office building, or institutional facility, sound isolation remains one of the most important factors in occupant comfort.

Flanking transmission in mass timber construction is a familiar concept, but consistent detailing and execution to address it still lag. This occurs when sound bypasses a wall or floor assembly by moving through the structure around it: a continuous cross-laminated timber (CLT) panel, a shared beam, or a floor topping that runs unbroken underneath a demising wall. While the case studies in this article are based on CLT structures, the considerations and detailing requirements also extend to other types of mass timber.

Stopping flanking transmission depends on decisions made at every stage of a project, from early design through construction.

- Co-ordination between structural, architectural, and acoustical decisions needs to be foundational. Working together early identifies risks and opportunities that no single discipline would catch on its own. It aligns fundamental design decisions that affect every consultant

on the project, including structural spans, CLT thicknesses, beam layouts, wall locations, floor build-ups, and facade interfaces.

- Construction detailing is critical to sound isolation performance. Decisions that may look minor on a drawing set can make or break sound transmission, such as where a topping breaks, how a beam penetration is sealed, or the sequence in which a slab-to-slab partition is installed.

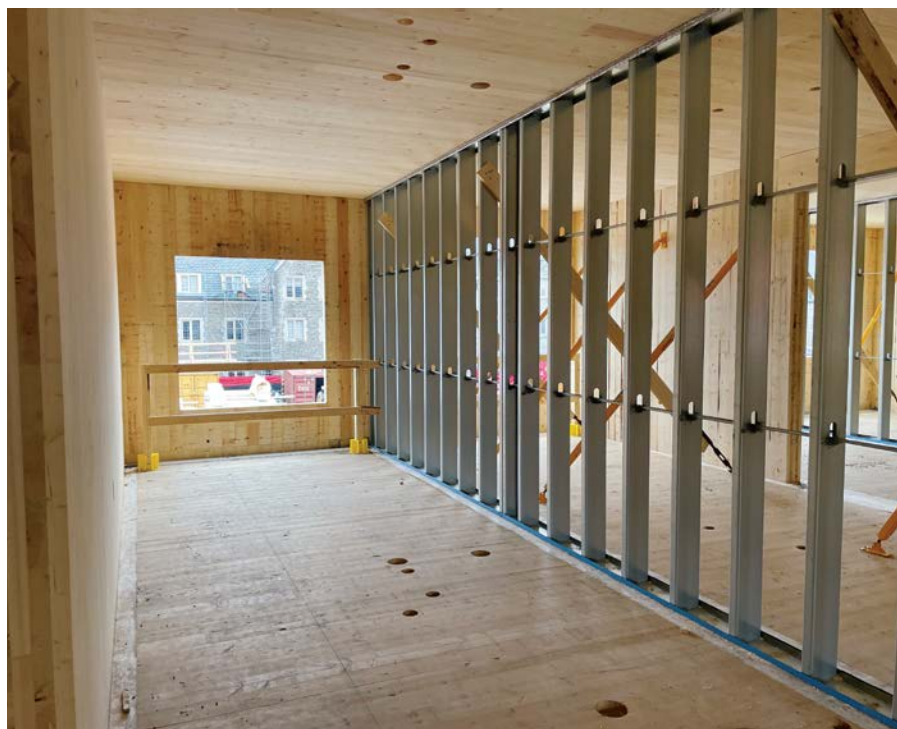
Without early and consistent co-ordination, correcting a flanking path becomes a change order or remediation rather than a design decision, and this is often both costlier and less effective.

Mass timber is not concrete

One of the most persistent misconceptions in the industry is that mass timber behaves acoustically like concrete. Both materials can achieve long, clear spans, serve as the finished ceiling, and meet practical demands across a wide range of building types. But acoustically, they behave in different ways.

Concrete's mass naturally limits airborne sound transmission and helps dampen vibration. Designers accustomed to concrete construction often assume that replacing a concrete slab with a CLT panel is primarily a structural substitution.

Mass timber assemblies have substantially lower mass than concrete assemblies of the same thickness. Based on typical material densities, mass timber averages approximately 500 to 600 kg/m³ (31 to 37 lb/ft³), compared with approximately 2,000 to 2,300 kg/m³ (125 to 144 lb/ft³) for normal-weight concrete. As a result, mass timber may have roughly one-quarter of the mass of a comparable concrete assembly, although the exact difference depends on the specific materials and assembly layers. The lower mass of the material reduces resistance to sound transmission compared to a concrete structure. Controlling flanking transmission also becomes correspondingly important. The strategies developed for traditional lightweight wood-frame construction, including separation of elements, structural discontinuities, resilient layers, and careful junction detailing (all of which are often unnecessary in concrete structures), remain directly relevant to mass timber buildings.



Understanding sound transmission in mass timber buildings

Sound Transmission Class (STC) is the standard laboratory rating for how well a wall or floor assembly blocks airborne sound, tested in isolation from the rest of the building. It captures direct transmission through that assembly alone, not the sound that travels through the surrounding structure, while building occupants experience the combined effect of both paths.

Flanking occurs when sound bypasses the primary separating assembly and travels through adjoining structural elements. In mass timber buildings, common flanking paths include:

- Continuous timber floor panels
- Continuous concrete or lightweight floor toppings
- Structural beams and columns
- Exterior wall interfaces
- Partition junctions

A high-performing demising wall can achieve excellent laboratory test ratings and still suffer significant field performance losses if the surrounding assemblies are not equally well designed and constructed. Because flanking losses in mass timber are predictable, that risk can be addressed from the outset. While this often starts with specifying higher-performing assemblies for the demising wall or floor rather than selecting partitions with a lab rating that

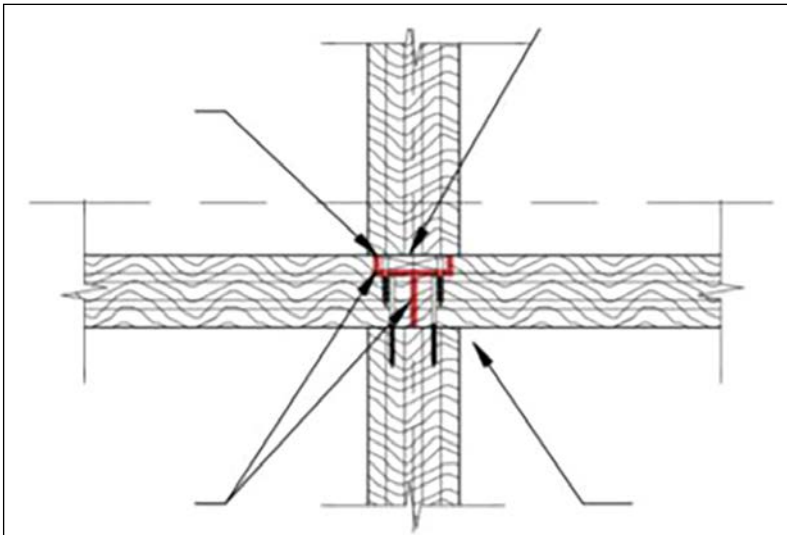
Continuous cross-laminated timber (CLT) panels and steel stud walls separating residence units.

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Vertical junction gap between continuous cross-laminated timber (CLT) panels.

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Detail of the acoustic separation at continuous cross-laminated timber (CLT) panels.

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clears the code minimum, the most important design consideration remains the interfaces between the assemblies.

The details that matter

These details consistently determine whether a project meets its sound isolation targets:

- **Discontinuous toppings**—Continuous floor toppings, whether concrete or lightweight “dry-applied” layers, can create efficient paths for vibration and sound transmission below the demising walls. Providing a physical separation in the topping below the wall helps interrupt these paths and improves overall sound isolation.
- **Slab-to-slab demising walls**—Walls that extend from the floor to the underside of the structure

help limit sound transmission around the perimeter of the wall assembly. A wall that stops at a suspended ceiling or a dropped soffit leaves a gap above it that can carry sound over the wall, no matter how well the wall itself performs.

- **Acoustic sealants**—Even small gaps can compromise acoustic performance. Flexible acoustic sealants are often required at floor, ceiling, beam, wall, and facade interfaces. Unlike in gypsum board partitions, where sealant can be painted to match the wall, it is difficult to hide a sealant joint between wood elements.
- **Structural transitions**—Beam and column intersections frequently require special attention to prevent sound from bypassing the primary acoustic separation. One way to improve this is to offset a partition from the beam line rather than seal a continuous wood-to-wood joint. A single continuous beam running through a demising wall can carry sound between suites regardless of how the wall around it is detailed, since the beam itself becomes the flanking path.
- **Mechanical and plumbing penetrations**—Poorly detailed penetrations remain one of the most common causes of acoustic complaints in completed buildings of all types. But in mass timber construction, these penetrations are often pre-cut in factory-produced panels. They may be oversized depending on the construction tolerances and the level of detail in the design contract documents. An oversized opening becomes harder to seal, and a poorly sealed gap can compromise the isolation performance of the entire wall or floor surrounding it, regardless of how well the rest of the assembly was built.

Case study: Basswood Senior Residences

The Basswood Senior Residences project in Brampton, Ont., demonstrates an important lesson for the mass timber market: when structure doubles as finish, the structural decisions are the acoustic decisions. There is no outer layer, suspended ceiling, or furred-out wall to correct a flanking path once the building structure is completed.

Designed by Kasian Architecture, Basswood is part of Peel Region’s Seniors Health and Wellness Village and will provide affordable housing for 198 seniors. It is Brampton’s first mass timber building, a hybrid structure with one concrete



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Isolation pad in between and on top of continuous cross-laminated timber (CLT) panels.
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Wood cover over isolation pad.
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storey and eight residential storeys constructed of timber, designed to meet net-zero emissions and zero-carbon building targets. Much of that timber structure is left exposed, which shaped the acoustic detailing decisions for the project.

Whereas STC is measured on an assembly alone in a lab, Apparent Sound Transmission Class (ASTC) is measured with the flanking paths included. It reflects what occupants actually hear in the finished building. As a residential building, Basswood was required to satisfy the *Ontario Building Code's* (OBC) ASTC 47 requirement between suites at a minimum.¹ The building design also fell under the Peel Region Affordable Housing Design Guidelines, which recognize that

improved sound isolation between apartments creates higher-quality housing. The decision was ultimately made to pursue the best improvement over the minimum ASTC that could be practically achieved, while prioritizing exposed timber ceilings and staying within a zero-carbon, net-zero design.

