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## Overview of common causes of foundation shifts and their impacts on structural integrity

When discussing the overview of common causes of foundation shifts and their impacts on structural integrity, it's crucial to recognize the various factors that can lead to these movements. Hydraulic jacks are used to lift and level sunken foundations safely **foundation repair expert service** soil mechanics. Foundation shifts can have significant consequences for the stability and safety of any structure, from residential homes to large commercial buildings.

One of the primary causes of foundation shifts is soil movement. This can occur due to several factors including changes in moisture content, temperature fluctuations, and the natural settling of soil over time. For instance, expansive soils, which tend to swell when wet and shrink when dry, can cause considerable shifting in foundations built upon them. This cyclical expansion and contraction can lead to cracks in walls, uneven floors, and other structural issues.

Another common cause is poor construction practices. If a foundation is not properly designed or constructed to withstand the pressures exerted by the soil and the structure above it, shifts are more likely to occur. This includes inadequate compaction of the soil before construction, insufficient reinforcement of the foundation, or using materials that are not suited to the local soil and climate conditions.

External factors such as earthquakes, landslides, and nearby construction activities can also induce foundation shifts. Seismic activities can cause the ground to move suddenly and violently, leading to significant shifts in the foundation. Similarly, excavations for adjacent buildings or infrastructure can alter the load-bearing capacity of the soil, causing existing foundations to shift.

The impacts of foundation shifts on structural integrity are profound. Minor shifts may result in cosmetic damages like cracks in walls or floors, but more severe shifts can compromise the entire structure. This can lead to safety hazards, increased maintenance costs, and in extreme cases, the necessity for costly repairs or even complete rebuilding.

Incorporating root barriers is one effective strategy to prevent foundation shifts, particularly those caused by the growth of tree roots. Tree roots seek out moisture and nutrients, and in doing so, can exert significant pressure on nearby foundations. Root barriers serve as a physical obstruction, preventing roots from growing too close to the foundation and thereby reducing the risk of shifts.

In conclusion, understanding the common causes of foundation shifts and their potential impacts is essential for maintaining structural integrity. By employing preventative measures such as root barriers and ensuring proper construction practices, the risk of foundation shifts can be significantly mitigated, safeguarding the longevity and safety of structures.

## **Explanation of what root barriers are and how they function to prevent root intrusion**

When it comes to maintaining the structural integrity of pavements, driveways, and other surfaces, one often overlooked culprit is the intrusion of tree roots. Tree roots naturally seek out water and nutrients, and unfortunately, they can find their way into cracks and gaps in concrete, asphalt, and other materials. Over time, this root growth can cause significant shifts and damage, leading to costly repairs. To combat this issue, root barriers are employed.

Root barriers are specialized materials or structures designed to prevent the intrusion of tree roots into specific areas. They are typically made from durable materials such as high-density polyethylene (HDPE), metal, or even specialized fabrics. These barriers are installed below the surface, creating a physical obstruction that roots cannot easily penetrate.

The function of root barriers is straightforward yet effective. When placed in the ground, they create a continuous barrier that roots encounter as they grow. Since roots generally avoid dense, impenetrable materials, they are redirected to grow around the barrier rather than through it. This redirection prevents roots from causing damage to pavements, foundations, and other structures.

There are several types of root barriers available, each suited to different applications. For instance, flexible root barriers made from fabric or plastic sheets are often used in landscaping to protect utility lines and prevent root intrusion into garden beds. Rigid root barriers, such as those made from HDPE or metal, are more commonly used in construction projects to safeguard pavements and foundations.

Installing root barriers requires careful planning and execution. They must be placed at an adequate depth to effectively intercept root growth, typically extending below the frost line to ensure stability. Additionally, they should be installed with minimal gaps to prevent roots from finding a way through.

In conclusion, root barriers play a crucial role in preventing root intrusion and the subsequent damage it can cause. By creating a physical barrier that roots cannot easily penetrate, they help maintain the integrity of pavements, foundations, and other structures. Whether in landscaping or construction, incorporating root barriers is a proactive measure that can save time, money, and headaches in the long run.

## **Types of root barriers available for residential foundation repair services**

When it comes to residential foundation repair services, one significant concern homeowners often face is the intrusion of tree roots. These roots can cause shifts and damage to the foundation, leading to costly repairs. To mitigate this issue, various types of root barriers are employed. Understanding these options can help homeowners make informed decisions to protect their homes.

One common type of root barrier is the physical barrier, typically made from materials like plastic, metal, or dense fabrics. These barriers are installed around the perimeter of the foundation to create a physical obstruction that roots cannot easily penetrate. Plastic barriers are often preferred for their flexibility and ease of installation, while metal barriers offer durability and strength.

Another effective method is the use of chemical root barriers. These barriers involve the application of chemicals that inhibit root growth. The chemicals are typically injected into the soil around the foundation, creating a zone where roots are less likely to grow. This method is particularly useful in areas where physical barriers may be difficult to install due to space constraints or other factors.

A third option is the use of root-resistant materials in the construction of the foundation itself. This approach involves incorporating materials that are less attractive to roots, such as certain types of concrete or specialized coatings. While this method is more preventative than reactive, it can be a valuable addition to other root barrier strategies.

Lastly, some homeowners opt for a combination of these methods to ensure maximum protection. For instance, a physical barrier might be supplemented with a chemical treatment to create a dual layer of defense against root intrusion.

In conclusion, the types of root barriers available for residential foundation repair services vary, each offering unique benefits. Whether through physical obstruction, chemical inhibition, or root-resistant materials, these barriers play a crucial role in preventing shifts and damage caused by tree roots. Homeowners should consider their specific needs and consult with professionals to determine the best approach for their situation.

### **Steps involved in incorporating root barriers during foundation repair processes**

Incorporating root barriers during foundation repair processes is a crucial step to prevent future shifts and damage caused by tree roots. Here's a detailed look at the steps involved in this process:

1. **Assessment and Planning**: The first step involves a thorough assessment of the foundation and surrounding environment. Professionals evaluate the extent of root intrusion and determine the most effective type of root barrier to use. This planning phase is critical for ensuring that the barrier will be effective and long-lasting.
2. **Excavation**: Once the plan is in place, excavation begins around the affected area of the foundation. This involves carefully removing soil to expose the roots and the foundation. It's important to handle this step with care to avoid further damage to the foundation or surrounding landscape.
3. **Installation of the Root Barrier**: The next step is the actual installation of the root barrier. This typically involves placing a physical barrier, such as dense polyethylene

sheeting or metal mesh, around the foundation. The barrier is positioned to prevent roots from growing towards the foundation. It's essential that the barrier is installed at a sufficient depth to be effective, usually extending at least 2-3 feet below the surface.

4. **Securing the Barrier**: After the barrier is in place, it needs to be securely anchored to prevent it from shifting or being displaced. This may involve staking the barrier or using other securing methods to ensure it remains in position.

5. **Backfilling**: With the root barrier securely in place, the excavated soil is carefully backfilled. This step requires attention to detail to ensure that the soil is packed evenly and compacted properly to support the foundation and the barrier.

