STEEL BRACING VS. TIEBACKS:

A Proposed Regulatory Change That Study Shows To Be Counter-Productive and Costly

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CONTEXT

The following report and case study have been prepared at the request of the Residential Construction Council of Ontario (RESCON) and the Ontario Association of Foundation Specialists (OAFS).

The author, Isherwood Geostructural Engineers, is a Toronto area consulting engineering firm founded in 1972 that designs geostructures for new and renovation construction. Isherwood has been responsible for excavation support, retaining walls, slope stabilization, tunnels, shafts, underpinning and foundations for many prominent Toronto structures, including the CN Tower, Skydome Stadium (now Rogers Centre), Royal Ontario Museum, the Toronto Opera House, Pearson Airport, Don Valley Parkway, the Toronto subways and over 3,000 excavation support systems for private and public projects in Canada and internationally.

This report will present the benefits of using tiebacks (also called earth anchors) as a method of supporting deep retaining walls and compare it with alternative solutions.

The case study within the report will compare the impacts on cost, schedule and risk of an internally braced excavation versus tieback supported.

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EXECUTIVE SUMMARY

Temporary retaining walls are critical to the safe and efficient development of deep excavations in urban environments. Among the available options for supporting these retaining walls, tiebacks (also called earth anchors) offer significant advantages over internal bracing systems in terms of construction efficiency, cost, duration, safety, and site optimization. Despite their proven performance and widespread engineering acceptance, recently, some Ontario municipalities are considering restricting or banning their use underneath public rights-of-way in the future.

This report evaluates the benefits of tiebacks compared to the primary alternative of steel bracing, using a case study to illustrate. The findings demonstrate tiebacks enable faster and more economical project delivery by reducing site congestion, allowing concurrent construction activities, and simplifying excavation and concrete forming procedures. Tiebacks also shortened the duration of necessary sidewalk and lane closures, minimizing associated traffic congestion. In a representative high-rise multi-unit residential development scenario, the use of internal steel bracing resulted in an estimated $5 to 6.5 million of additional costs, or $14,000 to $18,000 per unit, and increased the excavation and forming timeline by 5 to 7 months compared to tiebacks. These inefficiencies directly hurt project viability and housing affordability.

Furthermore, tiebacks promote industry competitiveness by enabling construction methods aligned with modern scheduling, logistics, and safety expectations. The engineering profession has established robust design, construction, and testing standards for tiebacks. More than two million have been installed in the Greater Toronto Area alone over the past 50 years.

In conclusion, permitting practices in Ontario should continue to reflect best engineering practices and construction realities. Continued acceptance of tiebacks, particularly under the municipal right-of-way, would support housing supply objectives, minimize building construction impacts on communities, and reduce unnecessary cost burdens on developers and contractors, but more importantly, reduce costs to end users and avoid further erosion of housing affordability.

