

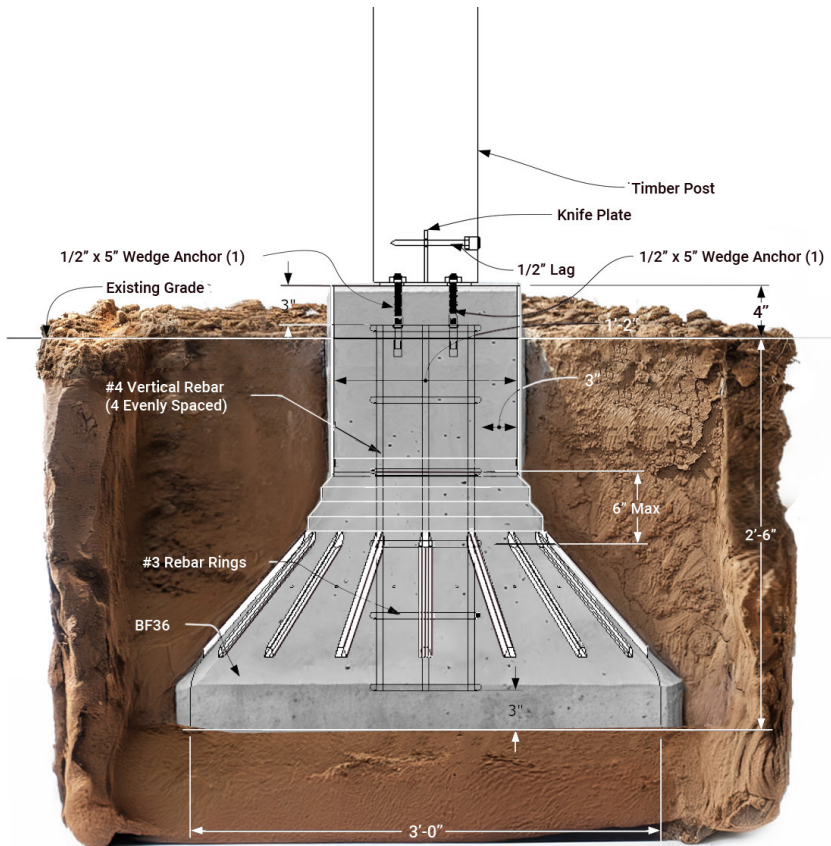


# KNOW YOUR FOOTINGS:

A Guide for DIY and Professional Success







In the world of construction, footings are the heart of structural integrity. These seemingly simple elements are, in fact, the cornerstone of architectural stability and strength. Much like the roots of a mighty tree, footings distribute weight, handle environmental stresses, and ultimately determine the longevity of the building above.

In this guide, we'll delve into the art and science of footings, uncovering how meticulous planning and precision engineering converge to create structures that endure. Whether you're an architect, a builder, or simply curious, join us as we explore why footings are not merely a part of the process, but the bedrock of architectural excellence.



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# The Heart Behind Our Craft

Our portfolio is a testament to our versatility and creativity. We design pergolas that offer shade and serenity, gazebos that radiate elegance, and pavilions that become the heart of celebrations. Our arbors invite nature to intertwine with design, trellises create enchanting garden escapes, and our post and beam structures and trusses defy gravity. Each project a unique blend of form and function, reflecting our commitment to excellence and innovation.

A few other things about us: we are the four-time winner of Best of Show at the Salt Lake Home and Garden Show. We've been on the Inc. 5000 list for multiple years. We've won the Best of State award multiple times, evolving from the best small business to the best large business in fabrication and wood products. However, what has been the most rewarding for us are the customer stories, discovering how our work has changed their lives. This is

something we never anticipated.

One story we wanted to share is about a structure we helped design for a family who needed a private place to grieve. They wanted privacy, which is why you see the various panels behind it – they didn't want to be seen by their neighbors. They needed a space to get outside as they felt cooped up after their daughter, Cadee, whom they affectionately called Cadee Bug, passed away. They described their desire to keep the world away and just get back outside to improve their health. Their son had dropped out of school because he was very close to his sister. They just wanted a space to go and be outside, as advised by their doctors to get some sunlight.

The story they shared with us is on our website, but in short, it transformed their lives. They weren't very social before, but the neighborhood kids started coming over, helping their son



Ed & Aubree Conner

come out of his shell. He returned to school, and they began having large gatherings. Their son's multi-state company started sponsoring events at their location, which was something new for them. They even hosted neighborhood dog parties. These kinds of transformational stories are beyond what we could have imagined. It has been a deeply fulfilling and humbling experience to share in the lives of others, and we are grateful for the privilege to witness their transformative journeys.





Lunch Time at Western Timber Frame





# Foundations of Our Journey

## About Western Timber Frame

At Western Timber Frame™, we're not just builders; we're creators of timeless masterpieces. With a fusion of old-world craftsmanship and cutting-edge patented dovetail technology, we have mastered the art of crafting solid timber structures that stand as enduring testaments to architectural excellence.

## Our Craftsmanship

Our journey begins with a deep-rooted passion for preserving the time-honored traditions of timber framing. Every structure we create is a labor of love, meticulously handcrafted by artisans who share a profound respect for wood's inherent beauty and strength. Our commitment to craftsmanship is unwavering, resulting in structures that are both functional and awe-inspiring works of art.

## Innovative Dovetail Technology

While we honor tradition, we also embrace innovation with our patented dovetail technology. This method combines the beauty of old-world craftsmanship with the precision of modern engineering. The result is so precise that DIY enthusiasts can easily put everything together themselves, experiencing the joy of traditional timber framing firsthand.





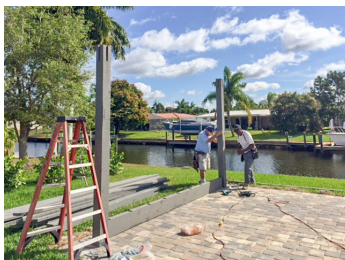
"We researched quite a few sites and talked to many people before investing in a Western Timber Frame pergola. What sold us was the dove tails! The ordering process was quite simple. It arrived in a nice bundle. We were able to put up our Western Timber Frame pergola with only 3 of us. It was amazingly simple."  
 -Terri Mullins, Kentucky



Family in Arizona



Owens family, Arizona



Soy Williams, Florida

Hyrum Thompson, the founder of Western Timber Frame (we'll introduce you to him hereafter), has a profound passion for timber framing. Wanting to share this experience with others, he designed a kit specifically for those who wish to experience the joy of timber framing themselves.

The purpose of this book is to guide those who want to do their own footings or at least understand the critical factors for making informed decisions about footings.

Many of our ShadeScape® clients take pride in installing their own arbors, gazebos, pavilions, or pergolas.

Though these heavy-duty kits are massive, their engineered design makes them easy to set in place with the help of a friend or two.

This book is here to ensure you have all the knowledge you need about footings to make your project a lasting success.



Hyrum Thompson, the founder of Western Timber Frame™ installing a timber frame pergola.

"Installation not your thing? Let us handle it!"



## **Hyrum Thompson: Master Craftsman and Innovator, Founder of Western Timber Frame™**

Hyrum Thompson, the visionary founder of Western Timber Frame, has over 45 years of construction experience. His enthusiasm and passion for woodworking, along with his pioneering new techniques in massive old-world timber framing, draw people to work with him. Hyrum's love of making others laugh and his strong work ethic attract people to him and inspire them to work alongside him. While he prefers not to be in the limelight, we can't tell our beginnings without highlighting his contributions and the joy he brings to our team.

Hyrum's unique approach, known as "The Dovetail Difference," revolutionized the industry, setting a new standard in timber construction. He believes and often reminds us that our work is not just about building structures; it's about creating spaces that invite people outdoors and foster stronger relationships.

Recently, Hyrum faced a personal challenge



when he woke up paralyzed due to spinal stenosis. In his journey towards recovery, he has spent countless hours in his pergola, soaking up sunlight and finding solace in the very structures he has dedicated his life to creating. Through this experience, he has become an even firmer believer in the transformative power of his work. Hyrum's pergola, like many he has built for clients, has proven to be a source of healing and joy, profoundly enriching his life.



Smith family, Washington



Brooks family, Alabama

Pictured on the right are the sons of one of our architects, doing what kids love best—digging in the dirt. Now, let's dig into this topic ourselves so we can get ready for some digging of our own and build some strong foundations.



Tomorrow's Foundations Start Today

# The Backbone of Construction

Foundations are the backbone of construction, providing the vital underpinning for every structure's success. Their significance cannot be overstated, encompassing various foundation types such as footings, concrete pad foundations and screw piles. Here's why foundations are absolutely indispensable:

**Stability and Weight Distribution:** Foundations serve as the bedrock upon which a building rests, ensuring that the weight of the structure is evenly distributed. Without a solid foundation, a building risks settling unevenly, potentially leading to structural instability and long-term damage.

**Preventing Sinking:** In areas with soft or unstable soil, foundations play a pivotal role in preventing the building from sinking into the ground. They establish a sturdy base that resists settling and sinking, providing stability even in challenging soil conditions.

**Foundation Support:** A well-constructed foundation provides the necessary support for the entire building. It acts as an anchor, enhancing the structural integrity and longevity of the entire structure.

**Resisting Settling:** Over time, natural factors like changes in soil moisture and earth settling can impact a building's foundation. Properly designed foundations are engineered to resist these settling forces, preserving the building's stability.



**Moisture Protection:** Foundations act as a barrier against moisture and water infiltration. This is crucial for safeguarding the foundation against water damage, which can lead to cracks, erosion, and other structural issues.

**Safety Assurance:** The construction of a robust foundation is paramount for safety. It ensures that the building remains steadfast, reducing the risk of structural failure, which could result in accidents or injuries.

**Adaptability to Soil Conditions:** Foundations can be tailored to suit specific soil conditions at a construction site. This adaptability is essential to ensure that the foundation effectively supports the structure in varying environments.

In summary, the foundation is the bedrock of a building's stability and longevity. They ensure even weight distribution, prevent settling and sinking, and protect against moisture-related issues. Without a strong foundation, the entire construction project is at risk, underscoring the fundamental importance of this crucial component in construction.



# Building Permit

In most cases, obtaining a building permit is a necessary step when constructing a deck. Acquiring a building permit is typically straightforward, involving a few uncomplicated steps.

Securing a building permit for your deck is typically a straightforward process, but it's essential to be aware that the specific application procedure may vary depending on your location. To guide you through the steps:

First you will need to find out who is responsible for granting construction permissions in your area. In most cases, this is the Building Inspections Department, usually housed within the City Hall.

## **Contact Your Local Building Department:**

Reach out to your local building department to discuss your proposed deck project. If a permit is required, they will provide you with the appropriate application form.

**Prepare Your Application:** The next step involves meticulously completing your deck building permit application, ensuring that you include all the necessary documentation.

**Submission and Fees:** Lastly, submit your application to the designated department and be prepared to pay the requisite fees.

## **What You Need for a Deck Building Permit**

The documents you need can vary based on your location, but generally, these are the requirements for a deck building permit:

**Site Plan:** A site plan is essential for several reasons. It helps inspectors ensure that your deck complies with building codes and local regulations. It may also be required for HOA approval and zoning permits. This plan indicates the deck's distance from property lines and existing structures.



**Construction Plan:** The construction plan provides detailed information about your deck, including its size, dimensions, spacing, and the locations of beams, joists, and frost footings.

**Elevation Plans:** In some cases, you might need elevation drawings that show how your deck looks from the front or side.

By having these documents in order, you'll be better prepared to obtain a building permit for your deck.

**There are some instances where a building permit is not required.**

In most cases, you won't need a permit for your deck if it meets these criteria:

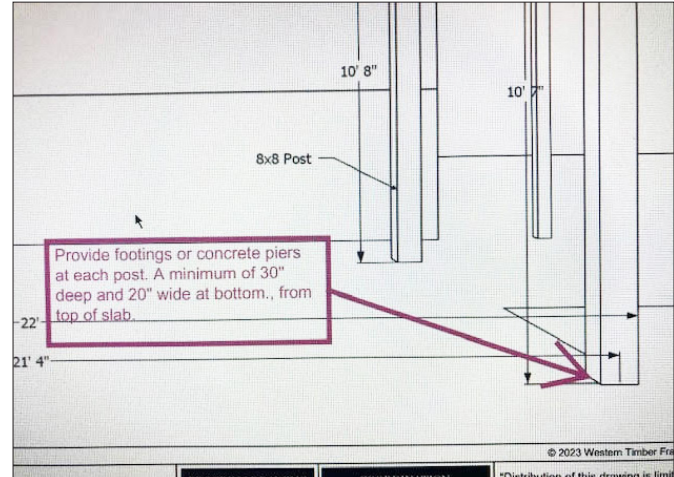
**Height:** If your deck is less than 30 inches above the ground, it usually doesn't require a permit.

**Attachment:** Decks not attached to your home, typically located more than 10 feet away, often don't need a permit.

**Size:** Decks smaller than 200 square feet in size are often exempt from permitting.

**Types of Decks and Permit Considerations**

Decks come in two main types: attached to your house or unattached (freestanding). While attached decks offer convenient access to your home, there are advantages to unattached decks, such as not needing permits in some areas.