6. **Final Inspection and Testing**: Before concluding the process, a final inspection is conducted to ensure that the root barrier is installed correctly and effectively. Professionals may also perform tests to check for any potential issues that could compromise the barrier's integrity.

7. **Maintenance and Monitoring**: Even after the root barrier is installed, ongoing maintenance and monitoring are necessary. This involves regular checks to ensure the barrier remains intact and effective, and addressing any issues promptly to prevent future damage.

Incorporating root barriers during foundation repair is a proactive measure that can significantly reduce the risk of future damage from tree roots. By following these steps, homeowners can protect their foundations and ensure the longevity of their property.

### **Benefits of using root barriers in preventing future foundation shifts**

Certainly! Here's a short essay on the benefits of using root barriers in preventing future foundation shifts:

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When it comes to maintaining the structural integrity of a home, one often overlooked factor is the impact of tree roots on the foundation. Over time, roots can grow and expand, causing shifts and cracks that compromise the stability of a building. This is where root barriers come into play, offering a practical and effective solution to prevent future foundation issues.

First and foremost, root barriers serve as a physical impediment to root growth. By installing these barriers around the perimeter of a building's foundation, homeowners can effectively redirect root growth away from critical areas. This proactive measure helps to prevent roots from penetrating the soil beneath the foundation, thereby reducing the risk of shifts and cracks.

Another significant benefit of using root barriers is the preservation of landscape aesthetics.

Many homeowners are reluctant to remove trees and shrubs that contribute to the beauty and value of their property. Root barriers provide a middle ground, allowing individuals to maintain their greenery while protecting their home's foundation. This balance is crucial for those who value both the aesthetic and structural aspects of their property.

Additionally, root barriers are a cost-effective solution in the long run. While the initial installation may require an investment, the savings accrued from avoiding costly foundation repairs can be substantial. By preventing root-related damage before it occurs, homeowners can sidestep the expenses associated with repairs and renovations, making root barriers a wise financial decision.

Moreover, root barriers contribute to the overall stability and longevity of a home. A stable foundation is the cornerstone of a durable structure, and by mitigating the risk of root-induced shifts, homeowners can ensure that their investment remains sound for years to come. This stability not only enhances the living experience but also adds to the property's resale value.

In conclusion, the benefits of using root barriers in preventing future foundation shifts are clear. From physical root redirection and landscape preservation to cost savings and enhanced structural stability, root barriers offer a comprehensive solution to a common yet often neglected issue. By incorporating root barriers into home maintenance practices, homeowners can protect their investment and enjoy peace of mind knowing that their foundation is safeguarded against the encroaching threat of tree roots.

### **Case studies or examples of successful incorporation of root barriers in residential properties**

Incorporating root barriers in residential properties is a smart strategy to prevent issues like foundation shifts, plumbing blockages, and damage to structures caused by expansive tree roots. Several case studies exemplify the successful implementation of root barriers, showcasing their efficacy and the benefits they offer to homeowners.

One notable example is a suburban neighborhood in California where a series of homes experienced repeated plumbing issues due to tree roots infiltrating sewer lines. After extensive analysis, local authorities and homeowners' associations decided to install root barriers around the most affected areas. The barriers, made from durable materials such as high-density polyethylene, were placed at strategic depths to intercept root growth. Within a year, the frequency of plumbing issues decreased significantly, leading to cost savings for homeowners and improved property values.

Another case study involves a residential complex in the Midwest, where new homes were being constructed near an existing grove of mature trees. Anticipating potential root-related problems, the developers opted to install root barriers before laying the foundation. The barriers were integrated into the landscaping design, ensuring that they did not disrupt the aesthetic appeal of the property. Over the years, the homes remained free from root-induced damages, proving the foresight and effectiveness of the root barrier strategy.



In a coastal town in the Southeast, a homeowner faced challenges with a large oak tree whose roots were lifting the driveway and cracking the foundation. After consulting with arborists and engineers, the homeowner installed a root barrier around the affected areas. The barrier was carefully positioned to allow the tree to continue receiving necessary nutrients while preventing root encroachment. The solution not only halted further damage but also preserved the aesthetic and sentimental value of the tree for the homeowner.

These examples illustrate that incorporating root barriers in residential properties is not only a preventive measure but also a sustainable solution that enhances the longevity and safety of homes. By learning from these successful case studies, other homeowners can make informed decisions to protect their properties from the potentially costly and disruptive effects of tree roots.



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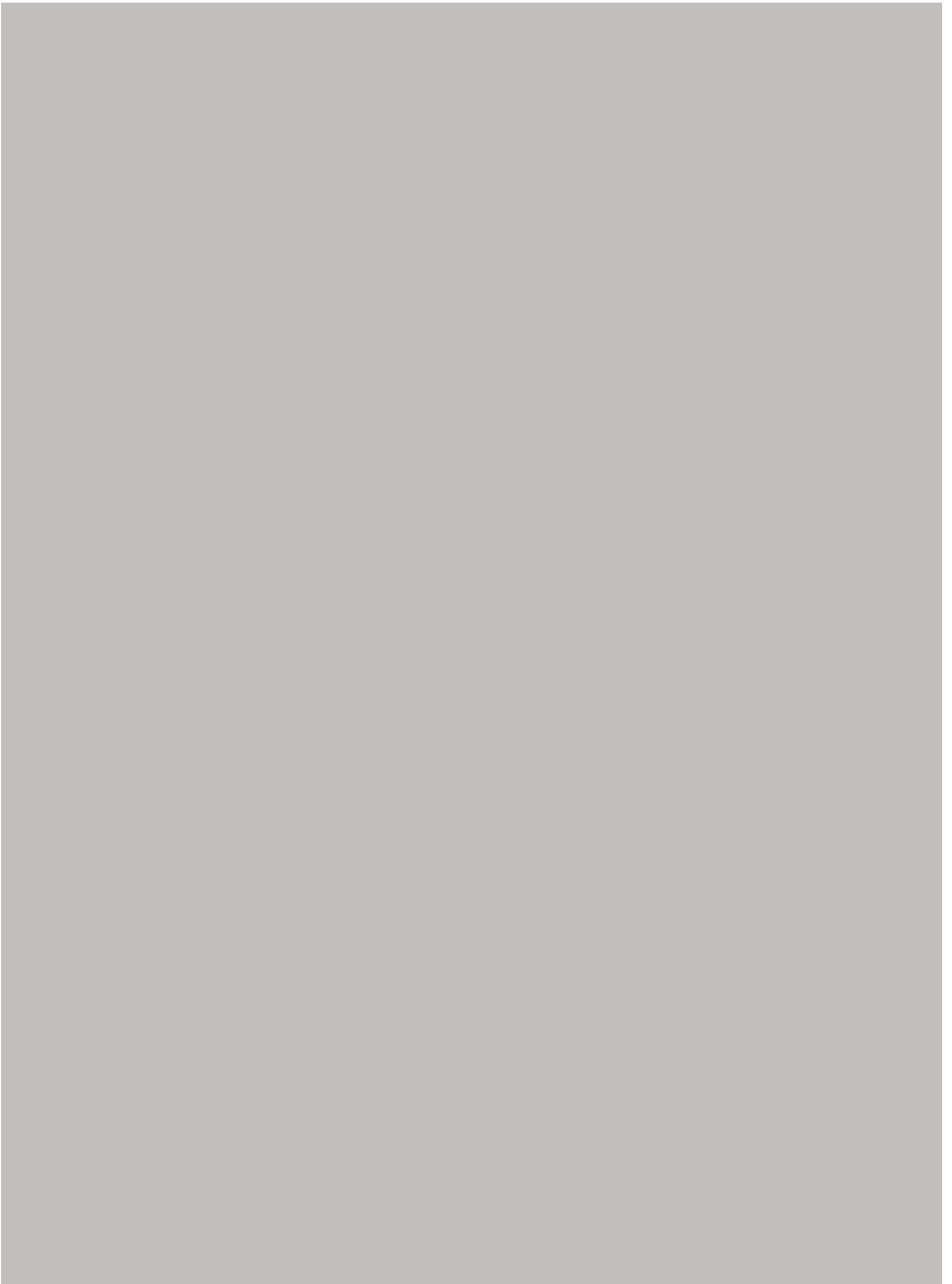