Understanding the challenge

The design team recognized early that achieving an ASTC rating above the code minimum would depend on more than floor assembly selection. It would hinge on controlling the flanking paths that could bypass an otherwise effective floor or wall assembly. That understanding shaped decisions from floor design through wall detailing and structural co-ordination.

Designing for ASTC performance

The floor assembly combined a 197-mm (7.8-in.) CLT panel with an acoustic rubber mat used as an isolation layer and a concrete topping. Meeting the ASTC rating in the finished building meant treating the floor interfaces with equal care. The concrete topping was interrupted by the stud track at demising walls, maintaining a full-depth acoustic break rather than pouring the topping through as a continuous slab. The project also incorporated slab-to-slab demising walls, acoustic sealants at structural connections and facade junctions, and detailing at floor-to-wall interfaces built specifically to prevent the topping and structure from bridging between suites.

The 5-ply versus 7-ply discussion

Basswood is one example of collaboration that uncovered a more cost-effective way to build. Panel thickness often seems like a straightforward cost decision, with conventional wisdom suggesting that a thinner panel is the most economical option. Thicker mass timber panels are often viewed as premium products and can be dismissed early in design based on material cost alone.

But a broader evaluation told a different story. Through collaboration among the construction manager, timber supplier, designers, and acoustic engineers, the project team examined the implications of panel selection that extend beyond pricing.

The analysis found that a 7-ply, 197-mm (7.8-in.) CLT panel not only provided a better acoustic

rating but also offered meaningful benefits for installation logistics and construction sequencing, as it would allow for a larger panel size to be used. Fewer crane lifts were required during erection, construction processes were simplified, and overall efficiency improved.

Once those savings were included, the project found that the cost premium for the thicker panel largely disappeared. The panel selected for its acoustic advantage was also the one that could be used more efficiently.

Solving flanking paths without compromising exposed-timber architecture

Where glulam beams formed the top of suite demising walls, sealing every wood-to-wood joint between the beam and the CLT panel would have meant a visible bead of sealant running across an otherwise exposed structure. Instead, the design team offset the partition from the beam line, keeping the acoustic barrier largely intact while preserving the exposed timber in one suite. The offset increased the STC rating of the beam assembly itself, reduced the flanking path, and removed the need for prominent sealant at a highly visible junction.

For a project team balancing exposed timber against acoustic requirements, the offset satisfied both the acoustic requirement and the architectural goal.

Lessons learned

Basswood's design approach stemmed from the co-ordination of structural design, acoustic detailing, constructability planning, and early collaboration among the project team, rather than from any single product or assembly. On two occasions, an acoustic requirement was resolved by the same decision that served a separate project priority rather than competing with it: panel thickness served both performance and construction efficiency, and the beam offset served both flanking control and architectural expression.

Case study: Trinity College Lawson Centre for Sustainability

Trinity College's Lawson Centre for Sustainability, a 14,450-m² (155,539-sf) mass timber building at the University of Toronto designed by Mecanoo and RDHA, combines academic space with a 262-unit, 342-bed student residence and was designed to achieve LEED Platinum and Canada Green Building Council (CaGBC) Zero Carbon certification. Where Basswood's acoustic challenge centred on floor and demising wall assemblies, Trinity's centred on the building envelope: a facade system of large CLT panels spanning multiple storeys.

Understanding the challenge

Trinity's CLT facade panels were large enough to run across several floors at once, making the facade itself a flanking path.

Sound entering a panel on one floor could travel and surface again a storey or two away, in a different room entirely.

The building's two program types raised different challenges. In academic spaces, the facade needed to support high-STC wall performance directly. In the residence tower, the same panels ran continuously behind dozens of individual suites, and treating every panel-suite intersection with the same level of detail as a classroom wall would have added complexity the project could not absorb.

Designing the solution

In academic areas, the project team worked with the manufacturer to align facade panel joints with the high-STC walls required for classrooms and lecture spaces, so that panel breaks and wall separations occurred at the same points, preventing sound from flanking around the walls.

The residence tower called for a different approach. Rather than detailing a joint in the facade panel at every suite individually, facade panels ran continuously behind several storeys of suites, with the panel encapsulated with drywall within most units to control sound flanking. In the building's lounges and common areas, where the acoustic demands were lower, the timber could remain exposed.

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Continuous cross-laminated timber (CLT) structure with corridor cutout for services, and covered floor junctions.

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To further control sound movement, isolation strips and resilient pads were installed between panels and at floor-to-floor connections, reducing sound transfer between rooms and floors. In residence rooms and classrooms, the project team explored a thin nanoCLT finish paired with a single layer of drywall on one side of the CLT wall. NanoCLT is a non-structural CLT panel that uses very thin laminated wood layers to provide the same visual effect as standard CLT. While the nanoCLT finish was ultimately not included in the design, it was a considered approach to improving sound isolation while keeping CLT visible on both sides.

Conclusion: The systems behind sound isolation

The mass timber industry has largely proven that high levels of sound isolation are achievable.

Projects such as Basswood Senior Residences and Trinity College Lawson Centre for Sustainability demonstrate that successful sound isolation depends on understanding how sound travels through a building, identifying potential flanking paths, co-ordinating structural, architectural, and acoustical decisions from the earliest stages of design, and carrying those decisions through into the construction details.

The industry's task is to apply that same co-ordination consistently. This extends well beyond residential construction. Mass timber is being



Exterior view of Basswood Senior Residences in Brampton, Ont., under construction.

PHOTO COURTESY AERCOUSTICS ENGINEERING LIMITED

piloted and increasingly specified for hospitals, academic buildings, and other complex, mixed-use programs. These building types will meet the same co-ordination challenges and others. 📌

Note

¹ Ontario Regulation 332/12, *Building Code*, section 5.8.1.1.



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Load Path Oversights

A Leading Cause of Residential Structural Issues

By Reza Parsiavash,
Ph.D., P.Eng.

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In houses and other small-scale residential construction, performance problems are rarely caused by a single member being “too weak.” More often, the root cause is an interrupted or misunderstood load path, especially at transitions between framing elements, connections, and foundations.

These discontinuities can be small, but the consequences can be large: excessive deflection, floor vibration, drywall cracking, doors that bind, and, in some cases, localized structural distress that is expensive to correct once finishes are installed.

Although wood framing is the primary focus, the load-path principles discussed also apply where steel beams and posts, concrete foundations, or masonry elements form part of the residential structural system.

In Canada, the issue is amplified by the realities of housing stock and climate.

Renovations are common, basements and walkout conditions create frequent vertical discontinuities, and seasonal effects, such as frost and moisture cycling, can magnify serviceability problems over time. This article explains common residential load path oversights and outlines practical measures to reduce risk, with references to Canadian codes and standards where appropriate.

Load paths are often implied, not explicitly traced

A load path describes how forces move through a structure, from where loads are applied to where the supporting soil resists them. In engineered design, this is typically verified through analysis and detailing. However, in residential work, load paths are often assumed. Drawings show beams, posts, and walls, but the continuity of force transfer among them is not always verified when architectural layouts evolve, construction



removed. Walls that appear non-structural for gravity may function as internal shear walls or braced wall panels required by the *NBCC* or provincial building codes, such as the *OBC*. Installing a beam may resolve gravity demands, but it does not replace the lateral resistance provided by these elements.

Temporary diagonal bracing installed to stabilize framing during interior structural modifications while permanent load paths are interrupted.

PHOTO COURTESY SEPSCO CONSULTING ENGINEERS

tolerances accumulate, or renovation scopes change midstream.

Canadian building codes focus on safety and minimum performance, and the *National Building Code of Canada (NBCC)*, adopted with provincial modifications such as the *Ontario Building Code (OBC)*, relies on a combination of prescriptive provisions commonly used for many housing elements and engineered design where conditions fall outside those prescriptive limits. Regardless of the route, the structure still needs an intentional, continuous load path.

Load path oversights tend to fall into three categories: vertical load discontinuities, lateral load discontinuities, and connection and bearing assumptions. Many residential symptoms that appear “mysterious” are explained by one of these categories.

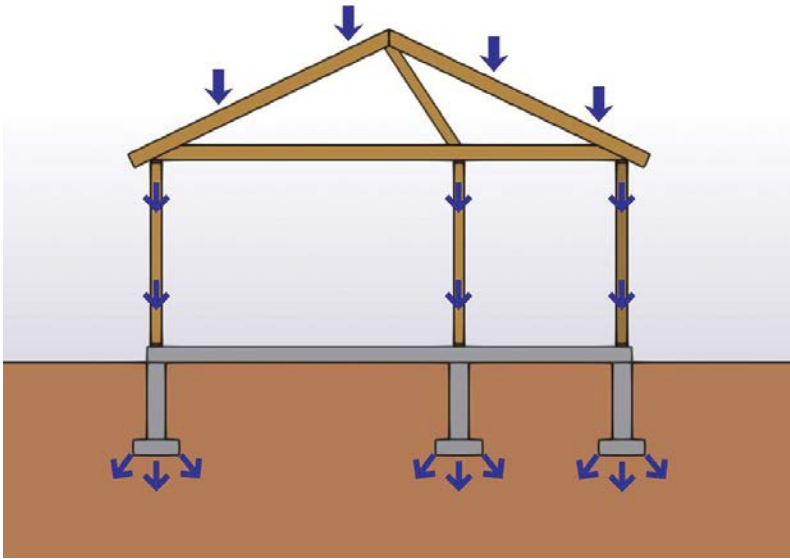
In renovation work, lateral load paths are frequently overlooked when interior walls are

Vertical load discontinuities across floors

Misalignment of vertical load-resisting elements is one of the most frequent issues observed in houses and small buildings. The load is present, and the members are often conservatively sized, but the force does not have a clear path through successive storeys.

Common situations include:

- Concentrated loads that do not align with supporting framing below, for example, a post supporting a new beam that does not align with a joist, beam, bearing wall, or other designed support below.
- Stud packs or posts terminating on headers that were not designed as transfer members, especially at open-concept layouts where existing openings are widened.
- New point loads introduced during renovations, such as a relocated column or an added steel beam, without reassessing the lower levels and existing foundations.



Simplified vertical load path in a typical residential structure, illustrating the transfer of gravity loads from roof framing through walls and into foundations.

ILLUSTRATION COURTESY
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In these cases, the floor system becomes an unintended transfer structure. It can work in the short term due to redundancy and stiffness distribution, but often, there are serviceability issues. Even when strength is adequate, the stiffness and load sharing may not be.