# Call Early & Plan Before You Dig

It's crucial to remember that essential utilities serving your home may be buried directly beneath where a deck footing needs to go. These utilities can include:

- Sewer lines
- Gas lines
- Water lines
- Electric lines
- Secondary electric or gas lines to a shed, post lamp, or fire pit
- Low-voltage cables for landscape lights



When planning to undertake any construction involving footings or a foundation, it's essential to take the following steps:

### 1. Contact 811 - The Utility-Locate Hotline:

- Before beginning your project, call 811, which is the utility-locate hotline.
- Reach out to them a few days prior to breaking ground, or you can submit an online request for assistance.
- A service agent will provide you with a ticket number and inform you of an approximate timeframe for a utility worker to visit your site and mark underground utilities with paint or flags.

### 2. Exercise Caution Around Marked Lines:

- Once the buried utility lines have been marked, exercise extreme caution when digging in the vicinity.

- If your project is close to these marked utilities, seriously consider revising or relocating your project to prevent inadvertent harm to yourself or any underground utility lines.

By following these steps, you can ensure the safety of your project and avoid potential risks associated with underground utilities.



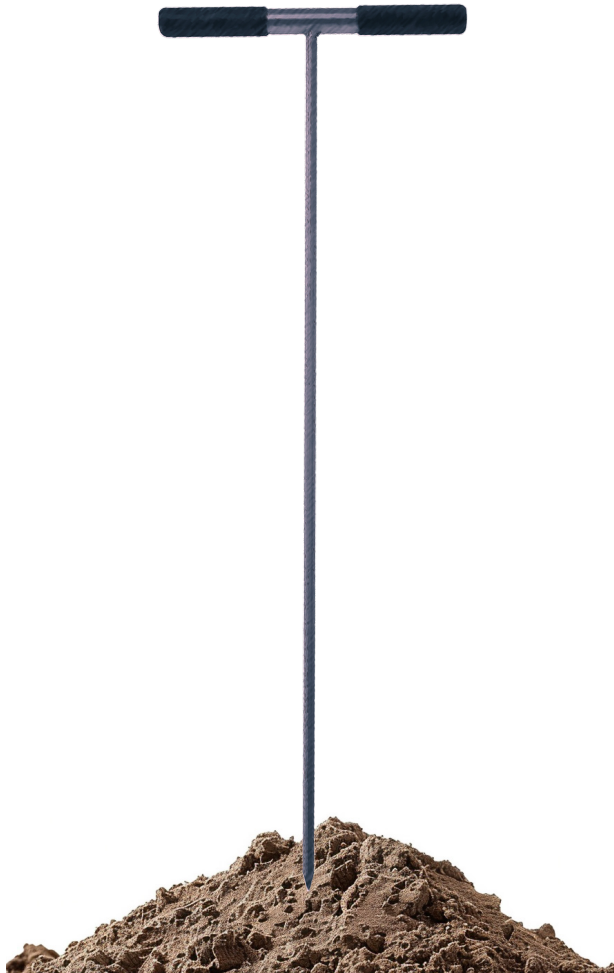
## Simple Soil Test

The quality of the soil upon which your house or deck rests is of paramount importance in any construction project, and I want to emphasize its significance. It's crucial to consult the local building code (Table R403.1(2)) to determine the appropriate size of footings or piers for your specific soil conditions, ensuring that they are both adequately thick and tailored to the soil type.

You can easily acquire a soil probe, available at Box Store retailers. This simple tool consists of a T-bar with a fiberglass shaft and a semi-sharp, bullet-like metal point. Its purpose is to assess the soil's compaction, providing valuable insights into its quality. This probe can also be used to detect subsurface objects, such as a septic tank.

For more comprehensive soil analysis, there are more advanced (and expensive) devices available that can measure the soil's PSI (pounds per square inch) rating, offering precise information about its load-bearing capacity in pounds per square foot (PSF).





If, however, you possess one of these soil probe devices, you can often determine whether your construction will meet code requirements before the inspector arrives.

When you insert this probe into the ground, it should penetrate approximately an inch before encountering resistance, indicating favorable conditions for code compliance. This is a good indicator that the ground is solid and capable of supporting your structure. Conversely, if the probe sinks too easily, it signals unstable soil that could lead to settling and potential collapse of your deck or house.

In cases where the soil is sandy or soft, you may need to engage an engineer to design specialized footings or piers tailored to your specific load-bearing requirements. The engineer will calculate the necessary size and thickness to ensure stability.

# Design For Wind Resilience

The question we get asked most often is: How well do our timber frame structures hold up against the wind?

This is a fantastic question because it allows us to share our passion for building timber frame structures that will last for generations.

\*The short answer is, yes, they hold up exceptionally well. We could write an entire book explaining why, our innovative patents and designs, but let's summarize it as clearly and concisely as possible.

People have good reason to be concerned with wind. We've seen many structures, like these vinyl and wood frame pergolas, blown down by strong winds. These examples highlight the importance of building a durable and well-engineered structure.

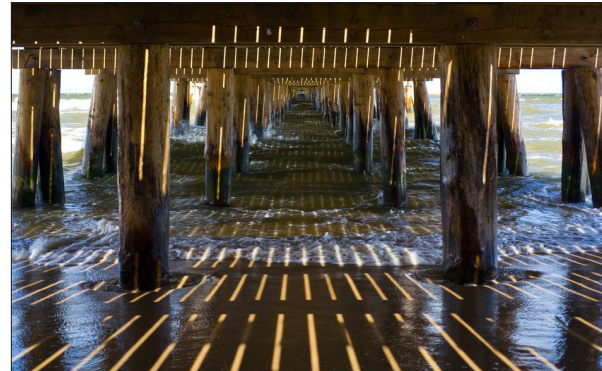


Architectural frameworks and immobile structures are typically viewed as solid and unmovable. However, we live on a planet that constantly experiences motion, with seismic waves causing micro-movements both vertically and horizontally. Additionally, severe weather conditions, such as strong winds and heavy snow, further increase the load on these structures.

Timber frame bridges stand as some of the most visible and noble testaments to the integrity of timber framing. Remarkably, some of these bridges, still in use today, date back to the 16th century. They are proven masterpieces of engineering and technology, demonstrating long-lasting endurance by spanning great distances and withstanding the forces of water and storms.

Timber meets the strength, lightweight, and structural requirements for energy-absorbent properties essential in constructing safe bridges. It conforms to highway safety standards HL-93 and AASHTO HS20-44 for vehicular bridges that handle continuous

traffic. While a pavilion or pergola doesn't experience this constant load, it's remarkable to consider the load-bearing strength of timber under the most adverse conditions.



With superior construction techniques, properly engineered designs, and expert craftsmanship, a pressure-treated timber pergola can last even longer than historic timber structures. Timber framing is an investment for future generations, providing safe, durable structures that resist powerful coastal storms, high winds, heavy mountain snows, and seismic activity, all while maintaining structural integrity.



Wind speeds vary across different topographical regions, and building codes are tailored accordingly for each public and private building. For instance, in Southern Florida, significant changes were made to building code standards in 2012 following Hurricane Andrew. The region adopted the American Society of Civil Engineers' standards and implemented a Product Evaluation Approval Program involving architectural, structural, and mechanical engineers. Due to the high-velocity hurricane zones, the construction of stud-framed houses was prohibited.

Western Timber Frame™ outdoor timber frame pavilions and pergolas not only meet but exceed the highest building code standards in the nation. We confidently install our timber frame pavilion and pergola kits in regions like Southern Florida, ensuring superior durability and safety.





**No matter how strong a structure you build, if it isn't on a solid, durable foundation and properly tied in, it won't hold up.** In high wind zones, structures experience a lot of tension back and forth.



For structures like pavilions or cabanas, they can experience uplift. This might sound surprising, but imagine a pavilion with a pitched roof—it's similar to an airplane wing. When airflow flows over it, it creates lift.

I took aviation science in college, and the same principle applies to a pavilion. Our engineers must account for this uplift when designing these structures.

We had a client back East who bought a kit from us. We didn't install it, but despite clear

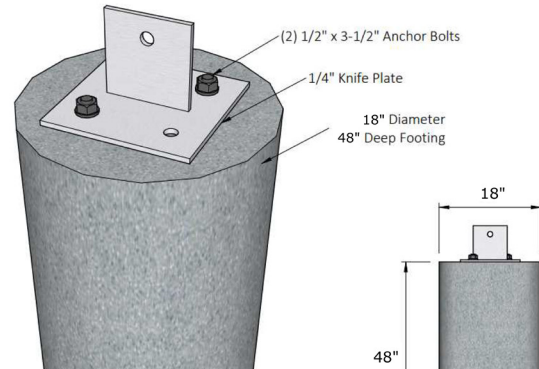
"So, you chose not to anchor your structure on solid footings, but to redecorate your yard instead?"



instructions they placed this pavilion on footings and decided not to use an anchor lag to tie the posts into our knife plate and anchor it properly. Well, it lifted off.

It was thousands of pounds, and the wind lifted it off. They chose not to anchor it properly, leading to an unfortunate result.

***Proper anchoring is essential, even for massive heavyweight timbers, as this case demonstrates.***





"To be clear: I'm not out of shape but I can't lift a tank. Tanks just have an awkward shape that isn't aerodynamic!"



"Who needs cranes when you have wind that can lift tanks!"



Think of a large jet lifting off with thousands of pounds of cargo. They even put tanks in some planes, and they still get off the ground. The same thing can happen with a pavilion—if there's enough airflow curving over the top, it can lift the pavilion. Even if it doesn't actually come off the ground, the footings have to hold it down. They need to be substantial enough to keep it anchored in place.



Hurricane Irma was an extremely powerful and catastrophic hurricane in 2017. It reached its peak intensity as a Category 5 hurricane with maximum sustained winds of 180 mph (285 km/h). It was one of the strongest hurricanes ever recorded in the Atlantic in terms of sustained wind speed. Irma caused widespread devastation across the Caribbean and the southeastern United States, particularly in Florida. The hurricane's intensity and massive size led to significant damage and disruption, making it one of the most impactful hurricanes in recent history.



Hurricane-Tested Western Timber Frame™ Pergola

*"Yikes! I was having one of those days where everything just spins out of control and I blew things way out of proportion!"*

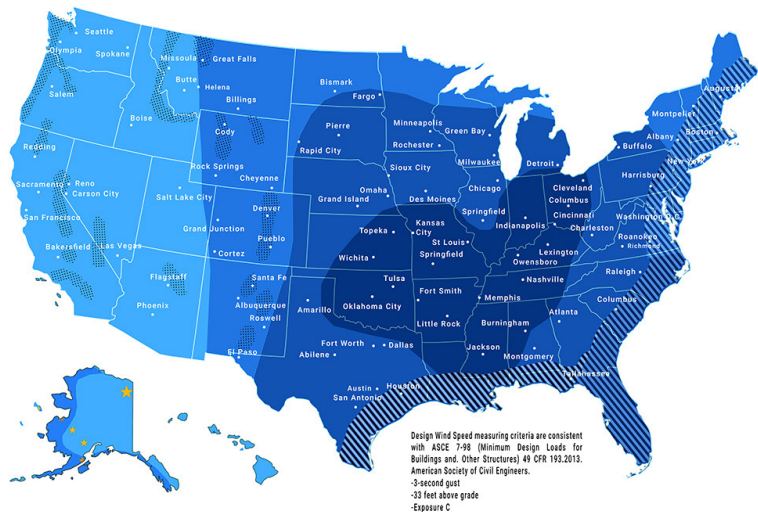


"Are you kidding this Pergola has already been through its first hurricane, Irma. She stood tall and proud and never wavered.

Our neighbors with us sat under her and watched as men from Texas cut trees down off the lines and restored our power.

Thank you for your wonderful product she gave our neighbors shade when there was none. Be proud of your product. Thanks." – Kenneth Baker

## UNITED STATES OF AMERICA WIND ZONES



Design Wind Speed measuring criteria are consistent with ASCE 7-98 (Minimum Design Loads for Buildings and Other Structures) 49 CFR 192.2013. American Society of Civil Engineers.  
 -3-second gust  
 -33 feet above grade  
 -Exposure C



"Think of me as the ultimate footing fitness trainer! I test footings to see if they can handle my crazy workouts!"



Once again, wind plays a crucial role in the stability and structural integrity of footings, especially for tall buildings or structures with large surface areas. Here's a brief overview of how wind affects footings:

**Lateral Forces:** Wind exerts lateral (horizontal) forces on a building. These forces can cause the structure to sway or lean, creating lateral loads on the footings. Footings must be designed to withstand these lateral forces to prevent tilting or structural damage.

**Shear and Uplift:** Strong winds can create shear forces, which try to push the structure sideways, and uplift forces, which try to lift the structure off its foundation. Footings must be designed to resist these forces to keep the building firmly anchored to the ground.

**Design Considerations:** Engineers take into account wind loads when designing footings and foundations. The specific design will depend on factors like the building's height, shape, location, and the local wind speed and direction. Adequate reinforcement and anchoring are crucial to ensure that the footings can withstand wind-induced stresses.

Tall and Slender Structures: Tall and slender buildings, such as skyscrapers, are more susceptible to wind forces. In these cases,

deep and well-anchored footings are essential to counteract the potential for tipping or structural failure.

**Wind Load Calculations:** Wind load calculations are an integral part of structural engineering for any construction project. These calculations help determine the forces that will act on the building and its footings, enabling engineers to design the appropriate foundation and anchoring systems.

**Location Matters:** The location of the building also plays a role. Buildings in areas prone to high winds, such as coastal regions or open plains, require extra attention to ensure the footings can withstand the wind loads common to those areas.

