PRIMER

BY **JUSTIN M. SPIVEY**
Senior Associate
Wiss, Janney, Elstner Associates, Inc.

BY **ALEXANDAR J. MLYNARCZYK**
Senior Associate
Wiss, Janney, Elstner Associates, Inc.

Planning for new building projects should consider the impacts of demolition, excavation, dewatering, and construction on adjacent buildings.

Locations:
WJE Philadelphia
601 Walnut Street, Suite 875W
Philadelphia, PA 19106

WJE Princeton
5 Vaughn Drive, Suite 100
Princeton, NJ 08540

Contact:
T: 215.567.0703
E: jspivey@wje.com

T: 609.799.7799
E: amlynarczyk@wje.com

www.wje.com

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS
Wiss, Janney, Elstner Associates, Inc.

An Overview of Risks in Adjacent Demolition and Construction

With effective planning and communication, the risks of demolition and construction next to existing buildings can be evaluated and managed, reducing the likelihood of damage and disputes between adjacent property owners. Many of the same physical risks also apply where a building is demolished or constructed next to an existing one with the same owner.

Construction activities next to existing buildings are a common occurrence, not only in urban environments where buildings adjoin property lines or share party walls, but also in many projects involving building additions. Demolition, excavation, dewatering, and construction carry greater risk of causing damage when performed close to existing buildings (Figure 1), especially if the new building is taller or extends deeper into the ground than its predecessor. New buildings can also move differently in response to wind or earthquake loading, redirect the flow of water from precipitation, or alter the pattern of snow drift formation, creating new demands that existing buildings might not have the capacity to accommodate.

The Need for Communication

The risk of damage to existing buildings is typically lower on projects where adjacent property owners proactively communicate, where experienced design professionals are engaged to evaluate risks and develop mitigation strategies, and where qualified contractors are hired to implement them. A peer review of the proposed adjacent design can identify potential risks to the adjacent property. Mitigation strategies often include monitoring of building movement and/or ground vibration, which could be performed by a design professional, subcontractor, or third-party consultant. It is recommended that owners of existing buildings retain their own consultants for an independent review of the risk mitigation strategies proposed by the new building design team and any issues that arise during project execution.

Figure 1. Cracking and displacement of existing stone arches due to foundation settlement associated with adjacent construction. New floor slabs also extend into a required seismic gap, where they can apply damaging earthquake loads to the existing building.

An Overview of Risks in Adjacent Demolition and Construction (CONTINUED)

Figure 2. Inadequately secured sheets of plywood, intended for roof protection, can be dislodged by wind. This city's building code requires the plywood to be fastened over a layer of scaffold plank.

Figure 3. Installation of seismograph (at right) and monitoring data logger (at left) in progress at foundation wall of existing building.

The property owner and design team for the new building should be aware of the vulnerabilities of existing buildings and minimum building code requirements for protection of adjacent properties (Figure 2). Experienced consultants and knowledgeable attorneys can help inform existing building owners about their rights to protection and their duties to provide access for installing monitoring and protection measures. These rights and duties are established in the building code and can be further defined through legal contracts such as a license or access agreement between adjacent property owners. In some instances, these agreements include payment of a license fee by the developer for use of an adjacent property.

Although consultants and attorneys should remain involved throughout the duration of a project, it is critical to engage them during the planning phase to help set expectations, limit miscommunication, and mitigate risks posed by demolition, excavation, dewatering, and construction.[1] Negotiating an access agreement requires adjacent property owners to achieve compromise on the scope of monitoring and protection measures, which may increase project cost but reduce the risk of even greater expenditures in the event of damage or collapse. Access agreements should include provisions for independent review of all proposed construction details affecting the existing building, including those discussed in the following sections. Failure to reach an agreement may result in litigation, with the new building project proceeding without communication between parties. In some cities, failure to reach an agreement can result in the responsibility for underpinning and other protections being assigned to the owners of existing adjacent buildings.

If the opportunity for communication is missed during project planning, e.g., due to adversarial relationships or limited knowledge of building code requirements, schedule and budget pressures may discourage consideration of risk mitigation measures, or make them more challenging or costly to implement, once work is under way. Also, the rising new building can obstruct access to existing walls along property lines, making it significantly more difficult and expensive to perform needed bracing or weatherproofing work. Although it may still be possible to mitigate risks to existing buildings later in the project, this often comes at an increased cost due to litigation, work stoppage or delay, and inefficient out-of-sequence work.