Transfer through floor framing

Residential floors can redistribute load through joists, blocking, subfloor diaphragms, and adjacent bearing walls. This is often cited informally as evidence that a misalignment “doesn’t matter.” The problem is that the redistribution path is rarely quantified or detailed. Unintended transfer can introduce:

- Local crushing at bearing points (wood perpendicular-to-grain, concrete edge bearing, or masonry pockets).
- Excess rotation at supports, increasing deflection and crack risk.
- Load concentrations in a small fastener group. For example, joist hangers or ledger connections that were not selected for a concentrated reaction.

When a transfer is required, it should be explicit. This may include a designed header, a beam under a bearing wall, a stud pack sized for concentrated reaction, or a transfer element designed in accordance with relevant Canadian standards, such as CSA O86, *Engineering Design in Wood*, CSA S16, *Design of Steel Structures*, and CSA A23.3, *Design of Concrete Structures*.

Connections govern load transfer

Connections are where load paths become real. A beam can be sized correctly on paper, but if the reaction cannot be transferred through bearing, fasteners, and supporting elements, the system performance suffers. In residential work, connections are sometimes treated as secondary details, especially when construction is fast-paced, and trades rely on habits or generic hardware.

Common connection and bearing oversights seen on site include:

- Relying on bearing alone without positive mechanical attachment, where uplift or lateral movement is possible, such as at roof-to-wall interfaces.
- Underestimating eccentricity at beam supports. For example, when a beam bears on a narrow post cap that shifts the reaction off-centre, it increases rotation and localized crushing.
- Assuming fastener groups share load evenly. In reality, screw, bolt, and nail groups distribute load based on stiffness, edge distances, and installation quality, and the weakest “fasteners” can demand more attention than expected.

Renovation details that frequently break the load path

Renovations are a high-risk context for load path discontinuities because the original structure was not designed with the new load distribution in mind. Several repeat scenarios appear in forensic investigations and site reviews:

- Partial wall removals where short wall segments remain as “posts,” but there is no continuous stud pack down to a suitable bearing point.
- In many Canadian renovations, the post itself has adequate compressive capacity, but crushing of the top or bottom wall plates perpendicular to the grain governs because the effective bearing area was not verified.
- Large openings created in load-bearing walls where new beam reactions land on the floor framing instead of a designed post-to-foundation line.
- New stair openings that cut joists and remove bridging, reducing floor stiffness and changing the load path for adjacent bearing lines.
- Additions or dormers that impose new roof loads on existing walls and foundations, sometimes in older homes with irregular framing layouts.



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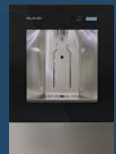
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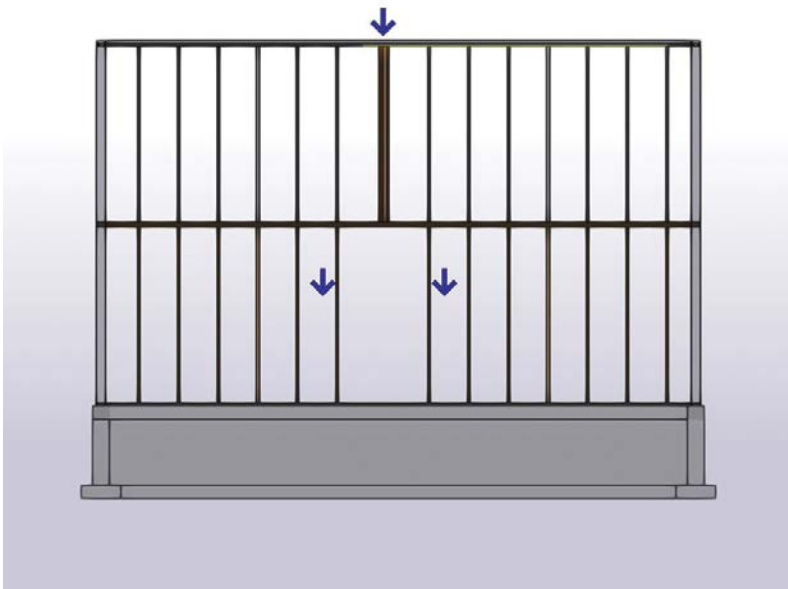


Finish Plumbing



Water Dispensers





Concentrated beam reaction bearing on a wall top plate between studs, resulting in unintended bending of the plate and redistribution of loads into adjacent studs.

ILLUSTRATION COURTESY SEP CO
CONSULTING ENGINEERS

These examples all show why field verification matters. Older homes may include balloon framing, non-standard joist spacing, notched members, or previous unpermitted alterations. A simple site opening can reveal whether a presumed stud pack is continuous, whether a beam pocket has adequate bearing length, or whether a supporting wall is aligned with foundation support below.

Completing the load path to the foundation

A complete load path does not stop at framing. Forces must continue through the foundation system and into the supporting soil. Many residential problems originate at or below grade. In Canada, the effects of frost and moisture can worsen small design or construction errors over time. Frequent foundation-level oversights include:

- Concentrated loads introduced onto slabs-on-grade that were intended as non-structural floors. A slab can support localized loads in some cases, but this should be engineered, with attention to thickness, reinforcement, subbase support, and settlement risk; where a full footing is not provided, a locally thickened slab is typically the standard engineered solution.
- Footings sized for uniform wall loads having to support a new point load from a post introduced during a renovation.
- Assuming existing foundations can accept increased load without checking bearing capacity, differential settlement, and the effect on adjacent elements, such as brittle masonry veneer.

Canadian site conditions to explicitly consider

Several site realities commonly influence residential load path performance in Canada.

They include:

- Frost action and seasonal moisture cycling, which can affect shallow exterior footings, porch slabs, garage slabs, and unsupported exterior steps.
- Expansive or sensitive clays in parts of southern Ontario and other regions, which can contribute to heave or settlement, especially when drainage patterns change during renovations.
- High snow loads in many areas of Canada, which increase roof reactions. Unbalanced snow loading from drifting on modified rooflines, such as dormers or stepped additions, can also introduce increased and non-uniform loading that the original load path was not designed to accommodate.
- High wind exposure in coastal and other wind-prone regions, which can increase uplift and lateral demands on roof-to-wall and wall-to-foundation connections and make continuity of the lateral load path particularly important.
- Seismic demands in regions of higher seismicity, particularly parts of British Columbia, eastern Ontario, and southern Quebec, where continuity of lateral load paths, diaphragm connections, and anchorage to foundations requires particular attention.
- Basements and walkouts, which create frequent transitions in foundation height and can introduce discontinuities in shear walls and bearing lines.

The practical implication is that load path checks should be coupled with water management checks. Downspouts, grading, foundation drains, and roof drainage are not simply architectural elements. They influence soil support and, ultimately, the final link in the load path.

Behavioural checks beyond span tables

Span tables and prescriptive rules are useful tools, but they do not replace an understanding of structural behaviour. Many load path errors become obvious when the designer asks a few behavioural questions early in the process:

- Where do the reactions go, and what element receives them?

- Is the supporting element stiff enough relative to what it supports, or will differential stiffness cause localized cracking and movement?
- Do connections and bearing details match the assumed behaviour (pinned, fixed, uplift restraint, and/or lateral restraint)?
- If an element is removed or modified, what is the alternate path, and is it intentional?

For example, a new steel beam replacing a wall can solve a gravity problem, but create serviceability and detailing issues if the end reactions are not aligned with bearing points below. Similarly, a beam pocket cut into a masonry wall may provide bearing, but it can compromise the wall locally if the pocket removes too much material or introduces a moisture pathway.

Practical measures to reduce load path errors

Many residential load path issues can be avoided by applying a consistent, repeatable approach. The following measures are practical for consultants, designers, and builders.

Trace loads deliberately from the roof to the foundation

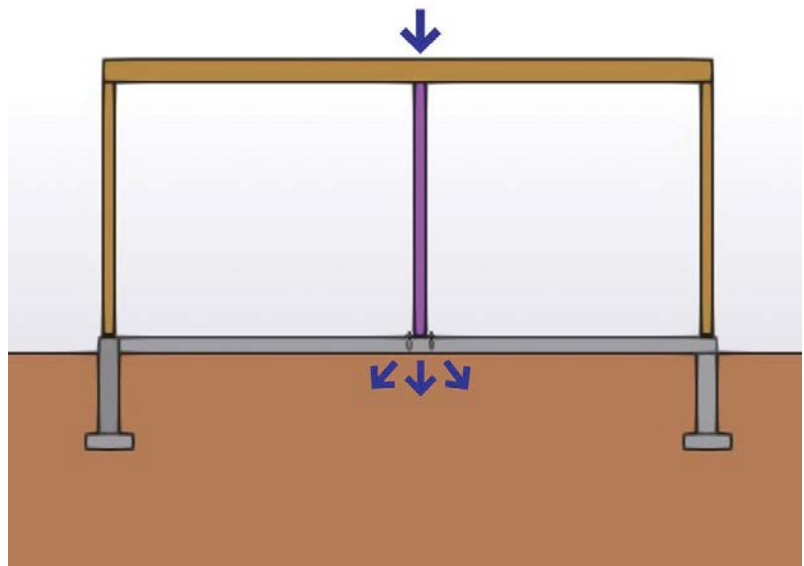
At the concept stage, sketch the gravity load path with the same discipline used for lateral systems. Identify where major reactions occur and confirm there is a continuous line of support to the foundation. Where transfer is needed, design it explicitly rather than relying on “distribution.”

Verify alignment across floors and document transfer elements

Where posts or stud packs do not align, note the transfer method on drawings. Provide details for headers, beams, blocking, and joist reinforcement where concentrated loads are introduced. If a bearing wall is intended to take a load, confirm it is continuous, not interrupted by openings or non-structural partitions.

Treat connections as primary structural components

Select and detail connectors based on realistic demand, including uplift, eccentricity, and lateral restraint where applicable. For example, provide clear installation notes, specifying fastener type, quantity, and minimum edge distances. Consider construction tolerance: a connection that only



works at “perfect” alignment may not perform in the field. Where helpful, manufacturer installation guides for common connectors and fasteners may be referenced for installation practices, but they do not replace engineering design.

