5.7 GRADE-SEPARATED CROSSINGS

Bridges, overpasses, and underpasses make it possible for active transportation facilities to cross major barriers such as waterways, limited-access highways, and railways. These grade-separated crossings are required for the sake of continuity and directness. In their absence, users may be forced to make long detours to cross a barrier.

There are cases where a grade-separated crossing is not essential but may be preferable to a level crossing for the safety and convenience of users. This can be the case for crossing a high volume roadway where motorists are not likely to yield to crossing pedestrians and cyclists, where gaps in traffic are infrequent, and where the provision of a signalized crossing is not viable. In such a case, a grade-separated crossing is likely to be safer and can help pedestrians and cyclists avoid long delays.

Grade-separated crossings have some notable disadvantages. For users, the primary disadvantage is that they tend to require more physical effort to cross than a level crossing because they entail a change in elevation. For municipalities, they are more expensive to construct and maintain, particularly if the crossing is to be kept open through the winter. For this reason, locations for grade-separated crossings must be chosen strategically and the crossings must be designed carefully to meet the needs of pedestrians and cyclists.

Exhibit 5-51. Examples of Grade Separated Crossings in Ontario

QEW/Red Hill Valley Active Transportation Bridge

Hamilton

- 220 m long
- $7.6 M construction cost (2010 dollars)

Trans Canada Trail over Highway 401

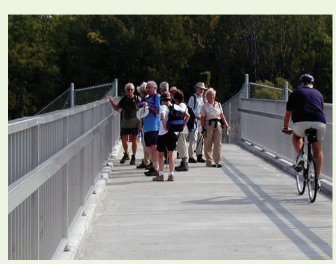
Kitchener/Cambridge

- 102 m long
- $1.7 M (2007 dollars)

Radial Line/Chedoke Trail crossing Highway 403,

Hamilton

- 80 m long



5.7.1 Bridges and Overpasses

For road and rail crossings, overpasses are generally preferable to underpasses from a user comfort and safety perspective. They benefit from natural lighting and allow users to see and be seen. However, they tend to require a greater change in elevation than underpasses. An overpass must rise enough to provide a clearance of 5.3 m above a roadway or 7 m above a railway. In contrast, an underpass for pedestrians and cyclists requires a vertical clearance of only 3 m (refer to Exhibit 5-52). As a result, underpasses are typically more common than overpasses in York Region (refer to Section 5.7.2).

Design

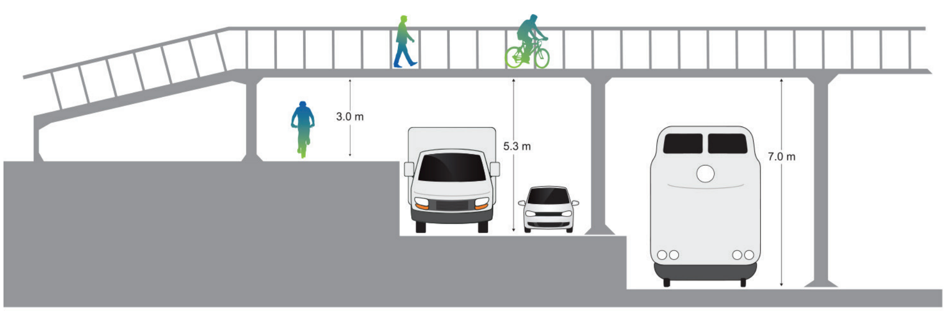
Bridges and overpasses for pedestrians and cyclists can be stand-alone structures or can be connected to larger bridges or viaducts. In either case, the preferred width for an elevated, mixed pedestrian and cyclist crossing is at least 4 m. A minimum width of 3 m is acceptable in cases where pedestrian traffic is limited.

If necessary, pedestrians and cyclists can be separated using a barrier curb, flexible posts, or a railing (refer to Section 9.2). This is only warranted when user volumes are high. In these cases, it is necessary that both sections have the minimum required widths—i.e., 1.8 m for pedestrians and 3 m for cyclists (for bidirectional use). It is important to avoid crossing the pedestrian and cycling paths at either end of the bridge or overpass, particularly at the foot of steep slopes.