# **Residential Foundation Repair Services**



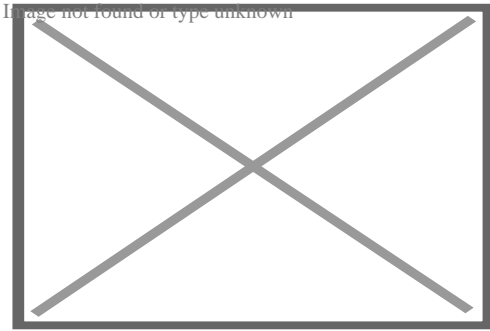
# **Strong Foundations, Strong Homes**



## About building code

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The examples and perspective in this article **may not represent a worldwide view of the subject**. You may improve this article, discuss the issue on the talk page, or create a new article, as appropriate. *(November 2021) (Learn how and when to remove this message)*

Not to be confused with Zoning laws.



Code Violation: This fire-rated concrete block wall is penetrated by cable trays and electrical cables. The hole should be firestopped to restore the fire-resistance rating of the wall. Instead, it is filled with flammable polyurethane foam.

A **building code** (also **building control** or **building regulations**) is a set of rules that specify the standards for construction objects such as buildings and non-building structures. Buildings must conform to the code to obtain planning permission, usually from a local council. The main purpose of building codes is to protect public health, safety and general welfare as they relate to the construction and occupancy of buildings and structures——for example, the building codes in many countries require engineers to consider the effects of soil liquefaction in the design of new buildings.<sup>[1]</sup> The building code becomes law of a particular jurisdiction when formally enacted by the appropriate governmental or private authority.<sup>[2]</sup>

Building codes are generally intended to be applied by architects, engineers, interior designers, constructors and regulators but are also used for various purposes by safety inspectors, environmental scientists, real estate developers, subcontractors, manufacturers of building products and materials, insurance companies, facility managers, tenants, and others. Codes regulate the design and construction of structures where adopted into law.

Examples of building codes began in ancient times.<sup>[3]</sup> In the USA the main codes are the International Building Code or International Residential Code [IBC/IRC], electrical codes and plumbing, mechanical codes. Fifty states and the District of Columbia have adopted the I-Codes at the state or jurisdictional level.<sup>[4]</sup> In Canada, national model codes are published by the National Research Council of Canada.<sup>[5]</sup> In the United Kingdom, compliance with Building Regulations is monitored by building control bodies, either Approved Inspectors or Local Authority Building Control departments. Building Control regularisation charges apply in case work is undertaken which should have had been inspected at the time of the work if this was not done.<sup>[6]</sup>



## Types

[edit]

The practice of developing, approving, and enforcing building codes varies considerably among nations. In some countries building codes are developed by the government agencies or quasi-governmental standards organizations and then enforced across the country by the central government. Such codes are known as the **national building codes** (in a sense they enjoy a mandatory nationwide application).

In other countries, where the power of regulating construction and fire safety is vested in local authorities, a system of model building codes is used. Model building codes have no legal status unless adopted or adapted by an authority having jurisdiction. The developers of model codes urge public authorities to reference model codes in their laws, ordinances, regulations, and administrative orders. When referenced in any of these legal instruments, a particular model code becomes law. This practice is known as 'adoption by reference'. When an adopting authority decides to delete, add, or revise any portions of the model code adopted, it is usually required by the model code developer to follow a formal adoption procedure in which those modifications can be documented for legal purposes.

There are instances when some local jurisdictions choose to develop their own building codes. At some point in time all major cities in the United States had their own building codes. However, due to ever increasing complexity and cost of developing building regulations, virtually all municipalities in the country have chosen to adopt model codes instead. For example, in 2008 New York City abandoned its proprietary *1968 New York City Building Code* in favor of a customized version of the International Building Code.<sup>[7]</sup> The City of Chicago remains the only municipality in America that continues to use a building code the city developed on its own as part of the *Municipal Code of Chicago*.

In Europe, the Eurocode: Basis of structural design, is a pan-European building code that has superseded the older national building codes. Each country now has National Annexes to localize the contents of the Eurocodes.

Similarly, in India, each municipality and urban development authority has its own building code, which is mandatory for all construction within their jurisdiction. All these local building codes are variants of a National Building Code,<sup>[8]</sup> which serves as model code providing guidelines for regulating building construction activity.

## Scope

[edit]



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The purpose of building codes is to provide minimum standards for safety, health, and general welfare including structural integrity, mechanical integrity (including sanitation, water supply, light, and ventilation), means of egress, fire prevention and control, and energy conservation.<sup>[9][10]</sup>

Building codes generally include:

- Standards for structure, placement, size, usage, wall assemblies, fenestration size/locations, egress rules, size/location of rooms, foundations, floor assemblies, roof structures/assemblies, energy efficiency, stairs and halls, mechanical, electrical, plumbing, site drainage & storage, appliance, lighting, fixtures standards, occupancy rules, and swimming pool regulations
- Rules regarding parking and traffic impact
- Fire code rules to minimize the risk of a fire and to ensure safe evacuation in the event of such an emergency<sup>[citation needed]</sup>
- Requirements for earthquake (seismic code), hurricane, flood, and tsunami resistance, especially in disaster prone areas or for very large buildings where a failure would be catastrophic<sup>[citation needed]</sup>
- Requirements for specific building uses (for example, storage of flammable substances, or housing a large number of people)
- Energy provisions and consumption
- Grandfather clauses: Unless the building is being renovated, the building code usually does not apply to existing buildings.
- Specifications on components
- Allowable installation methodologies
- Minimum and maximum room ceiling heights, exit sizes and location
- Qualification of individuals or corporations doing the work
- For high structures, anti-collision markers for the benefit of aircraft

Building codes are generally separate from zoning ordinances, but exterior restrictions (such as setbacks) may fall into either category.

