RAILSIDE AT THE FORKS - CONCEPT PLAN

07/2017

RAILSIDE AT THE FORKS

10.5 : RAIL PROXIMITY

Overall, it is FRC's aim to ensuring consistency with the general intent of the Federation of Canadian Municipalities' Guidelines for New Developments in Proximity to Railway Operations (May 2013), as well as the City of Winnipeg's ongoing efforts to establish its own regulatory regime, to mitigate the impacts associated with development in proximity to active railways.

The Railside development offers a unique opportunity to implement innovative mitigation approaches that contribute to urban design excellence and, which in turn, can serve as a demonstration for other jurisdictions contemplating large scale urban redevelopment projects in proximity to active railways.

As a minimum benchmark, the FCM Guidelines suggest that new developments achieve a minimum setback of 30m from the mutual property line. Given the variability of the mutual property line that exists between CN and FRC, and the significant reduction in developable area that such a setback would impose, this Concept Plan proposes an alternative approach. Rather than using the mutual property line as the basis from which the setback is measure, this Concept Plan proposes applying 30m setback from the eastern-most rail line.

FRC has retained Hatch, an engineering firm with railway expertise, to provide an independent and professional assessment of the proposed setback from the existing rail line. Hatch's analysis concluded that based on a consideration of risk factors, site attributes, and the fact that the subject rail corridor is low speed, the proposed setback is acceptable and in keeping with the spirit and intent of the FCM/RAC Guidelines.

Recognizing that life-safety is of paramount concern, the proposed approach establishes a consistent separation distance between the planned development and the active rail line, while attenuating potential impacts on the viability of the development.

GUIDELINES

for New Development in Proximity to Railway Operations

PREPARED FOR
THE FEDERATION OF CANADIAN MUNICIPALITIES
AND THE RAILWAY ASSOCIATION OF CANADA

May 2013

DIALOG

J.E. COULTER
ASSOCIATES
LIMITED

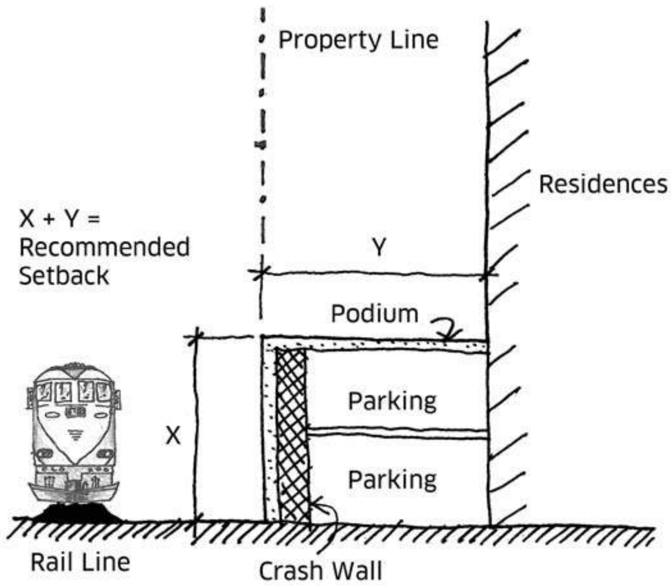


FIGURE 4 // INCORPORATING A CRASH WALL INTO A DEVELOPMENT CAN REDUCE THE RECOMMENDED SETBACK.

3.3 // BUILDING SETBACKS FOR NEW DEVELOPMENTS

A setback from the railway corridor, or railway freight yard, is a highly desirable development condition, particularly in the case of new residential development. It provides a buffer from railway operations; permits dissipation of rail-oriented emissions, vibrations, and noise; and accommodates a safety barrier. Residential separation distances from freight rail yards are intended to address the fundamental land use incompatibilities. Proponents are encouraged to consult with the railway early in the development process to determine the capacity of the site to accommodate standard setbacks (see below). On smaller sites, reduced setbacks should be considered in conjunction with alternative safety measures. Where the recommended setbacks are not technically or practically feasible due, for example, to site conditions or constraints, then a Development Viability Assessment should be undertaken by the proponent to evaluate the conditions specific to the site, determine its suitability for new development, and suggest options for mitigation. Development Viability Assessments are explained in detail in Appendix A.

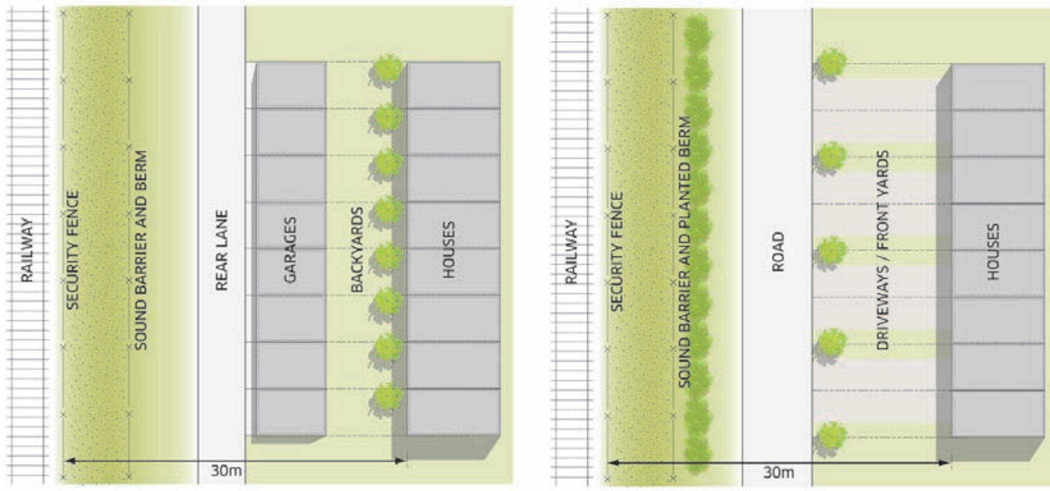
3.3.1 Guidelines

- The standard recommended building setbacks for new residential development in proximity to railway operations are as follows:
  - » Freight Rail Yard: 300 metres
  - » Principle Main Line: 30 metres
  - » Secondary Main Line: 30 metres
  - » Principle Branch Line: 15 metres
  - » Secondary Branch Line: 15 metres
  - » Spur Line: 15 metres
- Setback distances must be measured from the mutual property line to the building face. This will ensure that the entire railway right-of-way is protected for potential rail expansion in the future.

» **Policy Recommendation**

Municipalities should establish minimum setback requirements through a zoning bylaw amendment.