In summary, wind can exert significant forces on footings, which must be taken into account during the design and construction phases of a building. Properly designed and anchored footings are essential to ensure the structural stability and safety of the entire construction.

# Stability and Weight Distribution

Footings are hidden underground, so people often overlook how crucial they are. They support all the weight of the structure and any extra loads like snow. Cutting corners here can lead to major problems, so they need to be done right!"





Imagine you have a structure that weighs 10,000 pounds supported by four posts. Each post holds about 2,500 pounds. Now, if it's a

pavilion, you need to consider the snow load too, which can add a lot of extra weight in the winter.

**For example:**

Snow load: 30 pounds per square foot

Structure size: 20 feet by 20 feet (400 square feet)

Total snow weight: 30 pounds/square foot x 400 square feet = 12,000 pounds



So, with just a 30-pound snow load, each footing now needs to support 5,500 pounds instead of the original 2,500 pounds. The total

weight the structure supports, including the snow load, is 22,000 pounds. That's a lot of extra weight!

Now, let's place that same structure in Heber or Park City, Utah: Snow load there can be 45, 50, or even 60 pounds per square foot

At 45 pounds: 45 pounds/square foot x 400 square feet = 18,000 pounds

At 50 pounds: 50 pounds/square foot x 400 square feet = 20,000 pounds

At 60 pounds: 60 pounds/square foot x 400 square feet = 24,000 pounds

Total weight per footing with snow load:

At 45 pounds: (10,000 pounds + 18,000 pounds) / 4 footings = 7,000 pounds per footing

At 50 pounds: (10,000 pounds + 20,000 pounds) / 4 footings = 7,500 pounds per footing

At 60 pounds: (10,000 pounds + 24,000 pounds) / 4 footings = 8,500 pounds per footing

Total weight of structure plus snow load:

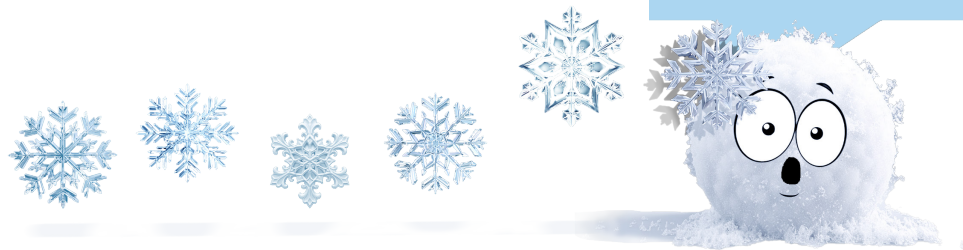
At 45 pounds: 10,000 pounds + 18,000 pounds = 28,000 pounds

At 50 pounds: 10,000 pounds + 20,000 pounds = 30,000 pounds

At 60 pounds: 10,000 pounds + 24,000 pounds = 34,000 pounds

**It is easy to see how the weight those footings need to support increases dramatically.**

"Down south, I'm just a flake, but up north, I'm a snow boulder! Okay, I weigh a lot, but that's just because I'm retaining a lot of water!"



And if the soil is sandy or unstable, the footings need to be even larger to handle this extra load. Sand can't be compacted and, as such, will never be a solid piece of earth to place a foundation on top of.



8,500 pounds each! That's like supporting a massive T-Rex!

"Wow, I didn't realize I was the villain in the book!"



This is why it's so important to consider these factors when designing and building structures.



Now, let's talk about pergolas and decks for a moment. A pergola doesn't have a solid roof, so it doesn't typically carry a snow load. The snow just falls right through it.



"Falling from the roof?  
I just can't resist a  
deck!"

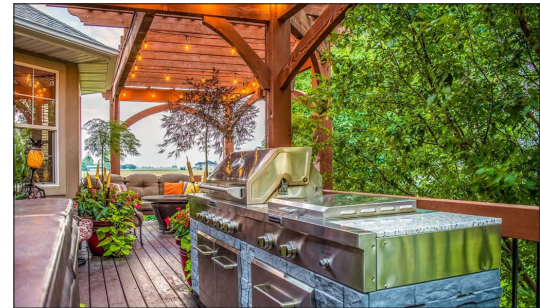


But with a deck, the snow sits on top and can accumulate all winter long, especially if it's a second or third home or a cabin property where no one shovels it off. Snow can also fall off the roof onto the deck, adding even more weight.

Because of this, engineers have to design decks to be incredibly strong. Imagine a two- or three-story parking garage filled with cars.



Now, think about the weight of all those cars. Surprisingly, a home deck must support even more weight than that!



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[www.WesternTimberFrame.com](http://www.WesternTimberFrame.com) | 37

While a car spreads its weight over four tires, a deck might support twenty or thirty people, creating concentrated weight. Engineers must plan for large gatherings on the deck, possibly combined with snow, to prevent it from failing. When people gather on a deck for a party or event, the weight can add up quickly.

Just like cars in a parking garage, people on a deck create a concentrated load. Engineers must

ensure the deck can handle this heavy load, plus any additional weight from snow or other factors. This makes deck construction very complex and if you don't get it right, you're risking serious safety issues.



Decks have to bear a lot of dense weight so they can bench press an entire party!



“Bearing dense weight” means supporting a heavy and concentrated load. It refers to the capacity of a structure, like a deck, to hold up a substantial amount of weight in a small area. This could be from people standing closely together, heavy furniture, or accumulated snow, which creates significant pressure on the supporting structure. The deck must be strong enough to handle this concentrated, heavy load without failing.

Another big consideration is hot tubs. Think about how much weight all that water adds. When we deal with hot tubs, the footings need to be pretty substantial. They can really complicate the project.”





Decks need to be that strong!  
But it is wild! It's like building  
a fortress for a deck!



Building a deck involves a lot more than a typical freestanding structure. Decks must support not only regular use but also heavy snow loads, so they need to be engineered to be about twice as strong as your house's roof. Building a deck is a lot more involved than constructing a typical freestanding structure. Decks must support not only regular use but also heavy snow loads, so they need to be engineered to be about twice as strong as your house's roof.



*Your deck must be  
twice as strong as the  
roof of your house.*

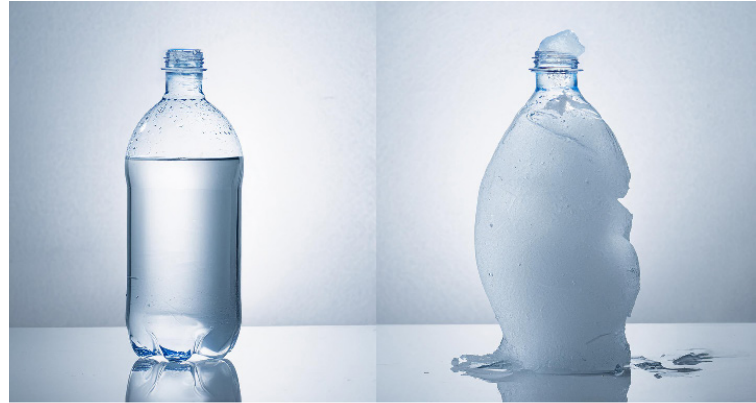


It's critical to thoroughly research and properly construct your deck. There's a lot more that can go wrong with a deck compared to a nearby freestanding structure. If you don't get it right, you're risking serious safety issues.

Unlike pavilions, decks don't have the same runoff, meaning they often require footings capable of supporting up to an 80-pound snow load. Suddenly, what seemed like a straightforward project can escalate. We've seen instances where the cost of deck footings alone exceeded initial estimates by \$20,000. Why? Because bigger footings mean more excavation, more materials, and more complexity.



# What Is Frost Heave?



Liquid

Solid

**Frost Formation:** When it gets really cold, tiny ice crystals form on things outside. This is called frost.

**Ice Lenses:** When this frost gets into the ground, it mixes with the water in the soil and makes “ice lenses.” Think of these ice lenses like flat ice sheets that form under the ground. As they freeze they grow larger in size.

**Heaving:** The word “heave” means to lift or haul (a heavy thing) with great effort.

**Frost Heave:** Frost heave is the upward or outward movement of the ground surface, or objects within it, caused by the formation of ice in the soil. This lifting action can cause the ground to move and crack because nothing can withstand the force of expanding water!

## Nothing can withstand the force of expanding water!



Water seeps down into the soil.

Temperature drops and the water freezes and expands.

Temperature rises and the ice melts, sinking back down.

# What Is Your Frost Line?

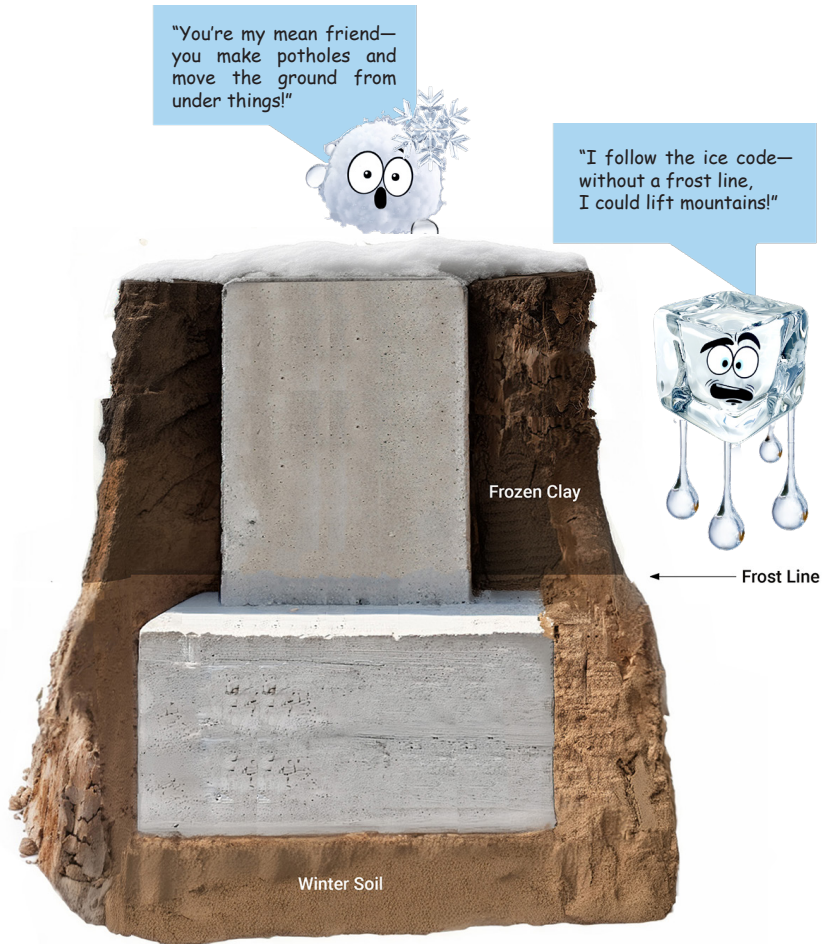


It's important to understand and manage frost heave to protect your yard and buildings. Making sure water drains well and building strong foundations can help prevent damage from frost heave. In order to do this you must know how deep your frost line is.

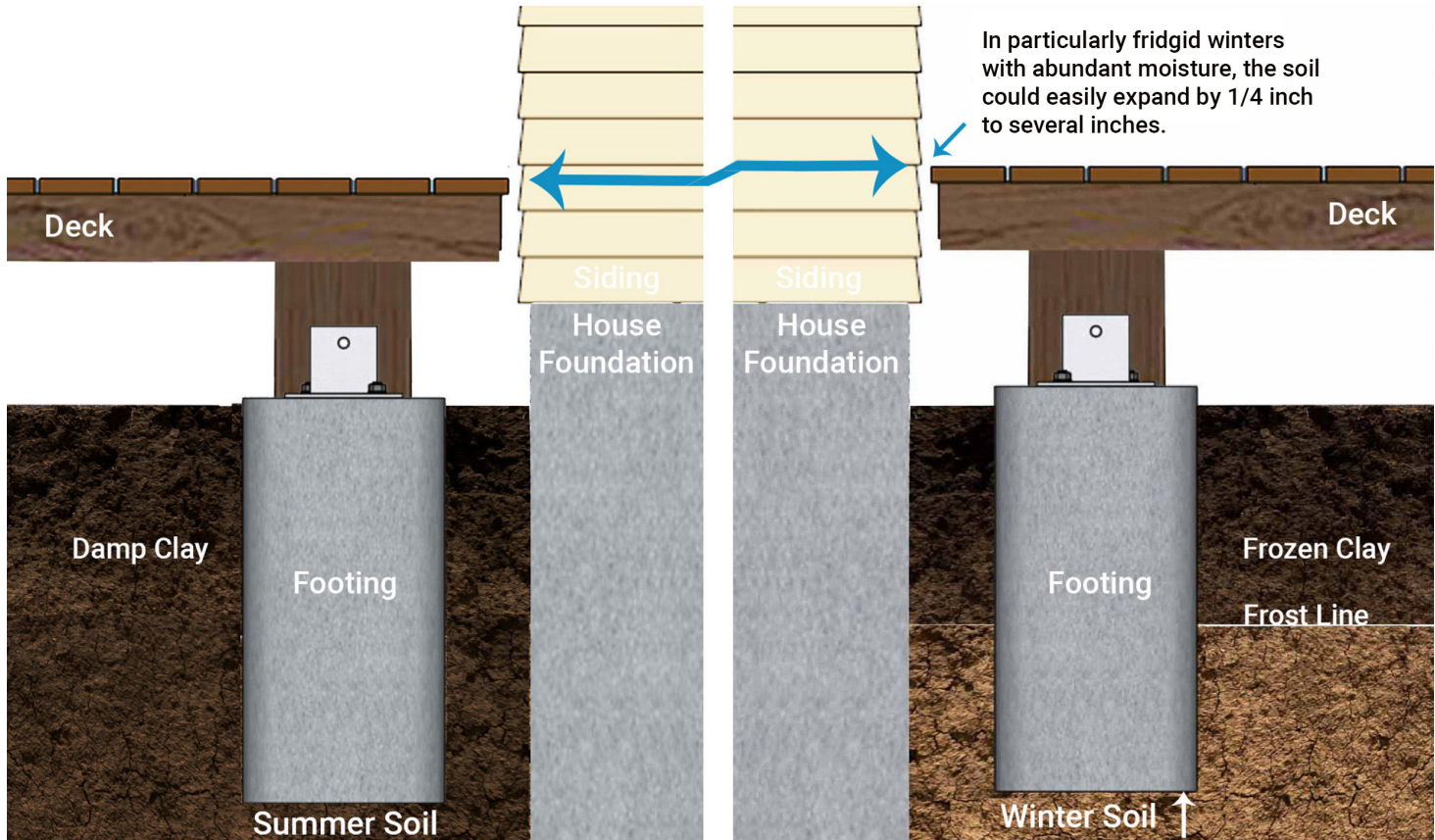
For construction purposes, the frost line is simply the deepest point within the ground, also known as frost depth or freezing depth, at which the earth will freeze and thaw. The remitting of freezing and thawing over time could cause uneven settling of the foundation.

