Number 25

MAINTENANCE MATTERS

BC HOUSING RESEARCH CENTRE

Podium Overloading and Weight Restriction

Adding heavy items to an existing building can seriously impact its durability, especially if you're not sure what the structure was originally built to handle. This can lead to unexpected problems in the future. When looking to add new landscaping, amenities, or changing the usage of an exterior building space, Owners need to be aware of the potential limitations and when to seek additional professional guidance.

This bulletin focuses on reinforced concrete structures in non-combustible buildings, which includes podiums (suspended slabs over parking spaces) and parking structures of concrete buildings; however, the information can also be generally applied to concrete roof decks and balconies.

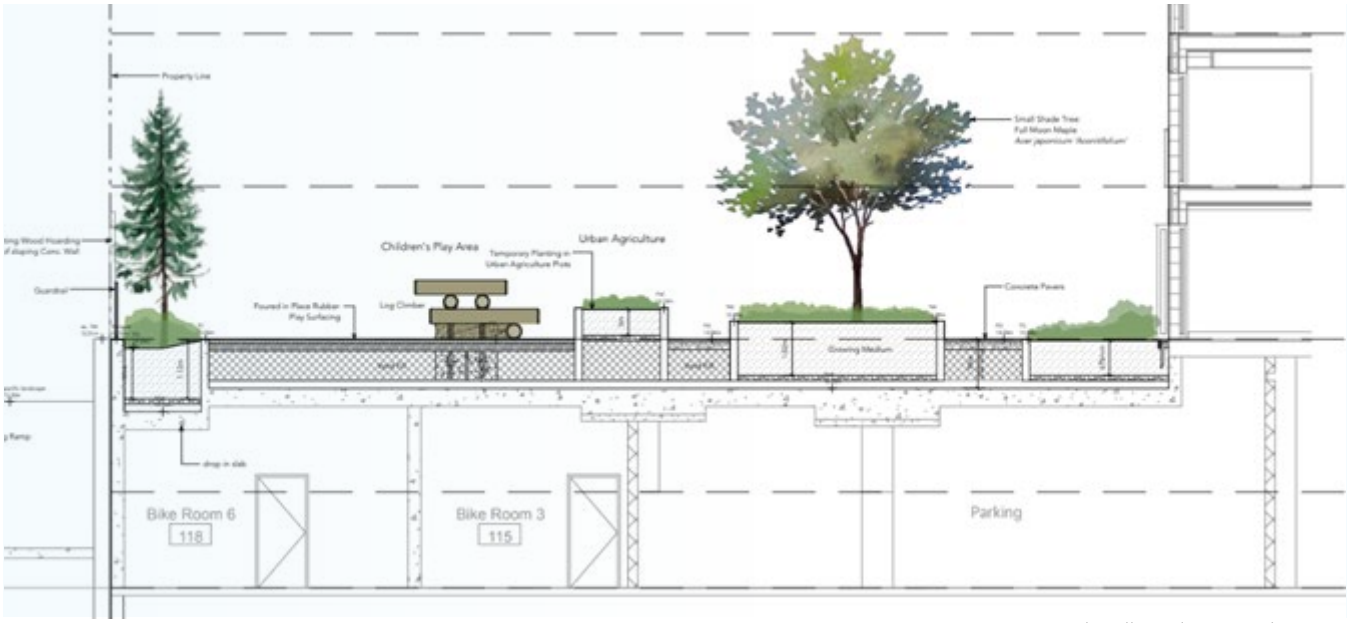
Changing the Loads on Existing Structures

Reinforced concrete structures are extremely robust and are typically used when high load capacities are required. An example of this would be podium assembly around the base of building that acts as a roof over the underground parkade. Like wood frame construction, these components are designed for specific load criteria which owners must consider when making changes to an existing building. Typically podium structures are covered by soft and hard landscaping which hides the structural system. It is very easy to overload hidden structures as the area above them looks the same as the natural ground that is beyond the building footprint.

Source: RDH

Maintenance Matters

This series of bulletins and companion videos is designed to provide practical information on maintaining residential buildings. Produced by BC Housing, this bulletin was prepared by JRS Engineering and RDH Building Science in collaboration with the Condominium Home Owners Association.



Source: Groundswell Landscape Architecture

Regardless of what is visible the podium structure has been designed for specific loads. This typically includes items like soil, sidewalks, planters, driveways, trees, snow, people and vehicles. All these heavy loads should be considered when designing the podium structure, especially if the building's use changes or new components are added later on.

