

In this guide:

- Purpose
- Design
- Construction
 - Walls and Footings
- Maintenance and Repair
 - Dampness
 - Crawl Spaces
 - Care
 - Settlement and Cracks
- Radon Gas Testing and Reduction
 - What is Radon Gas?
 - How Radon Can Enter a Building
 - Radon Testing?
 - Hiring a Professional

Foundations

Introduction

Foundations comprise the base of a building and act as a stable platform on which structures are built. They allow weight to be transferred evenly into the ground, and anchor the building against forces, such as strong winds. The way a foundation is built will be determined by the quality of the earth beneath it, whether it is hard or soft, wet or dry. Without a proper foundation, buildings are subject to movement and shifting due to settlement, water penetration and freeze-thaw cycles. Movement in a building often results in cracked walls and window panes, heaving floors and stuck doors. This practical guide provides an overview of foundation construction and materials, and explains how to prevent, identify and repair foundation deficiencies and natural threats such as the presence of radon gas, in heritage buildings.

Purpose

Foundations serve several significant functions. They support the weight of a structure, hold back the surrounding earth, protect the building from water, dampness and insects, and form the shell of the basement, often the “service centre” of a structure housing its infrastructure. Before purchasing an older house, inspect the foundation to ensure it is sound.

Design

Foundation walls are generally constructed of stone, brick, cast concrete or concrete block – materials that withstand the effects of moisture. Due to the aesthetic concerns of builders, often the foundation material exposed above grade will be more attractive than the material below. Stone

and brick of various types were the preferred construction material for above-grade foundation walls in the 1800s. Poured concrete or concrete block foundations, sometimes concealed behind stone or brick cladding, became more common after 1890 and into the 1900s.

Construction

Understanding proper construction practices for foundations can help you, as a property owner, identify causes of trouble, anticipate future issues and better understand the process of undertaking major foundation work. The image to the right shows the parts of a foundation. Note that a foundation should extend a minimum of six inches above the soil level to protect the home from contact with excessive moisture.

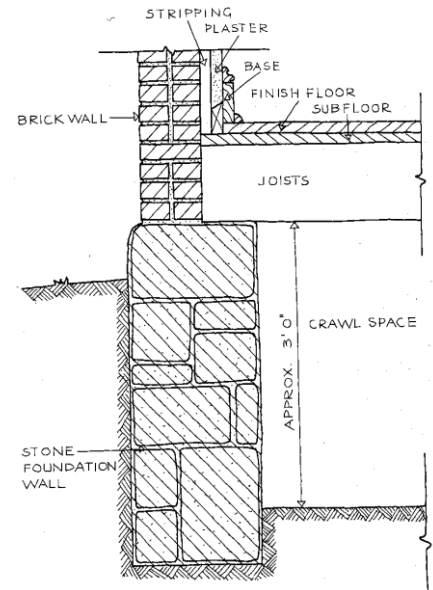


Image: Parts of a foundation (Betty Anderson, 1983, p. 196)

A crawl space is the shallow area beneath a house that does not have a full basement, and is usually enclosed by foundation walls. Girders (not labeled) should be placed at least 24 inches above the ground, and joists 36 inches above the soil in crawl spaces. Any replacement wood should be treated with a preservative if it will be in contact with masonry or installed within eight inches of the ground. Wood already located in a crawl space should also be protected from moisture and treated to prolong its life. For information, see the [Practical Guide: Structural Woodwork](#).

Walls and Footings

Footings are the foundations base and their function is to distribute the structure's load to prevent uneven settling. Some older houses' footings may be the same width as or wider than the foundation walls or they may be nonexistent. Many heritage buildings have stone foundation walls that simply sit on earth below grade, often

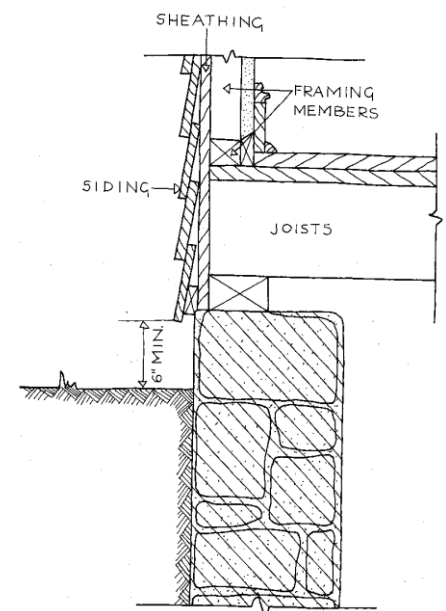


Image: Minimum recommended foundation height (Betty Anderson, 1983, p. 197)

below the frost line (the lowest depth that frost reaches). Soil under the foundation should be undisturbed and compact. For this reason good drainage around the foundation walls and footings extending below the frost line will help to achieve a stable foundation.