Confirm field conditions before relying on existing framing

For renovations, verify as-built framing and supports. Where access is limited, plan selective openings. Confirm member sizes, spacing, bearing conditions, and any signs of prior distress. This step often prevents incorrect assumptions that lead to redesign or costly change orders.

Use serviceability as a diagnostic tool

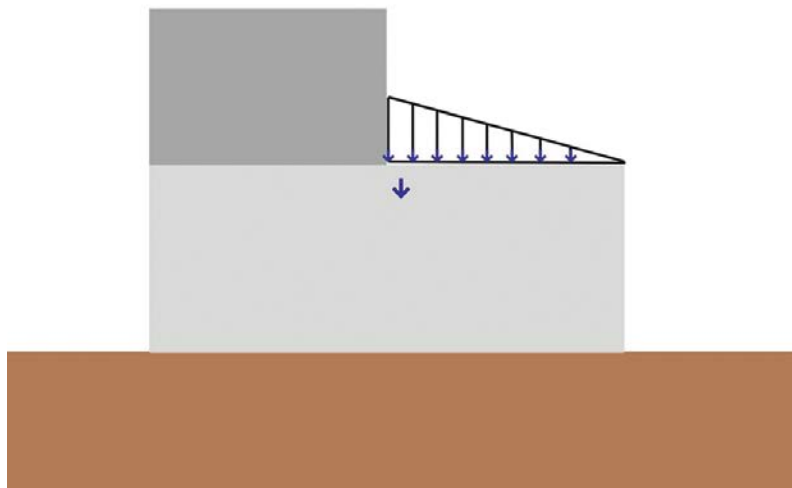
In many residential cases, early indicators are serviceability-related, such as deflection, vibration, and finish cracking. These symptoms can indicate load-path discontinuities, unintended transfer, or connection slip. Addressing the load path early can reduce rework, protect finishes, and improve long-term performance, thereby supporting sustainability objectives by reducing material waste and the need for repeat construction activities.

Illustrative detailing examples

The following examples are common in residential work and illustrate how small detailing choices affect load path continuity. They are presented generically, and the final design should reflect project-specific loads, materials, and applicable code requirements.

Introduction of a concentrated vertical load through a new post bearing on an existing slab-on-grade or foundation element, altering the original distributed load path.

ILLUSTRATION COURTESY SEPSCO CONSULTING ENGINEERS



Partial second-floor addition causing unbalanced snow accumulation on an adjacent lower roof, introducing localized gravity loads not considered in the original design.

ILLUSTRATION COURTESY
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Beam reaction onto a post, bearing, and eccentricity

A built-up wood or steel beam often bears on posts at its ends. If the post cap or bearing plate does not align with the beam centreline, the reaction is eccentric, increasing rotation and local crushing. Practical mitigation includes:

- Use of a centred bearing plate sized to distribute stress within allowable limits.
- Provision of mechanical attachment where uplift can occur, such as wind-governing roof edges.
- Ensuring the post is continuous to a footing designed for the concentrated load.

Point loads on floor systems when a transfer member is needed

When a point load lands between joists, the floor system must transfer the concentrated load to the supporting system. Where this cannot be avoided, typical solutions include double joists, engineered blocking, a short flush or dropped beam to collect load, or aligning the point load to a supporting wall or beam below. The key is to detail the load collection and clearly identify the transfer member on drawings.

New openings, headers, and the 'short post' problem

Enlarged openings commonly create short wall segments that are treated as posts. If these segments lack a continuous load path to the foundation bearing, the load can be transferred into the floor structure. Designers should verify:

- Adequate header sizing for combined gravity and lateral effects, where applicable.
- Continuous studs or stud packs to a supporting element below.

- Adequate bearing length and crushing checks, particularly for wood perpendicular to the grain.

Conclusion

Residential structures are often forgiving, but they still rely on continuous, intentional load paths. Small oversights rarely cause immediate failure, but they commonly lead to serviceability issues, long-term performance concerns, and expensive corrective work after finishes are installed.

A practical load-path mindset, tracing forces from roof to soil, detailing transfers where alignment is not possible, and treating connections as core structural components can significantly improve performance without increasing material quantities. In a market where renovations and upgrades are constant, these measures help protect owners, reduce rework, and support more durable, sustainable housing outcomes. 🏡

References and suggested Canadian sources

- *National Building Code of Canada (NBCC)*, current adopted edition in the project jurisdiction.
- *Ontario Building Code (OBC)* or the applicable provincial or territorial building code for the project location.
- CSA O86, *Engineering Design in Wood*
- CSA S16, *Design of Steel Structures*
- CSA A23.3, *Design of Concrete Structures*
- CSA A370 series, *Connectors for Masonry* (where bearing on masonry or anchorage is relevant).
- Manufacturer installation guides for generic connectors and fasteners (used as installation references, not as proprietary design justification).



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The Hidden Cost of Poor Firestop Specifications

By John Valiulis

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Firestop systems play a critical role in passive fire protection, preventing the spread of fire, smoke, and toxic gases through required penetrations and joints in fire separations. Despite that importance, they remain misunderstood by many engineers, architects, and specification writers. As a result, firestop specifications frequently fail to provide the direction and details necessary to achieve consistent, effective, and code-compliant installations.

Poor firestop specifications can affect almost every aspect of a project, including:

- Construction costs
- Project schedules
- Inspection outcomes
- Building code compliance
- Long-term building maintenance
- Fire and life safety performance

This is an overview of specification improvements that can affect one or more of the variables mentioned above. The focus will be on those improvements that will prevent the most common problems.

Before learning to run together, it is important to be sure that everyone can walk. Here is some general advice to help improve firestop specifications.

Firestopping is a system, not a product

One common shortcoming in Canadian specifications is language requiring the use of a “firestop sealant” or “approved firestop product” without emphasizing the need for tested and listed firestop systems. This distinction is critical. The *National Building Code of Canada (NBCC)* does not require firestop products. The *NBCC* definition of firestop is “a system” (Section 1.4.1.2). The code requires penetrations and joints in fire separations to be protected in a manner that fully maintains the assembly’s required fire-resistance rating and does not create any weak point for the spread of fire or smoke. Firestop products achieve that performance only when installed as part of a tested and listed system.

The *NBCC* sections covering each type of penetration or joint firestop mandate that each installed system must have been “subjected to the fire test method in CAN/ULC-S115...” (Section



narrow set of conditions. Each system limits its applicability to a unique combination of:

- The exact type of wall or floor assembly
- Fire-resistance rating
- Penetrant materials
- Penetrant diameters
- Insulation types and thicknesses
- Opening dimensions
- Joint size
- Specific firestop products

All of this makes it clear that every single variable matters.

Changing one variable often requires selecting an entirely different system. Therefore, selecting a few listed firestop systems that might be “typical” for purposes of a specification is unlikely to provide the actual systems to be installed that will comply with the *NBCC* requirement for each firestop to be installed as tested.

To improve system selection, specifiers should use manufacturer system-selection tools (web or smartphone apps), engage manufacturer technical representatives on larger projects, or require a qualified firestop specialty contractor for penetration and joint firestopping.

Because firestop listings are highly application-specific, copying firestop specifications from previous projects results in systems that do not match actual field conditions, leading to non-compliant installations, rework, delays, and added costs.

The future of firestop specifications should focus on providing a list of selected, tested systems that should meet the known, specific needs of each project. Merely identifying acceptable products serves no purpose.

3.1.9.1). In the case of the curtain wall perimeter gap, firestopping must be “subjected to the fire test method in ASTM E2307...” (Section 3.1.8.3.[4]). Canadian fire test listings in accordance with these standards are primarily maintained by Standards Council of Canada (SCC)-accredited organizations, UL Solutions and Intertek.

Would an improved specification solve the problem by including a selection of systems that might have been used on a previous project? Unfortunately, no.

A search of the UL Solutions “Product iQ” online listing directory (UL.com/PIQ) reveals that the following number of firestop systems are certified for Canada: (UL designation for each category is in parentheses)

- Through penetrations = 5,915 systems (XHEZ7)
- Joints = 2,005 systems (XHBN7)
- Perimeter fire containment systems (curtain wall firestopping) = 244 systems (XHDG); Intertek has an approximately equivalent or greater number of systems as well.

The reason there are thousands of systems is that each one is typically tested and listed for a very

Why “or equal” can be problematic

Generic “or equal” clauses are common throughout construction specifications. Firestopping is different. Firestop performance depends on tested system configurations, as strictly required by the *NBCC*. Substituting individual products without verifying that the replacement products have been tested for each required application could leave the job without any path to code compliance, except perhaps through the lengthy and uncertain process of seeking approval of firestop technical evaluations (TEs) (historically referred to as “engineering judgments”). Specifications should

FIGURE 1



Intumescent action closes off a combustible pipe exposed to fire (photo from CAN/ULC-S115 fire test).

FIGURE 2



Example of “tuck-in” intumescent wrap strip firestopping.

therefore require that substitutions demonstrate equivalency at the system level, not simply at the product level. Seemingly similar products do not necessarily create equivalent firestop systems. This distinction is especially important when substitutions occur after permit approval, during procurement, or in response to supply chain disruptions.

With the “motherhood and apple pie” advice above out of the way, this article will now focus on a few very common, specific firestopping problems that could readily be prevented and solved with some specific specification inclusions.

Combustible pipe firestopping: where projects go wrong

Poorly planned or completely unplanned combustible pipe firestopping is probably the most common cause of unnecessary costs and delays.

Combustible pipes, especially those over 50 mm (2 in.) in diameter, require a specific type of

firestopping. That type is “intumescent” firestopping, which involves the use of sealants or strips that will expand when exposed to the heat of a fire. That expansion will need to crush and close the melting or burning pipe, thus closing off the pipe and preventing the spread of fire across the fire separation. See Figure 1 for an example of intumescent action that seals a pipe.

Allowing that intumescent expansion to do its job requires each firestop system to be installed very precisely.

The firestopping options for combustible pipes are as follows:

- Intumescent sealant (caulk) within the annular space of the penetration
- Intumescent “tuck strips” which are tucked into the annular space between the pipe and the opening in the fire separation
- Metal collar fastened to the assembly containing the intumescent strips.

The images below illustrate the tuck strip (wrap strip) and collar options.

Hole size control

This very common problem that prevents combustible pipe firestopping from being installed quickly and economically is having a hole size in the substrate that does not match the minimum and maximum hole sizes allowed by the referenced (or any) tested firestop system.