INTRODUCTION

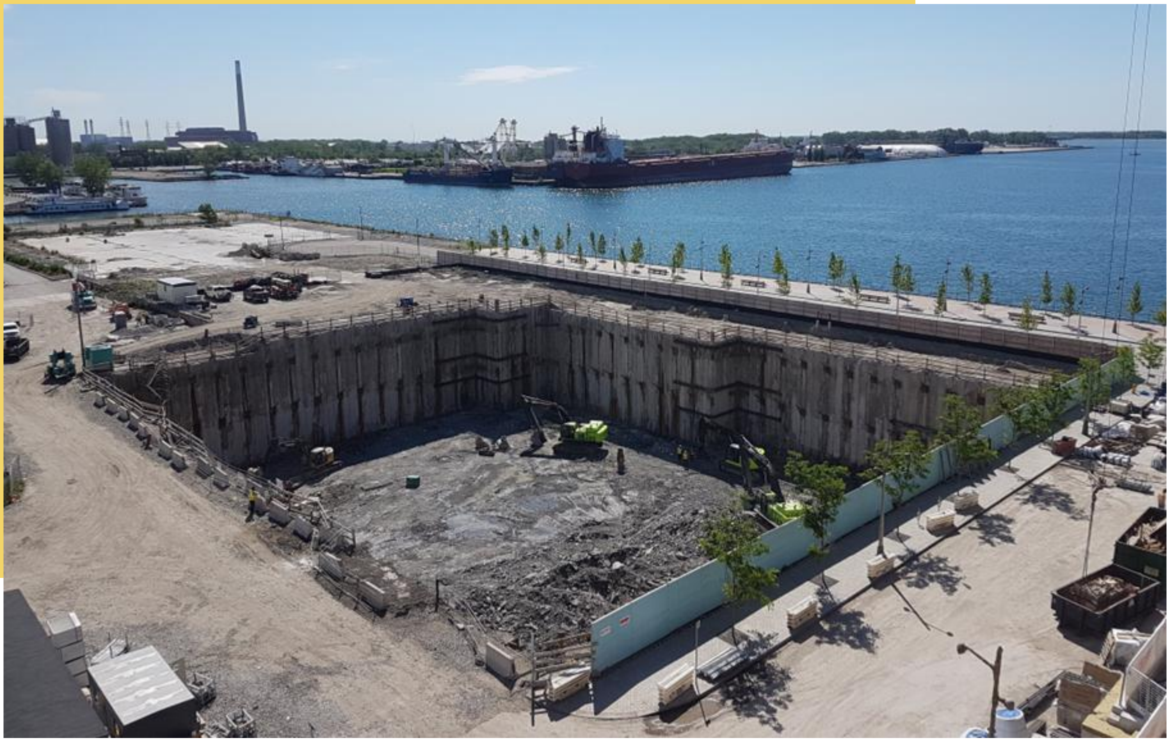

Figure 1: Excavation at East Bayfront, Toronto.

Across Ontario, construction regularly delves underground to build subways, utilities, tunnels, deep basements for underground parking and other programming. The majority of these excavations are kept open and safe with support from a technology called tiebacks, which are drilled underground and hidden from view. However, recently, some municipalities are exploring possible bans that would prevent tieback use under public rights-of-way. This report endeavours to explain what tiebacks are, their benefits and risks, and why their continued use is critical to Ontario's construction industry and delivery of new housing.