Typical Risks and Mitigation Strategies

Project plans should anticipate how the new building could impact adjacent properties, not only during demolition, excavation, and construction, but also in its completed state. Typical risks and mitigation strategies to be considered by the new building design team, and the adjacent property owners and consultants reviewing their work, include the following:

Preparation: Before starting work, monitoring of background (ambient) vibrations, pre-construction condition assessments of existing buildings, installation of crack width gauges or monitors, and optical surveying or laser scanning can identify vulnerabilities and set a baseline for evaluation of any subsequent reports of adjacent building movement or damage. Some building codes include limits on building movement and vibration. For existing buildings of exceptional sensitivity or significance, preemptive stabilization or bracing, temporary removal of fragile contents, or lower-than-typical movement and vibration limits may be appropriate.[2] Access should be arranged for installing monitoring and protection measures before work begins (Figure 3).

Demolition: Where demolition is necessary to clear the site for the new building, plans should consider limiting vibration from demolition equipment and falling material, protecting lower roof surfaces and adjacent areas from uncontrolled debris, carefully removing joists from party walls and filling the resulting pockets, and preventing collapse due to structural instability

An Overview of Risks in Adjacent Demolition and Construction (CONTINUED)

Figure 4. Timber sheeting at underpinning approach pit with adjacent areas improperly excavated alongside the existing foundation, increasing the risk of soil movement.

as bracing elements are removed. If temporary backfill of the basement or cellar is required after demolition, existing adjacent foundation walls should be evaluated and braced as necessary to resist lateral earth pressure imposed by the backfill. Water management measures, such as pumps with backup power, should be considered to prevent water from precipitation, dust control, or other construction operations from collecting in open cellars and infiltrating through foundation walls of adjacent buildings. Existing wall surfaces and roof edges exposed by demolition should be assessed for air and water penetration resistance and weatherproofed, at least for the duration of temporary exposure, if not also to provide a continuous weathertight building envelope for each adjacent building.

Excavation and Foundations: Removal of soil from beneath an existing foundation (undermining) is generally unacceptable, except in controlled underpinning operations. Excavating vertically downward alongside an existing foundation (Figure 4) should also be avoided, as it removes lateral support provided by the soil beneath or adjacent to the foundation, which may slide downward or buckle outward into the excavation. Excavation support systems (e.g., sequential underpinning with concrete piers, soldier piles with timber lagging, secant piles, and soil berms or benches) and associated dewatering schemes should be selected to keep vertical and lateral soil movement within acceptable limits. Equipment for installing excavation support systems, drilling or driving deep foundation elements, and removing rock should be selected to prevent excessive vibrations from damaging adjacent buildings. Water management measures should be considered to prevent precipitation, groundwater, drilling fluids, and water leaking from utility lines from infiltrating through foundation walls of adjacent buildings, promoting settlement of supporting soil, or causing erosion of soil berms or benches within the excavation.

Superstructure Construction: The risks of adjacent building movement and damage due to foundation settlement or lateral displacement may decrease once the new building's foundation walls are braced by the permanent structure of the first floor, allowing monitoring to be reduced or discontinued. However, it may be prudent to continue some monitoring until after the new building is "topped out," as the increasing dead load on its foundations may cause additional settlement of soil supporting the foundations of adjacent buildings. Building code may also require horizontal separations, also called seismic gaps, to allow new and existing buildings to displace independently in response to wind and earthquake forces without impacting each other or transferring loads between lateral force-resisting systems. Required separations may be filled with compressible material but should be clear of rigid protrusions that reduce their width. As in the demolition phase, the need to protect lower roof surfaces and adjacent areas from falling material should be considered.

Building Interfaces: Vertical and skyward-facing interfaces between new and existing buildings should be detailed to exclude water and vermin. Where the new building rises above adjacent buildings, existing roof drainage systems should be evaluated for additional flow from precipitation running down rising walls onto lower roof surfaces (Figure 5). Existing roof structures should be evaluated for the additional weight of snow sliding from higher roof surfaces or forming drifts against rising walls. The need for extending or redirecting existing chimney flues, exhaust ducts, plumbing vents, fire escapes, means of egress, and similar items should also be evaluated. Openings in walls covered by the new building typically require infill; fire resistance considerations may apply to the detailing of infill or to the protection of existing openings in adjacent walls.

Figure 5. This interface between a rising wall and an existing roof will require careful detailing to exclude water. Any active chimney flues will also need to be extended above the new, higher roof line.

Figure 6. Former shared wall following demolition of existing building, with short lengths of steel channel attached to anchors bracing the masonry to floor structure at each level.