Maintenance and Repair

Dampness

Dampness is a common problem in foundations, crawl spaces and basements. Excess moisture may result in rotted wood and insect infestation, which can lead to weakened materials. The first step in controlling dampness is to identify the source. Poor drainage is a common cause and can be avoided by installing gutters, downspouts and water drainage systems (i.e. storm drains, dry wells) that direct water away from the house. Water entering through window wells is another source of dampness. The addition of a shield over the window well or a drain leading from the window well to a dry well at least 15 feet from the foundation is another solution. The ground surrounding the foundation should slope away from the house for six or more feet. If it does not, earth can be moved around the house to create this slope. On a sloping lot, drains installed underground on the high side of a retaining wall built roughly 15 feet from the house on the uphill side may effectively direct water past the house.

Seepage and Condensation

Seepage of water into the basement and condensation are other common sources of dampness. The best remedy for condensation is continuous ventilation on dry days or the use of a dehumidifier. Seepage takes more work to correct and can be accomplished by sealing the interior walls of the basement with a waterproof coating after a thorough cleaning and filling of all cracks in the mortar. Although many techniques and products are recommended for coating foundation walls, like oil-based and latex waterproofing paint and clear sealers, their effectiveness can be limited and should be used with caution.

Rising Damp

“Rising damp” is a term used when water is absorbed from moist soil and drawn into brick or stone walls by capillary action. Poor drainage and soil that does not slope away from the foundation are sources of this problem. Consult with a specialist to determine the best intervention, which may include installing a vapour barrier on the walls to protect them and adjacent wood from deterioration.

Major Interventions

For serious issues of water penetration through foundation walls, a trench may need to be excavated and drains installed to a sump pump inside the walls. Another solution involves digging soil away from the foundation on the exterior, installing drain tiles at the level of the footings and installing a waterproof membrane to the exterior foundation wall. For interventions such as these, it is advised to contact a reputable firm that specializes in waterproofing.

Crawl Spaces

Rising damp is also a common problem with crawl spaces, as is condensation resulting from heating a building in cool weather and air-conditioning a house in hot, humid weather. Proactive measures taken to keep a crawl space dry will reduce the likelihood of decay and insect infestation.

Vents installed around the perimeter of the foundation, ideally near the corners, will improve the movement of air within the crawl space. As well, unheated crawl spaces should be insulated and the vapour barrier should be installed above the insulation facing the heated room.

Care

Foundations, crawl spaces and basements should be inspected once a year for the following common problems as outlined in the Province of Manitoba's, [Heritage Building Maintenance Manual](#):

Moisture

- After a hard rain, are gutters, downspouts and water drainage systems working properly and directing water away from the foundation?
- Are there any signs of leaking?
- Are there any signs of excessive moisture – musty smell, corrosion, insect infestation?

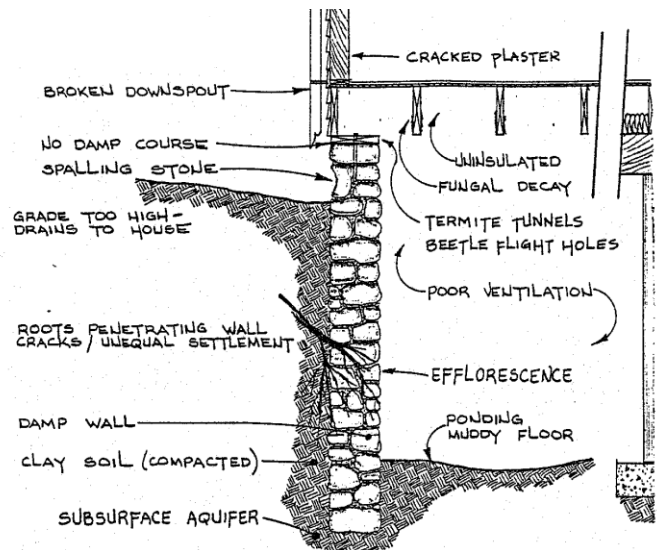


Image: Illustration depicting problems that impact foundations (Phillip Marshall, 1981, p. 140)

- Is there any condensation forming or rising ground moisture?
- Are there water stains or rotted wood near the floor?
- Are the wood posts, beams or floor joists damp or soft?
- In a finished basement, are floor tiles loosened or the bottom of walls showing signs of mold, mildew and warping (for more information, see [Practical Guide: Asbestos, Mold & Lead Abatement](#))?