Firestopping a hole whose size and shape do not correspond to the best (or any) tested penetration firestop systems will result in unnecessary time, costs, and aggravation. To prevent that, it would be wise for the specification to add the following hole-size requirements to CSC/CSI MasterFormat Division 22 00 00—Plumbing and Division 23 00 00—HVAC for penetrations of fire separations.

a) Pipes nominal 50 mm (2 in.) and smaller:

- Optimal hole or sleeve diameter: 16 mm (0.625 in.) larger than actual pipe diameter.
- Maximum hole or sleeve diameter: 32 mm (1.25 in.) larger than pipe. This maximum already provides fewer firestop options than a hole that would be the optimal 16 mm (0.625 in.) larger than the pipe.

b) Pipes larger than nominal 50 mm (2 in.), where a “tuck-in” wrap strip firestop solution is desired.

c) The hole sizes should follow this table:

Nominal pipe diameter	Maximum diameter of opening
30 mm (1.2 in.)	76 mm (3 in.)
50 mm (2 in.)	89 mm (3.5 in.)
75 mm (3 in.)	102 mm (4 in.)
75 mm (3 in.) where the tested system requires 2 layers of wrap strip	127 mm (5 in.)
100 mm (4 in.)	152 mm (6 in.)

d) Pipes larger than nominal 50 mm (2 in.), where a firestop collar solution is desired. The hole sizes should be no more than 25 mm (1 in.) larger than the actual pipe diameter.

If the hole size is unfortunately too large, some systems provide a “rescue” option: using a sheet-metal cover plate, minimum 18-gauge, retrofitted and attached over the opening before attaching a firestop collar. See Figure 4 for an example of such a firestop system.

This involves multiple additional time- and material-consuming steps that would not be required if the hole size were properly matched to the pipe diameter. Even this system has limitations on the hole size. If the hole is non-circular or far too large, there might not be any tested system that meets field conditions. In that case, the project will incur the additional time and aggravation of seeking a technical evaluation (TE) from the firestop manufacturer for the non-tested condition, and then navigating the approval process to obtain approval from the authority having jurisdiction (AHJ). In some cases, partial reconstruction of the wall to create an opening with the proper size and shape is a perfectly acceptable solution. Doing so should allow the selection and installation of a tested and listed firestop system. However, oversized or irregular openings are often discovered only after wall construction and piping installation are complete, making reconstruction difficult, disruptive, and costly. For that reason, retrofit-type solutions, where available within the limitations of a tested system, are often the preferred approach.

Pipe spacing requirements

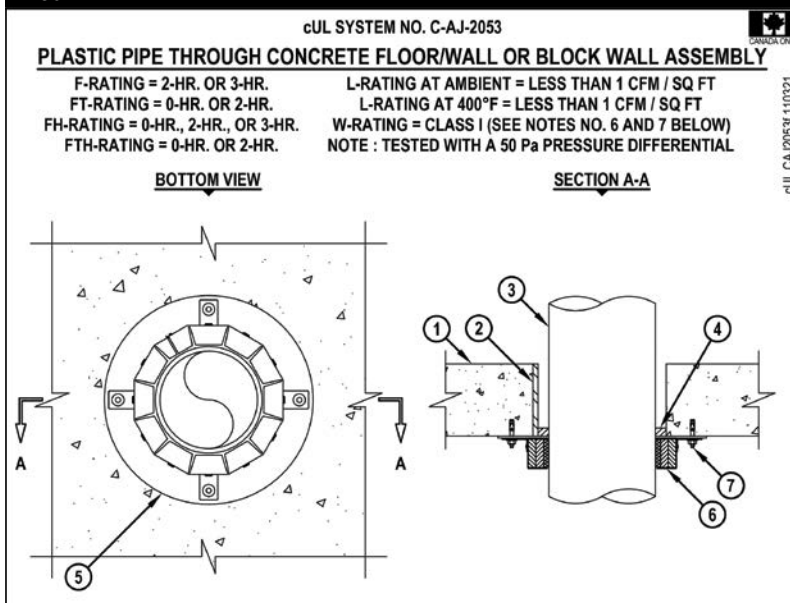
Intumescent solutions that wrap around a combustible pipe to seal it during fire exposure

FIGURE 3



Example of intumescent firestop collar for combustible pipe firestopping.

FIGURE 4



Example of a listed firestop system for a hole that is too large compared to the pipe diameter (cUL system C-AJ-2053).

need some clearance for the intumescent materials to be positioned between adjacent pipes in the same hole.

- Space combustible pipes 50–75 mm (2–3 in.) apart within one large hole containing all of them, or preferably specify that the pipes should be within individual holes separated by this minimum distance.

Angled penetrations

A combustible pipe must enter and exit a fire separation at a 90-degree angle for it to be firestopped. There are no listed firestop solutions in Canada for a combustible pipe exiting a fire separation at an angle.

FIGURE 5



Example of combustible pipe penetration at an angle. No tested firestop systems exist in this situation.

FIGURE 6



Examples of penetrations with available firestop listings (perpendicular, unobstructed) and without available firestop listings (no room for intumescent collar).

Angled pipe penetrations are most commonly the result of plumbers' improvisation. Piping is normally specified, designed, and expected to penetrate any wall or floor at right angles to the surface.

- Provide a specification (e.g. in Division 22 00 00) that all pipe penetrations of fire separations must be at a right angle to the fire separation (wall or floor).

Where the specification clearly requires perpendicular penetrations, an angled combustible-pipe penetration should preferably be corrected by redoing the piping to comply with that requirement. In practice, however, many existing specifications do not expressly address penetration angle. When an angled penetration is discovered under those circumstances, the project team must

determine whether a compliant alternative can be developed and accepted.

Where a pipe penetrates at an angle, the firestop manufacturer will, at best, propose a technical evaluation (TE) that must be submitted to and approved by the authority having jurisdiction (AHJ), which can cause delays. A commonly proposed TE for such situations involves building a fire-rated gypsum box around the pipe penetration site, and then firestopping a perpendicular penetration through the gypsum box. However, because such solutions lack any known listed systems for reference, some manufacturers will refuse to issue such TEs, and some AHJs refuse to accept them.

Pipe elbows at fire separations

In a similar vein, there are no listed systems for a pipe elbow in or near the plane of a wall. See Figure 6 for examples of both a properly firestopped combustible pipe, using an intumescent collar, and of a pipe that cannot be firestopped due to an elbow at the plane of the wall, with no space for a collar. Where the specification clearly requires a perpendicular, unobstructed penetration with sufficient clearance for the selected firestop system, piping that does not meet those conditions should preferably be corrected.

Emerging pipe and insulation materials

Emerging pipe materials and insulation systems may not yet have any corresponding listed firestop systems. Because firestop testing and certification typically lag behind product innovation, specifiers should verify system availability during design rather than during construction. Where listed systems do not exist, TE and AHJ approvals may be required, creating schedule risk.

- For firestopping of emerging piping and insulation materials, select firestop systems early, or request a TE for AHJ approval.

Modern firestop technologies

Joint and penetration firestopping of the 1970s through 1990s consisted mostly of stuffing the open gap with compressed mineral wool, and then using an appropriate elastomeric, silicone-based, or intumescent sealant of the appropriate depth, or using intumescent strips and collars for combustible pipe penetrations. Since then,

the firestopping industry has invested greatly in innovations that make installation faster, easier, more mistake-proof, and less dependent on installer experience and skill. It can be almost guaranteed that the plumbing, electrical, interior finishing, insulation, or mechanical contractor's labourers will have little to no experience with firestopping. Nevertheless, those same contractors are expected—or at least hoped—to deliver code-compliant firestopping for the components they install in a building. One solution is to specify that all firestopping be contracted to a firestop specialty contractor, who will have expertise in both system selection and installation.

Since the 2000s, knowledgeable builders, developers, and contractors have increasingly turned to pre-formed firestop solutions. These products, when used within their listing parameters, provide firestopping for penetrations and joints that are fast and easy to inspect and install. General categories of 21st-century firestop solutions and their respective applications are as follows:

- Cast-in-place firestop devices (sleeves) for combustible and non-combustible piping penetrations through concrete floors (flat deck and corrugated deck) (see Figure 7).
- Drop-in firestop sleeves for cored holes in concrete decks
- Foam-like intumescent firestop plugs for cable penetrations
- Foam-like intumescent firestop blocks for large rectangular openings, often used for multiple different penetrating items (see Figure 8).
- Cable sleeve devices (cable pathway devices), both modular/nestable and individual, for penetrations by cable bundles (see Figure 9).
- Pre-formed joint firestopping (see Figure 10).

Although pre-formed firestop devices generally cost more than traditional sealant-based solutions, labour savings, reduced installation errors, and faster inspections often lower total installed costs.

A benefit of specifying pre-formed firestop solutions for each application is that firestopping becomes planned rather than an afterthought. Pre-planned firestopping is far more likely to consistently meet the *NBCC* requirement of installing firestops “as tested.” This eliminates

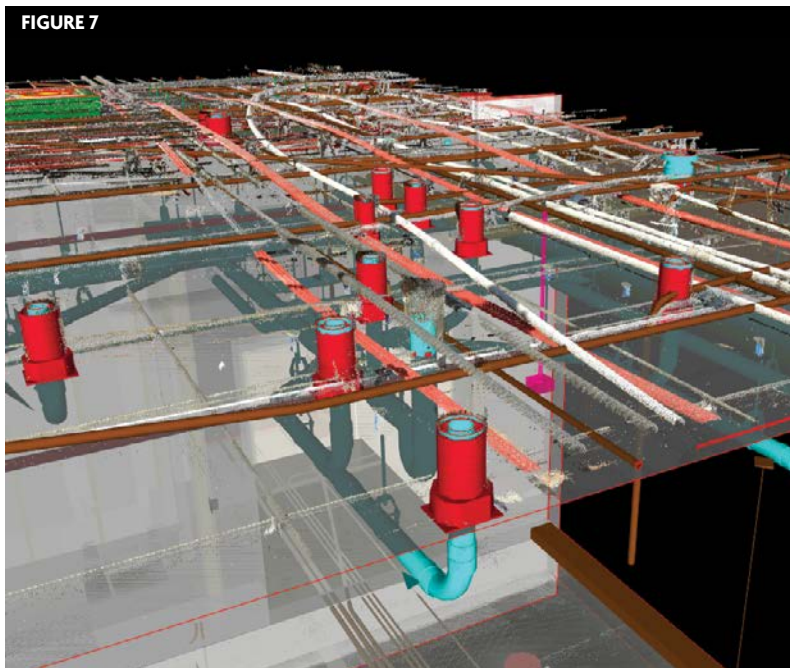


FIGURE 7
Specification of cast-in firestop devices allows easy integration with BIM MEP (mechanical, electrical, and plumbing) design.