TIEBACKS

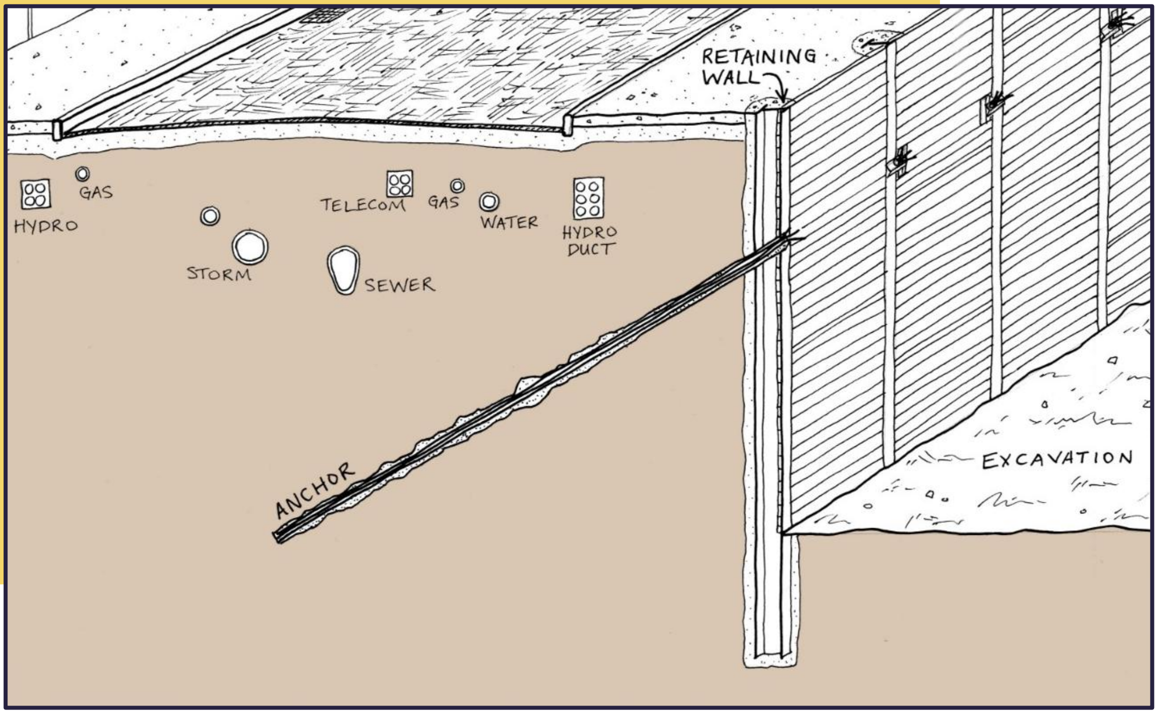

Figure 2: Diagram of an excavation supported with tiebacks next to a city street.

A tieback (also called an earth anchor) consists of a small hole drilled into the ground with steel cables inserted. The hole is then filled with cement grout, the steel is attached to the retaining wall and the cables are pre-stretched to snugly support the wall. Once the new underground structure has been constructed within the excavation, the tiebacks become redundant.

Figure 3: An exhumed tieback sample with steel cables and surrounding grout, 6” in diameter.

Figure 4: Steel tieback cables protruding from and attached to a retaining wall; view from within the excavation.

Anchors were introduced into the Toronto market in the 1970s during Ray Bremner's time as the City of Toronto Works Commissioner and quickly gained popularity because they free up construction sites compared to bulky steel braces, making it easier, faster and more cost-effective to build while simultaneously providing the best protection of streets and neighbouring buildings. Bremner allowed tiebacks to be installed in public rights-of-way based on their significant advantages for construction sites and their limited risk to utilities, which are typically above the zone where tiebacks are needed. Utility records are used to verify that tiebacks will not cause damage, with utility owners confirming acceptable clearances before construction permits are issued by cities.

Tiebacks are a state-of-the-art tool in the construction industry and are better than alternatives at limiting excavation retaining wall movements whilst protecting nearby buildings and municipal infrastructure. They are the preferred method of support unless something restricts their use. The authors estimate more than two million have been safely installed in the GTA alone over the past 50 years.

Tiebacks are a state-of-the-art tool in the construction industry, with more than two million installed in the GTA alone over the past 50 years.

TIEBACK USE IN ONTARIO

To our knowledge, tiebacks are permitted in the public rights-of-way in the majority of Ontario municipalities, including Hamilton, Burlington, London, Windsor, Oakville, Milton, Mississauga, Vaughan, Markham, Toronto, Waterloo, Kitchener, Cambridge, and Ottawa, with varying limitations, conditions and fees applied. Although there is a long history of tieback use in Ontario and around the world, some local municipalities are considering restricting or banning the use of tiebacks underneath public rights-of-way. The authors believe this is due to several factors:

- **Potential damage to utilities during tieback drilling:** Despite efforts to confirm the location of underground sewers and other utilities, they can be damaged by tieback drilling. This is a rare outcome, especially with conscientious parties and good locating and drilling practice, particularly as municipalities require wide clearances between utilities and tiebacks, and is outweighed by the benefits to construction and housing costs, schedule, safety and environmental benefits.
- **Lack of understanding:** Tiebacks are a mainstay tool in a niche part of the construction industry, and yet many municipal employees and engineers are not familiar with the technology and its benefits.
- **Tunnelling backlash:** In 2022, a tunnel boring machine for a sewer became stuck on old tiebacks along Old Mill Drive in Toronto. The recovery costs ballooned, and the story was highly publicized. However, the tiebacks that entangled the tunnelling machine had gone through typical permit approvals with drawings submitted, and their existence was known to the City of Toronto who commissioned the tunnelling work. Had the available records been provided to the tunnelling contractor, the problem would have been avoided, just as the other utilities along that street were avoided. Typically, coordination for all existing buried utilities and structures is carried out at the design stage by engineers to avoid conflicts and clashes during construction.