For example, if a driveway on the podium that is normally restricted to cars and light trucks is opened for garbage truck access, that is over a 100% increase in the vehicle live loading. This can happen over time if physical records and signs about vehicle restrictions get lost or damaged, and no one remembers the original restrictions.
Another example of an increase in loading is when trees mature and grow well beyond an anticipated size. The concentrated load from a tall tree can be much heavier than was originally allowed for. These overloading situations can lead to damage or failure of the structural system and Owners need to be aware these risks.

Source: RDH

Typical Design Loads

Live loads: Loads on the structure that are temporary or variable due to the intended use and occupancy.

- **People.** Places where people assemble or where they exit a building have a much higher design load than otherwise. Loading from people is generally not applicable to landscaped areas.
- **Vehicles.** The lightest vehicle loading is for cars and light trucks. Much higher loading applies for garbage trucks, fire trucks, and moving trucks.

Dead loads: Permanent loads on the structure that can be considered constant and functionally immovable, such as soft and hard landscaping including soil, gravel, pavers, plants, trees, and planters.

While assumed to be permanent, these can still be highly variable across a building site due to depths of over burden, size of planters, thickness of concrete layers, and the size of mature trees. Dead loads other than the self weight of the structural system, are usually defined by the requirements shown on the landscaping and architectural drawings.

Snow loads: The additional temporary weight from precipitation buildup on a structure, such as snow, ice, and rain.

- At lower elevation areas in Metro Vancouver, the loads from combined snow and rain loads are relatively similar, except in extreme past events where heavy snow 50+ cm is followed by heavy rain. However, there are large increases in snow loads at higher elevations. Snow loads are considered in all exposed exterior areas.

Accounting for Podium Loads

In the building code there are specific requirements to account for these loads based on the area of the structure being subjected to the loads and the climatic conditions for a given building location. A typical podium slab is usually designed for one of three combinations of loading:

i) soft landscaping with snow loading,

ii) passenger vehicles with roadways, or

iii) hard walking surfaces with people.

Usually soft landscaping includes approximately 45cm (18") of soil overburden, but the depth of soil depends on the types of landscaping and plants used. Larger plants or trees require much thicker soil layers. Roadways and hard walking surfaces typically require 30cm (12") of hard surface overlay but can be thinner. If the dead load from this landscaping is combined with the appropriate live or snow loads the overall design loading is between 9.5 kPa (200 psf) and 14.0 kPa (300 psf).

Although these three loading conditions have similar overall design loads, the load can vary greatly if the depth of soil changes or if the types of vehicles allowed on the podium are modified. Very large closely spaced trees that grow well beyond their original intended size will also be problematic.

Typically fire trucks are not allowed to access podium areas unless there is a provision in the original design. This provision should be posted with signs indicating where trucks are permitted. Cranes or boom lifts that are used to replace roof top equipment or perform building maintenance work may need to drive on the podium structure. Most owners will not be aware of the risks of overloading a podium slab until the damage is done to the structure. It is recommended that owners have accurate records of the design provisions for the podium areas around their buildings. This will include the original structural, architectural, engineering, and landscaping drawings. Signage should be displayed that prevents vehicle overloading. Landscaping renewal projects should consider the original design intent so that work done during the project does not overload the podium structure.

Use of Area of Floor or Roof	Minimum Specified Load, kPa (psf)
Balconies/Decks	
Exterior	4.8 (100 psf)
Garages	
• Vehicles not exceeding 4,000 kg gross weight (such as passenger vehicles)	2.4 (50 psf)
• Vehicles exceeding 4,000 kg but not exceeding 9,000 kg in gross weight (such as ambulances and unloaded buses)	6.0 (125 psf)
• Vehicles exceeding 9,000 kg gross weight (such as fire and garbage trucks)	12.0 (250 psf)

Specific Loads in the BC Building Code

The BC Building Code specifies minimum live load requirements based on the intended use of the structure (Table 4.1.5.3 of the BCBC 2018).

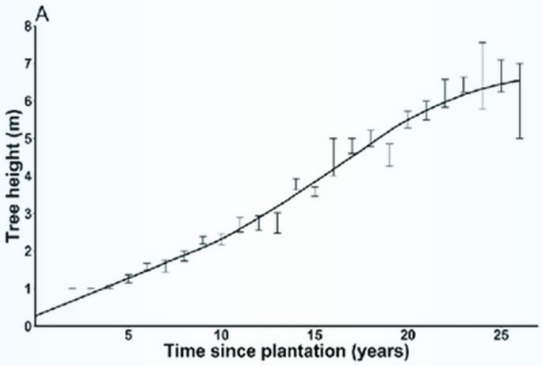
Conditions That Will Require Further Review

The following conditions would trigger the need for further evaluation by a design professional to confirm possible overloading of the structure, which is usually a structural engineer.