Grades on access ramps should be limited to 5% to meet AODA requirements. To provide 5.3 m of clearance above a roadway with 0.7 m thick structure, a 120 m ramp would be required to meet the 5% maximum slope requirement. Ramps can be straight, curved or spiral in shape. Spiral or U-shaped ramps take up less space and have the advantage of forcing cyclists to slow down when descending. However, the continuous curve of a spiral ramp demands an extra effort on the part of wheelchair users.

If the road ROW that is being crossed includes active transportation facilities, a link between those facilities and the overpass is required to ensure that pedestrians and cyclists travelling along the roadway can access the overpass to cross the road.

Exhibit 5-52. Vertical clearances for road and railway overpasses



Adapted from Velo Quebec 2010

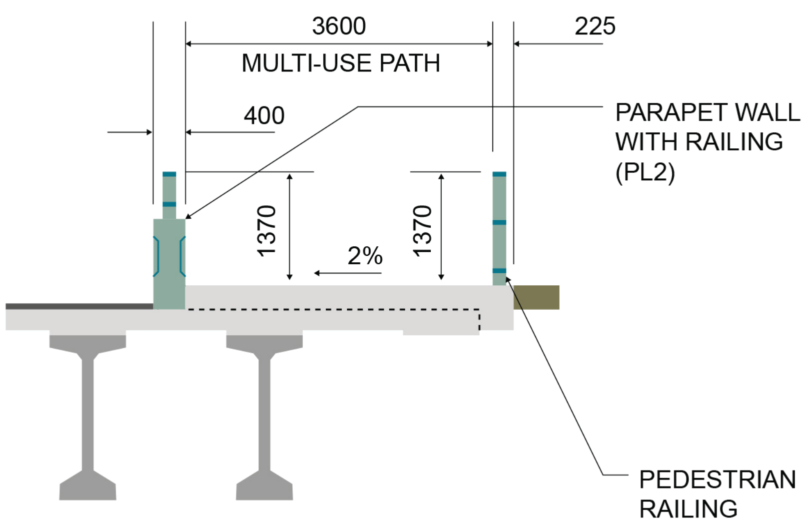
Construction

The common types of overpasses and bridges include:

- **Single spans**: These are the most common design for waterway crossings. Abutments on either side of the barrier to be crossed support single-span bridges.
- **Multiple spans**: These require several piles to support the spans. They are fairly easy to integrate into a road crossing but expensive for waterway crossings. When installed above a river, piles can impede water flow and catch debris. The use of precast concrete beams can help reduce cost but sometimes yield visually unappealing results.
- **Suspension bridges**: These are visually appealing and make it possible to span greater distances. They are most often used for river crossings but can be used over roadways as well.
- **Cantilever decks**: These are structures added onto an existing a bridge or viaduct or integrated into the structure by design. They benefit from the main structures carrying capacity while offering pedestrians and cyclists a separate space.

The deck surfacing can be concrete, asphalt or wood. In the case of wood, the planks must be placed crosswise, at a 45° or greater angle to the path of travel, to ensure bicycle and wheelchair wheels cannot get caught in the gaps in between. Metal surfacing such as plates or grating are not recommended because they are too slippery when wet. Expansion joints should be covered to prevent small wheels from being caught in the openings and provide a smoother ride.

Exhibit 5-53. Sample Cross-section of a Multi-use Path along a Bridge



5.7.2 Underpasses

Underpasses are rectangular or vaulted structures that make it possible to cross a man-made barrier such as a roadway or a railway. They particularly useful for crossing roadways and railways that atop an high embankments.