- Under typical conditions, the setback is measured as a straight-line horizontal distance.
- Where larger building setbacks are proposed (or are more practicable, such as in rural situations), reduced berm heights should be considered.
- Marginal reductions in the recommended setback of up to 5 metres may be achieved through a reciprocal increase in the height of the safety berm (see Section 3.6 Safety Barriers)
- Horizontal setback requirements may be substantially reduced with the construction of a crash wall (see Section 3.6 Safety Barriers). For example, where a crash wall is incorporated into a low-occupancy podium below a residential tower, the setback distance may be measured as a combination of horizontal and vertical distances, as long as the horizontal and vertical value add up to the recommended setback. This concept is illustrated in FIGURE 4.
- Where there are elevation differences between the railway and a subject development property, appropriate variations in the minimum setback should be determined in consultation with the affected railway. For example, should the railway



FIGURES 5 (LEFT) & 6 (RIGHT) // SETBACK CONFIGURATION OPTIONS FOR OPTIMUM SITE DESIGN

Note that in both scenarios displayed in Figures 5 & 6, the presence of intervening structures between the railway and the outdoor amenity areas may negate the need for a sound barrier. Where a barrier is not required for noise, vegetative or other screening is recommended to provide a visual barrier to the sometimes frightening onset of a high speed passenger train.

tracks be located in a cut, reduced setbacks may be appropriate.

- Appropriate uses within the setback area include public and private roads; parkland and other outdoor recreational space including backyards, swimming pools, and tennis courts; unenclosed gazebos; garages and other parking structures; and storage sheds.

Example setback configurations are illustrated in FIGURES 5 AND 6.

3.4 // NOISE MITIGATION

Noise resulting from rail operations is a key issue with regards to the liveability of residential developments in proximity to railway facilities, and may also be problematic for other types of sensitive uses, including schools, daycares, recording studios, etc. As well as being a major source of annoyance for residents, noise can also have impacts on physical and mental health, particularly if it interferes with normal sleeping patterns.[1] The rail noise issue is site-specific in nature, as the level and impact of noise varies depending on the type of train operations. (see Appendix B for a sample rail classification system). Proponents will have to carefully plan any new development in proximity to a railway corridor to ensure that noise impacts are minimized as much as possible. Generally, during the day, noise should be contained to a level conducive to comfortable speech communication or listening to soft music, and at night it should not interfere with normal sleeping patterns.[2] For building retrofits, while the majority of the guidelines below will apply, special attention should be paid to windows, doors, and the exterior cladding of the building.

3.4.1 Guidelines

- Since rail noise is site-specific in nature, the level and impact of noise on a given site should be accurately assessed by a qualified acoustic consultant through the preparation of a noise impact study. The objective of the noise impact study is to assess the impact of all noise sources affecting the subject lands and to determine the appropriate layout, design, and required control measures. Noise studies should be undertaken by the proponent early in the development process, and should be submitted with the initial proposal.

> » **Policy Recommendation**
>
> Municipalities should consider amending their Official Plan or other appropriate legislation to require noise impact studies as part of any rezoning or Official Plan amendment near railway operations.

- The recommended minimum noise influence areas to be considered for railway corridors when undertaking noise studies are:
  - » Freight Rail Yards: 1,000 metres
  - » Principal Main Lines: 300 metres
  - » Secondary Main Lines: 250 metres
  - » Principal Branch Lines: 150 metres
  - » Secondary Branch Lines: 75 metres
  - » Spur Lines: 75 metres

1 Berglund, B., Lindvall, T., & Schwela, D. H., eds. (1999). Guidelines for community noise [Research Report]. Retrieved from World Health Organization website: http://www.who.int/docstore/peh/noise/guidelines2.html

2 Canada Mortgage and Housing Corporation. (1986). Road and rail noise: Effects on housing [Canada]: Author.

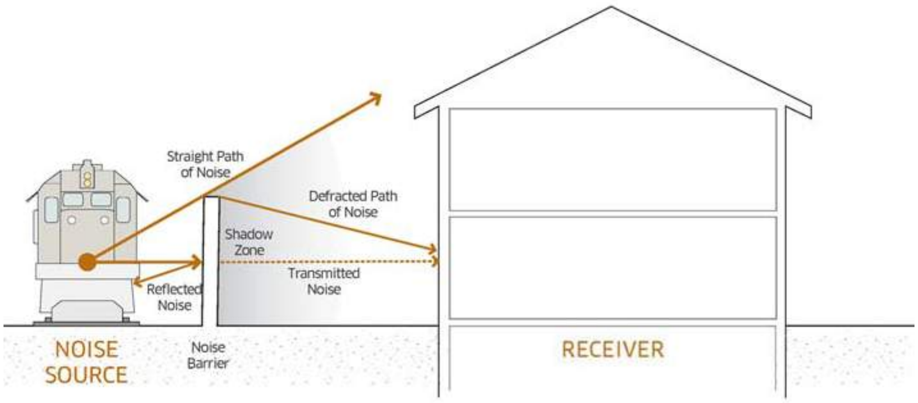


FIGURE 7 // EFFECT OF A NOISE BARRIER ON THE PATH OF NOISE FROM THE RECEIVER TO THE SOURCE. A NOISE BARRIER REDUCES NOISE LEVELS IN THREE WAYS: BY DEFLECTING NOISE OFF OF IT, BY DAMPENING THE NOISE THAT IS TRANSMITTED THROUGH IT, AND BY BENDING, OR DIFFRACTING NOISE OVER IT. THE AREA RECEIVING THE MOST PROTECTION BY THE NOISE BARRIER IS TYPICALLY REFERRED TO AS THE "SHADOW ZONE".

- The acoustic consultant should calculate the external noise exposure, confirm with measurements if there are special conditions, and calculate the resultant internal sound levels. This should take into account the particular features of the proposed development. The measurements and calculations should be representative of the full range of trains and operating conditions likely to occur in the foreseeable future at the particular site or location. The study report should include details of assessment methods, summarize the results, and recommend the required outdoor as well as indoor control measures.
- To achieve an appropriate level of liveability, and to reduce the potential for complaints due to noise emitted from rail operations, new residential buildings in proximity to railway operations should be designed and constructed to comply with the sound level limits criteria shown in AC.1.4 (see AC.1.6 for sound limit criteria for residential buildings in proximity to freight rail shunting yards). Habitable rooms should be designed to meet the criteria when their external windows and doors are closed. If sound levels with the windows or doors open exceed these criteria by more than 10 dBA, the design of ventilation for these rooms should be such that the occupants can leave the windows closed to mitigate against noise (e.g. through the provision of central air conditioning systems).
- In Appendix C, recommended procedures for the preparation of noise impact studies are provided, as well as detailed information on noise measurement. These should be observed.
- It is recommended that proponents consult Section 2.4 of the Canadian Transportation Agency (CTA) report, *Railway Noise Measurement and Reporting Methodology* (2011) for guidance on the recommended content and format of a noise impact study.

3.4.1.1 Avoiding Adverse Noise Impacts through Good Design

Many of the adverse impacts of railway noise can be avoided or minimized through good design practices. Careful consideration of the location and orientation of buildings, as well as their internal layout can minimize the exposure of sensitive spaces to railway noise. Site design should take into consideration the location of the rail corridor, existing sound levels, topography, and nearby buildings. Noise barriers, acoustic shielding from other structures, and the use of appropriate windows, doors, ventilation, and façade materials can all minimize the acoustic impacts of railway operations. Note that many of the design options recommended below have cost and market acceptability liabilities that should be evaluated at the outset of the design process.