- Changing soft landscape area to another use such as vehicle parking or a driveway.
- Installing a new structure on the podium such as a gazebo or trellis that weighs over 400 kgs (1,000 lbs).
- Increasing the thickness of the overburden on the podium slab. This occurs when new topsoil is brought in to created raised planter boxes and beds, without removing existing covering.
- Regrading of the pathways that raises the height of the finished grade.
- Changing the access allowance for heavier vehicles such as garbage or moving trucks. If current permissions have not been evaluated for some time it is recommended that a structural review be completed to ensure that current use of the podium areas complies with the original design intent.
- Driving cranes, boom lifts, or forklifts in driveways that are normally used for cars. This also applies to soft landscape areas or walkways.
- Erection of scaffolding around a building.
- Temporarily storing materials much higher than the original grade. This could be for the movement of soil or gravel during relandscaping or waterproofing. This can also happen when snow is piled up around roadways and parking stalls.
- Converting exterior space to include storage of materials on a long-term basis.
- The growth of mature trees that are well beyond the original intended size is also a concern when many trees are closely spaced together. As a general guide, if trees are over 45cm (18") diameter measured at 120cm (48") above grade the weights of these trees may exceed the planting allowance in the original podium design. See next paragraph for tools to estimate tree weights.

Estimating Tree Weight

The inclusion of trees over a concrete structure requires careful consideration, both in original construction and if adding trees to an existing podium or deck. Many trees can grow much larger than when they were first planted. When installing new trees on a building, it's important to take into account the tree's potential maximum size and weight—this includes the leaves, branches, and roots—throughout its entire lifespan. Otherwise, this may lead to damage, both from structural loading and on the waterproofing. **Note:** when a podium undergoes a renewal of the waterproofing, any large trees or those with extensive roots will likely need to be fully removed to be able to access top of the podium.

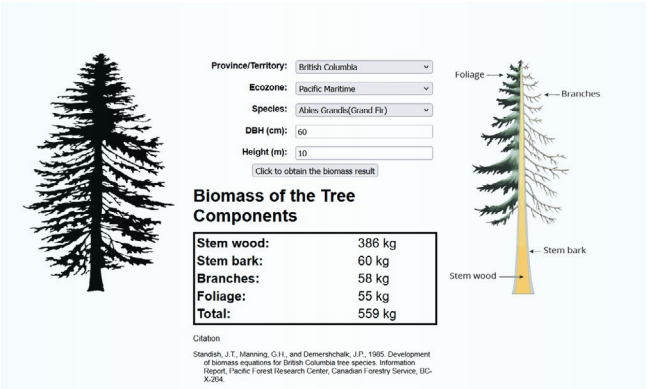


Villemaire-Côté, O., Ruel, J.-C., & Sirois, L. (2017). Development of Northern White-Cedar (Thuja occidentalis L.) Plantations within and outside Deer Yards. Forests, 8(9), 326. https://doi.org/10.3390/f8090326

Estimating live tree weights accurately is very difficult. For this bulletin, it is assumed that any tree that weighs more than 1,000 kgs (2,200 lbs) to be a *heavy* tree. If trees are further apart than 4.5 m (15 ft) then each tree would be considered separately.

Example White Cedar Growth Rates

Cedar trees can grow significantly in a relatively short amount of time, which can localize weight on the podium at these locations.



Example Tree Weight Calculator

The size and weight of a mature red hemlock tree, from Canada's National Forest Inventory.

https://nfi.nfis.org/en/biomass

Example Roof Deck

Never assume that both balconies and roof decks can add large weight loads beyond its original design without confirmation by a professional.

www.rew.ca/buildings/9996/milano-burnaby-bc

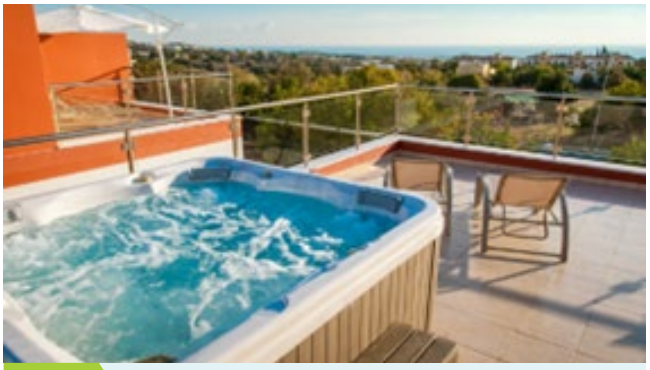
There are numerous online sources and tools that can help estimate mature tree weight and aide owners when considering certain tree species. Owners are recommended to work with a landscaper to select the appropriate tree species for consideration in any project. If intending to install a new tree that will be over 1,000 kgs, this should be evaluated by a design professional for the impact on the podium structure. Close groupings of smaller trees should also be reviewed if the trees are over 40cm (16") in diameter.