Designers use building code standards out of substantial reference books during design. Building departments review plans submitted to them before construction, issue permits [or not] and inspectors verify compliance to these standards at the site during construction.

There are often additional codes or sections of the same building code that have more specific requirements that apply to dwellings or places of business and special construction objects such as canopies, signs, pedestrian walkways, parking lots, and radio and television antennas.

## Criticism

[edit]

Building codes have been criticized for contributing to housing crisis and increasing the cost of new housing to some extent, including through conflicting code between different administrators.<sup>[11]</sup> Proposed improvements include regular review and cost-benefit analysis of building codes,<sup>[12]</sup> promotion of low-cost construction materials and building codes suitable to mass production.<sup>[11]</sup>

reducing bureaucracy, and promoting transparency.[<sup>13</sup>]

## History

[edit]

## Antiquity

[edit]

Building codes have a long history. The earliest known written building code is included in the Code of Hammurabi,<sup>[3]</sup> which dates from circa 1772 BC.

The book of Deuteronomy in the Hebrew Bible stipulated that parapets must be constructed on all houses to prevent people from falling off.<sup>[14]</sup>

In the Chinese book of rites it mentions that ancestral temples and houses should be a certain standard length in ancient China they measured land in the chu or well field system so it was important to be precise though most of the actual lengths are lost or obscure.<sup>[15][16]</sup>

In ancient Japan a certain official destroyed a courtiers house because the size was above his rank.<sup>[17]</sup>

## Modern era

[edit]

## France

[edit]

In Paris, under the reconstruction of much of the city under the Second Empire (1852–70), great blocks of apartments were erected<sup>[18]</sup> and the height of buildings was limited by law to five or six stories at most.

## United Kingdom

[edit]

After the Great Fire of London in 1666, which had been able to spread so rapidly through the densely built timber housing of the city, the Rebuilding of London Act 1666 was passed in the same year as the first significant building regulation.<sup>[19]</sup> Drawn up by Sir Matthew Hale, the act regulated the rebuilding of the city, required housing to have some fire resistance capacity and authorised the City of London Corporation to reopen and widen roads.<sup>[20]</sup> The Laws of the Indies were passed in the 1680s by the Spanish Crown to regulate the urban planning for colonies

throughout Spain's worldwide imperial possessions.

The first systematic national building standard was established with the Metropolitan Buildings Act 1844. Among the provisions, builders were required to give the district surveyor two days' notice before building, regulations regarding the thickness of walls, height of rooms, the materials used in repairs, the dividing of existing buildings and the placing and design of chimneys, fireplaces and drains were to be enforced and streets had to be built to minimum requirements.<sup>[21]</sup>

The Metropolitan Buildings Office was formed to regulate the construction and use of buildings throughout London. Surveyors were empowered to enforce building regulations, which sought to improve the standard of houses and business premises, and to regulate activities that might threaten public health. In 1855 the assets, powers and responsibilities of the office passed to the Metropolitan Board of Works.

## United States

[edit]

The City of Baltimore passed its first building code in 1891.<sup>[22]</sup> The Great Baltimore Fire occurred in February 1904. Subsequent changes were made that matched other cities.<sup>[23]</sup> In 1904, a Handbook of the Baltimore City Building Laws was published. It served as the building code for four years. Very soon, a formal building code was drafted and eventually adopted in 1908.

The structural failure of the tank that caused the Great Molasses Flood of 1919 prompted the Boston Building Department to require engineering and architectural calculations be filed and signed. U.S. cities and states soon began requiring sign-off by registered professional engineers for the plans of major buildings.<sup>[24]</sup>

More recently, the 2015 Berkeley balcony collapse has prompted updates to California's balcony building codes, set for 2025, which include stricter material requirements, enhanced load-bearing standards, and mandatory inspections which known as SB326 and SB721.<sup>[25]</sup> These laws mandate regular inspections every six years for multifamily buildings. Property owners and HOAs are required to address any structural or waterproofing issues identified during inspections to ensure compliance and safety. Failure to comply can result in fines, increased liability, and legal consequences. The updates aim to prevent tragedies like the Berkeley collapse, which was caused by dry rot and structural failure, by ensuring the long-term safety and durability of elevated structures.<sup>[26]</sup>

## Energy codes

[edit]

The current energy codes<sup>[clarification needed]</sup> of the United States are adopted at the state and municipal levels and are based on the International Energy Conservation Code (IECC). Previously,

they were based on the Model Energy Code (MEC). As of March 2017, the following residential codes have been partially or fully adopted by states:[<sup>27</sup>]

- 2015 IECC or equivalent (California, Illinois, Maryland, Massachusetts, Michigan, Pennsylvania, New Jersey, New York, Vermont, Washington)
- 2012 IECC or equivalent (Alabama, Connecticut, Delaware, District of Columbia, Florida, Iowa, Minnesota, Nevada, Rhode Island, Texas)
- 2009 IECC or equivalent (Arkansas, Georgia, Idaho, Indiana, Kentucky, Louisiana, Montana, Nebraska, New Hampshire, New Mexico, North Carolina, Ohio, Oklahoma, Oregon, South Carolina, Tennessee, Virginia, West Virginia, Wisconsin)
- 2006 IECC or equivalent (Utah)
- 2006 IECC or no statewide code (Alaska, Arizona, Colorado, Kansas, Maine, Mississippi, Missouri, North Dakota, South Dakota, Wyoming)

## Australia

[edit]

Australia uses the National Construction Code.

## See also

[edit]

- Building officials
- Construction law
- Earthquake-resistant structures
- Energy Efficiency and Conservation Block Grants
- Outline of construction
- Seismic code
- Uniform Mechanical Code
- Variance (land use) – permission to vary zoning and sometimes building to code

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[edit]

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## External links

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Wikimedia Commons has media related to ***Building and Fire Code Violations***.