For a solid foundation, footings must go below the frost line to prevent heaving caused by the expansion of frozen ground.

This depth varies based on the climatic conditions of the area, the heat transfer properties of the soil and nearby materials, like buildings or underground pipes.



When the soil freezes in winter, it expands, and in spring when it thaws, it settles back down. Depending on soil moisture and frost line depth, this gradual up-and-down motion is almost imperceptible, except when gauged against the supporting structure, such as an existing house or building. If a footing is placed below the frost line, moisture cannot reach under the footing to lift it, preventing the damaging effects of frost heave.

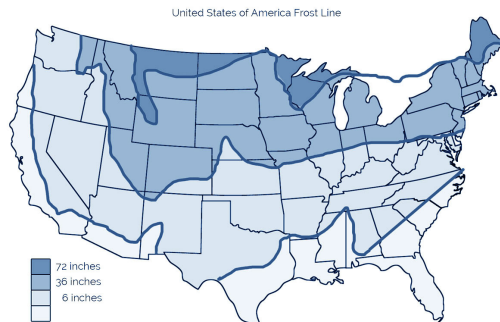


In particularly frigid winters with abundant moisture, the soil could easily expand by up to 1/4 inch to several inches.

Provide a gap of 3/4" to 1" between the house's siding and the deck to accommodate any seasonal expansion or contraction.

When excavating for your deck, arbor, cabana, gazebo, pavilion, pergola, or trellis footings, you must dig below the frost line.

Our frost line depth map will only give you a rough estimate of what your frost depth may be. Use your address and zip code and check with your local building codes before you begin.



# Airflow and Durability

Have you ever wondered how trees manage to stand so tall without toppling over? It's truly fascinating. The remarkable strength of a tree allows it to withstand the sheer force of high winds, rarely snapping its trunk or branches. This natural resilience stems from the unique properties of wood.

Wood is a marvel of nature—it possesses a balance of flexibility, stiffness, and lightness that no manufactured material can replicate. It's flexible enough to bend without shattering, stiff enough to resist breaking, and light enough to avoid buckling under its own weight. No manufactured material can do it all: plastics aren't rigid enough, bricks lack the necessary strength, glass is too brittle, and steel is too heavy. But wood? Pound for pound, wood offers the best engineering properties of any material. It's a marvel of nature, demonstrating that the solutions we seek often lie in the resources we've had all along. So it is not surprising that we still use more wood than any other material

to make our own structures.”

This combination of properties is why trees stand tall and resilient, and why wood remains a cornerstone in our construction and engineering endeavors. It's nature's blueprint for strength and adaptability—a lesson we can apply to our own designs and structures.

Wood buildings endure for centuries. Durable and strong, wood is a resilient material that provides decades, even centuries, of service. Effective design is what truly counts for any structural material.

Ancient wood buildings continue to stand tall, including 8th century Japanese temples, 11th century Norwegian stave churches, and many medieval post-and-beam structures of England and Europe. Beyond their cultural significance, these old wood buildings endure because they were well-designed, built, and maintained. The same holds true for ancient





Lom stave church, Norway

wood bridges, which have spanned rivers and gorges for centuries, showcasing the incredible durability and strength of timber.

But the one thing that timber must have in a structure is the ability to breathe. This breathability ensures that wood can adapt to environmental changes, preventing decay and extending its lifespan. Proper ventilation and maintenance allow wood structures to remain strong and resilient, standing the test of time just as these ancient marvels have.

To prevent water pooling on footings, it's essential to slightly slope the top of your footings, allowing proper drainage, ventilation and airflow.

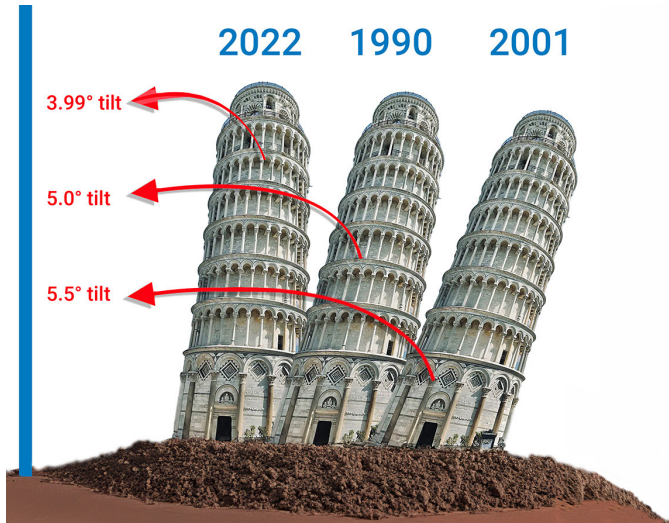




# Building Firm Foundations

When it comes to preventing structures from sinking, the Leaning Tower of Pisa serves as a famous cautionary tale. The Leaning Tower of Pisa is the most famous structural failure due to a poor foundation. Built to house a cathedral bell, it was constructed on an unstable 3-meter deep limestone base in

dense clay. Construction was halted, allowing the foundation to settle. Five years after completion, it began leaning nearly 10 degrees. In the '90s, 600 tons of counterweights were added to stabilize it. Despite this, its lean has made it a beloved tourist attraction!



"Building on disturbed soil or unstable base? That's like trying to balance on Jell-O!"



Another thing to keep in mind with decks and attached structures close to the house is that when you dig out a foundation, you often have to overdig anywhere from four to eight feet away from the house, depending on the location. Typically, you will see this range from four to five feet.

However, if you are close to the house, you are not on virgin soil. This soil has already been disturbed, and very often it isn't compacted right next to the home.



So, when you're putting in a footing in this soil, even if you dig down far enough, it tends to settle. Even a small settlement of half an inch can be disastrous for something attached to a home, causing it to sink. Does that make sense?



These are some issues you might face. Sometimes you might need a footing that goes down four or five feet, or you may have to compact the soil or make an extra-large footing to prevent it from sinking.

Improper drainage can also be a problem. If you have a downspout that leaks or overflows, and it warms up in the winter, you see this happen in Utah all the time. It's like having a nice spring day in December where everything melts, and then it freezes at night. That's the cycle you see. A detached deck might handle this better because it can move up and down a bit, but even then, over time, this movement can deteriorate the deck, causing connections, screws, and nails to loosen and the deck to become rickety. People wonder why this happens and think it wasn't built well, but it's often due to improper footings. A firm foundation is essential, which is why footings are so important.

The value of proper footings can be difficult for customers to see because they are not always visible. They might wonder, "Why do I have to pay that much for something?" when they just want to build a deck. Others might suggest using pier blocks, but we stand behind our work because we know it will last a long time.

In some areas, like Southern Texas, you can build a deck right on top of piers, and it won't go anywhere because there's no frost heave. It's the same in parts of Arizona. In Utah, we wouldn't dream of having water lines above ground. They are buried deep below the freezing point. When I first visited Arizona, I was amazed to see water lines just above ground. I wondered, "What if they had a freak freeze?" But that's just how they do it there.



# Testing Soil Bearing Capacity

Let's dig into testing soil bearing capacity. In soils with robust bearing capacity, minor oversights may be forgiven. However, when dealing with feeble or borderline soils, it's imperative to exercise extreme caution.

If you compact the soil mechanically, it raises its bearing capacity. Soil compaction plays a pivotal role in the initial site preparations required for concrete placement. The process of compaction yields four crucial outcomes:

- Enhances load-bearing capacity.
- Ensures stability and guards against frost damage.
- Mitigates water infiltration, as well as the risks of expansion and contraction.
- Minimizes soil settling.

You can get a reasonable perception of the soil bearing capacity in the bottom of your footing hole with a pocket penetrometer. This pocket-sized device is a spring-loaded probe that estimates the pressure the soil can resist and is calibrated

to give readings in tons per square foot.

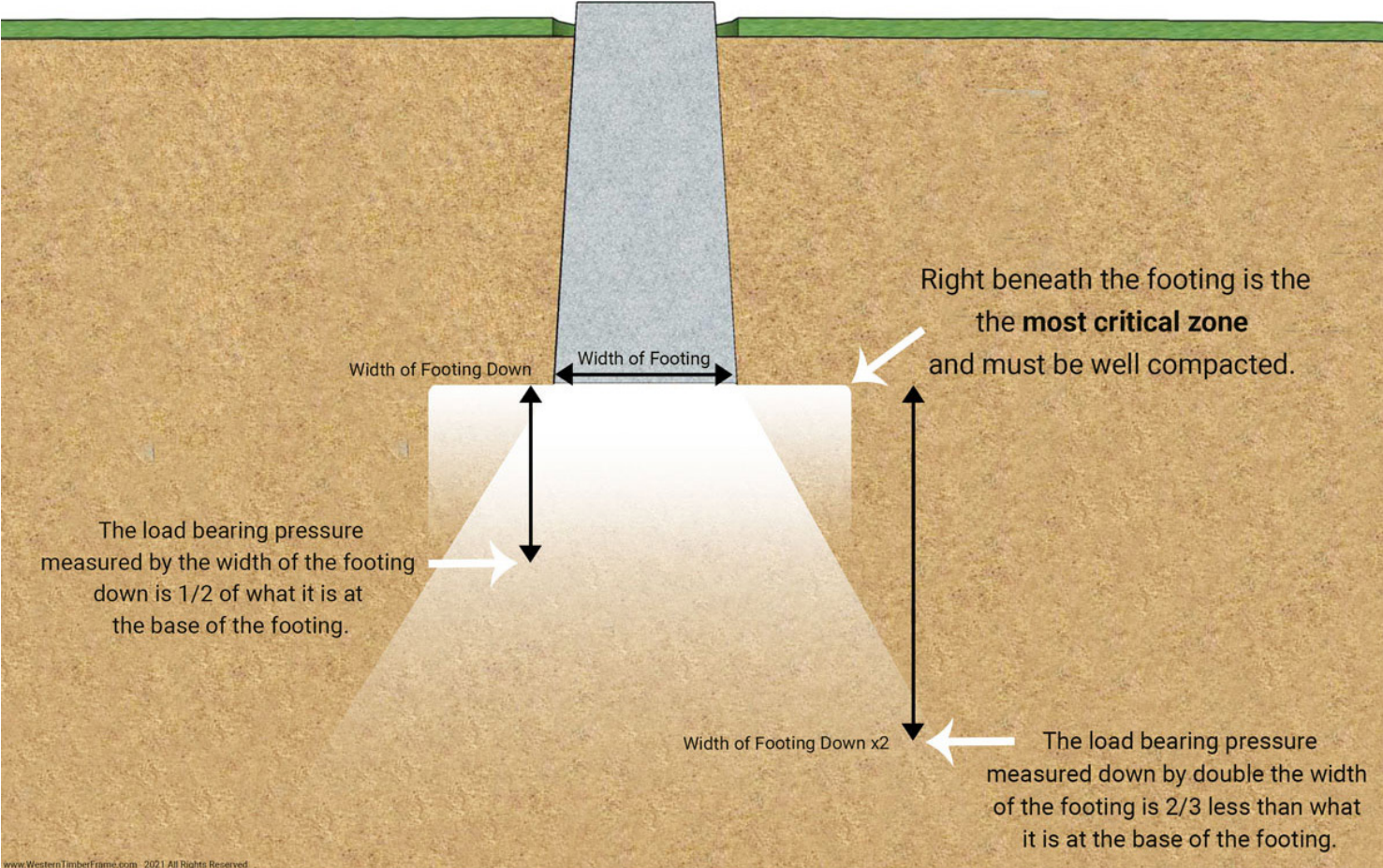
Unlike an area being poured for a concrete pad. Footings are always specified to go on undisturbed soil.

Whether any building is new or an addition, it will settle a bit in the first year. If you are tying into an existing building it makes sense to minimize this by oversizing the footer and paying close attention to the details.