FIGURE 8
the need to request and hope for firestop TEs, along with their inherent costs and delays. Specifiers should periodically review available pre-formed firestop technologies and update specifications accordingly.

Example of use of foam-like intumescent firestop blocks.

Reducing dependence on technical evaluations and improving TEs

Because many Canadian jurisdictions scrutinize or reject TEs in favour of tested systems, specifications should be written to minimize the need for TEs wherever practical.

A few jurisdictions will take the time and trouble to evaluate the technical basis of any proposed TE critically, scrutinizing the applicability of the referenced listings and tests on which the TE is based, as listed in the

FIGURE 9



Example of firestopping using cable pathway devices.

FIGURE 10



Example of pre-formed bottom-of-wall joint firestop.

document. Sometimes the TE is rejected based on the jurisdiction's technical opinion. Such rejections may, in fact, be warranted based on how much of a "stretch" the TE is from tested systems. Some firestop manufacturers have only a few listings (fire tests) to draw from, some have dozens, some have hundreds, and a few even have thousands. It is clear that questionable "stretches" will be attempted, depending on whether the given firestop manufacturer actually has fire tests that are sufficiently close.

To improve the quality and credibility of TEs, UL Solutions created the Technical Evaluation Developer Program. Participating manufacturers must demonstrate personnel competency, implement quality-management procedures, undergo audits, and submit evaluation concepts for periodic validation.

Accredited participants are identified in UL Product iQ under category WYGB.

Conclusion

Despite the evolution of firestopping technology and practices, many specifications continue to rely on language developed in years past. As a result, specifications often:

- Reference outdated products
- Omit newer tested systems
- Fail to take advantage of labour-saving firestop technologies
- Overlook simplified installation methods

Specifications should be reviewed regularly to reflect the current code edition, testing standards, and available system solutions.

In an industry where thousands of tested systems already exist, many project challenges arise not because compliant solutions are unavailable, but because specifications fail to direct project teams toward those solutions.

Ultimately, the goal is not simply better specifications, but also better buildings that perform as intended, satisfy code requirements, and provide the level of life safety expected by Canadians who live, work, and gather within them.

In the world of passive fire protection, a few pages of better specification language can make all the difference. 🔧



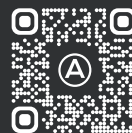
John Valiulis is the director of codes and standards with Hilti North America. He has more than 40 years of experience working in multiple countries as a fire protection engineer in research, construction applications, and national codes and standards development. He holds degrees in chemical engineering and fire protection engineering. He has instructed fire protection engineering seminars in North America, South America, Europe, Asia, the Middle East, and the Caribbean and has written for many U.S. and Canadian publications. He has served on six National Fire Protection Association (NFPA) technical committees and numerous ASTM committees. He has contributed to the development of the *National Building Code of Canada (NBCC)* and the *International Building Code (IBC)*. Valiulis can be reached at john.valiulis@hilti.com.

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Protecting the Building Envelope

A Practical Guide to Commercial Roof Sealants

By Jessica Lacerda

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It is easy to evaluate a commercial roofing budget and focus almost entirely on the high-dollar items, the acres of membranes, and pallets of insulation boards that dominate the job site. However, while these are major physical components of the system, the true reliability of a commercial roof system often rests on a component often thought of as merely a filler—the sealants.

Sealants step in precisely where the roofing membranes and flashing materials reach their limits. From flashing terminations and expansion joints subjected to daily thermal cycles to complex mechanical penetrations, sealants fill the critical gaps that standard materials cannot bridge. On low-slope commercial roofing systems, where rapid water shedding often cannot be relied upon, these materials provide the final seal protecting the building's interior.

Ultimately, choosing the wrong sealant chemistry or neglecting joint preparation can compromise an otherwise pristine roof system, often resulting in leaks and failures that shorten its lifespan. Beyond leaks,

warranty exposure, premature repairs, and interior damage, overall lifecycle costs are all potential issues that could arise from a single sealant failure.

With such complex chemistries at play, this guide serves as encouragement for further research into the role of sealants in the industry.

Sealant selection

Selecting the correct commercial roofing sealant begins at the molecular level. A sealant's chemical backbone dictates its resistance to ultraviolet (UV) radiation, thermal movement limits, tear strength, and long-term durability under environmental stress.

Commercial sealants are categorized into five primary chemical families, each engineered with distinct trade-offs that make them suitable for specific building envelopes. The five families are: silicone, polyurethane, hybrid, acrylic, and bituminous. No single sealant is the “best.” But even the highest-grade or most expensive sealant can fail if it is incompatible with the substrate it is protecting.

Commercial roof assemblies often must reconcile adjacent materials with drastically different coefficients of thermal expansion, surface energies, and chemical formulations. Achieving a durable building envelope requires matching the sealant chemistry to specific jobsite conditions.

Silicone sealants

Silicone sealants feature an inorganic silicon-oxygen (Si-O) polymer backbone. Because the chemical bond energy of the Si-O bond is higher than the energy of solar UV radiation, silicones resist breakdown, chalking, and embrittlement under prolonged exposure to sunlight.

Silicone sealants maintain flexibility and elongation performance across extreme temperature ranges, typically -40 to 149 C (-40 to 300 F). Because of their hydrophobic nature, silicones also resist degradation under ponding water conditions.

This feature makes both silicone sealants and silicone coatings the industry standard for ponding water conditions that cannot be fixed by other means. Another benefit is their capability to handle high movement, which is also considerable, typically rated as high as a Class 100/50 under ASTM C920, *Standard Specification for Elastomeric Joint Sealants*.

However, there are also limitations. Silicone sealants are more prone to mechanical damage in high-traffic areas because their inherent resistance to tearing and abrasion is relatively low. In addition, standard silicones bleed siloxane oils into porous substrates, leading to dirt pickup and preventing adhesion of subsequent non-silicone products.

The primary applications for silicone sealants are where the sealant is somewhat protected from mechanical damage or where silicone will be the primary material in use going forward. These uses include penetration flashings, curb terminations, wet-seal glazing, and restoration coatings over weathered single-ply or metal roofs.

Polyurethane (PU) sealants

Polyurethane sealants rely on organic carbon-chain chemistry linked by urethane bonds. This organic structure delivers superior resistance to mechanical puncture and abrasion, exceptional handling of dynamic shear, and adhesion strength across most common construction substrates. Polyurethane sealants exhibit exceptional adhesion to concrete, masonry, brick, wood, and metal without requiring



surface primers. Once fully cured, they are typically paintable with elastomeric topcoats and paints.

However, non-stabilized aromatic polyurethane is highly susceptible to UV exposure, resulting in surface chalking, micro-cracking, and a loss of elasticity over time. The addition of UV stabilizers helps, but will increase costs. Prolonged exposure of a roof to standing water can soften the sealant matrix, leading to hydrolytic cleavage.

Primary applications for polyurethane sealants are where resistance to movement is required and where standing water is to be avoided, including expansion joints, parapet wall coping joints, and other raised flashing details.

Hybrid formulations

Hybrid chemistry sealants combine the mechanical toughness of polyurethane with the inorganic weatherability of silicone. Typically, even on damp surfaces, hybrid sealants adhere reliably without primers, where traditional sealants fail.

In most cases, they contain lower levels of volatile organic compounds (VOCs) and solvents, eliminating off-gassing and bubbling during the curing process. Movement capability is balanced, usually between Class 25 and Class 50, resulting in a sealant with strong tear resistance and non-chalking UV stability.

No product is perfect, and hybrids have their limitations as well. Compared to traditional sealants, the material unit cost is typically much higher. As they are sensitive to ambient moisture, their shelf life may vary drastically as well.

Hybrid sealant used for flashing repairs over an existing aluminum-coated modified bitumen roof.

System-compatible silicone-based sealants applied to metal roofing seams before installation of a silicone coating system.



Primary applications for hybrid sealants include emergency roof repairs, transitions, or roofs with multiple substrates, and projects that must be installed in damp weather conditions.

Acrylic sealants

Acrylic sealants are water-based or solvent-borne dispersions of acrylic polymers. They cure primarily through simple evaporation rather than through a chemical process.

In and out of the roofing world, acrylic sealants are among the most widely used. They are typically economical and simple to tool, and most formulations clean up with water.

Acrylic sealants are generally compatible with other sealant chemistries, but only when acrylic is installed first. Many acrylic sealants also feature high solar reflectivity. Their primary limiting factor is high cure shrinkage. Volumetric loss during evaporation can be 15 to 30 per cent, creating stress at the bond line.

Acrylic sealants are also susceptible to temperature and moisture limits, requiring installation temperatures above 4 C (40 F), low humidity, and no rain in the forecast. The water-based formulations are particularly weak in ponding water applications and should not be used where this is likely.

Acrylic sealants are most appropriate for use in seams or transitions with low movement, non-ponding area roof repairs, repairs where high reflectivity is needed, or as a complement to an acrylic coating system.

Bituminous and asphaltic sealants

Bituminous sealants consist of refined asphalt blended with mineral fillers, fibres, and hydrocarbon solvents. They represent the legacy standard for asphaltic roofing assemblies and are often used for their low cost and high level of compatibility. They can be used with both traditional asphalt built-up roofing and modified bitumen roofing.

While popular with those working with asphalt, these bituminous sealants are severely limited in use compared to the others discussed here. Their volatile oils evaporate under heat and UV exposure, making the material hard, brittle, and prone to cracking as early as two years after installation.

Bituminous sealants are chemically incompatible with both single-ply membranes and silicone coatings, eliminating their use in some of the most common roofing systems. Primary applications of bituminous sealants include maintenance and repairs on asphalt roofing systems.

Special considerations in substrate compatibility

Single-ply membranes, such as polyvinyl chloride (PVC), thermoplastic polyolefin (TPO), and ethylene propylene diene monomer (EPDM), are currently commonly used in the modern commercial low-slope roofing market. They are chemically very different from bituminous roofing systems and require special consideration when selecting compatible materials.