Toronto is one of the municipalities contemplating restricting tieback use, with a report currently commissioned to investigate alternatives, however, other municipalities are also questioning whether they should restrict tiebacks. For example, in 2019 the Region of Peel considered banning tiebacks altogether, but after considering the impact to construction and housing developments, altered course and is instead in the process of refreshing its policies to allow tiebacks, with extra documentation required to ensure utility tunnelling works can avoid old tiebacks no longer in use. Given the state of the housing market and affordability concerns, it would seem illogical for any government to consider new regulatory measures that make it more complicated and costly to deliver new housing.

In 2022, a tunnel boring machine became stuck on old tiebacks. Had the available records from past permit applications been provided, the problem would have been avoided.

ALTERNATIVES TO TIEBACKS

Figure 5: Internally braced excavation adjacent to a building, Toronto.

Figure 6: Strutted excavation for Spadina subway extension, Toronto.

Figure 7: Site braced with steel props due to lack of permission to install tiebacks, Toronto.

The most common alternative to tiebacks is steel props (referred to as corner braces, rakers, struts and walers depending on how they are deployed) used to hold up retaining walls from inside the excavation. These were the main method of supporting deep excavations before the adoption of tiebacks in the 1970s to 90s.

Steel braces become more challenging when sites become too deep or too wide, needing complicated frames and supports to keep them from becoming inadequate to do their job. This style of support also leads to more retaining wall movement and surrounding ground movement, making it more challenging to adequately support neighbouring properties and buildings.

As can be seen in figures 5 to 8, steel braces clutter up excavations, making it more difficult to transport material, obstructing site lines, and lengthening construction schedules. A cluttered worksite creates more pinch points where workers can be pinned and fatally

Steel braces clutter up excavations, obstruct site lines, and create more pinch points where workers can be pinned and fatally injured.