Prepare the construction site, considering different post foundation options, whether it's attaching to an existing or new deck, a building, a concrete post base, or a concrete pad. Ensure proper drainage by grading the ground away from the site to avoid water accumulation. If drainage is a concern, use gravel as a sub-base before installing the foundation.

**TIP:** To avoid water pooling, ensure that the site slopes at a rate of 1/8 inch per foot in the desired direction around the entire structure.

# LOAD BEARING PRESSURE DEMINISHES WITH DEPTH



# How to Square a Deck or Shade Shelter

## Gather Materials:

Collect the necessary materials, including wooden stakes, 2x4 or 2x6 boards, nails, and string.

## Layout the Perimeter:

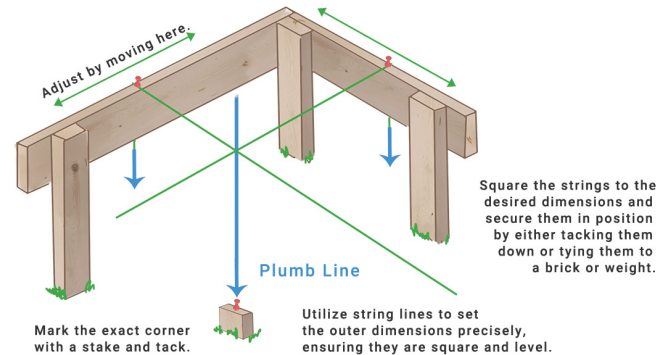
Determine the exact location and dimensions of your construction project, such as a foundation or building corners. Mark the corners with stakes.

## Set the Batter Boards:

Place two sturdy, vertical wooden stakes at each corner, making sure they are securely anchored in the ground.

## Install Horizontal Boards:

Attach horizontal 2x4 or 2x6 boards to the stakes at a level above the expected grade or foundation height. Ensure these boards are perfectly level.



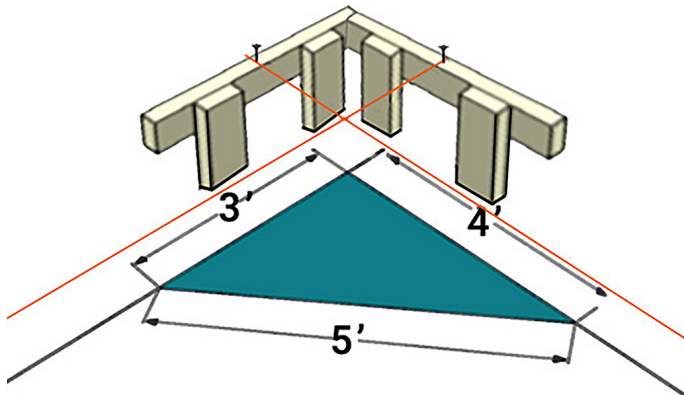
## Square the Layout:

Use the 3-4-5 method or a carpenter's square to ensure the layout is perfectly square. Measure diagonally from one corner to another, and the measurements should be equal if the layout is square.



## The 3-4-5 Method

- 1. Measure the First Line:** Start by measuring 3 feet along one of the lines and place a mark at that point.
- 2. Measure the Second Line:** Next, measure 4 feet along the other line and mark it at that spot.
- 3. Check the Diagonal:** Measure the diagonal distance between these two marked points.
- 4. Verify the Squareness:** If the diagonal measurement reads exactly 5 feet, you can be confident that your pergola is perfectly square.



## The Math Free Approach

There are various methods available to ensure the precision of your layout in terms of being square. Some individuals prefer mathematical approaches like employing the Pythagorean theorem or the 3-4-5 method. Alternatively, others, prefer a practical, math-free carpenter's square approach, like this:

- 1. Measure Opposite Corners:** Begin by measuring the distance between opposite corners.
- 2. Compare Measurements:** Compare this measurement to the distance between the other two corners.
- 3. Adjust as Needed:** If the measurements don't match, adjust the position of your reference point (e.g., string) to the right or left of your reference board and repeat the measurement.
- 4. Confirm Squareness:** Once you've achieved squareness, you can proceed to establish and mark the locations for your post holes.

# Footing Sizes

Smaller footings? Sure, you can dig those by hand. But when they get bigger, you're bringing in the heavy machinery. Think excavation equipment, mini-excavators, and the added headache of maneuvering around existing structures or difficult site conditions. It's not that it's impossible; it's just a whole lot more tedious and costly.

Then there's the reality of permits and engineering requirements. This isn't just a box to check—it's a growing trend driven by industry standards and economic shifts. As new home construction slows, cities are turning their attention to remodels, demanding permits, charging fees, and scrutinizing every detail. It's not a conspiracy; it's the new normal in our industry.

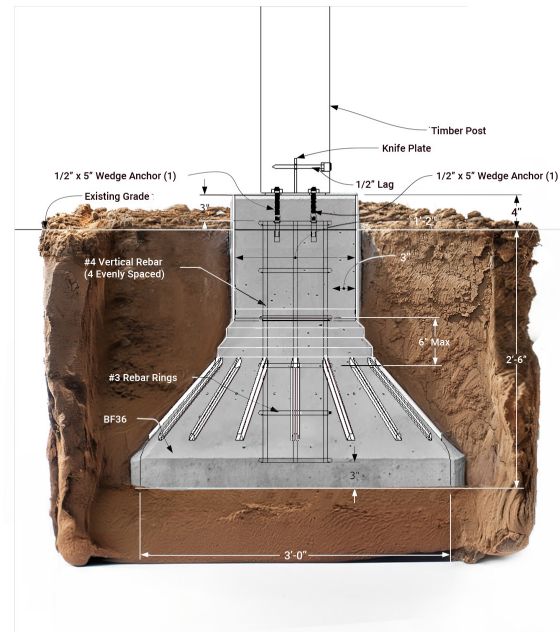
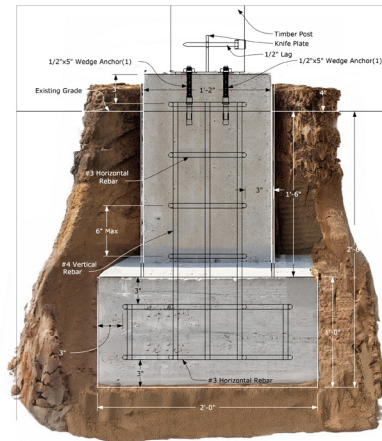
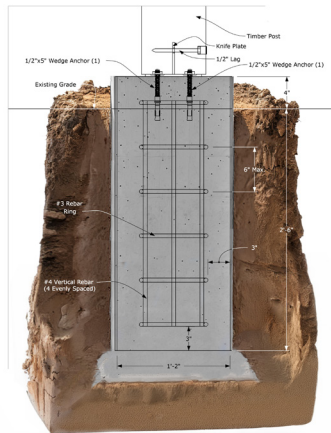
So, whether you're a DIY enthusiast or a seasoned pro, understanding the importance of proper footings is non-negotiable. It's about ensuring your structure is safe, compliant, and built to last. Embrace this knowledge, and you'll be equipped to navigate the complexities of construction with confidence and foresight.



At Western Timber Frame™, we ensure that our people receive the most appropriate footings for their pergolas and pavilions based on their specific needs and local regulations. We sell footings by size, tailored to the unique requirements of each project.

For instance, when you purchase a pavilion from us, we recommend and provide a specific footing size that typically meets most conditions. However,

if your city's regulations require a larger footing due to specific ground conditions, such as sandy soil or elevated areas, we will address this through a formal change order. This approach allows us to manage any necessary adjustments effectively, keeping you informed and minimizing unexpected costs. Our goal is to deliver the right solutions from the start, ensuring that your structure is safe, compliant, and built to last.



## Deck Footings: What to Consider

A solid foundation is essential for the durability of any structure. Without it, a deck may experience unwanted shifts, instability, and even structural compromise. However, the decision regarding footing or foundation material and design necessitates a comprehensive evaluation of multiple factors.

### **What is the slope of the property?**

Slope, or pitch, is essentially how steep a surface is, and commonly expressed as the ratio of vertical rise to horizontal span, or in degrees or percentages. The degree of slope on the property dictates the level of support required from a foundation. For instance, when dealing with a steep slope, it becomes imperative to strengthen footings, particularly in sections where posts have greater height.

### **How high from the ground is the deck?**

If the deck is going to be installed on the

second floor or in a location on the house that's higher above the ground, there will be a greater distance between the footing and the deck's surface. This increased distance necessitates a higher level of stability for the foundation.

### **How large will the deck be?**

Regardless of whether the deck is only a few inches above the ground, a larger deck will demand a stronger foundation compared to a smaller one. This is mainly because the larger deck is likely to bear more weight.

### **Will the deck be attached to the home or a separate permanent structure?**

Whether the deck is attached or floating is a big determining factor in what kind of footing and foundation is required. When the deck is attached to a home it benefits from the strong foundation the home itself already has.

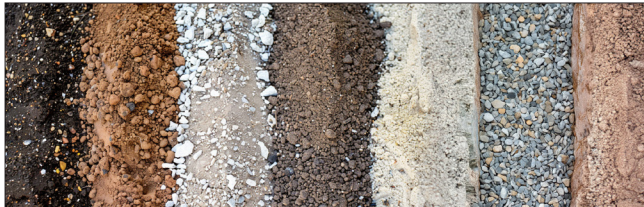
## What are your plans for utilizing the deck?

When deciding on the footing or foundation material for the deck, it's crucial to take into account the potential weight it will bear, such as a heavy bar or hot tub. In such cases, it's advisable to opt for the strongest foundation or footing that you can feasibly install.



## What is the soil composition around the deck?

Depending on your location, you might encounter different soil conditions. Coastal areas may have soft, sandy ground, while mountainous regions may have rocky soil. The type of soil surrounding your deck significantly impacts its support and dictates the appropriate style of deck footing needed.



# Concrete Pad Strength Assessment

If you're fortunate enough to have an established concrete pad, you may already be well on your way to a building your dream deck or outdoor living area.

Now, let's talk about the strength of the concrete, measured in PSI (pounds per square inch). A typical residential patio, which is 4 inches thick and has a PSI rating of 3000, is designed to handle more weight than two average compact cars.

## To put it in perspective:

- A compact car weighs about 3,000 to 3,500 lbs.
- A mid-size car, van, or light truck is around 5,000 to 7,000 lbs.
- A full-size truck is hefty, ranging from 7,000 to 12,000 lbs.

So, two cars on your patio won't cause any problems. Now, consider a typical heavy-duty



Pictured above is a pavilion featuring a carport on one side, with an outdoor kitchen/living room on the other side.

timber frame pergola; which is nearly 4,000 lbs. It would be similar to having four extra-large people standing on one corner of your patio. Plus, when the weight is evenly spread across multiple beams, it significantly reduces the PSI rating.

### **Inspection of the Concrete Pad**

Start by visually inspecting the concrete pad to identify any visible issues or concerns.

Look for cracks, chips, or spalling on the surface.

Check for signs of uneven settling or sloping.  
Note any previous repairs or patchwork.

### **Structural Assessment**

Assess the thickness and quality of the concrete.

Determine the size and layout of the proposed deck or pergola.



**For a Hot Tub:** The depth for a concrete base for a hot tub, when filled with water, should be a minimum of 4 to 6 inches deep. It should be compacted with gravel and use a concrete mix with at least 5000 psi strength or higher. Reinforcement with steel mesh or rebar is essential. The base should also be level and flat, with a slight slope away from the hot tub to facilitate water drainage.



In this project the concrete ends and the hot tub is placed below ground on a solid base. There are alternatives to consider if the concrete isn't strong enough for the hot tub.







The pictured patio was not suitable or large enough of an area to install a pergola, and so we put in footings.

# Tools for Your Footing Dig Project

## Unearth the Secrets of Digging Deck Footings Like a Pro

Let's face it - digging holes for your deck's footings can be a challenging task, especially when you're up against stubborn rocks, unruly roots, or dense clay soil. And if your project demands deep footings, the challenge intensifies. But fear not! We've got the tips and tools to make this journey enjoyable and efficient.

### **Rent the Right Tools:**

Weekend warriors, rejoice! Renting digging tools is a wallet-friendly option.

If your hole-count surpasses four or five, consider the mighty mechanized diggers. They'll save your back and your time.



## Dig It!

Digging deep footings might seem like the pinnacle of unpleasant tasks in deck building. For a few shallow holes, a post hole digger can do the trick.

But for the deeper excavations, splurge on a power auger. It's an investment that pays dividends, although **be cautious with one-person augers, as they can dangerously kick back on rocky encounters.**

## Break It Down with a Digger Bar:

Meet your newfound best friend - the digger bar. Wonder how you ever coped without it!

This heavyweight tool, with its chisel-like end, effortlessly breaks up rock and clay. You'll be scooping it out with a shovel or clamshell digger in no time.



## Shovel Variety:

Don't underestimate the power of the right shovel. A trenching shovel is perfect for smoothing hole walls and maneuvering in tight corners.

Meanwhile, a round-point shovel is your go-to for grading, digging, and mixing concrete.



If you're digging deep and by hand, using a small mini shovel can often be beneficial and easier in some cases.





### **Post Hole Digger to the Rescue:**

When your hole is too deep for a shovel to handle, bring out the trusty post hole digger.