Movement

- Are any serious cracks visible?
- Are there any signs of movement – patched cracks re-opening, cracks in walls, bulging siding, windows or doors unaligned?
- Is the roofline straight and horizontal?
- Are beams, columns, posts and joists sound?
- Are posts vertical and stable?
- Are the foundation walls straight and vertical?

Exterior

- Is the parging or mortar in good condition? Are there any new cracks or flaking?
- Is the ground properly sloped away from the building?
- Are there any trees or saplings growing within two feet of the foundation?

Settlement and Cracks

As mentioned in the “Movement” section above, foundations may settle and move as a result of shifting or shrinking soil. There are many causes for foundation movement:

- A house may have been built on soil with insufficient bearing capacity
- Underground water in the form of streams or pressure due to impervious soil (i.e. clay)
- Vibrations from traffic
- Tree roots near the foundation
- Flooding
- Improper drainage away from the foundation
- Expansion and contraction of building materials
- Rotting timbers
- Insufficient footings

- Significant increase in the load that a floor must carry, often due to a change in building use
- Installation of an HVAC (heating, ventilation, air-conditioning) system requiring new loads on the floors

Settlement Tests

If there is a crack in your wall or foundation, your building may have moved or may be moving. A foundation settlement test includes determining whether or not your floor is sloping by placing a marble or ball on an uncarpeted floor. If it rolls to the same side almost every time in various rooms, then the foundation is likely settling.

Once it has been determined that a foundation is settling, it is useful to know if the movement has ceased (keep in mind that there may not always be a crack indicating the foundation is settling). For a test, attach two strips of metal overlapping in the form of an X to the cracked mortar with a nail at the top of each piece. Etch the starting point in the metal with a sharp object. If the settlement is active, you will be able to see which way the wall is moving by watching the position of the etched lines over time – allow an extended period of time for observation. For an active crack or a very large crack seek advice from a structural engineer or a knowledgeable contractor to determine the best means of intervention.

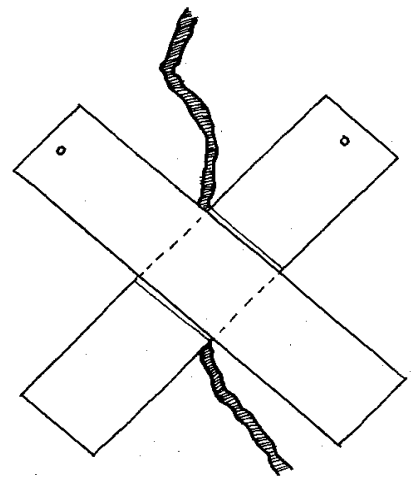


Image: Method used to test for foundation settlement (Betty Anderson, 1983, p. 198)

If it is determined that the foundation is stable, fill the cracks in a brick or stone foundation with mortar of the same strength as the original mortar (for more information on masonry restoration and mortar composition, please refer to the [Practical Guide: Masonry](#)). Ensure that the mortar in the joints is in good condition and repoint when necessary. In exposed foundation walls, repair or replace any deteriorated stones or bricks with replacements of the same size, colour and texture as the original material. On portions of the foundation wall that are not visible, it is not necessary to match materials as closely. Work should be done in small sections to prevent the wall from collapsing, and the mortar should be allowed to harden before proceeding to the next section.

Radon Gas Testing and Reduction

What is Radon Gas?

Radon is a gas formed by the breakdown of uranium, a natural radioactive material found in all soil and rock. You can't see, smell or taste it. When radon escapes from the ground into the outdoor air it is diluted to low concentrations and is no cause for concern. However, when radon enters an enclosed space, like a home, it can accumulate to high levels and become a health hazard. Long-term exposure to radon is the second leading cause of lung cancer after smoking and the leading cause of lung cancer for people who have never smoked. If the radon level in your home is high it can be easily fixed at a reasonable price.

How Radon Can Enter a Building

For most of the year, the air pressure inside your home is lower than the pressure in the soil surrounding your foundation. This difference in pressure can draw air and other gases in the soil, including radon, into the house. Gas containing radon can enter your home at any opening where the house contacts the soil. There are many potential entry routes for radon in the foundations of heritage buildings including cracks, areas with exposed soil or rocks, and openings for utility fixtures or hollow objects such as support posts.