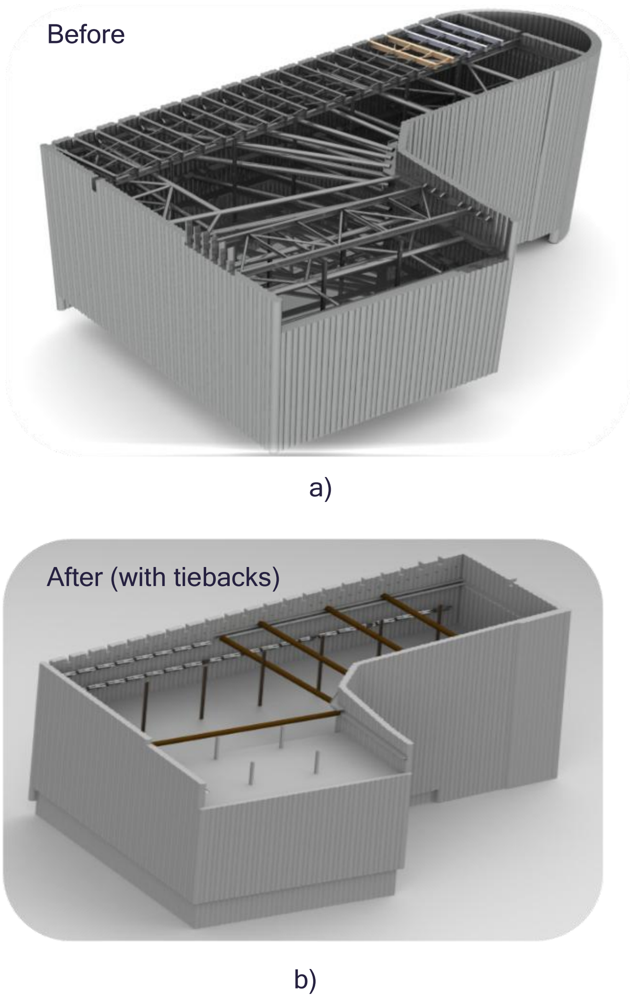

Figure 8: Eglinton Crosstown LRT excavation for launching the tunnel-boring machine: a) shows the initial design using only internal bracing, making it difficult to fit machinery, b) shows the same shaft with tiebacks added, making it easier to operate out of and creating significant cost and schedule savings.

injured, and these large steel braces need to be hoisted into and out of a site.

Steel braces can be vulnerable to damage, particularly when excavators and other large equipment are being maneuvered around them, risking collapse of the retaining wall. For example, during construction of the Sheppard subway line in 1992, a crane boom fell onto a steel brace and caused it to collapse.

With regard to impact on the public, transportation and delivery of large steel braces to construction sites creates additional trucking demand on public roads that are already congested. The large braces often need additional staging space and lane closures, and can lengthen construction timelines.

Steel braces can also interfere with construction of foundations and foundation walls, requiring holes in the waterproofing layer and concrete that must be patched after the braces are removed. This can reduce the quality of the wall and make structures vulnerable to persistent water leaks.

Transportation of steel braces adds to traffic congestion and lane closures, lengthens construction schedules, and prolongs disruption of neighbourhoods.

TIEBACK VARIATIONS

A common question from municipalities is whether tiebacks can be removed when they are no longer required. At best, removing traditional tiebacks would cause huge disruptions to the roadways and utilities above, but often tiebacks are too deep underground to be dug up.

Although there are some alternative tieback types that are considered “removable,” almost all options leave a small portion of steel cable or bar in the ground as well as the cement grout. The mechanisms they rely upon to release the steel can be unreliable, with a success rate of 70-90% removal in practice. The only exception are “helical anchors,” which are a different technology with limited practical application, often requiring three times more anchors to support the same loads.

Tiebacks are occasionally installed using fibreglass bars instead of steel, with the benefit that the fibreglass material can be chewed through by tunnelling machines. However, this material is relatively new with unusual properties still being vetted by suppliers, trades and engineers, with added concerns about structural capacity over time in ground anchors. Fibreglass anchors are not a proven, reliable technology, making them more difficult to use successfully. These lingering problems, the limited use of fiberglass anchors, and the inherent lower strength for tieback applications add a 20-30% cost premium for the entire shoring system compared to standard tiebacks.

CASE STUDY: TIEBACKS VS. STEEL BRACING

The following case study looks at a high-rise residential building that was previously built using tiebacks, comparing the schedule, cost and logistical impacts of the tieback-supported excavation (figure 9) with hypothetical alternatives using steel bracing (figures 10 and 11). The schedule and costs included are based on current market estimates provided by multiple industry contractors.

Tieback option: As you can see in figure 9, the tieback supported site is open for equipment and materials to move around freely, with nothing to work around while building the basement structure. The underground construction of this scenario would take 16 months and cost approximately $13 million, including temporary retaining wall construction, excavation, waterproofing, concrete formwork (from footings to ground floor) and indirect costs like financing and site staffing.