3.4.1.2 Noise Barriers

- A noise barrier can effectively reduce outdoor rail noise by between 5dBA and 15dBA, although the largest noise reductions are difficult to achieve without very high barriers. Noise barriers provide significant noise reductions only when they block the line of sight between the noise source and the receiver. Minimum noise barrier heights vary by the classification of the neighbouring rail line.[3] Though the required height will be determined by

3 Note that the height of a noise barrier can be achieved in combination with that of a berm, if present.

FIGURE 8 // PRECEDENT IMAGERY DEMONSTRATING THE INCORPORATION OF URBAN DESIGN AND LIVING WALLS INTO NOISE BARRIERS
SOURCES: (LEFT) WESTFIELD WINDBREAK BY WILTSHIREBLOKE. CC BY-NC-ND 3.0. RETRIEVED FROM: HTTP://WWW.FLICKR.COM/PHOTOS/WILTSHIREBLOKE/3580334228/. (MIDDLE) AUTUMN COLORS BY GEIR HALVORSEN. CC BY-NC-SA 3.0. RETRIEVED FROM: HTTP://WWW.FLICKR.COM/PHOTOS/DAMIEL/47160698/. (RIGHT) IMAGE BY DIALOG.

an acoustic engineer in a noise report, they are typically at least:

» **Principal Main Line:** 5.5 metres above top of rail

» **Secondary Main Line:** 4.5 metres above top of rail

» **Principal Branch Line:** 4.0 metres above top of rail

» **Secondary Branch Line:** no minimum

» **Spur Line:** no minimum

Differences in elevation between railway lands and development lands may significantly increase or decrease the required height of the barrier, which must at least break the line of sight. Thus, when not at the same grade, the typical barrier heights are measured from an inclined plane struck between the ground at the wall of the dwelling and the top of the highest rail.

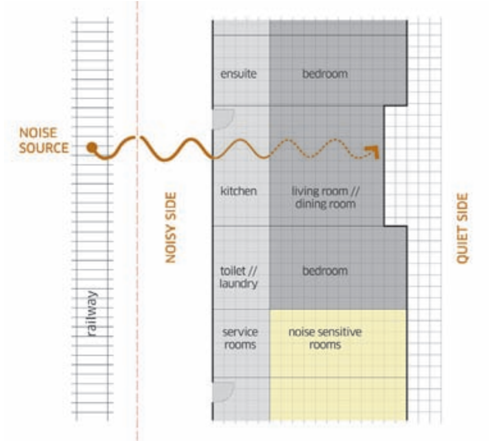
- In keeping with existing railway guidelines for new developments, noise barriers must be constructed adjoining and parallel to the railway right-of-way with returns at each end. They must be constructed without holes or gaps and should be made of a durable material with sufficient mass to limit the noise transmission to at least 10dBA less than the noise that passes over the barrier,[4] at least 20 kg per square metre of surface area. Masonry, concrete, or other specialist construction is preferred in order to achieve the maximum noise reduction combined with longevity. Well-built wood fences are acceptable in most cases. Poorly constructed fences of any type are an unnecessary burden on future residents.
- Consideration should be made to limiting the visual impact of noise barriers in order to maintain a high level of urban design in all new developments, and to discourage vandalism. This can be accomplished by incorporating public art into the design of the barrier, or through the planting of trees and shrubs on the side of the barrier facing the development, particularly where it is exposed to regular sunlight.
- Alternatively, the barrier itself may be constructed as a living wall, which also has the benefit of providing additional noise attenuation. FIGURE 8 provides some examples of how good design practices may be incorporated into the design of noise barriers.

N.B. New barriers constructed on one side of a railway opposite an older neighbourhood without barriers may lead to concerns from existing residents about the potential for noise increases due to barrier reflections. It is common for the characteristics of the noise to change due to frequency, duration, and time of onset, which, combined, may be perceived as a significant increase in noise levels. However, this is not generally supported through onsite measurement, as the train will act as its own barrier to any reflected noise during pass-by.

3.4.1.3 Building Location, Design Orientation, and Room Layout

While low-rise buildings may benefit from shielding provided by topography, barriers, or other buildings, high-rise buildings usually receive less noise shielding, and are, therefore, typically more exposed to noise from

4 Rail Infrastructure Corporation. (November 2003). Interim guidelines for applicants: Consideration of rail noise and vibration in the planning process. Retrieved from http://www.daydesign.com.au/downloads/Interim_guidelines_for_applicants.pdf



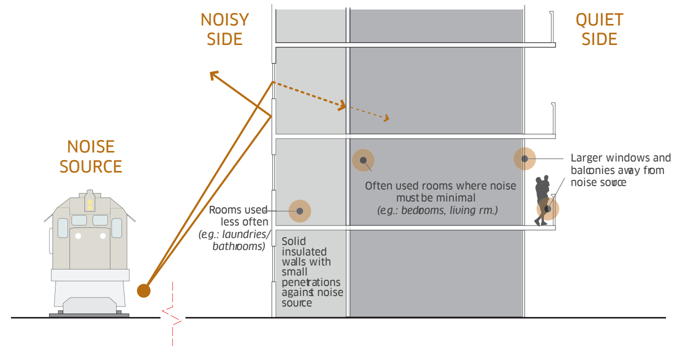


FIGURE 9 // **LOCATING NOISE SENSITIVE ROOMS AWAY FROM RAIL NOISE IN DETACHED DWELLINGS; AND FIGURE 10 (RIGHT) - LOCATING NOISE SENSITIVE ROOMS AWAY FROM RAIL NOISE IN MULTI-UNIT DWELLINGS.** (SOURCE: ADAPTED FROM FIGURE 3.6 IN THE DEVELOPMENT NEAR RAIL CORRIDORS AND BUSY ROADS - INTERIM GUIDELINE BY THE STATE OF NEW SOUTH WALES, AUSTRALIA)

FIGURE 10 // **LOCATING NOISE SENSITIVE ROOMS AWAY FROM RAIL NOISE IN MULTI-UNIT DWELLINGS** (SOURCE: ADAPTED FROM FIGURES 3.5 & 3.6 IN THE DEVELOPMENT NEAR RAIL CORRIDORS AND BUSY ROADS - INTERIM GUIDELINE BY THE STATE OF NEW SOUTH WALES, AUSTRALIA)

» **Policy Recommendations**

Urban Design Guidelines for development near railway corridors would be a valuable tool in suggesting building layout and design. Alternatively, municipal planners should pay close attention to these issues through a site planning process. Jurisdictions that do not allow comprehensive site planning may wish to consider amendments to their land use planning legislation.

Comprehensive zoning for podiums would be a valuable tool for areas in proximity to railway operations that municipalities have identified for redevelopment. Urban Design Guidelines can also speak to appropriate built form, including podium design, setbacks, step backs etc. At a minimum, municipal planners should secure podium massing as part of a site-specific zoning by-law amendment.