Additional Considerations for Party Walls

Party walls, also known as shared walls, are located along property lines and provide support shared by the buildings on either side. If the building on one side is demolished, the party wall must be maintained in good condition to provide continuing support to the adjacent building (Figure 6). Responsibilities related to party walls may be defined in the building code, property easements, and/or access agreements.

Party walls are common in rows of homes or small commercial buildings that were built concurrently and intended to function together as one structure. As with many structures constructed prior to the development of modern building codes, row structures were not designed to resist wind pressure and other lateral loads. Instead, designers or builders chose wall thicknesses and floor and roof joist sizes and spacings based on empirical rules, which would allow relatively slender party walls with as little as two wythes (vertical layers) of brick masonry between adjacent buildings in a row.

In row structures, party walls carry primarily gravity loads, are not exposed to wind pressure, and are braced against buckling by the floor and roof joists on both sides. The combined length of the front and rear facades helps compensate for the lateral resistance lost to door and window openings and gives the group a greater lateral resistance than the sum of its parts, which is known as the “bookend effect.”

The demolition of one or more buildings in a row structure can have several negative impacts on structural stability.[3] The removal of floor and roof joists from one side of a party wall often means that the wall is no longer effectively braced against buckling in that direction, unless joist-to-wall anchors are installed as demolition proceeds. The resulting discontinuity in the front and rear facades disrupts the “bookend effect,” reducing the overall lateral resistance of the buildings that remain.

Disruption of the “bookend effect” can occur even when a building is removed from the end of a row structure, as the connections between front and rear facades and party walls at the interior of a row are typically not as strong as the exterior wall corners of end units. Disturbance of masonry at facade-to-party wall intersections during demolition can also reduce the bracing of party walls against buckling. Given that party walls were typically built of lower-quality materials not intended for exposure to weather, exposure by demolition can result in rapid deterioration of masonry, deterioration of wood framing embedded in masonry, moisture infiltration, and damage to interior finishes.

Bracing and waterproofing are typically recommended when existing party walls are exposed, especially if the new building is structurally independent and separated from adjacent buildings. If a former party wall is not properly anchored to the remaining floor and roof joists after the corresponding joists are removed from the opposite side, it could buckle into the gap between the buildings and/or collapse. While it may be less disruptive to install joist-to-wall anchors from the exposed face of a former party wall, they can also be installed from the interior, even after the exposed face is obstructed by the new building. Connections between front and rear facades and exposed party walls should also be reviewed and reinforced if necessary. If waterproofing of the exposed face is either temporary or omitted, it will be particularly critical to ensure that interfaces between new and existing buildings are properly sealed in accordance with details developed and reviewed by qualified design professionals.

Conclusions

Planning for new building projects should consider the impacts of demolition, excavation, dewatering, and construction on adjacent buildings. New buildings that rise above or extend below adjacent ones present additional risks and increase the need for evaluation. Where a new building replaces a demolished portion of a row structure, there are additional considerations related to bracing and weatherproofing of former party walls. In all cases, communication between adjacent property owners and independent review of proposed monitoring and protection measures by a qualified consultant can help limit the risk of damage to existing buildings.

[1] For a more detailed discussion focused on historic buildings, see Chad Randl, *Preservation Tech Note 3: Protecting a Historic Structure During Adjacent Construction* (Washington, D.C.: National Park Service, 2001), https://www.nps.gov/tps/how-to-preserve/tech-notes/Tech-Notes-Protection03.pdf

[2] See Arne P. Johnson and W. Robert Hannen, "Vibration Limits for Historic Buildings and Art Collections," *APT Bulletin* 46:2-3 (2015), pp. 66-74, https://www.apti.org/assets/docs/Johnson-HannenHiRes_SampleArt_46.2-3.pdf

[3] See Dan Eschenasy, "Cases of Failure of Unreinforced Brick Walls Due to Out-of-Plane Loads," Structure (May 2011), pp. 14-17, https://www.structuremag.org/wp-content/uploads/2014/08/C-StrucForensics-Eschenasy-May111.pdf ; Dan Eschenasy, "Development Along Old Party Walls," *Structure* (June 2017), pp. 12-15, https://www.structuremag.org/wp-content/uploads/2017/05/C-StrucPractices-Eschensay-Jun17.pdf

Locations:

WJE Philadelphia
601 Walnut Street
Suite 875W
Philadelphia, PA 19106

WJE Princeton
5 Vaughn Drive
Suite 100
Princeton, NJ 08540

Contact:

T: 215.567.0703 | E: jspivey@wje.com

T: 609.799.7799 | E: amlynarczyk@wje.com