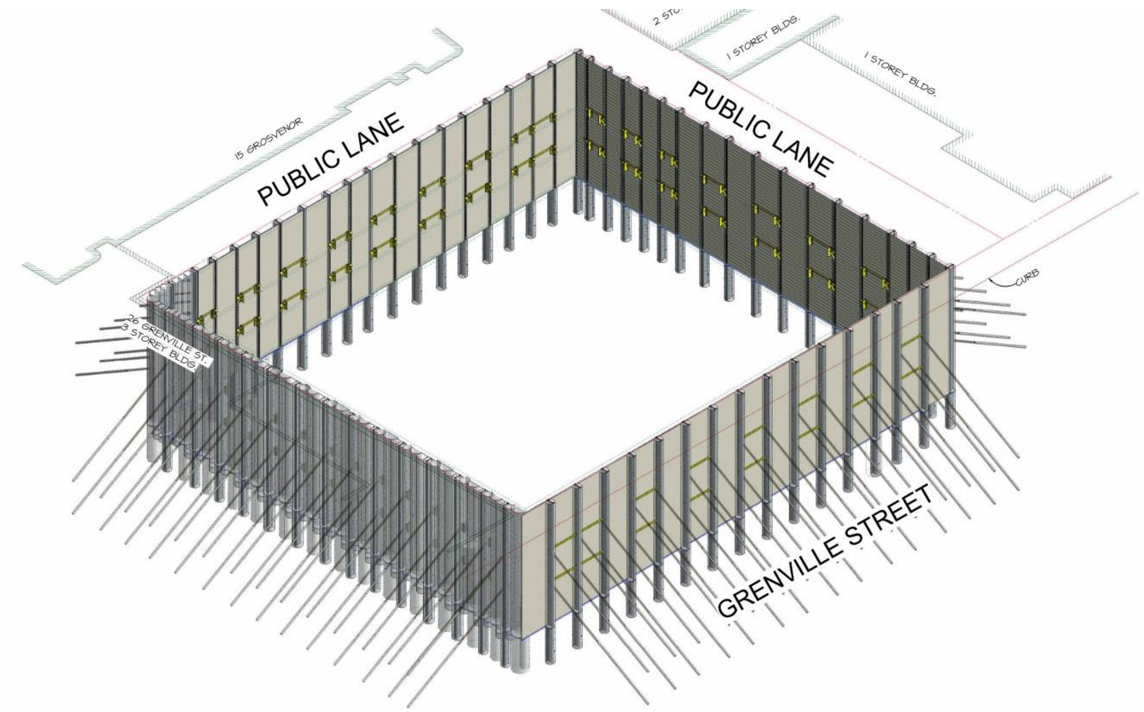

Figure 9: Tieback supported excavation.

Angled steel brace option: In comparison, figure 10 shows a version supported with steel "raking" braces (props bearing on soil within the excavation) and corner braces. This excavation is congested, requiring more planning and logistics to move equipment and material. When building the basement structure, holes would need to be left for the steel braces to pass through the foundation walls and base slab with patches to seal them afterwards. The underground construction of this scenario would take roughly 5 extra months and result in an estimated $5 million premium, or 40% extra on the underground construction costs compared to the tieback base case. This accounts for impacts to temporary retaining wall construction, excavation, waterproofing and concrete formwork. Assuming a typical high-rise building, the steel bracing adds approximately $14,000 to the purchase price of each unit.