Balconies can be regulated through zoning if administered comprehensively and can be secured as part of a site-specific zoning by-law. Urban Design Guidelines should also speak to appropriate balcony design (e.g. recessed versus protruding balconies).

Urban Design Guidelines should contain comprehensive information on best practices for landscape design, and appropriate types and species of plants.

Urban Design Guidelines can speak to materiality. Some jurisdictions, such as Ontario, allow municipalities to regulate external materials through the site plan process. This practice should be encouraged and jurisdictions that do not currently allow for this should consider making appropriate amendments to their land use planning legislation.

rail operations. In either case, noise mitigation needs to be considered at the outset of a development project, during the layout and design stage.

- One of the most effective ways of reducing the impact of rail noise is through the use of a setback, by increasing the separation between the source of noise and the noise sensitive area. Generally, doubling the distance from the noise source to the receiver will reduce the noise levels by between 3dBA and 6dBA.[5] (See Section 3.3 Building Setbacks)
- The layout of residential buildings can also be configured to reduce the impact of rail noise. For example, bedrooms and other habitable areas should be located on the side of the building furthest from the rail corridor. Conversely, rooms that are less sensitive to noise (such as laundry rooms, bathrooms, storage rooms, corridors, and stairwells) can be located on the noisy side of the building to act as a noise buffer. This concept is illustrated in FIGURES 9 AND 10.
- Minimizing the number of doors and windows on the noisy side of the dwelling will help to reduce the intrusion of noise. In the case of multi-unit developments, a single-loaded building where the units are located on the side of the building facing away from the rail corridor is another potential solution for reducing noise penetration.

3.4.1.4 Podiums

- Outdoor rail noise can be substantially reduced by building residential apartments on top of a podium or commercial building space. If the residential

5 State Government of New South Wales, Department of Planning. (2008). Development near rail corridors and busy roads - interim guideline. Retrieved from http://www.planning.nsw.gov.au/rdaguidelines/documents/DevelopmentNearBusyRoadsandRailCorridors.pdf

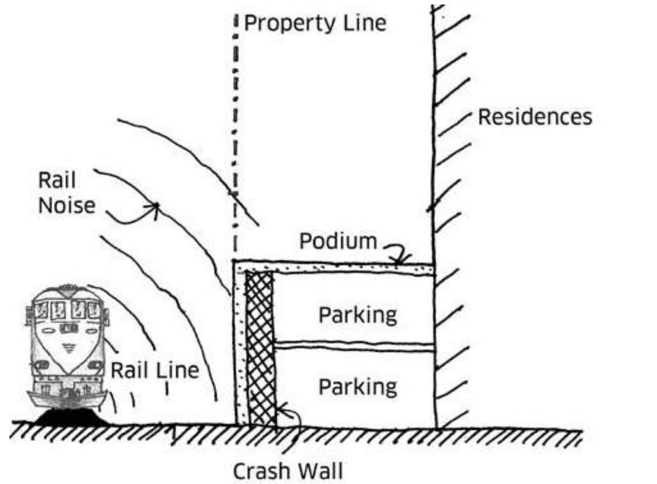


FIGURE 11 // PODIUMS CAN HELP REDUCE THE AMOUNT OF NOISE THAT REACHES RESIDENCES IF A SETBACK IS USED. (SOURCE: ADAPTED FROM FIGURE 3.13 IN THE DEVELOPMENT NEAR RAIL CORRIDORS AND BUSY ROADS - INTERIM GUIDELINE BY THE STATE OF NEW SOUTH WALES, AUSTRALIA).

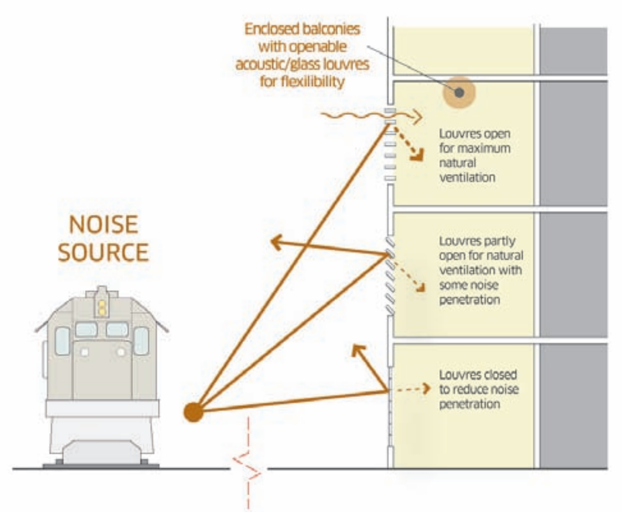


FIGURE 12 // USING ENCLOSED BALCONIES FACING A RAILWAY CORRIDOR AS NOISE SHIELDS. (SOURCE: ADAPTED FROM FIGURE 3.16 IN THE DEVELOPMENT NEAR RAIL CORRIDORS AND BUSY ROADS - INTERIM GUIDELINE BY THE STATE OF NEW SOUTH WALES, AUSTRALIA).

tower is set back, then the podium acts to provide increased distance from the railway corridor, thus reducing the noise from the corridor and providing extra shielding to the lower apartments. This concept is illustrated in FIGURE 11.

3.4.1.5 Balconies

- Providing enclosed balconies can be an effective means of reducing the noise entering a building. Where enclosed balconies are used, acoustic louvres and possibly a fan to move air into and out of the balcony space may be installed to address ventilation requirements. This concept is illustrated in FIGURE 12.

3.4.1.6 Vegetation

- While vegetation such as trees and shrubs does not actually limit the intrusion of noise, it has been shown to create the perception of reduced noise levels. Vegetation is also valuable for improving the aesthetics of noise barriers and for reducing the potential for visual intrusion from railway operations.

3.4.1.7 Walls

- In order to reduce the transmission of noise into the building, it is recommended that masonry or concrete construction or another form of heavy wall be used for all buildings in close proximity to railway corridors. This will aid in controlling the sound-induced vibration of the walls that rattles windows, pictures, and loose items on shelving. Additionally, care should be taken to ensure that the insulation capacity of the wall is not weakened by exhaust fans, doors, or windows of a lesser insulation capacity. To improve insulation response, exhaust vents can be treated with sound-absorbing material or located on walls which are not directly exposed to the external noise.