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Sealant Compatibility*

Substrate	Silicone	Polyurethane	Hybrid	Acrylic	Bituminous
TPO	Compatible**	Conditional	Compatible	Conditional**	Incompatible
PVC	Compatible	Incompatible	Compatible	Conditional**	Incompatible
EPDM	Compatible**	Compatible**	Compatible	Conditional**	Incompatible
Kynar / PVDF Metal	Compatible	Compatible	Compatible	Compatible**	Compatible***
Galvanized Steel	Compatible	Compatible	Compatible	Compatible**	Compatible
Concrete / Brick	Compatible**	Compatible	Compatible	Compatible	Conditional
Asphalt	Incompatible	Conditional	Conditional	Compatible**	Compatible

*Sealant chemistry varies widely between manufacturers. Ratings shown are indicative of typical results.

**Primer usually required.

***Technically compatible but not recommended due to poor performance.

Due to the specificity of materials chemistry and the variability in formulations, manufacturers generally encourage the use of proprietary hybrid sealants designed for the most common scenarios in single-ply roofing systems. While sometimes seen as a sales ploy, it can be crucial to the roofing system when subtle changes in membrane chemistry can yield massive changes in how they react with various sealants.

Primer use is also extremely important, since most single-ply membranes are more resistant to adhesion than older, more bituminous roofing materials. EPDM typically requires solvent wiping and dedicated solvent-borne primers before applying almost any type of sealant.

Additionally, sealants installed on single-ply roofs without proper preparation, such as cleaning and priming, often experience rapid adhesive failure during initial thermal cycles.

Because they exhibit significant thermal movement and unique surface chemistries, metal roofing substrates also require special considerations for sealants. Coated metals, especially high-performance fluoropolymer coatings, resist dirt and chemical adhesion. In turn, they become equally resistant to sealant adhesion.

Thorough solvent cleaning using a two-cloth method is typically recommended before installing neutral-cure or hybrid primers. Bare galvanized steel, aluminum, or copper benefit

the most from neutral-cure silicones. Acetoxycure silicones should be avoided, as they can rapidly corrode the metal substrate, leading to catastrophic bond failure and rust staining.

Concrete or masonry parapet walls also present unique challenges with their porous, highly alkaline, and hydrodynamic surfaces. Due to its high pH (typically 12 to 13), cured concrete can rapidly degrade water-based acrylics and poor-quality polyurethane sealants. Its weaker surface layers require high-pressure air blasting, wire brushing, or mechanical grinding, followed by solvent-free primers to seal porous surfaces before sealants can be applied.

Joint design and geometry

A sealant's movement capability is expressed as the maximum percentage of both expansion and compression that the cured sealant is able to withstand before failure occurs (either adhesive or cohesive). "Movement" below can be either expansion or contraction in the joint width. While most classes are fairly symmetrical in their movement capability, note that Class 100/50 bears an asymmetric movement rating.

Class 12.5: $\pm 12.5\%$ movement

Class 25: $\pm 25\%$ movement

Class 35: $\pm 35\%$ movement

Class 50: $\pm 50\%$ movement

Class 100/50: +100% expansion and 50% compression capability

Strengths and Weaknesses of Sealant Types*

Property	Silicone	Polyurethane	Hybrid	Acrylic	Bituminous
UV Stability	Excellent	Fair	Excellent	Good	Poor
Ponding Water Resistance	Excellent	Good	Excellent	Poor	Good
Tear Resistance	Fair	Excellent	Good	Fair	Poor
Adhesion to Substrate	Good	Excellent	Excellent	Good	Good (asphalt only)
Damp Substrate Adhesion	No	No	Yes	No	Conditional
Topcoating	Conditional	Yes	Yes	Yes	Conditional
ASTM C920 Class Rating	Class 25 to 50	Class 25 to 50	Class 25 to 50	Class 7.5 to 25	Unrated

*Sealant chemistry varies widely between manufacturers. Ratings shown are indicative of typical results.

ASTM C1193, *Standard Guide for Use of Joint Sealants* serves as a standard guideline for which classes of sealants work best in different scenarios. Class 12.5 and 25 are standard for perimeter control joints and low-movement field lap seams. While the products are not uncommon in the market, Class 35 was only introduced in 2014 into the ASTM C920 standard and tends to be less commonly seen in specifications. Class 50 is preferred for commercial expansion joints and dissimilar substrate interfaces that are subject to heavy thermal cycling. Class 100/50, the strongest classification, is used for situations that require the highest stress under dynamic conditions.

ASTM C920, *Standard Specification for Elastomeric Joint Sealants* also classifies sealants by the Type, Grade, and Use.

The Type classification describes how the sealant is supplied and whether it requires mixing in the field. Type S is a single-component material that requires no mixing, typically pre-packaged in cartridges, sausage packs, or pails for direct application. Type S materials eliminate human error in mixing, though curing in the package can often be an issue when stored improperly or only partially used. Type M is a multi-component material that must be mechanically mixed immediately prior to application. Type M materials benefit from a more uniform cure rate, though it is vitally important that the field mixing is done correctly. Improper mixing can

compromise the entire application, resulting in non-uniformity in cure (soft and/or hard spots), as well as differences in physical properties compared to the properly mixed material.

The Grade classification defines how a sealant flows and how much sag resistance it has. There are two Grades: Grade P and Grade NS. Grade P is considered pourable or self-levelling. These products are designed to flow easily and rarely require more than minimal tooling. Pourable type sealers are typically used in expansion joints, pitch pockets, or other horizontal flashing applications. Grade NS is considered non-sag or “caulk grade.” These sealants will not sag or run when applied to vertical or overhead joints and are typically used in vertical applications, such as termination bar, counterflashings, and pipe flashings.

The Use classification separates sealants into three primary uses. Use T (traffic) designates a harder, more abrasion resistant sealant, typically used in areas subject to foot or vehicular traffic. Use NT (non-traffic) prioritizes flexibility over hardness and is the more common of the three classifications used in commercial roofing. Use I (immersion) sealants are becoming more common with hybrid technology. These sealants are capable of withstanding continuous immersion either in water or in specific liquid chemicals (Class 1 vs Class 2).

Going further, the Use classification also defines the reference materials used to test sealant adhesion. Bonding without adhesive



Hybrid flashing-grade sealant used to flash a pipe penetration on a previously aluminum-coated roof.

PHOTO COURTESY BITEC INC.

failure to a particular substrate earns a sealant the Use designation for that material. These include Use M (mortar), Use G (glass), Use A (aluminum), and Use O (other—used for specific, non-standard substrates).

When specifying a particular sealant to be used in a commercial roofing project, a specifier should adhere to industry standards, based on the ASTM C920 classifications. For more comprehensive information on formatting, please see the CSI MasterFormat Section 07 92 00—Joint Sealants or Section 07 50 00—Membrane Roofing.

Format: ASTM C920, Type [S/M], Grade [P/NS], Class [12.5, 25, 35, 50, 100/50], Use [Exposure], Use [Substrates]

Example: ASTM C920, Type S, Grade NS, Class 50, Use NT, M, A, O (TPO membrane and PVDF / Kynar coated metal)

When calculating joint width requirements, specifiers must account for the coefficient of the substrate's thermal expansion, the expected temperature differential, the panel length, and the sealant movement class. Accounting for construction tolerances and installation temperature offsets is another safety factor.

A common misconception is that “more is better,” leading the installer to fill deep joints with sealant. As a joint stretches, internal tensile stress concentrates heavily at the deepest cross-section. Excessively deep sealant joints create

high internal stresses that quickly exceed the cohesive strength, leading to failure.

To ensure uniform stress distribution during elongation and compression, it is best to follow the industry-standard depth-to-width ratio rules, as defined in ASTM C1193, *Standard Guide for Use of Joint Sealants*:

- Joint widths under 6 mm (0.25 in.) are not recommended for dynamic joints.
- Widths from 6 to 13 mm (0.25 to 0.5 in.) require a 1:1 ratio where the depth of the joint is equal to the width, with a strict minimum depth of 6 mm (0.25 in.).
- Widths from 13 to 38 mm (0.5 to 1.5 in.) require a 2:1 ratio, where the depth of the joint is equal to half of the width.
- For any joints wider than 38 mm (1.5 in.), the maximum depth is capped at 13 mm (0.5 in.).

Adhering to these ratios will ensure there is sufficient surface area for substrate adhesion while preventing excessive internal stress during expansion.

Three-sided adhesion, often wrongly considered an extra layer of protection, must be avoided. For a sealant joint to function as designed, the sealant must deform freely in two directions.

When the sealant adheres to three rigid surfaces, it cannot neck down or flex, creating a restriction that concentrates shear stress at the bottom corners of the bead. This can lead to adhesive failure (pulling from the substrate) or cohesive failure (tearing of the sealant).

Three-sided adhesion can be prevented by installing a non-adhering backer rod or bond-breaker tape at the base of the joint cavity before sealant application.

ASTM C1330, *Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants*, designates three basic types of backer rods, describing the nature of the internal cells and outer skin: Type C (closed cell), Type O (open cell), and Type B (bicellular).

Type C backer rod has a non-porous outer skin and closed internal cells, making it non-absorbent, rigid, and water impermeable. This type of backer rod is typically sized 20–25 per cent larger than the joint width. It is suitable for horizontal joints, gutter joints, or roof transitions where the backer rod needs to resist deflection under tooling pressure and provide a secondary barrier to water migration.

Type O backer rod has a discontinuous outer skin and open cells, making it more porous. This structure makes it highly compressible and vapour-permeable, often sized 40–50 per cent larger than the joint width. Type O backer rods are most commonly used with moisture-curing sealants (polyurethanes and silicones), vertical expansion joints, and for joint widths that may be too irregular for a firmer backer rod.

Type B backer rod is a hybrid of the first two types. It offers both the water-resistance of closed cell materials and the compressibility and flexibility of open cell. Typically sized 25–30 per cent larger than the joint width, Type B backer rod is used in applications where both outgassing resistance and water resistance are desired. It can withstand significant thermal expansion and contraction and is preferred in more dynamic transitions and joints.

Surface preparation considerations

A sealant cannot adhere to a loose or contaminated surface. Every substrate requires specific mechanical cleaning before chemical cleaning.

Porous substrates, such as concrete, masonry, and brick, must be cleaned down to sound material using wire brushing, grinding, or oil-free abrasive blasting. All residual concrete form-release agents, laitance, and curing compounds must be mechanically removed, after which dry, oil-free compressed air should be used to clear dust from deep pore walls.