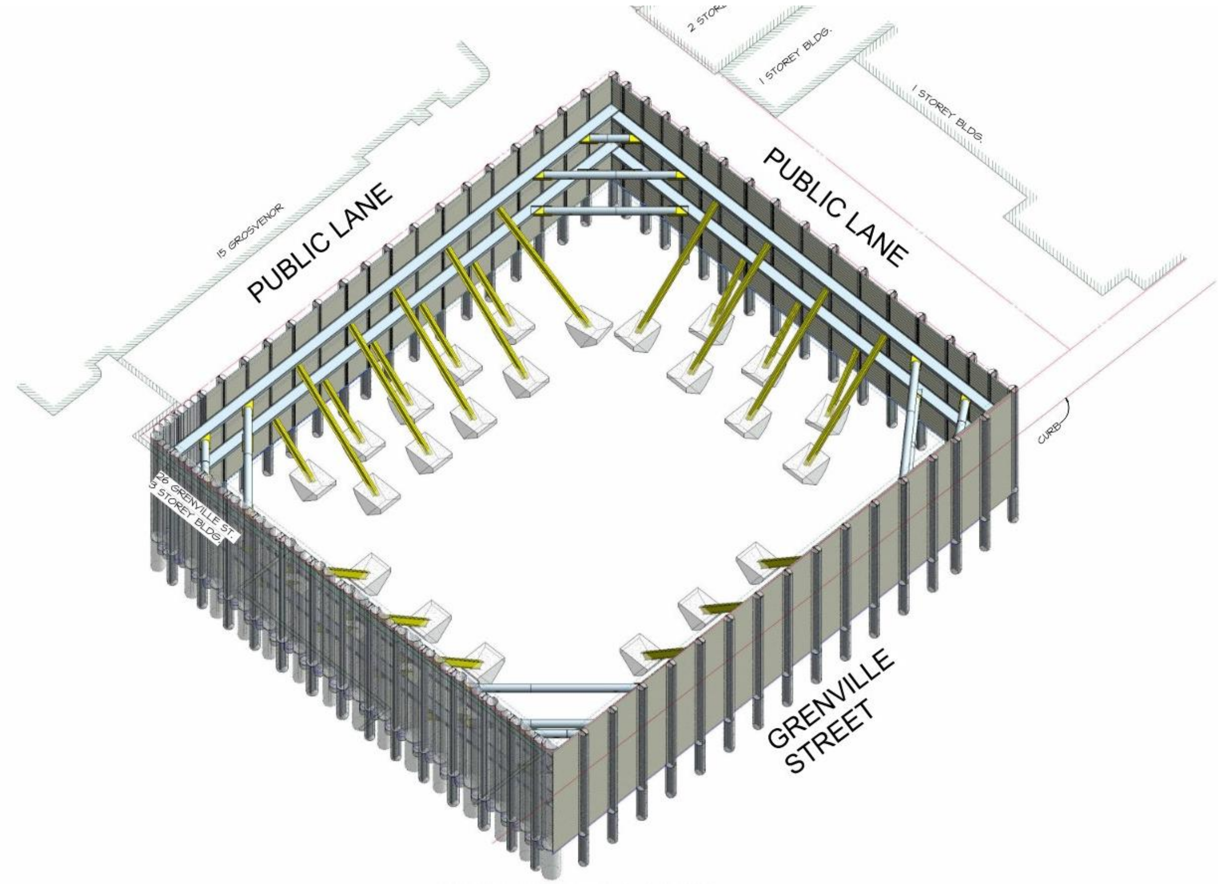

Figure 10: Internally supported excavation using steel "raked" and corner braces.

Cross-site steel brace option: The third scenario in figure 11 is an alternative approach with steel braces that could be required if "raked" props cannot be used; for example, if the soils are too soft to support them, the site is too narrow to leave room, or waterproofing requirements do not allow penetrations. This version of internal bracing would take roughly 7 extra months and result in an estimated $6.5 million premium, or 50% extra on the underground construction costs compared to the tieback base case. Assuming a typical high-rise building, this scenario adds approximately $18,000 to the purchase price of each unit.