3.4.1.8 Windows

Acoustically, windows are among the weakest elements of a building façade. An open or acoustically weak window can severely negate the effect of an otherwise acoustically strong façade.[6] Therefore, it is extremely important to carefully consider the effects of windows on the acoustic performance of any building façade in proximity to a railway corridor. In addition to the recommendations below, proponents are advised to familiarize themselves with the Sound Transmission Class (STC) rating system, which allows for a comparison of the noise reduction that different windows provide.[7] In order to successfully ensure noise reduction from windows, proponents should:

- ensure windows are properly sealed by using a flexible caulking such as mastic or silicone on both the inside of the window and outside, between the wall opening and the window frame;
- use double-glazed windows with full acoustic seals. When using double-glazing, the wider the air space between the panes, the higher the insulation (50 mm to 100 mm is preferable in non-sealed widows and 25mm in sealed windows). It is also desirable in some cases to specify the panes with different thicknesses to avoid sympathetic resonance or to use at least one laminated lite to dampen the vibration within the window;
- consider reducing the size of windows (i.e. use punched windows instead of a window wall or curtain wall);

6 State Government of New South Wales, Department of Planning. (2008). Development near rail corridors and busy roads - interim guideline. Retrieved from http://www.planning.nsw.gov.au/rdaguidelines/documents/DevelopmentNearBusyRoadsandRailCorridors.pdf

7 The STC rating of a soundproof window is typically in the range of 45 to 54.

- consider increasing the glass thickness;
- consider using absorbent materials on the window reveals in order to improve noise insulation in particularly awkward cases;
- consider using hinged or casement windows or fixed pane windows instead of sliding windows;
- ensure window frames and their insulation in the wall openings are air tight; and
- incorporate acoustic seals into operable windows for optimal noise insulation.

Note that window frame contributions to noise penetration are typically less for aluminum and wood windows than for vinyl frames, as above.[8]

3.4.1.9 Doors

In order to ensure proper acoustic insulation of doors:

- airtight seals should be used around the perimeter of the door;
- cat flaps, letter box openings, and other apertures should be avoided;
- heavy, thick, and/or dense materials should be used in the construction of the door;
- there should be an airtight seal between the frame and the opening aperture in the façade;
- windows within doors should be considered as they exhibit a higher acoustic performance than the balance of the door material; and
- sliding patio doors should be treated as windows when assessing attenuation performance.

8 Note that STC ratings should include the full window assembly with the frame, as frames have been shown to be a weak component, and may not perform as anticipated from the glazing specifications.

3.5 // VIBRATION MITIGATION

Vibration caused by passing trains is an issue that could affect the structure of a building as well as the liveability of the units inside residential structures. In most cases, structural integrity is not a factor. Like sound, the effects of vibration are site specific and are dependent on the soil and subsurface conditions, the frequency of trains and their speed, as well as the quantity and type of goods they are transporting.

The guidelines below are applicable only to new building construction. In the case of building retrofits, vibration isolation of the entire building is generally not possible. However, individual elevated floors may be stiffened through structural modifications in order to eliminate low-frequency resonances. Vibration isolation is also possible for individual rooms through the creation of a room-within-a-room, essentially by floating a second floor slab on a cushion (acting like springs), and supporting the inner room on top of it.[9] Additional information regarding vibration mitigation options for new and existing buildings can be found in the *FCM/RAC Railway Vibration Mitigation Report*, which can be found on the Proximity Project website.

3.5.1 Guidelines

- Since vibration is site-specific in nature, the level and impact of vibration on a given site can only be accurately assessed by a qualified acoustic or vibration consultant through the preparation of a vibration impact study. It is highly recommended that an acoustic or vibration consultant be obtained by the proponent early in the design process, as mitigation can be difficult. It is recommended

9 Howe, B., & McCabe, N. (March 15 2012). Railway vibration reduction study: Information on railway vibration mitigation [Ottawa, ON]: Railway Association of Canada.

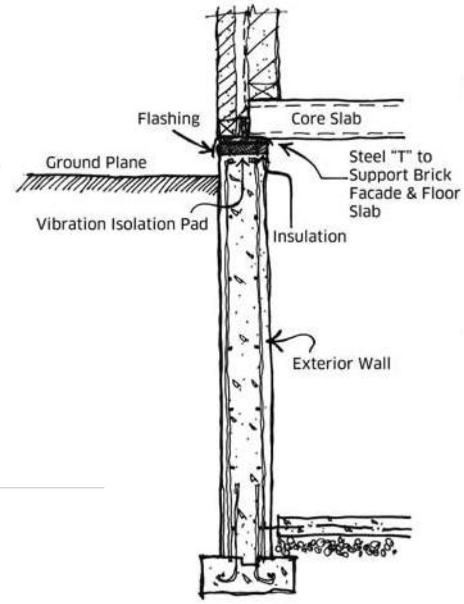


FIGURE 13 // SHALLOW VIBRATION ISOLATION

that the consultant be used to determine whether vibration mitigation measures are necessary and what options are available given the particular conditions of the development site in question. The consultant will employ measurements to characterize the vibration affecting the site in question. In the absence of a future rail corridor not yet operating, estimates based on soil vibration testing are required, although such sites are quite rare.

» **Policy Recommendation**

Municipalities should consider amendments to their Official Plan, where necessary, to make vibration studies a requirement for any zoning by-law amendment and Official Plan amendment applications.

- The recommended minimum vibration influence area to be considered is 75 metres from a railway corridor or rail yard.
- The acoustic consultant should carry out vibration measurements and calculate the resultant internal vibration levels. This should take into account the particular features of the proposed development. The measurements and calculations should be representative of the full range of trains and operating conditions likely to occur at the particular site or location. The study report should include details of the assessment methods, summarize the results, and recommend the required control measures.
- See AC.2.5 for recommended procedures for the preparation of vibration impact studies. These should be observed.
- The important physical parameters that should be considered by the consultant for designing vibration control can be divided into the following four categories:
  - Operational and vehicle factors: including speed, primary suspension on the vehicle, and flat or worn wheels.
  - Guideway: the type and condition of the rails and the rail support system.
  - Geology: soil and subsurface conditions are known to have a strong influence on the levels of ground-borne vibration. Among the most important factors are the stiffness and internal damping of the soil and the depth of bedrock. Experience with ground-borne vibration is that vibration propagation is more efficient in stiff soils. Shallow rock (within a metre or two of the surface) seems to prevent significant vibration. Additional factors such as layering of the soil and depth to the water table, including their seasonal fluctuation, can have significant effects on the propagation of ground-borne vibration.
  - Receiving building: the vibration levels inside a building depend on the vibration energy that reaches the building foundations, the coupling of the building foundation to the soil, and the propagation of the vibration through the building. The general guideline is that the heavier a building is, the lower the response will be to the incident vibration energy.

3.5.2 Examples of Vibration Mitigation Measures

Full vibration isolation requires a significant amount of specialist design input from both the acoustic consultant and the structural engineer, and is therefore more suited to larger developments, which exhibit greater economies of scale.

3.5.2.1 Low-rise Buildings

- Vibration isolation of lightweight structures is difficult but possible for below grade floors. Normally, the upper floors are isolated from the foundation wall and any internal column supports using rubber pads designed to deflect 5 to 20mm under load. This concept is illustrated in FIGURE 13. Additionally, the following factors should be taken into consideration when designing vibration isolation for lightweight structures:
  - » Using hollow core concrete or concrete construction for the first floor makes the isolation problem easier to solve.
  - » Thought must be given to temporary wind and earthquake horizontal loads.
  - » A seam is created around the foundation wall that must be water sealed and insulated.
  - » Finishing components such as wood furring cannot be attached either above or below the isolation joint.
  - » All of these special items would likely be carried out by trades untrained in vibration control and therefore, a good deal of site supervision is required.
- Minor vibration control (usually only a 30% reduction) can be achieved by lining the outside of the foundation walls with a resilient layer. This practice takes advantage of the fact that the waves of vibration from surface rail travel mostly on the surface, dying down with depth. To obtain reasonable results, however, the lining must be quite soft and yet be able to withstand the lateral soil pressures present on the foundation wall.