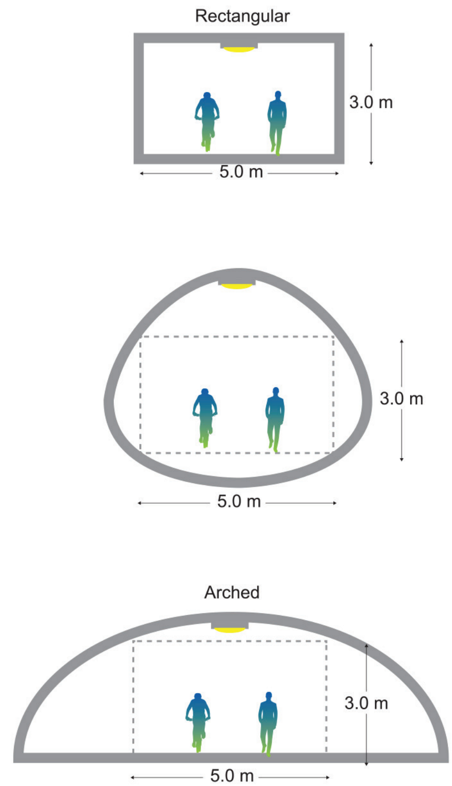
Design

An underpass must be wide and tall enough for pedestrians and cyclists travelling in both directions to pass through safely. Regardless of the shape, the recommended width is 5 m (refer to Exhibit 5-54). A narrower tunnel increases the risk of accidents due to a combination of descent speed, low light, and the presence of sidewalls. A vertical clearance of at least 3 m throughout the tunnel will help ensure user comfort and optimal natural light.

Vaulted or elliptical cross-sections are preferable to rectangular cross-sections for maximizing natural lighting. Artificial lighting is usually required at the centre of a tunnel to ensure visibility. If lighting fixtures are not recessed, their dimensions should be taken into consideration in the calculation of the overhead clearance. They should also be protected from vandalism, which is common in tunnels, by a metal cage or other device.

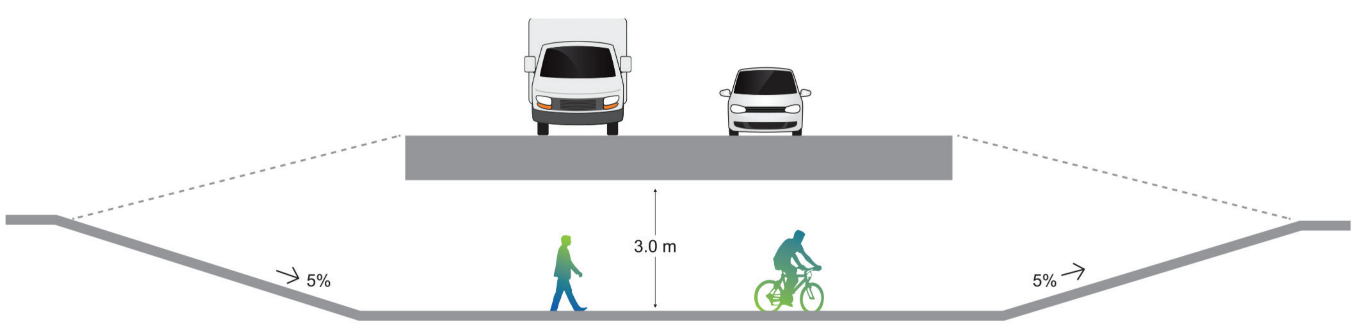
As with ramps for bridges and overpasses, the grade on the approaches to an underpass should be no greater than 5% to meet AODA requirements (refer to Exhibit 5-57). Ideally, the approaches to the tunnel entrance should not include tight curves. They must allow users to see the entrance before entering and perceive the end of the tunnel as soon as they are inside. However, when the tunnel is perpendicular to the route of a path or trail, an S-curve-shaped approach is useful for reducing speed before users enter the tunnel.