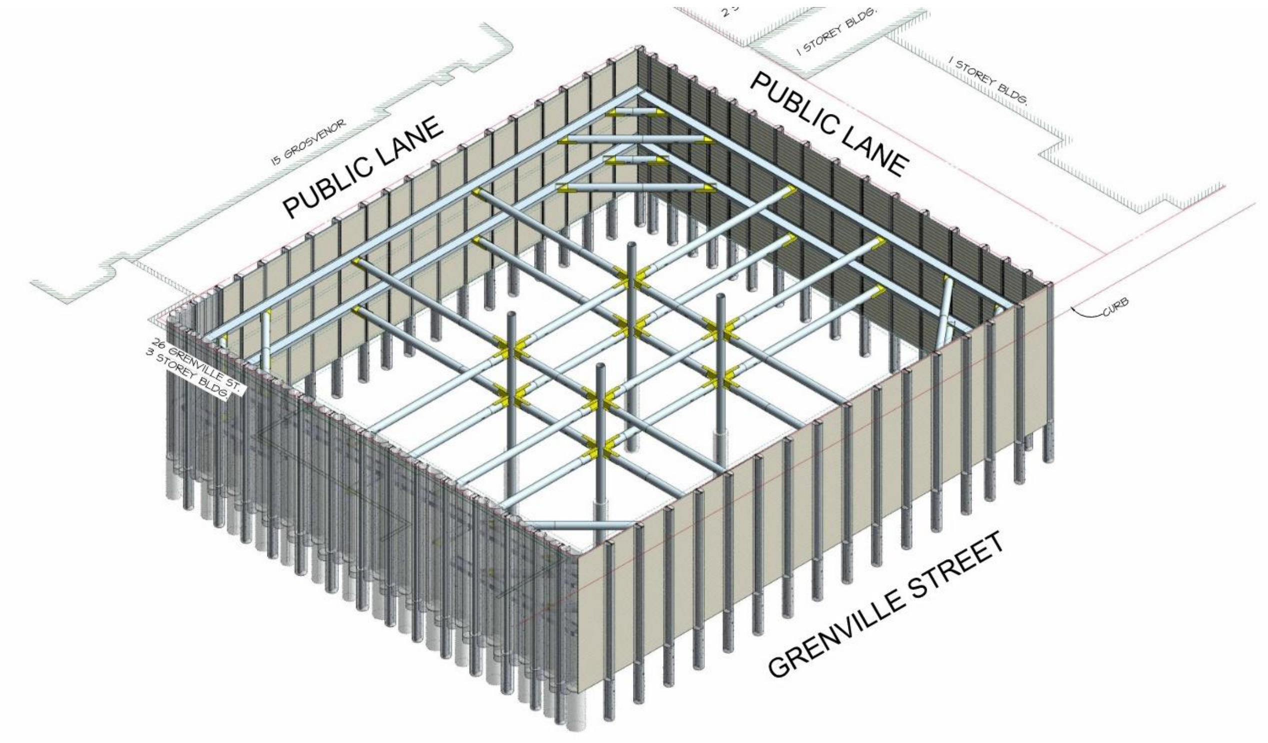

Figure 11: Internally supported excavation using cross-site steel braces.

Internal bracing cost an estimated $5 to 6.5 million extra, or $14,000 to $18,000 per unit, and increased the excavation and forming timeline by 5 to 7 months compared to tiebacks.

Using either internal bracing method also introduces new challenges for the installation of underground waterproofing. Tiebacks facilitate a more continuous waterproofing membrane installation, offering the best barrier against long-term leaks in an underground parking garage structure. In contrast, removal of the temporary steel braces results in patches in the foundation wall and waterproofing system creating a higher risk of future leaks. This is particularly problematic in the city of Toronto where watertight underground construction is mandated under the Toronto Foundation Drainage Policy, and the inability to use tiebacks would make watertight performance more challenging. Alternatively, municipalities could relax mandates for underground parking, allowing some levels to be moved above ground and reducing the need for below ground construction.

CONCLUSION

Tiebacks are a safe, state-of-the-art technology to support excavation retaining walls with clear advantages over alternatives. They allow for significant cost and schedule savings, helping to provide more affordable housing and infrastructure. The Ontario construction industry is geared up for the use of tiebacks, with specialized equipment and trades and over 50 years of expertise in their use. With all the challenges to provide affordable housing and infrastructure, the construction and development industries cannot afford the cost of retooling this vital retaining wall support element.

Continued acceptance of tiebacks, particularly within municipal rights-of-way, would shorten project timelines, minimize traffic congestion and road closures, and reduce disruption to neighbourhoods. Use of tried and true tieback technology supports housing supply objectives, maintains construction efficiency and speed, and reduces unnecessary additional cost burdens on developers, contractors, and ultimately, end-users. Permitting practices in Toronto should continue to reflect current engineering standards and construction realities. We hope this report helps promote continued support for the continued use of tiebacks in Ontario.

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