- o IAPMO Website
- o IAPMO Codes Website

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## Construction

### Types

- o Home construction
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- o Underground construction
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### History

- o Architecture
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- o Structural engineering
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- o Water supply and sanitation

### Professions

- o Architect
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- o Site manager
- o Structural engineer
- o Superintendent

## **Trades workers (List)**

- Banksman
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- Bricklayer
- Carpenter
- Concrete finisher
- Construction foreman
- Construction worker
- Electrician
- Glazier
- Ironworker
- Millwright
- Plasterer
- Plumber
- Roofer
- Steel fixer
- Welder

## **Organizations**

- American Institute of Constructors (AIC)
- American Society of Civil Engineers (ASCE)
- Asbestos Testing and Consultancy Association (ATAC)
- Associated General Contractors of America (AGC)
- Association of Plumbing and Heating Contractors (APHC)
- Build UK
- Construction History Society
- Chartered Institution of Civil Engineering Surveyors (CICES)
- Chartered Institute of Plumbing and Heating Engineering (CIPHE)
- Civil Engineering Contractors Association (CECA)
- The Concrete Society
- Construction Management Association of America (CMAA)
- Construction Specifications Institute (CSI)
- FIDIC
- Home Builders Federation (HBF)
- Lighting Association
- National Association of Home Builders (NAHB)
- National Association of Women in Construction (NAWIC)
- National Fire Protection Association (NFPA)
- National Kitchen & Bath Association (NKBA)
- National Railroad Construction and Maintenance Association (NRC)
- National Tile Contractors Association (NTCA)
- Railway Tie Association (RTA)
- Royal Institution of Chartered Surveyors (RICS)
- Scottish Building Federation (SBF)
- Society of Construction Arbitrators

**By country**

- India
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- Interior architecture
- Landscape architecture
- Vernacular architecture

**Engineering**

- Architectural engineering
- Building services engineering
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  - Coastal engineering
  - Construction engineering
  - Structural engineering
- Earthquake engineering
- Environmental engineering
- Geotechnical engineering

**Methods**

- List
- Earthbag construction
- Modern methods of construction
- Monocrete construction
- Slip forming

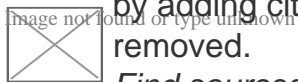
- Building material
  - List of building materials
  - Millwork
- Construction bidding
- Construction delay
- Construction equipment theft
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- Construction waste
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- Design–build
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- Sustainability in construction
- Unfinished building
- Urban design
- Urban planning

## Other topics

 [Outline](#)  [Category](#)  [Other type unknown](#)

## About radon mitigation

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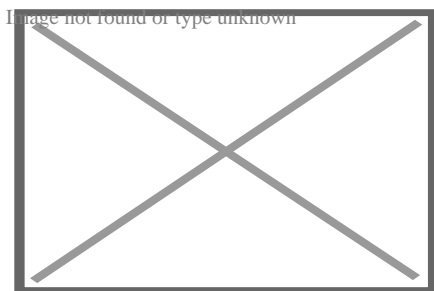
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**Radon mitigation** is any process used to reduce radon gas concentrations in the breathing zones of occupied buildings, or radon from water supplies. Radon is a significant contributor to environmental radioactivity and indoor air pollution. Exposure to radon can cause serious health problems such as lung cancer.<sup>[1]</sup>

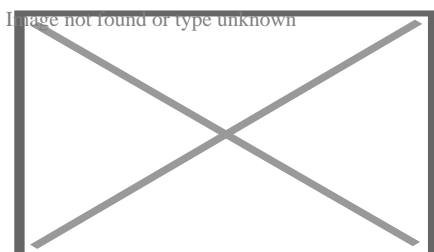
Mitigation of radon in the air by active soil depressurization is most effective. Concrete slabs, sub-floors, and/or crawlspaces are sealed, an air pathway is then created to exhaust radon above the roof-line, and a radon mitigation fan is installed to run permanently. In particularly troublesome dwellings, air exchangers can be used to reduce indoor radon concentrations. Treatment systems using aeration or activated charcoal are available to remove radon from domestic water supplies. There is no proven link between radon in water and gastrointestinal cancers; however, extremely high radon concentrations in water can be aerosolized by faucets and shower heads and contribute to high indoor radon levels in the air.

## Testing

[edit]



A typical radon test kit



## Fluctuation of ambient air radon concentration over one week, measured in a laboratory

The first step in mitigation is testing. No level of radiation is considered completely safe, but as it cannot be eliminated, governments around the world have set various *action levels* to provide guidance on when radon concentrations should be reduced. The World Health Organization's International Radon Project has recommended an action level of 100 Bq/m<sup>3</sup> (2.7 pCi/L) for radon in the air.<sup>[2]</sup> Radon in the air is considered to be a larger health threat than radon in domestic water. The US Environmental Protection Agency recommendation is to not test for radon in water unless a radon in air test shows concentrations above the action level. However, in some U.S. states such as Maine where radon levels are higher than the national average, it is recommended that all well water should be tested for radon. The U.S. government has not set an action level for radon in water.

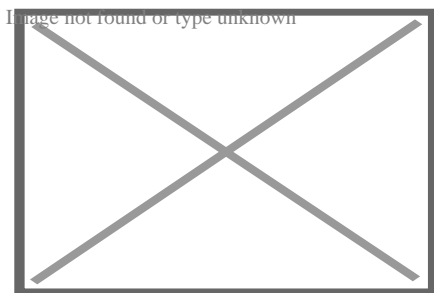
Air-radon levels fluctuate naturally on a daily and seasonal basis. A short term test (90 days or less) might not be an accurate assessment of a home's average radon level, but is recommended for initial testing to quickly determine unhealthy conditions. Transient weather such as wind and changes in barometric pressure can affect short-term concentrations as well as ventilation, such as open windows and the operation of exhaust fans.

Testing for radon in the air is accomplished using passive or active devices placed in the building. Some devices are promptly sent to a laboratory for analysis, others calculate the results on-site including digital Radon detectors. Radon-in-water testing requires a water sample being sent to a laboratory.

Retesting is recommended in several situations, for example, before spending money on the installation of a mitigation system. Test results which exceed accuracy tolerances also require retesting. When a mitigation system installation is warranted, a retest after the system is functional is advised to be sure the system is effectively reducing the radon concentration below the action level, and after any mitigation system repairs such as replacing a fan unit. The US EPA recommends retesting homes with radon problems every two years to ensure proper system function. Due to the vast fluctuation in indoor radon levels, the EPA recommends all homes be tested at least once every five years.<sup>[3]</sup>

## Testing in the United States

[edit]



Radon map of the United States



ASTM E-2121 is a US standard for reducing airborne radon in homes as far as practicable below the action level of 4 picocuries per liter (pCi/L) (148 Bq/m<sup>3</sup>).<sup>[4][5]</sup> Some states recommend achieving 2.0 pCi/L or less.

Radon test kits are commercially available<sup>[6]</sup> and can be used by homeowners and tenants and in limited cases by landlords, except when a property is for sale.

Commercially available test kits include a passive collector that the user places in the lowest livable floor of the house for 2 to 7 days. The user then sends the collector to a laboratory for analysis. Long-term kits, taking collections from 91 days to one year, are also available. Open land test kits can test radon emissions from the land before construction begins, but are not recommended by the EPA because they do not accurately predict the final indoor radon level. The EPA and the National Environmental Health Association have identified 15 types of radon test devices.<sup>[7]</sup> A Lucas cell is one type of device.

Retesting is specifically recommended in several situations. Measurements between 4 and 10 pCi/L (148 and 370 Bq/m<sup>3</sup>) warrant a follow-up short-term or long-term radon test before mitigation. Measurements over 10 pCi/L (370 Bq/m<sup>3</sup>) warrant only another short-term test (not a long-term test) so that abatement measures are not unduly delayed.