3.5.3.2 Deep Foundation Buildings

- In the case of deep concrete foundations near rail lines, the design of vibration isolation for the surface wave should consider whether or not it is necessary to isolate the base of the building columns and walls. Often, these structures are anchored well below the depth where the surface wave penetrates and there are several levels of parking that the vibration must climb to reach a floor where vibration is of concern. Therefore, unless the rail corridor is running in a tunnel, isolation of deep foundation buildings may only require isolation of the foundation wall away from the structure.
- In severe cases, or locations where the foundation is not deeper than the surface wave, vibration isolation may also be required beneath the columns and their foundations, though it may only be necessary to isolate those portions of the structure located closest to the rail line. Consideration should be given to the differential deflection from one column row to the next, if only part of the building is vibration isolated.
- This is an unusual type of construction, which requires considerable professional supervision. The design is usually a joint effort between the vibration and structural engineers. Some architectural expertise is also needed, particularly for waterproofing the gap at the top of the foundation wall below the grade slab and making sure that there are no inadvertent connections between internal walls on the parking slabs and the vibrating

foundation wall, or between the grade slab and the lowest parking slab if the columns are isolated.

3.6 // SAFETY BARRIERS

Safety barriers reduce the risks associated with railway incidents by intercepting or deflecting derailed cars in order to reduce or eliminate potential loss of life and damage to property, as well as to minimize the lateral spread or width in which the rail cars and their contents can travel. The standard safety barrier is an earthen berm, which is intended to absorb the energy of derailed cars, slowing them down and limiting the distance they travel outside of the railway right-of-way. The berm works by intercepting the movement of a derailed car. As the car travels into the berm, it is pulled down by gravity, causing the car to begin to dig into the earth, and pulling it into the intervening earthen mass, slowing it down, and eventually bringing it to a stop.

3.6.1 Guidelines

3.6.1.1 Berms

- Where full setbacks are provided, safety barriers are constructed as berms, which are simple earthen mounds compacted to 95% modified proctor. Setbacks and berms should typically be provided together in order to afford a maximum level of mitigation. Berms are to be constructed adjoining and parallel to the railway right-of-way with returns at the ends and to the following specifications:
  - » Principle Main Line: 2.5 metres above grade with side slopes not steeper than 2.5 to 1
  - » Secondary Main Line: 2.0 metres above grade with side slopes not steeper than 2.5 to 1

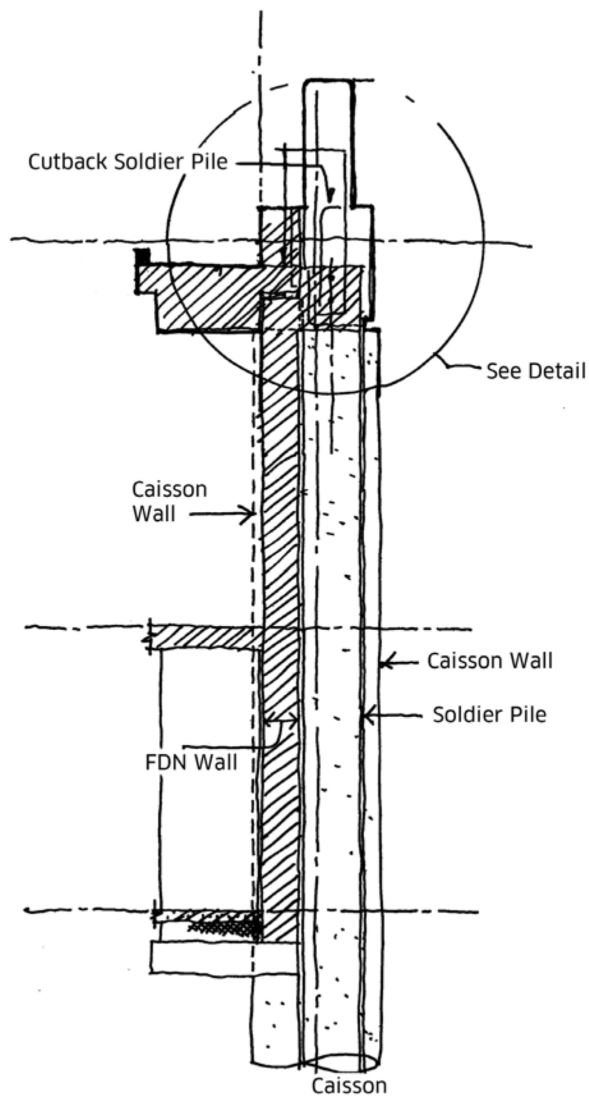


FIGURE 14A // DEEP VIBRATION ISOLATION, COMBINED WITH CRASH WALL.