Non-porous substrates, such as metal, glass, or single-ply membranes, require mechanical abrasion if oxidation is present. This should be followed by strict solvent cleaning to remove protective oils, plasticizers, and ambient atmospheric film. Especially for single-ply membranes, special consideration must be given to the manufacturer's instructions on surface preparation.

To avoid simply spreading surface contaminants rather than cleaning, the industry standard ASTM C1193, *Standard Guide for Use of Joint Sealants*, mandates the two-cloth method. This involves saturating a clean, lint-free cloth with solvent by pouring it directly onto the cloth (not dipping). The wet cloth is then used to vigorously wipe the joint surface, dissolving surface oils and grease. A second clean, dry, and lint-free cloth should be used to wipe away

any remaining contaminants before the solvent evaporates. If dirt or residue appears on the cloth after wiping, repeat the process from the beginning until the second rag remains completely clean.

Environmental considerations

Applying sealants outside strict thermal and moisture windows can cause premature adhesive failure and surface blistering during cure. Technical data sheets and manufacturer's instructions should always be carefully reviewed before installation.

In addition, a few general environmental rules have been established in the industry.

If the surface temperature approaches or falls below the dew point, a microscopic, invisible film of condensation can form on the substrate, preventing chemical wetting and contact with the substrate. Sealant application should occur only when the substrate surface temperatures are at least 3 C (5 F) above the calculated dew point.

Both extremely low and high temperatures can affect how sealants cure. In general, sealants should be applied within an ambient temperature range of 4 to 32 C (40 to 90 F). If the installation begins at a temperature at the lower end of the range, the contractor should be confident that the temperature will rise throughout the day. Similarly, if the installation



Acrylic flashing compound used to protect and seal a cricket formed at the high point of a skylight on a metal roof.

PHOTO COURTESY BITEC INC.



Hybrid flashing-grade sealant used to flash an irregular roof detail.
PHOTO COURTESY BITEC INC.

begins at a higher temperature, ensure that the temperature will fall as the day progresses.

Low temperatures can lead to drastically slow cure times, especially for moisture-cured materials. Frost can also form inside porous joint walls. High temperatures accelerate skinning times, leading to poor tooling and potential outgassing.

Tooling and application

Tooling is the process of pressing wet sealant into the joint cavity immediately after dispensing. Proper tooling serves two vital structural functions: forcing the sealant into close contact with the joint sidewalls to eliminate voids, and shaping the outer surface into a smooth, water-shedding bead. "Wet tooling," using soapy water, solvents, or liquid detergents on raw sealants, should be heavily avoided and can lead to joint failure. Unless the manufacturer

specifically recommends otherwise due to job-specific circumstances, dry tooling must always be performed.

ASTM C1521 adhesion testing

To verify that field-surface preparation and primer applications meet project performance specifications, quality control (QC) inspectors perform destructive field pull testing in accordance with ASTM C1521, *Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints*. This test's methodology is beyond the scope of this article, but it should be noted that adhesion testing on site-constructed mock-ups prior to actual sealant application is generally recommended as a standard industry best practice.

Theoretical conditions in a laboratory can vary drastically from real-world field conditions, and many of these changes can directly affect sealant performance. With proper planning and preparation, an adhesion test can prevent major failures down the road.

Sealant failure

When water breaches a commercial building envelope, the investigation often traces the root cause to joint sealant degradation. Distinguishing among physical, chemical, and mechanical failure modes is essential for determining liability, performing functional repairs, and preventing recurrence throughout the roof system.

Adhesive failure, typically indicated by the sealant bead peeling cleanly from the sidewall, is most often caused by surface contamination, invisible or unnoticed condensation, lack of required primer, or chemical incompatibility.

Cohesive failure occurs when the sealant material remains firmly adhered to both joint sidewalls, but the centre of the sealant bead exhibits a split or jagged tear. Primary root causes of cohesive failure include poor joint geometry (excessive joint depth relative to joint width), three-sided adhesion, under-engineered movement rating, and UV photo-oxidation.

Substrate failures can be observed when the sealant remains intact while the adjacent substrate is softened, discolored, rusted, or structurally disintegrated. These failures are often the result of acidic corrosion, plasticizer migration due to incompatible sealants on PVC,



or solvent softening, especially common in TPO and EPDM membranes.

Blistering, bubbling, and outgassing, while not always outwardly visible, can be observed when slicing the sealant, revealing a Swiss-cheese appearance with small hollow chambers or voids within the cured sealant. Substrate outgassing is commonly seen in porous concrete when sealants are applied during rising ambient temperatures. Closed-cell backer rods, punctured with screwdrivers or dull blades, can also release trapped gas into wet sealants.

Another common cause, in the case of single-component polyurethane sealants, is installation during hot, humid weather and/or in excessively thick beads. In these circumstances, the rapid reaction can generate carbon dioxide gas faster than it can diffuse, creating internal voids.

All of these failures are avoidable with planning and preparation.

Conclusion

While sealants represent a tiny fraction of the overall capital costs of a commercial roofing installation, they bear a disproportionate burden

in maintaining the building envelope's integrity. An incorrectly specified chemistry, an overlooked dew point, or an improper depth-to-width ratio can compromise not just the roofing system itself but also an entire building's insulation and interior finishes. Achieving long-term waterproofing performance requires discipline at every stage, from specifications to installation to field QC. 🛠️

Silicone flashing compound installed on roof penetrations before the silicone coating system, so the two blend seamlessly into the full system.

PHOTO COURTESY BITEC INC.



With 20 years of experience across various sectors of the commercial roofing industry, Jessica Lacerda is currently the product manager at BITEC. She takes pride in helping shape the product line to meet the needs of current and future roofing contractors and distributors. She drives the portfolio forward by managing comprehensive technical documentation, pricing strategies, and dependable commercial solutions. Lacerda can be reached at jlacerda@bitec.com.



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CSC First Quarter Update

As we move through the first quarter of our governance year, I am pleased to share an update on the work the Executive Council (EC) has been advancing on behalf of CSC members.

One of our ongoing initiatives is the redevelopment of the Principles of Construction Documentation (PCD) course. Significant progress has been made on updating the course content, and I would like to acknowledge the many volunteers who have dedicated their expertise to this important undertaking. This work will help ensure that CSC's educational offerings remain current, relevant, and valuable to both emerging and experienced construction professionals. We are targeting an early 2027 release date for the revised course.

Earlier this year, we relaunched the News in Brief (NIB), providing members with timely updates on CSC initiatives, educational programming, committee member opportunities, and industry partnerships. We have also continued our social media designation spotlight campaign, recognizing the achievements of members who have earned CSC credentials and highlighting the value these designations bring to our industry.

Behind the scenes, the EC has reviewed internal processes to improve efficiency, transparency, and consistency. This includes restructuring board meetings for more focused discussion,

stronger strategic oversight, and better use of volunteer time. We are also reviewing operational practices to identify cost savings and strengthen long-term effectiveness.

Multiple Canadian Construction Documents Committee (CCDC) documents remain under active review through CSC's volunteer network, ensuring that member perspectives continue to be represented in the development of these important industry tools.

Looking ahead, planning for our upcoming conference in London, Ont., is well underway, and we are excited to bring members together for another exceptional learning and networking experience. We are also pleased to support discounted Canadian member pricing for the CSI Dynamic Standards initiative. It is important to note that CSC is not responsible for the development or implementation of this platform. Our role has been to advocate for and support discounted access for CSC members.

Thank you for your continued support, volunteerism, and commitment to CSC. Together, we are building a stronger, more connected community and advancing the future of construction documentation, specifications, and contract administration across Canada. 🇨🇦



Abigail MacEachern,
Architect, RSW,
LEED AP, CDT

Mise à jour du premier trimestre à DCC

Alors que nous amorçons le premier trimestre de notre année de gouvernance, je suis heureuse de vous faire part d'une mise à jour sur les travaux réalisés par le Conseil exécutif (CE) au nom des membres de DCC.

L'une de nos initiatives en cours est la réélaboration du cours sur les principes de documentation de la construction. Des progrès importants ont été réalisés dans la mise à jour du contenu du cours et je tiens à remercier les nombreux bénévoles qui ont consacré leur expertise à cette importante initiative. Ce travail contribuera à faire en sorte que les offres de formation de DCC restent actuelles, pertinentes et précieuses tant pour les professionnels de la construction émergents que chevronnés. Nous visons une date de sortie début 2027 pour le cours révisé.

Plus tôt cette année, nous avons relancé le programme Nouvelles en bref, qui fournit aux membres des mises à jour opportunes sur les initiatives de DCC, les programmes éducatifs, les occasions pour les membres de comités et les partenariats avec l'industrie. Nous avons également poursuivi notre campagne de reconnaissance sur les médias sociaux, en reconnaissant les réalisations des membres qui ont obtenu des titres de compétence de DCC et en soulignant la valeur que ces désignations apportent à notre industrie.

En coulisses, le CE a revu plusieurs processus internes au sein de l'organisation afin d'améliorer l'efficacité, la transparence et la cohérence. Les réunions du conseil d'administration ont été

restructurées pour favoriser des échanges plus ciblés, une supervision stratégique accrue et une meilleure utilisation du temps des bénévoles. Le CE examine également les pratiques opérationnelles afin de repérer des possibilités de réduction des coûts et de renforcer l'efficacité organisationnelle à long terme.

Plusieurs documents du Comité canadien des documents de construction (CCDC) sont toujours en cours d'examen par le réseau de bénévoles de DCC, ce qui permet de s'assurer que les perspectives des membres continuent d'être représentées dans l'élaboration de ces outils importants pour l'industrie.

À l'avenir, la planification de notre prochain congrès à London, en Ontario, est bien avancée et nous sommes ravis de réunir les membres pour une autre expérience d'apprentissage et de réseautage exceptionnelle. Nous sommes également heureux d'appuyer la tarification réduite pour les membres canadiens dans le cadre de l'initiative des normes dynamiques de CSI. Il est important de noter que DCC n'est pas responsable de l'élaboration ou de la mise en œuvre de cette plateforme. Notre rôle a été de défendre et de soutenir l'accès à prix réduit pour les membres de DCC.

Merci pour votre soutien continu, votre bénévolat et votre engagement envers DCC. Ensemble, nous bâtissons une communauté plus forte et mieux connectée, tout en façonnant l'avenir de la documentation, des spécifications et de l'administration des contrats de construction au Canada. 🇨🇦



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