Progress has been made regarding radon in the home. A total of 37 states have now<sup>[when?]</sup> passed legislation requiring home-sellers to disclose known radon levels before completing the transaction (although only a handful have introduced criminal penalties for misrepresentation)<sup>[8]</sup> And over half the legislatures have written radon into their state's building code.<sup>[9]</sup> Purchasers of real estate may delay or decline a purchase if the seller has not successfully abated radon to less than 4 pCi/L.

The accuracy of the residential radon test depends upon whether closed house conditions are maintained. Thus the occupants will be instructed not to open windows, etc., for ventilation during the pendency of test, usually two days or more. However, the occupants, if the present owners, will be motivated to pass the test and insure the sale, so they might be tempted to open a window to get a lower radon score. Moreover, there may be children or immature teens or young adults in the house who will open a window for ventilation notwithstanding instructions not to do so, particularly in uncomfortably hot weather. Accordingly, whether the potential purchaser should trust the result of such a test is problematic.

Management of radon service provider certification has evolved since being introduced by the EPA in 1986. In the 1990s this service was "privatized" and the National Environmental Health Association (NEHA) helped transition the voluntary National Radon Proficiency Program (NRPP) to be administered by private firms. As of 2012, the NRPP is administered by the American Association of Radon Scientists and Technologists (AARST).<sup>[10]</sup>

Some states, such as Maine, require landlords to test their rental properties and turn the results in to the state. In limited cases the landlord or tenants may do the testing themselves. The rules in each state vary. In many cases there are private contractors that will inspect hired by the city.

## Testing in Canada

[edit]

Health Canada recommends regular annual testing, either by hiring a qualified tester or by using a home-testing kit that should be checked quarterly.<sup>[11]</sup>

Canadian Government, in conjunction with the territories and provinces, developed the guideline<sup>[12]</sup> to indicate when remedial action should be taken was originally set at 800 Bq/m<sup>3</sup> (becquerels per cubic meter) and since reduced to 200 Bq/m<sup>3</sup>. This new guideline was approved by the Federal Provincial Territorial Radiation Protection Committee in October 2006.<sup>[13]</sup>

## Testing in the UK

[edit]

Radon testing in the UK is managed by UKradon and the UKHSA.<sup>[14]</sup>

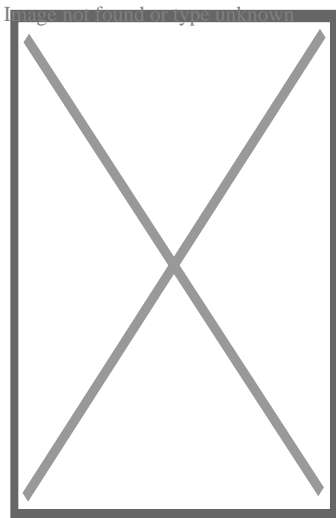
## Testing in Norway

[edit]

The Norwegian Radiation and Nuclear Safety Authority (DSA) developed the protocol<sup>[15]</sup> for radon measurements in residential dwellings<sup>[16]</sup> with respect to rental accommodation, which is governed by The Radiation Protection Regulations.<sup>[17]</sup>

## Methods of radon gas mitigation

[edit]

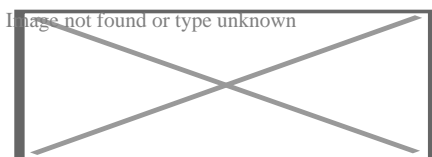


Part of a radon mitigation system including the fan and vent pipe is visible near the gutter downspout.

Because high levels of radon have been found in every state of the United States,<sup>[18]</sup> testing for radon and installing radon mitigation systems has become a specialized industry since the 1980s. Many states have implemented programs that affect home buying and awareness in the real estate community; however, radon testing and mitigation systems are not generally mandatory unless specified by the local jurisdiction.<sup>[19]</sup>

Anticipated high radon levels can be mitigated during building design and construction by a combination of ensuring a perfectly sealed foundation, allowing sufficient passive dispersal of under-slab gas around rather than through the building, and proper building ventilation. In many instances, such approaches may achieve a sufficient reduction of radon levels compared to other buildings where such approaches were not taken. However, quality of implementation is crucial and testing after construction is necessary. For instance, even a small gap in the sealing of the slab may be sufficient for excessive quantities of radon to enter, given pressure differentials.

Where such approaches were not taken during construction or have proven insufficiently effective, remediation is needed. According to the EPA's "A Citizen's Guide to Radon",<sup>[20]</sup> the method to reduce radon "primarily used is a vent pipe system and fan, which pulls radon from beneath the house and vents it to the outside", which is also called sub-slab depressurization, soil suction, or active soil depressurization (ASD). Generally indoor radon can be mitigated by sub-slab depressurization and exhausting such radon-laden air to the outdoors, away from windows and other building openings.<sup>[21]</sup> "EPA generally recommends methods which prevent the entry of radon. Soil suction, for example, prevents radon from entering your home by drawing the radon from below the home and venting it through a pipe, or pipes, to the air above the home where it is quickly diluted" and "EPA does not recommend the use of sealing alone to reduce radon because, by itself, sealing has not been shown to lower radon levels significantly or consistently" according to the EPA's "Consumer's Guide to Radon Reduction: How to Fix Your Home".<sup>[22]</sup> Ventilation systems can utilize a heat exchanger or energy recovery ventilator to recover part of the energy otherwise lost in the process of exchanging air with the outside. For crawlspaces, the EPA states<sup>[22]</sup> "An effective method to reduce radon levels in crawlspace homes involves covering the earth floor with a high-density plastic sheet. A vent pipe and fan are used to draw the radon from under the sheet and vent it to the outdoors. This form of soil suction is called submembrane suction, and when properly applied is the most effective way to reduce radon levels in crawlspace homes."



High radon levels in a Minnesota (USA) basement with a passive under slab vent pipe system can be seen in the left half of the graph. After installation of a radon fan (ASD), a permanent reduction in radon levels to approximately 0.6 pCi/L can be seen in the right half of the graph.

- The most common approach is active soil depressurization (ASD). Experience has shown that ASD is applicable to most buildings since radon usually enters from the soil and rock underneath and mechanical ventilation is used when the indoor radon is emitted from the building materials. A less common approach works efficiently by reducing air pressures

within cavities of exterior and demising walls where radon emitting from building materials, most often concrete blocks, collects.