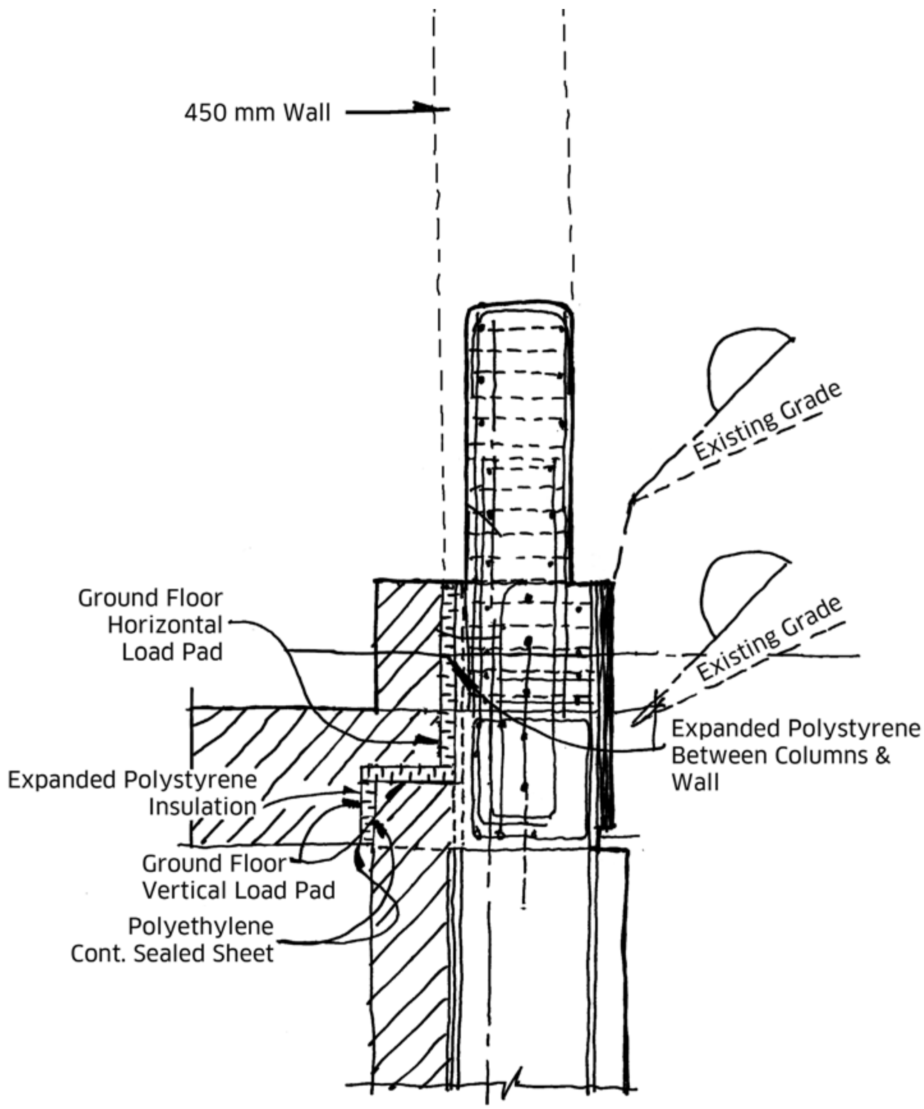


FIGURE 14B // DEEP VIBRATION ISOLATION DETAIL, COMBINED WITH CRASH WALL.

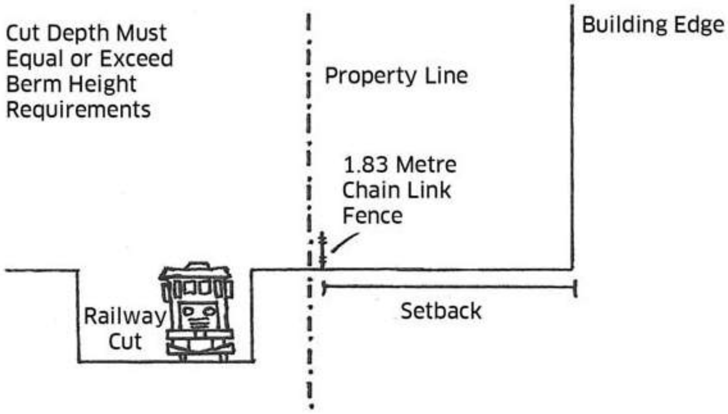


FIGURE 15 // NO BERM IS REQUIRED WHERE THE RAILWAY IS IN A CUT OF EQUIVALENT DEPTH

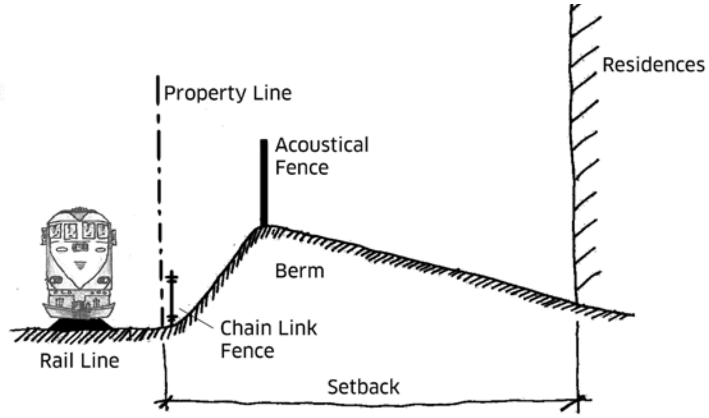


FIGURE 16 // GRADUALLY RETURNING TO GRADE FROM THE TOP OF THE BERM AVOIDS CREATING UNUSABLE BACKYARD SPACE OR BLOCKING SUNLIGHT

- » Principle Branch Line: 2.0 metres above grade with side slopes not steeper than 2.5 to 1
- » Secondary Branch Line: 2.0 metres above grade with side slopes not steeper than 2.5 to 1
- » Spur Line: no requirement

N.B. Berms built to the above specifications will have a full width of as many as 15 metres.

- Berm height is to be measured from grade at the property line. Reduced berm heights are possible where larger setbacks are proposed.
- Steeper slopes may be possible in tight situations, and should be negotiated with the affected railway.
- Where the railway line is in a cut of equivalent depth, no berm is required (FIGURE 15).
- There is no requirement for the proponent to drop back to grade on the side of the berm facing the subject development property. The entire grade of the development could be raised to the required height, or could be sloped more gradually. This may be desirable to avoid creating unusable backyard space, due to the otherwise steep slope of the berm. This concept is illustrated in FIGURE 16.
- Marginal reductions in the recommended setback of up to 5 metres may be achieved through a reciprocal increase in the height of the berm.
- If applicable to the site conditions, in lieu of the recommended berm, a ditch or valley between the railway and the subject new development property that is generally equivalent to or greater than the inverse of the berm could be considered (e.g. a ditch that is 2.5 metres deep and approximately 14 metres wide in the case of a property adjacent to a Principle Main Line). This concept is illustrated in FIGURE 17.
- Where the standard berm and setback are not technically or practically feasible, due for example, to site conditions or constraints, then a Development Viability Assessment should be undertaken by the proponent to evaluate the conditions specific to the site, determine its suitability for development, and suggest alternative safety measures such as crash walls or crash berms. Development Viability Assessments are explained in detail in APPENDIX A.

» **Policy Recommendation**

Urban Design Guidelines may be useful tools for establishing specifications for the proper use and design of berms.

3.6.1.2 Crash Berms

Crash berms are reinforced berms – essentially a hybrid of a regular berm and a crash wall. They are generally preferable to crash walls, because they are more effective at absorbing the impact of a train derailment. This results from both the berm's mass and the nature of the material of which it is composed. Crash berms are also highly cost effective and particularly useful in spatially constrained sites where a full berm cannot be accommodated.