Radon Testing

Almost all homes have some radon in them, but it may be advantageous to determine how much. Radon levels in a home can vary from hour to hour and day to day, so the most accurate way to find out if you have a problem is to measure radon levels in your home for at least three months.

There are two options for testing a house for radon:

1. purchase a do-it-yourself long-term radon test kit
2. hire a certified radon measurement professional

If the radon level in your home is higher than the Canadian guideline of 200 Bq/m³, the suggested timeline in which you should make an effort to reduce the level vary:

- between 200-600 Bq/m³ address the problem within **two** years
- above 600 Bq/m³ address the problem within **one** year

Reducing the amount of radon in your home is easy. Techniques to lower radon levels are effective and can be reduced by more than 80% for about the same cost as other common home repairs, such as replacing the furnace or air conditioner.

For more information about radon testing and radon reduction methods visit [Health Canada's Radon Reduction Guide for Canadians](#).

Hiring a Professional

If radon levels in your home are above the Canadian guideline, Health Canada recommends that you hire a professional certified under the [Canadian National Radon Proficiency Program \(C-NRPP\)](#). Lowering radon levels in a home requires specific technical knowledge and skill to ensure the job is done properly. Choose a contractor to fix a radon problem just as you would choose someone to do other home renovations or repairs. It is wise to get more than one quote that outlines all of the work to be carried out, and to ask for references. Contact some of those references to ask if they are satisfied with the contractors' work.

Summary

Foundations are a vital component of building construction, especially heritage structures, and they require proactive maintenance for proper functioning. Improper foundation construction, uneven settling, insufficient sloping of earth away from the foundation, poor perimeter draining, deterioration of soft mortar, flaking stone or crumbling brick are the key threats to a foundation. Unbalanced settlement or extensive degeneration may require replacing portions of or all of the foundation, which can be an expensive undertaking and calls for the assistance of professionals. Substantial foundation work should be undertaken before other improvements to the house. Foundations should be inspected annually and after heavy rain to determine if any repairs are needed.

References

If you would like to learn more about conserving your foundation, please refer to the following primary sources:

Hanson, S. & Hubby, N. (1983). "Preserving and maintaining the older home." New York: McGraw-Hill.



Foundations

Practical Conservation Guide for Heritage Properties

Kalman, H. (1979). "The sensible rehabilitation of older houses." Prepared for Canada Mortgage and Housing Corporation, Ottawa.

Province of Manitoba. (n.d.). "Heritage building maintenance manual."
http://www.gov.mb.ca/chc/hrb/pdf/maintenace_for_heritage_bldgs.pdf

Schechtman, J. (1981, June). "Wet basements." The Old-House Journal, Vol. IX, No. 6.

Additional sources:

AmeriSpec. (n.d.). "Ask the Inspector - Foundations." AmeriSpec Canada Home Inspection Service. http://calgaryinspectionsservices.ca/files/Inspector_Foundations.pdf

Anderson, B. (1983). "Preserving and maintaining the older home." Illustrations. New York: McGraw-Hill.

Fuller, G. (2013). "Foundation cracks: Inspection and DIY diagnosis." Lineberger Consulting Engineers. <http://structuralsciences.com/?p=1207/foundation-cracks-inspection-and-diy-diagnoses.htm>

Health Canada. (2013). "Radon – Reduction Guide for Canadians." http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radon_canadians-canadiens/index-eng.php

Marshall, P. (1981, June). "Wet basements." Image: Foundation problems. The Old-House Journal, Vol. IX, No. 6.

Ottawa Foundation Repair. (n.d.). "Structural issues."
<http://www.ottawafoundationcrackrepair.com/structural-issues/>

Alternate formats of this document are available upon request. Please contact Lindsay Benjamin at LBenjamin@regionofwaterloo.ca, 519-575-4757 ext. 3210, TTY 519-575-4608 to request an alternate format.

Disclaimer

This practical guide contains useful information on restoring and preserving heritage buildings, but it is intended as a general resource only. Content from third parties with specific expertise has been heavily relied upon and their original works have been acknowledged in the list of references included at the end of this document. The Region of Waterloo has taken all reasonable steps to ensure the accuracy of the information in this publication. However, it is recommended that building owners consult with trained specialists, such as contractors, builders, plumbers, heating and air professionals and electricians, before undertaking any renovations, repairs or construction on their properties. The Region does not assume responsibility for any loss or damage resulting from adherence to the information in this practical guide.