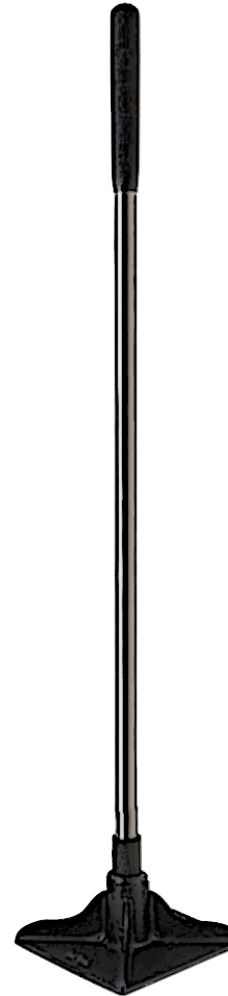
Plunge, break, and conquer that soil. Then, with the clamshell, seize the spoils and pull them to the surface. Don't forget to don your gloves - these diggers can be knuckle busters!

### **Hand Tamper for Precision:**

When it comes to consolidating soil around posts and preparing small areas for stairway landings, a hand tamper is your secret weapon for speed and precision.

### **Motorized Magic (Tamper):**

Planning a paver paradise, a hot tub haven, or just want a smooth canvas beneath your deck? A motorized tamper is your speedy solution.





## Easy Breezy Pier Digging:

Tired of heavy lifting and bone-jarring jams? Say hello to the towable, hydraulic earth drill.

This remarkable machine makes pier digging a breeze, and it's well worth the rental cost for projects with numerous holes to conquer.

"My head may be a cloud but I think gloves would be a good idea!"



## Wheelbarrow Wonder:

A wheelbarrow might not be exclusive to deck building, but it's your trusty companion.

Use it to transport dirt, mix concrete, and when the day's work is done, haul all your tools back to the garage in style.

Armed with this arsenal of tools and tips, you'll dig those deck footings like a seasoned pro, leaving the challenging soil and rocks no chance to dampen your construction spirit. Happy digging!



"You will also need a measuring tape and level."



Even with the right tools, it's a lot of work. You have to dig out the footings and dispose of the dirt. **People often don't realize how much dirt comes out, especially when they have a nicely manicured yard. We have to haul the dirt off, sometimes using a small dump tray because there can be a lot of it.**

For example, we had a deck project earlier this year where the client wanted it close to the ground. To allow for proper airflow, we needed \$7,000 worth of excavation work just to get the deck low enough. This wasn't included in the original project cost. Little things like this can come into play when

dealing with footings, decks, and other structures that carry a load.

We had a deck project where the client wanted it close to the ground. It's important to have enough room under the deck to allow for airflow. This required \$7,000 worth of excavation work to achieve the necessary depth for proper airflow, which wasn't included in the initial project estimate. These are the kinds of additional considerations that come into play when dealing with footings, decks, and other load-bearing structures.





# The Art of a Tidy Construction Site

When debris is left lying around a jobsite, it's like rolling out the red carpet for injuries. If debris is strewn about like a DIY minefield, one wrong step, and you're doing an impromptu dance with gravity. Plus, as well call know, In a clean environment, the mind feels refreshed and at ease. You'll make better decisions.

## The Marvel of a Clean Site

**Injury Prevention:** A tidy site is like your trusty sidekick in preventing accidents. No tripping hazards, no surprise encounters!

**Efficiency Booster:** Cleaning as you go doesn't just prevent injuries; it also keeps your workflow smooth. No more searching for lost tools in the debris jungle.

## The Clean Site Commandments

Now that you're ready to don your safety cape, here are some commandments to keep your construction site sparkling:

## The Rule of Regular Tidying:

- Make cleaning a habit, not a chore. The more you tidy, the less mess accumulates.

## 'Tools Off the Stage' Policy:

- After using tools, return them to their designated spots. A tidy tool area is a happy tool area.

## Debris Disposal Dance:

- Set up designated bins for waste and debris. It's like giving your site its very own trash tango!

## In Conclusion

Remember, a clean construction site isn't just about looking good; it's about feeling safe. So, it is important to keep construction sites tidy. With a clean construction site, you'll be less likely to have accidents and have smoother operations. **Safety first, always!**

# Doing a Footing Hole Dig

## Determine the Spot for Your Footing Hole

Locate the exact spot for your footing hole on the ground. Rely on measurements from your construction plans to ensure spot-on accuracy.

### Tip: Protect Your Lawn

During the excavation process, you'll likely encounter rocks and soil that are best kept off your lawn. To minimize the impact on your grass:

Position a wheelbarrow or tarp outside the designated construction area for your deck or shade shelter.

Place the excavated soil from the footing hole onto the nearby tarp or into the wheelbarrow. This allows you to move it out of the way when you have finished the dig.



## Excavate the Footing Hole

When excavating footings, aim to reach solid, virgin undisturbed soil or soil that passes a compaction test. Do not taper the pier from a wider top to a narrower bottom; this reduces its load-bearing capacity. Instead, ensure the bottom is as flat as possible, as it provides the best support for your structure.



## Shaping a Footing Hole

Creating the right shape for the foundation's footing hole is essential to ensure stability and durability. To achieve strength, it's important to shape the footing in a **bell-like form** with a **flat bottom** to prevent wind uplift and frost heave.

Digging that out is hard work. If you've ever dug footings, you know it involves chiseling and using the right equipment to create that shape.

**If the foundation is built properly it will act as a barrier against moisture and water filtration.** This is crucial for safeguarding the foundation against water damage, which can lead to cracks, erosion, and other structural issues.

Make sure to keep the excavated soil nearby, as it will be used to fill the hole after pouring the concrete.



## Check Depth and Levelness

Periodically gauge the hole's depth using a measuring tool, such as a tape measure or a laser level, to confirm alignment with the specified depth in your plans. A level bottom is essential for solid support.



## Check Dimensions

Measure the hole's width and length to confirm they match your required dimensions. Make necessary adjustments to align with the building plans.



## Reinforcement and Formwork

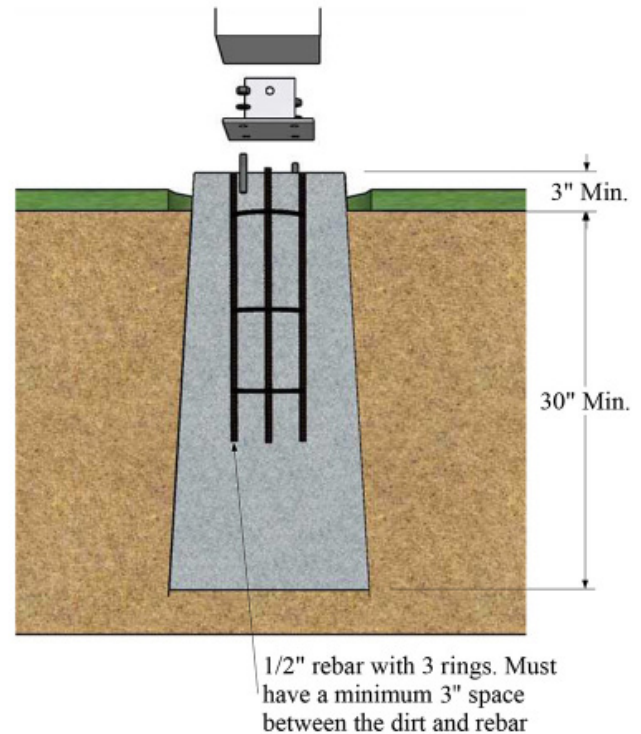
Introduce reinforcement, such as rebar, and set up formwork according to your project's requirements.



## Rebar Reinforcement

Footings are typically made of concrete with rebar reinforcement that has been poured into an excavated trench.

Steel escalates the tensile strength of concrete and footings. Quality concrete has anywhere between 3500 to 4000 pounds per square inch (PSI) of strength to resist tension failure. Rebar a minimum of 40,000 PSI of tensile strength.



### Step 6: Inspect for Debris

Before pouring concrete, inspect the hole thoroughly for debris, loose soil, or water. Remove these contaminants to ensure a clean and sturdy footing.

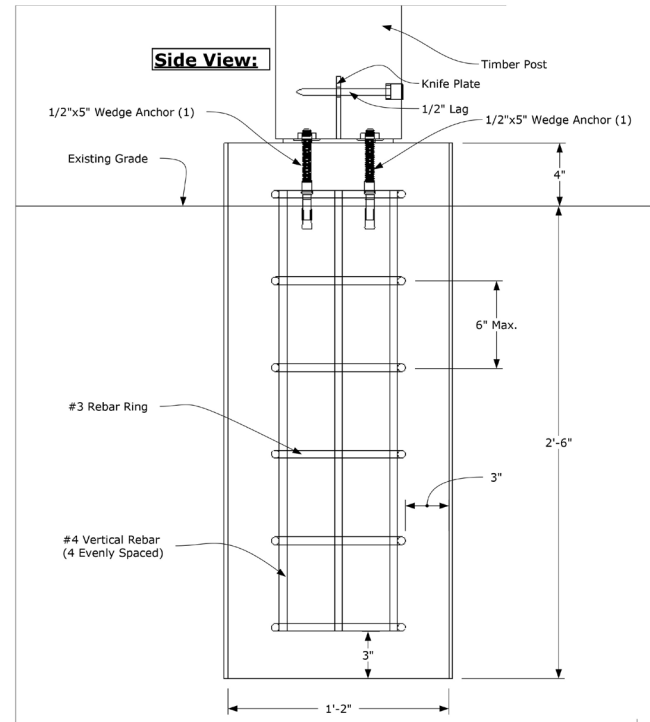
# Can I Pour Without Using a Form?

Most of the time, footings can be poured without forms, and sometimes it's not only allowed but even preferred. However, there are cases where forms are truly necessary. Generally, if the concrete mix is designed to be cast directly against the ground and the reinforcing bars are adequately covered within the footing, pouring without forms is acceptable. Forms might be needed for footings in sandy soils or above natural ground level.

For those interested in more details, let's explore when it might be better to pour a footing without forms and when it's not. We'll also look at how this choice affects the footing's structural behavior, whether molds were used during construction or not.

In reality, structural drawings often depict ideal conditions, especially for footing construction. Footings can either be cast directly into the ground or surrounded by forms. Here's a typical

detail you might see in structural drawings, depending on your project.



All Footings  
**Western Timber Frame**

© 2024 Western Timber Frame All Rights Reserved  
02  
"Distribution of this drawing is limited to the purchaser or contractor for the limited purpose of assembling the structure. No copies or further distribution of this drawing is allowed."  
Drawn By: ParB.



A typical footing detail you might find in Structural Drawings often shows that the footing is formed and not cast directly against the ground. However, in real-world construction, that same footing may often appear more like this...



In the real world, a footing poured without forms—where concrete is cast directly against the ground—often appears more rustic and less refined. However, as long as it meets minimum structural dimensions (footing depth, width, founding depth, and reinforcement cover), its slightly rough appearance typically does not affect its structural integrity.

This artist's representation of what such a footing might look like when cast directly against the ground, without forms, especially for footing construction.

Footings can either be cast directly on the ground or surrounded by forms.

## **Why Pouring a Footing Without Forms may be Desirable**

Pouring a footing without forms can be easier and sometimes lead to better structural outcomes, depending on the footing's design and the loads it supports.

Some footings need to support lateral stability elements, which resist horizontal forces like wind, earthquakes, and impacts. These elements rely on passive resistance from the soil next to the footing to stay in place. Imagine a footing supporting a column under horizontal load—it relies on soil resistance and friction between the base of the footing and the soil surface.

The key benefit of pouring a footing directly against the soil (without forms) is to maintain optimal passive soil bearing capacity. When footings are excavated and over-dug, using forms leaves a gap between the footing and natural ground. This gap would typically need filling with cement-stabilized sand or concrete,

adding unnecessary complexity.

## **Here's a checklist if you're pouring footings without forms:**

Consult your project's Structural Engineer to ensure the design supports pouring without forms.

Ensure minimum structural dimensions are met without forms (thickness, width, length, founding depth, and reinforcement cover).

Inform your concrete supplier that the concrete will be placed directly against soil, potentially affecting their mix design assumptions.

For large and deep footings, consult a Geotechnical Engineer to assess soil stability during excavation.

By considering these factors, you can decide whether pouring footings without forms is suitable for your project.

## When Pouring a Footing Without Forms is Not Recommended

Pouring without forms isn't suitable in every situation:

If part of the footing is above natural ground level, forms are necessary to support the wet concrete.

If the type of soil or the moisture content is not suitable.



## Considerations for Pouring Footings With Forms

**Above Ground Level:** When footings are above natural ground level, forms are necessary to support the wet concrete until it sets. This prevents slumping or deformation during curing.

**Special Soil Conditions:** In sandy or loose soils, forms are needed to provide a stable mold for the concrete. This ensures the footing retains its shape and strength despite soil conditions.

**Structural Requirements:** Footings supporting heavy loads or requiring precise dimensions often require forms to achieve specified thickness, width, and depth.

**Aesthetic Purposes:** Sometimes, forms are required to achieve a specific finish or appearance, particularly in visible areas where the footing might be exposed.

**Building Code Compliance:** Local building codes may mandate the use of forms to meet

"Wait! I'm so confused. Forms? I always thought I was supposed to become one with the earth!"



"No worries, YOU DO directly fill the ground! The forms are just our little secret to standing tall."



structural and safety standards, ensuring the footing's durability and longevity.