In derailment scenarios other than a head-on or close to head-on interception, the standard earthen berm and setback distance will be more effective in absorbing the kinetic energy of the derailed train than a reinforced concrete crash wall. The reason for this is that anything other than a 90 degree interception of the crash wall will result in some deflection of the energy in the derailing

PHOTO SOURCE: RAILWAY ASSOCIATION OF CANADA

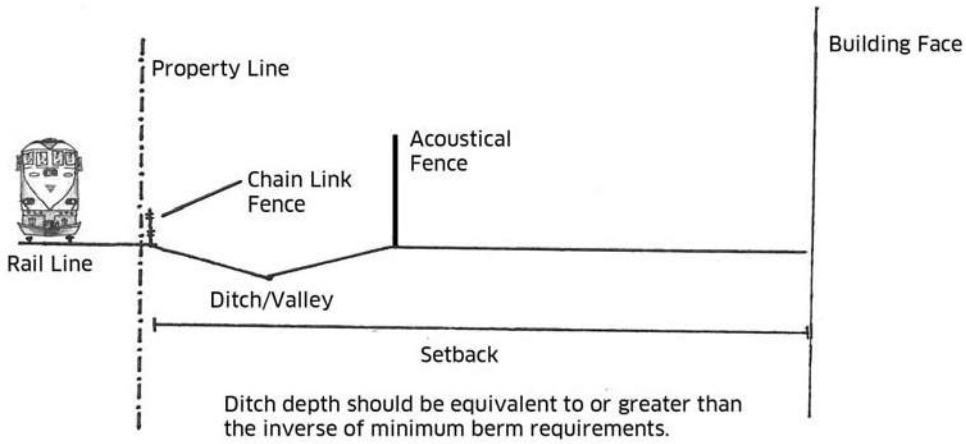


FIGURE 17 // A DITCH OR VALLEY OF EQUIVALENT DEPTH CAN BE USED IN PLACE OF A STANDARD BERM ADJACENT TO A MAIN LINE RAILWAY

train back towards the corridor, thus extending the time and distance of the derailment event. This extension of derailment time and distance results in greater risk of damage to private property along a longer section of the rail corridor, to more lives, and results in more expensive clean up and restoration work within the rail corridor. The preference therefore, is to design "crash berms" which are typically concrete wall structures retaining more earth behind the wall that in-turn provide more energy absorption characteristics (see FIGURE 18).

3.6.1.3 Crash Walls

Crash walls are concrete structures that are designed to provide the equivalent resistance in the case of a train derailment as the standard berm, particularly in terms of its energy absorptive characteristics. The design of crash walls is dependent on variables such as train speed, weight, and the angle of impact, which will vary from case to case. Changes in these variables will affect the amount of energy that a given crash wall will have to absorb, to effectively stop the movement of the train. In addition, the load that a wall is designed to withstand will differ based on the flexibility of the structure, and therefore, on how much deflection that it provides under impact. For these reasons, it is not possible to specify design standards for crash walls. In keeping with existing guidelines developed by AECOM, the appropriate load that a crash wall will have to withstand must be derived from the criteria outlined below.

- When proposing a crash wall as part of a new residential development adjacent to a railway corridor, the proponent must undertake a detailed study that outlines both the site conditions as well as the design specifics of the proposed structure. This study must be submitted to the affected municipality for approval and must contain the following elements:

  » a location or key plan. This will be used to identify the mileage and subdivision, the classification of the rail line, and the maximum speed for freight and passenger rail traffic;

  » a Geotechnical Report of the site;

  » a site plan clearly indicating the property line, the location of the wall structure, and the centreline and elevation of the nearest rail track;

  » layout and structure details of the proposed crash wall structure, including all material notes and specifications, as well as construction procedures and sequences. All drawings and calculations must be signed and sealed by a professional engineer;

  » the extent and treatment of any temporary excavations on railway property; and

  » a crash wall analysis, reflecting the specified track speeds for passenger and/or freight applicable within the corridor, and which includes the following four load cases:

    i. Freight Train Load Case 1 - Glancing Blow: three locomotives weighing 200 tonnes each plus six cars weighing 143 tonnes each, impacting the wall at 10 degrees to the wall;

    ii. Freight Train Load Case 2 - Direct Impact: single car weighing 143 tonnes impacting the wall at 90 degrees to the wall;

    iii. Passenger Train Load Case 3 - Glancing Blow: two locomotives weighing 148 tonnes each plus 6 cars weighing 74 tonnes each impacting the wall at 10 degrees to the wall; and

    iv. Passenger Train Load Case 4 - Direct Impact: Single car weighing 74 tonnes impacting the

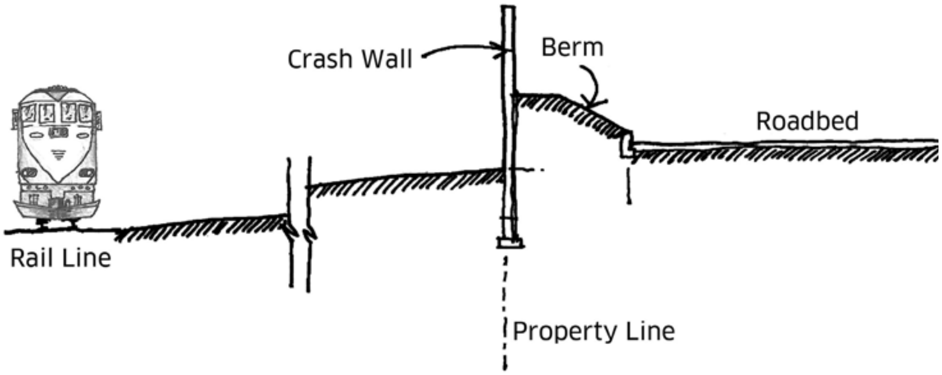


FIGURE 18 // EXAMPLE CONFIGURATION OF A CRASH BERM

wall at 90 degrees to the wall.

- The crash wall design must include horizontal and vertical continuity to distribute the loads from the derailed train.
- To assist in designing the crash wall safety structure, the following should be considered:
  i. The speed of a derailed train or car impacting the wall is equal to the specified track speed;
  ii. The height of the application of the impact force is equal to 0.914 m (3 feet) above ground; and
  iii. The minimum height of the wall facing the tracks is equal to 2.13 m (7 feet) abovethe top of rail elevation.
- For energy dissipation calculations, assume:
  i. Plastic deformation of individual car due to direct impact is equal to 0.3 m (1 foot) maximum;
  ii. Total compression of linkages and equipment of the two or three locomotive and six cars is equal to 3.05 m (10 feet) maximum; and
  iii. Deflection of the wall is to be determined by the designer, which would depend on material, wall dimensions and stiffness of crash wall.

3.7 // SECURITY FENCING

Trespassing onto a railway corridor can have dangerous consequences given the speed and frequency of trains, and their extremely large stopping distances, and every effort should be made to discourage it. This will save lives, reduce emergency whistling, and minimize disruptions to rail service.

3.7.1 GUIDELINES

- At a minimum, all new residential developments in proximity to railway corridors must include a 1.83 metre high chain link fence along the entire mutual property line, to be constructed by the owner entirely on private property. Other materials may also be considered, in consultation with the relevant railway and the municipality. Noise barriers and crash walls are generally acceptable substitutes for standard fencing, although additional standard fencing may be required in any location with direct exposure to the rail corridor in order to ensure there is a continuous barrier to trespassing.

» **Policy Recommendation**

Tresspass issues can be avoided through careful land use planning. Land uses on each side of a railway corridor or yard should be evaluated with a view to minimizing potential trespass problems. For example, schools, commercial uses, parks or plazas should not be located in proximity to railway facilities without the provision of adequate pedestrian crossings.

- Due to common increased trespass problems associated with parks, trails, open space, community centres, and schools located in proximity to the railway right-of-way, increased safety/security measures should be considered, such as precast fencing and fencing perpendicular to the railway property line at the ends of a subject development property.