Extended Balconies and Decks

Above grade decks and balconies in concrete buildings can be subject to overloading when the occupants install personal amenities, like hot tubs, and landscaping that can exceed the typical design live loading of 4.8kPa (100psf). This also includes extended balconies and roof decks over conditioned space, which is common at lower levels of mid and high-rise residential buildings.

Even if a deck is fully supported on all sides, Owners still need to be aware of possible weight limitations before installing any new heavy items onto the structure.

Typically decks and balconies are not designed to allow for larger planters or hot tubs. For example, an 8-person hot tub would have a superimposed weight of over 4.8kPa (100 psf) and a larger planter with 600mm (24") of wet soil in it would be substantially more than the design loading. These types of additions to balconies or decks are not recommended unless a review is done by a structural engineer.



Example Significant Localized Load Increase

Hot tubs can add significant weight to a structure due to the components, water and people all localized in one area.

www.trip.com/hotels/paphos-hotel-detail-5618651/new-day-apartments/

Action Plan Tips

Before you proceed with projects that may affect the podium structure consider the following:

- ☐ If landscape projects are being contemplated, ensure that the design intent of the podium structure is well understood. Engage a structural engineer to complete this review.
- ☐ Landscape renewals that are raising the finished grade must be evaluated for overall loading impact. If deeper soil beds are being considered, alternative solutions using Styrofoam layers can allow for increased height without adding extra weight.
- ☐ If new trees are included in a landscape renewal project, consider how large the mature trees will be.
- ☐ When the podium structure is exposed during podium membrane renewal projects, have the concrete condition reviewed by a design professional. Repair the deteriorated concrete at that time.
- ☐ Ensure podium overburden is well drained and free of ponding. Slope finished grade away from the building. The soil should not be significantly compacted during the project so that it does not allow for a free flow of drainage.
- ☐ Snow removal, over burden landscaping, and roofing or waterproofing loading should be avoided in concentrated areas to avoid stressing the structure.
- ☐ Equipment used during landscape renewal projects should be vetted by a design professional for impact on the structural capacity of the podium structure. Generally small bobcats will be acceptable but larger equipment like dump trucks will not be.
- ☐ If not already known, engage a professional engineer to assist with determining where heavy vehicles such as garbage trucks can drive and park.
- ☐ Equipment that is being moved or set up on the podium structure, in areas not including truck zones, that exceeds weights of 4,000 kg (8,400 lbs should be reviewed by a design professional. This includes boom lifts, cranes, garbage trucks, disposal bins, and temporary storage containers.
- ☐ Conduct semi-annual reviews of the underside of the podium structure checking for concrete deterioration and other unusual signs of movement or cracking. Moisture ingress can lead to reinforcing steel corrosion and concrete spalling that should be monitored.

More Information

- Maintenance Matters 17: Replacing Podium Waterproofing
- Maintenance Matters 22: Balcony Overloading and Weight Restrictions

We gratefully acknowledge all people facing accessibility barriers, who have responded to the surveys and have participated so diligently throughout this process.

About BC Housing's Research Centre

BC Housing's Research Centre collaborates with industry, non-profit, and public sector partners to foster excellence, innovation, and affordability in British Columbia's housing sector. We share leading-edge research, advance science and technologies to encourage best practices, and provide data analysis to understand and find solutions to housing issues across the province. The Research Centre identifies and bridges research gaps in the following topic areas: populations & communities, built environment & design, sustainable & resilient housing, housing assistance & policy, housing & wellbeing. Mobilizing knowledge and research expertise accelerates innovation and facilitates the adoption of new housing models, building methods, and standards. Housing studies and program evaluations drive policy changes and support access to affordable housing in British Columbia. Sign up to receive the latest news and updates from BC Housing's Research Centre at www.bchousing.org/subscribe.

BC HOUSING RESEARCH CENTRE

1701- 4555 Kingsway,
Burnaby, BC V5H 4V8

Toll-free: 1-866-465-6873
Email: research@bchousing.org

www.bchousing.org