Each city's regulations may vary, so it's essential to consult with local building authorities or a structural engineer to determine specific requirements for footing forms based on your project's location and characteristics.

When constructing footings, using a wood form instead of a tube can offer several advantages. Wood forms are flexible and can be customized to fit various shapes and sizes, making them ideal for unique or irregular footing designs. They provide a sturdy structure that supports the concrete as it sets, ensuring a smooth and level finish. Unlike tubes, wood forms can be adjusted on-site to accommodate any changes

or specific project needs. Additionally, wood forms help prevent the concrete from mixing with soil and debris, ensuring a cleaner and more controlled pour. Although setting up wood forms may take more time initially, they offer greater versatility and precision, particularly for complex footing projects.



# Materials for Concrete Pour

Pouring a large concrete footer as a single person without access to a truck or large mixer can be challenging but is not impossible.

**Concrete Mix:** A blend of cement, sand, gravel, and other aggregates that hardens into a solid mass when mixed with water.

**Water:** Essential for activating the cement and creating a workable consistency in the concrete mix.

**Mixing Container:** A large container, such as a wheelbarrow, used to combine the concrete mix with water.

**Shovel:** A tool for mixing the concrete and transferring it into forms.

**Sturdy Mixing Stick:** A strong stick for thoroughly blending the concrete mix and water.



6. Level: A tool to ensure the poured concrete is flat and even.



**Formwork:** Structures made of wood or metal to shape and contain the concrete until it sets.

**Reinforcement (Rebar):** Steel bars or mesh added to the concrete to increase its strength and durability.

**Trowel:** A hand tool with a flat blade used for smoothing and finishing the surface of the concrete.

**Float:** A tool for leveling and smoothing the surface of the wet concrete.

These materials and tools are essential for preparing, mixing, and finishing concrete for various construction projects.



# Calculating Concrete



## FIGURING CONCRETE REQUIREMENTS FOR TUBES AND FOOTINGS:

To calculate the amount of concrete required for tubes and rectangular footings, follow these steps:

### For Tubes:

**Multiply the height of the tube in feet by the corresponding factor below:**

- 8-inch pier: 0.013 cubic yards (0.6 bags per linear foot)
- 10-inch pier: 0.02 cubic yards (0.9 bags per linear foot)
- 12-inch pier: 0.029 cubic yards (1.3 bags per linear foot)

### For Rectangular Footings:

**Use these amounts per footing:**

- 8x16x16-inch footing: 0.044 cubic yards (2 bags each)
- 10x20x20-inch footing: 0.086 cubic yards (3.8 bags each)
- 2x24x24-inch footing: 0.15 cubic yards (6.75 bags each)

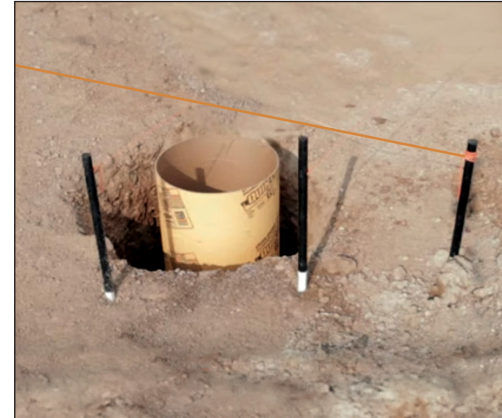


**Example:**

Suppose you have four tubes that are 8 inches in diameter and 4 feet deep, with a total linear footage of 16 feet.

**Calculate as follows:**

- Tubes require 9.6 bags of concrete mix (0.6 bags per foot).
- Four 8x16x16 footings require 8 bags (2 bags per footing).
- To complete the job, you'll need a total of 18 bags.





Here, you see the holes are round but the wood forms are square to form a square surface on top.



For soils with a bearing capacity exceeding 4,000 psf, excavate beneath the footing, then fill the area with compacted coarse gravel.

## **Mixing the Concrete**

a.) Start by adding a portion of the required clean water to your mixing container. Follow the water-to-concrete mix ratio instructions provided on the concrete mix packaging. Typically, this ratio is around 1 gallon of water per 50-pound bag of concrete mix. However, always refer to the specific instructions on your concrete mix.

b.) Gradually add the concrete mix to the water while continuously stirring with a shovel or hoe. Mix the concrete thoroughly to achieve a consistent, lump-free mixture. Avoid adding too much water at once, as it can weaken the concrete.

c.) Continue adding concrete mix and water in small increments and mixing until you achieve the desired consistency. The ideal concrete consistency is similar to thick oatmeal or cake batter.

d.) If you accidentally add too much water, you can adjust the consistency by adding

more concrete mix until it reaches the proper thickness

## **Pouring the Concrete**

With the hole meticulously prepared, and your mixed concrete ready, it's time to pour it into the footing holes you've prepared. Work quickly but carefully to ensure a smooth and consistent pour.

Fill the holes up to ground level, leaving enough space for any additional adjustments or leveling. After pouring, use appropriate tools to refine the surface of the concrete footing. This step guarantees a smooth and level finish. Repeat this process for each hole

## **Avoiding Common Pitfalls**

To prevent common issues like air pockets and uneven surfaces, consider the following tips:

After pouring each footing hole, tap the sides gently with a mallet or shovel handle to help eliminate air bubbles and settle the concrete.

## Finishing

After pouring, use the concrete float and trowel tools to refine the surface of the concrete footing. This step guarantees a smooth and level finish. Repeat this process for each hole

This is important. When you're doing footings, make it look pretty on top. If you have anything to do with footings, don't leave it ugly and undone. Ensure everything is squared off and nicely shaped. A clean finish isn't much more work and makes a big difference.

Footings should have a slight slope to prevent water from sitting on top. Sometimes, people will even dip it in the middle, which is really bad because then you have water sitting on top of it. The slope should gently lead water away from the center of the footing.



## Curing the Concrete

Proper curing is vital for achieving the strength needed for your structure. Follow these guidelines:

We seldom ever use additives to concrete. If you're using concrete with a quick-setting additive, it's advisable to wait at least one sunny day before proceeding. For standard concrete footing mixtures, I recommend a curing period of no less than seven days and no more than 28 days, provided that the environmental conditions are conducive to proper concrete curing and achieving the desired hardness.

By following these steps and techniques, you'll ensure that your concrete footings are properly mixed, poured, and cured, setting a solid foundation for your deck or gazebo that will stand the test of time.

## Ensure a Strong Foundation

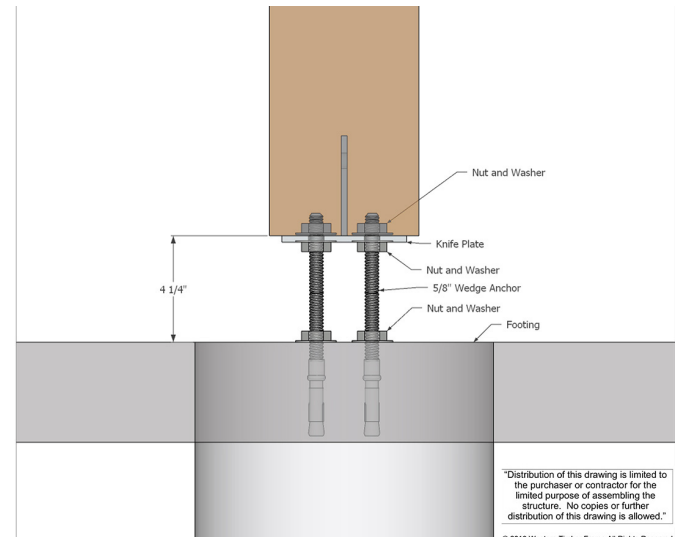
Remember, a well-prepared foundation serves as the cornerstone of a secure and long-lasting construction project.

By following these steps meticulously, you'll create sturdy and reliable footings for your deck, ensuring its stability and durability.





Alright, listen up. We don't want to see posts set directly into the ground through the pavers. When you cut the pavers to drop the posts into the ground, you're exposing the wood to moisture. That means the timber starts soaking up water from all around. Not good. Ideally, you install the posts above the pavers, and then place the pavers around and under the post. This way, the timber can breathe. Proper ventilation and keeping the wood dry are non-negotiable. It's essential for extending the life of the timber.









# Can You Excavate and Pour in Winter?

Waiting for Fall and Winter to Kick Off Your Project Has Its Benefits.

Before diving in, it's essential to grasp how cold weather affects excavation work:

**1. Soil Freeze Levels:** Generally, the ground doesn't freeze solid in most winters, especially when excavating for a home's foundation. You can carry out winter excavation projects for most of the year without major issues. Concrete placement in winter is a regular practice.

**2. Snow and Ice Risks:** Snow and ice can pose hazards to your team and equipment. However, with the right crew and precautions like covering work areas with tarps during snowfall, you can manage these challenges.

**3. Below-Freezing Temperatures:** While temperatures can drop below freezing, they don't stay there all day, every day for weeks. As the sun shines and warms the earth, it can become more manageable.

## Advantages of Winter Excavation

Now, let's explore the benefits of starting your project in the winter:

**1. Reduced Competition:** Winter is typically a slower season for construction, so your project can get full attention from your crew without competing for resources.

**2. More Labor Availability:** Construction companies often have extra personnel available during the winter, which can speed up your project.

**3. Efficient Scheduling:** Winter excavation can be scheduled to coincide with slower construction periods, potentially leading to shorter project timelines and cost savings.

**4. Favorable Soil Conditions:** In many regions, cold weather often leads to frozen or dry soil, providing stable and compacted ground, reducing the risk of collapses or slippage during excavation.

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## Tips for Winter Excavation

To make your winter excavation project successful:

- 1. Don't Assume Frozen Ground:** The earth isn't always as hard as a rock during winter. The sun can help thaw the topsoil.
- 2. Use Water:** High-pressure water can be an effective way to excavate through frozen ground, often more cost-effective than other methods.
- 3. Don't Delay Unnecessarily:** If delaying your project costs more money, it might be worth the extra expense to start winter excavation and finish sooner.



## Here are the crucial instructions for cold weather concreting, simplified and emphasized:

**Get the Mix Right:** Pay meticulous attention to your mix design.

**Mind the Concrete Temperature:** Keep a close eye on the temperature of the concrete.

**CONCRETE TEMPERATURE** (Yes, It's That Important): Seriously, maintaining the right concrete temperature is paramount.

**Balance the Accelerator Correctly:** Very rarely do we ever use accelerator but if you are using is, ensure you strike the perfect balance between the accelerator and concrete temperature.

In a nutshell, winter construction offers significant advantages, including cost savings and shorter wait times due to decreased demand. It allows you to use your new structure immediately, making it a practical choice despite the cold weather.



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# Sloped Landscape

## Measuring Sloped Grade with Transits and Lasers:

Professionals use transits and lasers to accurately determine the slope of a graded surface.



**To figure out the slope of a terrain in a simple way, you can follow these steps:**

1. Get a long piece of string or a rope.
2. Find a flat area at the top of the terrain, and mark it as your starting point.
3. Go down the terrain and stop where you want to measure the slope.
4. Hold one end of the string at your starting point and let the other end hang down to where you stopped.
5. Use a level or something flat to make sure the string is straight and not slanted.
6. Measure the length of the string from where you're holding it to the ground where it touches.
7. Now, divide the height you measured by the horizontal distance you traveled. This will give you the slope.

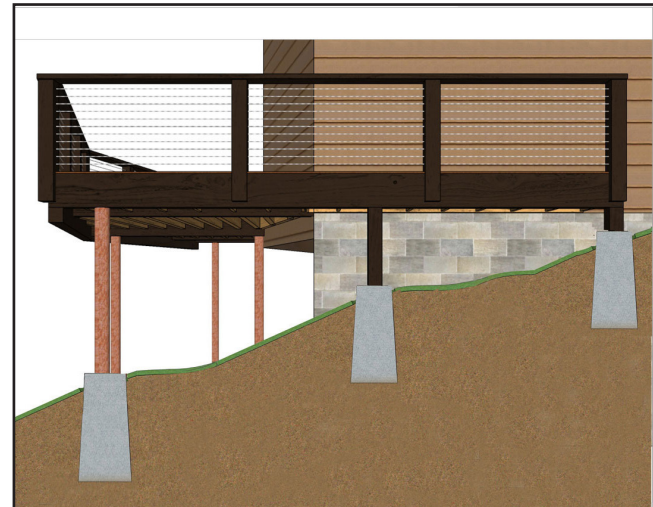
For example, if the height is 10 feet, and you traveled 50 feet horizontally, the slope would be 10 divided by 50, which equals 0.2. You can also express this as a percentage by multiplying it by 100, so in this case, the slope is 20%.

That's it! You've figured out the slope of the terrain.



## The 7-Foot Rule

When dealing with steeply sloped properties, it's important to consider how the ground's slope might impact the stability of your footings. In such situations, you should ensure that there is a minimum distance of 7 feet between the bottom of a footing and where the ground level naturally meets the light of day.



## Concrete Free Footings

What if you're eager to get started without waiting for concrete? Or perhaps you're considering an option that doesn't involve concrete at all? That's absolutely feasible.

With DIY deck or pergola plans from Western Timber Frame™, you have the flexibility to create your dream outdoor living space without major construction efforts. No need for large holes in your yard, and no waiting for concrete to dry.

One of the advantages of our DIY solutions is that you can complete your space gradually, expanding and budgeting as you go. Traditional foundation and footing methods typically require excavation and waiting for concrete to set.