- Above slab air pressure differential barrier technology (ASAPDB) requires that the interior pressure envelope, most often drywall, as well as all ductwork for air conditioning systems, be made as airtight as possible. A small blower, often no more than 15 cubic feet per minute (0.7 L/s) may then extract the radon-laden air from these cavities and exhaust it to the out of doors. With well-sealed HVAC ducts, very small negative pressures, perhaps as little as 0.5 pascal (0.00007 psi), will prevent the entry of highly radon-laden wall cavity air from entering into the breathing zone. Such ASAPDB technology is often the best radon mitigation choice for high-rise condominiums as it does not increase indoor humidity loads in hot humid climates, and it can also work well to prevent mold growth in exterior walls in heating climates.
- In hot, humid climates, heat recovery ventilators (HRV) as well as energy recovery ventilators (ERV) have a record of increasing indoor relative humidity and dehumidification demands on air conditioning systems. Mold problems can occur in homes that have been radon mitigated with HRV and ERV installations in hot, humid climates.<sup>[citation needed]</sup> HRVs and ERVs have an excellent record in cold dry climates.
- A recent technology is based on building science. It includes a variable rate mechanical ventilation system that prevents indoor relative humidity from rising above a preset level such as 50% which is currently suggested by the US Environmental Protection Agency and others as an upper limit for the prevention of mold. It has proven to be especially effective in hot, humid climates. It controls the air delivery rate so that the air conditioner is never overloaded with more moisture than it can effectively remove from the indoor air.
  - It is generally assumed that air conditioner operation will remove excess moisture from the air in the breathing zone, but it is important to note that just because the air conditioner cools does not mean that it is also dehumidifying. If  $t$  is 14 degrees or less, it may not dehumidify at all even though it is cooling.
  - Factors that are likely to aggravate indoor humidity problems from mechanical ventilation-based radon installations are as follows and an expert radon mitigator/building scientist will check for and correct any and all of the following when he or she performs radon mitigation procedures:
    - Air conditioner duct leaks located outside the breathing zone, such as in the attic.
    - Excessive exhaust fan operation
    - Oversize or over-capacity air conditioners
    - AC air handler fans that do not stop running when the air conditioner compressor stops running.
    - Delta  $t$  ( $\Delta t$ ), which is the amount that the air is cooled as it is passed through the air conditioner's cooling coils. A good  $\Delta t$  performance figure for home air conditioners is about 20 °F (11 °C). In comparison, automobile air conditioners deliver  $\Delta t$  performance of 32 to 38 °F (18 to 21 °C). A  $\Delta t$  of 14 °F (8 °C) will dehumidify poorly if at all.

In South Florida, most radon mitigation is performed by use of fixed rate mechanical ventilation. Radon mitigation training in Florida does not include problems associated with mechanical ventilation systems, such as high indoor humidity, mold, moldy odors, property damage or health consequences of human occupation in high humidity of moldy environments<sup>[citation needed]</sup>. As a

result, most Florida radon mitigators are unaware of and do not incorporate existing building science moisture management technology into mechanical ventilation radon installations. Home inspectors may not necessarily be aware of the mold risks associated with radon mitigation by mechanical ventilation.

The average cost for an ASD radon mitigation system in Minnesota is \$1500.<sup>[23]</sup> These costs are very dependent on the type of home and age of construction.<sup>[24]</sup>

## Methods of radon-in-water mitigation

[edit]

Radon removal from water supplies may be at a treatment plant, point of entry, or point of use. Public water supplies in the United States were required to treat for radionuclides beginning in 2003 but private wells are not regulated by the federal government as of 2014. The radon can be captured by granular activated charcoal (GAR) or released into the air through aeration of the water. Radon will naturally dissipate from water over a period of days, but the quantity of storage needed to treat the water in this manner makes home systems of this type impracticably large.<sup>[25]</sup>

Activated carbon systems capture radon from the water. The amount of radiation accumulates over time and the filter material may reach the level of requiring disposal as a radioactive waste. However, in the United States there are no regulations concerning radiation levels and disposal of radon treatment waste as of 2014.

Aeration systems move the radon from the water to the air. Radon gas discharged into the air is the release of a pollutant, and may become regulated in the United States.

## References

[edit]

- <sup>1</sup> <sup>^</sup> *Nunnally, Diamond (2022-03-30). "Dangerous radon gas dangers and detection tips". WBMA. Retrieved 2022-04-10.*
- <sup>2</sup> <sup>^</sup> *WHO Handbook on Indoor Radon: A Public Health Perspective. World Health Organization. 2009.*
- <sup>3</sup> <sup>^</sup> *US EPA, OAR (2013-08-27). "Radon". www.epa.gov. Retrieved 2023-02-04.*
- <sup>4</sup> <sup>^</sup> *"Recommended Residential Radon Mitigation Standard of Practice". United States Environmental Protection Agency. Archived from the original on 2008-01-16. Retrieved 2008-02-02.*
- <sup>5</sup> <sup>^</sup> *"ASTM E2121-03 Standard Practice for Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings". ASTM International. Retrieved 2008-02-02.*
- <sup>6</sup> <sup>^</sup> *"Commercially Available Radon Kits". Alpha Energy Labs. Archived from the original on 2012-07-12. Retrieved 2012-04-19.*
- <sup>7</sup> <sup>^</sup> *"Radon Measurement Method Definitions". The National Environmental Health Association—National Radon Proficiency Program. Archived from the original on 2007-12-24. Retrieved 2008-02-02.*

8. ^ *"State Radon Laws"*. *lawatlas.org*. Retrieved 2021-07-12.
9. ^ *"National Conference of State Legislatures (NCSL) - Radon"*.
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14. ^ *"UKradon - Home"*. *www.ukradon.org*.
15. ^ *"Radon measurements in residential dwellings"*.
16. ^ *"Radon boliger 2013" (PDF)*.
17. ^ *"Legislation"*.
18. ^ *"Radon: Myth vs Fact"*. *Radon-Rid/EPA*. Retrieved 2009-11-13.
19. ^ *"Listing of States and Jurisdictions with RRNC Codes"*. *EPA*. Retrieved 2009-11-13.
20. ^ *"A Citizen's Guide to Radon" (PDF)*. *EPA*. Retrieved 2024-12-27.
21. ^ *"Radon Mitigation Methods"*. *Radon Solution*. Archived from the original on 2008-12-15. Retrieved 2008-12-02.
22. ^ **a b** *"Consumer's Guide to Radon Reduction: How to Fix Your Home" (PDF)*. *EPA*.
23. ^ *"Radon Mitigation System - EH: Minnesota Department of Health"*. *Health.state.mn.us*. 2014-12-10. Retrieved 2019-03-26.
24. ^ *"Featured Radon Mitigation System Archives"*. *Radonreductioninc.com*. Retrieved 2015-03-30.
25. ^ *"Radon in Drinking Water Health Risk Reduction and Cost Analysis: Notice" (PDF)*. *Federal Register*. **64**. February 26, 1999. Retrieved 2015-03-30.