Exhibit 5-54. Typical Underpass Cross-sections



Adapted from Velo Quebec 2010

Exhibit 5-57. Underpass elevation profile



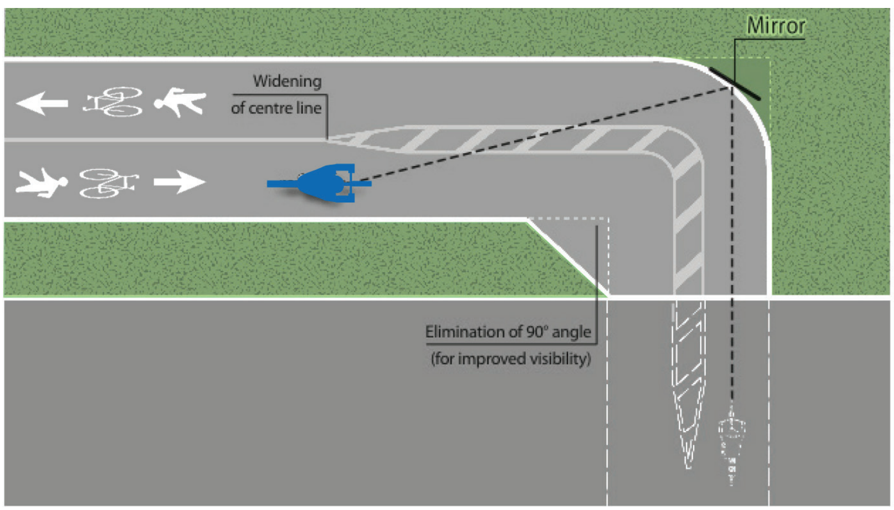
Adapted from Velo Quebec 2010

When the sightlines are not ideal—for example, when space constraints require an approach with a tight curve at the tunnel entrance—several measures can be used to improve the situation (refer to Exhibit 5-58):

- Vandal-proof convex mirrors
- Markings that clearly separate traffic in each direction and discourage passing, such as a yellow centreline or a double line with a hatched buffer zone
- No passing signs at critical locations

To meet AODA requirements, handrails must be installed on both sides of ramps providing access to underpasses. These are essential for mobility-impaired individuals, helping them manoeuvre and remain stable on slopes. They are also useful for in-line skaters, helping them to control their speed when descending.

Exhibit 5-58. Perpendicular underpass approach showing mitigation strategies



Source: Adapted from Vélo Québec 2010

Lighting is particularly important through underpasses, which typically are not served by street lighting. Exhibit 5-59 illustrates recommended lighting guidelines for cycling facilities, which should be maintained through underpasses.

Exhibit 5-59. Recommended illumination of Active Transportation Facilities

Level of Pedestrian or Cyclist Activity	Maintained Average Horizontal Illuminance (lux)	Maximum Horizontal Uniformity Ratio	Minimum Maintained Vertical Illuminance (lux)
High(>50/Hour)	*20.0*	*4.0:1*	*10.0*
Medium (10 to 50/Hour)	*5.0*	*4.0:1*	*2.0*
Low (<10/Hour)	*3.0*	*6.0:1*	*0.8*

Source: OTM Book 15

In some cases, the addition of CCTV cameras or emergency help stations to underpasses may be considered.

Construction

An underpass can be constructed either as a covered trench or a channel bored under the barrier being crossed. The inner structure is either a concrete box or a concrete or galvanized steel tube forming a circular or elliptical vault.

It is best to build a tunnel at the same time as the road or railway it crosses or during major roadwork. In addition to reducing construction costs, this can create the opportunity to slightly raise the road or railway in order to minimize the necessary change in grade along the active transportation path.

Under an existing road, when traffic can be rerouted, tunnel construction is facilitated by completely closing the road above. If road closure is not an option, creating temporary lanes and taking the necessary precautions to divert traffic around the work site will significantly increase project costs.

5.7.3 Road Underpasses

Pedestrians and cyclists can travel through road tunnels provided adequate facilities are in place: lightly coloured walls, ideally covered with ceramic tiles; adequate lighting; a sidewalk separated from the roadway by a railing or protective barrier; and appropriate cycling facilities for the road context.

When new road bridges, underpasses or overpasses are designed, the provision of high quality pedestrian and cycling facilities should be included in the design and costing of the structure, even where the route may not be identified on an existing network plan. This is to ensure the structure accommodates all users, during the full lifespan of the structure.