Western Timber Frame™ offers exclusive anchoring solutions for pavilions, pergolas, and gazebos. These solutions allow for a swift and straightforward installation without excavation, eliminating any delays between installation completion and project commencement.



### Benefits include:

- No damage to your landscape or existing structures.
- Precisely leveled structures.
- Suitable for confined spaces.
- Usable year-round, regardless of the season.
- A removable and reusable system for added convenience.

These options provide you with the flexibility and ease without the wait of traditional concrete-based foundations.

## Screw Piles Pros & Cons

Screw piles can be driven into most types of ground but solid rock does require some pre-drilling. And it does add to your cost.

**PROS:** Screw piles are super fast to put in. And it works in a variety of soil conditions. It is kind of like an instant foundation. Concrete on the other hand needs 2 to 3 days to cure.

**CONS:** While screw piles are an easy install, they are not a DIY job. It takes specialized machinery to install it.



## Simplifying A Complex Install



In certain projects, the need arises to employ multiple foundational systems. In this project, pictured here, the objective was to install a pergola over an existing tongue and groove deck.

Typically, this would require disassembling the deck to accommodate regular concrete and rebar footings. However, a more non-intrusive solution was found in the form of Helical piers, also called helical piles or screw piles,

Helical piles were strategically positioned adjacent to the house and torqued until they were leveled with the existing deck, creating a raised foundation.

Regular concrete footings were excavated and poured for the front of the deck.

Combining two different foundation systems allowed for the installation of a Western Timber Frame™ DIY pergola kit without the need to disrupt or disassemble the deck.





"Installing two strong foundation systems, for one perfect pergola!"

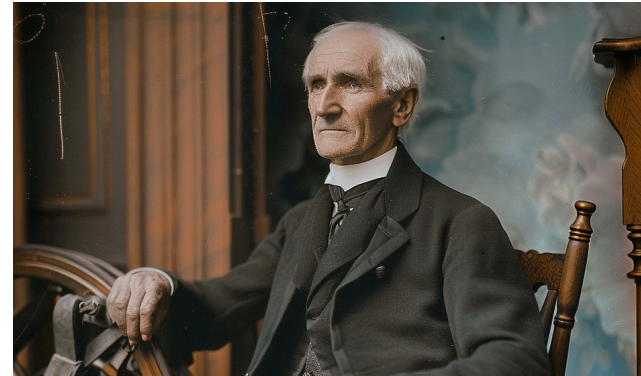


## Vision That Shaped Modern Foundations

When we envision foundations, concrete is often the first image that comes to mind. While concrete serves as a reliable choice, it's merely the surface of a deeper foundation story. The world of foundations extends far beyond concrete, encompassing materials such as timber, gravel, stone, piers, metal, and more.

Some foundation support techniques have endured the test of time for centuries. Modern-day foundation contractors employ cutting-edge solutions like helical piers to fortify structures in challenging terrain. These methods draw inspiration from seafaring communities and regions grappling with unstable or waterlogged ground.

Sandbanks, those ever-shifting, perilous sand beds found near coastlines, river mouths, and ports, have long plagued maritime navigation. Their unpredictable nature makes it challenging to establish warning systems like lighthouses or lightships. Yet, one remarkable individual, Alexander Mitchell (1780 – 1868), an Irish brick-maker near Belfast, took on this challenge, even though he was blind.



Born in Dublin in 1780, Mitchell's eyesight progressively deteriorated, leading to complete blindness by age twenty-two. Despite this, he was an outgoing and optimistic man, running a successful brick-making business and entertaining guests like astronomers and mathematicians at his home.

In 1833, at the age of 52, Mitchell patented a revolutionary solution—helical piles. Instead of driving iron piles into the soft mud, he proposed screwing them into place with propeller-like blades.



He tested his invention by secretly anchoring a helical pile on a sandbank in Belfast Lough, which proved successful. Finally, in 1838, the first helical-pile lighthouse was erected at Maplin Sands in the Thames estuary. Mitchell oversaw the entire project and scaled ladders and scaffolding. He humorously told his men that he wasn't afraid of heights because he couldn't see the sea below.

Mitchell's ingenious helical piles not only revolutionized lighthouse construction but also found use in various industries due to their cost-

efficiency and minimal environmental impact. Today, they remain crucial for fast and sustainable installations.

In 1848, Mitchell was elected a member of the Institution of Civil Engineers, and he received the esteemed Telford Medal in 1849 for his groundbreaking invention. He passed away at the age of 88 in 1868, leaving a lasting legacy in construction practices.

## Freestanding Structure

A freestanding structure is a construction or architectural element that stands independently and is not physically attached or supported by another building or structure.

Placing a freestanding structure adjacent to a building can allow you to enjoy the benefits of both an attached structure and a freestanding one simultaneously, including:

**Reduced risk of water damage:** By not attaching the deck or shade shelter directly to the building, you can minimize the risk of water infiltration and potential damage to the building's exterior. Water can seep into the wall and foundation through ledger connections, leading to rot and structural issues.

**Easier maintenance:** Detached structures are often easier to maintain because they don't require as much attention to the building's exterior. This can save you time and money on upkeep



**Preserves architectural integrity:** Some homeowners prefer not to alter the look of their home's exterior with attached structures. A detached deck or shade shelter allows you to preserve the original architectural design of your building.

**Fewer permits and regulations:** Depending on your local building codes and regulations, detached structures may be subject to fewer permitting requirements and inspections compared to attached ones. This can simplify the construction process and reduce potential delays.

**Lower Insurance Costs (Potentially):** While it's essential to check with your insurance provider for specific details, some homeowners have reported lower insurance costs for unattached structures. Since these structures are not directly connected to your home, they may be considered separate and, in some cases, subject to different insurance rates.

**Minimal Disruption during Construction:**

When you add an unattached structure, it often involves less disruption to your existing home. Construction can proceed without major alterations to your building's structure or layout, making the process smoother and less intrusive.

In summary, having an adjacent deck or shade shelter that is close but not attached to your building offers a host of benefits. It provides creative freedom, potential cost savings, privacy, and a flexible space that can adapt to your changing needs.



## Attached Structure



An attached deck, pavilion, or pergola are outdoor architectural structures that are built onto a house or other building using a ledger board.

### Here are some of the key advantages:

**Seamless Protection:** Attached shade shelters are a versatile means to bestow shelter and protection upon an exposed outdoor stairway or entryway, effectively enhancing their utility and longevity.



**Fewer Footings:** An attached deck or shade shelter uses less posts; which means less footings. This may result in some upfront lower cost unless the extra labor and house facade work offsets that.

**Privacy:** When strategically positioned, a pavilion or pergola can provide privacy by screening your outdoor area from neighbors or busy streets.

**Energy Efficiency:** A well-designed pergola or pavilion can provide passive cooling benefits by shading your home's windows during the hot summer months, potentially reducing your energy bills.



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## Anchoring With A Ledger Board

If you're not an experienced builder, and do not have one to guide you, it's advisable not to attempt attaching a deck to the ledger of an existing home.

Correctly attaching a ledger board to an existing home can be a major task. If the ledger is installed and the deck is constructed as part of the house's original construction, then all the details like flashing and siding are so much simpler.

However, the ledger board is the Achilles' heel of your home's structure if it's not correctly installed and protected. It is imperative that this wooden support beam, which spans horizontally across the framing of the house attaching the deck to the house is waterproofed and shielded. The occurrence of water damage to a ledger board will jeopardize the integrity both the deck and the dwelling.

Installing a ledger onto an already established structure is much easier with vinyl siding than

brick, stucco or cementitious fiber board. But it is still a big job.

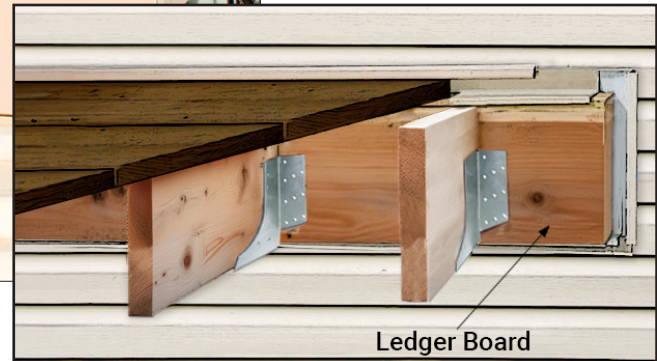
In the realm of home construction, an array of distinct challenges awaits, primarily because each house possesses its own unique structural characteristics. Take, for example, a scenario such as encountering a natural gas line for the grill to connect to, or the intricacies involved with engineered I-beams, requiring the removal of the siding to match it. And if it had OSB board, making it necessary to place blocks within the spaces between the joists.

With siding, it's important to make sure that you go high enough under the existing siding to ensure that everything stays dry.

If you are working with a masonry exterior you have a ton more work to do and would require a whole independent lesson.

If you do have the experience and skills, attaching a deck or pergola to a building using





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A ledger board ingeniously leverages the existing building's structural integrity, providing a robust foundation for a variety of applications

**Foundation for Everything:** A ledger board is like the foundation of a building. It's typically a long, sturdy piece of wood or metal that attaches directly to an existing structure, like a house or a wall. This attachment is like a strong handshake between the old and new, ensuring everything stays connected.

**Load-Bearing Hero:** This board bears the weight of whatever you're building. The ledger board carries the load of your deck or platform, making sure it doesn't collapse.

**Precise Placement:** Installing a ledger board is like hitting the bullseye in darts – it has to be exactly right. If it's too high or too low, your structure won't be level. If it's not attached securely, things could wobble or, worse, fall apart. So, precise measurement and installation are essential.

**Materials Matter:** Ledger boards can be made of different materials, such as treated wood, pressure-treated lumber, or even metal. Each material has its strengths and weaknesses, just like superheroes have unique powers. The choice of material depends on factors like durability, climate, and personal preference.

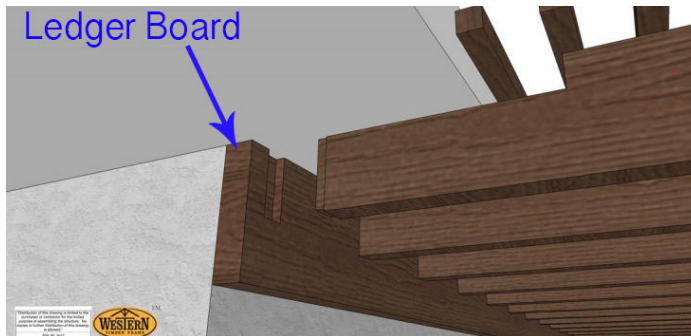
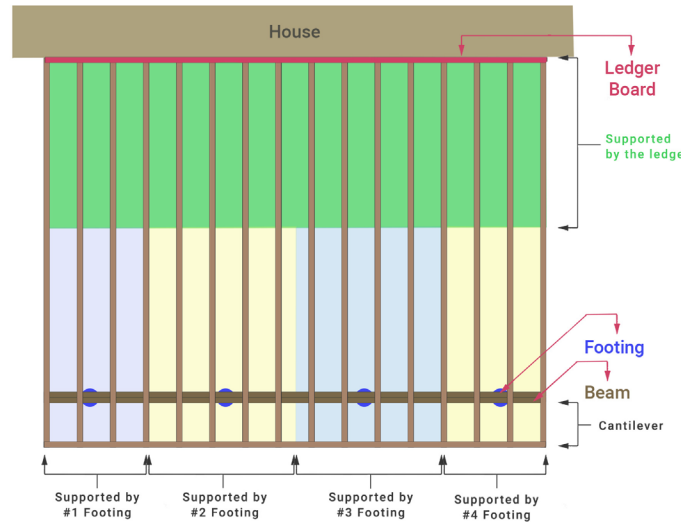
**Guardian Against Rot:** Ledger boards are often exposed to the elements, so they need protection. They might be coated with waterproofing agents or flashed with metal to prevent rot and decay. Think of this as giving your hero armor to withstand the elements.

**Teamwork with Fasteners:** Ledger boards work closely with fasteners like lag screws or bolts. These fasteners are like sidekicks, ensuring the ledger board stays firmly attached to the structure. It's a dynamic duo!

**Continuous Care:** Ledger boards require regular inspections and upkeep to ensure they remain strong and reliable. Neglecting

maintenance can lead to problems down the road.

**In summary**, a ledger board quietly supports the weight of your structures and making sure everything stays together. See the deck diagram, for an illustrated comparison of footings to the ledger board in weight distribution. It may be hidden from view, but its importance cannot be overstated. So, the next time you step onto a deck or balcony, remember the ledger board working tirelessly behind the scenes to keep you safe and stable.



Exemplified here is Western Timber Frame's innovative ledger design for attached pergolas and pavilions allows for the natural expansion and contraction of wood through the seasons for a more dependable ledger.

# Build A Firm Foundation

You can construct the most handsome, robust building imaginable, one designed to stand the test of time and endure for millennia. But if that structure isn't built on a firm foundation, it's all for nothing. It won't be trustworthy, it won't be reliable, and it won't last. A weak foundation is a liability, a vulnerability waiting to be exploited by the relentless forces of nature. In the end, the integrity of any great structure starts from the ground up. Without a rock-solid foundation, everything else crumbles.

So take the time to plan and execute your footings diligently. We wish you every success in your construction endeavors, and may your projects stand strong for years to come.

"Happy Building!"



Copelan family, Alabama



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