## External links

[edit]

- Radon at the United States Environmental Protection Agency
- National Radon Program Services hosted by Kansas State University
- Radon and Lung Health from the American Lung Association
- It's Your Health - Health Canada
- Radon's impact on your health – Quebec Lung Association

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Radiation protection

- Main articles**
  - Background radiation
  - Dosimetry
  - Health physics
  - Ionizing radiation
  - Internal dosimetry
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  - Radiobiology
  
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- Euratom
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- UNSCEAR

- IRR (UK)
- NRC (USA)
- ONR (UK)
- Radiation Protection Convention, 1960

- Acute radiation syndrome
- Radiation-induced cancer

See also the categories Medical physics, Radiation effects, Radioactivity, Radiobiology, and Radiation protection

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Heating, ventilation, and air conditioning



**Fundamental  
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- Absorption-compression heat pump
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- Solar combisystem
- Solar cooling
- Solar heating

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- Air door
- Air filter
- Air handler
- Air ionizer
- Air-mixing plenum
- Air purifier
- Air source heat pump
- Attic fan
- Automatic balancing valve
- Back boiler
- Barrier pipe
- Blast damper
- Boiler
- Centrifugal fan
- Ceramic heater
- Chiller
- Condensate pump
- Condenser
- Condensing boiler
- Convection heater
- Compressor
- Cooling tower
- Damper
- Dehumidifier
- Duct
- Economizer
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- Evaporative cooler
- Evaporator
- Exhaust hood
- Expansion tank
- Fan
- Fan coil unit
- Fan filter unit
- Fan heater
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- Fireplace
- Fireplace insert
- Freeze stat
- Flue
- Freon
- Fume hood
- Furnace
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- Gas heater
- Gasoline heater
- Grease duct
- Grille

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- Air flow meter
- Aquastat
- BACnet
- Blower door
- Building automation
- Carbon dioxide sensor
- Clean air delivery rate (CADR)
- Control valve
- Gas detector
- Home energy monitor
- Humidistat
- HVAC control system
- Infrared thermometer
- Intelligent buildings
- LonWorks
- Minimum efficiency reporting value (MERV)
- Normal temperature and pressure (NTP)
- OpenTherm
- Programmable communicating thermostat
- Programmable thermostat
- Psychrometrics
- Room temperature
- Smart thermostat
- Standard temperature and pressure (STP)
- Thermographic camera
- Thermostat
- Thermostatic radiator valve

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trades,  
and services**

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- Architectural engineering
- Architectural technologist
- Building services engineering
- Building information modeling (BIM)
- Deep energy retrofit
- Duct cleaning
- Duct leakage testing
- Environmental engineering
- Hydronic balancing
- Kitchen exhaust cleaning
- Mechanical engineering
- Mechanical, electrical, and plumbing
- Mold growth, assessment, and remediation
- Refrigerant reclamation
- Testing, adjusting, balancing

## Industry organizations

- AHRI
- AMCA
- ASHRAE
- ASTM International
- BRE
- BSRIA
- CIBSE
- Institute of Refrigeration
- IIR
- LEED
- SMACNA
- UMC

## Health and safety

- Indoor air quality (IAQ)
- Passive smoking
- Sick building syndrome (SBS)
- Volatile organic compound (VOC)

## See also

- ASHRAE Handbook
- Building science
- Fireproofing
- Glossary of HVAC terms
- Warm Spaces
- World Refrigeration Day
- Template:Fire protection
- Template:Home automation
- Template:Solar energy

## About Cook County

### Photo

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## Things To Do in Cook County

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### Photo

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### Sand Ridge Nature Center

4.8 (96)

### Photo

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### River Trail Nature Center

4.6 (235)

### Photo

**Palmisano (Henry) Park**

**4.7 (1262)**

## Driving Directions in Cook County

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Driving Directions From Palmisano (Henry) Park to

Driving Directions From Lake Katherine Nature Center and Botanic Gardens to

Driving Directions From Navy Pier to

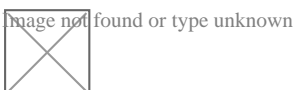
<https://www.google.com/maps/dir/Navy+Pier/United+Structural+Systems+of+Illinois%2C+187.6050944,14z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1sunknown!2m2!1d-87.6050944!2d41.8918633!1m5!1m1!1sChIJ-wSxDtinD4gRiv4kY3RRh9U!2m2!1d-88.1396465!2d42.0637725!3e0>

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## Reviews for

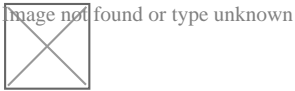
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**Jeffery James**

**(5)**

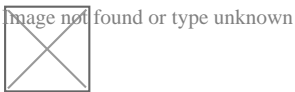
Very happy with my experience. They were prompt and followed through, and very helpful in fixing the crack in my foundation.



**Sarah McNeily**

**(5)**

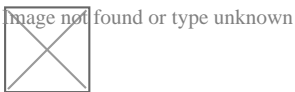
USS was excellent. They are honest, straightforward, trustworthy, and conscientious. They thoughtfully removed the flowers and flower bulbs to dig where they needed in the yard, replanted said flowers and spread the extra dirt to fill in an area of the yard. We've had other services from different companies and our yard was really a mess after. They kept the job site meticulously clean. The crew was on time and friendly. I'd recommend them any day! Thanks to Jessie and crew.



**Jim de Leon**

**(5)**

It was a pleasure to work with Rick and his crew. From the beginning, Rick listened to my concerns and what I wished to accomplish. Out of the 6 contractors that quoted the project, Rick seemed the MOST willing to accommodate my wishes. His pricing was definitely more than fair as well. I had 10 push piers installed to stabilize and lift an addition of my house. The project commenced at the date that Rick had disclosed initially and it was completed within the same time period expected (based on Rick's original assessment). The crew was well informed, courteous, and hard working. They were not loud (even while equipment was being utilized) and were well spoken. My neighbors were very impressed on how polite they were when they entered / exited my property (saying hello or good morning each day when they crossed paths). You can tell they care about the customer concerns. They ensured that the property would be put back as clean as possible by placing MANY sheets of plywood down prior to excavating. They compacted the dirt back in the holes extremely well to avoid large stock piles of soils. All the while, the main office was calling me to discuss updates and expectations of completion. They provided waivers of lien, certificates of insurance, properly acquired permits, and JULIE locates. From a construction background, I can tell you that I did not see any flaws in the way they operated and this an extremely professional company. The pictures attached show the push piers added to the foundation (pictures 1, 2 & 3), the amount of excavation (picture 4), and the restoration after dirt was placed back in the pits and compacted (pictures 5, 6 & 7). Please notice that they also sealed two large cracks and steel plated these cracks from expanding further (which you can see under my sliding glass door). I, as well as my wife, are extremely happy that we chose United Structural Systems for our contractor. I would happily tell any of my friends and family to use this contractor should the opportunity arise!

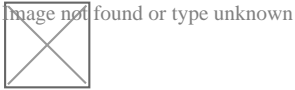


**Chris Abplanalp**

**(5)**

USS did an amazing job on my underpinning on my house, they were also very courteous to the proximity of my property line next to my neighbor. They kept things in order with all the dirt/mud they had to excavate. They were done exactly in the timeframe they indicated, and the contract was very details oriented with drawings of what would be done. Only thing that would have been nice, is they left my concrete a little muddy with boot prints but again, all-in-all a great job





**Dave Kari**

**(5)**

What a fantastic experience! Owner Rick Thomas is a trustworthy professional. Nick and the crew are hard working, knowledgeable and experienced. I interviewed every company in the area, big and small. A homeowner never wants to hear that they have foundation issues. Out of every company, I trusted USS the most, and it paid off in the end. Highly recommend.

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- [Identifying Areas Vulnerable to Soil Erosion](#)
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